HOMESTAKE MINING COMPANY
P.O. BOX 98
GRANTS, NEW MEXICO 87020
(505) 287-4456

December 18, 1995

1/4/96 conversation w/Craft
~1000 acres final survey
90 days used CRFS report

NEXT DAY AIR TRACKING LABEL
DELIVERY CONFIRMATION REQUEST

U.S. Nuclear Regulatory Commission
Division of Waste Management, MST7J9
Attn. Mr. Joseph J. Holonich, Chief
High Level Waste and Uranium
Recovery Projects Branch
11555 Rockville Pike
Rockville, MD 20850

Re: Docket No. 40-8903
License No. SUA-1471 Completion Report for Soil Cleanup and Verification

Dear Mr. Holonich:

As per condition 29F of License SUA-1471, the Completion Report documenting the cleanup activities, and providing results of all soil sampling and gamma surveys conducted to verify the adequacy of cleanup is attached. Also, as per condition 29F of License SUA-1471 the Completion Report is required to be submitted 90 days following verification. This condition is met, as the final verification was completed September 20, 1995.

This Completion Report demonstrates that the areas have been decontaminated to the 10 CFR Part 40, Appendix A criteria. I will also, point out that we tested soils beyond the scraped areas, so as to increase our level of confidence that the site meets 10 CFR Part 40, Appendix A criteria. Should you have any questions please contact me at (505)287-4456.

Sincerely,

F.R.Craft
Resident Manager

Attachments(2 sets)

xc: H. Barnes (1 set)
S. Collins, NRC (1 set)

Drawings listed in Central Files

NMSS/1

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill

Grants Operation

License No. SUA-1471

November 1995

Prepared for:

Homestake Mining Company of California
Grants Operations
P. O. Box 98
Grants, NM 87020

Prepared By:

Environmental Restoration Group, Inc.
12809 Arroyo de Vista NE
Albuquerque, NM 87111

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LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company Uranium Mill

Grants Operation

1. Introduction

Homestake Mining Company of California (HMC), owner of the uranium mill near Grants, New Mexico, has completed the reclamation of the off-pile areas in compliance with the NRC-approved Reclamation Plan (HMC, 1993a) and the Radioactive Materials License Conditions (SUA-1471). The uranium mill facilities were decommissioned in 1994 and 1995 according to the Decommissioning Plan, as approved by the NRC as License Condition No. 29. Byproduct contaminated asbestos containing material was placed in the Large Tailings Pile. Mill debris containing process residues or yellowcake contamination was placed in the Large Tailings Pile. Structures and other less contaminated debris were placed in pits on the east and south side of the Large Tailings Pile. Mill site surface soils containing the majority of the radiological source term were removed and placed on the tailings pile. A clean soil cover was then placed over the entire 50-acre mill site. A report on the decommissioning of the mill and reclamation of the mill site is currently being prepared for submittal to the NRC (HMC, 1995a).

The cleanup of the windblown contaminated soils began early in 1988. A February 16, 1989 plan approved by the NRC as License Condition No. 19 committed HMC to remediate certain areas near the tailings piles that exceeded the 10.5 pCi/g cleanup criteria for Ra-226. After the mill decommissioning was complete, cleanup of the windblown contamination and other off-pile contaminated materials resumed in 1993 using cleanup criteria and verification procedures specified in License Condition 29C. Areas that were to be covered with clean materials were verified according to the NRC-approved procedure applicable at the time. Cleanup continued throughout 1994 and 1995 with the final verification completed on September 20, 1995. A new verification plan was approved by the NRC on March 1, 1995 and used for the verification of cleanup for the major portion of the decontaminated areas.

Figure 1-1 shows the Mill Site and Tailings Features as they currently exist. The Large Tailings Pile currently has radon barrier and an erosion protection layer placed on the side slopes according to the NRC-approved reclamation plan. The top of the pile currently has an interim cover and is awaiting final settlement before radon barrier placement. Evaporation Pond No. 1 was built on the small tailings pile. The new Evaporation Pond No. 2 was constructed in the spring of 1995.

Areas of the site currently used for activities associated with the groundwater restoration project include the collection ponds and evaporation ponds. Evaporation Pond No. 2 was placed on an area that had been decontaminated to meet the cleanup criteria. This pond along with the older collection ponds and Evaporation No. 1 will be decommissioned after the groundwater restoration project has been completed. All liners and contaminated residues and soils will be placed in Evaporation Pond No. 1 on the small tailings pile. Upon decommissioning, these off-

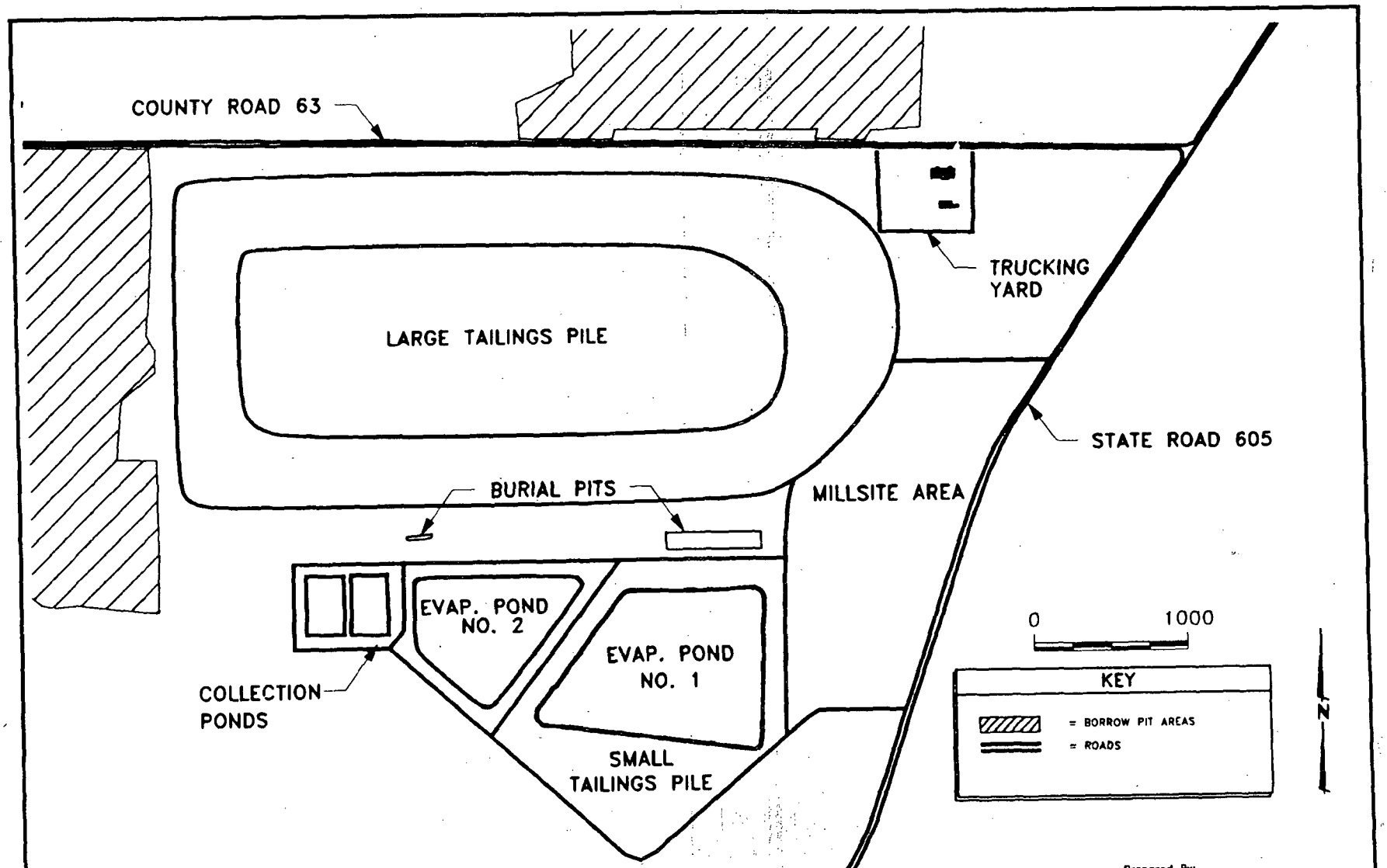

Figure 1-1 Homestake Mining Company Millsite-Current Grants Operations Site Facility

pile areas will be resurveyed and verified as meeting the soil cleanup criteria. The Small Tailings Pile will then be reclaimed according to 10 CFR Part 40, Appendix A.

Other areas shown on the map that do not require verification are the borrow areas where several feet of borrow material have recently been removed. Prior to removal, some decontamination of the surface layer occurred by removal and placement on the top of the tailings pile. Surface soil samples were taken to assure that the area was suitable as a borrow source for radon barrier material. The characterization data are presented in Section 5.0. Additional confirmation that the borrow material was not contaminated with windblown tailings was presented in Table 3-1 of the report, Final Radon Barrier Design for the Large Tailings Pile (HMC, 1995b).

This report consolidates all data taken over the three-year reclamation period to demonstrate that the areas have been decontaminated to the 10 CFR Part 40, Appendix A criteria. During the reclamation period, new technology became available that enabled site characterization and verification data to be obtained in a much more accurate and less costly manner than had been used previously. Verification plans were developed based on this technology and approved by the NRC. For work completed prior to the new technology, the areas were verified using the plan that was approved at that time. Therefore this report includes data for areas verified using the two different verification methods.

