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Environmental Aspects of Commercial Radioactive Waste Management

Volume 3 of 3

May 1979

U.S. Department of Energy
Assistant Secretary for Energy Technology
Office of Nuclear Waste Management

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Volume 3 of 3

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U.S. Department of Energy
Assistant Secretary for Energy Technology
Office of Nuclear Waste Management
Washington, D.C. 20545

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APPENDIX A

A REFERENCE ENVIRONMENT OF ASSESSING ENVIRONMENTAL IMPACTS ASSOCIATED WITH CONSTRUCTION AND OPERATION OF WASTE TREATMENT, INTERIM STORAGE AND/OR FINAL DISPOSITION FACILITIES

APPENDIX A

A REFERENCE ENVIRONMENT FOR ASSESSING ENVIRONMENTAL IMPACTS ASSOCIATED WITH CONSTRUCTION AND OPERATION OF WASTE TREATMENT, INTERIM STORAGE AND/OR FINAL DISPOSITION FACILITIES

The following reference environment was developed as an aid in assessing environmental impacts associated with construction and operation of waste treatment, interim storage and/or final disposition facilities. The reference environment concept is used to replace, where appropriate, the criteria-type approach to generic environmental assessment.

The reference environment was developed primarily from data on existing plant sites in the midwestern United States. There is, however, no intent to endorse this area or type of environment for any nuclear fuel cycle facility. Since the reference environment is to be used in a generic or hypothetical sense, references supporting the descriptive material were not considered necessary and are not included.

For assessment of environmental effects, it is assumed that each waste management facility is located (independently, not colocated) within the reference environment.

Although an artificiality, analysis of impacts from waste management facilities centered at the same location simplifies calculations and permits direct comparison of impacts among facilities on the same environmental features.

LOCATION OF SITE

Regardless of the size of the site or purpose to which it is to be put, the center of the site is assumed to be located 8 km west of the R River, about 13 km northwest of Town A in County A, and 50 km northwest of a major metropolitan area (City G) in a midwestern state.

REGIONAL DEMOGRAPHY AND LAND USE

The reference environment is located in a region which is mainly rural, with the land used chiefly for farming. The nearest communities are A, about 13 km southest of the site, with a population* of about 2,000; B (population 400) about 16 km northwest; C (population about 1,000) about 8 km east; D (population 1,100) about 16 km southwest; and E (population 3,000) about 16 km south. The closest large citites are F (population 40,000) about 32 km northwest and G (population 1,800,000) about 50 km southeast.

The population within a 16-km radius (800 km^2) of the site is about 12,000. Similarly, within a 80-km radius of the site (20,000 km^2) the population is about 2,000,000, of which about 93% resides in the G metropolitan area (see Table A.1).

In County A, and in County B just across the River to the northeast, about 82% of the land is used for farming. The main crops in these two counties, which include all land within 16 km of the site, are soybeans, corn, oats, and hay. It is expected that these two counties will remain largely agricultural and that the population distribution will not change significantly with time.

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* Populations are assumed to be those for the year 2000.

TABLE A.1. Projected Year 2000 Population in Reference Environment

RANGE, km	1.6	3.2	4.8	6.4	8.0	16	32	48	64	80	TOTALS
N	0	4	4	18	160	210	1,115	3,641	2,137	1,209	8,498
NNE	0	4	4	14	26	157	986	3,350	4,185	1,872	10,598
NE	0	6	18	72	109	232	1,306	4,897	2,848	6,371	15,859
ENE	0	4	12	72	145	333	2,025	2,677	8,743	6,209	20,220
E	0	4	12	145	537	993	1,321	9,094	6,344	14,195	32,645
ESE	0	4	20	353	118	610	3,400	50,482	123,104	163,155	341,246
SE	0	25	245	1,069	194	632	5,063	46,789	581,389	579,114	1,214,520
SSE	0	4	18	45	157	374	3,466	18,642	59,435	32,445	114,586
S	0	4	41	67	112	1,097	5,438	5,844	10,131	7,334	30,068
SSW	0	15	26	67	126	571	3,177	4,809	6,411	7,317	22,523
SW	0	30	65	58	50	423	1,835	4,656	6,106	6,856	20,079
WSW	0	6	55	93	65	414	3,007	1,901	7,515	4,442	17,498
W	0	9	31	78	73	379	1,730	3,600	3,326	4,805	14,031
WNW	4	8	8	44	29	332	1,662	6,495	6,493	5,984	21,059
NW	0	6	9	21	44	293	5,277	47,196	4,061	4,501	61,408
NNW	0	8	15	55	181	165	1,204	2,753	2,480	4,533	11,394
TOTALS	8	141	583	2,271	2,126	7,215	42,012	216,826	834,708	850,342	1,956,232
CUM TOTL (rounded)	8	150	730	3,000	5,100	12,000	54,000	270,000	1,100 000	2,000,000	2,000,000

A wildlife refuge is located about 14 km northeast to 19 km north of the site. A state park is located about 10 km west-southwest of the site, and a state forest and campground are about 14 km northest of the site.

GEOLOGY

The area in which the reference sites are situated is assumed to occupy a terrace at an elevation of 300 m above sea level (MSL). Several flat alluvial terraces comprise the main topographic features in the vicinity. Many of these terraces are lower than that at the site and lie at an average elevation of 280 m above sea level and, in general, slope away from the river at grades of 2 or 3%. The topography in the area of the site is essentially typical of that in the region.

The rocks which underlie this region are classifed as pre-Cambrian and are very old. Glaciation probably less than 1,000,000 years in age, as well as recent alluvial deposition, has mantled the older basement rocks with a variety of unconsolidated materials in the form of glacial moraines, glacial outwash plains, glacial till and river bed sediments. This cover of young soils rests upon a surface of glacially carved deeper rock consisting sequentially in depth of sandstone, shale and granitic rocks. The upper surface of underlying rock can support unit foundation loads up to 73,000 kg/m^2. The bedrock surface is irregular and slopes generally to the east or southeast.

The nearest known or inferred fault is 37 km southeast of the site. There is no indication that faulting has affected the area of the site in the last few million years. Within the last 110 years, only two earthquakes were recorded as having occurred within 160 km of the site. The first occurred in 1917 and had an intensity of VI on the modified Mercalli scale. The epicenter was located about 100 km northwest of the stie. The second occurred in 1950 and had an estimated intensity of V-VI and the epicenter located about 130 km north-northwest of the site. For construction of facilities in this area the design basis earthquake relates to a horizontal acceleration of 0.1 g.

HYDROLOGY

Large supplies of groundwater are available from the R River outwash plain alluvium, glacial moraine, and from underlying sandstones in the area. The general course of deep groundwater flow is to the southeast. The regional gradient broadly parallels the trend of the topography and the surface drainage. The natural surface drainage of the immediate site area is mainly to the southeast, toward the river.

R River tributaries close to the site area are S Creek, 8 km northwest, and T Creek, 5 km southwest. B River flows parallel to and east of the R River, joining the R 24 km downstream from the site area.

The groundwater levels near the site are relatively flat and slope toward the river during normal river stages. During periods of high river flow, there may be some reversal of groundwater flow near the river. These reversals would be of short duration and infiltration of water from the river limited. The gradient toward the river is re-established after the high water recedes.

River flow information based on data from the R River gauging station is as follows:

Number of years of record	40
Average annual flow, ℓ/sec	120,000
Minimum recorded flow, ℓ/sec	6,200
Maximum recorded flow, ℓ/sec	1,300,000

River flow and temperature data pertinent to the Reference Site are shown in Figures A.1 and A.2 respectively.

Flow duration data for the R River calculated in the vicinity of the reference site are shown in Figure A.3. Based on these data, the flow is expected to exceed 50,000 ℓ/sec 90% of the time and 27,000 ℓ/sec 99% of the time.

The average river velocity at the site varies between 0.5 and 0.8 m/sec for flows below 280,000 ℓ/sec. The river drops about 3 m from 2.4 km upstream to 2.4 km downstream of the site. Rapids frequently occur in this stretch of the river.

The 1 in 1000 years flood would be expected to reach 281 m MSL (mean sea level), and the maximum flow of record (1965) was estimated to have reached 279 m MSL. Normal river stage in the vicinity of the site is about 276 m MSL, and the site grade is 300 m MSL.

A study was conducted to determine the predicted flood discharge flow and water level at the site resulting from the "maximum probable flood" as defined by the U.S. Army Corps of Engineers. The "maximum probable flood" was estimated as 10 million ℓ/sec with a corresponding peak stage of elevation 286 m MSL at the reference site. The peak level at the site would be reached in about 12 days from the onset of the worst combination of conditions resulting in the "maximum probable flood."

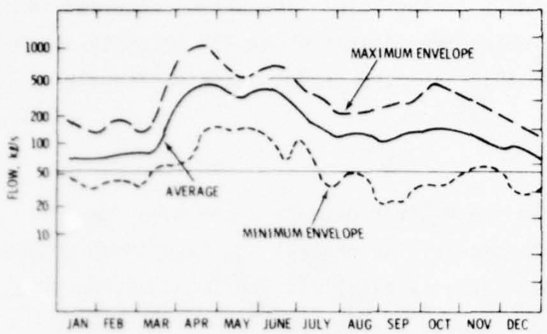

FIGURE A.1. Daily Average and Extreme River Flows at the Reference Site

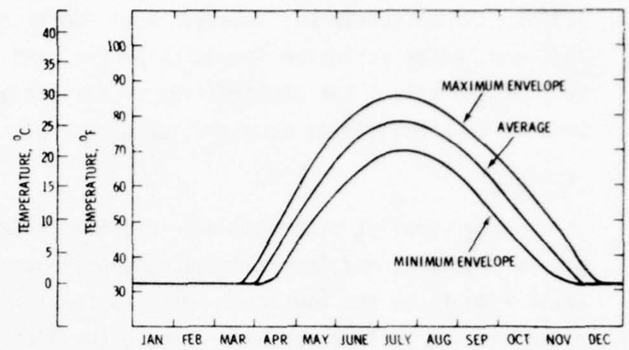

FIGURE A.2. Daily Average and Extreme Water Temperatures at the Reference Site

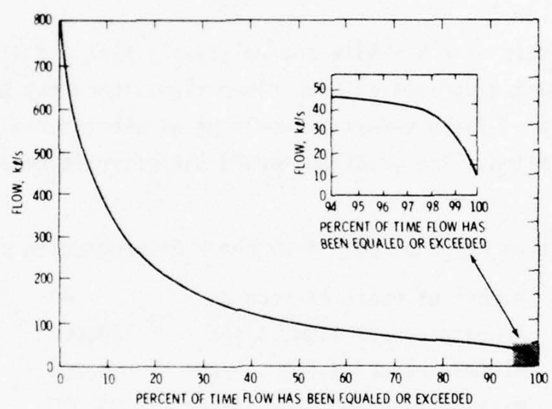

FIGURE A.3. River Flow Duration Date for R River at the Reference Site

R River water chemical characteristics are given in Table A.2.

The nearest domestic water supply reservoir is the G Water Works Reservoir. This reservoir is located in northern G and is fed by the R River from an intake about 64 km downstream from the Reference Site area.

The groundwater table under normal conditions is higher than the river; thus groundwater and runoff drain to the river. There are numerous shallow wells supplying residences and farms along the river terrace. The closest public water supply well is the A city well obtaining water 72 m below ground level.

METEOROLOGY

The general climatic regime of the site is that of a marked continental type characterized by wide variations in temperature, scanty winter precipitation, normally ample summer rainfall, and a general tendency to extremes in all climatic features. Temperature data, obtained by adjusting 54-year climatological summaries for G and B, indicate that January is the coldest

TABLE A.2. R River Water Chemistry Summary of 12 Monthly Samples

	Minimum	Maximum	Average	Std. Dev.	No.
Solids-mg/ℓ					
Total	143	216	185	23.2	12
Dissolved	125	208	178	27.8	12
Suspended	1.2	18.4	7.5	6.2	12
Hardness-mg/ℓ (As $CaCo_3$)					
Total	98	174	147	24.8	12
Calcium	70	120	99	15.6	12
Magnesium	28	58	48	9.9	12
Alkalinity-mg/ℓ (As $CaCO_3$)					
Total	91	165	140	24.3	12
Phenolphthalein	0	12	1.8	4.1	12
Gases-mg/ℓ					
Free carbon dioxide	--	--	--	--	--
Ammonia-nitrogen (N)	0.0	0.09	0.02	0.03	12
Anions-mg/ℓ					
Carbonate (CO_3)	0.0	14.4	2.10	4.96	12
Bicarbonate (HCO_3)	111	201	166	29.1	12
Hydroxide (OH)	--	--	--	--	--
Chloride (Cl)	0.30	5.00	1.43	1.48	12
Nitrate-nitrogen (N)	0.07	0.55	0.26	0.15	12
Sulfate (SO_4)	6.3	13.5	9.5	2.2	12
Phosphorus-soluble (P)	0.012	0.057	0.030	0.012	12
Silica (SiO_2)	3.2	12.5	7.7	3.3	12
Cations-mg/ℓ					
Calcium (Ca)	28.0	48.1	39.7	6.28	12
Magnesium (Mg)	6.8	14.1	11.6	2.4	12
Sodium (Na)	2.8	6.4	5.0	1.1	12
Total iron (Fe)	0.04	0.52	0.23	0.13	12
Total manganese (Mn)	--	--	--	--	--
Potassium (K)	--	--	--	--	--
Miscellaneous					
Color (APHA units)	20	80	39	22	12
Turbidity (JTU)	1.00	4.50	2.53	1.48	12
Ryznar index (AT 77 F)	6.64	7.86	7.21	0.377	12
Conductivity (mmhos)	192	350	292	49.8	12
pH	7.40	8.60	8.15	0.308	12
BOD (mg/ℓ)	0.9	2.5	1.4	0.58	12
Dissolved oxygen (mg/ℓ)	8.0	15.0	10.6	2.1	11
Temp. (DEG. C)	0.0	23.0	9.69	9.03	12

month, with average daily maximum, mean, and minimum temperatures of -6, -11, and -16°C, respectively. July is the warmest month, with corresponding temperatues of 28, 22, and 16°C. Table A.3 shows monthly statistics.

TABLE A.3. Monthly Temperature Statistics (°C)

	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Maximum	-6.1	-4.4	3.3	12.8	20.0	25.0	28.3	26.7	22.2	15.0	4.4	-3.3
Minimum	-16.1	-14.4	-6.7	1.7	7.8	13.3	16.1	15.0	10.0	3.9	-4.4	-12.2
Mean	-11.1	-9.4	-1.7	7.2	13.9	18.9	22.2	21.1	16.1	9.4	0.0	-7.8
Extreme Max	15.0	16.1	27.8	32.8	40.6	39.4	41.7	40.0	40.6	32.2	23.9	17.2
Extreme Min	-38.9	-36.7	-34.4	-15.6	-6.7	6.0	5.6	3.3	-5.6	-13.3	-27.8	-33.9

The number of days with maximum temperatures of 32°C and above is estimated to be 12. The number of days with a minimum temperature of 0°C or below and -18°C or below is estimated to be 168 and 40, respectively. The January relative humidities at 7:00 a.m., 1:00 p.m., and 7:00 p.m., EST, are estimated to be 76, 68, 70%, respectively. The corresponding humidities for July are 86, 55, and 55%. Monthly average humidities are shown in Table A.4.

TABLE A.4. Mean Monthly Relative Humidity, %

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
74	75	73	66	62	66	68	70	70	66	73	78

The annual average rainfall is about 76 cm. The maximum 24-hr total rainfall for the period 1894-1965 for B was 13 cm and occurred in May. Thunderstorms have an annual frequency of 36 and are the chief source of rain from May through September. Snowfall in the area has an annual average of 110 cm, with occurrences recorded in all months except June, July and August. The extremes in annual snowfall of record are 15-cm minimum and a 220-cm maximum.

Annually, the winds are predominantly from the northwest or from the south through southeast. This bimodal distribution is characteristic of the seasonal wind distributions as well. The average windspeed for spring is 11 km/hr, and for other seasons about 16 km/hr. The maximum reported windspeed of 160 km/hr, reported in July 1951, was associated with a tornado. Tornadoes and other severe storms occur occasionally. Eight tornadoes were reported in the period 1916-67 in County A. The theoretical expected frequency of a tornado striking a given point in this area is 5×10^{-4} per year. For design purposes a maximum windspeed of 580 km/hr is assumed to be associated with tornadoes.

It is estimated that natural fog restricting visibility to 0.4 km or less occurs about 30 hr/year. Icing due to freezing rain can occur between October and April, with an average of one to two storms per year. The mean duration of icing on utility lines is 36 hr.

Diffusion climatology comparisons with other locations indicate that the site is typical of the region, with relatively favorable atmospheric dilution conditions prevailing.* Frequency of thermal inversion is expected to be about 32% of the year, and the frequency of thermal stabilities is 19% slightly stable, 27% stable, 20% neutral, and 34% unstable. The joint distribution of windspeed, direction, and stability is given in Table A.5.

TABLE A.5. Annual Average Joint Frequency Distribution, (10 m Height) Percent of Occurrence

WIND SPEED(M/S)	STABILITY TYPE	WIND DIRECTION NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
1.10	A	.02	0.00	.01	0.00	.01	.01	0.00	.02	.02	0.00	0.00	.01	.02	0.00	0.00	0.00
2.50	A	.10	.11	.17	.12	.07	.15	.11	.15	.25	.21	.31	.35	.32	.37	.19	.26
4.30	A	.27	.31	.21	.22	.22	.30	.47	.58	.40	.58	.42	.41	.62	.77	.62	.58
6.50	A	.06	.07	.01	.06	.25	.72	.73	1.38	.62	.16	.15	.09	.51	.64	.59	.16
9.10	A	0.00	0.00	0.00	0.00	0.00	.02	.32	.31	.07	0.00	.04	.04	.10	.17	.14	.02
12.20	A	0.00	0.00	0.00	0.00	0.00	0.00	.02	.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.10	B	.02	.02	.02	.04	.02	.02	.02	.06	.01	.04	.04	.01	0.00	.01	0.00	0.00
2.50	B	.09	.04	.16	.05	.12	.09	.06	.15	.11	.14	.12	.16	.14	.16	.10	.16
4.30	B	.19	.14	.05	.14	.05	.09	.14	.23	.21	.19	.07	.23	.16	.22	.22	.12
6.50	B	.01	.01	.02	.01	.07	.07	.05	.07	.02	0.00	0.00	.06	.21	.21	.17	.05
9.10	B	0.00	0.00	0.00	0.00	.01	0.00	.01	.02	.01	0.00	0.00	.01	0.00	.11	.01	0.00
12.20	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.10	C	.02	.01	.04	0.00	0.00	.01	.01	.01	.01	0.00	.05	.01	.02	0.00	0.00	.04
2.50	C	.05	.10	.04	.06	.07	.07	.06	.06	.12	.06	.09	.10	.07	.09	.09	.02
4.30	C	.11	.04	.07	.04	.07	.05	.17	.12	.05	.04	.02	.16	.17	.22	.14	.10
6.50	C	.02	.01	.04	.01	.04	.05	.04	.07	.01	.01	.02	0.00	.17	.15	.07	.06
9.10	C	.05	0.00	0.00	0.00	0.00	0.00	0.00	.02	0.00	0.00	.01	.02	.02	.07	0.00	0.00
12.20	C	.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.10	D	.19	.16	.22	.04	.07	.09	.07	.10	.10	.14	.10	.11	.07	.10	.09	.23
2.50	D	.54	.61	.65	.82	.47	.46	.47	.53	.32	.32	.41	.67	.47	.99	.90	.68
4.30	D	.73	.64	.62	1.03	.94	1.17	.90	.66	.49	.36	.36	.72	1.30	1.65	1.30	.76
6.50	D	.21	.27	.19	.46	.61	.61	.37	.35	.20	.22	.16	.38	1.24	1.40	.78	.73
9.10	D	.10	.04	0.00	0.00	.01	.04	.07	.05	.02	.01	.01	.16	.07	.21	.10	.02
12.20	D	.02	0.00	0.00	0.00	0.00	0.00	0.00	.02	0.00	0.00	0.00	0.00	0.00	.01	0.00	.01
1.10	E	.06	.02	.11	.15	.07	.20	.09	.14	.11	.10	.10	.12	.05	.17	.06	.09
2.50	E	.51	.35	.25	.61	.57	.72	.33	.30	.21	.42	.52	.65	.49	.75	.48	.57
4.30	E	.27	.10	.06	.38	.26	.91	.69	1.16	.57	.49	.30	.67	.64	.76	.35	.22
6.50	E	[illegible]	0.00	0.00	.11	.01	.15	.30	.56	.30	.10	.06	.05	.22	.09	.02	.10
9.10	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.20	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.10	F	.07	.11	.11	.10	.12	.06	.12	.19	.10	.15	.15	.21	.09	.10	.20	.15
2.50	F	[illegible]	.22	.15	.42	.40	.46	.58	.65	.32	.35	.35	.63	.37	.67	.38	.25
4.30	F	0.00	.01	0.00	.02	.05	.20	.30	.48	.27	.14	.05	.10	.04	.17	.14	.01
6.50	F	0.00	0.00	0.00	0.00	0.00	0.00	.04	.01	.05	0.00	0.00	.01	0.00	0.00	0.00	0.00
9.10	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.20	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.10	G	.09	.04	.12	.20	.11	.19	.32	.31	.17	.31	.46	.33	.22	.20	.12	.11
2.50	G	.05	.05	.07	.14	.17	.32	.65	.74	.21	.23	.28	.28	.15	.35	.36	.11
4.30	G	.01	.01	0.00	.01	.01	.01	.02	.16	.02	0.00	.02	.01	0.00	.12	.04	0.00
6.50	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.10	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.20	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY DATA, FOR STABILITY-TYPE	A	B	C	D	E	F	G
TOTAL PERCENT FOR STABILITY IS	17.85	5.90	4.00	34.37	19.46	10.44	7.94

* An investigation of the variations in atmospheric dispersion among a number of sites around the nation was made to determine differences to be expected in radiation dose calculations based on atmospheric dispersion because of different synoptic conditions for different locations. For five of the eight sites studied it was determined that the maximum atmospheric dispersion coefficient at 1100 m and at 72 km from the point of release was not greater by more than a factor of two over that of the reference site. It was no greater than a factor of six for any of the other three sites studied.

TERRESTRIAL ECOLOGY

Vegetation in the area was originally identified as supporting a climax deciduous forest. Farming has resulted in the removal of much of this forest. Remnants of the native climax hardwood forest are found on the larger island, with some lesser stands in isolated pockets along the river bank. Virtually all accessible virgin woodland areas in the region have been burned, cut, and plowed.

Broad-leaved trees characteristic of the study site include oak, elm, basswood, maple and hackberry. These species occur abundantly on the larger islands, with lesser stands in isolated pockets along the river banks. The climax community probably comprised maple and basswood. Farming, grazing and logging activities, however, have caused considerable change from the climax vegetation. Most areas which would be actually in use at the reference site (e.g., buildings, parking lot) occupy land formerly cultivated. There is no evidence of the existence of rare or threatened plant species at the reference site.

The soil in the area is thin and varies from sand to silt loam, with an underlay of glacial till. The water table in lower areas is close to the surface, and during river flood these areas are frequently inundated.

The numerous ponds, lakes and swampy areas bounding the site provide nesting areas for waterfowl. Most nest fairly close to water. A study conducted in C County showed that 60% of the nests were within 20 m of the water and 90% within 50 m. The percentage of successful duck nests in four county study areas is shown in Table A.6.

TABLE A.6. Percentage of Successful Duck Nests in Seven Types of Cover from Four County Study Areas, 1957-1960

Cover Type	D		E		F		G		All	
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
Alfalfa	1	0	90	21	10	30	5	0	106	21
Undisturbed prairie	75	27	--	--	--	--	--	--	75	27
Dry marsh	38	26	22	46	1	100	--	--	61	34
Upland grass	--	--	57	40	19	21	10	40	86	36
Pasture	--	--	--	--	1	0	15	40	16	38
Soil bank lands	--	--	--	--	22	41	--	--	22	41
Wet marsh	105	46	--	--	2	0	--	--	107	45
Miscellaneous	8	38	--	--	--	--	3	66	11	45
Wild hay	--	--	--	--	3	33	3	100	6	67
All	227	36	169	31	58	31	36	42	490	34

The two most important nesting waterfowl species in the area are blue-winged teal and mallards. The teal begin nesting activities early to mid-May during most years. Mallards start nesting earlier--April 20 to April 25. The production of ducks to flying stage in a three-county study is shown in Table A.7. The actual production of waterfowl at the reference site is not known but is probably similar to that reported for P County, which is located about

TABLE A.7. Production of Ducks to Flying Stage[a] Per Acre of Wetland in Three County Waterfowl Study Areas. Average figures for the 4 years 1957-1960.

Item	Study Area D[c]	E	F
Average Production			
Mallard	0.21	0.11	0.11
Blue-winged Teal	0.24	0.37	0.27
Other ducks	0.43	0.08	0.05
All ducks	0.88	0.56	0.43
Highest Production Year[b]			
Mallard	0.25	0.10	0.22
Blue-winged Teal	0.24	0.70	0.40
Other ducks	0.59	0.20	0.00
All ducks	1.08	1.00	0.62

a. Production estimated on basis of six ducklings per brood reaching flying age.
b. Highest production occurred in the D Area in 1959, E Area in 1959, and F Area in 1960.
c. Production based on 1958, 1959 and 1960 data.

160 km west. Bird hunting is mainly directed at waterfowl, both jump shooting and hunting from blinds. This portion of the river is not a preferred hunting area, nor is it used to a significant extent as a resting area for migrating waterfowl. Some of the important waterfowl species are included in Table A.8. Ruffed grouse are occasionally hunted, but there is little hunting for other birds.

Table A.9 lists wildlife considered threatened or endangered within the reference state. The southern bald eagle nests along the Atlantic and Gulf Coasts but moves northward after the nesting season and is occasionally sighted in the reference state. The Arctic peregrine falcon nests in the treeless tundra and migrates southward through the midwestern states to the Gulf Coast and South America. The prairie falcon, which nests in southern British Columbia and Texas, is occasionally sighted in the area. The northern greater prairie chicken is also present at the reference site.

Some important mammals include white-tailed deer, red fox, raccoon, red and gray squirrels, short-tailed shrews, red-backed and meadow voles, pocket gophers, white-tailed jack rabbits, beavers, and muskrats. A more complete list is shown in Table A.10. Squirrel is the major animal hunted in the area. A 1-day season for hunting deer with a gun and a prolonged season for bow and arrow hunting suggest a limited deer population. There is also some hunting of fox and raccoon.

Some important fur-bearing animals include raccoon, mink, muskrat, beaver, and fox. Other wide-ranging fur-bearing mammals will probably occur in the vicinity from time to time, especially the coyote, bobcat and possibly the river otter.

TABLE A.8. Species Composition of Duck Population as Calculated from Hunters During 1957 Season in D County

Species	N	Percent
Mallard	92	13.5
Pintail	12	1.8
Shoveler	6	0.9
American Widgeon	39	5.7
Black Duck	2	0.3
Blue-winged Teal	128	18.8
Green-winged Teal	53	7.8
Wood Duck	7	1.0
Redhead	108	15.9
Canvasback	44	6.4
Lesser Scaup	103	15.2
Ring-necked Duck	57	8.4
Ruddy Duck	20	2.9
Surf Scoter	4	0.6
Bufflehead	4	0.6
Total	679	100

TABLE A.9. Wildlife Considered Rare, Endangered, or Threatened Within the Reference State

Southern bald eagle
Arctic peregrine falcon
Prairie falcon
Northern greater prairie chicken

TABLE A.10. Some Important Mammals that Probably Occur in the Vicinity of the Reference Site

Opossum	Red Squirrel
Mole	Gray Squirrel
Shrew	Fox Squirrel
Bat	Pocket Gopher
Raccoon	Beaver
Weasel	Muskrat
Mink	Harvest Mouse
Badger	Deer Mouse
Skunk	Vole
Red Fox	Jumping Mouse
Coyote	Whitetail Jackrabbit
Bobcat	Cottontail Rabbit
Ground Squirrel	Whitetail Deer
Chipmunk	

AQUATIC ECOLOGY

The ecosystem in the R River near the reference site is very diverse and is capable of alteration with no apparent damage. Studies of the river have shown the presence of over 40 species of algae, more than 70 species of invertebrates, and 25 species of fish. This region of the river does not have a discrete phytoplankton population. Supended algal forms are mostly associated with periphyton populations and provide a source of organisms for recruitment of colonization of new substrates. However, some of the abundant algal species are planktonic and may represent a true phytoplankton (or potamoplankton) population. Diatoms of genera Melosira,, Stephanodiscus and Asterionella are most abundant during the warmer months. Other suspended algal forms present in lesser but significant abundance were green algae (Chlorophyta - Ankistrodesmus, Dictosphaerium, Crucigenia and Scenedesmus), brown flagellated algae (Cryptophyta - Cyrptomonas and Chroomonas), and blue-green algae (Cyanophyta - Aphanizomenon). Chlorophyll pigments representing these suspended algae are concentrated near surface. Highest levels recorded for this region of the river were between 40 and 50 μg/ℓ (September). There was no evidence that these concentrations were associated with spatial or temporal differences in water temperature. Vascular aquatic plants are scarce, found mostly in the backwater areas where current velocities are low.

The dominant species of attached algae, based on collections made on artificial substrates in July and August of 1970, include the blue-green algae, Chroococcus minimus, C. minor, Phormidium fareolarum, Ocillatoria geminata; the green algae, Stigeoclonium spp.; and the diatoms, Cocconeis placentula, C. pediculus, Diatoma vulgare, Fragilla spp. Melosira varians, Navicula tripunctata, N. spp. and Nitzschia spp. Algal productivity, as indicated by pigment measurements (chlorophyll "a"), was at a minimum in winter, reached a maximum in September, followed by a marked decrease in early October and a considerable increase in late October and early November. No clear reason for this pattern of periodicity can be offered. Differences in pigment concentration in the attached algae from different locations were noted, but these were not consistent throughout the season; i.e., stations having comparatively low concentrations during one part of the year would have the highest levels at other times. Chlorophyll "a" pigment concentrations ranged from 0.3 to 13.4 $\mu g/cm^2$. Reported average values for chlorophyll "a" in some other streams in the United States are 185 $\mu g/cm^2$ in Valley Creek, Minnesota; 2.2 $\mu g/cm^2$ in the Columbia River, and 30 $\mu g/cm^2$ in the Logan River, Utah. The annual range in the Columbia River was 0.36 to 5.4 $\mu g/cm^2$. Based on these values, the pigment concentrations of attached algae in the upper R River are fairly typical of other temperate zone streams.

Algal biomass determinations made at 14 different locations were relatively constant throughout the summer and fall, with a range of 0.2 to 0.37 mg dry weight cm^2.

Biomass values for other U.S. streams range from 0.42 to 2.5 mg/cm^2. The annual range for the Columbia River was 0.06 to 1.0 mg/cm^2. Cell density varied from 1600 to 1,700,000 $cells/cm^2$ in the same period. Studies on the attached algal communities show a rather wide natural seasonal and annual variation, which may limit their value in defining postoperational environmental changes.

Insects are the dominant group in the benthos of the river near the reference site. The two major habitats are best described in terms of bottom substrate, which in turn is a reflection of current velocities. The first type is stable and productive and is composed of sand, gravel and rubble. The major invertebrates in this area are the caddisflies (Trichoptera) and mayflies (Ephemeroptera). The second type has a bottom composed of silt and muck, and is usually representative of areas of low or rapidly fluctuating current velocity. Dipterans, isopods and beetles (Coleoptera) are dominant in this area. There is a marked difference in the numbers of species found near shore as compared to the offshore areas. Qualitative shoreline collections produce representatives of 66 genera of invertebrates, whereas a qualitative analysis of offshore river bottom fauna produced representatives of only 25 genera.

Table A.11 shows the seasonal variation in abundance of the major groups obtained in the quantitative study of the river. The caddisflies (Trichoptera) are the most consistently numerous group in the main river. The 1969 average annual biomass for the major benthic organisms was about 2 g dry weight/m^2.

TABLE A.11. Percentage Composition of Invertebrate Populations at all Transect Locations, R River near the Reference Site

	Trichoptera	Ephemeroptera	Diptera	Others
Feb 1969	43.73%	34.53%	8.44%	13.30%
May	6.94	0.31	92.68	0.07
June	21.62	9.38	68.48	0.53
July	61.12	11.70	26.50	0.68
Aug	59.28	19.46	19.95	1.31
Sept	75.14	11.23	11.11	2.52
Oct	41.42	6.57	35.05	16.97
Nov	24.75	3.91	49.30	22.05
TOTAL %	41.75	12.14	38.94	7.18
Feb 1970	52.47%	8.89%	37.53%	1.11%
May	51.53	1.57	45.71	1.19
June	53.34	11.79	34.23	0.64
July	78.76	8.61	12.12	0.50
Aug	57.13	28.23	13.38	1.26
Sept	63.08	19.68	16.27	0.97
Oct	43.74	8.82	25.93	21.52
Nov	16.70	6.08	63.65	13.57
TOTAL %	52.10	11.71	31.10	5.10

The presence of fairly abundant populations of caddisflies and mayflies in the benthos of the R River near the reference site indicates that the river at this point is relatively unspoiled compared with downstream areas. The stonefly population in the reference site area is low in number and diversity and may be an important index of future environmental stress. The stoneflies make up less than 5% of the bottom invertebrates, and one genus, Neoperla, comprises more than 80% of the stonefly population.

In the section of the R River from about 1 km above the site to 6 km downstream, the bigmouth shiner, sand shiner, spotfin shiner and blunthead minnow were the most abundant species near shore (see Table A.12). The smallmouth bass was the most numerous game fish in this habitat although comprising only 2.5% of the population. Crappie and bullheads were rarely obtained in shoreline collections, made with 0.8 cm^2 or 1.6 cm^2 mesh seines. The relative numbers of the several most numerous species often differed markedly in areas close to each other, indicating a species perference of habitat. No information is available on the distribution of these fishes during winter, but they probably seek the deep, slow water areas during the period of ice cover.

TABLE A.12. Fish Collected by Shoreline Seining near the Reference Site

Species	Total Catch	Percent of Catch
Bigmouth Shiner - Notropis dorsalis	1400	29.4
Sand Shiner - N. stramineus	987	20.9
Spotfin Shiner - N. spilepterus	793	16.6
Blunthead Minnow - Pimephales notatus	568	11.9
Johnny Darter - Etheostoma nigrum	262	5.5
White Sucker - Catostomus commersoni	164	3.4
Longnose Dace - Rhinichthys cataractae	156	3.3
Common Shiner - Notropis cornutus	155	3.3
Smallmouth Bass - Micropterus dolomieui	117	2.5
Hornyhead Chub - Hybopsis bigutta	95	2.0
Shortnose Dace - Rhinichthys atratulus	24	0.5
Northern Creek Chub - Semotilus atromaculatus	19	0.4
Spottail Shiner - Notropis hudsonius	11	0.23
Redhorse - Moxostoma spp.	8	0.17
Crappie - Pomoxis sp.	2	<0.1
Bullhead - Ameiurus spp.	1	<0.1
Golden Shiner - Notemigonus crysoleucas	1	<0.1

Capture with electrofishing gear permitted study of the fish populations inhabiting the main river channel. A portion of the population was tagged for recapture to permit estimates of population and of the degree of movement in the river. Summer (June to September) fish populations in the reach of the river from 2 km upstream from the site to 8 km downstream are made up mostly of rough fish (see Table A.13). The apparent increase in the proportion of game fish to rough fish with time may not be real, but the result of sampling variation. The cyprinids, northern redhorse and carp, are by far the most abundant species found offshore in the river near the reference site. The redhorse is frequently the only species found in the shallow riffle areas with gravel and stony bottoms. The dominance of the redhorse is clearly the result of favorable river characteristics: swift current, shallow depth, stone and gravel

TABLE A.13. Fish Captured by Electrofishing in a Six-Mile Section of River near the Reference Site

Species	1969 Number Captured	1969 % of Total Catch	1968-69 Estimated Total Population
Northern Redhorse *Moxostoma macrolipidotum*	867	51.2	33,376
Carp *Cyprinus carpio*	443	26.1	21,666
Silver Redhorse *Moxostoma anisurum*	112	6.6	3,576
Black Crappie *Pomoxis nigromaculatus*	107	6.3	2,360
White Sucker *Catostomus commersoni*	68	4.0	2,270
Smallmouth Bass *Micropterus dolomieui*	46	2.7	1,359
Walleye *Stizostedion vitreum*	33	1.9	1,609
Bullhead *Ameiurus* spp.	10	0.5	179
Rock Bass *Ambloplites rupestris*	7	0.4	608
Burbot *Lota lota*	1	0.05	143
Northern Pike *Esox lucius*	1	0.05	161
Perch *Perca flavescens*	--	--	54
Bowfin *Amia calva*	--	--	18

bottom. Carp are most commonly found in the deep, slowly flowing pools, but not necessarily confined to these areas. The game fish, walleye, smallmouth bass, crappie, rock bass and northern pike, inhabit areas where there is cover in the form of submerged brush, piled stumps and boulders.

Because of their more specialized and localized habitat preference, these game fish were probably not sampled by electrofishing in the same proportion as some of the rough fish with less restricted habitats. The population estimates in Table A.13 were adjusted to compensate for this difference. The limited suitable habitat for the game species may be one of the factors limiting their numbers in this area. There is no marked migration of fish in this part of the river.

The age versus length of fish collected by electrofishing near the reference site is given in Table A.14. This method of collection tends to be selective for the larger animals; hence the data in Table A.14 may be biased because of this. The age structure in the rough fishes

TABLE A.14. Relationship of Age to Length of Fish Captured by Electrofishing near the Reference Site

Age, Year	Northern Redhorse Number	Northern Redhorse Length, mm	Silver Redhorse Number	Silver Redhorse Length, mm	Carp Number	Carp Length, mm	Walleye Number	Walleye Length, mm	Smallmouth Bass Number	Smallmouth Bass Length, mm
1	18	227.8	0	--	0	--	15	158.2	2	228.5
2	100	275.2	3	197.0	3	379.3	6	241.7	11	271.8
3	113	378.0	3	380.7	26	405.5	19	260.7	9	285.9
4	478	429.8	5	464.4	102	448.5	15	304.9	9	327.7
5	513	455.2	33	485.3	157	461.2	11	363.9	12	355.0
6	110	466.9	57	503.0	137	477.6	2	444.5	8	378.6
7	19	477.8	34	498.1	61	491.8	1	403.0	4	372.0
8	6	488.3	15	518.8	18	522.1	1	552.0	2	433.0
9	3	527.3	10	538.6	8	528.8	0	--	0	--
10	0	--	0	--	1	749.0	0	--	1	470.0
11	0	--	0	--	0	--	1	673.0	0	--

shows a definite dominance of two or three consecutive year classes. This is not apparent in the game fish, possibly as the result of small sample size and/or cropping of the dominant age classes by sport fishing.

No diet analyses of the fishes in the river near the site were made, but the important food items can be inferred from studies of other areas. In regional lakes, large northern pike, walleye and bass had a diet composed mainly of fish; black crappie consumed about 40% insects, 21% plant and 6% crustaceans; the diet of the black bullhead was made up of mollusca, crustaceans and plants. Primary foods of the northern and silver redhorse in an Iowa stream were immature chironomids, mayflies and caddisflies. The diet of a regional lake population of spottail shiner was mainly small crustaceans, chironomids and algae. Although fishes are selective in their diet, food availability is controlling in diet composition. All the food items, with the possible exception of crustaceans and vascular plants, are abundant in the river near the site.

Several spawning areas are known to exist within a 10-km section of the river (including tributaries) near the reference site. Smallmouth bass (Micropterus dolomieui) spawn in the shallow regions of the river and its tributaries near the reference site. Burbot (Lota lota) spawning areas also occur in a few deeper locations within this 10-km region of the river. Although these spawning areas are sparsely distributed within the reference site region, fish eggs and larvae are potentially vulnerable to environmental changes.

Of the fishes known to inhabit the river near the reference site, two species are considered threatened. The hornyhead chub (Hybopsis bigutta), considered rare, inhabits the shallows of the river. The other is the bonefin (Amin calva), considered rare and endangered; it inhabits the deeper regions of the river.

Although sizeable populations of fish are present in the river near the reference site, no commercial fishing is conducted due to obstructions in the stream that limit the use of commercial fishing gear. The sport fishery for walleyes, northern pike, smallmouth bass and crappie has an estimated annual value of about $345,000 in the 50-km stretch of river from the site downstream. This fishery is supported entirely by natural production.

Fishing and other recreational uses of the river, such as boating and canoeing, are presently limited by the lack of public access to the river. No actual measurement has been made of the amount of boating on the river or of canoeing, a recreation that is increasing near the reference site. Based on casual observation, there is an average of about 14 canoe trips weekly in this part of the river during summer. Motor boating in the summer is limited to those few individuals who are familiar with the summer low-water channels.

PATHWAY PARAMETERS RELEVANT TO RADIOLOGICAL DOSE CALCULATIONS

Radiation exposure of man via airborne pathways may include that from radiation emitted from overhead plumes and ground-level clouds; direct radiation from radionuclides deposited on the ground; inhalation of radionuclides released to the atmosphere; and consumption of foods produced from vegetation upon which radionuclides have been deposited or which have been grown in soils on which deposition has accumulated. Such foods may include vegetables from local gardens; milk from cows foraging on pasture grass; or meat from animals raised on pasture and feed grown in the vicinity of the plant. These pathways are illustrated in Figure A.4.

Radiation exposure of man via surface water pathways may include that from ingesting radionuclides with drinking water, consumption of aquatic foods, and direct radiation from surface waters received through shoreline activities or swimming or boating, as illustrated in Figure A.4.

For the milk and home garden pathways, the nearest dwelling is assumed to be a farmhouse adjacent to the site boundary southeast of the main plant where the maximum ground-level atmospheric dispersion factor ($\overline{\chi}/Q'$) is about 3×10^{-7} sec/m^3 for ground-level releases and 1.5×10^{-8} sec/m^3 for tall stack releases. A milk cow is assumed to be kept at this farm and maintained on fresh pasture 7 months of the year. It is assumed that a garden is kept for vegetables; however, there are no large truck gardens in the area.

For the farm-crop-irrigation pathway, it is assumed that about 82% of land in the vicinity of the site is farmed. Production is essentially 60% soybeans (0.7 kg wet weight/m^2) 30% corn, oats and other grain (0.35 kg wet weight/m^2) and 10% hay (1.5 kg wet weight/m^2). For dose calculation purposes, it is assumed that 10% of the average flow rate ($\sim$12 kℓ/sec) of the R River in the vicinity of the plant site is drawn from the river during June, July and August for irrigation of 250 km^2.

For the recreational and aquatic food pathways, it is assumed that in the vicinity of the plant a "maximum individual"* may spend 100 hr/yr swimming or boating and may spend 500 hr/yr obtaining 10 kg of fish and 10 kg of fresh water mollusca. Aquatic foods are assumed to be consumed within 24 hours of the time they are harvested.

For pathways to the population, it is assumed that 85% of the 2 million residents within 80 km of the site obtain their drinking water from the R River. Travel time to the consumer

* A "maximum individual" is an individual whose habits tend to maximize his or her dose.

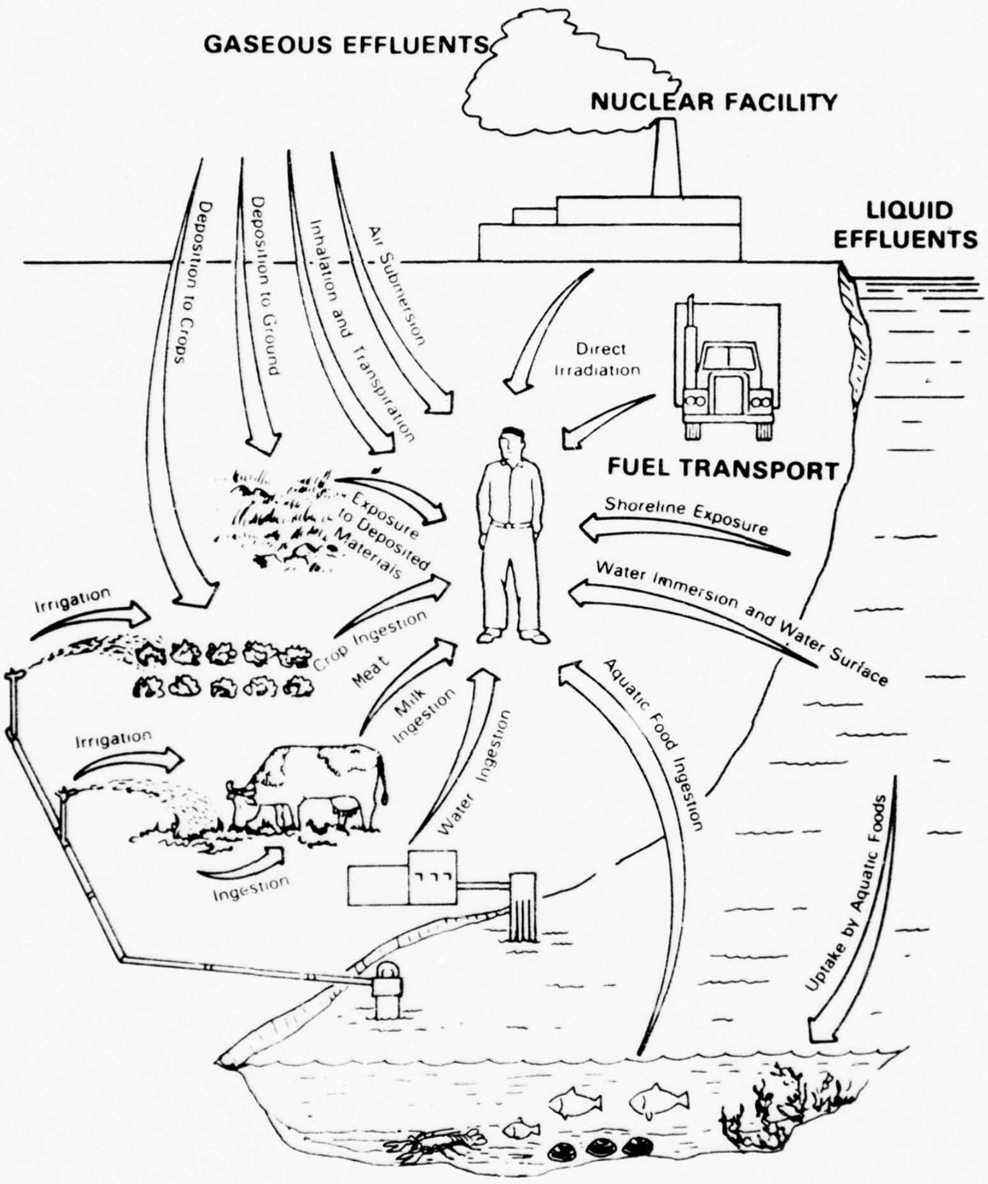

FIGURE A.4. Radiation Exposure Pathways to Man

from a point on the river nearest the site is taken to be 48 hr. It is assumed that on the average each person will spend 5 hr/yr swimming and 10 hr/yr boating or fishing downstream from the site. The average per capita fish consumption for this area has been estimated to be 1.1 kg/yr. It is assumed that 10% of this consumption is from fish obtained downstream from the site.

APPENDIX B

DOSE CALCULATIONS AND RADIOLOGICALLY RELATED HEALTH EFFECTS

APPENDIX B

DOSE* CALCULATIONS AND RADIOLOGICALLY RELATED HEALTH EFFECTS

DOSE TO REGIONAL POPULATION

Calculational models and parameters used in evaluating the radiological dose from both chronic and accidental releases of gaseous and liquid effluents from the facilities and processes investigated in this study have been selected to give a realistic but conservative appraisal. These models represent the state of the art, keeping in mind that, because of the natural variability of the input parameters, excessive sophistication does not necessarily lead to more accurate results.

Chronic Releases

Air Concentration

The concentrations of radionuclides released in the atmosphere from these facilities were estimated using a Gaussian model.[1] Meteorological data on the joint frequency of occurrence of wind speed, wind direction, atmospheric stability and release parameters such as height and velocity for a particular plant were taken from the reference environment. The horizontal and vertical dispersion parameters, σ_y and σ_z, were taken from curves derived from the work of Pasquill and modified by Gifford.[2]

Air Submersion Dose

Air concentrations were estimated for each of 16 sectors. For these sectors the center-line ground level dose was calculated for ten downwind distances from 0 to 80 km. Radiation doses to skin and to total body were estimated from these air concentrations.

Both photons and beta particles can contribute significantly to the external dose to skin. The beta dose contribution is easily calculated using a semi-infinite cloud model. This model can be used because the range of beta particles in air is short compared to the dimensions of plumes considered. The gamma dose calculation is more complicated because of the relatively long range of photons in air. To properly determine the gamma contribution it is necessary to perform a space integration over the plume volume. The integration technique used in the reactor accident analysis computer program SUBDOSA[3] is employed here except that the plume width is determined by sector boundaries rather than by a Gaussian concentration gradient. The contribution of gamma radiation to total-body dose was estimated by calculating the tissue dose at 5 cm depth. An occupancy factor may be used to account for the fraction of the year a person is exposed to the cloud. Also a shielding factor may be employed to correct for any shielding by buildings or structures between the recipient and the cloud.

Inhalation Dose

The air concentrations derived as described above were used along with the breathing rate and dose factors to estimate the dose through the inhalation of radionuclides dispersed in the air.

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* In accordance with common practice, the term "dose," when applied to individuals and populations is used in this report instead of the more precise term "dose equivalent" as defined by the International Commission on Radiation Units and Measurements (ICRU).

The breathing rate is the volume of air taken in by an individual per unit time. A value of 0.23 ℓ/sec was used in this study.[4]

The inhalation dose factor is given in units of rem/yr per Ci/yr intake and is dependent on the complex transport, retention, and elimination of radionuclides through the respiratory and gastro-intestinal tracts. The model of the respiratory tract adopted by the Task Group on Lung Dynamics forms the general basis for the calculation of this dose factor.[5] The computer code used for the calculations was DACRIN.[6]

Ground Contamination Dose

Radionuclides from the air may settle on the ground, where they can accumulate during the time of the release. These can be a source of radiation that will irradiate an individual or population groups.

This dose is determined using the 1) air concentration, 2) deposition "velocity" of the radionuclides traveling to the surface from the air, 3) an exponential expression which accounts for the accumulation of the radionuclide on the ground over a certain time period, 4) a dose factor, and 5) an occupancy factor.

The deposition "velocity" given in terms of m/sec is highly dependent on surface roughness, wind speed, and particle size. Based on many experimental studies, values of 0.001 m/sec for particles and 0.01 m/sec for iodine gas were selected for use in this report.[1]

The time over which the radionuclides accumulate in the soil is dependent on the lifetime of the facility releasing the material. In this study a value of 30 years is used, which is considered to be about the average lifetime of a nuclear facility.

The dose factor for the dose from ground irradiation is calculated by assuming that a receptor is 1 m above a large, nearly uniform, thin sheet of contamination.[7,8] A factor of 0.5 to account for dose reduction due to ground surface roughness is also included in dose factors. These dose factors have units of rem/hr per pCi/m^2 of surface.

Ingestion of Food Crops

Food crops may become contaminated by deposition of radionuclides directly from the air or from irrigation water upon the plant surfaces or by radionuclides taken up from soil previously contaminated via air or water. Many factors must be considered when calculating doses via ingestion of these foods. These factors account for the movement of radionuclides from release to the receptor and form a complex sequence.[9]

Equations used to calculate such doses are given in two parts: the first accounts for direct deposition onto leaves and translocation to the edible parts of the plant, while the second accounts for long-term accumulation in the soil and root uptake.

For sprinkler irrigation (and for deposition of airborne materials) both parts of the equation are used, while only the part dealing with root uptake is required for ditch irrigation. Tables of transfer factors and plant uptake factors are stored in files in the program FOOD.[10] The program can handle nine crops and their pathways to man. The output of the program lists the concentrations of radionuclides in the food crops and the fraction of the concentration from each part of the equation (i.e., leaf or root). It also lists the dose to each organ from each nuclide/crop combination, with a summary of total doses from all crops and nuclides combined.

The nuclides ^{3}H and ^{14}C are treated as special cases in the FOOD program. The concentrations in the initial environmental media (air or water) are calculated on the basis of the specific activity of the nuclide in the naturally occurring stable element.

Ingestion of Animal Products

Five products--milk, eggs, beef, pork, poultry--are included in the FOOD program. The concentrations in the animals' feed are first calculated as discussed above for human food crops.

The equation, the values of animal feed and water consumption, and a listing of the transfer factors (fraction of each day's intake appearing per liter of milk or kilogram of eggs or meat) are given by Baker et al.[9] The output of FOOD lists doses to various organs by nuclide and food type and summarizes total dose from all nuclides in milk, eggs, and meat (beef, pork, and poultry).

Accumulated Doses from Foods

A computer program, called PABLM, was written to calculate cumulative radiation dose to people from the ingestion of food. A total of eight food categories (leafy vegetables, other above-ground vegetables, root vegetables, fruit, grain, eggs, milk, and meat) can be selected with corresponding consumption rates, growing periods, and irrigation rates or atmospheric dilution parameters assigned by the user. Radionuclides may be deposited via water used for irrigation or directly from the atmosphere onto vegetation or the ground for the expected operating life of the facility. Dose commitments to the total body and six internal organs from 186 radionuclides can be accumulated for a specified dose period. However, computer core space limitations restrict input considerations to only four organs and 75 radionuclides. A summary of cumulative dose and percent contribution by nuclide for each food type is calculated. Radionuclide concentrations in soil, plants, and animal products are also calculated.

Accidental Releases

External Dose from Passing Cloud

The dose to individuals exposed to a passing cloud of accidentally released radionuclides consists of external and internal components. The external radiation doses are calculated using the computer code SUBDOSA,[3] and the spatial distribution determined by the methods described in Meteorology and Atomic Energy[1] and code XOQDOQ[2] for a semi-infinite cloud. External exposure results from both gamma radiation and beta particles emitted from radionuclides while they are airborne and external to the human receptor. This dose is dependent not only upon the type of radiation; i.e., gamma or beta, but also upon the energy of the radiation and the spatial distribution of the airborne radionuclides with respect to the receptor. The type and energy of radiation are characteristic of each radionuclide.

Because the range of beta particles in the air is only a few meters, the air concentration at ground level is sufficient to calculate the doses resulting from beta-emitting radionuclides. Ground-level air concentrations are not sufficient, however, for calculating the dose from gamma radiation. This is due to the relatively large range of gamma radiation in air. This range varies according to gamma energy and can be as long as a few hundred meters. As a result, the dose from external exposure to gamma radiation during cloud passage depends upon the air concentration at distances up to a few hundred meters. Thus the height of release has much less effect on gamma dose than it does on beta dose, particularly at close distances. As before for air submersion doses, both beta and gamma radiations contribute to skin dose; but only gamma radiation contributes to total-body dose (calculated at 5 cm depth).

Internal Dose from Passing Cloud

Inhalation doses are calculated using the same models and codes as used for chronic release except for increased ventilation rate (0.35 ℓ/sec).[4]

Dose to Biota Other Than Man

The doses to terrestrial and aquatic animals living within the influence of the nuclear facilities described in this report were not calculated separately. Two recent comprehensive reports[11,12] have been concerned with radioactivity in the environment and pathways to biota other than man. Depending on the pathway being considered, terrestrial and aquatic organisms will receive either about the same radiation doses as man or somewhat greater doses. Although no guidelines have been established to set acceptable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also conservative for these species.[13]

The literature relating to radiation effects on organisms is extensive, but very few studies have been conducted on the effects of continuous low-level exposure to radiation from ingested radionuclides on natural aquatic or terrestrial populations. The most recent and pertinent studies point out that, while the existence of extremely radiosensitive biota is possible and while increased radiosensitivity in organisms may result from environmental interactions, no biota have yet been discovered that show a sensitivity to radiation exposures as low as those anticipated in the area surrounding fuel cycle plants. The BEIR Report[14] states in summary that evidence to date indicates that no other living organisms are very much more radiosensitive than man. Therefore, no detectable radiological impact is expected on the aquatic biota or terrestrial mammals as a result of the quantity of radionuclides to be released into the River R and into the air by fuel cycle plants.

Direct Radiation from Transportation

The method used to calculate the dose to persons along the shipping route from a vehicle containing a shipment of radioactive material follows that developed in WASH 1238.[15]

The equation used to estimate population doses incorporates several factors that integrate the dose to an individual as the radiation source passes his location. The formula then integrates the dose to all persons within a designated population distribution. The factors considered are radiation source strength, velocity of the transport vehicle, population density in areas of exposure to passing source, attenuation factors due to gamma interactions with air, and buildup factor to account for the contribution of scattered radiation.

The Department of Transportation's regulations limit the radiation level allowable outside the transport container rather than restrict the contents. Consequently, the shipping containers are designed and loaded with that regulatory limit in mind. For this calculation, based on the regulatory limit of 10 mrem/hr at 1.8 m (6 ft) from the surface of the vehicle, the maximum radiation dose rate at 3 m (10 ft) from the apparent center of the source was estimated to be 10 mrem/hr.(15) The radioactive shipment on the vehicle was considered to be a point source for distances from the source of 100 ft or more.

The length of time an individual spends near a source is a determining factor in the total dose received; thus the velocity of the source is important. It was assumed that a long haul, maximum weight motor carrier shipment averages 1160 km (720 miles) per day and that a carload rail shipment averages 320 km (200 miles) per day. Based on a uniform distance traveled each day and uniform distribution of persons along the route, the cumulative radiation dose to the population is the same whether the vehicle is always moving at a constant rate of speed or is standing still part of the day.

It was assumed that the average population density is 127 persons per square kilometer (330 persons per square mile) in the United States east of the Mississippi River and in California, and 42 persons per square kilometer (110 persons per square mile) in the other midwestern and western states. It is further assumed that no people live within 30 m (100 ft) of the railroad or highway right-of-way. The dose to persons farther than 800 m (2600 ft) is negligible. The population was assumed to be uniformly distributed between 30 and 800 m on each side of the route and grouped at 30 m (100 ft) intervals. Since the nuclear power facilities under consideration are assumed to have useful life times of 30 years, the 70-year cumulative dose from transportation of wastes from a given facility is approximated by multiplying the annual dose by 30.

DOSE TO WORLDWIDE POPULATION

Worldwide population doses were calculated for the three radionuclides that are considered to be the major contributors to total-body dose rates and long-term dose commitments: ^{3}H, ^{14}C, and ^{85}Kr. A constant world population of 6.4×10^9 persons was used for this analysis. This value, which is based on a United Nations projection, was reported by Killough(16) for the year 2000. It agrees with the value of 6.3×10^9, which is derived from the method of the Environmental Protection Agency (EPA)(17) using projections based on a 1970 population of 3.56×10^9 persons and an annual growth rate of 1.9%.

A different method was used to determine the quantity of each of the radionuclides to which the population was exposed. For ^{3}H, dispersion was calculated using a seven-compartment model that considered diffusion into and out of latitudinal bands. The exposure of the population was calculated using assumed diets whose concentrations of tritium were related to those in local surface waters. A specific activity approach was used for ^{14}C in which the concentration of ^{14}C per gram of carbon in people was assumed to be equal to that in atmospheric carbon dioxide. It was assumed that ^{85}Kr diffused readily across latitudinal bands so that in a few years the concentration was uniform throughout the world's atmosphere. The dosimetry for ^{85}Kr is based on external exposure of the body to a semi-infinite cloud containing this radionuclide, with no accumulation within the body or in any environmental reservoirs other than the air.

Although the method for each radionuclide is different, each probably estimates the population dose to within an order of magnitude. Additional uncertainty is therefore introduced when doses from all three radionuclides are totaled. Moreover, care must be exercised in comparing the relative contributions of these three radionuclides because of the different methods and because of the uncertainty inherent in each.

Each of the three methods is discussed below.

Tritium

Tritium and tritium oxide released to the environment mix rapidly with the ambient water and become part of the hydrologic cycle. Tritium rains out or is washed out of the atmosphere almost entirely in the hemisphere in which it is released. Transport across latitudinal bands even in the same hemisphere, is slow.[(18)] As a result, the tritium released from facilities in the United States will reach peak environmental concentrations in the 30° to 50° band of the northern hemisphere where most of the world's population resides.

Baker[(19)] has calculated the radiation doses received by local 80 km (50-mile radius), regional (eastern United States), and worldwide populations from a continuous release of 1 Ci/yr of tritium to the atmosphere using the "box" model of Renné et al.[(18)] The facility releasing the tritium was assumed to be located in the Midwest. Although the magnitude of the dose to the local population is sensitive to the specific site chosen, the regional population dose should be similar for most midwestern sites. In addition, the world population dose depends upon the latitude band and not the longitude of the release point.

Baker's analysis indicates that for a constant world population of 3.8×10^9 persons, the collective population dose rate, at equilibrium with a continuous release of 1 Ci/yr of ^3H, was 1×10^{-2} man-rem/yr for all three population groups combined. Less than 10% of this dose was received by persons residing within 80 km of the plant site but about half was received by the eastern U.S. population during the initial pass of the tritium released from the midwestern site. The actual dose to the regional U.S. population from a tritium release to the atmosphere could range from near zero for plants situated on the eastern seaboard to values approximately equal in magnitude to the equilibrium worldwide population dose for plants situated in the West or Midwest.

In Baker's model[(19)] the tritium content of water and food consumed by the world's population was assumed to be related to, but not necessarily as high as, the tritium concentration in the surface waters of the appropriate latitude band. Even so, the population-weighted average surface water concentrations are higher than those obtained in the simpler model used by the EPA,[(17,20)] which assumes mixing of the ^3H in the circulating ocean water of the northern hemisphere. As a result, Baker's calculations of dose to the world population (excluding the United States) are about seven times greater than those estimated by EPA.*

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* The calculated U.S. population dose, however, is only two times higher for the Baker model than for the EPA model. The net result is that the combined world population dose (including the U.S. population) is about three times higher via Baker's model than via the model used by EPA.

For the commercial waste management study, the methods used by Baker were adopted with the exceptions of changing the world population from 3.8 x 10^9 persons to 6.4 x 10^9 persons and using a release time of 30 years in place of a continuous release out to equilibrium. The resulting dose factors per unit release are summarized in Table B.1.

TABLE B.1. Total-Body Dose Factors, Accumulated Dose Factors, and Dose Commitment Factors for the World Population (6.4 x 10^9 persons), man-rem per Ci/yr released(a)

Radionuclide	Dose Factor (1/1)(b)	Dose Factor (1/30)(c)	Accumulated Dose Factor (70/30)(d)	Dose Commitment Factor (70/1)(e)
^{3}H	4.7 x 10^{-4}	6.8 x 10^{-3}	2.4 x 10^{-1}	8.2 x 10^{-3}
^{14}C	2.4	7.2 x 10^{1}	4.0 x 10^{3}	1.7 x 10^{2}
^{85}Kr	3.1 x 10^{-5}	4.1 x 10^{-4}	1.4 x 10^{-2}	4.7 x 10^{-4}

a. Exclusive of contribution to eastern U.S. population dose from first passage of FRP gaseous effluents if FRP is located in the Midwest or West.
b. World population dose in first year after a 1-Ci release (instantaneous equilibrium).
c. Annual world population dose in the 30th year (year 2000) after 30 years of continuous release of 1 Ci/yr.
d. Seventy-year accumulated dose to the world population from 30 years of release at 1 Ci/yr followed by 40 years exposure to the residual environmental contamination.
e. Seventy-year dose commitment to the world population from a 1-year release of 1 Ci/yr to the environment plus continued exposure to the residual environmental contamination.

Carbon-14

Most ^{14}C released to the atmosphere from nuclear facilities will be in the form of carbon dioxide (CO_2), with possible traces of organic compounds released from certain specific processes within the nuclear fuel cycle. After mixing with the existing CO_2 in the atmosphere, the $^{14}CO_2$ can either become incorporated directly in plant material or washed out of the atmosphere onto land or water surfaces.

Most analyses of the long-term radiation doses to large population groups from ^{14}C include the following assumptions:

1. Carbon-14 is released to the atmosphere as CO_2.
2. It mixes rapidly with all carbon in the world's atmosphere – 6.2 x 10^{17} g (320 ppm CO_2).
3. Mechanisms that remove carbon into less accessible sinks such as the deep ocean or that dilute the $^{14}CO_2$ with increased CO_2 releases from future fossil-fuel combustion can be ignored.
4. The specific activity (that is, activity of ^{14}C per unit weight of carbon) in the tissues of man eventually equilibrates with that in the atmosphere.

More complicated models are possible. Machta[21] developed a seven-compartment model for CO_2, similar to the one discussed for tritium. It was further modeled by the EPA[22,23] for use in predicting radiation doses to large populations from ^{14}C injected into the troposphere by the nuclear industry. The EPA model was used only to predict the specific activity of ^{14}C in the troposphere including, however, the corrections mentioned in assumption 3. Assumption 4 was then used to calculate dose to man. Reference 23 includes an estimate that 99% of the ^{14}C intake by man is via food and only 1% via inhalation.

Killough[16] further modified the EPA seven-compartment model to incorporate newer data on diffusive vertical transport of CO_2 in the deep ocean and the relationship between the concentration of inorganic carbon in the ocean surface waters and the partial pressure of dissolved CO_2. The computer code developed to implement the resulting model is documented in detail.[16]

For purposes of the commercial waste management analysis, the conservative model outlined in assumptions 1 through 4 was adopted. This model was also adopted by the Nuclear Regulatory Commission (NRC) in its testimony at the Allied General Nuclear Services (AGNS) reprocessing plant license hearings.[24] By comparison the doses calculated using this simple approach are about 25% higher than those calculated by EPA,[23] 50% higher than those estimated by Baker,[19] and nearly seven times higher than those obtained by Killough.[16] The comparison with Killough is not, however, straightforward because of the assumptions of growing population and increasing CO_2 concentrations used by that author.

<u>Dose Conversion Factors for Carbon-14</u>

The assumptions that the specific activity of ^{14}C per gram of carbon in man eventually reaches equilibrium with that in the atmosphere and that there are 16.1 kg of carbon in the 70-kg body of Reference Man[4] lead to the derivation of dose and dose commitment factors as discussed in the following paragraphs.

At a release rate of 1 Ci/yr over 30 years the accumulated quantity of ^{14}C in the environment will be 30 Ci. At the end of an additional 40 years there will still be 30 Ci in the environment. Diluting 30 Ci in the 6.16×10^{17} g of carbon in the atmosphere[16] yields a specific activity of

$$(30 \text{ Ci} \times 10^{12} \text{ pCi/Ci})/(6.16 \times 10^{17} \text{ g}) = 4.87 \times 10^{-5} \text{ pCi/g} \quad (1)$$

The dose rate (DR) factor after 30 years of release can be calculated from the following equation:[25]

$$DR = 0.0187 \; CE \text{ rem/yr} \quad (2)$$

where

$$C = \text{concentration in body (pCi of } ^{14}C \text{ per g of body tissue)} \quad (3)$$

$$= (4.87 \times 10^{-5} \text{ pCi of } ^{14}C \text{ per g of C})(1.61 \times 10^{4} \text{ g of C})/(7 \times 10^{4} \text{ g total body}) \quad (4)$$

$$= 1.12 \times 10^{-5} \text{ pCi/g} \quad (5)$$

$$E = 0.0538 \text{ (MeV/dis)} \cdot \text{(rem/rad)}, \quad (6)$$

$$0.0187 = (0.037 \text{ dis/sec per pCi})(3.156 \times 10^{7} \text{ sec/yr})(1.602 \times 10^{-8} \text{ g} \cdot \text{rad/MeV}). \quad (7)$$

Therefore

$$DR = (0.0187)\ (1.12 \times 10^{-5})\ (0.0538) \quad (8)$$
$$= 1.13 \times 10^{-8} \text{ rem/yr per person} \quad (9)$$

For 6.4×10^9 persons, the worldwide dose rate factor thus becomes 72.1 man-rem/yr after the release of 1 Ci/yr for 30 years.

The 70-year dose commitment (DC) factor, which is the sum of the dose during release and the dose after release has stopped, is calculated as follows:

$$DC = [(0 + 72.1 \text{ man-rem/yr})/2]\ (30 \text{ yr}) + [(72.1 \text{ man-rem/yr})\ (40 \text{ yr})] \quad (10)$$
$$= 3970 \text{ man-rem per 1 Ci/yr released for 30 years.} \quad (11)$$

These dose factors are summarized in Table B.1.

Krypton-85

When krypton-85 is released to the atmosphere it will mix rapidly with the atmosphere in the hemisphere in which it is released. After about 2 years it will also be fairly well mixed throughout the world's atmosphere. For purposes of this analysis, therefore, simple uniform worldwide mixing of ^{85}Kr in the world's atmosphere has been assumed. Similar assumptions have been used by the NRC in its testimony for the AGNS fuel reprocessing facility at Barnwell[26] and the EPA in its projections of population dose commitments from the nuclear industry.[17,20]

The National Council on Radiation Protection and Measurements has published a discussion of the behavior and significance of ^{85}Kr in the atmosphere.[27] In that report a comparison was made between the population exposure estimates made by detailed modeling of ^{85}Kr dispersion and estimates assuming uniform mixing in the world's atmosphere.

The model used in this analysis ignores the higher concentrations near the source and during the first pass through the latitudinal band where the release occurs. As a result, the model underestimates the local and regional dose at short times after the release. However, the net effect on the worldwide dose from long-term accumulated dose commitment exposure is small-about 10 to 20%, depending on whether the nuclear facility is sited in the Midwest or on the East Coast. The rapid mixing across the equator makes separate accounting of the northern and southern hemisphere population doses unnecessary.

Dose Conversion Factors for Krypton-85

The world's atmosphere contains 3.96×10^{18} m^3 of air at standard temperature and pressure.[27] The concentration of ^{85}Kr at any time is simply the cumulative amount released (corrected for radioactive decay) divided by the volume of the atmosphere. For a continuous uniform release rate of 1 Ci/yr the concentration (C_t) of krypton becomes

$$C_t = [(1 \text{ Ci/yr})\ (10^{12} \text{ pCi/Ci})/(3.96 \times 10^{18} \text{ m}^3)]\cdot[1 - \exp(-\lambda t)[/\lambda \quad (12)$$
$$= (2.53 \times 10^{-7})\ \left\{[1 - \exp(-\lambda t)]/\lambda\right\} \text{ pCi/m}^3 \text{ per Ci/yr released} \quad (13)$$

where

λ = radiological decay constant for ^{85}Kr (14)

= 0.0648 per year, (15)

t = years since start of release. (16)

For 30 years of continuous release at 1 Ci/yr the expression $[1 - \exp(-\lambda t)]/\lambda$ becomes 13.2. This indicates that at that time 13.2 Ci remain in the environment out of the total of 30 Ci released. The concentration (C_{30}) then becomes

$$C_{30} = 2.53 \times 10^{-7} (13.2) = 3.341 \times 10^{-6} \text{ pCi/m}^3 \text{ per Ci/yr.} \qquad (17)$$

The concentration during the next 40 years after the release has stopped is this 30th year concentration corrected for decay. Thus the total time-integrated concentration (TIC) is the sum of the combined expressions for concentration during the two time periods (0 to 30 years and 30 to 70 years). This yields the following equation:

$$\text{TIC} = (2.53 \times 10^{-7}) (1/\lambda^2) [\lambda t_1 + \exp(-\lambda t_2) - \exp(-\lambda \Delta t)] \\ (\text{pCi}\cdot\text{yr/m}^3) \text{ per Ci/yr release} \qquad (18)$$

where

t_1 = time over which release occurs, (19)

t_2 = time over which dose is calculated, (20)

$\Delta t = t_2 - t_1$. (21)

For t_1 = 30 years and t_2 = 70 years the expression within brackets becomes 448, which yields a time-integrated concentration of

$$1.13 \times 10^{-4} \text{ pCi}\cdot\text{yr/m}^3 \text{ per Ci/yr} \qquad (22)$$

Unlike ^3H and ^{14}C, which emit only low-energy beta particles during their radioactive decay, ^{85}Kr emits a gamma photon in a small percentage of its decays. These photons plus a small contribution from bremsstrahlung associated with the beta decay are capable of irradiating the total body* during external exposure to ^{85}Kr dispersed in air. Krypton-85 is not significantly absorbed into the body during inhalation and this pathway makes a negligible contribution to the total-body dose.(27)

Soldat, et. al., have calculated the total-body dose factor for a person immersed in a half-infinite cloud of ^{85}Kr to be 2.2×10^{-3} mrem/hr per μCi/m^3 (1.9×10^{-8} rem/yr per pCi/m^3).(28) Combining this dose factor and a constant world population of 6.4×10^9 persons with the expression for concentration (C_{30}) yields the world population total-body dose rate in the 30th year as follows:

$$[3.34 \times 10^{-6} (\text{pCi/m}^3) \text{ per (Ci/yr)}] (6.4 \times 10^9 \text{ persons}) \\ [1.9 \times 10^{-8} (\text{rem/yr}) \text{ per (pCi/m}^3)] \qquad (23) \\ = 4.08 \times 10^{-4} \text{ man-rem/yr per Ci/yr released for 30 years.}$$

* Defined as the layer of tissue lying 5 cm below the surface of the skin.

The accumulated 70-year dose is

$$[1.13 \times 10^{-4} \text{ (pCi·yr/m}^3\text{) per (Ci/yr)] (6.4} \times 10^9 \text{ persons)}$$
$$[1.9 \times 10^{-8} \text{ (rem/yr) per (pCi/m}^3\text{)]} \quad (24)$$

$= 1.38 \times 10^{-2}$ man-rem/70 years per Ci/yr released for 30 years.

