PROJECT RIO BLANCO

Environmental Surveillance

Summary Report

Part 2

July 1973 – December 1976

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Colorado Department of Health

Division of Occupational and Radiological Health

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STATE OF COLORADO

P R O J E C T R I O B L A N C O

Environmental surveillance

Summary Report

Part 2

July 1973 - December 1976

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Colorado Department of Health

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PRINCIPAL WELLS INVOLVED IN PROJECT
RIO BLANCO

- RB-E-01 The emplacement well for the nuclear explosives. This was also planned to be the production well for the project.
- RB-AR-2 This well was drilled to permit release of gas from the lower cavities after it was discovered that there was no communication between the cavity produced by the top detonation and the chimney, or cavity produced by the two lower explosives.
- Fawn Creek Government #1 Well. An exploratory well began in 1958 by Continental Oil Company. Located about 1300 feet south of RB-E-01 and drilled to a depth of 7895 feet, the well was approved as a disposal well for tritiated water to be removed from emplacement well gas.
- RB-D-01 Hydrologic document well located about 108 feet north of RB-E-01. It was drilled to a depth of 1651 feet to sample the "B" aquifer.
- RB-W-1 This was drilled near the above two wells to sample water in the alluvium.
- RB-D-02 Located above 1,000 feet north of RB-E-01. Used to sample the "A" aquifer at 744 feet.
- RB-D-03 Located near RB-D-02, drilled 1294 feet to sample the "B" aquifer.
- RB-W-5, 6 & 7 Wells dug 3.5 miles downstream from the RB-E-01 well in the vicinity of known faults to sample water in the alluvium.
- RB-W-2,3 & 4 Same as above, located 4 to 4.5 miles downstream.
- RB-W-9E & 9W Same as above.
- RB-W-8, Humble, and Marathon. Wells located 7.5 to 8.5 miles downstream
- RB-U-4 Located between RB-E-01 and the two sampling wells RB-D-02 and RB-D-03, beyond the maximum distance predicted for fragmentation by the nuclear explosives. This well was sunk to obtain additional information on the subterranean geological formations.

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* Figures 1, 2 and 3 were prepared by CER-Geonuclear.

LIST OF ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
CDH	Colorado Department of Health
EPA	U.S. Environmental Protection Administration
ERDA	U.S. Energy Research and Development Administration
FPCP	Firing Point Control Point
LLL	Lawrence Livermore Laboratory
MCF/D	Thousand Cubic feet per day
NERC-LV	National Environmental Research Center (Las Vegas)
NVOO	Nevada Operations Office, AEC
PSI	Pounds per square inch
RSC	Radiological Support Contractor
SCF	Standard Cubic Foot
TRY-KRY	Effluent document control system operated by CER-Geonuclear Corp.
umhos	micromhos
USGS	U.S. Geological Survey

FOREWARD

Project RIO BLANCO was a joint venture undertaken by the U.S. Atomic Energy Commission (AEC) representing the federal government, and CER Geonuclear Corporation representing private industry. As originally conceived, Phase I of the project involved the simultaneous detonation of three nuclear devices in a single emplacement well, and was the third event in the AEC's Plowshare program to develop peaceful uses for nuclear devices. The explosive services were provided for the Government by the Lawrence Livermore Laboratory (LLL) operated by the University of California. (The portion of the AEC containing the Plowshare program was transferred to the U.S. Energy Research and Development Administration (ERDA) in January 1975. ERDA was subsequently absorbed in October 1977 by the newly formed Department of Energy).

The main purpose of the RIO BLANCO experiment, as well as that of the other two Plowshare detonations, was to investigate the feasibility of using nuclear detonations in deep underground formations where the gas was too tightly held to be released under other known techniques.

A total of approximately 9,000 radiochemical analyses have been done on 4110 environmental samples pertaining to Project RIO BLANCO by the Department during the period July, 1973 through December, 1976. These include:

- 3186 Air Particulate Filter Samples
- 54 Air Moisture Samples
- 34 Sediment and Soil Samples
- 9 Compressed Air Samples
- 44 Municipal water supply samples
- 122 Special well samples
- 622 River and stream samples
- 39 Snow samples

The Colorado Department of Health is directed by State Statute (Title 25, Article 11, Section 3, CRS 1973) "To develop and conduct programs for evaluation and control of hazards associated with the use of any and all radioactive materials and other sources of ionizing radiation."

The Department's surveillance program for RIO BLANCO was based on experience gained during the previous two Plowshare operations;

- (A) GASBUGGY which took place near Farmington in northern New Mexico on December 10, 1967, and
- (B) RULISON which was detonated on September 10, 1969, at a point about halfway between Grand Junction and Glenwood Springs, Colorado.

The program received support and cooperation from other state and federal organizations, permitting the Department to take advantage of the expertise,

equipment, and capabilities which these agencies possessed. Levels of radioactivity in the environment and salinity in the surface and well waters were determined before the detonation so that any undesirable changes caused by the detonations could be more easily identified. The collected data identify environmental levels of radioactivity for an extensive area of western Colorado.

This report is prepared in two parts. Part I covers the period January 1, 1971 through June 30, 1973, including pre-shot activities and results of surveillance for the six weeks following the detonations. Part II contains the results of environmental surveillance during the periods of re-entry and production test flaring of the gas from the cavities produced by the nuclear explosions and during the period at final shutdown and abandonment of the site.

I. General Activities

Descriptions of the area and of major events through June, 1973, are contained in Part I. Figure 1 is a map of the area in the vicinity of the RIO BLANCO operation.

The Department's surveillance program detected no release of radioactivity following the detonations on May 17, 1973. Accordingly, the Department issued an amendment to the permit authorized by the Colorado Water Pollution Control Commission, reducing somewhat the scope of the monitoring program required by the permit. A copy of the modification is contained in Appendix A-1 of this report.

Permission for re-entry into the underground cavity caused by the detonations was granted by the Colorado Oil and Gas Conservation Commission following a hearing held on July 17, 1973. The permit is contained in Appendix A-2 of this report.

CER Geonuclear petitioned the Water Quality Control Commission on June 11, 1973, for permission to reinject tritiated water, removed from the RIO BLANCO gas, into the Fawn Creek Government #1 well. This was proposed in order to minimize the release of tritium into the biosphere. A public hearing was held on September 24, 1973. The amount of tritium to be reinjected represented about one-sixth of the tritium expected to be released from the well. The water was to be deposited at about the same depth as the detonation cavity, with the reinjection system being designed to prevent vertical movement of the reinjected water once it has been deposited. The Findings of Fact, issued on October 15, 1973, (Appendix A-3 stated that the petitioner had proven beyond a reasonable doubt" that there was no risk of significant migration of the reinjected water. Accordingly, the Department of Health issued a permit for reinjection on November 9, 1973. (Appendix A-4). It included monitoring requirements and time, volume, and reinjection pressure limits, as well as defining the depth at which the water would be deposited.

Re-entry drilling was begun on September 23, 1973. The interval between detonation and re-entry had been planned to permit the decay of fission products with short half-lives, to low or undetectable levels. One of the more important radionuclides of concern was iodine-131, whose activity would have decreased by a factor of more than 10,000 during the interval. Crushing of the casing by the detonations necessitated "whipstocking" out of the original

FIGURE 1

RIO BLANCO REGIONAL MAP

well and drilling parallel to the original well into the top of the cavity.

Re-entry drilling was completed on October 12, 1973. Calibration tests of the RB-E-01 well were conducted on October 17, 18, and 26. This was done to check the flow characteristics of the well. During the calibration tests, hydrogen sulfide gas was found in the gas. An H₂S alarm system was set up and all personnel in the area were instructed in safety procedures to be followed. The layout of facilities and a schematic gas flow diagram for production testing are shown in Figures 2 and 3.

Drawdown testing was conducted during the period November 15-21, 1973. The purpose of such tests was to reduce the pressure in the cavity produced by the three explosives and then to observe the buildup in pressure as gas entered the cavity from the gas-bearing sand lenses. The flaring part of this testing was suspended on November 21 because of higher than anticipated temperatures in the gases brought to the surface.

At this time, an additional matter of concern was discovered. Each of the three explosive devices contained a different rare gas tracer so that the source of the gas could be identified according to the location of the explosives. Analyses indicated that the cavity caused by the top explosive had no communication with the two lower cavities.

After fin fan coolers had been installed to cool the well gas before it passed through the separator, flaring was resumed on January 28, 1974. Further analyses of the gas confirmed the fact that there was no communication between the upper and the two lower cavities. In addition, it was noted that the flow capacity of the reservoir was not as great as predicted. The RB-E-01 well was shut in on February 15, 1974.

Directors of the project then determined to drill an alternate re-entry well (RB-AR-2) to test the conditions in the vicinity of the middle detonation, and possibly the bottom detonation. The top of the well was about 1200 feet south-south-west of the RB-E-01 well, near the Fawn Creek #1 well. Drilling commenced in mid-June and was completed on November 2, 1974.

Because of the additional flaring planned from the RB-AR-2 well, the program directors requested an amendment to their reinjection permit, (Appendix A-5). The Findings of Fact indicated that there was "no risk of significant migration". (Appendix A-6). The amended permit was issued on November 8, 1974 (Appendix A-7).

After contact had been made with the bottom cavity through the RB-AR-2 well, a short production test of about three hours was conducted on November 2, 1974. During this period, about 80 barrels of liquid were separated from the gas and stored in one of the holding tanks. Samples of the liquid were furnished to Eberline, LLL, and the Colorado Health Department. Traces of cesium-137 and

Figure 3 Flow configuration during production tests.

strontium-90 were discovered in the recovered water. It was presumed that these isotopes came from rock dust or mud carried to the surface by droplets of water or mud which had drained into the cavity produced by the lowest of the three nuclear explosives.

Analysis of surface soil and water in the vicinity did not show any release of the two isotopes in question. CER Geonuclear reported that a scintillator probe attached to the flare line and used to survey the stack gases continually show krypton-85 as the only detectable isotope emitting gamma radiation. A more detailed report of the Department's activity in connection with this event is contained in Appendix A-9. Fallout trays downwind of the flare stack up to a distance of 200 feet showed only naturally occurring radioactivity. The flare line sampler, which sampled the gas continuously showed only naturally occurring radioactivity in particulates collected by a paper-charcoal filter.

On September 29, 1975, the disposal permit was again amended, with extension of the permit being the only change (Appendix A-10).

In order to obtain additional information on the geology of the area, a formation evaluation well was drilled about 625 feet northeast of the emplacement well. The site selected for this RB-U-4 well was beyond any predicted fracture zone around the detonations. Drilling was started in September, 1974 and completed in November, 1974. Testing of the well was conducted in December, 1974, and showed low flow capacity from the Fort Union formation, as observed in the production testing from the top cavity of the RB-E-01 well. (This was the formation from which it was hoped to release gas by nuclear detonations). The well was tested again in the period November, 1975-April, 1976, and then shut in.

In the spring of 1976, ERDA decided to terminate the two Plowshare experiments in Colorado. On July 21, 1976, the Water Quality Control Division conducted a hearing on the request to plug and abandon the subsurface disposal system (Appendix A-11).

A permit to plug was issued by the Colorado Department of Health on August 23, 1976, (Appendix A-12). The permit also modified the monitoring requirements as previously established.

Copies of notices to close the Rulison re-entry well and the wells associated with the RIO BLANCO Project, as submitted to the United States Geological Survey (Form 9-331) are included in Appendix A-13 of this report.

II. Environmental Surveillance

A. General

Monitoring networks to sample airborne particulate material, surface waters, municipal water supplies, and commercial milk supplies throughout the State have been in existence since the early 1960's. These networks were established as part of the Department of Health's Air and Water Pollution Control program and the normal monitoring of water supplies and food-stuffs. An extensive program of radiological analysis of samples from designated stations in these networks has been in operation since 1967. In addition, supplementary networks had been established for radiological surveillance of such specific activities as uranium mill tailings piles, world-wide fallout, the Rocky Flats Plant, the Fort St. Vrain Nuclear Generating Station, and Projects RULISON AND GASBUGGY. Location of air and surface water sampling stations in northwestern Colorado are shown on Figure 4.

With the assistance from the Colorado Water Conservation Board, a special network of surface water sampling stations was established in and around the Piceance Basin. The purposes of the network were: (1) to obtain information concerning detectable radioactivity in the Basin (2) to record variations in flow volume and salinity of the streams, and (3) to determine whether or not changes in radioactivity and salinity might have been caused by the nuclear detonations. Locations of these stations are shown on Figure 5. In addition to the water samples noted above, the Department also analyzed samples of drinking water from all the ranches in the Basin for radioactivity and salinity. Department personnel visited families in the Basin frequently to inform them of the State's continuing surveillance of the project and to answer questions which the residents might have. Most of the questions raised were about radiation.

Other samples analyzed included soils and sediments, air moisture, compressed air, and fresh snow. Soils and sediments were analyzed for total alpha and total beta activity. Snow samples were checked for tritium concentration. Compressed air samples were sent to NERC-Las Vegas to be analyzed for krypton-85, radioactive xenon, and tritiated methane.

According to CER Geonuclear's reports the following amounts of radioactive material were reinjected into the Fawn Creek #1 well:

Tritium	278 curies
Cesium-137	4325 microcuries
Strontium-90	1021 microcuries

Radioactive materials released by Project RIO BLANCO to the atmosphere during flaring were:

<u>Radionuclide</u>	<u>Curies</u>
Tritium	75.31

Krypton-85	1020.
Argon-37	89.37
Argon-39	0.65
Carbon-14 (as CO ₂)	0.89
Xenon-131m	0.306

In comparison NV00 estimated that the flaring from Project Rulison released the following radioactive material:

Tritium	2824 curies
Krypton-85	1064 curies

The reason for the difference in the amount of tritium released by these two projects was the fact that the nuclear explosives used in Project RIO BLANCO had been specifically designed to minimize the production of tritium.

B. Airborne Particulate Material Surveillance.

The Air Pollution Control Division maintains about 100 high volume air sampling stations throughout the state. Particulate material collected on 8 x 10 inch fibre glass filters from 46 of these stations are routinely analyzed for total long-lived alpha and beta activity. Locations in ten communities were used for surveillance of RIO BLANCO, and seven of these were used for RULISON surveillance. (See Table 1 and Figure 2). Under normal conditions these stations operate for one 24-hour period every four days. The filters are not counted until seven days have passed to permit the short half-lived naturally-occurring daughters of radon and thoron to decay below the detectable level. Monthly and annual average readings for all stations are contained in Appendix B.

The average readings for the ten locations are plotted in Figure 6 and 7. The high alpha averages for Rifle, Grand Valley and Grand Junction reflect the high readings noted before the program for stabilizing tailings piles was initiated; and during the early period of this program, before the uranium processing mill in Rifle was shut down in June, 1972. For the period July, 1973, through December, 1976, there are no significant differences among the stations. Similarly, high beta averages may be associated with material retained locally by temperature inversions along the Colorado River. This is shown by the fact that, during the period covered by this report, the averages for stations along the Colorado River are relatively equal to one another, while Montrose and Black Sulfur Creek had significantly lower readings for the period 7/73 - 12/76.

The reduction in radioactivity in air since 1969 is illustrated in Figures 8 and 9. While the reduction in alpha activity may be credited chiefly to tailings pile stabilization, the reduction in beta activity may be attributed

FIGURE 5 PROJECT RIO BLANCO SURVEILLANCE Special Water Sampling Network

◆ EMPLACEMENT WELL
★ DRINKING WATER

⊖ WATER POLLUTION CONTROL STATION
* SURFACE WATER

Table 1

PROJECT RIO BLANCO SURVEILLANCE
Air Pollution Control Stations Employed
in Plowshare Surveillance

APC#	LOCATION	PERIOD OF OPERATION
46	Glenwood Springs	April 1969 - present*
47	Montrose	April 1969 - present
48	Rifle	April 1969 - present
62	Fruita	April 1969 - present
66	Palisade	April 1969 - present
67	Grand Junction	April 1969 - Jan. 1971
68	Fruita	April 1969 - Feb. 1970
69	Rifle	July 1969 - Dec. 1970
73	Grand Valley	August 1969 - present
97	Grand Junction	January 1971- January 1974
107	Meeker	September 1971 - present
108	Rangely	September 1971 - present
109	Black Sulfur Creek	September 1971 - present
119	Grand Junction	January 1974 - present

* The APC Stations were in operation at least through December, 1976, where the period of operation is indicated by -present.

FIGURE 7
PROJECT RIO BLANCO SURVEILLANCE
TOTAL LONG-LIVED BETA ACTIVITY IN AIR PARTICULATES

FIGURE 3

PROJECT RIO BLANCO SURVEILLANCE

ANNUAL AVERAGES OF TOTAL LONG-LIVED ALPHA ACTIVITY IN AIR PARTICULATES

FIGURE 9

PROJECT RIO BLANCO SURVEILLANCE

ANNUAL AVERAGES OF TOTAL LONG-LIVED BETA ACTIVITY IN AIR PARTICULATES

to the gradual inventory reduction of fission products injected into the atmosphere by nuclear weapons tests.

Figures 10 and 11 also show the reduced airborne radioactivity since the start of the Department's surveillance program. The March alpha peak is primarily due to elevated readings in March, 1970. Monthly alpha averages over the period of 1973-76 are relatively stable. The characteristic annual beta activity curve is shown in Figure 11. Normally an increase in activity occurs in the Spring due to vertical mixing of the atmosphere and resultant fallout of world-wide fission products. The continued reduction in the atmospheric inventory is shown by the difference in the averages for the period 1969-73 as compared to the period 1973-76. The elevated average for January is due to fallout from an atmospheric nuclear test in 1972. The October high level was caused by fallout from the nuclear test of September 26, 1976.

A more detailed picture of month-to-month variations in airborne radioactivity is illustrated in Figures 12 and 13. This prevents a comparison of average readings in the RIO BLANCO surveillance network with the average of fifteen stations in the Metropolitan Denver area. Months during which fallout from People's Republic of China nuclear weapons tests passed over Colorado are indicated by N. F indicates months during which gas from the RIO BLANCO well was flared. With the exception of the two Chinese nuclear weapons tests in September and November, 1976, none of the above events had any significant effect on the alpha activity observed. As illustrated in Figure 13, the flaring periods had no visible effect on beta activity.

It is interesting to note that the nuclear test of September 26, 1976, had such a significant effect in the following two months, while the test of November 11 had no visible effect. According to ERDA press releases, the September test was rated at 400 kilotons, while the November test had a yield of 4 megatons. The difference in activity observed may have been caused by (1) the difference in altitude of the two detonations, (2) the relative amounts of energy released through fission and fusion, or (3) the altitude and lateral dispersion of the cloud of radioactive debris. The total long-lived beta levels in air particulates for the period September 18-December 31, 1976, are shown on Figure 14. Daily beta averages during and following periods of gas flaring are plotted on Figures 15, 16, and 17. These illustrate in more detail the fact that no release of particulate beta emitting material was detected during or after flaring periods. The increasing readings noted in the latter part of March, 1974 on Figure 16 evidently are caused by the normal spring phenomenon (See also Figure 13)

C. Noble gases.

During periods of flaring from the RIO BLANCO cavities air samples were collected in compressed air tanks at pressures of about 400 psi, and sent to NERC-/LV for analysis. All samples were checked for krypton-85, xenon-133,

FIGURE 10

PROJECT RIO BLANCO SURVEILLANCE

MONTHLY AVERAGES OF TOTAL LONG-LIVED ALPHA ACTIVITY IN AIR PARTICULATES

FIGURE 11

PROJECT RIO BLANCO SURVEILLANCE

MONTHLY AVERAGES OF TOTAL LONG-LIVED BETA ACTIVITY IN AIR PARTICULATES

FIGURE 12
PROJECT RIO BLANCO SURVEILLANCE
TOTAL LONG-LIVED ALPHA ACTIVITY IN AIR PARTICULATE MATERIAL
(MONTHLY AVERAGES)

FIGURE 13
PROJECT RIO BLANCO SURVEILLANCE
TOTAL LONG-LIVED BETA ACTIVITY IN AIR PARTICULATE MATERIAL
(MONTHLY AVERAGE)

FIGURE 14

PROJECT RIO BLANCO SURVEILLANCE

EFFECT OF FALLOUT FROM NUCLEAR TESTS ON

TOTAL LONG-LIVED BETA ACTIVITY IN AIR

FIGURE 15
 PROJECT RIO BLANCO SURVEILLANCE
 TOTAL LONG-LIVED BETA ACTIVITY IN AIR PARTICULATE MATERIAL DURING
 FLARING (DAILY AVERAGES)
 OCTOBER 3 - DECEMBER 30, 1973

FIGURE 16
PROJECT RIO BLANCO SURVEILLANCE
TOTAL LONG-LIVED BETA ACTIVITY IN AIR PARTICULATE MATERIAL DURING
FLARING (DAILY AVERAGES)

JANUARY 1 - MARCH 30, 1974

FIGURE 17
 PROJECT RIO BLANCO SURVEILLANCE
 TOTAL LONG-LIVED BETA ACTIVITY IN AIR PARTICULATE MATERIAL DURING
 FLARING (DAILY AVERAGES)
 NOVEMBER 1, 1974 - JANUARY 28, 1975

and tritiated methane. The krypton and xenon concentrations were approximately the same as those observed in 1971-1975 in the vicinity of the Fort St. Vrain Nuclear Generating Station prior to its initial operation. (The station is located 35 miles north of Denver and 180 miles east of the Project RIO BLANCO site). Concentrations of tritiated methane varied from less than 5 pCi/m³ to 9 ± 1.6 pCi/m³.

D. Precipitation and Air Moisture.

During flaring periods air moisture samples were collected cryogenically and fresh snow was collected for tritium analysis. Moisture was collected on the surface of stainless steel vessels containing dry ice. A yield of at least 10 ml of liquid water was considered acceptable for tritium analysis.

The results of analyses are listed in Appendix C. No sample of condensed air moisture had tritium concentration above the normally observed levels for Colorado. During the two flaring periods for RB-E-01 well, snowfall occurred several times. Samples of freshly fallen snow were collected and analyzed for tritium. Several samples had elevated concentrations. The highest concentration (156,000 pCi/l) was observed in a sample collected during a snowstorm near sampling site F-1, located about 1.8 miles south of the flaring tower. (See Figure 5).

E. Water Surveillance.

1. Wells.

Fifteen wells throughout the Piceance Basin, used as water supplies for Basin families, were sampled periodically and analyzed for total alpha and beta activity and for tritium. All samples indicated concentrations below detectable levels.

Seven monitoring wells were drilled into the base of the alluvium in the vicinity of faults near Fawn, Black Sulfur and Piceance Creeks. (See Appendix A-9 of Part I). The sites were selected by the State Geologist and geologists from CER-Geonuclear and Shell Oil Company. The results of analyses for radioactivity in grab samples are listed in Appendix C. Detailed chemical analyses of these samples were performed in the Health Department laboratories. The results indicated no significant disturbance to water in the alluvium in the vicinity of faults. (See Appendix A-9 of Part I).

Surface water sampling involved two networks. The CDH Water Quality Control Division has 128 river sampling stations throughout the state. For the RIO BLANCO surveillance program, stations along the Yampa, White, and Colorado rivers were selected. A second network of stations in and around the Piceance Basin was established by the Department of Natural Resources for surveillance of Project RIO BLANCO and oil shale operations. All grab samples were analyzed for radioactivity, and the results are listed in Appendix C.

River samples collected by the Water Quality Control Division are routinely given an extensive chemical analysis. These results are not included in this report, but are available from the Water Quality Control Division. There are no significant differences between the data in Appendix C of Part II of this report. The results thus indicate no measurable release of radioactivity into any of the surface waters sampled as a result of Project RIO BLANCO operations.

It is noted that the streams in the Piceance Basin all have a high concentration of dissolved solids. Piceance Creek and streams draining into it are used extensively for irrigation of pastures and hay fields. The salinity of the streams vary with the degree of irrigation and the quantity of water flowing in the streams. The increase in salinity of water as it passes through the Basin is shown in Figure 18. Much of the downstream increase may be caused by leaching from deposits of nahcolite and dawsonite and from salt water escaping from improperly capped exploratory gas and oil wells. The area is semi-arid. High water levels are experienced in the Spring due to snow melt, resulting in reduced salinity. Some streams dry up in the late Summer and Fall. Spring and Yellow Creeks flow intermittently during the Summer and Fall at sites P-14 and P-15 (See Figure 5). Under these latter conditions stream flow is more dependent on water from the deeper aquifers, hence an increase in salinity.

Other water samples were collected and analyzed. During the second flaring period water samples were taken from the separator and storage tanks for tritium analysis.

<u>Date</u>	<u>Location</u>	<u>Tritium (u Ci/l)</u>
1/30/74	Separator	42,053 c 0.084
1/30/74	Tank 3	44,661 c 0.089
1/30/74	Tank 4	31,075 c 0.062
2/8/74	Separator (unfiltered)	60,576 s12.475
	(filtered)	31.885 s15.935

Values listed for the separator were the average of three analyses. Note the difference in concentration observed between filtered and unfiltered samples. The normal procedure in processing a sample was to filter it through a charcoal column to remove a rust inhibitor, which interfered with the further tritium analysis of the samples.

When cesium and strontium were discovered in the water from the bottom cavity, samples were taken from storage tanks. Water taken from the separator was contaminated with a rust inhibitor. This was removed by filtering the water through charcoal, resulting in a lower apparent tritium concentration. The results of tritium concentration in separator water (listed below) is the average of three separate analyses.

FIGURE 18
PROJECT RIO BLANCO SURVEILLANCE
TOTAL DISSOLVED SOLIDS IN PICCANCE BASIN
AND WHITE RIVER

TOTAL DISSOLVED SOLIDS (PPM)

SAMPLING STATIONS

<u>Date</u>	<u>Location</u>	<u>Total Alpha</u> (pCi/l)	<u>Total Beta</u> (pCi/l)	<u>Tritium</u> (pCi/l)	<u>Strontium-90</u> (pCi/ml)
11/19/74	-Tank 3	29.0 c 22.7	1588 c 64	2263 c 485	0.56
11/19/74	Tank 4	15.6 c 20.6	1154 c 55	- - -	0.46
12/11/74	Storage Tanks	70.3 c 37.6	15525 c 368	1162 c 454	0.58

During the shutdown of the RULISON well the separator was moved from the edge of the well pad to a drip pan near the center of the pad. The separator tipped over and released some water which was contained in a ditch. The water was recovered from the ditch and evaporated into the atmosphere.

<u>Date</u>	<u>Location</u>	<u>Total Alpha</u> (pCi/l)	<u>Total Beta</u> (pCi/l)	<u>Tritium</u> (pCi/l) MDA
7/25/75	Drip pan		-	
10/6/76	Near old location of separator	MDA	MDA	1955 c 475
10/6/76	Ditch contain- ing spill from separator	20.2 c 17.4	15.1 c 11.8	32,236 c 796

Analyses of municipal water samples are also included in Appendix C.

Conclusions.

Based on the Department's observations, the only measurable release of radioactivity to the environment was tritium released during flaring and falling to the surface as fresh snow on November 19 and 20, 1973 and on February 6, 1974. Traces of tritiated methane were noted in compressed air samples collected during flaring and analyzed by NERC-LV Vegas. One water sample collected at Bx-1 in December 11, 1974, had a slightly elevated tritium level. However, samples taken downstream on the next day showed only background levels, suggesting the possibility of errors in analysis and evaluation. Flaring of the gases from the Project RIO BLANCO cavities caused no detectable increase in radioactivity in air particulates. However, during the same period the radioactivity in world-wide fallout was elevated several times due to Communist Chinese nuclear weapons testing.

ACKNOWLEDGEMENTS

The Division of Occupational and Radiological Health is grateful for the assistance and cooperation it has received from many agencies and individuals in this environmental surveillance endeavor. A hopefully complete listing follows:

Colorado Department of Health
Division of Air Pollution Control
Division of Laboratories
Division of Sanitation and Engineering
Division of Water Quality Control

Environmental Protection Agency
National Environmental Research Center, Las Vegas, Nevada
Region VIII Headquarters, Denver, Colorado

United States Atomic Energy Commission
Nevada Operations Office, Las Vegas, Nevada
Lawrence Radiation Laboratory, Livermore, California

United States Geological Survey, Denver, Colorado

Colorado Water Conservation Commission, Denver, Colorado

Eberline Instrument Company, Santa Fe, New Mexico

Mesa County Health Department, Grand Junction, Colorado

CER Geonuclear Corporation, Las Vegas, Nevada

Rifle City Manager's Office

Bureau of Land Management, Meeker, Colorado

Office of the State Geologist, Denver, Colorado

The families of the Piceance Basin.

APPENDIX A
DOCUMENTS PERTAINING TO PROJECT RIO BLANCO

APPENDIX A Index

A-1.	Modification of permit issued by Water Pollution Commission (7/6/73)	A-1-1
A-2.	Oil and Gas Conservation Commission's permit for reentry and flaring (7/17/73)	A-2-1
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A-4.	Permit for Subsurface Disposal issued by the Water Quality Control Division of the Colorado Department of Health (11/9/73)	A-4-1
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A-7.	Amended Permit for Subsurface Disposal (11/8/74)	A-7-1
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A-11.	Notice of Public Hearing before the Colorado Water Quality Control Commission (6/28/76). .	A-11-1
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A-13.	USGS Forms 3-331 for abandoning wells (5/5/76 - 1/24/77).	A-13-1

COLORADO DEPARTMENT OF HEALTH

4210 EAST 11TH AVENUE • DENVER, COLORADO 80220 • PHONE 388-6111

Anthony Robbins, M.D., M.P.A. Executive Director

July 6, 1973

CER Geonuclear Corporation
P.O. Box 15090
Las Vegas, Nevada 89114

RE: Permit for Subsurface Nuclear Detonation Project Rio Blanco

Gentlemen:

The Occupational and Radiological Health Division of the Colorado Department of Health has detected no release or radioactivity through their surveillance program in the post detonation period of Phase I of Project Rio Blanco.

The monitoring program as specified in the permit issued by the Colorado Water Pollution Control Commission is therefore modified as follows:

Item 3(A) changed to read - "Water samples will be collected and analyzed quarterly from the sites listed in Table VII A-1 Volume II of the Project Rio Blanco Definition Plan. The minimum analysis per sample will be as listed in Table VII A-2 of the above reference. In addition, samples as listed in Table VII A-1 will be collected and analyzed during the week following any release or extraction from the emplacement well. CER Geonuclear will make available at least semi-annually a water sample to be split between CER Geonuclear subcontractor and the Colorado Department of Health to compare analytical results. The results of all analyses required in Item 3(A) of the permit will be submitted promptly to the Water Pollution Control Division."