2. Cleanup Criteria

The soil cleanup criteria for the site are specified in 10 CFR Part 40, Appendix A, Criterion 6. The Ra-226 cleanup for land, averaged over 100 m^2, may not exceed the background concentrations by more than 5 pCi/g in the top 15-cm layer beneath the surface. For 15-cm layers more than 15 cm below the surface, the average Ra-226 concentration is limited to 15 pCi/g above natural background levels. For areas not meeting the soil cleanup limits, the radon emissions must be limited to 20 pCi/m^2s and the area must meet the criterion for longevity of stabilization.

The NRC-approved Ra-226 background concentration for the site is 5.5 pCi/g which was incorporated in the cleanup criteria in Amendment No. 15 of License SUA-1471. Therefore the cleanup criteria for the HMC site limits the Ra-226 concentration to 10.5 pCi/g and 20.5 pCi/g for the surface and subsurface 15-cm thick layers, respectively.

3. Verification Procedures

3.1 Verification Procedure Based on Soil Samples and Gamma Measurements at Grid Intersection Points

The verification procedure used in the initial verification activities was based on License Condition No. 39 of License Amendment No 15 (NRC, 1993). Two areas were identified as shown in Figure 3-1. Within the line shown in the figure, the verification plan called for soil samples to be collected at a minimum of every 50-meter grid point and gamma-ray measurements made at ground level at every 10-meter grid point. Outside the boundary, soil samples were to be collected at every 100-meter grid point with the gamma measurements made at every 10-meter grid point. This procedure was implemented for those areas verified prior to March 1, 1995 at which time the NRC approved a new procedure (NRC, 1995) based on the use of the Global Positioning System (GPS)-based radiological surveys and soil samples as discussed below. This was approved in License Amendment No. 20.

A slight modification to the procedure approved as License Amendment No. 15 was implemented for the road ways. The modification was necessary since the roadways were long narrow strips of land which did not lend themselves to the 50-meter grid for soil sampling. This modified procedure was approved for use in the roadways as a part of License Amendment No. 20.

The License Amendments and Procedures for verifying the off-pile areas are included as Appendix A.

3.2 Verification Procedure Using Global Positioning System-Based Gamma Surveys and Soil Samples

The Global Positioning System(GPS)-based radiological surveys generate high density gamma survey data with relative ease since the gamma data are recorded automatically every two seconds along with the corresponding location coordinates. Studies were done to correlate the gamma-ray count rate data to the Ra-226 concentration in soil. Action levels were developed based on the gamma data to indicate where additional cleanup was required. After all cleanup was completed, the area was resurveyed according to the following procedure approved for use by the NRC (NRC, 1995).

Two zones were considered for soil verification purposes with different approaches taken for each zone. The inner zone encompasses the area in the immediate vicinity of the large and small tailings piles and mill site as shown in Figure 3-2. All surface soil within the inner zone excluding the tailings piles, the two debris disposal pits, and the mill site are included in the inner zone. All areas noted as excluded have or will be covered with fill or radon barrier as indicated in the NRC-approved Reclamation Plan. This inner zone has a higher probability of the existence of localized contaminated areas and is also influenced by gamma-ray shine from the small tailings pile. The outer zone includes all of the area outside of the inner zone that has

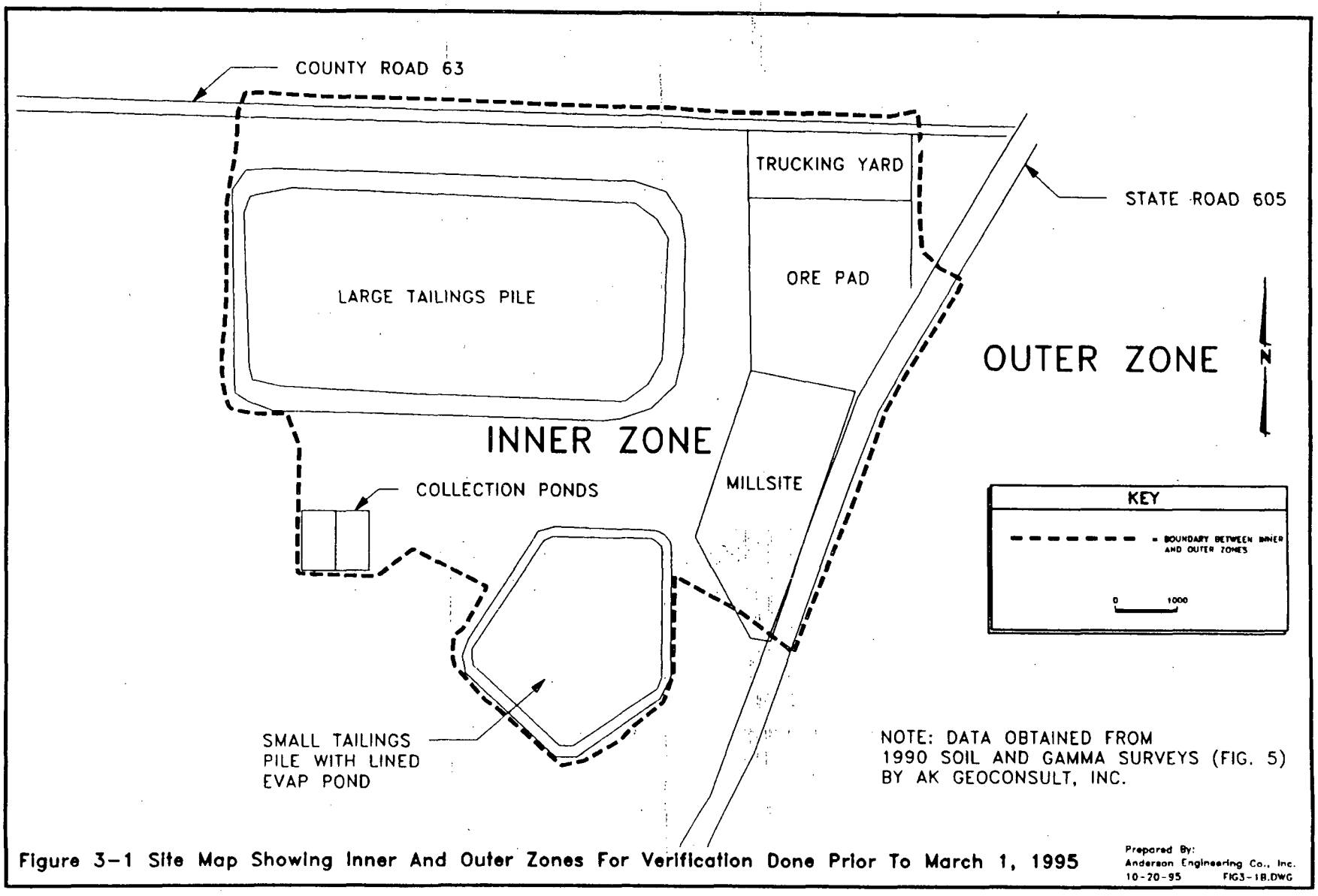

Figure 3-1 Site Map Showing Inner And Outer Zones For Verification Done Prior To March 1, 1995

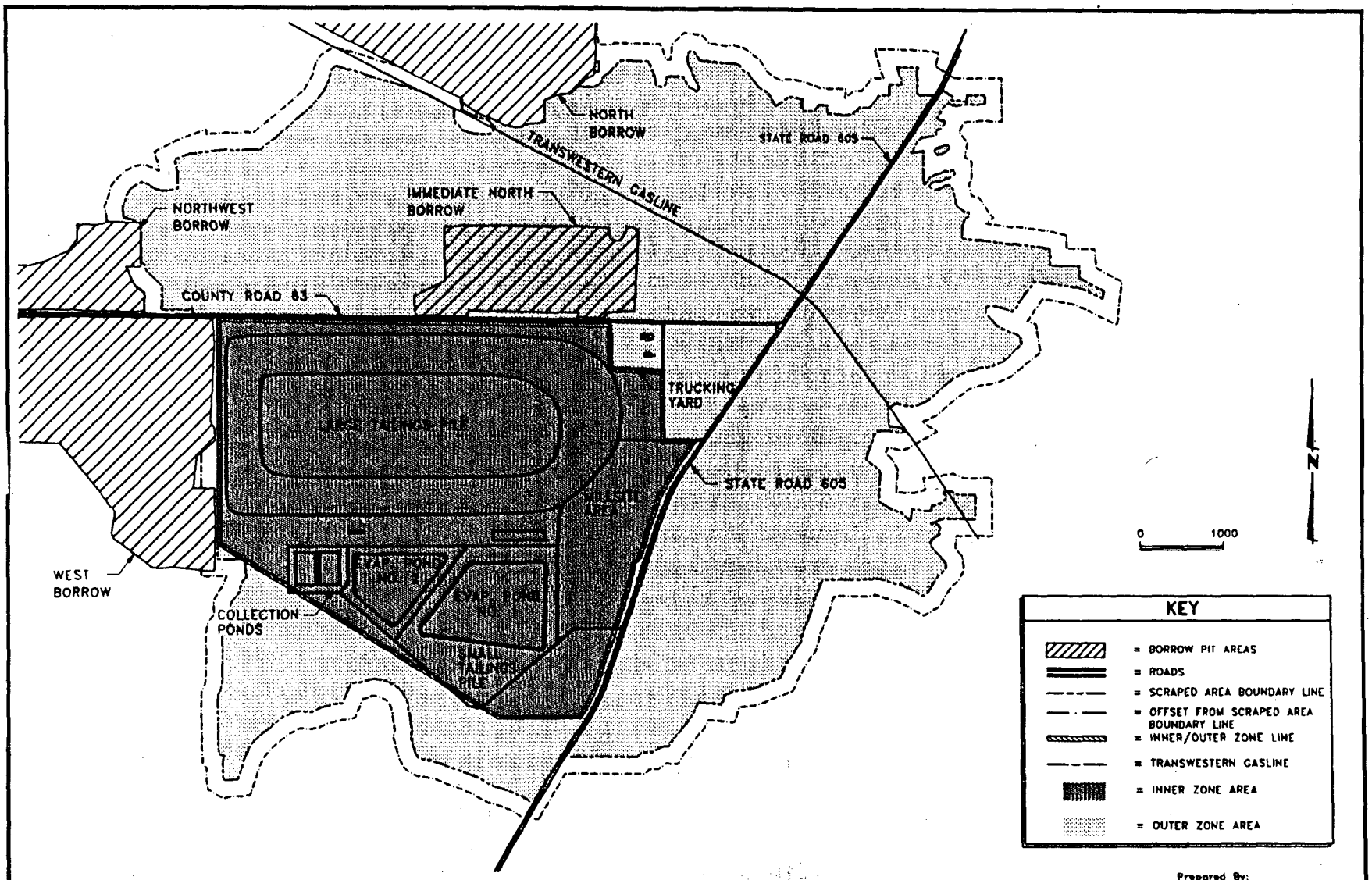

Figure 3-2 Site Map Showing The Inner And Outer Zones For Verification Done After March 1, 1995

