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Office of
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EPA/ROD/R08-86/004
March 1986

EPA

Superfund Record of Decision:

Denver Radium Site Streets, CO

[redacted]

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

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16. ABSTRACT

Denver Radium Site Streets is located in Denver, Colorado. This operable unit is comprised of eight street segments in the Cheesman Park area and one segment in the upper downtown area. The nine contaminated street segments are owned by the City and County of Denver and extend approximately 4.5 miles through largely residential areas. The Denver Radium Site Streets contain a 4- to 6-inch layer of radium contaminated .sphalt. The contaminated layer is underlain by compacted gravel road base and is usually overlain by 4 to 12 inches of uncontaminated asphalt pavement. There is an estimated 38,500 cubic yards of contaminated material covering approximately 832,000 square feet. Radioactive contamination does not extend beyond the paved right-of-way of the streets and generally does not appear to have migrated into the soils below the contaminated asphalt. Radium concentrations at representative locations on the streets range from 4 to 79 picocuries per gram. Surface gamma radiation readings generally fall below 20 microroentgens per hour above background.

The selected remedial action for this site includes: leaving the contaminated material in place; improving institutional controls; and removing any contaminated material excavated during routine maintenance, repair, or construction activities in the affected streets to a facility approved for storage or disposal of contaminated material. The estimated initial cost of the remedy is $30,000. This includes the cost of studying and (See Attached Sheet)

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Record of Decision Denver Radium Site Streets, CO Contaminated Media: asphalt Key contaminants: radium		

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16. ABSTRACT (continued)

then establishing the institutional controls which would monitor all construction and utility work for the affected streets. The annual operation and maintenance cost will vary depending upon the amount of material excavated during any particular year.

Record of Decision

Remedial Alternative Selection

Site Name: Denver Radium Site Streets
Operable Unit 7

Site Location: Denver, Colorado

Documents Reviewed

I have reviewed the following documents describing the analysis of the remedial alternatives for the Denver Radium Site Streets Operable Unit:

- Denver Radium Streets Feasibility Study, prepared for the EPA Region VIII by CH2M Hill, July 26, 1985.
  - City and County of Denver recommendations/comments on FS.
  - Colorado Department of Health recommendations/comments on FS.
  - DOE recommendations/comments on FS prepared by Bendix Field Engineering Corp, August 29, 1985.
  - Endangerment Assessment (Appendix A of FS).
  - EPA Region VIII Staff recommendations/comments on FS.
  - General public recommendations/comments on FS.
- Denver Radium Sites Disposal Method Study, prepared for the Colorado Department of Health by Dames & Moore, March, 1983.
- Engineering Assessment and Remedial Action Plan for Radium Processing Residues at Nine Streets and One Alley in the City and County of Denver, Colorado, unpublished Report prepared for the Colorado Department of Health by Arix, Inc., 1982.
- Letter from Colorado Department of Health dated February 18, 1986 containing comments on the draft Streets ROD.
- Memorandum dated March 3, 1986 from Philip Nyberg to John Brink pertaining to Radiation Protection Standards.
- National Oil and Hazardous Waste Pollution Contingency Plan, 40 CFR Part 300.
- Responsiveness Summary, prepared for EPA Region VIII by CH2M Hill, January 13, 1986, (attached).
- Standards for Remedial Actions at Inactive Uranium Processing Sites, 40 CFR Part 192.
- Summary of Remedial Alternative Selection, EPA Region VIII, January 9, 1986, (attached).

Description of Selected Remedy

The EPA selected remedy combines features of excavation and disposal with the Modified No Action Alternative. This remedy entails:

- leaving the contaminated material in place,
- improving institutional controls so that all routine maintenance, repair, or construction activities in the affected streets by government agencies, utility companies, contracting companies, and private individuals will be monitored, and
- removing any contaminated material excavated during routine maintenance, repair, or construction activities in the affected streets to a facility approved for storage or disposal of contaminated material.

The EPA may share in the capital costs of designing improved institutional controls to be implemented by the City and County of Denver. Consistent with CERCLA Section 104(c)(3), the State of Colorado or the City and County of Denver will be responsible for assuring the payment of all future costs of maintaining and operating the institutional controls, including proper disposal of any contaminated material excavated during routine maintenance, repair, or construction activities in the affected streets.

Declarations

Consistent with the Comprehensive Environmental Response, Compensation tion, and Liability Act of 1980 (CERCLA), and the National Contingency Plan (40 CFR Part 300), I have determined that the selected remedy described in the preceding section at the Denver Radium Site Streets Operable Unit is a cost-effective remedy that effectively mitigates and minimizes threats to and provides adequate protection of public health, welfare, and the environment. The action will require future operation and maintenance activities by the State of Colorado or the City and County of Denver to ensure the continued effectiveness of the remedy. These activities will be considered part of the approved action and will be funded by the State of Colorado or subdivision thereof. The selected remedy is the alternative which the State of Colorado recommended in its August 12, 1985 comments on the Feasibility Study. The State has reviewed and commented on the Record of Decision.

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The EPA selected remedy combines features of excavation and disposal with the Modified No Action Alternative. This remedy entails:

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I have also determined that the action being taken is appropriate when balanced against the availability of Trust Fund monies for use at other sites. In addition, the limited off-site transport and secure disposition of the contaminated material recommended in the institutional controls is more cost-effective than any other remedial action and is necessary to protect public health, welfare, or the environment from the misuse of contaminated material excavated from the Denver Radium Site Streets Operable Unit in the course of any routine maintenance, repair, or construction activities in the affected streets.

3/24/86

John G. Welles
Regional Administrator
Region VIII
U.S. Environmental Protection Agency