Items 3(C) changed to read - "Water samples will be collected and analyzed weekly for chemical and radiological characteristics from the wells and the zones indicated in Exhibit A (Stations A-1 through A-7, Marathon #1, RBW, RBS-03, RBD-01, RBD-02, and RBD-03) until August 1, 1973. After August 1, 1973, the sampling and testing program referred to above shall be on a monthly basis until October 1, 1974, at which time the program will be evaluated. Radiological analysis will not be required for wells A1-A7 after August 1, 1973. In the event a significant increase in chemical or radiological characteristics is noted in the testing program, the Division shall be promptly notified for further instructions.

CER Geonuclear Corporation
July 6, 1973
Page Two

If there are any questions concerning these amendments to the permit,
please contact this Division

Very truly yours,

Approved:

Original signed by

Original signed by

Kenneth W. Webb, P.E.
Subsurface Consultant

Frank J. Rozich, P.E.
Director, Water Quality
Control Division

KWW:dls

cc: Belmont Evans, Radiological Health
John Rold, State Geologist

Table VIIA-1. Classification and description
of sampling locations.

<u>Class</u>	<u>General Description</u>	<u>Specific Locations</u>	<u>Sec., Twp., Range</u>
A.	Emplacement Well and Vicinity (within several hundred feet)	1. Near EW	14-3S-98W
		2. Two up-valley	14-3S-98W
		3. Two down-valley	14-3S-98W
		4. Two near flare stack	14-3S-98W
		5. Two on Fawn Creek; one up- stream, one down- stream	14-3S-98W
B.	Nearby Habitations	1. Berthelson Ranch (P-L)	35-2S-98W
		2. Brennan Ranch	16-2S-98W
		3. Equity Oil Camp	28-2S-99W
		4. Norell Ranch	19-2S-98W
C.	Population Centers	1. Grand Junction (Clifton)	11-1S-1E
		2. Grand Valley	12-7S-96W
		3. Meeker	23-1N-94W
		4. Rangely	1-1N-102W
		5. Rifle	16-6S-93W
D.	Lakes and Streams	1. Colorado River (SW of De Beque)	33-8S-97W
		2. East Rifle Creek	4-5S-42W
		3. Main Elk Creek	*
		4. Piceance Creek	16-2S-98W
		5. White River (W of Piceance Creek)	34-2N-97W
		6. White River (Meeker)	27-1N-94W

*Unsurveyed, about 39° 40' 40" N. Lat.
107° 34' 20" W. Long.

Table VIIA-2. Environmental sample analysis and annual frequency.

Type of Sample and Analysis	Class of Location																				
	Class A (near EW)					Class B (nearby ranches)				Class C (population centers)					Class D (lakes and streams)						
	1	2	3	4	5	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6	
Air: Gross Beta Gamma Scan ⁽¹⁾ Gamma Scan-charcoal Gross Alpha ⁽²⁾	2					(3)	(3)	(3)	12 ⁽³⁾	12	12	12	12	12							
	4					(3)	(3)	(3)	4 ⁽³⁾	4	4	4	4	4							
						(3)	(3)	(3)	(3)												
Water: Gross Beta					4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
Gamma Scan					4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
89, 90Sr ⁽⁴⁾																					
Gross Alpha					4	4	4	4	4	4	4	4	4	4							
Actual ³ H						4	4	4	4												
Air Moisture - (1) - Lh. Scint. ⁽⁵⁾									1												
Soil: Gamma Scan	2	2	2	2		2	2	2	2	2	2	2	2	2							
³ H by Liquid Scint.	2	2	2	2																	
238, 239Pu	(6)	(6)	(6)	(6)																	
U and Th	(6)	(6)	(6)	(6)																	
Vegetation: Gamma Scan	2	2	2			2	2	2	2												
89, 90Sr	2	2	2			2	2	2	2												
³ H-Liq Scint.	2	2	2																		
Milkcow Feed: Gamma Scan						2	2	2	2												
89,90Sr						2	2	2	2												
Milk:																					
Gamma Scan						4	4	4	4												
89, 90Sr						(4)	(4)	(4)	(4)												
³ H by Liquid Scint.						(8)	(8)	(8)	(8)												
Animal Tissue: Gamma Scan	2	2				2	2	2	2												
89, 90Sr						2	2	2	2												
³ H-Liq Scint.	2	2																			
Fish: Gamma Scan					2										2	2	2	2	2	2	
89, 90Sr															2	2	2	2	2	2	
³ H-Liq Scint					2																
External Background: TLD ⁽⁷⁾	4	4	4	4		4	4	4	4	4	4	4	4	4							

(1)Quarterly Composite

(2)Save all filter papers until conclusion of program for possible alpha analyses

(3)Daily, D-1 through D+3

(4)Initial sample from each location only. Subsequent samples if gamma scan indicates presence of significant quantity of ¹³⁷Cs.

(5)Collected during month preceding D-day. Analyze as background, if necessary.

(6) Initial and final samples only

(7)Exchanged quarterly

(8)Sample collected at about D-7 days from locations indicated plus Meeker dairy. Analysis only if necessary to establish background.

PROJECT RIO BLANCO

SUBSURFACE SAMPLING STATIONS

Colorado Water Pollution Control Division

BEFORE THE OIL AND GAS CONSERVATION COMMISSION
OF THE STATE OF COLORADO

IN THE MATTER OF THE PROMULGATION)
AND ESTABLISHMENT OF FIELD RULES TO)
GOVERN OPERATIONS IN THE RIO BLANCO)
FIELD, RIO BLANCO COUNTY, COLORADO)

CAUSE NO. 264

ORDER NO. 264-2

REPORT OF THE COMMISSION

This cause came on for hearing before the Commission on July 17, 1973, at 9 a.m., in the Auditorium, Social Services Building, Denver, Colorado, after giving Notice of Hearing as required by law, on the application of CER Geonuclear Corporation for an order approving the re-entry and testing of the Rio Blanco Unit Well No. RB-E-01.

FINDINGS

The Commission finds as follows:

1. That due notice of the time, place, and purpose of the hearing has been given in all respects as required by law.
2. That the Commission has jurisdiction over the subject matter embraced in said Notice, and of the parties interested herein, and jurisdiction to promulgate the hereinafter prescribed order.
3. That the Commission by its Order No. 264-1, which authorized the implantation and detonation of nuclear stimulation devices in the Unit Well No. RB-E-01, further ordered that the Commission be notified no less than 60-days prior to the date of the intention to re-enter and test said well and that the Commission be furnished with the plan and other information at an additional hearing for consideration of the proposed plan of re-entry and testing.
4. That re-entry and testing is required to evaluate the results of the nuclear stimulation.
5. That the plan of re-entry into the Well No. RB-E-01 as proposed and set forth on OGCC Form 4 attached to the application, is reasonable and in accordance with good engineering practices; however, should alternate plan 2 be used, in which it will be necessary to drill a new well into the chimney, sufficient 10 3/4 inch casing should be run and cemented through the aquifers that underly the area and are known as the "A" and "B" ground water subsystems.
6. That the testing program as proposed in the application and the release of gas thereunder is reasonably necessary and does not constitute waste as defined in 100-6-3 CRS 1963, as amended.
7. That approval of the re-entry and testing of the Well No. RB-E-01 as proposed, is in the public interest in that it complies with the purpose of the Oil and Gas Conservation Act in fostering, encouraging and promoting the development, production and utilization of gas in the State of Colorado as provided in 100-6-22 CRS 1963, as amended.

O R D E R

NOW, THEREFORE, IT IS ORDERED, that CER Geonuclear Corporation is hereby authorized to re-enter and test the well No. RB-E-01, located in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ Section 14, Township 3 South, Range 98 West, 6th P.M., Rio Blanco County, Colorado. Such re-entry and testing shall be in compliance with good engineering practices and methods as proposed in the application and described on the Oil and Gas Conservation Commission Form 4; provided, however, that if it shall be necessary to drill a new well for re-entry into the chimney, sufficient 10 3/4 casing shall be run and cemented in said well to a depth through the aquifers that underly the area and are known as the "A" and "B" ground water subsystems.

IT IS FURTHER OREERED, that the Commission expressly reserves its right, after notice and hearing, to alter, amend or repeal any part or all of the above order.

ORDERED this 17th day of July 1973.

OIL AND GAS CONSERVATION COMMISSION
OF THE STATE OF COLORADO

By _____
Frank J. Piro, Secretary

BEFORE THE WATER QUALITY CONTROL COMMISSION
OF THE STATE OF COLORADO

IN THE MATTER OF APPLICATION OF C.E.R.	)	
GEONUCLEAR CORPORATION ENTITLED "PROJECT	)	
RIO BLANCO SUBSURFACE WATER DISPOSAL	)	<u>FINDINGS OF FACT</u>
APPLICATION" DATED JUNE 11, 1973, AS	)	
AMENDED.	)	

This matter came on for public hearing on September 24, 1973 before John Phillip Linn, Hearing Officer for the Water Quality Control Commission, State of Colorado. The hearing was closed the same day.

Continental Oil Company, the unit operator for the Rio Blanco unit, whose employees and executives are making the management decisions concerning Project Rio Blanco, was admitted as a party to the proceedings.

C.E.R. Geonuclear Corporation, hereinafter referred to as Petitioner, and Continental Oil Company were represented by James D. Voorhees, Esp., of the firm Moran, Reidy & Voorhees, Denver, Colorado

William Tucker, Assistant Attorney General, State of Colorado, appeared on behalf of the Water Quality Control Commission.

FINDINGS OF FACT

1. The Water Pollution Control Commission of the State of Colorado approved the Petitioner's request for a permit in regard to a nuclear detonation plan for Rio Blanco County, applicable to Phase One only of Project Rio Blanco, on May 4, 1973, nunc pro tunc as of April 17, 1973.

2. Three 30 kiloton nuclear explosives, especially designed for gas stimulation purposes, which had been placed in the Project Rio Blanco Well No. RB-E-01 bore at depths of 5840, 6230 and 6690 feet below the surface of the earth, were detonated on May 17, 1973. The simultaneous explosions of the detonations created a cylindrical chimney, having an overall height of approximately 1,350 feet and a radius from the center line of the chimney of some 80 feet. The maximum extent of fracture from the centerline of the chimney is less than 400 feet. The object of the detonation was to fracture various sandstone layers or lenses in which natural gas occurs.

3. The chimney exists within the base of the Fort Union Formation and the top of the Mesa Verde Formation. Between the top of the chimney and the surface of the earth are approximately 1,000 feet of Fort Union Formation; over 2,000 feet of Wasatch Formation; and some 3,000 feet of the Green River Formation.

4. Contained within the chimney interval are some five million feet of void volume into which an estimated 540,000,000 standard cubic feet of natural gas has flowed. The gas in the chimney is expected to consist primarily of methane (CH_4)--54 to 42 volume percent; carbon dioxide (CO_2)--30 to 25 volume percent; hydrogen (H_2)--10 to 13 volume percent; and water vapor (H_2O)--6 to 20 volume percent.

5. Following detonation of the Project Rio Blanco, the Oil and Gas Conservation Commission of the State of Colorado authorized Petitioner to re-enter and test Well No. RB-E-01 of the Project Rio Blanco by its Order No. 264-2 dated July 17, 1973

6. The Petitioner now seeks a permit approving the underground disposal of radioactive waste, i.e., tritiated water separated during the testing of Well No. RB-E-01, as part of the Second Phase of the Project Rio Blanco experiment, which is a joint activity of the Atomic Energy Commission and Petitioner to determine the feasibility of using nuclear explosives in the production of natural gas from formations which will not produce under conventional methods.

7. The Petitioner expects to produce 300,000,000 standard cubic feet of natural gas, but there is a contingency to produce up to 800,000,000 standard cubic feet of natural gas, during the testing period.

8. The radioisotopes of primary interest in all of the natural gas created by the explosion are krypton-85 (^{85}Kr)-- something less than 2,000 curies; and tritium (^3H)-- something less than 3,000. Three thousand curies is the equivalent of approximately 3/10s of a gram of tritium. Essentially all of the ^{85}Kr and about 10 percent of the ^3H are mixed with the chimney gas. Other contributions to the total radioactivity of the chimney gas are small amounts of carbon-14 (^{14}C); argon-37 (^{37}Ar); and argon-39 (^{39}Ar).

9. Through Well No. RB-E-01, re-entry will penetrate the chimney and fractured zone, and at the conclusion of the re-entry conventional production separation equipment will be placed on the surface of the earth. Gas from the chimney will be produced up the well bore as a result of the pressure and temperature decrease during this production and some water will condense from the vapor phase and be separated as liquid water in the separator.

10. The Applicant proposes to reinject the water produced in the Rio Blanco Project into the formation and area from which it came in order to minimize the amount of radioactivity to the biosphere during the testing of the project re-entry well. This water will be stored in four 400-barrel storage tanks, analyzed for its radioactivity and other contents, and then be re-injected through a 2-inch line into the Fawn Creek Government Number 1 Well, some 1320 feet to the south, into an area essentially opposite of the chimney and in the same lower Fort Union Formation.

11. Hydrocarbon condensate, which will condense out in the separator, will be sent to condensate storage tanks, be checked for radioactivity, be pumped up the flare stack and be burned along with the gas.

12. Tritium concentrations in the water produced along with the gas, which will be separated at the surface of the earth, will be 0.05 micro-curies per milliliter, or .05 millions of a curie of tritium per milliliter of water. This is 16 times greater than the present standard accepted for drinking water as published by the Federal Radiation Council and the International Council for Radiation Protection, which is .003 micro-curies per milliliter for an individual, and .001 micro-curies per milliliter for the populous at large.

13. Tritium is an isotope of hydrogen, having a mass of three. It is unique radioactivity of the isotope hydrogen. It decays with a 12.26 year half life, emitting exclusively beta particles. Half life is a convenient representation of the life time that the radionuclide exhibits. A half life of 12.26 years means a given quantity of tritium will be reduced to one-half that level in a period of 12.26 years, and will be one-fourth of the initial amount in two one-half lives, or 24 years. Tritium decays into inactive helium-3. Water having .05 micro-curies of tritium per milliliter would take approximately 50 years to decay to .003 micro-curies per milliliter, and would take approximately 70 years to decay to .001 micro-curies per milliliter. Consequently, water which will be produced from and during the testing of the RB-E-01 Well will be potable in approximately 70 years on the basis of present knowledge and under existing standards.

14. In the production of 300,000,000 standard cubic feet of natural gas from Well No. RB-E-01, some 296 curies of tritium will be produced, of which 50 curies will be separated in the separator in the liquid water condensed from the gas phase and be diluted in 6,500 barrels of water. That 6,500 barrels of water will be injected into the Fawn Creek Government Number 1 Well. The remaining 246 curies of tritium existing in the gas will be metered, sent to the flare stack, and burned off into the atmosphere.

15. If production of natural gas goes to the full 800,000,000 standard cubic feet, the total tritium production from the well will be 580 curies, of which 130 curies would be diluted in 20,000 to 24,000 barrels of water which would be injected into the Fawn Creek Government Number 1 Well. The remaining 450 curies of tritium existing in the gas would be metered, sent to the flare stack, and burned off into the atmosphere. In any case, the krypton-85 and carbon-14 will have to be flared into the atmosphere.

16. Radiological protection and documentation of radioactive effluents will be provided until the end of the production testing and subsequent site rollup. It is expected that measurable quantities of radioactivity will be deposited in the immediate vicinity of both the Emplacement Well, No. RB-E-01, and the flare stack areas. Water samples will be collected immediately before and after the flaring operation at each of six locations. Intermediate samples will be taken at intervals of 3 days. Additional samples will be collected at two class locations weekly during and after the flaring operation for a period of at least 4 weeks, extending until at least 1 week following the conclusion of flaring. These samples will be assayed for tritium activity by liquid scintillation methods and for other nuclides by gamma spectrometry. Meteorological and ecological studies indicate that even with release of all gaseous radioactivity to the atmosphere, the maximum commitment in the vicinity will be much less than 1 percent of the annual natural background radiation.

17. The Fawn Creek Government Number 1 Well, into which the tritiated water will be injected, was drilled by Equity Oil Company in 1958. The Petitioner tested two intervals in 1969. Then, in early 1973, Petitioner perforated additional sand lenses and ran a water injectivity test which showed that the rate of water influx into the sand intervals of 5745 to 6072 feet was in excess of 3,000 barrels a day at 1,500 psi surface pressure. The interval from 5600 to 5630 feet was shown from experience to take water. In early September, 1973, Petitioner perforated the zone from 5084 to 5126 feet and received ample quantities of gas for its production facility. Petitioner also ran a cement bond log from the interval 5400 to 4600 feet and it was shown that there is solid cement from the gas interval at 5084 to 5126 to the interval where the water will be injected from 5600 down to 6072 feet. The cement will constitute a barrier so that there will be no water migration up on the outside of the casing.

18. Petitioner has successfully seated a Baker FH Hydrostatic Packer 5300, in the casing of the Fawn Creek Government Number 1 Well. This particular type of packer has been used in connection with water containing tritium. Any packer failure would be evidenced immediately because water would move up through the 1.9 inch casing of the gas production string and eventually the gas production would die. In the event of a leak, it would be necessary to pull the tubing strings and run a new packer after inhibiting the water or filling the casing with fresh water pumped down the 1.9 inch tube.

19. There is a dual tubing hanger in the Fawn Creek Government Number 1 Well. The connection at which the tubing screws into the tubing hangers has been tested to 4300 psi and was found to have no leaks. The joints between the 2 1/16" water injection tubing and the entire string have been pressure tested to 3,000 psi. The injection pressure through that tubing will be less than 1500 psi, probably 1000 psi. An injection pressure of 1500 psi would provide 3770 psi pressure at the point against the bottom of the packer. The gas zone has a bottom hole pressure of 1890 psi so the differential is less than 2000 psi. The packer should hold even when the differential is 7000-8000 psi.

20. The calculated flooded radius from injected water during the flow period, if approximately 6500 barrels of water would be produced, in the sand interval from 5600 to 6072 feet, where the net sand that has been opened is 150 feet, would be roughly a radius of 100 feet (less than an acre) even if only 20 feet of the 150 feet interval were taking water. If 20,000 to 24,000 barrels of water were produced and injected into the same area under a maximum 30-day injectivity test, the flooded area would be 190 to 195 feet in radius if only 20 feet of the interval took water. The water will be distributed reasonably uniformly around the well bore in an eccentric ellipse approaching a circle. Water injectivity tests, performed by Petitioner in 1973 from roughly 5660 feet down below that point, which did not include the zone from 5600 to 5630, showed that in excess of 3,000 barrels of water per day could be injected into these lower zones at 1500 psi. surface pressure. The rate of water production which Petitioner anticipates during the testing is 600 barrels a day.

21. Petitioner's understanding of the geological formations within a radius of at least ten miles from the Fawn Creek Government Number 1 Well is based upon all available geological information, with respect to that area, including an examination of all available well logs, drilling records, core analysis, and other physical data generally developed as part of a drilling program; including geophysical studies and reflection seismic studies; including a detailed study in the emplacement well area to determine if there were any faults and to check the authenticity and accuracy of previous geophysical surveys; and including examinations of the outcrops in the area.

22. In the area of Well No. RB-E-01 and the Fawn Creek Government Number 1 Well, the lowest or deepest geological aquifer or rock that contains sufficient permeability and porosity to have a reasonable amount of water is the B-aquifer located under the Mahogany Zone in the area of the Fawn Creek Government Number 1 Well. The bottom of this zone is approximately 1400 feet subsurface. There is no evidence of aquifers containing moving water below the B-aquifer.

23. The Mahogany Zone constitutes a barrier to water migration. Above the Mahogany Zone is a fractured shale sequence called the A-aquifer. Above the A-aquifer is the Evacuation Creek, which is shales and sandstones having very low capacity. And in the stream valleys there is a thin layer of alluvium which contains water. The alluvium, the A-aquifer and the B-aquifer constitute the viable aquifers in the area in question.

24. The bottom of the B-aquifer is approximately 5,000 feet above sea level. The top of the fractured zone of Well No. RB-E-01 is approximately 1,000 feet above sea level. The tritiated water will be injected into the Fawn Creek Government Number 1 Well at an interval from 500 to 1,000 feet above sea level. There is approximately 3,000 feet of impermeable shale between the top of the zone into which water will be injected and the B-aquifer.

25. The B-aquifer, as the lowest and deepest area containing presently useable water, moves at a rate of about 35 feet per year. There is no source of withdrawal from the B-aquifer, near the location of any Fawn Creek Government Number 1 Well, for human use or irrigation or any other public use. Approximately three and one-half miles from this location there is a fault zone which may allow vertical migration of water which might results in water occurring in the alluvium, but at the rate of water movement in the B-aquifer it would take several hundred years for that water in the area of the Fawn Creek Government Number 1 Well to travel to this fault.

26. The A-aquifer has a velocity approximately ten times that of the B-aquifer. Water from the A-aquifer is being used within a distance of approximately four miles from Project Rio Blanco. The hydrologic report shows that the flow volume in the A-aquifer, the B-aquifer and the alluvium aquifer systems is so great that the dilution factor would prevent any hazard even if tritiated water could somehow mingle with the waters in these aquifers.

27. The water that will be produced during the test is connate water or fossil water, i.e., water deposited with the sediments or very close to the sediments in which it is currently found, which was laid down 50 to 60 million years ago and has remained localized in the sands during that time.

28. The water which will be injected into the Fawn Creek Government Number 1 Well to the same stratigraphic levels from which it came will have no present or foreseeable beneficial use and there is no reasonable probability that such water, while adversely affected, will mingle with or be tributary to beneficial, useable waters of the State of Colorado.

29. Petitioner has proven beyond a reasonable doubt that in disposing of radioactive water by injection into Fawn Creek Government Number 1 Well, as detailed in its "Project Rio Blanco Subsurface Water Disposal Application," dated June 11, 1973, as amended, that there will be no pollution resulting therefrom or that the pollution, if any, will be limited to waters in a specified limited area from which there is no risk of significant migration and that the disposal of the radioactive water is justified by public need.

Original Signed by:

October 15, 1973

John Phillip Linn, Hearing Officer

WATER QUALITY CONTROL DIVISION

COLORADO DEPARTMENT OF HEALTH

November 9, 1973

APPLICATION OF CER - GEONUCLEAR)
CORPORATION AND THE CONTINENTAL)
OIL COMPANY TO OPERATE A SUBSURFACE)
DISPOSAL SYSTEM UPON AND UNDER A)
TRACT OF LAND 739 FEET FROM THE)
WEST LINE AND 2357 FEET FROM THE)
NORTH LINE OF SECTION 14, T3S,)
R98W, RIO BLANCO COUNTY, COLORADO)

PERMIT FOR
SUBSURFACE DISPOSAL

1. The Colorado Water Quality Control Commission has found, after Public Hearing and due consideration, that subsurface disposal, as proposed in the application by CER Geonuclear Corporation and the Continental Oil Company, could take place within the meaning of Section 66-28-505(1) of the Colorado Water Quality Control Act of 1973.
2. The Colorado Water Quality Control Division hereby grants CER Geonuclear and the Continental Oil Company a permit for the operation of a subsurface disposal system as provided for in Section 66-28-505(2) of the Act and as provided for in Section 3(d) of the Emergency Rules for Subsurface Disposal Systems, effective October 16, 1973; subject to the following conditions and stipulations:
 - A) Discharge under this permit may occur for a period of twelve months beginning on November 10, 1973.
 - B) Total volume injected shall not exceed 24,000 barrels (42 gal./bbl) and concentration of tritium shall not exceed 0.05 micro Ci/ml.
 - C) Injection pump pressure shall not exceed 1800 p.s.i.g.
 - D) Injection interval shall be from 5600 feet to 6072 feet.
 - E) Construction of the system and appurtenances, either as constructed or to be constructed, shall conform to the plans and specifications as proposed in the Project Rio Blanco - Subsurface Water Disposal Application submitted by CER Geonuclear June 11, 1973, except that the disposal interval includes the zone from 5600 to 5630 feet, as subsequently amended by the applicant.

- F) Operational procedures, including alarm systems, shall be implemented as proposed in the application referred to above.
 - G) If testing of the RB-E-01 well and subsequent disposal into the Fawn Creek Government No. 1 well (proposed disposal system) is conducted in phases, the Water Quality Control Division and the Occupational and Radiological Health Division of the Colorado Department of Health shall be notified immediately upon completion of the testing period and at least five days before the resumption of a new testing period.
 - H) Any deviation from testing or injection procedures as outlined in the application referred to in (E) above shall require prior approval of the Water Quality Control Division and shall be requested in writing in sufficient time to provide adequate time for review and approval.
 - I) Employees of Department of Health and Department of Natural Resources shall be allowed access to the site without prior notification for purpose of observation of operations and sample collection of waste and/or products. Such access, however, to be subject to established health and safety precautions.
 - J) This permit shall not be assigned nor operations contracted to another party without prior written approval of the Colorado Water Quality Control Division.
3. Monitoring shall be conducted by CER Geonuclear and the Continental Oil Company as follows:
- A) Samples of gas and injected fluid shall be analyzed for chemical and radiological constituents from the locations and at the frequencies indicated in Exhibit "A". Analyses shall be performed by the applicant's laboratory or an independent laboratory approved by the Division and the results of the analyses certified.
 - B) Upon request of the Colorado Water Quality Control Division, the applicant shall promptly furnish, at the time intervals indicated and at the applicant's cost, samples for analysis by the Colorado Department of Health. The samples shall be in the quantity and from the locations as specified by the Division and shall be properly labeled.
 - C) CER Geonuclear Corporation and Continental Oil Company, by undertaking the discharge which is the subject of the application, agree to perform such additional monitoring procedures and installations as may be required upon subsequent review by the Division, at the expense of the applicants.
4. All rules, regulations, orders, guidelines, etc., by the Colorado Water Quality Control Commission presently in effect, as well as any subsequent rules or regulations adopted by the Commission, shall be observed by the applicants.

5. This authority to discharge shall terminate in all respects, except for such monitoring and reporting procedures as required in Exhibit "A", twelve months from the effective date, unless the Colorado Water Quality Control Division shall extend the termination date.
6. This permit shall in no way be construed to relieve the applicants from complying with the requirements and regulations of other State and Federal regulatory agencies, including the Occupational and Radiological Health Division of the Colorado Department of Health. Nothing herein contained shall be construed to relieve the permittees from the observance of, performance of, or compliance with, any conditions, duties, or obligations imposed by any order, permit or license issued by any agency of the State of Colorado.

BY ORDER OF THE COLORADO WATER QUALITY CONTROL DIVISION

Frank J. Rozich, P.E.
Director, Colorado Water
Quality Control Division

Roy L. Cleere, M.D., M.P.H.
Executive Director, Colorado
Department of Health

WATER QUALITY CONTROL DIVISION

COLORADO DEPARTMENT OF HEALTH

November 9, 1973

MONITORING PROCEDURES FOR)
SUBSURFACE DISPOSAL SECTION 14,)
T3S, R98W, RIO BLANCO COUNTY,)
COLORADO)

EXHIBIT "A"

As a condition of the permit for subsurface disposal, CER Geonuclear and Continental Oil Company shall perform the following monitoring procedures:

1. Gas and water sampling schedules and analyses as proposed in the application (Table IVD-1, Page 94), shall also include an analysis for tritium for the gas and water produced from the disposal well (Fawn Creek Government No. 1). Results of the chemical and radiological analyses of the samples will be submitted to the Division within five days after the completion of the analyses.
2. Water injection rates and pressures shall be monitored continuously and recorded on a daily basis. Daily records shall indicate the maximum injection pump pressure as well as the average (or operating) pressure and rate. Daily records, including volume, shall be submitted monthly in duplicate to the Division by the tenth day of the month for the proceeding month, or ten days after the completion of any testing period.
3. The disposal well shall be shut down and a pressure fall off test performed at each ten day interval and at the conclusion of any testing period. The shut down period is to be as long as necessary to obtain conclusive results. Data and/or charts are to be submitted to the Division within five days after completion of the pressure fall off test.
4. Water samples shall be collected and analyzed for radioactive constituents from the following wells: RB-D-01, RB-S-03, and RB-W-01(W-1), as identified and located on Plate II of the Project Rio Blanco - Subsurface Water Disposal Application.

Collection and analysis shall be weekly throughout the disposal period and for one month thereafter. If no anomalous amounts of radioactive constituents are observed during this period, then collection and analysis shall be on a monthly basis for twelve months after injection has terminated. If at any time anomalous amounts of radioactive constituents are observed, the injection system shall be shut down and the Water Quality Control Division promptly notified. Reinjection shall not be started without permission from the Division.

Monitoring procedures and conditions outlined above are supplemental to the present monitoring program required in the Permit for Subsurface Nuclear Detonation and in no way relieves CER Geonuclear from the requirements of the previous permit.

NOTICE OF PUBLIC HEARING
BEFORE THE
COLORADO WATER QUALITY CONTROL COMMISSION

Pursuant to the provisions of 66-28-202(g), -401, -505, and 3-16-4, Colorado Revised Statutes 1963 as amended, and to the Rules for Subsurface Disposal Systems, NOTICE is hereby given that a hearing officer of the Colorado Water Quality Control Commission will hold a public hearing on September 4, 1974, beginning at 9:00 A.M., in Room 150, Colorado Department of Health Building, 4210 E. 11th Avenue, Denver, Colorado.

The purpose of the hearing is to consider an application from Continental Oil Company to amend the Permit for Subsurface Disposal, dated November 9, 1973, issued to Continental Oil Company and CER Geonuclear Corporation by the Water Quality Control Division, for the operation of a subsurface disposal system in connection with the testing of the RB-E-01 nuclear stimulated well, in Section 14, Township 3 South, Range 98 West, Rio Blanco County, Colorado and providing for the discharge of wastes underground from 5,600 to 6,072 feet subsurface, so as to (i) increase the permitted total volume to be injected from 24,000 barrels to 34,000 barrels; (ii) provide a limit of 450 curies in the radioactive contents of all permitted wastes in place of the permit limit of 0.05 micro Ci/ml; and (iii) extend the permitted discharge period beyond November 10, 1974.

The Commission is to determine (i) whether waters of the State will be polluted by the proposed activity or (ii) if waters of the State may be polluted thereby, whether such pollution will be limited to waters of a specified limited area from which there is no risk of significant migration and that the proposed activity is justified by public need.

A prehearing conference will be held August 20, 1974, at 9:00 A.M. at 4210 E. 11th Avenue, Denver, Colorado in the office of the Technical Secretary to the Commission. The purpose of this conference is to consider any matters which will simplify the issues and aid in disposition. Any person who desires to appear as a party to the proceeding pursuant to CRS 66-28-401(3) and CRS 3-16-4(2) is requested to file his request prior to August 20, 1974.

The authority for the Commission to hear, consider and approve or disapprove said application is contained in sections 66-28-202, -401, and -505, Colorado Revised Statutes as amended in 1973.

Dated this 18th day of July, 1974.

