**COMIN**
A Cogema Resources Company

January 5, 1996

**LICENSE SUA-1341**
**DOCKET NO. 40-8502**

U.S. Nuclear Regulatory Commission
ATTN: Mr. Joseph J. Holonich, Chief
High-Level Waste and Uranium Recovery Projects Branch
Division of Waste Management
Mail Stop T 7 J9
Washington, D.C. 20555

**RE: Submittal of Supplemental Information for the Renewal of Source Material License SUA-1341, Irigaray and Christensen Ranch Sites and Request for Performance Based License**

Dear Mr. Holonich:

Please find enclosed three (3) copies of COGEMA Mining, Inc.'s supplemental information package for the renewal of Source Material License SUA-1341 for the Irigaray and Christensen Ranch sites. This is the remainder of the materials COGEMA will be submitting for your staff to complete their review of the license renewal.

Additionally, COGEMA hereby requests that the NRC renew Source Material License SUA-1341 in a performance based license format. To initiate this process, we have assembled our current license conditions into a performance based license format, based on the license issued to Power Resources, Inc. We have also made some changes to the wording to better reflect current conditions. We look at the draft as a starting point, and look forward to working with NRC to achieve a workable performance based license. The draft license is included with the attached documents under the first tab inside the front cover.

COGEMA also requests that the NRC consider re-issuing the license for a ten year period rather than a five year period. We believe that the performance based license, which allows annual updates of the application, will keep the application and operational programs more up-to-date than is typically found during the five year renewal period.

I look forward to working with your staff on this project.

Sincerely,

Donna L. Wichers

Donna L. Wichers
Manager, ISL Environmental and Regulatory Services

cc: NRC Region IV

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*COGEMA Mining, Inc. • 935 Pendell Boulevard • P.O. Box 730 • Mills, Wyoming 82644*
*Tel: (307) 234-5019* *Fax: (307) 473-7306*

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B PDR

COGEMA
Mining, Inc.

# SUPPLEMENTAL DATA FOR RENEWAL

# SOURCE MATERIAL LICENSE SUA-1431

# IRIGARAY AND CHRISTENSEN RANCH PROJECTS

December, 1995

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B PDR

**DRAFT MATERIALS LICENSE**
**(PERFORMANCE BASED LICENSE)**

COGEMA Mining, Inc.
[Applicable Amendments: 2, 17, 34]

PO Box 730
Mills, Wyoming 82644
[Applicable Amendments: 2, 14, 18, 34]

Performance Based License
SUA-1341, Amendment No. 41
40-8502

| | | |
|---|---|---|
| Uranium | Unspecified | Unlimited |

**Section 9.0: Administrative Conditions**

9.1 The authorized place of use shall be the licensee's Irigaray and Christensen Ranch Satellite facilities in Johnson and Campbell Counties, Wyoming.

[Applicable Amendments: 10]

9.2 All notices to the NRC under this license, with the exception of incident and event notifications requiring telephone notification, shall be addressed to the Chief, High-Level and Uranium Recovery Projects Branch, Division and Waste Management, Office of Nuclear Safety and Safeguard. Incident and event notifications that require telephone notification shall be made to the NRC Operations Center at (301) 816-5100.

9.3 For use in accordance with statements, representations, and conditions contained in the License Renewal Application dated January 5, 1996 (hereinafter referred to as the "application").

The licensee shall conduct operations in accordance with the conditions, representations, and statements referenced above, which are hereby incorporated by reference, except where superseded by license conditions below.

The licensee shall incorporate the 517 and USMT sites into Production Unit 10 as described in Attachment 3 to the October 31, 1988, amendment application.

Wherever the word "will" is used in the above referenced sections, it shall denote a requirement.

[Applicable Amendments: 3, 4, 10, 12, 17, 18, 20, 22, 27, 33, 34, 36]

9.4 A. The licensee may, without prior U.S. Nuclear Regulatory Commission approval, and subject to the conditions specified in Part B. of this condition:

(1) Make changes in the facility or process, as presented in the application.

(2) Make changes in the procedures presented in the application.

(3) Conduct tests or experiments not contained in the application.

B. The licensee shall file an application for an amendment to the license, unless the following conditions are satisfied:

(1) The change, test, or experiment does not conflict with any requirement specifically stated in the license (excluding the License Condition Referencing the License Application or Reclamation Plan), or impair the licensee's ability to meet all applicable NRC regulations.

(2) There is no degradation in the essential safety or environmental commitments in the license application, or provided by the approved reclamation plan.

(3) The change, test, or experiment is consistent with the conclusions of actions analyzed and selected in the most recent Environmental Assessment (EA).

C. The licensee's determinations concerning section (B) above, shall be made by a "Safety and Environmental Review Panel (SERP)". The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management and shall be responsible for managerial and financial approval changes; one member shall have expertise in operations and/or construction and shall have expertise in implementation of any changes; and, one member shall be the Manager, Environmental and Regulatory Services or the radiation safety officer (RSO) or equivalent. Other members of the SERP may be utilized as appropriate, to address technical aspects of (A) and (B) above, in several area, such as health physics, groundwater hydrology, surface water hydrology, specific earth sciences, and others. Temporary members, or permanent members other than the three identified above, may be

consultants.

D. The licensee shall maintain records of any changes made pursuant to this condition. These records shall include written safety and environmental evaluations, made by the SERP, that provide the basis for the determination that the change is in compliance with the requirements referred to in (B) above. The licensee shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the safety and environmental evaluation of each. The annual report shall be incorporated into the license application to reflect changes.

[Applicable Amendments: 3, 10, 11, 15, 36]

9.5 The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR 40, Appendix A, Criterion 9, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination, offsite disposal of radioactive solid process or evaporation pond residues, and ground-water restoration as warranted. The surety shall also include the costs associated with all soil and water sampling analysis necessary to confirm the accomplishment of decontamination. Within 3 months of NRC approval of a revised decommissioning plan, the licensee shall submit for NRC review and approval, a proposed revision to the financial surety arrangement if estimated costs in the newly approved decommissioning plan exceed the amount covered in the existing financial surety. The revised surety shall then be in effect within 3 months of written NRC approval. Annual updates to the surety amount, required by 10 CFR 40, Appendix A, Criterion 9, shall be provided to the NRC by August 18 in each successive year. Financial surety coverage for the full amount of the NRC-approved decommissioning cost estimate shall not lapse for any time period prior to license termination.

Along with each proposed revision or annual update, the licensee shall submit supporting documentation showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation, maintenance of a minimum 15 percent contingency, changes in engineering plans, activities performed, and any other condition affecting estimated costs for site closure. The licensee shall also provide the NRC with copies of surety-related correspondence submitted to the State, a copy of the State's surety review, and the final approved surety arrangement. The licensee must also ensure that the surety, where authorized to be held by the State, identifies the NRC-related portion of the surety and covers the cost of decommissioning and decontamination, offsite disposal, soil and water sample analyses, and ground-water restoration associated with the site.

The basis for the cost estimate is the NRC-approved site closure plan or the NRC-approved revisions to the plan. Reclamation/decommissioning plan, cost estimates, and annual updates should follow the outline in the attachment to SUA-1341 entitled "Recommended Outline for Site Specific Reclamation and Stabilization Cost Estimates."

The licensees' currently approved surety, irrevocable standby letter of credit number 93/832 issued by the Credit Commercial de France of New York in favor of the State of Wyoming, shall be continuously maintained in an amount no less than $11,384,319 for the purpose of complying with 10 CFR 40, Appendix A, Criterion 9 until a replacement is authorized by both the State and the NRC.

[Applicable Amendments: 14, 17, 33, 34, 39]

9.6 The licensee is authorized to dispose of byproduct material at a site licensed by the NRC to receive byproduct material. The licensee's approved waste disposal agreement must be maintained onsite. In the event the agreement expires or is terminated, the licensee shall attain a new agreement within 90 days after expiration.

[Applicable Amendments: 19, 34]

9.7 The Radiation Safety Officer (RSO), or his designee, shall have the education, training and experience as specified in Regulatory Guide 8.31.

[Applicable Amendments: 3, 10, 34]

9.8 Standard operating procedures (SOPs) shall be established for all operational activities involving radioactive materials that are handled, processed, stored, or transported by employees. SOP's shall include appropriate radiation safety practices to be followed in accordance with 10 CFR Part 20. Written procedures shall be established for non-operational activities to include in-plant and environmental monitoring, bioassay analysis, and instrument calibration. An up-to-date copy of each SOP shall be kept in specified locations in the area where it is used.

All written procedures for both operational and nonoperational activities shall be reviewed and approved in writing by the RSO (Radiation Safety Officer) before implementation and whenever a change in procedure is proposed to ensure that proper radiation protection principals are being applied. Additionally, the RSO shall perform an annual documented review of all operating procedures.

[Applicable Amendments: 10]

9.9 Release of equipment or packages from the restricted area shall be in accordance with the attachment to this license entitled "Guidelines for Decontamination of facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials", dated September 1984.

[Applicable Amendments: 10]

9.10 The licensee is exempted from the requirements of Section 20.1902(e) of 10 CFR 20 for areas within the facility, provided that all entrances to the facility are conspicuously posted in accordance with Section 20.1902(e) and with the words "Any area within this facility may contain radioactive materials".

[Applicable Amendments: 36]

9.11 The licensee shall maintain a restricted area boundary pursuant to 10 CFR 20.1003. The Irigaray plant and Christensen Ranch Satellite plant process areas shall represent restricted areas. The Irigaray and Christensen Ranch well field buildings shall be restricted if radiological surveys indicate appropriate radiological levels.

[Applicable Amendments: 3, 7, 9, 10, 11, 15, 28]

**Section 10.0: Operations, Controls, Limits, and Restrictions**

10.1 The licensee shall perform well integrity tests on each injection and production well before the wells are utilized and on wells that have been serviced. Integrity tests shall be performed in accordance with the current license renewal application. Any failed well casing that cannot be repaired to pass the integrity test shall be plugged and abandoned.

[Applicable Amendments: 3, 7, 10]

10.2 The licensee shall establish baseline water quality data for all production units. The data shall be from wells established in the mining zone, the mining zone perimeter, the upper aquifer and the lower aquifer. The data shall, at a minimum, consist of the sample analyses shown in Table 5.25 of the application.

[Applicable Amendments: 4, 6, 8, 10, 35]

10.3 The wells used for obtaining baseline groundwater quality in future production areas shall be established at the following minimal density:

| Monitored Unit | Density |
|---|---|
| Ore Zone Monitors | All |
| Ore Zone Baseline (restoration) | 1 well per 4 acres of pattern area |
| Shallow Zone Monitors | 1 well per 3.5 acres of pattern area |
| Deep Zone Monitors | 1 well per 3.5 acres of pattern area |

Wells utilized to establish baseline groundwater quality for past Irigaray production areas were as follows:

| Monitored Unit | Wells per Monitored Unit |
|---|---|
| Irigaray Unit 1 Sandstone | 2 |
| Irigaray deep monitor zone | 2 |
| Irigaray perimeter and trend monitor wells (Units 1-9) | 70 percent of installed wells |

[Applicable Amendments: 6, 8, 10, 11, 12, 21, 22, 29, 31, 34, 35, 38]

10.4 The annual plant throughput shall not exceed 2,500,000 pounds of $U_3O_8$.

[Applicable Amendments: 7, 9, 10]

10.5 Solution evaporation ponds A, B, C, D, E and the 517 ponds shall have a 2 foot freeboard requirement. Ponds RA and RB shall have an 8 foot freeboard requirement. The 8 foot freeboard may be temporarily changed to 2 foot in either RA or RB as long as sufficient reserve capacity is available in the overall pond system to accept the contents of one of the ponds in case of leakage. The Christensen Ranch permeate storage ponds and lined brine ponds shall have a 2 foot freeboard.

Additionally, the licensee shall, at all times, maintain sufficient reserve capacity in the evaporation pond system to enable the transfer of the contents of a pond to other ponds. In the event of a leak and subsequent transfer of liquid, the freeboard requirements shall be suspended during the repair period.

[Applicable Amendments: 10, 11, 14]

10.6 All liquid effluents from process buildings and other process waste streams, with the exception of sanitary wastes, shall be disposed of as described in the application.

[Applicable Amendments: 3, 13, 24]

10.7 The licensee shall maintain effluent control systems as specified in the current license application, with the following conditions:

A. Operations shall be suspended in the dry/pack area of the plant upon verification that the emission control equipment for the yellowcake drying or packaging areas is not operating within the ranges permitted by WDEQ Air Quality Permit No. OP-254.

B. The licensee shall, during all periods of yellowcake drying operations, assure that the scrubber is operating within recommended ranges in Permit No. OP-254 for water flow and air pressure differential necessary to achieve design performance. This shall be accomplished by either (1) performing and documenting checks of water flow and air pressure differential approximately every four (4) hours during operation, or (2) installing instrumentation which will signal an audible alarm if either water flow or air pressure differential fall below the recommended levels. If an audible alarm is used, its operation shall be checked and documented daily.

10.8 The licensee shall use a Radiation Work Permit (RWP) for jobs where the potential for significant exposure to radioactive material exists and for which no standard operation procedure exists. All RWP's shall be accompanied by a breathing zone air sample or applicable area air sample. The RWP shall be issued in accordance with the requirements of Regulatory Guide 8.31.

[Applicable Amendments: 4, 10]

10.9 Before leaving any restricted area, all process workers shall shower or monitor themselves in conformance with Regulatory Guide 8.30.

[Applicable Amendments: 10]

10.10 All radiation monitoring, sampling and detection equipment shall be recalibrated after each repair and as recommended by the manufacturer or at least annually. In addition, all radiation survey instruments shall be operationally checked with a radiation source at least daily during usage.

[Applicable Amendments: 5, 7, 9, 11, 13, 26, 34]

10.11 The licensee will not commence mining in the northern zone of Mine Unit 5 north of an imaginary line connecting wells 5MW65 and 5MW66, until two additional trend wells are constructed in that zone and their baseline water quality has been established.

One well will be constructed at a distance not greater than 300 feet south of the pinch out where the K Sand (production zone) merges with the Deep Sand #1 (deep monitoring zone). The purpose of this well will be to detect potential lixiviant migration from the K Sand into the Deep Sand #1. Action levels for this well will be set using the UCLs established for the other monitoring wells that are completed in Deep Sand #1.

The second well will be constructed to monitor the lower part of the K Sand north of where the K Sand is split horizontally by a clay layer. This well should be located approximately on an imaginary line that connects wells 5MW12 and 5MW5. Action levels for this well will be set using the UCLs established for the perimeter ore zone monitoring wells.

These two trending wells will be monitored at the same two week frequency used for the larger network of monitoring wells.

[Applicable Amendments: 38]

10.12 The licensee will not commence mining in the lower part of the K Sand in Mine Unit 5 north of an imaginary line that connects wells 5MW10 and 5MW3 until additional hydrological data verifying the vertical isolation of the Deep Sand #2 from the lower part of the K Sand is provided and approved by the NRC.

## Section 11.0: Monitoring, Recording, and Bookkeeping Requirements

11.1 The licensee shall establish Upper Control Limits (UCL) for each mining unit, prior to operation, in accordance with Section 5.8 of the application. UCLs shall be applied to all monitor wells in conformance with the application. Lixiviant excursions shall be verified and monitored in conformance with the application. Corrective actions for confirmed excursions may be, but are not limited to, those described in the application.

An excursion is considered concluded when two of the three UCLs are below the concentration levels defining an excursion for three consecutive 1 week samples.

[Applicable Amendments: 3, 7, 8, 9, 10, 11, 12, 22, 29, 31, 32, 33, 34, 35, 36, 38]

11.2 The results of sampling, analyses, surveys and monitoring, the results of calibration of equipment, reports on audits and inspections, all meetings and training courses required by this license and any subsequent reviews, investigations and corrective actions, shall be documented. Unless otherwise specified in the NRC regulations, all such documentation shall be maintained for a period of at least 5 years.

11.3 The RSO or his designee shall document a daily walkthrough of the Irigaray and Christensen Ranch Satellite facilities to determine if radiation control practices are being implemented. This is in addition to the inspection and audit programs described in the application.

[Applicable Amendments: 10]

11.4 Occupational exposure calculations for soluble uranium shall be performed and documented within 1 week of the end of each regulatory compliance period as specified in 10 CFR 20.1201(e). Routine radon daughter and particulate samples shall be analyzed in a timely manner to allow exposure calculations to be performed in accordance with this condition. Nonroutine samples shall be analyzed and the results reviewed by the RSO within 2 working days after sample collection.

[Applicable Amendments: 36]

11.5 The licensee shall sample particulates and radon daughters on a monthly frequency at the Irigaray and Christensen Ranch Satellite locations as described in the application.

[Applicable Amendments: 3, 10, 11, 15]

11.6 The licensee shall implement the respiratory protection program as described in the application.

[Applicable Amendments: 3, 11]

11.7 The licensee shall implement the bioassay program discussed in Regulatory Guide 8.22 and the application.

[Applicable Amendments: 10]

11.8 The licensee shall monitor for external exposure in accordance with 10 CFR

20.1502(a)(1). The licensee shall monitor for internal exposure in accordance with 10 CFR 20.1502(b)(1).

[Applicable Amendments: 3]

11.9 The licensee shall perform and document weekly visual inspections of the Irigaray and Christensen Ranch Satellite evaporation pond embankments, fences, and liners, as well as measurements of pond freeboard and checks of the leak detection system standpipes.

[Applicable Amendments: 4, 10, 14, 36]

11.10 As part of the licensee's groundwater monitoring program, they shall conduct annual sampling and analysis for chloride and conductivity from 517 and USMT Wells M-1, NM-3, M-4, SM-1, M-219, M-220, and M-221.

**Section 12.0: Reporting Requirements**

12.1 The results of effluent and environmental monitoring described in the application shall be reported in accordance with 10 CFR 40, Section 40.65, to the NRC.

[Applicable Amendments: 3, 6, 8, 10]

12.2 Anytime 6 vertical inches or more of fluid is found in an evaporation pond leak detection system standpipe, it shall be analyzed for chloride, conductivity, pH and uranium. Should analysis indicate that a pond is leaking, the NRC shall be notified within 48 hours of verification and the pond level lowered by transferring its contents into an alternate cell. Standpipe water quality samples shall be analyzed for chloride, conductivity, pH and uranium once every 7 days during the leak period and once every 7 days for at least 2 weeks following repairs.

A written report shall be filed with the NRC, within 30 days of first notifying the NRC that a leak exists. This report shall include analytical data and describe the mitigative action and the results of that action.

[Applicable Amendments: 4, 10, 14, 36]

12.3 In the event a monitor well is verified to be in excursion status, the NRC shall be notified, by telephone with 24 hours and within 7 days in writing from the time the confirmation sample was taken. The report shall describe the excursion event, corrective actions taken and results obtained to date.

Written progress reports describing the status of the excursion shall be submitted on a quarterly basis until the situation has been mitigated.

[Applicable Amendments: 3, 7, 8, 9, 10, 11, 12, 22, 29, 31, 32, 33, 34, 35, 36]

12.4 The licensee shall report incidences in accordance with 10 CFR 20.2202. Additionally, 1 month subsequent to a reportable incident, a written report shall be submitted to the NRC detailing the conditions leading to the incident, corrective actions taken, and results achieved.

[Applicable Amendments: 10, 36]

12.5 The licensee shall submit a detailed decommissioning plan for the Irigaray, and Christensen Ranch Satellite facilities to the NRC at least 12 months prior to planned shutdown of mining operations.

[Applicable Amendments: 14, 37]

12.6 The licensee shall conduct restoration activities in accordance with the groundwater restoration plan included in the Reclamation Plan of the application. Target Restoration Values shall be as described in the Reclamation Plan of the application.

[Applicable Amendments: 7, 15, 16, 17, 19, 23, 25, 28, 34, 36]

12.8 The licensee shall submit to the NRC a copy of the annual ALARA report as specified in the application within 2 months of the end of the reporting period.

[Applicable Amendments: 3, 10]

FOR THE NUCLEAR REGULATORY COMMISSION

Dated: _____

Joseph J. Holonich, Chief High-Level Waste and
Uranium Recovery Projects Branch.
Division of Waste Management
Office of Nuclear Material Safety and Safeguards

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# 1.0 PROPOSED ACTIVITIES

## 1.1 LICENSING ACTION REQUESTED

This application is made by COGEMA Mining, Inc. (COGEMA) for renewal the United States Nuclear Regulatory Commission (USNRC) Source Material License No. SUA-1341 for the continuation of in situ mining operations at the Irigaray/Christensen Ranch facilities located in Johnson and Campbell counties, Wyoming. This application is also being made to the Wyoming Department of Environmental Quality (WDEQ) as an update to Permit to Mine No. 478, Amendment No. 2.

The renewal application has been prepared using suggested guidelines and standard formats from both state and federal agencies. The application is primarily structured in the USNRC format of Regulatory Guideline No. 3.46.

This renewal application essentially updates the Irigaray and Christensen Ranch commercial ISL uranium mining operations since 1987, the time of the last USNRC license renewal and the issuance of Amendment No. 2 to Permit to Mine No. 478. This introductory section will briefly summarize the project ownership history, the projects themselves. The last of this section will concentrate on the document itself, and changes that have been incorporated since the last license renewal and permit update.

In addition to the request to renew License SUA-1341, COGEMA is also asking the USNRC to renew the license in a performance based format, based on the content of this application. If at all possible, COGEMA requests that the license be re-issued for a ten year period, rather than the normal five year period, as it will be a performance based license which allows updating of the application for certain operations on an annual basis.

## 1.2 PROJECT AND OWNERSHIP HISTORY

### 1.2.1 PROJECT OWNERSHIP HISTORY

The Irigaray project was licensed for commercial ISL uranium operation in August 1978. The project was then owned and operated by Wyoming Mineral Corporation, a subsidiary of Westinghouse Electric Corporation. The Irigaray project was licensed to operate at an 800 gallon per minute (gpm) flow rate, using an ammonium bicarbonate lixiviant. Due to the difficulties with restoring formations mined with ammonia, the lixiviant was changed to sodium bicarbonate in 1980. The uranium (yellowcake) dryer at the Irigaray facility was operated non-continuously during 1980. Additionally, the use of sodium bicarbonate was discontinued in the uranium

precipitation cycle in the processing plant in factor of precipitation with hydrogen peroxide. In 1982, operations ceased at the Irigaray plant and wellfields, and the facility was placed on standby status pending improvements in the uranium market.

In June of 1987, Malapai Resources Company (a subsidiary of Arizona Public Service) purchased the Irigaray site from Westinghouse and resumed operations. In 1988, Malapai amended the WDEQ Permit 478 and USNRC SUA-1341 Irigaray permits and license to include the Christensen Ranch satellite ion exchange plant and associated mine units. The Irigaray process was then upgraded to include facilities for processing ion exchange resin from Christensen Ranch, and the flow rate of the Irigaray recovery plant was increased to a 2,400 gpm capacity. Although the dryer unit was available for processing the uranium, Malapai chose to ship a slurry product for economic reasons. Malapai Resources Company continued operations through February of 1990. Due to financial difficulties within Arizona Public Service, Malapai Resources Company was sold to Electricite de France (EdF), the French Nuclear utility, in September 1990. EdF chose not to operate the Irigaray site themselves, and selected another French company, Total Minerals Corporation (TOMIN), to be the operator of the Irigaray and Christensen Ranch projects. Effective September 20, 1990, all State and Federal permits and licenses formerly held by Malapai were transferred to TOMIN. TOMIN resumed operations of the Malapai properties in 1991.

In April 1993, a large stock exchange occurred in France between COGEMA and TOTAL (parent of Total Minerals Corporation), in which TOTAL acquired 10% of COGEMA stock and, in return, COGEMA acquired all of TOTAL's uranium properties in the world, plus stock in TOTAL. As a result, COGEMA acquired the operatorship of the EdF Malapai properties in Wyoming and Texas. The exchange was formalized in July, 1993, and in November, 1993 the name of Total Minerals Corporation was changed to COGEMA Mining, Inc. (COGEMA). COGEMA maintains its operational offices in Mills, Wyoming.

Operations continue under COGEMA management. Well field activities at the Irigaray site are now completely in the restoration phase. Uranium slurry produced at the Christensen Ranch satellite ion exchange plant is processed to yellowcake form at the Irigaray central plant. Operations at Christensen Ranch include production from Mine Units 2, 4, and 5, with Mine Unit 3 in standby pending groundwater restoration. Orebody delineation and monitor well installation is in progress in Mine Unit 6. It is expected that Christensen Ranch will produce upwards of 750,000 pounds of uranium in 1996.

### 1.2.2 LOCATION AND LAND OWNERSHIP

The Irigaray and Christensen Ranch projects are in-situ leach (ISL) uranium mining operations located approximately 55 miles southeast of Buffalo, Wyoming, and 51 miles northeast of Midwest, Wyoming.

The site is actually composed of two distinct areas. The first area, generally referred to as the Irigaray site or the Irigaray central plant, is located in southeast Johnson County, Wyoming. The deposit is one of many located in the Powder River Basin in northeast Wyoming. The property consists of approximately twenty-eight square miles within Townships 45, 46, 47 North, Ranges 77 and 78 West. The current mine site is located within Sections 5, 8, 9 and 16 of Township 45 North, Range 77 West.

Interest/ownership of lands which make up the approximately 21,100 acres of leases and Federal unpatented lode mining claims located in the Irigaray property are owned by the following:

**TABLE 1.1**
**IRIGARAY LAND OWNERSHIP**

| SURFACE OWNERSHIP | MINERAL OWNERSHIP |
|---|---|
| L. Brubaker, et al. | Irigaray and BLM |
| Bureau of Land Management | Bureau of Land Management (BLM) |
| State of Wyoming | State of Wyoming |
| Steeter | BLM and Streeter |

Land or mineral ownership of the Irigaray area has not changed significantly since the issuance of the Final Environmental Statement for the Irigaray Site, NUREG-0481, in 1978, nor are any future changes foreseen at this time. Maps of the surface and mineral ownership are discussed in Chapter 2.0, Section 2.1, "Site Location and Layout", of this renewal application.

The second area is the Christensen Ranch wellfield and satellite operation (ion exchange plant), which is located approximately 13 miles southeast of the Irigaray site. The Christensen Ranch operations consist of approximately 14,000 acres in Townships 44 and 45 North, Ranges 76 and 77 West in Johnson and Campbell Counties, Wyoming. COGEMA maintains approximately 600 unpatented lode mining claims and two State mining leases within and surrounding the Christensen Ranch area. Ownership of the property is as follows:

TABLE 1.2
CHRISTENSEN RANCH LAND OWNERSHIP

| SURFACE OWNERSHIP | MINERAL OWNERSHIP |
|---|---|
| Bureau of Land Management (BLM) | BLM |
| State of Wyoming | State of Wyoming |
| John O. Christensen | John O. Christensen, et al. and BLM |

### 1.2.3 DESCRIPTIONS OF EXISTING FACILITIES

Roll-front uranium mineralization is present at the both the Irigaray and Christensen Ranch properties in the Wasatch formation. Remaining reserves on the entire Irigaray property controlled by COGEMA is approximately seven million pounds. Reserves remaining on the Christensen Ranch property are approximately thirteen million pounds in today's low value uranium market.

Previous mining operations at the Irigaray Site were conducted in twelve acres of wellfield (Production Units 1 through 5) in 1978 through 1981 by Westinghouse. Production Units 6 through 9 were operated by Malapai in 1987 through 1990, in addition to continued operations in Units 1 through 5. Restoration of Units 1 through 3 began in 1990 and stabilization monitoring ended at the beginning of 1994. Restoration in Units 4 and 5 began in 1992, was temporarily suspended in 1994, and resumed in April, 1995 in combination with restoration in Units 6 through 9. Restoration of all units is expected to be completed by 1998.

Operations at Christensen Ranch began in April, 1989 in Mine Unit 3. Operations were suspended in February, 1990 with the sale of the company. Operations in Mine Unit 3 resumed in 1992, as well as the startup of Mine Unit 2. Mine Unit 4 came on line in 1994, and Mine Unit 5 in 1995. Mine Unit 3 is now in standby status pending aquifer restoration.

Processing facilities include the central plant at Irigaray which is an average 2,400 gpm ion exchange plant in addition to the other circuits common to both Irigaray and Christensen processing such as the resin elution, precipitation and drying/packing circuits. The Christensen Ranch satellite extraction plant consists of an ion exchange circuit which will be operated at a flow rate of 3,600 gpm on an annual average, and a lixiviant makeup circuit. Water treatment processes such as reverse osmosis are used to clean well field bleed water for use in future restoration. Uranium-laden resin from the ion exchange columns will periodically be transferred to a tanker trailer and

trucked to the Irigaray central plant for elution, final uranium precipitation, and drying.

Drying capability at the Irigaray plant is equivalent to approximately 2.5 million pounds throughput per year. COGEMA now accepts slurry product from its own operations in Texas; toll drying of other licensee's uranium may be considered in the future.

Wastewater disposal capability includes evaporation in lined ponds, storage of cleanwater (reverse osmosis permeate) in clay lined ponds, treatment and disposal via surface discharge under a Wyoming NPDES permit, and deep well injection. Solid wastes are transported to an industrial landfill (non-radioactive) and byproduct materials are transported to Pathfinder Mines Corporation's Shirley Basin tailings facility for final burial.

## 1.3 SUMMARY OF OPERATIONAL CHANGES SINCE LAST RENEWAL

Since the last license renewal in March, 1987, several significant operational changes have occurred. The first and most obvious is the amendment of the entire Christensen Ranch operations into the Irigaray license, and WDEQ Permit to Mine, in 1988. Other changes over the past seven years, as well as planned changes for the future, are discussed in the following sections of this document:

1.0 Proposed Activities
2.0 Site Characteristics
3.0 Mine Plan
4.0 Effluent Control Systems
5.0 Operations
6.0 Restoration and Reclamation Plan
7.0 Environmental Effects
8.0 Alternatives to Proposed Action
9.0 Benefit-Cost Summary
10.0 Environmental Approvals and Consultations

Changes or updates specifically included in each of the above sections are:

<u>Section 1.0, Introduction</u>

- Summary of mine plan status for Irigaray and Christensen Ranch.