Dose Conversion Factors for System Analysis

The nuclear fuel cycle facilities in place and operating will change year by year. To obtain a realistic assessment of the long-term population dose commitments, calculation of the dose commitment from each year's operation followed by a summation of these yearly values is necessary. This can best be assessed by deriving population dose commitment factors for a one-year unit release.

Because of the nature of the three radionuclides involved in the world population dose estimates (^3H, ^{14}C, and ^{85}Kr), there is no long-term accumulation in the body. Hence, each year's release and resulting dose commitment can be treated independently of the others.

The following expression relates the 70-year dose commitment (from a 1-year chronic release) to the dose in the first year.

$$R = (1/\lambda^2)[\lambda t_1 + \exp(-\lambda t_2) - \exp(-\lambda \Delta t)] \text{ (yr)}^2 \quad (25)$$

where

t_1 = 1 year, (26)

t_2 = 70 years, (27)

$\Delta t = t_2 - t_1$ = 69 years, (28)

λ = radioactive decay constant (ln2/half-life). (29)

The values of this ratio for ^3H, ^{14}C, and ^{85}Kr are given in Table B.2. Table B.2 also includes the dose commitment factors per unit release obtained when these ratios are applied to the first-year dose (item 1/1 from Table D.1).

TABLE B.2. 70-Year World Population Dose Commitment from a 1-Year Chronic Release, man-rem/70 years per Ci/yr released

Radionuclide	Ratio[a]	Dose Commitment Factor[b]
^3H	17	8.2×10^{-3}
^{14}C	69	1.7×10^2
^{85}Kr	15	4.7×10^{-4}

a. Ratio of 70-year dose commitment from a 1-year chronic release to the dose in the year of release.

b. Seventy-year dose commitment to the world population from a 1-year release of 1 Ci to the environment plus continued exposure to the residual environmental contamination.

Using these dose factors and annual releases of ^{3}H, ^{14}C, and ^{85}Kr from waste management facilities, estimates of worldwide population dose can be obtained for the evolving fuel cycle systems.

RADIOLOGICALLY RELATED HEALTH EFFECTS

The radiation dose to man from ingestion, inhalation, or external exposure to specified quantities of radionuclides can be calculated with reasonable confidence. Estimates of the amounts of radioactive material that may be released from Commercial Waste Management (CWM) operations, however, and fractions reaching man via various environmental pathways are not as well defined. The relationship of dose to so-called "health effects" is even less well defined. Thus, estimates of "health effects" that may result from radiation exposure consequent to CWM activities can derive only from a chain of estimates of varying uncertainty. The usual practice in making these estimates is that if an error is to be made, it will be made in a way intended to overprotect the individual. As a result, if the chain of estimates is long, considerable overestimation may be made in the final value.

Because expected releases of radioactive materials are small, and the radiation dose to any individual is small, the effects considered are long-delayed somatic and genetic effects; these will occur, if at all, in a very small fraction of the persons exposed. Except as a consequence of the unusually severe accident involving larger doses, no possibility exists for an acute radiation effect. The effects that must be considered are cancers that may result from whole body exposures, and more specifically, from radioactive materials deposited in lung, bone, and thyroid; and genetic effects that are reflected in future generations because of exposure of the germ cells.

Knowledge of these delayed effects of low doses of radiation is necessarily indirect. This is because their incidence is too low to be observed against the much higher background incidence of similar effects from other causes. Thus, for example, it is not possible to attribute any specific number of human lung cancers to the plutonium that is present in everyone's lungs from weapons-test fallout, because lung cancers are known to be caused by other materials present in much more hazardous concentrations, and because lung cancers occurred before there was any plutonium. Even in controlled studies with experimental animals, one reaches a low incidence of effect that cannot be distinguished from the level of effect in unexposed animals, at exposure levels far higher than those predicted to result from CWM activities. Hence, one can only estimate a relationship between health effect and radiation dose, basing this estimate upon observations made at very much higher exposure levels, where effects have been observed in man, and carefully studied animal experiments.

An alternative approach involves direct comparison of the estimated radiation doses from CWM activities with the more accurately known radiation doses from other sources. This avoids the most uncertain step in estimating health effects (the dose-effect relationship) and provides a comparison with firmly established data on human exposure (i.e., the exposure to naturally occurring radiation and radioactive materials). Some people prefer to judge a risk's acceptability on knowledge that that risk is some certain fraction of an unquantifiable, but unavoidable, natural risk, than to base this judgement on an absolute estimate of future deaths that might be too high or too low by a large factor. Because of these judgmental problems it is the practice in this Statement to compare estimated radiation exposure from CWM activities with naturally occurring radiation exposure as well as to indicate estimates of cancer deaths and genetic effects.

LATE SOMATIC EFFECTS

Recently much literature has dealt with the prediction of late somatic effects of very low-level irradiation. This literature is not reviewed in detail here because it is recent and readily available. Instead, the various dose-effect relationships that have been proposed are briefly considered and justification is given for the range of values employed in this Statement.

Two publications have served as the basis for most recent efforts to quantify late somatic effects of irradiation. These are the so-called BEIR Report, issued in 1972 by the National Academy of Sciences as a report of its Advisory Committee on the Biological Effects of Ionizing Radiations;[14] and the so-called UNSCEAR Report, a report to the General Assembly by the United Nations Scientific Committee on the Effects of Atomic Radiation, most recently revised in 1977.[29]

Both the BEIR and UNSCEAR Reports draw their conclusions from human effects data derived from medical, occupational, accidental, or wartime exposures to a variety of radiation sources: external x-irradiation, atomic bomb gamma and neutron radiation, radium, radon and radon daughters, etc. These observations on humans were, of course, the result of exposures to relatively large total doses of radiation at relatively high dose rates. Their extrapolation to the low doses and dose rates of concern to us is acknowledged by the BEIR Report as "fraught with uncertainty" (p. 7). The BEIR Report concludes, however, that the assumption of a linear relationship between dose and effect, extending to zero dose with no threshold dose below which no effects are predicted, "in view of its more conservative implications, . . . warrants use in determining public policy on radiation protection." But it further cautions that "explicit explanation and qualification of the assumptions and procedures involved in such risk estimates are called for to prevent their acceptance as scientific dogma" (p. 97).

The BEIR Report makes estimates of both absolute risk (cancer deaths per unit of radiation exposure) and relative risk (percentage increase above normal incidence of cancer deaths per unit of radiation exposure). And for each of these approaches it assumes either a 30-year or a duration-of-life interval following the latent period, during which risk remains elevated for non-leukemic cancer. Separate risk estimates are derived for the in utero, 0-9 years, and 10+ years age periods, reflecting presumed age differences in the sensitivity to radiation. The derivation of these risk estimates and their application to the U.S. population is summarized in the BEIR Report (p. 169) where the number of excess cancer deaths per year in the U.S. population, because of continual exposure at a rate of 0.1 rem/yr, is estimated as:

- 1726 for the absolute risk model with 30-year risk plateau
- 2001 for the absolute risk model with duration-of-life risk plateau
- 3174 for the relative risk model with 30-year risk plateau
- 9078 for the relative risk model with duration-of-life risk plateau.

It is of interest to note that the exposure rate of 0.1 rem/yr employed in these estimates is in the range of place-to-place variations in dose received from natural radiation sources in the continental U.S.

The BEIR Report risk estimates are shown in Table B.3, converted to a man-rem basis. This conversion involved dividing the risk estimates of Table 3-1, page 169, of the BEIR Report, by 20,000,000, since the U.S. population, taken as 200,000,000, if exposed to 0.1 rem/yr, receives a total annual exposure of 20,000,000 man-rem. The BEIR Report provides estimates for leukemia and for "all other cancers;" the "all other cancers" category is further subdivided for the absolute risk model as applied to those aged 10 or more. Values for bone and lung cancer are shown in Table B.3 as though the apportionment applied to the total population. It is important to note that the approximately five-fold range of values for total cancer deaths predicted by the four different BEIR Report models do not define a range between maximum and minimum possible values. They are merely four estimates, based on different assumptions, between which it is not possible to make a confident choice based on present knowledge.

The Environmental Protection Agency (EPA) in its Environmental Analyses of the Uranium Fuel Cycle[30-32] chose single risk estimates, based on the BEIR Report, which it considered "the best available for the purpose of risk-cost benefit analyses, [while cautioning that] they cannot be used to accurately predict the number of casualities." (Ref. 31, p. C-14) These EPA risk estimates, expressed as cancer deaths per million man-rem, are also listed in Table B.3. The derivation of these numbers is not detailed in the EPA publications, but they continue to be used by the EPA and have been adopted by others.

The Reactor Safety Study (RSS) of the Nuclear Regulatory Commission (Rasmussen Report) included an effort by an Advisory Group on Health Effects to update and extend the conclusions of the BEIR Report.[33] Among the 17 members of this Advisory Group were five who also had served on the BEIR Committee. The RSS derived three classes of risk estimates: an "upper-bound estimate," a "central estimate," and a "lower-bound estimate." In contrast to the different BEIR Report risk estimates, the RSS estimates do purport to establish a range within which the true value should be found. The RSS risk estimates for organs of interest to this Statement, and as applied to low-dose exposure, are listed in Table B.3. The details of the temporal exposure patterns, age distributions, and computational approaches employed in the BEIR and RSS Reports are not identical, and the risk estimates are therefore not strictly comparable; but errors from this source are negligible in comparison to the other uncertainties involved.

In arriving at upper-bound estimates, the RSS made two significant changes in BEIR assumptions and modified several numerical values on the basis of newer data. The "relative risk model" of the BEIR Report was eliminated and all estimates were based on the "absolute-risk model;" and the plateau period for expression of non-leukemic cancer following postnatal exposure was taken as 30 years, the duration-of-life plateau option of the BEIR Report was dropped. The rationale for these changes are presented in the RSS Report. The major change resulting from new data was a 40% reduction in the leukemia risk of in utero exposure; this was based upon revised dosimetry provided by the authors of the publication from which the BEIR risk

TABLE B.3. Comparison of Various Estimates of Cancer Deaths per Million Man-Rem

Type of Cancer	BEIR Report[14]				Environmental Protection Agency	Reactor Safety Study[33]			UNSCEAR Report[29]	ICRP-26[35]
	Absolute Risk Model		Relative Risk Model							
	30-Year Plateau	Life Plateau	30-Year Plateau	Life Plateau		Upper Bound	Central Estimate[b]	Lower Bound[b]		
Leukemia	-26-[a]		-37-[a]		54[30]	28	5.6	0	15-25	20
Non-leukemic	60	74	122	417		106	42	0		
Lung	16	19			50[31]	22	4.4	0	25-50	20
Bone	2.4	3.0			16[30]	7	1.4	0	2-5	5
Thyroid					15[32]	13	2.6	0	5-15	5
Total	86	100	159	454	200[31]	134	48	0	100	100

a. 10-year risk plateau following in utero exposure, otherwise 25 years.
b. Calculated on the assumption that no individual dose will exceed 10 rem.

estimate was primarily derived. The upper-bound estimates shown in Table B.3 are taken directly from Table VI 9-4, p. 9-33, of the RSS Report,[33] except for the thyroid cancer risk; this is derived from a "case" estimate of 134 per million man-rem modified by a mortality estimate of 10% (Ref. 33, p. 3-26 and 9-27).

The RSS central estimate "modifies the upper-bound estimate by correcting for risk reduction caused by both the ameliorating effects of dose protraction and the lesser effectiveness of very small acute doses" (Ref. 33, p. G-7). This correction acknowledges the preponderance of data from experimental studies, which indicate that the dose-effect relationship is not linear and that low doses of low LET (linear energy transfer) radiation delivered at low dose rates afford a significant opportunity for repair of radiation damage. The RSS discusses and references the extensive radiobiological literature on this subject and concludes that at doses below 10 rem, or at dose rates below 1 rem/day, a "dose-effectiveness factor" of 0.2 is justified (i.e., for a given total dose the dose effectiveness in producing a "health effect" is less at smaller dose rates). This was still considered a conservative position, the RSS Advisory Group on Health Effects being "of the unanimous opinion that the dose effectiveness factors they recommended probably overestimate the central estimate" (Ref. 33, p. 9-22). It should be recognized that some may not agree in applying such a factor in the human case, where the very limited data do not entirely support the RSS position.[34] *

Finally, the RSS acknowledges in its lower-bound estimate the possibility that a threshold for cancer induction may exist. While a threshold for primary radiation effects at the molecular level is considered unlikely on theoretical grounds, the mechanisms by which such effects become expressed as cancers are not understood, and available data in no way preclude the possibility of a threshold for these expressed effects. The RSS calculates its lower-bound estimate assuming a 10- or 25-rem threshold dose, either of which is larger than most doses predicted to occur to an individual from CWM activities.

The most recent and most thoroughly documented estimates of cancer risk from radiation exposure are those contained in the 1977 UNSCEAR Report.[29] These values are listed in Table B.3. The UNSCEAR Report cautions that these values are ". . . derived essentially from mortalities induced at doses in excess of 100 rad. The value appropriate to the much lower dose levels involved in occupational exposure, and even more so in environmental exposures to radiation, may well be substantially less; . . ." (p. 414). Also shown in Table B.3 are the risk estimates adopted in the 1977 Recommendations of the International Commission on Radiological Protection,[35] which were based primarily on the UNSCEAR Report.

For this Report, a range encompassing commonly used cancer risk factors has been employed, as indicated in Table B.4. While the possibility of zero risk at very low exposure levels is not excluded by the available data, the lower range of risk estimates in Table B.4 are considered "realistic" estimates, appropriate for comparison with the estimated risks of other energy technologies. The upper part of the range are "conservative" estimates, more appropriate for radiation protection considerations. In this context one should recall the admonition of the National Council on Radiation Protection and Measurement:[36] "The NCRP wishes to caution governmental policy-making agencies of the unreasonableness of interpreting or assuming 'upper limit' estimates of carcinogenic risks

* The EPA disagreed with the 0.2 dose rate effectiveness factor, and concluded that the RSS central estimate of late somatic effects "may be underestimated by a factor of 2 to 10."[80]

TABLE B.4. Health Effects Risk Factors Employed in this Statement

Type of Risk	Predicted Incidence per 10^6 Man-Rem
Cancer from:	
Total body exposure	50-500
Lung exposure	5-50
Bone exposure	2-10
Thyroid exposure	3-15
Specific genetic effects to all generations from:	
Total body exposure	50-300

at low radiation levels derived by linear extrapolation from data obtained at high doses and dose rates, as actual risks, and of basing unduly restrictive policies on such an interpretation or assumption" (Ref. 36, p. 4).

GENETIC EFFECTS

It is known that genetic effects result from alternatives within genes, called mutations, or from rearrangements of genes within chromosomes. There is no radiation-dose threshold for the production of mutations, but repair of damage to genetic material can occur during exposure at low dose rates. This information is reviewed and discussed at length in the 1977 UNSCEAR Report.[29]

The conventional approach to this problem has been to estimate a "mutation doubling dose," i.e., the radiation dose required to double the existing mutation rate. The BEIR Report concludes that this doubling dose for humans lies in the range of 20 to 200 rem. The UNSCEAR Report considers additional experimental data and opts for a single value of 100 rem. Given a number for the doubling dose, if one can assume that radiation-induced mutations have the same effect on health as normally occurring mutations, and if one knows the burden of human ill health attributable to such normally occurring mutations, one can directly estimate the genetic effect of any given radiation dose. Unfortunately, it is not clear that radiation-induced mutations are equivalent in effect to normally occurring mutations. Nor is there any confidently accepted quantification of the human ill health attributable to these normally occurring mutations.

Four kinds of specifically recognized genetically associated diseases are usually distinguished.

1. Autosomal dominant disorders are those caused by the presence of a single gene. The most common examples are: chondrodystrophy (abnormal cartilage development), osteogenesis imperfecta (abnormally brittle bones), neurofibromatosis (disease characterized by multiple soft tumors), eye anomalies including congenital cataract, and polydactylism (more than 10 fingers or toes).[37] It is generally agreed that these disorders will double in frequency if the mutation rate is doubled.[14,29] There is some disagreement on their normal frequency of occurrence: the earlier data,[38] employed in the BEIR Report, indicate a 1% normal incidence, while a more recent study of Doughty and Trimble,[37]

indicates an incidence of something less than 0.1%. These new data have not been fully accepted, however, and the 1977 UNSCEAR Report continues to employ the 1% normal incidence figures.[29]

2. Multifactorial (irregularly inherited) disorders have a more complex and ill-defined pattern of inheritance. These diseases include a wide variety of congenital malformations and constitutional and degenerative diseases. Their normal incidence in the population was estimated in the BEIR Report to be about 4%,[14] however the newer data of Doughty and Trimble suggest an incidence as high as 9-10 percent.[29] The BEIR Report states that, "The extent to which the incidence of these diseases depends on mutation is not known" but assumes a "mutational component" of 5 to 50% (p. 56). The 1977 UNSCEAR Report employs a single figure of 5% and considers 10% to be an upper limit (ref. 29, p. 429). Newcombe has argued that "the bulk of the most directly pertinent experimental studies thus fail to demonstrate any important effect of irradiation on the irregularly inherited diseases, or on general health and well being," and concludes that "the collectively numerous irregularly inherited diseases of man are unlikely to be substantially increased in frequency by exposure of his germ plasm to radiation.[39]

3. Disorders due to chromosomal aberrations include diseases characterized by changes in the number of chromosomes, or in the structural sequence within chromosomes. It is generally agreed that these diseases will show little increase as a result of low-level, low-LET irradiation, and they were not quantitated in the BEIR Report. The 1977 UNSCEAR Report includes a numerical estimate for such effects.

4. Spontaneous abortions are known to occur as a result of chromosomal effects, often so early in pregnancy as to be undetectable. Such effects have been generally excluded as not a relevant health effect.[14]

In addition to the above specifically identifiable genetic effects, there may well be genetic influence on other unquantifiable aspects of physical and mental ill health. The BEIR Report assumed that two-tenths of this "ill health" was due to genetic factors related to mutation, acknowledging that "it may well be less, but few would argue that it is much higher" (p. 57). Using this factor and a mutation doubling dose of 100 rem, one calculates an eventual 0.2% increase in "ill-health" as a consequence of continual exposure to 1 rem per generation. Such ill-defined effects cannot be quantitatively compared to specific genetic effects, or carcinogenic effects, nor can they be stated on a man-rem basis.

Table B.5 summarizes the BEIR Report and UNSCEAR Report genetic risk estimates. The EPA has employed an estimate of 300 genetic effects per million man-rem,[31] as has also the Medical Research Council in England.[40] The newer data on the normal frequency of autosomal dominant disorders,[37] and Newcombe's evaluation of the significance of multifactorial disorders,[39] lead to an estimate for total genetic effects of only 10 per million man-rem. All of these estimates are for total effects, to be experienced over all future generations.

A range of 50-300 specific genetic effects to all generations per million man-rem was employed in this Statement. The lower value recommended by Newcombe has not been generally

TABLE B.5. Estimates of Genetic Effects of Radiation Over all Generations

Type of Effect	BEIR Report(14)	UNSCEAR Report(29)	EPA(31)	Newcombe(39)
Autosomal Dominant Disorders	50-500	100		10
Chromosomal Disorders		40		
Multifactorial Disorders	10-1000	45		
Total	60-1500	185	300	10

accepted and the upper end of the BEIR Report range seems too high in the light of newer evidence discussed in the 1977 UNSCEAR Report. As in the case of the somatic risk estimates, the lower end of the range may be considered more appropriate for comparitive risk evaluations, while the upper end of the range may be appropriate to radiation protection considerations.

SUMMARY

All estimates of health effects, as quoted elsewhere in this Statement, employ the risk factors summarized in Table B.4. No special risks are considered to be associated with any specific radionuclide except as reflected in the calculation of their dose equivalent (in rems) in the various tissues of concern. However, because of their particular significance, effects attributable to certain radionuclides (tritium, ^{14}C, ^{85}K, and plutonium) are discussed separately on the following pages.

SPECIFIC CONSIDERATION OF HEALTH EFFECTS FROM TRANSURANICS

Data relevant for predicting specific health effects from transuranics have been considered elsewhere, in great detail.[41-43] Only the kinds of data available and the approaches that might be taken if specific transuranic health effect predictions were desired are considered here.

Experience with Transuranic Elements in Man

No serious health effects attributable to transuranic elements have been reported in man. There are extensive data, however, on exposure of man to transuranic elements. Such exposures arise from two main sources: the worldwide plutonium fallout from atmospheric testing of nuclear weapons and other devices, and the accidental exposure of persons working with transuranics. Since these exposures have produced no effects distinguishable from effects caused by other causes, the information is useful in health effects prediction only as an indication that unusual or unexpectedly severe effects are not to be anticipated; i.e., such negative data can be used only to set an upper limit on possible effects.

Experience with Natural Radiation in Man

Alpha-emitting elements are a natural part of man's environment. He has lived with these internally deposited radioelements and with radiation from other natural sources throughout the history of the species. It is of some relevance to note that inhaled naturally occurring alpha-emitting radionuclides contribute an average annual dose of about 0.1 rem to the lung, and that naturally occurring alpha emitters in bone contribute an average annual dose at bone surfaces of about 0.04 rem.[44] While these doses cannot be related to any measure of specific effects, they have been at least "tolerable" on the evolutionary scale, and therefore slight increases can hardly have catastrophic effects.

Data from Experiments with Animals

Direct information on the toxicity of transuranic elements is available only from studies in experimental animals. The radiobiological literature suggests that the biological effects observed in such animal experiments will at least qualitatively approximate those that would occur in man exposed under the same conditions. Based on extensive data from several animal species, it is concluded that the most probable serious effects of long-term, low-level exposure to transuranics are lung, bone, and possibly liver tumors. Most of these data are from experiments with plutonium, but can probably be applied to other transuranics with less error than is involved in many other necessary assumptions. While quantitative extrapolation from animal to man involves considerable uncertainty, the animal data suggest tumor risks per million organ-rem of 60 to 200 for lung,[45] and 10 to 100 for bone.[42,46] These estimates are compared with others in Table B.6.

TABLE B.6. Comparison of Transuranic Health Risk Estimates

(Tumor deaths per million organ-rem)

	Risk Estimates Based on Data from Humans				Risk Estimates Based on Data from Animals
	BEIR(14)				
	High(a)	Low(b)	MRC(43)	Mays(46)	
Lung tumors	100	16	25		60-200(c)
Bone tumors	17	2	5	4	10-100(d)
Liver tumors			20		

a. Relative risk model with lifetime plateau.(39)
b. Absolute risk model with 30-year plateau.(39)
c. Data from Ref. 45
d. Data from Ref. 42,46

Data on Effects of Other Types of Radiation on Man

Inferences concerning the effects of transuranic elements in man may be drawn from information available on the effects of other forms of ionizing radiation in man; e.g., data derived from medical, occupational, accidental, or wartime exposure of humans to different radiation sources, including external x-radiation, atomic bomb gamma and neutron radiation, radium, radon and short-lived radon decay products, etc. Such information has been summarized in the BEIR and UNSCEAR Reports, as previously described. England's Medical Research Council (MRC), considering much the same information covered in the BEIR and UNSCEAR Reports, derived risk estimates specifically applicable to plutonium.[43]

Also of interest are recently accumulated data on the carcinogenicity of ^{224}Ra in human bone.[47,48] These data are particularly relevant to risks from plutonium, since ^{224}Ra is predominantly an alpha emitter and, because of its very short half-life (3.64 days), irradiates only the surface layer of bone, in much the same manner as plutonium dose. From these ^{224}Ra data, Mays[46] has estimated a bone cancer risk of 4 per million bone-rem.

Table B.6 compares tumor risk estimates from these several sources. Quantitative application of these data to the very low exposure levels involved in population exposure resulting from commercial waste management practices is uncertain, however, the kinds of data presented in Table B.6 are reassuring because of their general agreement, and because they predict no unusual incidence of effects not contemplated in the selection of the general risk estimates used in this Statement.

SPECIFIC CONSIDERATION OF HEALTH EFFECTS FROM KRYPTON-85

The radiological significance of ^{85}Kr was reviewed in a recent report of the National Council on Radiation Protection and Measurements (NCRP).[49] Most of the discussion in this appendix derives from that report, which should be consulted for details or for more extensive citation of the literature.

Because krypton is virtually inert chemically, it is not metabolized. Exposure of humans results from ^{85}Kr in the atmosphere external to the body, from ^{85}Kr inhaled into the lung, and to a much smaller degree from ^{85}Kr dissolved in body fluids and tissues. Over 99% of the decay energy of ^{85}Kr is in the form of a relatively weak beta ray (mean energy, 0.25 meV) which limits the hazard from external exposure. There is general agreement that the dose to the sensitive cells of the skin from external exposure is about 100 times larger than the dose to the lung or any other internal organ.[49-52]

The NCRP Report[49] considers four categories of delayed effects from long-term exposure to low-level environmental concentrations of ^{85}Kr. These are: 1) genetic effects, 2) overall carcinogenic effects, 3) carcinogenic effects on skin, and 4) possible interaction of ionizing and ultraviolet radiation.

Estimation of genetic and overall carcinogenic effects of ^{85}Kr exposure involves no unusual features. Dose to gonads and to total body have been considered essentially identical by all who have considered the problem.[49-51] Genetic and carcinogenic risk factors chosen for general application in this Statement (Table B.4) should be appropriate to ^{85}Kr.

Carcinogenic effects on skin do constitute a unique problem, however, since the human exposure dose from ^{85}Kr is 100-fold higher to the skin than to any other tissue. Dose-response data on radiation-induced skin cancer are limited, but suggest a threshold-type response; certainly the skin is less susceptible to radiation carcinogenesis than are many other tissues. The BEIR Report,[53] after review of the available data, concludes that "numerical estimates of risk at low dose levels would not seem to be warranted."

As a consequence, neither dose to skin nor estimated health effects that might result from low-level skin irradiation are presented in this Statement. (It may be noted that skin cancer is perhaps the most easily controlled of all malignancies and rarely fatal.)

The possibility of interaction between the radiation from ^{85}Kr and solar ultraviolet radiation, the latter of which is considered to be responsible for most human skin cancer, was raised in the NCRP Report.[49] There is no direct evidence for such interaction, but the possibility was thought to justify further epidemiological and laboratory studies.

SPECIFIC CONSIDERATION OF HEALTH EFFECTS FROM TRITIUM

Although tritium is subject to the uncertainties involved in any prediction of effects at dose levels far below those for which there are experimental data, the relatively uniform distribution of hydrogen throughout the body and our understanding of the metabolism of hydrogen and water by the body do provide more confident dosimetry than is available for most other radionuclides. If there is special concern about tritium effects, it relates primarily to the difficulties of preventing its release to the environment, and to its worldwide distribution and availability to man following release. Many aspects of the biological concerns for tritium in the biosphere are reviewed in the proceedings of a symposium on the subject, held in 1972.[54]

There has been some concern that tritium incorporated in organic compounds, either prior to or following ingestion by man, might present a substantially increased hazard. Such an increased hazard might be due to: (a) prolonged retention of the tritium-containing compound, (b) enhanced biological effectiveness of the radioactive disintegration due to conversion of the hydrogen atom in a vital molecule to a helium atom (transmutation effect), or (c) an enhanced radiation effect due to origin of the beta ray within a vital molecule. If the hydrogen of all molecules in the body were uniformly labeled with tritium, this would add perhaps 50% to the whole body radiation dose from body water alone. Any larger increased radiation dose from organically bound tritium could occur only if tritium were preferentially incorporated or retained, in comparison with ordinary hydrogen. This possibility was reviewed by Weston who concluded that, "it is apparent that large kinetic isotope effects are often found for tritium-labeled compounds. In tracer experiments utilizing tritium, observed rate constants could easily differ by an order of magnitude from those for the analogous unlabeled compound. If tritium from a source of HTO at constant specific activity is incorporated into a biological system by irreversible chemical reactions, it will be discriminated against; and the tritium level in the biological system will remain lower than that of the source. Conversely, kinetic isotope effects in the back exchange to remove tritium after incorporation will favor retention of tritium in the biological system."[55]

Although rather large isotope effects occur in individual chemical reactions, the overall effects in biological organisms seem relatively small, as discussed by Shtukkenberg.[56] Thompson and Ballou[57] compared tritium and deuterium in rats, as did Glascock and Duncombe.[58] The effects were small, as they were in a study of algae.[59] It therefore seems reasonable to assume, as was done in the dosimetric calculations for this Statement, that tritium will behave like ordinary hydrogen; any error introduced by such an assumption will probably overestimate the effects of tritium.

The significance of transmutation effects has been a controversial subject, but there now appears to be agreement on the following conclusions, as expressed by Feinendegen and Bond: "The effects of intracellular tritium are overwhelmingly due to beta irradiation of the nucleus. Transmutation effects do not produce a measurably increased effect under most conditions and are detectable only, if at all, under highly specialized laboratory conditions. The origin of tritium beta tracks in, or their close juxtaposition to, the DNA molecule does not appear to enhance the degree of somatic effects."[60] Studies of the induction of gene mutations in mice also indicate no substantial transmutation effect.[61]

Concern has been expressed for the case in which a developing female fetus is exposed to elevated body water levels during oocyte formation; tritium incorporated in these germ cells would be retained until ovulation, and this might constitute a special genetic hazard.[62] Osborne, however, has estimated[63] that in such a circumstance, less than 0.2% of the initial dose rate to the nucleus originates from tritium incorporated in DNA, and that it would be 30 years before the initial dose from body water was equaled by the cumulative dose from DNA-incorporated tritium.

It would thus appear quite certain that tritium incorporated into organic compounds poses no substantially increased hazard beyond that accounted for by its contribution to whole body dose.

Tritium is a pure beta emitter of very weak energy--18.6 keV maximum. The linear energy transfer (LET) of such a weak beta is higher than that of more energetic beta, x-, or gamma radiation, and much experimental effort has been devoted to determining whether this higher LET is reflected in an increased relative biological effectiveness (RBE). The International Commission on Radiological Protection (ICRP) in its 1959 report on Permissible Dose for Internal Radiation[64] used a quality factor of 1.7 for tritium, the value employed in the dosimetric calculations for this Statement. RBE studies were reviewed by Vennart,[65] who concluded "that a value of QF different from unity of either tritium or other β-emitters is hardly justified," and the ICRP reduced the tritium quality factor to unity in 1969, an action concurred in by the National Council on Radiation Protection and Measurements.[66] More recently, there has been further evidence presented to justify a value higher than unity.[67,68] Of particular interest are studies of Dobson et al.[69,70] on the survival of female germ cells in young mice exposed to a continuously maintained level of tritium oxide in body water. These studies seem to indicate an increasing RBE with protraction of exposure, with the suggestion of a limiting RBE value of about 4 at very low doses. It is important to note, however, that an increasing RBE at very low doses for the relatively high-LET beta radiation from tritium, is (on theoretical grounds, at least) more likely due to a decreased biological effectiveness of the reference, low-LET radiation, than to an absolute increase in tritium effectiveness.

With specific regard to the RBE for genetic effects, the induction of mutations by tritium in mice has been recently studied at Oak Ridge National Laboratory.[61] The report of these studies presents the following conclusion: "Thus, if absorbed dose to the testis is accepted as meaningful for purposes of comparison with gamma or X-rays, the . . . point estimate of relative biological effectiveness (RBE) for postspermatogonial germ-cell stages is close to 1, with fairly wide confidence intervals. The point estimate of RBE for spermatogonia is slightly above 2, with confidence intervals which include 1, and there remains the suggestion that the distribution of mutants among the seven loci may differ from that produced by gamma rays."[61]

In summary, it may be concluded that research on both somatic and genetic effects attributed to tritium has failed to produce results markedly different from those which would have been predicted from a general knowledge of ionizing radiation. It may then be assumed that the conventional methods of estimating radiation dose and biological effect, as employed in this Statement, are applicable to tritium.

SPECIFIC CONSIDERATION OF HEALTH EFFECTS FROM CARBON-14

The radiological significance of ^{14}C has received much attention because carbon occurs everywhere in nature, including man; ^{14}C has a long half-life, 5730 years; and weapons tests have significantly increased global ^{14}C levels.(71) Only recently has attention been directed to the considerably smaller ^{14}C releases that may be expected from the nuclear fuel cycle.(72,73)

As with tritium, there is concern that transmutation effects (i.e., effects resulting from the conversion of a carbon atom to a nitrogen atom in a vital molecule) may increase the health risk from ^{14}C beyond that attributable to the beta-radiation dose. This is of particular concern with regard to genetic effects. Direct experimental data to settle this question are not available. In his original article (1958) calling attention to health risks from ^{14}C, Pauling concluded, "that the special mechanism involving ^{14}C atoms in the genes themselves is less important than irradiation in causing genetic damage."(74) Totter, Zelle and Hollister, reviewing the then available data, concluded that, "subject to large uncertainty, the transmutation effect of ^{14}C atoms contained in the genetic material of the human body could lead to about the same number of genetic mutations as the radiation effect from ^{14}C."(75)

The general problem of transmutation effects has received much recent study, and the occurrence and importance of such effects has been clearly demonstrated for ^{32}P.(76) Less work has been done with ^{14}C, and reported results are not entirely consistent. In studies with Drosophila (fruit flies), Lee and Sega observed little, if any, mutagenic effect from ^{14}C-thymidine incorporated in sperm.(77) They concluded that, "if transmutation of ^{14}C is mutagenic at all, it is less effective than ^{32}P (in similar experiments) by two orders of magnitude"; and that, "for practical purposes in considering mutagenic hazards or toxicity effects due to chromosome breakage, only the beta radiation of ^{14}C needs to be considered."

On the other hand, McQuade and Friedkin observed twice the frequency of chromosome breakage in onion root tips after administering thymidine with ^{14}C-labeling in the methyl group, as with ^{14}C-*labeling in the 2 position.* This seems to imply a differential transmutation effect, since the labeling position should not influence beta-radiation-induced effects.(78) There is, in any case, no experimental evidence for a transmutation effect that is many times larger than the radiation effect, although such claims have been made on theoretical grounds.(79) Therefore, based on what appears a preponderance of informed opinion,(76,77) this report does not consider the possibility of ^{14}C transmutation effects.

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APPENDIX C

SOCIOECONOMIC IMPACT ASSESSMENTS

Appendix C

SOCIOECONOMIC IMPACT ASSESSMENTS

C.1 APPROACH TO ASSESSMENT OF SOCIOECONOMIC IMPACTS

The socioeconomic impact analysis developed in this report gives particular emphasis to changes in local employment and population attributable to the construction and operation of a waste management facility. A model for projecting individual components of population and employment change over the life of the facility has been constructed. In addition, changes in demands for public services that are closely related to population and employment change are examined.

Each of the alternative waste management facilities considered generates socioeconomic impacts through 1) the employment requirements of construction and operation, 2) the demand generated for locally supplied material and service inputs, 3) the secondary economic growth generated by the project, and 4) the public revenues resulting from project operation. The first three of these impact sources affect the character and magnitude of private and public service demands of all kinds; the fourth affects governments' capacity to provide public services. In addition, project labor demands affect local labor markets by competing with labor employed in other activities in the site region and through a reduction in local unemployment.

For purposes of estimating socioeconomic impacts associated with each of the reference waste management facilities, only the employment requirements associated with facility construction and operation are considered. Other attributes of each alternative are not considered for three reasons. First, employment requirements more directly affect impact categories than do other input requirements or revenue generation. Examples of impact categories directly affected by employment and population change are demands for housing, education, and health services. Second, locally supplied material inputs are likely to contribute only minimally to the local socioeconomic impacts of the facilities in question. Considering the rural or semirural locations of the sites, most material inputs are expected to be imported rather than locally supplied. Finally, tax structures and prospective revenues vary widely across potential sites, making it difficult to provide estimates of revenue impacts in a generic study.

C.1.1 Socioeconomic Impact Categories

The identification of socioeconomic impact categories for this report has been guided by several considerations. The first of these is the legal requirement under the National Environmental Policy Act of 1969 (NEPA). The Act itself, as well as subsequent interpretations by the courts and clarification by the Council on Environmental Quality, has provided a minimum guide as to what must be treated in environmental impact statements. Accordingly, this report examines in considerable detail the impact of waste management strategies upon population concentration and population composition. Second, changes in population and employment are emphasized because of their certainty or inevitability. In contrast, the identification of more precise categories of impacts depends upon which mitigating strategies are adopted. In a generic study, especially, the adoption of specific mitigating strategies cannot be anticipated. Finally, the report adopts impact categories for which objective and creditable forecasting methodologies are available and it neglects categories for which impact forecasts could be only speculative. For example, the report does not attempt to evaluate impacts related directly to mental illness, juvenile delinquency, educational attainment, or quality of life.

The generic nature of the study limits its ability to provide specific estimates for some categories of impacts. Important site-specific attributes essential to an estimation of more specific impacts include economic composition and tax structure of the site community, availability of community assistance funds to compensate affected communities, and extent of prior capacity utilization or excess capacity in capital-intensive public service areas such as utilities and transportation. Lacking such information, it is not possible to predict accurately how a major population addition to a community would affect requirements for new schools, hospitals, roads, water treatment facilities, and other community services. Neither is it possible to judge the fiscal capability of the community to provide the services called for by the new population, or the likelihood of taxes or community impact assistance being available to compensate for the additional cost of these services. For these reasons, the report's treatment of impacts beyond population and employment change is limited to an indication of the project-associated demand for various categories of public services that either are likely to have distributional impacts (especially upon the native population, which does not benefit from project operation and construction) or are closely linked to changes in demographic components included in the forecasting model. These service requirement estimates are based upon observed per-capita service ratios in the three regions considered.

C.1.2 Impact Forecasting: Population and Employment

A refined population projection model is used to generate a distribution of population by age and sex over time. The analysis provides for a projection of the baseline population in 5-year increments beginning with the assumed construction start-up date in 1980 and running through the operation phase of the project, which varies in duration depending on the facility being analyzed. The in-migrant employees and dependents associated with the project are estimated and distributed residentially throughout a commuting region. Migrants are allocated to the site county with a gravity model that takes account of distance, initial population distribution, and housing availability. The numbers of migrants who take up residence in the site county are then projected, separately from the baseline, over the same period.

In this study, impacts result solely from in-migrant primary and secondary* employment and associated dependents who relocate in the site county. Persons who commute to the site

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* Primary employment is that employed directly by the project in question; secondary employment is indirectly caused by primary employment. The components of secondary employment are described in greater detail in Section C.1.3. [For a fuller discussion of these concepts, see Richardson(1) and Mertaugh.(2)]

county from residences outside the county are assumed to have no measurable or important impacts on the site county except, perhaps, on the provision of improved transportation systems, which are not considered in this analysis.* Additionally, workers and their families who resided in the site county prior to the project and remain there while employed on the project exert no new impacts on the county.

The size, rate of growth, and age and sex composition of the project-related migrant population are projected over the life of the project. The size and age structure of this population varies over time as a result of employment turnover and replacement and relocation of workers formerly employed on the project. Assumptions regarding the standard components of population change (fertility, mortality, and net migration) are also incorporated in the projection model. They, too, influence the size and structure of the population over time.

The projection of regional baseline population and employment begins with a population projection that uses information regarding the age/sex composition of the local population in the site regions and recent patterns of net migration, also differentiated by age and sex. These regional baseline projections provide estimates of the population change that the respective site regions are likely to experience in the absence of waste management facilities. The population data are transformed into labor force estimates through the use of the 1976 national labor force participation schedule for males and females of each adult age group. This labor force provides a portion of the manpower to meet employment demands of the project, depending on skill distribution, levels of unemployment, and availability to work on the project.

The projection model distinguishes primary and secondary employment resulting from construction and operation of waste management facilities. The migrant and nonmigrant components of primary and secondary employment are estimated from available labor supply and known employment requirements for each of the project alternatives using the projection model. Innovative features of this model are that it explicitly incorporates the elements of worker displacement from other regional jobs to project construction, excess migration, dependent additions to local labor force, turnover in the project operational staff, and propensity to leave the area after job separation.

C.1.3 Employment Multiplier Derivation

The accuracy of the primary and secondary employment estimates is critical to the quality of the impact forecasts provided in this report. Primary employment is actual employment in construction and operation of the facilities. Estimates of primary employment requirements for each of the technical alternatives are shown in Table C.1.

Secondary employment is the labor force generated by a project but not directly employed on the project. Although secondary employment is often described simply as "household serving," or meeting the consumption needs of the primary project labor force, there

* See Kasarda[3] for evidence that suburban population growth produces growth in central city service functions.

TABLE C.1. Manpower Requirements (in man-years per year) for Construction and Operation of Selected Waste Management and Production Facilities and Reference Facility Components

Facility	Mean Annual Construction Employment(a)	Mean Annual Operation Employment(b)	Impact Forecasts: Table No.
FRP production facility	1630	1000	C.6-C.11
FRP waste management reference system			
HLLW vitrification	165	54	C.12-C.17
Fuel residue packaging without compaction	38	15	
Failed equipment packaging	55	13	
Incineration of general trash and combustible waste	35	52	
ILW and LLW cement immobilization	35	7	
Group III filter module FRP	29	4	
Dissolver off-gas treatment	75	22	
Vessel off-gas treatment	82	9	
Krypton storage (Phase I)	194	26	
Fuel residue storage	130	4	
Outdoor surface storage LLW	2	3	
Indoor subsurface ILW	65	6	
Water basin storage of SHLW	290	60	
Total	1195	275	
FRP combined system	2825	1275	C.18-C.23
MOX FFP production facility	571	300	C.24-C.29
MOX FFP waste management reference system			C.30-C.35
Failed equipment packaging	4	5	
TRU LLW incineration	14	7	
LLW cement immobilization	34	2	
Outdoor surface storage of LLW	2	2	
Total	54	16	
MOX FFP combined system	625	316	C.36-C.41
Independent spent fuel storage facility (ISFSF): once-through, prompt disposal			C.42-C.47
Vent off-gas treatment	17	5	
Spent fuel storage modified for packaging	800	150	
Spent fuel packaging	533	146	
Total	1350	301	
Extended fuel storage system (ISFSF, SFPF, and DSCF)			C.48-C.53
Vent off-gas treatment	17	5	
Spent fuel storage (ISFSF) modified for packaging	800	150	
Spent fuel packaging (SFPP colocated with ISFSP)	533	146	
Dry caisson storage (DCSF)	340	60	
Total	1690	361	
Retrievable waste storage facility (RWSF)			C.54-C.59
Sealed cask storage for SHLW	800	127	
Fuel residue subsurface storage	168	7	
ILW indoor subsurface storage	88	22	
LLW outdoor surface storage	4	8	
Total	1060	164	
Waste repository, salt formation: U and Pu Recycle	1570	1000	C.60-C.65
Waste repository, salt formation: once-through	1430	688	C.66-C.71
Waste repository, granite: U and Pu recycle	3140	1200	C.72-C.77
Waste repository, granite: once-through	4290	800	C.78-C.83
Waste repository, shale: U and Pu recycle	1860	1000	C.84-C.89

TABLE C.1. (Contd)

Facility	Mean Annual Construction Employment(a)	Mean Annual Operation Employment(b)	Impact Forecasts: Table No.
Waste repository, shale: once-through	2000	722	C.90-C.95
Waste repository, basalt: U and Pu recycle	3710	1170	C.96-C.101
Waste repository, basalt: once-through	5290	760	C.102-C.107

a. Construction manpower estimates were obtained from DOE/ET-0028 expressed as total man-years for the duration of construction. Mean annual construction employment was derived by dividing the total manpower estimates by the assumed duration of construction to yield average person years per year as follows:

- FRP - 4 years
- MOX-FFP - 3.5 years
- ISPSF - 3 years
- ISFSF, SFPF and DSCF - 10 years
- RWSR - 15 years
- Repository - 7 years.

Since the projection methodology utilized in this impact forecasting procedure is based on a 5-year construction period, variation in the actual duration of construction is difficult to handle. See Section C.1.5.3 for further discussion of this issue.

b. Operation manpower estimates were obtained from DOE/ET-0028. For the waste management facilities, these estimates included operators, radiation monitors, and maintenance and craftsmen. In order to take account of supervisory and other overhead and administrative personnel, a constant factor (1.87), derived from cases where complete data were provided by field personnel, was used to inflate the data obtained from DOE/ET-0028.

are at least two distinct economic processes linking primary to secondary employment. The first of these is indirect employment expansion, which occurs as plant construction creates demands for locally supplied materials. The second determinant of secondary employment expansion is the stimulus to output and employment resulting from spending and successive respending of the wages and salaries of primary employees.

To transform these primary employment estimates for construction and operation into secondary employment estimates, a technique for secondary employment estimation developed by Stenehjem and Metzger[4] at Argonne National Laboratory has been utilized.

This technique combines the simplicity of economic base analysis and some of the industrial disaggregation of input-output analysis.* Stenehjem and Metzger provide a set of region and industry group-specific** secondary employment multipliers for each of 21 regions in the contiguous United States. Each multiplier is estimated by a cross-sectional regression of employment data by county and represents the change in secondary employment that is expected to accompany an exogenous change in employment in the respective industry groups. The advantages of this technique are that it 1) is easily implemented, 2) distinguishes between major industry groups, 3) includes the experiences of counties with diverse industrial mixes and at different stages of development, and 4) accounts for regional differences affecting secondary employment generation.

The source of the secondary employment multipliers used in deriving population and employment impact projections differs according to the projection series in question. For the construction phase (1980 to 1985) for each facility alternative, the "expected impact" multiplier is the Stenehjem-Metzger regional multiplier for manufacturing and construction employment for the respective reference sites. The "maximum impact" multiplier for construction is the maximum of the regional manufacturing and construction employment multipliers reported by Stenehjem and Metzger; it is, therefore, the same magnitude for all three sites.

The industry group breakdown adopted by Stenehjem and Metzger in estimating their regression employment multipliers does not offer a viable category for plant operation. For

* Economic base analysis discerns two major components of employment and output in a region: basic or export industries, whose output is sold primarily outside the region and is therefore independent of local demand conditions, and nonbasic or "household-serving" industries, whose output is primarily locally sold and depends upon local demand conditions elaborated in Richardson[1] and Mertaugh.[2] Growth of total regional output and employment is characterized by economic base analysis as being narrowly linked to exogenous changes in demand for the output of export industries. According to this view, growth of export industries is the source of all regional output and employment growth, bringing into the region external funds which are then spent and respent for locally provided goods and services. A major deficiency of economic base analysis is its artificial distinction of only two categories of output and employment. Essentially, all basic industries in a region are assumed to be identical in their characteristics affecting secondary employment and output generation. But important differences among basic industries in a region may lead to sizable errors in secondary employment estimates derived from economic base analysis. Input-output analysis, in which production technologies for all the industries of a region are represented in an input-output matrix, fully accounts for such industry differences, but is unwieldy and expensive to implement.

**The industry group that represents construction in the model combines manufacturing and construction.

this reason, the simple economic base multiplier was used as the basis of the employment estimates for the operation stage of each of the facility and process alternatives. These multipliers, again, are taken from Stenehjem and Metzger,[4] and were calculated from county employment data. The expected impact multiplier in each case is the simple economic base multiplier for the site county, and the maximum impact multiplier is the maximum of the simple economic base multipliers for all the counties in the respective site states (see Table C.2 for a detailed presentation of these multipliers).

TABLE C.2. Employment Multipliers

Work Phase	Impact Condition	Reference Site Southwest	Midwest	Southeast
Construction	Expected[a]	1.7	0.6	0.2[b]
	Maximum[c]	1.7	1.7	1.7
Operations	Expected[d]	1.4	1.0	0.7
	Maximum[e]	4.2[f]	2.5	3.2

Source: E. J. Stenehjem and J. E. Metzger, A Framework for Projecting Employment and Population Changes Accompanying Energy Development, prepared for the Assistant Administrator for Planning Analysis and Evaluation, U.S. Energy Research and Development Administration, Argonne National Laboratory, Argonne, IL, August 1976.

a. Regional multipliers for manufacturing and construction.
b. The regional multiplier for the Southeast site region was zero; the lowest nonzero multiplier for a nearby region was substituted here.
c. The largest of all the estimated regional multipliers has been applied to each reference site to represent the maximum impact condition.
d. County-specific simple multiplier representing the reference site county.
e. Largest county multiplier for state containing reference site.
f. Largest county multiplier considered too large (>17) compared with other sites; therefore substituted next-largest county multiplier for site state.

C.1.4 Social Service Demands

Primary and secondary labor force and associated dependents who reside in proximity to the construction site will require the support of a wide range of social services. Interest in this study focuses on demands (expectations) for social services by the in-migrant population residing in the site county.

The mechanism by which in-migrant population size and age composition are translated into social service demand in the model is a set of social service ratio multipliers (Table C.3). These multipliers are expressed as a ratio of units of the service to units of a relevant population. The product of these ratios and the projected net in-migrant project population will provide a measure of new demand for selected services over time.

There are several assumptions and important limitations related to this procedure. Although it is clear from casual observation that large populations have larger, more complex social service infrastructures than small populations, it is not necessarily clear how

TABLE C.3. Social Service Impact Demand Ratios by Site

Social Service	Southwest Site	Midwest Site	Southeast Site
Health			
Physicians/1000[a]	1	1.3	0.9
Nurses/1000[b]	2.6	5	2.9
Dentists/1000[c]	0.3	0.6	0.3
Hospital beds/1000[d]	3.3	5.9	3.7
Nursing care beds/1000 aged 65+[e]	40.8	105.1	38.3
Education			
Teachers/100 students: K-8[f]	4.3	4.3	4.3
Teachers/100 students: 9-12[f]	5.3	5.3	5.3
Classroom space: sq. ft./100 students 9-12[g]	15,000	15,000	15,000
Sanitation			
Water treatment: gal/person/day[g]	150	150	150
Solid waste: collection vehicles/1000[g]	0.1	0.1	0.1
Solid waste: garbage men/1000[g]	0.3	0.3	0.3
Liquid waste: gal/person/day[g]	100	100	100
Fire and Police			
Firemen/1000[g]	0.7	0.7	0.7
Policemen/1000[g]	2	2	2
Recreation			
Playgrounds: acres/1000[g]	1	1	1
Neighborhood parks: acres/1000[g]	0.8	0.8	0.8
Community parks: acres/1000[g]	1.2	1.2	1.2
Social Problems			
Crime index: crimes/1000[h]	58.4	43	46.4
Government			
Administrative staff/10,000[g]	9	9	9

a. Active nonfederal physicians providing patient care in state containing site. AMA Center for Health Services Research and Development, Distribution of Physicians in the U.S., 1973, Table 9, G. A. Roback, ed., American Medical Association, Chicago, IL, 1974. As cited in the U.S. Department of Health, Education, and Welfare, Health: United States 1975, DHEW Publication No. (HRA)76-1232, Public Health Service, Health Resources Administration, National Center for Health Statistics, Rockville, MD, 1976 (hereinafter referred to as HRA 76-1232), Table B.I.12.

b. Registered nurses employed in nursing in state containing site. American Nurses Association, Statistics Department, 1972 Inventory of Registered Nurses, Kansas City, 1974. As cited in HRA 76-1232, Table B.I.19.

c. Active nonfederal dentists in state containing site. U.S. Department of Health, Education, and Welfare, Division of Dentistry, Bureau of Health Manpower, Health Resources Administration. As cited in HRA 76-1232, Table B.I.15.

d. Nonfederal and nonprofit hospital beds in state containing site, 1973. U.S. Department of Health, Education, and Welfare, National Center for Health Statistics, Hospitals: A County and Metropolitan Area Data Book, 1973, Rockville, MD, 1976.

e. Beds in nursing care homes, personal care homes with or without nursing, and domiciliary care homes in state containing site, 1973. National Center for Health Statistics, unpublished data from the Master Facility Census. As cited in HRA 76-1232, Table B.II.6.

f. National teacher/student ratios. U.S. Bureau of the Census, Statistical Abstract of the United States: 1975 (96th edition, Table 211: Public Elementary and Secondary Teachers, 1974), Washington, DC, 1975.

g. E. J. Stenehjem and J. E. Metzger, A Framework for Projecting Employment and Population Changes Accompanying Energy Development, Phase II, report prepared for the Assistant Administrator for Planning and Analysis and Evaluation, U.S. Energy Research and Development Administration, Argonne National Laboratory, Argonne, IL, October 1976.

h. Number of "index crimes," referring to seven major offenses known by the police, in state containing site. U.S. Department of Justice, Federal Bureau of Investigation, Crime in the United States: 1975, Uniform Crime Reports, Washington, DC, 1976.

population fluctuations over time are translated through political and fiscal mechanisms into changes in the quantity or quality of services provided. As a case in point, a careful study of the impacts of the construction of a large steel facility in a rural community concluded that even a 10% increase in the local population resulted in no significant difference in public expenditures for most social services compared with similar neighboring communities experiencing less than 2% growth in population.[5] It will not only be assumed that population is directly related to service demand by way of the ratio multiplier, but also that this relationship is described by a continuous function that ignores both economies of scale and the discrete nature of services. Stenehjem and Metzger[6] focus on population size as one of the more important of 11 primary variables determining social service provision, but they emphasize the importance of unique local conditions in influencing this relationship between changes in population and changes in service levels.

The selection of an appropriate ratio multiplier is problematic, especially in a generic study. The actual demand for services involves a balancing of local expectations with potentially higher expectations on the part of the in-migrants. It is difficult to estimate either local standards or standards existing in the migrants' communities of origin that could be said to properly represent their respective demand. In this study, the county is taken as the unit of analysis, and standards for communities within these counties may vary considerably from the county average. State standards will be utilized where available and either national or other empirically estimated standards where state data are lacking. In-migrants will probably expect a higher level of services than is likely to be provided in the relatively rural reference sites, since most of these construction and operation workers will be coming from nearby urban areas where more adequate services are available. The state's level of service provision thus becomes the best estimate of the in-migrants' service demands. The use of a ratio multiplier also assumes that added incremental service demands are distributed uniformly throughout the area--clearly a simplification of reality. Finally, these multipliers will be applied to in-migrant populations only, and will not reflect the unique demands for service support exerted on the site county by the facility itself.

Service demands take the form of new capital and operational requirements. The former refers to the need to expand a system's capacity by adding buildings and equipment. The latter refers to the addition of personnel within an existing capital structure. Personnel needs can be satisfied more readily than capital needs as, for example, teachers versus schools, or doctors versus hospitals. The use of ratio multipliers in a generic study ignores the extent to which a system is operating at or near capacity. A system forced to expand capacity will suffer larger impacts than one that can absorb new demand with existing excess capacity. The multiplication of these ratios and net new in-migration can only estimate the size of new demand, not how that demand will be met by the system. Projected impacts are, then, only potential, or implied, impacts.

C.1.5 Limitations to Approach

The approach adopted is limited both by the nature of the task and by the methodology employed. Some of these limitations are discussed in some detail elsewhere in this appendix; therefore, the more important issues in this regard are briefly presented here.

C.1.5.1 Focus of the Study

This is a generic study of socioeconomic impacts. In this context it is not possible to use information on service system capacity to absorb additional impacts; to analyze local tax structures and specific fiscal impacts; or to anticipate mitigating strategies that might be adopted in response to impending impacts. The objective of this study is to forecast the demographic structure from which impacts are derived and to estimate demand for services. The accuracy of impact forecasts will depend upon the model's specifications and on the validity of the assumptions incorporated in the model. The assumptions are judgmental and are presented in Table C.4. (See Pittenger[7] for a discussion of standards by which to evaluate forecasts of this type.)

C.1.5.2 Sensitivity Testing

The model used in this analysis has not been subjected to extensive sensitivity testing. Therefore, it is not possible at this time to specify precisely how parameters of the model (for example, fertility rate, secondary employment multipliers, distance elasticity in the gravity model) affect the forecasted level of output--namely, the size of the in-migrant population at a future time. In any case, multivariate models are complex and subject to interaction effects, such that the specification of precise relationships between parameters and output values may not be possible. While it would be convenient to say that a doubling of employment demand on the project would result in a doubling of impacts, it is not clear--in the absence of sensitivity testing--that the relationship between input variables and forecasted impacts is linear.

C.1.5.3 Projection Methodology

The projection methodology is based on a 5-year projection cycle, as opposed to a 1-year cycle, due to greater ease in data handling and implementation of the model. There are, however, several inherent drawbacks associated with this approach.

First, the construction phase of the project is constrained in this model to the first 5-year period (1980 to 1984). Construction, however, may be completed in less than 5 years. In addition, for certain storage facilities, the construction of facility components depends upon the volume and rate of flow of wastes to be managed. This means that construction activities may be spread out over a long period while those facilities first constructed are in the maintenance or operation phase. These difficulties are dealt with by estimating the mean person-years per year required for construction and by assuming that all construction is completed during the 1980 to 1984 period. In the few instances when construction is planned to take place after 1985, the construction employment in the later period is absorbed into the operation employment estimate for purposes of impact forecasting.

TABLE C.4. *Selected Assumptions Incorporated in Impact Projection Model by Site, Impact Condition, and Data Source*

Model Component	Data Source	Baseline	Expected Impact	Maximum Impact	Comments
Fertility rate	a,b	State rate	Same	Same	Fertility rate converges to replacement by 1990.
Mortality rate	c	State rate	Same	Same	Constant rate throughout.
Net migration rate	d,e	County rate	Same	Same	Converges to zero by 1990.
Sex ratio at birth	b	State ratio	Same	Same	
Labor force participation rate	f		National rate	Same	Total labor force as a percentage of noninstitutionalized population aged 16+. Assume constant overtime.
Unemployment rate	g		State rate	Same	Assume 1975 rate. Converges to 1970 rate by 1990.
Total construction employment	a		Regional level	Same	1970 county levels aggregated.
Proportion of labor force in construction	h		Regional level	Same	1970 county levels aggregated.
Ratio of regional construction unemployment to national unemployment	a	2.04	2.04		
Housing vacancy rate	i		County rate	Same	Input to gravity model.
Proportion of housing dilapidated	i		County rate	Same	Input to gravity model.
Distance from county to site	j		Miles	Same	Site assumed to be in geographic center of county.
Proportion of females in labor force	k		0.45	0.45	Assumed constant over time, though it is rising slowly.
Proportion of wives of male employees employed in secondary activities	k		0.45	0.45	Assumed to be the same as proportion of females in labor force.
Age-specific proportion of women married, spouse present, of all married	l		National	Same	Intercounty movers 1975-76.

TABLE C.4 (Continued)

Model Component	Data Source	Baseline	Expected Impact	Maximum Impact	Comments
Nonspouse dependents of male by age	l		National	Same	Intercounty movers 1975-76.
Age/sex distribution of dependents	l		National	Same	Intercounty movers 1975-76.
Age distribution of never-married females in civilian labor force	l		National	Same	Intercounty movers 1975-76.
Age distribution of male employees:					
· Primary construction	m		Western region	Same	Based on responses of workers on selected coal projects.
· Secondary construction	m		Western region	Same	
· Primary operation	l		National	Same	Intercounty movers 1975-76.
· Secondary operation	l		National	Same	Intercounty movers 1975-76.
Age-specific male employment turnover rate	k		Same	Same	20% age 15-19 to 10% age 60-64, then 100% age 65-69 over 5-year period.
Proportion of unemployed construction labor force who work on project	k		0.20	0.05	Empirical data bearing on this item (and the next five items) are either scarce or nonexistent. Estimates are conjectural and may be easily altered by the user.
Proportion of construction employment displaced (of project employment)	k		0.20	0.05	
Proportion of construction employment displaced (of regional labor force)	k		0.40	0.10	
Proportion of displaced construction employment replaced by migrants	k		0.50	0.85	
Proportion of construction employment constituting excess migration	k		0.10	0.20	
Proportion of region's unemployed available for secondary employment	k		0.10	0.05	

TABLE C.4 (Continued)

Model Component	Data Source	Baseline	Expected Impact	Maximum Impact	Comments
Distance exponent in gravity model:					
• Primary construction	m		0.85	1.60	
• Secondary construction	n		1.50	2.60	
• Primary operation	k		1.00	2.00	Exponent for each category of operation worker is assumed to be larger than for construction.
• Secondary operation	k		2.50	3.00	
Household dependency multiplier:					
• Primary construction	m		2.28	2.28	
• Secondary construction	l		3.47	3.47	Intercounty movers 1975-76.
Proportion of migrant construction employees who stay after 1985:					
Primary construction					
• Southwest site			0.10	0.10	Proportion staying is a function of estimated net migration in 1985, and Mountain West Research findings on workers who planned to stay.
• Midwest site			0.71	0.71	
• Southeast site			0.32	0.32	
Secondary construction					
• Southwest site			0.32	0.32	
• Midwest site			0.81	0.81	
• Southeast site			0.50	0.50	
Proportion of migrant operation employees who stay after turnover			0.34	0.34	Assumed zero net migration by 1990 for all sites.
Proportion of operation dependents who independently leave site at age 20	k		0.50	0.50	
Employment multipliers	o		See Table C.2		

a. U.S. Bureau of the Census, Census of Population: 1970, Vol. 1, Characteristics of the Population (state volumes), U.S. Government Printing Office, Washington, DC, 1973.
b. U.S. Department of Health, Education, and Welfare, National Center for Health Statistics, Vital Statistics of the United States, Vol. 1, Natality, Table 1-54, Rockville, MD, 1970.
c. U.S. Department of Health, Education, and Welfare, National Center for Health Statistics, U.S. Decennial Life Tables for 1969-71: State Life Tables, Rockville, MD, June 1975.
d. U.S. Bureau of the Census, Current Population Reports, Population Estimates and Projections, Series P-25, U.S. Government Printing Office, Washington, DC, 1976-1977.

TABLE C.4 (Continued)

e. U.S. Department of Agriculture, Net Migration of the Population, 1960-70, by Age, Sex, and Color, University of Georgia Printing Department, Athens, GA, December 1975.

f. U.S. Bureau of Labor Statistics, Employment and Earnings, Vol. 24, No. 1, U.S. Government Printing Office, Washington, DC, January 1977.

g. U.S. Bureau of Labor Statistics, PWEDA Area Employment and Unemployment, 1975 (Annual), U.S. Government Printing Office, Washington, DC, November 1976.

h. U.S. Bureau of the Census, Census of Population: 1970, Vol. 1, Characteristics of the Population, Tables 87 and 123, U.S. Government Printing Office, Washington, DC, 1973.

i. U.S. Bureau of the Census, Census of Housing: 1970, Housing Characteristics for States, Cities, and Counties (state volumes), U.S. Government Printing Office, Washington, DC, 1972.

j. Straight-line miles from county center to site.

k. Estimated by authors.

l. U.S. Bureau of the Census, Current Population Reports, Population Characteristics, Series P-20, No. 305, "Geographical Mobility: March 1975 to March 1976," U.S. Government Printing Office, Washington, DC, 1977.

m. Mountain West Research, Inc., Construction Worker Profile, Final Report, a study for the Old West Regional Commission, Denver, CO, December 1975.

n. F. L. Leistritz and S. H. Murdock, Research Methodology Applicable to Community Adjustments to Public Land Use Alternatives, discussion paper for presentation at the Forum on the Economics of Public Land Use in the West, Reno, NV, March 10-11, 1977, North Dakota State University, Fargo, ND, 1977.

o. E. J. Stenehjem and J. E. Metzger, A Framework for Projecting Employment and Population Changes Accompanying Energy Development, prepared for the Assistant Administrator for Planning Analysis and Evaluation, U.S. Energy Research and Development Administration, Argonne National Laboratory, Argonne, IL, August 1976.

The second problem here is that construction employment is differentially phased over the construction period such that a marked peak occurs about two-thirds of the way into project construction. The use of the mean person-years per year during the first 5-year projection cycle essentially ignores the peaking of employment. However, it is reasonable to assume that workers who come onto the job during peak periods of construction tend to be specialists who are transient with respect to their employment histories. They have a particularly low probability of residing in the site county and are most likely to commute to work. If these assumptions are correct, then mean employment is a good, unbiased estimator of construction employment.

C.1.5.4 Level of Analysis

The last limitation to be discussed reflects the level of analysis chosen for this generic study. Based on the relative availability of secondary data, the county has been adopted as the unit of analysis. Impacts are felt and managed at different levels, all the way from the nation to the household. But most of the important socioeconomic impacts likely to be generated by the construction and operation of waste management facilities will be exerted at or below the county level. Once demographic effects and service demands have been forecast at the county level, individual communities or school districts, for example, can readily assess the likelihood of localized effects and develop mitigating strategies accordingly. In the context of a county-level analysis, it is also apparent that the total effects attributable to a project are not being addressed. Some portion of the total project-induced impacts will accrue to other counties and communities within the impact region (and perhaps outside the region also). While the methodology adopted here could, with minor alteration, address total regional impacts, attention is limited to impacts on the county containing the site.

C.2 REFERENCE ENVIRONMENTS

A generic assessment of socioeconomic impacts incorporates the assumption that a variety of sites may be under consideration for development of nuclear waste management facilities. Since the potential sites may differ considerably in terms of their distinguishing characteristics--especially population size, composition, distribution, industrial composition of the labor force, and availability of social services--it is necessary to examine the potential effects of energy facilities on a number of alternative sites. For example, it is reasonable to assume that a highly urbanized community offering a wide range of services to residents will experience fewer negative effects from the construction and operation of a project than will a sparsely populated rural community. In the latter, even a relatively small project could produce disruptive effects.

In addition to considering alternative reference sites, it is also necessary to assess the effects of several types of nuclear waste management facilities. These facilities differ substantially in terms of the number of workers needed for construction and operation, the potential hazards created through storage and transportation of noxious materials, and the amount of land occupied. It is thus reasonable to expect that socioeconomic impacts will differ in type and degree according to the facility in question.

C.2.1 Criteria for Reference Site Selection

Three reference sites were chosen from a larger number of possible locations for nuclear waste facilities on the basis of several criteria.

- Geologic conditions: One reference site offers sufficient salt deposits to be used as a waste disposal facility. Another is underlaid by granite.
- Population size: The three sites vary markedly in terms of the total number of inhabitants at the site and in the surrounding region.
- Population distribution: The three sites exhibit variations in population density and degree of urbanization.

Although it was not feasible to consider a sufficient number of alternative sites to exhaust all possible combinations of the above criteria, the three sites selected for analysis permit an assessment of a wide range of variation in impacts to be expected.

C.2.2 Characteristics of Reference Sites

In order to emphasize that the reference sites are hypothetical, they are labeled Midwest, Southeast, and Southwest. Each reference site consists of a single county. The region within which the county is located is defined as the aggregation of all counties falling substantially within a 50-mile radius of the site. If more than half of a county is included within that 50-mile radius, it is included in the region.

Regional populations are important for assessing site impacts because a sizable portion of the project employees may commute to work from regional localities. Fifty miles represents the maximum commuting distance that most workers are willing to undertake. Furthermore, population redistribution within the region may result in project-related impacts.

Summary data for the site counties and surrounding regions are presented in Table C.5. Two types of comparisons can help in interpreting these data. First, there are marked differences among the sites, whether based on county or regional comparisons. Second, there are important differences between the county and region for each site. From the population data it is evident that the Southwest and Midwest regions are highly urbanized when compared with the Southeast region. Differences among the three counties are even greater. While the Midwest site falls within the most urbanized region, the county containing that site has the smallest urban component. In fact, each site county is less urbanized than its corresponding region, reflecting the likelihood that disposal sites will be situated away from urban centers and densely settled areas. The density figures also support this observation.

The sites vary dramatically in terms of population change over the 1965 to 1970 period, with the Southwest site showing a marked decline, the Midwest site showing a comparable increase, and the Southeast site remaining relatively stable. From 1970 to 1975 all sites gained population, and the differences among the rates of change are smaller than in the preceding 5-year period. These changes over the decade can be attributed to two components: natural change and net migration. Natural change is the difference between births and deaths. Net migration is the difference between the number of persons moving into an area

TABLE C.5. Selected Data Characteristics of Three Reference Sites

Characteristic	Southwest Site County	Southwest Site Region	Midwest Site County	Midwest Site Region	Southeast Site County	Southeast Site Region
Population:						
Estimated total population 1975[a]	41,000	134,000	47,000	2,154,000	17,000	487,000
% Change 1965-1970	- 8.5	- 8.6	15.0	11.1	-1.4	4.2
% Change 1970-1975	3.2	5.8	24.9	3.8	11.9	2.6
Unemployed construction labor force, 1980[b]	...	390.0	...	10,660.0	...	2,420.0
Net migration rate 1965-1970[c]	-14.9	-14.6	7.4	3.0	-6.6	-2.4
Net migration rate 1970-1975[c]	- 0.9	0.5	18.4	-0.7	6.1	-2.2
% Urban 1970[d]	76.9	78.9	8.4	85.1	40.9	50.1
Density 1970 (persons per sq. mi.)[d]	9.9	9.2	57.8	246.8	31.1	60.1
% Nonwhite 1970[d]	2.9	5.0	0.3	2.4	41.3	38.3
% Families with children under 18, 1970[d]	56.8	59.3	59.4	59.7	57.6	57.6
Median age 1970[d]	27.2	26.3[e]	25.6	25.6[e]	24.9	24.5[e]
Employment:						
Nonworker to worker ratio[d]	1.7	1.7	1.6	1.3	1.4	1.5
% Employed in farming[d]	5.7	5.8	13.6	2.2	8.5	4.9
% Employed in construction[d]	7.7	5.6	6.0	3.7	5.2	5.8
% Unemployed[d]	5.1	5.1	4.5	3.3	4.6	4.3
% Below poverty level[d]	17.8	16.6	10.8	5.5	24.6	22.3
Median family income[d]	7,870	7,965[e]	8,936	11,242[e]	6,997	7,166[e]
Education:						
Median years school completed[d]	11.9	12.0[e]	12.2	12.3[e]	9.8	10.6[e]
% High school graduates[d]	49.3	51.3	56.0	64.5	29.8	37.0
Housing:						
% Housing units renter occupied[f]	25.9	25.7	15.8	31.5	33.4	33.2
% Units vacant[f]	16.1	18.2	6.4	3.4	9.4	8.3
Trailers as % of housing units[f]	2.5	3.3	6.5	1.8	7.2	5.8
% Units lacking plumbing[f]	5.0	3.6	8.7	4.0	29.3	19.7
% Units built 1939 or earlier[f]	19.2	17.6	53.3	41.1	36.8	30.6
% Units with 1+ persons per room[f]	11.7	11.6	9.5	6.9	15.1	13.1
% Units using public sewer service[f]	77.8	82.1	39.3	82.7	45.8	46.3

a. U.S. Bureau of the Census, Current Population Reports, Population Estimates and Projections, Series P-25, U.S. Government Printing Office, Washington, DC, 1976-1977.
b. Estimated in population impact projection model.
c. U.S. Department of Agriculture, Net Migration of the Population, 1960-70, by Age, Sex, and Color, University of Georgia Printing Department, Athens, GA, December 1975.
d. U.S. Bureau of the Census, Census of Population: 1970, Vol. 1, Characteristics of the Population, U.S. Government Printing Office, Washington, DC, 1973.
e. Weighted estimates.
f. U.S. Bureau of the Census, Census of Housing: 1970, General Housing Characteristics, Final Report, U.S. Government Printing Office, Washington, DC, 1971.

and the number moving out. Each site has experienced an excess of births over deaths, thus serving to moderate the population loss due to emigration from the Southwest and Southeast sites over this period while increasing the growth experienced by the Midwest site. Population change has important consequences with respect to the capacity of a site to absorb impacts. Counties which are experiencing rapid population growth may be more likely to plan to accommodate excess demand on local services than would counties that are not growing. On the other hand, counties which are losing population may have underutilized service sectors, which would then be available to serve the needs of project-related in-migrants.

While the Southwest county has a high urban component compared with the Midwest county, it is only one-fifth as densely populated. In the Southwest region most people live in towns just large enough to qualify as urban by the U.S. Census Bureau (2500 or more). The nearest metropolitan center (population 50,000 or more) is over 100 miles from any part of the Southwest region. The Midwest region, however, contains a very large metropolitan center, though the site itself is primarily rural.

Looking briefly at the data related to employment, it is apparent that the Midwest site residents enjoy the highest standard of living. This is true for both the county and the region and is reflected by relatively high family income, low percentage of unemployed, and low percentage below the poverty level (defined for 1975 by the U.S. Census Bureau as $5500 for a nonfarm family of four). In contrast, almost one-fourth of the Southeast site residents are below the poverty level, and the median income for the Southeast region is less than two-thirds that for the Midwest region. Similar regional differences are reflected in the data presented on education. The Southeast site residents are substantially less educated than residents from the other two sites--a condition to be expected from the more rural character of the Southeast site.

Housing variables are critical because they reflect the ability of a community to adequately accommodate a substantial population influx. Vacancy rates and housing conditions determine the ease with which the incoming workers and their families can find adequate, affordable living space. In this regard, the Southwest site is apparently best situated to accommodate a population influx. It has a higher vacancy rate and its housing units are both newer and in better condition than are those at the other two sites. In addition, a very high proportion of the Southwest site housing facilities is connected to a public sewer service.

The three reference sites selected are each distinct in terms of demographic, economic, and social service characteristics. If the waste management facilities to be considered are to result in significant socioeconomic impacts, this should be evident at one or more of these sites.

C.3 WASTE MANAGEMENT REFERENCE SYSTEMS

The model used in this generic study postulates that social and economic impacts are caused by the settlement of new migrants in the site county. Therefore, projection of the in-migrating, project-related population is based on a determination of the construction and operation manpower requirements specific to the waste management system to be built and operated. A fuel reprocessing plant, for example, can be configured in a variety of ways, depending upon the size and types of facilities which will manage waste by-products. The major systems and their alternative configurations to be analyzed include the fuel reprocessing plant (FRP), the mixed-oxide fuel fabrication plant (MOX FFP), the independent spent fuel storage facility (ISFSF), the extended spent fuel storage system (ESFSF), the retrievable waste storage facility (RWSF), and waste repositories in three geologic media for two fuel cycles.