E. B. Pugsley, P.E., Technical Secretary
Colorado Water Quality Control Commission

BEFORE THE WATER QUALITY CONTROL COMMISSION
OF THE STATE OF COLORADO

IN THE MATTER OF APPLICATION OF)
CONTINENTAL OIL COMPANY AND C.E.R.)
GEONUCLEAR CORPORATION TO AMEND)
THE PERMIT FOR PROJECT RIO BLANCO)
SUBSURFACE DISPOSAL, DATED)
NOVEMBER 9, 1973, AND ISSUED TO)
CONTINENTAL OIL COMPANY AND TO)
C.E.R. GEONUCLEAR CORPORATION)
BY THE WATER QUALITY CONTROL)
DIVISION)

FINDINGS OF FACT

This matter came on for public hearing on September 4, 1974, before John Phillip Linn, Hearing Officer for the Water Quality Control Commission, State of Colorado.

The only parties appearing at the hearing were Continental Oil Company, together with C.E.R. Geonuclear Corporation, and the State Division of the Colorado Department of Health.

Continental Oil Company and C.E.R. Geonuclear Corporation, herein referred to as the Applicant, were represented by James D. Voorhees, Esq., of the firm Moran, Reidy & Voorhees, Denver, Colorado.

The State Division of the Colorado Department of Health, herein referred to as the Division, was represented by Michael Paul Isbell, Assistant State Solicitor General.

FINDINGS OF FACT

1. The purpose of the application in this matter is to amend the Permit for Subsurface Disposal, dated November, 1973, issued to the Applicants by the Water Quality Control Division, to (i) increase the permitted total volume to be injected from 24,000 barrels to 34,000 barrels; (ii) change the method of determining radioactive pollution from a per-unit measure of 0.05 micro Ci/ml, as provided under the existing Permit limit, to a total of 450 curies in the radioactive contents of all permitted wastes; and (iii) extend the permitted discharge period beyond the present cut-off date of November 10, 1974.

2. The desired changes affect the operation of a subsurface disposal system in connection with the testing of the RB-E-01 nuclear stimulated well in Section 14, Township 3 South, Range 98 West, Rio Blanco County, Colorado, which provides for the discharge of wastes underground from 5,600 to 6,072 feet subsurface.

3. Proof was made of publication of the required notice of hearing in the Major Herald, the county paper of Rio Blanco County, Colorado, and in the Daily Journal, published in Denver, Colorado. Affidavits of mailing a copy of the application here to all owners of records, to within two miles of the proposed facility, as determined by certificate from the County Abstractor, accompanied the application filed with the Water Quality Control Commission. All notice requirements have been met.

4. The increase in the allowed water for disposition is necessitated because initial test procedure, which occurred following the issuance of the existing Permit, determined that the top cavity of an expected chimney of three cavities was not connected to the lower cavities. In an attempt to confirm this fact, Applicants released a total of ninety-eight million standard cubic feet of dry gas, which was much more gas than was originally intended, with a resulting larger amount of tritiated water produced (13,340 barrels). The Permit prohibited the re-injection of this water if it contained more than .05 micro-curies of radioactive waste per milliliter. The water contained tritium values ranging between .07 and .075 micro-curies per milliliter. Consequently, the water taken from the cavity by the test was diluted with fresh surface water. Approximately 20,837 barrels of water, containing 149.5 curies of tritium, was injected under the Permit into the Fawn Creek Government Number 1 Well.

5. Further, more water was produced than was originally planned because bottom hole temperatures were higher than expected (the Applicant had anticipated 375-425 degrees, but the temperature, in fact, was in the range of 500 degrees); and the bottom hole pressures were lower than had been predicted (the Applicant had anticipated pressures in the range of 2400 psi but pressures were, in fact, about 2000 psi). Additional steam was produced in order to lower the temperature. Consequently, the water produced was higher than predicted.

6. The Applicant seeks permission to take the additional water it needs in the re-entry process, to the second and/or third cavity of the Project Rio Blanco Well No. RB-E-01, from the RB-AR-2 Well.

7. In the re-entry process, the Applicant will determine the degree of communication between the second, or middle, and third, or bottom, cavities or chimneys; the flow capacity of the formations adjacent to the chimneys; the fractured region and any associated vergent formation; as well as the quality of the gas. There is no way to make these determinations except by the release of gas from the zones in question. Water production rates during the 10-15 day flow period is expected to average about 650 barrels per day. Applicant believes that any modifications required due to encountered conditions can be accommodated with the amount of additional water sought here in the amended permit.

8. The surface test facilities will be the same equipment that was used during the former testing phase. The entire injection test system will be the same as was operated satisfactorily in the former testing phase, in the manner in which the applicant represented that it would in the earlier hearing before the Water Quality Control Commission.

9. The Baker FH Hydrostatic Packer 5300 was used successfully in the former testing phase and will be used in the next testing phase.

10. During the former testing phase, the Applicant detected a minute leak of about one barrel of water total of the 21,000 barrels injected through the injection tubing string. This leaked water stayed in the annular, or gas, area above the packer inside of the 5 1/2" casing. There is no connection between this water and any aquifer holding water of the State of Colorado. This leak was detected as a result of the monitoring of gas being produced from the concrete well above the packer for tritium, as required in the November 9, 1973 Permit. The Applicant has plans to detect and correct the leak, which remedial action is consistent with proper oil field procedures and is without any possibility of tritiated water getting into the environment.

11. During the former testing phase, the monitoring and safety checks in the environmental sampling program revealed very small quantities of tritium in the soil moisture within 100 feet of the flare stacks, as was expected. There was no observable evidence of tritium off the test site. There was no tritium above background detected in any underground waters from the wells tested in the area at distances from four to twelve miles. Regular monthly sampling has been made and all results of that testing have been made available to appropriate State agencies. The amended permit application sets forth new radiological and environmental sampling plans for personnel protection and public safety.

12. On the basis of geological evidence learned before and after the first testing phase, the Fawn Creek Government Number 1 Well into the Fort Union sandstone lenses has the capacity to receive the additional water sought by Applicants here, with no possibility of this water connecting with any known aquifers containing useable water. There is no natural movement or flow of the water within the Fort Union formation. There is evidence of some pressure parting, but this will not permit radioactive waters to mingle with other waters of the State

13. It is expected that the tritium content of the water that will be produced in the proposed test phase, which will penetrate the third cavity and possibly intersect the fracture zone of the second cavity, will be essentially the same as that produced in the top chimney, i.e., about .075 micro-curies per milliliter, but allowing for a reasonable margin of error, it is estimated that the tritium content will be between .05 and .15 micro-curies per milliliter.

14. The instant application asks that the per unit limit of tritium be changed to a total quantity of 450 curies to be injected into the subsurface disposal well so that Applicant can avoid having to dilute the water as was necessary in the former testing phase. Because approximately 150 curies have already been injected into the disposal well, the application seeks to inject an additional 300 curies of radioactive waste into the disposal well. At the rate of expected concentrations of tritium, the production of the additional barrels of water will not exceed the total 450 curies of tritium.

15. The Division of Administration of the Colorado Department of Health has received the reports of independent experts to whom it referred the instant application for evaluation. Dr. Maurice Major, of the Colorado School of Mines, reported that the possibility of earthquakes is so slight that one need not consider it. Messrs. H.C. Classen and T.A. Ehlke, of the United States Geological Survey, evaluated the application from the standpoint of subsurface relations and found no matters of concern which could not be controlled

as necessary through the conditions of the permit. Dr. Van Poolen of H.K. Van Poolen and Associates, Inc., concluded that there is no better method of disposing of the water than into Fawn Creek Government Number 1 Well, and that the risks involved, if any, are minimal.

16. The findings set forth are considered together with the findings of fact as set forth in the report of the hearing of the matter of application of the Applicant entitled "Project Rio Blanco Subsurface Water Disposal Application" dated June 11, 1973, as amended, of the undersigned.

17. The Applicant has proven beyond a reasonable doubt that in disposing of radioactive water by injection into Fawn Creek Government Number 1 Well, as detailed in its Application dated June 18, 1974, to Amend the Permit for Project Rio Blanco Subsurface Water Disposal, dated November 9, 1973, that there will be no pollution resulting therefrom or that the pollution, if any, will be limited to waters in a specified limited area from which there is no risk of significant migration and that the disposal of the radioactive water is justified by public need.

Original Signed by:

September 30, 1974

John Phillip Linn, Hearing Officer

COLORADO DEPARTMENT OF HEALTH

November 8, 1974

APPLICATION OF CER-GEONUCLEAR	)	
CORPORATION AND THE CONTINENTAL	)	
OIL COMPANY TO OPERATE A SUBSURFACE	)	
DISPOSAL SYSTEM UPON AND UNDER A	)	AMENDED PERMIT FOR
TRACT OF LAND 739 FEET FROM THE	)	SUBSURFACE DISPOSAL
WEST LINE AND 2357 FEET FROM THE	)	
NORTH LINE OF SECTION 14, T3S,	)	
R98W, RIO BLANCO COUNTY, COLORADO	)	

1. The Colorado Water Quality Control Commission has found, after Public Hearing and due consideration, of the subsurface disposal, as proposed in the application for amended permit by CER-Geonuclear Corporation and the Continental Oil Company, that there will be no pollution resulting therefrom, or that the pollution, if any, will be limited to waters in a specified limited area from which there is no risk of significant migration and that the disposal of the radioactive water is justified by the public need.
2. The Division of Administration of the Colorado Department of Health hereby amends the permit issued to CER-Geonuclear and the Continental Oil Company, dated November 9, 1973, as follows:
 - Item 2(A) Changed to read: "Discharge under this permit may occur for a period of twelve months from November 9, 1974.
 - Item 2(B) Changed to read: "Total volume injected shall not exceed 34,000 barrels (42 gal./bbl.) and total amount of tritium shall not exceed 450 curies, and all other radioactive materials are not to exceed limits specified in RH 4.5 State of Colorado, Rules and Regulations pertaining to Radiation Control."
3. All other conditions of the original permit and monitoring procedures shall remain in full force and effect.

BY ORDER OF THE COLORADO DEPARTMENT OF HEALTH DIVISION OF ADMINISTRATION

Edward G. Dreyfus, M.D., M.P.H.
Division of Administration
Executive Director
COLORADO DEPARTMENT OF HEALTH

COLORADO DEPARTMENT OF HEALTH

4210 EAST 11TH AVENUE • DENVER, COLORADO 80220 • PHONE 388-6111

Edward G. Dreyfus, M.D., M.P.H. Executive Director

December 6, 1974

Mr. James D. Voorhees
Moran, Reidy, and Voorhees
818 Patterson Building
Denver, Colorado 80202

Dear Mr. Voorhees:

SUBJECT: YOUR REQUEST, DATED NOVEMBER 19, 1974, REGARDING SUBSURFACE
DISPOSAL WELL PERMIT AMENDMENT FOR PROJECT RIO BLANCO

In summary, the November 19 letter states that your clients would not be able to function under the referenced requirements of RH 4.21, Appendix A, Table II limitation, and are requesting an additional amendment of the permit to allow usage of RH 4.21, Appendix A, Table I limitations; and, that such limitations are in accord with the Water Quality Control Commission's Findings of Fact and pose no hazard to public health and safety.

Department staff has reviewed the November 25, 1974 letter to Mr. A.J. Hazle of the Department from Mr. H.H. Aronson, Vice President, CER Geonuclear, and other supporting documentation. Information contained therein identifies that the anticipated maximum injection water concentrations of cesium-137 and strontium-90 would approximate 34 pCi/ml and 4.5 pCi/ml, respectively. Based on the remaining 13,000 barrels, out of a total volume of 34,000 barrels (42 gallons/barrel) to be injected, the total inventory of these radionuclides would approximate 70 and 12 millicuries, respectively.

The Department concurs that the injection of these concentrations into the Fort Union sandstone lenses will not pose a public health hazard, and that pollution, if any, will be confined to a specified limited area. Accordingly, enclosed is Amendment #2 of the Permit for Subsurface Disposal providing for injection of concentrations of radioactive materials other than tritium, not to exceed limitations of RH 4.21, Appendix A (and its appropriate footnotes), Table I.

It is hoped that the provision of this Amendment, which allows the injection of a mixture of radioactive materials, not limited to cesium-137 and strontium, adequately provides for production testing, and that further amendment of the permit will not be necessary.

Sincerely,

A handwritten signature in dark ink, appearing to read "E. G. Dreyfus".

Edward G. Dreyfus, M.D., M.P.H.
Executive Director

EGD/bjp

COLORADO DEPARTMENT OF HEALTH
December 6, 1974

APPLICATION OF CER - GEONUCLEAR)
CORPORATION AND THE CONTINENTAL)
OIL COMPANY TO OPERATE A SUBSURFACE)
DISPOSAL SYSTEM UPON AND UNDER A)
TRACT OF LAND 739 FEET FROM THE)
WEST LINE AND 2357 FEET FROM THE)
NORTH LINE OF SECTION 14, T3S,)
R98W, RIO BLANCO COUNTY, COLORADO)

PERMIT FOR
SUBSURFACE DISPOSAL
(AMENDMENT #2)

1. The Division of Administration of the Colorado Department of Health has received an additional application for a second amendment to its original permit by CER-Geonuclear Corporation and the Continental Oil Company, and after appropriate review of supporting documentation, finds that this amendment is consistent with the findings of the Colorado Water Quality Control Commission made with respect to the original permit as first amended.
2. The Division of Administration of the Colorado Department of Health hereby amends the permit issued to CER-Geonuclear and the Continental Oil Company, dated November 9, 1973, and first amended November 8, 1974, as follows:

Item 2(B) Changed to read: "Total volume injected shall not exceed 34,000 barrels (42 gallons/barrel), the total amount of tritium shall not exceed 450 curies, and all other radioactive materials are not to exceed the limits specified in RH 4.21, Appendix A (and appropriate footnotes), Table I of the State of Colorado Rules and Regulations Pertaining to Radiation Control."

3. All other conditions of the original permit as first amended and monitoring procedures shall remain in full force and effect.

BY ORDER OF THE COLORADO DEPARTMENT OF HEALTH DIVISION OF ADMINISTRATION
COLORADO DEPT. OF HEALTH
Division of Administration

Edward G. Dreyfus, M.D., M.P.H.
Executive Director

COLORADO DEPARTMENT OF HEALTH

4210 EAST 11TH AVENUE • DENVER, COLORADO 80220 • PHONE 388-6111

OCCUPATIONAL AND RADIOLOGICAL HEALTH DIVISION

January 15, 1975

Mr. Larry M. Ozbun, Chairman
Moffat County Republican Central Committee
Craig, CO 80200

Dear Mr. Ozbun:

This letter is in response to your correspondence of November 8 in which you expressed concern over the detection of cesium-137 in the Rio Blanco well. I have delayed replying to your letter until we had received a full report of the entire incident, and the final report on the total amount of radioactive material involved in the flaring of the well.

As you may be aware, we have had an environmental surveillance program in effect since before the detonations on May 17, 1973. Since the incident we had personnel visit the area on November 8, 19, and 22. The information furnished you is based on our own investigation and a written report submitted at our request by CER Geonuclear, the industrial co-sponsor of the project.

During the drilling of the reentry well RB-AR-02, when the drill reached the fracture region surrounding the lowest of the three cavities formed by the detonations, drilling fluid was lost into the cavity. The operator estimated the loss of fluid eventually to be about 4000 barrels (one barrel is equal to 42 gallons).

On November 2, a three-hour flow test was conducted to check out the entire system. As expected, water came up with the gas. The gas was run through a separator to remove the water--a normal gas field procedure--and then was flared through a stack on a ridge above the well.

Initially, there was no readily detectable activity except some krypton-85, an isotope of a so called "noble gas".

After flaring had continued for 1½ to 2 hours, cesium was detected in the water coming out of the well. Had the water come up as steam, it is probable that none of the cesium would have been removed from the cavity.

Mr. Larry Ozbun, Chairman
January 15, 1975
Page Two

All of the water from the separator and water used to clean up the equipment was pumped into two of four 400-barrel storage tanks, where it awaited ultimate disposal. The amount of cesium brought up from the well at this time was calculated to be about 82 microcuries of cesium-137 and 2.1 microcuries of strontium-90 by the Eberline Instrument Company, who are subcontractors to CER Geonuclear. Our own analysis of water taken from the storage tanks confirmed the concentrations of cesium and strontium as determined by Eberline.

On November 8 and 9, Department representatives collected samples of water, soil, and milk in the Piceance Basin, concentrating the sampling in areas where any release from the well, storage tanks, or flaring stack might be expected to be present in detectable levels. With the exception of water drawn from the storage tanks, no cesium or strontium was detected in any of the samples analyzed in the Department's facilities. Additional samples have been collected during the production flaring beginning December 10, and further surveillance is planned for the period following the termination of flaring and site cleanup.

The Water Quality Control Division had issued a permit to CER Geonuclear to reinject the separated water into the U.S. Government Fawn Creek #1 well at a depth similar to that of the cavities in the emplacement well. At this depth there is no movement of underground water. At the time that the original permit was issued, our only concern was to allow the disposal of water containing quantities of tritium, the radioactive form of hydrogen, which was produced by the nuclear detonations. When the additional radionuclides were discovered, the Division reviewed its original recommendation. Because of the depth of the reinjection site and the immobility of water in that region, the permit was amended for reinjection to allow for safe disposal of the material.

We have recently received a final report on the reinjection of water by CER Geonuclear. All of the water removed from the flared gas was reinjected into the Fawn Creek #1 well during the period December 9-22, 1974. A total of 2512 barrels of water (42 gallons per barrel) containing 4326 microcuries of cesium-137 and 1021 microcuries of strontium-90 were reinjected. These quantities are in addition to the 20,837 barrels of water containing 149.9 curies of tritium previously reinjected as a result of earlier flaring and are well within the limits established by the reinjection permit issued by the Department.

We shall continue our surveillance of the area to insure that no possible hazard to health and safety may develop.

Sincerely,

Original Signed by:

Albert J. Hazle, Director

AJH/ljw

COLORADO DEPARTMENT OF HEALTH

September 29, 1975

APPLICATION OF CER-GEONUCLEAR	)	
CORPORATION AND THE CONTINENTAL	)	
OIL COMPANY TO OPERATE A SUBSURFACE	)	AMENDED PERMIT FOR
DISPOSAL SYSTEM UPON AND UNDER A TRACT	)	SUBSURFACE DISPOSAL
OF LAND 739 FEET FROM THE WEST	)	
LINE AND 2537 FEET FROM THE NORTH	)	
LINE OF SECTION 14, T3S	)	
R98W, RIO BLANCO COUNTY, COLORADO	)	

1. The Colorado Water Quality Control Commission has found, after public hearing and due consideration, of the subsurface disposal as proposed in the application for amended permit by CER-Geonuclear Corporation and the Continental Oil Company, that there will be no pollution resulting therefrom, or that the pollution, if any, will be limited to waters in a specified limited area from which there is no risk of significant migration and that the disposal of the radioactive water is justified by the public need.
2. The permit is dated November 9, 1973 and has been amended as of November 8, 1974 and December 6, 1974.
3. By letter of their attorneys, Moran, Reidy, and Voorhees, dated August 29, 1975, Continental Oil Company and CER-Geonuclear Corporation have requested an amendment of item 2(A) of the permit. As presently amended this condition reads: "Discharge under this permit may occur for a period of twelve months from November 9, 1974." As it is proposed to conduct certain additional testing of the RB-E-01 well, and as such test will make necessary the disposal of radioactive water, Continental Oil Company and CER-Geonuclear Corporation request the Division of Administration of the Colorado Department of Health to amend permit item 2(A) to read: Discharge under this permit may occur for a period of twelve months from November 8, 1975.
4. No other amendment to the permit is requested. No change of conditions dealing with quantity of water or quantity or type of radiation is requested.
5. The permit condition concerning the date upon which the injection is to terminate is a condition included for the convenience of the Division of Administration in its supervision of injection under the permit. The date upon which injection must be terminated does not affect any of the findings of fact made by the Water Quality Control Commission's hearing officer, John Phillip Linn, after the public hearing held on September 4, 1974.

6. Item 2(A) of the permit as amended is hereby amended to read: "Discharge under this permit may occur for a period of twelve months from November 8, 1975."
7. All other conditions of the original permit and monitoring procedures shall remain in full force and effect.

BY ORDER OF THE COLORADO DEPARTMENT OF HEALTH DIVISION OF ADMINISTRATION

Original Signed by:

Robert D. Siek
Assistant Director, Department of Health
Environmental Health

COLORADO DEPARTMENT OF HEALTH

4210 EAST 11TH AVENUE • DENVER, COLORADO 80220 • PHONE 388-6111
Anthony Robbins, M.D., Executive Director

NOTICE OF PUBLIC HEARING
BEFORE THE
COLORADO WATER QUALITY CONTROL DIVISION

Pursuant to the provisions of Sections 25-8-401, 25-8-505(2), and 24-105, C.R.S. 1973 and to Section 7 of the Rules for Subsurface Disposal Systems,

NOTICE is hereby given that the Colorado Water Quality Control Division will hold a public hearing concerning the application of CER Geonuclear Corporation and Continental Oil Company to terminate, plug and abandon a subsurface disposal system and for amendments for monitoring conditions.

The hearing will be held on Wednesday, July 21, 1976, at 9:00 A.M., in room 150, State Health Department Building, 4210 East 11th Avenue, Denver, Colorado 80220.

The subsurface disposal system, Fawn Creek #1 Government Well, is upon and under a tract of land in Section 14, Township 3 South, Range 98 West, Rio Blanco County, Colorado. The disposal system was operated in connection with the testing of the RB-E-01 nuclear stimulated well in Section 14, Township 3 South, Range 98 West, Rio Blanco County, Colorado. Operation of the RB-E-01 is to be terminated and CER Geonuclear has made application to terminate the disposal system.

The purpose of the hearing is to provide opportunity for interested persons to submit written and oral data, views, and comments on the proposal. Written statements must be presented at the hearing. They will not be accepted after the conclusion of the hearing.

Dated at Denver, Colorado, this 28th day of June, 1976.

COLORADO DEPARTMENT OF HEALTH
Division of Administration

Anthony Robbins
Anthony Robbins, M.D.
Executive Director

COLORADO DEPARTMENT OF HEALTH

4210 E. 11TH AVENUE

DENVER 80220

PHONE 388-6111

ANTHONY ROBBINS, M.D., M.P.A. EXECUTIVE DIRECTOR

July 14, 1976

Hearing Officer
Colorado Water Quality Control Division
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220

RE: Application of CER Geonuclear Corporation and Continental Oil
Company to plug and abandon a subsurface disposal system, Rio
Blanco County, Colorado

The application referred to above and the Site Cleanup and Restoration plan submitted to the Colorado Department of Health have been reviewed by staff members of the Occupational and Radiological Health Division and the Colorado Water Quality Control Division. In addition, the application and restoration plan were submitted to the Colorado Oil and Gas Conservation Commission, Water Resources Division, Water Conservation Board, and the Colorado Geological Survey for review and comments. There have been no objections from the reviewing agencies to the proposal or method of plugging the disposal zone in the Fawn Creek Government #1 well. Recommendations have been received regarding the monitoring program subsequent to the plugging operation.

Following our own staff review and considering the comments from the agencies in the Department of Natural Resources, the Water Quality Control Division has the following comments and recommendations:

1. Authority to permit the applicants to plug the disposal zone is contained in Section 7 of the "Rules for Subsurface Disposal Systems" adopted by the Colorado Water Quality Control Commission (as amended) January 15, 1974.
2. The applicant has advised the Division that this phase of Project Rio Blanco is to be terminated, therefore, there is a need to isolate, in the most technological feasible manner, certain radioactive contaminated water in the zone from 5600 feet to 6072 feet in the Fawn Creek Government No. 1 well located in Section 14-T3S-R9W, Rio Blanco County, Colorado.

3. Procedures to plug the disposal well shall be as stated in Annex "I" which is attached and a part of the application as submitted by the applicant. It is further stipulated that such cement slurry volumes as outlines in Annex "I" will be modified during the course of the plugging operation so as to permanently cement off the zone from 5600 to 6072 feet. Volumes of cement slurry shall also be adequate to fill the production casing from 6460 feet to 5225 feet $\pm$ 25 feet upon completion of the two cement squeezing operations outlined in Annex "I".
4. Any gas and/or water produced from the Fawn Creek Government #1 well subsequent to the plugging procedure outlined above will be subject to such requirements, procedures, permits, etc. as required by the Occupational and Radiological Health Division of the Colorado Department of Health.
5. Upon completion of the plugging operation, site cleanup and restoration, the applicant shall submit a report to the Water Quality Control Division stating any deviation from the procedures outlined in Annex "I", including actual measurements of the top of the cement plugs and gas and water sample analysis for radiation levels.
6. Monitoring requirements after plugging will be amended as follows:
"Collection and analysis of water samples from water sampling wells RB-D-01, RB-S-03, and RB-W-01 shall be on a weekly basis until one month after completion of the plugging operation, if no anomalous amounts of radioactive constituents are observed during this period, then collection and analysis shall be monthly for three months and then quarterly (3 month period) for twelve months after plugging and abandonment."
7. The Division further recommends that if either one or both of the applicants (CER Geonuclear and Continental Oil Company) have a bond posted with the Colorado Oil and Gas Commission in sufficient amount to replug the Fawn Creek Government #1 well in the event of a plugging failure that no further bonding requirement be imposed.

Very truly yours,

FOR DIRECTOR, WATER QUALITY CONTROL DIVISION

Kenneth W. Webb
Subsurface Consultant

cc: Jim Vorhees
CER Geonuclear, Las Vegas
Al Hazle
Fred Matter

STATE OF COLORADO
DIVISION OF ADMINISTRATION
COLORADO DEPARTMENT OF HEALTH

IN THE MATTER OF A SUBSURFACE DISPOSAL)
SYSTEM UPON AND UNDER A TRACT OF LAND)
739 FEET FROM THE WEST LINE AND 2357)
FEET FROM THE NORTH LINE OF SECTION 14,) PERMIT TO PLUG
TOWNSHIP 3 SOUTH, RANGE 98 WEST, RIO)
BLANCO COUNTY, COLORADO)

1. The Division of Administration of the Colorado Department of Health, after Public Hearing and due consideration, authorizes CER Geonuclear Corporation and Continental Oil Company to terminate, plug, and abandon the subsurface disposal system in the well described above and otherwise known as the Fawn Creek Government No. 1 Well.
2. Authority to grant a permit to plug is contained in section 25-8-505(2) C.R.S. 1973, as amended, and in section 7 of the "Rules for Subsurface Disposal Systems" adopted by the Colorado Water Quality Control Commission (as amended) January 15, 1974. The disposal system was authorized by a Permit for Subsurface Disposal, dated November 9, 1973, and amendments thereto.
3. CER Geonuclear Corporation and Continental Oil Company are to isolate, in the most technologically feasible manner, certain radioactive contaminated water in the zone from 5600 feet to 6072 feet in the Fawn Creek Government No. 1 Well.
4. Procedures to plug the disposal well shall be as stated in Annex "1" which was attached and a part of the application to plug as submitted by the applicant. It is further ordered that such cement slurry volumes as outlined in Annex "1" will be modified during the course of the plugging operation so as to permanently cement off the zone

from 5600 to 6072 feet. Volumes of cement slurry shall also be adequate to fill the production casing from 6460 feet to 5225 feet $\pm$ 25 feet upon completion of the two cement squeezing operations outlined in Annex "1".

5. Any gas and/or water produced from the Fawn Creek Government #1 Well subsequent to the plugging procedure outlined above will be subject to such requirements, procedures, permits, etc. as required by the Occupational and Radiological Health Division of the Colorado Department of Health.
6. Upon completion of the plugging operation, site cleanup and restoration, the applicant shall submit a report to the Water Quality Control Division stating any deviation from the procedures outlined in Annex "1", including actual measurements of the top of the cement plugs and gas and water sample analysis for radiation levels.
7. Monitoring requirements after plugging will be amended as follows:
"Collection and analysis of water samples from water sampling wells RB-D-01, RB-S-03, and RB-W-01 shall be on a weekly basis until one month after completion of the plugging operation, if not anomalous amount of radioactive constituents are observed during this period, then collection and analysis shall be monthly for three months and then quarterly (3 month period) for twelve months after plugging and abandonment." Results of the analysis shall be

submitted to the Colorado Water Quality Control Division of the
Co Colorado Department of Health.

THIS ORDER EXECUTED THIS 23rd DAY OF AUGUST, 1976.

COLORADO DEPARTMENT OF HEALTH
Division of Administration

Original Signed by Robert D. Siek for

Anthony Robbins, M.D., M.P.A.
Executive Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SUBMIT IN TRIPLICATE*
(Other instructions on re-verse side)

Form approved.
Budget Bureau No. 42-R1424.

5. LEASE DESIGNATION AND SERIAL NO.

FED 14-08-001-8884

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

1.

OIL WELL ☐ GAS WELL ☒ OTHER

2. NAME OF OPERATOR

Austral Oil Company Incorporated

3. ADDRESS OF OPERATOR

2700 Exxon Bldg., Houston, Texas 77002

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.*
See also space 17 below.)
At surface

2235.95' East of West Line and 1694.81' North of
South Line of Section 25, T-7-S, R-95-W of the
6th P.M.

14. PERMIT NO.

67-393

15. ELEVATIONS (Show whether DF, RT, GR, etc.)

8171.28' GR.

7. UNIT AGREEMENT NAME

Rulison

8. FARM OR LEASE NAME

Hayward

9. WELL NO.

25-95

10. FIELD AND POOL, OR WILDCAT

Rulison

11. SEC., T., R., M., OR BLK. AND
SURVEY OR AREA

Sec. 25, T-7-S, R-95-W
of the 6th P.M.

12. COUNTY OR PARISH 13. STATE

Garfield

Colorado

16.

Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF

FRACTURE TREAT

SHOOT OR ACIDIZE

REPAIR WELL

(Other)

PULL OR ALTER CASING

MULTIPLE COMPLETION

ABANDON*

CHANGE PLANS

X

SUBSEQUENT REPORT OF:

WATER SHUT-OFF

FRACTURE TREATMENT

SHOOTING OR ACIDIZING

(Other)

REPAIRING WELL

ALTERING CASING

ABANDONMENT*

(Note: Report results of multiple completion on Well
Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

Plugging and Abandonment of Re-Entry Well (R-EX) of Project Rulison.
Complete description of plugging operation is enclosed in NVO-174, "Project
Rulison Well Plugging and Site Abandonment Plan", dated May, 1976.

1. Plug set in Otis S-1 nipple at 7536'. Perf. tubing at 5300'.
2. Spot balanced 1000' cement plug from 5300' to 4300'.
3. Perf. tubing at 1000'. Spot cement plug from 1000' to 400'.
4. Cut 3-1/2" tubing off at 200' and spot cement plug from 200' up to 2' below surface.
5. Clean up well site.
6. Well and site abandonment schedule for the period April 1, 1976 through August 14, 1976 is shown on the last page of NVO-174 plan.