<u>Section 2.0, Site Characteristics</u>

- Incorporation of both Irigaray and Christensen Ranch background data into one section.

- Incorporation of new background data collected since 1987, where appropriate.

Section 3.0, Mine Plan

- Combination of both Irigaray and Christensen Ranch revised and updated mine and development plans into one plan.

- Updated estimates of disturbance for each site.

- Updated reserve estimates and development schedule.

- Updated facilities location maps, mine unit and development area locations, and areas mined to date.

- Deletion of the plan for four satellite plants in each of four operational phases at Christensen Ranch; phase areas are now called geographical areas of the permit area.

- Incorporation of the 2,400 gpm annual average production flow rate for Irigaray (amended upwards in 1989).

- Incorporation of a 3,600 gpm annual average flow rate at the Christensen Ranch satellite (currently licensed for 2,500 gpm annual average), and increase in annual yellowcake production estimates, including a 2.5 million pound throughput. Includes the addition of process equipment to accommodate the flow increase (one sand filter, two ion exchange columns and a 40′ extension to the plant building).

- Updated discussion of the drying and packaging unit at Irigaray; includes the possibility of toll-drying other licensee's yellowcake product.

- Updated flow and material balance process sheets for Christensen Ranch and Irigaray.

- Updated equipment lists for both the Irigaray central plant and the Christensen satellite plant.

- Incorporation of a new generic low water crossing design in place of the previous low water crossing design for Willow Creek, or other significant drainages.

- Incorporation of topsoil volumes stockpiled.

Section 4.0, Effluent Control Systems

- Discussion incorporates both Irigaray and Christensen Ranch effluent control and disposal systems.
- Incorporation of a detailed dryer description, with recent stack emissions survey results.
- Discussion of the new disposal well at Christensen Ranch.

Section 5.0, Operations

- Recent revisions to COGEMA's management structure are addressed.
- A discussion of the Safety and Environmental Review Panel (SERP) for the performance based license is provided.
- Contents of the training programs have been incorporated.
- Results of environmental and radiological monitoring programs from 1987 through 1994 are summarized and included for each facility.
- Proposed radiological and non-radiological monitoring programs for future operations based on historical data; includes changes made for the new 10 CFR 20, revised monitoring locations for radon, uranium airborne particulate, and regional groundwater monitoring, and a new proposed ALI and DAC for Unat based on actual solubility test results.
- Revision to the mine unit groundwater quality baseline program to change from one baseline well per acre of well field to one baseline well per four acres of well field; standardization of the baseline water quality program for both Irigaray and Christensen.
- Standardization of the upper control limit calculation methods for Irigaray and Christensen monitor wells.
- Revision to the chloride upper control limit calculation method from baseline average plus five standard deviations to baseline average plus 15 mg/l.
- Inclusion of all current upper control limits for all Irigaray and Christensen Ranch monitor wells.

Section 6.0, Restoration and Reclamation Plan

- Summaries of past groundwater restoration activities at Irigaray and Christensen Ranch.
- Revised restoration plan for Christensen Ranch and future well fields.
- Updated financial surety estimate included for 1995-1996 (previously submitted to USNRC and WDEQ).

Section 7.0, Environmental Effects

- Inclusion of results of new MILDOS computer modeling; worst case analysis includes Irigaray and Christensen Ranch both in full production (2400 and 3600 gpm each), with dryer operating at 2.5 million pounds/year.
- Completely revised Section 7.3 - Radiological Effects, based on new 10 CFR 20, new MILDOS modeling and EPA guidance.
- Incorporation of a discussion of incidents, including excursion history since 1987, well field spills, the yellowcake thickener incident and repair of the permeate storage pond.

Section 8.0, Alternatives to Proposed Action

- Generally updated.

Section 9.0, Benefit-Cost Summary

- Generally updated.

Section 10.0, Environmental Approvals and Consultations

- Incorporation of a listing of current primary licenses and permits.

# 2.0 SITE DESCRIPTION AND CHARACTERISTICS

## 2.1 AREA LOCATION AND DESCRIPTION

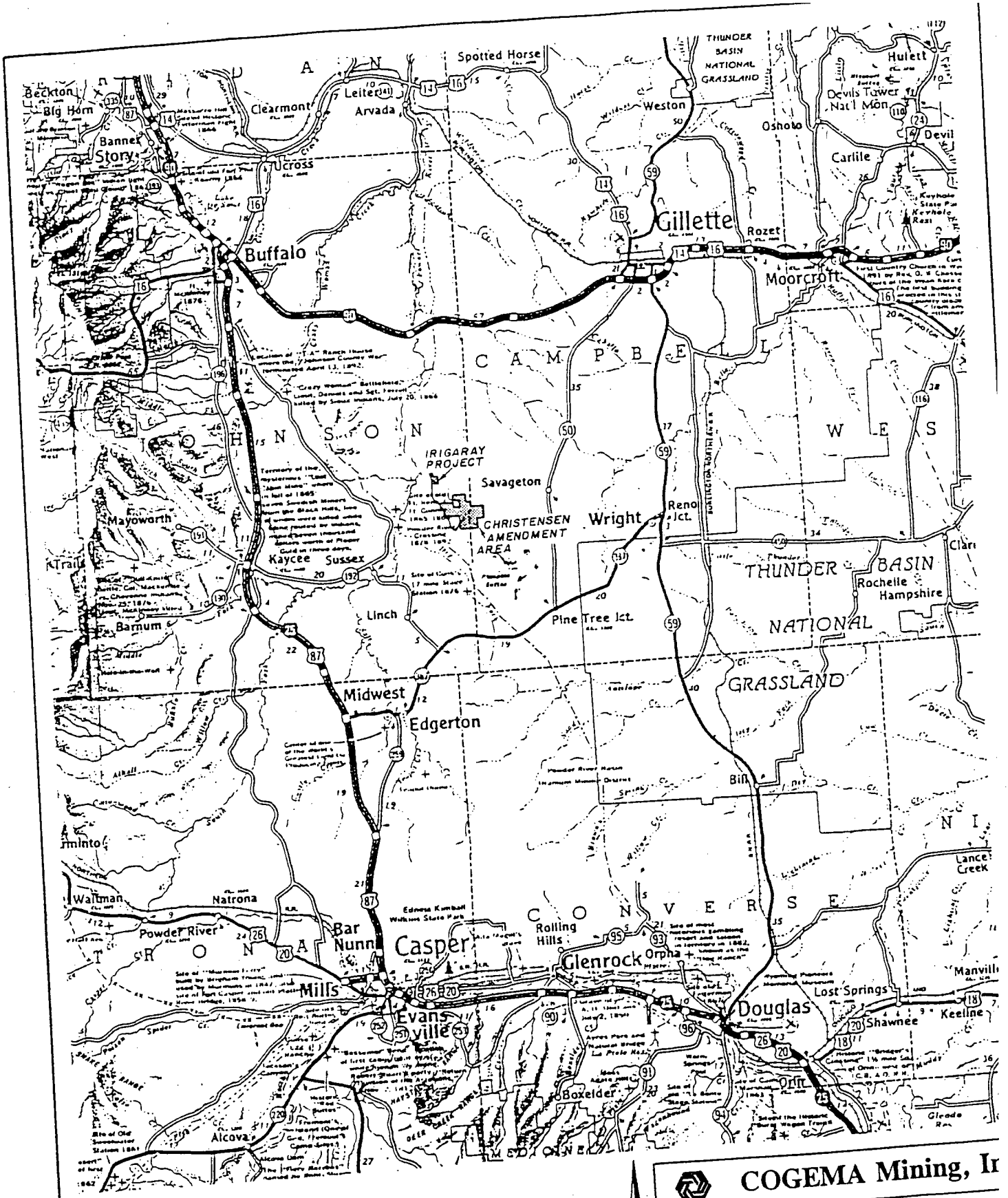
The Irigaray and Christensen Ranch permit areas contain approximately 15,000 acres located within the southern portion of the Powder River Basin. The Powder River Basin is a part of the Great Plains physiographic province and is a structural and topographic basin of approximately 64,750 $km^2$ (25,000 square miles) located in eastern Wyoming and southern Montana. The basin is bounded on the east by the Black Hills and on the west by the Bighorn Mountains. Its southern boundary is the Laramie Range and Hartville uplift and the Miles City Arch in Montana forms the basin's northern extent. The most dominant topographic features within the area are the Pumpkin Buttes. The Christensen Ranch area lies at the base of the North Pumpkin Butte to the northwest and is dissected by the Johnson/Campbell County line with portions of the area in each county. The Irigaray project is located approximately 5 miles to the northwest of the Christensen permit boundary (see Figure 2.1). Surface configurations of the properties are characterized by rolling uplands which are dissected by sharp, deeply cut drainages. The primary drainage within both the Irigaray and Christensen Ranch permit areas is Willow Creek, an ephemeral tributary to the Powder River, which enters the southeast corner of each property and proceeds through each in a northwesterly direction to the Powder River. Most drainage in the area flows into Willow Creek via a series of sharply cut side drainages which are normally dry. Elevations range from 1300 m (4300 feet) where Willow Creek leaves the area in the far northwest corner of the Irigaray permit area to almost 1585 m (5200 feet) where the eastern boundary of the Christensen Ranch permit boundary crosses the toe of the North Butte slope. Table Mountain is the high point between the two projects, located in the western part of the Christensen Ranch property at 1482 m (4861 feet) and the higher elevation in the southern parts of the area are around 1518 m (4980 feet). General topography of the project areas and its surroundings may be seen on Figure 2.1.

## 2.2 LAND AND WATER USE AND OWNERSHIP

Surface ownership of the projects is approximately half privately owned and the other half BLM and State lands. Oil production is the other major mineral activity in the area.

### 2.2.1 AREA AND ADJACENT LANDS

The Irigaray and Christensen Ranch project lands have historically been used for livestock grazing by both sheep and cattle. The Christensen Ranch no longer has any sheep and presently the lands are used for cattle grazing and mineral exploration. The




COGEMA Mining, In

**Irigaray and Christensen Ranch Area General Location Map**

| | | |
|---|---|---|
| REVISED: 2/1/95 | SCALE: As Noted | FIGURE: |
| DRAWN BY: PAS | DATE: 9/1/87 | |

use of the land for the immediate future includes in-situ uranium mining on a commercial scale (see Appendix D1 of the Irigaray and Christensen Ranch permit applications). Surface owner consent to develop commercial scale mines within the permitted areas has been obtained from the private landowners. Subsequent to the mining activities the land will be returned to the pre-mining use of cattle grazing. The reclamation plan to be used to return the land to cattle grazing use after mining is included in Section 6 of this application. Names and addresses of the surface and mineral owners of record within the Irigaray and Christensen Ranch areas are given in each project's permit to mine applications in the Adjudication File, Appendix A. Names and addresses of the surface owners and mineral owners of record within one-half mile (.8 km) adjacent to the areas are also given in the Adjudication File, Appendix B. These appendices also list owners of record with valid legal estate in the permit areas and on adjacent lands. Appendix C of the Adjudication Files lists all lands included within permit areas by section, township and range and gives an acreage tabulation. The Christensen Ranch permit area contains approximately 14,000 acres, and the Irigaray permit area includes approximately 1,000 acres.

### 2.2.2 AGRICULTURE ACTIVITY

Livestock grazing is the main source of food production and agriculture activity in the area. Due to the short growing season the forage provided by natural vegetation, although nutritious, is very sparse. According to personnel from the U.S.D.A. Soil Conservation Service Office in Gillette, the stocking rate in the vicinity of the projects averages .28 (AUM), or animal units per acre per month, on range that is in good condition. Some of the better lands along Willow Creek in the northwestern portion of the Christensen Ranch project area are cut for native hay production. There is also a small hay field in the southeast corner of the Christensen Ranch project area where alfalfa and intermediate wheat grasses have been seeded for hay production. These areas average about 1 ton per acre and the hay is used for winter livestock feed. There are no known commercial row or grain crops within or adjacent to the projects.

### 2.2.3 RECREATION

The Irigaray and Christensen Ranch areas are not well suited for many recreational activities such as camping, fishing, picnicking, hiking, skiing and snowmobiling, which are most often done in the national forest areas of the Bighorn Mountains over 50 miles (80 km) to the west of the sites. The area does, however, get some use by antelope and deer hunters during fall hunting seasons.

### 2.2.4 WATER RIGHTS

Water rights of record were obtained from the Wyoming State Engineer's Office for the project areas and adjacent areas within three miles for the initial permitting in 1978 (Irigaray) and 1988 (Christensen Ranch).

Groundwater rights of record are listed, mapped and discussed for each project in Appendix D6 of the individual mine permit application documents. They include established groundwater rights for several domestic wells, livestock wells, several miscellaneous wells and industrial wells in and adjacent to the project areas.

Surface water rights of record are listed, mapped and discussed in Appendix D6 of each project's mine permit application. Surface water rights in the area are generally livestock related. They include several surface water reservoirs ranging in capacities from 8.4 to 402 acre feet. Most of these reservoirs are adjacent to the project areas.

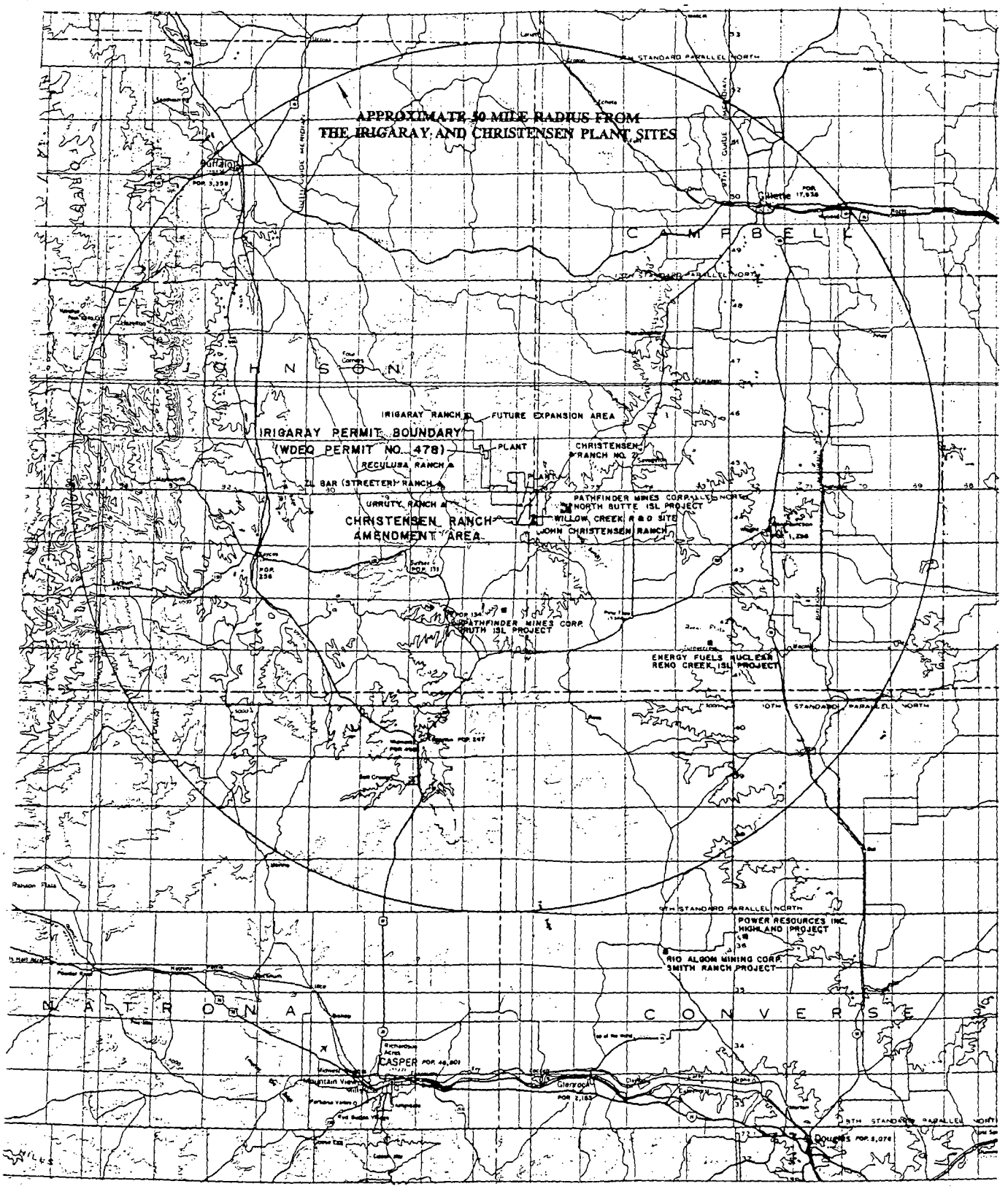
### 2.2.5 PROTECTION OF OTHER MINERAL RESOURCES

Other mineral resources within the project area have not been affected by the ISL mining operations. Other uranium facilities in the vicinity are shown on Figure 2.2. Oil and gas production within and adjacent to the Christensen Ranch area include the Heldt draw unit of the Table Mountain oil field. There are 24 oil wells within the Christensen Ranch area; of these, 17 are currently producing and seven have been abandoned. There are no oil wells within the Irigaray project area. Information on the oil and gas interests as well as all other mineral rights of record are detailed in Appendices A and B of the Adjudication File for each project area and adjacent areas, respectively. Owners of all mineral interests within the project areas and adjacent lands within one-half mile were notified by certified mail of the proposed in-situ leach mining activities during the initial permitting. COGEMA has worked with owners of other mineral interest to obtain a mutually agreeable upon solution to any conflicts which arise. It is unlikely that any subsurface problems will be encountered with oil wells because those in the area are much deeper than the uranium deposits. Potential hazards do exist with well field installations around the oil field equipment, especially where oil and gas lines have been buried. Appropriate considerations which include surveys of the buried equipment locations and well field engineering and planning in cooperation with the oil field operators will be conducted so as to avoid potential hazards and conflicts in advance of well field installations.

## 2.3 REGIONAL DEMOGRAPHY AND SOCIOECONOMICS (POPULATION DISTRIBUTION)

### 2.3.1 DEMOGRAPHY

Both the Irigaray and Christensen Ranch areas are isolated from any significant population centers. The closest resident to the Christensen Ranch satellite plant site is the Christensen Ranch house and headquarters located approximately 3 miles southeast of the satellite plant site. The nearest residence to the Irigaray process plant is the Irigaray Ranch, located 4 miles to the north. There are six other known ranching operations scattered around the projects ranging from 6 miles to 13 miles




## LEGEND

- ■ ISL MINE SITE
- ▲ RANCH
- • SMALL TOWN OR JUNCTION
- ● LARGE TOWN, COUNTY SEAT

POPULATIONS FROM 1990 CENSUS

N

SCALE

0 5 MILES 10 MILES 20 MILES

**COGEMA Mining, Inc**
P.O. Box 730 Mills, Wyoming 82644

**Irigaray and Christensen Ranch**
JOHNSON & CAMPBELL COUNTIES, WYOMING

TITLE:

**POPULATION CENTERS WITHIN A 50 MILE RADIUS OF THE IRIGARAY AND CHRISTENSEN RAN PLANT SITES**

DATA BY: D. WICHERS | DATE: 11-6-97 | FIGURE:
REVISED: 2-7-98

straight line distance from each project's plant centers. These scattered ranch residences are typical of the ranch population in the Powder River Basin. Additionally, there are four other uranium ISL operations located or proposed within a 50 mile radius of the Irigaray and Christensen Ranch projects. These operations are listed in Table 2.1. Table 2.2 provides an updated population estimate for ranches within a 50 mile (80 km) radius of the project sites.

Additional populations surrounding the project areas are concentrated in small towns and settlements which are also scattered. Most of these are associated with local livestock interests, oil production activities or coal mines in the area. Kaycee, Midwest, Linch and Edgerton are examples of settlements within an 80 km (50 miles) radius of the site.

The vast majority of the population in the area is located within the larger towns. Figure 2.2 shows the locations of towns and settlements in relationship to an 80 km (50 miles) radius from each project's plant center. Populations of the larger settlements and towns are also given in Table 2.2.

Transient population in the vicinity is primarily tourists who use the campgrounds, motels and other travel facilities along the main interstate highways. These include Interstate Highway 25 which is a north-south route between Casper and Buffalo, Wyoming, and Interstate Highway 90, an east-west route between Gillette and Buffalo, that provides access to the Bighorn Mountains, Yellowstone and Grand Teton National Parks in the western part of Wyoming.

### 2.3.2 SOCIOECONOMICS

There are three counties which have been affected to some degree by the Irigaray and Christensen Ranch operations. Although the project areas are located within Johnson and Campbell counties, the city of Casper, Wyoming, located in Natrona County, is the largest and closest industrial city to the site. Due to its industrial services and transportation facilities, COGEMA Mining, Inc. has established its operational headquarters in Casper. The majority of all employees (approximately 50) reside in Buffalo, Casper, Kaycee or Gillette, Wyoming. There are no other plants, schools, hospitals, sports facilities, parks or residential areas within 3.3 km or two miles of the project areas. According to the most recent county and community profile information from the Gillette-Campbell County, Buffalo-Johnson County and Casper-Natrona County areas, the majority of these services are contained within the three communities named, each of which is the county seat for the respective counties.

The Campbell County school district operates one high school, one combined high school/junior high school, two junior high schools, two rural elementary schools and eight elementary schools within the Gillette city limit. The closest Campbell County rural school is located at Savageton, 13 miles east of the Christensen Ranch. This

## TABLE 2.1

## OTHER URANIUM SOLUTION MINING OPERATIONS WITHIN A 50 MILE RADIUS OF THE IRIGARAY AND CHRISTENSEN RANCH PROJECTS

| Operation | Status | Direction and Distance from Christensen Ranch Plant |
|---|---|---|
| Pathfinder Mines Corporation North Butte Project | Commercial ISL License | ESE 5 miles |
| Pathfinder Mines Corporation Ruth Project | Commercial ISL License | S 12.5 miles |
| Energy Fuels Nuclear Reno Creek Project | Commercial ISL - Application in progress | ESE 27 miles |
| Power Resources, Inc. Highland Project | Commercial ISL License - operating - | SE 51 miles |

## TABLE 2.2

## RANCH AND TOWN POPULATIONS NEAR THE IRIGARAY AND CHRISTENSEN RANCH PLANT SITES
(1990 Census and 1995 Communications with Local Ranches)

| Name | Distance and Direction from Irigaray Plant site | Distance and Direction from Christensen Plant Site | Population |
|---|---|---|---|
| John Christensen Ranch | 11 miles SE | 3 miles SSE | 4 |
| Reculusa Ranch | 4 miles WSW | 9 miles WNW | 3 |
| ZL Bar Ranch (Streeter) | 6 miles WSW | 10 miles W | 9 |
| Christensen Ranch #2 | 10 miles E | 8 miles NE | 3 |
| Urruty Ranch | 8 miles SW | 9 miles W | 2 |
| Irigaray Ranch | 4 miles N | 11 miles NW | 6 |
| Brown Ranch | 14 miles SE | 9 miles SSE | 12 |
| Pfister Ranch | 13 miles ESE | 6 miles ESE | 6 |
| Sussex | 15 miles SW | 15 miles WSW | 111 |
| Linch | 20 miles SSW | 17 miles SW | 134 |
| Wright | 31 miles ESE | 28 miles E | 1,236 |
| Edgerton | 32 miles S | 29 miles SSW | 247 |
| Midwest | 33 miles SSW | 30 miles SW | 495 |
| Kaycee | 28 miles WSW | 32 miles W | 256 |
| Gillette | 42 miles NE | 43 miles NNE | 17,635 |
| Buffalo | 42 miles NW | 50 miles NW | 3,358 |

school is a one room trailer with enrollment design capacity for 20 students. The last known enrollment figure was 14 students. The student to teacher ratio is 14 to 1 in the county school system.

The Johnson County school district has two high schools, one middle school, three elementary schools and two rural elementary schools. These include one elementary school at Linch, 17 miles southwest of the Christensen Ranch site, with an enrollment of 24 students. There is a high school and elementary school at Kaycee, 32 miles west of the site, with total enrollment of 202 students. The student to teacher ratio at the elementary levels is 14 to 1 and 12 to 1 at the high school level in the county school system.

The closest medical facility to the projects is the 130 bed Campbell County Memorial Hospital located at Gillette, 43 miles to the north northeast of the Christensen Ranch. The Johnson County Memorial Hospital at Buffalo, 55 miles northwest of Irigaray, has a 44 bed capacity. There are 5 doctors and 3 dentists in the Buffalo area serving Johnson County and some 30 doctors and 11 dentists in the Gillette Campbell County area.

Buffalo has a police department of eight which is augmented by the Johnson County Sheriffs department. Gillette has a 35 officer police department augmented by the Campbell County Sheriffs department with 40 deputies. Fire protection in both counties are handled by the county and include volunteer fire fighters.

1988 figures on housing and occupancy for Buffalo in the Johnson County, Gillette and the surrounding area are provided in Table 2.3. Single family dwellings made up 74% of the available housing in the Buffalo, Johnson County area while they were only 46% of the available housing in the Gillette and surrounding Urban Service areas. Vacancy rates were approximately 4.8% in Johnson and 10.8% in Campbell County at this time.

In 1988, the total assessed tax value of Johnson County was $122,404,049 of which $10,727,427 was assessed within the Buffalo City Limit. Total assessed tax value of Campbell County was $1,738,582,032 with $56,133,821 belonging to the city of Gillette.

Major industries listed for Johnson County include tourism, agriculture and oil production, while Campbell County's major industries are coal mining, oil and gas production and agriculture. In 1988, Johnson County boasted a total labor force of 3,829 from the city of Buffalo and a 70 mile radius around it. Campbell Counties total labor force was approximately 17,150. Unemployment figures were 5.8% and 5.5% for Johnson and Campbell Counties, respectively.

## TABLE 2.3

## JOHNSON AND CAMPBELL COUNTIES HOUSING AVAILABILITY 1985

| | Buffalo and Johnson County | | Gillette and Campbell County | |
|---|---|---|---|---|
| | occupied | vacant | occupied | vacant |
| Single Family Dwellings | 1858 | 88 | 4122 | 362 |
| Mobile Homes | 479 | 23 | 2120 | 429 |
| Multi Family | 140 | 7 | 2194 | 180 |
| Other | 20 | 1 | 573 | NA |
| TOTALS | 2497 | 119 | 9009 | 971 |

Table 2.4 shows the distribution of the majority of the labor force in the two counties.

According to the Wyoming Data Handbook, 1985, prepared by the Department of Administration and Fiscal Control, Division of Research and Statistics, 7th Edition, Wyoming leads the nation in production of bentonite and trona, is second in production of uranium and coal products, sixth in oil and seventh in natural gas production. Table 2.5 shows the population growth from 1960 through 1980 by counties and larger towns. With the economic decline in energy related industries, such as the drop in oil and gas prices, drop in uranium prices and softening of the coal market during the early 1980's, there has been a decline in population and increase in unemployment which coincide with the loss of work associated with the mineral related industries. Table 2.6 shows this decrease along with the projected population forecasts in each county to 1995. This area of Wyoming is rich in minerals and while the agricultural interests have been relatively stable through the years, the main factors affecting population density are related to the fortune and fluctuations of the mineral and related support industries.

## 2.4 REGIONAL HISTORICAL, ARCHAEOLOGICAL, ARCHITECTURAL, SCENIC, CULTURAL AND NATIONAL LANDMARKS

Archaeological and paleontological clearance was provided to the Irigaray project by the Wyoming State Archaeologist in 1977. The Irigaray area is of a relatively small size, and did not support any archaeological sites. There is one historic marker, Fort Reno, six miles to the southwest of Irigaray. The State Historic Preservation office has indicated that a site called Reno Cantonment locate 10 miles southwest of Irigaray, is nominated to the National Register of Historic Places.

Archaeological and paleontological investigations were conducted on portions of the Christensen Ranch permit area during the fall of 1986. These investigations included a Class III Historical Cultural Resource Inventory, a Class III Prehistoric Cultural Resource Inventory and an Inventory of Paleontological Resources, all covering 7,082 acres or 52 percent of the permit area. Detailed results of these studies are provided in Appendix D2 Historical Cultural Resources, Appendix D3A Prehistoric Cultural Resources and Appendix D3B, Paleontological Resources of the Christensen Ranch permit application.

Two historic sites, 61 prehistoric sites and five sites with both prehistoric and historic components were evaluated. Six historic and 55 prehistoric isolates were recorded. None of the 68 sites was determined to be eligible for the National Register of Historic Places (NRHP). Cultural resource clearance was recommended for these sites. There were three isolated paleontological specimens recorded. They were bone fragments, the only identifiable one appearing to be the pelvic bone of an amphibian. Because of the limited surface outcropping of potential fossil-bearing geologic formations and

## TABLE 2.4

## DISTRIBUTION OF LABOR FORCE, JOHNSON AND CAMPBELL COUNTIES

| | Johnson County | | Campbell County | |
|---|---|---|---|---|
| | No. of Employees | % | No. of Employees | % |
| Agriculture, Forestry and Fisheries | 834 | 43.1 | 3,382 | 21.4 |
| Construction | 170 | 8.8 | 1,856 | 11.7 |
| Manufacturing | 82 | 4.2 | 171 | 1.1 |
| Transportation Communications & Utilities | 83 | 4.3 | 936 | 5.9 |
| Wholesale & Retail Trades | 519 | 26.8 | 3,061 | 19.4 |
| Finance, Insurance & Real Estate | 108 | 5.6 | 421 | 2.7 |
| Public Administration | 141 | 7.2 | 557 | 3.6 |
| Mining and Minerals | --- | --- | 5,429 | 34.2 |
| TOTALS | 1937 | 100% | 15,813 | 100% |

## TABLE 2.5

## POPULATION GROWTH BY COUNTY AND LARGER COMMUNITIES
1960 -1980

| Town | 1960 | 1970 | 1980 |
|---|---|---|---|
| Johnson County | | | |
| Buffalo | 2,907 | 3,394 | 3,799 |
| Kaycee | 284 | 272 | 271 |
| Total County | 5,475 | 5,587 | 6,700 |
| Campbell County | | | |
| Gillette | 3,580 | 7,194 | 12,134 |
| Total County | 5,861 | 12,957 | 24,367 |
| Natrona County | | | |
| Casper | 38,930 | 39,361 | 51,015 |
| Edgerton | 512 | 350 | 510 |
| Evansville | 678 | 832 | 2,652 |
| Midwest | NA | 604 | 638 |
| Mills | 1,477 | 1,724 | 2,134 |
| Total County | 49,623 | 51,264 | 71,856 |

## TABLE 2.6

## POPULATION FORECAST BY COUNTY FOR 1985 AND 1995

| County | 1980 | % Decrease/ Increase | 1985 | % Decrease/ Increase | 1995 |
|---|---|---|---|---|---|
| Johnson | 6,700 | -3.0 | 6,507 | +4.4 | 6,807 |
| Campbell | 24,367 | +16.8 | 29,280 | +29.4 | 41,461 |
| Natrona | 71,856 | -10.5 | 64,997 | +17.7 | 78,952 |

Source: Wyoming Data Handbook, 1985

the limited disturbances associated with in-situ mining, the surveyor concluded that potential impacts to paleontological resources on the 7,082 acre survey would be minimal, if any.