Date

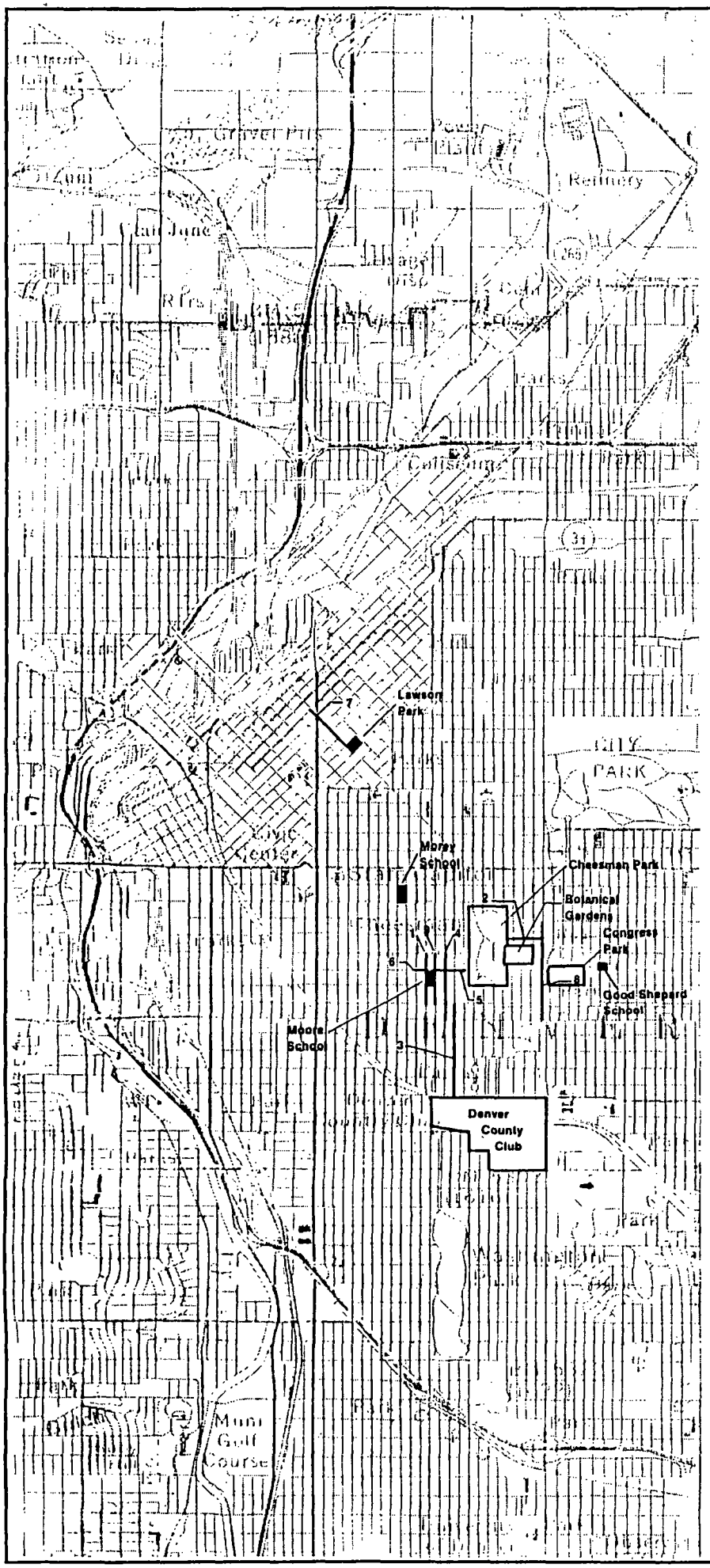

Figure 1-2
Location Map
Denver Radium Streets

Summary of Remedial Alternative Selection

Site Name: Denver Radium Site Streets
Operable Unit 7

Site Location

Denver Radium Site Streets Operable Unit is located in Denver, Colorado. The Operable Unit is comprised of eight street segments in the Cheesman Park area and one segment in the upper downtown area (See Figure 1):

- 9th Avenue from Ogden Street to Cheesman Park
- 11th Avenue from Josephine Street to Cheesman Park
- 23rd Street from California Street to Lawrence Street
- Corona Street from 7th Avenue to 10th Avenue
- Downing Street from 7th Avenue to 10th Avenue
- Humboldt Street from 7th Avenue to 9th Avenue
- Lafayette Street from 1st Avenue to 9th Avenue
- Marion Street from 6th Avenue to 9th Avenue
- York Street from 6th Avenue to 13th Avenue.

The nine contaminated street segments are owned by the City and County of Denver and extend approximately 4.5 miles through largely residential areas. An estimated 800 households border the contaminated streets. The streets are adjacent to various parks and public-use areas and properties. Except for minimal controls on excavation imposed by the Denver Public Health Engineering and the Denver Public Works Departments, use of the streets has not been restricted.

Site History

In 1979, EPA discovered a reference to Denver's National Radium Institute in a 1916 U.S. Bureau of Mines report. Subsequent research identified the presence of several long-forgotten radium processing operations which were active in the Denver area from about 1914 through the mid-1920's. Production of the refined radium, primarily for cancer therapy and research, generated large quantities of radioactive residues. Radium contaminated tailings and other wastes were discarded or left on site when the facilities were closed. Changes in ownership and use of the properties resulted in the residues being used as cover, fill, and foundation material and as aggregate in concrete and asphalt mixtures. Contaminated asphalt pavement was placed in the streets either when the streets were originally built or when streetcar lines were removed. No conclusive proof which identifies the source of this material has been found.

The Denver Radium Site was placed on the Interim Priorities List in October 1981. Final promulgation to the National Priorities List (NPL) occurred on September 8, 1983. After initial site discovery, the Colorado Department of Health undertook engineering assessment work using RCRA grant funds. The nine street segments were identified by the State contractor, the Arix Corporation, as being contaminated with radioactive materials. As a result of the Arix study, the Denver Public Health Engineering Department began monitoring gamma radiation levels during any excavation carried out in the streets.

State studies were discontinued when RCRA grant funds ran out. The EPA resumed fund-lead RI/FS activities in 1983 because the Colorado State Legislature failed to approve the cost share required for RI/FS funding under EPA's policy at the time. In July 1985, the EPA completed a study further defining the contamination of the streets. On July 26, 1985, the Draft Feasibility Study was released.

Site Description

The Denver Radium Site Streets contain a 4- to 6-inch layer of radium-contaminated asphalt. The contaminated layer is underlain by compacted gravel road base and is usually overlain by 4 to 12 inches of uncontaminated asphalt pavement. There is an estimated 38,500 cubic yards of contaminated material covering approximately 832,000 square feet. Radioactive contamination does not extend beyond the paved right-of-way of the streets and generally does not appear to have migrated into the soils below the contaminated asphalt.

Radium concentrations at representative locations on the streets range from 4 to 79 picocuries per gram (Table 1). (Units of measurement are described in Section 1.4 of the Feasibility Study and in the Endangerment Assessment.) These levels exceed the standards for "Remedial Actions at Inactive Uranium Processing Sites," 40 CFR Part 192, which serve both as the initiator and the goal of the remedial actions at the Denver Radium Site. Surface gamma radiation readings generally fall below 20 microroentgens per hour above background (Table 2 and Figure 2). The peak gamma level reported to date is 57 microroentgens per hour. Gamma exposure rates in outdoor contaminated areas are not directly addressed in 40 CFR Part 192. However, the gamma exposure levels found in the streets are well below the guidelines set by Federal agencies such as the Nuclear Regulatory Commission (NRC) and by national and international advisory groups such as the National Committee on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP).

Current Site Status

The Denver Radium Site Streets Operable Unit poses a minimal threat to public health. There is every indication that the material is bound in the asphalt and is not free to move in any direction. As long as the material remains in its present location, the potential routes of human exposure to the radioactivity are limited because the contaminated material is well contained. None of the streets are near surface water or groundwater resources and the material has little potential for erosion or leaching due to the pavement capping. For these reasons, contamination of the surface water or groundwater is not considered a potential exposure pathway.

The most significant routes of exposure to the radiation associated with the Denver Radium Site Streets material are, in order of decreasing significance: (1) inhalation of radon gas and its decay products, which are the immediate decay products of the radium, (2) direct gamma radiation exposure from the decay of radium and its progeny, and (3) ingestion or inhalation of radium-contaminated material. In general, the greater the exposure rate and the longer the exposure to radiation, the greater the associated health risks. Each of the three exposure routes will be examined briefly in order to describe the potential health risks.

Inhalation of Radon Decay Products:

Radon gas and its decay products, called daughters, present the greatest health hazard of long-term exposure. Radon daughters may attach to airborne particulates and be inhaled. The lungs and internal organs are then exposed to the highly ionizing particles which the radon daughters

Table 1
RADIUM CONCENTRATION
DENVER RADIUM STREETS

Boring No.	Location[2]	Contamination[1] Depth (inches)	Pavement Thickness (inches)	Maximum Radium Concentration (pCi/gm)
1	York St. near 7th Ave.	18	12	54
2	York St. near 11th Ave.	10	10	23
3	11th Ave. near Race St.	16	4	38
4	8th Ave. near Cheesman Park	--	5.5	12
5	Humboldt St. near 7th Ave.	6	6	62
6	Downing St. near 10th Ave.	6	6	79
7	Marion St. near 8th Ave.	6	6	16
8	23rd St. near California St.	6	6	8
9	23rd St. near Lawrence St.	--	10.5	4
10	7th Ave. near Marion St.	--	6	4
11	Lafayette St. near 1st Ave.	6	6	19
12	Lafayette St. near 5th Ave.	12	6	70

[1]Contamination defined as a 6" (15cm) layer of surface material with greater than 5 pCi/gm radium concentration or a 6" (15cm) layer of subsurface material with greater than 15 pCi/gm radium concentration.

