FINAL STATUS SURVEY REPORT
SUBAREA G

for

Cimarron Corporation's Former
Nuclear Fuel Fabrication Facility
Crescent, Oklahoma

License Number: SNM-928

Prepared for:

Cimarron Corporation
Oklahoma City, Oklahoma

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FINAL STATUS SURVEY REPORT FOR DECOMMISSIONING CIMARRON FACILITY SUBAREA G

1.0 PURPOSE

This Final Status Survey Report (FSSR) is being submitted by Cimarron Corporation to the Nuclear Regulatory Commission (NRC) for an area on the Cimarron site designated as Phase II Subarea G. This subarea is shown on Drawing No. 95MOST-RF3 which is included in Appendix 1, and includes both affected and unaffected open land areas that have been surveyed as part of the ongoing site decommissioning process. This report discusses the initial characterization surveys which were performed to precisely define the extent and magnitude of residual contamination present in soils located within Subarea G. The characterization data generated during the initial surveys were utilized in designing the Final Status Survey (FSS) for this subarea which is included in the NRC approved Phase II Final Status Survey Plan (FSSP) and Decommissioning Plan. Based upon the Phase II FSSP, this FSS was performed for Subarea G to demonstrate that the established guideline values for unrestricted release had been met. The results of the Subarea G FSS are presented in this FSSR as justification for release of this Subarea from License SNM-928 for unrestricted use.

2.0 BACKGROUND

Cimarron Corporation, a subsidiary of Kerr-McGee Corporation, operated two plants near Crescent, Oklahoma, for the manufacture of enriched uranium and mixed oxide reactor fuels. The 840-acre Cimarron Facility site was originally licensed under two separate SNM Licenses. License SNM-928[1] was issued in 1965 for the Uranium Plant (U-Plant) and License SNM-1174[2] was issued in 1970 for the Mixed Oxide Fuel Fabrication (Pu-Plant) Facility. Both facilities operated through 1975, at which time they were shut down and decommissioning work was initiated.

Decommissioning efforts at the Pu-Plant Facility were completed in 1990 and Cimarron Corporation applied to the NRC on August 20, 1990[3] to terminate License SNM-1174. After confirmatory surveys, the NRC terminated the Pu-Plant License, SNM-1174, on February 5, 1993[4].

Decommissioning efforts at the Cimarron U-Plant Facility involving characterization, decontamination and remediation were initiated in 1976 and are nearing completion. The goal of the decommissioning effort is to release the entire 840-acre site for unrestricted use.

Based upon historic knowledge of site operations and the characterization work completed to date, Cimarron Corporation completed and submitted the 1994 Cimarron Radiological Characterization Report[5] to the NRC. As discussed in that report, the site was divided into affected and unaffected areas. The affected and unaffected areas are shown on Drawing No. 95MOST-RF3 which is included in Appendix 1. For the final status survey, the entire 840-acre site was divided into three major areas containing both affected and unaffected areas. Each of these three major areas are shown on Drawing No. 95MOST-RF3 and are designated by Roman Numerals I, II, and III (herein referenced as Phases I, II, and III). These three major areas were

then further subdivided into smaller "subareas" (i.e., A, B, C, D, etc.). The FSSP's for the Phase I, II and III areas have been approved by the NRC and are discussed briefly below:

2.1 Phase I Area

As presented in the NRC approved[6] Cimarron Decommissioning Plan[7], the FSSP's (Phases I, II and III) were discussed in general terms, with the understanding that each of these three phases would be submitted to the NRC under separate cover for approval. The FSSP for the first of these three phases (Phase I[8]), which includes Subareas A, B, C, D, and E, was approved by the NRC by letter dated May 1, 1995[9]. By letter dated November 13, 1995[10], Cimarron modified the southern boundary of two Phase I areas (i.e., Subareas C and E) and placed these portions of Subareas C and E into Phase II Subareas G and H. With this modification, the Phase I FSSR[11] was submitted to the NRC and confirmatory sampling for the Phase I Subarea was completed by the Oak Ridge Institute for Science and Education (ORISE). Cimarron Corporation received Amendment #13 which released all of the Phase I areas from License SNM-928; the amendment was forwarded to Cimarron by NRC letter dated April 23, 1996[12]. This amendment reduced the licensed facility acreage from 840 to approximately 152 acres.

2.2 Phase II Area

The area designated as Phase II on Drawing No. 95MOST-RF3 contains both affected and some contiguous unaffected areas and represents approximately 122 of the remaining licensed 152-acres. The Phase II FSSP was submitted to the NRC in July 1995[13] and approved on March 14, 1997[14]. Phase II includes Subareas F, G, H, I and J. Included within Phase II is Burial Area #1 which was released in December 1992 by the NRC[15], subsequently backfilled with clean soil, and then seeded. Also included in Phase II are the East and West Sanitary Lagoons, the Pu-Plant Building exterior and yard area, the Emergency Building, Warehouse Building #4 and surrounding yard, and numerous drainage areas. Cimarron has essentially completed all remediation in each of the Phase II Subareas and final status surveys are currently being completed.

The FSSR for Subarea J was the first Phase II Subarea to be submitted to the NRC for license release; it was submitted in September 1997[16]. Subarea J is West of Highway #74, and represents approximately 7 of the 122 acres in Phase II. The FSSR for Subarea J has been approved by the NRC[17], and a confirmatory survey was performed by NRC staff during their site visit of September 21-23, 1998. By NRC letter dated December 4, 1998[18], Cimarron was informed that the NRC staff plans to release Subarea J from license SNM-928 in the near future.

Subarea H is the second Subarea included within Phase II where final status surveys have been completed. As discussed above, the East and West Sanitary Lagoons are included within Subarea H, which includes approximately 38.5 acres. The FSSR for Subarea H was submitted to the NRC on November 16, 1998[19].

Also included in Phase II is some concrete previously surveyed for release and placed in a drainage way located within Subarea F. Survey results for this concrete have been

reported to the NRC in the March 1998 FSSR[20]. By letter dated March 1, 1999[21], the NRC informed Cimarron that all NRC staff comments concerning the Subarea F Concrete FSSR have been resolved.

The Subarea I FSSR has been completed. This subarea includes both affected and unaffected open land areas, buildings, fences and walkways. The Subarea I FSSR was submitted to the NRC on June 29, 1999[22]. Subarea I represents approximately 19.1 acres.

Subarea G is the next subarea included within Phase II where final status surveys have been completed. Included within Subarea G are both affected and unaffected open land areas. This subarea includes approximately 37.8 acres. The results of the FSS for Subarea G are presented in this Report.

Final Status Survey Report preparation for Subarea F, which will be the last FSSR for Phase II, is in progress. Subarea F includes approximately 19.6 acres.

2.3 Phase III Area

The area designated as Phase III on Drawing No. 95MOST-RF3 contains only affected areas and represents approximately 30 acres of the remaining licensed 152 acres. This area is designated as Phase III on Drawing No. 95MOST-RF3. The FSSP for release of this area from the site license, was submitted to the NRC for approval in June 1997[23]. Phase III includes the former Uranium Processing buildings and yard area, Burial Areas #2 and #3, New Sanitary Lagoon, the NRC approved BTP Option #2 On-site Disposal Cell (Burial Area #4), and the Five Former Waste Water Ponds, consisting of Uranium Waste Ponds #1 and #2, the Plutonium Waste Pond, the Uranium Emergency Pond, and the Plutonium Emergency Pond. By letter dated September 11, 1998[24], the NRC approved the Phase III Final Status Survey Plan.

The FSSR for Subarea L (Subsurface) was the first Phase III FSS to be submitted to the NRC. The Subarea L FSSR (Subsurface) was submitted to the NRC on May 29, 1996[25]. The NRC, by letter dated August 16, 1996[26], sent Cimarron comments concerning the Subarea L FSSR. Cimarron responded to the NRC comments by letters dated September 9, 1996[27] and October 17, 1996[28]. Additionally, in order to resolve the NRC staff concerns pertaining to the potential presence of subsurface contamination, additional subsurface soil samples were collected for analysis within Subarea L. Cimarron provided the results of this additional subsurface sampling event to the NRC by letter dated November 4, 1996[29]. Based upon the NRC staff review of these submittals and the additional subsurface sampling data, Cimarron's request to backfill Subarea L was approved by NRC letter dated November 8, 1996[30]. Subarea L has been backfilled, contoured and vegetated. Subsequently, the FSS for the Subarea L surface soils was completed and the FSSR was submitted to the NRC on July 27, 1998[31]. Subarea L represents approximately 5-acres.

The FSSR for Subarea O (Subsurface) was submitted to the NRC in March 1998[32]. Subsequent to the submittal of the FSSR for Subarea O (Subsurface), a FSS was performed on the surface soils with the results presented in the February 1999[33] FSSR.

Subarea O represents approximately 6.4 acres. By letter dated March 1, 1999[20], the NRC staff notified Cimarron that they have no further questions concerning the Subarea O (Subsurface) FSSR. The NRC collected confirmatory surface and subsurface soil samples for Subarea O while on-site on July 9, 1999. By letter dated September 14, 1999[34], the NRC stated that "[t]hese confirmatory sample results provided additional assurance that residual soil contamination in Waste Ponds 1 and 2 met the NRC Branch Technical Position Option 1 criteria."

Another subarea addressed by Cimarron personnel was Subarea M, which is shown on Drawing No. 95MOST-RF3 and represents approximately 2.5 acres. The Subarea M FSS has been completed and the results were presented in Cimarron's December 1998 FSSR[35] to the NRC.

Final Status Survey Report preparation for Subareas K and N are in progress.

3.0 DECOMMISSIONING ACTIVITIES

The purpose of this section is to discuss briefly the status of the site decommissioning activities for Subarea G and to present the radiological criteria and guideline values utilized throughout the remediation and final status survey. Also included in this section is a discussion of the limited characterization data available for this subarea; no remediation was required on the open land areas located within Subarea G.

3.1 Identification of Contaminants

Based upon the knowledge of past site operations, the results of numerous characterization efforts to date, and other independent characterization efforts by regulatory agencies and their respective subcontractors, the radiological contaminants on the Cimarron site have been determined to consist of U-234, U-235, and U-238 with an average enrichment above the naturally occurring level of approximately 2.7 weight percent. Thorium, although not considered a significant contaminant of concern for this subarea, has been included in the soil and sediment analyses and reported on the data summary sheets along with the total uranium sample results.

3.2 Site Background Levels

3.2.1 Soils

Natural background levels for uranium in soil have been established through numerous measurements by Cimarron personnel utilizing the on-site soil counter and through independent regulatory review and laboratory analysis. Cimarron personnel collected, analyzed and performed a statistical evaluation on 30 surface soil samples from the perimeter of the Cimarron site during the first quarter of 1995 to further validate background levels. Total uranium ranged from 2.3 pCi/g to 6.6 pCi/g, with the average being 4.0 ± 2.6 (2σ) pCi/g. These values were obtained using the Cimarron on-site soil counter. This on-site soil counter is calibrated to assume an enrichment of 2.7 weight

percent as this is the average uranium enrichment found throughout the site. When a correction factor (0.67/1.5) is applied to these results to convert the values from an assumed 2.7 weight percent enrichment to a natural enrichment, the converted results ranged from 1.0 pCi/g to 2.9 pCi/g with an average of 1.8 ± 1.0 (2σ) pCi/g total uranium. This evaluation was submitted to the NRC staff in Cimarron's June 1995 letter[36]. Based upon this sampling event, the average value of 4 pCi/g total uranium for background was adopted and applied when the on-site soil counter sample analytical results were compared to guideline values.

3.2.2 Exposure Rate

Background exposure rates have been established by Cimarron by taking micro-R readings and pressurized ion chamber (PIC) readings at off-site sample locations in addition to Cimarron site areas which are unaffected by past operations. Exposure rates of approximately 7 to 10 μR/h have been observed in background areas by Cimarron personnel utilizing Ludlum micro-R survey meters. In addition, site background exposure rates were measured by ORAU (now ORISE) personnel utilizing a PIC[37], and were determined to be 9 to 10 μR/h.

Cimarron personnel performed exposure rate measurements at background locations along the site boundary in 1997 using a Reuter-Stokes PIC. These data are tabulated below in Table 3.1. Additionally, measurements at background locations were taken with the micro-R meter for comparison to the PIC. These data also are presented in Table 3.1. Based upon this data, Cimarron uses 9 μR/h as representative of background exposure rates for micro-R measurements. Table 3.1 demonstrates good agreement between the micro-R measurements and the PIC measurements.