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG3-2.DWG

been affected by windblown tailings or ore dust. The outer zone is more homogeneous in that the characteristic size of contaminated areas was normally hundreds of meters across. Because of the difference in the two zones, individual verification plans were prepared for each zone.

For the inner zone, a GPS-based gamma survey was conducted to assure that all 100-m^2 areas had an average count rate of less than 28,000 cpm. If gamma shine from the uncovered small tailings pile did not allow removal to the 28,000 cpm action level to be achieved, the entire area above 28,000 cpm was divided into 100-m^2 grids and sampled using a five point composite sample and analyzed for Ra-226. All other areas were divided into 500-ft grids. The gamma survey map was used to identify the 100-m^2 grid block within each 500-ft by 500-ft grid having the highest average gamma count rate. A five point composite sample was prepared for each grid block by taking 6-inch deep surface samples. The NRC-approved procedure provided for areas exceeding the 10.5 pCi/g Ra-226 cleanup criterion to be further excavated and a new gamma survey done. If any sampled area required additional decontamination, the second highest area within the grid block was to have been sampled and evaluated. This procedure was to have been followed until it was evident that the entire 500-ft grid block meets the cleanup criterion of 10.5 pCi/g.

For the outer zone, beginning at the closest point near the northwest corner of the Large Tailings Pile (but within the outer zone), 500-ft grids were established in an easterly direction extending to the State Highway 605. All areas had been cleaned so that the average gamma reading for any area of 100-m^2 size was 21,000 cpm or less. The 100-m^2 grid block within each 500-ft by 500-ft grid block having the highest average gamma reading was sampled and analyzed for Ra-226. A five-point composite sample was prepared from each of 30 five hundred-ft grids from the north side of the Large Tailings Pile. An additional 10 grids were sampled in a similar manner from each of the areas in the southerly direction and easterly direction at the boundary of the inner zone and outer zone.

A statistical test was specified to determine whether the mean concentration of the 50 grid blocks is 10.5 pCi/g or less at the 95 per cent confidence level using equation 8-13 of NUREG/CR-5849. Since this represents the mean of a set of 50 biased samples (selected from the grid that has the highest gamma exposure rate), the passing of this test provides assurance that the error rate is very low for the entire sample set made up of all the possible grids that could have been sampled.

If any sample was found to exceed the 10.5 pCi/g limit, the area was to have been recleaned and a new gamma survey done. For any grid block that failed the 10.5 pCi/g criterion, the 100 m^2 grid block with the second highest average gamma reading was to have been sampled and analyzed in a similar manner. This procedure was to have been followed until it was evident that there is a high probability that all portions of the grid block meets the cleanup criteria.

If the data passed the statistical test (equation 8-13 of NUREG/CR-5849), HMC was allowed to establish 1000-ft grids for the remaining portion of the outer zone. The 100-m^2 grid block having the highest average count rate within each 1000-ft grid was then sampled and analyzed

for Ra-226 in a manner as described above. Equation 8-13 of NUREG/CR-5849 was used for this set of samples to demonstrate compliance with the desire to clean all grid blocks to meet the 10.5 pCi/g cleanup criterion with a low error rate.

The test provided for the situation where if the mean of the samples is less than the 10.5 pCi/g criterion but the data fails the statistical test, HMC would follow procedures similar to those recommended in Section 8.6 of NUREG/CR-5849. The number of samples would have been increased to include the grids with the second highest average gamma levels and again perform the statistical test. This could have been done until the statistical test is met. In any case, all grid blocks that were sampled and measured to exceed the 10.5 pCi/g were to have been recleaned and resurveyed.

If the statistical test for the samples from the highest samples within the 1000-ft grid blocks would have failed, HMC would have established 500-ft grids over the entire outer area and sampled the 100-m^2 grid block lying to the northeast of each 500-ft grid line intersection. The northeast grid was proposed to assure that no bias was factored into the sampling strategy.

The gamma-ray count rate from the GPS-based radiological survey equipment is recorded once every 2 seconds and represents an average count rate over the field of view of the detector (placed 18 inches above the ground surface). The fact that the detector is moving slowly along the traverses also indicates that the count rate is influenced by the count rate behind the moving system. Therefore, each number represents an average over an area with dimensions of approximately 3 meters by 2 meters, or approximately 6 square meters. In order to obtain a good estimate of the mean gamma count rate for a large area, fewer measurements are required compared to point measurements since each number represents an average over a rather large area.

The density of measurements within any 100 m^2 grid block averaged between 8 and 9. However the uniformity of data depends on operator skill and topography. In some cases, areas on maps may have as few as 5 or 6 records. Homestake reviewed all data maps and where the density was considered too low to assure a good average gamma level, additional data were obtained and added to the data base. For the outer zone where gamma levels are uniform and slowly varying, as few as 5 records were considered adequate; for the inner zone where the characteristic size of contaminated areas may be smaller, a minimum of 7 records per 100 m^2 was considered adequate.

The verification procedure has been included in Appendix A.

4.0 Site Coordinate Systems

The major coordinate system used by HMC for the site is expressed in State Plane Coordinates. However, in the expression of sampling points and grids it is normally desirable to adopt naming conventions for points and grid blocks. During the initial cleanups and verification where the verification plan was based on the soil samples taken at grid intersection points as described in Section 3.1, the nomenclature shown in Figure 4-1 was used to reference points. Three points were established, A, B, and C as shown. The numerical increments to the north, south, east, and west represent 300 feet. A point directly north of point "C" at a distance of 300 ft is labeled CN1.0. Each 300 feet segment is divided into 100 feet segments. A point 100 feet north of point CN1.0 is CN1.1, a point 200 feet north of CN1.0 is CN1.2, and a point 300 feet north of CN1.0 is CN2.0. Similarly, points in the three other directions are similarly referenced and may be referenced relative to point A, B, and C. The only exception to this is CW7.0, CW8.0, and CW9.0 which lie on even increments of 100 feet from point C as shown in Figure 4-1 but do not follow the 300-ft unit convention described above. The only place that these references were used, however, is in the cleanup of the mill site which is not addressed in this report. Points off the principal axes are referenced using the conventional (x,y) coordinate nomenclature, where x and y are defined above.

The coordinate labeling convention described above was not used for the areas where the GPS radiological surveys were performed. For ease in computerized data management, the state plane coordinates were used for all gamma data recorded. All grid blocks were referenced by the coordinates of the northwest corner, regardless of size. Grid blocks were named according to the convention shown in Figure 4-2. Major grid lines one thousand feet apart were created from north to south and east to west across the site corresponding to thousand feet increments of state plane coordinate system grid spacing. The East-West rows were labeled from A to L while the North-South columns were labeled from 1 to 15. Each 1000-ft by 1000-ft grid block is named by its row and column position such as E02. If the major grid block as shown in Figure 4-2 is E02, then it can be seen that E02 is divided into four 500-ft square grid blocks, E021, E022, E023, and E024. These 500-ft grid blocks are further divided into 100-ft square grid blocks as seen in the figure. Reference to these 100-ft grid blocks shown in the figure would be E02401, E02402,... E02425. Further subdividing into the 33.3-ft square grid blocks would be done by adding the respective number of the 33.3-ft square grid block as given in the figure. The use of 33.3-ft grid blocks for verification was used since the area is approximately 100 m^2 which relates to the cleanup criteria which averages the Ra-226 and gamma count rate over areas of 100 m^2.

