NOTICE

All drawings located at the end of the document.

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Mining Exposure Scenario for Baseline Risk Assessments at the Rocky Flats Environmental Technology Site

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MINING EXPOSURE SCENARIO FOR BASELINE RISK ASSESSMENTS AT THE ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

The purpose of this report is to present the current mining operations at the Rocky Flats Environmental Technology Site (Rocky Flats) Included are both current and proposed permitted mining locations in the buffer zone of Rocky Flats Previous geological and mining studies are reviewed to identify the areas of the site which contain potentially minable deposits of sand and gravel, the economic considerations which affect the viability of sand and gravel removal, and the operational considerations supporting currently permitted mining operations This report also presents the exposure scenarios currently being evaluated for Baseline Risk Assessment (BRA) and recommends a Department of Energy (DOE) position on a regulatory request for consideration of an exposure scenario which considers sand and gravel mining at Rocky Flats Parameters which would be used to calculate the potential impacts to a receptor under a sand and gravel mining scenario are also included

1.0 MINING OPERATIONS AT ROCKY FLATS

Permitted mining of sand and gravel has been underway inside the western edge of the Rocky Flats buffer zone since the early 1900s for both private and public (e g The Jefferson County Mine) uses Since 1990, Western Aggregates, Inc has operated a mine and a processing plant immediately adjacent to the mine (see Figure 1) Currently permitted reserves will be processed in 15 years with the plant in the current configuration Recently, Western Aggregates, Inc submitted an application for a permit to mine sand and gravel in two additional DOE owned locations (see Figure 2) These reserves potentially represent another 10 years of mining operations The area to the south would be mined first The area to the northeast which extends onto the National Renewable Energy Laboratory (NREL) would be mined 20 years from now under an agreement between Western Aggregates and NREL

The owners of mineral rights at Rocky Flats include Charlie McCay of Church Ranch Estates,

Lance Kilgrow of Coal Creek Canyon Stone, Union Pacific Railroad, Harold Spicer, and the DOE

In their currently permitted mining location (Figure 1), Western Aggregates, Inc operates a mining crew of five to six employees and a collocated processing plant crew of 13 employees The mining crew is made up of two truck drivers, one backhoe operator, one bulldozer operator and one reliever These crews typically operate 10 to 12 hours/day, one shift/day, 12 months per year During winter months, they may work less than eight hours/day, during peak summer demand, they may work up to fourteen hours/day The pace of mining is limited by the processing plant throughput of 500 tons/hour as well as product demand and ambient temperature Currently permitted reserves are expected to last 15 years with the processing plant in the current configuration

The sole target of mining operations is sand and gravel extraction and processing The capabilities of the processing plant include crushing, screening and washing (to remove clay) It is not currently planned to attempt to remove clay from the claystone which surrounds the sand and gravel deposits

2.0 SUMMARY OF PREVIOUS GEOLOGICAL AND MINING STUDIES RELEVANT TO ROCKY FLATS

To further understand mining operations at Rocky Flats, this section summarizes previous mining studies and sand and gravel permits at the site

In response to regulations promulgated by the State of Colorado regarding the State Geological Survey, the Colorado Geological Society commissioned a study of sand, gravel, and quarry aggregate resources in Colorado front range counties (Schwochow, et al , 1974) This document contains descriptions of the sand and gravel resources for Jefferson County and presented a map of sand and gravel resources of the county

EG&G commissioned a study of the surficial geology of the Rocky Flats Plant and vicinity (Shroba and Carrara, 1994) This is a preliminary document and presents a surficial geologic

map of the site (Figure 3)

As part of the preparation of a workplan for background soils characterization at Rocky Flats (EG&G, 1994), EG&G presented a generalized map of soil maps at Rocky Flats (Figure 4)

EG&G is preparing isopach maps of alluvial deposits, as part of a sitewide geologic characterization program Figure 5 presents a preliminary isopach map that will be finalized as part of this geologic characterization program

According to Schwochow et al , (1974) the Rocky Flats alluvial fan and associated upland deposits represent a large untapped reserve of alluvial gravel Schwochow et al , depicted the entire areal extent of the Rocky Flats Alluvium Geologic Deposit as a potential sand and gravel resource, designating it as alluvial fan gravel containing significant fines, decomposed rock, and calcium carbonate