18. I hereby certify that the foregoing is true and correct

SIGNED

Walter Reynolds, Jr.

TITLE

Vice President

DATE

May 6, 1976

(This space for Federal or State office use)

APPROVED BY

TITLE

DATE

CONDITIONS OF APPROVAL, IF ANY:

*See Instructions on Reverse Side

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEYSUBMIT IN TRIPLICATE*
(Other instructions on re-
verse side)Form approved:
Budget Bureau No. 42-R1424.

5. LEASE DESIGNATION AND SERIAL NO.

C-021764
6. IF INDIAN, ALLOTTEE OR TRIBE NAME

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL WELL ☐ GAS WELL ☒ OTHER Nuclear Emplacement Well		7. UNIT AGREEMENT NAME	
2. NAME OF OPERATOR CER Corporation		RIO BLANCO	
3. ADDRESS OF OPERATOR Post Office Box 15090, Las Vegas, Nevada 89114		8. FARM OR LEASE NAME	
4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.) At surface 1080.5 FNL 1188.5 FWL Sec. 14, T3S, R98W, 6th p.m.		9. WELL NO. RB - E - 01	
14. PERMIT NO. 71-677 (Colorado)		10. FIELD AND POOL, OR WILDCAT	
15. ELEVATIONS (Show whether DF, RT, GR, etc.) 6627' GL		11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA Sec. 14, T3S, R98W 6th p.m.	
		12. COUNTY OR PARISH Rio Blanco	
		13. STATE Colo.	

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF ☐FRACTURE TREAT ☐SHOOT OR ACIDIZE ☐REPAIR WELL ☐(Other) ☐PULL OR ALTER CASING ☐MULTIPLE COMPLETE ☐ABANDON* ☐CHANGE PLANS ☐

SUBSEQUENT REPORT OF:

WATER SHUT-OFF ☐FRACTURE TREATMENT ☐SHOOTING OR ACIDIZING ☐(Other) ☐REPAIRING WELL ☐ALTERING CASING ☐ABANDONMENT* ☒

(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

Plugging operations began July 14, 1976, operations observed and approved by USGS Engineer. Set two plugs of 50 sx Class G cement - 30% Silica Flour each in liner followed by 15 cubic feet frac sand. Then set 25 sx Class G cement, pressure tested tubing and annulus to 1250 psi, T/cement 5088' in tubing (90' above bottom of tubing). Perf tubing 5040' - 5041', set 200 sx Class G cement plug 5040' - 3874' in tubing and annulus. Pressure tested tubing and annulus at 1000 psi. Perf tubing 3750' - 3751', set 175 sx Class G cement plug 3750' - 2810', pressure tested tubing and annulus at 1000 psi, T/cement 2720' in tubing. Perf tubing 850' - 851', set 150 sx Class G cement plug 850' - 50' in tubing and annulus, pressure tested to 1000 psi. Cut off tubing at 15', recovered tubing and christmas tree. On September 25, 1976, squeezed tubing head and flange with 2 sx cement at 2000 psi. Welded 1" plate to top flange, removed cellar. On October 2, 1976, recovered casing head valves, bull plugged openings and squeezed casing head with 1 sx cement at 2000 psi. In November, leveled location, set concrete monument, seeded and fenced location. BLM inspected and approved work.

18. I hereby certify that the foregoing is true and correct

SIGNED

TITLE

Chief Engineer

DATE January 24, 1977

(This space for Federal or State office use)

APPROVED BY

CONDITIONS OF APPROVAL, IF ANY:

TITLE

DATE

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEYSUBMIT IN TRIPLICATE
(Other instructions on reverse side)Form approved.
Budget Bureau No. 42-R1424.

5. LEASE DESIGNATION AND SERIAL NO.

C-021764

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME

Rio Blanco

8. FARM OR LEASE NAME

9. WELL NO.

RB-E-01

10. FIELD AND POOL, OR WILDCAT

11. SEC., T., R., M., OR BLM. AND
SURVEY OR AREASec. 14, T3S, R98W
6th p. m.

12. COUNTY OR PARISH

Rio Blanco

13. STATE

Colo.

1. OIL WELL ☐ GAS WELL ☒ OTHER

2. NAME OF OPERATOR

CER CORPORATION

3. ADDRESS OF OPERATOR

Post Office Box 15090, Las Vegas, Nevada 89114

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.*
See also space 17 below.)
At surface

1080.5 FNL 1188.5 FWL Sec. 14, T3S, R98W, 6th p. m.

14. PERMIT NO.

71-677 (Colo.)

15. ELEVATIONS (Show whether DY, RT, GR, etc.)

6627' GL

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF

FRACTURE TREAT

SHOOT OR ACIDIZE

REPAIR WELL

(Other)

PULL OR ALTER CASING

MULTIPLE COMPLETE

ABANDON*

CHANGE PLANS

SUBSEQUENT REPORT OF:

WATER SHUT-OFF

FRACTURE TREATMENT

SHOOTING OR ACIDIZING

(Other)

REPAIRING WELL

ALTERING CASING

ABANDONMENT*

(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

Date of Work: July 1, 1976 (approximately)

As a result of the meeting between USGS, ERDA and CER, the P & A plans for RB-E-01 submitted on May 25, 1976 will be revised as attached.

18. I hereby certify that the foregoing is true and correct

SIGNED

TITLE

Vice President

DATE

June 30, 1976

(This space for Federal or State office use)

APPROVED BY

TITLE

DISTRICT ENGINEER

DATE

JUL 12 1976

CONDITIONS OF APPROVAL, IF ANY:

CONDITIONS OF APPROVAL ATTACHED
TO OPERATOR'S COPY

*See Instructions on Reverse Side

A-13-3

File

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SUBMIT IN TRIPLICATE*
(Other instructions on re-
verse side)

Form approved,
Budget Bureau No. 42-R1424.

3. LEASE DESIGNATION AND SERIAL NO.

C-021764

7. IF INDIAN, ALLOTTEE OR TRIBE NAME

SUNDRY NOTICES AND REPORTS ON WELLS

*Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL WELL ☐ GAS WELL ☒ OTHER

7. UNIT AGREEMENT NAME

Rio Blanco

2. NAME OF OPERATOR

CER Geonuclear Corporation

8. FARM OR LEASE NAME

3. ADDRESS OF OPERATOR

Post Office Box 15090, Las Vegas, Nevada 89114

9. WELL NO.

RB-E-01

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.*
See also space 17 below.)
at surface

10. FIELD AND POOL, OR WILDCAT

1080.5 FNL 1188.5 FWL Sec. 14, T3S, R98W

11. SEC., T., R., OR BLM., AND

Sec. 14, T3S, R98W
6th p. m.

14. PERMIT NO.

71-677 (Colo.)

15. ELEVATIONS (Show whether DP, RT, GR, etc.)

6627 GR

12. COUNTY OR PARISH 13. STATE

Rio Blanco Colo.

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF

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PULL OR ALTER CASING

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☐
☐

FRACTURE TREAT

MULTIPLE COMPLETE

SHOOT OR ACIDIZE

ABANDON*

REPAIR WELL

CHANGE PLANS

(Other)

SUBSEQUENT REPORT OF:

WATER SHUT-OFF

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☐
☐

REPAIRING WELL

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☐
☐
☐
☐

FRACTURE TREATMENT

ALTERING CASING

SHOOTING OR ACIDIZING

ABANDONMENT*

(Other)

(NOTE: Report results of multiple completion on Well
Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

1. Date of Work - July 1, 1976 (approximately)

2. Reason for abandonment: Experiment on nuclear stimulation completed.

3. Abandonment procedure attached.

4. A copy of NVO-173 is also included. This report includes details of site restoration and Rad Safe programs.

Revised 6/30/76

18. I hereby certify that the foregoing is true and correct

SIGNED

Robert H. Brown

TITLE Vice President

DATE 5/25/76

(This space for Federal or State office use)

APPROVED BY

TITLE

DATE

CONDITIONS OF APPROVAL, IF ANY:

*See Instructions on Reverse Side

PROJECT RIO BLANCO RB-E-01 DOWNHOLE STATUS (P & A) SEA LEVEL ELEV. 6628.76'

10-3/4" PRIMARY CSG
 0-971' N-80, 51, LB/FT
 971'-5499' K-55, 45 LB/FT
 5499'-6990' K-55, 51 LB/FT
 "RUFF COAT" 3188'-5499'

7" EMPLACEMENT CSG, 500-90, 23 LB/FT
 ID - 6.366"

2ND PLUG
 200 SACKS CLASS G CEMENT
 5172' to 4070'

2-7/8" (167 JIS) TO 5178'

TOP OF LINER HANGER 5205'

BOTTOM PLUG - 60 SACKS w/ 30% Silica
 FLOW

PERFORATIONS (150 SHOTS)

5"-15 LB/FT CASING LINER TO 5712'

6-1/2" HOLE TO 5723'

5278' WHISTOCK
 5170' BRIDGE PLUG

5329-5700 COLLAPSED
 CSG INTERVAL

5838' EXPLOSIVE III

6230' EXPLOSIVE II

6689' EXPLOSIVE I

UNDEFINED
 CHIMNEY
 REGION

10-3/4" CASING SHOE 6990'

BOTTOM OF CEMENT PLUG 7206'

8-3/4" HOLE

DRILLING FLUID

TOTAL DEPTH 7869'

WASATC
 FORT UNION
 MESAVERDE

4000

5000

5350'

6000

6160'

7000

8000

VERTICAL SCALE: 1" = 600'

U.S. GEOLOGICAL SURVEY
 OIL AND GAS DIVISION
 DENVER, CO

JUL 1 1976

SALT LAKE CITY, UTAH

A-13-6

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEYSUBMIT IN TRIPLICATE*
(Other instructions on re-
verse side)Form approved,
Budget Bureau No. 42-R1424
5. LEASE DESIGNATION AND SERIAL No.

C-021764

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL WELL ☐ GAS WELL ☒ OTHER Nuclear Reentry Hole		7. UNIT AGREEMENT NAME Rio Blanco	
2. NAME OF OPERATOR CER Corporation		8. FARM OR LEASE NAME	
3. ADDRESS OF OPERATOR Post Office Box 15090, Las Vegas, Nevada 89114		9. WELL NO. RB-AR-2	
4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.) At surface 2193.9 FNL 789.6 FWL Sec. 14, T3S, R98W, 6th p.m. At Proposed Production Zone: 1179.3 FNL 1126.7 FWL @ TVD 6677 GL		10. FIELD AND POOL, OR WILDCAT	
14. PERMIT NO.	15. ELEVATIONS (Show whether DF, RT, CR, etc.) 6622.5' GL	11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA Sec. 14, T3S, R98W 6th p.m.	12. COUNTY OR PARISH Rio Blanco
		13. STATE Colo.	

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:		SUBSEQUENT REPORT OF:	
TEST WATER SHUT-OFF ☐	PULL OR ALTER CASING ☐	WATER SHUT-OFF ☐	REPAIRING WELL ☐
FRACTURE TREAT ☐	MULTIPLE COMPLETE ☐	FRACTURE TREATMENT ☐	ALTERING CASING ☐
SHOOT OR ACIDIZE ☐	ABANDON* ☐	SHOOTING OR ACIDIZING ☐	ABANDONMENT* ☒
REPAIR WELL ☐	CHANGE PLANS ☐	(Other) ☐	(Other) ☐

(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

Plugging operations commenced July 19, 1976, operations were observed and approved by an USGS engineer. Set wire line BP in 5" liner at 6633', sand and cement on top, followed by 25 sx and 75 sx plugs of Class G cement. Set 110 sx Class G cement plug at 6494' - 5291' in tubing and casing. Pressure tested tubing and annulus to 1000 psi, T/cement in tubing 5269'. Perf tubing 4501' - 4502', set 110 sx Class G cement plug 4502' - 2635' in tubing and casing. Pressure tested tubing and annulus to 1000 psi, T/cement in tubing 2635'. Perf tubing 2310' - 2311', set 150 sx Class G cement plug 2310' - 30' in tubing and casing. Cut off tubing at 8' and pulled. On September 15, 1976, cut off 4 1/2" casing at 6', recovered casing spool. Cut 7" casing at 3' and recovered casing spool. Filled 10 3/4" casing and 16" casing head with cement, welded 1" plate on top, removed cellar, set monument. In November, 1976, leveled, seeded and fenced location. BLM inspected and approved work.

18. I hereby certify, that the foregoing is true and correct

SIGNED

TITLE

Chief Engineer

DATE January 24, 1977

(This space for Federal or State office use)

APPROVED BY

TITLE

DATE

CONDITIONS OF APPROVAL, IF ANY:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SUBMIT IN TRIPLICATE*
(Other instructions on reverse side)

Form approved.
Budget Bureau No. 42-R1421.
3. LEASE DESIGNATION AND SERIAL NO.

C-021764

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir. Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL WELL ☐ GAS WELL ☒ OTHER		7. UNIT AGREEMENT NAME Rio Blanco
2. NAME OF OPERATOR CER CORPORATION		8. FARM OR LEASE NAME
3. ADDRESS OF OPERATOR Post Office Box 15090, Las Vegas, Nevada 89114		9. WELL NO. RB-AR-2
4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.) At surface 2193.9 FNL 789.6 FWL Sec. 14, T3S, R98W, 6th p.m. At proposed prod. zone: 1179.3 FNL 1126.7 FWL @ TVD 6677GL		10. FIELD AND POOL, OR WILDCAT
14. PERMIT NO.	15. ELEVATIONS (Show whether DF, RT, GR, etc.) 6622.5' GL	11. SEC., T., R., M., OR BLE. AND SURVEY OR AREA Sec. 14, T3S, R98W 6th p.m.
		12. COUNTY OR PARISH Rio Blanco
		13. STATE Colo.

18. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF

FRACTURE TREAT

SHOOT OR ACIDIZE

REPAIR WELL

(Other)

FULL OR ALTER CASING

MULTIPLE COMPLETE

ABANDON*

CHANGE PLANS

SUBSEQUENT REPORT OF:

WATER SHUT-OFF

FRACTURE TREATMENT

SHOOTING OR ACIDIZING

(Other)

REPAIRING WELL

ALTERING CASING

ABANDONMENT*

(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)

Date of work: July 1, 1976 (approximately)

As a result of the meeting between USGS, ERDA and CER, the P & A plans for RB-AR-2 submitted May 25, 1976, will be revised as attached.

19. I hereby certify that the foregoing is true and correct

SIGNED

TITLE Vice President

DATE June 30, 1976

(This space for Federal or State office use)

APPROVED BY

TITLE DISTRICT ENGINEER

DATE JUL 12 1976

CONDITIONS OF APPROVAL, IF ANY

CONDITIONS OF APPROVAL ATTACHED
TO OPERATOR'S COPY

*See Instructions on Reverse Side

File

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SUBMIT IN TRIPLICATE*
(Other instructions on reverse side)

Form approved.
Budget Bureau No. 4-

3. LEASE DESIGNATION AND SERIAL NO.
C-021764

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL WELL ☐ GAS WELL ☒ OTHER Experimental		7. UNIT AGREEMENT NAME Rio Blanco
2. NAME OF OPERATOR CER Corporation		8. FARM OR LEASE NAME
3. ADDRESS OF OPERATOR Post Office Box 15090, Las Vegas, Nevada 89114		9. WELL NO. RB-U-4
4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.) At surface 648 FNL 1665 FWL Sec. 14, T3S, R98W, 6th p.m.		10. FIELD AND POOL, OR WILDCAT
14. PERMIT NO. 74-533		11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA Sec. 14, T3S, R98W, 6th p.m.
15. ELEVATIONS (Show whether DF, RT, GR, etc.) 6597' GL		12. COUNTY OR PARISH Rio Blanco
		13. STATE Colo.

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:		SUBSEQUENT REPORT OF:	
TEST WATER SHUT-OFF ☐	PULL OR ALTER CASING ☐	WATER SHUT-OFF ☐	REPAIRING WELL ☐
FRACTURE TREAT ☐	MULTIPLE COMPLETE ☐	FRACTURE TREATMENT ☐	ALTERING CASING ☐
SHOOT OR ACIDIZE ☐	ABANDON* ☐	SHOOTING OR ACIDIZING ☐	ABANDONMENT* ☒
REPAIR WELL ☐	CHANGE PLANS ☐	(Other) ☐	
(Other) ☐		(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)	

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.) *

Operations began August 27, 1976. Squeezed perfs 5698' - 5775' with 50 sx Class G and 50 sx Class G-0.2% Diacel, packer set at 5571', squeeze pressure 3000 psi, T/cement 5600'. Pulled tubing, set open-ended at 4700', set 50 sx Class G cement plug 4700' - 4450' in 7" casing. On September 13, 1976, moved in casing jacks, cut 7" casing at 2800' and pulled. Set three 75 sx Class G cement plugs as follows: At 2830' - 2700' in top of 7" casing and 12 1/4" open hole; at 2260' - 2165' in 12 1/4" open hole and bottom of 13 3/8" casing; and at 123' - 25' in 13 3/8" casing. On September 18, 1976, cut off casing head, filled 13 3/8" casing to surface with cement, welded 1" plate on top of stub, removed cellar and cleaned location. Plugging completed September 18, 1976. In October, 1976, leveled and seeded location, set monument over hole, fenced location. Location inspected and approved by BLM in November, 1976.

18. I hereby certify that the foregoing is true and correct

SIGNED

[Signature]

TITLE

Chief Engineer

DATE

January 24, 1977

(This space for Federal or State office use)

APPROVED BY

TITLE

DATE

CONDITIONS OF APPROVAL, IF ANY:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SUBMIT IN TRIPPLICATE*
(Other instructions on re-
verse side)

Form approved.
Budget Bureau No. 42-R1124.

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

☐ OIL WELL ☐ GAS WELL ☒ OTHER

NAME OF OPERATOR

CER Geonuclear Corporation

ADDRESS OF OPERATOR

Post Office Box 15090, Las Vegas, Nevada 89114

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.*
See also space 17 below.)
At surface

648 FNL 1665 FWL Sec. 14, T3S, R98W, 6th p.m.

14. PERMIT NO.

74-533

15. ELEVATIONS (Show whether DF, RT, GR, etc.)

6597 GLM

5. LEASE DESIGNATION AND SERIAL NO.

C-021764

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME

Rio Blanco

8. FARM OR LEASE NAME

9. WELL NO.

RB-U-4

10. FIELD AND POOL, OR WILDCAT

11. SEC., T., R., M., OR BLM. AND
SURVEY OR AREA

Sec. 14, T3S, R98W
6th p.m.

12. COUNTY OR PARISH

Rio Blanco

13. STATE

Colo.

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF

FRACTURE TREAT

SHOOT OR ACIDIZE

REPAIR WELL

(Other)

PULL OR ALTER CASING

MULTIPLE COMPLETION

ABANDON*

CHANGE PLANS

SUBSEQUENT REPORT OF:

WATER SHUT-OFF

FRACTURE TREATMENT

SHOOTING OR ACIDIZING

(Other)

REPAIRING WELL

ALTERING CASING

ABANDONMENT*

(NOTE: Report results of multiple completion on Well
Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)

1. Date of Work - August 1, 1976

2. Reason for Abandonment: The nuclear stimulation experiment is completed.
This well was drilled and testing conducted as part of the over-all experiment.

3. P & A Plans are attached.

4. NVO-173 report is also enclosed giving the over-all site restoration plans.

Revised.
w/ SN 6/30/76

18. I hereby certify that the foregoing is true and correct

SIGNED [Signature]

TITLE Vice President

DATE 5/25/76

(This space for Federal or State office use)

APPROVED BY _____

TITLE _____

DATE _____

CONDITIONS OF APPROVAL, IF ANY:

*See Instructions on Reverse Side

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEYSUBMIT IN TRIPPLICATE*
(Other instructions on reverse side)Form approved.
Budget Bureau No. 42-R1424.

5. LEASE DESIGNATION AND SERIAL NO.

C-021764

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME

Rio Blanco

8. FARM OR LEASE NAME

9. WELL NO.

RB-U-4

10. FIELD AND POOL, OR WILDCAT

11. SEC., T., R., M., OR BLE. AND
SURVEY OR AREASec. 14, T3S, R98W
6th p.m.

12. COUNTY OR PARISH

Rio Blanco

13. STATE

Colo.

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL WELL ☐ GAS WELL ☒ OTHER	
2. NAME OF OPERATOR CER CORPORATION	
3. ADDRESS OF OPERATOR Post Office Box 15090, Las Vegas, Nevada 89114	
4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.) At surface 648 FNL 1665 FWL Sec. 14, T3S, R98W, 6th p.m.	
14. PERMIT NO. 74-533	15. ELEVATIONS (Show whether DF, RT, GR, etc.) 6597' GL

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF

FRACTURE TREAT

SHOOT OR ACIDIZE

REPAIR WELL

(Other)

PULL OR ALTER CASING

MULTIPLE COMPLETE

ABANDON*

CHANGE PLANS

SUBSEQUENT REPORT OF:

WATER SHUT-OFF

FRACTURE TREATMENT

SHOOTING OR ACIDIZING

(Other)

REPAIRING WELL

ALTERING CASING

ABANDONMENT*

(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

Date of Work: August 1, 1976

As a result of the meeting between USGS, ERDA and CER on June 29, 1976, the Sundry Notice of May 25, 1976 is modified as follows:

7. Run tubing to top of squeeze plug (approximately 5385') *Step 5*
Displace 167 sacks of Class G cement down tubing. Follow with 17 bbls of water and balance plug. Plug will be from approximately 5385' to 4440'

11a. If casing is backed off substantially above 4000', a 75' plug will be run on top of the casing stub.

11b. Change depth from 2250' to 2200'.

(Sundry Notice of NIA 5/25/76 Attached)

18. I hereby certify that the foregoing is true and correct

SIGNED

Robert H. [Signature]

TITLE

Vice President

DATE

June 30, 1976

(This space for Federal or State police use)

APPROVED BY

CONDITIONS OF APPROVAL, IF ANY:

TITLE

DISTRICT ENGINEER

DATE

JUL 12 1976

PROJECT RIO BLANCO
WELL RB-U-4 CONFIGURATION

(P+A)

GROUND LEVEL
REFERENCE = 0

GROUND ELEV. = 6596.89' ABOVE SEA LEVEL

DEPTH
FEET

12-1/4" HOLE TO 4438"

STAGE COLLAR AND
CEMENT TOP AT 4430'

7" CSG CUT AND PULLED
c ~ 4300'

2ND PLUG
50 SACKS CLASS G
4440' - 4700'

9-7/8" HOLE TO TD

7" CSG. ~ 4300' TO TD

BOTTOM PLUG
75 SACKS CLASS G CEMENT
BRADEN HEAD SQUEEZE

PERFORATIONS

SQUEEZE PACKER ~ 5690'

~ 50 SACKS SQUEEZE CEMENT

HOWCO "EZ" SQUEEZE

PACKER 5825'

150 SACKS SQUEEZE CEMENT

"GO" DRILLABLE
BRIDGE PLUG 6160'

9.8 lb/gal. MUD

BAKER RETRIEVABLE "D" PACKER
WITH BROKEN PIECE OF RETRIEV-
ABLE PACKER FROM ABOVE 6870'

TOP OF CEMENT 6988'

5608' - 5654'

5698' - 5794'

5836' - 5892'

6196' - 6248'

6602' - 6632'

6738' - 6750'

6898' - 6942'

WASATCH FORMATION

FORT UNION
FORMATION

MESAVERDE
FORMATION

4000

5000

5330'

6000

6160'

VERT. SCALE: 1" = 500'

7000

A-13-13

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SUBMIT IN TRIPLICATE*
(Other instructions on re-
verse side)

Form approved.
Budget Bureau No. 42-R1424.

5. LEASE DESIGNATION AND SERIAL NO.
C-021764

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL ☐ GAS ☒ OTHER ☐ Dual Completion - Water disposal well and gas producer

2. NAME OF OPERATOR
CER Corporation

3. ADDRESS OF OPERATOR
Post Office Box 15090, Las Vegas, Nevada 89114

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.*
See also space 17 below.)
At surface

2280 FNL, 750 FWL, Sec. 14, T3S, R98W, 6th p.m.

7. UNIT AGREEMENT NAME
Rio Blanco

8. FARM OR LEASE NAME

9. WELL NO.
Fawn Creek Govt. #1

10. FIELD AND POOL, OR WILDCAT

11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA
Sec. 14, T3S, R98W
6th p.m.

14. PERMIT NO.

15. ELEVATIONS (Show whether DF, RT, GR, etc.)

6618 GLM

12. COUNTY OR PARISH 13. STATE
Rio Blanco Colo.

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF ☐

FRACTURE TREAT ☐

SHOOT OR ACIDIZE ☐

REPAIR WELL ☐

(Other) ☐

PULL OR ALTER CASING ☐

MULTIPLE COMPLETE ☐

ABANDON* ☐

CHANGE PLANS ☐

SUBSEQUENT REPORT OF:

WATER SHUT-OFF ☐

FRACTURE TREATMENT ☐

SHOOTING OR ACIDIZING ☐

(Other) Abandon lower zone of dual well ☒

REPAIRING WELL ☐

ALTERING CASING ☐

ABANDONMENT* ☐

(NOTE: Report results of multiple completion or Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

Recompletion operations began August 25, 1976 to abandon the lower radioactive SWD zone of a dual well and recomplete the well as a single gas well from the upper producing interval. Killed well with KCl brine and pulled upper zone production tubing. Squeezed SWD perfs 5600' - 6072' through injection tubing; packer set at 5273', with 120 sx Class G cement at 1700 psi. Pressure tested tubing and squeeze at 3000 psi, T/cement 5479' in 5 1/2" casing. Pulled packer and injection tubing. Perf 5 1/2" casing at 5245' - 5246', set squeeze retainer by wire line at 5200', squeezed perfs with 57 sx Class G cement at 2300 psi, T/cement 5189'. Ran 2 3/8" OD tubing, set at 5120', swabbed well dry. On September 22, 1976 fractured perfs 5084' - 5126' with 10,000 gals gelled 2% KCl brine and 9000 lbs 20-40 mesh sand, using 700 cubic feet/bbl CO₂. Swabbed and flowed well through September 30, 1976. On October 1, 1976, treated producing zone with 2000 gal methanol and 300 cubic feet/bbl nitrogen. Swabbed and flowed well, continuing flowing to date, sampling water and gas for radioactivity.

18. I hereby certify that the foregoing is true and correct

SIGNED

TITLE

Chief Engineer

DATE

January 24, 1977

(This space for Federal or State office use)

APPROVED BY

TITLE

DATE

CONDITIONS OF APPROVAL, IF ANY:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEYSUBMIT IN TRIPLICATE*
(Other instructions on re-
verse side)Form approved.
Budget Bureau No. 42-R1424.

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL WELL ☐ GAS WELL ☒ OTHER	5. LEASE DESIGNATION AND SERIAL NO. C-021764
2. NAME OF OPERATOR CER Geonuclear Corporation	6. IF INDIAN, ALLOTTEE OR TRIBE NAME
3. ADDRESS OF OPERATOR Post Office Box 15090, Las Vegas, Nevada 89114	7. UNIT AGREEMENT NAME Rio Blanco
4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.) At surface 2193.9 FNL 789.6 FWL Sec. 14, T3S, R98W, 6th p.m. Bottom Hole Location: 1179.3 FNL 1126.7 FWL @ TVD 6677' GL	8. FARM OR LEASE NAME
14. PERMIT NO.	9. WELL NO. RB-AR-2
15. ELEVATIONS (Show whether DF, RT, CR, etc.) 6622.5 GL	10. FIELD AND POOL, OR WILDCAT
	11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA Sec. 14, T3S, R98W 6th p.m.
	12. COUNTY OR PARISH Rio Blanco
	13. STATE Colo.

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF

FRACTURE TREAT

SHOOT OR ACIDIZE

REPAIR WELL

(Other)

PULL OR ALTER CASING

MULTIPLE COMPLETE

ABANDON*

CHANGE PLANS

X

SUBSEQUENT REPORT OF:

WATER SHUT-OFF

FRACTURE TREATMENT

SHOOTING OR ACIDIZING

(Other)

REPAIRING WELL

ALTERING CASING

ABANDONMENT*

(Note: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.) *

1. Date of Work - July 1, 1976 (approximately)
2. Reason for Abandonment: Nuclear stimulation experiment completed.
3. Abandonment procedure attached.
4. Copy of NVO-173 report attached. Report covers details of site restoration and rad safe plans.

Revised 6/30/76

18. I hereby certify that the foregoing is true and correct

SIGNED

Robert L. H. H.

TITLE Vice President

DATE 5/25/76

(This space for Federal or State office use)

APPROVED BY

TITLE

DATE

CONDITIONS OF APPROVAL, IF ANY:

*See Instructions on Reverse Side

RB-AR-2 DOWNHOLE STATUS

P & A
PLUGS

CELLAR 8 WIDE x 8' DEEP x 12' LONG
24" CONDUCTOR CEMENTED AT 25'
15" SURFACE CASING CEMENTED AT
100' WITH 375 FT

10 1/2" SLIDE COLLAR AT 1032' CEMENTED
OUT COLLAR WITH 1000 FT

PERF 7" 2100'-2111' SQUEEZE PERF
WITH 50 JOBS NO 1, 3, 4, 11 WITH A
TOTAL OF 1000 SACKS

10 1/2" CASING SHOE AT 2116' CEMENTED
OUT SHOE WITH 1000 FT

PERF 2200' SQUEEZE PERF WITH
250 SACKS

PERF 2626' SQUEEZE PERF WITH 50
JOBS NO 8, 9 WITH A TOTAL OF 400
SACKS

PERF 2020' SQUEEZE NO 7 WITH
250 SACKS

DRILLING LEVEL
22" HOLE

15" HOLE

EL 4427.5'
RB-AR 2

N10° 12' 06" E 1200.45'

EL 4628.76'
RB-E-01

ALLUVIUM

PARACHUTE
CREEK MEMBER

MAHOLIAN
MATERIAL

GREEN RIVER
BLACK MARKER

ORANGE
MARKER

PICANCE
CREEK SAND

Top Plug
200 Sacks Class G
3000' to 150'

0'

1000'

2000'

3000'

A-13-16

7" STAGE COLLAR AT 3084' CEMENTED
OUT COLLAR WITH 2176 FT³ OF SLURRY
STAGE COLLAR SQUEEZED WITH JOBS
NO 2,3,6 WITH A TOTAL OF 225 SACKS

KICK OFF POINT (KOP) 4502'

4 1/2" CASING SET AT 8150' WITH STINGER ON BOTTOM SET
IN THE PRODUCTION PACKER CEMENTED OUT STAGE COLLAR
AT 8149' WITH 709 FT³

BAKER "FA" PRODUCTION PACKER SET AT 8150' DRILLED OUT
WITH 3 1/2" BIT

7" CASING SHOE AT 6476' 706' NIS'E OF SURFACE LOCATION
CEMENTED OUT SHOE WITH 1390 FT³ OF SLURRY.