In the case of two systems, the FRP and the MOX FFP, waste management represents only a part of the total facility. The manpower required to construct and operate the production components of these two systems will be analyzed separately. It will then be possible to integrate this projection with the respective waste management reference alternative to determine the impact of waste management both alone and relative to the total impact attributable to the whole facility.

Each of the major systems is assumed to have a construction period lasting a maximum of 5 years (1980 to 1984) and an operational life expectancy prior to decommissioning ranging from 25 years for the waste repository to 35 years for the ISFSFs. The manpower requirements associated with decommissioning are typically smaller than those for operation; given uncertainty in the timing, nature, and duration of the decommissioning phase, their requirements are not treated specifically in this study.

Table C.1 depicts the size of the construction and operation employment for each reference waste management system and its component facilities. This table indicates how colocated facilities are aggregated to produce the employment inputs to the impact forecasting model. The employment estimates for 15 different waste management systems will be examined over each of the three reference sites, producing 45 separate forecasts of impacts (Tables C.6 through C.107).

C.4 THE FORECASTING MODEL

The demographic forecasting model uses a cohort-component projection methodology. This technique precisely forecasts the size and structure (age and sex) of the population. Such precision is a critical aspect of the model, since impacts are viewed as being responsive to changes in both of these demographic variables. The initial projected population serves both as a comparative baseline and as a source for a portion of the future project labor force. Employment demand associated with the project is met in part from the baseline population and in part from new in-migrants. The following description deals first with the construction phase of the project (1980 to 1984) and then with the operation phase (from 1985). A brief discussion of output from the model concludes this section.

Figure C.1 illustrates the principal components of the demographic forecasting model, and shows the interrelationships of demographic and economic characteristics of both the impact region and the site county. The determination of employment-generated in-migration and the projection of baseline and project populations over time, as outlined in Figure C.1, are discussed in the following sections.

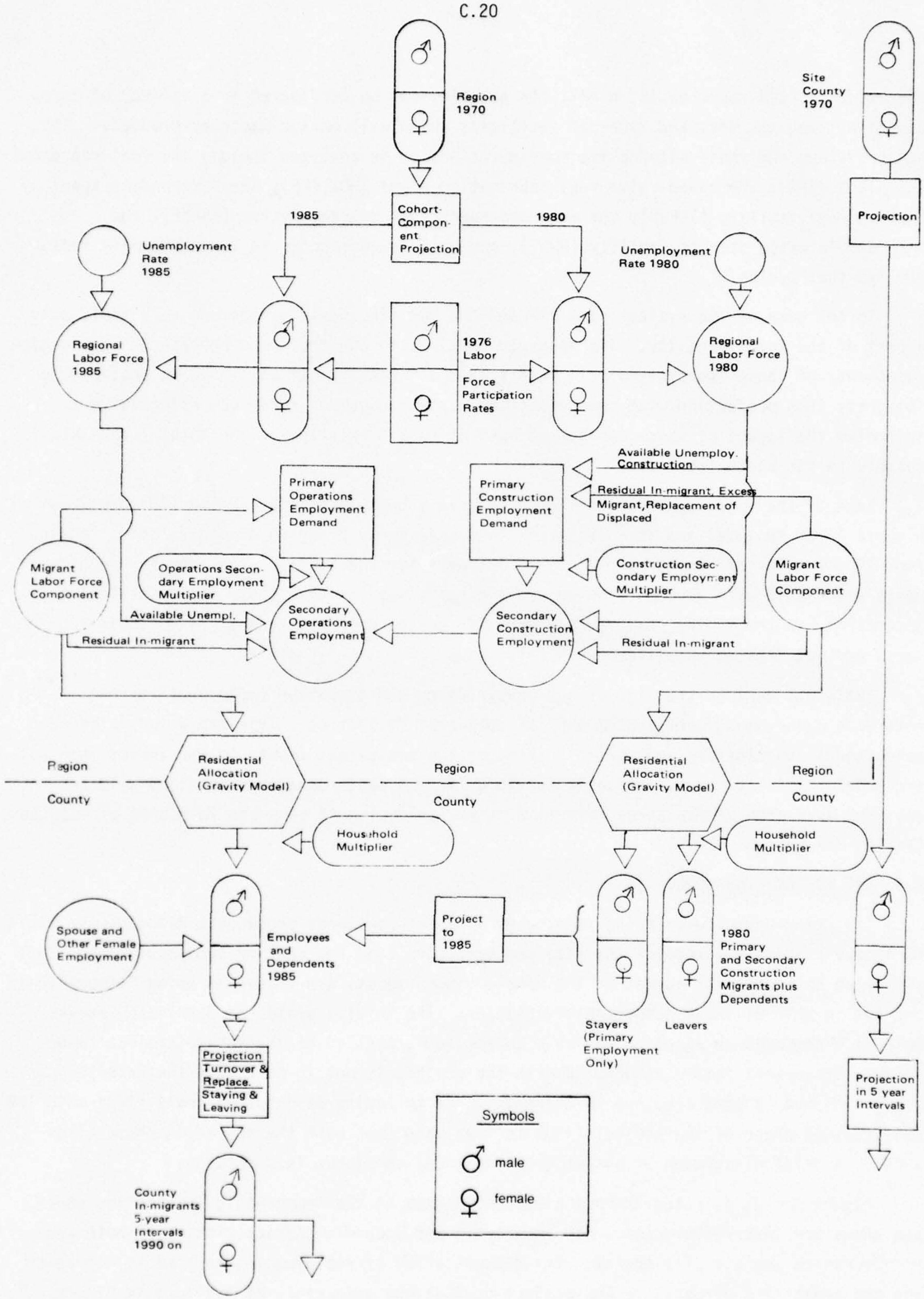

FIGURE C.1. Demographic Forecasting Model

C.4.1 Construction Phase

The model first determines the size of the regional population in 1980, which is the startup date for construction. These figures are projected from 1970 census data through the use of independent assumptions about the future course of the three components of population change: fertility, mortality, and net migration. Specifically, fertility is assumed to converge from the observed 1970 state rate to a replacement or zero-population-growth level in 1990; mortality is assumed to remain constant at the state level in 1970; and net migration is assumed to converge to zero in 1990.

The selection of a schedule of migration rates for the initial period, 1980 to 1984, is subject to substantially more error than is the case for rates of fertility and mortality. The selection of assumptions regarding future trends in net migration is even more difficult. Part of the difficulty is that net migration, being responsive to economic opportunities outside of the project under investigation, subsumes all future opportunity in the region, including other construction activity.

Migration rates for counties by age and sex are available for the period 1960 to 1970.(8) More recent rates are available from the U.S. Census for counties,(9) but these data do not provide sufficient detail on age and sex to construct a fully disaggregated model. The problem is further complicated by the fact that migration patterns at the county level have departed significantly from historical trends.(10)

A comparison of aggregate, county-level net migration rates across the two time periods illustrates the pronounced trend toward rural net in-migration. Table C.5 presents these rates as 5-year rates, assuming that net migration changed in a linear fashion between 1960 and 1970. To attribute an age/sex structure to the new rate pattern, the site county migration rate for 1970 to 1975 was matched with that of another county (or set of counties) that had the same rate in the 1960 to 1970 period. In addition, counties chosen were of the same relative rural/urban character in 1960 to 1970 as the site county was in the 1970 to 1975 period.

The age/sex composition of net migrants for the matching county (county group) was then adopted as the appropriate age/sex composition for the site county. Although the overall rate of net migration is allowed to change over time (convergence to zero by 1990 is the best guess in the absence of more information), the age/sex structure of the changing rates remains the same. That is, each age/sex specific rate changes by proportionately the same amount until all reach zero by 1990.

The size of the regional labor force is determined according to the labor force participation schedule observed throughout the United States in 1976. It is assumed that the project construction labor force will be filled sequentially as follows. The first source of labor for the project is unemployed construction workers in the region. The number of workers available from this source is estimated by multiplying the proportion of the region's 1970 labor force that was in construction by the total regional labor force. The number of unemployed is projected as the product of construction labor force and the regional unemployment rate in 1975, inflated by the ratio of national unemployment in construction to national unemployment in all industries. Finally, an estimate of the proportion of unemployed construction workers available to work on the project is applied. The result indicates the component of the construction labor force that is made up of unemployed local construction workers. Reduction of local unemployment is usually interpreted as a positive impact.

If this component does not satisfy the project employment demand, the next source taken into account is the construction workers in the region who will leave other jobs to work on the project. It is necessary to estimate the proportion of these "displaced" workers who will be replaced by migrants, since it is only the migrant component that produces the impacts of concern.

If demand for the construction labor force is still unmet, then it is assumed that migrants from outside the region will fill the remaining jobs. In addition, an assumption is made regarding project-induced "excess migration"--migrants who come to the region seeking employment on the project but are unsuccessful in obtaining such jobs. The total primary construction employment migration is thus composed of new migrants who work on the project, migrant replacements for local workers who are displaced from other jobs, and excess migrants to the site county who are unable to find work on the project.

The second important migration component includes migrants responding to secondary employment opportunities arising from project construction. Secondary employment expansion is computed by applying a multiplier to project construction employment. The migratory component of the secondary labor force is also computed in a residual fashion. A fixed proportion of the region's unemployed labor force, less those who will be employed in the primary construction labor force, is assumed to be available for secondary employment. Residual demand is assumed to be met by migrants. It is also assumed that a portion of these migrants will be spouses of primary construction workers.

The model next allocates the primary and secondary migrant labor forces to the site county using a residential allocation model* that incorporates housing vacancy rates and

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* The residential allocation model ("gravity" model) as applied in this study assumes that in-migrants will choose their residence in direct proportion to the population size of the county of residence and inversely proportional to the distance between the project site and the county of residence. The population size of county i is weighted by the proportion and condition of vacant housing units in the county. The form of the model is:

$$M_i = \frac{\left[\frac{P_i}{D_i^{\alpha}}\right] V_i Q_i}{\sum_i \left[\frac{P_i}{D_i^{\alpha}}\right] V_i Q_i}$$

where: M_i = proportion of in-migrants residing in county i

P_i = population size of county i

D_i = distance from site to center of county i

α = distance exponent (see Table C.4)

V_i = housing vacancy rate in county i

Q_i = proportion of housing in good condition housing quality in communities in the site county as indicators of the residential attractiveness of the site county. This model also incorporates the assumption that secondary workers will locate closer to the site than will primary workers. Estimates of the number of dependents who will accompany primary and secondary workers are based, respectively, on construction worker studies[11] and U.S. national data.[9] To expand these numbers into age distributions of workers and dependents, age and sex schedules. which are derived from the same sources as the dependency multipliers and which indicate how many males and females are in each five-year age group from ages 0 to 4 through 85 and over, are then applied to the primary and secondary construction migrants.

The result is an age/sex profile of the migrant construction employment for 1980. These workers are assumed to remain on the job until 1985, at which time it is assumed that a portion enters secondary employment with the operation phase of the project, and a portion settles in the region without further involvement in the project. The proportion of primary construction workers remaining in the site county after 1985 is assumed to be a function of the level of net migration experienced in the county, a summary indicator of employment opportunities in the area, and the expressed preference of workers to remain in the area as reported in a recent survey.[11] Out-migrating construction workers are assumed to be accompanied by their dependents. The proportion of secondary construction workers that remains in the site county depends on the demand for secondary operation employment as discussed below.

C.4.2 Operation Phase

In 1985, the operation labor force is assumed to replace the construction labor force. Because of the specialized skill requirements for primary operation work, it is assumed that all of these workers migrate from outside of the region. In addition, it is assumed that all primary operation workers are males. Application of a modified gravity model (described above) determines how many workers are allocated to the site county. These workers are assumed to be accompanied by their spouses and other dependents and to reside in the site county at the outset of the operation phase in 1985.

The operation phase is expected to last from 25 to 35 years, depending on the type of facility. This relatively long period necessitates the consideration of social, economic, and demographic forces which will alter the composition of the operation employees over time. Specifically, the projection of the migrant labor force over the operation phase incorporates job turnover (from separation and retirement) and replacement in addition to the standard projection components of fertility, mortality, and migration. Additionally, the projection is complicated by the fact that workers leaving the project will also be likely to leave the site county. That is, some of those who no longer work on the project will settle in the area and some will leave.

In order to take turnover and replacement into account properly in the projection model, it is necessary to treat three components of the labor force separately. These include the primary workers, their spouses, and their other dependents. Turnover and replacement must be incorporated into the model for two reasons. First, it is untenable to assume that all employees will stay on the job for 25 to 35 years, disregarding retirement and separation other than through death (which is taken into account through the mortality schedule used in this projection). Second, replacement of deceased, separated, and retired employees will have a significant impact on the age distribution of project workers over time. The reasons for treating these components of turnover separately are: 1) only employees of the project are subject to separation and retirement, 2) spouses are linked to the employees by an age-specific set of multipliers, and 3) other dependents of these employees are directly affected by primary labor force changes until age 20, at which time a portion of them is assumed to leave the county. (Other dependents aged 25 and above operate independently of primary employment, subject only to the prevailing forces of fertility, mortality, and migration that apply to the baseline population during this period.)

All primary operation employees are assumed to be male. The gravity model that determines the size of the site county migrant male employment produces only the total size of this component. In order to treat this population in the projection model, it is necessary to determine both its age distribution and the number and age/sex distribution of all associated dependents. The age distribution for the primary operation employment males was derived from the distribution of civilian labor force males who lived in a different house in a different county in March 1976 as compared with their residence in March 1975.(9) A smoothed age distribution in 5-year intervals from 15 to 65 years old was derived by fitting a curve to the cumulative age distribution as determined from the U.S. Census report,(9) which reported only five age groups in the labor force years.

The number of spouses accompanying this labor force is determined by multiplying age-specific multipliers times the male age distribution. These multipliers indicate the proportion of the male civilian labor force classified as intercounty movers who had a spouse present in their new residence by age of the male mover. The spouses obtained in this fashion assume the same age distribution as their husbands. This process assumes that both husbands and their wives are in the same 5-year age interval.*

The U.S. Census provides information pertaining to the number of persons per male family head by age of the male head who was classified as an intercounty mover. Although these data are not specific to members of the civilian labor force, it is assumed that the number of dependents for all males who are heads of households is distributed in a similar fashion. Dependents other than spouses include children of the primary male as well as other related individuals who live in the same household.

The age distribution for males is derived from the total numbers of intercounty male movers who are not in the labor force by age.(9) Since the ages considered run from 16 to 65+, an additional age and sex distribution for ages 1 through 14 was determined from U.S. Census data,(12, Table 5) which provides a complete age distribution for intercounty movers by sex. Five-year age intervals in the labor force years are determined by fitting

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* In fact, wives are, on the average, about 3 years younger than their husbands but this distinction is not considered critical in the context of this 5-year projection model.

a curve to the cumulative age distribution determined for the abridged age categories as provided. Persons above age 65 are distributed in 5-year intervals through 85+ by taking the U.S. life table proportions of the stationary population at age x who survive to age x+5 and multiplying by the number of persons at age x. The female age distribution was derived in a similar fashion, except that the female age distribution for spouses in the labor force years was composed of intercounty female movers not in the labor force and not classified as married, spouse present.

These computations provide a complete component profile of the in-migrating primary operation employees, their spouses, and their other dependents in 1985. In addition to the primary operation employment and its components, the model projects the secondary employment effects generated by the operation phase of the project. An empirically derived secondary employment multiplier is applied to the primary operation employment. Secondary operation employment is assumed to be met sequentially, first by the nonmigrant component of the available secondary construction employment in the region. Secondary construction employment is assumed to be associated with primary construction employment. This association is maintained for that portion of primary construction employment remaining in the region after termination of the construction phase in 1985. Only those secondary workers who have become "disenfranchised" by the departure of a portion of the primary employees are considered to be available for secondary operation employment. Other unemployed workers in the region are then considered for any remaining positions.

Computation of the unemployed labor force in the region in 1985 involves application of the unemployment rate estimated for 1985 to the projected 1985 baseline labor force. If this source satisfies the demand, then a portion of migrant secondary construction employment is projected to remain in the region. This figure is calculated in a fashion similar to primary construction employment that remains; however, a different assumption regarding the proportion staying is used, based on a survey of nonconstruction workers in an area experiencing construction activity.(11)

If the demand is still not satisfied, then migrant secondary construction employment is drawn upon. Any residual unemployed migrant secondary construction employment is also subject to the above assumption about the proportion remaining in the region. Finally, if new migrants are needed to satisfy the remaining demand for secondary operation employment, the model assumes that they will be added to the migrant secondary construction employment in the region in 1985.

The primary and secondary operation employment are next distributed to the site county according to a gravity model specifying residential location. Members of the operation work force are assumed to reside closer to the site than are construction workers, because of the longer time they can expect to be on the job. Although the primary operation employment is assumed to be all male, the model allows for a portion of the secondary operation employment to be composed of females. The female component is first filled by spouses of both primary and secondary operation workers. Their participation rate is the same as the overall female labor force participation rate. That is, if 45% of the secondary operation employment demand is met by females, then 45% of the spouses of primary and secondary male employees will be considered first for those positions. If more female positions remain, then new in-migrating females are assumed to fill them. These additional female labor force members are assumed to be unmarried initially. This assumption substantially simplifies the model, since it is assumed that additional females are not accompanied by dependents. These women will, however, be subjected to the same rates of fertility and mortality as the spouses of male employees.

To obtain an age distribution for single female employees, data on never-married females of the civilian labor force (who are intercounty movers) is multiplied by the difference between female employment demand and the number of participant spouses. Labor force participation for these women is concentrated in younger ages compared with the participation of spouses, whose childbearing competes with labor force participation. The incorporation of female labor force participation by spouses reduces the effective in-migrating population, since some families account for two members of the labor force.

The model next projects the resulting population forward in 5-year intervals, taking into account fertility, mortality, job turnover, retirement, and employment replacement. From this point on, the primary and secondary migrant employees and their dependents are treated identically in the projection routine. Each of the three components (employees, spouses, and dependents) is survived forward 5 years. The baseline fertility schedule is applied to spouses and female dependents; births during the 5-year projection cycle are survived forward; surviving births to both components are distributed by sex using the baseline sex ratio at birth; these births are added to the dependent age/sex distribution in the 0 to 4 age categories. An age-specific schedule of job turnover is applied to the employees and their spouses. This schedule assumes that higher rates of job separation occur at younger ages and decrease until retirement age, which is set at age 65. At that time, all project employees are assumed to retire. Spouses continue throughout the projection to be associated with their employed husbands in the same proportions indicated by the distribution of multipliers by age. Although this assumption fails to take differential mortality by sex into account, the resulting errors are small. For employees and their spouses two new age distributions are produced. These involve employees and spouses who do not turn over during the projection cycle and those that do. The dependents are more complicated to take into account, since it is not possible to derive a one-to-one correspondence between employees and their dependents by age as the projection moves forward. The best approximation of the dependent turnover age/sex distribution can be obtained by multiplying the dependent age distribution by the proportion of the male employment turning over in that period. Those who remain on the job are obtained as a residual.

Given the turnover/stayer split for each of the three components, the next step is to determine what portion of each of the turnover components remains in the site county and what portion leaves, since only those migrants who stay will continue to exert impacts locally. A factor based on the estimated level of net migration in the region--a proxy measure of economic opportunity in the area--is multiplied by each of the turnover components to determine the portion of each component that will remain in the site county.

Dependent children are treated differently at this point. Upon reaching age 20, a fixed proportion of dependents in the 20 to 24 age category is assumed to emigrate, independent of parental residential mobility. Employees who leave the job during the 5-year projection period due to separation or retirement are added to employees who die during the period. These persons are assumed to be replaced by new in-migrant workers with the same age and dependency characteristics as the initial 1985 employment. The replacement male employment is multiplied by the age-specific spouse multiplier schedule to obtain the new spouse age distribution and by the age-specific dependent multiplier schedule to obtain the number of new dependents. These dependents are distributed by age and sex according to the original age-and-sex-specific proportional age distribution.

It is now possible to define the total number of migrants associated with the project in 1985, or at the end of any future projection cycle running from year t to year t + 5, in terms of the three components of employment: spouses and dependents, the subsets of each component representing turnover stayers and nonturnovers, and turnover replacements. Summing across these groups provides the total migrant age and sex distribution at year t + 5.

The subsequent projection cycles begin repeating at the point at which each component is subjected to the survival schedules. The only difference is that the turnover stayers are no longer subjected to turnover and replacement. They are, however, subject to fertility, mortality, and net migration rates for the period in question. Nonturnovers and replacements continue to be subject to these schedules, as well as the specified schedules of turnover, leaving and staying, and replacement.

C.4.3 Model Output

Output from the model provides two projections for each combination of reference site and facility as shown in Tables C.6 through C.95. The first projection provides a most probable estimate (expected impact) of future employment associated with the project and is based on the most likely value for each variable component in the model, based on prior research and best judgment. The second projection incorporates a set of extreme but plausible assumptions that serve to maximize the forecast of the project-related in-migrant population (maximum impact). The less confidence that can be placed in a given assumption, the wider will be the range between the expected and the maximum impact estimate; this range will increase with the length of the projection period, reflecting diminishing confidence over time in the result. Some estimates are considered sufficiently accurate that they will remain unchanged (e.g., mortality). Others incorporate wide variation (e.g., distance exponent in the gravity model). The true value of the projected outcome is assumed to fall within these limits, though this method clearly is biased toward the high end of impact estimates. This is considered appropriate since policy intervention must be designed to deal with maximum impacts. The accuracy of the projected output may also be influenced by unforeseen changes in volatile component relationships, policy accommodations to estimated or experienced impacts, and by misspecification of component relationships and assumptions.

TABLE C.6. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, FRP Production Facility

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1630	1630	1000	1000	1000	1000	1000	1000
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	5129	7631	5879	12146	7006	14600	7675	15817
BASELINE PLUS PROJECT	49372	51874	52012	58279	57388	64982	62288	70429
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	10.4	14.7	11.3	20.8	12.2	22.5	12.3	22.5
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.5	23.5	22.0	21.9	32.7	32.4	38.8	38.7
BASELINE PLUS PROJECT	26.4	26.2	27.4	26.7	31.4	31.5	34.7	35.1
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	37.0	37.9	57.2	54.7	31.3	33.5	26.2	26.0
BASELINE PLUS PROJECT	58.5	57.4	65.9	64.3	50.2	48.3	43.9	41.6
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	101.6	106.9	113.2	106.2	116.4	112.0	117.1	113.9
BASELINE PLUS PROJECT	94.7	95.8	95.9	96.3	96.9	98.1	98.3	99.7

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	1.15	2.08	2.73	9.30	1.17	1.23	.61	.53
BASELINE PLUS PROJECT	.66	.87	1.04	2.33	.66	.73	.55	.54

TABLE C.7. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, FRP Production Facility

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	4.9	7.3	5.6	11.7	6.7	14.0	7.4	15.2
NURSES	13.2	19.7	15.2	31.3	18.1	37.7	19.8	40.8
DENTISTS	1.6	2.4	1.8	3.8	2.2	4.5	2.4	4.9
HOSPITAL BEDS	17.0	25.3	19.5	40.3	23.3	48.5	25.5	52.5
NURSING CARE BEDS	5.1	7.3	8.8	17.6	15.2	30.6	23.7	47.7
EDUCATION								
TEACHERS: K-8	33.5	50.7	53.6	107.6	45.4	101.8	34.7	71.4
TEACHERS: 9-12	31.7	46.3	39.4	86.3	43.4	87.0	29.4	61.5
CLASSROOM SPACE: (SQUARE METERS 9-12)	8341.5	12193.6	10359.0	22708.1	11414.5	22912.1	7732.9	16185.0
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	2912.2	4332.4	3338.0	6895.9	3977.9	8289.3	4357.7	8980.0
SOLID WASTE (VEHICLES)	.6	.8	.6	1.3	.8	1.6	.8	1.7
SOLID WASTE (PERSONNEL)	1.7	2.5	1.9	4.0	2.3	4.8	2.5	5.2
LIQUID WASTE (CUBIC METERS/DAY)	1941.5	2888.3	2225.3	4597.3	2651.9	5526.2	2905.1	5986.7
FIRE AND POLICE								
FIREMEN	3.4	5.1	3.9	8.1	4.7	9.8	5.1	10.6
POLICEMEN	10.3	15.3	11.8	24.3	14.0	29.2	15.4	31.6
RECREATION								
PLAYGROUNDS (HECTARES)	2.0	3.0	2.3	4.8	2.8	5.7	3.0	6.2
NEIGHBORHOOD PARKS (")	1.7	2.6	2.0	4.1	2.4	4.9	2.6	5.3
COMMUNITY PARKS (")	2.6	3.8	2.9	6.1	3.5	7.3	3.8	7.9
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	299.6	445.6	343.4	709.3	409.2	852.7	448.2	923.7
GOVERNMENT								
ADMINISTRATIVE STAFF	4.6	6.9	5.3	10.9	6.3	13.1	6.9	14.2

TABLE C.8. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, FRP Production Facility

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1630	1630	1000	1000	1000	1000	1000	1000
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	310	3948	687	6947	802	8312	900	9030
BASELINE PLUS PROJECT	21561	25200	23789	30050	27075	34585	29504	37634
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.4	15.7	2.9	23.1	3.0	24.0	3.1	24.0
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.5	22.6	22.1	33.1	32.3	38.2	38.2
BASELINE PLUS PROJECT	25.5	24.9	26.7	25.5	30.3	30.9	33.4	34.5
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	36.7	60.5	54.3	26.7	32.2	27.4	25.4
BASELINE PLUS PROJECT	59.6	55.7	60.7	59.1	48.9	45.1	45.0	40.2
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	99.8	132.6	107.5	127.0	112.3	121.9	113.2
BASELINE PLUS PROJECT	94.1	94.3	95.0	97.0	95.9	99.0	96.2	99.5

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	3.05	2.36	15.91	11.30	1.04	1.20	.77	.55
BASELINE PLUS PROJECT	.90	1.15	1.97	3.52	.86	.94	.57	.56

TABLE C.9. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, FRP Production Facility

SOCIAL SERVICE UNIT	1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2015 EXPECTED	2015 MAXIMUM
HEALTH								
PHYSICIANS	.3	3.4	.6	6.0	.7	7.1	.8	7.8
NURSES	.9	11.6	2.0	20.4	2.4	24.4	2.6	26.5
DENTISTS	.1	1.1	.2	1.9	.2	2.2	.2	2.4
HOSPITAL BEDS	1.2	14.7	2.6	25.9	3.0	31.0	3.4	33.7
NURSING CARE BEDS	.1	3.7	.9	9.2	1.6	15.3	2.5	23.5
EDUCATION								
TEACHERS: K-8	2.2	25.7	6.6	61.5	4.4	57.0	4.3	41.5
TEACHERS: 9-12	1.9	24.5	3.8	48.5	5.2	49.9	3.4	35.5
CLASSROOM SPACE: (SQUARE METERS 9-12)	507.0	6458.7	1001.9	12766.5	1369.2	13133.0	897.4	9345.3
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	175.9	2241.6	389.8	3944.4	455.5	4719.4	511.2	5126.9
SOLID WASTE (VEHICLES)	.0	.4	.1	.8	.1	.9	.1	1.0
SOLID WASTE (PERSONNEL)	.1	1.3	.2	2.3	.3	2.7	.3	3.0
LIQUID WASTE (CUBIC METERS/DAY)	117.3	1494.4	259.9	2629.6	303.7	3146.3	340.8	3418.0
FIRE AND POLICE								
FIREMEN	.2	2.6	.5	4.7	.5	5.6	.6	6.1
POLICEMEN	.6	7.9	1.4	13.9	1.6	16.6	1.8	18.1
RECREATION								
PLAYGROUNDS (HECTARES)	.1	1.6	.3	2.7	.3	3.3	.4	3.5
NEIGHBORHOOD PARKS (")	.1	1.3	.2	2.3	.3	2.8	.3	3.0
COMMUNITY PARKS (")	.2	2.0	.3	3.5	.4	4.1	.4	4.5
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	14.4	183.2	31.9	322.4	37.2	385.7	41.8	419.0
GOVERNMENT								
ADMINISTRATIVE STAFF	.3	3.6	.6	6.3	.7	7.5	.8	8.1

TABLE C.10. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, FRP Production Facility

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1630	1630	1000	1000	1000	1000	1000	1000
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	130	1395	1586	3875	1857	4560	2093	5140
BASELINE PLUS PROJECT	60506	61771	74284	76572	91401	94104	100099	103146
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.2	2.3	2.1	5.1	2.0	4.8	2.1	5.0
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.3	22.2	23.0	33.4	33.5	39.2	38.8
BASELINE PLUS PROJECT	27.8	27.7	29.2	29.0	35.1	35.1	36.2	36.3
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	42.8	62.6	58.9	27.2	28.6	27.3	30.0
BASELINE PLUS PROJECT	51.2	51.0	47.7	48.0	42.6	42.2	47.7	47.2
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	145.4	130.9	134.1	127.7	128.8	125.0	124.0
BASELINE PLUS PROJECT	99.5	100.2	99.8	100.8	99.4	100.2	97.1	97.8

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	7.93	3.73	50.00	20.44	1.05	1.09	.80	.80
BASELINE PLUS PROJECT	1.44	1.46	4.10	4.30	1.38	1.37	.61	.61

TABLE C.11. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, FRP Production Facility

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.2	1.9	2.1	5.2	2.5	6.1	2.8	6.8
NURSES	.6	6.9	7.9	19.2	9.2	22.6	10.4	25.4
DENTISTS	.1	.8	.9	2.2	1.1	2.6	1.2	2.9
HOSPITAL BEDS	.8	8.2	9.3	22.8	10.9	26.8	12.3	30.2
NURSING CARE BEDS	.2	2.2	6.3	13.5	11.2	26.1	17.7	45.2
EDUCATION								
TEACHERS: K-8	.9	10.0	15.4	36.7	10.1	25.4	9.5	24.8
TEACHERS: 9-12	.8	8.3	9.1	20.8	12.2	27.8	7.6	18.6
CLASSROOM SPACE: (SQUARE METERS 9-12)	213.1	2185.9	2399.5	5485.6	3202.0	7325.2	2011.1	4897.5
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	73.9	791.9	900.6	2199.9	1054.2	2588.8	1188.4	2918.3
SOLID WASTE (VEHICLES)	.0	.2	.2	.4	.2	.5	.2	.6
SOLID WASTE (PERSONNEL)	.0	.5	.5	1.3	.6	1.5	.7	1.7
LIQUID WASTE (CUBIC METERS/DAY)	49.3	527.9	600.4	1466.6	702.8	1725.8	792.3	1945.5
FIRE AND POLICE								
FIREMEN	.1	.9	1.1	2.6	1.2	3.1	1.4	3.4
POLICEMEN	.3	2.8	3.2	7.7	3.7	9.1	4.2	10.3
RECREATION								
PLAYGROUNDS (HECTARES)	.1	.5	.6	1.5	.7	1.8	.8	2.0
NEIGHBORHOOD PARKS (")	.0	.5	.5	1.3	.6	1.5	.7	1.7
COMMUNITY PARKS (")	.1	.7	.8	1.9	.9	2.3	1.0	2.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	5.6	60.0	68.2	166.6	79.8	196.1	90.0	221.0
GOVERNMENT								
ADMINISTRATIVE STAFF	.1	1.3	1.4	3.5	1.7	4.1	1.9	4.6

TABLE C.12. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, FRP Waste Management Reference System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1195	1195	275	275	275	275	275	275
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	3654	5520	2382	4039	2859	4864	3106	5261
BASELINE PLUS PROJECT	47897	49763	48515	50172	53241	55246	57718	59873
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	7.6	11.1	4.9	8.1	5.4	8.8	5.4	8.8
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.5	32.4	38.7	38.6
BASELINE PLUS PROJECT	26.6	26.4	27.9	27.6	31.2	31.2	34.3	34.4
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	37.0	38.0	54.8	53.7	33.2	34.1	26.5	26.5
BASELINE PLUS PROJECT	59.2	58.4	66.4	65.9	52.1	51.4	45.6	44.8
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	101.9	107.3	108.3	105.7	113.2	111.6	114.5	113.3
BASELINE PLUS PROJECT	94.5	95.4	94.5	94.8	95.3	95.8	96.9	97.3

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	-.46	-.14	-8.55	-6.25	1.22	1.24	.55	.52
BASELINE PLUS PROJECT	.53	.53	.26	.16	.62	.64	.54	.54

TABLE C.13. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, FRP Waste Management Reference System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	3.5	5.3	2.3	3.9	2.7	4.7	3.0	5.1
NURSES	9.4	14.2	6.1	10.4	7.4	12.6	8.0	13.6
DENTISTS	1.1	1.7	.7	1.3	.9	1.5	1.0	1.6
HOSPITAL BEDS	12.1	18.3	7.9	13.4	9.5	16.1	10.3	17.5
NURSING CARE BEDS	3.6	5.2	3.4	5.7	6.0	10.0	9.5	15.9
EDUCATION								
TEACHERS: K-8	23.9	36.7	21.2	35.5	19.7	34.4	14.2	24.0
TEACHERS: 9-12	22.6	33.5	16.5	28.6	17.0	28.5	12.0	20.5
CLASSROOM SPACE: (SQUARE METERS 9-12)	5935.9	8810.6	4350.2	7535.7	4479.6	7494.5	3162.9	5389.7
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	2074.5	3134.0	1352.6	2293.2	1623.2	2761.7	1763.2	2986.7
SOLID WASTE (VEHICLES)	.4	.6	.3	.4	.3	.5	.3	.6
SOLID WASTE (PERSONNEL)	1.2	1.8	.8	1.3	.9	1.6	1.0	1.7
LIQUID WASTE (CUBIC METERS/DAY)	1383.0	2089.4	901.7	1528.8	1082.2	1841.2	1175.5	1991.2
FIRE AND POLICE								
FIREMEN	2.4	3.7	1.6	2.7	1.9	3.3	2.1	3.5
POLICEMEN	7.3	11.0	4.8	8.1	5.7	9.7	6.2	10.5
RECREATION								
PLAYGROUNDS (HECTARES)	1.4	2.2	.9	1.6	1.1	1.9	1.2	2.1
NEIGHBORHOOD PARKS (")	1.2	1.9	.8	1.4	1.0	1.6	1.0	1.8
COMMUNITY PARKS (")	1.8	2.7	1.2	2.0	1.4	2.4	1.5	2.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	213.4	322.4	139.1	235.9	167.0	284.1	181.4	307.2
GOVERNMENT								
ADMINISTRATIVE STAFF	3.3	5.0	2.1	3.6	2.6	4.4	2.8	4.7

TABLE C.14. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, FRP Waste Management Reference System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1195	1195	275	275	275	275	275	275
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	192	2615	226	2152	264	2572	295	2794
BASELINE PLUS PROJECT	21444	23866	23328	25254	26537	28845	28899	31398
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.9	11.0	1.0	8.5	1.0	8.9	1.0	8.9
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.5	23.2	22.4	33.1	32.3	37.8	38.0
BASELINE PLUS PROJECT	25.5	25.1	26.8	26.4	30.2	30.4	33.2	33.7
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	37.1	57.5	53.2	28.1	32.6	29.6	26.7
BASELINE PLUS PROJECT	59.7	57.0	60.6	60.0	49.5	48.0	45.4	43.7
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	102.0	135.2	110.2	127.6	113.5	120.7	113.2
BASELINE PLUS PROJECT	93.8	94.3	94.4	95.4	95.4	96.6	95.8	97.0

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	1.23	.19	3.22	-3.90	1.05	1.19	.74	.55
BASELINE PLUS PROJECT	.85	.78	1.68	1.13	.86	.89	.57	.57

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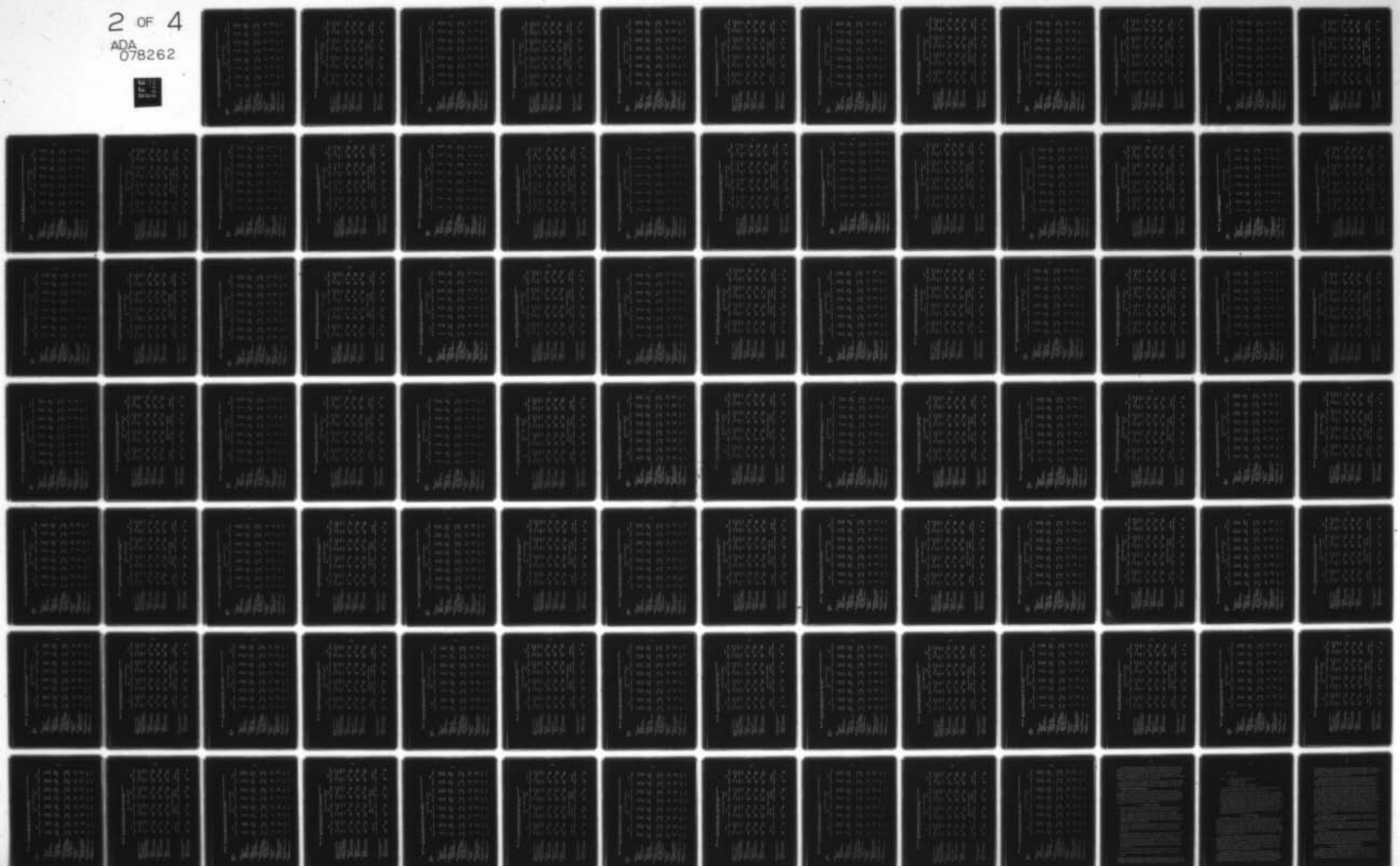

TABLE C.15. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, FRP Waste Management Reference System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2015 EXPECTED	2015 MAXIMUM
HEALTH								
PHYSICIANS	.2	2.2	.2	1.9	.2	2.2	.3	2.4
NURSES	.6	7.7	.7	6.3	.8	7.6	.9	8.2
DENTISTS	.1	.7	.1	.6	.1	.7	.1	.8
HOSPITAL BEDS	.7	9.8	.8	8.0	1.0	9.6	1.1	10.4
NURSING CARE BEDS	.1	2.4	.3	2.7	.5	4.6	.9	7.4
EDUCATION								
TEACHERS: K-8	1.4	17.1	2.1	19.0	1.5	17.6	1.5	13.2
TEACHERS: 9-12	1.2	16.1	1.2	14.5	1.6	15.0	1.1	11.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	314.4	4245.9	311.4	3807.8	424.5	3954.6	294.0	2883.3
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	109.1	1484.5	128.2	1221.6	149.9	1460.2	167.6	1586.4
SOLID WASTE (VEHICLES)	.0	.3	.0	.2	.0	.3	.0	.3
SOLID WASTE (PERSONNEL)	.1	.9	.1	.7	.1	.8	.1	.9
LIQUID WASTE (CUBIC METERS/DAY)	72.7	989.7	85.4	814.4	100.0	973.5	111.7	1057.6
FIRE AND POLICE								
FIREMEN	.1	1.8	.2	1.4	.2	1.7	.2	1.9
POLICEMEN	.4	5.2	.5	4.3	.5	5.1	.6	5.6
RECREATION								
PLAYGROUNDS (HECTARES)	.1	1.0	.1	.8	.1	1.0	.1	1.1
NEIGHBORHOOD PARKS (")	.1	.9	.1	.7	.1	.9	.1	.9
COMMUNITY PARKS (")	.1	1.3	.1	1.1	.1	1.3	.1	1.4
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	8.9	121.3	10.5	99.8	12.3	119.3	13.7	129.7
GOVERNMENT								
ADMINISTRATIVE STAFF	.2	2.4	.2	1.9	.2	2.3	.3	2.5

TABLE C.16. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, FRP Waste Management Reference System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1195	1195	275	275	275	275	275	275
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	35	781	436	1330	510	1576	575	1777
BASELINE PLUS PROJECT	60411	61157	73133	74027	90054	91121	98581	99783
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.1	1.3	.6	1.8	.6	1.7	.6	1.8
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.1	22.2	24.0	33.4	33.5	39.2	38.3
BASELINE PLUS PROJECT	27.8	27.7	29.3	29.2	35.1	35.1	36.2	36.2
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	43.6	62.6	54.1	27.2	30.5	27.2	33.9
BASELINE PLUS PROJECT	51.2	51.1	47.5	47.5	42.8	42.7	48.1	47.9
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	157.7	130.8	138.6	127.7	130.3	125.0	122.6
BASELINE PLUS PROJECT	99.4	99.9	99.4	99.8	99.1	99.4	96.7	97.0

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	8.00	2.35	50.44	10.64	1.05	1.13	.80	.80
BASELINE PLUS PROJECT	1.40	1.40	3.82	3.82	1.39	1.38	.60	.61

TABLE C.17. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, FRP Waste Management Reference System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.0	1.0	.6	1.8	.7	2.1	.8	2.4
NURSES	.2	3.9	2.2	6.6	2.5	7.8	2.8	8.8
DENTISTS	.0	.4	.2	.8	.3	.9	.3	1.0
HOSPITAL BEDS	.2	4.6	2.6	7.8	3.0	9.3	3.4	10.4
NURSING CARE BEDS	.0	.9	1.7	3.8	3.1	8.4	4.9	16.4
EDUCATION								
TEACHERS: K-8	.3	5.6	4.2	12.2	2.8	9.1	2.6	9.2
TEACHERS: 9-12	.2	4.9	2.5	6.5	3.3	8.7	2.1	6.4
CLASSROOM SPACE: (SQUARE METERS 9-12)	57.2	1278.6	659.2	1709.6	879.7	2285.4	552.3	1674.1
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	19.9	443.6	247.3	755.1	289.5	894.9	326.3	1008.8
SOLID WASTE (VEHICLES)	.0	.1	.0	.1	.1	.2	.1	.2
SOLID WASTE (PERSONNEL)	.0	.3	.1	.4	.2	.5	.2	.6
LIQUID WASTE (CUBIC METERS/DAY)	13.2	295.7	164.9	503.4	193.0	596.6	217.5	672.5
FIRE AND POLICE								
FIREMEN	.0	.5	.3	.9	.3	1.1	.4	1.2
POLICEMEN	.1	1.6	.9	2.7	1.0	3.2	1.1	3.6
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.3	.2	.5	.2	.6	.2	.7
NEIGHBORHOOD PARKS (")	.0	.3	.1	.4	.2	.5	.2	.6
COMMUNITY PARKS (")	.0	.4	.2	.7	.3	.8	.3	.9
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	1.5	33.6	18.7	57.2	21.9	67.8	24.7	76.4
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.7	.4	1.2	.5	1.4	.5	1.6

TABLE C.18. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, FRP Combined System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	2825	2825	1275	1275	1275	1275	1275	1275
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	9183	13429	9110	16742	10901	20144	11880	21799
BASELINE PLUS PROJECT	53426	57672	55243	62874	61282	70526	66493	76411
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	17.2	23.3	16.5	26.6	17.8	28.6	17.9	28.5
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.5	23.5	22.0	21.9	32.6	32.4	38.8	38.7
BASELINE PLUS PROJECT	26.0	25.7	27.0	26.2	31.5	31.6	34.9	35.4
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	36.9	37.8	55.9	54.3	32.3	33.7	26.2	26.1
BASELINE PLUS PROJECT	56.6	55.2	65.1	63.5	49.1	47.1	42.7	40.3
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	101.2	106.5	110.0	105.7	114.4	111.6	115.6	113.6
BASELINE PLUS PROJECT	95.2	96.8	96.4	96.9	97.7	99.0	99.2	100.7

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	.74	1.38	-.16	4.41	1.20	1.23	.57	.53
BASELINE PLUS PROJECT	.63	.80	.67	1.73	.69	.77	.54	.53

TABLE C.19. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, FRP Combined System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	8.8	12.9	8.7	16.1	10.5	19.3	11.4	20.9
NURSES	23.7	34.6	23.5	43.2	28.1	52.0	30.7	56.2
DENTISTS	2.8	4.2	2.8	5.2	3.4	6.2	3.7	6.8
HOSPITAL BEDS	30.5	44.6	30.2	55.6	36.2	66.9	39.4	72.4
NURSING CARE BEDS	9.1	12.8	13.3	24.1	23.3	42.0	36.3	65.6
EDUCATION								
TEACHERS: K-8	59.9	89.1	81.9	147.7	73.2	141.5	53.8	98.6
TEACHERS: 9-12	56.8	81.6	62.5	119.3	66.2	119.3	45.8	84.9
CLASSROOM SPACE: (SQUARE METERS 9-12)	14950.1	21487.0	16463.1	31397.7	17413.8	31404.8	12052.4	22333.9
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	5213.6	7624.6	5172.0	9505.0	6188.8	11436.7	6745.0	12376.1
SOLID WASTE (VEHICLES)	1.0	1.5	1.0	1.8	1.2	2.2	1.3	2.4
SOLID WASTE (PERSONNEL)	3.0	4.4	3.0	5.5	3.6	6.6	3.9	7.2
LIQUID WASTE (CUBIC METERS/DAY)	3475.7	5083.0	3448.0	6336.7	4125.9	7624.5	4496.6	8250.8
FIRE AND POLICE								
FIREMEN	6.2	9.0	6.1	11.2	7.3	13.5	8.0	14.6
POLICEMEN	18.4	26.9	18.2	33.5	21.8	40.3	23.8	43.6
RECREATION								
PLAYGROUNDS (HECTARES)	3.6	5.3	3.6	6.6	4.3	7.9	4.7	8.6
NEIGHBORHOOD PARKS (")	3.1	4.5	3.1	5.6	3.7	6.8	4.0	7.3
COMMUNITY PARKS (")	4.6	6.7	4.5	8.3	5.4	10.0	5.9	10.9
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	536.3	784.3	532.0	977.7	636.6	1176.4	693.8	1273.0
GOVERNMENT								
ADMINISTRATIVE STAFF	8.3	12.1	8.2	15.1	9.8	18.1	10.7	19.6

TABLE C.20. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, FRP Combined System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	2825	2825	1275	1275	1275	1275	1275	1275
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	633	7611	958	10704	1120	12832	1254	13898
BASELINE PLUS PROJECT	21885	28863	24060	33806	27393	39105	29858	42502
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	2.9	26.4	4.0	31.7	4.1	32.8	4.2	32.7
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.5	22.9	22.1	33.1	32.3	38.0	38.1
BASELINE PLUS PROJECT	25.4	24.6	26.7	25.0	30.3	31.1	33.4	34.9
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	36.3	58.9	53.5	27.5	32.8	28.5	25.5
BASELINE PLUS PROJECT	59.3	52.9	60.6	58.3	48.7	43.7	44.8	38.4
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	97.7	133.9	106.0	127.3	111.3	121.3	112.4
BASELINE PLUS PROJECT	94.8	94.5	95.4	97.7	96.3	100.2	96.5	100.7

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	1.95	1.72	8.27	6.82	1.04	1.21	.75	.53
BASELINE PLUS PROJECT	.89	1.11	1.90	3.16	.86	.97	.57	.56

TABLE C.21. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, FRP Combined System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.5	6.5	.8	9.2	1.0	11.0	1.1	12.0
NURSES	1.9	22.4	2.8	31.5	3.3	37.7	3.7	40.9
DENTISTS	.2	2.1	.3	2.9	.3	3.5	.3	3.8
HOSPITAL BEDS	2.4	28.4	3.6	39.9	4.2	47.9	4.7	51.8
NURSING CARE BEDS	.3	7.3	1.2	14.0	2.2	23.3	3.6	36.1
EDUCATION								
TEACHERS: K-8	4.6	49.1	9.1	93.9	6.2	89.6	6.2	64.0
TEACHERS: 9-12	3.9	47.6	5.2	75.5	7.0	76.0	4.7	54.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	1036.3	12537.4	1357.3	19881.3	1852.7	19997.1	1249.3	14423.8
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	359.6	4321.4	543.7	6076.9	635.8	7285.5	711.9	7890.6
SOLID WASTE (VEHICLES)	.1	.8	.1	1.2	.1	1.4	.1	1.5
SOLID WASTE (PERSONNEL)	.2	2.5	.3	3.5	.4	4.2	.4	4.6
LIQUID WASTE (CUBIC METERS/DAY)	239.7	2880.9	362.5	4051.3	423.8	4857.0	474.6	5260.4
FIRE AND POLICE								
FIREMEN	.4	5.1	.6	7.2	.8	8.6	.8	9.3
POLICEMEN	1.3	15.2	1.9	21.4	2.2	25.7	2.5	27.8
RECREATION								
PLAYGROUNDS (HECTARES)	.2	3.0	.4	4.2	.4	5.0	.5	5.5
NEIGHBORHOOD PARKS (")	.2	2.6	.3	3.6	.4	4.3	.4	4.7
COMMUNITY PARKS (")	.3	3.8	.5	5.3	.6	6.4	.6	6.9
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	29.4	353.2	44.4	496.6	52.0	595.4	58.2	644.9
GOVERNMENT								
ADMINISTRATIVE STAFF	.6	6.9	.9	9.6	1.0	11.5	1.1	12.5

TABLE C.22. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, FRP Combined System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	2825	2825	1275	1275	1275	1275	1275	1275
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	432	5234	2227	9852	2614	11759	2947	13014
BASELINE PLUS PROJECT	60808	65610	74924	82550	92159	101304	100953	111020
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.7	8.0	3.0	11.9	2.8	11.6	2.9	11.7
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.5	22.6	22.6	33.5	32.9	39.0	38.8
BASELINE PLUS PROJECT	27.8	27.3	29.1	28.4	35.1	34.8	36.2	36.5
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	38.4	60.6	55.9	28.0	31.8	28.7	28.7
BASELINE PLUS PROJECT	51.1	50.1	47.8	48.4	42.5	41.6	47.6	45.6
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	110.0	132.5	120.1	128.3	120.5	124.5	119.0
BASELINE PLUS PROJECT	99.7	100.2	100.1	101.5	99.7	101.2	97.3	99.0

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	5.48	2.60	32.79	12.65	1.07	1.18	.80	.68
BASELINE PLUS PROJECT	1.45	1.50	4.18	4.59	1.38	1.36	.61	.61

TABLE C.23. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, FRP Combined System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.6	7.0	3.0	13.1	3.5	15.6	3.9	17.3
NURSES	2.1	25.9	11.0	48.8	12.9	58.2	14.6	64.4
DENTISTS	.2	3.0	1.3	5.6	1.5	6.7	1.7	7.4
HOSPITAL BEDS	2.5	30.8	13.1	57.9	15.4	69.1	17.3	76.5
NURSING CARE BEDS	.5	12.6	8.3	34.4	15.3	64.4	25.4	109.0
EDUCATION								
TEACHERS: K-8	3.1	35.1	21.3	89.9	14.4	74.6	13.8	61.4
TEACHERS: 9-12	2.7	31.5	12.4	60.5	16.5	69.0	10.7	49.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	707.3	8281.9	3256.6	15923.9	4347.3	18173.4	2819.0	12895.0
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	245.4	2971.6	1264.4	5593.6	1484.1	6676.3	1673.0	7388.6
SOLID WASTE (VEHICLES)	.0	.6	.2	1.1	.3	1.3	.3	1.4
SOLID WASTE (PERSONNEL)	.1	1.7	.7	3.3	.9	3.9	1.0	4.3
LIQUID WASTE (CUBIC METERS/DAY)	163.6	1981.0	842.9	3729.1	989.4	4450.9	1115.3	4925.7
FIRE AND POLICE								
FIREMEN	.3	3.5	1.5	6.6	1.8	7.9	2.0	8.7
POLICEMEN	.9	10.5	4.5	19.7	5.2	23.5	5.9	26.0
RECREATION								
PLAYGROUNDS (HECTARES)	.2	2.1	.9	3.9	1.0	4.6	1.2	5.1
NEIGHBORHOOD PARKS (")	.1	1.8	.7	3.3	.9	4.0	1.0	4.4
COMMUNITY PARKS (")	.2	2.6	1.1	4.9	1.3	5.9	1.5	6.5
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	18.6	225.1	95.8	423.6	112.4	505.6	126.7	559.6
GOVERNMENT								
ADMINISTRATIVE STAFF	.4	4.7	2.0	8.9	2.4	10.6	2.7	11.7

TABLE C.24. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, MOX FFP Production Facility

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	571	571	300	300	300	300	300	300
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	1537	2492	1322	3129	1562	3752	1730	4079
BASELINE PLUS PROJECT	45780	46735	47455	49262	51944	54134	56342	58692
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	3.4	5.3	2.8	6.4	3.0	6.9	3.1	7.0
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	33.0	32.5	38.9	38.8
BASELINE PLUS PROJECT	26.8	26.7	28.1	27.8	31.1	31.2	34.2	34.4
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	37.3	38.2	59.6	55.4	29.3	32.8	26.6	26.2
BASELINE PLUS PROJECT	60.4	60.0	66.9	66.3	52.4	51.7	46.1	45.2
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	103.4	108.9	120.6	108.5	120.9	113.4	120.1	114.9
BASELINE PLUS PROJECT	94.3	94.7	94.5	94.7	95.1	95.6	96.6	97.1

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	.34	1.41	-3.02	4.55	1.11	1.21	.68	.56
BASELINE PLUS PROJECT	.59	.65	.72	1.05	.60	.63	.54	.54

TABLE C.25. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, MOX FFP Production Facility

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2015 EXPECTED	2015 MAXIMUM
HEALTH								
PHYSICIANS	1.5	2.4	1.3	3.0	1.5	3.6	1.7	3.9
NURSES	4.0	6.4	3.4	8.1	4.0	9.7	4.5	10.5
DENTISTS	.5	.8	.4	1.0	.5	1.2	.5	1.3
HOSPITAL BEDS	5.1	8.3	4.4	10.4	5.2	12.5	5.7	13.5
NURSING CARE BEDS	1.5	2.3	2.0	4.6	3.5	7.9	5.5	12.4
EDUCATION								
TEACHERS: K-8	10.1	16.6	12.4	28.0	9.4	25.6	7.9	18.5
TEACHERS: 9-12	9.4	15.0	8.3	21.8	10.0	22.6	6.5	15.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	2485.0	3957.7	2184.4	5726.9	2628.8	5943.7	1716.1	4152.0
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	872.8	1415.0	750.4	1776.8	886.9	2130.1	982.1	2315.9
SOLID WASTE (VEHICLES)	.2	.3	.1	.3	.2	.4	.2	.4
SOLID WASTE (PERSONNEL)	.5	.8	.4	1.0	.5	1.2	.6	1.3
LIQUID WASTE (CUBIC METERS/DAY)	581.9	943.3	500.3	1184.5	591.3	1420.0	654.8	1543.9
FIRE AND POLICE								
FIREMEN	1.0	1.7	.9	2.1	1.0	2.5	1.2	2.7
POLICEMEN	3.1	5.0	2.6	6.3	3.1	7.5	3.5	8.2
RECREATION								
PLAYGROUNDS (HECTARES)	.6	1.0	.5	1.2	.6	1.5	.7	1.6
NEIGHBORHOOD PARKS (")	.5	.8	.4	1.1	.5	1.3	.6	1.4
COMMUNITY PARKS (")	.8	1.2	.7	1.6	.8	1.9	.9	2.0
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	89.8	145.5	77.2	182.8	91.2	219.1	101.0	238.2
GOVERNMENT								
ADMINISTRATIVE STAFF	1.4	2.2	1.2	2.8	1.4	3.4	1.6	3.7

TABLE C.26. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, MOX FFP Production Facility

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	571	571	300	300	300	300	300	300
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	39	702	187	805	219	941	246	1056
BASELINE PLUS PROJECT	21290	21954	23290	23908	26492	27214	28850	29660
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.2	3.2	.8	3.4	.8	3.5	.9	3.6
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.5	22.2	22.6	33.2	33.1	38.4	38.2
BASELINE PLUS PROJECT	25.5	25.4	26.8	26.7	30.2	30.3	33.2	33.4
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	40.3	62.4	60.5	25.9	26.8	26.0	27.4
BASELINE PLUS PROJECT	59.8	59.1	60.7	60.7	49.5	48.8	45.4	44.8
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	121.8	131.0	132.6	126.6	127.0	122.6	121.9
BASELINE PLUS PROJECT	93.4	94.2	94.3	95.2	95.4	96.1	95.7	96.4

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	5.29	1.17	31.55	2.75	1.03	1.04	.79	.77
BASELINE PLUS PROJECT	.87	.86	1.80	1.71	.86	.86	.57	.57

TABLE C.27. **Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, MOX FFP Production Facility**

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2015 EXPECTED	2015 MAXIMUM
HEALTH								
PHYSICIANS	.0	.6	.2	.7	.2	.8	.2	.9
NURSES	.1	2.1	.6	2.4	.6	2.8	.7	3.1
DENTISTS	.0	.2	.1	.2	.1	.3	.1	.3
HOSPITAL BEDS	.1	2.6	.7	3.0	.8	3.5	.9	3.9
NURSING CARE BEDS	.0	.6	.3	1.1	.4	1.9	.7	3.0
EDUCATION								
TEACHERS: K-8	.3	4.8	1.8	7.7	1.2	5.1	1.1	5.1
TEACHERS: 9-12	.2	4.1	1.1	4.5	1.5	6.1	.9	4.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	63.3	1071.8	282.4	1173.7	386.4	1603.9	245.2	1052.6
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	22.0	398.6	106.3	457.3	124.1	534.3	139.6	599.6
SOLID WASTE (VEHICLES)	.0	.1	.0	.1	.0	.1	.0	.1
SOLID WASTE (PERSONNEL)	.0	.2	.1	.3	.1	.3	.1	.3
LIQUID WASTE (CUBIC METERS/DAY)	14.6	265.7	70.9	304.9	82.7	356.2	93.1	399.7
FIRE AND POLICE								
FIREMEN	.0	.5	.1	.5	.1	.6	.2	.7
POLICEMEN	.1	1.4	.4	1.6	.4	1.9	.5	2.1
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.3	.1	.3	.1	.4	.1	.4
NEIGHBORHOOD PARKS (")	.0	.2	.1	.3	.1	.3	.1	.4
COMMUNITY PARKS (")	.0	.3	.1	.4	.1	.5	.1	.5
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	1.8	32.6	8.7	37.4	10.1	43.7	11.4	49.0
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.6	.2	.7	.2	.8	.2	1.0

TABLE C.28. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, MOX FFP Production Facility

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	571	571	300	300	300	300	300	300
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	17	247	459	986	536	1159	605	1306
BASELINE PLUS PROJECT	60393	60623	73156	73683	90081	90703	98611	99312
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.0	.4	.6	1.3	.6	1.3	.6	1.3
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.1	22.0	22.8	33.4	33.5	39.2	38.9
BASELINE PLUS PROJECT	27.8	27.8	29.3	29.2	35.1	35.1	36.2	36.2
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	43.6	63.4	59.7	26.9	28.3	26.7	29.4
BASELINE PLUS PROJECT	51.2	51.1	47.5	47.6	42.8	42.7	48.1	47.9
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	157.7	130.2	133.4	127.5	128.6	125.3	124.2
BASELINE PLUS PROJECT	99.4	99.5	99.4	99.6	99.1	99.3	96.7	96.9

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	10.25	4.76	66.25	27.68	1.04	1.08	.80	.80
BASELINE PLUS PROJECT	1.40	1.41	3.83	3.90	1.39	1.39	.60	.60

TABLE C.29. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, MOX FFP Production Facility

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.0	.3	.6	1.3	.7	1.5	.8	1.7
NURSES	.1	1.2	2.3	4.9	2.7	5.7	3.0	6.5
DENTISTS	.0	.1	.3	.6	.3	.7	.3	.7
HOSPITAL BEDS	.1	1.5	2.7	5.8	3.2	6.8	3.6	7.7
NURSING CARE BEDS	.0	.3	1.9	3.5	3.3	6.7	5.1	11.4
EDUCATION								
TEACHERS: K-8	.1	1.8	4.5	9.4	2.9	6.4	2.7	6.2
TEACHERS: 9-12	.1	1.5	2.7	5.4	3.6	7.2	2.2	4.7
CLASSROOM SPACE: (SQUARE METERS 9-12)	27.3	404.1	703.3	1416.5	938.4	1891.2	581.9	1246.8
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	9.5	140.2	260.4	559.7	304.5	657.8	343.3	741.6
SOLID WASTE (VEHICLES)	.0	.0	.1	.1	.1	.1	.1	.1
SOLID WASTE (PERSONNEL)	.0	.1	.2	.3	.2	.4	.2	.4
LIQUID WASTE (CUBIC METERS/DAY)	6.3	93.5	173.6	373.1	203.0	438.6	228.8	494.4
FIRE AND POLICE								
FIREMEN	.0	.2	.3	.7	.4	.8	.4	.9
POLICEMEN	.0	.5	.9	2.0	1.1	2.3	1.2	2.6
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.1	.2	.4	.2	.5	.2	.5
NEIGHBORHOOD PARKS (")	.0	.1	.2	.3	.2	.4	.2	.4
COMMUNITY PARKS (")	.0	.1	.2	.5	.3	.6	.3	.7
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	.7	10.6	19.7	42.4	23.1	49.8	26.0	56.2
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.2	.4	.9	.5	1.0	.5	1.2

TABLE C.30. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site MOX Waste Management Reference System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	54	54	16	16	16	16	16	16
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	6	69	34	52	40	60	45	68
BASELINE PLUS PROJECT	44249	44312	46167	46184	50421	50442	54657	54680
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.0	.2	.1	.1	.1	.1	.1	.1
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.1	23.1	22.0	22.5	33.4	33.3	39.1	38.8
BASELINE PLUS PROJECT	27.0	27.0	28.3	28.2	31.0	31.0	34.0	34.0
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	43.6	43.6	63.6	60.9	26.4	27.6	26.4	28.5
BASELINE PLUS PROJECT	61.4	61.4	67.1	67.1	53.3	53.2	46.8	46.8
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	157.7	157.7	130.0	132.4	126.8	127.5	124.4	123.4
BASELINE PLUS PROJECT	94.0	94.0	93.9	93.9	94.4	94.5	96.0	96.0

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	5.82	-.03	35.30	-5.72	1.04	1.06	.77	.77
BASELINE PLUS PROJECT	.60	.60	.85	.83	.59	.59	.54	.54

TABLE C.31. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, MOX Waste Management Reference System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.0	.1	.0	.0	.0	.1	.0	.1
NURSES	.0	.2	.1	.1	.1	.2	.1	.2
DENTISTS	.0	.0	.0	.0	.0	.0	.0	.0
HOSPITAL BEDS	.0	.2	.1	.2	.1	.2	.1	.2
NURSING CARE BEDS	.0	.0	.1	.1	.1	.1	.1	.2
EDUCATION								
TEACHERS: K-8	.0	.5	.3	.5	.2	.3	.2	.3
TEACHERS: 9-12	.0	.4	.2	.3	.3	.4	.2	.2
CLASSROOM SPACE: (SQUARE METERS 9-12)	9.5	112.2	52.3	75.5	70.7	102.4	43.4	65.7
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	3.3	38.9	19.3	29.3	22.6	34.3	25.3	38.5
SOLID WASTE (VEHICLES)	.0	.0	.0	.0	.0	.0	.0	.0
SOLID WASTE (PERSONNEL)	.0	.0	.0	.0	.0	.0	.0	.0
LIQUID WASTE (CUBIC METERS/DAY)	2.2	26.0	12.9	19.5	15.0	22.9	16.9	25.6
FIRE AND POLICE								
FIREMEN	.0	.0	.0	.0	.0	.0	.0	.0
POLICEMEN	.0	.1	.1	.1	.1	.1	.1	.1
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.0	.0	.0	.0	.0	.0	.0
NEIGHBORHOOD PARKS (")	.0	.0	.0	.0	.0	.0	.0	.0
COMMUNITY PARKS (")	.0	.0	.0	.0	.0	.0	.0	.0
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	.3	4.0	2.0	3.0	2.3	3.5	2.6	4.0
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.1	.0	.0	.0	.1	.0	.1

TABLE C.32. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, MOX Waste Management Reference System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	54	54	16	16	16	16	16	16
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	1	7	10	27	11	31	13	35
BASELINE PLUS PROJECT	21253	21259	23112	23129	26284	26304	28617	28639
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.0	.0	.0	.1	.0	.1	.0	.1
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.1	22.1	22.3	33.2	33.2	38.5	38.4
BASELINE PLUS PROJECT	25.5	25.5	26.8	26.8	30.2	30.2	33.2	33.2
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	43.6	62.9	62.0	25.7	26.1	25.7	26.4
BASELINE PLUS PROJECT	59.8	59.8	60.7	60.7	49.7	49.7	45.6	45.6
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	157.7	130.6	131.4	126.5	126.6	122.8	122.5
BASELINE PLUS PROJECT	93.4	93.4	94.1	94.1	95.1	95.2	95.5	95.6

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	6.21	4.56	38.01	26.45	1.03	1.03	.79	.78
BASELINE PLUS PROJECT	.85	.85	1.68	1.69	.86	.86	.57	.57

TABLE C.33. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, MOX Waste Management Reference System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.0	.0	.0	.0	.0	.0	.0	.0
NURSES	.0	.0	.0	.1	.0	.1	.0	.1
DENTISTS	.0	.0	.0	.0	.0	.0	.0	.0
HOSPITAL BEDS	.0	.0	.0	.1	.0	.1	.0	.1
NURSING CARE BEDS	.0	.0	.0	.0	.0	.1	.0	.1
EDUCATION								
TEACHERS: K-8	.0	.1	.1	.3	.1	.2	.1	.2
TEACHERS: 9-12	.0	.0	.1	.2	.1	.2	.0	.1
CLASSROOM SPACE: (SQUARE METERS 9-12)	2.4	11.7	14.9	40.3	20.3	55.1	12.8	35.3
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	.8	4.1	5.6	15.3	6.5	17.9	7.3	20.1
SOLID WASTE (VEHICLES)	.0	.0	.0	.0	.0	.0	.0	.0
SOLID WASTE (PERSONNEL)	.0	.0	.0	.0	.0	.0	.0	.0
LIQUID WASTE (CUBIC METERS/DAY)	.6	2.7	3.7	10.2	4.3	11.9	4.9	13.4
FIRE AND POLICE								
FIREMEN	.0	.0	.0	.0	.0	.0	.0	.0
POLICEMEN	.0	.0	.0	.1	.0	.1	.0	.1
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.0	.0	.0	.0	.0	.0	.0
NEIGHBORHOOD PARKS (")	.0	.0	.0	.0	.0	.0	.0	.0
COMMUNITY PARKS (")	.0	.0	.0	.0	.0	.0	.0	.0
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	.1	.3	.5	1.2	.5	1.5	.6	1.6
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.0	.0	.0	.0	.0	.0	.0

TABLE C.34. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, MOX Waste Management Reference System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	54	54	16	16	16	16	16	16
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	2	8	25	48	29	57	33	64
BASELINE PLUS PROJECT	60378	60384	72722	72746	89574	89601	98039	98070
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.0	.0	.0	.1	.0	.1	.0	.1
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.1	22.1	22.5	33.4	33.5	39.2	39.0
BASELINE PLUS PROJECT	27.8	27.8	29.3	29.3	35.1	35.1	36.1	36.1
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	43.6	62.9	61.2	27.1	27.7	27.0	28.2
BASELINE PLUS PROJECT	51.2	51.2	47.4	47.4	42.9	42.9	48.2	48.2
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	157.7	130.6	132.0	127.6	128.1	125.1	124.6
BASELINE PLUS PROJECT	99.4	99.4	99.3	99.3	98.9	98.9	96.6	96.6

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	8.68	6.03	55.22	36.63	1.05	1.06	.80	.80
BASELINE PLUS PROJECT	1.38	1.39	3.72	3.73	1.39	1.39	.60	.60

TABLE C.35. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, MOX Waste Management Reference System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.0	.0	.0	.1	.0	.1	.0	.1
NURSES	.0	.0	.1	.2	.1	.3	.2	.3
DENTISTS	.0	.0	.0	.0	.0	.0	.0	.0
HOSPITAL BEDS	.0	.0	.1	.3	.2	.3	.2	.4
NURSING CARE BEDS	.0	.0	.1	.2	.2	.3	.3	.5
EDUCATION								
TEACHERS: K-8	.0	.1	.2	.5	.2	.3	.1	.3
TEACHERS: 9-12	.0	.0	.1	.3	.2	.4	.1	.2
CLASSROOM SPACE: (SQUARE METERS 9-12)	2.6	12.7	38.0	71.5	50.7	95.5	31.7	61.3
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	.9	4.4	14.2	27.5	16.6	32.2	18.7	36.3
SOLID WASTE (VEHICLES)	.0	.0	.0	.0	.0	.0	.0	.0
SOLID WASTE (PERSONNEL)	.0	.0	.0	.0	.0	.0	.0	.0
LIQUID WASTE (CUBIC METERS/DAY)	.6	2.9	9.5	18.3	11.1	21.5	12.5	24.2
FIRE AND POLICE								
FIREMEN	.0	.0	.0	.0	.0	.0	.0	.0
POLICEMEN	.0	.0	.0	.1	.1	.1	.1	.1
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.0	.0	.0	.0	.0	.0	.0
NEIGHBORHOOD PARKS (")	.0	.0	.0	.0	.0	.0	.0	.0
COMMUNITY PARKS (")	.0	.0	.0	.0	.0	.0	.0	.0
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	.1	.3	1.1	2.1	1.3	2.4	1.4	2.8
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.0	.0	.0	.0	.1	.0	.1

TABLE C.36. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, MOX FFP Combined System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	625	625	316	316	316	316	316	316
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	1720	2754	1481	3376	1754	4049	1937	4400
BASELINE PLUS PROJECT	45963	46997	47614	49509	52135	54431	56550	59012
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	3.7	5.9	3.1	6.8	3.4	7.4	3.4	7.5
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.9	32.5	38.9	38.8
BASELINE PLUS PROJECT	26.8	26.7	28.0	27.7	31.1	31.2	34.2	34.4
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	37.3	38.2	59.0	55.2	29.8	32.9	26.5	26.2
BASELINE PLUS PROJECT	60.3	59.8	66.8	66.2	52.4	51.6	46.0	45.1
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	103.1	108.6	118.9	108.3	119.8	113.3	119.4	114.8
BASELINE PLUS PROJECT	94.3	94.8	94.6	94.8	95.2	95.7	96.7	97.2

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	.34	1.34	-3.00	4.07	1.13	1.21	.66	.55
BASELINE PLUS PROJECT	.59	.65	.71	1.04	.60	.63	.54	.54

TABLE C.37. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, MOX FFP Combined System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	1.7	2.6	1.4	3.2	1.7	3.9	1.9	4.2
NURSES	4.4	7.1	3.8	8.7	4.5	10.4	5.0	11.4
DENTISTS	.5	.9	.5	1.0	.5	1.3	.6	1.4
HOSPITAL BEDS	5.7	9.1	4.9	11.2	5.8	13.4	6.4	14.6
NURSING CARE BEDS	1.7	2.6	2.2	4.9	3.9	8.6	6.1	13.4
EDUCATION								
TEACHERS: K-8	11.3	18.4	13.8	30.1	10.7	27.7	8.8	19.9
TEACHERS: 9-12	10.6	16.6	9.4	23.5	11.1	24.3	7.3	17.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	2783.7	4377.7	2481.9	6192.2	2927.0	6401.4	1928.4	4481.4
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	976.8	1563.7	840.8	1916.6	995.6	2298.7	1099.9	2498.0
SOLID WASTE (VEHICLES)	.2	.3	.2	.4	.2	.4	.2	.5
SOLID WASTE (PERSONNEL)	.6	.9	.5	1.1	.6	1.3	.6	1.5
LIQUID WASTE (CUBIC METERS/DAY)	651.2	1042.5	560.5	1277.8	663.8	1532.5	733.3	1665.3
FIRE AND POLICE								
FIREMEN	1.2	1.8	1.0	2.3	1.2	2.7	1.3	2.9
POLICEMEN	3.4	5.5	3.0	6.8	3.5	8.1	3.9	8.8
RECREATION								
PLAYGROUNDS (HECTARES)	.7	1.1	.6	1.3	.7	1.6	.8	1.7
NEIGHBORHOOD PARKS (")	.6	.9	.5	1.1	.6	1.4	.7	1.5
COMMUNITY PARKS (")	.9	1.4	.7	1.7	.9	2.0	1.0	2.2
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	100.5	160.8	86.5	197.2	102.4	236.4	113.1	256.9
GOVERNMENT								
ADMINISTRATIVE STAFF	1.5	2.5	1.3	3.0	1.6	3.6	1.7	4.0