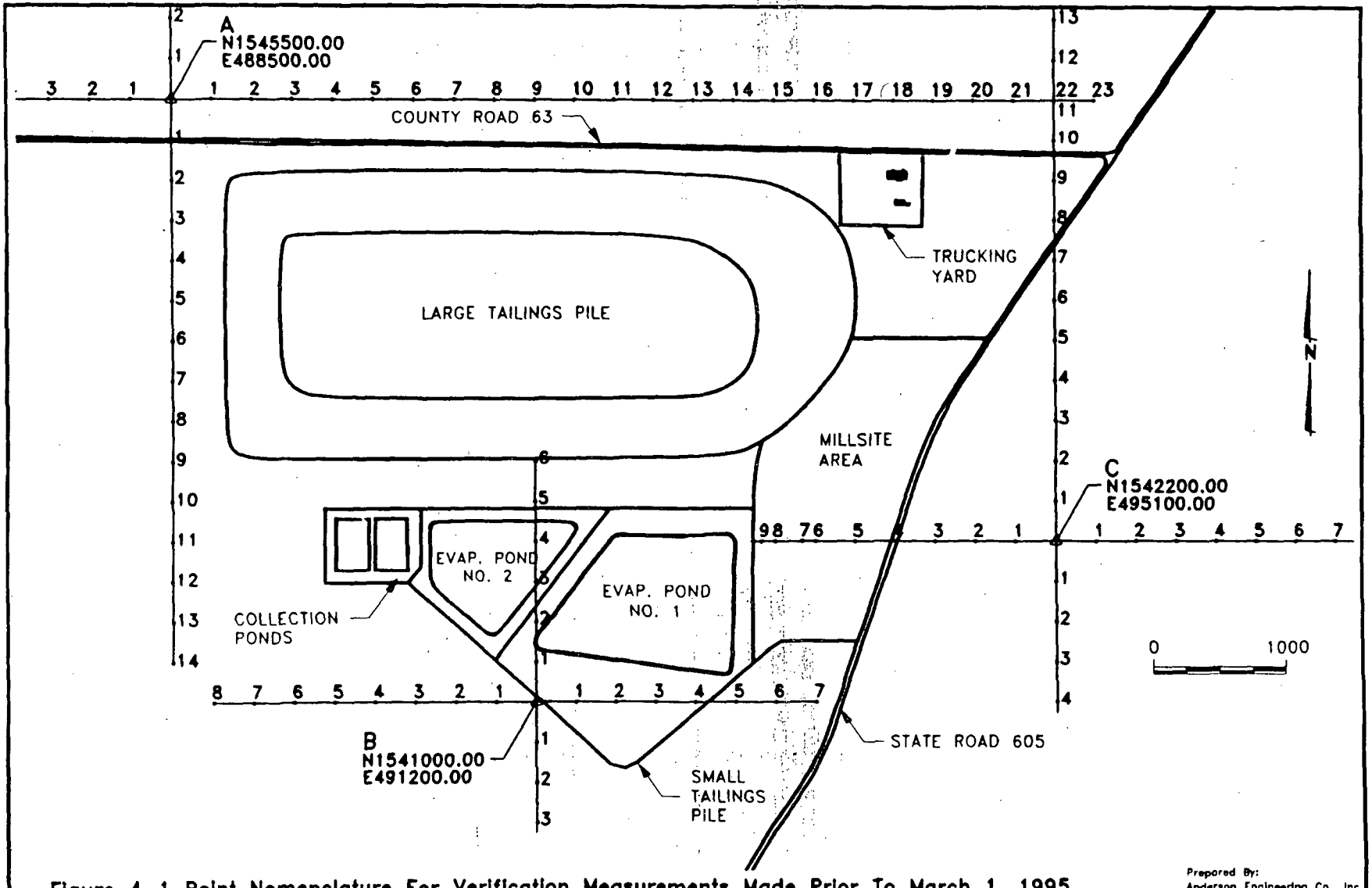

Figure 4–1 Point Nomenclature For Verification Measurements Made Prior To March 1, 1995

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG4-1.DWG

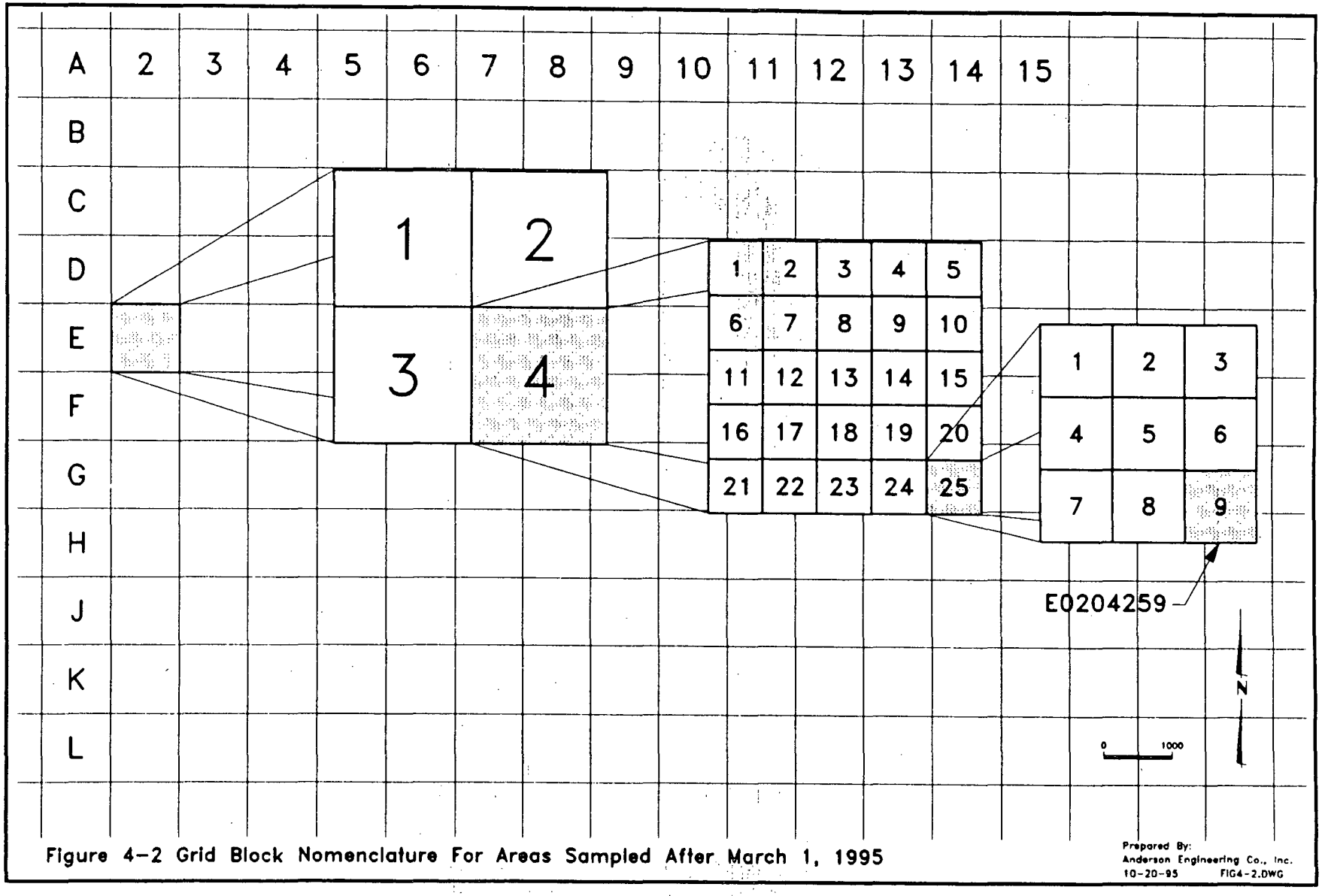

Figure 4-2 Grid Block Nomenclature For Areas Sampled After March 1, 1995

5.0 Characterization of Areas to be Used for Material Borrow

The areas used for borrow material are shown in Figure 3-2. The North, Northwest, and West Borrow Areas are located primarily out of the influence of windblown tailings from the pile as can be observed from the contamination zone boundary also shown in Figure 3-2. A comprehensive borrow area study was conducted to identify borrow sources near the site (HMC, 1994). Twenty-one soil samples randomly selected from the North Borrow Area showed near or below normal background values for the site. The Northwest Borrow Area was sampled on February 21, February 23, and March 8-9, 1994 by taking 0-6 inch deep and 6-12 inch deep samples at 34 locations on a grid of 300 feet. All results were at background levels. The data and sampling locations are provided in Appendix B.

The West Borrow Area was sampled on March 5, 1993, February 17, 1994, and March 8-9, 1994 by taking 110 samples up to depths of six feet. All samples taken met the cleanup criteria with the highest sample having 6.28 pCi/g Ra-226. The data and a map showing the sampling locations are provided in Appendix D.

The development of the Immediate North Borrow Area was done in May-June 1994. Prior to the use of the area, the top surface layer was removed and placed on the large tailings pile. Soil samples were taken to confirm that the area had been decontaminated. The results of 86 soil samples were taken which averaged 3.6 pCi/g. In reviewing the data, a few samples were reported as above the 10.5 pCi/g criterion for unrestricted release. While HMC staff believe that these areas were further remediated, no documentation could be found. The material was then used as radon barrier on the West and North Side Slope of the Large Tailings Pile. Characterization data for the Immediate North Borrow Area is provided in Appendix B.

As indicated in earlier, the borrow material from all of these areas, with the exception of the North Borrow Area, was used as interim cover on the top and side slopes of the Large Tailings Pile and for radon barrier on the North, West, and South side slopes. These materials were sampled after placement on the Large Tailings Pile (see Table 3-1 of HMC, 1995) and found to have background levels of Ra-226. The North Borrow material has been used for the radon barrier on the east side slope, aprons of the north and south side slope, and will be used for radon barrier on the top of the Large Tailings Pile.

Since the tailings on the Large Tailings Pile have been covered, there is no potential for the areas used for borrow to have become contaminated by windblown tailings. Therefore no verification measurements were required for the borrow areas.

6.0 Verification of Soil Cleanup

The verification measurements were done under two different sets of NRC-approved procedures using the two different conventions for labeling sampling points. The verification procedures and grid-naming and point-location conventions have been discussed in Section 3 and Section 4.