TABLE 3.1
Comparison Micro-R vs. PIC Measurements

Sample ID No.	Grid Location	PIC Reading (μR/h)	Micro-R Reading μR/h
UAF-BKG-1	819W-81N	9.8	10
UAF-BKG-7	1600E-120N	7.6	7.5
UAF-BKG-11	840W-700S	9.5	10
UAF-BKG-13	840W-288S	9.8	10.5
UAF-BKG-16	808W-282N	9.7	9.5
UAF-BKG-19	640W-700S	10.5	11
UAF-BKG-23	1610E-300S	7.8	7.5
UAF-BKG-25	1610E-69N	7.6	8
UAF-BKG-27	1610E-469N	7.8	8.5
UAF-BKG-28	1610E-634N	9.6	9.5
	AVERAGE	**9.0 ± 2.3 (2σ)**	**9.2 ± 2.8 (2σ)**

3.2.3 Natural Background Radioactivity of Concrete

Concrete background is addressed in detail in the "Final Status Survey Report for Concrete Rubble in Subarea F[20]". In that report, several independent sources were referenced including NUREG-1501[38], Eicholz[39], and Ingersoll[40]. In addition, a sample of concrete was collected by Cimarron to determine concrete background. The total uranium for background which will be used in this report is 1.5 pCi/g; this value is based upon the background sample collected at the facility and the literature which has been cited. A summary and justification for the above background value is presented in Section 6.2.1 of the FSSR for Concrete Rubble in Subarea F[20]. Data utilized in the determination of background for gross alpha and gross beta-gamma surface activity are summarized in Table 3.2, which is reprinted from the FSSR for Concrete Rubble in Subarea F.

Table 3.2
Gross Alpha and Gross Beta Surface Activity Background Data for Concrete

Location*	Ave. Alpha Dpm/100cm^2	Max. Alpha dpm/100cm^2	Ave. Beta dpm/100cm^2	Max. Beta dpm/100cm^2	Surface μR/h***	1m μR/h***
Grid #6	10	40	1045	1650	7	8
Grid #7	10	40	278	1584	7	6
Grid #8	10	40	924	1397	7	7
Grid #9	10	80	557	935	6	6
Grid #21	50	80	1199	3212	6	6
Grid #33	5	20	889	1386	7	7
Grid #103	10	40	860	1353	7	7
Representative "background"**	60	60	649	649	5	5
Average	21	50	800	1520	6.5	6.5

* Grid locations represent grids for the concrete rubble in Subarea F.

** Sample measurements taken at the surface of the area to be cored prior to sampling. As this area is within a building over a concrete slab, the ambient background exposure rate was lower.

*** Exposure rate measurements include background contribution. All other measurements are net (instrument background subtracted).

Based upon Table 3.2, the average background for gross alpha surface activity was established as 21 dpm/100 cm^2. The gross alpha background activity is presented for reference purposes only. The data and evaluations presented in this Report did not utilize the gross alpha background for subtraction due to the fact that this value was insignificant when compared to the overall conclusions made in the Report. Thus, all data tables reflect the gross alpha activity, including background.

The average background for gross beta surface activity was established as 800 dpm/100 cm^2. The gross beta background was subtracted from the gross beta surface activity data prior to calculation of the volumetric activity concentration of total uranium. Additional information regarding the grid areas and methods utilized to determine these background values is presented in Section 6.2.2 of the FSSR[20] for Concrete Rubble in Subarea F.

3.3 Characterization Data

Throughout the decommissioning process at the Cimarron site, a survey unit was characterized, remediated (if required), and then a final status survey was performed. The description of the decommissioning activities and final status survey data were then submitted to the NRC for review and approval (i.e., FSSR). After review of the final status survey report, the NRC either released the unit, performed a confirmatory survey with staff personnel, or contracted with ORISE to perform a confirmatory survey. Based upon the confirmatory survey (if requested by the NRC), the NRC would either release the unit or require additional characterization and/or remediation.

For discussion and data presentation, Subarea G has been divided into affected and unaffected area survey units (for reference see drawing 95MOST-RF3) as follows:

- Affected Area Roadway;
  - Centerline Roadway Surface Data
  - Expanded Roadway North of Waste Pond #2 Data
  - Roadway Depth Data

- Affected Open Land Drainage Areas; and
  - Drainage Centerline Surface Data
  - Expanded Drainage Area Data
  - Reservoir #3 Spillway Data
  - Drainage Depth Data

- Unaffected Open Land Areas.
  - Surface Data
  - Depth Data

3.3.1 Affected Area Roadway

This unit includes the roadway that traverses through Subarea G which was utilized by site vehicular traffic during prior site operations to access the eastern edges of the site. This unit also includes an expanded roadway area just north of former Uranium Waste Pond #2. This expanded area was classified an affected area because at one time, it included the roadway prior to it being moved slightly south to its present position (Ref., Drawing No. 95MOST-RF3).

Even though this unit was classified as an affected area, the potential for residual contamination being present was minimal; thus, no characterization sampling was performed prior to the FSS. The FSS data for this survey unit are discussed in Section 5.2.1.

3.3.2 Affected Open Land Drainage Areas

This unit includes two drainage ways that have been classified as affected areas. The first drainage flows from Subarea H east expanding into the Cimarron River floodplain; the

second drainage flows north from Reservoir #3 through the adjoining cliffs and bluffs to the floodplain and then combines with the first drainage to flow north toward the Cimarron River. These drainages were included in the 1979 site-wide random micro-R survey discussed in the Characterization Report[5]. The limited micro-R survey results collected from the vicinity of the survey unit were representative of background. The first drainage was included as an affected area because of its potential to receive run-off from the operating facility.

A small amount of the concrete, approximately 196 m^3, surveyed for alpha and released from the Uranium Building, was placed within the second Subarea G drainage area for erosion control. This concrete is located in the drainage way that discharges from Reservoir #3 at approximately 820E-694N, and is scattered over an area of approximately 196 m^2. This concrete, which was surveyed for gross alpha surface activity, met the applicable criteria for free release prior to being placed within the drainage area. However, since this concrete was removed from an affected area and not beta/gamma surveyed, the concrete and the drainage down stream from the concrete was surveyed as an affected area for this FSS. The affected area final status survey data for these drainages and concrete areas are addressed in Section 5.2.2.

3.3.3 Unaffected Open Land Areas

With the removal of the areas discussed previously in Section 3.3.1 and 3.3.2 all remaining areas within Subarea G were classified as unaffected and surveyed accordingly. Cimarron previously had not performed any specific characterization surveys on these unaffected areas, though these areas were included in the site-wide micro-R survey that was completed in 1979. The limited micro-R survey results were representative of background. The final status survey data for the unaffected areas are discussed in Section 5.2.3.

Also, slabs of concrete recently removed from the floor of the Uranium Building were surveyed for free release and then placed in the unaffected area of Subarea G. These concrete slabs were surveyed for both gross alpha and beta, and shown to meet the free release criteria. Additionally, these concrete slabs have been surveyed by the NRC to verify that they meet the release criteria for unrestricted use. By letter dated December 4, 1998[41], the NRC confirmed that they did meet the release criteria and could be broken into rubble and placed in unaffected areas for erosion control. These slabs are still being stored in Subarea G and have not been broken into sections for placement into drainage ditches. Cimarron intends to use the concrete for erosion control sometime in the future.

3.4 Environmental Monitoring Data

As approved by the NRC in the Cimarron Decommissioning Plan[7], Cimarron Corporation committed to address groundwater for the site in separate reports. One such report titled "Decommissioning Plan – Groundwater Evaluation Report", was submitted to the NRC in July 1998[42]. This Groundwater Evaluation Report summarizes the site environmental data, presents trending analyses and a dose assessment, and commits to a plan for resolving the issues associated with elevated residual groundwater radionuclide

concentrations. Per discussions held at NRC headquarters on January 11, 1999, and by letter dated January 19, 1999[43], the NRC approved a groundwater criteria of 180 pCi/l for total uranium. The total uranium concentrations in groundwater being monitored are to be below this concentration for eight consecutive quarterly samples or for two consecutive years depending upon the frequency of sampling. There are two environmental monitoring locations within Subarea G; one monitoring well and one surface monitoring location. The well is #1336A and the surface location is #1208. Neither of these locations monitored within Subarea G contains total uranium concentrations in groundwater exceeding the criteria as prescribed in NRC's January 1999 letter. Additionally, the concentrations at location #1208 has been below the guideline value of 180 pCi/l for total uranium for the past six years; and for location #1336A, the concentration has always been below the guideline value.

4.0 FINAL STATUS SURVEY PROCEDURE

The purpose of this section is to discuss the methodology utilized for the collection of the survey and soil sampling data presented as FSS data in this report, and to discuss the radiological guideline values utilized for comparison to the FSS data. The FSS data were used to demonstrate that the applicable radiological parameters (i.e., guideline values) were satisfied for release of Subarea G from License SNM-928. The guideline values utilized for comparison to the FSS data are described in this section.

In general, for Phase II areas, Cimarron Corporation has committed to follow the methodology prescribed in NUREG/CR-5849[44] and as approved in the Phase II FSSP for performing the FSS. This report includes all necessary data to support the FSS for the soils and concrete within Subarea G and the release for unrestricted use of Subarea G from License SNM-928.

4.1 Survey Method

Survey and soil sampling data were collected utilizing established methods that have been demonstrated through the release of other areas at the Cimarron site. The instrumentation available for use by site personnel as well as the minimum detectable activity (MDA) and typical efficiency for those instruments are listed in Table 4.1. The survey methods are discussed further below:

4.1.1 Grid Areas

Subarea G was subdivided into the 100m x 100m grid pattern shown on Drawing No 95MOST-RF3. The 100m x 100m grids were further subdivided for affected area surveys into 10m x 10m grids. For systematic surveys, the 10m grids were further subdivided into 5m x 5m grids. The 5m x 5m grids were utilized for locating survey and soil sampling points for this FSS. Cimarron employs a Global Positioning Survey (GPS) unit to check pre-established grid points and to locate sample collection and survey positions in the field. This GPS unit is accurate to within less than ± 1 m. The 0.0 grid point is located just south and slightly west of the main Uranium Building and has been tied into a permanent marker for future reference.

TABLE 4.1

RADIATION MONITORING INSTRUMENTS

INSTRUMENT TYPE	NUMBER AVAILABLE	RADIATION DETECTED	SCALE RANGE	BKG	TYPICAL EFFICIENCY	TYPICAL MDA 95% CONFIDENCE LEVEL
Scintillation (Ludlum 2224) Scaler/Ratemeter	2	Alpha Beta	0-500,000 cpm	< 10 cpm < 300 cpm	20% 19%	100 dpm/100 cm^2 500 dpm/100cm^2
Micro-R Meter (Ludlum 12 & 19) 1" x 1" NaI Detector	3	Gamma	0 – 5,000 µR/h	7 µR/h- 9 µR/h	N/A	2 µR/h
Ion Chamber (Victoreen)	1	Gamma	0.1 - 300 mR/h	<.0 1 mR/h	N/A	< 0.2 mR/h
3" x 1/2" NaI Scintillation (43-82) Digital Scaler (Ludlum 2220/2221)	3	Gamma	0 - 500,000 cpm	3,000 cpm avg shielded 9,000 cpm avg unshielded	N/A	250 cpm (Shielded) 500 cpm (Unshielded)
100 cm^2 gas flow (43-68) Digital Scaler (Ludlum 2220/2221)	2	Alpha	0 - 500,000 cpm	<10 cpm	20%	100 dpm/100 cm^2
60 cm^2 gas flow (43-4) Digital Scaler	1	Alpha	0 - 500,000 cpm	<10 cpm	25%	200 dpm/100 cm^2
60 cm^2 Count Rate Meter (PRM-6)	7	Alpha	0 - 500,000 cpm	<100 cpm	50%	350 dpm/100 cm^2
50 cm^2 Personnel Room Monitor (Ludlum 177)	2	Alpha	0 - 500,000 cpm	<100 cpm	50%	500 dpm/100 cm^2
Tennelec LB5100 Computer Based Auto Sample Counter	1	Alpha Beta	0 - 99,999,999 cpm	<0.3 cpm 1.5 cpm	38% 42%	0.4 dpm 1.5 dpm
Soil Counter - Computer Linked 4" x 4" x16" NaI (Tl) Detector	1	Gamma	---	4 pCi/g Total U 1.5 pCi/g Th (Nat)	4% 15%	5 pCi/g U (5min. count) 0.6 pCi/g Th (Nat) (5min. count) 3 pCi/g U (15min. count) 0.3 pCi/g Th (Nat) (15min. count)
100 cm^2 gas flow (43-68) Digital Scaler (Ludlum 2220/2221)	2	Beta, Gamma	0 - 10,000 cpm	<300 cpm	20%	600 dpm/100 cm^2
*Reuter-Stokes PIC Model RSS-112	1	Gamma	0 - 100 mR/h	9 – 10 µR/h	N/A	0.5 µR/h (10min. count)

*(Cushing Instrument available for Cimarron Use)

4.1.2 Survey Procedure (Open Land Areas)

The Subarea G open land affected areas were 100% scanned utilizing a 3" x 1/2" unshielded NaI detector and the unaffected subarea surfaces were 10% scanned. The specific instruments used were selected by the RSO/Health Physics Supervisor.