TABLE C.38. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, MOX FFP Combined System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	625	625	316	316	316	316	316	316
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	18	293	484	1064	566	1251	638	1410
BASELINE PLUS PROJECT	60394	60669	73181	73761	90110	90796	98644	99416
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.0	.5	.7	1.4	.6	1.4	.6	1.4
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.1	22.0	22.9	33.4	33.5	39.2	38.9
BASELINE PLUS PROJECT	27.8	27.8	29.3	29.2	35.1	35.1	36.2	36.2
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	43.6	63.4	59.2	26.9	28.5	26.7	29.7
BASELINE PLUS PROJECT	51.2	51.1	47.5	47.6	42.8	42.7	48.0	47.9
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	157.7	130.2	133.8	127.5	128.7	125.3	124.1
BASELINE PLUS PROJECT	99.4	99.6	99.4	99.7	99.1	99.3	96.8	96.9
	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	10.15	4.49	65.50	25.77	1.04	1.08	.80	.80
BASELINE PLUS PROJECT	1.40	1.41	3.84	3.91	1.39	1.39	.60	.60

TABLE C.39. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, MOX FFP Combined System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.0	.4	.6	1.4	.8	1.7	.8	1.9
NURSES	.1	1.5	2.4	5.3	2.8	6.2	3.2	7.0
DENTISTS	.0	.2	.3	.6	.3	.7	.4	.8
HOSPITAL BEDS	.1	1.7	2.8	6.3	3.3	7.4	3.7	8.3
NURSING CARE BEDS	.0	.3	2.0	3.8	3.4	7.2	5.3	12.4
EDUCATION								
TEACHERS: K-8	.1	2.1	4.7	10.1	3.1	7.0	2.9	6.8
TEACHERS: 9-12	.1	1.8	2.8	5.8	3.8	7.7	2.3	5.1
CLASSROOM SPACE: (SQUARE METERS 9-12)	29.9	479.8	741.3	1516.5	989.1	2025.0	613.6	1344.9
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	10.4	166.5	274.6	603.9	321.1	710.3	362.0	800.7
SOLID WASTE (VEHICLES)	.0	.0	.1	.1	.1	.1	.1	.2
SOLID WASTE (PERSONNEL)	.0	.1	.2	.4	.2	.4	.2	.5
LIQUID WASTE (CUBIC METERS/DAY)	6.9	111.0	183.1	402.6	214.1	473.5	241.3	533.8
FIRE AND POLICE								
FIREMEN	.0	.2	.3	.7	.4	.8	.4	.9
POLICEMEN	.0	.6	1.0	2.1	1.1	2.5	1.3	2.8
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.1	.2	.4	.2	.5	.3	.6
NEIGHBORHOOD PARKS (")	.0	.1	.2	.4	.2	.4	.2	.5
COMMUNITY PARKS (")	.0	.1	.2	.5	.3	.6	.3	.7
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	.8	12.6	20.8	45.7	24.3	53.8	27.4	60.6
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.3	.4	1.0	.5	1.1	.6	1.3

TABLE C.40. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, MOX FFP Combined System

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	625	625	316	316	316	316	316	316
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	38	868	196	992	229	1165	258	1298
BASELINE PLUS PROJECT	21289	22119	23299	24095	26502	27438	28862	29903
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.2	3.9	.8	4.1	.9	4.2	.9	4.3
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.5	22.2	22.5	33.2	32.9	38.4	38.2
BASELINE PLUS PROJECT	25.5	25.4	26.8	26.6	30.2	30.3	33.2	33.4
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	39.4	62.5	59.1	25.9	27.9	26.0	27.1
BASELINE PLUS PROJECT	59.8	58.9	60.7	60.6	49.5	48.7	45.4	44.7
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	116.3	130.9	127.2	126.5	123.8	122.7	120.0
BASELINE PLUS PROJECT	93.4	94.2	94.3	95.3	95.4	96.2	95.7	96.5

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	5.48	1.15	32.92	2.68	1.03	1.07	.79	.72
BASELINE PLUS PROJECT	.87	.86	1.80	1.71	.86	.87	.57	.57

TABLE C.41. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, MOX FFP Combined System

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2015 EXPECTED	2015 MAXIMUM
HEALTH								
PHYSICIANS	.0	.7	.2	.9	.2	1.0	.2	1.1
NURSES	.1	2.6	.6	2.9	.7	3.4	.8	3.8
DENTISTS	.0	.2	.1	.3	.1	.3	.1	.4
HOSPITAL BEDS	.1	3.2	.7	3.7	.9	4.3	1.0	4.8
NURSING CARE BEDS	.0	.7	.3	1.3	.5	2.3	.7	3.6
EDUCATION								
TEACHERS: K-8	.3	5.9	1.9	9.3	1.2	6.7	1.2	6.2
TEACHERS: 9-12	.2	5.1	1.1	5.8	1.5	7.4	1.0	5.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	61.9	1346.5	296.5	1518.9	405.7	1951.5	257.0	1304.0
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	21.5	492.5	111.4	563.3	130.1	661.4	146.3	737.2
SOLID WASTE (VEHICLES)	.0	.1	.0	.1	.0	.1	.0	.1
SOLID WASTE (PERSONNEL)	.0	.3	.1	.3	.1	.4	.1	.4
LIQUID WASTE (CUBIC METERS/DAY)	14.3	328.4	74.3	375.5	86.7	440.9	97.6	491.5
FIRE AND POLICE								
FIREMEN	.0	.6	.1	.7	.2	.8	.2	.9
POLICEMEN	.1	1.7	.4	2.0	.5	2.3	.5	2.6
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.3	.1	.4	.1	.5	.1	.5
NEIGHBORHOOD PARKS (")	.0	.3	.1	.3	.1	.4	.1	.4
COMMUNITY PARKS (")	.0	.4	.1	.5	.1	.6	.1	.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	1.8	40.3	9.1	46.0	10.6	54.1	12.0	60.2
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.8	.2	.9	.2	1.0	.2	1.2

TABLE C.42. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Independent Spent Fuel Storage Facility (ISFSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1350	1350	301	301	301	301	301	301
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	4180	6272	2765	4574	3322	5511	3604	5956
BASELINE PLUS PROJECT	48423	50515	48898	50707	53704	55892	58217	60569
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	8.6	12.4	5.7	9.0	6.2	9.9	6.2	9.8
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.5	32.4	38.7	38.6
BASELINE PLUS PROJECT	26.5	26.3	27.8	27.5	31.2	31.2	34.3	34.5
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	37.0	37.9	54.5	53.6	33.4	34.2	26.5	26.5
BASELINE PLUS PROJECT	58.9	58.1	66.3	65.8	51.9	51.2	45.4	44.5
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	101.7	107.1	107.6	105.4	112.7	111.4	114.2	113.1
BASELINE PLUS PROJECT	94.6	95.5	94.6	94.9	95.5	96.0	97.0	97.5

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	-.42	-.15	-8.26	-6.32	1.22	1.24	.54	.52
BASELINE PLUS PROJECT	.53	.52	.20	.08	.62	.65	.54	.54

TABLE C.43. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Independent Spent Fuel Storage Facility (ISFSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	4.0	6.0	2.7	4.4	3.2	5.3	3.5	5.7
NURSES	10.8	16.2	7.1	11.8	8.6	14.2	9.3	15.4
DENTISTS	1.3	1.9	.9	1.4	1.0	1.7	1.1	1.8
HOSPITAL BEDS	13.9	20.8	9.2	15.2	11.0	18.3	12.0	19.8
NURSING CARE BEDS	4.1	6.0	3.9	6.4	6.9	11.4	11.0	18.0
EDUCATION								
TEACHERS: K-8	27.3	41.7	24.5	40.1	23.0	39.1	16.4	27.2
TEACHERS: 9-12	25.8	38.1	19.3	32.5	19.7	32.2	14.0	23.2
CLASSROOM SPACE: (SQUARE METERS 9-12)	6793.1	10016.0	5083.4	8556.4	5184.2	8473.9	3676.8	6107.0
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	2373.0	3561.0	1570.1	2546.8	1886.0	3128.6	2046.2	3381.7
SOLID WASTE (VEHICLES)	.5	.7	.3	.5	.4	.6	.4	.7
SOLID WASTE (PERSONNEL)	1.4	2.1	.9	1.5	1.1	1.8	1.2	2.0
LIQUID WASTE (CUBIC METERS/DAY)	1582.0	2374.0	1046.7	1731.2	1257.4	2085.8	1364.1	2254.5
FIRE AND POLICE								
FIREMEN	2.8	4.2	1.9	3.1	2.2	3.7	2.4	4.0
POLICEMEN	8.4	12.5	5.5	9.1	6.6	11.0	7.2	11.9
RECREATION								
PLAYGROUNDS (HECTARES)	1.6	2.5	1.1	1.8	1.3	2.2	1.4	2.3
NEIGHBORHOOD PARKS (")	1.4	2.1	.9	1.5	1.1	1.9	1.2	2.0
COMMUNITY PARKS (")	2.1	3.1	1.4	2.3	1.7	2.7	1.8	3.0
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	244.1	366.3	161.5	267.1	194.0	321.8	210.5	347.9
GOVERNMENT								
ADMINISTRATIVE STAFF	3.8	5.6	2.5	4.1	3.0	5.0	3.2	5.4

TABLE C.44. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Independent Spent Fuel Storage Facility (ISFSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1350	1350	301	301	301	301	301	301
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	234	3090	255	2615	299	3130	334	3394
BASELINE PLUS PROJECT	21486	24342	23358	25717	26572	29403	28938	31998
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.1	12.7	1.1	10.2	1.1	10.6	1.2	10.6
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.5	23.3	22.3	33.0	32.3	37.8	38.0
BASELINE PLUS PROJECT	25.5	25.0	26.8	26.3	30.2	30.5	33.2	33.8
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	36.9	57.0	52.9	28.3	32.9	30.0	26.5
BASELINE PLUS PROJECT	59.6	56.5	60.6	59.8	49.5	47.7	45.4	43.3
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	101.0	135.6	108.7	127.7	112.7	120.5	112.7
BASELINE PLUS PROJECT	93.9	94.3	94.5	95.5	95.4	96.9	95.8	97.2

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	1.01	.27	1.73	-3.34	1.05	1.20	.74	.54
BASELINE PLUS PROJECT	.85	.78	1.67	1.10	.86	.89	.57	.56

TABLE C.45. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Independent Spent Fuel Storage Facility (ISFSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.2	2.7	.2	2.2	.3	2.7	.3	2.9
NURSES	.7	9.1	.8	7.7	.9	9.2	1.0	10.0
DENTISTS	.1	.8	.1	.7	.1	.8	.1	.9
HOSPITAL BEDS	.9	11.5	1.0	9.8	1.1	11.7	1.2	12.7
NURSING CARE BEDS	.1	2.9	.3	3.3	.6	5.6	1.0	8.9
EDUCATION								
TEACHERS: K-8	1.7	20.2	2.4	22.9	1.7	21.6	1.7	16.0
TEACHERS: 9-12	1.5	19.1	1.3	17.8	1.8	18.2	1.3	13.3
CLASSROOM SPACE: (SQUARE METERS 9-12)	383.0	5034.4	348.8	4692.3	475.3	4794.3	332.3	3510.2
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	132.9	1754.3	144.9	1484.5	169.6	1777.0	189.4	1926.9
SOLID WASTE (VEHICLES)	.0	.3	.0	.3	.0	.3	.0	.4
SOLID WASTE (PERSONNEL)	.1	1.0	.1	.9	.1	1.0	.1	1.1
LIQUID WASTE (CUBIC METERS/DAY)	88.6	1169.5	96.6	989.6	113.1	1184.7	126.3	1284.6
FIRE AND POLICE								
FIREMEN	.2	2.1	.2	1.8	.2	2.1	.2	2.3
POLICEMEN	.5	6.2	.5	5.2	.6	6.3	.7	6.8
RECREATION								
PLAYGROUNDS (HECTARES)	.1	1.2	.1	1.0	.1	1.2	.1	1.3
NEIGHBORHOOD PARKS (")	.1	1.0	.1	.9	.1	1.1	.1	1.1
COMMUNITY PARKS (")	.1	1.5	.1	1.3	.1	1.6	.2	1.7
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	10.9	143.4	11.8	121.3	13.9	145.2	15.5	157.5
GOVERNMENT								
ADMINISTRATIVE STAFF	.2	2.8	.2	2.4	.3	2.8	.3	3.1

TABLE C.46. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Independent Spent Fuel Storage Facility (ISFSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1350	1350	301	301	301	301	301	301
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	40	914	478	1501	560	1780	631	2006
BASELINE PLUS PROJECT	60416	61290	73176	74198	90104	91324	98637	100012
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.1	1.5	.7	2.0	.6	1.9	.6	2.0
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.1	22.2	24.1	33.4	33.5	39.2	38.3
BASELINE PLUS PROJECT	27.8	27.7	29.3	29.2	35.1	35.1	36.2	36.2
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	43.6	62.6	53.8	27.2	30.7	27.3	34.2
BASELINE PLUS PROJECT	51.2	51.1	47.5	47.5	42.8	42.7	48.1	47.9
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	157.7	130.9	138.9	127.7	130.5	125.0	122.5
BASELINE PLUS PROJECT	99.4	100.0	99.4	99.9	99.1	99.5	96.8	97.1

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	7.87	2.25	49.57	9.92	1.05	1.14	.80	.80
BASELINE PLUS PROJECT	1.40	1.40	3.83	3.82	1.39	1.38	.60	.61

TABLE C.47. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Independent Spent Fuel Storage Facility (ISFSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.1	1.2	.6	2.0	.7	2.4	.8	2.7
NURSES	.2	4.5	2.4	7.4	2.8	8.8	3.1	9.9
DENTISTS	.0	.5	.3	.9	.3	1.0	.4	1.1
HOSPITAL BEDS	.2	5.4	2.8	8.8	3.3	10.5	3.7	11.8
NURSING CARE BEDS	.0	1.1	1.9	4.2	3.4	9.5	5.3	18.6
EDUCATION								
TEACHERS: K-8	.3	6.6	4.6	13.8	3.0	10.3	2.9	10.5
TEACHERS: 9-12	.2	5.7	2.7	7.3	3.7	9.7	2.3	7.2
CLASSROOM SPACE: (SQUARE METERS 9-12)	65.6	1495.8	722.9	1914.9	964.7	2560.1	606.2	1888.7
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	22.8	519.0	271.5	852.2	317.8	1010.4	358.2	1139.0
SOLID WASTE (VEHICLES)	.0	.1	.1	.2	.1	.2	.1	.2
SOLID WASTE (PERSONNEL)	.0	.3	.2	.5	.2	.6	.2	.7
LIQUID WASTE (CUBIC METERS/DAY)	15.2	346.0	181.0	568.1	211.9	673.6	238.8	759.3
FIRE AND POLICE								
FIREMEN	.0	.6	.3	1.0	.4	1.2	.4	1.3
POLICEMEN	.1	1.8	1.0	3.0	1.1	3.6	1.3	4.0
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.4	.2	.6	.2	.7	.2	.8
NEIGHBORHOOD PARKS (")	.0	.3	.2	.5	.2	.6	.2	.7
COMMUNITY PARKS (")	.0	.5	.2	.7	.3	.9	.3	1.0
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	1.7	39.3	20.6	64.5	24.1	76.5	27.1	86.3
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.8	.4	1.4	.5	1.6	.6	1.8

TABLE C.48. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Extended Fuel Storage System (ISFSF, SFPF, DCSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1690	1690	361	361	361	361	361	361
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	5333	7922	3617	5770	4350	6956	4712	7513
BASELINE PLUS PROJECT	49576	52165	49750	51903	54732	57338	59324	62126
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	10.8	15.2	7.3	11.1	7.9	12.1	7.9	12.1
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.4	32.3	38.7	38.6
BASELINE PLUS PROJECT	26.4	26.1	27.7	27.4	31.2	31.3	34.4	34.6
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	37.0	37.9	54.1	53.4	33.7	34.3	26.4	26.5
BASELINE PLUS PROJECT	58.4	57.3	66.1	65.4	51.5	50.7	45.0	44.0
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	101.5	106.9	106.5	104.9	112.1	111.1	113.7	112.9
BASELINE PLUS PROJECT	94.8	95.8	94.7	95.0	95.7	96.3	97.2	97.8

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	-.35	-.15	-7.77	-6.34	1.23	1.25	.53	.51
BASELINE PLUS PROJECT	.51	.50	.07	-.10	.64	.66	.54	.53

TABLE C.49. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Extended Fuel Storage System (ISFSF, SFPF, DCSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	5.1	7.6	3.5	5.5	4.2	6.7	4.5	7.2
NURSES	13.8	20.4	9.3	14.9	11.2	17.9	12.2	19.4
DENTISTS	1.7	2.5	1.1	1.8	1.3	2.2	1.5	2.3
HOSPITAL BEDS	17.7	26.3	12.0	19.2	14.4	23.1	15.6	24.9
NURSING CARE BEDS	5.3	7.5	5.1	8.1	9.0	14.3	14.3	22.7
EDUCATION								
TEACHERS: K-8	34.8	52.6	31.9	50.5	30.5	49.6	21.5	34.3
TEACHERS: 9-12	33.0	48.1	25.5	41.2	25.7	40.5	18.3	29.3
CLASSROOM SPACE: (SQUARE METERS 9-12)	8673.3	12660.2	6709.6	10838.1	6752.5	10668.5	4818.3	7711.6
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	3027.8	4497.7	2053.4	3276.1	2469.8	3949.5	2675.0	4265.7
SOLID WASTE (VEHICLES)	.6	.9	.4	.6	.5	.8	.5	.8
SOLID WASTE (PERSONNEL)	1.8	2.6	1.2	1.9	1.4	2.3	1.6	2.5
LIQUID WASTE (CUBIC METERS/DAY)	2018.5	2998.5	1368.9	2184.1	1646.6	2633.0	1783.3	2843.8
FIRE AND POLICE								
FIREMEN	3.6	5.3	2.4	3.9	2.9	4.7	3.2	5.0
POLICEMEN	10.7	15.8	7.2	11.5	8.7	13.9	9.4	15.0
RECREATION								
PLAYGROUNDS (HECTARES)	2.1	3.1	1.4	2.3	1.7	2.7	1.9	3.0
NEIGHBORHOOD PARKS (")	1.8	2.7	1.2	1.9	1.5	2.3	1.6	2.5
COMMUNITY PARKS (")	2.7	3.9	1.8	2.9	2.2	3.5	2.3	3.7
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	311.4	462.6	211.2	337.0	254.1	406.3	275.2	438.8
GOVERNMENT								
ADMINISTRATIVE STAFF	4.8	7.1	3.3	5.2	3.9	6.3	4.2	6.8

TABLE C.50. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Extended Fuel Storage System (ISFSF, SFPF, DCSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1690	1690	361	361	361	361	361	361
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	326	4132	322	3642	377	4368	420	4725
BASELINE PLUS PROJECT	21578	25384	23424	26745	26650	30641	29024	33329
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.5	16.3	1.4	13.6	1.4	14.3	1.4	14.2
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.5	23.5	22.3	33.0	32.2	37.7	38.0
BASELINE PLUS PROJECT	25.5	24.9	26.8	26.1	30.2	30.6	33.3	33.9
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	36.6	56.3	52.5	28.7	33.3	30.6	26.3
BASELINE PLUS PROJECT	59.6	55.5	60.6	59.5	49.4	47.1	45.3	42.5
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	99.6	136.3	106.9	127.9	111.6	120.2	112.0
BASELINE PLUS PROJECT	94.1	94.3	94.6	95.7	95.5	97.3	95.8	97.7

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	.73	.38	-.26	-2.52	1.05	1.21	.73	.52
BASELINE PLUS PROJECT	.85	.78	1.64	1.04	.86	.91	.57	.56

TABLE C.51. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Extended Fuel Storage System (ISFSF, SFPF, DCSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2015 EXPECTED	2015 MAXIMUM
HEALTH								
PHYSICIANS	.3	3.6	.3	3.1	.3	3.8	.4	4.1
NURSES	1.0	12.1	.9	10.7	1.1	12.8	1.2	13.9
DENTISTS	.1	1.1	.1	1.0	.1	1.2	.1	1.3
HOSPITAL BEDS	1.2	15.4	1.2	13.6	1.4	16.3	1.6	17.6
NURSING CARE BEDS	.1	3.9	.4	4.6	.7	7.8	1.2	12.4
EDUCATION								
TEACHERS: K-8	2.3	26.8	3.0	31.8	2.1	30.7	2.2	22.2
TEACHERS: 9-12	2.0	25.7	1.6	25.3	2.2	25.3	1.6	18.6
CLASSROOM SPACE: (SQUARE METERS 9-12)	533.6	6763.9	433.5	6653.3	590.5	6659.7	418.5	4901.2
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	185.1	2346.0	182.7	2067.9	213.9	2479.9	238.7	2682.4
SOLID WASTE (VEHICLES)	.0	.5	.0	.4	.0	.5	.0	.5
SOLID WASTE (PERSONNEL)	.1	1.4	.1	1.2	.1	1.4	.1	1.6
LIQUID WASTE (CUBIC METERS/DAY)	123.4	1564.0	121.8	1378.6	142.6	1653.3	159.1	1788.3
FIRE AND POLICE								
FIREMEN	.2	2.8	.2	2.4	.3	2.9	.3	3.2
POLICEMEN	.7	8.3	.6	7.3	.8	8.7	.8	9.4
RECREATION								
PLAYGROUNDS (HECTARES)	.1	1.6	.1	1.4	.1	1.7	.2	1.9
NEIGHBORHOOD PARKS (")	.1	1.4	.1	1.2	.1	1.5	.1	1.6
COMMUNITY PARKS (")	.2	2.1	.2	1.8	.2	2.2	.2	2.4
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	15.1	191.7	14.9	169.0	17.5	202.7	19.5	219.2
GOVERNMENT								
ADMINISTRATIVE STAFF	.3	3.7	.3	3.3	.3	3.9	.4	4.3

TABLE C.52. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Extended Fuel Storage System (ISFSF, SFPF, DCSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1690	1690	361	361	361	361	361	361
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	100	1576	613	2292	719	2712	811	3057
BASELINE PLUS PROJECT	60476	61952	73311	74989	90264	92256	98817	101063
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.2	2.5	.8	3.1	.8	2.9	.8	3.0
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.3	22.5	23.8	33.5	33.5	39.0	38.4
BASELINE PLUS PROJECT	27.8	27.7	29.3	29.1	35.1	35.1	36.2	36.2
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	42.5	61.2	55.1	27.8	30.1	28.3	33.1
BASELINE PLUS PROJECT	51.2	50.9	47.5	47.6	42.8	42.5	48.0	47.7
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	141.2	132.1	137.6	128.1	130.0	124.6	122.9
BASELINE PLUS PROJECT	99.4	100.2	99.5	100.2	99.1	99.7	96.8	97.3

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	5.98	1.89	36.26	7.49	1.06	1.12	.80	.80
BASELINE PLUS PROJECT	1.40	1.40	3.85	3.82	1.39	1.38	.60	.61

TABLE C.53. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Extended Fuel Storage System (ISFSF, SFPF, DCSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.1	2.1	.8	3.0	1.0	3.6	1.1	4.1
NURSES	.5	7.8	3.0	11.3	3.6	13.4	4.0	15.1
DENTISTS	.1	.9	.3	1.3	.4	1.5	.5	1.7
HOSPITAL BEDS	.6	9.3	3.6	13.5	4.2	15.9	4.8	18.0
NURSING CARE BEDS	.1	2.7	2.3	6.8	4.2	14.7	7.0	28.0
EDUCATION								
TEACHERS: K-8	.7	11.2	5.9	21.2	4.0	15.5	3.8	15.6
TEACHERS: 9-12	.6	9.2	3.4	11.4	4.6	15.3	3.0	11.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	163.8	2430.3	905.5	3009.0	1208.7	4021.5	776.8	2886.9
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	56.8	894.7	348.3	1301.1	408.5	1539.5	460.5	1735.5
SOLID WASTE (VEHICLES)	.0	.2	.1	.3	.1	.3	.1	.3
SOLID WASTE (PERSONNEL)	.0	.5	.2	.8	.2	.9	.3	1.0
LIQUID WASTE (CUBIC METERS/DAY)	37.9	596.5	232.2	867.4	272.3	1026.4	307.0	1157.0
FIRE AND POLICE								
FIREMEN	.1	1.1	.4	1.5	.5	1.8	.5	2.0
POLICEMEN	.2	3.2	1.2	4.6	1.4	5.4	1.6	6.1
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.6	.2	.9	.3	1.1	.3	1.2
NEIGHBORHOOD PARKS (")	.0	.5	.2	.8	.2	.9	.3	1.0
COMMUNITY PARKS (")	.0	.8	.3	1.1	.4	1.4	.4	1.5
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	4.3	67.8	26.4	98.5	30.9	116.6	34.9	131.4
GOVERNMENT								
ADMINISTRATIVE STAFF	.1	1.4	.6	2.1	.6	2.4	.7	2.8

TABLE C.54. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Retrievable Waste Storage Facility (RWSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1060	1060	164	164	164	164	164	164
BASELINE	44243		46133		50382		54613	
PROJECT IN-MIGRATION (CUMULATIVE)	3196	4865	1832	2868	2206	3460	2387	3735
BASELINE PLUS PROJECT	47439	49108	47965	49001	52588	53841	56999	58347
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	6.7	9.9	3.8	5.9	4.2	6.4	4.2	6.4
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		34.0	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.1	32.4	32.3	38.6	38.6
BASELINE PLUS PROJECT	26.6	26.4	28.0	27.8	31.1	31.2	34.2	34.3
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		46.8	
PROJECT IN-MIGRATION	37.4	38.0	53.7	53.0	34.1	34.6	26.6	26.7
BASELINE PLUS PROJECT	59.5	58.7	66.5	66.2	52.4	51.9	45.9	45.4
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.9	
PROJECT IN-MIGRATION	102.0	107.4	105.9	104.9	111.7	111.0	113.3	112.7
BASELINE PLUS PROJECT	94.5	95.2	94.3	94.5	95.1	95.4	96.6	96.9

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.60		.84		.59		.54	
PROJECT IN-MIGRATION	-.83	-.76	-11.13	-10.57	1.24	1.25	.52	.51
BASELINE PLUS PROJECT	.52	.49	.22	-.04	.61	.63	.54	.54

TABLE C.55. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Retrievable Waste Storage Facility (RWSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	3.1	4.7	1.8	2.8	2.1	3.3	2.3	3.6
NURSES	8.2	12.6	4.7	7.4	5.7	8.9	6.2	9.6
DENTISTS	1.0	1.5	.6	.9	.7	1.1	.7	1.2
HOSPITAL BEDS	10.6	16.2	6.1	9.5	7.3	11.5	7.9	12.4
NURSING CARE BEDS	3.1	4.6	2.6	4.0	4.6	7.1	7.2	11.3
EDUCATION								
TEACHERS: K-8	20.9	32.3	16.1	25.0	15.6	24.8	10.9	17.1
TEACHERS: 9-12	19.7	29.5	13.0	20.4	12.9	20.0	9.3	14.6
CLASSROOM SPACE: (SQUARE METERS 9-12)	5189.3	7760.7	3408.7	5373.7	3394.9	5265.6	2444.1	3834.0
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	1814.5	2762.1	1040.3	1628.3	1252.7	1964.2	1355.0	2120.4
SOLID WASTE (VEHICLES)	.4	.5	.2	.3	.2	.4	.3	.4
SOLID WASTE (PERSONNEL)	1.1	1.6	.6	.9	.7	1.1	.8	1.2
LIQUID WASTE (CUBIC METERS/DAY)	1209.7	1841.4	693.5	1085.5	835.1	1309.5	903.4	1413.6
FIRE AND POLICE								
FIREMEN	2.1	3.3	1.2	1.9	1.5	2.3	1.6	2.5
POLICEMEN	6.4	9.7	3.7	5.7	4.4	6.9	4.8	7.5
RECREATION								
PLAYGROUNDS (HECTARES)	1.3	1.9	.7	1.1	.9	1.4	.9	1.5
NEIGHBORHOOD PARKS (")	1.1	1.6	.6	1.0	.7	1.2	.8	1.3
COMMUNITY PARKS (")	1.6	2.4	.9	1.4	1.1	1.7	1.2	1.9
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	186.6	284.1	107.0	167.5	128.9	202.0	139.4	218.1
GOVERNMENT								
ADMINISTRATIVE STAFF	2.9	4.4	1.6	2.6	2.0	3.1	2.1	3.4

TABLE C.56. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Retrievable Waste Storage Facility (RWSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1060	1060	164	164	164	164	164	164
BASELINE	21252		23102		26273		28604	
PROJECT IN-MIGRATION (CUMULATIVE)	156	2201	149	1527	174	1827	194	1981
BASELINE PLUS PROJECT	21407	23453	23251	24629	26447	28100	28798	30585
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.7	9.4	.6	6.2	.7	6.5	.7	6.5
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		33.2	
PROJECT IN-MIGRATION	23.1	23.5	23.5	22.5	33.0	32.3	37.6	37.9
BASELINE PLUS PROJECT	25.5	25.2	26.8	26.5	30.2	30.4	33.2	33.5
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		45.6	
PROJECT IN-MIGRATION	43.6	37.3	56.1	52.4	28.8	33.1	30.7	27.2
BASELINE PLUS PROJECT	59.7	57.4	60.6	60.1	49.6	48.5	45.5	44.2
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	103.2	136.5	110.2	127.9	113.4	120.1	112.7
BASELINE PLUS PROJECT	93.7	94.2	94.3	95.0	95.3	96.2	95.7	96.6

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.85		1.67		.86		.57	
PROJECT IN-MIGRATION	.63	-.30	-.89	-7.31	1.05	1.20	.73	.54
BASELINE PLUS PROJECT	.85	.76	1.65	.98	.86	.88	.57	.57

TABLE C.57. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Retrievable Waste Storage Facility (RWSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.1	1.9	.1	1.3	.1	1.6	.2	1.7
NURSES	.5	6.5	.4	4.5	.5	5.4	.6	5.8
DENTISTS	.0	.6	.0	.4	.0	.5	.1	.5
HOSPITAL BEDS	.6	8.2	.6	5.7	.6	6.8	.7	7.4
NURSING CARE BEDS	.1	2.0	.2	1.8	.3	3.2	.6	5.3
EDUCATION								
TEACHERS: K-8	1.1	14.5	1.4	13.4	1.0	12.6	1.0	9.5
TEACHERS: 9-12	1.0	13.5	.8	10.2	1.0	10.5	.7	7.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	254.6	3559.2	199.4	2685.1	271.6	2759.0	193.4	2045.8
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	88.3	1249.6	84.5	866.9	98.9	1037.2	110.3	1124.8
SOLID WASTE (VEHICLES)	.0	.2	.0	.2	.0	.2	.0	.2
SOLID WASTE (PERSONNEL)	.1	.7	.0	.5	.1	.6	.1	.7
LIQUID WASTE (CUBIC METERS/DAY)	58.9	833.1	56.3	578.0	65.9	691.5	73.5	749.9
FIRE AND POLICE								
FIREMEN	.1	1.5	.1	1.0	.1	1.2	.1	1.3
POLICEMEN	.3	4.4	.3	3.1	.3	3.7	.4	4.0
RECREATION								
PLAYGROUNDS (HECTARES)	.1	.9	.1	.6	.1	.7	.1	.8
NEIGHBORHOOD PARKS (")	.1	.7	.1	.5	.1	.6	.1	.7
COMMUNITY PARKS (")	.1	1.1	.1	.8	.1	.9	.1	1.0
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	7.2	102.1	6.9	70.9	8.1	84.8	9.0	91.9
GOVERNMENT								
ADMINISTRATIVE STAFF	.1	2.0	.1	1.4	.2	1.6	.2	1.8

TABLE C.58. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Retrievable Waste Storage Facility (RWSF)

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1060	1060	164	164	164	164	164	164
BASELINE	60376		72697		89545		98006	
PROJECT IN-MIGRATION (CUMULATIVE)	31	666	268	947	313	1125	353	1268
BASELINE PLUS PROJECT	60407	61042	72965	73644	89858	90670	98359	99274
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.1	1.1	.4	1.3	.3	1.2	.4	1.3
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.1	22.3	24.4	33.4	33.5	39.1	38.1
BASELINE PLUS PROJECT	27.8	27.7	29.3	29.3	35.1	35.1	36.1	36.2
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		48.2	
PROJECT IN-MIGRATION	43.6	43.6	62.0	52.3	27.4	31.3	27.7	35.5
BASELINE PLUS PROJECT	51.2	51.1	47.5	47.5	42.9	42.8	48.1	48.0
SEX RATIO								
BASELINE	99.4		99.3		98.9		96.6	
PROJECT IN-MIGRATION	157.7	157.7	131.4	140.4	127.9	131.0	124.9	122.0
BASELINE PLUS PROJECT	99.4	99.8	99.4	99.7	99.0	99.3	96.7	96.9

	PERIOD AND IMPACT CONDITION							
	1980-2015		1980-1985		1985-2000		2000-2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.38		3.71		1.39		.60	
PROJECT IN-MIGRATION	6.95	1.84	43.09	7.04	1.06	1.15	.80	.80
BASELINE PLUS PROJECT	1.39	1.39	3.78	3.75	1.39	1.39	.60	.60

TABLE C.59. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Retrievable Waste Storage Facility (RWSF)

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2015	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.0	.9	.4	1.3	.4	1.5	.5	1.7
NURSES	.2	3.3	1.3	4.7	1.6	5.6	1.7	6.3
DENTISTS	.0	.4	.2	.5	.2	.6	.2	.7
HOSPITAL BEDS	.2	3.9	1.6	5.6	1.8	6.6	2.1	7.5
NURSING CARE BEDS	.0	.8	1.0	2.4	1.9	5.9	3.0	11.9
EDUCATION								
TEACHERS: K-8	.2	4.8	2.6	8.6	1.7	6.6	1.6	6.8
TEACHERS: 9-12	.2	4.1	1.5	4.4	2.0	5.9	1.3	4.5
CLASSROOM SPACE: (SQUARE METERS 9-12)	50.8	1089.4	400.7	1167.6	534.7	1561.6	339.1	1189.6
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	17.6	378.0	151.9	537.5	178.0	638.7	200.6	720.0
SOLID WASTE (VEHICLES)	.0	.1	.0	.1	.0	.1	.0	.1
SOLID WASTE (PERSONNEL)	.0	.2	.1	.3	.1	.4	.1	.4
LIQUID WASTE (CUBIC METERS/DAY)	11.7	252.0	101.3	358.3	118.6	425.8	133.8	480.0
FIRE AND POLICE								
FIREMEN	.0	.4	.2	.6	.2	.8	.2	.8
POLICEMEN	.1	1.3	.5	1.9	.6	2.3	.7	2.5
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.3	.1	.4	.1	.4	.1	.5
NEIGHBORHOOD PARKS (")	.0	.2	.1	.3	.1	.4	.1	.4
COMMUNITY PARKS (")	.0	.3	.1	.5	.2	.6	.2	.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	1.3	28.6	11.5	40.7	13.5	48.4	15.2	54.5
GOVERNMENT								
ADMINISTRATIVE STAFF	.0	.6	.2	.9	.3	1.0	.3	1.1

TABLE C.60. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Waste Repository, Salt Formation: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1570	1570	1000	1000	1000	1000	1000	1000
BASELINE	44243		46133		50382		51838	
PROJECT IN-MIGRATION (CUMULATIVE)	4926	7340	5768	12065	6871	14502	7034	14807
BASELINE PLUS PROJECT	49169	51583	51901	58198	57253	64883	58872	66645
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	10.0	14.2	11.1	20.7	12.0	22.4	11.9	22.2
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		31.6	
PROJECT IN-MIGRATION	23.5	23.5	22.0	21.9	32.7	32.4	35.8	35.6
BASELINE PLUS PROJECT	26.4	26.2	27.4	26.7	31.4	31.5	32.1	32.5
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		49.1	
PROJECT IN-MIGRATION	37.0	37.9	57.4	54.7	31.2	33.4	27.3	28.0
BASELINE PLUS PROJECT	58.6	57.6	65.9	64.4	50.2	48.4	46.1	43.9
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.0	
PROJECT IN-MIGRATION	101.6	107.0	113.5	106.2	116.6	112.0	117.2	113.1
BASELINE PLUS PROJECT	94.7	95.7	95.9	96.3	96.8	98.1	97.4	98.8

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.63		.84		.59		.57	
PROJECT IN-MIGRATION	1.42	2.81	3.16	9.94	1.17	1.23	.47	.42
BASELINE PLUS PROJECT	.72	1.02	1.08	2.41	.65	.72	.56	.54

TABLE C.61. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Waste Repository, Salt Formation: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	4.7	7.0	5.5	11.6	6.6	13.9	6.8	14.2
NURSES	12.7	18.9	14.9	31.1	17.7	37.4	18.1	38.2
DENTISTS	1.5	2.3	1.8	3.7	2.1	4.5	2.2	4.6
HOSPITAL BEDS	16.4	24.4	19.2	40.1	22.8	48.1	23.4	49.2
NURSING CARE BEDS	4.9	7.0	8.6	17.5	15.0	30.4	17.3	35.1
EDUCATION								
TEACHERS: K-8	32.2	48.7	52.7	106.9	44.4	101.0	37.8	83.5
TEACHERS: 9-12	30.4	44.6	38.5	85.7	42.6	86.5	34.9	77.9
CLASSROOM SPACE: (SQUARE METERS 9-12)	8009.7	11726.9	10136.1	22552.7	11218.2	22771.4	9195.5	20491.7
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	2796.7	4167.1	3275.0	6849.8	3901.1	8233.3	3993.5	8406.4
SOLID WASTE (VEHICLES)	.5	.8	.6	1.3	.8	1.6	.8	1.6
SOLID WASTE (PERSONNEL)	1.6	2.4	1.9	4.0	2.3	4.8	2.3	4.9
LIQUID WASTE (CUBIC METERS/DAY)	1864.5	2778.1	2183.3	4566.6	2600.7	5488.8	2662.3	5604.3
FIRE AND POLICE								
FIREMEN	3.3	4.9	3.9	8.1	4.6	9.7	4.7	9.9
POLICEMEN	9.9	14.7	11.5	24.1	13.7	29.0	14.1	29.6
RECREATION								
PLAYGROUNDS (HECTARES)	1.9	2.9	2.3	4.7	2.7	5.7	2.8	5.8
NEIGHBORHOOD PARKS (")	1.7	2.5	1.9	4.1	2.3	4.9	2.4	5.0
COMMUNITY PARKS (")	2.5	3.7	2.9	6.0	3.4	7.2	3.5	7.4
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	287.7	428.6	336.9	704.6	401.3	846.9	410.8	864.7
GOVERNMENT								
ADMINISTRATIVE STAFF	4.4	6.6	5.2	10.9	6.2	13.1	6.3	13.3

TABLE C.62. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Waste Repository, Salt Formation: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1570	1570	1000	1000	1000	1000	1000	1000
BASELINE	21252		23102		26273		27127	
PROJECT IN-MIGRATION (CUMULATIVE)	294	3764	681	6849	796	8194	821	8378
BASELINE PLUS PROJECT	21545	25016	23783	29952	27069	34467	27948	35505
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.4	15.0	2.9	22.9	2.9	23.8	2.9	23.6
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		31.0	
PROJECT IN-MIGRATION	23.1	23.5	22.6	22.0	33.1	32.4	35.7	35.3
BASELINE PLUS PROJECT	25.5	24.9	26.7	25.5	30.3	30.9	31.1	32.1
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		46.6	
PROJECT IN-MIGRATION	43.6	36.7	60.7	54.3	26.7	32.1	26.0	27.2
BASELINE PLUS PROJECT	59.6	55.9	60.7	59.2	48.9	45.1	45.9	41.5
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	100.0	132.4	107.6	126.9	112.4	125.6	113.2
BASELINE PLUS PROJECT	94.0	94.3	95.0	97.0	95.9	99.0	96.2	99.4

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.98		1.67		.86		.64	
PROJECT IN-MIGRATION	4.11	3.20	16.82	11.97	1.04	1.19	.63	.45
BASELINE PLUS PROJECT	1.04	1.40	1.98	3.60	.86	.94	.64	.59

TABLE C.63. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Waste Repository, Salt Formation: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.3	3.2	.6	5.9	.7	7.0	.7	7.2
NURSES	.9	11.1	2.0	20.1	2.3	24.1	2.4	24.6
DENTISTS	.1	1.0	.2	1.8	.2	2.2	.2	2.3
HOSPITAL BEDS	1.1	14.0	2.5	25.5	3.0	30.6	3.1	31.3
NURSING CARE BEDS	.1	3.5	.9	9.1	1.6	15.1	1.8	17.3
EDUCATION								
TEACHERS: K-8	2.1	24.5	6.5	60.7	4.3	56.1	4.1	46.9
TEACHERS: 9-12	1.8	23.4	3.8	47.8	5.2	49.2	3.5	43.6
CLASSROOM SPACE: (SQUARE METERS 9-12)	480.5	6153.5	996.5	12580.4	1362.0	12962.6	928.3	11477.9
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	166.7	2137.2	386.6	3888.6	451.7	4652.0	466.2	4756.7
SOLID WASTE (VEHICLES)	.0	.4	.1	.8	.1	.9	.1	.9
SOLID WASTE (PERSONNEL)	.1	1.2	.2	2.3	.3	2.7	.3	2.8
LIQUID WASTE (CUBIC METERS/DAY)	111.1	1424.8	257.7	2592.4	301.2	3101.3	310.8	3171.2
FIRE AND POLICE								
FIREMEN	.2	2.5	.5	4.6	.5	5.5	.6	5.6
POLICEMEN	.6	7.5	1.4	13.7	1.6	16.4	1.6	16.8
RECREATION								
PLAYGROUNDS (HECTARES)	.1	1.5	.3	2.7	.3	3.2	.3	3.3
NEIGHBORHOOD PARKS (")	.1	1.3	.2	2.3	.3	2.8	.3	2.8
COMMUNITY PARKS (")	.1	1.9	.3	3.4	.4	4.1	.4	4.2
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	13.6	174.7	31.6	317.8	36.9	380.2	38.1	388.7
GOVERNMENT								
ADMINISTRATIVE STAFF	.3	3.4	.6	6.2	.7	7.4	.7	7.5

TABLE C.64. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Waste Repository, Salt Formation: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1570	1570	1000	1000	1000	1000	1000	1000
BASELINE	60376		72697		89545		92441	
PROJECT IN-MIGRATION (CUMULATIVE)	111	1214	1571	3693	1839	4345	1895	4495
BASELINE PLUS PROJECT	60487	61590	74269	76390	91383	93890	94335	96935
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.2	2.0	2.1	4.8	2.0	4.6	2.0	4.6
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.2	22.1	23.0	33.4	33.5	36.3	36.0
BASELINE PLUS PROJECT	27.8	27.7	29.2	29.0	35.1	35.1	36.1	36.1
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		39.7	
PROJECT IN-MIGRATION	43.6	43.2	62.8	58.8	27.2	28.6	26.0	27.9
BASELINE PLUS PROJECT	51.2	51.0	47.7	47.9	42.6	42.2	39.4	39.1
SEX RATIO								
BASELINE	99.4		99.3		98.9		98.3	
PROJECT IN-MIGRATION	157.7	151.0	130.7	134.1	127.6	128.8	127.2	127.6
BASELINE PLUS PROJECT	99.4	100.2	99.8	100.7	99.4	100.1	98.8	99.5

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.70		3.71		1.39		.64	
PROJECT IN-MIGRATION	11.35	5.24	53.02	22.25	1.05	1.09	.60	.68
BASELINE PLUS PROJECT	1.78	1.81	4.11	4.31	1.38	1.38	.64	.64

TABLE C.65. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Waste Repository, Salt Formation: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.1	1.6	2.1	4.9	2.4	5.8	2.5	6.0
NURSES	.5	6.0	7.8	18.3	9.1	21.5	9.4	22.2
DENTISTS	.1	.7	.9	2.1	1.0	2.5	1.1	2.6
HOSPITAL BEDS	.7	7.1	9.2	21.7	10.8	25.6	11.1	26.4
NURSING CARE BEDS	.1	1.7	6.3	12.9	11.1	24.9	12.9	29.6
EDUCATION								
TEACHERS: K-8	.8	8.7	15.2	35.0	10.0	24.2	9.2	22.8
TEACHERS: 9-12	.7	7.4	9.1	19.9	12.1	26.5	8.2	18.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	181.5	1941.4	2385.2	5226.4	3182.8	6979.1	2146.5	4958.2
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	63.0	689.0	892.2	2096.5	1044.0	2467.1	1075.7	2551.8
SOLID WASTE (VEHICLES)	.0	.1	.2	.4	.2	.5	.2	.5
SOLID WASTE (PERSONNEL)	.0	.4	.5	1.2	.6	1.4	.6	1.5
LIQUID WASTE (CUBIC METERS/DAY)	42.0	459.4	594.8	1397.7	696.0	1644.7	717.1	1701.2
FIRE AND POLICE								
FIREMEN	.1	.8	1.1	2.5	1.2	2.9	1.3	3.0
POLICEMEN	.2	2.4	3.1	7.4	3.7	8.7	3.8	9.0
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.5	.6	1.5	.7	1.7	.7	1.8
NEIGHHORHOOD PARKS (")	.0	.4	.5	1.2	.6	1.5	.6	1.5
COMMUNITY PARKS (")	.1	.6	.8	1.8	.9	2.2	.9	2.2
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	4.8	52.2	67.6	158.8	79.1	186.9	81.5	193.3
GOVERNMENT								
ADMINISTRATIVE STAFF	.1	1.1	1.4	3.3	1.7	3.9	1.7	4.0

TABLE C.66. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Waste Repository, Salt Formation: Once Through

	1980 Expected	1980 Maximum	1985 Expected	1985 Maximum	2000 Expected	2000 Maximum	2005 Expected	2005 Maximum
	YEAR AND IMPACT CONDITION							
MANPOWER REQUIREMENT	1430	1430	688	688	688	688	688	688
BASELINE	44243		46133		50382		51838	
PROJECT IN-MIGRATION (CUMULATIVE)	4451	6660	4351	8495	5193	10213	5314	10429
BASELINE PLUS PROJECT	48694	50903	50484	54628	55575	60594	57152	62267
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	9.1	13.1	8.6	15.6	9.3	16.9	9.3	16.7
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		31.6	
PROJECT IN-MIGRATION	23.5	23.5	22.0	21.9	32.7	32.4	35.7	35.6
BASELINE PLUS PROJECT	26.5	26.2	27.6	27.0	31.3	31.4	32.0	32.3
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		49.1	
PROJECT IN-MIGRATION	37.0	37.9	56.7	54.6	31.7	33.5	27.5	28.1
BASELINE PLUS PROJECT	58.8	57.9	66.1	65.0	51.0	49.6	46.8	45.1
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.0	
PROJECT IN-MIGRATION	101.7	107.1	112.1	106.3	115.7	112.1	116.4	113.1
BASELINE PLUS PROJECT	94.6	95.6	95.3	95.7	96.2	97.2	96.8	97.8
	PERIOD AND IMPACT CONDITION							
	1980-2005 Expected	1980-2005 Maximum	1980-1985 Expected	1980-1985 Maximum	1985-2000 Expected	1985-2000 Maximum	2000-2005 Expected	2000-2005 Maximum
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.63		.84		.59		.57	
PROJECT IN-MIGRATION	.71	1.79	-.46	4.87	1.18	1.23	.46	.42
BASELINE PLUS PROJECT	.64	.81	.72	1.41	.64	.69	.56	.54

TABLE C.67. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Waste Repository, Salt Formation: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	4.3	6.4	4.2	8.2	5.0	9.8	5.1	10.0
NURSES	11.5	17.2	11.2	21.9	13.4	26.3	13.7	26.9
DENTISTS	1.4	2.1	1.3	2.6	1.6	3.2	1.6	3.2
HOSPITAL BEDS	14.8	22.1	14.4	28.2	17.2	33.9	17.6	34.6
NURSING CARE BEDS	4.4	6.3	6.4	12.3	11.2	21.4	13.0	24.7
EDUCATION								
TEACHERS: K-8	29.1	44.2	39.5	75.2	34.1	71.2	28.9	58.9
TEACHERS: 9-12	27.5	40.4	29.4	60.2	31.9	60.7	26.7	54.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	7235.5	10638.2	7725.6	15844.1	8388.2	15986.9	7023.6	14422.1
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	2527.1	3781.4	2470.1	4823.1	2948.2	5798.1	3016.8	5920.9
SOLID WASTE (VEHICLES)	.5	.7	.5	.9	.6	1.1	.6	1.1
SOLID WASTE (PERSONNEL)	1.5	2.2	1.4	2.8	1.7	3.4	1.8	3.4
LIQUID WASTE (CUBIC METERS/DAY)	1684.7	2521.0	1646.8	3215.4	1965.5	3865.4	2011.2	3947.3
FIRE AND POLICE								
FIREMEN	3.0	4.5	2.9	5.7	3.5	6.8	3.6	7.0
POLICEMEN	8.9	13.3	8.7	17.0	10.4	20.4	10.6	20.9
RECREATION								
PLAYGROUNDS (HECTARES)	1.7	2.6	1.7	3.3	2.0	4.0	2.1	4.1
NEIGHBORHOOD PARKS (")	1.5	2.2	1.5	2.9	1.7	3.4	1.8	3.5
COMMUNITY PARKS (")	2.2	3.3	2.2	4.2	2.6	5.1	2.6	5.2
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	259.9	389.0	254.1	496.1	303.3	596.4	310.3	609.0
GOVERNMENT								
ADMINISTRATIVE STAFF	4.0	6.0	3.9	7.6	4.7	9.2	4.8	9.4

TABLE C.68. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Waste Repository, Salt Formation: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1430	1430	688	688	688	688	688	688
BASELINE	21252		23102		26273		27127	
PROJECT IN-MIGRATION (CUMULATIVE)	256	3335	487	4578	569	5471	588	5598
BASELINE PLUS PROJECT	21507	24587	23589	27680	26842	31744	27714	32725
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.2	13.6	2.1	16.5	2.1	17.2	2.1	17.1
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		31.0	
PROJECT IN-MIGRATION	23.1	23.5	22.7	22.1	33.1	32.4	35.6	35.3
BASELINE PLUS PROJECT	25.5	25.0	26.7	25.9	30.3	30.7	31.1	31.8
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		46.6	
PROJECT IN-MIGRATION	43.6	36.8	60.0	54.3	27.0	32.0	26.4	27.3
BASELINE PLUS PROJECT	59.6	56.3	60.7	59.6	49.2	46.4	46.1	42.9
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	100.6	133.0	109.0	127.1	113.1	125.6	113.7
BASELINE PLUS PROJECT	93.9	94.3	94.8	96.4	95.7	98.0	96.0	98.4

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.98		1.67		.86		.64	
PROJECT IN-MIGRATION	3.33	2.07	12.89	6.34	1.04	1.19	.64	.46
BASELINE PLUS PROJECT	1.01	1.14	1.85	2.37	.86	.91	.64	.61

TABLE C.69. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Waste Repository, Salt Formation: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.2	2.9	.4	3.9	.5	4.7	.5	4.8
NURSES	.8	9.8	1.4	13.5	1.7	16.1	1.7	16.5
DENTISTS	.1	.9	.1	1.2	.2	1.5	.2	1.5
HOSPITAL BEDS	1.0	12.4	1.8	17.1	2.1	20.4	2.2	20.9
NURSING CARE BEDS	.1	3.1	.6	6.0	1.1	10.0	1.3	11.5
EDUCATION								
TEACHERS: K-8	1.8	21.7	4.7	40.6	3.1	37.1	3.0	31.3
TEACHERS: 9-12	1.6	20.7	2.7	31.5	3.7	32.8	2.5	28.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	418.4	5441.3	703.6	8279.6	961.1	8628.3	661.3	7587.3
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	145.2	1893.5	276.5	2599.2	323.2	3106.3	333.7	3178.3
SOLID WASTE (VEHICLES)	.0	.4	.1	.5	.1	.6	.1	.6
SOLID WASTE (PERSONNEL)	.1	1.1	.2	1.5	.2	1.8	.2	1.8
LIQUID WASTE (CUBIC METERS/DAY)	96.8	1262.4	184.4	1732.8	215.5	2070.8	222.5	2118.8
FIRE AND POLICE								
FIREMEN	.2	2.2	.3	3.1	.4	3.7	.4	3.8
POLICEMEN	.5	6.7	1.0	9.2	1.1	10.9	1.2	11.2
RECREATION								
PLAYGROUNDS (HECTARES)	.1	1.3	.2	1.8	.2	2.1	.2	2.2
NEIGHBORHOOD PARKS (")	.1	1.1	.2	1.5	.2	1.8	.2	1.9
COMMUNITY PARKS (")	.1	1.7	.2	2.3	.3	2.7	.3	2.8
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	11.9	154.8	22.6	212.4	26.4	253.9	27.3	259.7
GOVERNMENT								
ADMINISTRATIVE STAFF	.2	3.0	.4	4.1	.5	4.9	.5	5.0

TABLE C.70. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Waste Repository, Salt Formation: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1430	1430	688	688	688	688	688	688
BASELINE	60376		72697		89545		92441	
PROJECT IN-MIGRATION (CUMULATIVE)	66	983	1073	2580	1255	3043	1293	3152
BASELINE PLUS PROJECT	60442	61359	73771	75278	90800	92587	93734	95592
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.1	1.6	1.5	3.4	1.4	3.3	1.4	3.3
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.1	22.1	23.3	33.4	33.5	36.3	35.9
BASELINE PLUS PROJECT	27.8	27.7	29.2	29.1	35.1	35.1	36.1	36.1
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		39.7	
PROJECT IN-MIGRATION	43.6	43.6	63.0	57.5	27.1	29.2	26.0	28.6
BASELINE PLUS PROJECT	51.2	51.0	47.6	47.7	42.7	42.4	39.5	39.3
SEX RATIO								
BASELINE	99.4		99.3		98.9		98.3	
PROJECT IN-MIGRATION	157.7	157.7	130.6	135.4	127.6	129.3	127.2	127.7
BASELINE PLUS PROJECT	99.4	100.1	99.7	100.3	99.3	99.8	98.7	99.2

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.70		3.71		1.39		.64	
PROJECT IN-MIGRATION	11.91	4.66	55.82	19.31	1.05	1.10	.60	.70
BASELINE PLUS PROJECT	1.76	1.77	3.99	4.09	1.38	1.38	.64	.64

TABLE C.71. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Waste Repository, Salt Formation: Once Through

SOCIAL SERVICE UNIT	1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2005 EXPECTED	2005 MAXIMUM
HEALTH								
PHYSICIANS	.1	1.3	1.4	3.4	1.7	4.0	1.7	4.2
NURSES	.3	4.9	5.3	12.8	6.2	15.1	6.4	15.6
DENTISTS	.0	.6	.6	1.5	.7	1.7	.7	1.8
HOSPITAL BEDS	.4	5.8	6.3	15.2	7.4	17.9	7.6	18.5
NURSING CARE BEDS	.1	1.1	4.3	8.5	7.6	17.1	8.8	20.5
EDUCATION								
TEACHERS: K-8	.5	7.1	10.4	24.3	6.8	17.1	6.3	16.2
TEACHERS: 9-12	.4	6.1	6.2	13.5	8.3	18.1	5.6	13.1
CLASSROOM SPACE: (SQUARE METERS 9-12)	107.8	1607.9	1633.3	3556.9	2179.4	4751.1	1466.8	3443.2
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	37.4	557.9	609.2	1465.1	712.8	1727.5	734.3	1789.3
SOLID WASTE (VEHICLES)	.0	.1	.1	.3	.1	.3	.1	.3
SOLID WASTE (PERSONNEL)	.0	.3	.4	.9	.4	1.0	.4	1.0
LIQUID WASTE (CUBIC METERS/DAY)	24.9	371.9	406.2	976.7	475.2	1151.7	489.5	1192.9
FIRE AND POLICE								
FIREMEN	.0	.7	.7	1.7	.8	2.0	.9	2.1
POLICEMEN	.1	2.0	2.1	5.2	2.5	6.1	2.6	6.3
RECREATION								
PLAYGROUNDS (HECTARES)	.0	.4	.4	1.0	.5	1.2	.5	1.2
NEIGHBORHOOD PARKS (")	.0	.3	.4	.9	.4	1.0	.4	1.1
COMMUNITY PARKS (")	.0	.5	.5	1.3	.6	1.5	.6	1.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	2.8	42.3	46.1	111.0	54.0	130.8	55.6	135.5
GOVERNMENT								
ADMINISTRATIVE STAFF	.1	.9	1.0	2.3	1.1	2.7	1.2	2.8

TABLE C.72. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Waste Repository, Granite: U and Pu Recycle

YEAR AND IMPACT CONDITION	1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2005 EXPECTED	2005 MAXIMUM
MANPOWER REQUIREMENT	3140	3140	1200	1200	1200	1200	1200	1200
BASELINE	44243		46133		50382		51838	
PROJECT IN-MIGRATION (CUMULATIVE)	10251	14958	9413	16355	11283	19687	11533	20099
BASELINE PLUS PROJECT	54494	59201	55546	62488	61665	70068	63371	71937
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	18.8	25.3	16.9	26.2	18.3	28.1	18.2	27.9
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		31.6	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.5	32.4	35.6	35.5
BASELINE PLUS PROJECT	25.9	25.6	27.0	26.3	31.5	31.6	32.4	32.8
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		49.1	
PROJECT IN-MIGRATION	36.9	37.8	55.4	54.1	32.8	33.9	27.9	28.3
BASELINE PLUS PROJECT	56.1	54.7	65.0	63.5	49.1	47.3	44.7	42.6
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.0	
PROJECT IN-MIGRATION	101.2	106.5	108.8	105.5	113.6	111.5	114.5	112.6
BASELINE PLUS PROJECT	95.3	97.0	96.3	96.8	97.7	98.9	98.3	99.6

PERIOD AND IMPACT CONDITION	1980-2005 EXPECTED	1980-2005 MAXIMUM	1980-1985 EXPECTED	1980-1985 MAXIMUM	1985-2000 EXPECTED	1985-2000 MAXIMUM	2000-2005 EXPECTED	2000-2005 MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.63		.84		.59		.57	
PROJECT IN-MIGRATION	.47	1.18	-1.71	1.79	1.21	1.24	.44	.41
BASELINE PLUS PROJECT	.60	.78	.38	1.08	.70	.76	.55	.53

TABLE C.73. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Waste Repository, Granite: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	9.8	14.4	9.0	15.7	10.8	18.9	11.1	19.3
NURSES	26.4	38.6	24.3	42.2	29.1	50.8	29.8	51.9
DENTISTS	3.2	4.6	2.9	5.1	3.5	6.1	3.6	6.2
HOSPITAL BEDS	34.0	49.7	31.3	54.3	37.5	65.4	38.3	66.7
NURSING CARE BEDS	10.2	14.3	13.7	23.4	23.9	40.9	27.7	47.4
EDUCATION								
TEACHERS: K-8	66.9	99.2	84.1	144.0	76.8	138.7	64.2	114.4
TEACHERS: 9-12	63.4	90.9	65.3	116.6	67.9	116.2	59.4	106.3
CLASSROOM SPACE: (SQUARE METERS 9-12)	16692.1	23936.8	17178.4	30688.5	17873.8	30591.5	15643.2	27975.9
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	5820.2	8492.4	5344.4	9285.5	6405.8	11177.0	6547.6	11411.0
SOLID WASTE (VEHICLES)	1.1	1.6	1.0	1.8	1.2	2.2	1.3	2.2
SOLID WASTE (PERSONNEL)	3.4	4.9	3.1	5.4	3.7	6.5	3.8	6.6
LIQUID WASTE (CUBIC METERS/DAY)	3880.1	5661.6	5563.0	6190.3	4270.5	7451.4	4365.1	7607.3
FIRE AND POLICE								
FIREMEN	6.9	10.0	6.3	11.0	7.6	13.2	7.7	13.5
POLICEMEN	20.5	29.9	18.8	32.7	22.6	39.4	23.1	40.2
RECREATION								
PLAYGROUNDS (HECTARES)	4.0	5.9	3.7	6.4	4.4	7.7	4.5	7.9
NEIGHBORHOOD PARKS (")	3.4	5.0	3.2	5.5	3.8	6.6	3.9	6.8
COMMUNITY PARKS (")	5.1	7.5	4.7	8.1	5.6	9.8	5.7	10.0
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	598.7	873.5	549.7	955.1	658.9	1149.7	673.5	1173.8
GOVERNMENT								
ADMINISTRATIVE STAFF	9.2	13.5	8.5	14.7	10.2	17.7	10.4	18.1

TABLE C.74. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Waste Repository, Granite: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	3140	3140	1200	1200	1200	1200	1200	1200
BASELINE	21252		23102		26273		27127	
PROJECT IN-MIGRATION (CUMULATIVE)	719	8577	944	10728	1104	12867	1141	13149
BASELINE PLUS PROJECT	21970	29829	24046	33831	27377	39140	28267	40276
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	3.3	28.8	3.9	31.7	4.0	32.9	4.0	32.6
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		31.0	
PROJECT IN-MIGRATION	23.1	23.5	23.1	22.1	33.1	32.3	35.4	35.3
BASELINE PLUS PROJECT	25.4	24.6	26.7	25.0	30.3	31.1	31.2	32.4
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		46.6	
PROJECT IN-MIGRATION	43.6	36.3	58.2	53.2	27.8	33.0	27.4	27.6
BASELINE PLUS PROJECT	59.2	52.3	60.6	58.2	48.7	43.8	45.7	39.8
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	97.5	134.6	105.8	127.5	111.2	125.6	112.0
BASELINE PLUS PROJECT	95.0	94.5	95.4	97.7	96.3	100.1	96.5	100.6

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.98		1.67		.86		.64	
PROJECT IN-MIGRATION	1.85	1.71	5.45	4.48	1.04	1.21	.66	.43
BASELINE PLUS PROJECT	1.01	1.20	1.81	2.52	.86	.97	.64	.57

TABLE C.75. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Waste Repository, Granite: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.6	7.4	.8	9.2	.9	11.1	1.0	11.3
NURSES	2.1	25.2	2.8	31.5	3.2	37.8	3.4	38.7
DENTISTS	.2	2.3	.3	2.9	.3	3.5	.3	3.6
HOSPITAL BEDS	2.7	32.0	3.5	40.0	4.1	48.0	4.3	49.0
NURSING CARE BEDS	.3	8.2	1.2	13.9	2.1	23.2	2.5	26.7
EDUCATION								
TEACHERS: K-8	5.2	55.3	8.9	93.9	6.1	90.2	5.9	75.0
TEACHERS: 9-12	4.5	53.7	5.0	75.7	6.8	75.8	4.8	69.4
CLASSROOM SPACE: (SQUARE METERS 9-12)	1175.8	14139.7	1318.5	19929.0	1798.7	19945.6	1268.4	18260.5
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	408.0	4869.6	535.7	6091.0	626.7	7305.5	647.6	7465.5
SOLID WASTE (VEHICLES)	.1	.9	.1	1.2	.1	1.4	.1	1.4
SOLID WASTE (PERSONNEL)	.2	2.6	.3	3.5	.4	4.2	.4	4.3
LIQUID WASTE (CUBIC METERS/DAY)	272.0	3246.4	357.2	4060.7	417.8	4870.3	431.8	4977.0
FIRE AND POLICE								
FIREMEN	.5	5.7	.6	7.2	.7	8.6	.8	8.8
POLICEMEN	1.4	17.2	1.9	21.5	2.2	25.7	2.3	26.3
RECREATION								
PLAYGROUNDS (HECTARES)	.3	3.4	.4	4.2	.4	5.1	.4	5.2
NEIGHBORHOOD PARKS (")	.2	2.9	.3	3.6	.4	4.3	.4	4.4
COMMUNITY PARKS (")	.4	4.3	.5	5.3	.5	6.4	.6	6.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	33.3	398.0	43.8	497.8	51.2	597.1	52.9	610.1
GOVERNMENT								
ADMINISTRATIVE STAFF	.6	7.7	.8	9.7	1.0	11.6	1.0	11.8

TABLE C.76. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Waste Repository, Granite: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	3140	3140	1200	1200	1200	1200	1200	1200
BASELINE	60376		72697		89545		92441	
PROJECT IN-MIGRATION (CUMULATIVE)	524	6265	2186	10374	2569	12414	2655	12771
BASELINE PLUS PROJECT	60901	66642	74884	83071	92114	101958	95095	105211
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.9	9.4	2.9	12.5	2.8	12.2	2.8	12.1
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.5	22.8	22.6	33.5	32.8	36.1	35.7
BASELINE PLUS PROJECT	27.8	27.2	29.1	28.4	35.1	34.8	36.1	36.0
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		39.7	
PROJECT IN-MIGRATION	43.6	38.0	59.8	55.0	28.2	32.4	27.4	29.2
BASELINE PLUS PROJECT	51.1	49.8	47.7	48.3	42.5	41.6	39.3	38.3
SEX RATIO								
BASELINE	99.4		99.3		98.9		98.3	
PROJECT IN-MIGRATION	157.7	107.5	133.2	118.7	128.5	119.6	127.5	119.5
BASELINE PLUS PROJECT	99.7	100.1	100.1	101.5	99.6	101.2	99.0	100.7

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.70		3.71		1.39		.64	
PROJECT IN-MIGRATION	6.49	2.85	28.55	10.08	1.08	1.20	.66	.57
BASELINE PLUS PROJECT	1.78	1.83	4.13	4.41	1.38	1.37	.64	.63

TABLE C.77. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Waste Repository, Granite: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.7	8.3	2.9	13.8	3.4	16.5	3.5	17.0
NURSES	2.6	31.0	10.8	51.4	12.7	61.4	13.1	63.2
DENTISTS	.3	3.6	1.2	5.9	1.5	7.1	1.5	7.3
HOSPITAL BEDS	3.1	36.8	12.9	61.0	15.1	73.0	15.6	75.1
NURSING CARE BEDS	.6	15.3	7.9	35.6	14.9	67.2	17.6	79.5
EDUCATION								
TEACHERS: K-8	3.8	41.7	20.8	93.9	14.2	80.3	13.3	71.3
TEACHERS: 9-12	3.3	38.0	12.0	64.3	16.0	71.9	11.2	59.9
CLASSROOM SPACE: (SQUARE METERS 9-12)	858.1	9992.1	3152.2	16936.9	4208.5	18912.1	2948.7	15753.9
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	297.7	3557.2	1241.3	5889.8	1458.6	7047.9	1507.2	7250.6
SOLID WASTE (VEHICLES)	.1	.7	.2	1.1	.3	1.4	.3	1.4
SOLID WASTE (PERSONNEL)	.2	2.1	.7	3.4	.8	4.1	.9	4.2
LIQUID WASTE (CUBIC METERS/DAY)	198.5	2371.5	827.5	3926.5	972.4	4698.6	1004.8	4833.7
FIRE AND POLICE								
FIREMEN	.4	4.2	1.5	7.0	1.7	8.3	1.8	8.6
POLICEMEN	1.0	12.5	4.4	20.7	5.1	24.8	5.3	25.5
RECREATION								
PLAYGROUNDS (HECTARES)	.2	2.5	.9	4.1	1.0	4.9	1.0	5.0
NEIGHBORHOOD PARKS (")	.2	2.1	.7	3.5	.9	4.2	.9	4.3
COMMUNITY PARKS (")	.3	3.1	1.1	5.2	1.3	6.2	1.3	6.4
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	22.6	269.4	94.0	446.1	110.5	533.8	114.2	549.1
GOVERNMENT								
ADMINISTRATIVE STAFF	.5	5.6	2.0	9.3	2.3	11.2	2.4	11.5

TABLE C.78. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Waste Repository, Granite: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	4290	4290	800	800	800	800	800	800
BASELINE	60376		72697		89545		95378	
PROJECT IN-MIGRATION (CUMULATIVE)	861	10031	1850	13524	2186	16364	2370	17289
BASELINE PLUS PROJECT	61237	70407	74548	86221	91731	105909	97748	112667
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.4	14.2	2.5	15.7	2.4	15.5	2.4	15.3
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		35.8	
PROJECT IN-MIGRATION	23.1	23.5	23.6	22.6	33.5	32.5	37.2	37.1
BASELINE PLUS PROJECT	27.7	26.9	29.2	28.1	35.1	34.6	35.8	36.1
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		42.1	
PROJECT IN-MIGRATION	43.6	37.2	56.1	52.0	29.7	35.0	30.0	28.2
BASELINE PLUS PROJECT	51.1	49.0	47.6	48.1	42.6	41.7	41.8	39.8
SEX RATIO								
BASELINE	99.4		99.3		98.9		97.5	
PROJECT IN-MIGRATION	157.7	103.0	136.7	111.1	129.7	114.8	125.5	115.1
BASELINE PLUS PROJECT	100.0	99.9	100.0	101.0	99.6	101.2	98.1	100.0

	PERIOD AND IMPACT CONDITION							
	1980-2010		1980-1985		1985-2000		2000-2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.52		3.71		1.39		.63	
PROJECT IN-MIGRATION	3.37	1.81	15.30	5.97	1.11	1.27	.81	.55
BASELINE PLUS PROJECT	1.56	1.57	3.93	4.05	1.38	1.37	.64	.62

TABLE C.79. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Waste Repository, Granite: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	1.1	13.3	2.5	18.0	2.9	21.8	3.2	23.0
NURSES	4.3	49.7	9.2	66.9	10.8	81.0	11.7	85.6
DENTISTS	.5	5.7	1.1	7.7	1.2	9.3	1.4	9.9
HOSPITAL BEDS	5.1	59.0	10.9	79.5	12.9	96.2	13.9	101.7
NURSING CARE BEDS	1.0	25.3	5.7	44.1	12.1	84.5	17.4	118.5
EDUCATION								
TEACHERS: K-8	6.2	65.8	17.3	118.2	12.4	114.8	12.0	88.2
TEACHERS: 9-12	5.4	61.7	9.4	89.3	12.6	89.9	8.8	76.5
CLASSROOM SPACE: (SQUARE METERS 9-12)	1408.8	16235.6	2480.3	23492.8	3314.1	23671.2	2318.3	20128.1
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	488.8	5695.3	1050.6	7678.0	1241.3	9290.8	1345.4	9815.9
SOLID WASTE (VEHICLES)	.1	1.1	.2	1.5	.2	1.8	.3	1.9
SOLID WASTE (PERSONNEL)	.3	3.3	.6	4.5	.7	5.4	.8	5.7
LIQUID WASTE (CUBIC METERS/DAY)	325.9	3796.9	700.4	5118.7	827.6	6193.9	897.0	6543.9
FIRE AND POLICE								
FIREMEN	.6	6.7	1.2	9.1	1.5	11.0	1.6	11.6
POLICEMEN	1.7	20.1	3.7	27.0	4.4	32.7	4.7	34.6
RECREATION								
PLAYGROUNDS (HECTARES)	.3	3.9	.7	5.3	.9	6.4	.9	6.8
NEIGHBORHOOD PARKS (")	.3	3.4	.6	4.5	.7	5.5	.8	5.8
COMMUNITY PARKS (")	.4	5.0	.9	6.7	1.1	8.2	1.2	8.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	37.0	431.3	79.6	581.5	94.0	703.7	101.9	743.4
GOVERNMENT								
ADMINISTRATIVE STAFF	.8	9.0	1.7	12.2	2.0	14.7	2.1	15.6

TABLE C.80. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Waste Repository, Granite: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	4290	4290	800	800	800	800	800	800
BASELINE	44243		46133		50382		53318	
PROJECT IN-MIGRATION (CUMULATIVE)	14152	20538	10053	14762	12127	17824	12687	18636
BASELINE PLUS PROJECT	58395	64781	56186	60895	62509	68206	66004	71953
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	24.2	31.7	17.9	24.2	19.4	26.1	19.2	25.9
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		32.7	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.3	32.3	37.3	37.3
BASELINE PLUS PROJECT	25.6	25.3	26.9	26.4	31.4	31.5	33.6	33.8
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		47.6	
PROJECT IN-MIGRATION	36.9	37.8	53.3	53.0	34.5	34.7	26.2	26.3
BASELINE PLUS PROJECT	54.7	53.1	64.4	63.4	49.2	48.0	42.9	41.4
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.6	
PROJECT IN-MIGRATION	101.1	106.3	104.2	103.8	110.7	110.3	112.4	112.1
BASELINE PLUS PROJECT	95.6	97.7	95.6	96.2	97.4	98.3	98.6	99.6

	PERIOD AND IMPACT CONDITION							
	1980-2010		1980-1985		1985-2000		2000-2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.62		.84		.59		.57	
PROJECT IN-MIGRATION	-.36	-.32	-6.84	-6.60	1.25	1.26	.45	.45
BASELINE PLUS PROJECT	.41	.35	-.77	-1.24	.71	.76	.54	.53