6.1 Areas Verified Using Procedures Based on Grid Intersection Sampling and Gamma Measurements

Areas verified using this procedure consist of a few areas that were verified prior to the revision to the Verification Plan approved by the NRC on March 1, 1995. These areas include the Trucking Yard, areas immediately adjacent to the toe of the large tailings pile, county road removal, State Road 605 right-of-way, and other areas where it was desirable to decontaminate and verify early in the reclamation period. The data for these areas are presented below.

6.1.1 Trucking Yard Area

The area known as the Trucking Yard Area shown in Figure 1-1 was decontaminated and verified in preparation for further use in managing the decommissioning of the site. After the contaminated soil was removed, thirty-one soil samples were taken and analyzed. All sample results were below the Ra-226 cleanup criterion with the maximum measured value of 6.9 pCi/g. Because of the high shine from the large tailings pile, no gamma readings were recorded. The data are presented in Appendix C along with a map showing the location of the Trucking Yard Area. In reviewing the data, no soil samples were taken from an small area near the southwest corner of the parcel. This was the location of the fuel area which was later excavated to a significant depth to remove fuel contaminated soils.

While no additional soil samples were taken, a radiological survey was done on all accessible areas of the Trucking Yard area using the GPS-based radiological survey equipment. This survey was done after the Large Tailings Pile had been covered and therefore was not influenced by gamma shine from the pile. An isocontour map is included as Figure C-1 in Appendix C which shows that the gamma-ray count rates in the area that was not sampled meets the gamma-ray action levels for the outer perimeter. The gamma map indicates elevated gamma count rates in other portions of the Trucking Yard. These levels were due to the shine from water processing equipment that was stored on the site. The soil sample results along with the gamma survey date provide reasonable assurance that the area meets the cleanup criteria. Clean soil was applied to the area which was then used for management of the remedial construction activities.

6.1.2 North Toe Area

The north toe of the Large Tailings Pile lies within a few yards of the County Road

63 right of way. To assure that this narrow strip of land meets the cleanup criteria, a line along the strip was sampled at 100-ft intervals, with the sampling points identified by the site control point "A". A total of 44 samples were taken on February 24, 1994 and analyzed for Ra-226. None of the samples exceeded the 10.5 pCi/g Ra-226 criterion with the exception of samples No. 4634 and No. 4646. These samples were reported to have Ra-226 concentrations of 27.65 and 11.5 pCi/g, respectively. All samples were sent to a vendor laboratory for Ra-226 analysis and U-nat analysis. The Ra-226 analyses agreed well with the analyses of the HMC on-site laboratory. The uranium concentrations on the samples taken near the northeastern corner of the Large Tailings Pile were elevated in uranium, probably as a result of precipitate from water seepage from the Large tailings Pile. The aprons were added to the pile in part to cover this contamination that extended to several feet beneath the surface. The data for the North Toe area is included in Appendix D.

6.1.3 West Toe Area

One hundred ten samples were taken on February 17, 1994, March 5, 1993, and March 8-9, 1994 to demonstrate that the area west of the Large Tailings Pile was free of contamination, including the area later to be known as the West Borrow Area. Locations of these samples were identified using Control Point A of the site coordinate system. The data are presented in Appendix D.

Soil samples were taken at depths up to six feet deep in the area to be used as borrow. Samples were taken down to 12 inches near the West Toe of the Large Tailings Pile. All samples taken met the cleanup criteria with the highest measured concentration being 6.28 pCi/g Ra-226. Because of the high gamma shine from the pile, no gamma measurements were documented.

6.1.4 Ore Spillage Area Near the North Ore Storage Pad

During the cleanup of the north ore storage pad, the area contiguous to the ore pad had become contaminated with ore and windblown tailings. As a part of decommissioning the ore pad, the surface soils were removed and consolidated with the tailings. This area lies north of mill site between the mill site and the Trucking Yard Area.

Confirmation 6-inch deep soil samples were taken using the site control point coordinate system using control point "C". The soil samples were taken on March 8-9, 1994, February 21, 1994, and February 23, 1994. The laboratory results are included in Appendix E where the sampling locations are shown on a map that is enclosed. Thirty five sampling locations representing a grid spacing of 100 feet are shown on the map. Forty-seven soil sample results are provided in the table, with 12 being duplicate samples. Only one sample was measured above 10.5 pCi/g (13.52 pCi/g). However, another sample reportedly taken at the same location was reported

as 3.33 pCi/g. This may have been a second sampling after the area had additional material removed. Five QA samples submitted to Eberline Laboratory indicated agreement that the Ra-226 concentrations were below 10.5 pCi/g. The U-nat concentrations were also measured and were below 35 pCi/g, a value normally accepted for unrestricted release of property. Splits of these samples were also analyzed by Energy Laboratory with similar results for Ra-226. However, the U-nat concentration for one of the samples was measured at 69 pCi/g.

After the area was verified as clean, approximately two feet of clean borrow material was placed on the area to restore it to the initial grade. Because of the gamma shine from the Large Tailings Pile, no gamma measurements were documented.

6.2 Verification of Road Right of Ways

The cleanup of the State and County roads was done under agreements where backfilling excavated areas was required prior to obtaining the final radiological assay results. Soils on both sides of State Highway 605 were removed where the contamination could or was known to have arisen from site operations. This included the impact from windblown tailings as well as the two ore storage pads. However, a decision was made to limit the distance from the mill site at which the cleanup would be done since most of the roads in this region have uranium ore spillage from the transport of ore. Characterization data are presented that demonstrate that the contamination along State Highway 605 north of the mill site arises from ore spillage and therefore is not the responsibility of HMC. All data for the road ways is included in Appendix F.

6.2.1 Verification of State Highway 605 Right of Way along Mill Site

The verification of the State Highway 605 right of way along the mill site was done using the NRC-approved verification procedure included in Appendix A. Stations were surveyed at 25-ft intervals along each side of the road extending from the County Road 63 intersection to the entrance to Hamilton Construction south of mill site. The width of the right of way was variable, extending to the fence line in both directions. Gamma-ray measurements were made by walking within the 25-ft interval along each side of the road and recording the readings for each interval. After being convinced that the area met the gamma-ray action levels, soil samples were collected at approximately one-half the excavation width along each side of the road at 150-ft intervals. These samples were analyzed for Ra-226 using gamma-ray spectroscopy.

The excavation of tailings contaminated soils was done under an agreement with the State of New Mexico whereby HMC agreed to backfill the excavated area at the end of each day. This made it impossible to obtain soil sample results prior to placing backfill.

Two different gamma measurement instruments were used to guide the excavation and

to take the required gamma measurements. A Ludlum 2221 ratemeter/scaler and a Ludlum 44-10 NaI detector with a lead collimating shield was used with an action level of 10 kcpm. The second instrument was a Ludlum Model 3 ratemeter coupled to a shielded 44-2 NaI detector. The action level for this instrument was 10-12 μR/h. In both cases, an allowance for higher levels was made to correct for better geometry conditions when surveying deep excavations where side-wall shine increases the count rate significantly. The NRC reviewed and approved this procedure (NRC, 1995).

The gamma measurements are given in Table F-1 and show that all values were below the action levels of the instruments with the exception of a few. When levels exceeded the action levels, grab soil samples were taken and analyzed immediately using the HMC spectrometer. A safety factor of 1.5 was normally used to account for the disequilibrium of radon and its daughters with Ra-226. The elevated readings were normally attributable to geometry effects. If the soil samples showed levels that approached the cleanup limits, additional soil was removed.

A total of 78 soil samples were taken on July 28, August 1, 2, 8 and 11, 1994. The results of the soil samples are presented in Table F-2. The samples at stations 270, 446, and 547 were found to exceed 10.5 pCi/g. However the depth of excavation at these points was 3.1, 4.7, and 2.8 feet where the cleanup criterion is 20.5 pCi/g. Only the sample at station 446 exceeded the cleanup criterion (29.27 pCi/g). A review of the data suggest that the spectrometer operator made an error in recording a number by recording only 4 digits of a 5 digit number for a region of interest attributable to Th-232 decay. This results in an erroneously high Ra-226 concentration result rather that a result of approximately 6 pCi/g which is believed to be the actual value. The low gamma value for that area support the conclusion that the soil sample result is an anomaly.

The results of the Highway 605 right-of-way verification are presented in Appendix F.

6.2.2 Characterization of State Highway 605 Right of Way South of Hamilton Construction Company Entrance.

The area south of the entrance to Hamilton Construction Company entrance was done to assure that all contamination south of the mill site had been removed. Soil samples were taken from an additional 1600 feet of right of way. Stations were located by survey at 25-ft intervals and soil samples taken according in the same manner as specified in the verification plan.

The results of the soil sample analyses show that all samples were below the Ra-226 cleanup criterion of 10.5 pCi/g. Gamma readings were not documented. The Ra-226 concentration data are presented in Table F-3 of Appendix F.

6.2.3 Verification of County Road 63 Road Base

In June 1994, the rock and upper road base material was removed from County Road 63 along with right-of-way surface soils. The excavation began approximately 1000 feet west of the west end of the Large Tailings Pile and extended 7700 feet to State Highway 605. Soil samples (0-6 inch and 6-12 inch) were taken from the center of the road base at 100-ft intervals. Approximately two feet of road base material was then placed and the road immediately reconstructed prior to obtaining the sample results. Seven of the 154 soil samples exceeded the 10.5 pCi/g cleanup criterion for surface soils. Five of the elevated samples were taken from the excavated surface (0-6 inches) exceeded the 10.5 pCi/g cleanup criterion for the surface layer with a maximum Ra-226 concentration of 15.14 pCi/g. Only one sample exceeded the 20.5 pCi/g cleanup criterion for subsurface soils. The sample was taken at 6-12 inches beneath the excavated surface and was analyzed to have a Ra-226 concentration of 23.8 pCi/g and a U-nat concentration of 14.3 pCi/g. Since the 0-6 inch sample at that location had very low radioactivity, the 23.8 pCi/g probably represents the activity of a sample of the original road base material which commonly has a high uranium content in the area. The data are presented in Table F-4 of Appendix F.