[2]Reference: EPA, 1985b.

Table 2
LEVELS OF GAMMA RADIATION
DENVER RADIUM STREETS

Street	Percentage of Contaminated Area[a] Less than 20 μR/hr (above background)	20 to 40 μR/hr (above background)	Greater than 40 μR/hr[b] (above background)	Highes Readin μR/hr
9th Avenue (5-1/2 blocks, 80,000 ft²)	52	46	2	57
11th Avenue (4-1/2 blocks, 60,000 ft²)	51	48	1	50
23rd Street (6 blocks, 120,000 ft²)	93	7	0	23
Corona Street (3 blocks, 30,000 ft²)	73	27	0	29
Downing Street (3 blocks, 30,000 ft²)	84	16	0	34
Humboldt Street (2 blocks, 52,000 ft²)	56	44	0	40
Lafayette Street (9 blocks, 100,000 ft²)	59	40	1	51
Marion Street (4 blocks, 100,000 ft²)	30	67	3	57
York Street (7 blocks, 80,000 ft²)	70	30	1	57

[a]Based on data from Arix, 1982.

[b]The highest gamma radiation level reported is 57 μR/hour above background.

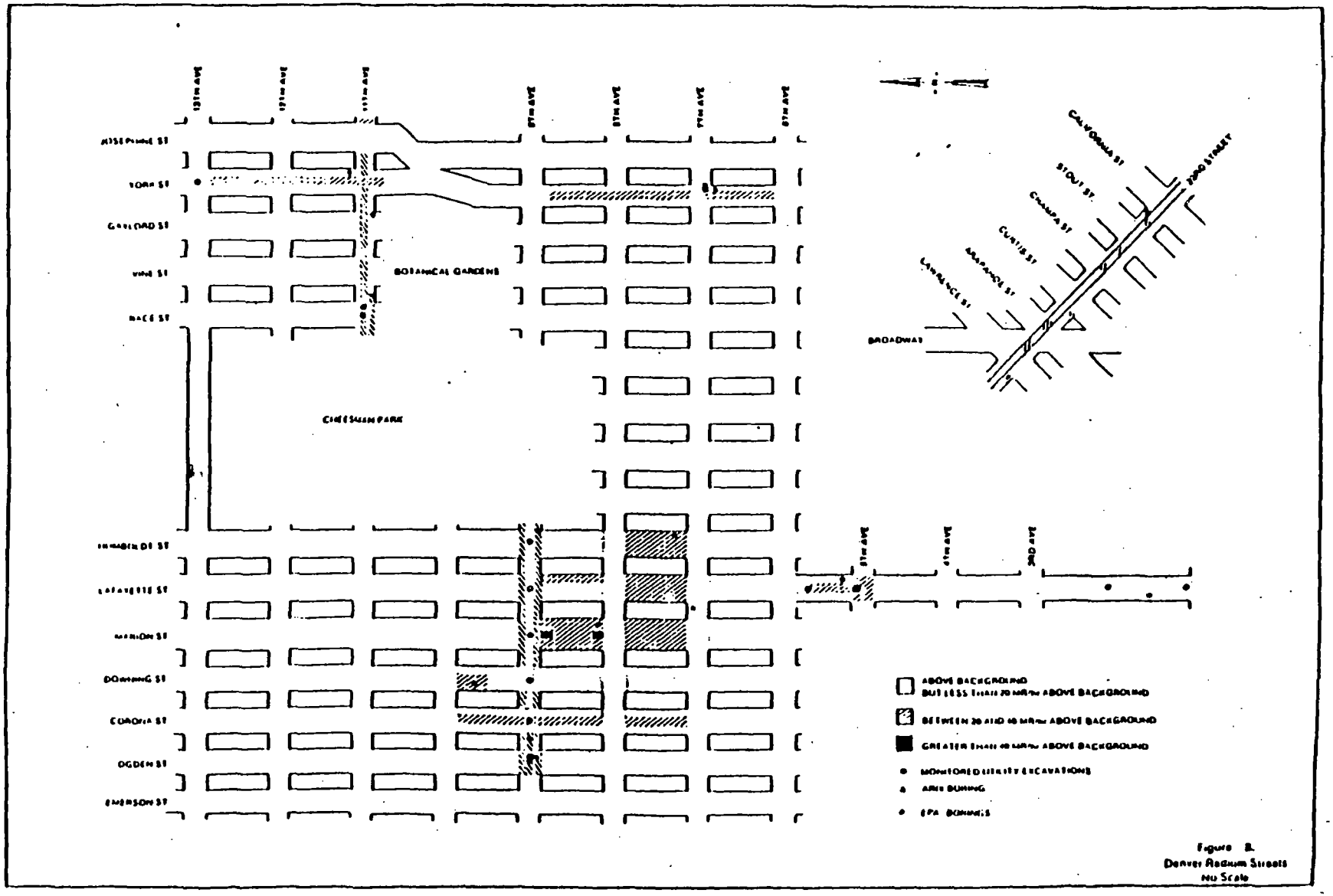

Figure 8.
Denver Radium Streets
No Scale

emit. Prolonged inhalation of radon decay products which are concentrated in the air has been shown conclusively to cause lung cancer in uranium miners. However, no effects have been observed at the lower concentrations to which the general public is exposed.

Radon daughters are not a problem in the out-of-doors where vertical dispersion quickly dilutes the radon emanating from the ground. This mechanism will minimize the concentration of radon in the air above the affected streets. However, radon decay products can concentrate to unacceptable levels in confined spaces such as in buildings built on contaminated ground. This is not a problem in this case because no buildings will be constructed in the streets.

The potential exists for diffusion of radon from the contaminated asphalt into the homes located along the affected streets. However, EPA has calculated that the relatively small amount of contamination in the streets is insufficient to cause elevated levels in any of the homes, given that there is typically 20 to 30 feet of compacted soil between any street and house and possible avenues for gas migration such as loosely filled pipe trenches are isolated from the contaminated asphalt layer. Solid material such as soil will sufficiently retard the diffusion of radon so that the gas will decay into a stable solid product before reaching the homes. This barrier should represent an attenuation factor of over one million times for radon moving from the streets to the homes. The resulting concentration from this source to the houses is negligible.

Gamma Radiation Exposure:

The radioactive decay of radium and its daughter products results in, among other things, the emission of highly penetrating gamma rays. Similar to x-rays, gamma rays are of concern because they can easily penetrate a few centimeters of soil to expose anyone walking above the contaminated area. The gamma ray emission, however, is limited to that area immediately above the contamination and is essentially not measurable beyond the paved rights-of-way of the streets. Furthermore, the gamma radiation exposure rates measured at even the areas of highest contamination in the streets represent a negligible health threat to the casual passerby. For example, if a person were to stand on the location of the highest measured exposure rate (57 microroentgens per hour at York Street) for 16 hours each day, 365 days a year, the resulting dose would be only 330 millirems per year. This may be compared to the guidelines of the Federal Radiation Council (FRC) and others which suggest a maximum annual exposure of no more than 500 millirems per year to any non-occupationally exposed individual member of the general population.