TABLE C.81. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Waste Repository, Granite: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	13.6	19.7	9.7	14.2	11.6	17.1	12.2	17.9
NURSES	36.5	53.0	25.9	38.1	31.3	46.0	32.7	48.1
DENTISTS	4.4	6.4	3.1	4.6	3.8	5.5	3.9	5.8
HOSPITAL BEDS	47.0	68.2	33.4	49.0	40.3	59.2	42.1	61.9
NURSING CARE BEDS	14.0	19.6	14.2	20.6	24.9	36.4	33.6	49.2
EDUCATION								
TEACHERS: K-8	92.3	136.1	87.8	128.4	86.9	128.5	61.9	91.3
TEACHERS: 9-12	87.6	124.9	72.3	106.4	70.6	103.1	57.7	85.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	23051.9	32880.3	19025.2	28000.8	18594.0	27142.2	15192.8	22374.5
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	8034.9	11660.5	5707.8	8381.3	6885.1	10119.5	7202.8	10580.6
SOLID WASTE (VEHICLES)	1.6	2.3	1.1	1.6	1.3	2.0	1.4	2.0
SOLID WASTE (PERSONNEL)	4.7	6.8	3.3	4.9	4.0	5.9	4.2	6.1
LIQUID WASTE (CUBIC METERS/DAY)	5356.6	7773.7	3805.2	5587.5	4590.1	6746.3	4801.9	7053.7
FIRE AND POLICE								
FIREMEN	9.5	13.8	6.7	9.9	8.1	11.9	8.5	12.5
POLICEMEN	28.3	41.1	20.1	29.5	24.3	35.6	25.4	37.3
RECREATION								
PLAYGROUNDS (HECTARES)	5.6	8.1	3.9	5.8	4.8	7.0	5.0	7.3
NEIGHBORHOOD PARKS (")	4.8	6.9	3.4	5.0	4.1	6.0	4.3	6.3
COMMUNITY PARKS (")	7.0	10.2	5.0	7.4	6.0	8.9	6.3	9.3
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	826.5	1199.4	587.1	862.1	708.2	1040.9	740.9	1088.3
GOVERNMENT								
ADMINISTRATIVE STAFF	12.7	18.5	9.0	13.3	10.9	16.0	11.4	16.8

TABLE C.82. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Waste Repository, Granite: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	4290	4290	800	800	800	800	800	800
BASELINE	21252		23102		26273		27935	
PROJECT IN-MIGRATION (CUMULATIVE)	1030	12102	819	11421	960	13741	1034	14373
BASELINE PLUS PROJECT	22281	33354	23922	34524	27233	40014	28969	42309
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	4.6	36.3	3.4	33.1	3.5	34.3	3.6	34.0
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		32.1	
PROJECT IN-MIGRATION	23.1	23.5	23.9	22.2	33.0	32.2	36.1	36.7
BASELINE PLUS PROJECT	25.4	24.4	26.7	25.0	30.3	31.0	32.2	33.7
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		46.1	
PROJECT IN-MIGRATION	43.6	36.2	54.6	51.8	29.5	34.0	30.1	25.7
BASELINE PLUS PROJECT	59.0	50.3	60.5	57.6	48.9	43.9	45.5	38.5
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	96.9	137.9	103.7	128.3	109.8	122.5	110.9
BASELINE PLUS PROJECT	95.6	94.6	95.3	97.2	96.1	99.9	96.4	100.5

	PERIOD AND IMPACT CONDITION							
	1980-2010		1980-1985		1985-2000		2000-2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.91		1.67		.86		.61	
PROJECT IN-MIGRATION	.01	.57	-4.57	-1.16	1.06	1.23	.74	.45
BASELINE PLUS PROJECT	.87	.79	1.42	.69	.86	.98	.62	.56

TABLE C.83. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Waste Repository, Granite: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.9	10.4	.7	9.8	.8	11.8	.9	12.4
NURSES	3.0	35.6	2.4	33.6	2.8	40.4	3.0	42.3
DENTISTS	.3	3.3	.2	3.1	.3	3.7	.3	3.9
HOSPITAL BEDS	3.8	45.1	3.1	42.6	3.6	51.3	3.9	53.6
NURSING CARE BEDS	.4	11.6	.8	14.3	1.7	24.2	2.4	32.4
EDUCATION								
TEACHERS: K-8	7.4	77.9	7.6	98.5	5.5	99.1	5.5	71.2
TEACHERS: 9-12	6.4	75.9	4.0	81.7	5.5	78.9	3.9	66.2
CLASSROOM SPACE: (SQUARE METERS 9-12)	1685.2	19989.6	1063.5	21509.7	1446.4	20767.2	1031.0	17414.2
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	584.7	6871.0	465.2	6484.4	545.0	7801.7	586.8	8160.5
SOLID WASTE (VEHICLES)	.1	1.3	.1	1.3	.1	1.5	.1	1.6
SOLID WASTE (PERSONNEL)	.3	4.0	.3	3.8	.3	4.5	.3	4.7
LIQUID WASTE (CUBIC METERS/DAY)	389.8	4580.7	310.1	4322.9	363.3	5201.1	391.2	5440.3
FIRE AND POLICE								
FIREMEN	.7	8.1	.5	7.7	.6	9.2	.7	9.6
POLICEMEN	2.1	24.2	1.6	22.8	1.9	27.5	2.1	28.7
RECREATION								
PLAYGROUNDS (HECTARES)	.4	4.8	.3	4.5	.4	5.4	.4	5.6
NEIGHBORHOOD PARKS (")	.3	4.1	.3	3.8	.3	4.6	.3	4.8
COMMUNITY PARKS (")	.5	6.0	.4	5.7	.5	6.8	.5	7.2
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	47.8	561.5	38.0	529.9	44.5	637.6	48.0	666.9
GOVERNMENT								
ADMINISTRATIVE STAFF	.9	10.9	.7	10.3	.9	12.4	.9	12.9

TABLE C.84. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Waste Repository, Shale: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1860	1860	1000	1000	1000	1000	1000	1000
BASELINE	60376		72697		89545		92441	
PROJECT IN-MIGRATION (CUMULATIVE)	150	2089	1601	4668	1875	5492	1933	5680
BASELINE PLUS PROJECT	60526	62465	74299	77366	91420	95037	94373	98120
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.2	3.3	2.2	6.0	2.1	5.8	2.0	5.8
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.4	22.2	22.9	33.4	33.5	36.3	36.1
BASELINE PLUS PROJECT	27.8	27.6	29.2	28.9	35.1	35.0	36.1	36.1
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		39.7	
PROJECT IN-MIGRATION	43.6	41.9	62.4	59.0	27.3	28.6	26.2	27.8
BASELINE PLUS PROJECT	51.2	50.8	47.7	48.1	42.6	42.0	39.4	38.9
SEX RATIO								
BASELINE	99.4		99.3		98.9		98.3	
PROJECT IN-MIGRATION	157.7	133.7	131.0	134.0	127.8	128.8	127.3	127.6
BASELINE PLUS PROJECT	99.5	100.3	99.8	101.1	99.4	100.4	98.8	99.8

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.70		3.71		1.39		.64	
PROJECT IN-MIGRATION	10.23	4.00	47.38	16.08	1.05	1.08	.61	.67
BASELINE PLUS PROJECT	1.78	1.81	4.10	4.28	1.38	1.37	.64	.64

TABLE C.85. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Waste Repository, Shale: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.2	2.8	2.1	6.2	2.5	7.3	2.6	7.6
NURSES	.7	10.3	7.9	23.1	9.3	27.2	9.6	28.1
DENTISTS	.1	1.2	.9	2.7	1.1	3.1	1.1	3.2
HOSPITAL BEDS	.9	12.3	9.4	27.4	11.0	32.3	11.4	33.4
NURSING CARE BEDS	.2	4.2	6.3	16.4	11.2	31.5	13.1	37.4
EDUCATION								
TEACHERS: K-8	1.1	14.8	15.5	44.3	10.2	30.6	9.5	28.7
TEACHERS: 9-12	.9	11.9	9.2	25.2	12.2	33.6	8.3	23.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	245.2	3122.9	2414.0	6626.4	3221.5	8848.4	2183.6	6272.4
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	85.1	1186.0	909.1	2650.4	1064.5	3118.2	1097.2	3224.8
SOLID WASTE (VEHICLES)	.0	.2	.2	.5	.2	.6	.2	.6
SOLID WASTE (PERSONNEL)	.0	.7	.5	1.5	.6	1.8	.6	1.9
LIQUID WASTE (CUBIC METERS/DAY)	56.7	790.7	606.1	1766.9	709.7	2078.8	731.5	2149.8
FIRE AND POLICE								
FIREMEN	.1	1.4	1.1	3.1	1.3	3.7	1.3	3.8
POLICEMEN	.3	4.2	3.2	9.3	3.7	11.0	3.9	11.4
RECREATION								
PLAYGROUNDS (HECTARES)	.1	.8	.6	1.8	.7	2.2	.8	2.2
NEIGHBORHOOD PARKS (")	.1	.7	.5	1.6	.6	1.8	.6	1.9
COMMUNITY PARKS (")	.1	1.0	.8	2.3	.9	2.7	1.0	2.8
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	6.4	89.8	68.9	200.7	80.6	236.2	83.1	244.2
GOVERNMENT								
ADMINISTRATIVE STAFF	.1	1.9	1.4	4.2	1.7	4.9	1.7	5.1

TABLE C.86. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Waste Repository, Shale: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1860	1860	1000	1000	1000	1000	1000	1000
BASELINE	21252		23102		26273		27127	
PROJECT IN-MIGRATION (CUMULATIVE)	372	4653	708	7324	828	8767	854	8964
BASELINE PLUS PROJECT	21624	25905	23810	30426	27101	35040	27981	36090
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.7	18.0	3.0	24.1	3.1	25.0	3.1	24.8
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		31.0	
PROJECT IN-MIGRATION	23.1	23.5	22.7	22.1	33.1	32.3	35.6	35.3
BASELINE PLUS PROJECT	25.5	24.9	26.7	25.5	30.3	30.9	31.1	32.1
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		46.6	
PROJECT IN-MIGRATION	43.6	36.6	60.0	54.0	27.0	32.4	26.4	27.3
BASELINE PLUS PROJECT	59.5	55.1	60.6	59.0	48.9	45.0	45.9	41.3
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	99.1	133.0	107.2	127.1	112.1	125.6	112.9
BASELINE PLUS PROJECT	94.2	94.4	95.1	97.1	96.0	99.1	96.3	99.5

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.98		1.67		.86		.64	
PROJECT IN-MIGRATION	3.33	2.62	12.87	9.07	1.04	1.20	.64	.44
BASELINE PLUS PROJECT	1.03	1.33	1.93	3.22	.86	.94	.64	.59

TABLE C.87. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Waste Repository, Shale: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2005 EXPECTED	2005 MAXIMUM
HEALTH								
PHYSICIANS	.3	4.0	.6	6.3	.7	7.5	.7	7.7
NURSES	1.1	13.7	2.1	21.5	2.4	25.8	2.5	26.4
DENTISTS	.1	1.3	.2	2.0	.2	2.4	.2	2.4
HOSPITAL BEDS	1.4	17.4	2.6	27.3	3.1	32.7	3.2	33.4
NURSING CARE BEDS	.2	4.4	.9	9.7	1.6	16.0	1.9	18.4
EDUCATION								
TEACHERS: K-8	2.7	30.2	6.8	64.7	4.5	60.4	4.3	50.5
TEACHERS: 9-12	2.3	29.0	3.9	51.2	5.3	52.4	3.7	46.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	608.9	7628.6	1022.8	13480.0	1397.2	13786.3	961.4	12318.1
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	211.3	2641.9	402.0	4158.2	469.9	4977.7	485.1	5089.2
SOLID WASTE (VEHICLES)	.0	.5	.1	.6	.1	1.0	.1	1.0
SOLID WASTE (PERSONNEL)	.1	1.5	.2	2.4	.3	2.9	.3	3.0
LIQUID WASTE (CUBIC METERS/DAY)	140.8	1761.3	268.0	2772.1	313.2	3318.5	323.4	3392.8
FIRE AND POLICE								
FIREMEN	.2	3.1	.5	4.9	.6	5.9	.6	6.0
POLICEMEN	.7	9.3	1.4	14.6	1.7	17.5	1.7	17.9
RECREATION								
PLAYGROUNDS (HECTARES)	.1	1.8	.3	2.9	.3	3.4	.3	3.5
NEIGHBORHOOD PARKS (")	.1	1.6	.2	2.5	.3	2.9	.3	3.0
COMMUNITY PARKS (")	.2	2.3	.4	3.6	.4	4.4	.4	4.5
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	17.3	215.9	32.9	339.8	38.4	406.8	39.6	415.9
GOVERNMENT								
ADMINISTRATIVE STAFF	.3	4.2	.6	6.6	.7	7.9	.8	8.1

TABLE C.88. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Waste Repository, Shale: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	1860	1860	1000	1000	1000	1000	1000	1000
BASELINE	44243		46133		50382		51838	
PROJECT IN-MIGRATION (CUMULATIVE)	5910	8747	6304	12457	7525	14979	7699	15294
BASELINE PLUS PROJECT	50153	52990	52437	58590	57906	65360	59538	67132
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	11.8	16.5	12.0	21.3	13.0	22.9	12.9	22.8
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		31.6	
PROJECT IN-MIGRATION	23.5	23.5	22.0	21.9	32.7	32.4	35.7	35.6
BASELINE PLUS PROJECT	26.3	26.1	27.3	26.6	31.4	31.5	32.2	32.6
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		49.1	
PROJECT IN-MIGRATION	37.0	37.9	56.7	54.5	31.7	33.5	27.5	28.1
BASELINE PLUS PROJECT	58.1	57.0	65.8	64.2	50.1	48.3	45.9	43.7
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.0	
PROJECT IN-MIGRATION	101.4	106.8	112.0	106.0	115.6	111.9	116.3	113.0
BASELINE PLUS PROJECT	94.8	96.0	95.9	96.3	96.9	98.2	97.5	98.8

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.63		.84		.59		.57	
PROJECT IN-MIGRATION	1.06	2.23	1.29	7.07	1.18	1.23	.46	.42
BASELINE PLUS PROJECT	.69	.95	.89	2.01	.66	.73	.56	.53

TABLE C.89. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Waste Repository, Shale: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	5.7	8.4	6.1	12.0	7.2	14.4	7.4	14.7
NURSES	15.2	22.6	16.3	32.1	19.4	38.6	19.9	39.5
DENTISTS	1.8	2.7	2.0	3.9	2.3	4.6	2.4	4.7
HOSPITAL BEDS	19.6	29.0	20.9	41.4	25.0	49.7	25.6	50.8
NURSING CARE BEDS	5.8	8.3	9.3	18.0	16.3	31.4	18.8	36.2
EDUCATION								
TEACHERS: K-8	38.6	58.1	57.2	110.2	49.4	104.7	41.8	86.5
TEACHERS: 9-12	36.5	53.1	42.6	88.5	46.2	89.1	38.7	80.5
CLASSROOM SPACE: (SQUARE METERS 9-12)	9613.5	13982.5	11213.1	23304.1	12166.7	23451.4	10185.9	21195.7
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	3355.2	4966.1	3579.3	7072.5	4272.1	8504.2	4371.2	8682.9
SOLID WASTE (VEHICLES)	.7	1.0	.7	1.4	.8	1.6	.8	1.7
SOLID WASTE (PERSONNEL)	2.0	2.9	2.1	4.1	2.5	4.9	2.5	5.0
LIQUID WASTE (CUBIC METERS/DAY)	2236.8	3310.7	2386.2	4715.0	2848.1	5669.4	2914.2	5788.6
FIRE AND POLICE								
FIREMEN	4.0	5.9	4.2	8.3	5.0	10.0	5.2	10.2
POLICEMEN	11.8	17.5	12.6	24.9	15.0	30.0	15.4	30.6
RECREATION								
PLAYGROUNDS (HECTARES)	2.3	3.4	2.5	4.9	3.0	5.9	3.0	6.0
NEIGHBORHOOD PARKS (")	2.0	2.9	2.1	4.2	2.5	5.0	2.6	5.1
COMMUNITY PARKS (")	2.9	4.4	3.1	6.2	3.7	7.5	3.8	7.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	345.1	510.8	368.2	727.5	439.4	874.8	449.6	893.1
GOVERNMENT								
ADMINISTRATIVE STAFF	5.3	7.9	5.7	11.2	6.8	13.5	6.9	13.8

TABLE C.90. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Waste Repository, Shale: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	2000	2000	722	722	722	722	722	722
BASELINE	44243		46133		50382		51838	
PROJECT IN-MIGRATION (CUMULATIVE)	6384	9426	5531	9634	6626	11593	6774	11837
BASELINE PLUS PROJECT	50627	53669	51664	55767	57008	61974	58612	63676
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	12.6	17.6	10.7	17.3	11.6	18.7	11.6	18.6
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		31.6	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.5	32.4	35.6	35.5
BASELINE PLUS PROJECT	26.3	26.0	27.4	26.9	31.3	31.4	32.1	32.4
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		49.1	
PROJECT IN-MIGRATION	37.0	37.9	55.5	54.2	32.7	33.3	27.9	28.3
BASELINE PLUS PROJECT	57.8	56.7	65.8	64.7	50.6	49.2	46.3	44.7
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.0	
PROJECT IN-MIGRATION	101.4	106.7	109.3	105.9	113.9	111.7	114.7	112.8
BASELINE PLUS PROJECT	94.9	96.1	95.4	95.8	96.5	97.4	97.1	98.1

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.63		.84		.59		.57	
PROJECT IN-MIGRATION	.24	.91	-2.87	.44	1.20	1.23	.44	.42
BASELINE PLUS PROJECT	.59	.68	.41	.77	.66	.70	.56	.54

TABLE C.91. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Waste Repository, Shale: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2005 EXPECTED	2005 MAXIMUM
HEALTH								
PHYSICIANS	6.1	9.0	5.3	9.2	6.4	11.1	6.5	11.4
NURSES	16.5	24.3	14.3	24.9	17.1	29.9	17.5	30.5
DENTISTS	2.0	2.9	1.7	3.0	2.1	3.6	2.1	3.7
HOSPITAL BEDS	21.2	31.3	18.4	32.0	22.0	38.5	22.5	39.3
NURSING CARE BEDS	6.3	9.0	8.0	13.8	14.1	24.1	16.3	27.9
EDUCATION								
TEACHERS: K-8	41.7	62.5	49.5	84.9	44.9	81.4	37.6	67.3
TEACHERS: 9-12	39.5	57.3	38.2	68.4	39.9	68.5	34.8	62.4
CLASSROOM SPACE: (SQUARE METERS 9-12)	10387.7	15071.0	10048.4	18012.6	10511.0	18027.0	9154.9	16430.3
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	3624.8	5351.8	3140.0	5469.8	3761.8	6581.7	3845.8	6720.7
SOLID WASTE (VEHICLES)	.7	1.0	.6	1.1	.7	1.3	.7	1.3
SOLID WASTE (PERSONNEL)	2.1	3.1	1.8	3.2	2.2	3.8	2.2	3.9
LIQUID WASTE (CUBIC METERS/DAY)	2416.5	3567.8	2093.3	3646.5	2507.9	4387.8	2563.9	4480.4
FIRE AND POLICE								
FIREMEN	4.3	6.3	3.7	6.5	4.4	7.8	4.5	7.9
POLICEMEN	12.8	18.9	11.1	19.3	13.3	23.2	13.5	23.7
RECREATION								
PLAYGROUNDS (HECTARES)	2.5	3.7	2.2	3.8	2.6	4.6	2.7	4.7
NEIGHBORHOOD PARKS (")	2.1	3.2	1.9	3.2	2.2	3.9	2.3	4.0
COMMUNITY PARKS (")	3.2	4.7	2.8	4.8	3.3	5.8	3.4	5.9
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	372.9	550.5	323.0	562.6	386.9	677.0	395.6	691.3
GOVERNMENT								
ADMINISTRATIVE STAFF	5.7	8.5	5.0	8.7	6.0	10.4	6.1	10.7

TABLE C.92. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Waste Repository, Shale: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	2000	2000	722	722	722	722	722	722
BASELINE	21252		23102		26273		27127	
PROJECT IN-MIGRATION (CUMULATIVE)	410	5082	560	5797	655	6943	677	7100
BASELINE PLUS PROJECT	21662	26334	23662	28900	26928	33216	27803	34226
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.9	19.3	2.4	20.1	2.4	20.9	2.4	20.7
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		31.0	
PROJECT IN-MIGRATION	23.1	23.5	23.1	22.2	33.1	32.3	35.4	35.3
BASELINE PLUS PROJECT	25.5	24.8	26.7	25.7	30.3	30.8	31.1	31.9
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		46.6	
PROJECT IN-MIGRATION	43.6	36.5	58.4	53.5	27.7	32.7	27.2	27.6
BASELINE PLUS PROJECT	59.5	54.7	60.6	59.2	49.1	45.8	46.1	42.2
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	98.8	134.4	107.4	127.4	112.1	125.6	112.8
BASELINE PLUS PROJECT	94.3	94.4	94.9	96.6	95.8	98.4	96.1	98.8

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.98		1.67		.86		.64	
PROJECT IN-MIGRATION	2.01	1.34	6.24	2.63	1.04	1.20	.66	.45
BASELINE PLUS PROJECT	1.00	1.05	1.77	1.86	.86	.93	.64	.60

TABLE C.93. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Waste Repository, Shale: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.4	4.4	.5	5.0	.6	6.0	.6	6.1
NURSES	1.2	14.9	1.6	17.0	1.9	20.4	2.0	20.9
DENTISTS	.1	1.4	.2	1.6	.2	1.9	.2	1.9
HOSPITAL BEDS	1.5	19.0	2.1	21.6	2.4	25.9	2.5	26.5
NURSING CARE BEDS	.2	4.8	.7	7.5	1.3	12.6	1.5	14.5
EDUCATION								
TEACHERS: K-8	2.9	32.9	5.3	51.0	3.6	48.0	3.5	40.3
TEACHERS: 9-12	2.5	31.7	3.0	40.3	4.1	41.0	2.9	37.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	670.9	8340.8	785.8	10601.7	1072.2	10792.5	753.7	9738.3
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	232.8	2885.5	318.0	3291.5	371.9	3941.8	384.3	4030.9
SOLID WASTE (VEHICLES)	.0	.6	.1	.6	.1	.8	.1	.8
SOLID WASTE (PERSONNEL)	.1	1.7	.2	1.9	.2	2.3	.2	2.3
LIQUID WASTE (CUBIC METERS/DAY)	155.2	1923.7	212.0	2194.3	247.9	2627.8	256.2	2687.3
FIRE AND POLICE								
FIREMEN	.3	3.4	.4	3.9	.4	4.7	.5	4.8
POLICEMEN	.8	10.2	1.1	11.6	1.3	13.9	1.4	14.2
RECREATION								
PLAYGROUNDS (HECTARES)	.2	2.0	.2	2.3	.3	2.7	.3	2.8
NEIGHBORHOOD PARKS (")	.1	1.7	.2	1.9	.2	2.3	.2	2.4
COMMUNITY PARKS (")	.2	2.5	.3	2.9	.3	3.5	.3	3.5
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	19.0	235.8	26.0	269.0	30.4	322.1	31.4	329.4
GOVERNMENT								
ADMINISTRATIVE STAFF	.4	4.6	.5	5.2	.6	6.2	.6	6.4

TABLE C.94. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Waste Repository, Shale: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	2000	2000	722	722	722	722	722	722
BASELINE	60376		72697		89545		92441	
PROJECT IN-MIGRATION (CUMULATIVE)	191	2532	1220	4288	1430	5068	1476	5242
BASELINE PLUS PROJECT	60567	62908	73917	76985	90975	94613	93916	97682
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	.3	4.0	1.6	5.6	1.6	5.4	1.6	5.4
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.5	22.5	23.1	33.5	33.4	36.2	35.9
BASELINE PLUS PROJECT	27.8	27.6	29.2	28.9	35.1	35.0	36.1	36.1
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		39.7	
PROJECT IN-MIGRATION	43.6	41.2	61.3	57.2	27.7	29.7	26.7	28.6
BASELINE PLUS PROJECT	51.1	50.7	47.6	47.9	42.7	42.2	39.5	39.0
SEX RATIO								
BASELINE	99.4		99.3		98.9		98.3	
PROJECT IN-MIGRATION	157.7	127.5	132.0	132.0	128.1	127.4	127.4	126.2
BASELINE PLUS PROJECT	99.5	100.4	99.7	100.8	99.3	100.3	98.7	99.6

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.70		3.71		1.39		.64	
PROJECT IN-MIGRATION	8.18	2.91	37.10	10.53	1.06	1.11	.63	.67
BASELINE PLUS PROJECT	1.75	1.76	3.98	4.04	1.38	1.37	.64	.64

TABLE C.95. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Waste Repository, Shale: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2005 EXPECTED	2005 MAXIMUM
HEALTH								
PHYSICIANS	.3	3.4	1.6	5.7	1.9	6.7	2.0	7.0
NURSES	.9	12.5	6.0	21.2	7.1	25.1	7.3	25.9
DENTISTS	.1	1.4	.7	2.4	.8	2.9	.8	3.0
HOSPITAL BEDS	1.1	14.9	7.2	25.2	8.4	29.8	8.7	30.8
NURSING CARE BEDS	.2	5.4	4.7	14.4	8.5	28.4	9.9	33.9
EDUCATION								
TEACHERS: K-8	1.4	17.7	11.7	40.1	7.9	29.3	7.3	27.3
TEACHERS: 9-12	1.2	14.4	6.9	23.3	9.1	30.1	6.3	22.3
CLASSROOM SPACE: (SQUARE METERS 9-12)	312.2	3802.8	1804.2	6127.6	2408.1	7911.6	1655.3	5867.4
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	108.3	1437.7	692.4	2434.5	812.0	2877.3	837.9	2976.0
SOLID WASTE (VEHICLES)	.0	.3	.1	.5	.2	.6	.2	.6
SOLID WASTE (PERSONNEL)	.1	.8	.4	1.4	.5	1.7	.5	1.7
LIQUID WASTE (CUBIC METERS/DAY)	72.2	958.5	461.6	1623.0	541.3	1918.2	558.6	1984.0
FIRE AND POLICE								
FIREMEN	.1	1.7	.8	2.9	1.0	3.4	1.0	3.5
POLICEMEN	.4	5.1	2.4	8.6	2.9	10.1	3.0	10.5
RECREATION								
PLAYGROUNDS (HECTARES)	.1	1.0	.5	1.7	.6	2.0	.6	2.1
NEIGHBORHOOD PARKS (")	.1	.9	.4	1.4	.5	1.7	.5	1.8
COMMUNITY PARKS (")	.1	1.3	.6	2.1	.7	2.5	.7	2.6
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	8.2	108.9	52.4	184.4	61.5	217.9	63.5	225.4
GOVERNMENT								
ADMINISTRATIVE STAFF	.2	2.3	1.1	3.9	1.3	4.6	1.3	4.7

TABLE C.96. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Waste Repository, Basalt: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	3710	3710	1170	1170	1170	1170	1170	1170
BASELINE	44243		46133		50382		51838	
PROJECT IN-MIGRATION (CUMULATIVE)	12185	17724	10356	16801	12436	20234	12706	20658
BASELINE PLUS PROJECT	56428	61967	56488	62933	62818	70616	64544	72496
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	21.6	28.6	18.3	26.7	19.8	28.7	19.7	28.5
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		31.6	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.5	32.4	35.6	35.5
BASELINE PLUS PROJECT	25.8	25.5	26.9	26.2	31.5	31.6	32.4	32.8
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		49.1	
PROJECT IN-MIGRATION	36.9	37.8	54.8	53.9	33.3	34.0	28.1	28.4
BASELINE PLUS PROJECT	55.4	53.9	64.7	63.3	48.9	47.2	44.5	42.6
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.0	
PROJECT IN-MIGRATION	101.1	106.4	107.4	105.2	112.7	111.3	113.7	112.4
BASELINE PLUS PROJECT	95.5	97.4	96.2	96.8	97.8	99.0	98.4	99.7

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.63		.84		.59		.57	
PROJECT IN-MIGRATION	.17	.61	-3.25	-1.07	1.22	1.24	.43	.41
BASELINE PLUS PROJECT	.54	.63	.02	.31	.71	.77	.54	.53

TABLE C.97. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Waste Repository, Basalt: U and Pu Recycle

SOCIAL SERVICE UNIT	1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2005 EXPECTED	2005 MAXIMUM
HEALTH								
PHYSICIANS	11.7	17.0	9.9	16.1	11.9	19.4	12.2	19.8
NURSES	31.4	45.7	26.7	43.3	32.1	52.2	32.8	53.3
DENTISTS	3.8	5.5	3.2	5.2	3.9	6.3	3.9	6.4
HOSPITAL BEDS	40.5	58.8	34.4	55.8	41.3	67.2	42.2	68.6
NURSING CARE BEDS	12.1	16.9	14.9	23.9	26.1	41.9	30.2	48.5
EDUCATION								
TEACHERS: K-8	79.5	117.5	91.9	147.6	86.0	143.2	71.5	118.0
TEACHERS: 9-12	75.4	107.8	72.6	119.9	74.1	118.9	66.2	109.5
CLASSROOM SPACE: (SQUARE METERS 9-12)	19844.3	28369.7	19113.4	31555.2	19510.0	31307.2	17427.1	28808.7
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	6917.9	10062.7	5879.4	9538.5	7060.7	11487.9	7213.7	11728.3
SOLID WASTE (VEHICLES)	1.3	1.9	1.1	1.8	1.4	2.2	1.4	2.3
SOLID WASTE (PERSONNEL)	4.0	5.8	3.4	5.5	4.1	6.7	4.2	6.8
LIQUID WASTE (CUBIC METERS/DAY)	4612.0	6708.5	3919.6	6359.0	4707.1	7658.6	4809.1	7818.9
FIRE AND POLICE								
FIREMEN	8.2	11.9	6.9	11.3	8.3	13.6	8.5	13.8
POLICEMEN	24.4	35.4	20.7	33.6	24.9	40.5	25.4	41.3
RECREATION								
PLAYGROUNDS (HECTARES)	4.8	7.0	4.1	6.6	4.9	7.9	5.0	8.1
NEIGHBORHOOD PARKS (")	4.1	6.0	3.5	5.6	4.2	6.8	4.3	6.9
COMMUNITY PARKS (")	6.1	8.8	5.2	8.4	6.2	10.1	6.3	10.3
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	711.6	1035.1	604.8	981.2	726.3	1181.7	742.0	1206.4
GOVERNMENT								
ADMINISTRATIVE STAFF	11.0	16.0	9.3	15.1	11.2	18.2	11.4	18.6

TABLE C.98. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Waste Repository, Basalt: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	3710	3710	1170	1170	1170	1170	1170	1170
BASELINE	21252		23102		26273		27127	
PROJECT IN-MIGRATION (CUMULATIVE)	873	10324	980	11547	1146	13860	1185	14161
BASELINE PLUS PROJECT	22124	31576	24082	34650	27419	40133	28312	41288
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	3.9	32.7	4.1	33.3	4.2	34.5	4.2	34.3
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		31.0	
PROJECT IN-MIGRATION	23.1	23.5	23.3	22.1	33.1	32.2	35.3	35.2
BASELINE PLUS PROJECT	25.4	24.5	26.7	25.0	30.3	31.1	31.2	32.5
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		46.6	
PROJECT IN-MIGRATION	43.6	36.2	57.2	52.8	28.3	33.2	27.9	27.8
BASELINE PLUS PROJECT	59.1	51.3	60.5	58.0	48.7	43.6	45.7	39.6
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	97.2	135.5	105.4	127.7	110.9	125.5	111.7
BASELINE PLUS PROJECT	95.3	94.6	95.5	97.7	96.3	100.3	96.5	100.7

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.98		1.67		.86		.64	
PROJECT IN-MIGRATION	1.22	1.26	2.31	2.24	1.05	1.22	.67	.43
BASELINE PLUS PROJECT	.90	1.07	1.70	1.86	.87	.98	.64	.57

TABLE C.99. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Waste Repository, Basalt: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION 1980 EXPECTED	1980 MAXIMUM	1985 EXPECTED	1985 MAXIMUM	2000 EXPECTED	2000 MAXIMUM	2005 EXPECTED	2005 MAXIMUM
HEALTH								
PHYSICIANS	.8	8.9	.8	9.9	1.0	11.9	1.0	12.2
NURSES	2.6	30.4	2.9	33.9	3.4	40.7	3.5	41.6
DENTISTS	.2	2.8	.3	3.1	.3	3.7	.3	3.8
HOSPITAL BEDS	3.3	38.5	3.7	43.1	4.3	51.7	4.4	52.8
NURSING CARE BEDS	.4	9.9	1.2	14.8	2.2	24.8	2.5	28.6
EDUCATION								
TEACHERS: K-8	6.3	66.5	9.2	100.7	6.4	97.8	6.2	81.2
TEACHERS: 9-12	5.4	64.7	5.1	81.7	7.0	81.1	5.0	75.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	1428.3	17039.2	1343.2	21496.0	1831.1	21335.6	1309.3	19730.9
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	495.6	5861.6	556.1	6555.9	650.8	7868.8	672.9	8040.1
SOLID WASTE (VEHICLES)	.1	1.1	.1	1.3	.1	1.5	.1	1.6
SOLID WASTE (PERSONNEL)	.3	3.4	.3	3.8	.4	4.6	.4	4.7
LIQUID WASTE (CUBIC METERS/DAY)	330.4	3907.7	370.7	4370.6	433.9	5245.9	448.6	5360.1
FIRE AND POLICE								
FIREMEN	.6	6.9	.7	7.7	.8	9.3	.8	9.5
POLICEMEN	1.7	20.6	2.0	23.1	2.3	27.7	2.4	28.3
RECREATION								
PLAYGROUNDS (HECTARES)	.3	4.1	.4	4.5	.5	5.4	.5	5.6
NEIGHBORHOOD PARKS (")	.3	3.5	.3	3.9	.4	4.7	.4	4.8
COMMUNITY PARKS (")	.4	5.1	.5	5.8	.6	6.9	.6	7.1
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	40.5	479.0	45.4	535.8	53.2	643.1	55.0	657.1
GOVERNMENT								
ADMINISTRATIVE STAFF	.8	9.3	.9	10.4	1.0	12.5	1.1	12.7

TABLE C.100. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Waste Repository, Basalt: U and Pu Recycle

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	3710	3710	1170	1170	1170	1170	1170	1170
BASELINE	60376		72697		89545		92441	
PROJECT IN-MIGRATION (CUMULATIVE)	691	8132	2270	12481	2672	15002	2764	15417
BASELINE PLUS PROJECT	61067	68508	74967	85179	92216	104547	95204	107858
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.1	11.9	3.0	14.7	2.9	14.3	2.9	14.3
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		36.1	
PROJECT IN-MIGRATION	23.1	23.5	23.0	22.6	33.5	32.7	36.0	35.6
BASELINE PLUS PROJECT	27.7	27.0	29.1	28.2	35.1	34.7	36.1	36.0
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		39.7	
PROJECT IN-MIGRATION	43.6	37.5	58.7	53.9	28.7	33.4	28.0	29.7
BASELINE PLUS PROJECT	51.1	49.4	47.7	48.3	42.5	41.5	39.3	38.2
SEX RATIO								
BASELINE	99.4		99.3		98.9		98.3	
PROJECT IN-MIGRATION	157.7	104.7	134.2	115.3	128.9	117.5	127.6	117.7
BASELINE PLUS PROJECT	99.9	100.0	100.2	101.5	99.7	101.4	99.0	100.9

	PERIOD AND IMPACT CONDITION							
	1980-2005		1980-1985		1985-2000		2000-2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.70		3.71		1.39		.64	
PROJECT IN-MIGRATION	5.54	2.56	23.78	8.57	1.09	1.23	.68	.55
BASELINE PLUS PROJECT	1.78	1.82	4.10	4.36	1.38	1.37	.64	.62

TABLE C.101. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Waste Repository, Basalt: U and Pu Recycle

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2005	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	.9	10.8	3.0	16.6	3.6	20.0	3.7	20.5
NURSES	3.4	40.3	11.2	61.8	13.2	74.3	13.7	76.3
DENTISTS	.4	4.6	1.3	7.1	1.5	8.6	1.6	8.8
HOSPITAL BEDS	4.1	47.8	13.3	73.4	15.7	88.2	16.3	90.7
NURSING CARE BEDS	.8	20.3	7.9	42.2	15.3	79.8	18.2	94.4
EDUCATION								
TEACHERS: K-8	5.0	53.6	21.5	111.4	14.9	100.4	14.0	88.3
TEACHERS: 9-12	4.3	49.7	12.2	79.7	16.3	85.2	11.6	74.0
CLASSROOM SPACE: (SQUARE METERS 9-12)	1131.1	13086.7	3206.7	20965.6	4282.2	22437.1	3046.5	19478.7
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	392.4	4617.0	1288.8	7086.2	1516.8	8517.5	1569.0	8753.0
SOLID WASTE (VEHICLES)	.1	.9	.2	1.4	.3	1.7	.3	1.7
SOLID WASTE (PERSONNEL)	.2	2.7	.7	4.1	.9	5.0	.9	5.1
LIQUID WASTE (CUBIC METERS/DAY)	261.6	3078.0	859.2	4724.1	1011.2	5678.3	1046.0	5835.4
FIRE AND POLICE								
FIREMEN	.5	5.4	1.5	8.4	1.8	10.1	1.9	10.3
POLICEMEN	1.4	16.3	4.5	25.0	5.3	30.0	5.5	30.8
RECREATION								
PLAYGROUNDS (HECTARES)	.3	3.2	.9	4.9	1.0	5.9	1.1	6.1
NEIGHBORHOOD PARKS (")	.2	2.7	.8	4.2	.9	5.0	.9	5.2
COMMUNITY PARKS (")	.3	4.1	1.1	6.2	1.3	7.5	1.4	7.7
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	29.7	349.7	97.6	536.7	114.9	645.1	118.8	662.9
GOVERNMENT								
ADMINISTRATIVE STAFF	.6	7.3	2.0	11.2	2.4	13.5	2.5	13.9

TABLE C.102. Site County Demographic Impacts for Selected Years by Impact Condition: Southwest Site, Waste Repository, Basalt: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	5290	5290	760	760	760	760	760	760
BASELINE	44243		46133		50382		53318	
PROJECT IN-MIGRATION (CUMULATIVE)	17544	25391	11753	16553	14206	20014	14837	20904
BASELINE PLUS PROJECT	61787	69634	57886	62686	64588	70395	68154	74222
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	28.4	36.5	20.3	26.4	22.0	28.4	21.8	28.2
MEDIAN AGE								
BASELINE	27.0		28.3		31.0		32.7	
PROJECT IN-MIGRATION	23.5	23.5	22.0	22.0	32.3	32.3	37.3	37.3
BASELINE PLUS PROJECT	25.4	25.1	26.7	26.2	31.4	31.5	33.7	33.9
DEPENDENCY RATIO								
BASELINE	61.4		67.1		53.3		47.6	
PROJECT IN-MIGRATION	36.9	37.8	52.7	52.5	35.0	35.1	26.3	26.4
BASELINE PLUS PROJECT	53.6	51.9	64.0	63.0	48.8	47.6	42.3	40.9
SEX RATIO								
BASELINE	94.0		93.9		94.4		95.6	
PROJECT IN-MIGRATION	101.0	106.3	102.8	102.9	109.8	109.8	111.6	111.6
BASELINE PLUS PROJECT	95.9	98.3	95.6	96.2	97.6	98.6	98.9	99.8

	PERIOD AND IMPACT CONDITION							
	1980-2010		1980-1985		1985-2000		2000-2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.62		.84		.59		.57	
PROJECT IN-MIGRATION	-.56	-.65	-8.01	-8.56	1.26	1.27	.43	.44
BASELINE PLUS PROJECT	.33	.21	-1.30	-2.10	.73	.77	.54	.53

TABLE C.103. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southwest Site, Waste Repository, Basalt: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	16.8	24.4	11.3	15.9	13.6	19.2	14.2	20.1
NURSES	45.3	65.5	30.3	42.7	36.7	51.6	38.5	53.9
DENTISTS	5.4	7.9	3.6	5.1	4.4	6.2	4.6	6.5
HOSPITAL BEDS	58.2	84.3	39.0	55.0	47.2	66.4	49.3	69.4
NURSING CARE BEDS	17.4	24.3	16.4	22.9	28.9	40.6	39.1	54.9
EDUCATION								
TEACHERS: K-8	114.4	168.2	101.9	143.2	103.3	145.8	72.7	102.8
TEACHERS: 9-12	108.6	154.5	85.5	120.0	81.9	114.8	68.1	95.8
CLASSROOM SPACE: (SQUARE METERS 9-12)	28582.1	40657.3	22496.4	31592.6	21560.6	30226.2	17922.5	25227.6
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	9960.7	14415.5	6672.9	9398.2	8065.4	11362.8	8423.5	11868.3
SOLID WASTE (VEHICLES)	1.9	2.8	1.3	1.8	1.6	2.2	1.6	2.3
SOLID WASTE (PERSONNEL)	5.8	8.4	3.9	5.5	4.7	6.6	4.9	6.9
LIQUID WASTE (CUBIC METERS/DAY)	6640.5	9610.3	4448.6	6265.4	5376.9	7575.2	5615.7	7912.2
FIRE AND POLICE								
FIREMEN	11.8	17.0	7.9	11.1	9.5	13.4	9.9	14.0
POLICEMEN	35.1	50.8	23.5	33.1	28.4	40.0	29.7	41.8
RECREATION								
PLAYGROUNDS (HECTARES)	6.9	10.0	4.6	6.5	5.6	7.9	5.8	8.2
NEIGHBORHOOD PARKS (")	5.9	8.5	4.0	5.6	4.8	6.7	5.0	7.0
COMMUNITY PARKS (")	8.7	12.6	5.9	8.2	7.1	10.0	7.4	10.4
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	1024.6	1482.8	686.4	966.7	829.6	1168.8	866.5	1220.8
GOVERNMENT								
ADMINISTRATIVE STAFF	15.8	22.9	10.6	14.9	12.8	18.0	13.4	18.8

TABLE C.104. Site County Demographic Impacts for Selected Years by Impact Condition: Southeast Site, Waste Repository, Basalt: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	5290	5290	760	760	760	760	760	760
BASELINE	21252		23102		26273		27935	
PROJECT IN-MIGRATION (CUMULATIVE)	1301	15168	890	13582	1043	16361	1123	17093
BASELINE PLUS PROJECT	22552	36419	23992	36685	27316	42634	29058	45029
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	5.8	41.6	3.7	37.0	3.8	38.4	3.9	38.0
MEDIAN AGE								
BASELINE	25.5		26.8		30.2		32.1	
PROJECT IN-MIGRATION	23.1	23.5	24.2	22.2	32.9	32.1	35.8	36.7
BASELINE PLUS PROJECT	25.3	24.3	26.7	24.8	30.3	31.1	32.2	33.8
DEPENDENCY RATIO								
BASELINE	59.8		60.7		49.7		46.1	
PROJECT IN-MIGRATION	43.6	36.1	53.2	51.3	30.3	34.4	31.1	25.8
BASELINE PLUS PROJECT	58.8	49.0	60.4	57.1	48.9	43.4	45.5	37.7
SEX RATIO								
BASELINE	93.4		94.1		95.1		95.5	
PROJECT IN-MIGRATION	157.7	96.7	139.3	102.8	128.6	109.2	122.1	110.4
BASELINE PLUS PROJECT	96.2	94.7	95.5	97.2	96.2	100.3	96.4	100.9

	PERIOD AND IMPACT CONDITION							
	1980-2010		1980-1985		1985-2000		2000-2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	.91		1.67		.86		.61	
PROJECT IN-MIGRATION	-.49	.40	-7.60	-2.21	1.06	1.24	.74	.44
BASELINE PLUS PROJECT	.84	.71	1.24	.15	.87	1.00	.62	.55

TABLE C.105. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Southeast Site, Waste Repository, Basalt: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	1.1	13.0	.8	11.7	.9	14.1	1.0	14.7
NURSES	3.8	44.6	2.6	39.9	3.1	48.1	3.3	50.3
DENTISTS	.4	4.1	.2	3.7	.3	4.4	.3	4.6
HOSPITAL BEDS	4.9	56.6	3.3	50.7	3.9	61.0	4.2	63.8
NURSING CARE BEDS	.6	14.6	.9	16.9	1.8	28.6	2.6	38.3
EDUCATION								
TEACHERS: K-8	9.4	97.6	8.2	116.5	6.0	119.1	6.1	85.0
TEACHERS: 9-12	8.1	95.3	4.2	97.8	5.8	93.2	4.2	79.1
CLASSROOM SPACE: (SQUARE METERS 9-12)	2128.1	25076.4	1118.3	25750.7	1518.7	24535.0	1110.8	20816.4
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	738.4	8611.4	505.1	7711.4	592.1	9288.8	637.4	9704.7
SOLID WASTE (VEHICLES)	.1	1.7	.1	1.5	.1	1.8	.1	1.9
SOLID WASTE (PERSONNEL)	.4	5.0	.3	4.5	.3	5.4	.4	5.6
LIQUID WASTE (CUBIC METERS/DAY)	492.2	5740.9	336.7	5140.9	394.8	6192.5	425.0	6469.8
FIRE AND POLICE								
FIREMEN	.9	10.2	.6	9.1	.7	11.0	.8	11.5
POLICEMEN	2.6	30.3	1.8	27.2	2.1	32.7	2.2	34.2
RECREATION								
PLAYGROUNDS (HECTARES)	.5	6.0	.3	5.3	.4	6.4	.4	6.7
NEIGHBORHOOD PARKS (")	.4	5.1	.3	4.6	.4	5.5	.4	5.7
COMMUNITY PARKS (")	.6	7.6	.4	6.8	.5	8.2	.6	8.5
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	60.3	703.8	41.3	630.2	48.4	759.1	52.1	793.1
GOVERNMENT								
ADMINISTRATIVE STAFF	1.2	13.7	.8	12.2	.9	14.7	1.0	15.4

TABLE C.106. Site County Demographic Impacts for Selected Years by Impact Condition: Midwest Site, Waste Repository, Basalt: Once Through

	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
MANPOWER REQUIREMENT	5290	5290	760	760	760	760	760	760
BASELINE	60376		72697		89545		95378	
PROJECT IN-MIGRATION (CUMULATIVE)	1154	13306	2016	17364	2388	21078	2592	22210
BASELINE PLUS PROJECT	61530	73682	74713	90061	91933	110623	97970	117587
IN-MIGRANTS AS PERCENT OF BASELINE PLUS PROJECT	1.9	18.1	2.7	19.3	2.6	19.1	2.6	18.9
MEDIAN AGE								
BASELINE	27.8		29.3		35.1		35.8	
PROJECT IN-MIGRATION	23.1	23.5	24.0	22.6	33.5	32.3	37.0	37.1
BASELINE PLUS PROJECT	27.7	26.6	29.2	27.8	35.1	34.4	35.8	36.1
DEPENDENCY RATIO								
BASELINE	51.2		47.4		42.9		42.1	
PROJECT IN-MIGRATION	43.6	36.9	54.4	51.3	30.4	35.8	31.1	28.2
BASELINE PLUS PROJECT	51.0	48.4	47.6	48.1	42.6	41.5	41.8	39.2
SEX RATIO								
BASELINE	99.4		99.3		98.9		97.5	
PROJECT IN-MIGRATION	157.7	101.2	138.3	108.6	130.3	113.3	125.3	113.9
BASELINE PLUS PROJECT	100.2	99.7	100.1	101.0	99.6	101.5	98.1	100.4

	PERIOD AND IMPACT CONDITION							
	1980-2010		1980-1985		1985-2000		2000-2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
ANNUAL RATE OF POPULATION GROWTH (PERCENT)								
BASELINE	1.52		3.71		1.39		.63	
PROJECT IN-MIGRATION	2.70	1.71	11.16	5.32	1.13	1.29	.82	.52
BASELINE PLUS PROJECT	1.55	1.56	3.88	4.01	1.38	1.37	.64	.61

TABLE C.107. Social Service Demands Associated with Project In-Migration to Site County by Impact Condition: Midwest Site, Waste Repository, Basalt: Once Through

SOCIAL SERVICE UNIT	YEAR AND IMPACT CONDITION							
	1980		1985		2000		2010	
	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM	EXPECTED	MAXIMUM
HEALTH								
PHYSICIANS	1.5	17.7	2.7	23.1	3.2	28.0	3.4	29.5
NURSES	5.7	65.9	10.0	86.0	11.8	104.3	12.8	109.9
DENTISTS	.7	7.6	1.1	9.9	1.4	12.0	1.5	12.7
HOSPITAL BEDS	6.8	78.2	11.9	102.1	14.0	123.9	15.2	130.6
NURSING CARE BEDS	1.3	34.0	5.8	56.3	12.8	107.5	18.9	150.7
EDUCATION								
TEACHERS: K-8	8.3	86.8	18.6	150.2	13.7	151.2	13.4	114.0
TEACHERS: 9-12	7.2	82.3	9.9	117.1	13.2	114.5	9.5	99.9
CLASSROOM SPACE: (SQUARE METERS 9-12)	1887.7	21664.8	2605.0	30832.1	3482.2	30124.6	2503.9	26292.5
SANITATION								
WATER TREATMENT (CUBIC METERS/DAY)	655.0	7554.5	1144.5	9858.3	1355.8	11967.2	1471.6	12609.5
SOLID WASTE (VEHICLES)	.1	1.5	.2	1.9	.3	2.3	.3	2.4
SOLID WASTE (PERSONNEL)	.4	4.4	.7	5.7	.8	7.0	.9	7.3
LIQUID WASTE (CUBIC METERS/DAY)	436.6	5036.3	763.0	6572.2	903.9	7978.1	981.1	8406.3
FIRE AND POLICE								
FIREMEN	.8	8.9	1.4	11.6	1.6	14.1	1.7	14.9
POLICEMEN	2.3	26.6	4.0	34.7	4.8	42.2	5.2	44.4
RECREATION								
PLAYGROUNDS (HECTARES)	.5	5.2	.8	6.8	.9	8.3	1.0	8.7
NEIGHBORHOOD PARKS (")	.4	4.5	.7	5.8	.8	7.1	.9	7.5
COMMUNITY PARKS (")	.6	6.6	1.0	8.6	1.2	10.5	1.3	11.1
SOCIAL PROBLEMS								
CRIMES (7 CRIME INDEX)	49.6	572.2	86.7	746.6	102.7	906.4	111.5	955.0
GOVERNMENT								
ADMINISTRATIVE STAFF	1.0	12.0	1.8	15.6	2.1	19.0	2.3	20.0

Projected population and employment are presented in tabular form for four 5-year time periods, including the construction phase (1980 to 1984); the beginning of operation (1985 to 1989); one period during operation (2000 to 2004); and the last period of the operation phase, which varies between the periods 2010 to 2014 and 2020 to 2024, depending on the facility. Baseline projections for the site county are shown, along with project in-migration projections, and combined baseline plus project projections.

In addition, statistics are included for these three projections to illustrate changes in age composition (median age and dependency ratio) and sex composition (sex ratio). Rates of population growth for each of the three projections are computed over four time periods.

C.5 PRESENTATION OF SOCIOECONOMIC EEFECTS

This section presents an assessment of the demographic and social service impacts on the reference sites resulting from construction and operation of the selected nuclear waste management facilities. Although only a limited number of indicators for each type of impact are considered, the data provided should be sufficient to determine whether significant discontinuities in demographic structure will occur and what the potential effects will be on local social service systems (see Tables C.6 through C.107).

C.5.1 Operational Indicators

- The baseline population is the site county population projected forward from 1970. The numbers given represent the population size expected in the absence of the project.
- Project in-migration includes primary and secondary employees, their dependents, migrant replacements for displaced workers, and excess migrants. These in-migrants are presented cumulatively and represent active members of the project labor force (plus dependents and secondary employees) as well as former employees of the project who have decided to remain in the site community.
- Median age is a summary measure of the age composition of a population. Half of the population is older than the median age and half is younger. Variation in the age composition of a population over time is reflected in increases or decreases in the median age.
- The dependency ratio represents the ratio of child "dependents" aged 0 to 14 plus adult "dependents" age 65 and over to the "working age" population aged 15 to 64.* This ratio also reflects the age composition of the population. It is designed as a proxy to a nonworker to worker ratio and, as presented here, represents an approximation to the number of dependents supported by 100 members of the labor force. The higher the dependency ratio, the greater the demands placed upon the economic resources generated by the labor force.
- The sex ratio is represented by the number of males in the population per 100 females.
- Annual rate of population growth, expressed as a percentage, is calculated by the formula,

* The labor force is usually assumed to include persons aged 16 and over. In this study the population is classified into 5-year age groups. Thus, the working-age population is assumed to begin with the group aged 15 to 19. Labor force participation rates for this group range from about 48% for civilians aged 15 to 17 to about 68% for civilians aged 18 and 19.

$$r = \frac{100 \ln \frac{P_2}{P_1}}{t}$$

where: r = annual rate of population growth

P_2 = population at time 2

P_1 = population at time 1

t = the number of years in the interval

As an aid in interpreting the tables that follow, it can be noted that a doubling of the population in 5 years would produce an annual growth rate of 14%.

Social service demands are assessed for a variety of service sectors, including health (nurses, dentists, hospital beds, and nursing care beds), education (teachers, kindergarten through grade 8, and grades 9 through 12, as well as classroom space), sanitation (water treatment, liquid waste volume, solid waste volume, solid waste collection personnel, and solid waste vehicles), fire and police protection, recreation (playground area and neighborhood and community park area), and government administrative staff. In addition, a social problems index, based upon seven representative crimes, is used. Estimates of these service demands are derived by multiplying the volume of project in-migration by a ratio of the service unit to the relevant unit of population. The service multipliers are presented in Table C.3.

C.5.2 Analytic Procedures

The demographic and social service impacts are examined for several time periods. The number of intervals and their duration vary according to the waste management facility being considered. For all facilities, construction is assumed to take place during the 5-year period from 1980 to 1984, and construction impacts are averaged over that length of time. The period of planned operation begins in 1985 and its duration varies, ranging from 20 years for same a waste repositories to 30 years for fuel storage facilities. In each case, impacts of facility operation are reported for two intervals; that is, 1985 to 2000 and 2000 to 2005, 2010, or 2015, depending on the facility.

Impact forecasts are made on the basis of two sets of assumptions regarding the impact condition, reflecting the probability that new project employees and their dependents will settle and remain in the site county. The expected impact condition is based on the most probable configuration of these assumptions. The maximum impact condition results from an extreme but plausible set of assumptions. Migrant settlement in the site county in excess of the maximum impact condition is considered highly unlikely. These two sets of assumptions regarding impact conditions are specified in Table C.4.

Several types of comparisons are possible for purposes of assessing impacts. First, for the demographic data, contrasts can be made between 1) baseline and expected values, 2) baseline and maximum values, and 3) expected and maximum values. The first two of these comparisons reflect impacts on the site county due to the project, while the third reflects a difference in the degree of impact due to variation in the assumptions of the model.

Although extensive sensitivity testing of the model has not been attempted, it is evident that two sets of assumptions, which vary by impact condition, have a major effect on projected employment size. These sets are the regional employment multipliers (Table C.2) and the distance exponent in the gravity model (Table C.4).

A second type of comparison involves assessing social service impacts in terms of the additional demands placed on the site community's existing service capabilities, that is, personnel, facilities, volume, etc. These data are presented for both "expected" and "maximum" impact conditions, and differences between the two values can also be evaluated.

As a third method, each of the measures mentioned above can be compared across the three site counties in order to determine whether differences in project impacts can be attributed to differences among site characteristics. These comparisons can be made for both "expected" and "maximum" impact conditions. Two factors are of particular importance here. As indicated in the description of the three reference sites (Table C.5), the size of the unemployed construction labor force in each region varies greatly. To the extent that the project employs available unemployed workers, forecasted employment in-migration will be reduced. In addition, the allocation of regional in-migrants to residence in the site county is a function of the number of competing destination counties and their size. Since the Southwest region contains only a few counties, none of which are metropolitan, a substantial portion of all regional in-migrants will be allocated to the site county. This is not true for the other two regions. For these reasons, larger impacts can be expected to occur in the Southwest site.

Fourth, temporal comparisons can be made for each site county. In this way it will be possible to determine whether impacts associated with a project are likely to be felt more acutely at one or another stage of the project.

A fifth comparison involves differences of impacts between the construction and operation phases of the project. Such comparisons can be specific to sites, facility types, and impact conditions. Results will suggest which of the two phases may be of greatest concern for a potential site.

Finally, the socioeconomic impacts associated with, for example, the waste management component of a major reprocessing facility, can be considered in terms of how large the waste management impacts are relative to impacts associated with the entire facility. This type of comparison is only applicable in the case of the fuel reprocessing plant (Tables C.6 through C.23) and the mixed-oxide fuel fabrication facility (Tables C.24 through C.41). All other facilities examined are devoted entirely to waste management.

C.5.3 Forecasted Impacts and Interpretations

Socioeconomic impacts are derived from the magnitude of employment demand for construction and operation. In addition, variations in impacts are a function of site-specific characteristics and assumptions internal to the projection model. Thus, similar levels of employment demand will produce similar impact forecasts for a given site and impact condition. The Southeast and Midwest sites are relatively similar in terms of characteristics

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that are most critical in affecting the projections. These characteristics include availability of local labor force, secondary employment multipliers, proximity of a metropolitan area, and number and demographic diversity of counties in the commuting region. Characteristics of the Southwest site consistently result in larger forecasted impacts, while the Midwest site results in the smallest impacts.

Another contributor to impacts is the time pattern of project-associated employment change. For example, a large employment buildup followed closely by rapidly declining project employment demand can cause serious regional economic and social disruptions. The following analysis thus gives emphasis to the differences among sites and over time for the facility combinations. The waste management systems for the fuel reprocessing plant and the mixed-oxide fuel fabrication plant are hypothetical, since they cannot exist apart from the primary facility itself. In the same way, the production facility is always colocated with a waste management component. These facilities are distinguished in this analysis to facilitate both comparison of waste management options across facility combinations and examination of waste management as a part of a whole system.*

Identical facilities at each site imply the same employment requirement. However, since the Southwest site has a substantially smaller unemployed construction labor force pool to draw labor from (390 persons versus 10,660 for the Midwest site and 2420 in the Southwest site), primary project employment generates a larger secondary employment component than do the other two sites (Table C.4). This effect is reinforced by the fact that there are fewer counties, and no metropolitan counties, in the Southwest region competing for the residency of regional in-migrants. Thus, the size of the projected in-migrant employment for construction is a complex function of employment demand, model assumptions, and site conditions. Data for the construction period (1980) presented in the even-numbered Tables C.6 through C.106 reveal that project in-migration is approximately a constant fraction of primary employment during the construction phase. This relationship is especially evident for the Southwest site. For the Southeast and Midwest sites, project-associated in migration under expected impact conditions is less than primary construction employment demand throughout the employment range investigated here (54 for the MOX FFP waste management reference system to 5290 for a waste repository in basalt – See Table C.1). In the Southwest site, in contrast, project-associated in-migration exceeds primary construction employment demand for both impact conditions, except in the expected impact condition for the MOX FFP reference system (Table C.30).

The projected in-migrant impacts during the operation phase are determined by a more complex process. All primary operation employment is assumed to be in-migrant, while

* Strictly speaking, the waste and production components of the FRP and MOX FFP are not additive in this model. That is, if employment statistics for colocated waste and production facilities were combined and processed together, the projected impacts would differ from the sum of their parts. In fact, in each time period and for each impact condition the combined facilities lead to larger impact forecasts than an addition of the separate effects. The projected differences between these two types of estimates increase over time, such that at the later time periods a linear combination of the waste and production components underestimates "true" impacts by up to 50%, depending on the site and impact condition.

secondary operation employment is derived from several potential sources (see Figure C.1). The projected in-migration in 1985 also includes construction workers and their families who have decided to remain in the region after project construction.

The following sections treat successively each of the facilities, with reference to Tables C.6 through C.107.

C.5.3.1 Reference Fuel Reprocessing Plant

The Reference Fuel Reprocessing Plant (Tables C.12 through C.17) will be analyzed in some detail to serve as a model for interpreting all of the tables. Employment demand associated with the construction and operation of the facility is shown on the first row of each even-numbered table for each site. Projections of the size of the site county baseline population are shown on the second row. The next row indicates the total cumulative projected number of in-migrant employees for each set of impact condition assumptions. These figures include primary and secondary employment, the employee's dependents, and, from 1985 on, persons who have separated from the job and continue to reside in the site county. The fourth row shows the projected baseline population with cumulative project-related persons added in. The fifth row provides a primary indicator of impacts; namely, it shows the number of project-related persons who reside locally as a percentage of the total population at that time.

Table C.14 demonstrates that expected project-related in-migrants during construction represent a small portion of the total population (0.9%). In the Midwest site, this portion is even smaller (0.1%), because of fewer in-migrants and a larger population base. The largest effects occur in the Southwest site (Table C.12), where projected construction-phase in-migrants represent 7.6% of the combined project and baseline population. The relative impact under maximum impact conditions is the same in the Southeast and Southwest sites, though the absolute magnitude of the Southwest maximum construction phase in-migration is more than twice that for the Southeast site (5520 vs. 2615).

The last section of Table C.16 gives the annual rate of population growth for both the baseline and for project in-migrants for selected periods. The expected increase in project personnel between the 1980 construction period and the first 5 years of operation in 1985 is 401 (436 minus 35). This represents a high annual rate of growth over the 5-year period (50%). However, the project has little effect on the overall rate of growth in the baseline-plus-project during that period (3.8% versus 3.7% in the baseline without project effects added in). The high rate of growth in the project in-migration is a consequence of the small starting population (35). Since the absolute number of in-migrants is small relative to the baseline, the impact on overall growth rates is small. Table C.12 shows that the expected number of project in-migrants actually declines by almost 35% (from 3654 to 2382) between 1980 and 1985, an annual rate of decline of 8.6%. This leads to a slower rate of growth (although at a higher level of population) than the region would have experienced without the project during this period. The potential exists for a serious boom-bust type of adjustment problem. This problem could also arise after 2015 during decommissioning, although the model does not address this process. Of course, not all of the 3106 expected project-related personnel forecast for 2015 would leave upon decommissioning. A significant portion of them are persons who retired or separated earlier and opted to settle in the site county.

The middle section of Table C.12 provides some insight into the effects of the project on the age and sex structure of the population. (Refer to Section C.5.1 of this report for a definition of the measures used here.) For certain categories of social-service impacts, the age structure of the in-migrants is as important as their number in determining the types of socioeconomic effects they will exert. In terms of observable trends in age structure, it is apparent that the median age is forecast to rise in each baseline population--by 7.0 years in the Southwest site and by 8.3 years in the Midwest site--during the interval from 1980 to 2015. This rise occurs because 1) a population ages primarily because of declining fertility, and 2) it is assumed that replacement fertility will be achieved by 1990 (2.1 children per woman in the childbearing ages). In addition, net migration is zero by 1990, so that fertility is left as the principal factor affecting age structure for most of the projection; mortality is assumed to remain constant throughout.

For every site and facility studied here, the median age of project in-migrants is lower in 1980 than the respective baselines (by from 2 to 7 years) and rises more rapidly over time to exceed the baseline median age, usually by the year 2000. The more rapid and extensive aging of the project-related population can be attributed to those persons who elect to remain in the county after employment and to the continuing process of out-migration of young dependents. Additional interpretations of variations in age structure can only be based on more extensive sensitivity testing of the model.

Fluctuations in age structure, as reflected by changes in median age and dependency, appear to be affected only somewhat by the size of the employment demand (compare Tables C.18 through C.23 with C.30 through C.35, where construction employment is 2825 and 54 respectively). Site characteristics appear to have a larger effect in this regard. Further, the dependency ratio tends to peak in the early operation phase. It is clear that construction workers are less likely to bring young or old family members with them during construction than during operation. Later in the operation phase, the dependency ratio declines well below baseline levels as retiring and separated workers are replaced by new, younger persons of working age. Declines in the dependency ratio are usually interpreted as beneficial for a community; that is, as implying higher per-capita levels of income, saving, and expenditures.

The greatest demographic differences between project and baseline populations appear to be in the sex structure of these two populations. In the baseline for each site and each time period, there are more females than males (sex ratio <100). The opposite is true for the project population, in which males outnumber females by as much as 50%, especially during construction. The sex ratio tends to decline over time as the effect of an initially all-male primary construction and primary operation labor force is diluted by subsequent fertility, mortality, and migration. The proportion of male project workers with spouse present is normally lower than the proportion of all males in the baseline population with spouse present. Note that the impact conditions (expected vs. maximum) appear to have less influence in determining variation in age and sex structure characteristics than does the magnitude of project employment.

Before turning to social service demands, one additional comparison will be made between the FRP reference system and the production facility without a waste management component (a hypothetical construct, Tables C.6 through C.11) to determine how much of the total impact (combined effect) is due to the waste management component. As illustrated by this example, it is particularly troublesome to determine how to separate the effects of the waste management component of a complete facility, given the observed interaction effects.

The manpower requirement for the production facility exceeds the requirement for the waste management reference system for both construction and operation (Table C.1). The manpower requirement for waste management as a proportion of the total combined system is 42% for construction and 28% for operation. In 1980, the expected number of in-migrants for the FRP waste management reference system in the Southeast site (Table C.14) is 192 persons; however, the comparable number of migrants for the FRP without waste management (Table C.6) is 310 persons. The sum of these parts (502) is 131 short of the projected total for the combined system (Table C.20). In every comparison, the parts will be less than the whole.

An analysis of waste management in the FRP as a percentage of waste plus production components shows that the range during construction is from 21% in the Midwest site [expected impact condition, 35/(35 + 130), compare Tables C.8 and C.14] to 44% in the Southwest site [maximum impact condition, 5520/(5520 + 7631), compare Tables C.6 and C.12]. The range during the final period of operation is from 22% in the Midwest site [expected impact condition, 575/(575 + 2093), compare Tables C.10 and C.16] to 32% in the Southwest site [expected impact, 3087/(1087 + 6697), compare Tables C.10 and C.16]. Clearly, manpower requirements attributable to waste management in a larger FRP system are not consistent predictors of the proportionate demographic impacts associated with waste management.

Finally, social service demands are derived from a set of ratio multipliers (Table C.3) applied directly to the project in-migration figures, except in the case of education and nursing care, where age-specific information is used. Each odd-numbered table from C.7 through C.107 indicates how many units of each social service will be expected by the new in-migrants. The seriousness of the impacts is both a function of the magnitude of the expectations and of the willingness and capacity of the site county to meet these expectations.

The FRP combined system produces the largest impacts of any of the waste management systems (Tables C.18 through C.23); for the Southeast and Midwest sites these impacts are manageable under the expected impact condition, while for the Southwest site they are severe (Tables C.18 and C.19). Without more detailed information on a community's ability to provide services at the levels indicated, for example, in Table C.19, it is difficult to say where the most severe impacts are likely to be concentrated. A general assumption that all service sectors in rural communities are operating at maximum capacity would provide one basis from which to make such judgments.

Some services will be more difficult and more costly to supply than others. For example, 31 hospital beds (1980 expected demand, Table C.19) might equal the capacity of many existing rural hospitals. The building of a new hospital may exceed the fiscal capacity of a rural area and be virtually impossible to finance. It is often difficult to attract qualified physicians into long-term rural practice. Education provides another example: although teachers are generally more readily available and less costly than are doctors or nurses, the addition of 60 to 89 elementary level teachers (Table C.19) would strain most rural communities. Policemen typically are hired locally, requiring a substantial investment of time and money in training and support structures. As many as 18 new policemen (Table C.19, expected condition) could represent a large burden for many communities. Certainly the levels of social disruption suggested by additional levels of crime attributable to project-related personnel (536 crimes in the expected condition, Table C.19) would necessitate expansion of social control capabilities.

In the absence of site-specific data, costs of the services have not been included. A complete understanding of the burden these service demands might represent to a community would also have to consider nonmonetary costs contained under the heading "quality of life." Specification of social service demands is only a first step in the assessment of impacts. The level of demand defines the "potential" for impacts and alerts planners and local officials to service sectors requiring attention, and it provides rough limits on the magnitude of anticipated effects.

C.5.3.2 Reference Mixed-Oxide Fuel Fabrication Plant

In contrast to the FRP system, the MOX FFP reference system requires the smallest employment input of all the systems examined (construction, 54; operation, 16). Forecasted impacts are trivial for each reference site, impact condition, and time period (Tables C.30 through C.35). The MOX FFP without waste management (Tables C.24 through C.29) also produces relatively small impacts for each site and time period. Only the maximum impact condition in the Southwest site (Tables C.24 and C.25) forecasts impacts that might require special consideration.

The MOX FFP is a system, like the FRP, which can be conceptualized in terms of its waste management and production components. In terms of manpower requirements for the combined system (Table C.1), waste management requires only 9% of the total work force for construction and 5% for operation. Forecasts of relative demographic impact during construction range from less than 1% (Tables C.24 and C.30) to 11% (Tables C.28 and C.34), using the method described in Section C.5.3.1 for the FRP. During the latter part of the operation phase, forecasts of relative effects attributable to waste management range from 2% to 5%.

C.5.3.3 Reference Independent Spent Fuel Storage Facility: Once-Through, Prompt Disposal

The forecasted effects of the construction and operation of the ISFSF are presented in Tables C.42 through C.47. In this facility, demand for operation manpower is small relative to demand for construction manpower (301 vs. 1350). Thus, a sharp decline in demographic impacts associated with the transition from the construction phase to the operation phase might be anticipated. This potential for boom-bust impacts can be examined for each site. In the Southeast site (Table C.44) expected impacts, in both absolute and relative terms, are small. In addition, the transition from construction to operation results in little change in demographic impacts in spite of the disparity in manpower requirements during these two periods.

The annual rate of population change between 1980 and 1985 is small, amounting to +1.7% per year under expected impact conditions and -3.3% per year under maximum impact conditions. These small, relative changes are based on substantially different population sizes. The gain of project-related personnel from 1980 to 1985 under expected conditions is 21 persons (from 234 to 255), while under maximum conditions a loss of 475 persons (from 3090 to 2615) is sustained. Relative impacts (line 5, Table C.44) are substantial in each time period under maximum impact conditions (ranging from 10.2% to 13.7% of the baseline plus project). The reason that the anticipated boom-bust effect is not large is that most of the manpower requirement is met through local sources. In fact, reductions in local unemployment are an important benefit (positive impact) attributable to the project.

This effect is even more pronounced in the Midwest site (Table C.46) where large numbers of unemployed construction workers are available. Since operation workers are all assumed to in-migrate, there is a large relative jump in the number of in-migrants from 1980 to 1985. Even though the annual rate of growth is 49.6% per year, the absolute numbers are so small relative to the baseline population (less than 1% in the expected condition) that the baseline rate of growth is only slightly altered by the project (3.7% versus 3.8%).

The most notable example of the potential impact of a rapid decline in project-related in-migrants is seen in the Southwest site (Table C.42). Under both impact conditions, relative impacts are likely to be significant during both construction and operation. In addition, substantial declines in the numbers of in-migrants resident in the site county occur between construction and operation under both impact conditions. Nevertheless, in neither this site nor in the other two sites does the decline in resident newcomers equal the decline in manpower demand for the project between construction and operation (78% fewer persons required during operation). In fact, at the Midwest site (Table C.46) resident in-migrants actually increase during this period. Clearly, the Southwest site represents a management challenge in terms of the numbers of new persons who must be accommodated and specifically in terms of the magnitude of service demands that will be placed on the community. The Midwest and Southeast sites are much less severely affected by the presence of these facilities, except for the maximum impact condition in the Southeast site. Tables C.45 and C.47 confirm that the level of implied social service demands should be manageable.

C.5.3.4 Reference Extended Fuel Storage System

This waste storage system has the same component facilities as the prior example (Section C.5.3.3) with the addition of dry caisson storage, which adds significantly to the construction manpower requirement (Tables C.48 through C.53). This addition increases the potential for the boom-bust type of impacts. The relative magnitude of the resident project-related personnel is substantial in the Southeast and Southwest sites, reaching one-sixth of the baseline plus project population during the operation phase under maximum impact assumptions. The effects in the Midwest site (Table C.52) are only moderate at best--the most notable exception being the rapid increase in the size of the in-migrant population from construction to operation (36% per year). Yet the relative increase is from 0.2% of baseline-plus-project to 0.8%, a trivial impact when the affected population size is taken into account. That is, the large baseline population should easily be able to absorb demographic impacts of this magnitude. An additional consideration in this regard relates to the way in which county level impacts are exerted at the community level. The operating principle is that impacts of a given magnitude may be trivial when spread out over a large population base, but the same magnitude of impact imposed upon a small local community could be a serious problem.

C.5.3.5 Reference Retrievable Waste Storage Facility

Demographic impacts associated with this facility are quite manageable at all sites (Tables C.54 through C.59). Under expected impact conditions for the Southeast and Midwest sites, in-migrants relative to the baseline are less than 1% throughout the life of the project. In the Southwest site (Table C.54), impacts are moderate under both impact conditions. An examination of Table C.55 suggests that the areas of potential difficulty for the Southwest site involve the need for additional teachers and classroom space and the likely need for greater social control facilities. Crimes in the range of 150 to 250 imply increased social disruption in communities within the county, especially when considering that the figures presented represent county-level average forecasts. The crime rate will certainly concentrate at higher levels in some parts of the county and not others. It is not possible in this generic study to pursue this line of inquiry, but clearly the potential exists for the greater concentration of forecasted county-level impacts in some subareas more than in others.

C.5.3.6 Waste Repositories

There are eight waste repository options incorporated in this study; they involve four geologic media (salt, granite, shale, and basalt) and two fuel cycles (U and Pu recycle and once-through). Construction manpower demand ranges from 1430 to 5290, and operation manpower demand ranges from 688 to 1200 (Tables C.60 through C.107). The once-through cycle tends to have a larger construction manpower demand than is true for the U and Pu recycle. The opposite is true for operation manpower requirements. For each of the four disposal media, operation employment for the once-through cycle is less than the employment requirement for the U and Pu recycle. Of the eight waste repository facilities analyzed in this study, the repository in basalt, once-through cycle, requires the largest construction labor force (5290 persons). Even a construction work force of this magnitude is judged not to produce significant impacts at either the Southeast or Midwest sites (Tables C.102 and C.104). Project-related in-migration which exceeds 10 percent of the corresponding baseline population is considered to produce significant impacts. As a percent of projected baseline population size, the potential for significant impacts under each of the waste repository facilities is much greater in the Southwest site. In this site, the expected number of in-migrants during construction is typically over three times the level of primary employment demand. For example, the construction of a waste repository in basalt, once-through cycle, produces a level of in-migration at about 9 percent of the baseline population (Table C.70) and a substantially larger relative in-migration for a waste repository in basalt, once-through cycle (28 percent of baseline, Table C.106).