HMC contends that the cleanup of the County Road 63 meets the intent of the standards since the 0-6 inch samples were taken below grade where the criterion is 20.5 pCi/g. The 23.8 pCi/g sample, because of the high uranium content, probably was taken from the original road base material.

No gamma exposure rate measurements were documented since the high gamma-ray shine from the uncovered north side slope of the Large Tailings Pile masked any radiation emitted from the road base at the time.

6.2.4 Characterization of Ore Spillage on State Highway 605 Right of Way North of County Road 93 Intersection.

Highway 605 was used to haul ore to the Homestake Mill and other mills in the area. Because the ore was hauled in open trucks, ore and ore dust is present in the soils along the roads throughout the region. This contamination has been found at significant depths due to regrading and ditching activities.

HMC decided to characterize the right of way north of the County Road 63 intersection to determine the character and depth of contamination. Samples were taken north of the intersection on both sides of the highway at approximately 150-feet intervals for approximately 2500 feet. Six-inch deep samples were taken to a total depth of 2 feet. The data showed that contaminated soils exceeding the Ra-226 cleanup criterion extended to 2 feet or more for much of the 2500 feet. No correlation with proximity to the HMC mill site is apparent.

The quality control samples that were split and sent to an outside laboratory were analyzed for Ra-226 and U-nat. As anticipated, the results of these twelve quality control samples showed that most of the Ra-226 activity in the samples could be attributed to uranium ore rather than tailings, especially since much of uranium would have been solubilized and transported away over the long period of time. Table F-5 and a map are included in Appendix F which provide the radiological data and sample locations.

HMC concluded that it was not their responsibility to decontaminate the right of way since the contamination did not result from HMC site operations.

6.3 Verification of Areas Using GPS-Based Radiological Survey Data and Soil Sampling Data

The GPS-based radiological survey data was down loaded into the AutoCADD computer application where site features, isocontours, and the state plane reference coordinates were shown on 24-in by 36-in maps. A set of 83 maps displaying this information is included as Appendix J. Isocontour lines at the action level of 21,000 cpm for the outer zone and 28,000 cpm for the inner zone are shown. Areas exceeding the action levels were either further decontaminated or the area was sampled to demonstrate compliance with the standard.

In order to implement the NRC-approved verification plan, it was necessary to evaluate each 33.3-ft by 33.3-ft grid block in order to determine that there were the required minimum number of gamma data points within the grid block, to determine the average gamma count rate within the grid block, and to identify those 33.3-ft by 33.3-ft grid blocks that exceeded the gamma action level of 21,000 cpm for the outer zone and 28,000 cpm for the inner zone. In addition, the location of the 33.3-ft by 33.3-ft grid blocks with the highest average count rates within the 500-ft by 500-ft (inner zone) and 1000-ft by 1000-ft (outer zone) were required for sampling purposes. This was accomplished by importing the data into a data base manager and sorting the data into the 33.3-ft by 33.3-ft grids. Note that each 500-ft by 500-ft grid block has 225 of the 33.3-ft by 33.3-ft grid blocks. For each 500-ft by 500-ft grid block, a summary sheet was created where the 33.3-ft grid block with the maximum average gamma was identified by name and location, the average gamma value, and the number of points that were available in calculating the average gamma count rate. In addition, those grid blocks having fewer than five data points for outer zone and fewer than seven data points for the inner zone were identified. Also all grids having average gamma count rates higher than the action level are listed. These GPS Data Sort Summary Sheets are included in Appendix I.

6.3.1 Verification of the Inner Zone

The verification of the portions of the inner zone (Figure 3-2) that were not previously discussed in Section 6-1 and Section 6-2 consist of areas to the south and east of the Large Tailings Piles. In some instances, there is overlap in the data due to the disturbance of an area from construction activities and the area was reverified or it