Each 5m x 5m grid was scan surveyed by technicians by traversing back and forth within each grid. Each traverse performed by the technician covered an area approximately 2 meters in width. The highest reading found within each grid area was recorded. Survey performance, documentation, and record retention were performed in accordance with the Cimarron Radiation Protection Program. In the event that any of the survey readings exceeded the limits discussed in Section 4.2.3, their location was flagged for additional surveys and/or soil sampling. The survey procedures followed were specified in Cimarron's Special Work Permit(s) and Work Plan(s) for this subarea.

Additionally, at the intersect of each 5m x 5m affected area grid location, a systematic survey was completed at ground surface and at 1m above the surface for ambient radiation using a micro-R meter. Also, a gamma survey at the ground surface, using a shielded or unshielded 3" x 1/2" NaI detector was performed and documented. For unaffected areas, each random soil sample location was surveyed with both the micro-R meter and the NaI detector.

4.1.3 Soil Sampling Procedure

The soil sampling frequency was specified in the Cimarron Special Work Permit(s) and Work Plan(s). Where practicable, systematic surface soil samples were collected at each 5m x 5m grid intersect location for open land areas and at each 5m interval for roads and drainages. All soil samples collected were analyzed for total uranium and natural thorium using the on-site soil counter. Any locations found exceeding the soil guideline values for affected or unaffected areas as discussed in Section 4.2.2 were investigated further.

For the unaffected area, a minimum of thirty surface soil samples (0 to 6 inches deep) was collected within the boundary of Subarea G. The samples from the designated unaffected area were selected from the 10m x 10m grid intersect points within the unaffected area utilizing a random number generator. All soil samples were analyzed for total uranium and natural thorium using the on-site soil counter.

Where practicable, for affected areas, surface soil samples were collected at each 5m x 5m intersect location and at 5 meter intervals along the length of drainage ways and roads when the width of such affected areas were less than 5 meters. Additionally, systematic and random subsurface soil sampling to a depth of 4 feet was performed at selected locations within the affected areas. Random subsurface samples were collected at a frequency of one (1) out of every twenty (20) 5m x 5m (or 5m linear) grid point located within this Subarea G open land affected area. One sample location out of every twenty (20) 5m x 5m grid areas equates to one (1) sample location for every 500 square meters.

All soil samples collected were analyzed for total uranium and thorium using the on-site soil counter. Any locations found exceeding the soil guideline values discussed in Section 4.2.2 for either affected or unaffected areas were investigated further.

4.1.4 Concrete Survey Locations

A grid system was established for the concrete rubble so that each grid area could be easily located in the future for additional survey work and/or confirmatory surveys. The concrete grid system consists of irregular shaped grids which range from approximately 1 m^2 to 22.5 m^2 in area.

Each grid area was then 100% scanned over the accessible surfaces for gross beta-gamma activity to identify any elevated areas of activity. Any location within each grid that exceeded 5,000 dpm/100cm^2 was documented on survey forms. The 5,000 dpm/100cm^2 cut-off value was chosen as an action level for recording data because it represents the unconditional release surface activity criteria (average) for total uranium. The final release of the concrete riprap is based upon the BTP Option 1 volumetric criteria, which is 30 pCi/g above background for total uranium.

Gross alpha scans to identify elevated locations were also performed, although gross alpha scanning over rough and porous surfaces has not proven to be an effective method due to the effects of geometry (source to detector distance) and attenuation (shields the alpha particles before they are able to reach the detector). The survey data for areas containing elevated measurements of gross beta-gamma activity versus the gross alpha measurement results provides evidence of this (see Table 5.5).

In addition to gross alpha and gross beta-gamma measurements, exposure rate measurements were obtained at the surface of the concrete and at a height of one meter. The surveys performed on each grid section can be summarized as follows:

- The average gross beta-gamma dpm/100cm^2 was measured.
- The maximum gross beta-gamma dpm/100cm^2 was measured.
- The average gross alpha dpm/100cm^2 was measured.
- The maximum gross alpha dpm/100cm^2 was measured.
- A μR/hour reading at the surface and at one meter above the surface directly above the location with the highest gross beta-gamma activity was measured.

Surface activity measurements for gross beta-gamma were obtained using a Ludlum Model 2221 with a Model 43-68 gas proportional probe, or equivalent (e.g., Ludlum Model 43-89). Gross alpha surface scans were obtained using a Ludlum Model 2220/2221 with a Model 43-68 gas proportional probe. Micro-R measurements were obtained utilizing a Ludlum Model 19. The top surface and any other accessible concrete surfaces were surveyed. The intent of the survey was to be representative of the concrete rubble as a whole, through the use of standard survey techniques and the application of reasonable calculational assumptions.

Removable contamination measurements were not obtained due to the fact that the concrete has been in the drainage area for over 10 years. It was determined that any potentially removable contamination remaining would have been removed by environmental interactions. Monitoring of soils and sediments downstream of the concrete provided confirmation that removable contamination has not significantly affected concentrations of uranium in downstream soils and sediment. In addition, based upon survey data from concrete in other areas (i.e., Subarea F and H), surface activity found on concrete has not been a source of subsurface soil contamination or surface water contamination.

Exposure rate measurements were obtained at the surface of the concrete and at one meter above the concrete surface utilizing a sodium iodide based micro-R meter, or equivalent. These measurements support the position that the concrete rubble does not pose an external dose hazard and that exposures are similar to background.

An environmental thermoluminescent dosimeter (TLD) was placed near the concrete rubble to support the results of the exposure rate measurements and to demonstrate that there are not any seasonal or long-term upward trends in exposure rates. Data from the TLD are compared to site background area TLD measurements.

Soil/sediment samples were collected from the concrete rubble area. All samples were analyzed for total uranium and thorium activity utilizing the Cimarron soil counter.

4.2 Radiological Guideline Values

The radiological guideline values discussed in this section were utilized for comparison with the FSS data in order to confirm that Subarea G can be released for unrestricted use from License SNM-928.

4.2.1 Buildings and Equipment

The release limits for contamination of all materials and equipment are in compliance with Facility License SNM-928 and are identical to the limits specified in Table 1 of the NRC's "Guidance for Decommissioning of Facilities and Equipment Prior to Release for Unrestricted Use"[45]. Subarea G contains no buildings or equipment and therefore these types of surveys were not applicable.

4.2.2 Volumetric Activity of Soil

For Subarea G, the unrestricted release guideline value for residual concentrations of total uranium, which may remain in the soil for unrestricted release is specified as BTP[46] Option #1 material. For enriched uranium, as specified in Table 2 of the BTP, the Option #1 limit is 30 pCi/g total uranium above background. The average total uranium background concentration has been established at 4 pCi/g[35]. The maximum enriched uranium soil concentration within any 10m x 10m grid area may not exceed three times the BTP Option #1 limit (i.e., 90 pCi/g total uranium) above background. Systematic soil sampling was performed within each 10m x 10m grid area to determine the average

residual total uranium concentration. This systematic sampling equates to four surface samples per 100 m^2 area; which is the same sample frequency as one sample collected at the intersect of each 5m x 5m grid intersect. Areas of elevated activity were determined based upon discrete sampling within the grid or were assumed to have a constant value (e.g., 25m^2 based upon 5m x 5m grid sampling frequency). The average value for the 10m x 10m grid then was compared to the BTP Option #1 guideline value of 30 pCi/g total uranium above background. Remediation or hot spot averaging was performed for each individual location which contained average total uranium concentrations in excess of 30 pCi/g above background as described in NUREG/CR-5849. Areas of elevated activity not remediated between one and three times the guideline value were tested to assure that the average concentration was less than $(100/A)^{1/2}$ times the guideline value, where "A" is the area of elevated activity in m^2.

The Option #1 unconditional release guideline value for residual concentrations of natural thorium, which may remain in soil per Table 2 of the BTP, is up to 10 pCi/g above background. The average background for natural thorium has been determined to be 1.5 pCi/g for soil analyzed with the on-site counter.

4.2.3 Gamma Surface Survey (Open Land Areas)

Cimarron personnel utilize a shielded or unshielded 3" x 0.5" sodium iodide (NaI) detector as a final screening device for qualitative identification of residual contamination in soil. Prior to the commencement of site-wide remediation, Cimarron evaluated several portable survey instruments for performing scan surveys including the 2" x 2" NaI detector. Based upon recommendations from Ludlum Instruments, Inc., Cimarron decided to use the 3" x 0.5" NaI detector for general area scans. This system is one of the more sensitive field detection instruments available to Cimarron.

Since the inception of Cimarron's site decommissioning, twice background has been used as the guideline for scan surveys when utilizing the 3" x 0.5" NaI detector. Survey readings above this guideline indicate an area requiring additional investigation. This guideline has been a standard in the nuclear industry for many years. With the submittal and approval by the NRC of numerous plans and reports, twice background also has become the accepted standard for the Cimarron Facility as a qualitative screening measure. This qualitative guideline was included in the Phase I Final Status Survey Plan[8], Phase I Final Status Survey Report[11], and the Phase II Final Status Survey Plan[13] just to name a few of the documents where this guideline was addressed and approved by NRC staff for this site.

Twice background (as noted in Section 6.4.2 of NUREG/CR-5849) is at the lower end of the range discernable for scanning instrumentation. During the scan survey the technician, upon noting a "discernable" difference in the audio output from the meter, will stop and attempt to locate the elevated area. It is difficult to discriminate low levels of residual uranium contamination when other naturally occurring isotopes are present which affect the gross count rate of the scan instrument. The guideline value of twice background provides a sufficient margin for technicians when conducting a scan to conclude that residual contamination may be present when a signal exceeds the twice

background level (i.e., a discernable audible increase above background). This discernable audible response alerts the surveyor to momentarily stop moving the probe (i.e., 2 to 3 seconds) and to further investigate the area. The survey instruments utilized at Cimarron indicate changes in radioactivity levels via either a higher or a lower pitch. These changes in pitch are easier to detect rather than simply noting an audible change in the count rate.

The unshielded detector was utilized to perform the initial 100% surface scan survey for Subarea G open land areas to identify regions or areas of slightly elevated activity. Also, the shielded or unshielded detector was utilized for systematic surveys at each grid intersect to identify elevated areas. As stated above, this instrument is only utilized for qualitative measurements. Quantitative measurements of residual contamination levels in soil are performed with the Cimarron soil counter. Additionally, daily "background" surveys are taken prior to performing surveys within a survey unit. These average daily "backgrounds" are listed on the data tables and drawings and were used for comparison to the guideline (i.e., twice background).

4.2.4 Exposure Rate Survey (Open Land Area)

The average exposure rate for Subarea G open land areas to be released for unrestricted use is 10 μR/h above background, at 1 meter above the surface. This includes paved surfaces and building exteriors. Exposure rates may be averaged over a 100 m^2 grid area as described in NUREG/CR-5849. The maximum exposure rate at any discrete location within a 100 square meter area cannot exceed 20 μR/h above background. Any area with average exposure rates greater than 10 μR/h above background and any discrete location within a 100 square meter area with an exposure rate greater than 20 μR/h above background was delineated and remediated as required. As discussed in Section 3.2.2, Cimarron has demonstrated that 9 μR/h is representative of the average background exposure rate for micro-R measurements.

4.2.5 Concrete Utilized for Riprap

4.2.5.1 Relationship Between Surface Activity and Concentration

A special study was conducted to determine the depth profile of the contamination in the concrete and for the purpose of establishing a relationship between gross beta-gamma surface activity (measured in dpm/100cm^2) and uranium concentrations (measured in pCi/g). Full details of this study are provided in the FSSR[20] for Concrete Rubble in Subarea F. The results of the special study are presented in Section 5.2.2.3.

4.2.5.2 Guideline Values

The radiological guideline values discussed in this section are utilized for comparison to the final survey data to verify that the concrete rubble in Subarea G can be released from License SNM-928.

NUREG/CR-5849[44], Section 2.2, states that "Volume concentration guideline values, which apply to soil, induced activity, and debris, are expressed in terms of activity per unit mass [typically picocuries per gram (pCi/g).]". Cimarron Corporation has established the release guideline values for concrete in Subarea G in accordance with the Branch Technical Position[46] (BTP) Option #1. The BTP Option #1 criteria is 30 pCi/g total uranium (enriched), above background.

The overall objective of the survey effort was to demonstrate that the release guideline values were complied with. Due to the nature of the sampling performed, the methods of NUREG/CR-5849 for "hot-spot" averaging were not directly utilized. Rather, justification that the overall average concentration meets the release criteria (i.e., BTP Option #1 guideline value) is provided herein. This was determined to be appropriate based upon the characteristics of the concrete rubble and the low probability that a portion of the concrete rubble would be extracted and used in a manner that would result in inadvertent exposure.