The Southwest site is subjected to these relatively large impacts primarily because there is a scarcity of skilled available local labor. The maximum impact condition produces substantially larger project-induced in-migrant flows for each site and disposal medium compared with the expected conditions. Very severe impacts are forecasted for the Southeast and Southwest sites under maximum conditions, though the likelihood of their occurance is not great for two reasons. First, the manpower estimates and model assumptions have been set to produce an upper bound on social impacts. Second, in-migration at these levels would produce unacceptable local imbalances in service structure, which would result in greater turnover on the project and increased out-migration from the site county. These kinds of feedback effects are not modeled in the forecasting procedures used here. Social service demands are particularly large under both expected and maximum impact conditions at the Southwest site for most of the waste repository facilities. Service demands are uniformly large under maximum impact assumptions. Heavy demands for social services during the construction and operation phases will be difficult for rural communities to deal with, even given anticipatory planning.

A final comment regarding the waste repository options is that they involve uniformly large numbers of persons residing at the site county after the year 2000, especially under the maximum impact set of assumptions. Decommissioning is not directly addressed in this study, but it is clear that potentially disruptive effects could ensue from the phasing out of a waste repository. In the Southwest site, for example, several of the waste repository alternatives generate a large influx of project-related persons by the end of the operation phase. For example, 14,837 persons are forecast under expected impact conditions and 20,904 under maximum impact conditions for a repository in basalt, once-through cycle (Table C.106). Though many of these persons have long since left the project and have other means of support in the area, many others may be forced to leave, given inadequate or unacceptable employment opportunities after decommissioning.

C.5.4 Conclusions

Each site varies in the size of the projected baseline population for the site county. The larger the baseline population, the greater the capacity of that population to absorb new in-migrants with minimal impact. Thus, for a given level of project in-migration, the Midwest site will exhibit the smallest impact and the Southwest site will exhibit the largest. The manpower that can be obtained regionally will directly affect manpower that must in-migrate from outside the region to fill jobs. Thus, impacts are favorable on two counts: unemployment is reduced with a commensurate rise in community per-capita income, and the volume of project-related in-migration is curtailed, resulting in a reduction of new social service demands on the community.

In conclusion, the critical determinant of the potential for socioeconomic impacts is the nature of the site in which the project is to be located. Even with a large manpower requirement (a waste repository in basalt once-through cycle, needs 5290 construction workers), in-migrants amount to less than 3% of the with-project county baseline in the Midwest reference site (Table C.106). In comparison, a project with only one-fifth of the construction manpower requirement (retrievable waste storage facility needs 1060 construction workers) produces employment in-migration almost three times as large in absolute size when maximum differences in reference site characteristics are allowed to take effect (Southwest site, Table C.54 vs.

Midwest site, Table C.106). Differences in this same example between impacts relative to the baseline population are even greater (6.7% versus 1.9%). The data produced in this generic study should prove useful to planners who are interested in estimating a probable range of socioeconomic impacts associated with the development of nuclear waste management facilities.

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APPENDIX D

RELEASE/DOSE FACTORS AND DOSE IN 5 YEAR INTERVALS TO REGIONAL AND WORLD WIDE POPULATION FROM REFERENCE INTEGRATED SYSTEMS

APPENDIX D

RELEASE/DOSE FACTORS AND DOSE IN 5 YEAR INTERVALS TO REGIONAL AND WORLD WIDE POPULATION FROM REFERENCE INTEGRATED SYSTEMS*

The 70 year dose commitment to the regional population of the reference environment was calculated for unit release (1 curie) of specific radionuclides from release points at various waste management facilities. Through use of a computerized dose accumulation program, dose to the regional population was accumulated for the several integrated systems described in Section 10. The computer program used for the compilation is described in DOE/ET-0028. The release points used are presented here in Table D.1. Release/dose factors for these release points are given in Tables D.2 through D.6, which present the population dose (2 millionpersons) for selected organs of reference in man-rem per curie released from each site. Exposure pathways included in the dose factors are air submersion, inhalation and ingestion of foodstuffs. A one-year release time was assumed with a 69-year dose period for a total dose commitment time of 70 years (for a facility operating lifetime of 30 years this technique generates in effect a 100 year dose commitment).

Doses to the regional population for the various integrated systems are presented in Tables D.7 through D.35.

Seventy year dose commitments to the world wide population were also calculated for annual releases from the various integrated systems. This dose was based only on release of ^{3}H, ^{14}C, and ^{85}Kr. The dose factors give the 70 year dose commitment to the world wide population in man rem per curies released. The factors are: ^{3}H - 8.2×10^{-3}; ^{14}C - 1.7×10^{2} and ^{85}Kr - 4.7×10^{-4}.

Doses calculated for the world wide population are presented in Tables D.36 to D.41 for the various reference integrated systems.

TABLE D.1. Radionuclide Release Points

Facility	Release Elevation, m
FRP main stack	110
MOX-FFP stack	20
Repository stacks	120
ISFSF, RWSF, ESFSF	45
Ground level releases	0

* See p. D.1.43 for tabulations of dose for a low power growth scenario.

TABLE D.2. Unit Release Dose Factors for FRP Main Stack

Nuclide	Dose to Organ of Reference (man-rem/Ci) Total Body	Bone	Lungs	Thyroid
^{3}H	4.2E-04	0	4.2E-04	4.2E-04
^{14}C	2.9E-02	1.4E-01	2.9E-02	2.9E-02
^{41}Ca	2.0E-01	1.9E+00	1.5E-03	0
^{51}Cr	2.7E-04	2.3E-05	3.2E-03	2.9E-04
^{54}Mn	4.8E-03	7.0E-04	3.6E-01	7.0E-04
^{55}Fe	1.7E-03	4.9E-03	2.0E-02	7.3E-09
^{59}Fe	1.8E-02	4.0E-03	1.5E-01	1.0E-03
^{58}Co	3.3E-03	0	1.5E-01	0
^{60}Co	1.2E-02	2.1E-03	2.4E+00	2.1E-03
^{59}Ni	1.0E-02	6.1E-02	3.2E-02	0
^{63}Ni	1.5E-02	4.6E-01	8.6E-02	0
^{85}Kr	1.7E-06	1.7E-06	1.7E-06	1.7E-06
^{90}Sr	1.1E+01	4.6E+01	4.4E+00	1.8E-11
^{90}Y	8.3E-04	3.1E-02	2.3E-02	6.0E-08
^{91}Y	1.3E-02	4.9E-01	2.6E-01	3.1E-06
^{95}Zr	2.5E-02	9.4E-02	2.7E-01	6.1E-04
^{93m}Nb	7.1E-03	1.0E-01	1.2E-01	7.1E-08
^{95}Nb	7.1E-03	1.9E-02	7.3E-02	6.3E-04
^{106}Ru	4.3E-03	3.3E-02	2.5E+00	7.3E-05
^{110m}Ag	5.9E-03	8.7E-03	1.2E+00	2.4E-03
^{123}Sn	6.4E-04	2.5E-02	1.8E-05	3.8E-04
^{125}Sb	4.0E-02	1.2E-01	7.2E-01	3.8E-04
^{125m}Te	1.5E-03	9.4E-03	6.2E-02	3.7E-01
^{127m}Te	4.5E-03	3.6E-02	2.3E-01	1.1E+00
^{127}Te	2.7E-05	1.2E-04	1.1E-03	2.7E-02
^{129}I	9.9E-01	3.5E-01	3.5E-02	7.8E+02
^{134}Cs	2.9E-01	1.6E-01	4.4E-02	1.3E-03
^{137}Cs	1.7E-01	2.1E-01	3.5E-02	2.0E-06
^{144}Ce	2.2E-02	4.1E-01	2.0E+00	1.5E-05
^{147}Pm	2.6E-03	6.8E-02	1.9E-01	0
^{154}Eu	7.4E-02	1.1E+00	3.3E+00	1.0E-03
^{155}Eu	4.9E-03	4.4E-02	2.3E-01	4.2E-05
^{185}W	2.5E-05	7.1E-04	7.6E-02	0
^{232}U	3.0E+00	4.3E+01	1.4E+03	1.6E-07
^{236}U	5.5E-01	8.9E+00	3.4E+02	0
^{237}U	6.2E-05	6.6E-05	6.1E-05	6.1E-05
^{238}U	4.6E-01	7.8E+00	3.2E+02	0
^{238}Pu	6.8E+01	1.4E+03	4.1E+02	1.3E-06
^{239}Pu	8.0E+01	1.7E+03	3.9E+02	1.3E-06
^{240}Pu	8.0E+01	1.7E+03	3.9E+02	1.1E-06
^{241}Pu	9.8E-01	2.4E+01	6.8E-01	0
^{241}Am	6.3E+01	9.1E+02	4.2E+02	1.8E-05
^{242m}Am	6.2E+01	8.9E+02	2.9E+02	2.9E-06
^{243}Am	6.2E+01	9.2E+02	4.0E+02	1.1E-06
^{242}Cm	1.1E+00	1.7E+01	1.2E+02	4.0E-08
^{244}Cm	3.0E+01	4.8E+02	4.1E+02	1.1E-06
^{245}Cm	6.9E+01	1.1E+03	4.0E+02	2.3E-05

TABLE D.3. Unit Release Dose Factors for MOX-FFP Stack

Nuclide	Dose to Organ of Reference (man-rem/Ci) Total Body	Bone	Lungs	Thyroid
^{3}H	1.1E-03	0	1.1E-03	1.1E-03
^{14}C	7.7E-02	3.8E-01	7.7E-02	7.7E-02
^{41}Ca	5.2E-01	4.9E+00	4.0E-03	0
^{51}Cr	7.4E-04	6.1E-05	8.5E-03	7.7E-04
^{54}Mn	1.3E-02	1.9E-03	9.6E-01	1.9E-03
^{55}Fe	4.5E-03	1.3E-02	5.4E-02	1.9E-08
^{59}Fe	4.6E-02	1.1E-02	4.0E-01	2.7E-03
^{58}Co	8.6E-03	0	4.1E-01	0
^{60}Co	3.3E-02	5.6E-03	6.3E-00	5.6E-03
^{59}Ni	2.8E-02	1.7E-01	8.6E-02	0
^{63}Ni	4.0E-02	1.2E+00	2.3E-01	0
^{85}Kr	4.6E-06	4.6E-06	4.6E-06	4.6E-06
^{90}Sr	2.9E+01	1.2E+02	1.2E+01	4.8E-11
^{90}Y	2.2E-03	8.2E-02	6.2E-02	1.6E-07
^{91}Y	3.5E-02	1.3E+00	7.0E-01	8.2E-06
^{95}Zr	6.6E-02	2.5E-01	7.2E-01	1.6E-03
^{93m}Nb	1.9E-02	2.7E-01	3.1E-01	1.9E-07
^{95}Nb	1.9E-02	5.0E-02	1.9E-01	1.7E-03
^{106}Ru	1.1E-02	8.8E-02	6.6E+00	1.9E-04
^{110m}Ag	1.6E-02	2.3E-02	3.2E+00	6.4E-03
^{123}Sn	1.6E-03	6.7E-02	4.9E-05	1.0E-03
^{125}Sb	1.0E-01	3.4E-01	1.9E+00	9.9E-04
^{125m}Te	4.0E-03	2.5E-02	1.6E-01	1.0E+00
^{127m}Te	1.2E-02	9.6E-02	6.2E-01	2.9E+00
^{127}Te	7.3E-05	3.2E-04	3.1E-03	7.2E-02
^{129}I	2.6E+00	9.2E-01	9.2E-02	2.0E+03
^{134}Cs	7.5E-01	4.0E-01	1.2E-01	3.4E-03
^{137}Cs	4.6E-01	5.6E-01	9.3E-02	5.2E-06
^{144}Ce	6.0E-02	1.1E+00	5.3E+00	4.0E-05
^{147}Pm	6.8E-03	1.8E-01	5.0E-01	0
^{154}Eu	1.9E-01	3.0E+00	8.8E+00	2.8E-03
^{155}Eu	1.3E-02	1.2E-01	6.0E-01	1.1E-04
^{185}W	6.7E-05	1.9E-03	2.0E-01	0
^{232}U	8.1E+00	1.1E+02	3.6E+03	4.2E-07
^{236}U	1.4E+00	2.4E+01	9.2E+02	0
^{237}U	1.6E-04	1.7E-04	1.6E-04	1.6E-04
^{238}U	1.2E+00	2.1E+01	8.4E+02	0
^{238}Pu	1.8E+02	3.6E+03	1.1E+03	3.5E-06
^{239}Pu	2.1E+02	4.4E+03	1.0E+03	3.5E-06
^{240}Pu	2.1E+02	4.4E+03	1.0E+03	3.0E-06
^{241}Pu	2.6E+00	6.3E+01	1.8E+00	0
^{241}Am	1.7E+02	2.4E+03	1.1E+03	4.7E-05
^{242m}Am	1.8E+02	2.4E+03	7.7E+02	7.8E-06
^{243}Am	1.6E+02	2.4E+03	1.1E+03	3.0E-06
^{242}Cm	3.0E+00	4.5E+01	3.1E+02	1.1E-07
^{244}Cm	7.9E+01	1.3E+03	1.1E+03	2.9E-06
^{245}Cm	1.8E+02	3.1E+03	1.1E+03	6.1E-05

TABLE D.4. Unit Release Dose Factors for Repository Stacks

Nuclide	Dose to Organ of Reference (man-rem/Ci) Total Body	Bone	Lungs	Thyroid
^{3}H	3.8E-04	0	3.8E-04	3.8E-04
^{14}C	2.6E-02	1.3E-01	2.6E-02	2.6E-02
^{41}Ca	1.8E-01	1.7E+00	1.4E-03	0
^{51}Cr	2.5E-04	2.1E-05	2.9E-03	2.7E-04
^{54}Mn	4.4E-03	6.4E-04	3.3E-01	6.4E-04
^{55}Fe	1.6E-03	4.5E-03	1.9E-02	6.7E-09
^{59}Fe	1.6E-02	3.6E-03	1.4E-01	9.2E-04
^{58}Co	3.0E-03	0	1.4E-01	0
^{60}Co	1.1E-02	1.9E-03	2.2E+00	1.9E-03
^{59}Ni	9.4E-03	5.6E-02	2.9E-02	0
^{63}Ni	1.4E-02	4.2E-01	7.9E-02	0
^{85}Kr	1.6E-06	1.6E-06	1.6E-06	1.6E-06
^{90}Sr	1.0E+01	4.2E+01	4.0E+00	1.6E-11
^{90}Y	7.6E-04	2.8E-02	2.1E-02	5.5E-08
^{91}Y	1.2E-02	4.5E-01	2.4E-01	2.8E-06
^{95}Zr	2.3E-02	8.6E-02	2.5E-01	5.5E-04
^{93m}Nb	6.5E-03	9.2E-02	1.1E-01	6.5E-08
^{95}Nb	6.6E-03	1.8E-02	6.7E-02	5.8E-04
^{106}Ru	3.9E-03	3.0E-02	2.3E+00	6.7E-05
^{110m}Ag	5.4E-03	7.9E-03	1.1E+00	2.2E-03
^{123}Sn	5.9E-04	2.3E-02	1.7E-05	3.5E-04
^{125}Sb	3.6E-02	1.1E-01	6.6E-01	3.4E-04
^{125m}Te	1.4E-03	8.6E-03	5.6E-02	3.4E-01
^{127m}Te	4.1E-03	3.3E-02	2.1E-01	1.0E+00
^{127}Te	2.5E-05	1.1E-04	1.0E-03	2.5E-02
^{129}I	9.0E-01	3.2E-01	3.2E-02	7.0E+02
^{134}Cs	2.5E-01	1.3E-01	4.0E-02	1.2E-03
^{137}Cs	1.6E-01	1.9E-01	3.2E-02	1.8E-06
^{144}Ce	2.0E-02	3.8E-01	1.8E+00	1.4E-05
^{147}Pm	2.3E-03	6.2E-02	1.7E-01	0
^{154}Eu	6.8E-02	1.0E+00	3.0E+00	9.5E-04
^{155}Eu	4.5E-03	4.0E-02	2.1E-01	3.9E-05
^{185}W	2.3E-05	6.5E-04	7.0E-02	0
^{232}U	2.8E+00	3.9E+01	1.3E+03	1.4E-07
^{236}U	5.0E-01	8.1E+00	3.2E+02	0
^{237}U	5.7E-05	6.0E-05	5.6E-05	5.6E-05
^{238}U	4.3E-01	7.2E+00	2.9E+02	0
^{238}Pu	6.2E+01	1.2E+03	3.8E+02	1.2E-06
^{239}Pu	7.3E+01	1.5E+03	3.6E+02	1.2E-06
^{240}Pu	7.3E+01	1.5E+03	3.6E+02	1.0E-06
^{241}Pu	9.0E-01	2.2E+01	6.2E-01	0
^{241}Am	5.7E+01	8.4E+02	3.8E+02	1.6E-05
^{242m}Am	5.6E+01	8.2E+02	2.7E+02	2.7E-06
^{243}Am	5.7E+01	8.4E+02	3.6E+02	1.0E-06
^{242}Cm	1.0E+00	1.5E+01	1.1E+02	3.7E-08
^{244}Cm	2.7E+01	4.4E+02	3.7E+02	9.9E-07
^{245}Cm	6.3E+01	1.0E+03	3.7E+02	2.1E-05

TABLE D.5. Unit Release Dose Factors for ISFSF, RWSF, ESFSF Stacks

	Dose to Organ of Reference (man-rem/Ci)			
Nuclide	Total Body	Bone	Lungs	Thyroid
^{3}H	8.6E-04	0	8.6E-04	8.6E-04
^{14}C	5.9E-02	2.9E-01	5.9E-02	5.9E-02
^{41}Ca	4.0E-01	3.7E+00	3.1E-03	0
^{51}Cr	5.7E-04	4.7E-05	6.5E-03	6.0E-04
^{54}Mn	9.6E-03	1.4E-03	7.3E-01	1.4E-03
^{55}Fe	3.4E-03	9.9E-03	4.2E-02	1.5E-08
^{59}Fe	3.6E-02	8.1E-03	3.1E-01	2.0E-03
^{58}Co	6.6E-03	0	3.1E-01	0
^{60}Co	2.5E-02	4.3E-03	4.8E+00	4.3E-03
^{59}Ni	2.1E-02	1.2E-01	6.5E-02	0
^{63}Ni	3.1E-02	9.3E-01	1.8E-01	0
^{85}Kr	3.5E-06	3.5E-06	3.5E-06	3.5E-06
^{90}Sr	2.2E+01	9.2E+01	8.9E+00	3.6E-11
^{90}Y	1.7E-03	6.2E-02	4.7E-02	1.2E-07
^{91}Y	2.7E-02	9.9E-01	5.3E-01	6.2E-06
^{95}Zr	5.0E-02	1.9E-01	5.5E-01	1.2E-03
^{93m}Nb	1.4E-02	2.1E-01	2.4E-01	1.4E-07
^{95}Nb	1.4E-02	3.8E-02	1.5E-01	1.3E-03
^{106}Ru	8.6E-03	6.8E-02	5.0E+00	1.5E-04
^{110m}Ag	1.2E-02	1.8E-02	2.4E+00	4.9E-03
^{123}Sn	1.3E-03	5.2E-02	3.7E-05	7.7E-04
^{125}Sb	8.0E-02	2.5E-01	1.5E+00	7.5E-04
^{125m}Te	3.0E-03	1.9E-02	1.2E-01	7.6E-01
^{127m}Te	9.2E-93	7.3E-02	4.7E-01	2.2E+00
^{127}Te	5.6E-05	2.4E-04	2.3E-03	5.5E-02
^{129}I	2.0E+00	7.1E-01	7.0E-02	1.6E+03
^{134}Cs	5.8E-01	3.0E-01	9.1E-02	2.6E-03
^{137}Cs	3.5E-01	4.2E-01	7.1E-02	4.0E-06
^{144}Ce	4.5E-02	8.4E-01	4.0E+00	3.0E-05
^{147}Pm	5.2E-03	1.4E-01	3.8E-01	0
^{154}Eu	1.5E-01	2.3E+00	6.7E+00	2.1E-03
^{155}Eu	1.0E-02	8.9E-02	4.6E-01	8.6E-05
^{185}W	5.2E-05	1.4E-03	1.5E-01	0
^{232}U	6.2E+00	8.7E+01	2.8E+03	3.2E-07
^{236}U	1.1E+00	1.8E+01	7.0E+02	0
^{237}U	1.2E-04	1.3E-04	1.2E-04	1.2E-04
^{238}U	9.5E-01	1.6E+01	6.4E+02	0
^{238}Pu	1.4E+02	2.8E+03	8.4E+02	2.6E-06
^{239}Pu	1.6E+02	3.4E+03	7.9E+02	2.6E-06
^{240}Pu	1.6E+02	3.4E+03	7.9E+02	2.3E-06
^{241}Pu	2.0E+00	4.8E+01	1.4E+00	0
^{241}Am	1.3E+02	1.9E+03	8.4E+02	3.6E-05
^{242m}Am	1.2E+02	1.8E+03	5.9E+02	5.9E-06
^{243}Am	1.3E+02	1.9E+03	8.0E+02	2.3E-06
^{242}Cm	2.3E+00	3.4E+01	2.3E+02	8.2E-08
^{244}Cm	6.0E+01	9.7E+02	8.3E+02	2.2E-06
^{245}Cm	1.4E+02	2.3E+03	8.2E+02	4.7E-05

TABLE D.6. Unit Release Dose Factors for Ground Level Releases

Nuclide	Dose to Organ of Reference (man-rem/Ci) Total Body	Bone	Lungs	Thyroid
^{3}H	2.0E-03	0	2.0E-03	2.0E-03
^{14}C	1.3E-01	6.6E-01	1.3E-01	1.3E-01
^{41}Ca	9.0E-01	8.4E+00	7.0E-03	0
^{51}Cr	1.3E-03	1.0E-04	1.4E-02	1.3E-03
^{54}Mn	2.2E-02	3.2E-03	1.6E+00	3.2E-03
^{55}Fe	7.8E-03	2.2E-02	9.4E-02	3.3E-08
^{59}Fe	8.0E-02	1.9E-02	6.9E-01	4.6E-03
^{58}Co	1.5E-02	0	7.0E-01	0
^{60}Co	5.7E-02	9.7E-03	1.1E+01	9.7E-03
^{59}Ni	4.7E-02	2.8E-01	1.5E-01	0
^{63}Ni	7.0E-02	2.1E+00	4.0E-01	0
^{85}Kr	7.9E-06	7.9E-06	7.9E-06	7.9E-06
^{90}Sr	5.0E+01	2.1E+02	2.0E+01	8.2E-11
^{90}Y	3.8E-03	1.4E-01	1.1E-01	2.7E-07
^{91}Y	6.1E-02	2.2E+00	1.2E+00	1.4E-05
^{95}Zr	1.1E-01	4.2E-01	1.2E+00	2.8E-03
^{93m}Nb	3.3E-02	4.6E-01	5.3E-01	3.2E-07
^{95}Nb	3.3E-02	8.6E-02	3.3E-01	2.9E-03
^{99}Tc	1.5E-02	3.6E-02	1.8E+00	0
^{106}Ru	2.0E-02	1.5E-01	1.1E+01	3.3E-04
^{110m}Ag	2.7E-02	4.0E-02	5.5E+00	1.1E-02
^{123}Sn	2.9E-03	1.2E-01	8.4E-05	1.7E-03
^{125}Sb	1.8E-01	5.7E-01	3.3E+00	1.7E-03
^{125m}Te	7.0E-03	4.3E-02	2.8E-01	1.7E+00
^{127m}Te	2.1E-02	1.6E-01	1.1E+00	5.0E+00
^{127}Te	1.3E-04	5.6E-04	5.2E-03	1.2E-01
^{129}I	4.5E+00	1.6E+00	1.6E-01	3.5E+03
^{134}Cs	1.3E+00	6.9E-01	2.1E-01	5.9E-03
^{137}Cs	7.9E-01	9.6E-01	1.6E-01	9.0E-06
^{144}Ce	1.0E-01	1.9E+00	9.0E+00	6.8E-05
^{147}Pm	1.2E-02	3.1E-01	8.6E-01	0
^{154}Eu	3.4E-01	5.2E+00	1.5E+01	4.8E-03
^{155}Eu	2.2E-02	2.0E-01	1.0E+00	1.9E-04
^{185}W	1.2E-04	3.2E-03	3.5E-01	0
^{232}U	1.4E+01	2.0E+02	6.3E+03	7.2E-07
^{236}U	2.5E+00	4.0E+01	1.6E+03	0
^{237}U	2.9E-04	3.0E-04	2.8E-04	2.8E-04
^{238}U	2.1E+00	3.6E+01	1.4E+03	0
^{238}Pu	3.1E+02	6.2E+03	1.9E+03	6.0E-06
^{239}Pu	3.7E+02	7.6E+03	1.8E+03	6.0E-06
^{240}Pu	3.6E+02	7.6E+03	1.8E+03	5.2E-06
^{241}Pu	4.5E+00	1.1E+02	3.1E+00	0
^{241}Am	2.9E+02	4.2E+03	1.9E+03	8.0E-05
^{242m}Am	2.8E+02	4.1E+03	1.3E+03	1.3E-05
^{243}Am	2.8E+02	4.2E+03	1.8E+03	5.2E-06
^{242}Cm	5.1E+00	7.7E+01	5.3E+02	1.8E-07
^{244}Cm	1.4E+02	2.2E+03	1.9E+03	4.9E-06
^{245}Cm	3.1E+02	5.25+03	1.8E+03	1.1E-04

TABLE D.6. contd

Nuclide	Dose to Organ of Reference (man-rem/Ci) Total Body	Bone	Lungs	Thyroid
^{210}Pb	8.0E+00	2.4E+02	1.3E+03	5.1E-06
^{210}Bi	7.3E-03	1.3E-02	1.6E+01	0
^{224}Ra	7.2E-01	3.6E+00	7.8E+01	3.4E-05
^{226}Ra	1.9E+03	2.9E+03	3.7E+03	2.6E-05
^{227}Ac	5.1E+02	8.2E+03	1.0E+04	1.6E-06
^{228}Th	6.9E+01	2.0E+03	6.5E+03	8.2E-06
^{229}Th	2.2E+03	4.6E+04	9.1E+03	8.3E-05
^{230}Th	3.3E+02	1.1E+04	1.6E+03	1.6E-06
^{232}Th	8.5E+03	1.2E+04	2.2E+03	0
^{231}Pa	9.0E+02	2.1E+04	2.4E+03	6.7E-05
^{233}Pa	3.5E-03	1.7E-02	1.8E-01	6.6E-04
^{233}U	2.6E+00	4.3E+01	1.7E+03	0
^{234}U	2.6E+00	4.2E+01	1.6E+03	3.2E-07
^{235}U	2.3E+00	3.8E+01	1.5E+03	4.3E-04
^{237}Np	3.1E+02	7.0E+03	1.6E+03	5.1E-05
^{239}Np	5.3E-04	3.2E-03	1.7E-02	3.5E-04
^{242}Pu	3.5E+02	7.0E+03	1.7E+03	6.4E-06
^{243}Am	2.8E+02	4.2E+03	1.8E+03	5.1E-06

TABLE D.7. Once-Through Option - Prompt Disposal - 70-Year Total Body Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	4WR FUEL SHIPMENTS ANNUAL	4WR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	6.50E-02	3.78E-01	2.95E+00	2.95E+00	3.50E+00	3.50E+00	6.52E+00	6.83E+00	1985
1990	1.18E-01	8.66E-01	9.57E+00	4.05E+01	1.53E+01	5.80E+01	2.50E+01	9.94E+01	1990
1995	[illegible].80E-01	1.64E+00	1.26E+01	9.98E+01	2.10E+01	1.56E+02	3.38E+01	2.57E+02	1995
2000	2.63E-01	2.78E+00	1.94E+01	1.82E+02	3.16E+01	2.88E+02	5.13E+01	4.73E+02	2000
2005	3.25E-01	4.31E+00	2.80E+01	3.04E+02	4.47E+01	4.85E+02	7.31E+01	7.93E+02	2005
2010	3.34E-01	5.97E+00	3.28E+01	4.65E+02	5.21E+01	7.39E+02	8.52E+01	1.21E+03	2010
2015	3.24E-01	7.63E+00	3.32E+01	6.28E+02	5.02E+01	9.96E+02	8.37E+01	1.63E+03	2015
2020	2.91E-01	9.14E+00	3.35E+01	7.92E+02	5.17E+01	1.25E+03	8.54E+01	2.05E+03	2020
2025	2.60E-01	1.05E+01	2.72E+01	9.38E+02	4.57E+01	1.49E+03	7.32E+01	2.44E+03	2025
2030	2.01E-01	1.16E+01	2.60E+01	1.08E+03	4.43E+01	1.71E+03	7.04E+01	2.80E+03	2030
2035	1.38E-01	1.24E+01	2.07E+01	1.20E+03	3.09E+01	1.89E+03	5.18E+01	3.10E+03	2035
2040	7.31E-02	1.30E+01	1.62E+01	1.29E+03	2.50E+01	2.03E+03	4.10E+01	3.33E+03	2040
2045	9.27E-03	1.31E+01	9.67E+00	1.35E+03	1.37E+01	2.12E+03	2.33E+01	3.48E+03	2045
2050	0.	1.31E+01	0.	1.36E+03	0.	2.13E+03	0.	3.51E+03	2050

TABLE D.8. Once-Through Option - Prompt Disposal - 70-Year Thyroid Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	2.80E-01	4.12E-01	0.	0.	0.	0.	2.80E-01	4.12E-01	1985
1990	1.35E+00	5.19E+00	0.	0.	0.	0.	1.35E+00	5.19E+00	1990
1995	1.86E+00	1.36E+01	0.	0.	0.	0.	1.86E+00	1.36E+01	1995
2000	2.85E+00	2.56E+01	0.	0.	0.	0.	2.85E+00	2.56E+01	2000
2005	4.10E+00	4.35E+01	0.	0.	0.	0.	4.10E+00	4.35E+01	2005
2010	5.09E+00	6.75E+01	0.	0.	0.	0.	5.09E+00	6.75E+01	2010
2015	5.01E+00	9.28E+01	0.	0.	0.	0.	5.01E+00	9.28E+01	2015
2020	4.97E+00	1.18E+02	0.	0.	0.	0.	4.97E+00	1.18E+02	2020
2025	4.34E+00	1.41E+02	0.	0.	0.	0.	4.34E+00	1.41E+02	2025
2030	3.97E+00	1.61E+02	0.	0.	0.	0.	3.97E+00	1.61E+02	2030
2035	2.85E+00	1.78E+02	0.	0.	0.	0.	2.85E+00	1.78E+02	2035
2040	2.07E+00	1.90E+02	0.	0.	0.	0.	2.07E+00	1.90E+02	2040
2045	9.70E-01	1.97E+02	0.	0.	0.	0.	9.70E-01	1.97E+02	2045
2050	0.	1.98E+02	0.	0.	0.	0.	0.	1.98E+02	2050

TABLE D.9. Once-Through Option - Prompt Disposal - 70-Year Lung Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	2.43E-02	1.40E-01	0.	0.	0.	0.	2.43E-02	1.40E-01	1985
1990	4.51E-02	3.25E-01	0.	0.	0.	0.	4.51E-02	3.25E-01	1990
1995	6.88E-02	6.20E-01	0.	0.	0.	0.	6.88E-02	6.20E-01	1995
2000	1.01E-01	1.06E+00	0.	0.	0.	0.	1.01E-01	1.06E+00	2000
2005	1.25E-01	1.65E+00	0.	0.	0.	0.	1.25E-01	1.65E+00	2005
2010	1.30E-01	2.29E+00	0.	0.	0.	0.	1.30E-01	2.29E+00	2010
2015	1.27E-01	2.93E+00	0.	0.	0.	0.	1.27E-01	2.93E+00	2015
2020	1.14E-01	3.53E+00	0.	0.	0.	0.	1.14E-01	3.53E+00	2020
2025	1.02E-01	4.07E+00	0.	0.	0.	0.	1.02E-01	4.07E+00	2025
2030	8.02E-02	4.51E+00	0.	0.	0.	0.	8.02E-02	4.51E+00	2030
2035	5.57E-02	4.84E+00	0.	0.	0.	0.	5.57E-02	4.84E+00	2035
2040	3.08E-02	5.05E+00	0.	0.	0.	0.	3.08E-02	5.05E+00	2040
2045	4.99E-03	5.10E+00	0.	0.	0.	0.	4.99E-03	5.10E+00	2045
2050	0.	5.10E+00	0.	0.	0.	0.	0.	5.10E+00	2050

TABLE D.10. Once-Through Option - Prompt Disposal - 70-Year Bone Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	1.17E-01	6.76E-01	0.	0.	0.	0.	1.17E-01	6.76E-01	1985
1990	2.10E-01	1.55E+00	0.	0.	0.	0.	2.10E-01	1.55E+00	1990
1995	3.20E-01	2.92E+00	0.	0.	0.	0.	3.20E-01	2.92E+00	1995
2000	4.67E-01	4.95E+00	0.	0.	0.	0.	4.67E-01	4.95E+00	2000
2005	5.76E-01	7.66E+00	0.	0.	0.	0.	5.76E-01	7.66E+00	2005
2010	5.93E-01	1.06E+01	0.	0.	0.	0.	5.93E-01	1.06E+01	2010
2015	5.78E-01	1.36E+01	0.	0.	0.	0.	5.78E-01	1.36E+01	2015
2020	5.18E-01	1.63E+01	0.	0.	0.	0.	5.18E-01	1.63E+01	2020
2025	4.66E-01	1.87E+01	0.	0.	0.	0.	4.66E-01	1.87E+01	2025
2030	3.62E-01	2.07E+01	0.	0.	0.	0.	3.62E-01	2.07E+01	2030
2035	2.51E-01	2.22E+01	0.	0.	0.	0.	2.51E-01	2.22E+01	2035
2040	1.36E-01	2.31E+01	0.	0.	0.	0.	1.36E-01	2.31E+01	2040
2045	1.78E-02	2.33E+01	0.	0.	0.	0.	1.78E-02	2.33E+01	2045
2050	0.	2.33E+01	0.	0.	0.	0.	0.	2.33E+01	2050

TABLE D.11. Once Through Option - Decision to Dispose Deferred or Repositories Unavailable Until Year 2000 - 70-Year Total Body Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	6.50E-02	3.78E-01	1.17E+00	1.17E+00	1.37E+00	1.37E+00	2.60E+00	2.92E+00	1985
1990	1.18E-01	8.66E-01	3.79E+00	1.60E+01	5.98E+00	2.27E+01	9.89E+00	3.96E+01	1990
1995	1.80E-01	1.64E+00	4.99E+00	3.95E+01	8.23E+00	6.09E+01	1.34E+01	1.02E+02	1995
2000	2.63E-01	2.78E+00	1.94E+01	8.36E+01	3.16E+01	1.32E+02	5.13E+01	2.18E+02	2000
2005	3.25E-01	4.31E+00	3.68E+01	2.37E+02	5.88E+01	3.75E+02	9.60E+01	6.16E+02	2005
2010	3.34E-01	5.97E+00	3.87E+01	4.29E+02	6.17E+01	6.81E+02	1.01E+02	1.12E+03	2010
2015	3.24E-01	7.63E+00	3.95E+01	6.23E+02	6.04E+01	9.88E+02	1.00E+02	1.62E+03	2015
2020	2.91E-01	9.14E+00	3.35E+01	7.92E+02	5.17E+01	1.25E+03	8.54E+01	2.05E+03	2020
2025	2.60E-01	1.05E+01	2.72E+01	9.38E+02	4.57E+01	1.49E+03	7.32E+01	2.44E+03	2025
2030	2.01E-01	1.14E+01	2.60E+01	1.08E+03	4.43E+01	1.71E+03	7.04E+01	2.80E+03	2030
2035	1.38E-01	1.24E+01	2.07E+01	1.20E+03	3.09E+01	1.89E+03	5.18E+01	3.10E+03	2035
2040	7.31E-02	1.30E+01	1.60E+01	1.29E+03	2.50E+01	2.03E+03	4.10E+01	3.33E+03	2040
2045	9.27E-03	1.31E+01	9.67E+00	1.35E+03	1.37E+01	2.12E+03	2.33E+01	3.48E+03	2045
2050	0.	1.31E+01	0.	1.36E+03	0.	2.13E+03	0.	3.51E+03	2050

TABLE D.12. Once Through Option - Decision to Dispose Deferred or Repositories Unavailable Until Year 2000 - 70-Year Thyroid Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	2.80E-01	4.12E-01	0.	0.	0.	0.	2.80E-01	4.12E-01	1985
1990	1.35E+00	5.19E+00	0.	0.	0.	0.	1.35E+00	5.19E+00	1990
1995	1.86E+00	1.36E+01	0.	0.	0.	0.	1.86E+00	1.36E+01	1995
2000	2.85E+00	2.56E+01	0.	0.	0.	0.	2.85E+00	2.56E+01	2000
2005	4.10E+00	4.35E+01	0.	0.	0.	0.	4.10E+00	4.35E+01	2005
2010	5.09E+00	6.75E+01	0.	0.	0.	0.	5.09E+00	6.75E+01	2010
2015	5.01E+00	9.28E+01	0.	0.	0.	0.	5.01E+00	9.28E+01	2015
2020	4.97E+00	1.18E+02	0.	0.	0.	0.	4.97E+00	1.18E+02	2020
2025	4.34E+00	1.41E+02	0.	0.	0.	0.	4.34E+00	1.41E+02	2025
2030	3.97E+00	1.61E+02	0.	0.	0.	0.	3.97E+00	1.61E+02	2030
2035	2.85E+00	1.78E+02	0.	0.	0.	0.	2.85E+00	1.78E+02	2035
2040	2.07E+00	1.90E+02	0.	0.	0.	0.	2.07E+00	1.90E+02	2040
2045	9.70E-01	1.97E+02	0.	0.	0.	0.	9.70E-01	1.97E+02	2045
2050	0.	1.98E+02	0.	0.	0.	0.	0.	1.98E+02	2050

TABLE D.13. Once Through Option - Decision to Dispose Deferred or Repositories Unavailable Until Year 2000 - 70-Year Lung Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	2.43E-02	1.40E-01	0.	0.	0.	0.	2.43E-02	1.40E-01	1985
1990	4.51E-02	3.25E-01	0.	0.	0.	0.	4.51E-02	3.25E-01	1990
1995	6.88E-02	6.20E-01	0.	0.	0.	0.	6.88E-02	6.20E-01	1995
2000	1.01E-01	1.06E+00	0.	0.	0.	0.	1.01E-01	1.06E+00	2000
2005	1.25E-01	1.65E+00	0.	0.	0.	0.	1.25E-01	1.65E+00	2005
2010	1.30E-01	2.29E+00	0.	0.	0.	0.	1.30E-01	2.29E+00	2010
2015	1.27E-01	2.93E+00	0.	0.	0.	0.	1.27E-01	2.93E+00	2015
2020	1.14E-01	3.53E+00	0.	0.	0.	0.	1.14E-01	3.53E+00	2020
2025	1.02E-01	4.07E+00	0.	0.	0.	0.	1.02E-01	4.07E+00	2025
2030	8.02E-02	4.51E+00	0.	0.	0.	0.	8.02E-02	4.51E+00	2030
2035	5.57E-02	4.84E+00	0.	0.	0.	0.	5.57E-02	4.84E+00	2035
2040	3.08E-02	5.05E+00	0.	0.	0.	0.	3.08E-02	5.09E+00	2040
2045	4.99E-03	5.10E+00	0.	0.	0.	0.	4.99E-03	5.10E+00	2045
2050	0.	5.10E+00	0.	0.	0.	0.	0.	5.10E+00	2050

TABLE D.14. Once Through Option - Decision to Dispose Deferred or Repositories Unavailable Until Year 2000 - 70-Year Bone Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	1.17E-01	6.76E-01	0.	0.	0.	0.	1.17E-01	6.76E-01	1985
1990	2.10E-01	1.55E+00	0.	0.	0.	0.	2.10E-01	1.55E+00	1990
1995	3.20E-01	2.92E+00	0.	0.	0.	0.	3.20E-01	2.92E+00	1995
2000	4.67E-01	4.95E+00	0.	0.	0.	0.	4.67E-01	4.95E+00	2000
2005	5.76E-01	7.66E+00	0.	0.	0.	0.	5.76E-01	7.66E+00	2005
2010	5.93E-01	1.06E+01	0.	0.	0.	0.	5.93E-01	1.06E+01	2010
2015	5.78E-01	1.36E+01	0.	0.	0.	0.	5.78E-01	1.36E+01	2015
2020	5.18E-01	1.63E+01	0.	0.	0.	0.	5.18E-01	1.63E+01	2020
2025	4.66E-01	1.87E+01	0.	0.	0.	0.	4.66E-01	1.87E+01	2025
2030	3.62E-01	2.07E+01	0.	0.	0.	0.	3.62E-01	2.07E+01	2030
2035	2.51E-01	2.22E+01	0.	0.	0.	0.	2.51E-01	2.22E+01	2035
2040	1.36E-01	2.31E+01	0.	0.	0.	0.	1.36E-01	2.31E+01	2040
2045	1.78E-02	2.33E+01	0.	0.	0.	0.	1.78E-02	2.33E+01	2045
2050	0.	2.33E+01	0.	0.	0.	0.	0.	2.33E+01	2050

TABLE D.15. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Repository in 1985
70-Year Total-Body Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	2.00E+02	5.30E+02	1.46E-03	4.30E-03	4.95E+00	4.95E+00	2.04E+02	5.35E+02	1985
1990	4.08E+02	2.35E+03	3.62E-03	1.87E-02	9.38E+00	4.66E+01	4.18E+02	2.40E+03	1990
1995	6.75E+02	4.99E+03	6.86E-03	4.40E-02	1.28E+01	1.03E+02	6.88E+02	5.09E+03	1995
2000	9.37E+02	8.89E+03	9.86E-03	8.50E-02	1.77E+01	1.77E+02	9.55E+02	9.07E+03	2000
2005	1.23E+03	1.41E+04	1.30E-02	1.43E-01	2.27E+01	2.76E+02	1.26E+03	1.44E+04	2005
2010	1.32E+03	2.06E+04	1.53E-02	2.16E-01	2.34E+01	3.91E+02	1.34E+03	2.10E+04	2010
2015	1.12E+03	2.67E+04	1.64E-02	2.96E-01	2.07E+01	5.02E+02	1.14E+03	2.72E+04	2015
2020	1.14E+03	3.22E+04	1.53E-02	3.70E-01	2.11E+01	6.04E+02	1.16E+03	3.28E+04	2020
2025	1.08E+03	3.81E+04	1.38E-02	4.51E-01	2.01E+01	7.10E+02	1.10E+03	3.88E+04	2025
2030	8.17E+02	4.27E+04	1.11E-02	5.13E-01	1.56E+01	7.98E+02	8.33E+02	4.35E+04	2030
2035	5.09E+02	4.59E+04	2.51E-03	5.41E-01	1.05E+01	8.60E+02	5.20E+02	4.67E+04	2035
2040	4.28E+02	4.82E+04	0.	5.43E-01	1.02E+01	9.11E+02	4.39E+02	4.91E+04	2040
2045	3.05E+01	4.91E+04	0.	5.43E-01	1.75E+00	9.37E+02	3.22E+01	5.01E+04	2045
2050	4.36E-06	4.92E+04	0.	5.43E-01	0.	9.40E+02	4.36E-06	5.01E+04	2050
2055	4.29E-06	4.92E+04	0.	5.43E-01	4.36E-01	9.42E+02	4.36E-01	5.01E+04	2055
2060	4.22E-06	4.92E+04	0.	5.43E-01	4.36E-01	9.43E+02	4.36E-01	5.01E+04	2060
2065	4.14E-06	4.92E+04	0.	5.43E-01	4.36E-01	9.44E+02	4.36E-01	5.01E+04	2065
2070	4.05E-06	4.92E+04	0.	5.43E-01	0.	9.44E+02	4.05E-06	5.01E+04	2070
2075	3.99E-06	4.92E+04	0.	5.43E-01	1.31E+00	9.47E+02	1.31E+00	5.01E+04	2075

TABLE D.16. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Repository in 1985
70-Year Thyroid Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	3.53E+02	9.57E+02	1.70E-11	5.01E-11	0.	0.	3.53E+02	9.57E+02	1985
1990	6.66E+02	3.99E+03	4.19E-11	2.18E-10	0.	0.	6.66E+02	3.99E+03	1990
1995	1.10E+03	8.28E+03	7.94E-11	5.10E-10	0.	0.	1.10E+03	8.28E+03	1995
2000	1.52E+03	1.46E+04	1.18E-10	9.94E-10	0.	0.	1.52E+03	1.46E+04	2000
2005	2.01E+03	2.32E+04	1.55E-10	1.69E-09	0.	0.	2.01E+03	2.32E+04	2005
2010	2.14E+03	3.37E+04	1.82E-10	2.56E-09	0.	0.	2.14E+03	3.37E+04	2010
2015	1.81E+03	4.36E+04	1.98E-10	3.52E-09	0.	0.	1.81E+03	4.36E+04	2015
2020	1.87E+03	5.26E+04	1.87E-10	4.43E-09	0.	0.	1.87E+03	5.26E+04	2020
2025	1.75E+03	6.21E+04	1.69E-10	5.41E-09	0.	0.	1.75E+03	6.21E+04	2025
2030	1.32E+03	6.96E+04	1.38E-10	6.18E-09	0.	0.	1.32E+03	6.96E+04	2030
2035	8.20E+02	7.47E+04	2.89E-11	6.51E-09	0.	0.	8.20E+02	7.47E+04	2035
2040	7.07E+02	7.85E+04	0.	6.53E-09	0.	0.	7.07E+02	7.85E+04	2040
2045	3.09E+01	7.99E+04	0.	6.53E-09	0.	0.	3.09E+01	7.99E+04	2045
2050	1.54E-13	8.00E+04	0.	6.53E-09	0.	0.	1.54E-13	8.00E+04	2050
2055	1.80E-13	8.00E+04	0.	6.53E-09	0.	0.	1.80E-13	8.00E+04	2055
2060	1.99E-13	8.00E+04	0.	6.53E-09	0.	0.	1.99E-13	8.00E+04	2060
2065	2.14E-13	8.00E+04	0.	6.53E-09	0.	0.	2.14E-13	8.00E+04	2065
2070	2.25E-13	8.00E+04	0.	6.53E-09	0.	0.	2.25E-13	8.00E+04	2070
2075	2.32E-13	8.00E+04	0.	6.53E-09	0.	0.	2.32E-13	8.00E+04	2075

TABLE D.17. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Repository in 1985 70-Year Lung Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	2.08E+02	5.55E+02	5.71E-03	1.68E-02	0.	0.	2.08E+02	5.55E+02	1985
1990	4.22E+02	2.44E+03	1.41E-02	7.32E-02	0.	0.	4.22E+02	2.44E+03	1990
1995	6.97E+02	5.17E+03	2.67E-02	1.71E-01	0.	0.	6.97E+02	5.17E+03	1995
2000	9.67E+02	9.19E+03	3.94E-02	3.34E-01	0.	0.	9.67E+02	9.19E+03	2000
2005	1.89E+03	1.64E+04	5.18E-02	5.66E-01	0.	0.	1.89E+03	1.64E+04	2005
2010	2.43E+03	2.87E+04	6.11E-02	8.58E-01	0.	0.	2.43E+03	2.87E+04	2010
2015	2.50E+03	4.10E+04	6.62E-02	1.18E+00	0.	0.	2.50E+03	4.10E+04	2015
2020	3.26E+03	5.47E+04	6.24E-02	1.48E+00	0.	0.	3.26E+03	5.47E+04	2020
2025	3.33E+03	7.25E+04	5.61E-02	1.81E+00	0.	0.	3.33E+03	7.25E+04	2025
2030	3.17E+03	9.06E+04	4.61E-02	2.07E+00	0.	0.	3.17E+03	9.06E+04	2030
2035	2.61E+03	1.04E+05	9.73E-03	2.18E+00	0.	0.	2.61E+03	1.04E+05	2035
2040	4.50E+02	1.14E+05	0.	2.18E+00	0.	0.	4.50E+02	1.14E+05	2040
2045	3.05E+01	1.15E+05	0.	2.18E+00	0.	0.	3.05E+01	1.15E+05	2045
2050	2.45E-05	1.15E+05	0.	2.18E+00	0.	0.	2.45E-05	1.15E+05	2050
2055	2.44E-05	1.15E+05	0.	2.18E+00	0.	0.	2.44E-05	1.15E+05	2055
2060	2.42E-05	1.15E+05	0.	2.18E+00	0.	0.	2.42E-05	1.15E+05	2060
2065	2.39E-05	1.15E+05	0.	2.18E+00	0.	0.	2.39E-05	1.15E+05	2065
2070	2.36E-05	1.15E+05	0.	2.18E+00	0.	0.	2.36E-05	1.15E+05	2070
2075	2.32E-05	1.15E+05	0.	2.18E+00	0.	0.	2.32E-05	1.15E+05	2075

TABLE D.18. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Repository in 1985
70-Year Bone Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	5.22E+00	1.44E+01	3.17E-02	9.34E-02	0.	0.	5.25E+00	1.45E+01	1985
1990	9.20E+00	5.76E+01	7.85E-02	4.07E-01	0.	0.	9.28E+00	5.80E+01	1990
1995	1.46E+01	1.15E+02	1.49E-01	9.56E-01	0.	0.	1.48E+01	1.16E+02	1995
2000	2.03E+01	2.00E+02	2.13E-01	1.84E+00	0.	0.	2.05E+01	2.02E+02	2000
2005	4.57E+01	3.69E+02	2.81E-01	3.10E+00	0.	0.	4.60E+01	3.73E+02	2005
2010	6.03E+01	6.77E+02	3.30E-01	4.68E+00	0.	0.	6.06E+01	6.82E+02	2010
2015	6.41E+01	9.88E+02	3.54E-01	6.40E+00	0.	0.	6.44E+01	9.95E+02	2015
2020	8.75E+01	1.35E+03	3.30E-01	8.01E+00	0.	0.	8.78E+01	1.35E+03	2020
2025	9.02E+01	1.83E+03	2.97E-01	9.74E+00	0.	0.	9.05E+01	1.84E+03	2025
2030	8.77E+01	2.33E+03	2.39E-01	1.11E+01	0.	0.	8.80E+01	2.34E+03	2030
2035	7.43E+01	2.71E+03	5.46E-02	1.17E+01	0.	0.	7.44E+01	2.72E+03	2035
2040	9.35E+00	2.99E+03	0.	1.17E+01	0.	0.	9.35E+00	3.00E+03	2040
2045	1.27E-03	3.01E+03	0.	1.17E+01	0.	0.	1.27E-03	3.02E+03	2045
2050	8.93E-05	3.01E+03	0.	1.17E+01	0.	0.	8.93E-05	3.02E+03	2050
2055	8.71E-05	3.01E+03	0.	1.17E+01	0.	0.	8.71E-05	3.02E+03	2055
2060	8.50E-05	3.01E+03	0.	1.17E+01	0.	0.	8.50E-05	3.02E+03	2060
2065	8.28E-05	3.01E+03	0.	1.17E+01	0.	0.	8.28E-05	3.02E+03	2065
2070	8.07E-05	3.01E+03	0.	1.17E+01	0.	0.	8.07E-05	3.02E+03	2070
2075	7.91E-05	3.01E+03	0.	1.17E+01	0.	0.	7.91E-05	3.02E+03	2075

TABLE D.19. Fuel Reprocessing for U and Pu Recycle - Decision to Recycle Delayed Until Year 2000 70-Year Total-Body Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	0.	0.	0.	0.	0.	0.	0.	0.	1985
1990	0.	0.	0.	0.	0.	0.	0.	0.	1990
1995	0.	0.	0.	0.	0.	0.	0.	0.	1995
2000	0.	0.	0.	0.	0.	0.	0.	0.	2000
2005	0.	0.	0.	0.	0.	0.	0.	0.	2005
2010	7.53E+00	7.53E+00	2.27E-04	2.27E-04	1.37E+00	1.37E+00	8.90E+00	8.90E+00	2010
2015	1.25E+02	3.66E+02	3.61E-03	1.09E-02	1.14E+01	3.78E+01	1.36E+02	4.04E+02	2015
2020	3.52E+02	1.65E+03	7.38E-03	4.03E-02	2.41E+01	1.33E+02	3.76E+02	1.78E+03	2020
2025	5.92E+02	4.14E+03	8.61E-03	8.44E-02	3.27E+01	2.84E+02	6.24E+02	4.48E+03	2025
2030	7.07E+02	7.47E+03	5.64E-03	1.19E-01	3.35E+01	4.50E+02	7.41E+02	7.92E+03	2030
2035	8.48E+02	1.14E+04	2.36E-03	1.37E-01	3.31E+01	6.16E+02	8.81E+02	1.20E+04	2035
2040	9.32E+02	1.60E+04	0.	1.39E-01	2.89E+01	7.77E+02	9.61E+02	1.68E+04	2040
2045	4.78E+02	1.99E+04	0.	1.39E-01	1.48E+01	8.91E+02	4.93E+02	2.08E+04	2045
2050	3.14E+01	2.01E+04	0.	1.39E-01	1.76E+00	9.06E+02	3.31E+01	2.10E+04	2050
2055	3.28E-06	2.01E+04	0.	1.39E-01	0.	9.06E+02	3.28E-06	2.10E+04	2055
2060	3.25E-06	2.01E+04	0.	1.39E-01	0.	9.06E+02	3.25E-06	2.10E+04	2060
2065	3.21E-06	2.01E+04	0.	1.39E-01	0.	9.06E+02	3.21E-06	2.10E+04	2065
2070	3.17E-06	2.01E+04	0.	1.39E-01	4.36E-01	9.07E+02	4.36E-01	2.10E+04	2070
2075	3.13E-06	2.01E+04	0.	1.39E-01	6.98E+00	9.13E+02	6.98E+00	2.11E+04	2075

TABLE D.20. Fuel Reprocessing for U and Pu Recycle - Decision to Recycle Delayed Until Year 2000
70-Year Thyroid Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	0.	0.	0.	0.	0.	0.	0.	0.	1985
1990	0.	0.	0.	0.	0.	0.	0.	0.	1990
1995	0.	0.	0.	0.	0.	0.	0.	0.	1995
2000	0.	0.	0.	0.	0.	0.	0.	0.	2000
2005	0.	0.	0.	0.	0.	0.	0.	0.	2005
2010	4.38E+01	4.38E+01	2.64E-12	2.64E-12	0.	0.	4.38E+01	4.38E+01	2010
2015	4.96E+02	1.60E+03	4.21E-11	1.27E-10	0.	0.	4.96E+02	1.60E+03	2015
2020	1.15E+03	6.03E+03	8.60E-11	4.69E-10	0.	0.	1.15E+03	6.03E+03	2020
2025	1.71E+03	1.35E+04	1.00E-10	9.84E-10	0.	0.	1.71E+03	1.35E+04	2025
2030	1.84E+03	2.25E+04	6.57E-11	1.38E-09	0.	0.	1.84E+03	2.25E+04	2030
2035	2.00E+03	3.20E+04	2.72E-11	1.60E-09	0.	0.	2.00E+03	3.20E+04	2035
2040	1.94E+03	4.23E+04	0.	1.62E-09	0.	0.	1.94E+03	4.23E+04	2040
2045	7.96E+02	4.95E+04	0.	1.62E-09	0.	0.	7.96E+02	4.95E+04	2045
2050	3.19E+01	4.98E+04	0.	1.62E-09	0.	0.	3.19E+01	4.98E+04	2050
2055	8.25E-14	4.98E+04	0.	1.62E-09	0.	0.	8.25E-14	4.98E+04	2055
2060	1.10E-13	4.98E+04	0.	1.62E-09	0.	0.	1.10E-13	4.98E+04	2060
2065	1.32E-13	4.98E+04	0.	1.62E-09	0.	0.	1.32E-13	4.98E+04	2065
2070	1.48E-13	4.98E+04	0.	1.62E-09	0.	0.	1.48E-13	4.98E+04	2070
2075	1.58E-13	4.98E+04	0.	1.62E-09	0.	0.	1.58E-13	4.98E+04	2075

TABLE D.21. Fuel Reprocessing for U and Pu Recycle - Decision to Recycle Delayed Until Year 2000 70-Year Lung Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	0.	0.	0.	0.	0.	0.	0.	0.	1985
1990	0.	0.	0.	0.	0.	0.	0.	0.	1990
1995	0.	0.	0.	0.	0.	0.	0.	0.	1995
2000	0.	0.	0.	0.	0.	0.	0.	0.	2000
2005	0.	0.	0.	0.	0.	0.	0.	0.	2005
2010	9.97E+00	9.97E+00	8.86E-04	8.86E-04	0.	0.	9.97E+00	9.97E+00	2010
2015	1.45E+02	4.35E+02	1.41E-02	4.27E-02	0.	0.	1.45E+02	4.35E+02	2015
2020	3.93E+02	1.88E+03	2.89E-02	1.57E-01	0.	0.	3.93E+02	1.88E+03	2020
2025	6.47E+02	4.63E+03	3.37E-02	3.30E-01	0.	0.	6.47E+02	4.63E+03	2025
2030	7.64E+02	8.24E+03	2.21E-02	4.64E-01	0.	0.	7.64E+02	8.24E+03	2030
2035	9.12E+02	1.24E+04	9.15E-03	5.36E-01	0.	0.	9.12E+02	1.24E+04	2035
2040	1.11E+03	1.76E+04	0.	5.42E-01	0.	0.	1.11E+03	1.76E+04	2040
2045	3.45E+03	2.81E+04	0.	5.42E-01	0.	0.	3.45E+03	2.81E+04	2045
2050	3.14E+01	2.84E+04	0.	5.42E-01	0.	0.	3.14E+01	2.84E+04	2050
2055	1.78E-05	2.84E+04	0.	5.42E-01	0.	0.	1.78E-05	2.84E+04	2055
2060	1.79E-05	2.84E+04	0.	5.42E-01	0.	0.	1.79E-05	2.84E+04	2060
2065	1.79E-05	2.84E+04	0.	5.42E-01	0.	0.	1.79E-05	2.84E+04	2065
2070	1.78E-05	2.84E+04	0.	5.42E-01	0.	0.	1.78E-05	2.84E+04	2070
2075	1.77E-05	2.84E+04	0.	5.42E-01	0.	0.	1.77E-05	2.84E+04	2075

TABLE D.22. Fuel Reprocessing for U and Pu Recycle - Decision to Recycle Delayed Until Year 2000
70-Year Bone Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	0.	0.	0.	0.	0.	0.	0.	0.	1985
1990	0.	0.	0.	0.	0.	0.	0.	0.	1990
1995	0.	0.	0.	0.	0.	0.	0.	0.	1995
2000	0.	0.	0.	0.	0.	0.	0.	0.	2000
2005	0.	0.	0.	0.	0.	0.	0.	0.	2005
2010	7.72E-01	7.72E-01	4.92E-03	4.92E-03	0.	0.	7.77E-01	7.77E-01	2010
2015	8.01E+00	2.62E+01	7.84E-02	2.37E-01	0.	0.	8.09E+00	2.64E+01	2015
2020	1.78E+01	9.56E+01	1.60E-01	8.74E-01	0.	0.	1.80E+01	9.65E+01	2020
2025	2.58E+01	2.10E+02	1.87E-01	1.83E+00	0.	0.	2.59E+01	2.12E+02	2025
2030	2.71E+01	3.44E+02	1.22E-01	2.58E+00	0.	0.	2.72E+01	3.46E+02	2030
2035	2.82E+01	4.81E+02	5.12E-02	2.98E+00	0.	0.	2.82E+01	4.84E+02	2035
2040	2.56E+01	6.20E+02	0.	3.01E+00	0.	0.	2.56E+01	6.23E+02	2040
2045	4.92E+01	7.95E+02	0.	3.01E+00	0.	0.	4.92E+01	7.98E+02	2045
2050	1.21E-03	7.95E+02	0.	3.01E+00	0.	0.	1.21E-03	7.98E+02	2050
2055	6.82E-05	7.95E+02	0.	3.01E+00	0.	0.	6.82E-05	7.98E+02	2055
2060	6.68E-05	7.95E+02	0.	3.01E+00	0.	0.	6.68E-05	7.98E+02	2060
2065	6.54E-05	7.95E+02	0.	3.01E+00	0.	0.	6.54E-05	7.98E+02	2065
2070	6.40E-05	7.95E+02	0.	3.01E+00	0.	0.	6.40E-05	7.98E+02	2070
2075	6.28E-05	7.95E+02	0.	3.01E+00	0.	0.	6.28E-05	7.98E+02	2075

TABLE D.23. Fuel Reprocessing for U and Pu Recycle - Delayed Disposal - Repository in 2000
70-Year Total-Body Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	2.00E+02	5.30E+02	1.46E-03	4.30E-03	0.	0.	2.00E+02	5.30E+02	1985
1990	4.08E+02	2.35E+03	3.62E-03	1.87E-02	0.	0.	4.08E+02	2.35E+03	1990
1995	6.75E+02	4.99E+03	6.86E-03	4.40E-02	0.	0.	6.75E+02	4.99E+03	1995
2000	9.37E+02	8.89E+03	9.86E-03	8.50E-02	1.88E+01	1.88E+01	9.56E+02	8.91E+03	2000
2005	1.23E+03	1.41E+04	1.30E-02	1.43E-01	2.84E+01	1.36E+02	1.26E+03	1.43E+04	2005
2010	1.32E+03	2.06E+04	1.53E-02	2.16E-01	3.13E+01	2.89E+02	1.35E+03	2.09E+04	2010
2015	1.12E+03	2.67E+04	1.64E-02	2.96E-01	3.26E+01	4.49E+02	1.15E+03	2.72E+04	2015
2020	1.14E+03	3.22E+04	1.53E-02	3.70E-01	2.11E+01	6.04E+02	1.16E+03	3.28E+04	2020
2025	1.08E+03	3.81E+04	1.38E-02	4.51E-01	2.01E+01	7.10E+02	1.10E+03	3.88E+04	2025
2030	8.17E+02	4.27E+04	1.11E-02	5.13E-01	1.56E+01	7.98E+02	8.33E+02	4.35E+04	2030
2035	5.09E+02	4.59E+04	2.51E-03	5.41E-01	1.05E+01	8.60E+02	5.20E+02	4.67E+04	2035
2040	4.28E+02	4.82E+04	0.	5.43E-01	1.02E+01	9.11E+02	4.39E+02	4.91E+04	2040
2045	3.05E+01	4.91E+04	0.	5.43E-01	1.75E+00	9.37E+02	3.22E+01	5.01E+04	2045
2050	4.36E-06	4.92E+04	0.	5.43E-01	0.	9.40E+02	4.36E-06	5.01E+04	2050
2055	4.29E-06	4.92E+04	0.	5.43E-01	4.36E-01	9.42E+02	4.36E-01	5.01E+04	2055
2060	4.22E-06	4.92E+04	0.	5.43E-01	4.36E-01	9.43E+02	4.36E-01	5.01E+04	2060
2065	4.14E-06	4.92E+04	0.	5.43E-01	4.36E-01	9.44E+02	4.36E-01	5.01E+04	2065
2070	4.05E-06	4.92E+04	0.	5.43E-01	0.	9.44E+02	4.05E-06	5.01E+04	2070
2075	3.99E-06	4.92E+04	0.	5.43E-01	1.31E+00	9.47E+02	1.31E+00	5.01E+04	2075

TABLE D.24. Fuel Reprocessing for U and Pu Recycle - Delayed Disposal - Repository in 2000
70-Year Thyroid Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	3.53E+02	9.57E+02	1.70E-11	5.01E-11	0.	0.	3.53E+02	9.57E+02	1985
1990	6.66E+02	3.99E+03	4.19E-11	2.18E-10	0.	0.	6.66E+02	3.99E+03	1990
1995	1.10E+03	8.28E+03	7.94E-11	5.10E-10	0.	0.	1.10E+03	8.28E+03	1995
2000	1.52E+03	1.46E+04	1.18E-10	9.94E-10	0.	0.	1.52E+03	1.46E+04	2000
2005	2.01E+03	2.32E+04	1.55E-10	1.69E-09	0.	0.	2.01E+03	2.32E+04	2005
2010	2.14E+03	3.37E+04	1.82E-10	2.56E-09	0.	0.	2.14E+03	3.37E+04	2010
2015	1.81E+03	4.36E+04	1.98E-10	3.52E-09	0.	0.	1.81E+03	4.36E+04	2015
2020	1.87E+03	5.26E+04	1.87E-10	4.43E-09	0.	0.	1.87E+03	5.26E+04	2020
2025	1.75E+03	6.21E+04	1.68E-10	5.41E-09	0.	0.	1.75E+03	6.21E+04	2025
2030	1.32E+03	6.96E+04	1.38E-10	6.18E-09	0.	0.	1.32E+03	6.96E+04	2030
2035	8.20E+02	7.47E+04	2.89E-11	6.51E-09	0.	0.	8.20E+02	7.47E+04	2035
2040	7.07E+02	7.85E+04	0.	6.53E-09	0.	0.	7.07E+02	7.85E+04	2040
2045	3.09E+01	7.99E+04	0.	6.53E-09	0.	0.	3.09E+01	7.99E+04	2045
2050	1.54E-13	8.00E+04	0.	6.53E-09	0.	0.	1.54E-13	8.00E+04	2050
2055	1.80E-13	8.00E+04	0.	6.53E-09	0.	0.	1.80E-13	8.00E+04	2055
2060	1.99E-13	8.00E+04	0.	6.53E-09	0.	0.	1.99E-13	8.00E+04	2060
2065	2.14E-13	8.00E+04	0.	6.53E-09	0.	0.	2.14E-13	8.00E+04	2065
2070	2.25E-13	8.00E+04	0.	6.53E-09	0.	0.	2.25E-13	8.00E+04	2070
2075	2.32E-13	8.00E+04	0.	6.53E-09	0.	0.	2.32E-13	8.00E+04	2075

TABLE D.25. Fuel Reprocessing for U and Pu Recycle - Delayed Disposal - Repository in 2000
70-Year Lung Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS		MOX-FFP TREATMENT SYSTEMS		TRANSPORTATION SYSTEM		TOTAL SYSTEM		YEAR
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE	
1985	2.08E+02	5.55E+02	5.71E-03	1.68E-02	0.	0.	2.08E+02	5.55E+02	1985
1990	4.22E+02	2.44E+03	1.41E-02	7.32E-02	0.	0.	4.22E+02	2.44E+03	1990
1995	6.97E+02	5.17E+03	2.67E-02	1.71E-01	0.	0.	6.97E+02	5.17E+03	1995
2000	9.67E+02	9.19E+03	3.94E-02	3.34E-01	0.	0.	9.67E+02	9.19E+03	2000
2005	1.89E+03	1.64E+04	5.18E-02	5.66E-01	0.	0.	1.89E+03	1.64E+04	2005
2010	2.43E+03	2.87E+04	6.11E-02	8.58E-01	0.	0.	2.43E+03	2.87E+04	2010
2015	2.50E+03	4.10E+04	6.62E-02	1.18E+00	0.	0.	2.50E+03	4.10E+04	2015
2020	3.26E+03	5.47E+04	6.24E-02	1.48E+00	0.	0.	3.26E+03	5.47E+04	2020
2025	3.33E+03	7.25E+04	5.61E-02	1.81E+00	0.	0.	3.33E+03	7.25E+04	2025
2030	3.17E+03	9.06E+04	4.61E-02	2.07E+00	0.	0.	3.17E+03	9.06E+04	2030
2035	2.61E+03	1.04E+05	9.73E-03	2.18E+00	0.	0.	2.61E+03	1.04E+05	2035
2040	4.50E+02	1.14E+05	0.	2.18E+00	0.	0.	4.50E+02	1.14E+05	2040
2045	3.05E+01	1.15E+05	0.	2.18E+00	0.	0.	3.05E+01	1.15E+05	2045
2050	2.45E-05	1.15E+05	0.	2.18E+00	0.	0.	2.45E-05	1.15E+05	2050
2055	2.44E-05	1.15E+05	0.	2.18E+00	0.	0.	2.44E-05	1.15E+05	2055
2060	2.42E-05	1.15E+05	0.	2.18E+00	0.	0.	2.42E-05	1.15E+05	2060
2065	2.39E-05	1.15E+05	0.	2.18E+00	0.	0.	2.39E-05	1.15E+05	2065
2070	2.36E-05	1.15E+05	0.	2.18E+00	0.	0.	2.36E-05	1.15E+05	2070
2075	2.32E-05	1.15E+05	0.	2.18E+00	0.	0.	2.32E-05	1.15E+05	2075

TABLE D.26. Fuel Reprocessing for U and Pu Recycle - Delayed Disposal - Repository in 2000
70-Year Bone Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	5.22E+00	1.44E+01	3.17E-02	9.34E-02	0.	0.	5.25E+00	1.45E+01	1985
1990	9.20E+00	5.76E+01	7.85E-02	4.07E-01	0.	0.	9.28E+00	5.80E+01	1990
1995	1.46E+01	1.15E+02	1.49E-01	9.56E-01	0.	0.	1.48E+01	1.16E+02	1995
2000	2.03E+01	2.00E+02	2.13E-01	1.84E+00	0.	0.	2.05E+01	2.02E+02	2000
2005	4.57E+01	3.69E+02	2.81E-01	3.10E+00	0.	0.	4.60E+01	3.73E+02	2005
2010	6.03E+01	6.77E+02	3.30E-01	4.68E+00	0.	0.	6.06E+01	6.82E+02	2010
2015	6.41E+01	9.88E+02	3.54E-01	6.40E+00	0.	0.	6.44E+01	9.95E+02	2015
2020	8.75E+01	1.35E+03	3.30E-01	8.01E+00	0.	0.	8.78E+01	1.35E+03	2020
2025	9.02E+01	1.83E+03	2.97E-01	9.74E+00	0.	0.	9.05E+01	1.84E+03	2025
2030	8.77E+01	2.33E+03	2.39E-01	1.11E+01	0.	0.	8.80E+01	2.34E+03	2030
2035	7.43E+01	2.71E+03	5.46E-02	1.17E+01	0.	0.	7.44E+01	2.72E+03	2035
2040	9.35E+00	2.99E+03	0.	1.17E+01	0.	0.	9.35E+00	3.00E+03	2040
2045	1.27E-03	3.01E+03	0.	1.17E+01	0.	0.	1.27E-03	3.02E+03	2045
2050	8.93E-05	3.01E+03	0.	1.17E+01	0.	0.	8.93E-05	3.02E+03	2050
2055	8.71E-05	3.01E+03	0.	1.17E+01	0.	0.	8.71E-05	3.02E+03	2055
2060	8.50E-05	3.01E+03	0.	1.17E+01	0.	0.	8.50E-05	3.02E+03	2060
2065	8.28E-05	3.01E+03	0.	1.17E+01	0.	0.	8.28E-05	3.02E+03	2065
2070	8.07E-05	3.01E+03	0.	1.17E+01	0.	0.	8.07E-05	3.02E+03	2070
2075	7.91E-05	3.01E+03	0.	1.17E+01	0.	0.	7.91E-05	3.02E+03	2075

TABLE D.27. Fuel Reprocessing for U Only Recycle Pu in HLW 70-Year Total Body Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	2.00E+02	5.30E+02	0.	0.	4.75E+00	4.75E+00	2.04E+02	5.34E+02	1985
1990	4.01E+02	2.34E+03	0.	0.	8.94E+00	4.45E+01	4.10E+02	2.38E+03	1990
1995	6.52E+02	4.90E+03	0.	0.	1.22E+01	9.81E+01	6.64E+02	5.00E+03	1995
2000	9.07E+02	8.68E+03	0.	0.	1.69E+01	1.68E+02	9.24E+02	8.85E+03	2000
2005	1.19E+03	1.37E+04	0.	0.	2.15E+01	2.62E+02	1.21E+03	1.40E+04	2005
2010	1.26E+03	1.99E+04	0.	0.	2.22E+01	3.71E+02	1.28E+03	2.03E+04	2010
2015	1.05E+03	2.57E+04	0.	0.	1.94E+01	4.76E+02	1.07E+03	2.62E+04	2015
2020	1.07E+03	3.08E+04	0.	0.	2.00E+01	5.73E+02	1.09E+03	3.14E+04	2020
2025	1.01E+03	3.63E+04	0.	0.	1.91E+01	6.73E+02	1.03E+03	3.69E+04	2025
2030	7.46E+02	4.05E+04	0.	0.	1.49E+01	7.57E+02	7.61E+02	4.13E+04	2030
2035	4.63E+02	4.34E+04	0.	0.	1.03E+01	8.17E+02	4.74E+02	4.42E+04	2035
2040	3.96E+02	4.55E+04	0.	0.	1.01E+01	8.68E+02	4.06E+02	4.64E+04	2040
2045	2.81E+01	4.64E+04	0.	0.	1.75E+00	8.93E+02	2.99E+01	4.73E+04	2045
2050	0.	4.65E+04	0.	0.	0.	8.97E+02	0.	4.74E+04	2050
2055	0.	4.65E+04	0.	0.	4.36E-01	8.98E+02	4.36E-01	4.74E+04	2055
2060	0.	4.65E+04	0.	0.	4.36E-01	8.99E+02	4.36E-01	4.74E+04	2060
2065	0.	4.65E+04	0.	0.	4.36E-01	9.01E+02	4.36E-01	4.74E+04	2065
2070	0.	4.65E+04	0.	0.	0.	9.01E+02	0.	4.74E+04	2070
2075	0.	4.65E+04	0.	0.	1.31E+00	9.03E+02	1.31E+00	4.74E+04	2075