A more realistic case might be the exposure of children playing in the street for two hours each day, five days per week. If the average exposure rate above the contaminated streets is assumed in this case to be 40 microroentgens per hour, the resultant dose would be only about 20 millirems per year - well below the recommended exposure guideline of the National Committee on Radiation Protection and Measurements (NCRP), 100 millirems per year above background, and a small fraction of the approximately 150 millirems that anyone in Denver receives each year from natural natural background radiation (cosmic, terrestrial, and internal).

Inhalation or Ingestion of Radium-Contaminated Material:

While direct ingestion or inhalation of radium-contaminated materials can result in significant doses to various internal organs of the body, the confined location of the material in the streets makes this the least significant of the major exposure routes. For exposure by this route to occur, the material would have to be moved from its current location and made available to the population. Also, it is unlikely that a person will intentionally eat or breathe significant amounts of contaminated material.

From the forgoing discussion it is clear that the radium-contaminated material in the streets represents only a minimal hazard in its present state. This situation will change, however, if the material is disturbed by activities such as utility excavations, trenching, or repaving. Uncontrolled excavation presents the possibility of release and dispersion of the radioactivity, potentially increasing the exposure from all three routes. For this reason, it is important to maintain proper controls over any activities which disturb the status quo so that the risks of population exposure are not unduly increased beyond the presently minimal level. Through proper administrative and technical controls, any disruption of the streets, up to and including complete reconstruction, can be conducted with little additional risk to the workers or the general public.

Enforcement

Responsible party search work presently underway has identified the paving contractors who are thought to have used asphalt containing the contaminated material. Since financially viable, present day successors of the original contractors have not been identified, the Region views the Denver Radium Site Streets as a fund-lead site. There is a potential for cost recovery if a responsible party is identified in the future.

Since the streets were owned by the City and County of Denver at the time of disposal, a minimum of 50% cost-share responsibilities, imposed by CERCLA Section 104(c)(3)(C)(ii), will also apply to the Denver Radium Site Streets. Also, the City and County of Denver could be considered a responsible party under CERCLA Section 107(a)(1) by virtue of its current ownership of the streets.

Alternatives Evaluation

The remedial objectives for the Denver Radium Site Streets Operable Unit are to take actions which protect public health by (1) minimizing the spread of the radium-bearing material to locations where it could pose a hazard and (2) preventing contamination, especially the radium decay progeny, from entering pathways that could result in greater risks of exposure. These objectives are consistent with the National Contingency Plan, 40 CFR Part 300, and the cleanup standards set by the EPA for "Remedial Actions at Inactive Uranium Processing Sites," 40 CFR Part 192. These cleanup standards have been adopted as remedial action objectives for the Denver Radium Site. These standards are relevant and appropriate Federal requirements as defined by the newly revised NCP because it is the radium content of uranium mill tailings which is regulated for the mill tailings cleanup actions. Other Federal criteria, advisories, guidances and State standards which were considered when developing the alternatives are discussed later in this document in the section entitled, "Consistency With Other Environmental Laws."

Initial screening of alternative actions resulted in the elimination of several remedial options because they are technically ill-suited to the site conditions or contrary to the remedial objectives. Among the options rejected are reprocessing/treatment; lead, concrete, or soil shielding for radiation attenuation; area exclusion; and dilution of contaminated material with clean soil.

Complete excavation and disposal of all the contaminated material was also considered. However, the cost of implementing this as a remedy (approximately $8,600,000) far exceeds the cost of the remaining alternatives described below without providing substantially greater public health or environmental protection. Although complete excavation and disposal might be considered the most reliable alternative because all of the contaminated material would be excavated over a short time, other alternatives, including the selected remedy, meet the relevant and appropriate standards at a much lower cost with much less impact on traffic and neighborhoods.

The selected remedy was developed from the remaining alternatives described below:

(1) Limited Excavation and Disposal: Approximately 194 cubic yards of material found within 4,600 square feet of the most contaminated street segments could be excavated and disposed at an EPA-approved facility. This alternative entirely removes the contamination in the areas where there is the greatest public health risk - where gamma radiation levels are greater than 40 microroentgens per hour above background. No action would be taken on the remaining areas.

(2) Asphalt Shielding: Approximately 36% of the total street area could be paved. The areas which show a gamma radiation level over 40 microroentgens per hour above background, approximately 4,600 square feet, would receive 5 inches of asphalt and areas which show a gamma radiation level between 20 and 40 microroentgens per hour above background, approximately 295,000 square feet, would receive 3 inches of asphalt. This alternative would reduce the exposure level by 50% to 70% in the areas of the greatest gamma radiation exposure (more than 20 microroentgens per hour above background).

(3) Limited Asphalt Shielding: Approximately 1% of the most contaminated portion of the streets could be paved. Those areas with gamma level readings greater than 40 microroentgens per hour above background (approximately 4,600 square feet) could be overlain by a 2-inch layer of asphalt. The asphalt "patches" would be tapered on all sides to provide a smooth road surface. This tapering would bring the total area of covered street surface to 8025 square feet. This alternative would reduce the exposure level by approximately 35% in the areas of peak gamma radiation exposure (more than 40 microroentgens per hour above background).

(4) Modified No Action: The contaminated material could be left in place and institutional controls could be established to monitor all routine maintenance, repair, or construction activities in the affected streets. This alternative limits the public health risk by preventing the spread of the contamination to areas where it could potentially enter pathways of exposure that could increase public health risks.

(5) No Action: The contaminated material could be left in place. This alternative does not reduce the public health risk from contamination being spread to areas where it could potentially enter pathways of exposure.

The factors used to evaluate the effectiveness of the remaining alternatives are cost, reliability, feasibility, technology, administraive and other concerns, and their relevant effects on public health, welfare and the environment. Results of the evaluation are summarized below:

(1) Limited Excavation and Disposal: High cost ($148,050); eliminates public health risks of long-term exposure in excavated areas only; high reliability due to the permanent removal and safe disposal of the contaminated material; moderate to high feasibility. Complete excavation and disposal would eliminate public health risks entirely but would cost approximately $8,600,000 - an expense that cannot be justified in light of the minimal health threat posed by the material as long as it remains in place.

(2) Asphalt Shielding: Very high cost ($1,233,410); adequate protection of public health attributable mainly to the long-term controls required for any alternative that includes leaving some or all of the material in place; moderate to high reliability with long-term controls on excavation and maintenance activities; high feasibility.

(3) Limited Asphalt Shielding: Moderate cost ($87,418); adequate protection of public health; moderate reliability with long-term controls on excavation and maintenance activities; high feasibility.

(4) Modified No Action: Low initial cost ($30,000); adequate protection of public health; moderate reliability with long term controls on excavation and maintenance activities; moderate to high feasibility.

(5) No Action: No cost; slight risk to public health except if contamination is spread during excavation and maintenance activities potentially increasing public health risk; moderate to low reliability due to lack of controls on excavation/maintenance activities; high feasibility.

The selected remedy combines features of excavation and disposal and the Modified No Action Alternative. Initially the Modified No Action Alternative was the EPA preferred alternative. However, in response to concerns raised during the public comment period, the EPA amended the Modified No Action Alternative to recommend that the institutional controls also provide for the safe disposal of contaminated material removed during routine maintenance, repair, or construction activities in the affected streets.