4.3 Equipment Selection

Special Work Permits (SWP) and Work Plans (WP) were written and approved prior to commencement of the field work required for this FSS. The SWP and/or WP for Subarea G specified the type of instrumentation to be utilized in performing the FSS.

4.3.1 Equipment and Instrumentation

The instrumentation utilized to generate the FSS data discussed herein was maintained by site personnel in accordance with the Cimarron Radiation Protection Program procedures. These procedures utilize the guidance contained in ANSI N323-1978, "Radiation Protection Instrumentation Test and Calibration[47]". Specific requirements, as specified by the Cimarron procedures for instrumentation, include traceability of calibrations to NIST standards, field checks for operability, background radioactivity checks, operation of instruments within established environmental bounds, training of individuals, scheduled performance checks, calibration with isotopes of energies similar to those to be measured, quality assurance tests, data review, and recordkeeping. An explanation of how Cimarron's Radiation Protection Program procedures are implemented with respect to instrumentation was discussed in Cimarron's responses to the NRC letter dated May 13, 1998[48].

With the exception of the exposure rate instrumentation (ion chamber, PIC and micro-R meter), health physics staff performs calibration on each of the instruments listed in Table 4.1. Portable survey instruments are calibrated on a quarterly basis. The exposure rate instruments are sent off-site for vendor calibration on a semi-annual basis. Where applicable, activities of sources utilized for on-site calibration are corrected for decay. In addition to the periodic calibration requirements, source response checks are performed on a daily basis for all instruments being utilized during characterization, remediation and final status survey work.

All calibration and source check records are completed, reviewed, signed-off and retained in accordance with the Cimarron Quality Assurance Program. The instrumentation utilized by site personnel is discussed below:

4.3.1.1 Unshielded 3" x 0.5" NaI Gamma Detector

The 3" x 0.5" detector is a sodium iodide (NaI) crystal gamma detector which is unshielded around all sides. The NaI detector is utilized with a portable scaler/ratemeter that has single channel analyzer capability. Americium-241, Uranium-235, and Natural Thorium sources are utilized to set the instrumentation window and threshold to detect gamma energies in the range of 50 to 250 keV. This energy range corresponds to the energies of interest when surveying for uranium and natural thorium contamination. The instrument is normally operated in the window "out" mode, meaning that the instrument response is for the entire range of detectable energies.

4.3.1.2 Shielded 3" x 0.5" NaI Gamma Detector

The 3" x 0.5" detector is a NaI crystal gamma detector which is shielded with lead around the top socket and sides to improve the directional sensing capabilities of the equipment. Similar to the unshielded detector, the shielded detector is utilized with a portable scaler/rate meter that has single channel analyzer capacity. This instrument is normally utilized in areas where background may be elevated.

4.3.1.3 Micro-R Meters

The micro-R meter is a 1" x 1" NaI crystal gamma detector which measures exposure rates between 0 and 5,000 μR/h. Background readings are obtained daily at a defined location prior to placing each instrument into service. This instrument is utilized, in general, for determination of exposure rates at both systematic and random locations and at locations of elevated radiation identified by area scans.

Confirmatory measurements are obtained routinely to provide information concerning any measurement bias. These comparisons or confirmatory measurements are made using a pressurized ion chamber. Confirmatory measurements for Subarea G are included in Table 4.2 and demonstrate good agreement between the micro-R meter and the PIC.

TABLE 4.2 SUBAREA G CONFIRMATORY MEASUREMENTS (Readings 1 Meter Above Grade)		
Reading Location	**Micro-R Reading (μR/h)**	**PIC Reading (μR/h)**
480E-660N	10.0	10.5
460E-685N	10.0	11.1
435E-670N	11.0	11.1
385E-715N	10.0	10.4
415N-735N	11.0	11.3
460E-710N	12.0	11.4
495E-730N	11.0	11.1
515E-705N	10.0	11.5
505E-700N	11.0	11.8
470E-690N	12.0	11.4
Average	**10.8**	**11.2**

4.3.1.4 Soil Counter (Gamma Spectroscopy)

The Cimarron Soil Counter System consists of a 4" x 4" x 16" sodium iodide crystal housed in a shielded chamber which is computer linked to a multi-channel analyzer (MCA). Cimarron's counting system is programmed to determine the total uranium present in the soil sample by calculating the U-234 activity based upon the U-235 activity measured in the soil sample. The U-234 and U-235 activities are summed with the detected U-238 activity to obtain the total U activity. The counter also adjusts for system background. Calibration of this counting system is performed annually and is traceable to NIST standards through contractor laboratory evaluations of the on-site standards.

Established quality assurance measures for the soil counter include Cesium-137 centroid checks, Chi-square tests, background determinations, and the counting of soil standards. All of these quality assurance controls are recorded on control cards and are trended on a continuing basis.

Standards used for calibration and quality assurance checks for the soil counter have been analyzed by outside laboratories and are NIST traceable through these analyses. Comparisons have been made between the standards as counted using the soil counter and two off-site laboratories. The assigned values for the standards are the average of the results obtained from the off-site laboratories, when the standards were analyzed by more than one laboratory. The standards range in concentration from 4.5 pCi/g total uranium to 292 pCi/g total uranium. Additional information pertaining to these standards and typical MDA calculations for the counting system were included in Cimarron's response to the NRC's comments on Subarea J[48].

Cimarron personnel determine uranium and thorium activities in soil based upon the evaluation of net counts from the soil counter. Activities are calculated through the use of efficiency and correction factors obtained using appropriate standards. Soil concentrations are calculated by dividing the net activity by the soil mass. Soil masses are determined on a laboratory scale which is checked on a daily basis (when in use)

utilizing NIST traceable standards. Corrections for soil moisture content are also made as necessary.

ORISE has been used by the NRC from time to time for verification of the decommissioning work completed to date at the Cimarron site. ORISE has conducted an evaluation of the Cimarron Soil Counting system's ability to measure accurately total uranium concentrations in soil samples. This was done by comparing ORISE sample analysis results obtained by gross alpha pulse height analysis and gamma spectroscopy with the results obtained from the use of the Cimarron Soil Counter. ORISE and Cimarron analysis results compared favorably at levels above background as demonstrated by the confirmatory analysis performed for the On-Site Disposal Cell, Pit #3 (NRC cover letter dated July 31, 1997)[49]. NRC inspection Report #70-925/97-02, which accompanied this letter, states that "no significant bias or statistical errors between the licensee's soil results and the NRC's results were identified". Additionally, the confirmatory analysis performed on selected soil samples collected during ORISE's site visit to investigate the South U-Yard[50], and DAP-3 stockpile[51] verified previously that Cimarron's on-site counter results are statistically identical to ORISE's results.

Two more recent inspections by the NRC also confirmed Cimarron's Soil Counting system's ability to accurately measure total uranium concentrations in soil samples. On September 24, 1998, the NRC collected twelve (12) soils and sediment samples from Subarea J. The samples were first counted on the On-Site Counter by Cimarron and then shipped by NRC to their Region III laboratory for analyses. The November 3, 1998 Inspection Report[52] (i.e., Report No. 70-925/98-02) stated the following:

"Overall, the NRC measurements confirmed that Subarea J soil and sediment had less than 30 pCi/g uranium. No significant bias or statistical errors between the licensee's soil and sediment sample results and the NRC's results were identified. Licensee measurement methods and counting times were found to be acceptable."

On July 9, 1999, the NRC collected soil samples from Subarea O for comparison to Cimarron's on-site soil counting system. The September 14, 1999 Inspection Report[34] (i.e., Report No. 70-925/99-01), stated the following:

"The results of the 12 NRC soil samples were found to be consistent with the licensee sample results."

4.4 Procedures/Plans

As discussed in Section 4.3, SWPs and WPs were written and approved prior to commencement of fieldwork required for this final status survey. These SWPs and WPs are an integral part of this site's radiation protection and quality assurance program. Project organization and responsibilities, which are a part of the site's quality assurance program, are discussed in this section.

4.4.1 Organization

The Subarea G FSS was performed by a survey team consisting of qualified personnel from the Cimarron Facility. The FSS team operated under the general direction of a Project Manager who reports directly to the Site Manager at the Cimarron Facility.

The selection of field measurement equipment and sample collection techniques was under the direction of the RSO/Health Physics Supervisor. Actual field measurements and sample collection were under the direction of the Project Manager. The Project Manager was responsible for developing the SWP and WP for Subarea G with input from the RSO/Health Physics Supervisor. The SWP and WP were reviewed and approved by the Cimarron Site Manager.

4.4.2 Training

Cimarron Corporation provides continuing training to Cimarron personnel and any other personnel (i.e., contractors, visitors, etc.) who are allowed access to the site. All members of the FSS team attended an in-house training session on the SWP and WP prior to commencement of work. All FSS procedures and quality assurance requirements were reviewed during this training session.

4.4.3 Radiation Protection Program

Cimarron Corporation maintains a radiation protection program that meets and/or exceeds all of the applicable regulatory requirements associated with activities conducted under Special Nuclear Materials License SNM-928. The Cimarron Radiation Protection Program currently in place for all decommissioning activities is administered through the use of the following documents:

- Cimarron Radiation Protection Plan (Annex A) and Procedures
- Cimarron Site Health and Safety Plan
- Cimarron Quality Assurance Plan and Procedures
- Cimarron Emergency Plan

It is the policy of Cimarron Corporation to perform all work in strict compliance with applicable regulatory and internal requirements. The goal of the Cimarron decommissioning effort is to conduct all operations at a level of excellence that exceeds regulatory requirements. Cimarron staff will continue to exercise appropriate radiation protection precautions throughout the remaining decommissioning work and final survey process.

Independent Kerr-McGee Corporate audits for regulatory and internal requirements are conducted on a periodic basis and include the review of the Cimarron Radiation Protection Program and associated programs. Assessments of program effectiveness are also performed periodically by the Cimarron RSO/Health Physics Supervisor. Additionally, the Cimarron Radiation Protection Program is inspected for compliance with applicable rules and regulations by NRC Region IV and NRC Headquarters staff.

4.4.4 Cimarron Quality Assurance Program (QAP)

The Cimarron Corporation QAP is an integral part of the Cimarron Radiation Protection Program. A principal component of the QAP is the confirmation of the quality of project work performed during decommissioning by assuring that all tasks are performed in a quality manner by qualified personnel. The Program ensures that samples are collected, controlled, and analyzed in accordance with applicable quality controls to provide confidence in the resulting data accuracy and validity. Cimarron's QA/QC program is structured to generate data that can be verified through independent review.

The Cimarron QAP is implemented and maintained in accordance with written policies, procedures, and instructions. This Program is administered under the direction of the Quality Assurance Coordinator. Periodic surveillance and reviews are conducted to ensure that all aspects of the Program are addressed. The Cimarron QAP satisfies the applicable requirements of ASME NQA-1[53].

Written procedures designated as SWPs and WPs, are prepared, reviewed and approved for activities involved in carrying out the decommissioning process. The Subarea G Survey SWP and WP were written in accordance with the Cimarron QAP. These documents designate the type of surveys to be performed, samples to be collected, frequency of sample collection, and the type of field instrumentation required for the tasks required.

Selection, calibration and use of radiation detection instrumentation used for final status survey release at Cimarron are directed by the Radiation Safety Officer (RSO). The RSO is responsible for the calibration performed by Cimarron Health Physics staff or by contract services. The RSO maintains a file for each technician on staff as to their qualifications and training.

The facility performs its own radiological soil analysis in accordance with written procedures and QA/QC protocols. Field data are gathered and maintained in logs for all samples in accordance with the Cimarron QAP. Necessary data are transferred to the on-site laboratory sample log when the sample is brought to the on-site laboratory for analysis. The sample logs provide a record of sample collection, transport (chain of custody), and are incorporated into the facility quality assurance records.

In addition, off-site independent radiological analysis of split samples (samples are first counted on site and then sent to an off-site independent laboratory) is an integral part of the Cimarron QAP. Samples sent to an off-site independent laboratory for analysis are accompanied by a chain of custody form in accordance with the Cimarron QAP. These forms provide documentation for all aspects of sample control and are maintained by the Quality Assurance Coordinator as permanent records.

Sample and survey data are reviewed by the Health Physics Department for accuracy and consistency and to determine if further characterization or remediation is required or if the data is acceptable. Additionally, the data are compared to the guideline values on a regular basis. The data review process verifies that approved QA/QC procedures have

been followed. When identified, corrections to recognized deficiencies are performed in accordance with the QAP.

5.0 SURVEY FINDINGS

As discussed in Section 1.0, FSS data were generated for Subarea G to justify the release of this subarea from License SNM-928. The survey findings, including the statistical methodology employed to evaluate the data for Subarea G, are discussed in this section.