Archaeological clearance for the Christensen Ranch project area was provided by the State of Wyoming and BLM in 1988, with the exception of two sites. When the Christensen Ranch area was amended into the Permit to Mine No. 478, the DEQ added a condition to the permit which stated that "no surface disturbing activities could take place within 100 feet of archaeological sites 48CA533 and 48CA534 without a detailed mitigation plan". These two sites are located in the North Prong geographical portion (northeast section) of the Christensen Ranch permit area. As COGEMA plans to develop Mine Units 6 and 7 within the North Prong area during 1996, additional cultural resource investigations were completed for these two sites in July and August, 1995. Preliminary findings and recommendations for the sites are that site 48CA533 should be reduced in size, with avoidance of an approximate 288 square meter area with potential for buried cultural materials; and the clearance for development of site 48CA534, as no cultural materials remain. These recommendations have been made to the BLM, the surface landowner, as the mitigation plan for these two sites prior to development. After BLM approval of the mitigation plan, COGEMA will request an appropriate revision to the DEQ permit condition for these two sites.

The 7,082 acres surveyed at Christensen Ranch constitute approximately 52 percent of the permit area. The remaining 48 percent of the surface of the permit area is located on private land that was not surveyed during the 1986 inventory at the landowner's request. If previously unrecorded cultural materials are encountered during construction or operations of the facility, COGEMA will report the findings to appropriate regulatory authorities and take action to prevent adverse impacts to the resources whether they are located on previously surveyed lands or uninventoried lands. A compromise will be worked out at that time between the landowner, COGEMA and the regulatory authorities to evaluate the significance of the materials and make recommendations for its disposal.

There are no known architectural resources in the area. The Pumpkin Buttes are themselves natural landmarks of scenic cultural value which will be undisturbed by the proposed in-situ mining operation.

## 2.5 CLIMATOLOGY AND METEOROLOGY

### 2.5.1 GENERAL AREA CHARACTERISTICS

The Irigaray and Christensen Ranch areas are classified as a semi-arid continental climate. Meteorological data collection sites operated by the National Oceanic and

Atmospheric Administration (NOAA) in the vicinity of the area include: Midwest - 30 miles SW, Kaycee - 31 miles W, Gillette - 43 miles NE, Buffalo - 51 miles NW, and Casper - 68 miles SW. Records from these locations provide general long term weather data for areas surrounding the sites.

This regional data may be supplemented by meteorological data collected at industrial sites, primarily coal mines located east of the Christensen Ranch and generally south of Gillette. Meteorological monitoring was conducted at Irigaray for one full year, December 1980 through December 1981. This data provides insight to local conditions and has served as the primary source of meteorological information for the Irigaray and Christensen Ranch projects. Copies of the two semi-annual meteorological reports for the Irigaray Mine are provided for review in Appendix D4 of the Christensen Ranch permit application.

### 2.5.2 TEMPERATURE

Temperatures in the vicinity vary considerably on both a diurnal and seasonal basis. Daily variations are due in part to the high elevation and relatively dry air conditions which enhance the diurnal solar radiation cycle. Seasonal differences are influenced by the movement of Arctic air masses across the area during winter months. Winters are generally harsh, with temperatures falling to lows near -40°C (-40°F) and summers are mild with highs often near 38°C (100°F). Spring and fall are transition seasons with warm daytime temperatures and cool nights. Monthly mean and daily extreme temperatures for Midwest, Kaycee, and Gillette, Wyoming are given in Table 2.7. By comparison, the monthly mean and extreme temperatures taken during 1980 at the Irigaray site are given in Table 2.8. The average growing seasons for Midwest, Kaycee and Gillette, Wyoming are given in Table 2.9.

Dew point and relative humidity in the area are discussed in the Irigaray studies in Appendix D4. Relative humidity is moderate to low and is usually highest during colder months and lower during warmer months because of the inverse relationship between temperature and relative humidity.

### 2.5.3 PRECIPITATION

Average annual precipitation in the vicinity is approximately 30 cm (12") per year. The majority of this precipitation occurs during the period of April through July. Summer precipitation is generally derived from scattered thunder showers created by local convection currents. Due to the scattered nature of these showers, the amount of precipitation from one location to another within the area varies considerably. Fall and winter precipitation is usually derived from stratified clouds associated with low pressure weather systems and up slope conditions resulting from the movement of large air masses. Topography surrounding the Powder River Basin has considerable affect on the local conditions with the basin. The Bighorn Mountains provide lifting

## TABLE
## MONTHLY MEAN AND DAILY EXTREME TEMPERATURE DATA[1]

| Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly Mean Temperature (°F) | | | | | | | | | | | | | |
| Midwest | 24.1 | 27.3 | 34.1 | 45.0 | 54.9 | 64.4 | 73.0 | 71.2 | 61.1 | 49.8 | 34.8 | 28.2 | 47.3 |
| Kaycee | 21.6 | 26.0 | 31.0 | 42.9 | 52.4 | 60.5 | 69.3 | 67.5 | 57.2 | 47.0 | 32.7 | 25.4 | 44.5 |
| Gillette | 21.1 | 26.5 | 31.7 | 42.1 | 52.8 | 62.1 | 70.5 | 69.5 | 58.2 | 47.9 | 33.1 | 24.8 | 45.0 |
| Monthly Mean Maximums (°F) | | | | | | | | | | | | | |
| Midwest | 36.3 | 40.2 | 47.5 | 59.7 | 70.1 | 80.8 | 91.1 | 89.5 | 78.9 | 65.9 | 47.6 | 39.9 | 62.3 |
| Kaycee | 37.4 | 41.0 | 45.3 | 57.8 | 67.3 | 76.5 | 87.8 | 86.6 | 75.3 | 64.7 | 48.1 | 40.8 | 60.7 |
| Gillette | 32.5 | 37.8 | 43.3 | 54.8 | 65.9 | 76.0 | 86.6 | 86.0 | 73.7 | 62.2 | 44.5 | 35.7 | 58.3 |
| Monthly Mean Minimums (°F) | | | | | | | | | | | | | |
| Midwest | 11.9 | 14.4 | 20.6 | 30.3 | 39.7 | 47.9 | 54.9 | 52.8 | 43.2 | 33.7 | 22.0 | 16.5 | 32.3 |
| Kaycee | 5.7 | 11.0 | 16.7 | 27.9 | 37.5 | 44.5 | 50.8 | 48.4 | 39.1 | 29.3 | 17.2 | 10.0 | 28.2 |
| Gillette | 9.7 | 15.2 | 20.1 | 29.3 | 39.7 | 48.2 | 54.3 | 52.9 | 42.7 | 33.6 | 21.7 | 13.9 | 31.8 |
| Record Maximum Temperatures (°F) | | | | | | | | | | | | | |
| Midwest | 62 | 69 | 77 | 89 | 94 | 102 | 106 | 105 | 100 | 89 | 76 | 69 | 106 |
| Kaycee | 66 | 71 | 76 | 83 | 92 | 104 | 105 | 103 | 97 | 87 | 77 | 66 | 105 |
| Gillette | 62 | 64 | 75 | 83 | 94 | 104 | 104 | 104 | 98 | 89 | 74 | 64 | 104 |
| Record Minimum Temperatures (°F) | | | | | | | | | | | | | |
| Midwest | -39 | -41 | -20 | -16 | 14 | 26 | 37 | 32 | 14 | 4 | -26 | -31 | -41 |
| Kaycee | -45 | -34 | -30 | -3 | 12 | 25 | 33 | 28 | 13 | -3 | -37 | -42 | -45 |
| Gillette | -34 | -22 | -23 | -1 | 11 | 28 | 35 | 32 | 20 | -3 | -26 | -31 | -34 |

[1]Period of Record: Midwest 1931-1960
Kaycee 1941-1967
Gillette 1951-1974

## TABLE 2.8

## MONTHLY TEMPERATURE MEANS AND EXTREMES (°F)
## DECEMBER 1980 - DECEMBER 1981
## IRIGARAY MINE SITE

| Month | Mean Maximum | Mean Minimum | Mean Monthly | Extremes High | Extremes Low |
|---|---|---|---|---|---|
| December | 48.2 | 26.6 | 37.4 | 60.8 | -0.4 |
| January | 44.6 | 21.2 | 32.0 | 62.6 | 8.6 |
| February | 39.2 | 19.4 | 28.4 | 62.6 | -16.6 |
| March | 50.0 | 26.6 | 37.4 | 60.8 | 10.4 |
| April | 60.8 | 37.4 | 48.2 | 78.8 | 21.2 |
| May | 60.8 | 42.8 | 51.8 | 80.6 | 32.0 |
| June | 75.2 | 51.8 | 62.6 | 95.0 | 35.6 |
| July | 86.0 | 60.8 | 73.4 | 102.2 | 50.0 |
| August | 84.2 | 57.2 | 69.8 | 96.8 | 57.2 |
| September | 77.0 | 48.2 | 62.6 | 91.4 | 35.6 |
| October | 57.2 | 35.6 | 46.4 | 86.0 | 21.2 |
| November | 53.6 | 28.4 | 41.0 | 66.2 | 10.4 |
| December | 37.4 | 17.6 | 28.4 | 62.6 | 1.4 |

1. Monitoring commenced December 19, 1980.

## TABLE 2.9

## AVERAGE GROWING SEASON[1]

| Station | No. of Days (32°F) | No. of Days (28°F) |
|---|---|---|
| Midwest | 127 | 152 |
| Kaycee | 106 | 132 |
| Gillette | 122 | 143 |

[1]Period of record: Midwest 1931-1960
Kaycee 1941-1967
Gillette 1951-1974

of air masses moving along the surface from the prevailing northwesterly direction causing moisture to precipitate out prior to reaching the basin. They also provide a barrier to up slope air. The average precipitation from 1970-1974 for four weather stations within the Powder River Basin is shown by month in Table 2.10. These data show both precipitation and snow for each location. The origin of the table is NUREG-0481, Final Environmental Statement related to Operation of the Irigaray Uranium Solution Mining Project, Wyoming Mineral Corporation, September 1978, Docket No. 40-8502. The last column in the table shows maximum and minimum values for all stations and illustrates the extreme variability in the area. Precipitation data in the 1980-1981 Irigaray study is incomplete and of limited value due to the short duration of the study. Monthly mean and daily extreme precipitation data and monthly mean and daily extreme snowfall data for Midwest, Kaycee and Gillette are provided in Tables 2.11 and 2.12, respectively.

Evaporation rates measured at the Irigaray site during 1980 and 1981 indicate a total evaporation from 98.1 cm (38.64 inches) to 108 cm (42.52 inches). Monthly evaporation rates varied from a high of 25.22 cm (9.93 inches) in July to a low of 10.4 cm (4.12 inches) in May. Measurements were not taken during periods of freezing temperatures. Considering an average annual precipitation of 30.4 cm (12 inches) per year, the net annual evaporation rate would be approximately 76.2 cm (30 inches) per year.

### 2.5.4 WIND

Synoptic scale winds in the area are dominated by a westerly component. Local surface winds in the area are affected by both regional weather patterns and topographic features. Table 2.13 shows prevailing wind directions and monthly mean wind velocity measured at the Irigaray site during the 1980-1981 study. Tabular and plot format wind roses are provided in Appendix D4 of the Christensen Ranch application. They include diurnal wind roses relating the frequency of occurrence to direction and velocity. The prevailing wind direction was primarily from the southeast quadrant occurring primarily at night. These are low velocity winds caused by drainage of cold dense air out of the local draws and down the Willow Creek drainage. Secondary predominance of north northeast and south southwest winds are generally of stronger velocity and occur during daylight hours. These winds are initially from the west, however, the blocking effect of the Bighorn Mountains results in a deflection to a more northerly or southerly direction. The Irigaray wind data are considered to be very applicable to the Christensen satellite plant location as both sites are located directly adjacent to the Willow Creek drainage.

TAB' `.10

AVERAGE PRECIPITATION 1970-1974
ALL VALUES IN INCHES

| Month | Kaycee | | Billy Creek | | Buffalo | | Reno | | All Stations | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Precip. | Snow | Precip. | Snow | Precip. | Snow | Precip. | Snow | Precip. | Snow |
| January | 0.54 | 6.4 | 0.33 | 5.2 | 0.42 | 4.5 | 0.34 | 4.6 | 1.28 | 0.03 |
| February | 0.27 | 3.0 | 0.30 | 3.7 | 0.52 | 6.5 | 0.16 | 1.0 | 1.26 | 0.01 |
| March | 0.82 | 7.4 | 0.75 | 8.6 | 1.39 | 9.4 | 0.59 | 4.7 | 1.75 | 0.00 |
| April | 2.51 | 11.9 | 1.37 | 6.2 | 1.91 | 2.2 | 1.22 | 7.3 | 4.62 | 0.92 |
| May | 1.93 | 1.0 | 1.37 | Trace | 1.73 | 0.4 | 1.96 | Trace | 3.88 | 0.37 |
| June | 1.80 | 0.0 | 1.21 | Trace | 1.55 | 0.0 | 1.99 | 0.0 | 3.53 | 0.58 |
| July | 1.02 | 0.0 | 1.55 | 0.0 | 1.04 | 0.0 | 1.49 | 0.0 | 3.30 | 0.15 |
| August | 0.76 | 0.0 | 1.08 | 0.0 | 1.07 | 0.0 | 1.04 | 0.0 | 2.90 | 0.00 |
| September | 0.86 | 5.5 | 0.75 | 1.0 | 1.14 | Trace | 0.85 | Trace | 2.65 | 0.28 |
| October | 1.41 | 4.0 | 1.68 | 6.1 | 1.64 | 2.0 | 1.14 | 8.3 | 3.58 | 0.37 |
| November | 0.45 | 3.4 | 0.42 | 5.2 | 0.52 | 9.0 | 0.16 | 0.3 | 0.92 | 0.01 |
| December | 0.37 | 4.7 | 0.27 | 4.2 | 0.17 | 3.3 | 0.47 | 5.4 | 0.45 | 0.00 |
| Yearly | 12.81 | 47.3 | 11.49 | 40.2 | 13.10 | 37.3 | 11.41 | 31.6 | | |

Source: Cooperative Weather Station Data, National Weather Service Station Data, National Climatic Center, Asheville, N.C., 1970-1974, U.S. Department of Commerce.

## TABLE 2.11

## MONTHLY MEAN AND DAILY EXTREME PRECIPITATION DATA[1]

| Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly Mean Precipitation (inches) | | | | | | | | | | | | | |
| Midwest | 0.55 | 0.55 | 1.01 | 1.72 | 2.21 | 1.74 | 1.19 | 0.80 | 0.93 | 0.90 | 0.72 | 0.52 | 12.84 |
| Kaycee | 0.40 | 0.32 | 0.61 | 1.56 | 1.97 | 2.20 | 1.01 | 0.66 | 1.09 | 0.82 | 0.51 | 0.35 | 11.50 |
| Gillette | 0.55 | 0.62 | 0.78 | 1.78 | 2.42 | 3.18 | 1.36 | 1.15 | 1.31 | 1.03 | 0.67 | 0.57 | 15.42 |
| Record Daily Precipitation (inches) | | | | | | | | | | | | | |
| Midwest | 0.63 | 0.90 | 1.50 | 2.35 | 2.29 | 1.38 | 1.74 | 2.69 | 3.56 | 1.53 | 0.62 | 0.60 | 3.56 |
| Kaycee | 0.58 | 0.40 | 0.56 | 1.52 | 1.60 | 3.62 | 0.92 | 1.72 | 1.19 | 1.58 | 0.39 | 0.45 | 3.62 |
| Gillette | 0.64 | 0.85 | 0.81 | 2.12 | 2.00 | 4.10 | 1.60 | 2.82 | 1.65 | 1.43 | 0.90 | 0.40 | 4.10 |

[1]Period of Record: Midwest 1931-1960
Kaycee 1941-1967
Gillette 1951-1974

## TABLE 2.12

MONTHLY MEAN AND DAILY EXTREME SNOWFALL DATA[1]

| Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly Mean Snowfall (inches) | | | | | | | | | | | | | |
| Midwest | 8.3 | 7.7 | 9.5 | 8.3 | 1.6 | 0.1 | 0.0 | 0.0 | 0.2 | 2.4 | 7.5 | 7.2 | 52.8 |
| Kaycee | 7.0 | 6.0 | 6.4 | 6.4 | 2.8 | 0.1 | 0.0 | 0.0 | 0.6 | 2.9 | 6.0 | 6.3 | 44.5 |
| Gillette | 9.0 | 10.0 | 10.1 | 9.9 | 2.0 | 0.3 | 0.0 | 0.0 | 1.0 | 4.1 | 7.5 | 9.2 | 63.2 |
| Record Daily Precipitation (inches) | | | | | | | | | | | | | |
| Midwest | 10.0 | 12.0 | 13.0 | 28.0 | 6.0 | 3.0 | 0.0 | 0.0 | 2.0 | 12.0 | 7.5 | 11.0 | 28.0 |
| Kaycee | 8.1 | 8.7 | 5.1 | 22.0 | 11.7 | 1.4 | 0.0 | 0.0 | 4.2 | 8.0 | 7.8 | 6.0 | 22.0 |
| Gillette | 14.0 | 12.0 | 7.0 | 13.0 | 10.0 | 2.0 | 0.0 | 0.0 | 4.0 | 8.0 | 12.0 | 8.0 | 14.0 |

[1]Period of Record: Midwest 1931-1960
Kaycee 1941-1967
Gillette 1951-1974

## TABLE 2.13

## PREVAILING WIND DIRECTIONS AND MONTHLY MEAN WIND VELOCITY AT THE IRIGARAY SITE DECEMBER 1980 - DECEMBER 1981

| Month | Direction | Velocity m/sec |
|---|---|---|
| December | Southeast | 4.1 |
| January | Southeast | 2.7 |
| February | South | 4.0 |
| March | Northwest | 3.0 |
| April | North Northwest | 4.2 |
| May | North Northwest | 4.5 |
| June | North | 4.4 |
| July | North Northwest | 3.5 |
| August | East Southeast | 2.8 |
| September | Southeast | 3.5 |
| October | South Southwest | 3.6 |
| November | Southeast | 3.0 |
| December | Southeast | 3.4 |

1. Wind speed monitoring commenced December 19, 1980.

Seasonal variations in predominant wind direction are shown on the monthly wind rose plats for the Irigaray site. Figures 2.3 and 2.4 are monthly wind speed and direction roses for the site during December 1980 and April 1981, respectively.

Wind velocities at Midwest, Gillette and Casper are estimated to average around 20.9 km/hr (13 mph) annually. Strong winds are typical in the area especially during spring and winter months. Wind velocities of 80.5 km/hr (50 mph) have been recorded regularly with damaging winds at speeds over 120.8 km/hr (75 mph) occurring during severe storms. Data from the Irigaray study include atmospheric stability classifications, regional air quality and air quality impacts analysis is discussed.

### 2.5.5 STORMS

Winter storms accompanied by snow, low temperatures and high winds are common. Thunderstorms occur frequently during spring and summer. They are also often accompanied by strong local wind and occasional hail. The potential for localized flash flooding does exist during dry periods with heavy thunderstorm activities. Tornadoes may occur as a result of these summer storms, however, they are smaller and much less frequent than the tornadoes occurring farther east over the Great Plains.

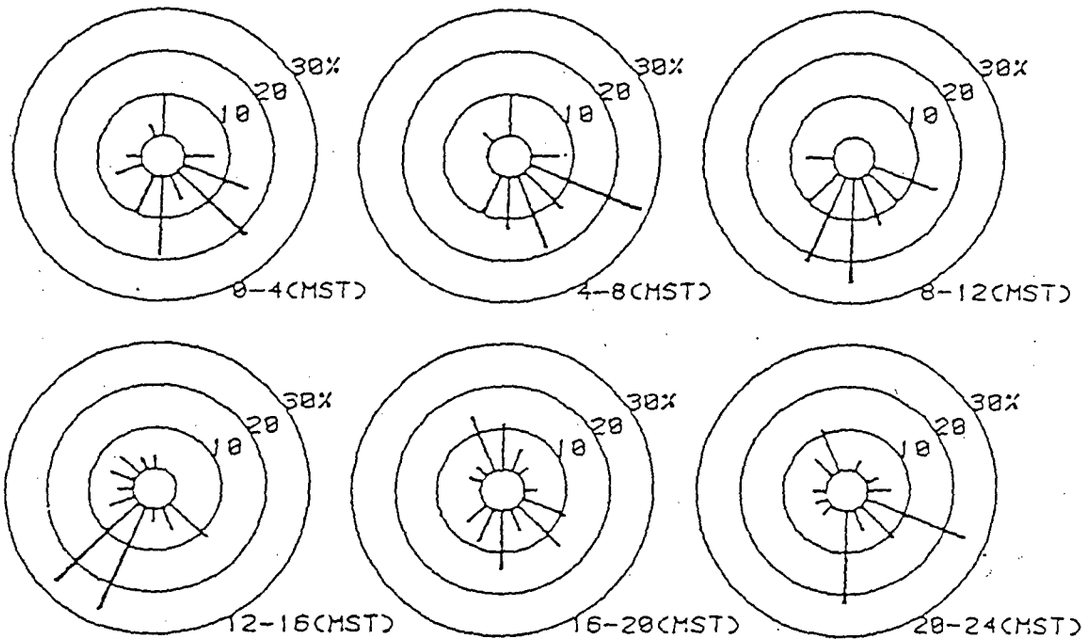
## 2.6 GEOLOGY AND SEISMOLOGY

### 2.6.1 REGIONAL GEOLOGY

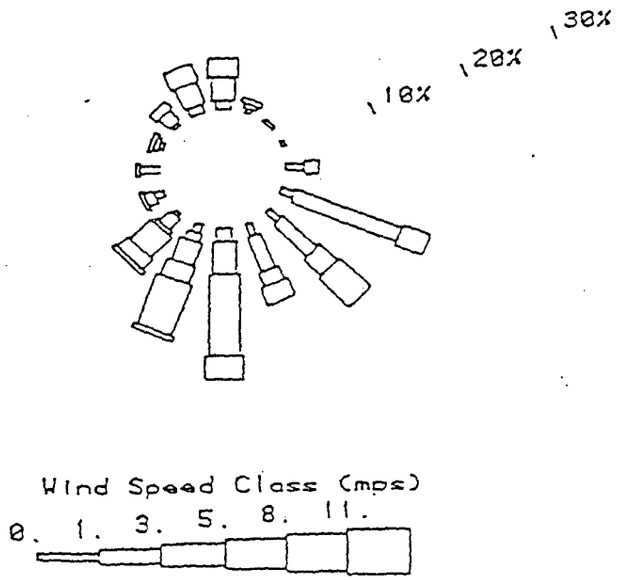
The Irigaray and Christensen Ranch project areas are located in the west-central portion of the Powder River Basin. Structurally the Powder River Basin is a broad north-south aligned asymmetrical syncline whose axis lies west of its center. A broad northward plunging anticline has its axis parallel to and slightly east of the Pumpkin Buttes alignment and is intersected by a broad westward plunging arch (Ayres, 1986). Strata in the Irigaray and Christensen Ranch areas dip northwesterly at one to two degrees, consistent with the position on the northwest flank of the anticline. Numerous cross-sections through the Irigaray and Christensen Ranch permit areas give no indication that detectable faulting has occurred in Tertiary sediments of the area. Figure 2.5 depicts the regional geologic setting of the area.

Structural and stratigraphic development in the area was associated with tectonic events during Late Cretaceous times extending through the Eocene Epoch. Surrounding uplifts (i.e., Central Rocky Mountain Region) created a basin in which up to 8000 feet of non-marine clastic sediments were deposited. Four distinct stratigraphic units are recognized in the Powder River Basin as a result of surrounding tectonic activities. These are the Cretaceous Lance Formation, Paleocene Fort Union Formation, Eocene Wasatch Formation, and Oligocene White River Formation. A

FIGURE 2.3
DIURNAL WIND DIRECTION ROSES

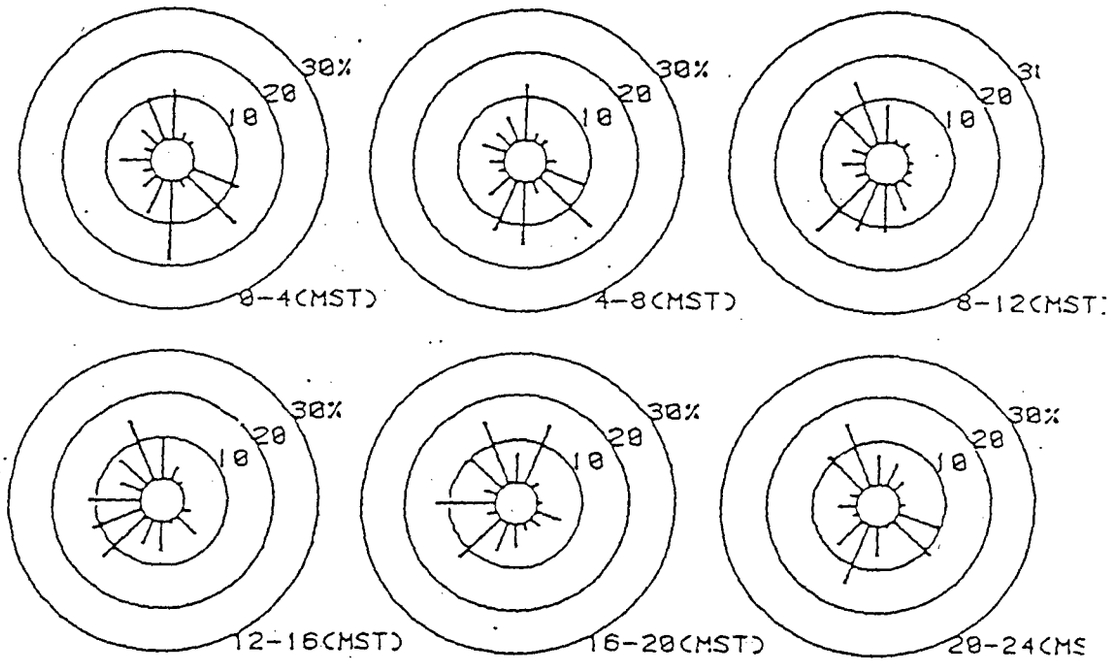



WIND SPEED AND DIRECTION ROSE

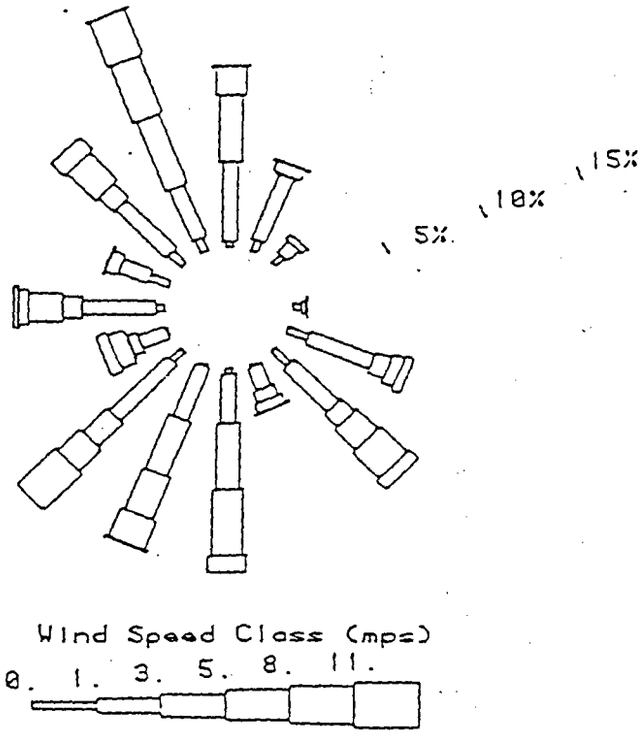



IRIGARAY DECEMBER 1980 WIND ROSE

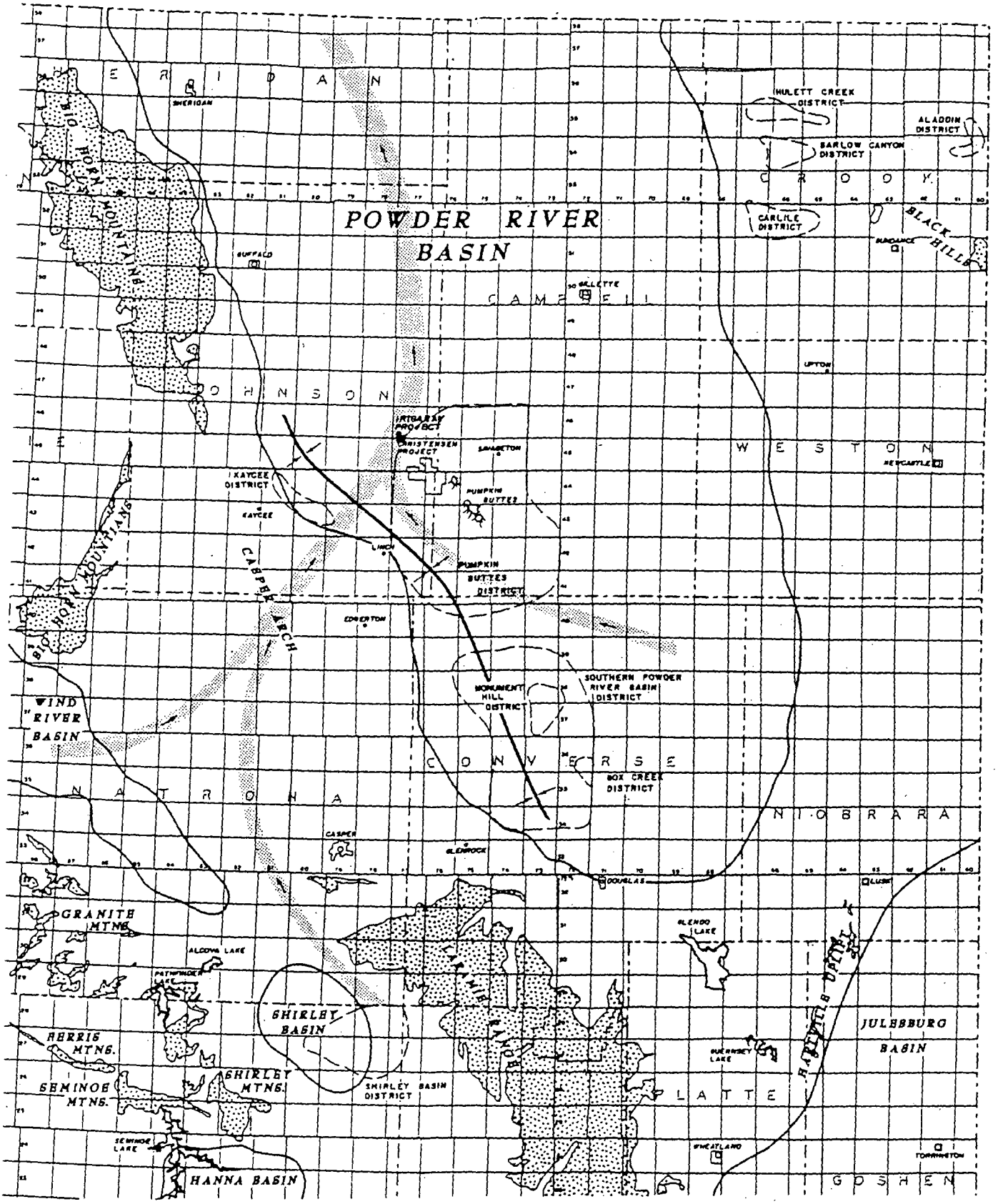
FIGURE 2.4
DIURNAL WIND DIRECTION ROSES




WIND SPEED AND DIRECTION ROSE




IRIGARAY APRIL 1981 WIND ROSE




COGEMA Mining, Inc

Generalized Geology of Powder River Basin of Wyoming

| | | |
|---|---|---|
| GEOLOGIST - T.G.H. | SCALE - AS NOTED | FIGURE - 2. |
| DRAWN BY - P.A.S. | DATE - 8/9/87 | |

stratigraphic column showing the succession of these units is provided in Figure 2.6. A more detailed description of geologic events forming the Powder River Basin is given in Appendix D5 of the Irigaray and Christensen Ranch applications, along with a description of how the basin uranium deposits developed.