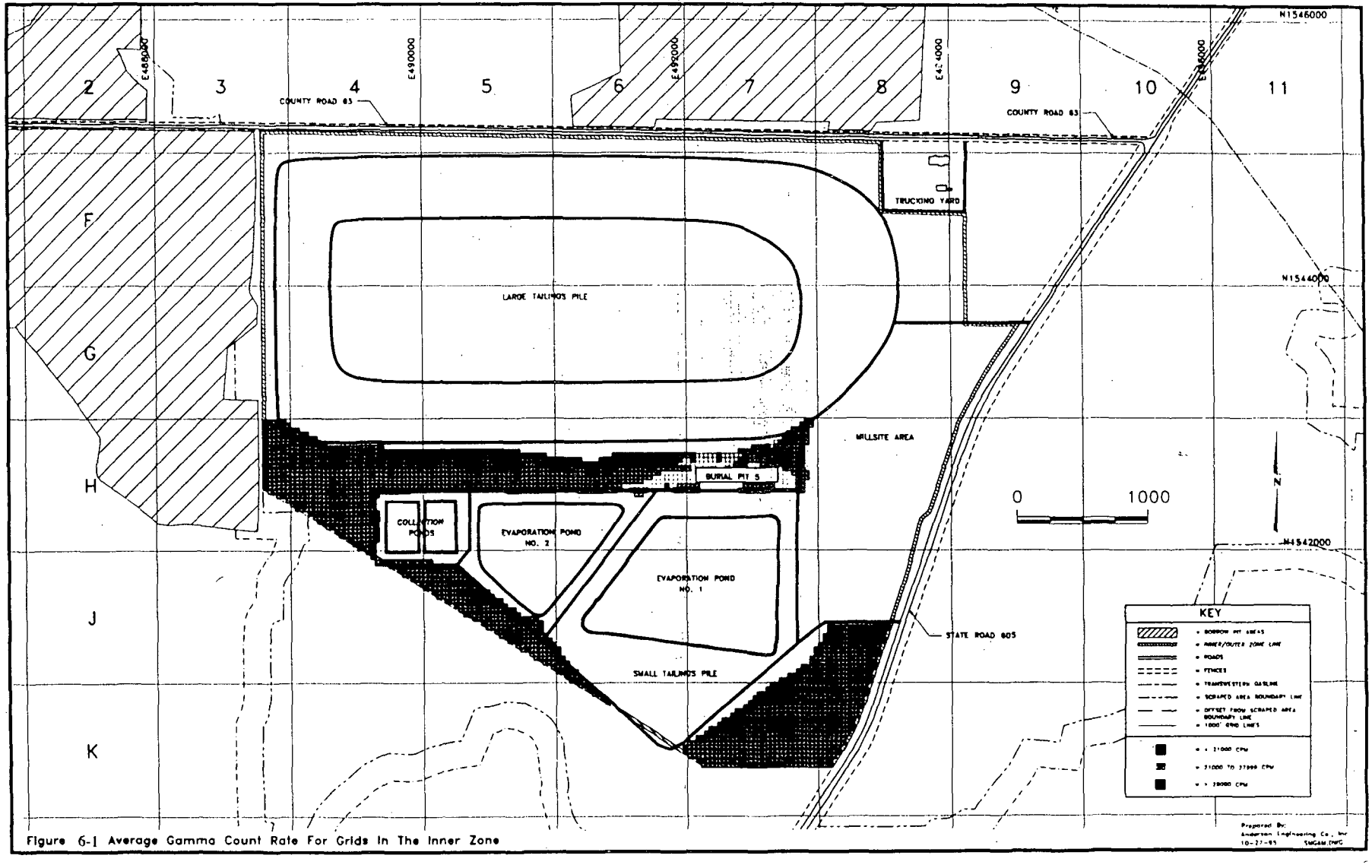

Figure 6-1 Average Gamma Count Rate For Grids In The Inner Zone

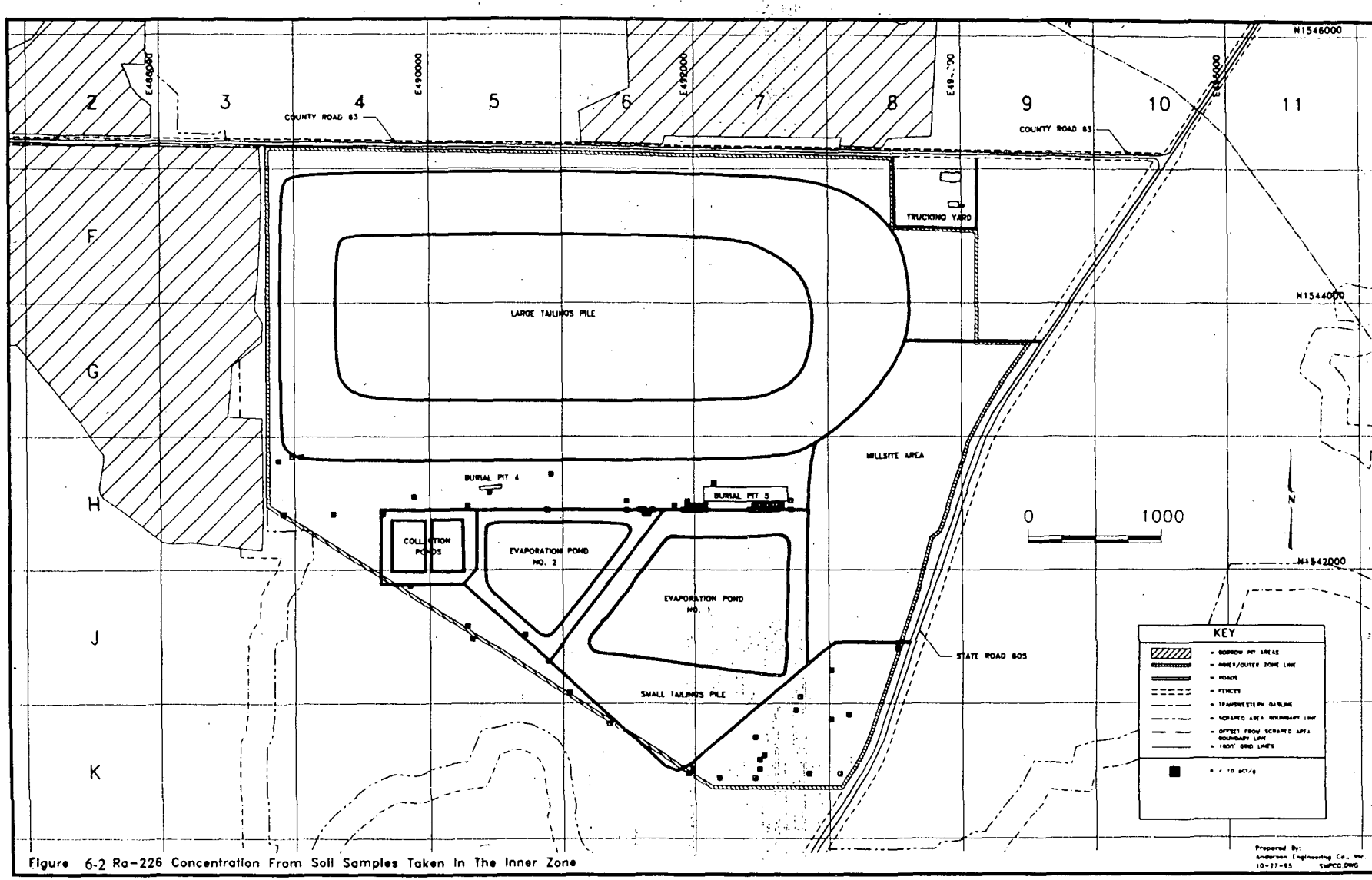

Figure 6-2 Ra-226 Concentration From Soil Samples Taken In The Inner Zone

was unknown to the verification field crew that the area had already been verified using the previously approved verification method.

Areas within the Inner Zone that will not be verified at this time are the tailings piles, the areas where the evaporation ponds and collection ponds are placed, the Mill Site Area, and the two Debris Disposal Pits. The reclamation of the Mill Site and two Debris Disposal Pits is addressed in the Uranium Mill Decommissioning Report. Evaporation Pond No. 2 was constructed during the summer of 1995. The area on which the pond was constructed was decontaminated and verified. However, since the license condition requires that, upon decommissioning of the facility, the pond will be removed and the underlying area verified, these data are not presented in this report.

The gamma-ray data resulting from averaging the gamma-ray count rates for each 33.3-ft by 33.3-ft grid block is represented in Figure 6-1, where the colors indicate areas where the average gamma-ray count rate is above 28,000 cpm, between 21,000 cpm and 28,000 cpm, and below 21,000. All areas above 28,000 required soil samples since the shine from the area prevented verification based on gamma-ray count rate. For 500-ft by 500-ft grid blocks having no areas higher than 28,000 cpm, the 33.3-ft by 33.3-ft grid block having the highest gamma count rate was sampled and analyzed for Ra-226. Also any grid than did not meet the minimum number of data records was either sampled or additional data obtained and added to the data base.

The grid blocks that were sampled are shown in Figure 6-2. The results of the Ra-226 analyses are presented in Table H-1 of Appendix H. The results show that this approach has been very conservative since no soil samples exceeded the 10.5 pCi/g cleanup criterion. In fact, no sample exceeded 5 pCi/g. The mean of the 72 samples is 1.11 pCi/g with a standard deviation of 1.05 pCi/g. This clearly indicates that the area has been remediated to meet the unrestricted release criteria.

The data in Figures 6-1 and 6-2 do not always align with the site features. In most cases, the exact boundary of the site feature had not been determined. In others, an overlap is shown where a portion of a grid block was sampled whereby the resolution of each point on the maps is 33.3-ft by 33.3-ft. Near the Large Tailings Pile, aprons had been constructed to cover the area where no radiological data are shown. The only area known to not have verification data is the area immediately north of Evaporation Pond No. 1 between the pond and Burial Pit No. 5. The soil from this area was removed to a large depth leaving a hole where water collected. Since the area will be disturbed during the reclamation of the Small Tailings Pile, it was decided to verify the area at that time.

6.3.2 Verification of Outer Zone

6.3.2.1 Statistical Test for Study Area within the Innermost Portion of the Outer Zone

A statistical test was developed in accordance with the verification plan to assure that the use of the 21,000 cpm gamma action level resulted in a high probability that each 100 m^2 (33.3-ft by 33.3-ft) grid block meets the cleanup criterion of 5 pCi/g above background, or 10.5 pCi/g. The test was applied to the 33.3-ft by 33.3-ft grid blocks within each 500-ft by 500-ft grid block that has the highest average gamma reading in the innermost portion of the outer zone. The verification plan indicated that if the mean concentration of this set of measurements met the soil concentration cleanup criterion at the 95 percent confidence level, then the soil sampling strategy would be to sample only the grid block within each 1000' by 1000' grid block that has the highest average gamma-ray count rate.

Fifty-two 500-ft by 500-ft grid blocks were evaluated for this test. The grid blocks were chosen according to the NRC-approved verification procedure and are highlighted in Figure 6-3. Data sorts were done to establish the 33.3-ft by 33.3-ft grid block having the highest average gamma-ray count rate. These data sort sheets are provided in Appendix G. Table 6-1 presents the data for each 33.3-ft by 33.3-ft grid block representing the average highest gamma count rate within each of the 52 larger grid blocks. The table shows that the average count rate is 16,629 cpm with a standard deviation of 2,460 cpm. The average Ra-226 concentration is 2.51 pCi/g with a standard deviation of 0.52 pCi/g.

The EPA recommended procedure for testing data for compliance with a guideline value at a desired level of confidence (NUREG/CR-5849, Equation 8-13) was applied to this set of data. The test is to calculate the mean plus the standard error corresponding to the desired level of confidence and compare that value to the cleanup criterion of 10.5 pCi/g. In equation form,

$$\mu_\alpha = \overline{X} + t_{1-\alpha, df}\frac{s}{\sqrt{n}}$$

where $t_{1-\alpha,df}$ is the "t" statistic for the 95% level for the degrees of freedom, df, taken from statistical tables, $\overline{X}$ is the arithmetic mean, s is the standard deviation, and n is the number of data points.

From the "student t" tables, the "t" statistic is 1.68 for 51 degrees of freedom at the 95 percent confidence (one sided) level. Substituting the numbers in the above equation gives 2.6 pCi/g. This value of 2.6 pCi/g must be less than the 10.5 pCi/g