The areal extent of the Rocky Flats alluvium is shown in Figure 3 As shown, the unit is widely exposed on the western portion of the site and extends eastward in topographically high areas of the site Figure 5 shows soil units which have formed on surficial geologic deposits In general, those soil units which are predominantly derived from the Rocky Flats Alluvium are the Flatiron and Nederland group and Valmont clay loam This map shows the location of IHHSs relative to soils which have developed on surficial geologic units This map enables the reader to assess which IHHSs may be located on areas underlain by potentially mineable gravel deposits

Figure 5 depicts the thickness of the Rocky Flats Alluvium and indicates that thicknesses of the deposit range up to 100 feet This area of maximum thickness corresponds to the West Spray Field Thicknesses of the deposit at the actual plant site range from approximately 30 feet at the western side to approximately 10 feet on the eastern side

In-place permitted reserves of sand and gravel are estimated to be worth $1 50/ton (Martin Jones, V P , Western Aggregates, Inc) The economic viability of gravel mining operations is dependent upon the gradation of the raw material, thickness and continuity of the deposit, and excavability and material handling characteristics Fines removal by sorting and screening is typically performed where necessary to alter the gradation of the material However, the

presence of a large percentage of fine material results in additional processing costs which could render portions of alluvial deposit as uneconomically minable material If it becomes necessary to refine the areal extent and potentially minable volume of alluvial gravel onsite, existing soil boring data could be evaluated in an attempt to characterize areal and vertical changes in gradation of the material

In response to Colorado Revised Statute (CRS) 1973, 34-1-304 et seq (House bill 1529), Jefferson County developed a Mineral Extraction Policy Plan (Jefferson County, 1977) This plan provides a series of County goals and related policy guidelines for the extraction of commercial sand, gravel, and quarry aggregate in unincorporated areas of the County The plan recognizes that Jefferson County has played an important local and regional role in the supply of mineral resources and will continue to do so in the future A series of guidelines are provided in this reference for defining areas of the County where mineral extraction should be located to maximize achievement of County goals Preliminary review of these guidelines confirms the availability of gravel resources on and adjacent to Rocky Flats and indicates that there is no express prohibition regarding gravel mining at Rocky Flats

3.0 RISK ASSESSMENT EXPOSURE SCENARIOS

This section presents the exposure scenarios currently being evaluated for BRAs and recommends a DOE position on a regulatory request for consideration of an exposure scenario which considers sand and gravel mining at Rocky Flats

3.1 Identification of Scenarios Currently Evaluated at Rocky Flats

The BRA process in place at Rocky Flats includes the provision of risk calculations for potential receptors under seven land use exposure scenarios These are

- Current offsite residential,
- Current onsite commercial/industrial,

- Future onsite commercial/industrial,
- Future onsite ecological reserve,
- Future onsite residential without groundwater ingestion,
- Future onsite residential with groundwater ingestion;
- Future onsite residential in the worst-case location

3.2 Identification of the Proposed Mining Land Use Scenario

In a recent letter to DOE, the Environmental Protection Agency (EPA) (1994) raised the following issue of the permit application by Western Aggregates, Inc to expand their mining operations, "The real possibility of mining in the Rocky Flats buffer zone dictates the consideration of mining as a land use scenario in the baseline risk assessments currently underway Given this proposal, DOE should reconsider the range of likely future uses for the buffer zone An ecological preserve scenario may no longer be reasonable, at least in areas where mineral rights are not owned by DOE " A central theme in the clean-up strategy for the buffer zone operable units was the realization that the public may favor an ecological reserve land use over all others (similar to the Rocky Mountain Arsenal) This clean-up strategy should be revisited

It is recommended that DOE considers an exposure scenario which incorporates mining as a viable land use scenario Whether this calculation is made part of the formal remedial investigation/feasibility study (RI/FS) process or not will be DOE's decision

4.0 CALCULATION OF CONTAMINANT INTAKES UNDER THE PROPOSED MINING LAND USE SCENARIO

This section outlines the selection of parameters for calculating contaminant intakes under the proposed sand and gravel mining scenario The pathways which make up the exposure scenario for a hypothetical mining receptor at some time in the future are