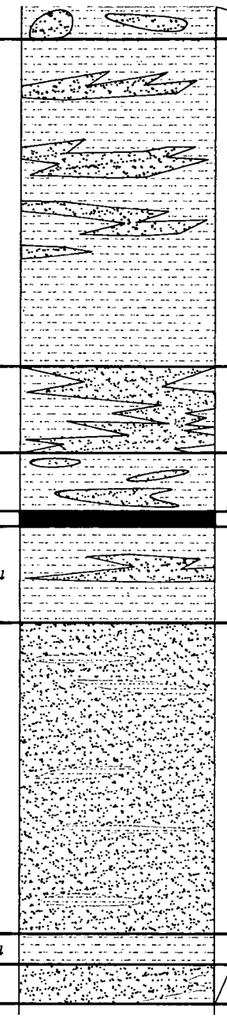
### 2.6.2 SITE GEOLOGY

Post-Oligocene erosion in the project areas has removed 900 to 1300 feet of the Wasatch Formation. Surficial geology of the area is made up of Quaternary alluvial and Tertiary Wasatch outcrops. The White River Formation has been removed from the Powder River Basin in the vicinity with the exception of a thin cap on top of the Pumpkin Buttes. Subsurface geology consists of fluvial deposits of the Eocene Wasatch Formation, Paleocene Fort Union and Cretaceous Lance Formation. The subsurface Wasatch sediments, which contain the uranium deposits being mined, are a complex, interrelated sequence of shales, mudstones, siltstones, sandstones and thin lignite coal seams. The Wasatch formation within the Christensen Ranch permit area has been divided into three units for the purpose of mine development. These units are designated the "L", "K" and "J" fluvial system which are briefly described in ascending order. The geologic unit designations at the Irigaray project differ, but correspond to the Christensen fluvial systems as follows: "L" - lower Irigaray sandstone; "K" - upper Irigaray sandstone; and "J" - Unit 1 sandstone. Figure 2.6 shows the stratigraphic succession of these units. Figure 2.7, a general cross section, shows how the three Christensen Ranch fluvial systems relate to the Irigaray property geology.

The lower most unit at the Christensen Ranch project ("L" fluvial system) is defined as those sediments between the Fort Union/Wasatch contact and the base of the lowest uranium bearing host sandstone. It consists of one to two continuous sandstone aquifers separated by shales, mudstones and siltstones. The "L" facies of prime concern is the shale/mudstone interval immediately underlying the lowest uranium host sandstone of the "K" fluvial system. This interval is the lower aquitard which serves as the confining layer separating aquifers of the "L" and "K" fluvial system. The average thickness of the "L" fluvial system in the permit area is approximately 241 feet and the thickness of the lower aquitard averages 65 feet. Structural contour maps and isopach maps of the lower aquitard, provided in Appendix D5 of the permit application, indicate that it is continuous throughout the area effectively blocking communications between aquifers of the "L" and "K" fluvial systems.

The "K" fluvial system at Christensen Ranch is defined as those sediments between the lower aquitard at the top of the "L" system and the upper aquitard which is the upper confining barrier to vertical fluid migration. The "K" system is the stratigraphic unit in which solution mining occurs. It is composed of fluvial channel sandstones which are the primary hosts for the uranium in the area. The "K" fluvial system has

# GENERAL IRIGARAY PROJECT GEOLOGIC COLUMN



0'

**OVERBURDEN UNIT**
Thickness : 60' – 125'
Lithology : Interbedded shale and sandstones lenses

110'

**UNIT I SANDSTONE**
Thickness : 5' – 50'
Lithology : Sandstone with inter-layered shales

135'

**INTERBURDEN UNIT**
Thickness : 15' – 30'
Lithology : Shale with occasional sandstone lenses

155'
160'

Thickness : 5' **COAL UNIT**

**CLAYSTONE UNIT**
Thickness : 10' – 25'
Lithology : Claystone with occasional sandstone lenses

190'

**UPPER IRIGARAY SANDSTONE (UISS)**
Thickness : 80' – 120'
Lithology : Sandstone unit with occasional thin mudstone lenses

*This unit contains the* ***ORE ZONE***

295'

Thickness : 20' – 50' **CLAYSTONE**
Lithology : Claystone with occasional sandstone lenses

305'

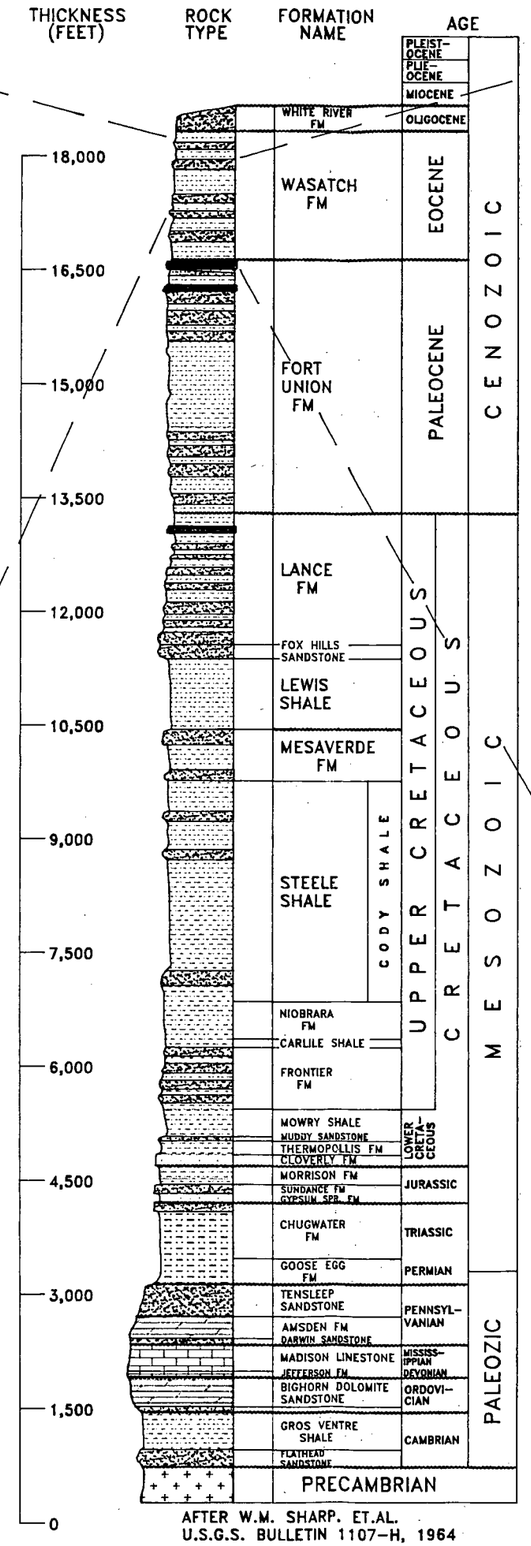
Thickness : 5' – 20' **SANDSTONE**
Lithology : Sandstone with siltstone and mudstone lenses

320'

## LEGEND

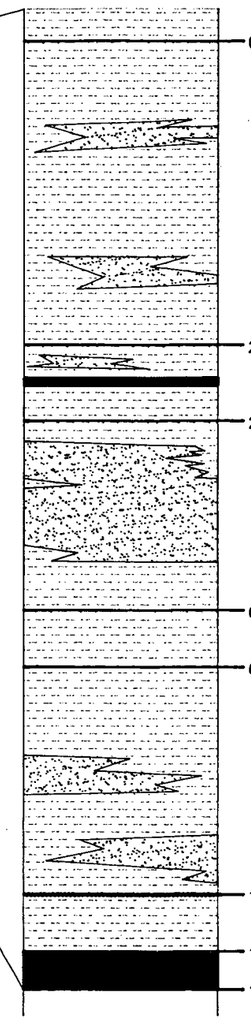
- SANDSTONE
- SHALE
- COAL
- MUDSTONE
- FM FORMATION
- LIMESTONE
- DOLOMITE
- GYPSUM
- IGNEOUS & METAMORPHIC ROCK
- UNCONFORMITY (A SURFACE OF EROSION)

# WESTERN POWDER RIVER BASIN




AFTER W.M. SHARP. ET.AL.
U.S.G.S. BULLETIN 1107–H, 1964

# GENERAL CHRISTENSEN RANCH GEOLOGIC COLUMN



0'

**"I – J" FLUVIAL SYSTEM**
Thickness : 180' – 550'
Lithology : Interbedded silts, shales and discontinuous sandstone lense with some associated uranium mineralization

200'

**UPPER AQUITARD**
Thickness : 33' – 186'
Lithology : Shale – claystone with thin lignitic coal seams

280

**"K" FLUVIAL SYSTEM**
Thickness : 86' – 260'
Lithology : Predominately arkosic sandstone – Lt. gray to pale red, VF – C grained, locally carbonaceous and pyritic, with interbedded clay stringers (Primary uranium host)

600

**LOWER AQUITARD**
Thickness : 23' – 110'
Lithology : Medium dark gray shale and claystone

650

**"L" FLUVIAL SYSTEM**
Thickness : 205' – 475'
Lithology : Interbedded sandstone and shales with thin lignites and no known uranium occurrences on Christensen project area

1125'

**PALEOENE, FT. UNION FM.**
Top placed in this interval. Gray shale with fine to coarse sandstone lenses and thick lignitic to subbituminous coals

1200'

1250'

**"THICK" COAL**
Coal of Sharp. Probably Badger or School equivalent

ANSTEC APERTURE CARD
Also Available on Aperture Card

9601180205-01

COGEMA Mining, Inc.

# Stratigraphic Column

| | |
|---|---|
| GEOLOGY: W. M. Sharp T. G. N. | STATE: WYOMING COUNTY: Campbell |
| | DATE: 22 Mar 95 |
| SURVEY: | SCALE: AS NOTED REVISED: |
| DATA PROC: TKK | MAP ID: FIGURE 2.6 |

three major sandstone units which have been designated "$K_1$", "$K_2$", and "$K_3$" sandstones in descending order. Separation of these units, where it occurs, is caused by thin shaley lenses which are limited both vertically and laterally. The average thickness of the "K" fluvial system in the Christensen Ranch permit area is approximately 177 feet. See Appendix D5 for detailed cross sections, isopach maps and structural contour maps of the base and top of the "K" fluvial system.

The "J" fluvial system at Christensen Ranch is defined as those Wasatch sediments from the base of the upper aquitard to the ground surface. It is dominated by siltstone and mudstone sediments with thin sandstone units and thin lignitive coal seams. Although the "J" fluvial system has one sandstone lens known to contain uranium, it is not incorporated into the present mine plans. The "J" facies of primary concern is the carbonaceous mudstone/lignite zone which have been labeled the upper aquitard. The average thickness of the "J" fluvial system in the area is approximately 348 feet. Thickness of the upper aquitard varies from 60 to 100 feet in the area. There is no evidence of breaching of the upper aquitard within the project area. See Appendix D5 for detailed cross sections of the "J" fluvial system and isopach maps of the upper aquitard.

Roll-type uranium mineralization at the Irigaray site is present in fluvial channel sands in the "Upper" and "Lower" sandstone units of the Wasatch formation. The "Upper" unit, termed the Upper Irigaray Sandstone, is the largest and most economically important. At present, only the "Upper" unit will be mined. The channel sands trend to the north, which is also the direction of the regional dip and hydraulic gradient. The host environment of the upper unit consists of arkosic, fine to coarse grained, poorly sorted sands. The mineralization has been stratigraphically confined by persistent layers of shales, mudstones or claystones. The top of mineralization is on the average about 200 feet below the surface and the host averages near 100 feet in thickness. The calcite content of the host ranges 1 to 3 percent.

Mineralization occurs along the margins of the large tongue of sand altered by oxidizing groundwater flow. This tongue measures some three miles in width near the center of the Irigaray property and extends from the southern boundary for a strike length of ten miles. Uranium deposition as uraninite and coffinite occurred where the groundwater encountered reducing conditions. Uranium is localized at the interface (roll front) between the oxidized and reduced sandstone. The oxidized zone is difficult to distinguish from the reduced zone; the sandstone on the oxidized side has a tan to yellowish green bleached color whereas the reduced portion is characterized by a gray color. Lack of strong red and brown coloration in oxidized material is due to the generally low pyrite content (less than 0.5 percent). In contrast to many uranium deposits of similar origin, no molybdenum mineralization has been found at the Irigaray site to date. Arsenic and selenium are present within and adjacent to the uranium mineralization. Barite, $BaSO_4$, is also found with the uranium mineralization.

The generalized stratigraphic column for the Irigaray site shown in Figure 2.6 identifies the major stratigraphic units in ascending order as follows:

- Upper Irigaray Sandstone, UISS - This is the ore zone which is being mined.

- Claystone Unit - This unit directly overlies the UISS and has previously been called the confining layer or upper aquitard.

- Coal Unit - This unit directly overlies the Claystone Unit and has previously been called the coal zone and shallow or upper monitor zone.

- Interburden Unit - This unit is the interval between the Coal Unit and the overlying Unit 1 Sand. It contains mostly interbedded claystones and discontinuous sandstones and several carbonaceous or coal layers.

- Unit 1 Sand - This unit directly overlies and interfingers with the Interburden Unit, and is designated the shallow or upper monitor zone.

- Overburden Unit - This unit is the interval between the Unit 1 Sand and the ground surface. It contains mostly interbedded discontinuous sandstones and claystones.

Appendix D5 of the Irigaray permit application contains detailed geologic cross sections and isopachs of the major units.

### 2.6.3 SEISMOLOGY

The regional structural geologic setting for the Irigaray and Christensen Ranch area shows little or no evidence of deep-seated faulting or fracturing, which is an indication that the area is not subject to earthquake shocks of magnitudes great enough to cause structural damage. According to the Earthquake Hazard-Seismic Risk map prepared by S.T. Algermissen, et. al. (1982), the area is located in a region of low earthquake probability where, if they occur, the earthquakes would most likely be of low magnitude. There have been eleven recorded earthquakes within 100 miles of the proposed area since 1873. The magnitude ranged from 3.8 to 5.1 on the Richter Scale. The strongest of these occurred near Casper, Wyoming during 1894 and 1897 while the nearest shock to the areas occurred in May of 1967 approximately 2 miles southeast of the South Pumpkin Butte. The 1967 earthquake, a 4.8 Richter Scale intensity, was the last recorded shock in the region (see Appendix D5 of the Christensen Ranch permit application for additional details).

## 2.7 HYDROLOGY

### 2.7.1 GROUNDWATER

Extensive investigation of the groundwater systems at the Irigaray and Christensen Ranch project areas were conducted to assess the impact of the proposed in-situ mining activities during initial permitting. The studies included a review of the hydrogeology of the area, extensive aquifer testing and field sampling to determine water quality. At Christensen Ranch, initial investigations included the "L" sandstone (underlying aquifer), lower confining layer, the "K" sandstone (mineralized zone), upper confining layer and the "J" sandstone (overlying aquifer). Potentiometric surfaces were developed for each aquifer and recharge and discharge areas were researched. There were nine aquifer - aquitard investigations performed at six test sites within the Christensen Ranch permit area to define aquifer characteristics. There were 10 horizontal permeability tests performed within the "K" sandstone at different locations within the permit area, to confirm permeability values calculated from pumping test data. Water quality was determined for the "K" sandstone, or mineralized aquifer, and the next overlying and underlying aquifer through a quarterly field sampling program using some 27 different wells at 10 different hydrologic test sites on the permit area. The water chemistry of the 3 aquifers sampled is summarized in Appendix D6 of the Christensen Ranch permit application.

Groundwater test site locations, methods and results of the aquifer tests and water quality sampling program for both Irigaray and Christensen Ranch are provided for review in Appendix D6 of each project's permit application.

In addition to the initial groundwater investigations done for permitting at each site, numerous hydrologic studies have been conducted at each site for the approval of individual production wellfields. These studies include detailed aquifer/aquitard properties analysis, confirmation of monitor well communication through pumping, and the sampling and water quality analysis of all monitor wells and ore zone restoration wells (baseline water quality wells). At Christensen Ranch, the following additional hydrologic and water quality investigations have been performed, and submitted to the DEQ and NRC on the following dates:

Mine Unit 2 South - November, 1992 (detailed aquifer analysis and baseline water quality)
Mine Unit 2 North - April, 1992 (detailed aquifer analysis and baseline water quality)
Mine Unit 3 - December, 1988 (baseline water quality)
Mine Unit 3 expansion - August, 1991 (baseline water quality)
Mine Unit 3 module 2 and 4A expansion - October, 1993 (baseline water quality)
Mine Unit 4 - April, 1994 (detailed aquifer analysis and baseline water quality)
Mine Unit 5 - February, 1995 (detailed aquifer analysis and baseline water quality)

In addition to the original hydrologic evaluations at the Irigaray property, the following hydrologic and water quality investigations have been performed, and submitted to the DEQ and NRC on or about the following dates:

Groundwater Properties of Production Units 6 through 9 - September, 1987
Groundwater Properties, 517 Test Site - November, 1987
Aquifer-Aquitard Characterization Production Units 2 and 3 - August, 1986
Aquifer-Aquitard Characterization Section 5 Test Site - March, 1987
Predicted Pumping Rates and Time for Restoration Sweep, Irigaray Units 1-9 - June, 1990
Production Unit 6 - April, 1988
Production Unit 7 - November, 1987
Production Unit 8 and 9 - January, 1988

### 2.7.2 SURFACE WATER

Surface water characteristics for the Irigaray project are described in Section D6 of the Irigaray permit application document. The descriptions are rather general, due to the relatively small size of the Irigaray project (less than 1,000 acres). Willow Creek, considered an intermittent stream, crosses the permit area to the north, and is the only surface water feature in the immediate vicinity of the permit area. Willow Creek flows northwesterly from the edge of the Irigaray permit area approximately two miles before its confluence with the Powder River. Water quality and available hydrologic characteristics for both Willow Creek and the Powder River are given in Section D6 of the Irigaray application document.

Regional and site specific surface water studies were conducted to develop quantitative and qualitative data and to assess the potential impact of the proposed mining operation on the surface water and drainage system within the Christensen Ranch permit area. The drainages basins within and adjacent to the area were mapped and described. They include 18 watersheds of the Willow Creek drainage basin which provide surface drainage for the majority of the area. Surface water bodies in the permit area and adjacent to it were characterized including Willow Creek, its primary tributaries and permanent stockponds. Drainage channel profiles were constructed for Willow Creek and its major tributaries.

Results indicate that drainages in the Christensen Ranch project area are ephemeral. Intermittent surface water occurs only in the extreme north west portion of the permit area. Flood frequency analyses were calculated from field data and indicate a range of flood events for the watershed.

Surface water quality was sampled along Willow Creek and its major tributaries. Appendix D6 of the Christensen permit application provides the surface water quality data. Drainage basin characteristics are also provided for review in Appendix D6, as well as sedimentology as related to the ongoing mining disturbance.

## 2.8 ECOLOGY (SOILS, VEGETATION AND WILDLIFE)

### 2.8.1 TERRESTRIAL ECOLOGY

A baseline soil study was conducted on the Christensen Ranch permit area during the fall of 1986. Soils were surveyed and sampled to the Order 1 level (approximately 8,548 acres) over the ore trend, proposed construction areas and along a 2,000 foot buffer zone, some of which could potentially be affected by mining activities. The remainder of the permit area (approximately 5,229 acres) was mapped at the Order 3 level. Soil investigations were conducted in accordance with Wyoming Department of Environmental Quality Guideline No. 1 (November 1984). The objective of this study includes the identification of quantitative and qualitative soil characteristics on the area for use in surface reclamation programs after mining has been concluded. Soils in the permit area generally pose no special problems and are rated as good for reclamation purposes. Area soils were correlated with U.S. Soil Conservation Service soil series criteria. There were 27 soils mapping units identified and soils ranged from shallow undeveloped to very deep well-developed soils which are characteristic of the area within the Powder River Basin where the Christensen Ranch permit area is located. The soils study also confirmed that there is no prime farmland in the area. Results of the study are provided for review in Appendix D7 of the Christensen permit application.

For the original Irigaray application, soil surveys were performed by the Soil Conservation Service (1977). Only the areas where building or pond construction was planned were sampled in any detail. In 1980, a new soil survey was conducted by Mine Reclamation Consultants, on non-disturbed areas adjacent to the wellfield areas, ponds and plant site. The new survey covered approximately 1,627 acres within and outside of the permit boundary. This survey is included in Appendix D7 of the Irigaray permit application, specifically in Attachment D-5.

In summary, fifteen soil map units comprised of nine soil series were delineated on the Irigaray survey area. Typical profiles were described and soil samples were obtained from pits representative of each soil series. As a result of the evaluation of the field laboratory data, the soils were placed in four suitability classes. Most of the surface and subsurface soil horizons rated fair to good as a source of topsoil material. Available topsoil generally increases from steeply sloping ridgetop areas with 6 to 12 inches of suitable material to about 5 feet of good material in relatively level, low land areas. The survey also confirmed that their is no prime farm land within the Irigaray permit area.

Vegetation at both the Irigaray and Christensen Ranch areas is a typical northern plains short grass prairie forage characteristic of areas of low annual precipitation. Dominant plant species present are sagebrush, Western wheatgrasses, needlegrasses, Blue grama and Threadleaf sedge. Baseline vegetation field studies were conducted

on the Christensen Ranch permit area during the fall of 1986 and spring of 1987. Principal tasks were to identify major vegetation types, determine vegetative species composition and estimate vegetative cover and frequency. A composite reference area not to be disturbed by mining was selected as the basis for determining success of reclamation after mining. There were eight vegetation and land use types identified by the study and a total of 258 plant species identified on the study area. Vegetation in the permit area and one-half mile adjacent to it was mapped. There were no threatened or endangered plant species observed, however, seven noxious weed species and five primary selenium indicator species were encountered. A discussion of the grazing history on the study area was included. Results of the vegetation study are provided for review in Appendix D8 of the Christensen Ranch permit application.

In the original Irigaray permit application (1977), quantitative vegetation baseline data was not available for the permit area. Much of the permitted area was previously disturbed, therefore vegetation data from a study in T44N, R77W was presented. In 1979, a new vegetation study was performed on and adjacent to the Irigaray permit area. The study area encompassed approximately 4,700 acres within and adjacent to the permit area. Quantitative baseline data included cover, production density, species composition and frequency. Reference areas were also established. The results of this study are included in Appendix D8 of the Irigaray permit application, Attachment D-6.

A four season baseline wildlife study was conducted on the Christensen Ranch permit area and adjacent areas to evaluate any potential adverse impacts to the native fauna. The only species of commercial value in the vicinity are domestic, principally range cattle. Wildlife species with some recreational value include the pronghorn antelope, mule deer, cottontail rabbit, sage grouse and mourning dove, which are hunted. Non-game species are typical of the sage brush grassland habitat in the region. Searches for threatened and endangered wildlife were conducted. The only potential conflict identified was with the nesting site of a golden eagle pair, a species of high Federal interest. A special study was commissioned in 1987 to evaluate the potential for mining activities conflicting with the eagle pair. The results of the wildlife baseline study and golden eagle study are included in Appendix D9, as are discussions of other potential impacts and mitigation measures for wildlife during the mining operation.

Wildlife species at the Irigaray project site are very much the same as found on the Christensen project site, and are described in detail in Appendix D9 of the Irigaray permit application.

Annually, COGEMA conducts a wildlife monitoring study to evaluate potential impacts from our mining activities on wildlife in the area. On an annual basis, the study includes the following at both the Irigaray and Christensen Ranch project areas:

* a wintering big game aerial survey to estimate populations, habitat usage and locations of herds (deer and antelope)

* sage grouse strutting ground (lek) censuses for population estimates and sex ratios, and searches for new leks

* nesting raptor surveys and searches for new nests

The Irigaray and Christensen Ranch 1995 Wildlife Monitoring Report, prepared for COGEMA by Powder River Eagle Studies, Gillette, WY, provides a summary of all wildlife surveys conducted on the properties since 1987. This report is contained in the 1995 Annual Report to the Wyoming DEQ, copies sent to NRC, dated August 18, 1995. In summary, no impacts to wildlife have been noted which can be attributed to the mining operations.

### 2.8.2 AQUATIC ECOLOGY

There is very little potential for aquatic life on the Irigaray and Christensen Ranch areas due to the intermittent and ephemeral nature of the drainage and relatively little surface water in the form of lakes or ponds. Two species of minnows, the plains minnow, Hybognathus placitus, and flathead minnow, Pimephales promelas, were trapped from the Willow Creek drainage in the northwest portion of the Christensen Ranch permit area. There are no known species of game fish in the immediate vicinity. Other aquatic life either observed or which could potentially occur on the area are listed in Appendix D9 of the Christensen Ranch permit application.

## 2.9 BACKGROUND RADIOLOGICAL CHARACTERISTICS

This section contains a summary of the environmental sampling program that was used to assess radiological background conditions in the vicinity of the Christensen Ranch permit area. The results of the Christensen program are included as they are more recent and in greater detail than background sampling at the Irigaray site. The pre-mining program included samples of the air, groundwater, surface water, soils, sediments, flora and fauna. The pre-mining data indicate that the existing concentrations of the radionuclides are in the range reported in similar studies.

Detailed information on the background radiological characteristics of the Christensen Ranch permit areas can be reviewed in Appendix D10 . Available data from Irigaray are included in Appendix D10 of the Irigaray permit application. Operational radiological data obtained since 1987 (for Irigaray) and since 1989 (Christensen) are found in Section 5.0 of this renewal document.

### 2.9.1 AIR SAMPLING PROGRAM

The pre-operational background air monitoring data include four quarters of sampling at six Christensen Ranch locations beginning in December 1986. It evaluated the

background concentrations of airborne radionuclides including ambient radon - 222 levels.

The average radionuclide concentration for the air samples and track etch radon cups are found in Table 2.14. The radionuclide concentrations observed in this study are consistent with reported background concentrations (NCRP 45, 1975).

## 2.9.2 WATER SAMPLING PROGRAM

### 2.9.2.1 Groundwater

Three wells at each of 10 regional monitor well sites and 6 domestic and livestock wells at the Christensen Ranch were used to determine the concentrations of various radionuclides in the groundwater. Water well sampling began in September 1986 and was conducted on a quarterly basis. The company was unable to obtain samples from three of the wells, thus a total of 27 wells were used to determine regional groundwater baseline.

The average results from the analysis of samples taken from the regional monitor wells and the domestic and livestock wells are found in Table 2.15. The data indicates that there is a higher average level of radionuclides in the ore zone than in the shallow or deep aquifers. The radionuclide level in the ore zone is also higher than the level observed in the domestic and livestock wells.

### 2.9.2.2 Surface Water

Surface waters in the Willow Creek drainage were sampled monthly at eight locations for a one year period, beginning in October of 1986. The results of the analyses for the surface water samples are shown in Table 2.16. A review of the data shows that the radionuclide concentrations in the surface water samples are generally within the ranges of natural background except in the case of uranium. The uranium background measured is substantially higher than the natural background reported in the literature, and this is most likely due to elevated levels of uranium in the soil in the area.