Community Relations

The public comment period for the Denver Radium Site Streets was August 1, 1985 to August 22, 1985. The Feasibility Study and fact sheets were placed in several convenient repositories. The public was notified of the availability of these documents two weeks prior to the beginning of the public comment period through a display ad in both the Denver Post and the Rocky Mountain News. Press releases sent to community newspapers and newsletters resulted in news reports about the solicitation of public comments in the two major newspapers and on at least two TV and two radio stations.

No public meetings were held during the comment period because prior public meetings held by the Colorado Department of Health were sparsley attended and current citizen concern remains low. The EPA has met with some concerned citizens and has expressed willingness to meet with neighborhood groups or hold public meetings if the level of interest warrants it.

Most residents and property owners on the affected streets who commented during and after the comment period expressed the preference that the material be excavated and disposed at an approved facility. Some government agencies voiced concerns about possible risks associated with street and utility repairs and the need for more vigorous institutional controls, in particular, provisions for the notification and monitoring of street and utility work and for the disposal of contaminated material as it is encountered during routine maintenance, repair, or construction activities in the streets. In response to the public comments, the EPA developed the selected remedy which recommends that institutional controls provide for the safe disposal of contaminated material removed during routine excavation and maintenance activities in the affected streets.

Consistency With Other Environmental Laws

The standards for "Remedial Action at Inactive Uranium Processing Sites," 40 CFR Part 192, serve as both the initiator and the goal of the remedial actions at the Denver Radium Site. For properties contaminated with uranium or radium processing residues, these standards establish limits for the gamma radiation level and the annual average radon decay product concentration in any occupied or habitable building and for the concentration of radium in soil on open lands. Since the standards in 40 CFR Part 192 do not directly address the gamma exposure rate in outdoor, contaminated areas, the relevant and appropriate standard is 40 CFR Section 192.12(a) which specifies the maximum allowable radium concentration in the near-surface soil. In order to comply with 40 CFR Section 192.12(a), remedial actions shall be conducted when the concentration of radium in land averaged over any area of 100 square meters exceeds the background level by more than 5 picocuries of radium per gram soil in the upper 15 centimeters of the surface.

Only total excavation would satisfy this standard. However, the Total Excavation Alternative was eliminated in the initial screening because the cost of implementing this alternative far exceeds the cost of other alternatives without providing substantially greater public health or environmental protection. In certain circumstances, 40 CFR Part 192 provides that supplemental standards may be invoked. See 40 CFR Sections 192.21 and 192.22. Supplemental standards are appropriate when:

> "The estimated cost of remedial action to satisfy 40 CFR Section 192.12(a) at a ...site...is unreasonably high relative to the long-term benefits, and the residual radioactive materials do not pose a clear present or future hazard. The likelihood that buildings will

be erected or that people will spend long periods of time at such a vicinity site should be considered in evaluating this hazard. Remedial action will generally not be necessary where residual radioactive materials have been placed semi-permanently in a location where site-specific factors limit their hazard and from which they are costly or difficult to remove, or where only minor quantities of residual radioactive materials are involved. Examples are residual radioactive materials under hard surface public roads and sidewalks, around public sewer lines, or in fence post foundations."

40 CFR Section 192.21(c).

If a supplemental standard is applied, the implementing agency must select and perform remedial actions that come as close to the otherwise pertinent standard as is reasonable under the circumstances. 40 CFR Section 192.22(a). All of the alternatives remaining after initial screening, including No Action, fully comply with these supplemental standards.

The following are other Federal criteria, advisories, guidances and State standards which were considered when developing the selected remedy:

(1) Colorado Department of Health, Rules and Regulations Pertaining to Radiation Control. CRS 25-11-101 et seq. and implementing regulations.

(2) FRC, ICRP, and NCRP Guidelines.

The radioactive material is not, at present, licensed by the Nuclear Regulatory Commission (NRC) or the State of Colorado. However, if the material is used in a way that presents a hazard to human health, it becomes subject to the control of the Colorado Department of Health. The EPA Region VIII will take steps to ensure that disposal of any contaminated material removed during routine maintenance, repair, or construction activities is consistent with the EPA's off-site disposal policy.

Selected Remedy

The EPA selected remedy combines features of excavation and disposal with the Modified No Action Alternative. The selected remedy meets the supplemental standards for "Remedial Action at Inactive Uranium Processing Sites" which were chosen as the goal of remedial actions at the Denver Radium Site. The selected remedy is a cost-effective remedial alternative that effectively mitigates and minimizes threats to and provides adequate protection of public health, welfare and the environment. The costs of the other alternatives are not justified in light of the marginal reduction in risk they would provide.

The estimated initial cost of the remedy is $30,000. This includes the cost of studying and then establishing the institutional controls which would monitor all construction and utility work in the affected streets. Since the streets were owned by a subdivision of the State of Colorado at the time of disposal, the State is responsible for 50% of the capital cost. A possible funding mechanism for the State is its Solid Waste Tax Fund or the cost share credit claimed by the State for its site-related activities between January 1, 1978 and December 11, 1980.

Operation and Maintenance

The operation and maintenance activities required to ensure the effectiveness of the remedy are (1) excavation controls and (2) recommended provisions for disposal of contaminated material removed during routine maintenance, repair, or construction activities in the streets. These activities will continue for an indefinite time. The EPA has determined that the State of Colorado or subdivision thereof such as the City and County of Denver should be responsible for all operation and maintenance costs including the costs of the ongoing program to dispose of contaminated material removed during street excavations. The annual operation and maintenance cost (non-EPA funded) will vary depending upon the amount of material excavated during any particular year.

Schedule

Project implementation dates cannot be scheduled at this time due to the CERCLA program slowdown. Once the slowdown is lifted, the following key milestones will be scheduled:

- Start the design of institutional controls
- Complete the Design of institutional controls
- Selection of either a temporary storage or permanent disposal site
- Implementation of improved institutional controls

Future Actions

The future remedial activities that are required to complete site response are:

(1) Design of institutional controls: A detailed analysis of the required activities to establish improved institutional controls must be completed.

(2) Selection of a disposal facility: A facility must be selected for the proper disposal of any contaminated material removed during normal maintenance and repair activities in the streets. The State of Colorado is responsible for selecting a site for the permanent disposal of the Denver Radium material. Until this decision is made, the State may opt to use a temporary storage/staging area. EPA may, pursuant to CERCLA Section 111(a), help the State fulfill its CERCLA obligation to assure the availability of a disposal site (CERCLA Section 104(c)(3)(C)(ii)) by sharing in the State's capital expenditures for a disposal site for the Denver Radium material.

COMMUNITY RELATIONS RESPONSIVENESS SUMMARY
DENVER RADIUM SITE--OPERABLE UNIT 7 (STREETS)

January 13, 1986 U.S. EPA Region VIII

INTRODUCTION

This Responsiveness Summary was prepared to accompany the Record of Decision announcing EPA's selection of remedial action for the Denver Radium Streets, Operable Unit 7 of the Denver Radium Site. The Denver Radium Site consists of 11 property groups, each considered as a separate operable unit for the purpose of investigation and remedial action under Superfund. EPA conducted a Remedial Investigation of the Denver Radium Streets and prepared a draft Feasibility Study and Endangerment Assessment for Operable Unit 7, which was released July 25, 1985.