- Ingestion of soil during excavation and/or processing activities,
- Inhalation of fugitive dust generated during excavation and/or processing activities,

- Inhalation of volatile organic compounds (VOCs) being volatilized from subsurface soils while miners are working in the excavation,
- Dermal absorption of volatile organic compounds contained in dust or soil,
- Direct radiation from radionuclides contained in the soil

Other pathways considered, but not recommended include

- Ingestion of groundwater (production well installation is not part of the permit)
- Ingestion of garden produce (cultivation is not part of the permit)
- Inhalation of organic chemicals volatilized through the basement (Their are no airtight structures)

4.1 Soil Ingestion

The equation for intake due to ingestion of soil during excavation/processing is

$$I = \frac{Cs \times IR \times EF \times ED}{BW \times AT} \text{ for chemicals} \quad (1)$$

$$I = Cs \times IR \times EF \times ED \text{ for radionuclides} \quad (2)$$

Parameters and values for this equation are presented in Table 1

Table 1
Parameters and Values for Soil Ingestion

Parameter	Parameter Description	Units	Recommended parameter Value
I	Intake	mg/kg/day or pCi	
Cs	Concentration of contaminant in soil	mg/mg or pCi/mg	Averaged over the anticipated depth of excavation
IR	Ingestion Rate	mg/day	100 mg/day (EPA, 1989), EPA default parameters for adults

Parameter	Parameter Description	Units	Recommended parameter Value
EF	Exposure frequency	days/year	250 days/year
ED	Exposure duration	years	25 years (EPA, 1989); EPA default parameter value for commercial/industrial workers
BW	body weight	kg	70 kg (EPA, 1989), EPA default parameter for adults
AT	Averaging time	days	25,550 days (70 years) for carcinogens and 9,125 days (25 years) for noncarcinogens (EPA, 1989), EPA default parameters

4.2 Inhalation of Fugitive Dust

The equation for the intake due to inhalation of fugitive dust during excavation/processing is

$$I = \frac{Ca \times BR \times EF \times ED}{BW \times AT} \text{ for chemicals} \quad (3)$$

$$I = Ca \times BR \times EF \times ED \text{ for radionuclides} \quad (4)$$

Parameters and values for this equation are presented in Table 2

Table 2
Parameters and Values for Fugitive Dust

Parameter	Parameter Description	Units	Recommended parameter Value
I	Intake	mg/kg/day or pCi	
Ca	Concentration of contaminant in air	mg/m^3 or Pci/m^3	Concentration in air modeled using the concentration of soil averaged over the anticipated depth of excavation
BR	Breathing rate	m^3/hour	0 83 m^3/hour (EPA, 1989), EPA default parameters for adults
EF	Exposure frequency	hours/year	3000 hour/year based on 12 hour/day x 250 day/year
ED	Exposure duration	years	25 years (EPA, 1989), EPA default parameter value for commercial/industrial workers
BW	body weight	kg	70 kg (EPA, 1989), EPA default parameter for adults
AT	Averaging time	days	25,550 days (70 years) for carcinogens and 9,125 days (25 years) for noncarcinogens (EPA, 1989), EPA default parameters

4.3 Inhalation of Volatile Organic Compounds (VOCs)

The equation for intake due to inhalation of VOCs being volatilized from subsurface soils while miners are working in the excavation is

$$I = \frac{Cv \times BR \times EF \times ED}{BW \times AT} \quad (5)$$

Parameters and values for this equation are presented in Table 3

Table 3
Parameters and Values for Inhalation of VOCs

Parameter	Parameter Description	Units	Recommended parameter Value
I	Intake	mg/kg/day*	
Cv	Concentration of volatile organic compound in air	mg/m^3	Concentration of VOCs in air modeled using subsurface soil concentration averaged over the anticipated depth of excavation
BR	Breathing rate	m^3/hour	0 83 m^3 hour (EPA, 1989), EPA default parameters for adults
EF	Exposure frequency	hours/year	3000 hour/year based on 12 hour/day x 250 day/year
ED	Exposure duration	years	25 years (EPA, 1989), EPA default parameter value for commercial/industrial workers
BW	body weight	kg	70 kg (EPA, 1989), EPA default parameter for adults
AT	Averaging time	days	25,550 days (70 years) for carcinogens and 9,125 days (25 years) for noncarcinogens (EPA, 1989), EPA default parameters