## 2.9.3 SOIL SAMPLING PROGRAM

Samples of the soils in and nearby the Christensen Ranch permit area were collected in October 1986 and July 1987. Samples were collected from three different areas including soils along ore trend transects, soils out to 1500 meters in four predominant downward directions from the satellite plant center, and soils at each of the air monitor stations.

## TABLE 2.14

## AVERAGE RESULTS OF BACKGROUND AIR PARTICULATE SURVEYS AND RADON MEASUREMENTS

## CHRISTENSEN RANCH PROJECT

| Sample I.D. | Natural Uranium uCi/ml x $10^{-16}$ | Thorium-230 uCi/ml x $10^{-16}$ | Radium-226 uCi/ml x $10^{-16}$ | Lead-210 uCi/ml x $10^{-16}$ |
|---|---|---|---|---|
| AS-1 through AS-6[1] | 2.7 +/- 0.9 | 8.0 +/- 2.8 | 1.7 +/- 0.3 | 188 +/- 59.2 |

| | Radon-222 Concentration uCi/ml x $10^{-9}$ |
|---|---|
| AS-1 through AS-6[2] and nearby residence | 0.66 +/- 0.34 |

(1) Each result represents the average and standard deviation for four quarterly samples at the six air sampling locations.

(2) Radon-222 average is based on four quarterly samples from the air sampling stations and the average of monthly samples for one year at the nearby residence.

## TABLE 2.15

## AVERAGE BACKGROUND RADIONUCLIDE CONCENTRATION IN GROUNDWATER SAMPLES

## CHRISTENSEN RANCH PROJECT

| Sample I.D. | # of Wells Sampled | # of Samples/ Well | U | Ra-226 | Th-230 | Po-210 | Pb-210 |
|---|---|---|---|---|---|---|---|
| Ore Zone | 10 | 4 | 16.7 ± 13.3 | 13.2 ± 20.6 | 3.3 ± 2.5 | 6.7 ± 13.1 | 20.0 ± 39.0 |
| Shallow Zone | 9 | 4 | 4.7 ± 2.7 | 1.3 ± 0.8 | 1.8 ± 1.7 | 2.7 ± 0.6 | 2.1 ± 0.6 |
| Deep Zone | 8 | 4 | 3.3 ± 4.0 | 1.8 ± 1.0 | 2.1 ± 1.6 | 1.5 ± 0.6 | 2.5 ± 2.2 |
| Potable Water & Livestock Wells | 6 | 1 | 4.0 ± 4.7 | 1.0 ± 1.0 | 1.9 ± 1.5 | 2.4 ± 3.3 | 1.4 ± 1.1 |

All data in uCi/ml x $10^{-9}$

## TABLE 2.16

## AVERAGE BACKGROUND RADIONUCLIDE CONCENTRATION IN SURFACE WATER SAMPLES

## CHRISTENSEN RANCH PROJECT

| Sample | U | Ra-226 | Th-230 | Po-210 | Pb-210 |
|---|---|---|---|---|---|
| 8 Sample Locations on Willow Creek | 21.3 ± 8.7(T)<br>14.7 ± 6.7(D) | 1.3 ± 0.5(T)<br>0.7 ± 0.3(D) | 3.3 ± 2.8(T)<br>1.8 ± 1.4(D) | 2.4 ± 1.5(T)<br>1.8 ± 1.4(D) | 4.9 ± 4.8(T)<br>32. ± 1.9(D) |
| Natural Background | 2.0 ± 2.0[1] | 1.2 ± 1.7[1] | -- | 1.3 ± 1.1[2] | 3.6 ± 4.8[2] |

All data in uCi/ml x $10^{-9}$

T = Total Concentration
D = Dissolved Concentration

[1]USEPA, 1985

[2]UNSCEAR, 1977

A summary of the results of the surface and subsurface soil sampling programs is presented in Table 2.17. This table also includes the natural background soil concentration as reported by Eisenbud, 1973, and UNSCEAR, 1977. The surface and subsurface radiometric concentrations at the air monitor stations are within the range of values considered natural. The higher values along the ore trend transects and directional transects presumably are a result of the known uranium ore in the vicinity.

### 2.9.4 SEDIMENT SAMPLING PROGRAM

Sediments along the Willow Creek drainage were collected twice from eight locations, as part of the pre-operational radiological sampling program. The sediment samples were collected once after spring runoff, and once after an extended period of low flow. The results from the analyses of the sediments are listed in Table 2.18.

### 2.9.5 VEGETATION SAMPLING PROGRAM

The Christensen Ranch area is considered range land, used primarily for grazing cattle. Vegetation samples were collected at the six air monitoring stations three times during the grazing season, from May through August 1987.

The results of the analyses are presented in Table 2.19. These analyses are typical of naturally occurring concentrations.

### 2.9.6 FISH AND MEAT SAMPLING PROGRAM

No game fish are known to be present in the Christensen Ranch area, aquatic life such as minnows may provide a food source for other wildlife species.

Fish (minnow) samples were Collected twice from standing water in the lower Willow Creek drainage. The meat samples were collected from the local land owners at the time of slaughter and consisted of commonly eaten muscle tissue.

Table 2.19 contains the results of the fish and meat sample analyses. The samples appear to have similar concentrations with Po-210 exhibiting the greatest variability between fish and meat. These values are considered background concentrations.

### 2.9.7 DIRECT GAMMA RADIATION

Gamma radiation in the environment around the Christensen Ranch project was measured using thermoluminescence dosimeter (TLD) chips located at the six air monitor stations in conjunction with gamma surveys of the project site along ore trends and out in four compass directions from the approximate plant center. The average of the TLD gamma monitors was 27.2 ± 0.09 mRem per quarter which

## TABLE 2.17

## AVERAGE OF THE BACKGROUND RADIOMETRIC ANALYSES IN SOILS

## CHRISTENSEN RANCH PROJECT

| Sample Location | Unat | Ra-226 | Th-230 | Pb-210 |
|---|---|---|---|---|
| Ore Trend Transects | | | | |
| 1986 0-5cm | 1.8 ± 1.3 | 1.8 ± 0.6 | 3.2 ± 3.2 | 4.7 ± 1.3 |
| 1987 0-5cm | 3.8 ± 0.4 | 3.5 ± 1.0 | 2.1 ± 0.2 | 0.5 ± 0.3 |
| Directional Transects | | | | |
| NW 0-5cm | 4.7 | 3.7 ± 0.3 | 2.5 ± 0.2 | 0.4 ± 1.0 |
| NE 0-5cm | 7.7 | 3.5 ± 0.7 | 1.7 ± 0.2 | 0.4 ± 1.0 |
| E 0-5cm | | 2.9 ± 0.8 | | |
| SE 0-5cm | | 3.4 ± .06 | | |
| Air Monitor Stations | | | | |
| 0 - 5 cm | <0.2 | 1.5 ± 0.3 | 1.6 ± 0.8 | 1.1 ± 0.4 |
| 6 - 37 cm | <0.2 | 1.4 ± 0.3 | 0.8 ± 0.1 | 1.0 ± 0.5 |
| 38 - 69 cm | <0.2 | 1.2 ± 0.2 | 5.0 ± 0.5 | 1.1 ± 0.5 |
| 70 - 100 cm | <0.2 | 1.3 ± 0.3 | 2.4 ± 0.3 | 1.4 ± 0.5 |
| Natural Background | 0.3 ± 1.4[1,2] | 0.3 ± 1.4[2] | 0.3 - 1.4[2] | 0.8 - 1.8[2] |

All data in uCi/g x $10^{-6}$

[1]Eisenbud, 1973

[2]UNSCEAR, 1977

## TABLE 2.18

## SUMMARY OF RESULTS OF THE BACKGROUND RADIOMETRIC ANALYSES OF SEDIMENT SAMPLES FROM WILLOW CREEK

## CHRISTENSEN RANCH PROJECT

| Sample I.D. | Unat | Ra-226 | Th-230 | Pb-210 |
|---|---|---|---|---|
| Sediments #1 - #8 | 3.4 ± 1.3 | 2.0 ± 0.8 | 2.5 ± 0.9 | 2.1 ± 0.9 |

All data in uCi/g x $10^{-6}$

## TABLE 2.19

## SUMMARY OF THE AVERAGE BACKGROUND CONCENTRATION OF RADIONUCLIDES IN VEGETATION, FISH AND MEAT

## CHRISTENSEN RANCH PROJECT

| Sample I.D. | Unat | Th-230 | Ra-226 | Pb-210 | Po-210 |
|---|---|---|---|---|---|
| Samples from AS-1 through AS-6 | | | | | |
| Vegetation | 30 ± 18 | 8.2±3.7 | 5.7±2.9 | 54 ± 19 | 15.3±9.7 |
| Fish | 2 ± 3 | 5 ± 3 | 2 ± 3 | 7 ± 4 | 1 ± 1 |
| Meat | 3 ± 2 | 8 ± 3 | 4 ± 5 | 5 ± 1 | 13 ± 14 |

All data in uCi/kg x $10^{-6}$

corresponds to 12.6 uR/hr. The gamma survey indicated a range of 11 uR/hr to 23 uR/hr with an average of 15 uR/hr. The average background gamma level in the Western Great Plains has been reported to be 14 uR/hr (USNRC, 1979b), which corresponds well to the results obtained using both the TLD gamma monitors and the gamma surveys. These values are considered to be appropriate for use as the background level for the Irigaray project.

## 2.10 BACKGROUND NON-RADIOLOGICAL CHARACTERISTICS

Background non-radiological characteristics of the site are discussed in depth in the applicable sections of Appendix D in both Irigaray and Christensen Ranch permit applications. Potentially toxic substances such as heavy metals in the surface and groundwater are presented in Appendix D6, Hydrology. Baseline water quality values for both surface and groundwater are also provided. Because of the relatively small surface disturbance necessary to construct the ISL facilities, very little atmospheric pollution in the form of dust and air particulates is produced. A significant change to the existing air quality in the vicinity is not anticipated.

# THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

## THAT CAN BE VIEWED AT THE RECORD TITLED:

## "STRATIGRAPHIC CROSS SECTION." FIGURE 2.7

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## 3.0 DESCRIPTION OF PROPOSED OPERATIONS

In the past, COGEMA Mining, Inc. has operated the Irigaray central processing facility and associated well fields plus a satellite ion exchange plant and well fields located at the Christensen site. All existing well fields at the Irigaray site have been mined out and are currently undergoing aquifer restoration. These well fields consist of Units 4 through 9, with the restoration in Units 1 through 3 having been completed in 1993. Mining continues at the Christensen satellite operation, in Mine Units 2, 4 and 5. Operations in Mine Unit 3 ceased in mid-1995 in preparation for aquifer restoration scheduled to commence in 1996.

Future operations at Irigaray will consist of the completion of restoration in the existing Irigaray well fields, plus the continuation of plant activities for the processing of the Christensen and Irigaray ion exchange resins (elution), uranium precipitation, yellowcake drying, packaging and shipping. Additionally, continued mining is eventually planned at the Irigaray site, within the current permit boundary plus areas to the north and south of the permit boundary. The existing Irigaray plant will be utilized for the processing, with the current 2400 gpm ion exchange circuit. The timing for resumption of mining at Irigaray is discussed in more detail later within this chapter.

Future operations at Christensen will consist of continued well field installation and operation. In the original plan for Christensen, four satellite plants were anticipated for installation and operation. It is now planned that the entire Christensen ore body will be mined through the use of the one existing satellite plant connected to the various well fields by injection and recovery trunklines. This system has worked well during operations in Mine Units 2 through 5. Booster pump stations are necessary periodically along the trunklines to help move the solutions over the distance to and from the satellite plant. The flow rate of the satellite plant will increase to an annual average of 3,600 gpm by January, 1996.

Mining operations at Christensen will continue with Mine Units 6 and 7, located in the North Prong geographical area of the Christensen permit boundary. After Mine Unit 7, well fields will progress to either the Heldt Draw or Table Mountain geographical areas for Mine Units 8 through 12. The development schedule is discussed in more detail later within this chapter.

The major components of both the Irigaray and Christensen Ranch in-situ mining operations are: 1) the orebody; 2) the well fields; 3) the lixiviant injection circuit; 4) the uranium extraction circuit; 4) uranium precipitation, drying and packaging (Irigaray only); 6) wastewater management systems; and 7) aquifer restoration and surface reclamation. The physical descriptions and operating characteristics of these components and processes are provided in detail in the following sections.

Wastewater management systems and aquifer restoration/surface reclamation are described in detail in Sections 4.0 and 6.0, respectively.

## 3.1 SITE DESCRIPTION AND FACILITIES LAYOUT

### 3.1.1 IRIGARAY SITE

The Irigaray site is located in Johnson County, approximately 90 miles NNE of Casper, Wyoming. The current operation consists of a 30-acre well field, uranium recovery plant with dryer, a well field restoration building, five lined evaporation ponds for wastewater disposal, two lined restoration water storage ponds, and the remains of the original pilot scale operation (517 test site). As previously stated, the 30 acres of well field are in various stages of restoration, and groundwater restoration has been completed at the 517 test site. Facilities remaining at the 517 site include the 0.75 acre well field and four shallow evaporation ponds. The 517 well field has not been reclaimed as it will become a part of the future Mine Unit 10 at a later date. The estimate of total acreage disturbed to-date by the Irigaray operations is approximately 132 acres.

The Irigaray portion of the WDEQ Permit No. 478 boundary encompasses 671.19 acres. The area licensed by the NRC is much larger, but operations were originally confined to a 50 acre well field due to questions regarding the restoration after use of an ammonium bicarbonate lixiviant. The Irigaray property (mining claims, leases, etc.) consists of approximately twenty-eight square miles within Townships 45, 46, 47 North, Ranges 77 and 78 West. The current mine permit area is located in portions of Sections 5, 8, 9 and 16 of T45N, R77W. Primary access roads are located in Sections 19, 29, 30 and 32, T46N, R77W as well as Sections 4, 5 and 9 of T45N, R77W.

The Irigaray processing plant will serve as the uranium recovery plant for the Christensen Ranch satellite facility. The Irigaray Mine site is located about 13 road miles from the Christensen Ranch satellite plant location. The Irigaray plant site is located in Section 9 of Township 45 North, Range 77 West, Johnson County, Wyoming. The location of the Irigaray plant site in relation to the Christensen Ranch permit area, satellite plant site and the access road connecting the two facilities is shown on Figure 3.1 (in pocket). Figure 3.2 (in pocket) provides a facilities location map of the Irigaray permit area.

### 3.1.2 CHRISTENSEN RANCH SITE

The Christensen Ranch permitted area is an irregular shaped but contiguous land unit which encompasses 14,035.19 acres in Townships 44 and 45 North, Ranges 76 and 77 West in Johnson and Campbell Counties, Wyoming. Originally, the permit area

# THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

## THAT CAN BE VIEWED AT THE RECORD TITLED:

## "IRIGARAY AND CHRISTENSEN RANCH PERMIT AREAS." FIGURE NO. 3.1

## WITHIN THIS PACKAGE... OR BY SEARCHING USING THE DOCUMENT/REPORT NO.

**D-02**

# THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

## THAT CAN BE VIEWED AT THE RECORD TITLED:

## "GENERAL LOCATION MAP MINE UNIT 1 THRU 9 PERMIT TO MINE NO 478." FIGURE 3.2

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**D-03**

was divided into four phases for the purposes of mine planning, with a satellite operation planned in each phase. This is no longer the case, as all well field development areas can be reached from the current satellite plant through trunkline connections. Existing facilities at Christensen include the satellite ion exchange plant, two lined brine evaporation ponds, one unlined permeate storage pond, one deep injection disposal well and well fields consisting of Mine Units 2, 3, 4 and 5. Additional construction planned in 1996 will include two additional brine evaporation ponds (already licensed), an office building, warehouse, a 40' extension on to the existing plant building, and a restoration building. A second permeate storage pond is licensed, but not currently scheduled for construction. Additionally, well field installation in Mine Unit 6, North Prong area, is ongoing.

Figure 3.1 shows the location of the Christensen Ranch permit area, in relation to the Irigaray site. The future well field development areas shown in Figure 3.1 consist of the North Prong geographical area (future Mine Units 6 and 7), the Heldt Draw area (future Mine Units 8 and 9) and the Table Mountain area (future Mine Units 10, 11 and 12). Existing Mine Units 2, 3, 4 and 5 are located in the Willow Creek geographical area. The development sequences for these areas are described in more detail in Section 3.7 of this chapter.

Figure 3.3 (in pocket) shows a detailed location map of all existing facilities at Christensen. The total estimate of acreage disturbed by existing operations is 233 acres. This acreage consists of approximately 14 acres for the plant and pond facilities, 182 acres of well field, pipeline corridors and staging areas, 30 acres of access roads and 7 acres of soil stockpiles (topsoil and subsoil). This compares reasonably with the original estimate of 388 acres (for Phase I), which included a peripheral disturbance around the well field areas (assuming an additional 40% of well field acreage to be disturbed for temporary construction activities). Table 3.1 summarizes the potential disturbances for the remainder of the Christensen Ranch development areas.

In summary, the new estimate of lands to be disturbed during all mining operations within the Christensen Ranch area totals approximately 930 acres. The total disturbance is only 7% of the 14,035.19 acres within the entire permit area. The size and configuration of the permitted area is necessary to encompass access roads, monitoring locations and mining claims for potentially minable areas.

## 3.2 DESCRIPTION OF THE OREBODIES

### 3.2.1 ORE BODY

Uranium deposits amenable to solution mining are generally associated with relatively shallow aquifers which are confined by impermeable stratigraphic units. Uranium was

# THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

## THAT CAN BE VIEWED AT THE RECORD TITLED:

## "CHRISTENSEN RANCH AREA FACILITIES LOCATION MAP." FIGURE 3.3

## WITHIN THIS PACKAGE... OR BY SEARCHING USING THE DOCUMENT/REPORT NO.

**D-04**

## TABLE 3.1
## ESTIMATED MINING DISTURBANCE BY DEVELOPMENT AREA
## CHRISTENSEN RANCH

| DEVELOPMENT AREA | LOCATION | DISTURBED AREA DESCRIPTION | | DISTURBED AREA (acres) | 1988 ORIGINAL PERMIT ESTIMATE (acres) |
|---|---|---|---|---|---|
| | | TYPE | ACRES | | |
| Willow Creek (Existing Facilities) | T.44N., R.76W.: Secs. 5: W 1/2; 6,7,8: W 1/2; 17,18,19 & 20 | Plant & Pond Facilities<br>Wellfield Mine Units 2 - 5<br>Peripheral Disturbance*<br>Access Roads<br>Soil Stockpiles | 14<br>76<br>106<br>30<br>7 | 233 | 388 |
| North Prong | T.44N., R.76W.: Secs. 3: W 1/2 W 1/2; 4,5: E 1/2; 8: E 1/2; 9, 10: W 1/2 W 1/2; 16 & 21 | Trunkline Access to Plant<br>Wellfield Mine Units 6 & 7<br>Peripheral Disturbance<br>Access Roads | 10<br>100<br>140<br>30 | 280 (estimate) | 518 |
| Heldt Draw | T.45N., R.76W.: Secs. 19: S 1/2 S 1/2; 30, 31 & 32: SW 1/4<br><br>T.45N., R.77W.: Secs. 24: S 1/2 S 1/2; 25: N 1/2, N 1/2 SW 1/4, SE 1/4 | Trunkline Access to Plant<br>Wellfield Mine Units 8 & 9<br>Peripheral Disturbance<br>Access Roads | 10<br>65<br>91<br>30 | 196 (estimate) | 361 |

* Includes pipeline corridors, monitor well roads, wellfield roads, staging areas, misc. distrubances associated with the wellfields and plant operations.

## TABLE 3.1
## ESTIMATED MINING DISTURBANCE BY DEVELOPMENT AREA
## CHRISTENSEN RANCH
(continued)

| DEVELOPMENT AREA | LOCATION | DISTURBED AREA DESCRIPTION | | DISTURBED AREA (acres) | 1988 ORIGINAL PERMIT ESTIMATE (acres) |
|---|---|---|---|---|---|
| | | TYPE | ACRES | | |
| Table Mountain | T.44N., R.77W.: Secs. 1, 2, 3, 10: N 1/2; 11: N 1/2; 12: N 1/2 | Trunkline Access to Plant | 10 | | |
| | | Wellfield Mine Units 10, 11 & 12 | 75 | | |
| | | Peripheral Disturbance | 105 | | |
| | T.45N., R.77W.: Secs. 34: S 1/2 N 1/2, S 1/2; 35: S 1/2 N 1/2, S 1/2 | Access Roads | 30 | 220 (estimate) | 434 |

| | | |
|---|---|---|
| Christensen Ranch Permitted Area (acres) | = | 14,035 |
| 1988 Estimate of Disturbance (acres) | = | 1,701 |
| 1995 Estimate of Disturbance (acres) | = | 929 |

transported to these locations as a soluble anionic complex by the natural movement of oxygenated groundwaters. Uranium deposition occurs in areas where chemical conditions change from an oxidizing to a reducing state. This condition produces a roll front deposit with uranium concentrated at the interface between the oxidized and unoxidized sandstones. This interface is commonly called the redox interface.

The orebodies at both the Irigaray and Christensen Ranch projects are typical roll front deposits. Uranium minerals occur as sand grain coatings and interstitial fillings in medium to fine-grained sandstones and arkosic sandstones of the Eocene Wasatch Formation. The uranium was derived from volcanics and granitic detritus by oxygen containing waters which leached and transported it via aquifers to where the oxidation potential of the groundwater was overcome by the reducing conditions in the aquifer. At that point, the uranium and some other dissolved metals became insoluble and precipitated as coatings and interstitial fillings in the aquifer.

The redox interface is more commonly termed a roll front. The roll front is actually a zone but relative to the broad extent of the aquifer; it is quite confined. This zone is represented by a sinuous and narrow area in plain view along which the commercial uranium occurrences are found as discontinuous masses. The roll fronts are found in more than one layer of an aquifer particularly where that aquifer is broken up by stratigraphic units (mudstones and/or siltstones) which are relatively impervious to the passage of groundwater. The roll fronts, therefore, converge and diverge causing variations in the concentrations of uranium in a given area. Detailed geologic characterization of the Irigaray and Christensen Ranch areas is provided in Appendix D5, Geology, of each permit application.

### 3.2.2 RESERVE ESTIMATES

Reserve estimates are calculated from exploration drill holes, as well as ore body delineation holes drilled during well field installation. Recent ore reserve evaluations have demonstrated that in today's market, approximately 16 million pounds of reserves exist on the Christensen Ranch project, with an additional 8 million pounds of reserves present on the Irigaray property. Previous ore reserve calculations for Christensen Ranch identified up to 34 million pounds of uranium using lower grade-thickness cutoff, which is not economical in today's uranium market.

### 3.2.3 MINE UNIT LOCATIONS

Each mine unit at Christensen is sized to recover approximately 1 million pounds of uranium. Assuming 50% to 60% recovery of the in-place reserves, each production unit could contain up to 2 million pounds of uranium reserves. The mine unit locations are described as follows:

Section and Subdivision

Operating Units:

| | |
|---|---|
| Unit 2 | Section 6 - NW 1/4 and SE 1/4 , T44N, R76W |
| Unit 3 | Section 7 - N 1/2 and SE 1/4, T44N, R76W |
| Unit 4 | Section 7 - SE 1/4, Section 18 - NE 1/4 and SE 1/4, T44N, R76W |
| Unit 5 | Section 17 - SE 1/4, Section 20 - NE 1/4, Section 21 - NW 1/4, and Section 16 - W 1/2, T44N, R76W |

Planned Units:

| | |
|---|---|
| Unit 6 | Section 4 - W 1/2, Section 9 - W 1/2, T44N, R76W |
| Unit 7 | Section 4 - E 1/2, Section 3 - W 1/2, Section 9 - E 1/2, Section 10 - NW 1/4, T44N, R76W |
| Unit 8 | Section 25 - E 1/2, T45N, R77W; Section 30 - W 1/2, T45N, R77W |
| Unit 9 | Sections 30 and 31, T45N, R76W |
| Units 10, 11, 12 | Sections 34 and 35, T45N, R77W; Sections 1 and 2, T44N, R77W |

Exact locations of planned units will depend upon mine planning within the above areas.

## 3.3 WELL FIELD DESIGN, CONSTRUCTION AND OPERATION

### 3.3.1 WELL FIELD DESIGN

#### 3.3.1.1 Pattern Types - Past and Current

During past operations at Irigaray and Christensen Ranch, well fields were sized so that each mine unit was capable of supplying a flow rate of 2500 gpm to the processing plant. Uranium recovery ranged from 300,000 to 500,000 pounds per mine unit. Newer mine units, such as Units 4 and 5 at Christensen Ranch, and future mine units are designed to recover approximately 1,000,000 pounds of uranium each. Final boundaries of future mine units will be verified during the actual well field installation.

When designing a well field, development holes are drilled perpendicular to the strike of mineralization. Ore grade and thickness are determined by gamma logging. Data from the development holes is then evaluated to determine minable areas. Development holes are then completed as either injection or recovery wells. Any sub-economic grade holes are sealed with abandonment mud or cement slurry.

Mine units consist of groups of cells or well patterns installed to correspond to the geometry of the orebody. Well patterns include five-spot patterns, alternating line drives and staggered line drives depending on the size and shape of the deposit. The tendency of the roll fronts to change direction abruptly typically result in irregularity of the pattern shapes.

A single five-spot pattern is roughly rectangular and consists of four injection wells surrounding one center recovery well. Spacing between the corner injection wells is typically 85 feet although it ranges from 50 to 100 feet depending upon the topography and ore characteristics.

Alternating line drives are used in areas where very narrow portions of the roll fronts occur. An alternating line drive is simply a line of wells spaced along the strike of the ore. One well will be an injector, the next a recovery well, the next an injector, etc. The well function may be reversed or changed at appropriate times to improve mining or restoration efficiency. A staggered line drive is used where a roll front is too wide for an alternating line drive. Essentially, the injection wells are on one side of the roll front, and midway between them, on the opposite side of the front, are the recovery wells. Well functions are reversed at appropriate times.

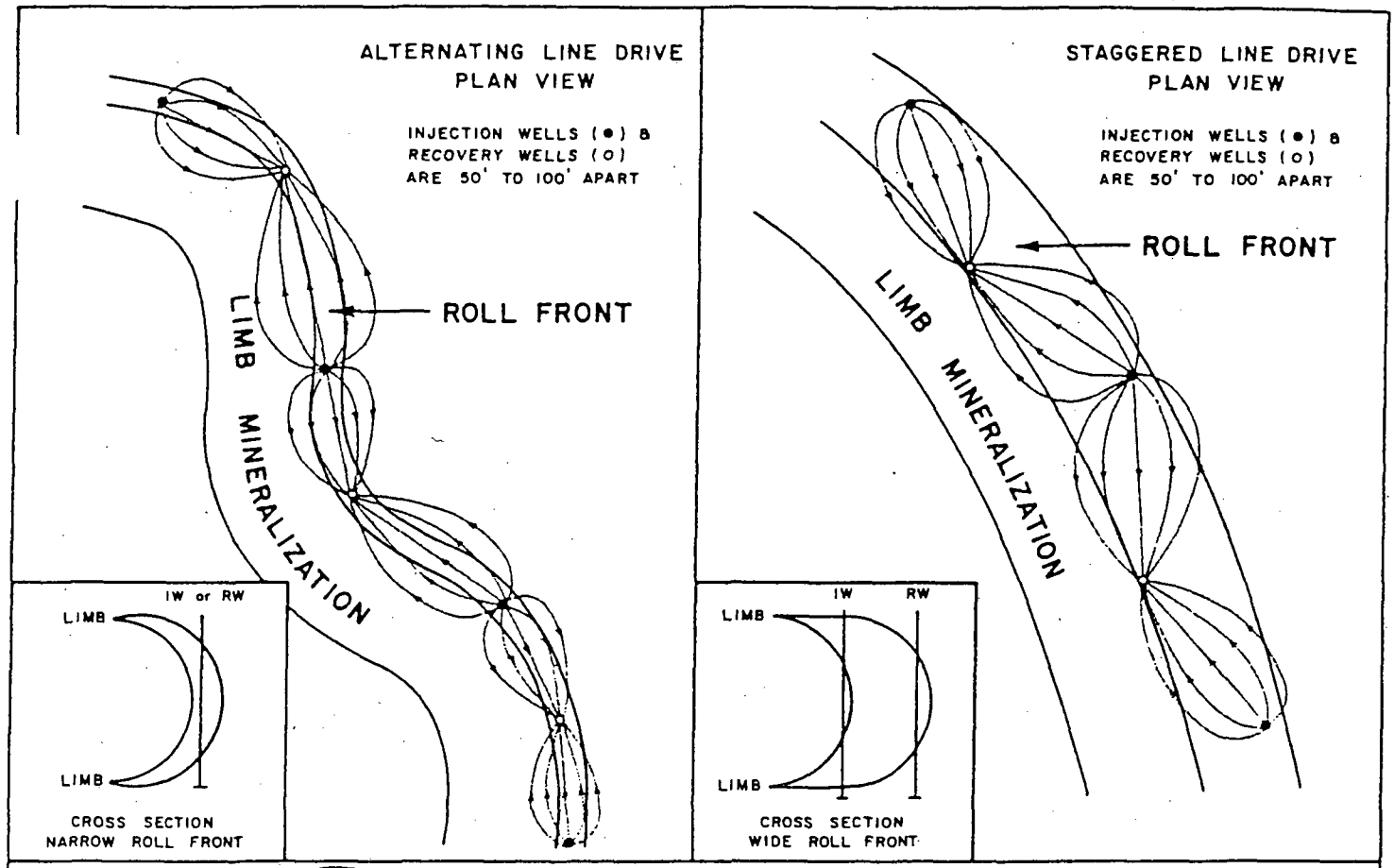
The typical five-spot pattern, alternating and staggered line drive patterns and examples of their corresponding flow lines are shown in Figure 3.4.