5.1 Data Evaluation

As discussed in NUREG/CR-5849, the guideline values for soil activity concentrations, surface activity, and exposure rates are average values (above background) established for areas of survey units. In order to compare the analytical and survey data developed for the final status survey with guideline values; data at each individual survey grid location were compared to the appropriate guideline values discussed in Section 4.2.

5.2 Comparison with Guideline Values

The FSS data for Subarea G was compared to the guideline value criteria and are discussed separately in this section. This section evaluates the data collected from both the scan and the systematic surveys performed at the grid intersects for open land areas for Subarea G which are shown on Drawing No. 95MOST-RF3 (Appendix 1). For discussion and comparison purposes, the FSS data for Subarea G were divided into the three survey units outlined in Section 3.3. These survey units are discussed separately in the following sections.

5.2.1 Data Evaluation - Affected Area Roadway

This survey unit includes the roadway that traverses through Subarea G which was utilized by site vehicular traffic during prior site operations to access the eastern edges of the site. This section evaluates the FSS data collected from both the 100% scan and the systematic survey performed at the affected area grid intersects for this unit. For data evaluation purposes, the FSS roadway survey unit was further divided as follows:

- Centerline Roadway Surface Data;
- Expanded Roadway North of Waste Pond #2; and
- Roadway Depth Data.

5.2.1.1 Centerline Roadway Surface Data

This survey unit includes the centerline of the roadway which exits Subarea N at approximately 460N-450E, traverses along the ridge of Subarea G, and enters Subarea F at approximately 590N-920E. This survey unit is shown on Drawing No. 99POSGCRSS-0.

For this survey unit, a 100% scan was performed on the open land area with an unshielded NaI detector for locating any areas exceeding twice background. No readings exceeded the twice background guideline value.

For the systematic soil sampling event, samples were collected at each 5m linear grid location. A total of 128 samples were collected for analysis, the soil analytical results ranged from 3 to 12 pCi/g total uranium. The mean value for all surface sample locations was 6.9 pCi/g total uranium, with a standard deviation of 1.9 pCi/g. The 95% confidence level value was 7.2 pCi/g which is below the guideline value for total uranium. Also, the soil sample analytical results for this data set showed natural thorium varying from 1 pCi/g to 2 pCi/g. The mean value was 1.2 pCi/g natural thorium, with a standard deviation of 0.4 pCi/g thorium.

For the final status surface sampling, all soil sample analytical results for this unit were below the total uranium guideline value (i.e., 34 pCi/g total uranium including background). The soil sample analytical results for each 5m linear grid location are tabulated in tables included in Appendix 2A. The soil sample locations and analytical results for total uranium are shown on Drawing No. 99POSGCRSS-0 This drawing is included in Appendix 2A.

The systematic surveys performed at the 5m linear grid locations with the 3" x 0.5" unshielded NaI detector and the μR meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a μR/h meter both ranged from 4 μR/h to 9 μR/h, with the mean being 7 μR/h. All measured exposure rates were below the guideline value of 19 μR/h (i.e., 10 μR/h above the average background of 9 μR/h). Exposure rate survey data is presented in tables included in Appendix 2A. The ground level unshielded NaI detector survey results for the 5m linear grid sample locations ranged from 4,802 CPM to 8,701 CPM. All survey results were less than twice background. The 3" NaI survey results are presented in tables included in Appendix 2A.

5.2.1.2 Expanded Roadway North of Waste Pond #2 Data

This survey unit includes the open land area just north of Uranium Waste Pond #2. As discussed in Section 3.3.1, the original portion of the roadway north of Uranium Waste Pond #2 was in the past routed slightly north of its present position. For this reason an expanded area encompassing the open land area previously traversed by the roadway was classified as an affected area. This area is shown on Drawing No. 99POSGERSS-0, included in Appendix 2B.

For this survey unit, a 100% scan was performed on the open land area with an unshielded NaI detector for locating any areas exceeding twice background. No readings exceeded the twice background guideline.

Systematic soil samples were collected at the surface at each 5m x 5m grid location. A total of 187 samples were collected for analysis with soil analytical results ranging from 3

to 12 pCi/g total uranium. The mean value for all surface sample locations was 6.8 pCi/g total uranium, with a standard deviation of 1.8 pCi/g. The 95% confidence level value was 7.0 pCi/g which is below the guideline value for total uranium. Also, the soil sample analytical results for this data set showed natural thorium varying from 1 pCi/g to 2 pCi/g. The mean value was 1.4 pCi/g natural thorium, with a standard deviation of 0.5 pCi/g natural thorium.

For the final status surface sampling, all soil samples analytical results for this unit were below the total uranium guideline value (i.e., 34 pCi/g total uranium including background). The soil sample analytical results for each 5m x 5m grid location are tabulated in tables included in Appendix 2B. The soil sample locations and analytical results for total uranium are shown on Drawing No. 99POSGERSS-0. This drawing and the statistical analyses are included in Appendix 2B.

The systematic surveys performed at the grid intersect with the 3" x 0.5" unshielded NaI detector and the μR meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a μR/h meter ranged from 5 μR/h to 11 μR/h, with the mean being 8 μR/h and from 6 μR/h to 10 μR/h with the mean being 8 μR/h, respectively. All measured exposure rates were below the guideline value of 19 μR/h (i.e., 10 μR/h above the average background of 9 μR/h). The exposure rates are presented in tables included in Appendix 2B. The ground level unshielded NaI detector survey results for the grid intersect sample locations ranged from 5,224 CPM to 9,608 CPM. All survey results were less than twice background. The 3" NaI survey results are presented in tables included in Appendix 2B.

5.2.1.3 Roadway Depth Data

Subsurface soil samples were collected within this affected roadway area in accordance with the approved Phase II FSSP at a frequency of one sample location (or greater) for each 100 meters in length of a roadway. In accordance with this requirement, a total of 55 samples were collected at depths of 0-6", 6"-1', 1'-2', 2'-3' and 3'-4'. The analytical results for these subsurface samples ranged from 4 pCi/g to 12 pCi/g total uranium with a mean value of 7.3 pCi/g total uranium for the data set. The standard deviation was 2.1 pCi/g total uranium with a 95% confidence level value of 7.7 pCi/g total uranium. All sample analytical results were below the guideline value of 34 pCi/g total uranium including background with background established at 4 pCi/g. Also, the soil samples analytical results showed natural thorium varying from 1 pCi/g to 2 pCi/g. The mean value was 1.2 pCi/g natural thorium with a standard deviation of 0.4 pCi/g thorium. The sample locations and analytical results are shown on Drawing No. 99POSGCRSS-1. This drawing, the statistical analyses, and the data tabulation sheets are included in Appendix 2C.

5.2.2 Data Evaluation – Affected Open Land Drainage Area

This survey unit includes the two drainage ways that traverse through Subarea G. The first drainage discharges from Subarea H and includes drainage which had collected runoff from the operating areas during plant operations. Also, included in this survey

unit is the drainage way from Reservoir #3. Although Reservoir #3 was classified an unaffected area, the drainage way received concrete rubble which had been surveyed and released from the operating plant. For these reasons, both drainage ways were surveyed as affected areas and have been divided into four data sets for FSS data presentation. The four data sets are:

- Drainage Centerline Surface Data;
- Expanded Drainage Area Data;
- Reservoir #3 Spillway Data; and
- Drainage Depth Data.

5.2.2.1 Drainage Centerline Surface Data

This survey unit includes the scan and systematic survey of the centerline of the two drainage ways that are discussed in Section 5.2.2 and shown on Drawing No. 99POSGCDSS-0 with the exception of the drainage area under the Reservoir #3 drainage way concrete riprap. The soils beneath the riprap are discussed in Section 5.2.2.3.

For this survey unit a 100% scan was performed on the open land area with an unshielded NaI detector for locating any area exceeding twice background. No areas were identified that exceeded the twice background guideline.

For the systematic soil sampling event, samples were collected at each 5m linear grid location with the exception of those grids where standing water or concrete riprap were present. The surface area survey included a total of 225 FSS soil samples collected for analysis with soil sample analytical results ranging from 2 pCi/g to 28 pCi/g total uranium (including background of 4 pCi/g total uranium). The mean value for all surface samples was 8.0 pCi/g total uranium, with a standard deviation of 4.2 pCi/g. The 95% confidence level value was 8.5 pCi/g, which is below the guideline value for total uranium. Also, the soil sample analytical results for this subarea showed natural thorium ranging from 0.6 pCi/g to 3.0 pCi/g. The mean value was 1.2 pCi/g natural thorium, with a standard deviation of 0.5 pCi/g thorium.

For the final status surface sampling, all soil samples analytical results for this unit were below the total uranium guideline value (i.e., 34 pCi/g total uranium including background). The soil sample analytical results for each 5m linear grid location are tabulated in tables included in Appendix 3A. The soil sample locations and analytical results for total uranium are shown on Drawing No. 99POSGCDSS-0. This drawing and the statistical analyses are included in Appendix 3A.

Systematic surveys were performed during the FSS at the 5m grid intervals with 3" x 0.5" shielded and unshielded NaI detectors and the μR meter. The exposure rates at the surface and at one meter above the surface, as measured using a μR/h meter, ranged from 5 μR/h to 13 μR/h, with the mean being 9.0 μR/h and from 5 μR/h to 12 μR/h, with the mean being 9.0 μR/h, respectively. All measured exposure rates were below the guideline value of 19 μR/h (i.e., 10 μR/h above the average background of 9 μR/h). The

exposure rate data tabulation is included in Appendix 3A. The ground level NaI detector survey results for the grid sample locations ranged from 2,410 CPM to 3,390 CPM for the shielded detector and from 4,780 CPM to 11,332 CPM for the unshielded detector. All survey results were less than twice background. The survey results are included in Appendix 3A.

5.2.2.2 Expanded Drainage Area Data

The drainage way discharge from Subarea H expands substantially when it encounters the floodplain located in Subarea G just below the cliffs. Because the potential exists for this area to have received drainage from the operating area, it was classified as an affected area and evaluated separately from the drainage centerline survey data discussed above. For this survey unit a 100% scan was performed on the open land area with an unshielded NaI detector for locating any area exceeding twice background. No readings exceeded the twice background guideline.

For the systematic soil sampling event, samples were collected at the surface at each 5m x 5m grid location with the exception of those locations where standing water was present. This surface area survey included a total of 694 FSS soil samples collected for analysis with soil sample analytical results ranging from 4.2 pCi/g to 21.2 pCi/g total uranium (including background of 4 pCi/g total uranium). The mean value for all surface samples was 11.3 pCi/g total uranium, with a standard deviation of 2.8 pCi/g. The 95% confidence level value was 11.5 pCi/g, which is below the guideline value for total uranium. Also, the soil sample analytical results for this subarea showed natural thorium ranging from 0.4 pCi/g to 2.4 pCi/g. The mean value was 1.3 pCi/g natural thorium, with a standard deviation of 0.3 pCi/g natural thorium.

For the final status surface sampling, all soil samples analytical results for this unit were below the total uranium guideline value (i.e., 34 pCi/g total uranium including background). The soil sample analytical results for each 5m x 5m grid location are tabulated in tables included in Appendix 3B. The soil sample locations and analytical results for total uranium are shown on Drawing No. 99POSGEDSS-0. This drawing and the statistical analyses are included in Appendix 3B.

Systematic surveys were performed during the FSS at the 5m x 5m grid intersects with 3" x 0.5" shielded NaI detectors and the μR meter. The exposure rates at the surface and at one meter above the surface ranged from 7 μR/h to 15 μR/h, with the mean being 11 μR/h and from 6 μR/h to 15 μR/h, with the mean being 11 μR/h, respectively. All measured exposure rates were below the guideline value of 19 μR/h (i.e., 10 μR/h above the average background of 9 μR/h). The exposure rate data tabulation is included in Appendix 3B. The ground level unshielded NaI detector survey results for the grid intersect sample locations ranged from 4,820 CPM to 13,200 CPM. All survey results were less than twice background which was recorded at 8,000 CPM. The survey results are included in Appendix 3B.

5.2.2.3 Reservoir #3 Spillway Data

This survey unit includes the scan and a systematic survey of select locations west of the centerline of the drainage way that discharges from Reservoir #3. The locations are shown on Drawing No. 99POSGR3SS-0 included in Appendix 3C. Also, as discussed in Section 3.3.2, concrete removed from the Uranium Building was surveyed for release and then placed as riprap in several locations within Subarea G for erosion protection. Some of this concrete was surveyed for alpha only. For this reason, FSS data was generated for the concrete rubble, the soil under the rubble, and ponding water located in the Reservoir #3 spillway in order to demonstrate that the concrete met the guideline values for release. The survey findings, including the methodology employed to evaluate the data, are described in this section.