5" LINER FROM 8372' TO 7040'. NOT CEMENTED PERFORATED
FROM 6937' TO 7037'

U.S. GEOLOGICAL SURVEY
OIL AND GAS DIVISION
RECEIVED

JUL 1 1976

SALT LAKE CITY, UTAH

NOTE:
ALL DEPTHS ARE GROUND LEVEL
MEASUREMENTS 19.5' (20') BELOW
KELLY BUSHING ELEVATION

8 1/2" HOLE

2 1/2" TUBING AT 6494'

8 1/2" HOLE

TOTAL MEASURED DEPTH/GROUND LEVEL 7087'
TOTAL VERTICAL DEPTH/GROUND LEVEL 6677'

WASATCH

RB-E-OI WELL

FORT UNION

MESA VERDE

EXPLOSIVE III

EXPLOSIVE II

EXPLOSIVE I

CEMENT PLUGS

50 SACKS TD to 6494'
CLASS G W/ 30% Silica Flour
100 SACKS CLASS G
6494 to 5400'

4000'

5000'

7000'

A-13-17

Form 1043
MAY 1963

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SUBMIT IN TRIPLICATE*
(Other instructions on re-
verse side)

Form approved.
Budget Bureau No. 42-R1424.

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir.
Use "APPLICATION FOR PERMIT—" for such proposals.)

5. LEASE DESIGNATION AND SERIAL NO.

C-021764

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME

Rio Blanco

8. FARM OR LEASE NAME

9. WELL NO.

Fawn Creek #1, Govt.

10. FIELD AND POOL, OR WILDCAT

11. SEC., T., R., M., OR BLK. AND
SURVEY OR AREA

Sec. 14, T3S, R98W
6th p.m.

12. COUNTY OR PARISH

Rio Blanco

13. STATE

Colo.

1. OIL WELL ☐ GAS WELL ☒ OTHER ☐ Dual Completion - Water Disposal Well
& Gas Producer

2. NAME OF OPERATOR

CER Geonuclear Corporation

3. ADDRESS OF OPERATOR

Post Office Box 15090, Las Vegas, Nevada 89114

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.*
See also space 17 below.)

At surface

22S0 FNL, 750 FWL, Sec. 14, T3S, R98W

14. PERMIT NO.

15. ELEVATIONS (Show whether DF, RT, GR, etc.)

6618 GLM

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:

TEST WATER SHUT-OFF ☐

FRACTURE TREAT ☐

SHOOT OR ACIDIZE ☐

REPAIR WELL ☒

(Other)

PULL OR ALTER CASING ☐

MULTIPLE COMPLETE ☐

ABANDON* ☐

CHANGE PLANS ☐

(Other)

SUBSEQUENT REPORT OF:

WATER SHUT-OFF ☐

FRACTURE TREATMENT ☐

SHOOTING OR ACIDIZING ☐

(Other)

REPAIRING WELL ☐

ALTERING CASING ☐

ABANDONMENT* ☐

(NOTE: Report results of multiple completion on Well
Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any
proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones perti-
nent to this work.)*

1. Date of Work - July 15, 1976 (approximately)

2. It is proposed to plug the water disposal zone (5600' to 6072')
and complete the well as a single zone gas well (5084' to 5126').

3. The rework procedure is attached.

18. I hereby certify that the foregoing is true and correct

SIGNED Robert H. Miller

TITLE Vice President

DATE 5/25/76

(This space for Federal or State Office use)

APPROVED BY E. W. [Signature]

TITLE

DISTRICT ENGINEER

DATE

JUL 1 1976

CONDITIONS OF APPROVAL, IF ANY:

Ltr June 30, 1976 CER
NVO 173 May 1976 TO OPERATOR'S COPY
See Instructions on Reverse Side

PRIMARY CEMENT TOP 4660'

PERFORATED GAS PROD.
ZONE 5084' TO 5126'

BAKER MODEL 'D' 5667' (Open)

5600'

5630'

PERF. WATER ZONE

5919'

6072'

BAKER MODEL 'N' BRIDGE
PLUG & 2 SKS. CMT. 6460'

7-7/8" HOLE TO 7993'

TOTAL DEPTH. 7893'

FIGURE 11

Perf. (Squeeze w/ 50 SACKS
AT 5245' Cement Top @ 5225'

Perforations 5600' to 6072'
SQUEEZED w/ 75 SACKS
CLASS 'G' cement Lv top cmt
@ 5300'

5745'

5792'

SQUEEZE

CEMENTED PERFORATIONS

WASATCH
FORMATION

FORT
UNION
FORMATION

MESAVERDE
FORMATION

4000

5000

5300'

6072'

6000

7000

8000

VERTICAL SCALE: 1" = 600'

A-13-20

FAWN CREEK GOVERNMENT No.1 WELL DOWN HOLE STATUS (PROPOSED)

APPENDIX B

AIR DATA

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Glenwood Springs (APC #46)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1973								
July	8	0.002	0.008	0.001	0.11	0.37	0.02	15802
August	7	0.004	0.015	0.001	0.07	0.09	0.03	13516
September	7	0.004	0.011	0.001	0.06	0.07	0.04	13388
October	8	0.004	0.011	0.001	0.05	0.08	0.01	16531
November	7	0.003	0.007	0.001	0.07	0.11	0.01	16514
December	8	0.007	0.015	0.003	0.10	0.16	0.06	16873
Year	89	0.004			0.07			177740
To Date		0.007			0.32			
1974								
January	8	0.006	0.012	0.001	0.15	0.22	0.07	17463
February	7	0.003	0.008	0.001	0.22	0.30	0.16	15401
March	8	0.007	0.016	0.002	0.56	0.86	0.35	17816
April	7	0.003	0.009	0.001	0.56	0.96	0.26	17199
May	8	0.006	0.012	0.001	0.58	0.93	0.31	16274
June	8	0.015	0.028	0.001	0.43	0.96	0.25	15375
July	6	0.005	0.012	0.001	0.26	0.72	0.08	10926
August	6	0.006	0.010	0.001	0.12	0.18	0.07	14403
September	8	0.008	0.028	0.002	0.14	0.19	0.11	20046
October	7	0.004	0.013	0.001	0.12	0.17	0.06	18139
November	8	0.005	0.009	0.001	0.13	0.28	0.01	21014
December	7	0.004	0.009	0.001	0.22	0.41	0.11	17607
Year	88	0.006			0.22			201663
To Date		0.006			0.31			
1975								
January	5	0.005	0.008	0.001	0.22	0.26	0.16	13116
February	7	0.003	0.009	0.001	0.19	0.27	0.09	18269
March	8	0.004	0.010	0.001	0.17	0.31	0.12	19984
April	8	0.008	0.019	0.002	0.23	0.33	0.13	18497
May	7	0.004	0.010	0.001	0.20	0.34	0.08	16865
June	8	0.004	0.011	0.001	0.14	0.18	0.10	19049
July	7	0.004	0.013	0.001	0.08	0.10	0.03	16444
August	7	0.004	0.008	0.001	0.06	0.13	0.02	15234
September	7	0.004	0.009	0.001	0.07	0.09	0.02	15418
October	8	0.004	0.009	0.001	0.06	0.10	0.03	17532
November	7	0.005	0.015	0.001	0.05	0.10	0.02	15418
December	7	0.003	0.006	0.001	0.04	0.05	0.02	16549
Year	86	0.004			0.13			202371
To Date		0.006			0.28			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Glenwood Springs (APC #46)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	8	0.006	0.014	0.002	0.06	0.07	0.03	17771
February	7	0.006	0.013	0.002	0.05	0.07	0.01	17587
March	7	0.004	0.006	0.001	0.03	0.07	0.01	17657
April	6	0.007	0.014	0.002	0.04	0.06	0.02	15170
May	8	0.003	0.007	0.001	0.06	0.08	0.03	20958
June	7	0.004	0.008	0.001	0.06	0.08	0.04	17927
July	8	0.004	0.008	0.001	0.06	0.08	0.04	20444
August	7	0.003	0.010	0.001	0.05	0.09	0.02	17881
September	7	0.004	0.010	0.001	0.07	0.09	0.05	17927
October	8	0.006	0.021	0.001	1.40	4.12	0.11	20488
November	7	0.007	0.017	0.001	0.27	0.59	0.11	17565
December	7	0.010	0.018	0.002	0.13	0.17	0.08	18005
Year	87	0.005			0.19			
To Date		0.006			0.27			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Montrose (APC #47)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1973								
July	7	0.005	0.008	0.002	0.11	0.32	0.02	18385
August	5	0.006	0.008	0.004	0.03	0.04	0.02	13266
September	7	0.003	0.007	0.001	0.04	0.06	0.03	19181
October	7	0.004	0.008	0.001	0.04	0.08	0.01	20086
November	7	0.004	0.008	0.001	0.05	0.10	0.01	19641
December	8	0.006	0.019	0.001	0.06	0.09	0.03	23116
Year	79	0.003			0.06			217184
To Date		0.006			0.38			
1974								
January	8	0.004	0.006	0.001	0.08	0.10	0.06	21952
February	6	0.005	0.013	0.001	0.14	0.23	0.08	16950
March	8	0.006	0.011	0.001	0.24	0.36	0.18	22258
April	7	0.007	0.012	0.002	0.30	0.59	0.07	19572
May	8	0.005	0.007	0.001	0.45	0.71	0.25	21578
June	6	0.006	0.009	0.002	0.26	0.38	0.11	15151
July	4	0.012	0.015	0.007	0.13	0.24	0.03	8796
August	8	0.011	0.024	0.006	0.26	0.61	0.16	17444
September	7	0.009	0.016	0.001	0.16	0.25	0.09	15073
October	2	0.009	0.010	0.008	0.11	0.12	0.10	4521
November	3	0.003	0.008	0.001	0.15	0.21	0.07	6759
December	8	0.006	0.012	0.001	0.21	0.36	0.11	18634
Year	75	0.007			0.21			188688
To Date		0.006			0.35			
1975								
January	7	0.004	0.011	0.001	0.29	0.60	0.19	15846
February	6	0.004	0.008	0.001	0.20	0.28	0.07	14328
March	8	0.003	0.011	0.001	0.20	0.33	0.11	19173
April	8	0.005	0.009	0.001	0.22	0.24	0.16	19719
May	6	0.005	0.010	0.001	0.17	0.24	0.09	13836
June	4	0.003	0.005	0.001	0.13	0.24	0.06	8996
July	8	0.004	0.014	0.001	0.06	0.11	0.01	20950
August	7	0.003	0.007	0.001	0.06	0.10	0.04	18625
September	7	0.004	0.008	0.001	0.06	0.10	0.03	17976
October	8	0.005	0.012	0.001	0.04	0.07	0.03	21500
November	7	0.004	0.008	0.001	0.04	0.06	0.03	23052
December	7	0.005	0.010	0.001	0.05	0.08	0.02	19225
Year	83	0.004			0.13			213226
To Date		0.006			0.32			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Montrose (APC #47)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	7	0.005	0.008	0.001	0.05	0.08	0.01	18925
February	5	0.005	0.015	0.002	0.06	0.08	0.03	13220
March	8	0.004	0.009	0.001	0.05	0.08	0.03	21113
April	4	0.004	0.006	0.001	0.06	0.08	0.05	10753
May	6	0.005	0.008	0.002	0.06	0.08	0.05	16011
June	6	0.005	0.009	0.001	0.06	0.08	0.03	15989
July	7	0.007	0.012	0.001	0.06	0.09	0.05	18453
August	7	0.002	0.006	0.001	0.06	0.08	0.05	18845
September	6	0.005	0.009	0.002	0.07	0.08	0.06	16158
October	6	0.006	0.008	0.001	0.75	1.61	0.09	16576
November	8	0.008	0.015	0.002	0.34	1.12	0.13	22389
December	6	0.008	0.014	0.001	0.15	0.20	0.11	16687
Year	76	0.005			0.15			
To Date		0.006			0.29			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Rifle (APC #48)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1973								
July	7	0.015	0.040	0.07	0.13	0.53	0.04	17520
August	6	0.008	0.015	0.002	0.07	0.08	0.05	16640
September	5	0.014	0.036	0.004	0.07	0.13	0.04	13900
October	7	0.012	0.022	0.005	0.05	0.09	0.02	19960
November	5	0.009	0.019	0.001	0.06	0.08	0.05	14450
December	4	0.006	0.009	0.001	0.10	0.13	0.09	10590
Year	82	0.009			0.07			221084
To Date		0.057			0.36			
1974								
January	0	--	--	--	--	--	--	--
February	3	0.002	0.004	0.001	0.06	0.09	0.01	8520
March	9	0.020	0.040	0.005	0.53	0.88	0.23	22910
April	7	0.014	0.027	0.001	0.81	1.29	0.59	16620
May	6	0.018	0.029	0.007	0.60	1.26	0.33	14514
June	6	0.014	0.043	0.002	0.32	0.55	0.21	14620
July	0	--	--	--	--	--	--	--
August	0	--	--	--	--	--	--	
September	0	--	--	--	--	--	--	--
October	0	--	--	--	--	--	--	--
November	0	--	--	--	--	--	--	--
December	0	--	--	--	--	--	--	--
Year	25	0.014			0.46			62564
To Date		0.052			0.38			
1975								
January	0	--	--	--	--	--	--	--
February	0	--	--	--	--	--	--	--
March	0	--	--	--	--	--	--	--
April	0	--	--	--	--	--	--	--
May	0	--	--	--	--	--	--	--
June	3	0.010	0.014	0.006	0.15	0.22	0.11	8466
July	7	0.005	0.009	0.001	0.04	0.07	0.02	20884
August	6	0.006	0.012	0.001	0.05	0.07	0.01	16747
September	8	0.007	0.013	0.001	0.04	0.07	0.02	21722
October	6	0.006	0.011	0.001	0.04	0.07	0.02	16099
November	4	0.007	0.012	0.004	0.07	0.08	0.05	10843
December	0	--	--	--	--	--	--	--
Year	34	0.007			0.07			94761
To Date		0.048			0.34			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Rifle (APC #48)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	3	0.002	0.004	0.001	0.04	0.07	0.01	8319
February	0	--	--	--	--	--	--	--
March	2	0.012	0.018	0.005	0.08	0.12	0.03	5344
April	0	--	--	--	--	--	--	--
May	0	--	--	--	--	--	--	--
June	2	0.018	0.019	0.017	0.06	0.10	0.03	5062
July	7	0.011	0.018	0.002	0.08	0.10	0.06	17632
August	8	0.009	0.017	0.006	0.06	0.10	0.05	20932
September	7	0.006	0.010	0.001	0.08	0.09	0.06	16286
October	8	0.007	0.017	0.001	1.309	3.09	0.11	17151
November	3	0.008	0.010	0.003	0.30	0.50	0.14	6402
December	7	0.010	0.018	0.003	0.14	0.21	0.08	16444
Year	47	0.009			0.24			
To Date		0.042			0.33			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Fruita (APC #62)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			Vol.
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	
1973								
July	8	0.007	0.016	0.001	0.17	0.52	0.04	12870
August	7	0.006	0.020	0.001	0.11	0.15	0.05	10922
September	8	0.010	0.016	0.006	0.07	0.12	0.04	13238
October	8	0.007	0.015	0.001	0.07	0.17	0.03	12749
November	7	0.010	0.019	0.001	0.10	0.18	0.05	12662
December	8	0.004	0.012	0.001	0.12	0.25	0.01	15248
Year	91	0.005			0.10			160370
To Date		0.008			0.42			
1974								
January	8	0.008	0.019	0.001	0.18	0.28	0.11	14467
February	6	0.006	0.009	0.001	0.25	0.36	0.18	12329
March	7	0.005	0.010	0.001	0.49	0.90	0.24	18655
April	7	0.005	0.012	0.001	0.53	1.04	0.04	18117
May	8	0.006	0.013	0.001	0.70	0.95	0.41	18340
June	8	0.008	0.013	0.001	0.54	1.11	0.25	18239
July	6	0.007	0.011	0.001	0.22	0.58	0.01	14847
August	8	0.008	0.019	0.001	0.29	0.69	0.14	19962
September	8	0.007	0.017	0.001	0.12	0.16	0.10	20327
October	7	0.005	0.012	0.001	0.11	0.16	0.03	18607
November	8	0.006	0.011	0.001	0.11	0.17	0.01	18501
December	8	0.008	0.029	0.001	0.22	0.39	0.08	13791
Year	89	0.006			0.31			207183
To Date		0.008			0.40			
1975								
January	7	0.002	0.005	0.001	0.23	0.36	0.03	12665
February	7	0.002	0.006	0.001	0.16	0.25	0.02	12982
March	8	0.005	0.013	0.001	0.22	0.36	0.16	14520
April	7	0.003	0.008	0.001	0.21	0.50	0.01	12620
May	7	0.003	0.008	0.001	0.19	0.28	0.03	12982
June	8	0.004	0.009	0.002	0.22	0.29	0.13	14429
July	8	0.002	0.005	0.001	0.08	0.18	0.03	13819
August	7	0.005	0.012	0.001	0.06	0.11	0.01	12346
September	8	0.003	0.006	0.001	0.06	0.10	0.02	14248
October	8	0.008	0.012	0.001	0.06	0.12	0.03	14202
November	7	0.006	0.027	0.001	0.07	0.12	0.01	12255
December	8	0.011	0.018	0.002	0.09	0.14	0.03	13837
Year	90	0.005			0.14			160905
To Date		0.007			0.36			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Fruita (APC #62)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	8	0.007	0.016	0.002	0.07	0.12	0.01	14157
February	7	0.009	0.019	0.001	0.06	0.11	0.03	12529
March	8	0.006	0.022	0.001	0.06	0.09	0.01	14791
April	7	0.003	0.009	0.001	0.07	0.09	0.04	12757
May	8	0.006	0.013	0.001	0.10	0.12	0.07	14474
June	7	0.004	0.010	0.001	0.10	0.13	0.06	12847
July	7	0.007	0.013	0.001	0.07	0.10	0.05	12755
August	7	0.007	0.012	0.001	0.09	0.13	0.06	12809
September	8	0.007	0.020	0.001	0.07	0.10	0.03	16425
October	8	0.008	0.013	0.001	1.25	2.38	0.15	15200
November	8	0.010	0.023	0.001	0.55	2.10	0.20	15271
December	7	0.011	0.024	0.001	0.18	0.27	0.14	13300
Year	90	0.007			0.22			
To Date		0.007			0.34			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Palisade (APC #66)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1973								
July	8	0.004	0.013	0.001	0.12	0.40	0.02	16264
August	7	0.003	0.005	0.001	0.07	0.10	0.04	14581
September	8	0.004	0.009	0.001	0.06	0.08	0.02	15935
October	5	0.007	0.012	0.003	0.06	0.11	0.03	11278
November	7	0.006	0.014	0.001	0.08	0.15	0.05	17185
December	8	0.006	0.013	0.001	0.09	0.14	0.03	20783
Year	87	0.004			0.07			
To Date		0.010			0.36			
1974								
January	7	0.007	0.018	0.001	0.17	0.23	0.13	15416
February	8	0.007	0.018	0.001	0.28	0.39	0.19	12343
March	8	0.005	0.013	0.001	0.60	0.90	0.32	13328
April	7	0.004	0.008	0.001	0.59	1.03	0.22	12431
May	8	0.007	0.016	0.001	0.81	1.23	0.42	13027
June	8	0.006	0.009	0.001	0.50	1.07	0.21	13497
July	6	0.006	0.016	0.001	0.26	0.57	0.11	10081
August	8	0.011	0.032	0.001	0.23	0.34	0.16	13070
September	8	0.004	0.008	0.001	0.16	0.31	0.11	13927
October	7	0.012	0.021	0.007	0.15	0.21	0.08	11918
November	7	0.004	0.005	0.001	0.12	0.19	0.01	12132
December	7	0.007	0.016	0.001	0.22	0.40	0.13	12006
Year	89	0.007			0.34			153176
To Date		0.009			0.36			
1975								
January	6	0.003	0.008	0.001	0.26	0.38	0.20	10424
February	6	0.005	0.010	0.001	0.24	0.28	0.16	10980
March	8	0.003	0.008	0.001	0.22	0.34	0.15	14228
April	8	0.003	0.013	0.001	0.27	0.52	0.16	13500
May	7	0.003	0.011	0.001	0.19	0.25	0.06	11705
June	7	0.005	0.010	0.001	0.24	0.33	0.15	10848
July	8	0.002	0.006	0.001	0.10	0.23	0.04	11100
August	7	0.010	0.024	0.001	0.07	0.13	0.01	9777
September	8	0.006	0.013	0.001	0.08	0.12	0.02	11229
October	8	0.009	0.017	0.001	0.08	0.18	0.02	11229
November	7	0.014	0.024	0.008	0.09	0.14	0.04	10078
December	8	0.008	0.013	0.001	0.09	0.20	0.06	11057
Year	88	0.006			0.16			136157
To Date		0.009			0.33			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Palisade (APC #66)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	8	0.013	0.030	0.001	0.08	0.12	0.03	11315
February	7	0.006	0.014	0.001	0.10	0.19	0.05	9080
March	8	0.005	0.014	0.001	0.08	0.13	0.06	11332
April	7	0.003	0.011	0.001	0.07	0.10	0.04	9992
May	6	0.008	0.017	0.001	0.11	0.13	0.09	8583
June	5	0.005	0.009	0.001	0.11	0.13	0.09	7310
July	8	0.006	0.013	0.002	0.08	0.13	0.04	13800
August	7	0.003	0.008	0.001	0.07	0.11	0.04	13557
September	7	0.002	0.004	0.001	0.08	0.11	0.05	13585
October	8	0.015	0.038	0.007	1.15	3.12	0.17	14127
November	7	0.009	0.017	0.001	0.45	1.65	0.14	11856
December	7	0.009	0.026	0.003	0.18	0.25	0.14	12316
Year	85	0.007			0.24			
To Date		0.008			0.32			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Grand Valley (APC #73)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			Vol.
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	
1973								
July	8	0.006	0.011	0.002	0.13	0.38	0.04	22363
August	7	0.004	0.007	0.001	0.06	0.08	0.04	18769
September	8	0.004	0.010	0.001	0.06	0.11	0.03	21460
October	8	0.006	0.010	0.001	0.07	0.11	0.03	21386
November	7	0.004	0.008	0.001	0.07	0.11	0.04	18194
December	7	0.009	0.019	0.001	0.11	0.22	0.05	18158
Year	93	0.004			0.07			243111
To Date		0.055			0.32			
1974								
January	8	0.006	0.019	0.001	0.16	0.23	0.08	20896
February	7	0.007	0.016	0.001	0.17	0.30	0.08	17829
March	8	0.007	0.013	0.001	0.40	0.67	0.12	20600
April	5	0.005	0.010	0.001	0.57	1.17	0.23	12875
May	8	0.009	0.023	0.001	0.65	1.32	0.31	20600
June	4	0.007	0.012	0.002	0.44	0.62	0.25	10152
July	7	0.009	0.017	0.001	0.25	0.49	0.09	16404
August	8	0.014	0.062	0.002	0.18	0.25	0.11	20866
September	7	0.005	0.007	0.002	0.17	0.27	0.12	18291
October	7	0.007	0.018	0.001	0.07	0.11	0.01	18291
November	6	0.004	0.008	0.001	0.12	0.15	0.08	17952
December	7	0.005	0.009	0.001	0.16	0.26	0.09	17988
Year	82	0.007			0.28			
To Date		0.043			0.31			
1975								
January	0	--	--	--	--	--	--	0
February	7	0.003	0.006	0.001	0.19	0.30	0.12	17877
March	8	0.003	0.009	0.001	0.16	0.27	0.05	20600
April	7	0.004	0.010	0.001	0.22	0.27	0.13	17385
May	7	0.002	0.004	0.001	0.14	0.18	0.03	17876
June	4	0.004	0.006	0.001	0.12	0.16	0.09	10152
July	8	0.006	0.010	0.001	0.06	0.08	0.03	20227
August	7	0.005	0.015	0.001	0.06	0.12	0.02	18500
September	8	0.004	0.007	0.002	0.06	0.10	0.03	21667
October	7	0.006	0.014	0.001	0.04	0.08	0.01	17576
November	7	0.007	0.017	0.001	0.06	0.09	0.02	17158
December	8	0.004	0.007	0.001	0.08	0.17	0.03	20000
Year	78	0.004			0.11			199068
To Date		0.036			0.28			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Grand Valley (APC #73)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	8	0.006	0.009	0.001	0.05	0.06	0.04	20190
February	5	0.003	0.007	0.001	0.04	0.06	0.02	12690
March	5	0.004	0.008	0.001	0.06	0.08	0.04	12084
April	7	0.003	0.007	0.001	0.05	0.08	0.02	16225
May	5	0.007	0.015	0.002	0.07	0.10	0.03	10728
June	7	0.010	0.018	0.003	0.07	0.12	0.05	15216
July	8	0.012	0.020	0.004	0.10	0.11	0.07	17506
August	4	0.007	0.018	0.001	0.07	0.10	0.06	10924
September	7	0.007	0.014	0.001	0.07	0.10	0.06	15722
October	7	0.006	0.017	0.001	1.11	3.36	0.11	16291
November	6	0.008	0.018	0.006	0.42	1.06	0.15	13650
December	6	0.014	0.022	0.008	0.15	0.19	0.11	13745
Year	75	0.007			0.19			
To Date		0.031			0.26			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Grand Junction (APC #97)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1973								
July	8	0.006	0.013	0.001	0.14	0.46	0.04	20090
August	6	0.007	0.011	0.002	0.07	0.11	0.04	15476
September	8	0.012	0.024	0.005	0.08	0.11	0.06	20147
October	8	0.016	0.024	0.003	0.09	0.15	0.06	18148
November	7	0.012	0.025	0.006	0.10	0.12	0.06	16883
December	7	0.011	0.024	0.001	0.14	0.26	0.04	17945
Year	89	0.008			0.09			222484
To Date		0.010			0.31			
1974								
January	4	0.007	0.015	0.002	0.17	0.22	0.13	9541
To Date		0.009			0.30			

Replaced by APC #119

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Meeker (APC #107)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			Vol
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	
1973								
July	8	0.004	0.008	0.001	0.13	0.41	0.04	19212
August	7	0.005	0.008	0.001	0.09	0.14	0.04	15402
September	2	0.002	0.003	0.002	0.06	0.07	0.04	4560
October	8	0.006	0.010	0.001	0.06	0.09	0.04	22652
November	5	0.007	0.012	0.003	0.08	0.11	0.04	14282
December	0	--	--	--	--	--	--	0
Year	73	0.004			0.07			196663
To Date		0.004			0.16			
1974								
January	0	--	--	--	--	--	--	0
February	5	0.004	0.009	0.001	0.12	0.27	0.01	13315
March	8	0.005	0.014	0.001	0.34	0.82	0.01	15512
April	6	0.006	0.012	0.001	0.42	1.35	0.03	12262
May	8	0.005	0.016	0.001	0.54	0.90	0.39	16584
June	8	0.006	0.016	0.001	0.53	0.94	0.22	14892
July	7	0.006	0.011	0.001	0.28	0.66	0.05	11830
August	7	0.009	0.024	0.001	0.24	0.37	0.15	11955
September	1	0.001	--	--	0.02	--	--	3268
October	7	0.007	0.015	0.001	0.09	0.15	0.01	11220
November	8	0.006	0.013	0.001	0.13	0.27	0.01	13460
December	8	0.003	0.009	0.001	0.20	0.36	0.09	12636
Year	73	0.005			0.26			136934
To Date		0.004			0.19			
1975								
January	7	0.003	0.007	0.001	0.20	0.32	0.15	11784
February	7	0.004	0.015	0.001	0.16	0.24	0.05	11957
March	8	0.004	0.013	0.001	0.18	0.27	0.03	15263
April	8	0.007	0.018	0.001	0.20	0.27	0.12	14901
May	4	0.007	0.020	0.001	0.13	0.21	0.02	7588
June	3	0.001	0.002	0.001	0.11	0.13	0.08	5692
July	8	0.004	0.014	0.001	0.09	0.15	0.04	14031
August	7	0.004	0.010	0.001	0.08	0.10	0.04	11818
September	8	0.007	0.014	0.002	0.06	0.10	0.03	13717
October	3	0.006	0.009	0.001	0.04	0.05	0.02	5891
November	7	0.004	0.015	0.001	0.04	0.07	0.01	12270
December	6	0.005	0.011	0.001	0.06	0.11	0.02	10013
Year	76	0.005			0.11			134925
To Date		0.004			0.17			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Meeker (APC #107)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	8	0.005	0.011	0.002	0.05	0.07	0.04	18506
February	7	0.005	0.014	0.001	0.04	0.07	0.02	18952
March	5	0.002	0.003	0.001	0.04	0.07	0.03	13755
April	2	0.004	0.008	0.001	0.08	0.09	0.08	3450
May	7	0.004	0.008	0.001	0.07	0.10	0.05	13099
June	7	0.009	0.022	0.001	0.08	0.10	0.04	12149
July	6	0.013	0.025	0.002	0.07	0.12	0.03	9883
August	4	0.002	0.002	0.001	0.06	0.08	0.04	7381
September	7	0.004	0.010	0.001	0.06	0.08	0.04	14207
October	8	0.005	0.015	0.001	1.33	3.64	0.05	17855
November	8	0.007	0.018	0.001	0.33	0.82	0.12	17141
December	7	0.007	0.017	0.001	0.11	0.15	0.07	15197
Year	76	0.005			0.19			
To Date		0.005			0.18			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Rangely (APC #108)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1973								
July	8	0.004	0.011	0.001	0.14	0.46	0.04	16480
August	7	0.005	0.012	0.001	0.08	0.12	0.04	15357
September	8	0.002	0.003	0.001	0.07	0.10	0.05	18458
October	8	0.008	0.018	0.001	0.06	0.11	0.02	18828
November	7	0.004	0.009	0.001	0.08	0.12	0.03	16344
December	8	0.010	0.017	0.003	0.13	0.25	0.06	18544
Year	86	0.004			0.10			204743
To Date		0.004			0.17			
1974								
January	7	0.007	0.016	0.001	0.20	0.30	0.11	16686
February	7	0.006	0.017	0.001	0.20	0.37	0.08	17070
March	6	0.004	0.010	0.002	0.48	0.77	0.22	14742
April	7	0.002	0.008	0.001	0.50	0.84	0.15	19021
May	8	0.004	0.010	0.001	0.79	1.23	0.35	19720
June	8	0.005	0.009	0.001	0.44	0.74	0.17	19524
July	6	0.005	0.011	0.001	0.23	0.51	0.08	14181
August	8	0.004	0.012	0.001	0.18	0.29	0.01	20588
September	8	0.007	0.013	0.001	0.15	0.23	0.11	20906
October	7	0.003	0.008	0.001	0.09	0.14	0.08	19648
November	8	0.004	0.008	0.001	0.16	0.41	0.07	22503
December	5	0.005	0.008	0.002	0.17	0.24	0.09	13814
Year	85	0.005			0.30			218403
To Date		0.005			0.21			
1975								
January	6	0.003	0.009	0.001	0.12	0.23	0.02	14724
February	7	0.004	0.007	0.001	0.19	0.24	0.13	18901
March	8	0.002	0.008	0.001	0.20	0.28	0.11	20682
April	6	0.003	0.006	0.001	0.26	0.39	0.12	13702
May	7	0.005	0.018	0.001	0.16	0.20	0.06	15619
June	8	0.003	0.007	0.001	0.17	0.24	0.11	18485
July	8	0.006	0.021	0.001	0.09	0.18	0.06	15172
August	7	0.004	0.009	0.001	0.08	0.13	0.03	13048
September	8	0.008	0.021	0.001	0.07	0.13	0.02	15191
October	8	0.005	0.020	0.001	0.06	0.12	0.03	15642
November	7	0.004	0.015	0.001	0.07	0.18	0.02	14151
December	8	0.011	0.020	0.003	0.16	0.28	0.05	16116
Year	88	0.005			0.14			191433
To Date		0.005			0.19			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Rangely (APC #108)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	8	0.005	0.018	0.001	0.09	0.14	0.02	16426
February	7	0.005	0.010	0.001	0.09	0.20	0.03	13432
March	7	0.007	0.017	0.003	0.06	0.14	0.02	15849
April	6	0.002	0.004	0.001	0.06	0.08	0.04	15195
May	8	0.004	0.010	0.001	0.07	0.10	0.03	20675
June	7	0.004	0.008	0.001	0.07	0.10	0.03	17940
July	7	0.004	0.008	0.001	0.06	0.12	0.03	17879
August	8	0.004	0.010	0.001	0.06	0.09	0.04	19678
September	6	0.003	0.006	0.001	0.06	0.07	0.04	14965
October	6	0.008	0.013	0.004	1.21	3.46	0.04	14825
November	7	0.010	0.028	0.001	0.26	0.51	0.12	18615
December	7	0.011	0.016	0.005	0.14	0.18	0.08	18901
Year	84	0.008			0.18			
To Date		0.005			0.19			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Black Sulfur Creek (APC #109)