BACKGROUND

The Denver Radium Streets (Operable Unit 7) consist of nine street segments, totalling approximately 45 blocks in the Denver Metropolitan area. One segment is located in the northern part of the central business district, while the remaining eight segments are located in the vicinity of Cheesman Park, an urban residential area with some commercial and institutional establishments.

The Remedial Investigation for Operable Unit 7 consisted of field surveys to determine the level of radioactivity at street level, and borings to determine the location and vertical extent of contamination. The results showed that the radioactive contamination is contained in a layer of material at a depth of about 6 inches under the roadbed, and is entirely confined to the paved street area.

The Feasibility Study (FS) identified a range of possible remedial actions, and evaluated them based on technical feasibility, cost, and extent of environmental or health protection each would provide. An Endangerment Assessment evaluated the risks associated with the existing exposure levels and the long-term effects from taking no action. It was concluded that the radioactivity present in the streets does not exceed the recommended limits for general public exposure, and that standing at the "hottest" location for 16 hours a day for an entire year would result in only two-thirds the maximum recommended exposure for general public health. Most of the street areas showed much lower levels. Since the asphalt pavement offers a degree of shielding, there is little risk if the material is left in place. A greater risk may result from excavation and removal of the material, resulting in exposure through other pathways.

Three categories of potential remedial actions were considered: removal and disposal of contaminated material; radiation shielding with appropriate materials; and other alternatives including no action, area exclusion, and institutional controls. Based on these categories, five remedial alternatives were developed and evaluated in detail in the Feasibility Study. The alternatives were:

(1) Limited Excavation and Disposal:

Excavation of 194 cubic yards of contaminated material found within 4,600 square feet of the most contaminated street segments, with removal and disposal of the material at an EPA-approved facility for radioactive waste. Total cost of this alternative was estimated at $148,050.

(2) Asphalt Shielding:

Shielding to reduce gamma radiation by placing asphalt pavement over portions of the streets that are most contaminated, based on readings of gamma radiation. Approximately 36 percent of the total street area would be paved, with about 295,000 square feet receiving 3 inches of asphalt, and 6,000 square feet receiving 5 inches. Total cost estimate: $1,233,410.

(3) Limited Asphalt Shielding:

Limited shielding of 8,025 square feet of the streets by overlaying with a layer of 2 inches of asphalt. Total cost estimate: $87,418.

(4) Modified No Action:

Leave material in place; establish institutional control and perform monitoring of all construction and utility work in the streets. Total cost estimate: $30,000.

(5) No Action:

Leave material in place; maintain at present level the monitoring of all construction and utility work in the streets.

As long as contamination exposed during street excavation is properly handled, any of the five alternatives would satisfy the applicable or relevant and appropriate environmental regulations and health standards and would maintain the gamma exposure below the maximum recommended levels for the general public.

The Asphalt Shielding Alternative is the most costly, but reduces the gamma exposure to the lowest level of the five alternatives. The contaminated material would remain in

place, however, with a possibility of exposure due to future excavations or utility work.

The Limited Excavation and Disposal Alternative would minimize future exposure to residents, users, and street workers. However, it requires the availability of a disposal site for the material that is removed, and might temporarily increase the hazards to residents and workers associated with removing and disposing of the contaminated material.

The Limited Asphalt Shielding Alternative would reduce the level of gamma exposure to about the same degree as the Limited Excavation and Disposal Alternative, but would leave the material in place.

The Modified No Action Alternative would leave the streets intact with no shielding and would not reduce current levels of radioactive exposure, but protection from unnecessary exposure would be provided by the enforcement of strict institutional controls.

The No Action Alternative would leave the streets intact with no shielding and would not reduce the current levels of radioactive exposure. The Denver Public Health Engineering Department would continue monitoring gamma radiation levels during any excavation in the streets.

As described in the Endangerment Assessment contained in the Feasibility Study, the existing level of gamma radiation does not exceed the maximum recommended exposure for the general public. Since all five alternatives maintain exposure levels below recommended limits and satisfy legal and environmental requirements, EPA considered the Modified No Action Alternative to be the most cost-effective remedy for Operable Unit 7.

The selected remedy is a combination of the Limited Excavation and Disposal and the Modified No Action Alternatives. Initially, the Modified No Action Alternative was the EPA-preferred alternative. However, in response to concerns raised during the public comment period, the EPA amended the Modified No Action Alternative to provide for the safe disposal of construction activities in the affected streets.

ACTIVITIES CONDUCTED BY EPA TO INFORM THE PUBLIC OF THE REMEDIAL ALTERNATIVES

The public comment period for the Operable Unit 7 Feasibility Study (FS) was held from August 1 through August 22, 1985. It was announced in a display ad placed in the Denver Post and the Rocky Mountain News two weeks prior to August 1. EPA also prepared a press release announcing the public comment period, identifying the Denver Radium Streets, and announcing the availability of the FS report and fact sheets.

The press release was sent to the Denver Post, the Rocky Mountain News, Westword, Life on Capitol Hill, and the Washington Park Profile. The latter two are local community publications. In addition, 650 copies of the press release were included as inserts in the Urban Dweller, a newsletter mailed to members of the Capitol Hill United Neighborhoods Association.

The study documents were placed in public repositories established at the EPA Library, the Denver Public Library, the Colorado Department of Health, and the Capitol Hill Community Center. A general fact sheet discussing the Denver Radium Site and a supplemental fact sheet summarizing the remedial alternatives for Operable Unit 7 were prepared. Copies of the documents were distributed to the repositories and the fact sheets were mailed to individuals and groups on the Denver Radium mailing list. As a result of EPA's activities, media interest led to news reports on two local TV stations (KCNC Channel 4 and KWGN Channel 2) and local radio stations (KIMN and KOA) at the start of the public comment period. Channel 2 and the Denver Post also did followup stories on the closing day of the comment period.

CONCERNS RAISED DURING REMEDIAL PLANNING PHASE

During the remedial investigation of Operable Unit 7, residents and property owners on the affected streets voiced few specific concerns. However, some government agencies raised concerns about possible risks associated with street construction or utility repairs. Following incidents in which street work was undertaken on Denver Radium Streets without workers being aware of the contamination, officials realized the need for better control measures. Provisions for notification and monitoring of street work were subsequently established by the City and County of Denver, but City, State, and EPA officials have continued to voice the need for establishing more rigorous institutional controls, which is reflected in EPA's choice of a remedy.

CONCERNS RAISED DURING THE FEASIBILITY STUDY COMMENT PERIOD

Fifteen written comments were received during the Feasibility Study public comment period. Nine letters were sent by affected residents and other concerned citizens, and a petition was signed by 12 residents of one of the Denver Radium Street blocks. One letter was sent by an environmental group, and a local energy firm sent a letter soliciting radon monitoring services. The City and County of Denver, the Colorado Department of Health, and the Department of Energy also submitted comments. Copies of all the written comments sent to EPA are attached to this Responsiveness Summary, and the letters are referenced by number in the following discussion.

The alternatives preferred by the commentors are as follows:

Excavation and Disposal	-	7
Shielding/Repaving	-	3
Leave Intact/Institutional Controls	-	4

One letter (No. 10) did not express a preference, but raised questions concerning the development and evaluation of the alternatives, and other related issues.