* Units for radionuclides are not included because RFETS radionuclides are not volatile

4.4 Dermal absorption of VOCs in soil

The equation for intake due to dermal absorption of VOCs in soil is

$$I = \frac{Cs \times SA \times AF \times ABS \times EF \times ED}{BW \times AT} \quad (6)$$

Parameters and values for this equation are presented in Table 4

Table 4
Parameters and Values for Dermal Absorption

Parameter	Parameter Description	Units	Recommended parameter Value
I	Intake	mg/kg/day	
Cs	Concentration of contaminant in soil	mg/mg	Concentration in soil averaged over the anticipated depth of excavation
SA	Skin surface area available for contact	m^2/day	0 312m^2/day (EPA, 1989), EPA default parameter for adults' hands and arms
AF	Soil to skin adherence factor	mg/m^2	1 mg/m^2 (EPA, 1992)
ABS	Absorption factor	unitless	Chemical-specific value
EF	Exposure frequency	days/year	250 days/year
ED	Exposure duration	years	25 years (EPA, 1989), EPA default parameter value for commercial/industrial workers
BW	body weight	kg	70 kg (EPA, 1989), EPA default parameter for adults
AT	Averaging time	days	25,550 days (70 years) for carcinogens and 9,125 days (25 years) for noncarcinogens (EPA, 1989), EPA default parameters

4.5 Direct Radiation Risk

The equation for direct radiation exposure to radionuclides in soil is

$$DR = Cs \times CF \times EF \times ED\ [ET_o \times (1 - SH_o) + ET_i \times (1 - SH_i)] \qquad (7)$$

Parameters and values for this equation are presented in Table 5.

Table 5
Parameters and Values for Direct Radiation

Parameter	Parameter Description	Units	Recommended Parameter Value
DR	Direct radiation exposure	pCi-year/g	
Cs	Concentration of contaminant in soil	PCi/g	Concentration in soil averaged over the anticipated depth of excavation
CF	Conversion factor	hours/year	1 1 x 10^{-4} year/hour
EF	Exposure frequency	days/year	250 days/year
ED	Exposure duration	years	25 years (EPA, 1989), EPA default parameter value for commercial/industrial workers
ET_o	Exposure time outdoors	hours/day	11 hours/day - Productive time at work
ET_i	Exposure time indoors	hours/day	1 hour/day - Time in lunch/break trailer
SH_o	Outdoor shielding factor	unitless	0
SH_i	Indoor shielding factor	unitless	0 5

5.0 REFERENCES

EPA, 1989, Risk Assessment Guidance for Superfund, *Volume I Human Health Evaluation*, EPA/540/1-89/002, Office of Emergency and Remedial Response, Washington, D C