Month	N	ALPHA (pCi/m ³)			BETA (pCi/m ³)			Vol.
		Total X̄	Long-Lived Max.	Min.	Total X	Long-Lived Max.	Min.	
1973								
July	8	0.002	0.004	0.001	0.10	0.28	0.05	19480
August	6	0.007	0.014	0.001	0.05	0.08	0.02	14610
September	8	0.004	0.012	0.001	0.06	0.09	0.03	19582
October	7	0.007	0.012	0.001	0.05	0.10	0.01	17045
November	7	0.004	0.014	0.001	0.07	0.10	0.05	17045
December	8	0.004	0.009	0.001	0.10	0.22	0.04	19480
Year	90	0.004			0.06			219368
To Date		0.004			0.19			
1974								
January	7	0.006	0.012	0.001	0.12	0.18	0.09	17045
February	7	0.004	0.017	0.001	0.18	0.34	0.04	17045
March	8	0.007	0.027	0.001	0.39	0.65	0.14	19480
April	7	0.003	0.006	0.001	0.52	0.87	0.14	17090
May	8	0.005	0.013	0.001	0.45	1.04	0.17	19480
June	6	0.008	0.014	0.004	0.34	0.58	0.20	14160
July	7	0.010	0.041	0.001	0.31	0.66	0.12	16415
August	8	0.010	0.037	0.002	0.18	0.23	0.15	19414
September	7	0.006	0.011	0.001	0.10	0.16	0.05	17178
October	3	0.008	0.015	0.004	0.08	0.10	0.05	7362
November	8	0.004	0.009	0.001	0.14	0.18	0.08	19632
December	5	0.006	0.008	0.001	0.17	0.28	0.07	12318
Year	81	0.006			0.25			262619
To Date		0.005			0.20			
1975								
January	6	0.003	0.009	0.001	0.12	0.23	0.02	14724
February	8	0.004	0.008	0.001	0.22	0.51	0.07	19680
March	8	0.002	0.007	0.001	0.18	0.26	0.12	19632
April	8	0.004	0.009	0.001	0.20	0.28	0.11	19586
May	7	0.003	0.007	0.001	0.15	0.25	0.03	17843
June	8	0.006	0.014	0.003	0.15	0.23	0.08	20392
July	8	0.002	0.005	0.001	0.05	0.06	0.03	20392
August	7	0.004	0.008	0.001	0.06	0.10	0.02	17843
September	8	0.007	0.018	0.001	0.05	0.06	0.03	20204
October	8	0.006	0.012	0.001	0.04	0.09	0.02	20063
November	7	0.004	0.008	0.001	0.04	0.09	0.02	17561
December	8	0.004	0.011	0.001	0.06	0.10	0.02	20016
Year	91	0.004			0.11			227936
To Date		0.004			0.18			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Black Sulfur Creek (APC #109)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976								
January	7	0.006	0.014	0.001	0.05	0.08	0.02	17386
February	7	0.006	0.011	0.001	0.05	0.07	0.03	15373
March	8	0.003	0.008	0.001	0.05	0.09	0.01	17684
April	0	--	--	--	--	--	--	0
May	6	0.003	0.008	0.001	0.06	0.08	0.05	14928
June	7	0.005	0.013	0.001	0.06	0.08	0.04	17136
July	2	0.001	0.001	0.001	0.06	0.07	0.05	4936
August	2	0.001	0.001	0.001	0.05	0.06	0.04	4936
September	0	--	--	--	--	--	--	0
October	0	--	--	--	--	--	--	0
November	0	--	--	--	--	--	--	0
December	0	--	--	--	--	--	--	0
Year	39	0.004			0.05			
To Date		0.004			0.17			

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Grand Junction (APC #119)
(Replaced APC #97)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1974								
January	4	0.008	0.009	0.008	0.17	0.27	0.08	10400
February	7	0.008	0.020	0.001	0.22	0.32	0.12	17701
March	8	0.009	0.018	0.002	0.45	0.86	0.20	20067
April	7	0.008	0.020	0.001	0.57	0.95	0.21	17903
May	8	0.009	0.020	0.001	0.61	1.07	0.11	16964
June	8	0.007	0.018	0.003	0.50	1.17	0.15	16973
July	3	0.009	0.015	0.006	0.44	0.55	0.33	6729
August	8	0.016	0.029	0.001	0.33	0.42	0.25	13171
September	8	0.010	0.017	0.001	0.21	0.39	0.14	13294
October	7	0.015	0.023	0.010	0.17	0.29	0.12	12031
November	9	0.014	0.030	0.001	0.18	0.30	0.07	15365
December	8	0.007	0.019	0.001	0.24	0.44	0.06	11416
Year	85	0.010			0.34			172014
To Date		0.010			0.34			
1975								
January	7	0.012	0.026	0.001	0.35	0.59	0.24	9989
February	7	0.015	0.025	0.006	0.30	0.39	0.18	9989
March	8	0.006	0.011	0.001	0.29	0.51	0.21	10967
April	7	0.007	0.021	0.001	0.34	0.73	0.02	9664
May	7	0.010	0.020	0.005	0.27	0.36	0.05	11663
June	8	0.014	0.024	0.008	0.26	0.35	0.13	13376
July	8	0.009	0.023	0.001	0.11	0.15	0.04	12681
August	6	0.010	0.019	0.003	0.10	0.20	0.03	9217
September	8	0.008	0.015	0.001	0.07	0.11	0.03	14767
October	8	0.009	0.016	0.002	0.06	0.12	0.02	14890
November	7	0.008	0.019	0.001	0.08	0.11	0.04	13219
December	8	0.014	0.044	0.004	0.10	0.16	0.04	15253
Year	89	0.010			0.19			145975
To Date		01010			0.27			
1976								
January	7	0.011	0.023	0.001	0.10	0.15	0.05	12870
February	7	0.009	0.018	0.001	0.07	0.09	0.06	13594
March	8	0.004	0.010	0.001	0.06	0.09	0.04	15250
April	7	0.002	0.006	0.001	0.06	0.11	0.04	13696
May	8	0.004	0.016	0.001	0.09	0.10	0.06	15547
June	7	0.006	0.010	0.003	0.07	0.12	0.06	14255
July	7	0.004	0.008	0.001	0.06	0.12	0.03	17879
August	8	0.004	0.010	0.001	0.06	0.09	0.04	19678
September	7	0.008	0.013	0.001	0.08	0.14	0.04	14014

AIR PARTICULATE SURVEILLANCE
TOTAL LONG-LIVED ACTIVITY (pCi/M3)
Grand Junction (APC #119)
(Replaced APC #97)

Month	N	Total Long-Lived ALPHA (pCi/m ³)			Total Long-Lived BETA (pCi/m ³)			
		$\bar{X}$	Max.	Min.	$\bar{X}$	Max.	Min.	Vol.
1976 (Cont'd)								
October	8	0.014	0.026	0.003	1.25	2.73	0.06	16200
November	8	0.011	0.020	0.001	0.46	1.01	0.18	15876
December	7	0.014	0.019	0.005	0.18	0.26	0.13	14406
Year	89	0.008			0.21			
To Date		0.009			0.25			

APPENDIX C

WATER DATA

MUNICIPAL WATER SAMPLES
(SOURCES OF WATER LISTED IN PARENTHESES)

DEBEQUE (Colorado River)

<u>DATE</u>	<u>Total Alpha</u>	<u>Total Beta</u>	<u>Tritium</u>	<u>Cond</u>	<u>TDS</u>
1/30/74	MDA	14.2 c 11.9	MDA	1778	1261
2/16/74	MDA	MDA	MDA	1749	1219
7/5/74	MDA	MDA	MDA	1172	885
9/20/74	MDA	11.8 c 11.4	MDA	1640	1030
10/15/74	14.4 c 17.6	11.7 c 11.6	MDA	--	--
3/12/75	30.8 c 21.5	14.4 c 12.2	MDA	1978	13611
5/17/76	20.2 c 15.2	MDA	MDA	--	--

GRAND VALLEY (Wells)

1/30/74	MDA	MDA	MDA	466	318
2/16/74	MDA	MDA	MDA	525	303
7/5/74	MDA	MDA	MDA	551	315
9/23/74	MDA	MDA	MDA	530	270
3/12/75	14.9 c 11.4	MDA	MDA	--	--

MEEKER (White River)

1/29/74	MDA	MDA	MDA	385	273
2/15/74	9.7 c 8.0	MDA	MDA	443	253
7/1/74	MDA	MDA	MDA	--	--
9/23/74	MDA	MDA	MDA	560	350
12/10/74	11.6 c 7.8	MDA	MDA	420	240
3/13/75	MDA	12.1 c 9.8	MDA	396	264

RANGLEY (White River)

1/29/74	MDA	16.4 c 10.1	MDA	816	562
2/16/74	30.3 c 13.7	MDA	MDA	793	509
7/1/74	MDA	MDA	469 c 446	610	365
9/23/74	MDA	MDA	MDA	862	540
10/22/74	11.4 c 13.0	MDA	--	728	510
11/14/74	MDA	MDA	MDA	557	343
12/10/74	24.9 c 13.3	MDA	MDA	885	570
3/13/75	16.2 c 15.4	MDA	MDA	836	536
5/18/76	MDA	MDA	MDA	--	--
11/12/76	12.3 c 11.7	MDA	--	--	--

RIFLE (Colorado River)

<u>Date</u>	<u>Total Alpha</u>	<u>Total Beta</u>	<u>Tritium</u>	<u>Cond</u>	<u>TDS</u>
1/31/74	MDA	MDA	MDA	385	253
2/16/74	10.0 c 8.6	MDA	MDA	361	229
3/12/74	MDA	MDA	MDA	--	--
7/2/74	MDA	MDA	MDA	260	144
9/23/74	MDA	MDA	MDA	1020	590
3/12/75	25.6 c 17.2	MDA	MDA	1051	613
5/20/76	MDA	MDA	MDA	--	--
11/22/76	26.6 c 15.8	MDA	--	--	--

GLENWOOD SPRINGS (No Name and Grizzley Creeks)

2/17/74	15.5 c 8.1	MDA	MDA	303	167
3/14/74	MDA	MDA	--	--	--
7/1/74	MDA	MDA	548 c 447	318	151

SILT (Colorado River)

3/12/74	MDA	MDA	--	--	--
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NEW CASTLE (Elk Creek)

3/15/74	MDA	MDA	--	--	--
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RIO BLANCO STORE (Well)

7/2/74	23.5 c 14.8	MDA	MDA	981	639
9/23/74	MDA	MDA	MDA	980	600
12/12/74	31.0 c 15.1	MDA	535 c 444	1030	710

WELL RB-D-w
(Alluvium well)

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
7-24-73		MDA	MDA	---	---
8-23-73		MDA	MDA	2050	---
Average		MDA	MDA	2050	---

WELL B-D-01
(B aquifer)

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta			Tritium			Conductivity umhos	Total Dissolved Solids (ppm)
7-24-73		MDA		MDA			MDA			---	---
8-3-73		MDA		MDA			MDA			---	---
9-27-73		14.4	c 17.6	12.9	c 11.7		MDA			---	---
11-30-73		MDA		MDA			2818	c 495		1632	1378
2-25-74		MDA		MDA			MDA			---	---
3-3-74		MDA		MDA			MDA			---	---
3-10-74		MDA		MDA			MDA			---	---
3-17-74		MDA		MDA			MDA			---	---
4-28-74		MDA		MDA			MDA			---	---
6-11-74		MDA		MDA			MDA			---	---
7-2-74							MDA				
7-28-76		47.7	c 25.4	17.1	c 12.8		MDA			1715	1270
Average		10.6	s 12.6	9.3	s 3.0		670	s 676		1674	1499

WELL RB-D-02
(A aquifer)

Date		Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day	Total Alpha	Total Beta		
7-2-73		MDA	MDA	991	584
7-24-73		16.7 c 14.3	MDA	---	---
8-2-73		MDA	MDA	---	---
9-27-73		MDA	MDA	---	---
11-3-73		MDA	MDA	875	517
11-30-73		MDA	MDA	670	521
4-28-74		MDA	MDA	---	---
6-11-74		MDA	MDA	---	---
7-1-74		MDA	MDA	---	---
Average		7.2 s 3.6	MDA	842	541

WELL RB-0-03
(B AQUIFER)

Date Month Day	Total Alpha	Radioactivity (pCi/L) Total Beta	Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
7/2/73	MDA	MDA	MDA	1603	951
8/2/73	MDA	MDA	MDA	--	--
9/27/73	MDA	MDA	MDA	--	--
11/3/73	MDA	MDA	679 c 457	875	503
11/30/73	MDA	MDA	MDA	1166	965
4/28/74	MDA	MDA	MDA	--	--
7/1/74	--	--	MDA	--	--
8/1/74	MDA	MDA	--	--	--
Average	MDA	MDA	504 s 77	1215	806

WELL RB-W-1

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
7/2/73		MDA	MDA	2332	1412
8/3/73		MDA	MDA	1982	1489
11/3/73		MDA	MDA	1807	1314
<hr/>					
2/25/74		MDA	MDA	--	--
3/3/74		MDA	MDA	--	--
3/10/74		MDA	MDA	--	--
3/17/74		MDA	MDA	--	--
4/28/74		MDA	MDA	--	--
6/11/74		--	--	--	--
7/2/74		MDA	MDA	--	--
<hr/>					
Average		MDA	MDA	2040	1405

WELL RB-W-2

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
6/29/73		MDA	MDA	--	--
8/2/73		20.9 c 22.2	20.8 c 13.2	MDA	--
9/27/73		29.4 c 25.2	44.6 c 15.8	MDA	--
11/3/73		62.1 c 30.2	40.6 c 15.8	606 c 456	1241
11/30/73		MDA	MDA	--	1797
4/28/74		21.7 c 19.6	MDA	MDA	--
7/2/74		MDA	MDA	--	--
8/15/74		10.6 c 18.7	MDA	--	--
Average		20.3 s 19.0	18.2 s 15.7	501 s 59	1458
					1519

WELL RB-W-3

Date		Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day	Total Alpha	Total Beta		
6/29/73		13.1 c 18.9	MDA	--	--
8/2/73		15.4 c 20.4	MDA	--	--
9/27/73		11.0 c 19.5	MDA	--	--
11/3/73		MDA	MDA	1691	1364
11/3/73		MDA	MDA	630 c 456	797
11/30/73		MDA	MDA	1166	1143
4/28/74		MDA	MDA	--	--
7/3/74		MDA	MDA	--	--
8/15/74		MDA	MDA	--	--
Average		8.4 s 3.8	MDA	1341	1101

WELL RB-W-4

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
6/29/73		MDA	MDA	--	--
8/2/73		21.9 c 25.0	32.0 c 14.8	--	--
9/27/73		21.2 c 22.7	15.6 c 12.7	--	--
11/3/73		MDA	MDA	2099	1487
11/30/73		MDA	MDA	1516	1361
4/28/74		MDA	MDA	--	--
7/3/74		MDA	MDA	--	--
8/15/74		MDA	MDA	--	--
Average		9.9 s 7.2	12.0 s 8.5	1808	1424

WELL RB-W-5

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
6/30/73		MDA	MDA	529 c 448	--
8/3/73		MDA	MDA	MDA	--
9/27/73		12.8 c 13.6	MDA	MDA	--
11/3/73		MDA	MDA	972 c 461	652
11/30/73		MDA	MDA	700	628
4/28/74		MDA	MDA	MDA	--
7/3/74		MDA	MDA	--	--
8/15/74		MDA	MDA	--	--
Average		6.8 s 2.3	MDA	567 s 200	846

WELL RB-W-6

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
6/30/73		MDA	19.3 c 39.0	MDA	1283	912
8/3/73		MDA	MDA	MDA	--	--
9/27/73		MDA	MDA	MDA	--	--
11/30/73		MDA	MDA	MDA	845	750
4/28/74		MDA	MDA	MDA	--	--
7/3/74		MDA	MDA	--	--	--
8/15/74		MDA	MDA	--	--	--
Average		MDA	9.6 s 4.3	MDA	1064	831

WELL RB-W-7

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
6/30/73		MDA	MDA	--	--
8/2/73		MDA	MDA	--	--
9/27/73		MDA	MDA	--	--
11/3/73		MDA	19.8 c 12.4	1049	637
11/30/73		MDA	MDA	758	606
4/28/74		MDA	MDA	--	--
7/3/74		MDA	MDA	--	--
8/15/74		MDA	16.2 11.6	--	--
Average		MDA	10.5 s 4.7	904	622

WELL RB-W-8

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
6/29/73		MDA	MDA	555 c 448	--	--
8/3/73		MDA	MDA	MDA	5713	3791
9/27/73		MDA	MDA	MDA	--	--
11/3/73		18.0 c 41.6	MDA	491 c 454	5364	3723
11/30/73		MDA	MDA	MDA	5305	3712
3/13/74		Dry	--	--	--	--
4/28/74		MDA	MDA	MDA	--	--
7/3/74		36.5 c 44.6	MDA	--	--	--
8/16/74		MDA	MDA	--	--	--
Average 11.3 s 11.0			MDA	491 s 32	5461	3742

WELL RB-S-03

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
8/3/73		MDA	MDA	--	--
9/27/73		MDA	MDA	--	--
11/30/73		MDA	MDA	641	516
2/25/74		MDA	MDA	--	--
3/3/74		MDA	MDA	--	--
3/10/74		MDA	MDA	--	--
3/17/74		MDA	MDA	--	--
4/28/74		MDA	MDA	--	--
7/2/74		MDA	MDA	--	--
Average		MDA	MDA	641	516

WELL RB-9-W

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
6/29/73		MDA	MDA	--	--
8/2/73		12.0 c 19.1	13.7 c 12.1	--	--
9/27/73		30.5 c 30.6	MDA	--	--
11/3/73		MDA	MDA	844 c 459	887
11/30/73		MDA	MDA	1049	845
4/28/74		MDA	MDA	--	--
7/2/74		MDA	MDA	--	--
8/15/74		MDA	MDA	--	--
Average 9.8 s 8.6			8.4 s 2.0	536 s 151	1195
					866

WELL RB-9-E

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
6/29/73		20.4 c 18.4	MDA	MDA	--
8/2/73		MDA	MDA	532 c 498	--
9/27/73		42.0 c 20.9	26.4 c 13.1	555 c 442	--
11/3/73		MDA	MDA	1022 c 462	909
11/30/73		MDA	MDA	1049	928
4/28/74		MDA	MDA	MDA	--
7/2/74		MDA	MDA	--	--
8/15/74		MDA	MDA	--	--
Average		12.3 s 13.0	10.3 s 6.5	612 s 232	1224
					918

RPS-43

WHITE RIVER AT MEEKER

Date		Total Alpha		Radioactivity (pCi/L)		Tritium		Conductivity	Total Dissolved
Month	Day			Total Beta				umhos	Solids (ppm)
9-21-73		MDA		MDA		---		---	---
1-29-74		MDA		31.3	c 12.4	---		583	376
2-15-74		15.4	c 10.0	MDA		MDA		---	---
4-3-74		MDA		MDA		MDA		---	---
7-1-74		MDA		MDA		MDA		424	280
8-14-74		MDA		MDA		---		---	---
11-19-74		18.7	c 10.5	MDA		---		---	---
1-17-75		22.7	c 12.7	MDA		1086	c 471	---	---
3-5-75		MDA		MDA		---		---	---
5-7-75		17.7	c 12.3	MDA		1127	c 461	---	---
7-8-75		MDA		MDA		MDA		---	---
9- -75		14.5	c 12.4	MDA		MDA		---	---
11-10-75		MDA		MDA		MDA		---	---
2- -76		25.1	c 12.2	MDA		502	c 452	---	---
4- -76		15.9	c 10.7	MDA		---		---	---
5-19-76		MDA		MDA		MDA		---	---
6-14-76		MDA		MDA		MDA		---	---
8-23-76		11.9	c 10.7	15.3	c 11.1	MDA		---	---
10-26-76		25.66	c 12.5	MDA		MDA		---	---
12-15-76		13.8	c 10.0	MDA		---		---	---
Average		12.1	s 7.0	9.5	s 5.4	574	s 236		

P-1

PICEANCE CREEK AT HIGHWAY 13

Date		Total Alpha		Radioactivity (pCi/L)		Tritium	Conductivity	Total Dissolved
Month	Day			Total Beta			umhos	Solids (ppm)
9-19-73		MDA		19.9	c 12.0	MDA	944	647
2-15-74		20.7	c 13.5	MDA		MDA	816	522
7-2-74		MDA		MDA		MDA	928	586
9-21-74		MDA		MDA		MDA	725	455
11-6-74		14.5	c 13.0	MDA		MDA	600	510
3-12-75		13.8	c 13.1	MDA		MDA	701	463
5-19-76		36.8	c 16.5	MDA		644 c 519	---	---
7-29-76		27.4	c 16.3	MDA		MDA	750	540
11-17-76		29.4	c 15.0	MDA		MDA	730	500
Average		16.8	s 13.0	9.3	s 4.0	494 s 56	774	528

P-2

PICEANCE CREEK ABOVE CONFLUENCE WITH COW CREEK

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
2-15-74		MDA		MDA		MDA	956	647
10-7-76		31.2	c 19.1	25.3	c 12.9	MDA	850	550
Average		18.6	s 17.8	16.6	s 12.2	MDA	903	598

P-3

PICEANCE CREEK AT WEILAND RANCH

Date		Radioactivity (pCi/L)				Conductivity	Total Dissolved
Month	Day	Total Alpha		Total Beta		umhos	Solids (ppm)
2-15-74		20.1	c 14.6	MDA		933	606
11-9-74		24.1	c 14.3	MDA		---	---
Average		22.1	s 2.8	MDA		933	606

PICEANCE CREEK AT BRIDGE TO P-L RANCH AND C-b OIL SHALE LEASE

Date		Radioactivity (pCi/L)				Conductivity		Total Dissolved	
Month	Day	Total Alpha		Total Beta		Tritium		umhos	Solids (ppm)
10-18-73		MDA		MDA		751 c 444		1720	1167
10-26-73		MDA		MDA		MDA		991	828
10-29-73		MDA		MDA		MDA		991	815
2-15-74		MDA		MDA		MDA		1143	799
7-2-74		MDA		MDA		MDA		1431	973
10-22-74		25.9	c 18.1	MDA		MDA		1248	894
11-6-74		25.4	c 17.7	MDA		560	c 456	1140	924
12-12-74		17.9	c 16.1	MDA		702	c 447	1215	780
3-12-75		24.0	c 16.7	MDA		MDA		1187	774
5-19-76		26.9	c 18.7	45.8	c 14.7	MDA			
10-7-76		21.0	c 12.5	MDA		MDA		1220	830
11-17-76		37.9	c 21.3	12	c 10	MDA		1320	960
Average		17.4	s 11.1	11.5	s 10.9	524	s 98	1237	886

PICEANCE CREEK NEAR ROCK SCHOOL ABOVE CONFLUENCE WITH BLACK SULFUR CREEK

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
10-18-73		MDA		12.2 c 11.8		MDA	1691	1147
11-20-73		MDA		MDA		MDA	---	---
11-20-73		33.3 c 18.7		MDA		MDA	---	---
2-15-74		38.6 c 20.6		MDA		695 c 457	1423	971
7-4-74		MDA		MDA		MDA	1855	1307
9-21-74		MDA		13.0 c 11.7		MDA	1705	1100
10-24-74		31.0 c 20.1		18.4 c 12.4		MDA	1560	1130
11-6-74		26.5 c 19.2		14.8 c 12.0		MDA	1160	1048
12-11-74		28.5 c 18.5		MDA		MDA	1325	870
3-12-75		21.0 c 17.2		MDA		MDA	1300	895
5-19-76		37.8 c 23.9		MDA		MDA	---	---
7-28-76		33.5 c 23.4		36.7 c 14.6		MDA	1445	1275
8-10-76		38.1 c 22.0		MDA		933 c 456	1820	1240
10-7-76		29.8 c 17.2		15.3 c 11.7		1107 c 458	1730	1240
11-17-76		37 c 21		MDA		MDA	1560	1170
Average		25.3 s 12.9		12.2 s 7.6		562 s 197	1548	1115

F-1

SPRING ABOUT 1.7 MILES SOUTH OF E.W.
ON FAWN CREEK

Date Month Day		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Total Alpha		Total Beta	Tritium	umhos	Solids (ppm)
7/24/73	MDA	MDA	MDA	1500	1188
8/23/73	MDA	MDA	--	1635	--
9/19/73	10.0 c 17.6	MDA	MDA	1416	1086
10/17/73	MDA	MDA	MDA	1516	1066
10/18/73	MDA	MDA	1474 c 454	1516	1076
10/25/73	MDA	MDA	1022 c 462	1166	1069
10/26/73	MDA	MDA	731 c 463	1166	1064
11/17/73	MDA	MDA	MDA	--	--
11/20/73	MDA	MDA	MDA	--	--
1/27/74	MDA	MDA	MDA	1370	1056
2/6/74	MDA	MDA	MDA	1469	1034
2/15/74	MDA	MDA	MDA	1399	1043
6/11/74	MDA	MDA	MDA	--	--
7/1/74	MDA	MDA	MDA	1458	1027
9/21/74	MDA	MDA	MDA	1340	970
10/22/74	24.5 c 19.2	MDA	692 c 458	1274	976
11/6/74	14.0 c 16.0	MDA	MDA	1120	984
12/11/74	26.8 c 16.9	MDA	MDA	1440	982
3/13/75	MDA	MDA	MDA	1413	974
5/19/76	26.4 c 19.9	MDA	MDA	--	--
7/28/76	26.5 c 20.8	21.8 c 12.9	MDA	1330	980
10/7/76	19.8 c 14.9	MDA	MDA	1380	970
11/17/76	23.4 c 18.4	MDA	--	1290	940
Average	11.4 s 8.3	8.6 s 2.9	571 s 247	1379	1027

F-2

FAWN CREEK NEAR EMPLACEMENT WELL

Date Month Day	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
	Total Alpha	Total Beta		
9/19/73	MDA	MDA	1593	1190
10/18/73	MDA	MDA	1632	1218
10/25/73	MDA	MDA	1224	1170
10/26/73	MDA	MDA	1283	1179
11/3/73	MDA	MDA	660 c 481	1182
1/14/73	25.6 c 18.5	MDA	1807	1219
11/16/73	12.1 c 17.4	MDA	--	--
11/17/73	12.0 c 17.3	MDA	--	--
11/18/73	MDA	MDA	--	--
11/20/73	MDA	MDA	--	--
1/28/74	11.6 c 18.4	MDA	1516	1218
2/6/74	MDA	MDA	1516	1158
2/15/74	28.2 c 20.4	MDA	2813 c 486	1241
7/1/74	MDA	MDA	1405	1036
9/21/74	MDA	MDA	1485	970
10/22/74	18.6 c 18.9	MDA	550 c 456	1008
11/6/74	26.0 c 18.1	MDA	1135	1037
12/12/74	26.2 c 18.3	MDA	1440	980
2/12/75	11.0 c 17.4	MDA	--	--
5/19/76	49.1 c 25.6	MDA	7.2 c 520	--
10/6/76	24 c 14	MDA	1380	990
11/17/76	35.0 c 21.4	MDA	1390	1050
Average	15.4 s 12.0	MDA	610 s 509	1115

FAWN CREEK AT CULVERT UNDER FAWN CREEK
ROAD ABOUT 4 MILES NORTH OF E.W.