5.2.2.3.1 Spillway Surface and Subsurface Soil Data

For this survey unit a 100% scan was performed on the open land area with an unshielded NaI detector for locating any area exceeding twice background. No reading exceeded the twice background guideline.

For the systematic soil sampling event, samples were collected at selected 5m x 5m grid locations, except for those grids where standing water or concrete riprap were present. The surface and subsurface area survey included a total of 35 FSS surface soil samples and 31 subsurface samples collected for analysis with soil sample analytical results ranging from 4.5 pCi/g to 25.1 pCi/g total uranium (including background of 4 pCi/g total uranium). The mean value for all samples was 9.1 pCi/g total uranium, with a standard deviation of 4.3 pCi/g. The 95% confidence level value was 10.0 pCi/g, which is below the guideline value for total uranium. Also, the soil sample analytical results for this subarea showed natural thorium ranging from 0.2 pCi/g to 1.2 pCi/g. The mean value was 0.8 pCi/g natural thorium, with a standard deviation of 0.2 pCi/g thorium.

For the final status survey sampling, all soil samples analytical results for this unit were below the total uranium guideline value (i.e., 34 pCi/g total uranium including background). The soil sample analytical results for each grid location are tabulated in tables included in Appendix 3C. The soil sample locations and analytical results for total uranium are shown on Drawing Nos. 99POSGR3SS-0 through 99POSGR3SS-4. These drawings and the statistical analyses are included in Appendix 3C.

Systematic surveys were performed during the FSS at the 5m x 5m grid intervals with 3" x 0.5" shielded NaI detector and the μR meter. The exposure rates at the surface and at one meter above the surface both ranged from 8 μR/h to 11 μR/h, with the mean being 9.0 μR/h. All measured exposure rates were below the guideline value of 19 μR/h (i.e., 10 μR/h above the average background of 9 μR/h). The exposure rate data tabulation is included in Appendix 3C. The ground level shielded NaI detector survey results for the grid sample locations ranged from 2,250 CPM to 5,510 CPM. All survey results were less than twice background. The survey results are included in Appendix 3C.

5.2.2.3.2 Spillway Concrete Riprap Survey Data

Final Status Survey data was generated for the concrete rubble located in Subarea G in order to demonstrate that this concrete rubble could be unconditionally released. The survey findings, including the methodology employed to evaluate the data, are described in this section.

A. Thermoluminescent Dosimeter (TLD) Exposure Rate Data

A thermoluminescent dosimeter was placed at one location (#AM019) above the concrete rubble. The coordinates for this TLD were 892E-630N. TLD data for 1996, 1997, and 1998 are provided in Tables 5.1 through 5.3, along with data for TLD location #AM014, which is located approximately one half mile south of the facility near the junction of Highways #33 and #74. Location #AM014 represents background. The TLDs were placed at a height of approximately one meter above the ground or concrete surface, and were oriented to face the area to be monitored. The TLD above the Subarea G concrete was removed after the second quarter of 1999.

Table 5.1
TLD Exposure Rate Measurements-1996

TLD#	Description	1Q96 µR/h	2Q96 µR/h	3Q96 µR/h	4Q96 µR/h	96 Ave. µR/h
AM014	Junction of Highways 33 & 74 (Background)	7.6	8.3	5.6	7.0	7.1
AM019	Subarea G Concrete	9.5	7.0	4.2	5.5	6.6

Table 5.2
TLD Exposure Rate Measurements-1997

TLD#	Description	1Q97 µR/h	2Q97 µR/h	3Q97 µR/h	4Q97 µR/h	97 Ave. µR/h
AM014	Junction of Highways 33 & 74 (Background)	9.2	6.9	8.8	11.3	9.1
AM019	Subarea G Concrete	5.7	5.1	5.7	9.3	6.5

Table 5.3
TLD Exposure Rate Measurements-1998

TLD#	Description	1Q98 µR/h	2Q98 µR/h	3Q98 µR/h	4Q98 µR/h	98 Ave. µR/h
AM014	Junction of Highways 33 & 74 (Background)	7.4	8.0	9.6	6.7	7.9
AM019	Subarea G Concrete	4.3	6.5	6.7	4.1	5.4

During 1996, the exposure rate near the concrete averaged 6.6 μR/h at the indicator location (#AM019), and averaged 7.1 μR/h at the background location (#AM014). The average exposure rates during 1997 were similar, averaging 6.5 μR/h at the indicator location, and 9.1 μR/h at the background location. During 1998, the indicator location averaged 5.4 μR/h, while the background location averaged 7.9 μR/h. During the first quarter of 1999, the indicator location averaged 7.1 μR/h, while the background location averaged 9.8 μR/h.

The TLD exposure data does not indicate any elevated exposures occurring as a result of the concrete surface contamination. The TLD data also supports the measurements obtained with micro-R meters. The TLD data indicates that the guideline value of 10 micro-R above background is met at each TLD location during calendar years 1996, 1997, and 1998, as well as during the first quarter of 1999.

B. Soil/Sediment Samples

Fifty soil/sediment surface samples (0-6" depth) were evaluated from areas upgradient of the concrete rubble, from areas within and beneath the concrete, and from areas downgradient of the concrete. The sampling locations and sample results are shown on Drawing No. 99POSGCONC-0 (Appendix 3C). Sample results did not indicate any samples above the BTP Option #1 guideline concentration of 30 pCi/g, above background. Concentrations of total uranium in these surface soil samples ranged from 4.0 pCi/g to 25.1 pCi/g, while total thorium ranged from 0.2 to 1.2 pCi/g, including natural background. Cimarron believes that concentrations of total uranium in several soil samples may have been enhanced through the activities associated with residual soil adhering to the concrete during removal and placement. Based upon our knowledge of concrete from Subareas F and H, we do not believe that the residual embedded contamination on the concrete has or will affect the concentrations present in soils or sediments.

C. Micro-R Measurements

A tabular summary of micro-R meter surveys for the concrete grids is provided in Table 5.5 (see right hand columns). The maximum exposure rate over any grid area ranged from 9 μR/h to 10 μR/h at one meter from the surface, including background. The overall average exposure rate for the concrete grids was 9.6 μR/h at one meter from the surface, and 10.3 μR/h at the surface, including background. Using a background of 9 μR/h, the net exposure rate due to the concrete averaged 0.6 μR/h at one meter above the surface and 1.3 μR/h at the surface.

The concrete in Subarea G was evaluated to determine any significance with respect to exposure of the general public. Under normal circumstances, it is unlikely that any additional exposure would occur to members of the public as the

concrete is within a drainage area, and is on land owned by Cimarron Corporation. The possible exposure scenarios evaluated included hunting the land or an intruder inadvertently remaining in the area for a period of time. Assuming that the intruder is exposed for ten hours per year, the hypothetical individual could potentially receive a maximum net annual dose of 40 μrem (i.e., 13 μR/h – 9 μR/h) x 10 h/y)) to the portion of the skin of the whole body or to any organs situated directly in contact with the concrete with the highest measured exposure rate. A more likely scenario is from a person standing in the area for a period of several hours per year. The maximum net annual dose rate above background from this hypothetical activity would be approximately 3 μrem/y ((i.e., 10 μR/hr – 9 μR/h) x 3 h/y)) to the whole body, based upon the net measured exposure rate at a height of one meter and an exposure time of three hours. Both of the above dose scenarios are unlikely, in that the concrete rubble is not in an area where it would be desirable to spend any amount of time. In comparison to the exposure that an individual receives from natural background radiation (≈300 mrem/y), the calculated hypothetical doses of 40 μrem/y (0.04 mrem/y) and 3 μrem/y (0.003 mrem/y) are insignificant.

D. Surface Water Analyses

Surface water samples were collected upstream and downstream of the concrete on April 24, 1998. Sample results are summarized below in Table 5.4.

Table 5.4
Summary of Results – Surface Water Samples
(Results in pCi/L)

Location	Th-228	Th-232	U-234	U-235	U-238
Upstream (WAT-SUR-395)	0.5 ± 0.8	0.5 ± 0.6	0.9 ± 0.6	0.1 ± 0.2	0.1 ± 0.2
Downstream (WAT-SUR-396)	<0.7	0.3 ± 0.4	0.4 ± 0.7	<0.8	0.5 ± 0.5

The upstream and downstream surface water sample results show low concentrations of naturally occurring uranium and thorium. There is no significant difference between the upstream and downstream sample results. In addition, the samples do not indicate any significant difference from the historical data reported for surface water monitored within Reservoir #3. This confirms that the concrete is not contributing to the concentrations of these naturally occurring contaminants.

E. Gross Alpha and Gross Beta-Gamma Surface Activity Data

Gross beta-gamma and gross alpha scans were performed over the entire surface of concrete grids to determine the nature and extent of the activity. Gross alpha and gross beta-gamma surface activity data are summarized in Table 5.5.

TABLE 5.5
SUB-AREA "G" CONCRETE DEBRIS RESULTS SUMMARY

GRID #	AREA (m^2)	GROSS BETA-GAMMA NET READING (dpm/100cm2) AVE	GROSS BETA-GAMMA NET READING (dpm/100cm2) MAX	GROSS BETA-GAMMA (background subtracted) (dpm/100cm2) AVE	GROSS BETA-GAMMA (background subtracted) (dpm/100cm2) MAX	GROSS BETA-GAMMA (background subtracted) (dpm/100cm2) WT. AVE.	NET CONCENTRATION (pCi/g) AVE. OVER 3"	NET CONCENTRATION (pCi/g) WT. AVE.	GROSS ALPHA (dpm/100cm2) AVE	GROSS ALPHA (dpm/100cm2) MAX	GROSS ALPHA (dpm/100cm2) WT. AVE.	EXPOSURE RATE (uR/h) SURFACE	EXPOSURE RATE (uR/h) 1 METER
1A	12	650	2,000	-150	1,200	-9	-0.43	-0.03	40	380	2	10	10
2A	9	700	2,000	-100	1,200	-5	-0.29	-0.01	40	600	2	10	10
3A	11	700	2,500	-100	1,700	-6	-0.29	-0.02	40	400	2	10	10
1	1	2,600	8,300	1,800	7,500	9	5.19	0.03	450	2,000	2	9	9
2	2.5	3,100	8,300	2,300	7,500	29	6.63	0.08	120	800	2	9	9
3	4.5	3,000	8,000	2,200	7,200	51	6.34	0.15	240	1,200	6	9	9
4	2.5	1,000	4,000	200	3,200	3	0.58	0.01	160	1,000	2	10	9
5	2	800	3,000	0	2,200	0	0.00	0.00	160	1,200	2	10	9
6	4	2,100	7,000	1,300	6,200	27	3.75	0.08	80	600	2	9	9
7	5	2,320	26,000	1,520	25,200	39	4.38	0.11	160	1,200	4	13	10
8	4.5	2,400	13,000	1,600	12,200	37	4.61	0.11	60	400	1	10	9
9	4	900	4,300	100	3,500	2	0.29	0.01	160	800	3	10	9
10	3.5	1,070	15,000	270	14,200	5	0.78	0.01	60	600	1	9	9
11	3.5	3,300	11,000	2,500	10,200	45	7.21	0.13	100	800	2	9	9
12	3	1,400	6,000	600	5,200	9	1.73	0.03	60	600	1	10	9
13	3	1,000	6,000	200	5,200	3	0.58	0.01	50	400	1	10	9
14	2.5	900	3,000	100	2,200	1	0.29	0.00	80	440	1	11	9
15	2.5	700	3,000	-100	2,200	-1	-0.29	0.00	80	600	1	11	9
16	3.5	1,800	11,000	1,000	10,200	16	2.88	0.05	50	400	1	10	9
17	5	2,100	9,000	1,300	8,200	33	3.75	0.10	40	400	1	11	10
18	5.5	1,900	8,000	1,100	5,200	31	3.17	0.09	80	600	2	10	10
19	5	2,600	11,000	1,800	10,200	46	5.19	0.13	80	380	2	11	10
20	5	3,400	5,000	2,600	4,200	66	7.49	0.19	40	400	1	10	10
21	5	1,300	6,000	500	5,200	13	1.44	0.04	40	500	1	11	10
22	5.5	3,000	25,000	2,200	24,200	62	6.34	0.16	80	1,600	2	11	10
23	8	2,900	10,000	2,100	9,200	84	6.05	0.19	40	600	1	12	10
24	5.5	2,000	6,000	1,200	5,200	34	3.46	0.10	60	600	2	10	10
25	5	3,000	11,000	2,200	10,200	56	6.34	0.16	40	500	1	10	10
26	4	2,500	11,000	1,700	10,200	35	4.90	0.10	60	800	1	11	10
27	4.5	2,800	5,000	2,000	4,200	46	5.77	0.13	120	1,600	3	10	10
28	4.5	3,530	16,000	2,730	15,200	63	7.87	0.18	42	440	1	10	10
29	4.5	4,700	10,000	3,900	9,200	90	11.24	0.26	60	600	1	10	10
30	5	4,100	12,000	3,300	11,200	84	9.51	0.24	80	800	2	11	10
31	22.5	2,000	11,000	1,200	10,200	138	3.46	0.40	40	1,600	5	12	10
32	20	3,025	24,000	2,225	23,200	227	6.41	0.65	40	800	4	11	10

DATA SUMMARY

			Average Gross Beta-Gamma (background subtracted) Minimum	Maximum	Overall Ave.	WT. AVE.		Gross alpha Minimum	Maximum	Overall Ave.	WT. AVE.		Exposure Rate (uR/h) Minimum	Maximum	Average
Total # of Grids:	35														
Total Area (m^2):	196	dpm/100cm2:	-150	3900	1351	1343	dpm/100cm2:	40	2,000	89	67	Surface:	9	13	10.3
Est. Volume (m^3):	196	pCi/g U (3" ave.):	-0.43	11.24	3.90	3.87						1 meter:	9	10	9.6

NOTES:

1. Gross beta background for concrete = 800 dpm/100cm^2 (net).
2. Results reported in units of dpm/100cm2 unless otherwise indicated.
3. The thickness of the concrete was estimated by field personnel as 1m.
4. Numbers in ( ) are negative (i.e., net result was less than zero after background subtraction).
5. Background not subtracted from gross alpha results and exposure rate results.
6. Gross alpha background for concrete = 21 dpm/100cm^2 (net)
7. Exposure rate background = 9 uR/h.