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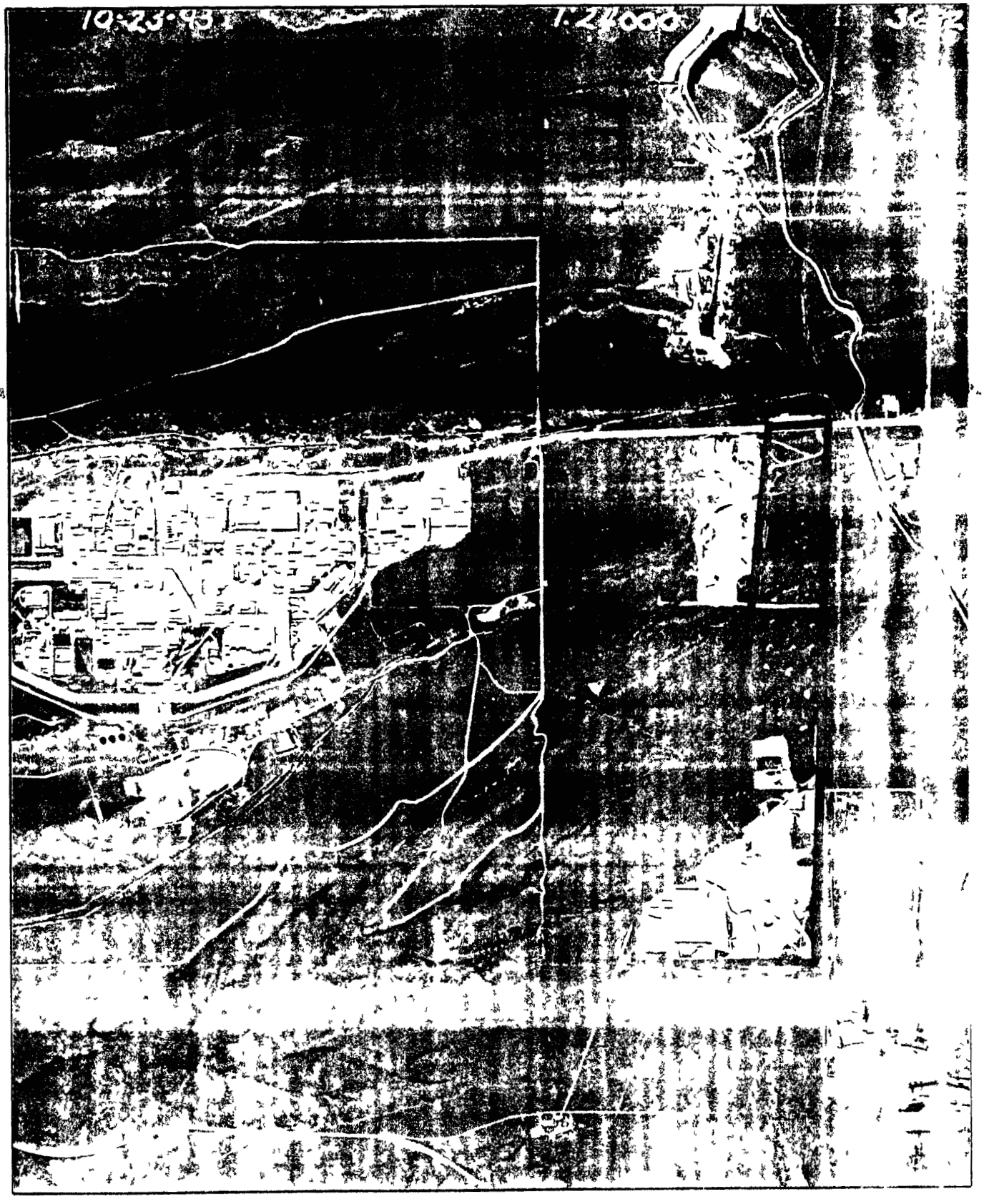