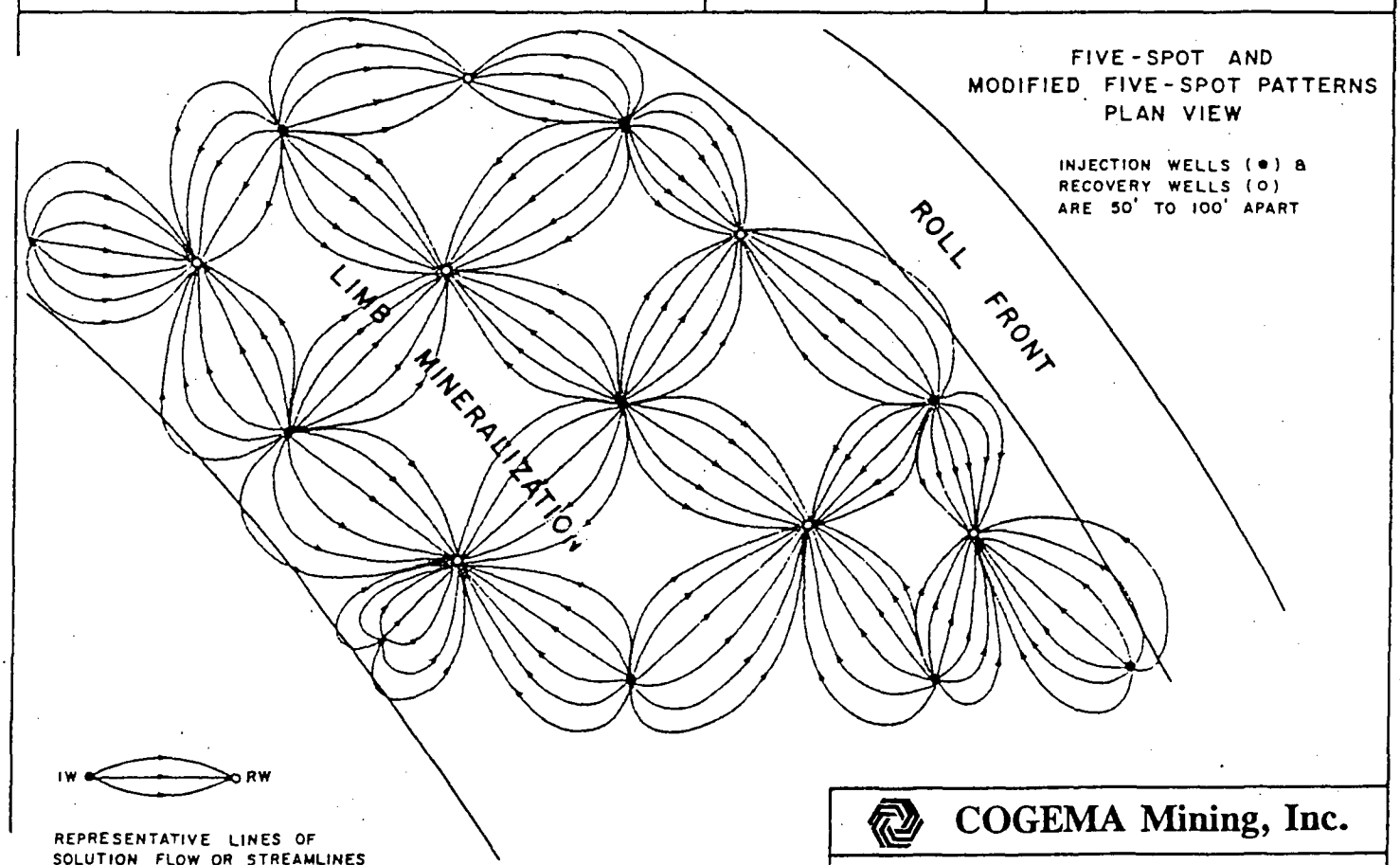
In the late 1970's, the Irigaray well fields were developed using a seven-spot pattern (one producing well with six injection wells, in roughly a hexagonal pattern). These patterns were later converted to five-spot patterns during operations in the 1980's and 1990's. Future development at Irigaray and Christensen Ranch will use a combination of the above patterns.

Through the use of a combination of the above patterns, a typical ratio of production wells to injection wells ranges from 1:1.2 to 1:1.3. To date, this has resulted in the completion of 663 production wells and 838 injection wells in the Christensen Ranch Mine Units 2, 3, 4 and 5, providing a ratio of 1:1.26 (producers to injectors). At Irigaray, the number of producers compared to injectors is lower (424 and 640, respectively), thus providing a ratio of 1:1.51, largely due to the installation of seven-spot patterns.

#### 3.3.1.2 Monitor Wells - Past and Current

After delineation of the mine unit boundaries, monitor wells are installed around the perimeter of the well pattern areas to detect any horizontal migrations of injection solutions, or excursions, during operations. At Irigaray, monitor wells were located at a distance of 400 feet from the edge of the well pattern areas and were spaced 400 to 600 feet apart. As more operational data was collected over the years, monitor




REPRESENTATIVE LINES OF SOLUTION FLOW OR STREAMLINES BETWEEN INJECTION AND RECOVERY WELLS.

**COGEMA Mining, Inc.**

TYPICAL FIVE-SPOT, ALTERNATING & STAGGERED LINE DRIVE PATTERNS WITH CORRESPONDING FLOW LINES

| | | |
|---|---|---|
| DATA BY: WDC | SCALE: NONE | FIGURE: 3.4 |
| DRAFTED BY: mll | DATE: 12-31-87 | |

well spacing on the perimeters of the well pattern areas has become more sophisticated, and is now based on hydrologic parameters of the mining formation, including gradient and transmissivities, and the ability to retrieve excursions within a 60 day regulatory time frame.

Based upon detailed studies of the hydrologic characteristics of the mining aquifers at both the Irigaray and Christensen Ranch sites, perimeter ore zone monitor wells will be located as follows:

1. Downgradient from the well field, where the well field orientation with the groundwater flow direction forms an angle greater than 45 degrees: 300 feet from the well field edge, spaced 300 feet apart.

2. Upgradient from the well field, where the well field orientation with the groundwater flow direction forms an angle greater than 45 degrees: 500 feet from the well field edge, spaced 500 feet apart.

3. Sides of the well field, which form angles with the flow direction of less than 45 degrees: 500 feet from the well field edge, spaced 500 feet apart.

Perimeter ore zone monitor wells within the trend of the orebody will eventually be abandoned or incorporated into the well field pattern as mining progresses. Ore zone monitor wells will have a completion interval which encompasses the same completed intervals of the adjacent mine unit wells.

Monitor wells are also installed within the mine unit boundaries to monitor for potential excursions to the aquifers overlying and underlying the host ore aquifer. Shallow monitor wells are completed in the first overlying aquifer above the ore aquifer. At the Irigaray site, the shallow aquifer is designated as the "Unit 1 Sand"; at the Christensen Ranch site, the "J" sandstone unit of the stratigraphic column is typically the shallow monitor zone. Deep monitor wells are completed in the first underlying aquifer at each project site. These are termed the lower Irigaray sandstone and the "L" sandstone unit at the Christensen Ranch site. One shallow and one deep monitor well will be installed within the mine unit boundaries for each three and one-half (3.5) acres of installed pattern area.

In the past, due to problems with improperly sealed exploration drill holes and poor well casing integrity, shallow excursions occurred at the Irigaray site. As a result, shallow monitor wells were installed within the existing well fields at a spacing of approximately one well per acre, or greater in some areas. However, in future Irigaray mine units, it is proposed to complete these wells at the same frequency as at Christensen Ranch, or one well for each 3.5 acres of installed pattern area. This is now possible due to the superior well casing integrity testing procedures now in use,

and the company's practice of sealing all exploration and delineation holes prior to operations.

Although not anticipated, if areas within any proposed mine units are encountered which exhibit very thin or absent confining layers, the company will evaluate the situation and may adjust the monitoring program accordingly. These adjustments may include the expansion of perimeter monitor well completion intervals to detect movement of lixiviant into areas not bounded by a confining layer (if the layer within the well field pinches out, for example) or the placement of overlying/underlying monitor wells in different stratigraphic horizons within the same well field. Additional operational controls may be instituted in the absence of a confining layer such as increased rates of overrecovery or decreased injection pressures.

## 3.3.2 WELL CONSTRUCTION AND COMPLETION TECHNIQUES

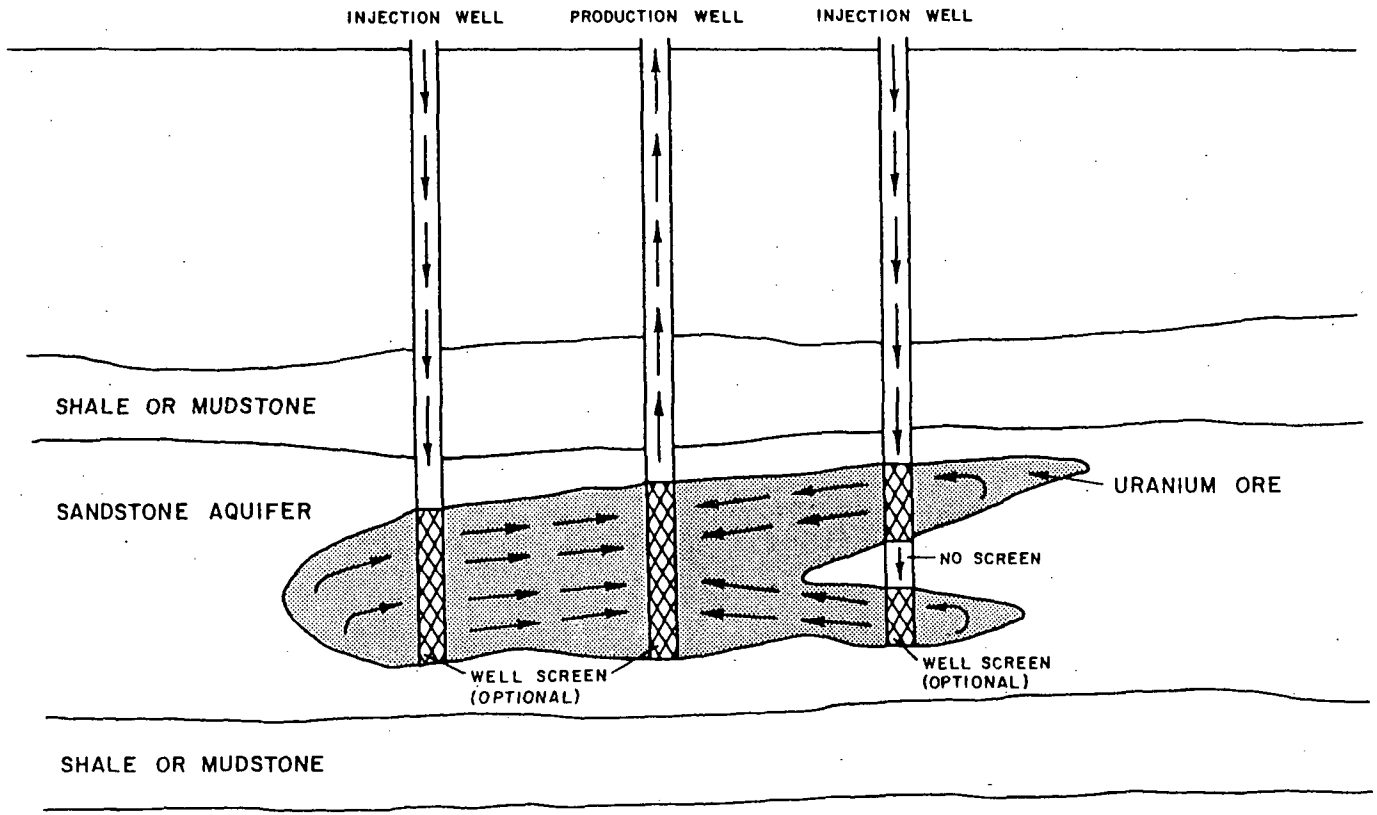
### 3.3.2.1 Well Completion Techniques

The vertical confinement of the injected fluids underground are controlled by the integrity of the overlying and underlying confining layers, the vertical permeability of the ore-bearing sands and the integrity of wells themselves. Descriptions of the well completion methods for recovery, injection and monitor wells are given below.

Injection and recovery wells are drilled and completed to similar specifications. This allows for alternating the well function as necessary to improve mining or restoration efficiency. The completed interval in the injection wells is limited to the mineralized zone intercepted by the hole. The recovery wells completed interval is limited either to the intercepted mineralized zones or to the uppermost and lowermost depths of the ore in the adjacent injection wells. An example of a uranium roll front deposit showing the typical completion intervals of injection and recovery wells is provided as Figure 3.5.

Wells are typically drilled with a rotary drill or similar technology such as reverse circulation drilling. A nominal 5" diameter pilot hole is first drilled from the surface through the ore zone and then logged with geophysical borehole logging equipment to provide a gamma ray log, resistivity log and self-potential log. If sufficient mineralization is not encountered to warrant well completion, the hole is plugged with cement slurry or abandonment gel over its entire depth. If abandonment muds are used, the hole is then capped with either a poured concrete plug at the top, terminating approximately two feet below the surface, or by placing a tapered cement cone at about the same depth. Each hole is then marked at the surface for identification.

If the hole meets the economic criteria, it is completed as a well by reaming to a 6 3/4" to 7 7/8" (or 7 3/4" to 8 7/8", if 6 inch casing is used) diameter prior to casing




COGEMA Mining, Inc.

TYPICAL INJECTION & RECOVERY WELL COMPLETION INTERVALS

| | | |
|---|---|---|
| REVISED: 2-6-95 | SCALE: NONE | FIGURE: 3.5 |
| DRAWN BY: mll | DATE: 1-5-88 | |

installation. Injection and recovery wells are cased with nominal 5" O.D. (4-1/2" I.D.) or 6" O.D. (5 1/2" I.D.) schedule 40 polyvinylchloride (PVC) pipe, or Yelomine (or equivalent), or fiberglass. The majority of wells installed in the Irigaray Units 1 through 5 are PVC or Yelomine cased; the majority of wells in Units 6 through 9 are fiberglass cased. Wells at Christensen Ranch are primarily PVC cased, with Yelomine being prevalent in Mine Unit 3.

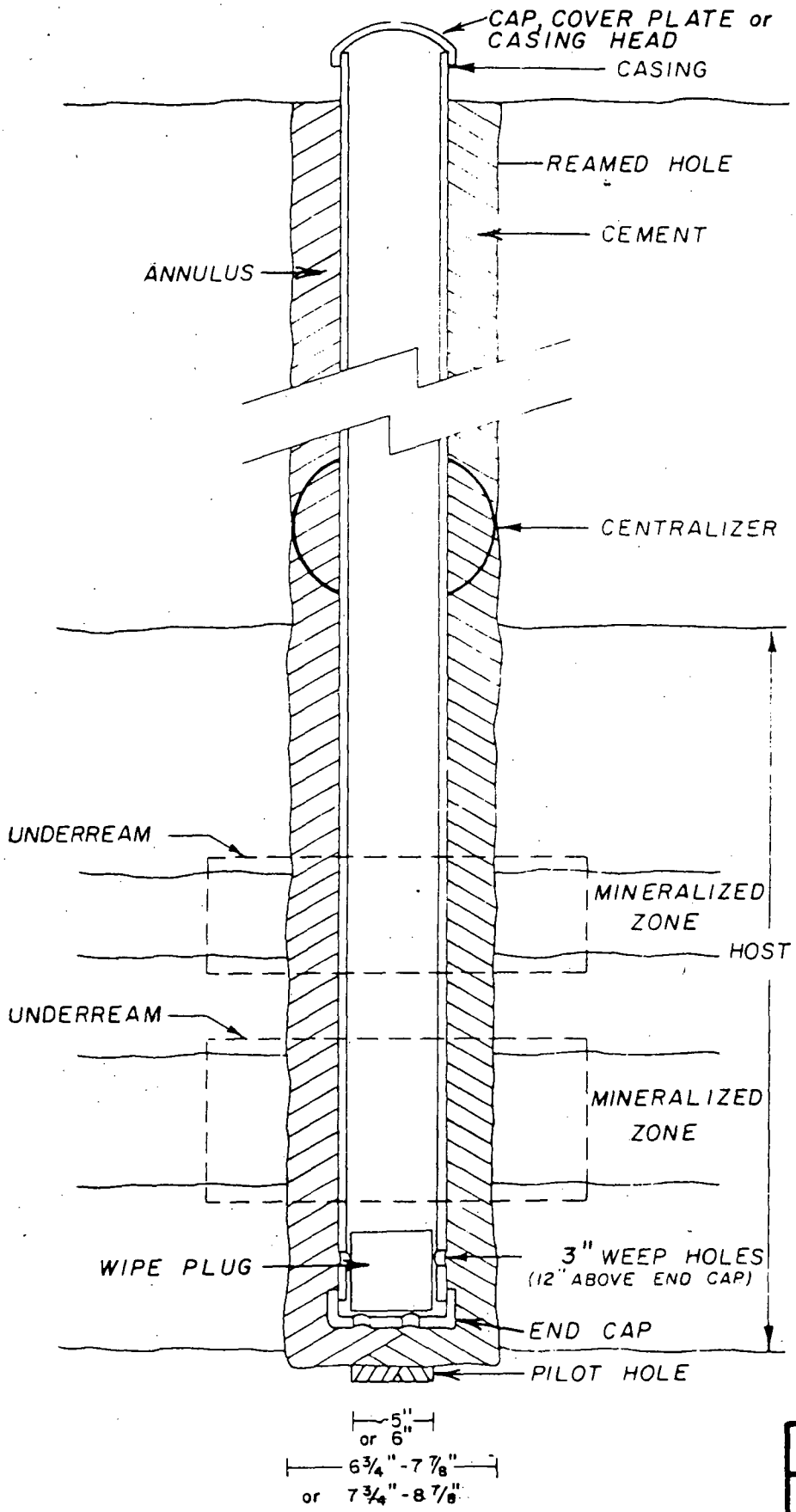
The well casing is emplaced with PVC centralizers on the top and bottom casing sections and with additional centralizers uniformly spaced at maximum 100' intervals to keep the casing away from the side walls. Although the bottom of the casing can be left open for cementing, the more common practice is to attach a cap on the bottom joint of casing and drill 3/4" diameter weep holes a few inches above the cap.

Cementing is done with a drill rig or cementing unit. A calculated column of neat mixture of Type II or III sulfate resistant cement with a pozzolanic additive (probably 2% to 4% bentonite) is first placed in the casing. The cement has a weight of 12 lbs. to 15 lbs. per gallon to provide sufficient fluidity to fill the annular space. The cement slurry is then forced up the casing annulus between the casing and the borehole wall by a calculated amount of displacement water. On occasion, a wiper plug may be used between the cement and the displacement water. When cement return is observed at the surface, the well is shut in to allow setting and curing (approximately 24 hours). Depending on conditions, additives may be used to hasten or extend cement setting time. Additional cement is then added to the well annular space at the surface to top off any void areas caused by the cement settling during curing.

After the cement has cured, the mineralized intervals of the well are made accessible to leaching solutions by either drilling through the bottom cement plug or by underreaming or perforating through the casing and cement. Figures 3.6, 3.7 and 3.8 show the three alternate well completion methods which are utilized. The drilling, logging, casing and cementing functions are essentially the same for all methods.

Underreaming is accomplished with a specialized tool utilizing retractable blades which is lowered downhole to the desired interval with the drill rig. The underreamer blades are activated with hydraulic pressure from the drilling rig pump and are held open by the weight of the drill string. The underreamer blades cut away the casing, cement and borehole wall to expose the mineralized part of the aquifer at the desired interval. When the pump pressure is released and the tool is withdrawn, the blades fold inward and remain in the collapsed position for the trip out of the well. The underreamed intervals are screened and/or gravel-packed if the formation is too poorly cemented or compacted to remain in place without support. An alternative to underreaming is to open mineralized zones by explosive or hydraulic perforating. The specific conditions encountered will determine which technique is most applicable.

Monitor wells are similarly constructed using primarily Methods 2 and 3 (Figures 3.7 and 3.8). If it becomes necessary to sample multiple horizons through a monitor well,

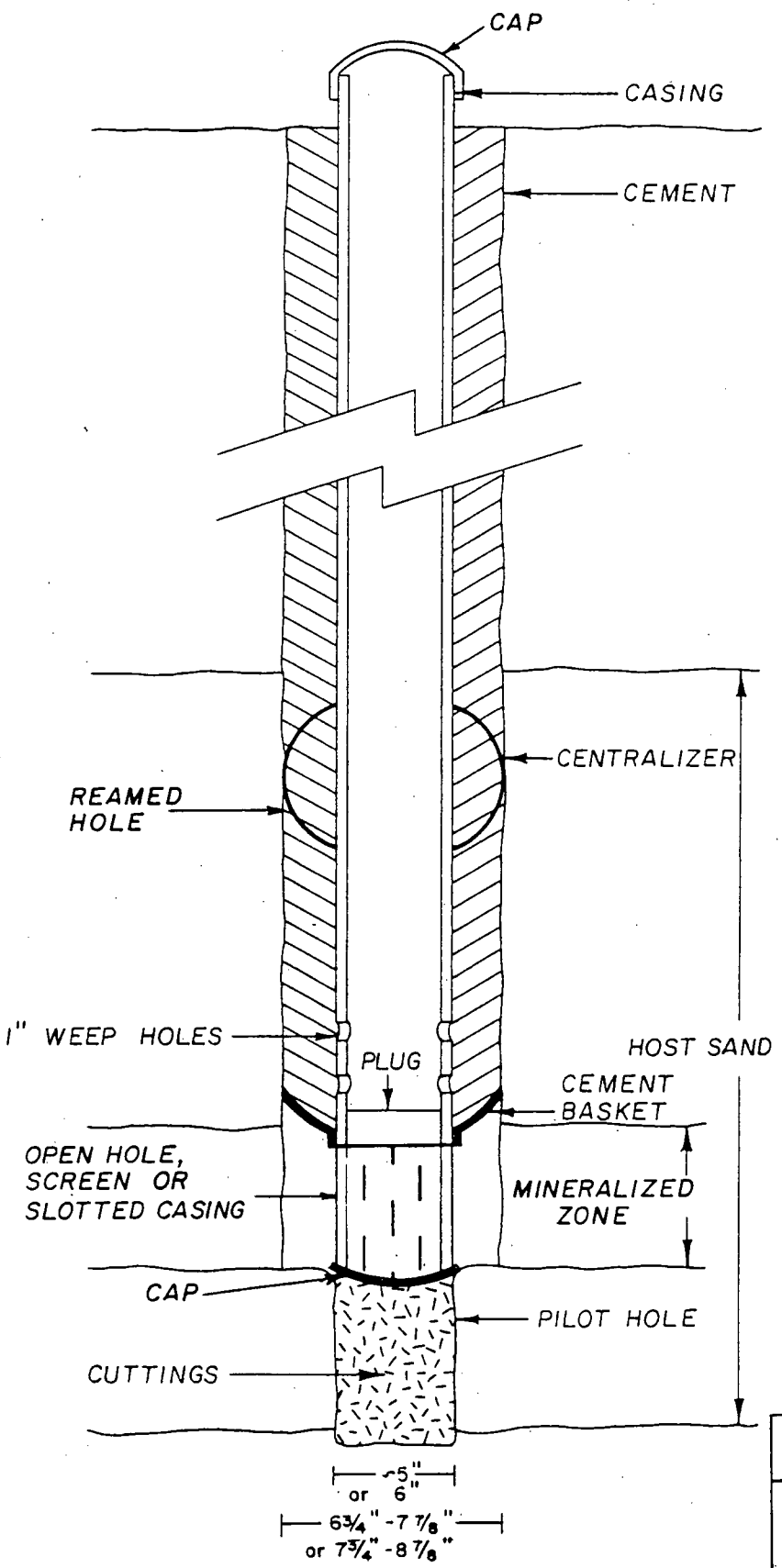



1. Drill 5" diameter pilot hole through the mineralized zone.
2. Run geophysical log.
3. Calculate depth, thickness and grade of mineralized zone.
4. Determine zones to be completed.
5. Ream the hole to 6 3/4" to 8 7/8" in diameter to approximately 15' past the bottom of the mineralized zone.
6. Install 5" to 6" casing approximately 10' past the bottom of the lowest completion interval.
7. Cement the annulus. Then use a 5" to 6" wipe plug, if needed, behind the cement but ahead of the chase water to wipe casing to bottom. Shut well in.
8. Top off the annulus with cement after settling has occurred.
9. Drill out residual cement to approximately 5' past the bottom of the lowest completion.
10. Underream all mineralized intervals through casing and cement. The mineralized intervals will average a total of 10' in one to three zones.
11. Airlift and swab casing until turbidity level is achieved.

**COGEMA Mining, Inc.**

WELL CONSTRUCTION
METHOD 1
UNDERREAMED INTERVALS

| | | |
|---|---|---|
| | SCALE: NONE | FIGURE: 3.6 |
| DRAWN BY: P.H. | DATE: 2/21/95. | |

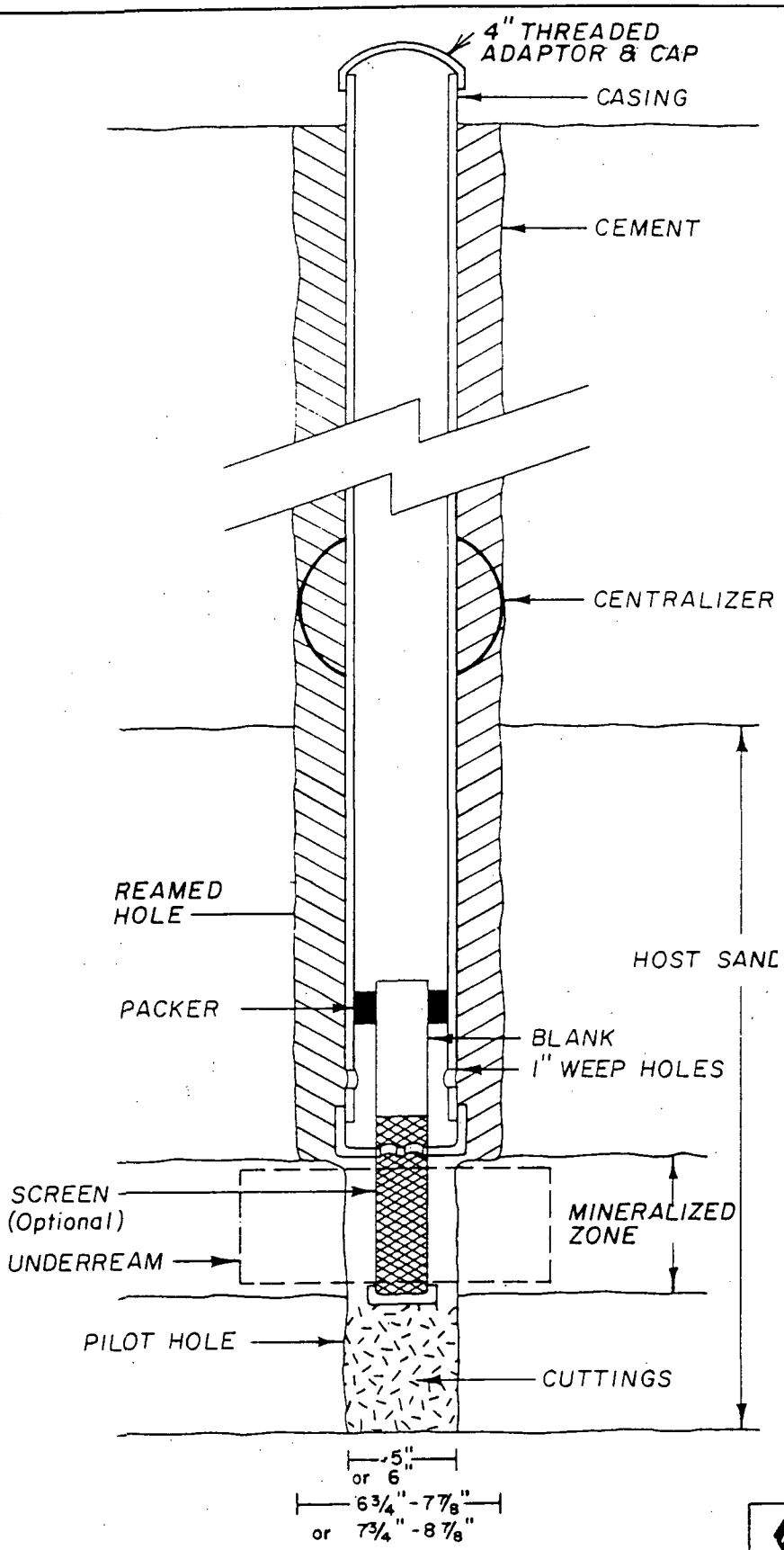



1. Drill 5" diameter pilot hole through the mineralized zone.
2. Run geophysical log.
3. Calculate depth, thickness and grade of mineralized zone.
4. Determine zones to be completed.
5. Ream the hole to 6 3/4" to 8 7/8" in diameter through the mineralized zone.
6. Install 5" to 6" casing to the top of designated mineralized zone with a cement basket.
7. Cement the annulus. Shut well in.
8. Top off the annulus with cement after settling has occurred.
9. Drill out residual cement inside the casing, plug and airflush.
10. Completion intervals will be approximately 20'-200' per hole and will be left open hole or screened or slotted casing will be installed.
11. Airlift and swab casing until required turbidity level is achieved.

**COGEMA Mining, Inc.**

WELL CONSTRUCTION
METHOD 2
SCREENED or SLOTTED INTERVAL

| | | |
|---|---|---|
| | SCALE: NONE | FIGURE: 3.7 |
| DRAWN BY: P.H. | DATE: 2/21/95 | |




1. Drill 5" diameter pilot hole through the mineralized zone.
2. Run geophysical log.
3. Calculate depth, thickness and grade of mineralized zone.
4. Determine zones to be completed.
5. Ream the hole to 6 3/4" to 8 7/8" in diameter to the top of the designated mineralized zone.
6. Install 5" to 6" casing to the top of designated mineralized zone.
7. Cement the annulus. Shut well in.
8. Top off the annulus with cement after settling has occurred.
9. Drill out residual cement inside the casing and airflush.
10. Completion intervals will be approximately 20'-200' per hole and will be underreamed or screened.
11. Airlift and swab casing until required turbidity level is achieved.
12. Install 5" to 6" threaded adaptor and threaded cap.