Background subtraction was performed on the gross beta-gamma data to obtain the expected increase that is due to residual activity from facility operations. The minimum, maximum, average, and weighted average activity (dpm per 100 cm^2) was calculated for each of the grids containing concrete. The average volumetric concentration over the grids was then calculated using the relationship between gross beta-gamma surface activity and volumetric concentration that is presented in Section G.

The volumetric concentration calculation assumes that the average gross beta-gamma surface activity is representative of the grid area as a whole, and that there is equal probability of measurement of the residual activity on the most elevated side of the concrete as there is for measurement on the least elevated side, since the small pieces of rubble were placed into the drainage area in a random manner. In order to account for the probability for residual activity to exist on both the top and bottom sides of each concrete slab, the average thickness for the pieces of concrete debris was divided by two. Therefore, since the average thickness of the concrete debris was estimated to be six inches, the volumetric concentration was calculated over a thickness of three inches.

The maximum gross beta-gamma surface activity (concrete background subtracted) was found within concrete grid #7 which has one hot spot measuring 25,200 dpm/100 cm^2. The average surface contamination over the 1 m^2 area surrounding this hot spot was 4,200 dpm/100 cm^2. Using the conversion to volumetric concentration, the average equates to 12.1 pCi/g average total uranium concentration over the $1m^2$ area, assuming a thickness of 6 inches. This concentration is well below the BTP Option #1 guideline value. The overall average volumetric concentration calculated for the concrete was 3.9 pCi/g. Although the average concentration is slightly above typical background levels for concrete, these concentrations are similar to those found in uncontaminated concrete and natural soils, and are well below the BTP Option #1 criteria. Therefore, the health and safety significance of leaving the concrete in place is similar to the health and safety considerations for natural soils. The potential future uses of the concrete are limited by its portability and by the difficulty that would be experienced through attempts to remove it from the drainage areas. Therefore, it is anticipated that the any exposures to the concrete would be from casual contact or from its gradual erosion over time due to environmental forces.

Gross alpha survey data are also presented in Table 5.5. Data indicate that the concrete rubble would meet the current gross alpha guideline criteria of 5,000 dpm/100 cm^2 (average) and 15,000 dpm/100 cm^2 (maximum) for unconditional release (assuming that it was being applied). The gross alpha measurements indicate that the most elevated location had an activity of 2,000 dpm/100 cm^2, which is well below the unconditional release criteria for surface contamination.

The criteria proposed for release of the concrete is based upon volumetric concentration. The concrete rubble does not have any smearable contamination

and the activity would have to be removed through mechanical or physical forces. While it is probable that environmental forces will eventually act to disperse the radioactivity remaining in the concrete this will result in insignificant quantities available for ingestion or inhalation.

F. Estimation of Average Concrete Thickness and Volume

Based upon visual observations in the field, the average thickness of the concrete pieces was estimated to be 6 inches (15 cm), while the total thickness of the concrete has been estimated as 1 meter. The area of the concrete is 196 m^2 (see Table 5.5). Therefore, the volume of the concrete is estimated to be 196 m^3 (i.e., 196 m^2 x 1.0 m).

G. Volumetric Concentration Conversion Factor

A special study was performed as described in the FSSR for concrete rubble in Subarea F^{20} to determine a relationship between gross beta-gamma surface activity on the concrete (measured in dpm/100cm^2) and the volumetric concentration (measured in pCi/g) of total uranium. Using the method contained in the FSSR for Concrete Rubble in Subarea F, the average conversion factor from surface activity to concentration was determined to be 347 dpm/100 cm^2 per pCi/g total uranium.

H. Volumetric Concentration Calculations

Calculation of the estimated volumetric concentration (in pCi/g total U) was performed by multiplying the conversion factor described in Section G times the measured gross beta-gamma surface contamination measurement (with background subtracted). These calculations, which are summarized in Table 5.5, resulted in average grid total uranium concentrations (after background subtraction) ranging from –0.4 pCi/g to 11.2 pCi/g. The negative results indicate that the grid average was less than 1.5 pCi/g (background). In these cases, subtraction of the 800 dpm/100cm^2 concrete background thus resulted in a value that was less than average background. Assuming a normal distribution of a background distribution, one half of the samples collected would be expected to be less than background.

The maximum grid average total uranium concentration was 11.2 pCi/g (grid #29). This concentration is approximately 40% of the guideline value of 30 pCi/g above background. The average total uranium concentration for the concrete sample was 3.9 pCi/g, which is 13% of the guideline value for enriched uranium (30 pCi/g). A "weighted average" concentration also was calculated to normalize the data in order to account for the volume differences between grids. The weighted average concentration was also 3.9 pCi/g. Therefore, the data indicate that the concrete in Subarea G falls well within the guideline value.

I. Source Term Calculation

The average and weighted average volumetric concentration for the random sample was calculated to be 3.9 pCi/g. Since the volume of concrete is known, an estimate of the total activity of uranium present in the concrete can be calculated as follows:

Total activity = (3.9 pCi/g-concrete) x (1.8 g-concrete/cm^3) x 10^6 cm^3/m^3 x 196 m^3 concrete

= 1.4 E+9 pCi = 1.4 E–3 Ci Total Uranium.

J. Pathway Analysis

The RESRAD computer code was used to evaluate the potential dose due to leaving the concrete in place. The RESRAD code considers direct radiation, inhalation of resuspended radioactivity, ingestion of groundwater and foodstuffs grown in contaminated soils, or in soils irrigated with contaminated surface or ground water, and all other credible pathways. The RESRAD model generally will predict a more conservative dose (i.e., a higher dose) than that which could potentially be received, as it generally utilizes conservative assumptions and includes scenarios for use of the land area that are generally not consistent with the expected uses for concrete rubble.

The input parameters for RESRAD include those defined in NRC's Policy and Guidance Directive (PG) 8-08, "Scenarios for Assessing Potential Doses Associated with Residual Activity"[53]. The uranium isotopic ratios were chosen to be the same as those used by the NRC for the "Environmental Assessment Associated with the BTP Option #2 Onsite Disposal Cell at Cimarron"[54], which were U-234 (79%), U-235 (1.7%), and U-238 (20%). The selected density for the concrete was 1.8 g/cm^3. The calculated area of the contaminated zone is 196 m^2, while the estimated thickness is 1.0 m. The previously established erosion rate of 10 mm/150y (i.e., 6.7E-5 m/y) was utilized for the concrete[20].

The RESRAD computer code calculated maximum dose rate (all pathways) will occur immediately (i.e., at t = 0 years) and will result in a maximum hypothetical annual dose to the resident of approximately 0.6 millirem per year. A calculation also was performed to conservatively determine an upper estimate of the dose due to inhalation of any resuspended material from the concrete. The extremely conservative RESRAD default mass loading variable of 200 $\mu g/m^3$ was utilized. In addition, an assumption was made that all of the radioactivity in the concrete was within the top 1/8 inch of the exposed surfaces. This assumption resulted in an average calculated concentration of 93.6 pCi/g in the uppermost 1/8 inch layer of concrete. This is equivalent to the average concentration previously calculated for the three inch layer of concrete rubble (i.e., 3.9 pCi/g) multiplied by a factor of 24 to account for the fact that all of the activity is concentrated in the uppermost layer. Based upon the above assumption, the RESRAD code calculated an

inhalation dose of 0.2 mrem/y. A printout of the parameters used and results of the RESRAD calculations are provided in Appendix 3C.

5.2.2.4 Drainage Depth Data

For the subsurface sampling survey, soil samples were collected at 106 5m x 5m grid intersects at the locations shown on Drawing No. 99POSGDDSS-0. Samples were collected and composited at intervals of 0-6", 6"-1', 1'-2', 2'-3', and 3'-4'.

A total of 447 FSS soil samples were collected for analysis with soil sample analytical results ranging from 3 pCi/g to 21 pCi/g total uranium. The mean value for all samples was 9.0 pCi/g total uranium, with a standard deviation of 3.0 pCi/g. The 95% confidence level value was 9.2 pCi/g total uranium, which is below the guideline value of 30 pCi/g total uranium above background. The sample analytical results are listed in tables included in Appendix 3D. The soil sample locations are shown on Drawing Nos. 99POSGDDSS-0 through 99POSGDDSS-4, which are included in Appendix 3D. Also, the soil sample analytical results for this subarea showed natural thorium ranging from 0.4 pCi/g to 2.4 pCi/g. The mean value was 1.2 pCi/g natural thorium, with a standard deviation of 0.4 pCi/g natural thorium. The statistical analyses and data tables for both uranium and natural thorium are included in Appendix 3D.

Systematic surveys were performed during the FSS at the 5m x 5m sample locations with 3" x 0.5" shielded and unshielded NaI detectors and the μR meter. The exposure rates at the surface and at one meter above the surface, as measured using the μR meter, were 7 μR/h to 15 μR/h, with the mean being 11 μR/h and from 8 μR/h to 15 μR/h, with the mean being 11 μR/h, respectively. All measured exposure rates were below the guideline value of 19 μR/h (i.e., 10 μR/h above the background of 9 μR/h). The exposure rate data tabulation is included in Appendix 3D. The ground level NaI detector survey results for the sample locations ranged from 4,920 CPM to 11, 300 CPM for the unshielded detector and from 2,570 CPM to 5,510 CPM for the shielded detector. All survey results were less than twice background. The survey results are included in Appendix 3D.

5.2.3 Survey Data – Unaffected Open Land Areas

All remaining areas not classified affected within Subarea G were classified unaffected and surveyed as such. The unaffected area is shown on Drawing No. 99POSGUNSS-0. This drawing is located in Appendix 4A. This section evaluates the data collected from the 10% scan of the unaffected area and the systematic survey performed at the random grid intersect locations. The 10% NaI scan that was performed prior to the systematic surveys did not identify any locations that exceeded twice background.

5.2.3.1 Unaffected Area Surface Data

For the systematic surveys, surface soil samples were collected from the unaffected area at the locations noted on Drawing No. 99POSGUNSS-0. The soil sample analytical results all were below the total uranium guideline values (i.e., 11.5 pCi/g which requires

further evaluation or 26.5 pCi/g which requires that an unaffected area be reclassified as an affected area).

For the unaffected area surface sampling event, a total of 103 samples were collected and analyzed for total uranium. The soil analytical results varied from 1.8 to 11.4 pCi/g total uranium, with a mean of 6.3 pCi/g. The standard deviation for this data set was 2.0 pCi/g total uranium with a 95% confidence level value of 6.7 pCi/g total uranium. Also, the soil sample analytical results showed natural thorium varying from 0.5 to 1.8 pCi/g. The mean value was 1.2 pCi/g natural thorium with a standard deviation of 0.3 pCi/g natural thorium.

The systematic surveys performed with the unshielded NaI detector, and the μR meter were all within guideline values. The dose rates at the surface and at one meter above the surface both ranged from 6 μR/h to 14 μR/h, with a mean of 10.0 μR/h. The exposure rates are presented in tables included in Appendix 4A. All measured exposure rates were below the guideline value of 19 μR/h. The unshielded NaI detector survey results for the 103 grid intersect soil sample locations ranged from 3,466 CPM to 10,546 CPM with a background of 7,800 CPM. All survey results were less than twice background. Survey locations and results are presented in tables included in Appendix 4A.