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
7/24/73		MDA	MDA	1400	1160
8/23/73		MDA	MDA	--	--
9/19/73		MDA	MDA	1593	1173
10/18/73		14.0 c 18.6	MDA	755 c 444	1207
10/25/73		MDA	MDA	1283	1149
10/26/73		MDA	MDA	567 c 461	1150
11/14/73		MDA	MDA	1516	1186
11/16/73		MDA	12.2 c 11.6	504 c 479	--
11/17/73		MDA	MDA	MDA	--
11/18/73		MDA	MDA	834 c 489	--
11/19/73		18.1 c 18.2	MDA	MDA	--
11/19/73		MDA	MDA	2038 c 503	--
11/20/73		10.7 c 17.0	MDA	MDA	--
11/20/73		MDA	MDA	970 c 488	--
1/28/74		MDA	MDA	1458	1181
2/6/74		MDA	MDA	1539	1135
2/15/74		MDA	MDA	1562	1136
4/24/74		MDA	MDA	1548	1119
6/11/74		MDA	MDA	--	--
7/1/74		MDA	MDA	1696	1179
9/21/74		MDA	MDA	1540	1040
10/22/74		19.1 c 19.1	MDA	1352	1048
10/24/74		18.8 c 18.8	MDA	1352	1046
11/6/74		25.8 c 18.7	MDA	1250	1069
12/10/74		33.1 c 19.7	MDA	1440	1029
3/12/75		23.2 c 19.0	MDA	602 c 466	1526
5/19/76		21.9 c 19.8	MDA	MDA	--
7/28/76		21.1 c 21.2	31.4 c 14.0	MDA	1270
8/10/76		44.9 c 21.9	MDA	MDA	1620
10/7/76		23.6 c 14.2	MDA	MDA	1420
11/17/76		44.4 c 20.7	MDA	MDA	1410
Average		13.8 s 11.4	8.9 s 4.2	577 s 306	1475
					1114

BS-1

BLACK SULFUR CREEK ABOUT 2½ MILES
ABOVE EQUITY OIL CAMP

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved	
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)	
10/18/73		MDA	MDA	1168 c 450	933	632
10/25/73		MDA	MDA	547 c 455	700	579
10/26/73		MDA	MDA	1365 c 472	758	626
11/16/73		MDA	MDA	MDA	--	--
11/17/73		MDA	MDA	MDA	--	--
11/20/73		MDA	MDA	MDA	--	--
1/28/74		MDA	MDA	MDA	845	636
2/6/74		MDA	MDA	741 c 461	840	581
2/15/74		16.7 c 13.1	MDA	MDA	921	589
9/21/74		MDA	MDA	MDA	1100	700
10/24/74		17.7 c 15.9	MDA	1177 c 465	962	680
11/6/74		17.9 c 14.7	MDA	MDA	750	611
12/11/74		14.9 c 12.8	MDA	3776 c 508	905	585
3/13/75		14.4 c 17.6	MDA	MDA	881	591
5/19/76		17.6 c 13.8	MDA	MDA	--	--
10/7/76		16.5 c 8.6	MDA	MDA	880	620
Average		10.6 s 5.5	MDA	845 s 838	873	619

BS-2

BLACK SULFUR CREEK AT EQUITY OIL CAMP

Date Month Day	Total Alpha	Radioactivity (pCi/L) Total Beta	Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
10/18/73	MDA	MDA	MDA	1049	709
10/25/73	MDA	MDA	974 c 467	845	682
10/26/73	MDA	MDA	MDA	816	695
11/14/73	MDA	MDA	MDA	1166	711
11/16/73	MDA	MDA	602 c 480	--	--
11/17/73	MDA	MDA	707 c 460	--	--
11/20/73	MDA	MDA	MDA	--	--
11/20/73	MDA	MDA	MDA	--	--
1/28/74	10.5 c 13.9	MDA	MDA	845	695
2/6/74	MDA	MDA	MDA	933	652
2/15/74	15.6 c 13.4	MDA	502 c 454	944	673
2/15/73	22.6 c 18.5	MDA	MDA	--	--
7/2/74	MDA	MDA	MDA	1087	702
7/2/74	MDA	MDA	MDA	1060	730
9/21/74	MDA	MDA	MDA	1090	690
10/24/74	24.2 c 16.9	15.5 c 11.7	824 c 460	1014	699
11/6/74	11.1 c 13.5	MDA	MDA	820	694
12/11/74	31.2 c 15.5	MDA	926 c 468	1090	733
3/13/75	--	--	MDA	--	--
5/19/76	13.1 c 13.1	MDA	MDA	--	--
7/28/76	43.3 c 19.8	18.0 c 12.1	MDA	970	640
10/7/76	20.1 c 11.3	21.8 c 11.7	MDA	1010	690
11/17/76	28.0 c 17.6	MDA	MDA	1020	710
Average	13.3 s 10.6	9.4 s 3.8	548 s 154	985	694

BS-3

BLACK SULFUR CREEK AT NORREL RANCH
ABOVE CONFLUENCE WITH FAWN CREEK

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
9/19/73		MDA	MDA	1298	1000
10/18/73		MDA	MDA	1574	1142
10/25/73		MDA	MDA	1134 c 463	961
10/26/73		MDA	MDA	1166	991
11/14/73		MDA	MDA	1399	1111
11/16/73		MDA	MDA	--	--
11/18/73		13.9 c 17.0	MDA	--	--
11/20/73		14.9 c 16.9	MDA	534 c 482	--
11/20/73		MDA	10.1 c 9.8	1385 c 473	--
1/28/74		MDA	MDA	1116	997
2/6/74		MDA	MDA	1364	1008
2/15/74		22.6 c 18.5	MDA	1516	1102
7/2/74		12.2 c 12.3	MDA	--	511
7/2/74		MDA	MDA	1696	1261
9/21/74		MDA	MDA	1560	1070
10/24/74		26.2 c 20.6	14.1 c 12.1	1404	1071
11/6/74		57.4 c 21.8	19.3 c 12.4	1080	964
12/12/74		26.4 c 19.1	MDA	1490	1068
3/13/75		22.2 c 18.2	MDA	1413	986
Average		13.7 s 12.6	9.0 s 2.8	1333	1016

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BLACK SULFUR CREEK AT FAWN CREEK ROAD
BELOW CONFLUENCE WITH FAWN CREEK

Date Month Day	Total Alpha	Radioactivity (pCi/L) Total Beta	Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
7/24/73	25.1 c 19.7	MDA	MDA	1400	1140
8/23/73	MDA	MDA	--	1610	--
9/19/73	MDA	MDA	MDA	1534	1123
10/17/73	MDA	MDA	640 c 449	1516	1175
10/18/73	MDA	MDA	992 c 447	1632	1175
10/25/73	MDA	23.3 c 12.6	732 c 457	1166	1069
10/26/73	MDA	MDA	MDA	1166	1064
11/14/73	MDA	MDA	MDA	1574	1186
11/16/73	MDA	MDA	766 c 482	--	--
11/17/73	MDA	MDA	MDA	--	--
11/18/73	10.8 c 17.1	MDA	738 c 485	--	--
11/19/73	MDA	MDA	677 c 480	--	--
11/20/73	26.7 c 19.3	MDA	609 c 480	--	--
11/20/73	MDA	MDA	MDA	--	--
1/24/74	MDA	16.0 c 12.5	--	1500	1091
1/28/74	MDA	MDA	MDA	--	--
2/6/74	20.5 c 19.5	MDA	MDA	1423	1065
2/15/74	13.7 c 18.1	MDA	MDA	1469	1126
3/26/74	MDA	13.3 c 11.7	1480 c 476	1595	1150
4/24/74	MDA	MDA	MDA	1635	1217
5/23/74	MDA	MDA	MDA	--	--
6/11/74	MDA	MDA	MDA	--	--
7/1/74	MDA	MDA	MDA	1643	1239
9/21/74	MDA	MDA	MDA	1595	1070
10/22/74	26.8 c 19.4	MDA	MDA	1352	1097
11/6/74	25.6 c 18.5	13.5 c 11.7	MDA	1160	1050
12/12/74	24.8 c 18.7	MDA	MDA	1440	1040
3/12/75	24.0 c 20.6	MDA	MDA	--	--

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Black Sulfur Creek at Fawn Creek Road

Below Confluence with Fawn Creek

Page Two

Date		Total Alpha	Radioactivity (pCi/L)		Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta				
5/19/76		38.0 c 20.8	18.8 c 12.4		MDA	--	--
7/28/76		32.0 c 23.2	17.6 c 12.8		MDA	1535	1190
8/10/76		39.6 c 22.3	MDA		MDA	1770	1200
10/7/76		30.8 c 18.9	MDA		MDA	1780	1350
11/17/76		41.4 c 23.3	MDA		MDA	1410	1060
Average		15.0 s 12.0	9.6 s 3.8		566 s 210	1496	1137

PICEANCE CREEK AT RYAN GULCH ROAD

Date		Radioactivity (pCi/L)		Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day	Total Alpha	Total Beta			
7-24-73		MDA	MDA	MDA	1600	1302
8-23-73		MDA	MDA	MDA	1590	---
10-25-73		MDA	MDA	504 c 454	1166	1058
10-26-73		MDA	13.1 c 11.5	MDA	1166	1067
1-29-74		13.8 c 16.9	MDA	MDA	1399	1039
2-6-74		MDA	16.4 c 12.2	MDA	1399	1017
2-16-74		MDA	MDA	MDA	1446	1087
7-1-74		MDA	MDA	MDA	2014	1514
9-21-74		11.5 c 18.3	MDA	MDA	1900	1290
10-22-74		22.7 c 19.5	MDA	MDA	1560	1143
11-6-74		30.8 c 18.8	MDA	MDA	1215	1057
12-11-74		30.5 c 19.3	MDA	640 c 464	1440	975
3-13-75		MDA	MDA	MDA	---	---
5-19-76		41.1 c 22.5	MDA	MDA	---	---
7-28-76		20.6 c 23.5	17.3 c 13.1		1465	1140

PICEANCE CREEK AT RYAN GULCH ROAD (page 2)

Date		Radioactivity (pCi/L)				Conductivity		Total Dissolved	
Month	Day	Total Alpha		Total Beta		Tritium		umhos	Solids (ppm)
8-10-76		27.0	c 22.1	MDA		MDA		1870	1290
10-7-76		19.2	c 15.7	MDA				1780	1270
11-17-76		26.5	c 16.0	11.8	c 10.2	855	c 470	1560	1190
Average		15.6	s 10.8	9.5	s 3.0	511	x 101	1536	1163

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PICEANCE CREEK AT SHELL PUMPING STATION

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
9-19-73		MDA		MDA		MDA		1534	1091
11-15-73		MDA		MDA		653 c 481		---	---
11-30-73		MDA		MDA		---		---	---
2-16-74		29.9 c 20.9		MDA		532 c 454		1516	1099
2-16-74		52.7 c 23.2		MDA		MDA		1446	1020
3-13-75		13.0 c 17.2		MDA		MDA		1469	1006
5-19-76		15.8 c 20.9		MDA		MDA		---	---
10-7-76		---		---		MDA			
Average		18.5 s 17.4		MDA		509 s 67		1491	1054

PICEANCE CREEK 3/4 MILE BELOW SHELL PUMPING STATION ADJACENT TO ROAD

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
11	30	MDA	MDA	---	---	---

PICEANCE CREEK AT ROAD TO LITTLE HILLS GAME EXPERIMENT STATION

Date		Radioactivity (pCi/L)						Conductivity	Total Dissolved
Month	Day	Total Alpha		Total Beta		Tritium		umhos	Solids (ppm)
2-16-74		57.3	c 24.4	MDA		MDA		1516	1107
7-1-74		MDA		MDA		---		2438	1753
3-13-75		14.4	c 17.6	MDA		MDA		1526	1026
5-19-76		26.8	c 23.0	15.6	c 12.7	MDA		---	---
Average		26.1	s 22.5	9.9	s 3.8	MDA		1827	1295

P-10

PICENACE CREEK BETWEEN STINKING SPRINGS AND YELLOW CREEK ROAD

Date		Radioactivity (pCi/L)						Conductivity	Total Dissolved
Month	Day	Total Alpha		Total Beta		Tritium		umhos	Solids (ppm)
2-7-74		24.7	c 21.1	26.9	c 13.5	MDA		1423	1021
7-30-74		MDA		MDA		---		---	---
8-21-74		52.7	c 236.1	97.7	c 130.4	---		---	---
9-25-75		31.5	c 19.3	MDA		---		---	---
5-19-76		27.2	c 24.5	MDA		MDA		---	---
Average		28.4	s 16.7	29.7	s 38.9	MDA		1423	1021

BRIDGE OVER PICEANCE CREEK ONE MILE ABOVE CONFLUENCE WITH WHITE RIVER

Date Month Day		Total Alpha		Radioactivity (pCi/l) Total Beta		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
10-18-73		MDA		MDA		657 c 442		2157	1441
11-14-73		15.7	c 22.6	16.3	c 12.9	1048 c 462		1924	1351
1-29-74		MDA		46.8	c 13.5				
2-16-74		11.8	c 18.7	MDA		MDA		1632	1093
7-1-74		21.0	c 25.7	MDA		MDA		4664	3147
9-23-74		MDA		MDA		MDA		2800	1920
10-27-74		19.9	c 21.3	MDA		MDA		2236	1601
12-10-74						MDA		1935	1270
3-13-75		19.6	c 18.6	MDA		MDA		1921	1304
5-19-76		46.8	c 67.4	30.0	c 44.4	MDA		---	---
7-28-76		36.0	c 27.1	16.9	c 13.6	MDA		2375	1810
10-5-76		26.6	c 20.0	MDA		MDA		1920	1450
11-17-76		48.7	c 26.7	21	c 13	MDA		1810	1370
Average		22.0	s 15.0	15.6	s 12.1	538 s 169		2344	1614

P-12

WHITE RIVER AT PICEANCE CREEK ROAD

Date		Radioactivity (pCi/L)		Conductivity		Total Dissolved Solids (ppm)
Month	Day	Total Alpha	Total Beta	Tritium	umhos	
11-14-73		MDA	MDA	---	787	474
1-29-74		MDA	31.3 c 12.4	616 c 454		
2-16-74		20.4 c 13.3	MDA	MDA	886	599
7-1-74		MDA	MDA	MDA	530	361
9-12-74		MDA	MDA	MDA	715	444
10-22-74		20.3 c 12.4	MDA	MDA	551	400
12-12-74		14.9 c 10.7	MDA	MDA	710	486
3-13-75		MDA	MDA	MDA	751	503
5-18-76		MDA	MDA	MDA	751	503
10-5-76		15.8 c 8.6	MDA	MDA	620	400
11-17-76		21.9 c 12.0	MDA	MDA	600	410
Average		11.4 s 7.2	10.1 x 7.0	489 s 45	683	453

P-13

WHITE RIVER AT HIGHWAY 64 BELOW CONFLUENCE WITH PICEANCE CREEK

Date		Total Alpha		Radioactivity (pCi/L)		Tritium	Conductivity	Total Dissolved Solids (ppm)
Month	Day			Total Beta			umhos	
9-21-73		MDA		MDA		---	---	---
2-16-74		MDA		MDA		MDA	793	517
4-13-74		MDA		MDA		MDA		
7-1-74		MDA		MDA		MDA	530	364
8-14-74		MDA		MDA		---	---	---
8-21-74		MDA		MDA		---	---	---
9-23-74		MDA		MDA		MDA	800	500
9-24-74		29.2	c 23.9	15.0	c 12.7			
10-22-74		18.5	c 12.9	MDA		MDA	676	459
11-19-74		19.1	c 13.4	12.6	c 11.1	MDA	---	---
3-13-75		33.7	c 17.2	MDA		MDA	904	581
7-8-75		12.4	c 9.0	MDA		MDA	---	---
9- -75		MDA		MDA		MDA	---	---
11-10-75		14.8	c 11.6	MDA		711 c 459	---	---
1-15-76		15.7	c 12.3	MDA		MDA	---	---
2- -76		19.8	c 12.9	MDA		MDA	---	---
4- -76		MDA		MDA		MDA	---	---
5-18-76		17.3	c 14.1	17.9	c 20.2	MDA	---	---
6-14-76		14.5	c 10.1	MDA		---	---	---
10-5-76		28.2	c 11.4	MDA		MDA	700	470
11-17-76		23.4	c 12.8	MDA			680	490
Average		14.3	s 8.9	9.0	s 2.7	491 s 61	726	483

Y-2

YELLOW CREEK AT 84 RANCH

Date		Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day	Total Alpha	Total Beta		
6/13/74		MDA	MDA	--	--
5/24/74		11.3 c 17.9	MDA	--	--
7/1/74		MDA	MDA	--	--
7/11/74		MDA	MDA	--	--
9/2/74		MDA	MDA	--	--
9/25/74		32.4 c 20.4	MDA	--	--
10/22/74		29.6 c 20.6	16.2 c 12.3	1560	1227
5/19/76		33.9 c 27.1	MDA	--	--
Average		16.4 s 13.1	9.0 s 2.9	1560	1227

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YELLOW CREEK AT HIGHWAY 64

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
11-14-73		28.0	c 26.6	21.6	c 14.2	MDA	3440	2376
9-23-74		MDA		MDA		MDA	3080	2100
10-22-74		29.6	c 20.6	16.2	c 12.3	MDA	---	---
10-24-74		20.7	c 23.6	MDA		MDA	2808	2118
12-11-74		13.4	c 23.7	19.9	c 13.6	MDA	3650	2499
3-13-75		17.5	c 25.2	MDA		MDA	3330	2297
5-18-76		26.7	c 42.4	MDA		696 c 492	---	---
11-17-76		15.1	c 23.9	16.5	c 14.6	MDA	3710	3070
Average		19.6	s 8.2	13.3	s 5.9	503 s 78	3336	2410

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SPRING CREEK AT HIGHWAY 64

Date		Radioactivity (pCi/L)				Conductivity	Total Dissolved	
Month	Day	Total Alpha		Total Beta		Tritium	umhos	Solids (ppm)
7-1-74		52.4	c 29.4	55.5	c 17.9	MDA	2862	2393
9-23-74		78.7	c 54.9	37.6	c 29.4	MDA	8200	7500
3-13-75		117.0	c 105.4	22.7	c 69.4	---	7345	6733
5-18-76		106.9	c 114.0	123.3	c 109.1	MDA	---	---
Average		88.8	s 29.2	59.8	s 44.4	MDA	6136	5542

C-1

CATHEDRAL CREEK AT STEELE RANCH
13 MILES FROM DOUGLAS PASS ROAD

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
3/13/75		17.7 c 18.9	16.7 c 12.2	MDA	1130	778

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DOUGLAS CREEK AT HIGHWAY 64

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
11-14-73		MDA		53.0 c 49.7		978 c 467		2274	1788
7-1-74		MDA		19.2 c 13.2		MDA		2544	2067
3-13-75		40.3 c 23.9		MDA		MDA		1978	1424
5-18-76		50,0 c 42.8		56.1 c 43.9		MDA		---	---
Average		25.6 s 23.0		34.1 s 24.1		601 s 252		2265	1760

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WHITE RIVER AT RANGELY

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
8-14-84		MDA		MDA		---		---	---
11-19-74		15.2	c 11.9	MDA		---		---	---
1-17-75		15.8	c 13.6	MDA		910	c 465	---	---
3-5-75		14.8	c 14.8	MDA		1120	c 471	---	---
7-8-75		MDA		MDA		516	c 441	---	---
9- -75		16.6	c 13.6	MDA		---		---	---
11-10-75		MDA		MDA		---		---	---
1-15-76		23.9	c 13.1	MDA		MDA		---	---
2- -76		20.1	c 13.1	MDA		525	c 453	---	---
4- -76		22.2	c 14.5	MDA		MDA		---	---
6-14-76		11.2	c 9.6	MDA		MDA		---	---
8-23-76		21.3	c 13.0	16.7	c 11.4	567	c 443	---	---
10-26-76		14.4	c 13.0	17.5	c 11.6	MDA		---	---
12-15-76		30.7	c 14.9	MDA		---		---	---
Average		16.0	s 7.3	9.3	s 3.3	615	s 235		

RPS-87

ROCK CREEK AT MC COY

Date Month Day	Total Alpha	Radioactivity (pCi/L)		Total Beta	Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
8-17-73	MDA	MDA		MDA	MDA	---	---
4-3-74	MDA	12.3	c	10.5	MDA	---	---
8-14-74	MDA	MDA		MDA	---	---	---
11-6-74	10.9 c 8.2	MDA		MDA	MDA	---	---
1-17-75					886 c 464	---	---
3-24-75	9.8 c 7.7	MDA			---	---	---
5-7-75	9.2 c 7.2	17.2	c	10.9	668 c 454	---	---
7-8-75					MDA	---	---
9- -75	11.8 c 10.2	MDA			565 c 458	---	---
11-10-75	12.2 c 8.8	MDA			MDA	---	---
11-18-75	MDA	MDA			---	---	---
2-4-76	16.9 c 8.6	MDA			MDA	---	---
4- -76	15.7 c 8.4	MDA			MDA	---	---
6-17-76	12.0 c 7.1	MDA			MDA	---	---
8-25-76	11.2 c 9.1	15.4	c	10.9	MDA	---	---
10-26-76	17.0 c 12.8	16.3	c	11.4	MDA	---	---
12-9-76	23.2 c 9.7	MDA			MDA	---	---
Average	11.6 s 5.0	10.0	s	3.5	525 s 118		

RPS-52

EAGLE RIVER AT GYPSUM

Date Month Day	Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
8-17-73	MDA		MDA		MDA		---	---
11-1-73	MDA		MDA		MDA		---	---
4-3-74	MDA		MDA		MDA		---	---
4-19-74	MDA		MDA		MDA		---	---
5-1-74	MDA		MDA		MDA		---	---
5-15-74	MDA		MDA		MDA		---	---
5-15-74	MDA		MDA		MDA		---	---
7-24-74	MDA		MDA		MDA		---	---
8-9-74	MDA		MDA		MDA		---	---
9-3-74	MDA		MDA		MDA		---	---
11-6-74	11.4	c 13.0	12.7	c 11.1	MDA		---	---
11-13-74	MDA		MDA		MDA		---	---
1-10-75	MDA		MDA		MDA		---	---
3-6-75	13.5	c 15.5	14.9	c 11.6	561	c 443	---	---
4-28-75	11.8	c 15.6	MDA		863	c 455	---	---
7-11-75	MDA		MDA		MDA		---	---
9-18-75	18.2	c 14.3	MDA		MDA		---	---
10-11-75	34.7	c 16.9	MDA		MDA		---	---
2-4-76	22.1	c 16.0	MDA		MDA		---	---
4- -76	MDA		MDA		MDA		---	---
6-8-76	MDA		MDA		MDA		---	---
8-3-76	14.1	c 8.9	14.5	c 10.8	MDA		---	---
10-6-76	12.8	c 12.1	16.3	c 1.4	MDA		---	---
12-9-76	23.6	c 15.2	11.4	c 9.7	MDA		---	---
Average	10.5	s 7.5	9.2	s 2.6	495	s 80		

RPS-46

COLORADO RIVER NEAR DOTSERO

Date Month Day	Total Alpha	Radioactivity (pCi/L) Total Beta		Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
8-17-73	MDA	MDA		MDA	---	---
11-1-73	MDA	MDA		---	---	---
4-3-74	MDA	MDA		MDA	---	---
4-11-74	MDA	15.9 c 10.8		MDA	---	---
4-19-74	MDA	MDA		MDA	---	---
7-24-74	MDA	MDA		MDA	---	---
8-9-74	MDA	MDA		MDA	---	---
9-3-74	MDA	MDA		MDA	---	---
11-6-74	8.3 c 7.9	MDA		MDA	---	---
1-10-75	15.2 c 11.0	MDA		969 c 553	---	---
3-6-75	MDA	14.9 c 10.8		---	---	---
4-28-75	22.8 c 13.5	MDA		758 c 446	---	---
7-11-75	14.1 c 9.2	MDA		MDA	---	---
9-18-75	11.1 c 7.2	MDA		MDA	---	---
11-10-75	MDA	MDA		MDA	---	---
2-4-76	MDA	MDA		---	---	---
4- -76	20.9 c 10.0	MDA		---	---	---
6-8-76	MDA	MDA		---	---	---
8-3-76	11.9 c 10.7	23.4 c 11.9		---	---	---
10-6-76	49.5 c 21.0	28.9 c 13.2		---	---	---
12-9-76	15.9 c 8.9	MDA		---	---	---
Average	11.5 s 10.2	10.4 s 5.7		535 s 152		

RPS-53

ROARING FORK AT MOUTH

Date		Radioactivity (pCi/L)			Conductivity		Total Dissolved	
Month	Day	Total Alpha	Total Beta	Tritium	umhos		Solids (ppm)	
8-17-73		MDA	MDA	MDA	---		---	
4-3-74		MDA	MDA	MDA	---		---	
4-19-74		MDA	MDA	MDA	---		---	
7-24-74		MDA	MDA	MDA	---		---	
8-9-74		MDA	MDA	MDA	---		---	
9-3-74		11.9 c 13.5	MDA	MDA	---		---	
11-6-74		20.4 c 12.5	MDA	MDA	---		---	
1-8-75		19.0 c 12.3	MDA	MDA	---		---	
3-6-75		20.7 c 13.1	MDA	MDA	---		---	
7-11-75		14.2 c 8.2	MDA	MDA	---		---	
9-18-75		15.0 c 11.8	MDA	MDA	---		---	
11-10-75		MDA	MDA	MDA	---		---	
2-4-76		16.8 c 10.6	MDA	MDA	---		---	
4- -76		MDA	MDA	1669 c 533	---		---	
6-8-76		MDA	17.0 c 10.9	MDA	---		---	
8-3-76		27.6 c 12.6	MDA	MDA	---		---	
10-6-76		25.8 c 13.2	MDA	MDA	---		---	
12-9-76		12.1 c 10.4	MDA	539 c 460	---		---	
Average		12.9 s 7.4	8.5 s 2.1	545 s 281				

RPS-47

COLORADO RIVER NEAR NEW CASTLE

Date		Total Alpha		Radioactivity (pCi/L)		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day			Total Beta					
8-17-73		MDA		MDA		MDA		---	---
4-3-74		MDA		MDA		MDA		---	---
4-11-74		MDA		13.0	c 11.0	MDA		---	---
4-19-74		11.7	c 11.7			MDA		---	---
5-1-74		MDA		MDA		MDA		---	---
5-15-74		MDA		MDA		MDA		---	---
5-15-74		MDA		MDA		MDA		---	---
5-15-74		MDA		MDA		MDA		---	---
7-24-74		MDA		MDA		MDA		---	---
8-9-74		MDA		MDA		MDA		---	---
9-3-74		MDA		MDA		MDA		---	---
11-6-74		22.6	c 13.8	12.1	c 11.0	MDA		---	---
1-8-75		18.8	c 15.3	12.2	c 11.2	MDA		---	---
3-6-75		16.4	c 14.8	16.6	c 11.7	491	c 442	---	---
4-28-75		35.7	c 19.0	MDA		654	c 452	---	---
7-11-75		MDA		15.1	c 10.9	MDA		---	---
9-18-75		12.7	c 12.7	MDA		MDA		---	---
11-10-75		22.3	c 15.0	MDA		MDA		---	---
2-4-76		24.7	c 16.1	MDA		MDA		---	---
4- -76		18.9	c 12.8	MDA		535	c 518	---	---
6-8-76		MDA		MDA		MDA		---	---
8-3-76		23.6	c 14.4	20.5	c 11.9	MDA		---	---
10-4-76		28.0	c 15.7	MDA		MDA		---	---
12-7-76		17.5	c 14.3	MDA		MDA		---	---
Average		13.5	s 9.0	9.7	s 3.4	486	s 38		

COLORADO RIVER AT RIFLE

Date		Total Alpha		Radioactivity (pCi/L)		Tritium		Conductivity	Total Dissolved
Month	Day			Total Beta				umhos	Solids (ppm)
7-2-74		MDA		MDA		MDA		477	305
9-22-74		MDA		13.7	c 11.1	MDA		1010	570
5-17-76		12.2	c 9.2	MDA		MDA		---	---
Average		8.1	s 3.6	9.9	s 3.3	MDA		744	438

G-1

GOVERNMENT CREEK AT HIGHWAY 13 NORTH
OF RIFLE

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
2/16/74		23.9 c 21.5	MDA	MDA	1866	1448

Ri-1

RIFLE CREEK AT HIGHWAY 13 IN RIFLE

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
2/16/74		29.4 c 21.2	MDA	MDA	1749	1503
7/2/74		15.6 c 19.0	19.6 c 12.6	MDA	1829	1509
9/21/74		20.1 c 20.1	MDA	MDA	1850	1375
Average		21.7 s 7.0	11.9 s 6.7	MDA	1809	1462

Pa-2

PARACHUTE CREEK AT ENTRANCE
TO THE COLONY OIL SHALE SITE

Date		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Month	Day	Total Alpha	Total Beta	umhos	Solids (ppm)
2/16/74		MDA	MDA	840	538
7/5/74		MDA	MDA	814	532
7/9/74		MDA	13.9 c 12.0	--	--
3/12/75		17.3 c 14.2	MDA	791	477
11/15/76		10.5 c 7.6	MDA	--	--
Average		9.2 s 5.0	9.2 s 2.6	815	516

Pa-1

PARACHUTE CREEK AT HIGHWAY 6
IN GRAND VALLEY

Date Month Day		Radioactivity (pCi/L)		Conductivity	Total Dissolved
Total Alpha		Total Beta	Tritium	umhos	Solids (ppm)
10/18/73	MDA	MDA	MDA	1283	891
1/30/74	12.4 c 15.1	MDA	MDA	1108	863
2/16/74	MDA	MDA	MDA	1119	770
4/23/74	MDA	MDA	MDA	--	--
5/10/74	MDA	MDA	MDA	774	459*
6/11/74	MDA	MDA	MDA	--	--
7/5/74	MDA	MDA	MDA	816	520
7/9/74	MDA	14.0 c 12.2	MDA	--	--
9/22/74	11.4 c 18.1	MDA	MDA	1720	1185
10/21/74	18.2 c 15.6	13.0 c 11.4	--	--	--
12/12/74	20.0 c 16.3	16.0 c 11.8	--	1215	807
3/12/75	21.2 c 16.6	MDA	MDA	1130	753
10/5/75	26.1 c 26.2	MDA	--	--	--
5/17/76	14.4 c 13.7	MDA	MDA	--	--
Average	11.4 s 7.0	9.4 s 2.8	MDA	1146	781

Ba-1

BATTLEMENT CREEK ABOVE RULISON SITE

Date		Total Alpha		Radioactivity (pCi/L)		Conductivity		Total Dissolved	
Month	Day			Total Beta	Tritium	umhos		Solids (ppm)	
11-15-76		15.9	c 8.5	MDA	MDA	---		---	

Ba-2

BATTLEMENT CREEK BELOW RULISON SITE

Date		Radioactivity (pCi/L)			Conductivity		Total Dissolved	
Month	Day	Total Alpha	Total Beta	Tritium	umhos		Solids (ppm)	
7-5-75		MDA	MDA	MDA	175		172	
10-24-75		14.6 c 9.2	MDA	604 c 457	307		185	
5-17-76		12.0 c 6.9	MDA	MDA	---		---	
7-26-76		12.5 c 8.1	MDA	MDA	240		160	
10-6-76		MDA	MDA	749 c 453	---		---	
11-15-76		17.5 c 8.5	MDA	MDA	---		---	
Average		11.4 s 4.6	MDA	542 s 114	241		172	