**COGEMA Mining, Inc.**

WELL CONSTRUCTION
METHOD 3
SCREENED INTERVALS
OR UNDERREAMED

| | | |
|---|---|---|
| | SCALE: NONE | FIGURE: 3.8 |
| DRAWN BY: PAS | DATE: 9/27/95 | |

the conventional casing, cementing and underreaming of intervals as described for injection and recovery wells are employed. The intervals selected for completion will correlate stratigraphically with injection-recovery intervals and may be isolated with packers for sampling of the appropriate groundwaters.

After a well is drilled and underreamed or completed "open hole", it is cleaned either by air flushing or swabbing techniques. Swabbing consists of the rapid raising and lowering of a tight fitting swab (similar to a hole wiper plug or a series of wiper plugs) within the casing with a pulling unit (Smeal) or drill rig. The vacuum created causes a very rapid inflow of water through the water-bearing open intervals. This inflow washes clay particles and other interstitial debris from the permeable strata, thereby promoting flow rates. Usually this step is followed by air flushing to remove any remaining particles from the well.

Other well cleaning techniques include injection of polyphosphates in aqueous solution. Polyphosphates disperse clays and permit their removal by swabbing and/or air flushing. If chemical precipitates such as calcite are plugging the aquifers the injection of acids (typically hydrochloric acid) or additives such as $CO_2$ gas, which reacts with water to form carbonic acid, may be required to solubilize the precipitates. These solutions are then washed from the formation by air flushing or swabbing or both.

#### 3.3.2.2 Well Integrity Testing Procedures

All cased wells are tested for integrity after installation. Wells are also retested for integrity after undergoing any physical alteration from underreaming or after any workover operation wherein the casing could be damaged. The integrity of operating wells will be routinely tested on a schedule of once every five years.

The integrity testing procedure involves the pressure testing of the well casing. The procedure is to set two inflated packers, one at the top of the interval being tested and one at the bottom, to seal the casing. A steel cable on a winch is used to connect the packer assemblies and run them into and out of the hole. High pressure nylon tubing is simultaneously extended and recovered on a reel. Nitrogen gas fed through the tubing inflates the packers after they are properly positioned. Prior to packer inflation, the casing is filled with water. An accumulator with an internal rubber bladder is used in combination with nitrogen tank to pressurize the water between the packers to the maximum operating pressure plus a 20% engineering safety factor.

Each well casing to be utilized for injection or recovery purposes is required to maintain the maximum operating pressure plus 20% for a ten minute period. If the measured pressure loss during the first ten minutes after pressurization is greater than 10% of the test pressure, the well is deemed suspect and must be retested. If, after

successive attempts to reseat the packers the well leakage is still greater than 10% of the test pressure, the well is deemed incompetent. All incompetent wells are either repaired or replaced and must pass the pressure test before being placed into service. Records of the integrity testing results are maintained for all wells.

Based on the depth of the ore zones and corresponding sandstone fracture pressures, the maximum operating pressure at the Irigaray site has been set at 120 psig. Accordingly, cased wells are tested at a pressure of 144 psig. At Christensen, the maximum operating pressure is 140 psi, and cased wells are tested at a pressure of 168 psig.

#### 3.3.2.3 Abandoned Exploration Drill Holes

Approximately 8,000 exploration holes were drilled over the 14,000 acre Christensen Ranch permit area during the period of 1967 through 1986 to establish the uranium ore reserves. An equal number exist on the extended Irigaray property, north and south of the existing permit boundary. A listing of the Christensen Ranch holes and their locations is given in Appendix D5, Geology, of the original permit application. A listing of exploration holes within the Irigaray permit area is also found in Appendix D5 of that original permit application.

In the case of Christensen Ranch, exploration holes that were drilled prior to 1979 were abandoned by sealing with drill and natural muds defined as drill muds commonly used to drill plug and core holes. No additional materials were added to increase viscosity. Holes drilled during and after 1979 were abandoned by sealing with fortified drill muds defined as T.D. or abandonment muds as required by Wyoming Statutes (W.S.) 35-11-404. Prior to commencement of mining, exploration holes drilled prior to 1979 which are within proposed mine unit boundaries will be relocated, to the extent possible, and resealed from total depth to the surface with approved abandonment muds or cement slurry, according to W.S. 35-11-404. All holes will be marked at the surface for future recognition. The same practice will be used in the future for any Irigaray mine unit development.

### 3.3.3 WELL FIELD OPERATIONS

#### 3.3.3.1 Lixiviant Composition

The lixiviant is the mining solution which is used to solubilize the uranium from the ore deposit. The lixiviant composition is designed to reverse the natural geochemical conditions which led to the uranium deposition. After injection into the mineralized zone, the solution is pumped to the surface for uranium extraction. Following the removal of uranium, the groundwater is refortified with lixiviant and reinjected into the mineralized zone. This cycle continues until mining is complete.

The lixiviant used during operations consists of either sodium bicarbonate/carbonate or carbon dioxide gas (contributes a carbonate complex), using gaseous oxygen or hydrogen peroxide as the oxidant. Carbon dioxide gas will also be added for pH control, and as an additional source of carbonate during the use of sodium bicarbonate. Carbon dioxide gas, alone, is capable of contributing enough carbonate, which along with naturally occurring cations such as sodium, magnesium and calcium, is sufficient to complex the uranium. The lixiviant is made up and refortified on a batch basis, and added continuously to the injection stream.

Typical concentrations of chemical constituents in the lixiviant are given below:

| | |
|---|---|
| Bicarbonate | 1,500 to 3,000 mg/l |
| Oxygen | 400 to 500 mg/l |
| Sodium | 750 to 1,200 mg/l |
| pH | 6.0 to 9.0 units |

3.3.3.2 Anticipated Geochemical Reactions

The major geochemical reactions which occur during the mining operation are the oxidation and mobilization of the uranium ore. Oxidation is accomplished through the introduction of gaseous oxygen or hydrogen peroxide with the lixiviant-fortified injection stream. The uranium, existing in the insoluble +4 valence state, is oxidized to the more soluble +6 valence by the following reaction:

$$2(UO_2)\ \text{(solid)} + O_2\ \text{(Dissolved Oxygen)} = 2\ (UO_3)$$

Once the uranium has been oxidized to the +6 valence state, the complexing agent in the lixiviant (bicarbonate) aids in the mobilization or dissolution of the uranium. The following reactions are examples of the leaching process when using a bicarbonate lixiviant:

$$UO_3 + 2(MHCO_3) = M_2UO_2(CO_3)_2 = H_2O \text{ (where M is any monovalent cation)}$$

or

$$UO_3 + M(HCO_3)_2 = MUO_2(CO_3)_2 + H_2O \text{ (where M is any divalent cation)}$$

The uranium is then recovered from the solution in the ion exchange process of the satellite extraction plant.

Other geochemical reactions that are anticipated are the dissolution of other metals in the formation and the ion exchange of lixiviant cations with any clays present in the formation. Analysis of the recovered mining solutions indicate that trace metals such as arsenic, selenium, vanadium, aluminum, iron and manganese are liberated during the leaching process. The mobilization of these metals did not cause significant problems during the groundwater restoration phase at Irigaray, nor at the Christensen

Willow Creek R & D test; a chemical reductant was used to reverse the oxidizing characteristics of the groundwater after mining and to precipitate the referenced metals underground at both sites. A summary of the changes in groundwater composition which occur during the mining process is provided in Table 3.2.

### 3.3.3.3 Well Field Piping, Instrumentation and Operation

In the well field, the uranium-laden (pregnant) solution is pumped from the recovery wells to the uranium-extraction circuit, located within satellite plant building at Christensen Ranch, and within the Irigaray central plant for mining operations at Irigaray. Following uranium extraction from the pregnant mining solution, the barren solution is refortified and returned to the ore zone through the injection wells. A pressure controller is located downstream from the injection pumps to maintain injection pressures at allowable levels.

Injection solution is sent to the well field via pumps located at the satellite extraction plant (or main Irigaray plant, in the case of Irigaray operations). Flows from recovery wells are pumped to the plant by individual submersible pumps. Booster pumping stations may be installed in the well field trunklines where necessary. Specific details of piping installation, instrumentation and operations for both Irigaray and Christensen Ranch is as follows.

Irigaray

At Irigaray, during mining operations, the lixiviant was recovered from the production wells via centrifugal-type submersible pumps which pushed the solutions to the extraction plant. Following uranium extraction, the barren solution was refortified and returned to the ore zone via the injection wells. Flows were monitored on the individual wells and on the collection lines and main trunkline. A pressure controller was installed downstream from the injection pumps to maintain injection pressures at the allowable limit of 120 psig.

In Units 1 through 5, all pipelines are located on the surface. The pipelines range from four-inch PVC collector lines to twelve-inch high density polyethylene (HDPE) trunklines. To prevent freeze-up during winter, the lines are insulated and contain an electrical heat trace. The production and injection lines are connected to the central well field building (now the restoration building) by collection lines. Skid-mounted pumps inside the well field building send the mining solutions to the central processing plant through the main trunklines (also on the surface and insulated). During mining operations, the well field building contained remote activated individual well flow meters and remote controls for the individual well flow valves.

In Units 6 through 9, all pipelines have been buried approximately two to six feet below the ground surface to prevent freezing. These pipelines include PVC and HDPE

## TABLE 3.2

## ANTICIPATED GEOCHEMICAL REACTIONS DURING MINING

CHANGES DUE TO REAGENTS ADDED DURING THE PROCESS:

All data in mg/l unless noted otherwise

| | Pre-Mining Baseline* | Post-Mining Analyses* |
|---|---|---|
| Bicarbonate | 118.0 | 1701.3 |
| Chloride | 7.2 | 152.3 |
| pH, units | 8.87 | 7.4 |
| Sodium | 136.0 | 780.0 |
| Sulfate | 194.8 | 387.3 |
| TDS | 425 | 2406.3 |

CHANGES DUE TO REACTION BETWEEN THE LIXIVIANT AND HOST ROCK:

| | Pre-Mining Baseline | Post-Mining Analyses |
|---|---|---|
| Calcium | 8.6 | 90.2 |
| Magnesium | 1.2 | 14.0 |
| Potassium | 2.6 | 5.4 |
| Silica | 9.11 | 22.0 |

CHANGES IN TRACE METAL COMPOSITIONS:

| | Pre-Mining Baseline | Post-Mining Analyses |
|---|---|---|
| Aluminum | <0.10 | 0.66 |
| Arsenic | <0.0025 | 0.148 |
| Iron | <0.06 | 0.12 |
| Manganese | <0.02 | 0.09 |
| Selenium | <0.001 | 3.094 |
| Vanadium | <0.10 | 2.61 |

CHANGES IN RADIONUCLIDE CONCENTRATIONS:

| | Pre-Mining Baseline | Post-Mining Analyses |
|---|---|---|
| Uranium | 0.0354 | 36.4 |
| Radium-226, pCi/l | 73.2 | 1225.7 |

* Results from the Christensen Ranch Willow Creek Research and Development test conducted in 1985-1986.

lines from individual wells to small well field buildings, and feeder lines from the buildings to the main trunkline (twelve-inch HDPE, also buried). The well field building in each unit is the collection point for all individual well lines, for the purposes of sampling the recovery wells and housing the flow metering and pressure gaging equipment. This is also where the individual lines feed the collection lines, which feed the main trunkline. One main trunkline system services Units 6 through 9, which is equipped with high/low flow and high/low pressure alarm systems for leak detection. All assembled strings of piping were leak tested prior to burial.

Restoration operations are currently ongoing at Irigaray using the same well field arrangement, with the exception that the reverse osmosis units are located within the Units 1 through 5 well field building, now termed the restoration building. Flows from Units 6 through 9 are routed to this building via a buried twelve-inch HDPE trunkline. Also, individual well flow rates and pressures are now monitored manually by operators.

Future well field piping, instrumentation and operations at Irigaray will occur using the current procedures for Christensen Ranch, which are described in detail following.

Christensen Ranch

Within each mine unit at Christensen Ranch, groups of approximately 40 recovery wells and 50 injection wells are piped individually with one inch to two inch polyethylene pipe into a central well field module building. The boundaries of each module within a mine unit are influenced greatly by topographic features. The flow capacity of each module typically ranges from 300 to 800 gpm.

Inside the module building, each individual well has a flow meter, a pressure gauge, and a manual valve to control the flow rate. The recovery wells are manifolded together on one side of the building and the injection wells are manifolded together on the opposite side. Flow meters giving both rate and totalizer readings are located on the six to eight inch diameter manifolds to record the combined recovery and injection flow. The module injection and recovery feeder lines are buried and connect to the main twelve to fourteen inch diameter trunklines which deliver the solution to and from the plant. It is possible to isolate each module from the main trunkline by closing a butterfly valve.

The recovery and injection flow meters connect via signal wires to remote collection devices. The instantaneous and totalized flow information is then entered directly into a computer data base for flow balancing. Remote transmitting units are used to transmit the data to a centralized location. The computer system is also used to flag abnormal flow values which could be indicative of a leak in the trunkline, or a problem with an individual well. Any irregularities will initiate inspection of the trunklines, feeder lines, or individual wells.

Well field pipelines are buried a minimum of 18 inches below ground surface to inhibit freezing. Although this is well above the freeze depth, the solutions will be circulated constantly thus preventing freeze-up. The piping may also be insulated prior to burial. In the event of a power failure, auxiliary power will be available or carbon dioxide will be used to clear the pipelines. The shallow burial of the pipelines is for easier placement and removal either for repair or final reclamation. Pipelines are pressure tested for leakage prior to final burial.

The materials of construction for the pipelines at Christensen range from PVC to HDPE, in sizes of four-inch to fourteen-inch. Individual well piping in the module buildings is typically two to three inch high quality rubber. In 1993, a series of failures of pipeline reducers occurred when Mine Unit 2 was brought on-line. The PVC reducers were manufactured so that the reduction, for example from a four inch line to an eight inch line, was so abrupt that turbulence in the line itself caused a breakage at the reducer. As a result, all of the pipeline reducers in question were replaced with a bell-type reducer that reduced the stress on the pipe and eliminated the failures. The use of bell-type reducers is now standard procedure for the pipe runs at Christensen Ranch. Bell type reducers have commonly been used at Irigaray, and will continue to be used.

#### 3.3.3.4 Well Field Balance and Injection Pressures

Flow rates from individual recovery wells range from less than 5 gpm to 40 gpm. Injection flow rates are maintained at a balanced level somewhat lower than the recovery flow rates. An overall solution bleed from the total recovery flow is taken in the extraction plant prior to injection. The bleed consists of approximately 1% of the overall flow rate; therefore, the injection flows are always approximately 1% lower than the recovery flows. The 1% bleed should maintain a net inflow of native groundwater to the production zone thus controlling any potential migration of lixiviant outside of the well field.

Injection pressures are maintained well below formation fracture pressure. Based upon the results of prior operations in the area, injection pressures for operational purposes will be maintained at a maximum of 140 psig at Christensen Ranch and 120 psig at the Irigaray site. All injection and recovery wells at the Christensen and Irigaray sites will be tested for integrity using the maximum operational pressure of 140 or 120 psig, respectively, plus the 20% engineering safety factor (a total of 168 psig at Christensen and 144 psig at Irigaray).

On occasion, operational pressures in excess of the maximum occur as a result of routine maintenance activities such as filter changes, startup or shutdown procedures, etc., or from power surges (very common). These very short term pressure increases are unavoidable, but do not occur for any length of time that could cause problems. To date, these increases have not exceeded the maximum operating pressure plus the

20% engineering safety factor at either the Irigaray or Christensen Ranch sites.

#### 3.3.3.5 Well Field Chlorination

In the case that bacterial action causes deleterious effects in the well fields during operations such as slime formation, reduction in flow rates, etc., chlorination of the well fields will be necessary. Chlorination is accomplished by the addition of liquid sodium hypochlorite (NaOCl) or gaseous chlorine to the injection stream in concentrations sufficient to maintain an approximate 1.0% residual chlorine in the recovery solutions. The breakdown products of the sodium hypochlorite are sodium and chloride, which are constituents already found in the lixiviant circuit:

$$2NaOCl = 2\,Na^{+} + 2OCl^{-} = 2Na^{+} + O_2 + 2Cl$$

Chemically, the chlorine gas will react the same as the sodium hypochlorite with the advantage of eliminating the additional sodium contribution from the hypochlorite. The residual breakdown products of chloride, and sodium if hypochlorite is used, will be a very small percentage of the chloride and sodium concentrations already present in the lixiviant circuit. Chlorination was used at the Christensen Ranch, Mine Unit 3 operations, after satellite plant vessels brought up from Texas were determined to have caused bacterial induced decreases in injection flows.

#### 3.3.3.6 Power Transmission and Communication Lines

Power is supplied to the Irigaray and Christensen Ranch satellite facilities by both the Johnson/Sheridan REA and Tri-County Power companies. Both companies have established powerlines in the vicinity. Power supplied to the Irigaray and Christensen Ranch operations is through pole-supported overhead transmission lines. Poles on BLM land will comply with federal regulations. Secondary overhead transmission lines will carry power from each plant site to the well fields. The secondary lines will deliver power to transformers located within the well fields. The transformers then step down the voltage for delivery to the well field downhole submersible pumps. Powerlines from the transformers to the well fields may either be on the surface or buried. Telephone lines to each area are buried.

## 3.4 URANIUM RECOVERY PROCESSING FACILITIES

### 3.4.1 IRIGARAY CENTRAL RECOVERY PLANT

The Irigaray mining operation consists of a 2,400 gpm uranium extraction and recovery plant, associated well fields and evaporation ponds. The plant facility is equipped with an ion exchange/lixiviant makeup circuit, ion exchange elution process, uranium precipitation circuit, yellowcake dewatering and drying circuit, yellowcake

storage and the capability to package and ship either slurry or dried uranium product. The elution, precipitation and packaging/shipping portions of the Irigaray operation are used to also process Christensen Ranch uranium-laden resin and uranium product. The Irigaray plant, therefore, serves as the central plant for the Christensen Ranch satellite plant. Additionally, the plant is equipped to receive, store and dry yellowcake slurry from other ISL operations.

Restoration operations are conducted using the ion exchange and sand filtration units within the central plant, plus ion exchange and reverse osmosis circuits located within the restoration building, located adjacent to Units 1 through 5. Resin from the restoration uranium removal process is processed on a batch basis similar to that for resin received from the Christensen Ranch satellite.

A description of each process at the Irigaray plant is provided as follows.

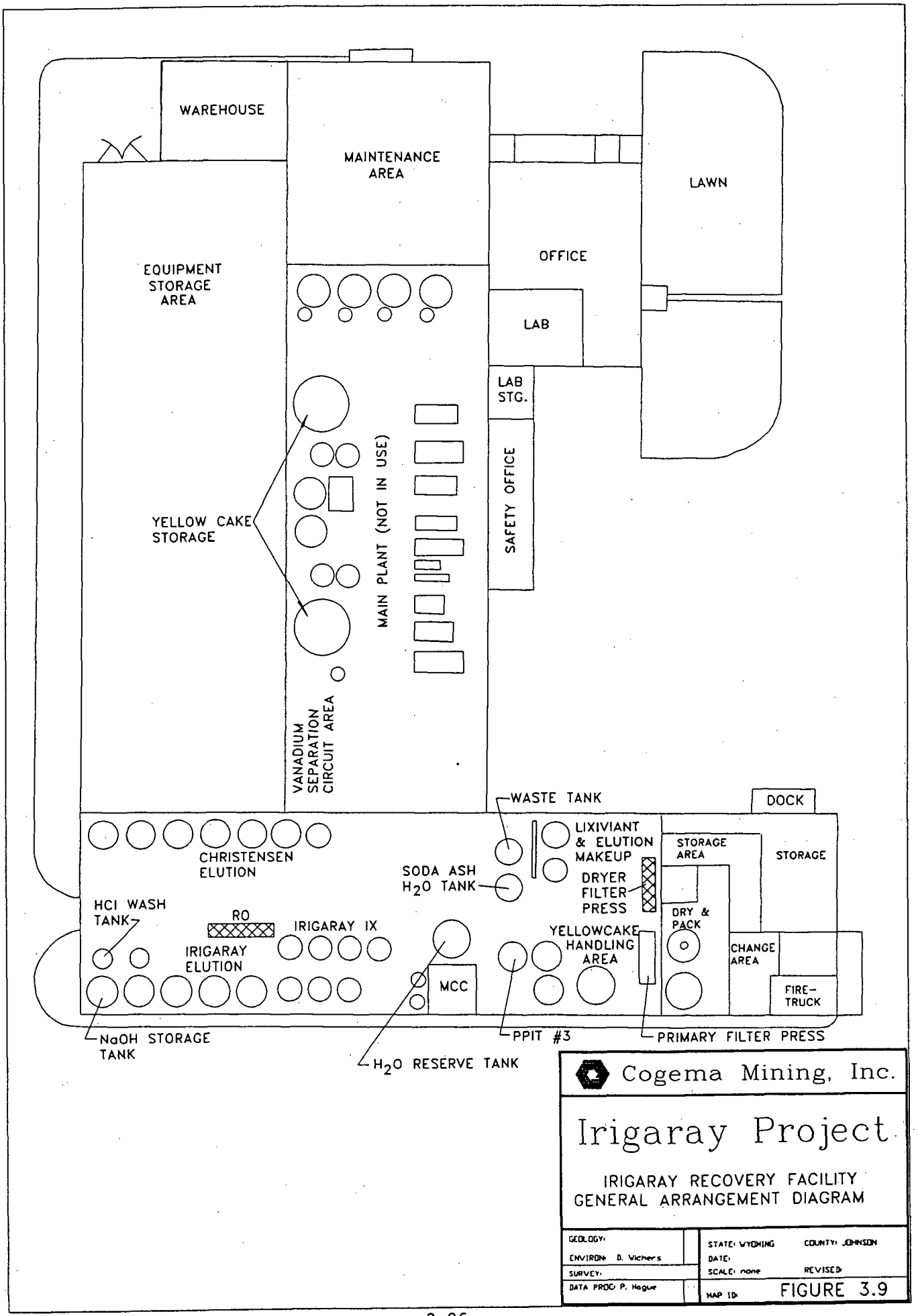
#### 3.4.1.1 General Arrangement

Figure 3.9 depicts the general arrangement of the Irigaray central plant. When the Irigaray plant was first constructed in 1977, the main plant contained a 1,600 gpm up-flow capacity ion exchange circuit (operated at 800 gpm) with accompanying resin transfer and elution columns, precipitation system, calcium clarifiers, lixiviant make-up and the multi-hearth calciner for drying. In 1988, additional processing equipment was installed in the annex to the main plant, consisting of a 2,400 gpm ion exchange circuit, elution circuit, precipitation circuit, and yellowcake dewatering capability (uranium thickeners and filter press). At the same time, the Christensen resin transfer and elution systems were installed in the annex. The portion of the plant termed "main plant" has not been used since 1982, with the exception of the calcium clarifiers which are now used for yellowcake slurry storage prior to drying. The clarifier units were converted over to yellowcake storage for use in holding COGEMA's Texas operations yellowcake slurry. The old portion of the plant is also used for storage of byproduct material, and will be used for a vanadium removal circuit, if deemed necessary in the future.

#### 3.4.1.2 Ion Exchange/Lixiviant Makeup Circuit

When the uranium-bearing solution from the Irigaray well fields reaches the process plant, it first passes through the ion exchange vessels that contain solid resin beads which preferentially removes the uranium from the solution. While the solution and resin beads are in contact, the uranium anionic complex is exchanged on the resin for chloride. This is the principal source of chloride ions in the circulating groundwater. The chemical equation for the reaction is:

$$2R(Cl) + Na_2 \cdot UO_2(CO_3)_2 = R_2 \cdot UO_2(CO_3)_2 + 2NaCl$$


WAREHOUSE
MAINTENANCE AREA
LAWN
OFFICE
EQUIPMENT STORAGE AREA
LAB
LAB STG.
SAFETY OFFICE
YELLOW CAKE STORAGE
MAIN PLANT (NOT IN USE)
VANADIUM SEPARATION CIRCUIT AREA
WASTE TANK
DOCK
LIXIVIANT & ELUTION MAKEUP
STORAGE AREA
STORAGE
CHRISTENSEN ELUTION
SODA ASH $H_2O$ TANK
DRYER FILTER PRESS
HCl WASH TANK
RO
IRIGARAY IX
DRY & PACK
YELLOWCAKE HANDLING AREA
IRIGARAY ELUTION
CHANGE AREA
MCC
FIRE-TRUCK
NaOH STORAGE TANK
PPIT #3
PRIMARY FILTER PRESS
$H_2O$ RESERVE TANK
Cogema Mining, Inc.
Irigaray Project
IRIGARAY RECOVERY FACILITY
GENERAL ARRANGEMENT DIAGRAM
GEOLOGY:
ENVIRON: D. Vichers
SURVEY:
DATA PROC: P. Hague
STATE: WYOMING
COUNTY: JOHNSON
DATE:
SCALE: none
REVISED:
MAP ID:
FIGURE 3.9

where R is the active resin ion exchange site. After uranium extraction, the mining solution leaving the IX unit is refortified with bicarbonate (in the form of $CO_2$ or soda ash). Gaseous oxygen, or hydrogen peroxide, is then added to the solutions at the plant, or in the well field, prior to reinjection into the well field to repeat the leach cycle. In the case of restoration solutions, the solutions are then either transferred to the restoration storage pond or to the restoration building for further processing. The ion exchange circuit at Irigaray is capable of processing a flow rate of 2,400 gpm.

#### 3.4.1.3 Elution and Precipitation Circuit

After the resin in one of the ion exchange vessels is essentially loaded with uranium, it is either transferred to another vessel, or is isolated from the normal process flow for further processing. The uranium is then stripped from the resin by a process called elution. In the elution process, the ion exchange resin is contacted with a strong sodium chloride (salt) solution which exchanges for the uranium and regenerates the resin in a process very similar to a home water softener. Sodium bicarbonate is then used to rinse the resin to keep the stripped uranium from precipitating in the vessel. The stripping solution concentrates the uranium to between 8 and 20 grams per liter, at which level it can be precipitated as a yellowcake product. After elution, the resin is placed back in service for additional uranium recovery.

The eluate from the resin elution circuit is then routed to the precipitation circuit. To initiate the precipitation cycle, hydrochloric acid is added to the uranium bearing solution to break down the uranyl carbonate present in the solution. Hydrogen peroxide is then added to the eluate to effect precipitation of the uranium. The last step of the precipitation process is to add caustic soda to neutralize the remaining acid in solution.

Resin from the Christensen Ranch site is first received in the annex on the west side of the building through large overhead doors. The resin trailer is backed into the building next to one resin elution column. The resin is then transferred from the trailer into the column via a flexible hose. The column of "loaded" resin is then eluted in place, such as described above. Once the resin is stripped of its uranium, it is then reconstituted using the above process. The resin is then transferred from the elution column back to an empty trailer for transport back to the Christensen Ranch facility.

#### 3.4.1.4 Yellowcake Dewatering, Drying and Packaging Circuit

After precipitation, the yellowcake solution is then washed, filtered and allowed to settle prior to entering the drying and product packaging circuit. The yellowcake solution is first processed through a filter press where it is washed, to remove excess chlorides and other soluble contaminants, and then dewatered to a thickened slurry. The slurry is then stored in a yellowcake thickener, or other cone-bottomed tank. At this time the yellowcake slurry, approximately 30 to 50% solids, is either shipped off-

site to a uranium refinery via a tanker trailer, or dried on-site.

When drying, the settled yellowcake slurry in the thickener or storage tank is then fed into the propane-fired multi-hearth dryer. There the slurry is dried at a low temperature (approximately 750° F) to a $UO_4 \cdot 2\ H_2O$ (uranate of peroxide) product. After cooling, the dried uranium product is packaged in drums for shipment. The off-gas discharge from the dryer is scrubbed with a high intensity Venturi scrubber to remove contaminants prior to discharge to the atmosphere. The scrubber maintains a 95% to 99% efficiency for removal of uranium particulate. Spent scrubber solutions are recycled back to the precipitation circuit to recover uranium captured during the scrubbing. The stack discharge to the atmosphere consists of essentially water vapor and small quantities of uranium fines.

Packaging of the dried product occurs on a continuous basis during the drying campaign. The dried product exits the bottom hearth of the dryer through a delumper and a rotary valve into 55 gallon drums (DOT approved). The system is equipped with a dust collection baghouse for personnel protection and dried product recovery. Air from the baghouse dust collection system is routed to the off-gas line from the dryer, which is drawn into the high-intensity Venturi scrubber through an induction fan. Through the scrubber and induction fan system, a vacuum is created, thus containing airborne uranium inside the dryer enclosure.

The yellowcake dryer was installed at the Irigaray plant in 1979, and operated briefly through 1981. When the dryer was initially operated in 1980, the unit was operated as a calciner, i.e. high temperature fired. The yellowcake product was dried at approximately 1600° F, in order to "burn-off" contaminants in the yellowcake, such as ammonium and chlorides (ammonium bicarbonate was used in the precipitation system at that time). As our product is now precipitated with hydrogen peroxide, operations at such high temperatures are not necessary. The hydrogen peroxide precipitation technique forms a superiorly clean cake which is again washed in the filter press prior to drying. Few contaminants will be present when the yellowcake enters the dryer, which in turn will reduce emissions from the scrubber stack.

Based on a performance test of the scrubber after the dryer was refurbished and first started in December, 1994, the WDEQ issued Operating Permit No. OP-254 for the dryer emissions. Several conditions were placed on the permit including a 0.30 lb./hour restriction for particulate emissions from the scrubber, and the following limits for the scrubber pressure loss (or gain), and the scrubbing liquid flow rate:

| | |
|---|---|
| Liquid Flow Range Allowance: | 21.4 to 39.6 gpm |
| Gas Pressure Differential Range Allowance: | 37.1 to 68.9 inches of water |

COGEMA will abide by these permit conditions, unless future stack testing proves that different limits should be used and the WDEQ permit is amended.