N

0 1/2 1

APPROXIMATE SCALE IN MILES

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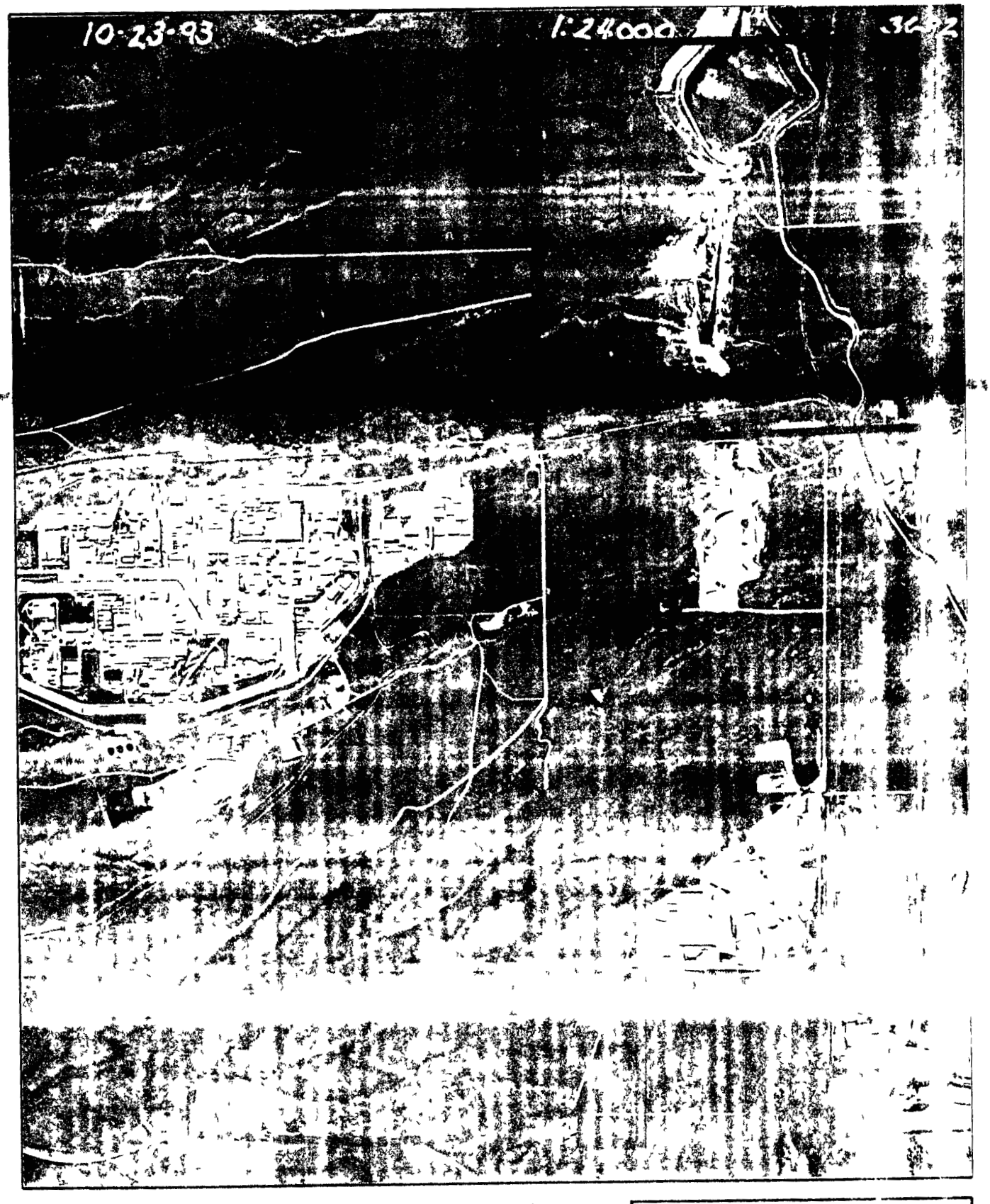
FIGURE 1