TABLE D.28. Reprocessing Option - U Only Recycle Pu in HLW - 70-Year Thyroid Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	3.53E+02	9.57E+02	0.	0.	0.	0.	3.53E+02	9.57E+02	1985
1990	6.53E+02	3.96E+03	0.	0.	0.	0.	6.53E+02	3.96E+03	1990
1995	1.06E+03	8.12E+03	0.	0.	0.	0.	1.06E+03	8.12E+03	1995
2000	1.47E+03	1.42E+04	0.	0.	0.	0.	1.47E+03	1.42E+04	2000
2005	1.93E+03	2.25E+04	0.	0.	0.	0.	1.93E+03	2.25E+04	2005
2010	2.03E+03	3.25E+04	0.	0.	0.	0.	2.03E+03	3.25E+04	2010
2015	1.69E+03	4.18E+04	0.	0.	0.	0.	1.69E+03	4.18E+04	2015
2020	1.74E+03	5.01E+04	0.	0.	0.	0.	1.74E+03	5.01E+04	2020
2025	1.62E+03	5.89E+04	0.	0.	0.	0.	1.62E+03	5.89E+04	2025
2030	1.19E+03	6.57E+04	0.	0.	0.	0.	1.19E+03	6.57E+04	2030
2035	7.43E+02	7.04E+04	0.	0.	0.	0.	7.43E+02	7.04E+04	2035
2040	6.47E+02	7.38E+04	0.	0.	0.	0.	6.47E+02	7.38E+04	2040
2045	2.85E+01	7.51E+04	0.	0.	0.	0.	2.85E+01	7.51E+04	2045
2050	0.	7.52E+04	0.	0.	0.	0.	0.	7.52E+04	2050
2055	0.	7.52E+04	0.	0.	0.	0.	0.	7.52E+04	2055
2060	0.	7.52E+04	0.	0.	0.	0.	0.	7.52E+04	2060
2065	0.	7.52E+04	0.	0.	0.	0.	0.	7.52E+04	2065
2070	0.	7.52E+04	0.	0.	0.	0.	0.	7.52E+04	2070
2075	0.	7.52E+04	0.	0.	0.	0.	0.	7.52E+04	2075

TABLE D.29. Reprocessing Option - U Only Recycle Pu in HLW - 70-Year Lung Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	2.09E+02	5.58E+02	0.	0.	0.	0.	2.09E+02	5.58E+02	1985
1990	4.34E+02	2.49E+03	0.	0.	0.	0.	4.34E+02	2.49E+03	1990
1995	7.05E+02	5.26E+03	0.	0.	0.	0.	7.05E+02	5.26E+03	1995
2000	9.79E+02	9.35E+03	0.	0.	0.	0.	9.79E+02	9.35E+03	2000
2005	1.27E+03	1.48E+04	0.	0.	0.	0.	1.27E+03	1.48E+04	2005
2010	1.35E+03	2.14E+04	0.	0.	0.	0.	1.35E+03	2.14E+04	2010
2015	1.13E+03	2.76E+04	0.	0.	0.	0.	1.13E+03	2.76E+04	2015
2020	1.14E+03	3.31E+04	0.	0.	0.	0.	1.14E+03	3.31E+04	2020
2025	1.08E+03	3.90E+04	0.	0.	0.	0.	1.08E+03	3.90E+04	2025
2030	8.06E+02	4.36E+04	0.	0.	0.	0.	8.06E+02	4.36E+04	2030
2035	4.98E+02	4.67E+04	0.	0.	0.	0.	4.98E+02	4.67E+04	2035
2040	4.30E+02	4.90E+04	0.	0.	0.	0.	4.30E+02	4.90E+04	2040
2045	2.81E+01	4.99E+04	0.	0.	0.	0.	2.81E+01	4.99E+04	2045
2050	0.	5.00E+04	0.	0.	0.	0.	0.	5.00E+04	2050
2055	0.	5.00E+04	0.	0.	0.	0.	0.	5.00E+04	2055
2060	0.	5.00E+04	0.	0.	0.	0.	0.	5.00E+04	2060
2065	0.	5.00E+04	0.	0.	0.	0.	0.	5.00E+04	2065
2070	0.	5.00E+04	0.	0.	0.	0.	0.	5.00E+04	2070
2075	0.	5.00E+04	0.	0.	0.	0.	0.	5.00E+04	2075

TABLE D.30. Reprocessing Option - U Only Recycle Pu in HLW - 70-Year Bone Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	5.24E+00	1.44E+01	0.	0.	0.	0.	5.24E+00	1.44E+01	1985
1990	9.61E+00	5.88E+01	0.	0.	0.	0.	9.61E+00	5.88E+01	1990
1995	1.55E+01	1.19E+02	0.	0.	0.	0.	1.55E+01	1.19E+02	1995
2000	2.14E+01	2.09E+02	0.	0.	0.	0.	2.14E+01	2.09E+02	2000
2005	2.80E+01	3.29E+02	0.	0.	0.	0.	2.80E+01	3.29E+02	2005
2010	2.92E+01	4.73E+02	0.	0.	0.	0.	2.92E+01	4.73E+02	2010
2015	2.42E+01	6.07E+02	0.	0.	0.	0.	2.42E+01	6.07E+02	2015
2020	2.52E+01	7.28E+02	0.	0.	0.	0.	2.52E+01	7.28E+02	2020
2025	2.36E+01	8.56E+02	0.	0.	0.	0.	2.36E+01	8.56E+02	2025
2030	1.76E+01	9.56E+02	0.	0.	0.	0.	1.76E+01	9.56E+02	2030
2035	1.09E+01	1.02E+03	0.	0.	0.	0.	1.09E+01	1.02E+03	2035
2040	1.01E+01	1.08E+03	0.	0.	0.	0.	1.01E+01	1.08E+03	2040
2045	1.86E-03	1.10E+03	0.	0.	0.	0.	1.86E-03	1.10E+03	2045
2050	0.	1.10E+03	0.	0.	0.	0.	0.	1.10E+03	2050
2055	0.	1.10E+03	0.	0.	0.	0.	0.	1.10E+03	2055
2060	0.	1.10E+03	0.	0.	0.	0.	0.	1.10E+03	2060
2065	0.	1.10E+03	0.	0.	0.	0.	0.	1.10E+03	2065
2070	0.	1.10E+03	0.	0.	0.	0.	0.	1.10E+03	2070
2075	0.	1.10E+03	0.	0.	0.	0.	0.	1.10E+03	2075

TABLE D.31. Fuel Reprocessing for U Only Recycle - Stored Pu - 70-Year Total Body Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	2.00E+02	5.30E+02	0.	0.	4.78E+00	4.78E+00	2.04E+02	5.34E+02	1985
1990	4.01E+02	2.34E+03	0.	0.	9.00E+00	4.49E+01	4.10E+02	2.38E+03	1990
1995	6.52E+02	4.90E+03	0.	0.	1.23E+01	9.87E+01	6.64E+02	5.00E+03	1995
2000	9.07E+02	8.68E+03	0.	0.	1.70E+01	1.69E+02	9.24E+02	8.85E+03	2000
2005	1.19E+03	1.37E+04	0.	0.	2.17E+01	2.64E+02	1.21E+03	1.40E+04	2005
2010	1.26E+03	1.99E+04	0.	0.	2.23E+01	3.73E+02	1.28E+03	2.03E+04	2010
2015	1.05E+03	2.57E+04	0.	0.	1.96E+01	4.79E+02	1.07E+03	2.62E+04	2015
2020	1.07E+03	3.08E+04	0.	0.	2.01E+01	5.76E+02	1.09E+03	3.14E+04	2020
2025	1.01E+03	3.63E+04	0.	0.	1.92E+01	6.78E+02	1.03E+03	3.69E+04	2025
2030	7.46E+02	4.05E+04	0.	0.	1.50E+01	7.61E+02	7.61E+02	4.13E+04	2030
2035	4.63E+02	4.34E+04	0.	0.	1.03E+01	8.22E+02	4.74E+02	4.43E+04	2035
2040	3.96E+02	4.55E+04	0.	0.	1.02E+01	8.73E+02	4.06E+02	4.64E+04	2040
2045	2.81E+01	4.64E+04	0.	0.	1.75E+00	8.99E+02	2.99E+01	4.73E+04	2045
2050	6.92E-06	4.65E+04	0.	0.	0.	9.02E+02	6.92E-06	4.74E+04	2050
2055	6.85E-06	4.65E+04	0.	0.	4.36E-01	9.04E+02	4.36E-01	4.74E+04	2055
2060	6.76E-06	4.65E+04	0.	0.	4.36E-01	9.05E+02	4.36E-01	4.74E+04	2060
2065	6.67E-06	4.65E+04	0.	0.	4.36E-01	9.06E+02	4.36E-01	4.74E+04	2065
2070	6.57E-06	4.65E+04	0.	0.	0.	9.06E+02	6.57E-06	4.74E+04	2070
2075	6.48E-06	4.65E+04	0.	0.	1.31E+00	9.09E+02	1.31E+00	4.74E+04	2075

TABLE D.32. Fuel Reprocessing for U Only Recycle - Stored Pu - 70-Year Thyroid Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	3.53E+02	9.57E+02	0.	0.	0.	0.	3.53E+02	9.57E+02	1985
1990	6.53E+02	3.96E+03	0.	0.	0.	0.	6.53E+02	3.96E+03	1990
1995	1.06E+03	8.12E+03	0.	0.	0.	0.	1.06E+03	8.12E+03	1995
2000	1.47E+03	1.42E+04	0.	0.	0.	0.	1.47E+03	1.42E+04	2000
2005	1.93E+03	2.25E+04	0.	0.	0.	0.	1.93E+03	2.25E+04	2005
2010	2.03E+03	3.25E+04	0.	0.	0.	0.	2.03E+03	3.25E+04	2010
2015	1.69E+03	4.18E+04	0.	0.	0.	0.	1.69E+03	4.18E+04	2015
2020	1.74E+03	5.01E+04	0.	0.	0.	0.	1.74E+03	5.01E+04	2020
2025	1.62E+03	5.89E+04	0.	0.	0.	0.	1.62E+03	5.89E+04	2025
2030	1.19E+03	6.57E+04	0.	0.	0.	0.	1.19E+03	6.57E+04	2030
2035	7.43E+02	7.04E+04	0.	0.	0.	0.	7.43E+02	7.04E+04	2035
2040	6.47E+02	7.38E+04	0.	0.	0.	0.	6.47E+02	7.38E+04	2040
2045	2.85E+01	7.51E+04	0.	0.	0.	0.	2.85E+01	7.51E+04	2045
2050	7.45E-13	7.52E+04	0.	0.	0.	0.	7.45E-13	7.52E+04	2050
2055	7.76E-13	7.52E+04	0.	0.	0.	0.	7.76E-13	7.52E+04	2055
2060	7.99E-13	7.52E+04	0.	0.	0.	0.	7.99E-13	7.52E+04	2060
2065	8.15E-13	7.52E+04	0.	0.	0.	0.	8.15E-13	7.52E+04	2065
2070	8.26E-13	7.52E+04	0.	0.	0.	0.	8.26E-13	7.52E+04	2070
2075	8.32E-13	7.52E+04	0.	0.	0.	0.	8.32E-13	7.52E+04	2075

TABLE D.33. Fuel Reprocessing for U Only Recycle - Stored Pu - 70-Year Lung Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	2.09E+02	5.58E+02	0.	0.	0.	0.	2.09E+02	5.58E+02	1985
1990	4.34E+02	2.49E+03	0.	0.	0.	0.	4.34E+02	2.49E+03	1990
1995	7.05E+02	5.26E+03	0.	0.	0.	0.	7.05E+02	5.26E+03	1995
2000	9.79E+02	9.34E+03	0.	0.	0.	0.	9.79E+02	9.34E+03	2000
2005	1.27E+03	1.48E+04	0.	0.	0.	0.	1.27E+03	1.48E+04	2005
2010	1.35E+03	2.14E+04	0.	0.	0.	0.	1.35E+03	2.14E+04	2010
2015	1.13E+03	2.74E+04	0.	0.	0.	0.	1.13E+03	2.74E+04	2015
2020	1.14E+03	3.31E+04	0.	0.	0.	0.	1.14E+03	3.31E+04	2020
2025	1.08E+03	3.90E+04	0.	0.	0.	0.	1.08E+03	3.90E+04	2025
2030	8.06E+02	4.36E+04	0.	0.	0.	0.	8.06E+02	4.36E+04	2030
2035	4.98E+02	4.67E+04	0.	0.	0.	0.	4.98E+02	4.67E+04	2035
2040	4.30E+02	4.90E+04	0.	0.	0.	0.	4.30E+02	4.90E+04	2040
2045	2.81E+01	4.99E+04	0.	0.	0.	0.	2.81E+01	4.99E+04	2045
2050	4.06E-05	4.99E+04	0.	0.	0.	0.	4.06E-05	4.99E+04	2050
2055	4.06E-05	4.99E+04	0.	0.	0.	0.	4.06E-05	4.99E+04	2055
2060	4.04E-05	4.99E+04	0.	0.	0.	0.	4.04E-05	4.99E+04	2060
2065	4.01E-05	4.99E+04	0.	0.	0.	0.	4.01E-05	4.99E+04	2065
2070	3.96E-05	4.99E+04	0.	0.	0.	0.	3.96E-05	4.99E+04	2070
2075	3.93E-05	4.99E+04	0.	0.	0.	0.	3.93E-05	4.99E+04	2075

TABLE D.34. Fuel Reprocessing for U Only Recycle - Stored Pu - 70-Year Bone Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FRP TREATMENT SYSTEMS ANNUAL	MOX-FRP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	5.01E+00	1.38E+01	0.	0.	0.	0.	5.01E+00	1.38E+01	1985
1990	9.17E+00	5.62E+01	0.	0.	0.	0.	9.17E+00	5.62E+01	1990
1995	1.48E+01	1.14E+02	0.	0.	0.	0.	1.48E+01	1.14E+02	1995
2000	2.03E+01	1.99E+02	0.	0.	0.	0.	2.03E+01	1.99E+02	2000
2005	2.65E+01	3.12E+02	0.	0.	0.	0.	2.65E+01	3.12E+02	2005
2010	2.76E+01	4.49E+02	0.	0.	0.	0.	2.76E+01	4.49E+02	2010
2015	2.27E+01	5.75E+02	0.	0.	0.	0.	2.27E+01	5.75E+02	2015
2020	2.36E+01	6.88E+02	0.	0.	0.	0.	2.36E+01	6.88E+02	2020
2025	2.21E+01	8.08E+02	0.	0.	0.	0.	2.21E+01	8.08E+02	2025
2030	1.62E+01	9.00E+02	0.	0.	0.	0.	1.62E+01	9.00E+02	2030
2035	1.00E+01	9.63E+02	0.	0.	0.	0.	1.00E+01	9.63E+02	2035
2040	9.05E+00	1.01E+03	0.	0.	0.	0.	9.05E+00	1.01E+03	2040
2045	8.24E-04	1.03E+03	0.	0.	0.	0.	8.24E-04	1.03E+03	2045
2050	1.30E-04	1.03E+03	0.	0.	0.	0.	1.30E-04	1.03E+03	2050
2055	1.27E-04	1.03E+03	0.	0.	0.	0.	1.27E-04	1.03E+03	2055
2060	1.25E-04	1.03E+03	0.	0.	0.	0.	1.25E-04	1.03E+03	2060
2065	1.22E-04	1.03E+03	0.	0.	0.	0.	1.22E-04	1.03E+03	2065
2070	1.20E-04	1.03E+03	0.	0.	0.	0.	1.20E-04	1.03E+03	2070
2075	1.18E-04	1.03E+03	0.	0.	0.	0.	1.18E-04	1.03E+03	2075

TABLE D.35. Once-Through Option - Prompt Disposal 70-Year World Wide Dose to Population from Entire Waste Management System (Man-Rem)

	(MAN-REM)	
YEAR	ANNUAL	CUMULATIVE
1985	1.60E+00	9.05E+00
1990	3.59E+00	2.32E+01
1995	5.42E+00	4.67E+01
2000	7.94E+00	8.10E+01
2005	9.92E+00	1.27E+02
2010	1.07E+01	1.80E+02
2015	1.03E+01	2.33E+02
2020	9.61E+00	2.82E+02
2025	8.56E+00	3.27E+02
2030	7.05E+00	3.65E+02
2035	4.85E+00	3.94E+02
2040	2.97E+00	4.12E+02
2045	9.07E-01	4.19E+02
2050	0.	4.20E+02

TABLE D.36. Once-Through - Decision to Dispose Deferred or Repositories Unavailable Until Year 2000 70-Year World Wide Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	ANNUAL	CUMULATIVE
1985	1.60E+00	9.05E+00
1990	3.59E+00	2.32E+01
1995	5.42E+00	4.67E+01
2000	7.94E+00	8.10E+01
2005	9.92E+00	1.27E+02
2010	1.07E+01	1.80E+02
2015	1.03E+01	2.33E+02
2020	9.61E+00	2.82E+02
2025	8.56E+00	3.27E+02
2030	7.05E+00	3.65E+02
2035	4.85E+00	3.94E+02
2040	2.97E+00	4.12E+02
2045	9.07E-01	4.19E+02
2050	0.	4.20E+02

TABLE D.37. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Repository in 1985 70-Year World Wide Dose to Population from Entire Waste Management System (Man-Rem)

	(MAN-REM)	
YEAR	ANNUAL	CUMULATIVE
1985	7.37E+03	2.01E+04
1990	1.36E+04	8.29E+04
1995	2.18E+04	1.69E+05
2000	3.02E+04	2.95E+05
2005	3.95E+04	4.63E+05
2010	4.11E+04	6.67E+05
2015	3.40E+04	8.54E+05
2020	3.49E+04	1.02E+06
2025	3.27E+04	1.20E+06
2030	2.38E+04	1.34E+06
2035	1.51E+04	1.43E+06
2040	1.35E+04	1.50E+06
2045	1.49E+03	1.53E+06
2050	1.14E+03	1.54E+06
2055	1.40E+03	1.54E+06
2060	1.39E+03	1.55E+06
2065	1.12E+03	1.56E+06
2070	1.12E+03	1.56E+06
2075	1.04E+03	1.57E+06

TABLE D.38. Fuel Reprocessing for U and Pu Recycle - Decision to Reprocess Delayed Until Year 2000, 70-Year World Wide Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	ANNUAL	CUMULATIVE
1985	1.58E+00	9.96E+00
1990	2.77E+00	2.15E+01
1995	4.35E+00	4.00E+01
2000	6.31E+00	6.75E+01
2005	7.44E+00	1.03E+02
2010	8.87E+02	1.02E+03
2015	9.67E+03	3.13E+04
2020	2.23E+04	1.17E+05
2025	3.32E+04	2.63E+05
2030	3.59E+04	4.39E+05
2035	3.77E+04	6.23E+05
2040	3.23E+04	8.04E+05
2045	1.48E+04	9.30E+05
2050	7.05E+02	9.36E+05
2055	9.21E+01	9.36E+05
2060	9.87E+01	9.36E+05
2065	2.08E+02	9.37E+05
2070	4.21E+02	9.39E+05
2075	6.07E+02	9.41E+05

TABLE D.39. Fuel Reprocessing for U and Pu Recycle - Delayed Disposal - Repository In Year 2000, 70-Year World Wide Dose to Population from Entire Waste Management System (Man-Rem)

YEAR	ANNUAL (MAN-REM)	CUMULATIVE
1985	7.37E+03	2.01E+04
1990	1.36E+04	8.29E+04
1995	2.18E+04	1.69E+05
2000	3.02E+04	2.95E+05
2005	3.95E+04	4.63E+05
2010	4.11E+04	6.67E+05
2015	3.40E+04	8.54E+05
2020	3.49E+04	1.02E+06
2025	3.27E+04	1.20E+06
2030	2.38E+04	1.34E+06
2035	1.51E+04	1.43E+06
2040	1.35E+04	1.50E+06
2045	1.49E+03	1.53E+06
2050	1.14E+03	1.54E+06
2055	1.40E+03	1.54E+06
2060	1.39E+03	1.55E+06
2065	1.12E+03	1.56E+06
2070	1.12E+03	1.56E+06
2075	1.04E+03	1.57E+06

TABLE D.40. Fuel Reprocessing for U Only Recycle - Pu in HLW - 70-Year World Wide Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	ANNUAL	CUMULATIVE
1985	7.37E+03	2.01E+04
1990	1.37E+04	8.31E+04
1995	2.21E+04	1.70E+05
2000	3.06E+04	2.97E+05
2005	4.01E+04	4.68E+05
2010	4.19E+04	6.75E+05
2015	3.48E+04	8.67E+05
2020	3.59E+04	1.04E+06
2025	3.35E+04	1.22E+06
2030	2.47E+04	1.36E+06
2035	1.56E+04	1.46E+06
2040	1.38E+04	1.53E+06
2045	1.52E+03	1.56E+06
2050	1.23E+03	1.57E+06
2055	1.51E+03	1.58E+06
2060	1.54E+03	1.58E+06
2065	1.27E+03	1.59E+06
2070	1.28E+03	1.60E+06
2075	1.19E+03	1.60E+06

TABLE D.41. Fuel Reprocessing for U Only Recycle - Stored Pu - Reference Treatment, 70-Year World Wide Dose to Population from Entire Waste Management System (Man-Rem)

(MAN-REM)

YEAR	ANNUAL	CUMULATIVE
1985	7.37E+03	2.01E+04
1990	1.37E+04	8.31E+04
1995	2.21E+04	1.70E+05
2000	3.06E+04	2.97E+05
2005	4.01E+04	4.68E+05
2010	4.19E+04	6.75E+05
2015	3.48E+04	8.67E+05
2020	3.59E+04	1.04E+06
2025	3.35E+04	1.22E+06
2030	2.47E+04	1.36E+06
2035	1.56E+04	1.46E+06
2040	1.38E+04	1.53E+06
2045	1.52E+03	1.56E+06
2050	1.23E+03	1.57E+06
2055	1.51E+03	1.58E+06
2060	1.54E+03	1.58E+06
2065	1.27E+03	1.59E+06
2070	1.28E+03	1.60E+06
2075	1.19E+03	1.60E+06

In addition to the 10,000 GWe-yr scenario, doses to the regional population were calculated by 5-year intervals and accumulated for a slow growth electric-power scenerio of about 6,500 GWe-yr for the once-through option and Uranium and Plutonium Recycle with prompt disposal. These doses are presented in Tables D.41 through D.49. Similarly doses to the worldwide population were calculated for the low growth scenario and these are presented in Tables D.50 and D.51 for the once-through option and Uranium and Plutonium Recycle respectively.

TABLE D.42. Once-Through Option - Prompt Disposal - Low Growth Scenario - 70-Year Total-Body Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	5.87E-02	3.66E-01	2.95E+00	2.95E+00	3.50E+00	3.50E+00	6.51E+00	6.82E+00	1985
1990	9.40E-02	7.70E-01	7.06E+00	3.80E+01	1.14E+01	5.41E+01	1.85E+01	9.29E+01	1990
1995	1.36E-01	1.38E+00	1.07E+01	8.76E+01	1.69E+01	1.33E+02	2.78E+01	2.22E+02	1995
2000	1.82E-01	2.18E+00	1.48E+01	1.52E+02	2.37E+01	2.37E+02	3.87E+01	3.91E+02	2000
2005	2.05E-01	3.18E+00	1.86E+01	2.36E+02	2.87E+01	3.70E+02	4.75E+01	6.09E+02	2005
2010	2.12E-01	4.23E+00	2.08E+01	3.39E+02	3.36E+01	5.34E+02	5.46E+01	8.77E+02	2010
2015	2.00E-01	5.26E+00	2.10E+01	4.42E+02	3.11E+01	6.94E+02	5.23E+01	1.14E+03	2015
2020	1.74E-01	6.18E+00	2.13E+01	5.46E+02	3.27E+01	8.58E+02	5.42E+01	1.41E+03	2020
2025	1.46E-01	6.98E+00	1.58E+01	6.34E+02	2.78E+01	1.01E+03	4.38E+01	1.65E+03	2025
2030	1.19E-01	7.62E+00	1.59E+01	7.16E+02	2.51E+01	1.13E+03	4.10E+01	1.85E+03	2030
2035	6.89E-02	8.03E+00	1.33E+01	7.84E+02	1.99E+01	1.23E+03	3.32E+01	2.03E+03	2035
2040	3.72E-02	8.29E+00	7.23E+00	8.31E+02	1.16E+01	1.31E+03	1.89E+01	2.15E+03	2040
2045	4.69E-03	8.34E+00	4.86E+00	8.62E+02	7.00E+00	1.35E+03	1.19E+01	2.22E+03	2045
2050	0.	8.35E+00	0.	8.67E+02	0.	1.36E+03	0.	2.24E+03	2050

TABLE D.43. Once-Through Option - Prompt Disposal - Low Growth Scenario - 70-Year Thyroid Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	2.78E-01	4.07E-01	0.	0.	0.	0.	2.78E-01	4.07E-01	1985
1990	1.04E+00	4.84E+00	0.	0.	0.	0.	1.04E+00	4.84E+00	1990
1995	1.54E+00	1.19E+01	0.	0.	0.	0.	1.54E+00	1.19E+01	1995
2000	2.20E+00	2.13E+01	0.	0.	0.	0.	2.20E+00	2.13E+01	2000
2005	2.71E+00	3.38E+01	0.	0.	0.	0.	2.71E+00	3.38E+01	2005
2010	3.27E+00	4.94E+01	0.	0.	0.	0.	3.27E+00	4.94E+01	2010
2015	3.12E+00	6.52E+01	0.	0.	0.	0.	3.12E+00	6.52E+01	2015
2020	3.08E+00	8.10E+01	0.	0.	0.	0.	3.08E+00	8.10E+01	2020
2025	2.57E+00	9.47E+01	0.	0.	0.	0.	2.57E+00	9.47E+01	2025
2030	2.28E+00	1.07E+02	0.	0.	0.	0.	2.28E+00	1.07E+02	2030
2035	1.72E+00	1.16E+02	0.	0.	0.	0.	1.72E+00	1.16E+02	2035
2040	9.71E-01	1.22E+02	0.	0.	0.	0.	9.71E-01	1.22E+02	2040
2045	4.96E-01	1.26E+02	0.	0.	0.	0.	4.96E-01	1.26E+02	2045
2050	0.	1.26E+02	0.	0.	0.	0.	0.	1.26E+02	2050

TABLE D.44. Once-Through Option - Prompt Disposal - Low Growth Scenario - 70-Year Lung Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	2.20E-02	1.36E-01	0.	0.	0.	0.	2.20E-02	1.36E-01	1985
1990	3.59E-02	2.89E-01	0.	0.	0.	0.	3.59E-02	2.89E-01	1990
1995	5.20E-02	5.22E-01	0.	0.	0.	0.	5.20E-02	5.22E-01	1995
2000	6.98E-02	8.31E-01	0.	0.	0.	0.	6.98E-02	8.31E-01	2000
2005	7.92E-02	1.21E+00	0.	0.	0.	0.	7.92E-02	1.21E+00	2005
2010	8.25E-02	1.62E+00	0.	0.	0.	0.	8.25E-02	1.62E+00	2010
2015	7.82E-02	2.03E+00	0.	0.	0.	0.	7.82E-02	2.03E+00	2015
2020	6.86E-02	2.39E+00	0.	0.	0.	0.	6.86E-02	2.39E+00	2020
2025	5.76E-02	2.70E+00	0.	0.	0.	0.	5.76E-02	2.70E+00	2025
2030	4.77E-02	2.96E+00	0.	0.	0.	0.	4.77E-02	2.96E+00	2030
2035	2.81E-02	3.13E+00	0.	0.	0.	0.	2.81E-02	3.13E+00	2035
2040	1.55E-02	3.23E+00	0.	0.	0.	0.	1.55E-02	3.23E+00	2040
2045	2.53E-03	3.26E+00	0.	0.	0.	0.	2.53E-03	3.26E+00	2045
2050	0.	3.26E+00	0.	0.	0.	0.	0.	3.26E+00	2050

TABLE D.45. Once-Through Option - Prompt Disposal - Low Growth Scenario - 70-Year Bone Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	STORAGE AND PACKAGING ANNUAL	STORAGE AND PACKAGING CUMULATIVE	BWR FUEL SHIPMENTS ANNUAL	BWR FUEL SHIPMENTS CUMULATIVE	PWR FUEL SHIPMENTS ANNUAL	PWR FUEL SHIPMENTS CUMULATIVE	TOTAL FUEL ANNUAL	TOTAL FUEL CUMULATIVE	YEAR
1985	1.06E-01	6.55E-01	0.	0.	0.	0.	1.06E-01	6.55E-01	1985
1990	1.68E-01	1.38E+00	0.	0.	0.	0.	1.68E-01	1.38E+00	1990
1995	2.40E-01	2.45E+00	0.	0.	0.	0.	2.40E-01	2.45E+00	1995
2000	3.22E-01	3.89E+00	0.	0.	0.	0.	3.22E-01	3.89E+00	2000
2005	3.64E-01	5.65E+00	0.	0.	0.	0.	3.64E-01	5.65E+00	2005
2010	3.77E-01	7.52E+00	0.	0.	0.	0.	3.77E-01	7.52E+00	2010
2015	3.57E-01	9.36E+00	0.	0.	0.	0.	3.57E-01	9.36E+00	2015
2020	3.11E-01	1.10E+01	0.	0.	0.	0.	3.11E-01	1.10E+01	2020
2025	2.62E-01	1.24E+01	0.	0.	0.	0.	2.62E-01	1.24E+01	2025
2030	2.16E-01	1.36E+01	0.	0.	0.	0.	2.16E-01	1.36E+01	2030
2035	1.24E-01	1.43E+01	0.	0.	0.	0.	1.24E-01	1.43E+01	2035
2040	6.91E-02	1.48E+01	0.	0.	0.	0.	6.91E-02	1.48E+01	2040
2045	8.97E-03	1.49E+01	0.	0.	0.	0.	8.97E-03	1.49E+01	2045
2050	0.	1.49E+01	0.	0.	0.	0.	0.	1.49E+01	2050

TABLE D.46. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Low Growth Scenario - 70-Year Total-Body Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	1.35E+02	4.65E+02	1.19E-03	4.03E-03	3.57E+00	3.57E+00	1.39E+02	4.69E+02	1985
1990	3.91E+02	1.89E+03	3.46E-03	1.49E-02	9.15E+00	3.79E+01	4.00E+02	1.93E+03	1990
1995	4.42E+02	4.01E+03	4.39E-03	3.56E-02	8.60E+00	8.46E+01	4.51E+02	4.10E+03	1995
2000	6.92E+02	6.74E+03	7.89E-03	6.61E-02	1.29E+01	1.36E+02	7.05E+02	6.87E+03	2000
2005	7.29E+02	1.03E+04	8.16E-03	1.07E-01	1.35E+01	2.02E+02	7.42E+02	1.05E+04	2005
2010	9.27E+02	1.43E+04	1.10E-02	1.55E-01	1.64E+01	2.74E+02	9.43E+02	1.45E+04	2010
2015	8.32E+02	1.84E+04	1.03E-02	2.07E-01	1.53E+01	3.49E+02	8.47E+02	1.87E+04	2015
2020	5.50E+02	2.14E+04	7.92E-03	2.52E-01	1.08E+01	4.07E+02	5.61E+02	2.18E+04	2020
2025	5.00E+02	2.40E+04	7.82E-03	2.92E-01	1.01E+01	4.58E+02	5.10E+02	2.45E+04	2025
2030	3.78E+02	2.59E+04	4.62E-03	3.18E-01	8.59E+00	5.00E+02	3.86E+02	2.64E+04	2030
2035	4.16E+02	2.81E+04	1.11E-03	3.32E-01	9.54E+00	5.47E+02	4.25E+02	2.86E+04	2035
2040	2.34E+02	2.99E+04	0.	3.33E-01	6.15E+00	5.89E+02	2.40E+02	3.05E+04	2040
2045	1.58E+01	3.03E+04	0.	3.33E-01	1.09E+00	6.01E+02	1.69E+01	3.09E+04	2045
2050	2.67E-06	3.03E+04	0.	3.33E-01	0.	6.03E+02	2.67E-06	3.09E+04	2050
2055	2.62E-06	3.03E+04	0.	3.33E-01	4.36E-01	6.04E+02	4.36E-01	3.09E+04	2055
2060	2.58E-06	3.03E+04	0.	3.33E-01	4.36E-01	6.05E+02	4.36E-01	3.09E+04	2060
2065	2.53E-06	3.03E+04	0.	3.33E-01	4.36E-01	6.07E+02	4.36E-01	3.09E+04	2065
2070	2.47E-06	3.03E+04	0.	3.33E-01	0.	6.07E+02	2.47E-06	3.09E+04	2070
2075	2.43E-06	3.03E+04	0.	3.33E-01	1.31E+00	6.09E+02	1.31E+00	3.09E+04	2075

TABLE D.47. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Low Growth Scenario - 70-Year Thyroid Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	2.41E+02	8.45E+02	1.39E-11	4.69E-11	0.	0.	2.41E+02	8.45E+02	1985
1990	6.51E+02	3.27E+03	4.01E-11	1.74E-10	0.	0.	6.51E+02	3.27E+03	1990
1995	7.17E+02	6.73E+03	5.06E-11	4.13E-10	0.	0.	7.17E+02	6.73E+03	1995
2000	1.14E+03	1.12E+04	9.41E-11	7.72E-10	0.	0.	1.14E+03	1.12E+04	2000
2005	1.19E+03	1.70E+04	9.81E-11	1.26E-09	0.	0.	1.19E+03	1.70E+04	2005
2010	1.52E+03	2.35E+04	1.32E-10	1.84E-09	0.	0.	1.52E+03	2.35E+04	2010
2015	1.34E+03	3.02E+04	1.25E-10	2.47E-09	0.	0.	1.34E+03	3.02E+04	2015
2020	8.94E+02	3.51E+04	9.68E-11	3.01E-09	0.	0.	8.94E+02	3.51E+04	2020
2025	8.38E+02	3.94E+04	9.64E-11	3.50E-09	0.	0.	8.38E+02	3.94E+04	2025
2030	6.47E+02	4.27E+04	5.70E-11	3.82E-09	0.	0.	6.47E+02	4.27E+04	2030
2035	7.15E+02	4.64E+04	1.29E-11	3.99E-09	0.	0.	7.15E+02	4.64E+04	2035
2040	3.69E+02	4.94E+04	0.	4.00E-09	0.	0.	3.69E+02	4.94E+04	2040
2045	1.60E+01	4.99E+04	0.	4.00E-09	0.	0.	1.60E+01	4.99E+04	2045
2050	8.14E-14	4.99E+04	0.	4.00E-09	0.	0.	8.14E-14	4.99E+04	2050
2055	9.72E-14	4.99E+04	0.	4.00E-09	0.	0.	9.72E-14	4.99E+04	2055
2060	1.09E-13	4.99E+04	0.	4.00E-09	0.	0.	1.09E-13	4.99E+04	2060
2065	1.18E-13	4.99E+04	0.	4.00E-09	0.	0.	1.18E-13	4.99E+04	2065
2070	1.25E-13	4.99E+04	0.	4.00E-09	0.	0.	1.25E-13	4.99E+04	2070
2075	1.29E-13	4.99E+04	0.	4.00E-09	0.	0.	1.29E-13	4.99E+04	2075

TABLE D.48. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Low Growth Scenario - 70-Year Lung Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	MOX-FFP TREATMENT SYSTEMS ANNUAL	MOX-FFP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	1.42E+02	4.90E+02	4.65E-03	1.57E-02	0.	0.	1.42E+02	4.90E+02	1985
1990	4.17E+02	1.99E+03	1.35E-02	5.83E-02	0.	0.	4.17E+02	1.99E+03	1990
1995	4.77E+02	4.29E+03	1.70E-02	1.39E-01	0.	0.	4.77E+02	4.29E+03	1995
2000	7.42E+02	7.20E+03	3.15E-02	2.59E-01	0.	0.	7.42E+02	7.20E+03	2000
2005	1.32E+03	1.23E+04	3.28E-02	4.23E-01	0.	0.	1.32E+03	1.23E+04	2005
2010	2.06E+03	2.07E+04	4.40E-02	6.17E-01	0.	0.	2.06E+03	2.07E+04	2010
2015	2.02E+03	3.06E+04	4.18E-02	8.27E-01	0.	0.	2.02E+03	3.06E+04	2015
2020	1.50E+03	3.83E+04	3.23E-02	1.01E+00	0.	0.	1.50E+03	3.83E+04	2020
2025	1.94E+03	4.80E+04	3.21E-02	1.17E+00	0.	0.	1.94E+03	4.80E+04	2025
2030	1.37E+03	5.47E+04	1.90E-02	1.28E+00	0.	0.	1.37E+03	5.47E+04	2030
2035	1.75E+03	6.45E+04	4.33E-03	1.34E+00	0.	0.	1.75E+03	6.45E+04	2035
2040	2.57E+02	7.18E+04	0.	1.34E+00	0.	0.	2.57E+02	7.18E+04	2040
2045	1.58E+01	7.22E+04	0.	1.34E+00	0.	0.	1.58E+01	7.22E+04	2045
2050	1.49E-05	7.22E+04	0.	1.34E+00	0.	0.	1.49E-05	7.22E+04	2050
2055	1.49E-05	7.22E+04	0.	1.34E+00	0.	0.	1.49E-05	7.22E+04	2055
2060	1.47E-05	7.22E+04	0.	1.34E+00	0.	0.	1.47E-05	7.22E+04	2060
2065	1.45E-05	7.22E+04	0.	1.34E+00	0.	0.	1.45E-05	7.22E+04	2065
2070	1.43E-05	7.22E+04	0.	1.34E+00	0.	0.	1.43E-05	7.22E+04	2070
2075	1.41E-05	7.22E+04	0.	1.34E+00	0.	0.	1.41E-05	7.22E+04	2075

TABLE D.49. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Low Growth Scenario - 70-Year Bone Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	FRP TREATMENT SYSTEMS ANNUAL	FRP TREATMENT SYSTEMS CUMULATIVE	NON-FRP TREATMENT SYSTEMS ANNUAL	NON-FRP TREATMENT SYSTEMS CUMULATIVE	TRANSPORTATION SYSTEM ANNUAL	TRANSPORTATION SYSTEM CUMULATIVE	TOTAL SYSTEM ANNUAL	TOTAL SYSTEM CUMULATIVE	YEAR
1985	3.58E+00	1.28E+01	2.58E-02	8.75E-02	0.	0.	3.60E+00	1.28E+01	1985
1990	9.20E+00	4.74E+01	7.50E-02	3.24E-01	0.	0.	9.27E+00	4.79E+01	1990
1995	9.67E+00	9.55E+01	9.54E-02	7.74E-01	0.	0.	9.77E+00	9.63E+01	1995
2000	1.54E+01	1.55E+02	1.71E-01	1.43E+00	0.	0.	1.56E+01	1.57E+02	2000
2005	3.25E+01	2.73E+02	1.76E-01	2.32E+00	0.	0.	3.26E+01	2.75E+02	2005
2010	5.30E+01	4.88E+02	2.37E-01	3.36E+00	0.	0.	5.32E+01	4.91E+02	2010
2015	5.20E+01	7.41E+02	2.23E-01	4.49E+00	0.	0.	5.22E+01	7.45E+02	2015
2020	3.94E+01	9.40E+02	1.71E-01	5.45E+00	0.	0.	3.96E+01	9.44E+02	2020
2025	5.43E+01	1.21E+03	1.69E-01	6.31E+00	0.	0.	5.45E+01	1.21E+03	2025
2030	3.82E+01	1.40E+03	9.97E-02	6.87E+00	0.	0.	3.83E+01	1.40E+03	2030
2035	4.99E+01	1.68E+03	2.42E-02	7.18E+00	0.	0.	4.99E+01	1.68E+03	2035
2040	4.93E+00	1.88E+03	0.	7.20E+00	0.	0.	4.93E+00	1.89E+03	2040
2045	6.38E-04	1.88E+03	0.	7.20E+00	0.	0.	6.38E-04	1.89E+03	2045
2050	5.49E-05	1.88E+03	0.	7.20E+00	0.	0.	5.49E-05	1.89E+03	2050
2055	5.35E-05	1.88E+03	0.	7.20E+00	0.	0.	5.35E-05	1.89E+03	2055
2060	5.22E-05	1.88E+03	0.	7.20E+00	0.	0.	5.22E-05	1.89E+03	2060
2065	5.09E-05	1.88E+03	0.	7.20E+00	0.	0.	5.09E-05	1.89E+03	2065
2070	4.96E-05	1.88E+03	0.	7.20E+00	0.	0.	4.96E-05	1.89E+03	2070
2075	4.86E-05	1.88E+03	0.	7.20E+00	0.	0.	4.86E-05	1.89E+03	2075

TABLE D.50. Once-Through Option - Prompt Disposal - Low Growth Scenario - 70-Year Worldwide Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	ANNUAL	CUMULATIVE
1985	1.42E+00	8.69E+00
1990	2.79E+00	2.05E+01
1995	4.11E+00	3.90E+01
2000	5.60E+00	6.36E+01
2005	6.29E+00	9.40E+01
2010	6.83E+00	1.27E+02
2015	6.37E+00	1.61E+02
2020	5.82E+00	1.91E+02
2025	4.89E+00	2.17E+02
2030	4.17E+00	2.39E+02
2035	2.62E+00	2.54E+02
2040	1.47E+00	2.64E+02
2045	4.64E-01	2.67E+02
2050	0.	2.68E+02

TABLE D.51. Fuel Reprocessing for U and Pu Recycle - Prompt Disposal - Low Growth Scenario - 70-Year Worldwide Dose to Population from Entire Waste Management System (man-rem)

(MAN-REM)

YEAR	ANNUAL	CUMULATIVE
1985	5.03E+03	1.78E+04
1990	1.32E+04	6.77E+04
1995	1.42E+04	1.37E+05
2000	2.22E+04	2.24E+05
2005	2.31E+04	3.37E+05
2010	2.89E+04	4.62E+05
2015	2.54E+04	5.89E+05
2020	1.65E+04	6.80E+05
2025	1.53E+04	7.58E+05
2030	1.19E+04	8.18E+05
2035	1.32E+04	8.87E+05
2040	7.33E+03	9.43E+05
2045	8.74E+02	9.55E+05
2050	8.06E+02	9.59E+05
2055	8.03E+02	9.63E+05
2060	9.59E+02	9.67E+05
2065	8.21E+02	9.71E+05
2070	5.16E+02	9.74E+05
2075	4.68E+02	9.76E+05

APPENDIX E

RESOURCE AVAILABILITY

APPENDIX E

RESOURCE AVAILABILITY

Selected resources were reviewed in the literature to provide a perspective for waste management impacts on resources.[1,2,3,4] The review emphasized consumption rates, sources, and near- and long-term availability of reserves. The review also considered types of usage as they may relate to the needs of nuclear waste management. Other pertinent environmental requirements for resource production were also considered.

CEMENT

In 1975, the United States produced 60.6 million MT of Portland cement, a chief binding agent in concrete and mortars. Forty-eight percent of the cement is produced in six states: Texas, California, Pennsylvania, Michigan, Missouri, and New York. Consumption of Portland cement in 1975 reached 63.8 million MT. Imports for that year amounted to 3.3 million MT, 43% of which came from Canada, 17% from the Bahamas, 12% from Norway, 11% from the United Kingdom, and 17% from other sources.

Sixty-six percent of the Portland cement produced is used for ready-mixed concrete, 15% for concrete products such as block, pipe, and prestressed precast concrete, 8% by building material dealers, 7% by highway contractors, and 4% by other contractors, government agencies and for miscellaneous uses.

World production figures for Portland cement in 1975 were 614 million MT. There is no recycling of Portland cement, because raw materials for making the cement are abundant in most countries. Many domestic companies reported reserves of raw materials exceeding 100 years at present annual capacity, while others reported reserves of 25 to 100 years. The United States demand for cement is predicted to grow at 3.2% per year; world demand is predicted to grow at 2.7% per year.

Manufacturing Portland cement is one of the most energy-intensive industries in the United States. One ton of cement uses an average of 5.6 million BTU of fuel energy and 124 kWh of electricity in production. Shortages of petroleum and natural gas and sharp increases in all fuel costs have impelled virtually all cement producers to consider using coal as a primary fuel. Energy costs comprise 40% or more of the direct production costs of manufacturing cement.

CHROMIUM

Domestic production of chromite ceased in 1961. However, the United States continues to be one of the world's leading consumers of this resource. In 1975, U.S. chromite consumption reached 816.3 thousand MT, while those of chromium ferroalloys amounted to 290.2 thousand MT. Imports of chromite (averaging 30% chromium content) for that year were 1.2 million MT. Thirty percent of these imports came from the Republic of South Africa, 29% from the U.S.S.R., 17% from the Phillipines, 16% from Turkey, and 8% from other sources. Ferrochromium imports (typically averaging 55% chromium content) of 263 thousand MT originated from the Republic of South Africa (35%), Souther Rhodesia (18%), and Japan (11%), with 36% coming from other sources.

Both domestic scrap and imported scrap were recycled in the production of stainless steel. In 1975, the estimated chromium content in purchased stainless steel scrap amounted to 13% of the total chromium demand. Consumption of chromium by end use was as follows: construction, 22%; transportation, 16% machinery and equipment, 14%; refractories, 14%; and all other uses, 34%.

World production figures in 1975 for chromite totaled 6.7 million MT; world reserves are estimated to be 1.7 billion MT. Domestic resources are low grade and represent only a 4 to 5 year supply. Most of the world resources lie in the Eastern Hemisphere, primarily in the Republic of South Africa and Southern Rhodesia.

Demand for primary chromium is expected to increase at an annual rate of about 2.1% through 1980. Along with other consuming countries, the United States must continue to rely on imports of chromium. International relationships in the future will influence the United States supply and demand position, as they have in the past.

COPPER

Refined copper production in the United States in 1975 was 1.36 million MT. Principal copper-producing states were Arizona (57%), Utah (13%), New Mexico (10%), Montana (17%), Nevada (5%), and Michigan (5%). Consumption of copper in 1975 was 1.36 million MT. Copper imports for the year totaled 77 thousand MT. Exports totaled 154 thousand MT. Thirty-three percent of the imports were obtained from Canada, 22% from Peru, 17% from Chile, 6% from the Republic of South Africa, and 22% from other sources

Recycled old scrap derived from obsolete end use items comprised 23% of 1975 copper consumption. The 320,000 MT of consumed old scrap (recoverable copper) compares with the consumption of 496,000 tons of new scrap derived from fabricating operations. Of this total, brass mills consumed 42%, smelters and refiners 53%, and other categories 5%. Most copper is consumed as refined metal. The use of copper (primary and old scrap) is estimated to be 52% electrical, 17% construction, 14% industrial machinery, 10% transportation, 2% ordnance and 5% miscellaneous.

Total world mine production figures for 1975 were 6.9 million MT; world reserves are estimated to be 408 million MT. Identified copper resources are located principally in western North America and South America, central Africa, southeastern and central Europe and the U.S.S.R. Domestic copper demand is expected to approximate an average growth rate of 3.5% through 1980.

LEAD

United States production of refined lead in 1975 was about 577,000 MT. Secondary lead production was 493,072 MT. Missouri supplied 83% of this metal in 1975, with Idaho contributing 8% of the total, Colorado 4% and Utah 2%. Domestic consumption of lead was approximately 1,116,336 MT in 1975. Imports of refined lead amounted to 91,581 MT, 29% of this coming from Canada, 24% from Peru; 19% from Australia, and 11% from Mexico, with other sources contributing 17%.

Old scrap (450,779 MT) furnished 86% of total secondary recovery of lead metal and alloys. Old and new lead scraps, mostly from batteries, accounted for 48% of domestic production and

47% of total consumption. The transportation sector was the major end user of lead, 53% as batteries and 16% as gasoline additives. Electrical uses totaled 7%; ammunition, 7%; paints, 6%; construction, 4%; and other, 7%.

World mine production figures for lead in 1975 totaled 3.4 million MT; world reserves are estimated to be 145 million MT. The prospect for discovery of additional resources at a rate that exceeds consumption is favorable. Domestic demand for lead is expected to increase at an annual rate of about 1.5% through 1980. The domestic resource base, augmented by recent developments in Missouri, appears adequate to supply the domestic component of primary lead demand at competitive prices.

NICKEL

United States mine production of nickel in 1975 was 14,965 MT. Plant production of refined metal from domestic ore was 11,791 MT. Domestic consumption of nickel in 1975 reached 131,515 MT. Imports contributed 154,190 MT in 1975, 68% of which were obtained from Canada, 8% from Norway, 6% from New Caledonia, 5% from the Dominican Republic, and 13% from other sources.

In 1975, production of secondary nickel was estimated to be 52,606 MT, which accounted for 28% of the total nickel consumed. Of the scrap consumed, 60% was estimated to be old and 40% to be prompt industrial. Major end uses of nickel were as follows: transportation, 22%; chemical industry, 15%; electrical equipment, 12%; construction, 10%.

World mine production figures for nickel in 1975 reached 745,100 MT, with world reserves estimated at 54 million MT. Demand for nickel is expected to increase at an annual rate of about 3% through 1980. Domestic mine production of nickel should remain at the level of the past 5 years and continue to supply approximately 8% of the primary nickel consumed. The United States should be able to obtain all the nickel it needs from relatively secure and diversified foreign sources.

NITRIC ACID

In 1975, United States production of fixed nitrogen reached 11.8 million MT, while consumption totaled 11.5 million MT. Imports and exports of fixed nitrogen were approximately equal, amounting to 1.196 and 1.106 million MT, respectively. The fixed nitrogen produced and consumed in the United States included 7.4 million MT of nitric acid, bearing a nitrogen content of 1.5 million MT. About three-fourths of fixed nitrogen is used as a fertilizer; other uses are in plastics and explosives. Nitrogen is not recycled or recovered after use.

World production of fixed nitrogen for 1975 was estimated at 46.9 million MT; resources of nitrogen in the air are for all practical purposes, unlimited. Total reserves for the production of all forms of elemental and fixed nitrogen are, therefore, also unlimited, because natural nitrates are essentially identical with the manufactured compounds. Demand for fixed nitrogen is expected to increase at an annual rate of about 4.4%.

PETROLEUM

United States production of crude oil in 1975 amounted to 3 billion barrels. Figures for the leading producing states (in million barrels) were: Texas, 1,222; Louisiana, 657.6; Oklahoma, 161.4; Wyoming, 129.5. Domestic demand for petroleum products was an estimated

5.9 billion barrels. Imports supplied 36.6% of domestic demand. Thirty-two percent of crude oil imports were obtained from Canada, 14% from Nigeria, 12% from Venezuela and 11% from Saudi Arabia. Petroleum products were imported from Venezuela (28%), Netherlands Antilles (19%), Virgin Islands (13%), and Canada (10%).

Principal end uses of refined petroleum products and their percentages of total consumption were: fuel, 89%; petrochemical feedstock, 6%; asphalt and road oil, 2%; miscellaneous uses, 3%. Consuming sectors used the following percentages of petroleum products in 1975; trasportation, 54%; household and commercial, 18%; industrial, 19%; and electrical generation and utilities, 9%.

World crude oil production in 1975 was 19.3 billion barrels, with world reserves totaling 712 billion barrels. Estimates of potentially recoverable crude petroleum resources, including heavy oils, vary from 2.0 to 4.5 trillion barrels. In 1975, Africa became the largest regional source of U.S. crude petroleum imports, with Nigeria becoming the principal country of origin, replacing Canada. Canada has been cutting crude oil exports to the U.S. and has announced plans to phase out exports entirely by 1981. Demand for petroleum is expected to rise at an annual rate of about 4.5% through 1980. Imports will continue to rise, assuming an even greater role in supplying increased demand.

ELECTRICITY

The total United States net production of electricity in 1976 was 2,037,415 millions of kWh, an increase from the 1975 figure of 1,917,638 millions of kWh. The projected production figure for 1985 is 3,960,000 million kWh, with demand for electricity rising at a growth rate of 5.7-6.2%.

The sources used to generate electrical power in 1976 and their respective contributions (1975 figures are in parentheses) were coal, 46.4% (44.5%); oil, 15.7% (15.1%); gas 14.4% (15.6%); nuclear, 9.4% (9.0%); hydroelectric, 13.9% (15.6%), and 0.2% (0.2%) from other sources.

REFERENCES FOR APPENDIX E

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3. Commodity Data Summaries 1976, Bureau of Mines, U.S. Department of the Interior.
4. Metal Statistics 1976, The Purchasing Guide of the Metal Industries, American Metal Market, Fairchild Publications.

APPENDIX F

ENVIRONMENTAL MONITORING

APPENDIX F

ENVIRONMENTAL MONITORING

F.0 INTRODUCTION

The environmental monitoring of commercial radioactive waste management facilities has several general objectives:

- the description or characterization of the environment prior to the establishment of the facilities. This characterization is necessary to provide a baseline for the evaluation of facility-induced environmental changes and to supply needed information for the development of facility design features that will produce minimal environmental effects.
- the development of data to verify compliance with state and Federal regulations and standards. Both radiological and nonradiological pollutant measurements will be required to assure that facility releases and the resulting environmental concentrations are within acceptable limits.
- the determination of the effects of plant construction and operation on natural populations of plants and animals. The emphasis will be on species of recognized value to man, or on those that are rare or endangered.

The suggested monitoring programs that follow are designed for normal facility construction and operation and will probably be inadequate for evaluating consequences of accidents or unusual events, e.g., a meteor strike on a waste repository. Although the reference environment (Appendix A) was considered in the development of the monitoring programs, the environmental information about the reference site is incomplete. Consequently, the monitoring program design may require modification to accommodate additional information from this site, or to accomodate site specific requirements for facilities that may be located elsewhere.

The generic treatment of environmental monitoring is more difficult in some disciplines than in others. For example, radiological monitoring deals with relatively few and generally accepted radiation pathways to man, and is guided by recognized radiation limits and standards. On the other hand, for ecological monitoring no limits have been established, and the "standards" require development on a site-specific basis. Usually baseline information is also needed before operational monitoring programs can be designed. Therefore, the monitoring programs presented here are examples that may undergo marked change before they can be applied.

The kinds of monitoring that will be discussed are radiological, meteorological, water, air, and soil, and ecological. Programs will be mutually supportive and where appropriate the same sampling locations and sampling frequencies will be used. The reference waste management facilities covered in the monitoring program include the fuel reprocessing plant (FRP), the mixed oxide fuel fabrication plant (MOX FFP), the independent spent fuel storage facility (ISFSF), the extended spent fuel storage facility (ESFSF), the retrievable waste storage facility (RWSF) and the geologic (salt) repository.

F.1 RADIOLOGICAL MONITORING

The radiological environmental monitoring programs have the following specific objectives:

- evaluation of the adequacy and effectiveness of plant radiation containment and effluent control systems
- detection of rapid changes and definition of long-term trends in the concentration of radionuclides in the facility environment
- assessment of the radiation doses (actual or potential) to man from radioactive materials released by the facility or the estimation of the probable limits of these doses
- collection of historical data of environmental releases of radioactivity to discover previously unconsidered exposure modes and pathways
- detection and evaluation of offsite sources of radioactivity that contribute to the site background radiation
- comparison of the applicable radiation standards with the measured or estimated radiation doses.

All environmental radiation measurements should supplement the adequate control and in-plant monitoring of effluents except for long-term accumulations of contaminants from sources too low to be conveniently measured. The time lag between sample collection and analysis, and the generally low concentrations of radioactive nuclides in most environmental samples make it unwise to rely completely on these measurements as an action signal.

The typical environmental surveillance programs described in this section are based on Regulatory Guide 4.8[1] (including Nuclear Regulatory Commission staff-proposed revisions of July, 1977) and have been modified to stress the critical and potential accident pathways for the waste management facilities considered in this document. Program design criteria from ERDA-77-24[2,3] were used to define measurement frequencies, nuclides, and media; numbers and locations of measurements and samples; and an estimate of quality assurance requirements. These criteria follow:

- If the total environmental dose commitment of site origin exceeds either a) 1 man-rem/yr to the whole body or specific organ dose of individuals or critical population groups or b) 100 man-rem/yr whole body dose per one million population within an 80-km (50-mi) radius of the release points (or centroid of a cluster of release points), then every exposure pathway that may contribute more than 10% of a total environmental dose commitment of site origin, as determined by site-specific exposure pathway analysis and either predicted or historical release rates should be routinely measured.
- For dose calculation, actual measurements on two media for each critical radionuclide/pathway combination are sufficient. One of the pathways may be the effluent stream.
- "Background" or "control" location measurements should be taken for those critical nuclide/pathway combinations that use environmental measurements in dose calculation.

- If reasonably achievable, routine measurement techniques for dose calculation should have minimum detection limits no higher than those equivalent to the dose criteria given above.
- Sampling or measurement intervals for each critical nuclide/medium combination should not exceed twice the half-life of the nuclide to be measured.
- Where significant periodic variations in environmental concentrations may be expected, samples or measurements should either be continuous or at an interval less than half the expected peak-to-peak interval.
- Gross activity analyses should be used only as trend indicators, unless supporting analyses show a reliable relationship to specific radionuclide concentrations or doses.
- Samples of wildlife (fish, game birds and mammals) used for dose estimation should be collected during normal fishing and hunting seasons.

The numbers of sampling locations and sampling frequencies during the initial phase of facility operation are conservative and later may be reduced or eliminated based on accumulative monitoring experience with effluent releases, local dispersion phenomena, and local exposure parameters. Baseline or preoperational monitoring usually begins two years before the start of facility operation and at about half the intensity of the operational program.

Figure F.1-1 shows the reference site and the location of sampling and measurement instrumentation that may be used in the monitoring program design for an FRP. Prevailing winds are assumed to give the highest annual mean airborne concentrations from stack releases from either the north or southeasterly directions. The farm with the nearest cow providing milk for human consumption is located just offsite at location "M," but the residence with the highest annual mean concentration of airborne effluents is assumed to be just offsite at location "L." Location "H," 20 miles to the west, is a control station. Although no routine offsite releases of radioactive liquids or solids are planned, nearby tributary streams and the R River are sampled to detect potential leaks of radioactive materials to ground or surface waters. No attempt is made to show sampling locations for other waste management facilities. However, the same general criteria, as indicated in the example above, apply to other facilities and are modified only to accommodate different critical pathways and nuclide releases.

Detection capabilities, shown in Table F.1-1, are based on those given in Regulatory Guide 4.8[1], and supplemented by those currently available from a commercial radioanalytical laboratory.

F.2 METEOROLOGICAL MONITORING

The meteorological monitoring program for the reference waste management facilities has the following objectives:

- provide a climatological history of the various meteorological parameters that are needed to determine site-specific meterological trends
- determine the atmospheric transport and diffusion characteristics of the site
- aid in the assessment of consequences of continuous or periodic releases of radiological and nonradiological pollutants to the atmosphere

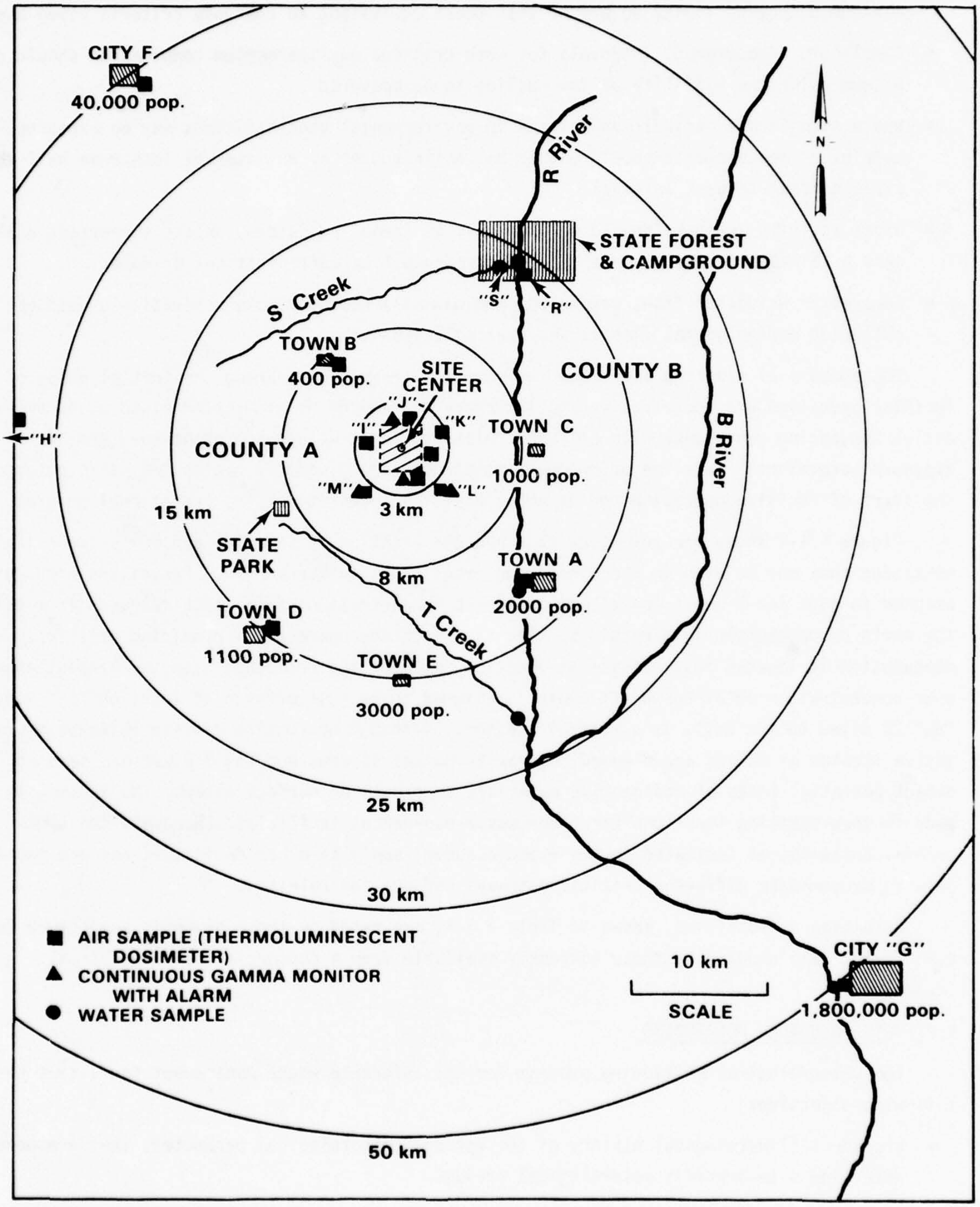

FIGURE F.1. Environmental Radiological Monitoring Stations

TABLE F.1-1. Detection Capabilities for Radiological Environmental Sample Analysis

Analysis	Milk and Water (pCi/ℓ)	Lower Limit of Detection (LLD)[a]: Airborne Particulate or Gas (pCi/m^3)	Foods or Vegetation (pCi/kg, Wet)	Soil (pCi/kg, Dry)
Gross Beta	2	1×10^{-2}		
^{3}H (HTO)	300	(b)		
^{54}Mn	15		150	50
^{59}Fe	30		300	100
^{58,60}Co	15		150	50
^{65}Zn	30		300	100
^{85}Kr		15		
^{89}Sr[c]	10	5×10^{-3}	10	150
^{90}Sr[c]	2	1×10^{-3}	2	30
^{95}Zr-Nb	15	1×10^{-2}	150	100
^{106}Ru-Rh	15	1×10^{-2}	150	100
^{129}I[c]	2	0.3	10	
^{131}I[c]	0.4	7×10^{-2}	2	
^{134,137}Cs	15	1×10^{-2}	150	100
^{140}Ba-La	15	1×10^{-2}	150	100
U-total[c]	2	1×10^{-2}	50	30
Pu-Alpha[c]	0.01	5×10^{-3}	5	1
Gamma - TLD		0.5 mR		
- Continuous Monitor		1×10^{-3} mR/h		

a. The nominal Lower Limit of Detection (LLD) is defined in HASL 300 (Rev. 8/74), pp. D-08-01, 02, 03 at the 95% confidence level. The LLD levels are decay corrected to the end of the total sampling period. The LLD for radionuclides analyzed by gamma spectrometry will vary according to the number of radionuclides encountered in environmental samples.
b. Dependent on moisture content, with same LLD as HTO in water.
c. After chemical extraction.

- provide real-time meteorological data for estimation of probable doses to man as a result of accidental atmospheric releases of radionuclides.

The models used to design the environmental meteorological monitoring programs are Nuclear Regulatory Commission (NRC) Regulatory Guides 3.24[4] and 3.26[5]. Information from NRC Regulatory Guide 1.23[6] is used to define location of sensors, measurement frequency, maintenance procedures, and reporting frequency. The program can be modified by the technical operating specifications for any given facility as discussed in NRC Regulatory Guide 4.8.[1]

The following program design criteria are used to define measurement frequencies, number and location of instruments, and an estimate of quality assurance requirements:

- Basic monitoring programs consist of an onsite meteorological tower with at least two levels of instrumentation for measuring wind direction, wind speed, and air temperature. The lower and upper sensor levels should provide measurements at 10 meters and 60 meters, respectively, above facility grade. At sites where fogging or icing may be caused by an increase in atmospheric moisture from facility operation, a sensor for measuring dew point temperature should be located at the 10-meter tower level.
- Data should be recorded on digital recording devices whose output is computer compatible. Data entry to the digital system should be electronically averaged for a period of 15 minutes.
- Starting speed of the anemometer should be less than 1 mph.
- If thermistors are used to sense ambient temperature, then an independent set of matched thermistor pairs will be required for measurement of temperature difference between the two sensor levels.
- Minimum recovery rate for each sensor should be 90%. The use of redundant sensors and/or recorders or an extensive inspection program are acceptable means to achieve the 90% data recovery rate. The sensors should be electronically calibrated quarterly with a full system calibration (physical and electronic) conducted semiannually.
- The base of the tower should be at or near plant grade with sensor levels representative of pollutant release levels.
- The tower should be located in the direction of prevailing winds, as determined by general climatological documents, and at a distance of 5 building heights away from the facility buildings. This siting minimizes any building influence.
- The tower should be located so that its instrumentation would not be influenced by local vegetation or topographical features.

Instrument accuracies are defined by Nuclear Regulatory Commission Regulatory Guide 1.23[6] and are listed below:

Meteorological Parameter	Accuracy
Wind direction	±5° arc
Wind speed	±0.5 mph
Ambient temperature	±0.5°C
Temperature difference	±0.1°C
Dew point temperature	±0.5°C

Meteorological monitoring should begin two years prior to facility startup and be coordinated with radiological and ecological monitoring. Operational monitoring will depend on results obtained in the pre-operational program and will vary among the several waste management facilities.

F.3 WATER SOILS AND AIR MONITORING

The monitoring of water, soils and air near radioactive waste management facilities has the following objectives:

- determination of preoperational data to define the normal air, water, and soil characteristics of the site
- detection of rapid changes in surface water and air quality and definition of long term trends in air, water, and soil contaminant levels
- estimation of the concentration of actual or potential hazardous chemicals in human food pathways, and in the aquatic and terrestrial environments
- collection of historical data on environmental releases of hazardous materials to discover previously unconsidered pathways and modes of exposure
- comparison of air, water, and soil quality parameters with applicable state and Federal standards
- identification of types and relative amounts of environmental pollutants originating from sources other than the waste management facility.

The monitoring of nonradiological pollutants will be coordinated with the radiological monitoring program and, as far as practical, the same sampling locations and frequencies will be adopted for each program. In addition to these objectives, the monitoring program will indicate necessary control or mitigating measures, and will provide evidence of no impact where insignificant levels of contamination are found.

The following criteria are used to define measurement frequencies, number and location of samples, and an estimate of quality assurance requirements:

- Pathways should be routinely monitored if significant releases to air and water of chemicals and heat could reasonably be expected to occur.
- Where significant random or periodic variations in environmental pollutant concentrations may be expected, sampling should either be continuous or at an interval less than half the peak-to-peak interval.
- Measurements of surface water temperatures and water quality should include worst case conditions (i.e., low flow and maximum ambient temperature).
- Monitoring locations and sample types and number should be similar during preconstruction, pre-operational and operational monitoring.
- For facilities that are judged to have little or no release of contaminants to soil or water during operation, no monitoring is recommended except for baseline characterization or construction stage.

Detection limits for some of the parameters that are often measured in water and air monitoring are given in Table F.3-1.

Air quality monitoring, including both baseline and operational measurements, will be based on very site-specific features and state and Federal requirements. Because of the uncertainties in the scope of necessary specific facility air monitoring needs, specific air monitoring programs are not presented in this discussion. Little or no air monitoring may be required because of the anticipated low levels of air contaminants released by the several waste management facilities.

TABLE F.3-1. Detection Limits for Nonradiological Environmental Water Samples

Parameter	Detection Limit - ppm[a]
Chloride (Cl)	1
Dissolved oxygen (DO)	0.05
Iron (Fe)	0.02
Arsenic (As)	0.002
Cadmium (Cd)	0.002
Chromium (Cr)	0.02
Copper (Cu)	0.01
Lead (Pb)	0.05
Mercury (Hg)	0.0002
Zinc (Zn)	0.005
Magnesium (Mg)	0.0005
Calcium (Ca)	0.003
Manganese (Mn)	0.01
Sodium (Na)	0.002
Potassium (K)	0.005
Alkalinity (as $CaCO_3$)	10
Sulfate (SO_4)	10
Fluoride (F)	0.05
Kjeldahl nitrogen (N)	0.05
Ammonia (NH_3 as N)	0.01
Nitrite (NO_2 as N)	0.01
Nitrate (NO_3 as N)	0.01
Orthophosphate (as P)	0.005
Total phosphorus (P)	0.001
Hardness (as $CaCO_3$)	10

a. Detection limits are based on EPA standards.[7] Actual limits may vary with procedures used by laboratories doing the analyses.

F.4 ECOLOGICAL MONITORING

The ecological monitoring program for the several waste management facilities discussed in this Appendix have the following objectives:

- characterizaton of the plants and animals and their habitat including prior identification of important sensitive or endangered species and their relative abundance to facility construction

- measurement of ecological changes that may result from facility construction and operation
- development of monitoring strategies that will enable the quantitative measurement of ecological impact
- verification of predicted impacts
- provision of a basis for mitigation or corrective action to reduce or eliminate detremental impacts.

The ecological features of the facility site have been described in the reference environment (Appendix A), but additional baseline and preoperational information will be required for the development of specific ecological monitoring programs. Absence of ecological monitoring standards or guidelines, such as exist for the abiotic parameters, make the formation of an ecological monitoring program very site specific. Because of this site specificity and the programs' dependence on baseline information, the suggested ecological monitoring programs for the waste management facilities are general and are offered as examples rather than sampling schemes that could be applied in a generic sense.

Ecological monitoring needs to be closely integrated with other monitoring programs, particularly the monitoring of nonradiological pollutant releases to air, soil, and water. As stated in an earlier section, an assumption of this report is that environmental radiation limits and controls that protect man will also protect other biota, and an ecological monitoring program will not attempt to evaluate the effects of radioactive material releases on terrestrial and aquatic biota. Because of the very small environmental radionuclide releases expected from the waste management facilities, such monitoring programs would probably be unproductive.

Programs design criteria used to define sampling frequencies, locations, methods and sample types include the following:

- Any important species that potentially could be affected by facility construction and operation should be monitored.
- Important plant and animal species are defined as those that are economically important; are a significant part of the food chain of important species, including man; or are classed as rare or endangered.
- All samples will be taken at points of maximum effluent concentration and at control locations "matched" to the exposed communities.
- Continuity in sampling locations and methodologies should be maintained throughout the baseline, preoperational, and operational monitoring to provide the necessary data for quantitative evaluation.
- Monitoring should provide information on:
  - kinds, abundance, and seasonal presence of important animals in the vicinity of the facility;
  - areas of breeding, feeding, and migration of important species; and
  - kinds of habitat (e.g., forest, grassland, lake, stream) that may be affected by facility construction and operation, and the relative availability of each habitat type.

F.5 MONITORING AT FUEL REPROCESSING PLANT (FRP)

Because of the greater probability of airborne release of radioactivity from a fuel reprocessing plant and because of the potential variety of radionuclides in those releases, the monitoring program for the FRP is larger and more complex than for any other fuel cycle facility. Environmental monitoring is also necessary for several nuclides for which little routine surveillance experience exists, notably ^{14}C. Either pathway analysis and dose calculations or EPA-suggested limitations on total releases from the uranium fuel cycle can be used.[3]

Figure F.1-1 shows the reference site and the sampling and measurement locations used in the monitoring program design.

Table F.5-1 summarizes the program for an FRP for either U recycle only or both U and Pu recycle. Potentially important nuclides from routine releases and minor accidents are ^{3}H and mixed fission products for whole body and annual lung doses, ^{129}I for thyroid doses, and TRU for long-term bone doses. Gross activity analyses are used primarily as trend indicators. Positive results from routine FRP operations are not expected beyond the 5-mile radius.

Onsite meteorological monitoring will consist of continuous measurement of wind direction and speed, ambient air temperature and dew point air temperature. Measurements will be made on at least two levels that are representative of levels of pollutant release. The sensor for the measurement of dew point will be located at the 10-meter tower level. The FRP has two stacks: the cooling tower stack with a release height of 110 meters and the main plant exhaust stack 45 meters high. At least two years of meteorological data will be collected prior to startup of the FRP.

Water, soil and air monitoring will be fairly comprehensive at the FRP, at least until site-specific environmental conditions that affect impacts are better known. This program will be closely integrated with both radiological and environmental monitoring, and is summarized in Table F.5-2.