Ba-3

BATTLEMENT CREEK NEAR RULISON CONTROL POINT

Date		Total Alpha		Radioactivity (pCi/L)		Tritium	Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day			Total Beta				
11-14-73		MDA		MDA		---	---	---
7-5-74		MDA		MDA		664 c 459	191	104
10-24-74		11.9 c 7.8		10.5 c 10.3		MDA	213	145
5-17-76		10.5 c 6.4		MDA		MDA	---	---
7-26-76		MDA		20.4 c 11.2		MDA	135	105
10-6-76		11.9 c 6.7		MDA		MDA	---	---
11-15-76		MDA		MDA		MDA	---	---
Average		8.3 s 2.9		10.1 s 4.6		506 s 77	180	118

Ro-3

ROAN CREEK AT D & D RANCH ABOUT 3/4 MILE
WEST OF ROAN CREEK COMMUNITY CENTER

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
7/5/74		MDA	MDA	MDA	1272	952

Ro-2

CLEAR CREEK AT BRIDGE SOUTH OF
ROAN CREEK COMMUNITY CENTER

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
2/16/74		MDA	MDA	MDA	840	547
7/5/74		10.3 c 20.7	MDA	MDA	3180	2678
3/12/75		20.0 c 15.1	MDA	MDA	859	537
Average		12.1 s 7.2	MDA	MDA	1626	1254

Ro-1

ROAN CREEK ABOVE DEBEQUE

Date		Total Alpha	Radioactivity (pCi/L)		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day		Total Beta	Tritium		
1/30/74		11.7 c 18.5	MDA	MDA	1632	1272
2/16/74		13.0 c 18.8	MDA	MDA	--	--
7/5/74		MDA	MDA	MDA	2544	2120
9/22/74		MDA	MDA	MDA	2585	1950
3/12/75		21.6 c 19.4	16.3 c 12.2	MDA	1582	1192
Average 9.2 s 3.7			9.7 s 3.7	MDA	2086	1634

RPS-48

COLORADO RIVER AT CAMEO

Date		Total Alpha		Radioactivity (pCi/L)		Tritium		Conductivity	Total Dissolved
Month	Day			Total Beta				umhos	Solids (ppm)
8-17-73		MDA		MDA		MDA		---	---
3-15-74		MDA		MDA		MDA		---	---
5-23-74		MDA		MDA		637 c 472		---	---
8-9-74		MDA		MDA		MDA		---	---
9-22-74		MDA		MDA		MDA		1070	590
11-19-74		14.6	c 13.1	MDA		MDA		---	---
1-8-75		24.6	c 16.6	MDA		MDA		---	---
5-7-75		MDA		MDA		1080 c 460		---	---
7-23-75		MDA		MDA		MDA		---	---
9-18-75		16.3	c 14.7	14.2	c 11.4	947 c 459		---	---
11-10-75		23.6	c 15.9	MDA		MDA		---	---
2-2-76		13.8	c 14.7	MDA		1130 c 476		---	---
4- -76		22.0	c 13.5	MDA		MDA		---	---
6-2-76		36.2	c 19.3	30.0	c 21.8	MDA		---	---
8-7-76		14.2	c 13.5	21.3	c 12.0	---		---	---
10-5-76		30.0	c 17.3	16.0	c 11.8	524 c 462		---	---
12-7-76		39.9	c 17.9	MDA		MDA		---	---
Average		16.3	s 11.3	10.9	s 6.2	596 s 232		1070	590

RPS-49

COLORADO RIVER AT FRUITA

Date		Radioactivity (pCi/L)				Conductivity		Total Dissolved	
Month	Day	Total Alpha		Total Beta		Tritium		umhos	Solids (ppm)
3-15-74		11.8	c 11.2		MDA		MDA	---	---
8-9-74		MDA			MDA		MDA	---	---
1-8-75		23.3	c 16.9	12.0	c 11.3		MDA	---	---
5-7-75		15.3	c 12.0		MDA	472	c 451	---	---
7-23-75		21.0	c 14.2		MDA	631	c 444	---	---
9-9-75		26.3	c 19.8	15.1	c 12.1		MDA	---	---
11-10-75		11.4	c 13.0		MDA		MDA	---	---
2-2-76		14.9	c 15.0		MDA	1062	c 475	---	---
4- -76		19.1	c 13.8		MDA	821	c 522	---	---
6-8-76		MDA			MDA		MDA	---	---
8-7-76		25.2	c 18.2	19.0	c 12.2		---	---	---
10-6-76		36.4	c 21.0		MDA		MDA	---	---
12-7-76		32.3	c 15.8		MDA		MDA	---	---
Average		19.2	s 9.4	9.7	s 3.5	566	s 188		

COLORADO RIVER AT LOMA

RPS-50

Date		Total Alpha		Radioactivity (pCi/L)		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
Month	Day			Total Beta					
8-17-73		MDA		MDA		---		---	---
9-21-73		MDA		MDA		---		---	---
3-15-74		MDA		MDA		MDA		---	---
4-11-74		13.7	c 14.6	16.4	c 11.7	516	c 455	---	---
4-19-74		MDA		MDA		523	c 469	---	---
5-1-74		MDA		MDA		---		---	---
5-15-74		MDA		MDA		---		---	---
5-15-74		10.9	c 9.3	MDA		---		---	---
5-15-74		MDA		MDA		MDA		---	---
7-24-74		MDA		MDA		MDA		---	---
9-3-74		13.5	c 17.9	MDA		MDA		---	---
11-6-74		19.9	c 15.0	MDA		MDA		---	---
1-8-75		17.7	c 14.4	MDA		MDA		---	---
3-6-75		16.6	c 15.8	12.1	c 11.4	561	c 443	---	---
4-28-75		18.4	c 16.6	MDA		526	c 450	---	---
7-11-75		15.1	c 13.6	MDA		MDA		---	---
9-9-75		40.2	c 22.0	MDA		MDA		---	---
11-10-75		17.1	c 15.4	MDA		MDA		---	---
2-2-76		19.5	c 15.3	MDA		515	c 467	---	---
4- -76		MDA		MDA		MDA		---	---
6-8-76		16.8	c 10.0	MDA		MDA		---	---
8-3-76		34.2	c 21.0	22.0	c 12.8	MDA		---	---
10-6-76		26.9	c 19.5	17.4	c 12.2	MDA		---	---
12-6-76		23.3	c 16.9	14.4	c 11.6	MDA		---	---
Average		14.9	s 9.4	9.8	s 3.8	489	s 26		

RPS-88

YAMPA RIVER SOUTH OF STEAMBOAT SPRINGS

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
9-21-73		MDA		MDA		---		---	---
4-3-74		MDA		MDA		MDA		---	---
8-14-74		MDA		MDA		697 c 459		---	---
11-13-74		9.0	c 7.0	12.2	c 10.4	MDA		---	---
1-17-75		9.5	c 8.6	MDA		MDA		---	---
3-17-75		18.2	c 9.1	MDA		812 c 447		---	---
5-7-75		13.8	c 8.2	MDA		709 c 454		---	---
7-8-75		17.9	c 8.5	MDA		MDA		---	---
9- -75		MDA		MDA		MDA		---	---
11-5-75		12.1	c 8.4	12.5	c 10.6	MDA		---	---
2-4-76		27.6	c 15.1	MDA		MDA		---	---
4- -76		12.7	c 8.8	MDA		MDA		---	---
6-17-76		MDA		MDA		MDA		---	---
8-25-76		12.2	c 8.2	MDA		885 c 450		---	---
10-26-76		15.0	c 8.6	20.2	c 11.3	MDA		---	---
Average		11.9	s 6.1	9.4	s 3.4	561	s 147	---	---

RPS-38

YAMPA RIVER AT MILNER

Date		Total Alpha		Radioactivity (pCi/L)		Tritium		Conductivity	Total Dissolved
Month	Day			Total Beta				umhos	Solids (ppm)
9-21-73		MDA		MDA				---	---
4-3-74		MDA		MDA		547 c	457	---	---
4-11-74		MDA		MDA		MDA		---	---
4-19-74		MDA		MDA		MDA		---	---
8-14-74		MDA		MDA		---		---	---
11-13-74		13.7	c 7.7	MDA		MDA		---	---
1-17-75		12.8	c 7.8	MDA		748 c	462	---	---
3-5-75		MDA		MDA		755 c	446	---	---
5-7-75		8.2	c 6.7	MDA		1509 c	466	---	---
7-8-75		9.5	c 5.3	MDA		617 c	443	---	---
9- -75		MDA		MDA		MDA		---	---
11-10-75		12.2	c 8.2	MDA		MDA		---	---
1-15-76						MDA		---	---
2- -76		12.5	c 7.7	MDA		MDA		---	---
4- -76		10.2	c 8.0	MDA		MDA		---	---
6-17-76		17.0	c 10.7	15.9	c 11.1	MDA		---	---
8-23-76		10.7	x 7.7	15.9	c 10.8	848 c	450	---	---
10-26-76		16.0	c 9.0	MDA		MDA		---	---
12-15-76		21.8	c 10.0	18.1	c 11.2	MDA		---	---
Average		10.4	s 4.7	9.4	s 3.3	603		263	

RPS-39

YAMPA RIVER NEAR MAYBELL

Date Month Day		Total Alpha		Radioactivity (pCi/L) Total Beta		Tritium		Conductivity umhos	Total Dissolved Solids (ppm)
9-21-73		MDA		MDA		---		---	---
4-3-74		MDA		MDA		503 c 456		---	---
8-14-74		MDA		MDA		---		---	---
11-19-74		13.1 c 10.3		MDA		---		---	---
1-17-75		12.5 c 10.8		MDA		1092 c 467		---	---
3-5-75		16.3 c 13.3		11.3 c 11.0		MDA		---	---
5-7-75		15.9 c 9.2		18.6 c 11.2		840 c 456		---	---
7-8-75		8.3 c 5.8		MDA		526 c 442		---	---
9- -75		MDA		MDA		MDA		---	---
11-10-75		10.4 c 9.9		MDA		MDA		---	---
1-14-76		MDA		MDA		---		---	---
1-15-76		MDA		MDA		MDA		---	---
2- -76		13.3 c 11.4		MDA		MDA		---	---
4- -76		19.3 c 12.6		MDA		MDA		---	---
6-14-76		MDA		MDA		604 c 467		---	---
8-23-76		MDA		22.3 c 11.5		772 c 448		---	---
10-26-76		11.9 c 10.7		45.8 c 13.8		MDA		---	---
12-15-76		24.3 c 12.4		MDA		MDA		---	---
Average		10.7 s 5.5		11.7 s 9.4		581 s 189			

RPS-40

YAMPA RIVER BELOW LITTLE SNAKE RIVER

Date		Radioactivity (pCi/L)				Conductivity		Total Dissolved	
Month	Day	Total Alpha		Total Beta		Tritium		umhos	Solids (ppm)
4-3-74		MDA		11.6	c 11.0	MDA		---	---
8-14-74		MDA		MDA		---		---	---
11-19-74		12.0	c 10.8	18.2	c 11.4	---		---	---
1-17-75		MDA		MDA		---		---	---
3-5-75		MDA		MDA		464	c 462	---	---
5-7-75		MDA		11.8	c 10.4	878	c 457	---	---
7-8-75		MDA		MDA		MDA		---	---
9- -75		13.5	c 12.8	MDA		MDA		---	---
11-10-75		35.2	c 37.6	43.9	c 93.0	MDA		---	---
1-15-76		20.0	c 13.0	MDA		MDA		---	---
2- -76		12.5	c 11.2	MDA		MDA		---	---
4- -76		MDA		MDA		MDA		---	---
6-14-76		12.3	c 6.6	MDA		MDA		---	---
8-23-76		MDA		MDA		1008	c 452	---	---
10-26-76		23.7	c 12.6	19.5	c 11.6	899	c 455	---	---
12-15-76		30.2	c 13.3	MDA		MDA		---	---
Average		13.0	s 9.5	12.1	s 9.3	579	s 201		

Project Rio Blanco Surveillance
Specific Conductance of Water Samples
Collected by Colorado Water Conservation Board
(Values expressed in micromhos)

Date	Sampling Sites																	Y-2	P-14	P-15
	P-1	P-2	P-3	P-4	F-1	F-3	F-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	P-13				
7/24/73	735	910	1010	1475	1650	-	-	1785	1900	1900	1975	2190	2200	2500	595	725	-	3500	615	
8/23/73	755	915	1000	1320	1635	1750	1610	1500	1590	1660	1560	1630	1650	1850	720	845	-	3300	695	
9/28/73	1050	1000	950	1290	1550	-	-	1650	1650	1650	1675	1825	1800	2125	675	785	-	3900	-	
11/14/73	800	980	990	1275	1500	-	-	1500	1500	1500	1500	1600	1600	2000	615	745	-	3350	595	
1/23-24/74	-	785	990	1315	1500	-	1700	1595	1530	1530	1650	1120	-	2400	-	775	-	3950	600	
3/26/74	760	1000	990	1250	1500	-	1575	1500	1585	1600	1625	1690	1775	2250	700	800	1825	3500	890	
4/24/74	495	650	870	1120	1525	-	-	1465	1425	1440	1490	1565	1500	1540	590	680	1960	3500	545	
5/23-24/74	775	940	930	1545	1500	-	-	1900	2550	2550	2610	2000	2050	3800	395	375	1890	3700	265	
6/11/74	760	1045	975	1450	1550	-	-	1900	2050	2390	2400	2700	2750	3400	395	450	1875	3650	375	
7/10/74	790	1010	970	1590	1500	-	-	1990	2350	2600	2800	2800	2700	4100	640	675	1850	3600	610	
8/20-21/74	775	900	955	1260	1500	-	-	1590	1610	1615	1615	1950	1950	2325	700	850	1800	3250	700	
9/24-25/74	790	920	985	1310	1525	-	-	1760	1985	2250	2300	2450	2350	3000	700	800	1850	3150	690	
10/22-23-74	825	900	950	1400	1500	-	-	1750	1800	1800	1850	2000	2000	2650	650	750	1800	3050	635	
11/18-21/74	800	850	980	1300	1500	-	-	1510	1530	1550	1600	1670	1700	2050	700	780	1790	3500	650	
Average	778	915	967	1350	1531	1750	1628	1793	1789	1789	1904	1943	2006	2571	622	723	1850	3493	605	

Project Rio Blanco Surveillance
Specific Conductance of Water Samples
Collected by Colorado Water Conservation Board
(Values expressed in micromhos)

Wells Date	RB-D-W	RB-D-01	RB-D-02	Colo. River at Rifle	Pa-2	Pa-1	Colo. River at Grand Valley
7/24/73	2300	2400	1010	--	--	--	--
8/23/73	2050	--	--	--	--	--	--
9/28-29/73	--	--	--	--	--	--	--
1/23-24/74	--	--	--	--	--	--	--
3/26/74	--	--	--	--	--	--	--
4/24/74	--	--	--	830	--	940	930
5/23-34-74	--	--	--	--	--	1050	360
6/11/74	--	--	--	--	790	1220	465
7/10/74	--	--	--	--	1000	2000	695
8/20-21-74	--	--	--	--	--	--	--
9/24-25/74	--	--	--	--	--	1700	--
10/22-23/74	--	--	--	--	1350	--	--
11/18-21/74	--	--	--	--	1250	1270	--
Average	2175	2400	1010	830	1098	1363	612

Tritium Concentrations in
Fresh Snow picocuries per
liter of melted snow

<u>Date</u>	<u>Location</u>	<u>pCi/l</u>
11/19/73	Downwind from flaring stack	39,754 c 881
11/20/73	Near separator	30,495 c 805
	Near well head	40,409 c 886
	F-1	MDA
	F-2	MDA
	BS-2	MDA
	Base of flare stack	804 c 486
	F-3	MDA
	BS-3	MDA
	F-4	MDA
1/28/74	F-3	MDA
	F-2	MDA
	BS-1	MDA
	F-4	608 c 464
	Flaring stack	MDA
	BS-3	MDA
1/29/74	P-7	MDA
	Meeker	MDA
	P-16	MDA
	P-14	516 c 453
	P-11	MDA
	Rangely	MDA
1/30/74	El Paso Gas Pumping Station (near FPCP)	MDA
1/31/74	Near water storage tanks	MDA
2/6/74	BS-2	MDA
	F-3	MDA
	P-6	MDA
	Flaring stack	1745 c 476
	BS-1	MDA
	F-4	63,710 c 1030
	Rock School	38,134 c 846
	F-2	50,172 c 937
	F-1	156,535 c 1521
	BS-3	13868 c 624

<u>Date</u>	<u>Location</u>	<u>pCi/l</u>
2/15/74	Flare stack	MDA
12/11/74	F-2 (old snow)	MDA
	North of Flaring stack (old snow)	951 c 451
	South of flaring stack (old snow)	917 c 450
12/12/74	Norell Ranch (old snow)	MDA

/jas

Tritium Concentration in Air
Moisture Samples (picocuries per
liter of condensed water)

<u>Date</u>	<u>Location</u>	<u>pCi/l</u>
9/28/73	Near RB-D-02	MDA
	Near Access Trailer at Emplacement Well	MDA
	Near Flaring Tower	MDA
	Near Water Storage tanks	MDA
	Entry Control Center	MDA
	F-2	MDA
10/17/73	Near Flaring Tower	455 c 439
	F-1	MDA
	Near DWC at emplacement well	999 c 447
	F-2	842 c 445
	Fawn Creek #1 well	598 c 441
11/14/73	Near flaring tower	479 c 460
	F-2	981 c 464
	F-4	581 c 461
	F-3	570 c 459
	BS-2	MDA
*	Near Water storage tower	717 c 460
11/17/73	Near Access trailer at em- placement well	1173 c 467
	F-2	MDA
	F-4	646 c 459
	F-3	967 c 464
	BS-2	544 c 457
11/15/73	F-3	500 c 457
	BS-2	MDA
	Rock School	MDA
	Shell Plant (P-7)	497 c 457
	F-4	774 c 461
11/16/73	F-4	683 c 460
	BS-2	544 c 457
*		
11/18/73	F-4	MDA
	F-3	991 c 464
	Brennan Ranch	MDA
	Near Separator	674 c 462
11/19/73	F-4	470 c 456
	Brennan Ranch	MDA
	Rock School	MDA
	Norell Ranch	470 c 456

<u>Date</u>	<u>Location</u>	<u>pCi/l</u>
11/20/73	Brennan Ranch	MDA
	Norell Ranch	544 c 457
11/30/73	Near DWC at emplacement well	752 c 456
	Brennan Ranch	MDA
	Rock School	MDA
	Norell Ranch	MDA
	Pat Johnson Ranch	MDA
2/16/74	F-1	MDA
	F-2	783 c 466
	F-3	652 c 455
	F-4	MDA
12/11/74	Near access trailer at emplacement well	895 c 468
	F-1	MDA
	F-2	783 c 466
	BS-2	827 c 467
	Rock School	691 c 465
	Norell Ranch	MDA

/jas

APPENDIX D
RADIOLOGICAL STANDARDS

The Maximum Permissible Concentration (MPC) stated below are based on the recommendations of the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection (NCRP) and the Federal Radiation Council (FRC). These recommendations are incorporated into the regulations of the Department and those of the National Regulatory Commission (NRC). The levels stated are those relating to general population exposures and are rounded, conservatively, to the second significant digit.

	Chemical Form	
	Insoluble (pCi/m ³)	Soluble (pCi/m ³)
Air*		
Unidentified radionuclides ¹⁾	0.007	0.007
Unidentified radionuclides ²⁾	33	33
Americium-241	1.3	0.066
Cerium-141	1,600	6,600
Cerium-144	66	100
Hydrogen-3	66,000	66,000
Krypton-85	100,000	100,000
Lead-210	2.6	1.3
Plutonium-238	0.33	0.023
Plutonium-239	0.33	0.020
Polonium-210	2.3	6.6
Ruthenium-103	330	6,600
Ruthenium-106	66	1,000
Uranium - natural	0.66	1.0
Zirconium-Niobium-95	330	1,300
	(pCi/m ³)	(pCi/m ³)
Water*		
Unidentified radionuclides ¹⁾	10.0	10.0
Unidentified radionuclides ²⁾	1,000	1,000
Americium-241	6,600	1,300
Cerium-141	30,000	30,000
Cerium-144	3,300	3,300
Hydrogen-3	1,000,000	1,000,000
Lead-210	66,000	33
Plutonium-238	10,000	1,600
Plutonium-239	10,000	1,600
Polonium-210	10,000	230
Ruthenium-103	26,000	26,000
Ruthenium-106	3,300	3,300
Uranium - natural	6,000 ⁵⁾	6,000 ⁵⁾
Zirconium-Niobium-95	20,000	20,000
	<u>Any (pCi/l)</u>	
Radium-226 in water supplies ³⁾	3.0	
Radium-226 in water supplies ⁴⁾	20.0	
Iodine-131 in milk ⁴⁾	100.0	
Strontium-90 in milk ⁴⁾	200.0	

*Air is used as an example of inhalation exposure and water is used as ingestion exposure. Where the ingestion exposure is from solid material, the units are expressed in picocuries/1,000 grams.

- 1) Any single radionuclide which decays by alpha emission or spontaneous fission.
- 2) Any single radionuclide with a decay mode other than alpha emission or spontaneous fission and with a radioactive half-life greater than 2 hours.
- 3) The Department's limit for accepting a municipal water supply or source without additional qualification on total radium intake. Units are picocuries/liter.
- 4) FRC Range II maximum total daily intake. Units are picocuries/day. Concentrations occurring in Range I require only minimal surveillance activities.
- 5) In the current NRC Regulations the level for uranium in water is 10,000 pCi/l.

APPENDIX E
ANALYTICAL PROCEDURES

P R O C E D U R E S

The procedures described include all radiological health analysis procedures used on a "routine" basis, although a specific surveillance program may not employ all the procedures contained herein.

SPECTROMETRIC DETERMINATIONS
FLOW CHART

SPECTROMETRIC DETERMINATIONS

Analysis for any specific radioactive material involves the intensity of the emission, the emission's energy and the radioactive half-life of the material in question.

Alpha particle and gamma ray emissions are given off by the nucleus of the radioactive atom at discrete or specific energies. By the use of alpha or gamma spectrometry, emissions and their energies can be determined. Should emission energies from different radioactive materials be similar, chemical separation of the materials will facilitate the determination.

Qualitative and quantitative analysis is accomplished through the determination of source emission energies and intensities the amount of material in the sample being analysed. Counting at different times enables half-life determinations to be made.

Alpha

As alpha particles do not readily penetrate air, counting of the sample is done under a high vacuum. The sensing portion of the system is a silicon surface barrier detector which is coupled with a power supply, pulse shapers, counting register and a pulse height analyzer unit. Pulses of different energies are sorted accordingly and the readout of the unit describes the emission energies.

Gamma

As gamma rays penetrate most environmental materials easily, sample preparation is generally concerned with fitting the sample size and shape to a uniform geometry for counting. The detector is a sodium iodide crystal which is optically coupled to a photomultiplier tube. This tube converts the scintillations in the crystal to electrical pulses and then provides amplification. Pulse shapers, a pulse height analyzer and its readout complete the unit. Pulses of different energies are sorted accordingly and the readout describes the emission energies.

AIR FILTER ANALYSIS FLOW CHART

AIR FILTER ANALYSIS

Routine

High volume air samplers are maintained by state and local government. Filter pads are collected at regular intervals (usually every 2 or 4 days) and sent to the Department laboratories and counting facility for analysis.

Particulate air filter sample pads routinely are stored at least seven (7) days post collection prior to counting to allow the short-lived naturally-occurring Radon and Thoron daughter radioactive material to decay from the sample.

Alpha determinations are made using a 4 inch diameter photomultiplier tube coated with zinc sulfide connected to an appropriate counting register. Analysis counting time is 10 minutes per sample. Calibration factors for this system include corrections for counting efficiency, sample and sample media self-absorption, aliquot of sample actually seen by the detector, and sample media collection efficiency.

Beta determinations are made using an 8 inch x 10 inch external proportional chamber connected to an appropriate counting register. Analysis counting time is 4 minutes per sample. Calibration factors for this system incorporate the items previously stated for alpha determinations.

The net counts per minute are converted to concentrations, i.e. picocuries per cubic meter of air (pCi/m^3), by multiplying the net counts per minute by the calibration factor and dividing by the air flow for the sampling period (previously determined).

In the case of an emergency situation, air filter samples can be counted on receipt. Because of Radon and Thoron progeny, the counting rates will normally be elevated if the sample is counted within four days of collection.

Should alpha or beta determinations be abnormal for the post-counting period, alpha or gamma spectrometry or special analyses are used to determine the cause of the abnormality.

Nominal minimum detectable activities are 0.003 picocurie Total Alpha per cubic meter and 0.02 picocurie Total Beta per cubic meter of air.

MILK ANALYSIS FLOW CHART

MILK ANALYSIS

Milk samples are collected with the cooperation of the Milk, Food, and Drug Section of the Department's Engineering Division, local health departments, and milk producing or processing plants and associations.

Normally one-half to one gallon of milk is obtained per sample, and is preserved by the addition of 5 milliliters of formaldehyde. The frequency of collection of samples from the various milk producing areas of the state depends on the surveillance system and its status.

Samples are received by the radiation counting facility of the Department's Occupational and Radiological Health Division within 2 days after sampling and are analyzed as soon thereafter as possible.

Routine analysis is accomplished by gamma spectrometry with iodine 131, barium-lanthanum 140, cesium 137 and natural potassium concentration determined. Gamma efficiency curves are available to determine the concentration of any gamma emitting radionuclide in a 2 quart sample. This "Compton-continuum subtraction-efficiency" procedure has not been utilized to date, as there has not been an instance of any gamma emitting radionuclides above minimum detectable activities ($\sim$ 20-25 pico-curies per liter).

Because tritium (Hydrogen 3) is a radionuclide of interest in the Public Service Company of Colorado's Fort St. Vrain Nuclear Power Generating Station at Platteville, tritium determinations are made on all milk samples produced in that area.

PLUTONIUM DETERMINATION FLOW CHART

Plutonium Determination

Any sample collected can be analyzed for Plutonium. Samples may be air suspended particulates, water, soil, or sediments.

Air filter pads approximating a 2400 to 4800 cubic meter sample can be individually analyzed; however, usually the samples from a specific sampling site are composited for a month and then analyzed for plutonium. Water samples, too, may be run individually using a 1 liter portion of the sample collected. However, where plutonium determinations are run routinely, samples are composited on a weekly and monthly basis. Where Total Alpha determinations indicate abnormalities, these individual air and water samples are specifically analyzed.

In the case of soil analysis, normally a composite sample will be collected over a specific geographical area. Because plutonium presents a hazard only when ingested or inhaled, samples are collected usually from surface soils only.

In determinations such as plutonium, the practice is to use only a portion of the entire sample. Should analytical problems develop, the remainder of the sample can be used. Selection of the portion to be analyzed presents a particular problem with soil or sediment samples. To insure that the portion of the sample taken for analysis is representative of the entire sample, the dried "soil" is "coned and quartered" until the remaining portion is approximately 30 grams in weight. The 30 grams portion is then finely ground and mixed. Then a 1 gram fraction is digested with hydrofluoric and concentrated nitric acids.

Upon complete dissolution of all the material, and chloride conversion of the plutonium, chemical separation is accomplished with the passage of the carrier liquid through an ion-exchange column. The plutonium remains on the column and is eluted with dilute hydrochloric acid and hydrogen peroxide. Counting is accomplished by alpha spectrometry using surface barrier detectors in a vacuum system. Isotopic distribution can be identified.

Because plutonium concentrations in the environment are normally low, counting times approximate 8 to 14 hours determinations of statistical significance.

The minimum detectable activity per sample aliquot is 0.02 picocurie.

TRITIUM DETERMINATION FLOW CHART

TRITIUM IN WATER DETERMINATION

Tritium released to the environment from nuclear facilities is generally in gaseous form. Tritium atoms readily exchange with the stable hydrogen (Hydrogen 1) and form tritiated water with the available oxygen in the atmosphere.

Because of this situation, tritium levels can be monitored by analyzing water from any environmental or biological system. Samples submitted may include water taken from the ambient atmosphere by cryogenic sampling devices, milk samples, well and surface water source samples, and urine. The latter is useful in determining body burden levels of personnel who work with large quantities of tritium, while the others are used in determining the effects of the facilities and their activities on the environment.

The liquid samples collected are slowly distilled in a simple distillation apparatus. Five milliliters of the distillate is placed in a counting vial with twenty milliliters of liquid scintillation solvent (a p-dioxane mixture). The sample is counted for 100 minutes in a counter which has about a 26% counting efficiency for tritium in this solution.

By knowing the moisture content of the sampled air, calculations can be made to determine the concentration of tritium in the sampled atmosphere.

The minimum detectable activity which can be observed with this system is 500 picocuries of tritium per liter of water and approximately 1 picocurie of tritium per cubic meter of air.

WATER ANALYSIS FLOW CHART

WATER SAMPLE ANALYSIS

Water samples may be collected by the Division staff or by other divisions in the State Health Department, local health departments, other state and local governmental agencies, and others.

In some instances, the collection of these samples are on prearranged schedules, while others are collected due to specific interest.

Total alpha and beta determinations are accomplished on a 100 milliliter portion of the sample evaporated on a counting planchet. Where the total solids are excessive (greater than) 20 milligrams deposited per square centimeter of planchet surface) a smaller portion is used. Normally the alpha determination requires a 100 minute counting time, while twenty minutes is used for the beta determination. A proportional counter having an automatic sample changer and "alpha" and "beta" plateaus is used for these determinations. Calibrations are based on natural uranium and Cesium 137 for alpha and beta determinations respectively. Calibration curves are attached. Special analysis calibrations utilize the radionuclide of interest. If either of these analyses are abnormal, either gamma spectrometry or special analysis utilizing chemical separation is used to determine the cause of the abnormality.

When water samples are collected in the vicinity of facilities where tritium is stored or used in large quantities, a tritium analysis is also formed.

Bismuth 210, Polonium 210, Lead 210, and other determinations done by the Department, but not on a routine basis. Uranium analysis is accomplished by strictly chemical procedures.

The minimum detectable activity for alpha and beta concentrations approximates 8 picocuries per liter of water and is 0.1 picocurie/liter for radium 226.

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COLORADO DEPARTMENT OF HEALTH

Richard D. Lamm
Governor

Frank A. Traylor, M.D.
Executive Director

September 8, 1980

PNE-RB-77 (Pt.2)

To the recipients of the Project Rio Blanco Environmental Surveillance Summary Report.

Transmitted herein is Part 2 of the Project Rio Blanco Environmental Surveillance Summary Report. This is the final report by the Colorado Department of Health on this project. Your comments on the report would be appreciated and if we can be of any assistance, do not hesitate to write.

Sincerely,

Albert J. Hazle, Director
Radiation and Hazardous
Wastes Control Division

AJH/MH/ddb

Enclosure