MINING OPERATIONS UNDER EXISTING PERMITS TO WESTERN AGGRECATES INC



N

0 1/2 1

APPROXIMATE SCALE IN MILES

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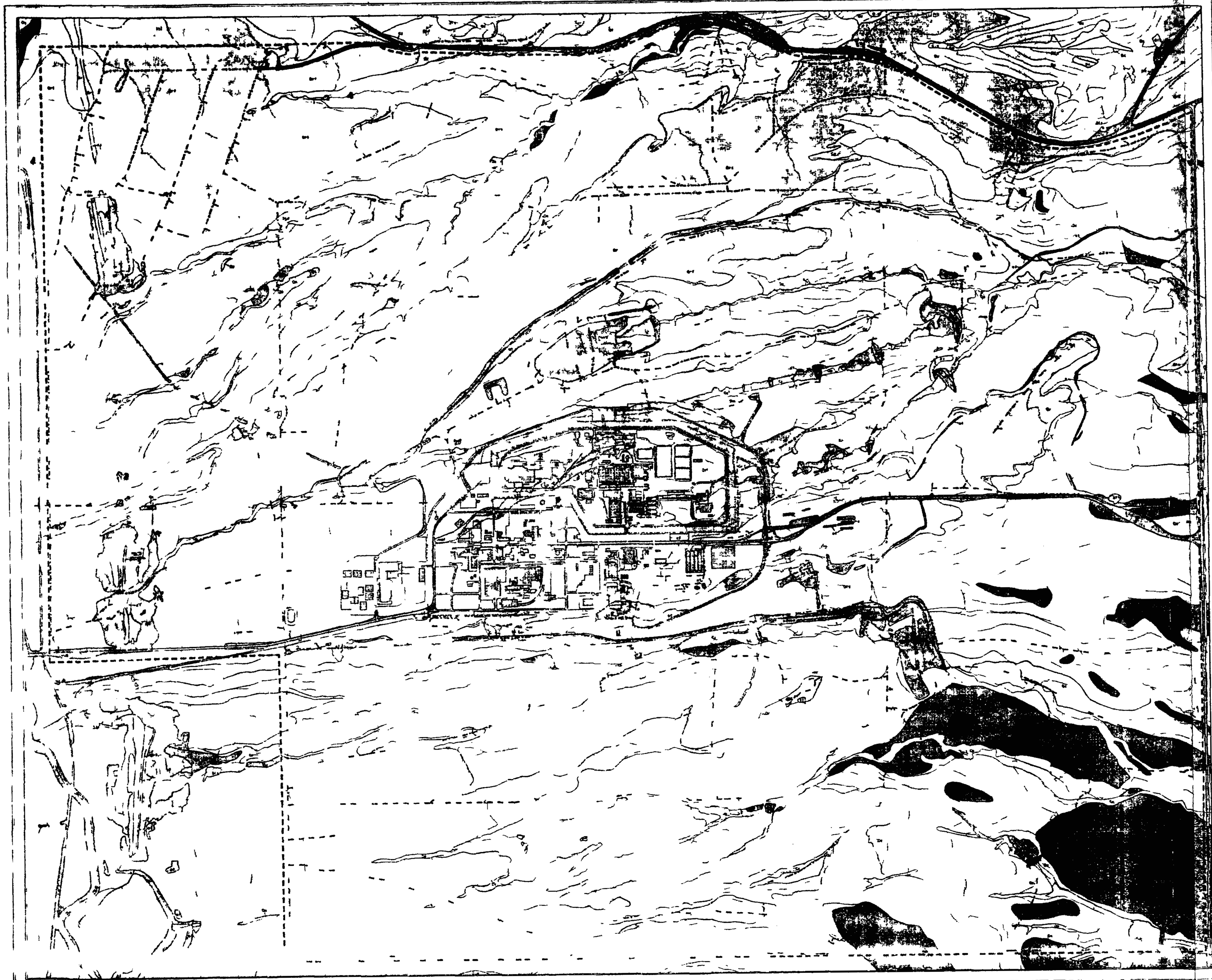
ROCKY FLATS PLANT
GOLDEN COLORADO

FIGURE 2

WESTERN AGGREGATES INC
PROPOSED MINE
PERMIT LOCATIONS



Geologic Units at Rocky Flats Plant EG&G

DRAFT

EXPLANATION

- af Artificial fill
- Qp Post-Piney Creed alluvium
- Qt Terrace alluvium
- Qs Slocum alluvium
- Qv Verdos alluvium
- Qrf Rocky Flats Alluvium
- Qc Colluvium
- Qls Landslide deposits
- Ka Arapahoe Formation
- Kl Laramie Formation
- Kfh Fox Hills Sandstone

Standard Map Features

- Buildings or other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

Scale 4400
Inch represents 200 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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FIGURE 3

U S Departme t of L ergy

Rocky Flats Plant

ROCKY FLATS PLANT

SOIL MAP UNITS

- Denver-Kutch-Midway clay loams
- Englewood clay loams
- Ratliers very stony sandy loam
- Haverson loam
- Leyden-Primen-Standley cbly clay loam
- McClave clay loam
- Midway clay loam
- Nederland very cobbly sandy loam
- Nunn clay loam
- Pits, gravel
- Rock outcrop, Sedimentary
- Valmont clay loam
- Willowman-Leyden cobbly loams

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FIGURE 4

Rocky Flats Alluvial Th ckness Map (DRAFT)

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Rocky Flats Plant

LEGEND

Streams

Rocky Flats Alluvium Outli

Alluvial Thickness Co t urs

5 All vial Thickness

Not Conto rs may devate f m ome observation va ues ue to the resoluti f the nderlying grid

Contou nterva 5 feet

2074000 2078000 2078000 2080000 2082000 2084000 2086000 2088000 2090000 2092000 2094000

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FIGURE 5

ROCKY FLATS ALLUVIAL THICKNESS WITH INDIVIDUAL HAZARDOUS SUBSTANCE SITES