Ecological monitoring will begin at least two years before the start of facility construction and will continue for at least five years of normal waste management facility operation at the FRP. Impacts from construction may result from change in land use (2400 ha for the FRP site with 40 ha occupied by facilities) and water use (1.8×10^5 m^3 during 4-yr construction period). Operational environmental releases from the FRP include heat to the air and water, cooling tower drift to land, and cooling tower blowdown to surface water. The possible enhancement of the ecological values because of change in land use and the resulting restriction of public access to the site is not a principal objective of the ecological program. An outline of a representative ecological monitoring study is given in Table F.5-3.

The approximate costs of environmental monitoring at the FRP are shown in Table F.5-4. The estimates are based on 1977 dollars and are subject to revision depending on more detailed site-specific information.

TABLE F.5-1. Environmental Radiological Monitoring Summary for Fuel Reprocessing Plant

Type of Analysis	No. of Locations	Frequency
Air		
Particulate Filters		
Total Alpha	4	Biweekly
Gross Beta	13	Biweekly
Gamma Scan	13	Monthly
^{90}Sr	4	Quarterly
U-Total	4	Quarterly
Pu-Alpha	4	Quarterly
^{241}Am	4	Quarterly
Gas Collectors		
^{3}H	4	Biweekly
^{14}C	4	Biweekly
^{85}Kr	3	Continuous
^{129}I	4	Monthly
Direct Radiation		
TLD (3 per location)	13	Monthly
Continuous γ Monitor	*3*	*Continuous*
Water		
Surface		
Gamma Scan	5	Monthly
Total Alpha	5	Quarterly
^{3}H	5	Quarterly
Drinking		
Gamma Scan	1	Monthly
^{226}Ra	1	Quarterly
Groundwater		
Gamma Scan	3	Quarterly
^{3}H	3	Quarterly
U-total	3	Quarterly
Milk		
Gamma Scan	3	Monthly
^{90}Sr	3	Quarterly
^{129}I	3	Quarterly

TABLE F.5-1. contd

Type of Analysis	No. of Locations	Frequency
Foods		
Fresh Produce		
Gamma Scan	9	Semiannual
^{129}I	3	Semiannual
Fish - (e.g., Crappie, Bass)		
Gamma Scan	4	3/yr
Water Fowl		
Gamma Scan	10	Annual
Game Animals - (e.g., Squirrel)		
Gamma Scan	10	Annual
Other		
Sediment		
Gamma Scan	2	Semiannual
Soil and Vegetation		
Gamma Scan	4(x2)	Annual
^{90}Sr	4(x2)	Annual
U-total	4(x2)	Annual
Pu-alpha Scan	4(x2)	Annual
^{241}Am	4(x2)	Annual
^{14}C (vegetation only)	4	Annual
^{129}I (vegetation only)	4	Annual

TABLE F.5-2. Environmental Water and Soils Monitoring - FRP

Sample Type and Monitoring Parameter	Sampling Locations	Sampling Frequency	Start	End
Surface water temperature	3 stations - R River	Continuous	2 yr before start of construction	Decommissioning
pH	1 - upstream of facility water intake			
Specific conductance				
Chloride (Cl)	1 - within effluent mixing zone			
Dissolved oxygen (DO)				
Turbidity	1 - downstream of mixing zone and upstream of other diversions or inflows			
Iron (Fe)		Quarterly		
Manganese (Mn)				
Calcium (Ca)				
Sodium (Na)				
Potassium (K)				
Arsenic (As)				
Cadmium (Cd)				
Chromium (Cr)				
Copper (Cu)				
Lead (Pb)				
Mercury (Hg)				
Zinc (Zn)				
Silica (SiO_2)				
Bicarbonate (HCO_3)				
Alkalinity (as $CaCO_3$)				
Sulphate (SO_4)				
Fluoride (F)				
Total Kjeldahl nitrogen (as N)				
Ammonia (NH_3 as N)				
Nitrite (NO_2 as N)				
Nitrate (NO_3 as N)				
Total nitrogen (N)				
Orthophosphate (as P)				
Total phosphorus (P)				
Chemical oxygen demand (COD)				
Fecal coliform				
Chlorophyll a				
Total organic carbon (TOC)				
Dissolved solids (residue of 180°C)				

TABLE F.5-2. contd

Sample Type and Monitoring Parameter	Sampling Locations	Sampling Frequency	Start	End
Surface water		Quarterly		
Suspended sediment				
Hardness (Ca, Mg)				
Noncarbonate hardness				
Sodium adsorption ratio				
Color				
Groundwater	3 stations - wells	Continuous	2 yr before construction	Decommissioning
Water level	1 - approximately 1 mi upstream of the plant site			
Temperature				
pH				
Iron (Fe)	1 - at the plant site	Quarterly	2 yr before operation	
Manganese (Mn)	1 - approximately 1 mi downstream of the plant site			
Calcium (Ca)				
Magnesium (Mg)				
Sodium (Na)				
Potassium (K)				
Arsenic (As)				
Cadmium (Cd)				
Chromium (Cr)				
Copper (Cu)				
Lead (Pb)				
Mercury (Hg)				
Zinc (Zn)				
Silica (SiO_2)				
Bicarbonate (HCO_3)				
Alkalinity (as $CaCO_3$)				
Carbon dioxide (CO_2)				
Sulphate (SO_4)				
Chloride (Cl)				
Fluoride (F)				
Total Kjeldahl nitrogen (as N)				
Ammonia (NH_3 as N)				
Nitrite (NO_2 as N)				

TABLE F.5-2. contd

Sample Type and Monitoring Parameter	Sampling Locations	Sampling Frequency	Start	End
Groundwater	3 stations (wells)			
Nitrate (NO_3 as N)	1 - approximately 1 mi upstream of the plant site	Quarterly	2 yr before operation	Decommissioning
Total nitrogen (N)				
Orthophosphate (as P)	1 - at the plant site			
Total phosphorous (P)				
Dissolved solids (residue at 180°C)	1 - approximately 1 mi downstream of the plant site			
Dissolved solids (sum of constituents)				
Hardness (Ca, Mg)				
Noncarbonate hardness				
Sodium adsorption ratio				
Specific conductance				
Fecal coliform				
Color				
Soil - saturation extracts	3 stations	Annually prior to growing season	2 yr before operation	
pH	1 station each in 2 downwind locations of predicted maximum salt deposition			
Electrical conductivity				
Calcium (Ca)				
Magnesium (Mg)	1 station upwind of plant and sufficiently removed to serve as a control			
Sodium (Na)				
Potassium (K)	Soil samples to be collected at 3 points at each station - at the surface, 10 to 25 cm and 25 to 50 cm depth. At each station the 3 samples from each depth to be combined into a single sample. All samples to be taken from undisturbed soil.			
Carbonate (CO_3)				
Bicarbonate (HCO_3)				
Sulphate (SO_4)				
Nitrate (NO_3)				
Chloride (Cl)				
Soil hydraulic conductivity			2 yr before operation	Decommissioning if sodium concentrations increase

TABLE F.5-3. Ecological Monitoring - FRP

Sample Type	Sampling Location	Frequency	Sampling Method	Information Obtained
Vegetation	Forest, Grassland, Forb-Grass: 1000 m upwind and downwind of stack; fenceline, upwind and downwind of stack	May, Aug	Forest-wt/unit area-permanent sites 40 litter fall collectors/site Grassland-wt/unit area-10 random plots along grid or transect Forb-grass - (same as grassland) All samples to be separated by species	Biomass, species distribution and abundance
		Jul	Aerial photography-entire site	Species distribution
Rare and Endangered Species	Within plant boundaries	May, Aug	Literature search; survey of the area	Presence, location relative abundance
Birds Passerine	Forest, Grassland, Forb-grass: In 20 ha or larger stands within plant boundaries	Breeding season Apr Spring migration Jun Fall migration (Sept-Oct) Winter (Jan)	Forest-line transect Grassland, Forb-grass: flush-map technique	Species composition, distribution by habitat, seasonal abundance
Rare and Endangered Species	Entire site and up to 10 km radius of plant	Spring (Apr-Jun) Fall (Sep-Oct)	Random ground survey	Presence, location, relative abundance
Waterfowl	Surface waters within the plant boundaries	Spring migration (Apr-May) Nesting (May-Jun) Fall migration (Sep-Oct) Winter (Jan)	Surface counts Brood counts Aerial photography	Species distribution and abundance
Rare and Endangered Species	All surface waters within plant boundaries	Quarterly (Jan, Apr, Jul, Oct)	Shoreline survey	Presence, location, relative abundance
Raptors	Nesting sites within plant boundaries	Breeding season (May-Jun)	Ground survey, nest count	Abundance, reproductive success
Rare and Endangered Species	Within the plant boundaries	Quarterly (Jan-Apr, Jul, Oct)	Ground survey-prairie falcon, arctic peregrine falcon, southern bald eagle	Presence, location, relative abundance
Upland Game Birds (ruffed grouse)	Forest, Grassland, Forb-grass: In 20 ha or larger stands within plant boundaries	Breeding season (May, Jun)	Forest-line transect Grassland, Forb-grass: Flush-map technique calling males	Distribution and abundance
Rare and Endangered Species	Within plant boundaries	Quarterly (Jan, Apr, Jul, Oct)	Ground survey-northern greater prairie chicken	Distribution and abundance

TABLE F.5-3. (contd)

Sample Type	Sampling Location	Frequency	Sampling Method	Information Obtained
Mammals				
Big Game Mammals	Along roads within plant boundaries	Monthly - 3 nights/mo.	Road counts, Ground counts } white-tailed deer	Seasonal and relative abundance
Small Game Mammals	Forest, Grassland, Forb-grass } In 20 ha or larger stands within plant boundaries	Quarterly (Apr, Jul, Oct, Jan)	Line transect-red squirrel, gray squirrel, cottontail rabbit, whitetail jackrabbit	Species composition and distribution
Terrestrial Fur Bearers	Along roads within plant boundaries	Monthly - 3 nights/mo	Road counts, Ground survey } opossum, badger, skunk, red fox, coyote, bobcat, mink, weasel	Seasonal and relative abundance
Aquatic Fur Bearers	Surface waters within plant boundaries; R River in the vicinity of plant water intake	Quarterly (Apr, Jul, Oct, Jan)	Shoreline survey counts-bearer, muskrat, raccoon	Species distribution and relative abundance
Small Mammals	Forest, Grassland, Forb-grass } In 20 ha plots within plant boundaries	Quarterly-3 consecutive days/quarter	Live traps, mark-recapture-deer mouse, jumping mouse, harvest mouse, ground squirrel, chipmunk, shrew, mole, vole, pocket gopher	Species composition and abundance, biomass, age-growth, sex ratio, general health
Zooplankton	Six locations-50, 100 and 1000 m downstream and 50, 100, and 1000 m upstream of plant effluent discharge to R River. Upstream stations should be matched with downstream stations insofar as possible. One station at the plant water intake	Monthly	Vertical haul nets, tow nets-numbers per unit volume of water	Species composition, abundance, distribution, seasonality and abundance
Benthic Invertebrates	(Same as zooplankton)	Monthly	Natural and artificial substrates number organisms per unit area	(Same as zooplankton)
Fish Eggs and Larvae	Six locations-50, 100, 1000 m downstream & upstream of plant effluent discharge to R River. Upstream stations should be matched with downstream stations insofar as possible.	Apr-Oct	Vertical haul nets, tow nets-number eggs and larvae per unit volume of water	Species composition, abundance, seasonality
	Water intake screens at R River	One 24-hr sample per month for first 2 yrs of plant operation. Discontinue after 2 yrs if losses are negligible	Separation and enumeration of fish washed from intake screens	Species composition, abundance, seasonality, biomass
Fish Juveniles and Adults	Four locations - 0 to 200 m and 1000 to 1200 m upstream and downstream of the plant effluent discharge. Insofar as possible the upstream stations should be matched to the downstream stations	Monthly (Apr-Oct)	Electroshocking, gill nets, beach seine-catch per unit effort	Species composition, abundance, seasonality, biomass

TABLE F.5-4. Cost Estimates for Environmental Monitoring at the FRP

Type of Monitoring	Annual Costs, $1,000 Baseline	Preoperational	Operational	Capital
Radiological		33	65	
Meteorological	50		50	75
Water and soil	13	13	25	
Ecological	75	75	75	

F.6 MONITORING AT THE MIXED OXIDE FUEL FABRICATION PLANT (MOX FFP)

Environmental monitoring at the MOX-FFP will generally be less than monitoring at the FRP because of the lower expected release of contaminants.

No routine liquid releases of radioactivity are expected, but a minimum amount of surface and ground water sampling is included for verification. Radionuclides considered include only uranium and TRU releases to the atmosphere.

Figure F.1-1 shows the reference site with the sampling and measurement locations used for the monitoring program design. The radiological monitoring program is given in Table F.6-1.

TABLE F.6-1. Environmental Radiological Monitoring Summary MOX Fuels Fabrication Plant

Type of Analysis	No. of Locations	Frequency
Air		
Particulate Filter		
Total Alpha	6	Biweekly
U-Total	6	Biweekly
Pu-Alpha	6	Biweekly
^{241}Am	6	Biweekly
Direct Radiation		
TLD (3 per location)	4	Monthly
Water		
Surface		
^{3}H	4	Quarterly
U	4	Quarterly
Pu	4	Quarterly
Drinking		
^{226}Ra	1	Monthly
Ground		
U-Total	3	Quarterly
Milk		
U-Total	2	Monthly
Foods		
Fresh Produce		
U-Total	9	Annually
Pu-Alpha	9	Annually
Other		
Sediment		
U-Total	1	Annually
Pu-Alpha	1	Annually
Soil and Vegetation		
^{90}Sr	6	Annually
U-Total	6	Annually
Pu-Alpha	6	Annually
^{241}Am	6	Annually

An onsite meteorological program may be required to provide a basis for monitoring the potential atmospheric release of fluoride (F). The need for air quality monitoring will similarly be controlled by the possible F release.

Water and soil monitoring requirements also will be small because of the low release of contaminants. The monitoring program is outlined in Table F.6-2. Approximately 7 x 10^3 m^3/yr of blowdown at a ΔT of 17°C will be released to surface water (R River).

The ecological monitoring program is outlined in Table F.6-3.

The approximate environmental monitoring costs for the MOX-FFP are summarized in Table F.6-4.

TABLE F.6-2. Environmental Water and Soil Monitoring - MOX-FFP

Sample Type and Monitoring Parameter	Sampling Locations	Sampling Frequency	Start	End
Surface water	2 Stations - R River			
Temperature	1 - upstream of plant water intake	Continuous	2 yrs before construction	2 yrs after plant startup unless otherwise indicated
pH				
Specific conductance	1 - downstream of plant water intake			
Chloride (Cl)				
Dissolved oxygen (DO)	Both stations should be upstream of other diversions and inflows			
Turbidity		Quarterly		
Other parameters - same as for FRP - Table F.5-2				
Groundwater	3 stations - wells			
Water level				
Other parameters - same as for FRP - Table F.5-2	1 mi upstream of plant site	Continuous	2 yrs before construction	2 yrs after plant startup unless otherwise indicated
	Plant site			
Soils (no monitoring required)	1 mi downstream of plant site	Quarterly		

TABLE F.6-3. Ecological Monitoring MOX-FFP

Sample Type	Sampling Location	Frequency	Sampling Method	Information Obtained
Vegetation	Forest / Grassland: Fenceline downwind and upwind of stack	May, Aug	Forest-wt/unit area--permanent sites, 40 litterfall collectors/site Grassland--wt/unit area - 10 random plots along grid or transect at each site All samples to be separated by species	Biomass, species distribution and abundance
		July	Aerial photography--entire site	Species distribution
Rare and Endangered Species	Within the plant boundaries	May, Aug	Literature search; ground survey of the plant site	Presence, location, relative abundance
Birds Passerine	Forest / Grassland: In 1-20 ha stand within plant boundaries	Breeding and spring migration (Apr-Jun); Fall migration (Sep-Oct); Winter (Jan)	Forest - line transect Grassland - flush-map technique	Species composition and distribution by habitat; seasonal abundance
Rare and Endangered Species	Within plant boundaries	Spring (Apr-Jun) Fall (Sep-Oct)	Random ground survey	
Waterfowl	Surface waters within plant boundaries	Spring migration (Apr-May) Nesting (May-Jun) Fall migration (Oct-May) Winter (Jan)	Shoreline counts Brood counts Aerial photography	Species distribution and abundance
Rare and Endangered Species	All surface waters within plant boundaries	(Same as above)	Shoreline survey	Presence, location and abundance
Raptors	Nesting sites within plant boundaries	Breeding season (May-Jun)	Ground survey, nest count	Abundance, nesting success
Rare and Endangered Species	Within plant boundaries	Quarterly (Jan, Apr, Jul, Oct)	Ground survey-prairie falcon, arctic peregrine falcon, southern bald eagle	Presence, location, relative abundance
Upland Game Birds	Forest / Grassland: In 20 ha or larger stand within plant boundaries	Breeding season (May, Jun)	Forest-line transect Grassland-flush-map technique	Distribution and abundance
Rare and Endangered Species	Within plant boundaries	Quarterly (Jan, Apr, Jul, Oct)	Ground survey-northern greater prairie chicken	Distribution and abundance
Big Game Mammals	Along roads within plant boundaries	Monthly-3 nights/mo	Road counts / Ground survey: white tailed deer	Seasonal and relative abundance
Small Game Mammals	Forest / Grassland: In 20 ha or larger stands within plant boundaries	Quarterly (Jan, Apr, Jul, Oct)	Line transect-red squirrel, gray squirrel, cottontail rabbit, white-tail rabbit	Species composition and distribution
Terrestrial Fur Bearers	Along roads within plant boundaries	Monthly-3 nights/mo	Road counts / Ground survey: opossum, badger, skunk, red fox, coyote, bobcat, mink, weasel	Seasonal and relative abundance

TABLE F.6-3. (contd)

Sample Type	Sampling Location	Frequency	Sampling Method	Information Obtained
Aquatic Fur Bearer	Surface waters within plant boundaries; R River in the vicinity of plant water intake	Quarterly (Jan, Apr, Jul, Oct)	Shoreline survey counts-beaver, muskrat, raccoon	Species distribution and relative abundance
Small Mammals	Forest / Grassland { In 20 ha or larger plots within plant boundaries	Quarterly (Jan, Apr, Jul, Oct) 3 consecutive days per quarter	Live traps; mark-recapture-deer mouse, jumping mouse, harvest mouse, ground squirrel, chipmunk, shrew, mole, vole, pocket gopher	Species composition and abundance, biomass, age-growth, sex ratio, general health
Zooplankton	Four stations-50 and 100 m downstream, and 50 and 100 m upstream of plant effluent discharge to R River. Upstream stations should be matched with downstream stations insofar as possible	Monthly	Vertical haul nets, tow nets-number per unit volume of water	Species composition, abundance, distribution, seasonality and biomass
	One station at the plant water intake at R River			
Benthic Invertebrates	(Same as zooplankton)	Monthly	Natural and artificial substrates-number of organisms per unit volume of water	(Same as zooplankton)
Fish Eggs and Larvae	Four stations-50 and 100 m downstream, and 50 and 100 m upstream of plant effluent discharge to R River. Insofar as possible upstream stations should be matched with downstream stations	Monthly (Apr thru Oct)	Vertical haul nets, tow nets-numbers of eggs and larvae per unit volume of water	Species composition, abundance, seasonality, biomass
	One station-plant water intake at R River	One 24-hr sample per month for the first 2 yrs of plant operation	Separation and enumeration of fish impinged on intake screens	Species composition, abundance, seasonality, biomass
Fish Juveniles and Adults	Four stations-0 to 200 m, and 1000 to 1200 m upstream and downstream of plant effluent discharge. Insofar as possible the upstream stations should be matched with the downstream stations	Monthly (Apr thru Oct)	Electroshocking, gill nets, beach seine-catch per unit effort	Species Composition abundance, seasonality, biomass

TABLE F.6-4. Cost Estimates for Environmental Monitoring at the MOX-FFP

Type of Monitoring	Annual Costs, $1,000 Baseline	Preoperational	Operational	Capital
Radiological		9	18	
Meteorological	50		50	75
Water and soil	18	18	18	
Ecological	50	50	50	

F.7 MONITORING AT THE INDEPENDENT SPENT FUEL STORAGE FACILITY (ISFSF)

The expected environmental release of pollutants from the ISFSF is expected to be very small. Expected releases and consequent doses are so small that only a minimal surveillance program is required which is primarily for verifying whether any radionuclides are released, or for the detection of unusual releases to the more significant exposure pathways. Meteorological, water and ecological monitoring efforts will also be small. No routine monitoring of water and soil will be required after the end of facility construction.

The program outlines for the ISFSF radiological, water and soil, and ecological monitoring are given in Tables F.7-1, F.7-2 and F.7-3, respectively. Cost estimates are given in Table F.7-4.

TABLE F.7-1. Environmental Radiological Monitoring Summary ISFSF

Type of Analysis	No. of Locations	Frequency
Air		
Particulate Filter		
Total Alpha	3	Biweekly
Gross Beta	6	Biweekly
Gamma Scan	6	Monthly
^{90}Sr	3	Quarterly
U-Total	3	Quarterly
Pu-Alpha	3	Quarterly
^{241}Am	3	Quarterly
Gases		
^{3}H	3	Biweekly
^{85}Kr	2	Continuous
^{129}I	3	Monthly
Direct Radiation		
TLD (3 per location)	6	Monthly
Cont. γ Monitor	2	Continuous

TABLE F.7-1. contd

Type of Analysis	No. of Locations	Frequency
Water		
Surface		
Gamma Scan	4	Monthly
^{3}H	4	Quarterly
Drinking		
^{226}Ra	1	Quarterly
Ground		
Gamma Scan	3	Quarterly
^{3}H	3	Quarterly
Milk		
^{90}Sr	2	Quarterly
^{129}I	2	Quarterly
Foods		
Fresh Produce		
Gamma Scan	9	Semiannually
^{129}I	3	Semiannually
Fish (e.g., Crappie, Bass)		
Gamma Scan	4	3/yr
Waterfowl		
Gamma Scan	10	Annually
Game Animals (e.g., Squirrel)		
Gamma Scan	10	Annually
Other		
Sediment		
Gamma Scan	2	Semiannually
Soil and Vegetation		
Gamma Scan	4 each	Annually
^{90}Sr	4 each	Annually
U-Total	4 each	Annually
Pu-Alpha	4 each	Annually
^{241}Am	4 each	Annually
^{129}I (vegetation only)	4	Annually

TABLE F.7-2. Environmental Water and Soil Monitoring--ISFSF

Sample Type and Monitoring Parameter	Sampling Locations	Sampling Frequency	Start	End
Surface water	2 locations--R River	Continuous	2 yrs prior to construction	Facility startup
Temperature	1 - upstream of facility water intake			
pH	1 - downstream of facility water intake			
Specific conductance	Both stations to be upstream of other diversions or inflows			
Chloride (Cl)				
Dissolved oxygen (DO)				
Turbidity				
Groundwater	3 stations - wells		2 yrs prior to construction	Facility startup
Water level	1 mi upstream of plant site	Continuous		
Other parameters	At the plant site	Quarterly		
	1 mi downstream of plant site			
Soils (no monitoring required)				

TABLE F.7-3. Ecological Monitoring--ISFSF

Sample Type	Sampling Location	Frequency	Sampling Method	Information Obtained
Vegetation	Forest / Grassland } at fenceline downwind and upwind of facility	May, August	Forest-litterfall collectors to measure wt/unit area Grassland - random plots along transect All samples to be separated by species	Biomass, species distribution and abundance
		July	*Aerial photography of entire site*	Species distribution
Passerine Birds	Forest / Grassland } One station each in the 4 vegetation sampling locations	Twice - Apr, June Twice - Sep, Oct	Forest - line transect Grassland - flush - map technique	Species distribution, abundance
Other Birds (raptors, waterfowl, upland game birds)	Within the facility fenceline	Incidental to vegetation and passerine bird sampling	Direct count by species	Presence, relative abundance
Small Mammals	Forest / Grassland } at vegetation sampling locations	Twice - Apr, Jun Twice - Sep, Oct	Live trapping	Species composition, abundance distribution
Benthic Invertebrates	One station in R River at facility water intake	Quarterly - Jan, Apr, Jul, Oct	Natural and artificial substrates number of organisms/unit area	Species composition, abundance, biomass
Fish Eggs and Larvae	One station in R River at facility water intake	Apr, Jul, Oct	Vertical haul nets, tow nets - numbers per unit volume of water	Species composition, abundance, biomass
Fish Larvae and Juveniles	Water intake screens at R River	One 24-hr sample per month - Apr through Oct Discontinue after one yr if losses are negligible	Separation and enumeration of fish impinged on intake screens	Species composition, abundance, seasonality, biomass

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TABLE F.7-4. Cost Estimates for Environmental Monitering at ISFSF

Type of Monitoring	Annual Costs, $1,000 Baseline	Preoperational	Operational	Capital
Radiological		20	40	
Meteorological	40		40	75
Water and soil	8	8		
Ecological	25	25	25	

F.8 MONITORING AT THE EXTENDED SPENT FUEL STORAGE FACILITY (ESFSF)

No routine environmental releases of radioactivity or non-radioactive effluents are expected from this facility. Radiological surveillance will be minimal (Table F.8-1). No onsite meteorological monitoring will be required at the ESFSF beyond that conducted at the ISFSF. The initial evaluation of the meteorological conditions at the site can be made by use of data from the nearest National Weather Service Office or by the use of general climatological dispersion models. Water and soil monitoring and ecological monitoring will be included with that of the ISFSF.

Estimated cost of the ESFSF radiological surveillance program is $6,000/year.

TABLE F.8-1. Environmental Radiological Monitoring ESFSF

Type of Analysis	No. of Locations	Frequency
Air		
Particulate Filter		
Gamma Scan	3	Monthly
Direct Radiation		
TLD (3 per location)	6	Monthly
Continuous Gamma Monitor	2	Continuous
Other		
Soil and Vegetation		
Gamma Scan	3 each	Annually
^{90}Sr	3 each	Annually
U-Total	3 each	Annually
Pu-alpha	3 each	Annually

F.9 MONITORING AT THE RETRIEVABLE WASTE STORAGE FACILITY (RWSF)

No release of radioactivity is expected that would be sufficient to give consequential off-site doses. No discharge to the environment of nonradiological effluents is expected. The radiological monitoring program is outlined in Table F.9-1. The initial evaluation of meteorological conditions at the site can be made by use of data from the nearest Weather Service Office or by use of general climatological dispersion models. The water and ecological monitoring at the RWSF is very minimal and is outlined in Tables F.9-2 and F.9-3, respectively.

TABLE F.9-1. Environmental Radiological Monitoring Summary Retrievable Waste Storage Facility

Type of Analysis	No. of Locations	Frequency
Air		
Particulate Filter		
Total Alpha	3	Biweekly
Gamma Scan	3	Monthly
Pu-Alpha Scan	3	Quarterly
Direct Radiation		
TLD (3 per location)	3	Monthly
Water		
Ground (at water table)		
Gamma Scan	3	Quarterly
Other		
Soil and Vegetation		
Gamma Scan	6 each	Annually
U-Total	6 each	Annually
^{90}Sr	6 each	Annually
Pu-Alpha	6 each	Annually
^{241}Pu	6 each	Annually

TABLE F.9-2. Environmental Water and Soil Monitoring--RWSF

Sample Type and Monitoring Parameter	Sampling Locations	Sampling Frequency	Start	End
Surface water	2 stations - R River		2 yrs prior to construction	Facility startup
Temperature	1 - upstream of the potentially impacted river reach	Continuous		
pH				
Specific conductance				
Chloride (Cl)	1 - within the potentially impacted river reach			
Dissolved oxygen (DO)				
Turbidity				
Groundwater	3 station - wells		2 yrs prior to construction	
Water level	1 mi upstream of facility site	Continuous		
Other parameters - same as for FRP - Table F.5-2	At the plant site	Quarterly		
Soils (no monitoring required)	1 mi downstream of of facility site			

TABLE F.9-3. Ecological Monitoring RWSF

Sample Type	Sampling Location	Frequency	Sampling Method	Information Obtained
Vegetation	Area within facility fenceline	July	Aerial photography of entire site	Species distribution
Passerine Birds	Grassland--one location near downwind facility fenceline	Twice-Apr, Jun Twice-Sep, Oct	Flush-map survey	Species distribution, abundance
Small Mammals	Grassland--one location near downwind facility fenceline	Twice-Apr, Jun Twice-Sep, Oct	Live trapping	Species composition, abundance
Fish Eggs and Larvae	One station-R River near facility water intake	Apr, Jul, Oct	Vertical haul nets, tow nets--numbers per unit volume of water	Species composition, abundance, biomass
Fish Larvae and Juveniles	Water intake at R River	One 24-hr sample per month-Apr thru Oct. Discontinue after one year if losses are negligible	Separation and enumeration of fish impinged on intake screen	Species composition, abundance, seasonality, biomass

Estimated monitoring costs are given in Table F.9-4.

TABLE F.9-4. Cost Estimates for Environmental Monitoring at the RWSF

	Annual Costs, $1,000		
Type of Monitoring	Baseline	Preoperational	Operational
Radiological		5	10
Meteorological			
Water and soil	8	8	0
Ecological	15	15	15

F.10 MONITORING AT THE GEOLOGIC WASTE REPOSITORY--SALT

Routine operation of the waste repository will not release any radioactivity. The only environmental contaminant of possible significance is salt that is mined and then stored at the surface at the repository. Some destruction of vegetation and animal habitat in the vicinity of the plant may result from air and water borne salt. Much of the monitoring effort will be measuring the effects of possible environmental contamination with salt.

No onsite meteorological monitoring will be required. Initial evaluation of meteorological conditions at the repository site can be made by using data from the nearest National Weather Service Office or by using general climatological dispersion models.

The radiological, water and soil, and ecological monitoring programs are presented in Tables F.10-1, F.10-2, and F.10-3, respectively. Monitoring cost estimates are given in Table F.10-4.

TABLE F.10-1. Environmental Radiological Monitoring Summary Geologic Repository

Type of Analysis	No. of Locations	Frequency
Air		
Particulate Filter		
Total Alpha	3	Biweekly
Gamma Scan	3	Monthly
Pu-Alpha Scan	3	Quarterly
Direct Radiation		
TLD (3 per location)	3	Monthly
Water		
Ground (at water table)		
Gamma Scan	3	Quarterly
Other		
Soil and Vegetation		
Gamma Scan	6 each	Annually
U-Total	6 each	Annually
^{90}Sr	6 each	Annually
Pu-Alpha	6 each	Annually
^{241}Pu	6 each	Annually

TABLE F.10-2. Environmental Water and Soils Monitoring--Geologic Repository--Salt

Sample Type and Monitoring Parameter	Sampling Locations	Sampling Frequency	Start	End
Surface water	2 stations each on each potentially affected stream	Continuous	2 yr prior to construction	Indefinitely during salt mining and waste storage
Temperature				
pH	Upstream of potential impact			
Specific conductance	Within the potentially impacted zone			
Chloride (Cl)				
Dissolved oxygen (DO)				
Turbidity				
Other parameters - same as for FRP - Table F.5-2		Quarterly		
Groundwater	10 stations - wells	Continuous		
Water level	1 at repository site			
Other parameters - same as for FRP - Table F.5-2	9 distributed over potentially affected area	Quarterly		
Soil - saturation extracts	10 stations	Annually prior to growing season	2 yr prior to construction	After backfilling and sealing of repository unless otherwise indicated
Parameters the same as for FRP - Table F.5-2	9 stations distributed over the potentially affected area			
	1 station upwind and sufficiently removed to serve as a control			
	Soil samples to be collected at 3 points at each station - at the surface, 10 to 25 cm and 25 to 50 cm depth. At each station the 3 samples from each depth to be combined into a single sample. All samples shall be taken from undisturbed soil.			

TABLE F.10-3. Ecological Monitoring at Geologic Repository

Sample Type	Sampling Location	Frequency	Sampling Method	Information Obtained
Vegetation	Forest, Grassland, Forb-grass: 4 stations in each habitat--located downwind of the facility at 0.4 km, fenceline, 2 km and 3 km distance	May, Aug	Forest--40 litterfall collectors/site Grassland, Forb-grass: 10 random plots/site along a grid or transect All samples to be separated by species	Biomass, species distribution and abundance
		July	Aerial photography-entire site	Species distribution
Rare and Endangered Species	Within plant boundaries	May, Aug	Ground survey; literature search	Presence, location, relative abundance
Birds Passerine	Forest, Grassland: In 20 ha or larger stands at 0.4 km and 2 km downwind from facility stack	Breeding season, Spring migration (Apr-Jun) Fall migration (Sep-Oct) Winter (Jan)	Forest--line transect Grassland--flush-map technique	Species composition, distribution, seasonal abundance
Rare and Endangered Species	Entire site and up to 10 km radius of facility	Spring (Apr-Jun) Fall (Sep, Oct)	Random ground survey	Presence, location, relative abundance
Waterfowl	Surface waters within plant boundaries	Breeding season, Spring migration (Apr-Jun) Fall migration (Oct-Nov) Winter (Jan)	Surface counts Brood counts Aerial photography	Species composition, distribution abundance
Rare and Endangered Species	Surface waters within plant boundaries	Quarterly (Jan, Apr, Jul, Oct)	Shoreline survey	Presence, location, relative abundance
Raptors	Nesting sites within facility boundaries	Breeding season (May-Jun)	Ground survey, nest count	Abundance, reproductive success
Rare and Endangered Species	Within facility boundaries	Quarterly (Jan, Apr, Jul, Oct)	Ground survey--prairie falcon, arctic perigrine falcon, southern bald eagle	Presence, location, relative abundance, nesting success

TABLE F.10-3. (contd)

Sample Type	Sampling Location	Frequency	Sampling Method	Information Obtained
Upland Game Birds	Forest / Grassland } In 20 ha or larger stands at 0.4 km and 2 km, downstream from facility stack	Breeding season (May-Jun)	Forest--line transect Grassland--flush-map technique ruffed grouse Calling males	Distribution and abundance
Rare and Endangered Species	Within facility boundaries	Quarterly (Jan, Apr, Jul, Oct)	Ground survey--northern greater prairie chicken	Distribution and abundance
Mammals				
Big Game Mammals	Along roads within facility boundaries	Monthly--3 nights/mo	Road counts--white tailed deer	Seasonal and relative abundance
Small Game Mammals	Forest / Grassland } In 20 ha or longer stands at 0.4 km and 2 km downstream from facility stack	Quarterly (Jan, Apr, Jul, Oct)	Line transect--red squirrel, gray squirrel, cottontail rabbit, white-tail rabbit	Distribution and relative abundance
Terrestrial Fur Bearers	Along roads within facility boundaries	Monthly--3 nights/mo	Road counts--oppossum, badger, skunk, red fox, coyote, bobcat, mink, weasel	Distribution and relative abundance
Aquatic Fur Bearers	Surface waters within facility boundaries	Quarterly (Jan, Apr, Jul, Oct)	Shoreline counts--beaver, muskrat, raccoon	Distribution and relative abundance
Small Mammal	Forest / Grassland } In 20 ha or larger stands at 0.4 km and 2 km downwind from facility stack	Quarterly--3 consecutive days/quarter	Live traps, mark--recapture--deer mouse, jumping mouse, harvest mouse, ground squirrel, chipmunk, shrew, mole, vole, pocket gopher	Distribution, abundance, biomass, age-growth, sex ratio, general health
Benthic Invertebrates	Two stations--one in R River immediately downstream and one upstream of the point of facility surface water runoff discharge. Upstream or control station should be matched to downstream station	Monthly (Apr thru Oct)	Natural and artificial substrates--numbers of organisms per unit volume of water	Species composition, abundance, biomass

TABLE F.10-4. Cost Estimates for Environmental Monitoring at the Geologic Repository--Salt

Type of Monitoring	Annual Costs, $1,000 Baseline	Preoperational	Operational
Radiological	5	10	10
Meteorological			
Water and Soil	25	25	25
Ecological	50	50	50

REFERENCES FOR APPENDIX F

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APPENDIX G

DETAILED DOSE RESULTS FOR RADIONUCLIDE MIGRATION IN GROUNDWATER FROM A WASTE REPOSITORY

APPENDIX G

DETAILED DOSE RESULTS FOR RADIONUCLIDE MIGRATION IN GROUNDWATER FROM A WASTE REPOSITORY

Radionuclide migration in flowing groundwater from a failed repository was modeled using the latest version of a computerized model called GETOUT. The program for this model that was developed at Pacific Northwest Laboratory, Richland, Washington has not been published; however, the theory used in its formulation has been published.(1) The GETOUT results were then used as input data to the same biosphere model that was used to generate the dose commitments for BNWL-1927,(2) except that the river flow rate was adjusted to be consistent with the R River in the Reference Environment (Appendix A).

Radionuclide source terms were developed from repository inventories given in DOE/ET-0028, Section 3. The results for twelve parametric cases are summarized in Tables G.1 through G.12, where each repository is assumed to contain 75,800 MTHM of spent fuel regardless of geologic media. Within reason, the results presented may be adjusted for other repository waste capacities by ratio of capacity of interest to 75,800 MTHM.

TABLE G.1. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 1 yr; Leach rate: 0.1%/yr; Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	Remarks
1.1E2	^{99}Tc, ^{129}I	3.2E-3	6.1E-2	6.7E0	3.4E-0	1.4E-1	2.1E-1	2.0E-3	4.2E-3	GI-LLI: 100% ^{99}Tc, Thyroid: 100% ^{129}I
2.2E2	^{14}C	0.0E0	9.3E-1	5.9E-1	1.1E0	4.6E0	9.3E-1	9.3E-1	9.3E-1	Bone: 98% ^{14}C
1.0E4	^{79}Se, ^{237}Np	6.6E-2	2.7E-1	4.8E-1	6.0E-2	2.6E0	8.0E0	6.0E-1	6.1E-2	Bone: 94% ^{237}Np, Liver: 65% ^{79}Se
1.1E5	^{107}Pd, ^{126}Sn	1.3E-1	1.4E-1	4.0E-1	1.3E-1	7.8E-1	1.5E-1	1.2E-1	1.2E-1	Bone: 100% ^{126}Sn
1.4E6	^{238}U	6.5E-2	9.1E1	2.1E0	5.8E-2	1.9E-2	2.4E1	5.8E-2	1.1E-1	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po
5.0E6	^{232}Th	2.2E-1	2.9E-1	3.6E-1	1.8E-1	3.5E0	3.6E-1	1.8E-1	1.8E-1	Bone: 99% ^{230}Th+D

TABLE G.2. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 1 yr; Leach rate: 0.01%; Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	Remarks
1.1E2	^{99}Tc, ^{129}I	3.2E-4	6.1E-3	6.7E-1	3.4E-1	1.4E-2	2.1E-2	2.0E-4	4.2E-4	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
1.0E3	^{14}C	3.2E-4	1.3E-1	7.5E-1	4.7E-1	6.4E-1	1.5E-1	1.3E-1	1.3E-1	GI-LLI: 90% ^{99}Tc Bone: 98% ^{14}C
3.4E4	^{59}Ni	1.5E-2	4.2E-2	8.3E-2	1.3E-2	5.9E-1	7.3E-2	1.3E-2	1.4E-2	Bone: 95% ^{237}Np
1.4E6	^{238}U	5.9E-2	8.4E1	1.9E0	5.3E-2	1.8E2	2.2E1	5.3E-2	9.7E-2	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po

TABLE G.3. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 100 yr; Leach rate: 0.1%/yr; Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem								Remarks
		Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	
1.1E3	^{99}Tc, ^{129}I	3.2E-3	6.2E-2	6.8E0	3.4E0	1.4E-1	2.1E-1	1.9E-3	4.1E-3	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
2.0E3	^{14}C	2.7E-3	1.2E0	6.3E0	4.0E0	5.8E0	1.3E0	1.2E0	1.2E0	Bone: 98% ^{14}C GI-LLI: 89% ^{99}Tc Thyroid: 71% ^{129}I
1.1E4	^{79}Se, ^{237}Np	2.1E-1	6.2E-1	1.3E0	1.9E-1	8.1E0	1.4E0	1.9E-1	1.9E-1	Bone: 100% ^{237}Np GI-LLI: 86% ^{237}Np Liver: 65% ^{237}Np, 35% ^{79}Se
3.5E4	^{59}Ni	4.4E-3	5.6E-2	4.4E-3	4.0E-3	4.3E-1	1.1E-1	4.0E-3	4.1E-3	Bone: 61% ^{59}Ni, 39% ^{237}Np
1.4E6	^{238}U	6.7E-2	9.0E1	3.8E0	6.0E-2	1.9E2	2.4E1	6.0E-2	1.1E-1	Bone: 88% ^{226}Ra+D Body: 98% ^{226}Ra+D Liver: 81% ^{210}Po

TABLE G.4. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 1000 yr; Leach rate: 0.01%; Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem								Remarks
		Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	
1.1E3	^{99}Tc, ^{129}I	3.2E-4	6.2E-3	6.8E-1	3.4E-1	1.4E-2	2.1E-2	1.9E-4	4.1E-4	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
2.0E3	^{14}C	3.2E-4	1.2E-1	7.5E-1	4.6E-1	5.8E-1	1.4E-1	1.2E-1	1.2E-1	Bone: 98% ^{14}C GI-LLI: 91% ^{99}Tc Tnyroid: 75% ^{129}I
1.1E4	^{69}Se, ^{237}Np	1.8E-2	9.5E-2	4.6E-1	2.2E-1	8.9E-1	1.8E-1	5.5E-2	5.5E-2	Bone: 78% ^{237}Np GI-LLI: 71% ^{99}Tc, 20% ^{237}Np
1.4E6	^{238}U	5.9E-2	8.4E1	1.9E0	5.3E-2	1.8E2	2.2E1	5.3E-2	9.6E-2	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po

TABLE G.5. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 100,000 yr; Leach rate: 0.1%/yr; Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem								Remarks
		Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	
1.0E5	^{99}Tc, ^{129}I	1.6E-3	2.3E-2	2.5E0	1.6E0	5.1E-2	7.7E-2	9.1E-4	2.0E-3	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
1.1E5	^{79}Se, ^{237}Np	2.1E-1	5.2E-1	1.1E0	1.9E-1	7.9E0	9.0E-1	1.9E-1	1.9E-1	Bone: 100% ^{237}Np GI-LLI: 94% ^{237}Np
2.1E5	^{107}Pd, ^{126}Sn	1.3E-1	1.4E-1	3.0E-1	1.2E-1	7.5E-1	1.3E-1	1.2E-1	1.2E-1	Bone: 100% ^{126}Sn
1.5E6	^{238}U	6.4E-2	8.9E1	2.1E0	5.7E-2	1.9E2	2.3E1	5.7E-2	1.1E-1	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po

TABLE G.6. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 100,000 yr; Leach rate: 0.01%; Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	Remarks
1.0E5	^{99}Tc, ^{129}I	3.3E-4	4.6E-3	4.9E-1	3.4E-1	1.1E-2	1.5E-2	1.9E-4	4.2E-4	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
1.1E5	^{79}Se, ^{237}Np	2.1E-2	5.2E-2	1.1E-1	1.9E-2	7.9E-1	9.0E-2	1.9E-2	1.9E-2	Bone: 100% ^{237}Np
1.5E6	^{238}U	5.8E-2	8.2E1	1.9E0	5.2E-2	1.7E2	2.1E1	5.2E-2	8.9E-2	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po

TABLE G.7. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 1,000,000 yr; Leach rate: 0.1%/yr; Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	Remarks
1.0E6	^{99}Tc, ^{129}I	1.6E-3	2.3E-3	1.3E-1	1.6E0	2.7E-3	1.3E-3	9.1E-4	2.0E-3	Thyroid: 100% ^{129}I
1.01E6	^{69}Se, ^{237}Np	7.8E-2	2.0E-1	4.0E-1	7.1E-2	3.0E0	3.4E-1	7.1E-2	7.1E-2	Bone: 100% ^{237}Np
2.4E6	^{238}U	6.0E-3	8.4E1	1.9E0	5.4E-2	1.8E2	2.2E1	5.4E-2	1.0E-1	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po

TABLE G.8. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 1,000,000 yr; Leach rate: 0.01%; Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	Remarks
1.0E6	^{99}Tc, ^{129}I	3.1E-4	6.8E-4	2.6E-2	3.3E-1	8.1E-4	1.0E-3	1.8E-4	4.0E-4	GI-LLI: 99% ^{99}Tc Thyroid: 100% ^{129}I
1.01E6	^{79}Se, ^{237}Np	1.6E-2	4.0E-2	9.7E-2	1.8E-1	6.0E-1	6.8E-2	1.4E-2	1.4E-2	Bone: 100% ^{237}Np
2.4E6	^{238}U	5.7E-2	8.1E-1	1.9E0	5.1E-2	1.7E2	2.1E1	5.1E-2	9.8E-2	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po

TABLE G.9. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 1 yr; Leach rate: 100%/yr (pulse release); Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	Remarks
1.0E2	^{3}H, ^{99}Tc, ^{129}I	2.9E0	5.5E1	6.0E3	3.0E3	1.3E2	1.9E2	1.8E0	3.8E0	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
1.0E3	^{14}C	1.5E-5	1.2E2	7.1E1	1.2E2	5.7E2	1.2E2	1.2E2	1.2E2	All: 100% ^{14}C
1.0E4	^{79}Se, ^{237}Np	7.0E-1	2.5E0	4.7E0	6.4E-1	2.7E1	7.5E0	6.4E-1	6.4E-1	Bone: 100% ^{237}Np Liver: 60% ^{79}Se
3.3E4	^{59}Ni	1.0E-1	3.8E-1	6.0E-1	9.2E-2	4.6E0	6.8E-1	9.2E-2	9.2E-2	Bone: 84% ^{237}Np, 16% ^{59}Ni
1.1E5	^{126}Sn	2.2E-1	2.3E-1	6.6E-1	2.1E-1	1.3E0	2.4E-1	2.0E-1	2.0E-1	Bone: 100% ^{126}Sn
1.4E6	^{238}U	6.1E-2	8.6E1	2.0E0	5.4E-2	1.8E-2	2.2E1	5.4E-2	1.1E1	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 98% ^{210}Po

TABLE G.10. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 1,000 yr; Leach rate: 100%/yr (pulse release); Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem								Remarks
		Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	
1.1E3	^{99}Tc, ^{129}I	2.9E0	5.5E1	6.0E3	3.0E3	1.3E2	1.9E2	1.7E0	3.6E0	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
2.0E3	^{14}C	1.3E-5	9.9E1	6.0E1	9.9E1	4.8E2	9.9E2	9.9E1	9.9E1	All: 100% ^{14}C
1.1E4	^{79}Se, ^{237}Np	1.6E0	4.9E0	9.8E0	1.5E0	6.2E1	1.2E1	1.5E0	1.5E0	Bone: 100% ^{237}Np Liver: 61% ^{237}Np, 39% ^{79}Se
3.4E4	^{59}Ni	1.8E-2	1.7E-1	1.5E-1	1.7E-2	1.4E0	3.3E-1	1.7E-2	1.7E-2	Bone: 51% ^{59}Ni, 49% ^{237}Np
1.1E5	^{126}Sn	2.2E-1	2.3E-1	6.6E-1	2.1E-1	1.3E0	2.4E-1	2.0E-1	2.0E-1	Bone: 100% ^{126}Sn
1.4E6	^{238}U	6.1E-2	8.6E1	2.0E0	5.4E-2	1.8E2	2.2E1	5.4E-2	1.1E-1	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po

TABLE G.11. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 100,000 yr; Leach rate: 100%/yr (pulse release); Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem								Remarks
		Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	
1.05E5	^{99}Tc, ^{129}I	2.9E0	4.1E1	4.3E3	3.0E3	9.2E1	1.4E2	1.7E0	3.6E0	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
1.1E5	^{69}Se, ^{237}Np	0.0E0	4.9E0	1.0E1	1.7E0	7.0E1	9.5E0	1.7E0	1.7E0	Bone: 100% ^{237}Np Liver: 84% ^{237}Np, 16% ^{79}Se
1.5E6	^{238}U	6.0E-2	8.4E1	2.0E0	5.3E-2	1.8E2	2.2E1	5.3E-2	1.1E-1	Bone: 88% ^{237}Ra+D Body: 97% ^{237}Ra+D Liver: 83% ^{210}Po

TABLE G.12. Summary of 50-Year Accumulated Dose to Maximum Individual. Time of initial release after Yr-2050: 100,000 yr; Leach rate: 100%/yr (pulse release); Groundwater travel time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem								Remarks
		Skin	Body	GI-LLI	Thyroid	Bone	Liver	Lung	Kidney	
1.0E6	^{99}Tc, ^{129}I	2.7E0	5.9E0	2.2E2	2.9E3	7.1E0	9.1E0	1.6E0	3.5E0	GI-LLI: 100% ^{99}Tc Thyroid: 100% ^{129}I
1.01E6	^{237}Np	1.4E0	3.5E0	7.5E0	1.3E0	5.3E1	5.9E0	1.3E0	1.3E0	Bone: 100% ^{237}Np
2.4E6	^{238}U	5.6E-2	7.9E1	1.8E0	5.0E-2	1.7E2	2.1E1	5.0E-2	1.0E-1	Bone: 88% ^{226}Ra+D Body: 97% ^{226}Ra+D Liver: 83% ^{210}Po

All of the runs were made with a groundwater flow path length of 10 km (6.2 miles) and a groundwater velocity of 100 m/year (0.9 ft/day). Groundwater travel time from the repository to the surface water (biosphere) was 100 years.

The only parameters that were varied were the time elapsed between repository closure and repository failure/leach incident initiation, and the nuclide release rate (leach rate). The values of each of these parameters is listed with each data table.

As shown in Tables G.1 through G.12, the predicted potential dose commitment to a maximum individual from the failure of any one of the five repositories is generally dominated by a ^{226}Ra bone dose of from 100 to 200 rem (cumulative) over a 50-yr period (following an initial 50-yr period of food chain concentration in the biosphere).

The source of the dose-significant ^{226}Ra is mainly the ^{238}U (90%) and ^{234}U (10%) in the spent fuel. The maximum ^{226}Ra dose occurs during the peak release of uranium isotopes to the surface water (at 1.4 million yr after leach incident initiation). Because the source of the radium is from complex decay chains, the resultant dose would probably be significantly reduced only by delaying the leach incident by an amount of time greatly exceeding the half-life of the slowest-decaying member of the chain (^{238}U half-life = 4.47×10^9 yr) or by providing a waste form with a "leach duration" exceeding the migration time of the slowest-moving member of the chain (in this particular case, ^{238}U at about 1.4×10^6 yr).

Dose calculations were also made for breach of a repository containing fuel reprocessing wastes. The calculations were made simply by ratio between the MTHM of spent fuel in a spent fuel repository and the MTHM equivalent of fuel reprocessing high-level waste. The major differences were:

- There is a slight increase in the dose potential from the ^{129}I, ^{237}Np and ^{126}Sn isotopes due to a higher inventory of these nuclides in the recycle case (and assuming that ^{129}I is in a form that is equivalent to being fixed in the SHLW).
- There is a significant reduction in the ^{226}Ra dose potential at the uranium release peak because of a small inventory of parent ^{234}U and grandparent ^{238}U.

Doses to the maximum individual are presented in Tables G.13 through G.28 for various times of release and leach rates for a model 50,000 MTHM-equivalent waste repository.

The extent of this analysis is very limited. It includes only one migration path length (10 km), while reasonable path lengths could vary from several hundred meters to perhaps a few hundred kilometers. The analysis looks at only one groundwater velocity, 100 m/year, while actual groundwater velocities can vary from zero to over 10,000 m/year. Sorption equilibrium constants (K_d) measured and estimated for one particular Hanford Reservation subsoil, under one set of conditions, at one temperature were used, while K_d can vary over several orders of magnitude for a single element. Even though a very reasonable scenario was modelled, the most likely range of variables has not been covered.

TABLE G.13. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1 yr
Leach Rate: 0.1%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.1E2	^{99}Tc, ^{129}I	4.1E-2
2.2E2	^{14}C	3.0E-1
1.0E4	^{79}Se, ^{237}Np	2.3E-1
1.1E5	^{107}Pd, ^{126}Sn	1.0E-1
1.4E6	^{238}U	5.3E-1
5.0E6	^{232}Th	1.7E-3

TABLE G.14. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1,000 yr
Leach Rate: 0.1%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.1E2	^{99}Tc, ^{129}I	4.1E-3
1.0E3	^{14}C	3.1E-2
3.4E4	^{59}Ni	4.3E-2
1.4E6	^{238}U	4.9E-1

TABLE G.15. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1 yr
Leach Rate: 0.01%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.1E3	^{99}Tc, ^{129}I	4.1E-2
2.0E3	^{14}C	2.8E-1
1.1E4	^{79}Se, ^{237}Np	3.5E-1
3.5E4	^{59}Ni	3.5E-2
1.4E6	^{238}U	7.2E-1

TABLE G.16. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1,000 yr
Leach Rate: 0.01%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.1E3	^{99}Tc, ^{129}I	4.1E-3
2.0E3	^{14}C	2.9E-2
1.1E4	^{79}Se, ^{237}Np	4.0E-2
1.4E6	^{238}U	6.6E-1

TABLE G.17. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 100,000 yr
Leach Rate: 0.1%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.0E5	^{99}Tc, ^{129}I	1.5E-2
1.1E5	^{79}Se, ^{237}Np	2.7E-1
2.1E5	^{107}Pd, ^{126}Sn	1.0E-1
1.5E6	^{238}U	7.2E-1

TABLE G.18. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 100,000 yr
Leach Rate: 0.1%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.0E5	^{99}Tc, ^{129}I	3.0E-3
1.1E5	^{79}Se, ^{237}Np	2.7E-2
1.5E6	^{238}U	6.5E-1

TABLE G.19. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1,000,000 yr
Leach Rate: 0.1%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.0E6	^{99}Tc, ^{129}I	1.6E-3
1.01E6	^{79}Se, ^{237}Np	1.0E-1
2.4E6	^{238}U	5.1E-1

TABLE G.20. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1,000,000 yr
Leach Rate: 0.1%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.0E6	^{99}Tc, ^{129}I	4.4E-4
1.01E6	^{79}Se, ^{237}Np	2.0E-2
2.4E6	^{238}U	4.9E-1

TABLE G.21. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1 yr
Leach Rate: 100%/yr (Pulse Release)
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.0E2	^{3}H, ^{99}Tc, ^{129}I	3.6E1
1.0E3	^{14}C	2.5E1
1.0E4	^{79}Se, ^{237}Np	2.4E0
3.3E4	^{59}Ni	3.5E-1
1.1E5	^{126}Sn	1.8E-1
1.4E6	^{238}U	5.1E-1

TABLE G.22. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1,000 yr
Leach Rate: 100%/yr (Pulse Release)
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.1E3	^{99}Tc, ^{129}I	3.6E1
2.0E3	^{14}C	2.0E1
1.1E4	^{79}Se, ^{237}Np	2.8E0
3.4E4	^{59}Ni	9.2E-2
1.1E5	^{126}Sn	1.8E-1
1.4E6	^{238}U	6.5E-1

TABLE G.23. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 100,000 yr
Leach Rate: 100%/yr (Pulse Release)
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.05E5	^{99}Tc, ^{129}I	2.6E1
1.1E5	^{79}Se, ^{237}Np	2.6E0
1.5E6	^{238}U	6.5E-1

TABLE G.24. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1,000,000 yr
Leach Rate: 100%/yr (Pulse Release)
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.0E6	^{99}Tc, ^{129}I	4.1E0
1.01E6	^{237}Np	1.8E0
2.4E6	^{238}U	4.8E-1

TABLE G.25. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 100,000 yr
Leach Rate: 100%/yr (Pulse Release)
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.05E5	^{99}Tc, ^{129}I	2.6E1
1.1E5	^{79}Se, ^{237}Np	2.6E0
1.5E6	^{238}U	6.5E-1

TABLE G.26. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1,000 yr
Leach Rate: 100%/yr (Pulse Release)
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.1E3	^{99}Tc, ^{129}I	3.6E1
2.0E3	^{14}C	2.0E1
1.1E4	^{79}Se, ^{237}Np	2.8E0
3.4E4	^{59}Ni	9.2E-2
1.1E5	^{126}Sn	1.8E-1
1.4E6	^{238}U	6.5E-1

TABLE G.27. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1 yr
Leach Rate: 100%/yr (Pulse Release)
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.0E2	^{3}H, ^{99}Tc, ^{129}I	3.6E1
1.0E3	^{14}C	2.5E1
1.0E4	^{79}Se, ^{237}Np	2.4E0
3.3E4	^{59}Ni	3.5E-1
1.1E5	^{126}Sn	1.8E-1
1.4E6	^{238}U	5.1E-1

TABLE G.28. Summary of 50-Year Accumulated Dose to Maximum Individual for Reprocessing Waste Repository (50,000 MTHM Equivalent)
Time of Initial Release After Yr-2050: 1,000,000 yr
Leach Rate: 0.01%/yr
Groundwater Travel Time: 100 yr

Years Since Burial	Peak Nuclides	Dose, rem Total Body
1.0E6	^{99}Tc, ^{129}I	4.4E-4
1.01E6	^{79}Se, ^{237}Np	2.0E-2
2.4E6	^{238}U	4.9E-1

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APPENDIX H

ANNUAL AVERAGE DISPERSION FACTORS FOR SELECTED RELEASE POINTS

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ANNUAL AVERAGE DISPERSION FACTORS FOR SELECTED RELEASE POINTS

Annual average atmospheric dispersion factors ($\overline{\chi}/Q'$) for several waste management facilities were calculated and are presented in Tables H.1 through H.5. The values are used in calculations of dose to the regional population described in Appendix A for the specified waste management facilities.

TABLE H.1. Annual Average Atmospheric Dispersion Factors ($\overline{\chi}/Q'$) for FRP Plant Stack Releases to Air Adjusted for Depletion by Dry Deposition

Release Height = 110 meters

Distance from Source, Kilometers:

Direction Sector	1.6	3.2	4.8	6.4	8.0	16.0	32.0	48.0	64.0	80.0
S	9.5E-09	1.2E-08	1.1E-08	9.8E-09	8.6E-09	4.7E-09	2.3E-09	1.4E-09	1.0E-09	7.7E-10
SSW	5.1E-09	7.5E-09	7.5E-09	6.8E-09	6.0E-09	3.5E-09	1.7E-09	1.1E-09	7.6E-10	5.8E-10
SW	6.8E-09	1.1E-08	1.1E-08	9.5E-09	8.3E-09	4.7E-09	2.3E-09	1.4E-09	9.9E-10	7.6E-10
WSW	3.7E-09	7.6E-09	8.1E-09	7.5E-09	6.8E-09	4.0E-09	2.0E-09	1.3E-09	9.1E-10	7.0E-10
W	4.1E-09	9.0E-09	9.5E-09	8.7E-09	7.7E-09	4.4E-09	2.2E-09	1.4E-09	9.8E-10	7.6E-10
WNW	4.6E-09	8.1E-09	8.1E-09	7.3E-09	6.3E-09	3.5E-09	1.6E-09	1.0E-09	7.0E-10	5.3E-10
NW	7.6E-09	1.2E-08	1.2E-08	1.1E-08	9.3E-09	5.3E-09	2.5E-09	1.6E-09	1.1E-09	8.6E-10
NNW	7.5E-09	1.1E-08	1.1E-08	1.0E-08	9.1E-09	5.3E-09	2.6E-09	1.7E-09	1.2E-09	9.4E-10
N	1.7E-08	1.9E-08	1.8E-08	1.6E-09	1.4E-08	7.5E-09	3.6E-09	2.3E-09	1.6E-09	1.2E-09
NNE	8.7E-09	1.0E-08	1.0E-08	9.5E-09	8.5E-09	5.1E-09	2.5E-09	1.6E-09	1.2E-09	9.1E-10
NE	1.0E-08	1.1E-08	1.1E-08	9.9E-09	8.8E-09	5.2E-09	2.6E-09	1.7E-09	1.2E-09	9.3E-10
ENE	6.9E-09	8.7E-09	9.0E-09	8.3E-09	7.5E-09	4.4E-09	2.2E-09	1.4E-09	1.0E-09	7.6E-10
E	1.1E-08	1.7E-08	1.7E-08	1.6E-08	1.4E-08	7.4E-09	3.4E-09	2.1E-09	1.4E-09	1.1E-09
ESE	1.6E-08	2.0E-08	1.9E-08	1.6E-08	1.4E-08	7.4E-09	3.4E-09	2.1E-09	1.5E-09	1.1E-09
SE	1.9E-08	2.7E-08	2.5E-08	2.1E-08	1.8E-08	9.2E-09	4.1E-09	2.5E-09	1.7E-09	1.3E-09
SSE	1.1E-08	1.5E-08	1.3E-08	1.2E-08	9.9E-09	5.2E-09	2.4E-09	1.4E-09	1.0E-09	7.5E-10

Units: sec/m^3

TABLE H.2. Annual Average Atmospheric Dispersion Factors ($\overline{\chi}/Q'$) for FRP Plant Stack Releases to Air Adjusted for Depletion by Dry Deposition

Release Height = Ground Level

Distance from Source, Kilometers:

Direction Sector	1.6	3.2	4.8	6.4	8.0	16.0	32.0	48.0	64.0	80.0
S	6.2E-07	2.1E-07	1.1E-07	7.2E-08	5.1E-08	1.8E-08	6.1E-09	3.2E-09	2.0E-09	1.4E-09
SSW	4.5E-07	1.5E-07	8.1E-08	5.2E-08	3.7E-08	1.3E-08	4.3E-09	2.3E-09	1.4E-09	1.0E-09
SW	3.9E-07	1.3E-07	7.0E-08	4.5E-08	3.2E-08	1.1E-08	3.6E-09	1.9E-09	1.2E-09	8.3E-10
WSW	5.1E-07	1.7E-07	9.2E-08	5.9E-08	4.2E-08	1.5E-08	5.0E-09	2.6E-09	1.7E-09	1.2E-09
W	7.0E-07	2.4E-07	1.3E-07	8.5E-08	6.0E-08	2.1E-08	7.4E-09	4.0E-09	2.5E-09	1.8E-09
WNW	5.8E-07	2.0E-07	1.1E-07	7.0E-08	5.0E-08	1.8E-08	6.1E-09	3.2E-09	2.1E-09	1.4E-09
NW	8.1E-07	2.8E-07	1.5E-07	1.0E-07	7.1E-08	2.5E-08	8.8E-09	4.7E-09	3.0E-09	2.1E-09
NNW	9.4E-07	3.4E-07	1.9E-07	1.2E-07	8.9E-08	3.2E-08	1.2E-08	6.3E-09	4.0E-09	2.8E-09
N	1.1E-06	4.1E-07	2.2E-07	1.5E-07	1.1E-07	3.8E-08	1.4E-08	7.4E-09	4.8E-09	3.3E-09
NNE	5.9E-07	2.1E-07	1.1E-07	7.5E-08	5.3E-08	1.9E-08	6.8E-09	3.7E-09	2.3E-09	1.6E-09
NE	7.2E-07	2.6E-07	1.4E-07	9.3E-08	6.7E-08	2.4E-08	8.7E-09	4.7E-09	3.0E-09	2.1E-09
ENE	8.4E-07	3.0E-07	1.7E-07	1.1E-07	8.0E-08	2.9E-08	1.2E-08	5.8E-09	3.7E-09	2.6E-09
E	1.0E-06	3.4E-07	1.9E-07	1.2E-07	8.8E-08	3.2E-08	1.1E-08	6.0E-09	3.9E-09	2.7E-09
ESE	7.0E-07	2.4E-07	1.3E-07	8.6E-08	6.1E-08	2.2E-08	7.5E-09	4.0E-09	2.6E-09	1.8E-09
SE	1.0E-06	3.5E-07	1.9E-07	1.2E-07	8.8E-08	3.1E-08	1.1E-08	5.7E-09	3.6E-09	2.5E-09
SSE	7.6E-07	2.6E-07	1.4E-07	9.2E-08	6.6E-08	2.3E-08	8.1E-09	4.3E-09	2.7E-09	1.9E-09

Units: sec/m^3

TABLE H.3. Annual Average Atmospheric Dispersion Factors ($\overline{\chi}/Q'$) for Repository to Air Adjusted for Depletion by Dry Deposition

Release Height = 122 meters

Distance from Source, Kilometers:

Direction Sector	1.6	3.2	4.8	6.4	8.0	16.0	32.0	48.0	64.0	80.0
S	4.2E-09	4.7E-09	5.0E-09	4.9E-09	4.6E-09	3.0E-09	1.6E-09	1.0E-09	7.5E-10	5.8E-10
SSW	1.9E-09	2.8E-09	3.2E-09	3.2E-09	3.1E-09	2.1E-09	1.2E-09	7.7E-10	5.6E-10	4.3E-10
SW	2.6E-09	3.8E-09	4.5E-09	4.5E-09	4.3E-09	2.9E-09	1.6E-09	1.0E-09	7.4E-10	5.7E-10
WSW	1.2E-09	2.3E-09	3.1E-09	3.3E-09	3.2E-09	2.3E-09	1.3E-09	8.7E-10	6.4E-10	5.0E-10
W	1.2E-09	2.8E-09	3.8E-09	4.1E-09	4.0E-09	2.7E-09	1.5E-09	9.7E-10	7.1E-10	5.5E-10
WNW	1.6E-09	2.9E-09	3.6E-09	3.6E-09	3.4E-09	2.2E-09	1.2E-09	7.4E-10	5.3E-10	4.1E-10
NW	3.3E-09	4.3E-09	5.1E-09	5.2E-09	4.9E-09	3.3E-09	1.8E-09	1.2E-09	8.5E-10	6.5E-10
NNW	3.7E-09	4.1E-09	4.8E-09	5.0E-09	4.8E-09	3.3E-09	1.8E-09	1.2E-09	8.9E-10	7.0E-10
N	9.0E-09	8.3E-09	8.4E-09	8.1E-09	7.6E-09	5.0E-09	2.6E-09	1.7E-09	1.2E-09	9.5E-10
NNE	4.3E-09	4.3E-09	4.6E-09	4.6E-09	4.4E-09	3.1E-09	1.7E-09	1.2E-09	8.6E-10	6.7E-10
NE	4.8E-09	4.7E-09	4.7E-09	4.6E-09	4.4E-09	3.1E-09	1.8E-09	1.2E-09	8.7E-10	6.8E-10
ENE	3.3E-09	3.2E-09	3.5E-09	3.6E-09	3.5E-09	2.6E-09	1.5E-09	9.8E-10	7.2E-10	5.6E-10
E	4.2E-09	5.8E-09	7.0E-09	7.2E-09	7.0E-09	4.7E-09	2.5E-09	1.6E-09	1.1E-09	8.5E-10
ESE	7.3E-09	8.3E-09	8.8E-09	8.5E-09	7.9E-09	4.9E-09	2.5E-09	1.6E-09	1.1E-09	8.6E-10
SE	7.8E-09	1.0E-08	1.2E-08	1.1E-08	1.0E-08	6.3E-09	3.0E-09	1.9E-09	1.3E-09	1.0E-09
SSE	4.8E-09	6.1E-09	6.4E-09	6.1E-09	5.6E-09	3.4E-09	1.7E-09	1.1E-09	7.7E-10	5.9E-10

Units: sec/m^3

TABLE H.4. Annual Average Atmospheric Dispersion Factors ($\overline{\chi}/Q'$) for FRP Storage Basin Stack Releases to Air Adjusted for Depletion by Dry Deposition

Release Height = 45 meters

Distance from Source, Kilometers:

Direction Sector	1.6	3.2	4.8	6.4	8.0	16.0	32.0	48.0	64.0	80.0
S	5.5E-08	4.7E-08	3.6E-08	2.8E-08	2.3E-08	1.1E-08	4.8E-09	2.9E-09	2.1E-09	1.5E-09
SSW	3.6E-08	3.3E-08	2.5E-08	2.0E-08	1.6E-08	7.9E-09	3.6E-09	2.2E-09	1.5E-09	1.1E-09
SW	5.0E-08	4.5E-08	3.4E-08	2.7E-08	2.2E-08	1.0E-08	4.5E-09	2.7E-09	1.9E-09	1.4E-09
WSW	3.4E-08	3.5E-08	2.8E-08	2.3E-08	1.9E-08	9.4E-09	4.3E-09	2.6E-09	1.9E-09	1.4E-09
W	4.4E-08	4.3E-08	3.3E-08	2.6E-08	2.1E-08	1.0E-08	4.7E-09	2.9E-09	2.0E-09	1.5E-09
WNW	4.1E-08	3.5E-08	2.6E-08	2.0E-08	1.6E-08	7.5E-09	3.2E-09	1.9E-09	1.3E-09	9.8E-10
NW	5.9E-08	5.3E-08	4.1E-08	3.2E-08	2.5E-08	1.2E-08	5.3E-09	3.2E-09	2.2E-09	1.7E-09
NNW	5.8E-08	5.5E-08	4.3E-08	3.4E-08	2.7E-08	1.3E-08	5.8E-09	3.5E-09	2.5E-09	1.9E-09
N	9.7E-08	8.3E-08	6.1E-08	4.7E-08	3.7E-08	1.7E-08	7.4E-09	4.5E-09	3.1E-09	2.3E-09
NNE	5.3E-08	5.0E-08	3.9E-08	3.1E-08	2.6E-08	1.3E-08	5.8E-09	3.6E-09	2.5E-09	1.9E-09
NE	5.2E-08	5.0E-08	4.0E-08	3.2E-08	2.6E-08	1.3E-08	5.9E-09	3.7E-09	2.6E-09	2.0E-09
ENE	3.9E-08	3.9E-08	3.1E-08	2.5E-08	2.1E-08	1.0E-08	4.7E-09	2.9E-09	2.0E-09	1.5E-09
E	7.6E-08	7.1E-08	5.4E-08	4.2E-08	3.4E-08	1.5E-08	6.6E-09	3.9E-09	2.7E-09	2.0E-09
ESE	1.0E-07	8.0E-08	5.8E-08	4.4E-08	3.5E-08	1.6E-08	6.7E-09	4.0E-09	2.8E-09	2.1E-09
SE	1.3E-07	9.9E-08	7.1E-08	5.3E-08	4.2E-08	1.8E-08	7.5E-09	4.4E-09	3.0E-09	2.2E-09
SSE	6.9E-08	5.3E-08	3.9E-08	2.9E-08	2.3E-08	1.1E-08	4.5E-09	2.7E-09	1.9E-09	1.4E-09

Units: sec/m^3

TABLE H.5. Annual Average Atmospheric Dispersion Factors ($\overline{\chi}/Q'$) for ISFSF Stack Releases to Air Adjusted for Depletion by Dry Deposition

Release Height = 45 meters

Distance from Source, Kilometers:

Direction Sector	1.6	3.2	4.8	6.4	8.0	16.0	32.0	48.0	64.0	80.0
S	4.5E-08	4.1E-08	3.2E-08	2.6E-08	2.1E-08	1.0E-08	4.6E-09	2.8E-09	2.0E-09	1.5E-09
SSW	2.9E-08	2.8E-08	2.3E-08	1.8E-08	1.5E-08	7.4E-09	3.4E-09	2.1E-09	1.5E-09	1.1E-09
SW	4.0E-08	3.9E-08	3.1E-08	2.4E-08	2.0E-08	9.7E-09	4.3E-09	2.6E-09	1.8E-09	1.4E-09
WSW	2.6E-08	3.0E-08	2.5E-08	2.0E-08	1.7E-08	8.7E-09	4.1E-09	2.5E-09	1.8E-09	1.4E-09
W	3.4E-08	3.7E-08	3.0E-08	2.4E-08	2.0E-08	9.8E-09	4.5E-09	2.8E-09	2.0E-09	1.5E-09
WNW	3.4E-08	3.1E-08	2.4E-08	1.9E-08	1.5E-08	7.1E-09	3.1E-09	1.9E-09	1.3E-09	9.6E-10
NW	4.8E-08	4.7E-08	3.7E-08	2.9E-08	2.4E-08	1.1E-08	5.1E-09	3.1E-09	2.2E-09	1.6E-09
NNW	4.6E-08	4.8E-08	3.9E-08	3.1E-08	2.5E-08	1.2E-08	5.6E-09	3.4E-09	2.4E-09	1.8E-09
N	8.1E-08	7.4E-08	5.6E-08	4.4E-08	3.5E-08	1.7E-08	7.2E-09	4.4E-09	3.0E-09	2.3E-09
NNE	4.3E-08	4.4E-08	3.6E-08	2.9E-08	2.4E-08	1.2E-08	5.6E-09	3.5E-09	2.5E-09	1.9E-09
NE	4.2E-08	4.3E-08	3.5E-08	2.9E-08	2.4E-08	1.2E-08	5.7E-09	3.5E-09	2.5E-09	1.9E-09
ENE	3.0E-08	3.3E-08	2.7E-08	2.3E-08	1.9E-08	9.7E-09	4.5E-09	2.8E-09	2.0E-09	1.5E-09
E	6.0E-08	6.1E-08	4.9E-08	3.8E-08	3.1E-08	1.5E-08	6.4E-09	3.8E-09	2.6E-09	2.0E-09
ESE	8.5E-08	7.1E-08	5.3E-08	4.1E-08	3.3E-08	1.5E-08	6.5E-09	3.9E-09	2.7E-09	2.0E-09
SE	1.1E-07	8.8E-08	6.5E-08	4.9E-08	3.9E-08	1.7E-08	7.3E-09	4.3E-09	3.0E-09	2.2E-09
SSE	5.7E-08	4.7E-08	3.5E-08	2.7E-08	2.2E-08	1.0E-08	4.4E-09	2.6E-09	1.8E-09	1.4E-09

Units: sec/m^3