The issues raised, the level of concern expressed, the number of commentors mentioning each issue, and EPA's responses are summarized below. The following discussion represents EPA's response to the individuals and groups that submitted comments. Also attached is an errata sheet with corrections to the Feasibility Study report. EPA's responses to the detailed technical comments submitted by the other agencies are not contained in this responsiveness summary; rather, they are addressed as corrections shown on the errata sheet or they will be addressed in the Feasibility Study process for other Denver Radium Operable Units.

General Concern About Radioactive and Hazardous Waste

Comment: One letter (No. 1) expressed general outrage about the presence of radioactive materials at the Denver Radium Site as well as at the Rocky Flats nuclear weapons plant and in uranium mill tailings. The writer also questioned the possible presence of radioactivity in streets in Boulder, Colorado Springs, or Denver suburban areas.

Response: EPA indicated that the Rocky Flats Plant is on the National Priorities List and is being studied as a separate Superfund site. The uranium mill tailings are being dealt with by the Department of Energy under the Uranium Mill Tailings Remedial Action Program. Other municipal streets in Denver and Boulder have been investigated with no radioactivity found. The Colorado Springs area has not been investigated because there is no evidence that radioactive materials were processed in that area.

Public Notification and Provision of Information

Comment: One letter (No. 10) expressed concern about EPA's provisions for notifying affected residents about the public comment period and providing information about the remedial alternatives. The commentor felt that each resident should have been directly notified and that an open forum (meeting) should have been provided. The same commentor also felt

that the fact sheet did not provide sufficient information about the technical aspects of the remedies.

Response: As described above, EPA pursued several avenues to notify the general public, as well as residents of the affected area about the Operable Unit 7 public comment period and the availability of information about the remedial alternatives. EPA felt that it was not necessary to send notices to every addressee, and that the 650 notices mailed with the Capitol Hill United Neighborhoods newsletter would adequately notify area residents.

EPA has met with concerned individuals and upon request would be willing to meet with neighborhood groups or hold public meetings if the level of interest or concern warrants it. Prior meetings held by the Department of Health were sparsely attended, and minimal interest has been expressed in site activities.

The fact sheets prepared by EPA are intended to provide general information about site activities, nontechnical summaries of the results, and the remedial alternatives. They also announce the availability of the technical study documents in the public repositories.

Technical study documents contain executive summaries, as well as detailed discussion of the technical information. EPA will continue to assure that the public has access to them in the repositories. In addition, EPA will provide copies of the executive summaries of future Denver Radium RI/FS documents directly to anyone requesting them.

Comment: The Colorado Department of Health (CDH) (No. 5) expressed concern about the amount of time for their review of the Feasibility Study document prior to public release.

Response: An earlier draft of the document was submitted to CDH for review and EPA considered these comments when revising the FS. Under the Management Assistance Cooperative Agreement between CDH and EPA, all Feasibility Studies and other major Denver Radium documents that have not already been provided for State review will be furnished to the State in advance of release.

Degree of Risk Associated with the Denver Radium Streets

Comment: One letter (No. 3) was received from a long-time resident on one of the streets who felt that there is no threat to human health and that EPA should leave the streets alone. However, six other commentors (Nos. 1, 2, 8, 9, 11 and 13) expressed considerable concern about exposure to radioactivity if no action was taken or if excavation or street repairs are done. These individuals felt that any amount of radioactive contamination warrants excavation and removal to prevent exposure.

Two letters (No. 2, 10) questioned the level or dose of radioactivity and the standards that are applied. Two writers (Nos. 9, 10) expressed concern about the cumulative effects of continued exposure to any amount of radioactivity and one (No. 9), who also spoke directly with an EPA representative, questioned the risk compared to other types or sources of radioactive exposure.

Response: These questions are addressed in EPA's Endangerment Assessment, as part of the Feasibility Study for Operable Unit 7. The levels of radioactivity measured on the streets during the field work was assessed and compared to the guidelines that establish maximum recommended limits to the general public for lifetime exposure. Information was provided about the level of risk associated with long-term exposure in the area where the highest readings occurred, and showed that levels were within the guidelines. Commentors are referred to the Endangerment Assessment for a detailed discussion. The results of the Streets investigation showed that the contamination and exposure levels do not justify complete excavation and disposal.

Comment: A related issue was raised concerning the detection of the radioactivity (No. 13). The writer felt that if the levels were high enough to be detected even though the streets have probably been repaved several times, then there must be a risk that would not be eliminated by covering the streets.

Response: This is explained by the sensitivity of the instruments used in EPA's investigations. The instruments can detect even small changes in natural background radioactivity and can detect levels of radioactivity significantly below levels thought to pose a significant health risk.

Comment: Another writer (No. 6) expressed "moderate" concern about the radioactivity unless digging or street work takes place. This letter reported that when some work was done on a Denver Radium street last year, the authorities were not notified and no precautions were taken. The commentor raised questions about risk to the street workers, and about potential exposure due to potholes in the contaminated streets.

Response: EPA encourages anyone observing such conditions to immediately notify the City and County of Denver, Department of Health and Hospitals (893-6241), which has responsibility for monitoring street work. The City has already established a permit/notification requirement for utility and street work involving excavation on the affected streets. EPA's recommended remedial action will augment the current requirements and establish more rigorous control and monitoring systems.

Availability of Disposal Site

Comment: Three commentors (Nos. 5, 6, and 13) referred to the availability of a suitable disposal site if material is removed from the streets. One commentor (No. 2) referred to the EPA requirement to dispose of radioactive hospital wastes, and questioned why other radioactive material, such as that found in streets, could be left in place.

Response: EPA responds that hospital wastes come under more stringent requirements because they are often much more radioactive than the material in the streets and are usually in forms that offer a much greater chance for human exposure.

Comment: Two commentors (Nos. 6 and 13) were in favor of removal, but were concerned about the availability of a disposal site. One questioned the cost of disposal and who would bear it, while the other (No. 13) encouraged the State and EPA to work together to establish a disposal site.

Response: EPA acknowledges the need for a disposal site, which is the legal obligation of the State. Since Colorado does not currently have a disposal facility for radioactive waste, EPA is studying disposal options for any material that may be removed from the Denver Radium Sites. The Disposal Site Study is intended to assist the State in fulfilling its obligation to provide a disposal site for Superfund wastes. EPA will announce the availability

of the study for public review. The preliminary conclusions that may be drawn from the study are that the options for immediate disposal are extremely costly, and other options will probably not be available for at least 3 years. For these and other reasons, EPA feels that the excavation and disposal alternative is not a cost-effective solution for the Denver Radium Streets at the present time.

Comment: Comments received from the Colorado Department of Health (No. 5) suggest gradual excavation and removal of the material as future street work is carried out. The State further suggests establishing a fund to provide for the cost of such activities.

Response: EPA believes that such a remedy is appropriate, but would have to be implemented by the State and/or City/County of Denver since funding for ongoing or future maintenance activities falls outside the Superfund program.

In arriving at its final selection of a remedy, EPA has also considered the costs of immediate versus gradual excavation/disposal as they may affect other agencies or individuals. Immediate excavation/disposal (Limited Excavation Disposal Alternative) would cost approximately $150,000 and provide no material health and safety advantages over "no action." Since the streets are City property, the costs of remedial action would be allocated 50 percent to Superfund and 50 percent to the State, as provided by CERCLA. The State in turn may pass the cost on to the City and eventually some cost burden may be borne by property owners. However, the health and safety benefits of better controls on excavation could be improved by providing a safe method to dispose of contaminated material found during excavations. Therefore, EPA has added a provision for this in its selection of a remedy.