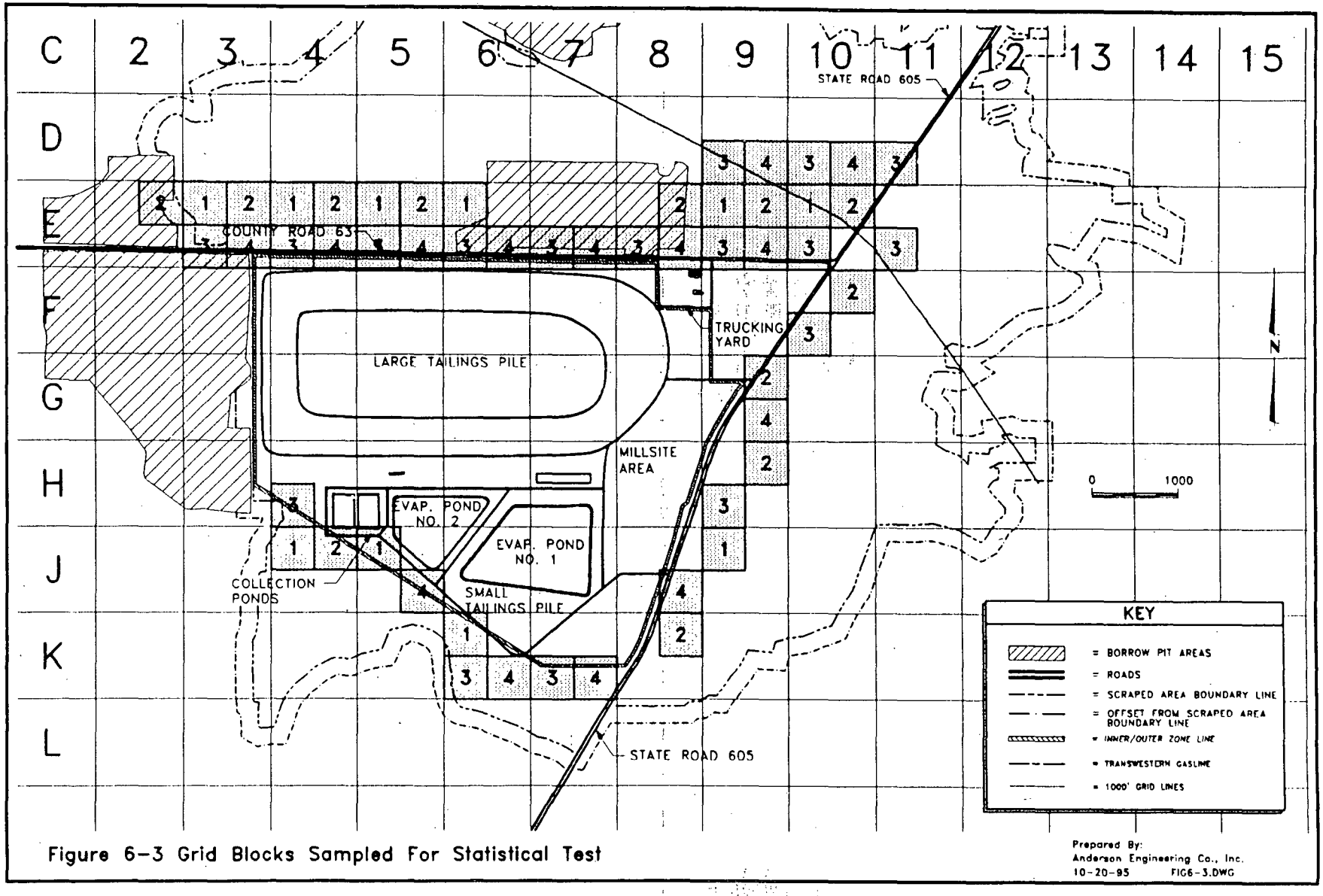

Figure 6-3 Grid Blocks Sampled For Statistical Test

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG6-3.DWG

Table 6-1 Ra-226 and Gamma Count Rate Data for the Outer Zone Statistical Test

Grid Number	HMC Laboratory (pCi/g)	Gamma (avg cpm)
E031222	3.54	15818
E032142	1.21	14898
E033049	1.65	12839
E034114	2.24	12936
E041056	1.77	13051
E042169	0.10	16630
E043111	1.00	13085
E044145	1.46	13569
E051195	2.72	13934
E052153	2.64	16153
E053151	1.75	15472
E054059	1.28	15365
E061067	2.22	15732
E063127	3.27	15801
E064147	3.29	15539
E073127	1.15	15075
E074147	2.45	15433
E082251	4.18	17779
E083203	1.12	16087
E084171	1.25	18796
E091155	5.86	19093
E092248	4.24	20767
E093135	5.47	19030
E094059	4.89	19882
E101114	5.49	21766
E102084	3.17	20674
E103101	4.86	20059
E113166	4.10	17927

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Table 6-1 Ra-226 and Gamma Count Rate Data for the Outer Zone Statistical Test

Grid Number	HMC Laboratory (pCi/g)	Gamma (avg cpm)
D093206	2.02	15253
D094229	2.79	17648
D103249	2.38	20918
D104176	4.02	21964
D113084	2.04	20785
F102237	1.74	18906
F103039	3.19	15298
G092096	2.38	13361
G094067	1.67	12833
H092225	1.37	17007
H093095	0.79	18226
J091041	2.10	17219
J084225	2.34	15199
K082076	3.38	16690
K073084	3.46	13934
K074174	0.47	15601
K061142	1.58	18007
K063196	3.07	17974
K064177	1.22	16043
J051164	2.26	14390
J054255	1.15	18230
J041053	2.27	15650
J042218	1.71	15408
H043239	2.79	14980
Mean	2.51	16629.12
Std. Deviation	1.33	2460.06
Number	52	52
Standard Error	0.03	47.31

cleanup criterion in order to pass the test, which obviously passes with ease. The data in Table 6-1 confirm the conservatism of the 21,000 cpm action level in that of the 52 grids tested, eight of the grids actually exceeded 20,000 cpm with two slightly above 21,000 cpm. However the maximum Ra-226 concentration was 5.9 pCi/g, much lower than the 10.5 pCi/g cleanup criterion.

Since the data passed the statistical test, the verification plan specifies that the 33.3-ft by 33.3-ft grid block having the highest average gamma count rate within each 1000-ft by 1000-ft grid block will be sampled. A similar statistical test will be done on the set of data from the grids sampled from the 1000-ft by 1000-ft grids.

6.3.2.2 Verification Data for Outer Zone

Upon passing the statistical test addressed in Section 6.3.2.1, the GPS-radiological survey maps were examined visually and by the data sort technique to assure that the minimum number of gamma data records existed for each grid block. In some grid blocks requiring additional data, more data were obtained and added to the data base; in others, a soil sample was taken from the grid block to demonstrate compliance with the 10.5 pCi/g cleanup criterion. The data sort provided the name of the 33.3-ft by 33.3-ft grid block having the highest average gamma count rate within each 500-ft grid block. These grid blocks made up the four possible grid blocks to be sampled for each 1000-ft by 1000-ft grid.

The Ra-226 concentration values for the grid blocks having the highest gamma-ray count rate within each 1000-ft by 1000-ft grid block are provided in Table H-2 of Appendix H. No samples were found to exceed the cleanup criterion and therefore no further decontamination was required. All samples were less than 8 pCi/g.

The set of Ra-226 concentration data for the 78 samples taken in the outer zone (not including the statistical test data presented in Section 6.3.2.1) has a mean of 2.95 pCi/g and a standard deviation of 1.89 pCi/g. Applying the statistical test as described in Section 5.3.2.1, the mean plus the standard error at the 95 percent confidence level is equal to 3.5 pCi/g. This clearly passes the statistical test and confirms the verification of the outer zone.

7.0 Quality Control

Condition 29C of License SUA-1471 requires that a minimum of 15 percent of soil verification samples be recounted by an off-site vendor laboratory using gamma-ray spectroscopy or chemical analysis. The condition also specifies that a minimum of 5 percent of the samples must be analyzed by chemical analysis. This has been interpreted and implemented by HMC as a minimum of 10 percent of the samples will be analyzed by gamma-ray spectroscopy and a minimum of one half of those ten percent will also be analyzed by chemical analysis.

The verification data presented in the tables shows the results of all analyses done on the samples. For example, Appendix H consists of the verification soil sample results using the verification procedure based on sampling the grid blocks with the highest gamma-ray count rate (post March 1, 1995 procedure). This procedure was applied to more than 90 percent of the area. The data in Appendix H shows that 150 verification soil samples were taken and analyzed by the on-site HMC laboratory. Of those 150 samples, 15 samples were analyzed by an off-site laboratory using gamma-ray spectroscopy. An additional 21 samples were analyzed at off-site laboratories using chemical analyses. Additional QC data are presented in the remaining appendices.

The results of the QC program were evaluated by the Radiation Protection Administrator at least monthly. Agreement was within normal analytical accuracy and precision.

8.0 Summary

The data presented in this report indicate that the cleanup of the off-pile windblown contaminated areas within the HMC site has been accomplished using procedures approved by the NRC. The extensive gamma-ray data as presented on the maps provide a high degree of assurance that every 100 m^2 grid block is either below the action level or has been sampled and demonstrated to be below the cleanup criteria. The statistical tests have also demonstrated that the action levels used were very conservative in that the set of samples representing 100 m^2 area grid blocks having the highest average gamma-ray count rates all were beneath the cleanup criteria. The statistical test showed that the means of these data sets for the inner zone, the outer zone, and the special statistical test within the outer zone were all below the cleanup criteria at the 95 percent level. In fact, the mean Ra-226 concentration of these samples was 1.1 pCi/g and 2.5 pCi/g for the inner zone and outer zone, respectively.

The cleanup of the road right of ways was done under somewhat more difficult conditions in that immediate backfilling was required by the state and local government agencies. However it was demonstrated that this was accomplished with a high degree of certainty that the cleanup criteria were met.

The application of the verification plan approved prior to March 15, 1995 was applied for the Trucking Yard Area, the area around the North Ore Storage Pad, and at the north and west toe of the Large Tailings Pile. These areas were verified using the soil sampling procedure in the NRC-approved verification plan. However, at the time of the cleanup, the north and west side slopes of the Large Tailings Pile had not been covered and thus the gamma-shine from the pile was the major contributor to the exposure rate. Therefore while the exposure rate measurements were used to guide the excavation, the levels were not documented. These areas were then backfilled to the original grade. The fact that the soil samples demonstrated that the surface cleanup criteria (10.5 pCi/g) had been met and that the area required extensive backfill to bring it back to grade provides additional assurance that these areas meet the cleanup criteria. This area constitutes a very small fraction of the total remediated area.

9. Bibliography

HMC,1993aReclamation Plan, Revision October 1993, Homestake Mining Company of California, Grants Operation, P. O. Box 98, Grants, New Mexico 87020. Prepared by AK Geoconsult., Inc. with Jenkins Environmental, Inc.

NRC,1993License Amendment No. 15 to Radioactive Materials License SUA-1471, August 25, 1993, U. S. Nuclear Regulatory Commission, Washington D. C.

HMC,1994Borrow Investigation, Homestake Mining Company, Grants Operation, P. O. Box 98, Grants, New Mexico 87020. Prepared by Knight Piesold and Company, Denver, Colorado.

HMC,1995aUranium Mill Decommissioning Report, Homestake Mining Company of California, Grants Operation, P. O. Box 98, Grants, New Mexico 871020.

HMC,1995bFinal Radon Barrier Design for the Large Tailings Pile, June 1995, Homestake Mining Company of California, Grants Operation, P. O. Box 98, Grants, New Mexico 87020

NRC,1995License Amendment No. 20 to Radioactive Materials License SUA-1471, March 1, 1995, U. S. Nuclear Regulatory Commission, Washington D. C.

Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill

Grants Operation

License No. SUA-1471

Appendices A-G

November 1995

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