5.2.3.2 Unaffected Area Depth Data

For the subsurface sampling, soil samples were collected at 10 5m x 5m grid intersect locations. Samples were collected and composited at depth intervals of 0-6", 6"-1', 1'-2', 2'-3', and 3'-4'. A total of 34 FSS soil samples were collected for analysis with soil sample analytical results ranging from 1.8 to 9.9 pCi/g total uranium. The mean value for all samples was 6.6 pCi/g total uranium, with a standard deviation of 1.8 pCi/g. The 95% confidence level value was 7.1 pCi/g, which is below the guideline value for total uranium. The soil sample locations are shown on Drawing No. 99POSGUNSS-1 which is included in Appendix 4B. Also, the soil sample analytical results for this subarea showed natural thorium ranging from 0.3 pCi/g to 1.8 pCi/g. The mean value was 1.2 pCi/g natural thorium, with a standard deviation of 0.4 pCi/g thorium. The statistical analyses and data tables for both total uranium and natural thorium are included in Appendix 4B.

The systematic surveys performed at the 10m grid locations with the 3" x 0.5" unshielded NaI detector and the μR meter were all within guideline values. The exposure rates at the surface and at one meter above the surface as measured using a μR meter ranged from 8 μR/h to 15 μR/h, with the mean being 12 μR/h, and from 8 μR/h to 14 μR/h, with the mean being 11 μR/h, respectively. All measured exposure rates were below the guideline value of 19 μR/h (i.e., 10 μR/h above the average background of 9 μR/h). The exposure rates are presented in tables included in Appendix 4B. The ground level unshielded NaI detector survey results for the 5m linear grid sample locations ranged from 7,522 CPM to 11,182 CPM. All survey results were less than twice background. The 3" NaI survey results are presented in tables included in Appendix 4B.

5.3 QA/QC Procedures

Cimarron Corporation's Quality Assurance Plans and Procedures are an integral part of the overall site decommissioning program and include off-site independent isotopic analysis of split samples. For the soil activity ranges that apply to this final status survey and for soil samples collected during the time frame that the survey data was being generated, a total of fifteen soil samples were split and sent off-site for analysis. The soil samples were first analyzed using the on-site counter prior to being packaged and sent off site for analysis at an independent laboratory. The independent laboratory for this project was Core Laboratories and they participate in a national inter-comparison quality assurance program. The results for both off-site and on-site analysis are listed in Table 5.6. These sample results show good agreement.

The data that was included in Table 5.6 represented soil samples with activities in the ranges that apply to the Subarea "G" FSS and also for samples collected during the time frame that the survey data for Subarea G was being generated. The data presented in this Table happened to be generated from samples collected outside Subarea G from other areas of the site or areas near the site. The first letter designation (i.e., "N", "J", "I", etc.) for the sample number included in Table 5.6 indicates the subareas where the samples were collected. Table 5.6 soil data are provided as examples of the success of Cimarrons's Quality Assurance Procedures by showing agreement between analysis from the on-site soil counter and those of an independent laboratory.

Table 5.6
Subarea G – QA/QC Comparisons

Sample ID No.	Cimarron (pCi/g Total-U)	Core Lab (pCi/g Total–U)
GU-111	8.0 ± 3.5 pCi/g	2.4 ± 0.9 pCi/g
GU-31	13.6 ± 6.9 pCi/g	8.1 ± 1.5 pCi/g
GU-48	6.5 ± 2.4 pCi/g	2.6 ± 0.7 pCi/g
GD-05	27.4 ± 2.5 pCi/g	29.0 ± 7.9 pCi/g
GU-555	17.1 ± 2.4 pCi/g	18.1 ± 4.2 pCi/g
GU-682	18.7 ± 2.3 pCi/g	18.6 ± 4.6 pCi/g
GU-17	14.4 ± 2.2 pCi/g	12.5 ± 2.6 pCi/g
GU-22	3.1 ± 1.5 pCi/g	0.6 ± 0.5 pCi/g
GU-40	4.4 ± 2.0 pCi/g	0.7 ± 0.5 pCi/g
GU-45	5.0 ± 1.7 pCi/g	1.3 ± 0.7 pCi/g
GU-53	8.0 ± 1.8 pCi/g	3.4 ± 1.2 pCi/g
GD-647	6.5 ± 1.6 pCi/g	7.2 ± 3.6 pCi/g
GD-654	12.9 ± 1.6 pCi/g	11.5 ± 4.8 pCi/g
GA-245	8.1 ± 1.6 pCi/g	3.0 ± 2.4 pCi/g
GA-219	25.0 ± 1.8 pCi/g	24.3 ± 7.0 pCi/g

6.0 SUMMARY

A FSS was performed in accordance with the NRC approved Phase II FSSP and Decommissioning Plan, and the SWP and WP approved by Cimarron Management for Subarea G. This report presents a comparison of the FSS results to the guideline values for affected and unaffected areas at the Cimarron site. The comparisons presented herein demonstrates that all guideline values for unrestricted release have been met and thus Subarea G can now be released from License SNM-928. Therefore, this report is being submitted to the NRC in conjunction with a request to release Subarea G from License SNM-928 for unrestricted use.

7.0 APPENDICES

- Appendix 1 Drawings 95MOST-RF3

- Appendix 2 Affected Area Roadway

  A. Surface Centerline Roadway – Data Tabulation Sheets, Statistical Analyses, and Drawings
  B. Expanded Roadway North of WP#2 – Data Tabulation Sheets, Statistical Analyses, and Drawings
  C. Roadway Depth - Data Tabulation Sheets, Statistical Analyses, and Drawings

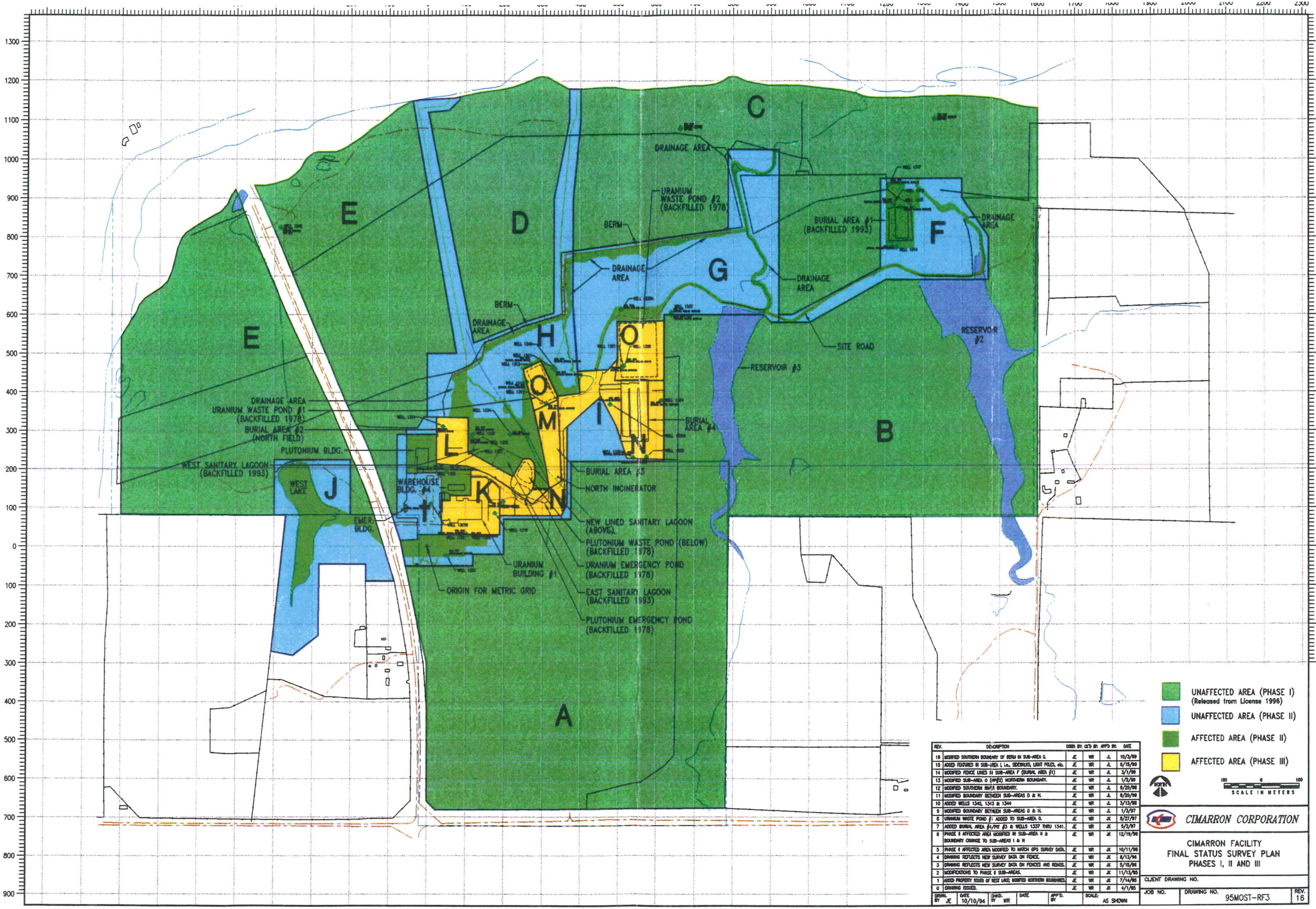
- Appendix 3 Affected Area Drainage

  A. Drainage Centerline Surface – Data Tabulation Sheets, Statistical Analyses, and Drawings
  B. Expanded Drainage Area – Data Tabulation Sheets, Statistical Analyses, and Drawings
  C. Reservoir #3 Spillway - Data Tabulation Sheets, Statistical Analyses, and Drawings
  D. Drainage Depth – Data Tabulation Sheets, Statistical Analyses, and Drawings

- Appendix 4 Unaffected Area

  A. Unaffected Area Surface – Data Tabulation Sheets, Statistical Analyses, and Drawings
  B. Unaffected Area Depth – Data Tabulation Sheets, Statistical Analyses, and Drawings

APPENDIX 1 – DRAWINGS 95MOST-RF3



REV.	DESCRIPTION	DRWN BY:	CK'D BY:	APP'D BY:	DATE
16	MODIFIED SOUTHERN BOUNDARY OF AREA M SUB-AREA G.	JE	WR	JL	10/5/99
15	ADDED FEATURES IN SUB-AREA L i.e., SIDEWALKS, LIGHT POLES, etc.	JE	WR	JL	6/15/99
14	MODIFIED FENCE LINES IN SUB-AREA F (BURIAL AREA #1)	JE	WR	JL	3/1/99
13	MODIFIED SUB-AREA O (##/##) NORTHERN BOUNDARY.	JE	WR	JL	1/5/99
12	MODIFIED SOUTHERN RIVER BOUNDARY.	JE	WR	JL	9/29/98
11	MODIFIED BOUNDARY BETWEEN SUB-AREAS D & H.	JE	WR	JL	9/29/98
10	ADDED WELLS 1342, 1343 & 1344	JE	WR	JL	3/13/98
9	MODIFIED BOUNDARY BETWEEN SUB-AREAS G & H.	JE	WR	JL	1/5/97
8	URANIUM WASTE POND #1 ADDED TO SUB-AREA O.	JE	WR	JL	8/27/97
7	ADDED BURIAL AREA #4/PIT #3 & WELLS 1337 THRU 1341.	JE	WR	JL	5/2/97
6	PHASE II AFFECTED AREA MODIFIED IN SUB-AREA N & BOUNDARY CHANGE TO SUB-AREAS I & N	JE	WR	JL	12/19/96
5	PHASE II AFFECTED AREA MODIFIED TO MATCH GPS SURVEY DATA.	JE	WR	JL	10/11/96
4	DRAWING REFLECTS NEW SURVEY DATA ON FENCE.	JE	WR	JL	6/13/96
3	DRAWING REFLECTS NEW SURVEY DATA ON FENCES AND ROADS.	JE	WR	JL	5/15/96
2	MODIFICATIONS TO PHASE II SUB-AREAS.	JE	WR	JL	11/13/95
1	ADDED PROPERTY SIZES OF WEST LAKE, MODIFIED NORTHERN BOUNDARIES.	JE	WR	JL	7/14/95
0	DRAWING ISSUED.	JE	WR	JL	4/1/95

DRWN. BY: JE | DATE: 10/10/94 | CHKD. BY: WR | DATE | APP'D. BY | SCALE: AS SHOWN

CIMARRON CORPORATION

CIMARRON FACILITY
FINAL STATUS SURVEY PLAN
PHASES I, II AND III

CLIENT DRAWING NO.

JOB NO. | DRAWING NO. 95MOST-RF3 | REV. 16