Effectiveness of Institutional Controls and Monitoring

Comment: Concern about controlling excavations and monitoring street work was expressed by two private citizens (Nos. 2, 6), by the City and County of Denver (No. 4), and by the Colorado Department of Health (No. 5). One commentor (No. 2) felt that control of private contractors would be difficult, and future street administrators would need to prevent

digging up the streets for repaving. Another writer (No. 6) felt that covering the streets would do little good if excavations were often taking place, and questioned how this could be controlled. The Department of Health (No. 5) cited the "difficulty of maintaining institutional control" and emphasized the need for a formal mechanism within the City and County of Denver to ensure control.

Response: EPA recognizes the need to establish strong institutional controls for notification and monitoring of work on the Denver Radium streets. This was the focal point of EPA's preferred alternative. EPA is aware that the present system has not always worked well in the past. Furthermore, the Agency recognizes that effective controls on excavation would be necessary even if shielding or partial excavation were implemented.

EPA believes that institutional controls are necessary to prevent inadvertent exposure and to ensure that any contaminated material that may be removed in the course of future street work is identified. With joint participation of all the involved agencies, EPA believes that an effective system can be established. EPA assistance will be made available to the City/County in devising appropriate systems for this purpose.

CONCLUSION

The foregoing summary indicates the nature of the comments received during the August 1-22 public comment period and the issues raised regarding the remedial alternatives considered for Operable Unit 7 (Streets) of the Denver Radium Site. EPA has taken the comments and recommendations into consideration, and its responses are summarized here. Based on the comments received during the public comment period, EPA amended the recommended remedy to include provisions for safe disposal of contaminated material exposed during street excavation and repair. However, because the type of excavation and disposal program recommended is largely a street maintenance activity, implementation of this remedy is primarily the responsibility of the City and County of Denver and the State of Colorado. On balance, this remedy is intended to satisfy the concerns of proponents of excavation and disposal without the adverse impacts of the costs and disruption that would accompany a major short-term program of excavation and disposal. Since the contamination present in the streets poses no significant health threat as long as it remains in place or is properly disposed of once excavated, the remedy will be fully protective of public health and the

environment as well as being cost-effective. Further details on EPA's decision and the justification for its choice of remedial action are provided in the accompanying Record of Decision.

DE/DENRD5/046

ADDENDUM
RESPONSIVENESS SUMMARY
DENVER RADIUM STREETS

On Wed., Jan. 22, John Brink, Phil Nyberg, and Marilyn Null met with a group of citizens living on and near the 100 block of Lafayette Street. The meeting was requested by Sally Russo, resident of 121 Lafayette, and was held in her home.

The group submitted a petition to EPA during the public comment period (Aug. 1-22, 1985) concerning the method by which EPA notified residents along streets contaminated with radium. In early September, the Denver Radium team met with Richard Russo (Sally's husband) to discuss the Denver Radium site and options for dealing with contamination in the streets. In early January, Sally called requesting a meeting.

Citizens at this meeting were interested in the health effects of radiation contamination in the streets, particularly Lafayette Street. They wanted to know what effect the gamma radiation from the streets might have on their children. They were interested in knowing what EPA's recommended final decision would be and how the institutional controls proposed in that decision would work.

John Brink and Phil Nyberg explained the effects of this kind of radiation on human health, and went into detail about the effects on children. John explained the recommended final decision of a modified no action alternative, pointing out that currently there is no acceptable disposal site for Denver Radium materials, even if they were dug up.

The majority of the group thought the concept of the Modified No Action alternative was acceptable, but were concerned about the ability of the City and County of Denver to actually establish and maintain such controls. They identified numerous occasions of digging in the streets which they were sure had not been permitted, thus nullifying any controls that are or may be established. The general consensus of the group, after some discussion, was that the citizens have to be watchful of digging in the streets and contact the proper City & County of Denver departments to ensure that the controls are enforced.

The group further agreed to work with EPA in keeping residents informed by including an article in a newsletter published monthly by the Cherry Creek Improvement Association (CCIA).

In addition, a copy of the Streets FS and a copy of the Denver Radium Community Relations Plan were left with the Russos for interested citizens to review. John told the group that EPA will be accepting comments from citizens until the ROD is signed. He told them that the final deicision would be signed soon, so any comments should be sent to EPA as soon as possible.

ERRATA
DRAFT FEASIBILITY STUDY
STREETS, DENVER RADIUM SITE
JULY 26, 1985

Page No.	Paragraph and Line Number(s)	Alterations
ii	3, 3	Should read "9th Avenue from Ogden Street to Cheesman Park"
iii	1, 4	Should read "Lafayette Street from 1st Avenue to 9th Avenue"
iii	1, 5	Should read "Marion Street from 6th Avenue to 9th Avenue"
iv	2, 1	Should read "...potential remedial actions..."
iv	3, 1	Should read "These remedial action alternatives..."
ix	Table	Table 2-1 should be labeled "Denver Radium Streets, Possible Remedial Actions"
ix	Table	Table 3-4 should be labeled "Rejected Alternatives, Denver Radium Streets"
1-1	2, 1 & 2	Should read "...remedial action alternatives..."
1-6	Figure 1-1	Identification of street segments should be made consistent with those on pages ii, iii, and on Figure 1-2.
1-7	Table 1-2	Title of table should read "Site Grouping, Denver Radium Sites"
1-8	3, 1	Paragraph heading should read "Denver Radium Streets." Replace "...Section 1.4" with "1.3."
1-10	Figure 1-2	Street No. 2: Change "York" to "Josephine Street" Street No. 3: Change "7th" to "9th" Avenue Street No. 4: Change "10th" to "9th" Avenue Street No. 5: Map should indicate segment and key should read "Humboldt Street from 7th Avenue to 9th Avenue" Street No. 6: Change "Downing" to "Cheesman Park" Street No. 7: Change "Stout" to "California Street" (Also note: same changes apply to map on Group 7: Streets Fact Sheet Supplement, August 1985)

ERRATA
(continued)

Page No.	Paragraph and Line Number(s)	Alterations
1-16	2, 13	Replace "Figure 1-2" with "1-3."
1-17	Table 1-4	For Boring No. 2, Contamination Depth is 12"; Pavement Depth is 10". For Boring No. 3, Contamination Depth is 10". For Boring No. 12, Contamination Depth is 6".
2-1	3, 2	Should read "...Denver Radium Streets."
2-1	5, 4	Should read "...(e.g. by an order of magnitude)..."
3-1	heading	Should read "Chapter 3"
3-1	1, 1	Should read "The remedial action alternatives..."
3-7	2, 10	Should read "...asphalt or regular..."
3-12	Table 3-4	Heading should read "Rejected Alternatives, Denver Radium Streets"
4-4	2, 4	Should read "...(Baker, et al., 1984)."
4-9	3, 4	Should read "... maximum gamma of 57 μR/hr."
4-12	Table 4-4	The total cost for Raising Manholes should be $300. Total cost for the limited shielding alternative is changed to $84,718. (Due to the relative cost of this change compared to the other alternative estimates, this total will not affect the cost evaluation of the alternatives.)
5-1	Table 5-1	Change Limited Shield Capital Cost to $84,718.
7-2	1, 1	Change "2 feet" to "3 feet"
7-3	5, 1	Responses to Comments are provided in a separate Responsiveness Summary to be attached to the Record of Decision.
8-1	2, 5	Should read "...exposure limit of 500 mrems per year for non-occupationally exposed individual members of the general population."