Toll-drying of Yellowcake

The dryer was re-furbished in late 1994 and is currently used to dry yellowcake product from Irigaray, Christensen Ranch and COGEMA's Texas operations. The dryer is capable of operating at a rate of 300 pounds per hour, or approximately 2.6 million pounds of throughput per year. The dryer is also permitted with the WDEQ for this rate through Operating Permit No. OP-254. It is estimated that during peak periods of production, the Christensen Ranch may produce up to 1 million pounds per year of uranium product which will be dried. COGEMA may wish to dry up to an additional 1.6 million pounds per year of yellowcake product from a combination of other uranium licensees and our Texas operations. MILDOS modeling has been performed at the 2.6 million pound throughput and no significant increases in exposures to the general public have been seen as a result of this level of drying.

As stated, the Irigaray plant is currently accepting yellowcake slurry from our Texas operations for drying. Shipments of slurry are received in exclusive-use slurry transport trailers. Upon arrival, the slurry trailer enters the old portion of the plant through an overhead door directly adjacent to the northern-most yellowcake storage tank (see Figure 3.9, General Arrangement Diagram). The slurry is then pumped to one of the two yellowcake storage tanks (previous calcium clarifiers), using flexible hoses and a diaphragm pump. Excess decant and wash water from the unloading process is routed either to the on-site evaporation ponds as waste, or to the yellowcake processing area for filtration.

The two yellowcake storage tanks used to receive yellowcake slurry for toll-drying were previously used in the process as calcium clarifiers when an ammonium-bicarbonate process was used at Irigaray. Each clarifier is a 45,000 gallon steel and reinforced concrete cone-bottomed tank, capable of storing about 200,000 pounds of uranium slurry (dried equivalent). The two tanks were refurbished to accept the yellowcake slurry, by sandblasting the interior concrete bottoms and steel sides, and the application of corrosion protection coatings. A detailed review of the tank construction and refurbished was conducted by NRC in December, 1994 and January, 1995, prior to their approval of a license amendment allowing COGEMA to accept yellowcake slurry from our Texas operations.

COGEMA may consider the acceptance of other licensee's yellowcake material for toll drying in the case that the volume of production from the Texas operations does not account for the total 2.6 million pounds per year capability. This would, in most likelihood, be product from the North Butte ISL operation currently licensed by Pathfinder Mines Corporation.

### 3.4.1.5 Vanadium Separation

Recovery solution and yellowcake analysis from the Christensen Ranch operations has

indicated that vanadium will co-leach with uranium during the mining process of portions of the Christensen Ranch ore body. Vanadium is also extracted onto the IX resin during the recovery solution processing. Vanadium is an undesirable constituent in the yellowcake product, therefore, it may become necessary to remove the vanadium prior to drying the Christensen Ranch yellowcake. This will only become necessary if the vanadium content reaches a level where the uranium refineries will penalize the product due to excessive levels of vanadium.

If vanadium removal from the Christensen Ranch product is necessary, a specialized circuit will be installed at the Irigaray central plant. Equipment required for the vanadium separation will consist of two precipitation tanks, two smaller tanks for chemical additions and solution overflow and a vanadium filter press. The vanadium separation equipment will be located in the old plant area next to one of the clarifier units used for yellowcake storage. The vanadium separation area is shown on the Irigaray general arrangement diagram provided as Figure 3.9.

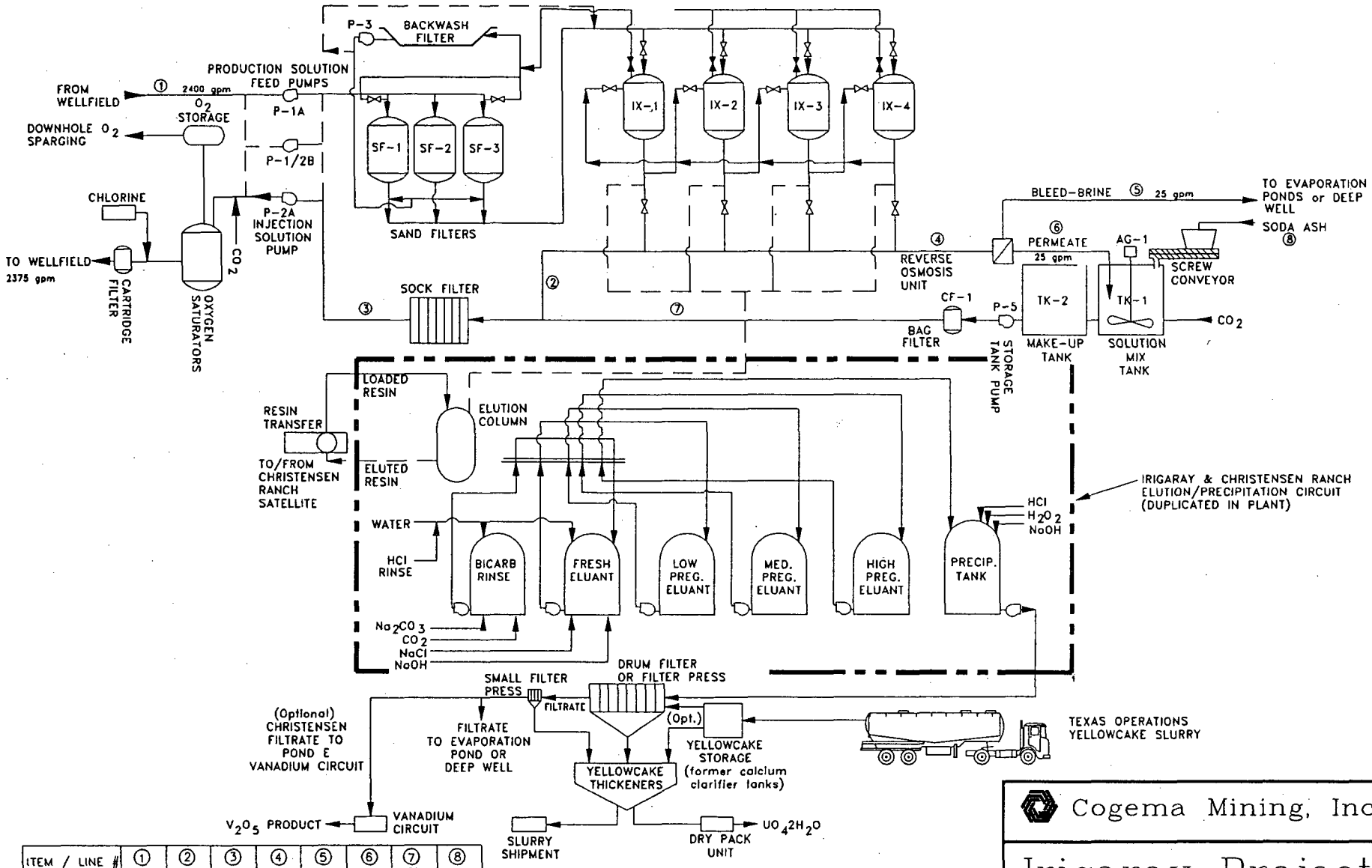
The vanadium removal process is very similar to that used for uranium processing. After elution of the Christensen resin, the high pregnant solution will be discharged from the elution unit to a high pregnant surge tank. The solutions would then be transferred to a tank where uranium will initially be precipitated and vanadium will be separated through a series of chemical additions to reduce the amount of vanadium in the uranium precipitate. Following the initial uranium precipitation, overflow solutions will enter another tank for vanadium precipitation.

Vanadium will be precipitated as a calcium vanadate product. The vanadium product will then be filtered in a pressure filter press to make a filter cake which can be marketed for its vanadium value. The vanadium product will be drummed for storage and shipped on a batch basis. Removing the vanadium allows recycle of the remaining solution (supernate) to the fresh eluant makeup tank; a small portion of the solution may be sent to the evaporation pond.

Based upon vanadium levels present in the yellowcake product from the Christensen Ranch it is anticipated that approximately 60,000 pounds of vanadium product could be produced per year from Christensen Ranch solutions.

#### 3.4.1.6 Flow and Material Balance

The process flow and material balance for the Irigaray central recovery plant is provided as Figure 3.10. The figure assumes a 2400 gpm recovery flow from operating mine units. A 1% bleed rate from the well field is used, which is taken from the processing of 50 gpm of barren lixiviant through a reverse osmosis unit, with a resultant 25 gpm brine flow to disposal (1% bleed) and 25 gpm of high quality permeate, which is used for lixiviant makeup.




| ITEM / LINE # | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ |
|---|---|---|---|---|---|---|---|---|
| Liquid TPH | 600 | 587 | 594 | 12 | 6 | 6 | 6 | – |
| S.G. | 1.01 | 1.01 | 1.01 | 1.01 | 1.03 | 1.01 | 1.06 | – |
| Flow Rate GP | 2400 | 2350 | 2375 | 50 | 25 | 25 | 25 | – |
| U3O8 lbs/hr | 72.0 | 1.2 | 1.2 | 0.0 | 0.0 | – | – | – |
| V lbs/hr | 0.90 | 0.90 | 0.12 | 0.12 | 0.00 | – | – | – |
| HCO3 lbs/hr | 2,400 | 2,303 | 2,565 | 49 | 49 | 1.0 | 236 | 235 |
| Na lbs/hr | 1,112 | 1,067 | 1,189 | 23 | 23 | .05 | 109 | – |
| Cl lbs/hr | 192 | 200 | 202 | 4 | 4 | 0.1 | 0.1 | – |
| U3O8 ppm | 60.0 | 1.0 | 1.0 | 1.0 | 2.0 | – | – | – |
| V ppm | 0.75 | 0.1 | 0.1 | 0.1 | 0.2 | – | – | – |
| HCO3 ppm | 2000 | 1960 | 2160 | 1960 | 3920 | 78.4 | 18,800 | – |
| Na ppm | 800 | 800 | 800 | 800 | 1568 | 32 | 5,148 | – |
| Cl ppm | 160 | 170 | 170 | 170 | 333 | 7 | 7 | – |

*NOTE:*
*EVAPORATION PONDS ARE EQUIPPED WITH EVAPORATION ENHANCEMENT (TRICKLE and/or SPRAY SYSTEM)*

Cogema Mining, Inc.

# Irigaray Project

PROCESS FLOW SHEET
IRIGARAY EXTRACTION & URANIUM RECOVERY PLANT
(ADSORPTION & DESORPTION CIRCUIT)

GEOLOGY:
ENVIRON: D. Wichers
SURVEY:
DATA PROC: P. Hague

STATE: WYOMING COUNTY:
DATE: SEPT. 1989
SCALE: None REVISED: SEPT. 1995
MAP ID:

FIGURE 3.10

Figure 3.10 includes the flow and material balance for both the Irigaray and Christensen Ranch elution and precipitation circuits. When mining is not occurring at Irigaray, only the ion exchange (restoration only), elution, precipitation and drying portions of the diagram apply. Restoration flows are addressed in Section 6.0 of this document.

#### 3.4.1.7 Wastewater Management

Wastewater management at the Irigaray site is through evaporation in lined ponds. Five lined evaporation ponds exist on the project that are used to evaporate the 1% bleed from the well field, during mining operations, and other miscellaneous minor bleeds from the process plant, including resin wash water, yellowcake wash water, plant washdowns, etc. Details regarding the evaporation ponds are contained in Section 4.0 of this document.

Restoration solutions comprise the largest volume of wastewater generated at the Irigaray project (up to 250 gpm). These solutions are stored in two lined restoration ponds, which do not receive plant process waters. The restoration solutions are treated for uranium, radium-226 and selenium removal, then surface discharged under a Wyoming NPDES permit. Details of the two restoration ponds are also provided in Section 4.0 of this document.

A deep disposal well is licensed for construction at the Irigaray site. To date, construction of the well for additional wastewater disposal has not been necessary. Permits for the well will be maintained, in the case that the well is deemed necessary.

#### 3.4.1.8 Equipment, Instrumentation and Control

A list of major equipment located at the Irigaray central recovery plant is presented in Table 3.3. The process plant is a closed system, with the exception of the lixiviant makeup (not used at this time) and precipitation through drying circuits, and is simplified in design to operate with minimal operator coverage.

Instrumentation is provided in the Irigaray plant to measure the following processes:

- recovery and injection flows to and from the well fields
- wastewater output to the lined evaporation ponds
- high/low flow indicator alarms
- pressure indicators (including pressure gauges and controllers on injection flow lines)
- pH indicators
- tank level indicators
- flow indicators

## TABLE 3.3

## IRIGARAY PLANT EQUIPMENT LIST

| | |
|---|---|
| **Ion Exchange Columns** | 4 |
| Dimensions | 10 Ft.x 9 Ft. (w x h) Rubber coated steel pressure vessels |
| **Sand Filters** | 3 |
| Dimensions | 8 Ft.x 8 Ft. (w x h) Rubber coated steel pressure vessels |
| **Oxygen Saturation System** | 2 |
| Vessels | 6 Ft.x 14 Ft. (w x h) Stainless Steel pressure vessels |
| **Bicarbonate Addition System** | |
| Type | Soda Ash or Casutic Soda/CO2 mixing system with serpentine type mixer |
| Tanks: | 1 - 4' X 4' FRP mix tank with mixer<br>1 - 4' X 4' FRP stock solution tank with submersible pump. |
| **Process Water System** | |
| Tanks: | 12' X 14' FRP w/o mixer |
| Pump | 1 - Goulds centrifugal |
| **Reverse Osmosis** | 250 gpm Feed with 1 feed pump and 2 metering pumps, and 1 wash pump |
| Tanks | 2 - 3 X 3 FRP w/o mixer Antiscalant and Caustic day tanks |
| **Chemical Storage Tanks*** | 1 - 6' X 10 ' FRP Caustic storage tank<br>1 - 6' X 10 ' FRP Hydrochloric Acid storage tank<br>1 - 6' X 10 ' Steel Sulfuric Acid storage tank<br>1 - 75,000 lb. Soda ash storage tank - exterior<br>1 - 4,000 gal. gasoline storage tank - exterior<br>1 - 4,000 gal. Diesel storage tank - exterior<br>1 - 30,000 gal. propane storage tank - exterior<br>1 - 45 ton CO2 storage tank - exterior<br>1 - 45 ton O2 storage tank - exterior |
| **Pumps** | 3 - 200 hp injection/recovery booster pumps - centrifugal<br>2- 10 hp sump pumps |
| **Other Supplementary Equipment** | 1 - 150 hp air compressor<br>2 - 40 hp air compressor<br>1 - 10 hp air compressor<br>1 - 1,500 kW emergency generator<br>1-MCC Power distribution center - maintenance area<br>1-MCC Power distribution center - Annex building |
| **Old Main Plant** | |
| Tanks | 4- FRP Uranium extraction Columns 7' x 30.5'<br>4- FRP Uranium elution Columns 2.5' x 30.5'<br>3- FRP Elution surge tanks 6' x 6'<br>1- FRP Elution surge tanks 4' x 4'<br>4- FRP Calcite reaction tanks with mixer 8' x 10.'<br>2- Metal Coated Yellowcake slurry storage tanks/clarifiers mixer 25' x 15.'<br>1- FRP Waste water surge tanks 6' x 8'<br>3- FRP mix tanks 6' x 6' |
| Pumps | 2 - Galagher slurry Pump<br>1 - Sandpiper diaphragm slurry Pump<br>2 - Centrifugal sump Pump<br>1 - Centrifugal Waste water Pump |
| Electrical | 1-MCC Power distribution center - Main Plant |

mon to IR and CR circuits

TABLE 3.3 (cont'd)

IRIGARAY PLANT EQUIPMENT LIST

| | |
|---|---|
| **Elution System - Central Plant*** | |
| Tanks | 1 - 12' X 14' FRP eluant Mix tank with mixer<br>3 - 12' X 14' FRP eluant storage tanks w/o mixer<br>1 - 12' X 8' FRP eluant acid Mix tank w/o mixer<br>1 - 12' X 18' FRP brine generator tanks w/o mixer *<br>1 - 12' X 14' FRP caustic storage tank w/o mixer *<br>1 - 10' X 14' Rubber coated pressure vessel - elution column<br>1 - 12' X 14' FRP Soda Ash mix tank with mixer, auger and serpentine mixer *<br>1 - 12' X 10' FRP Soda Ash water storage tank w/o mixer *<br>1 - 125,000 lb. Soda ash storage tank * |
| Pumps | 2 - eluant transfer magnetic drive pumps<br>1 - caustic transfer pumps- diaphragm metering * |
| **Precipitation System*** | |
| Tanks | 4 - 12' X 14' FRP pregnant eluant precipitation tank with mixer and exhaust fan system<br>1 - 700 gal. H2O2 aluminum day storage tank<br>1 - 7000 gal. H2O2 aluminum storage tank - exterior<br>1 - 700 gal. Caustic Soda FRP day storage tank<br>2 - 12' X 14' FRP Hydrochloric Acid storage tank - exterior<br>1 - 12' X 14' FRP caustic storage tank w/o mixer |
| Pumps | 2 - Filter Press Feed/transfer magnetic drive pumps<br>1 - caustic metering pump- centrifugal<br>1 - Hydrochloric Acid metering pump- centrifugal<br>1 - Hydrogen Peroxide metering pump- centrifugal |
| **Filter Press** | Shared with the CR circuit |
| Size | 1425 sq.Ft. |
| Capacity | Approx. 5000 lbs. U3O8 |
| Max. Press | 150 psi |
| Pump | 1 - Progressive cavity SS |
| **Backwash system** | |
| Building | 12 ft X 12 ft x 10 ft high with concrete floors - insulated and heated |
| Pumps | 1 - 40 hp sandfilter backwash pump - centrifugal<br>1 - 40 hp sandfilter backwash pump - submersible |
| **Barium Chloride Building** | |
| Building | 12 ft X 24 ft x 10 ft high with concrete bermed floors - insulated and heated |
| Tanks | 1 - 8 ft X 10 ft FRP tank w/o mixer - RXN tank<br>1 - 4 ft X 6 ft FRP tank with mixer - mixing tank |
| Pumps | 1 - 5 hp centrifugal pump<br>1 - 1/4 hp metering pump |
| **Wellfield & Lix. Distribution Buildings** | |
| Building | 24 ft x 30 ft x 10 ft high insulated and heated |
| Pumps | 1 - 1 1/2 hp submersible sump pump |
| Filters | 3 - Cuno cartridges 30 in length<br>1 - Cuno cartridges 30 in length - standby |
| Other | Solution distribution manifolds and wells with flowmeters |

* Common to IR and CR circuits

TABLE 3.3 (cont'd)

IRIGARAY PLANT EQUIPMENT LIST

| | |
|---|---|
| **Yellowcake Storage, Drying and Packaging** | 1 - 15' x 12' Rubber Coated yellowcake thickener Tank<br>1 12' x 22' Yellowcake slurry FRP storage tank<br>1 - 6' x 6' rotary drum filter<br>1 - Venturi wet scrubber unit for dryer off gases - 4 FRP tanks<br>1 - 6' x 6' 3 - hearth yellowcake dryer<br>2- 10 hp sump pumps<br>1 - filter press, 40 $ft^3$ capacity for filtering yellowcake wash water |
| **Restoration Building** | |
| Building | 60 ft x 60 ft x 14 ft high insulated and heated |
| Pumps | 1 - 1 1/2 hp submersible sump pump<br>2 - 40 hp permeate injection centrifugal pump<br>2 - 40 hp brine transfer centrifugal pump |
| Filters | 10 - Double length bag filter canisters<br>2 - 250 gpm RO units with pumps and chemical injection systems |
| Tanks | 3 - 6' x 10' Rubber coated steel pressure IX vessels<br>5 - 12 ft X 14 ft FRP tank w/o mixer - exterior<br>1 - 6' x 10 ' Stainless Steel Pressure vessel - Sulfuric Acid Storage - Exterior |
| Other | 1 Hydrogen Sulfide vaporization and injection system<br>1 - 500 kW emergency generator<br>1-MCC Power distribution center<br>1 - 10 hp air compressor |

The instrumentation, in conjunction with routine process samples collected, is used to monitor the operational efficiency of the process in addition to materials and water balances.

Alarm systems are built into a number of plant circuits to alert personnel of high or low flow situations, abnormalities in the dryer area, etc. A listing of the alarms in the Irigaray process are as follows (all are audible with the exception of the computer flagging system):

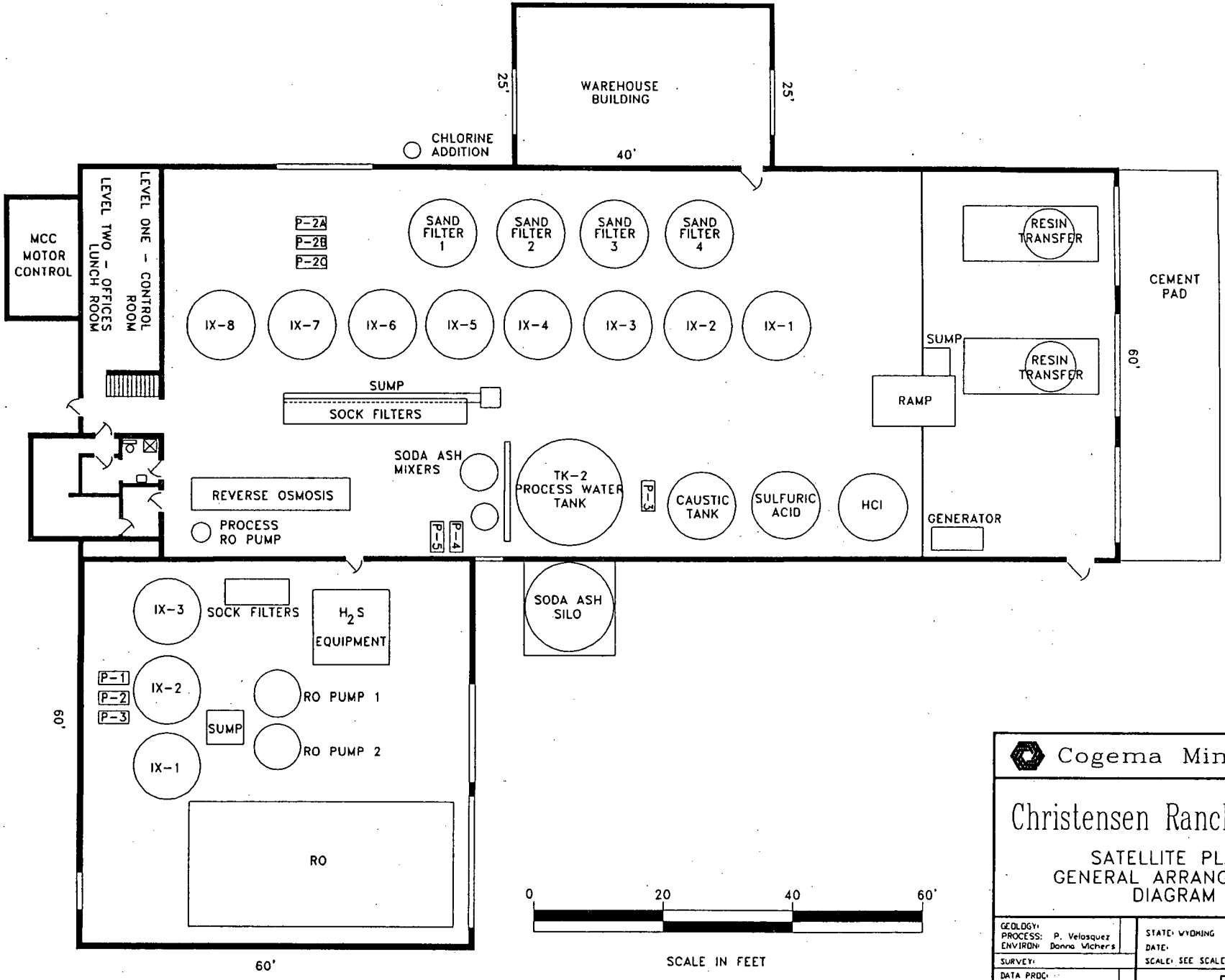
- elution pump (when pump stops)
- main recovery line, alarms at pressure change (high and low)
- main injection line, alarms at pressure change (high and low)
- computer alarm (pressure exceedances in well fields, high and low flow in well field feeder lines)
- dryer: drum high level, scrubber (high and low recirculation flow), scrubber (water level), scrubber (air pressure), combustion air failure, shaft cooling failure, main fuel (off), delumper high-low torque, burner flame failure, shaft (stopped), shaft (high temperature), furnace (low temperature)

## 3.4.2 CHRISTENSEN RANCH SATELLITE PLANT

### 3.4.2.1 General Arrangement

The Christensen Ranch satellite plant is an ion exchange (IX) uranium extraction plant with capabilities for lixiviant make-up and water treatment. Figure 3.11 is the general arrangement diagram of the satellite plant. Solutions from the well field at Christensen are routed through the satellite plant IX system and stripped of uranium then refortified with lixiviant and sent back to the well field. When the resin in the lead IX column is fully-loaded with uranium, it is withdrawn from the column and placed in a specially designed low-profile tanker trailer for transport to the Irigaray central plant. A receiving elution column is located within the annex of the Irigaray plant into which the resin is unloaded. The uranium is then stripped from the resin using the standard eluant process described previously in Section 3.4.1.3. The stripped resin is then reloaded into the tanker trailer and transported back to the satellite extraction plant.

At the satellite plant, the stripped resin is transferred from the tanker trailer into the empty IX column. Resin is then extracted from the next loaded column and the process cycle is repeated. The number of resin hauls per 24-hour day ranges from one to two during full scale operations. Descriptions of the individual processes described above are addressed in the following sections.


WAREHOUSE BUILDING
25'
25'
40'
CHLORINE ADDITION
MCC MOTOR CONTROL
LEVEL TWO - OFFICES LUNCH ROOM
LEVEL ONE - CONTROL ROOM
P-2A
P-2B
P-2C
SAND FILTER 1
SAND FILTER 2
SAND FILTER 3
SAND FILTER 4
RESIN TRANSFER
CEMENT PAD
IX-8
IX-7
IX-6
IX-5
IX-4
IX-3
IX-2
IX-1
SUMP
RESIN TRANSFER
60'
SUMP
SOCK FILTERS
RAMP
SODA ASH MIXERS
TK-2 PROCESS WATER TANK
P-3
CAUSTIC TANK
SULFURIC ACID
HCl
REVERSE OSMOSIS
PROCESS RO PUMP
P-5
P-4
GENERATOR
SODA ASH SILO
IX-3
SOCK FILTERS
$H_2S$ EQUIPMENT
P-1
P-2
P-3
IX-2
SUMP
RO PUMP 1
RO PUMP 2
IX-1
60'
RO
60'
0
20
40
60'
SCALE IN FEET
Cogema Mining, Inc.
Christensen Ranch Project
SATELLITE PLANT
GENERAL ARRANGEMENT
DIAGRAM
GEOLOGY:
PROCESS: P. Velasquez
ENVIRON: Donna Wichers
SURVEY:
DATA PROC: Penny Hague
STATE: WYOMING
COUNTY: JOHNSON
DATE:
SCALE: SEE SCALEBAR REVISED: Sept. 1995
MAP ID:
FIGURE 3.11

### 3.4.2.2 Ion Exchange/Lixiviant Makeup Circuit

The satellite plant contains four IX trains (sets of columns) with each train having two fixed-bed columns connected in series. The columns in each train have individual capacities of approximately 600 gpm, thus providing a maximum 4,800 gpm capacity of the system. The plant will be operated at an annual average flow rate of 3,600 gpm. The columns are designed to process well field solutions containing 100 parts per million (ppm) of uranium as $U_3O_8$ over a period of two days without incurring high uranium tailings losses into the injected well field solutions. Since the concentration of uranium in the well field will realistically average approximately 60 ppm, and the plant will be operated at an average 3,600 gpm, some conservatism is built into the design and the plant should be able to operate without transportation of resin for two or more days in the event that winter weather limits access to the site.

A portion of the effluent from the IX circuit is withdrawn to ultimately provide the 1% bleed from the well field for lixiviant migration control and clean water for lixiviant makeup and resin transfer. Up to 125 gpm of barren effluent from the IX circuit is passed through a 125 gpm reverse osmosis (RO) unit. The concentrated salts or brine from the RO process (up to 62.5 gpm) will be recycled to the injection stream to the well field, thereby reducing the chemical requirements of the lixiviant makeup and the waste volumes requiring disposal. An alternative to recycling the brine from the RO unit is to send the brine to lined ponds for evaporation, or to the deep disposal well. Approximately 36 gpm of the clean product water or permeate will be sent to the permeate storage pond for use in aquifer restoration. This 36 gpm will constitute the 1% bleed from the well field for lixiviant migration control. The remaining 26.5 gpm of permeate will be used for lixiviant makeup and resin transfer. A radium-226 adsorption column may be included in the line which will feed permeate to the unlined storage pond, for further radium-226 removal, if necessary.

The benefits of using RO treatment of the IX tails bleed are that pure water is discharged from the plant and problems with calcium buildup during lixiviant makeup are avoided. This results in a cleaner plant operation with reduced solids generation.

The lixiviant makeup system consists of chemical mixing tankage and an outside storage silo for solid soda ash. The 26.5 gpm of permeate discussed above is used to mix the lixiviant. The lixiviant makeup system is operated manually by filling the makeup tank with permeate and adding sodium bicarbonate from the external silo. The pH of the resulting solution is lowered by adding carbon dioxide gas and the resulting mixture is pumped to a day tank for metering into the injection stream. The pH instrumentation in the makeup tank is monitored during lixiviant makeup. The permeate is added to the makeup tank from a level-activated valve on the permeate discharge line. When the tank is full, the level control closes the valve and discharges the permeate to the outside storage pond. If $CO_2$ alone is used as the lixiviant, the lixiviant makeup system will be bypassed and the $CO_2$ gas will be added to the

injection stream immediately prior to entry to the well field.

Chemicals utilized and stored at the satellite plant site consist of carbon dioxide gas, gaseous oxygen, hydrochloric acid and sulfuric acid (small quantities), solid soda ash or sodium bicarbonate and sodium chloride crystals. Propane for heating, as well as gasoline and diesel fuel, are also present on site. All chemical storage tanks outside of the plant building are bermed to contain the volume of their contents in the case of a tank rupture.

### 3.4.2.3 Flow and Material Balance

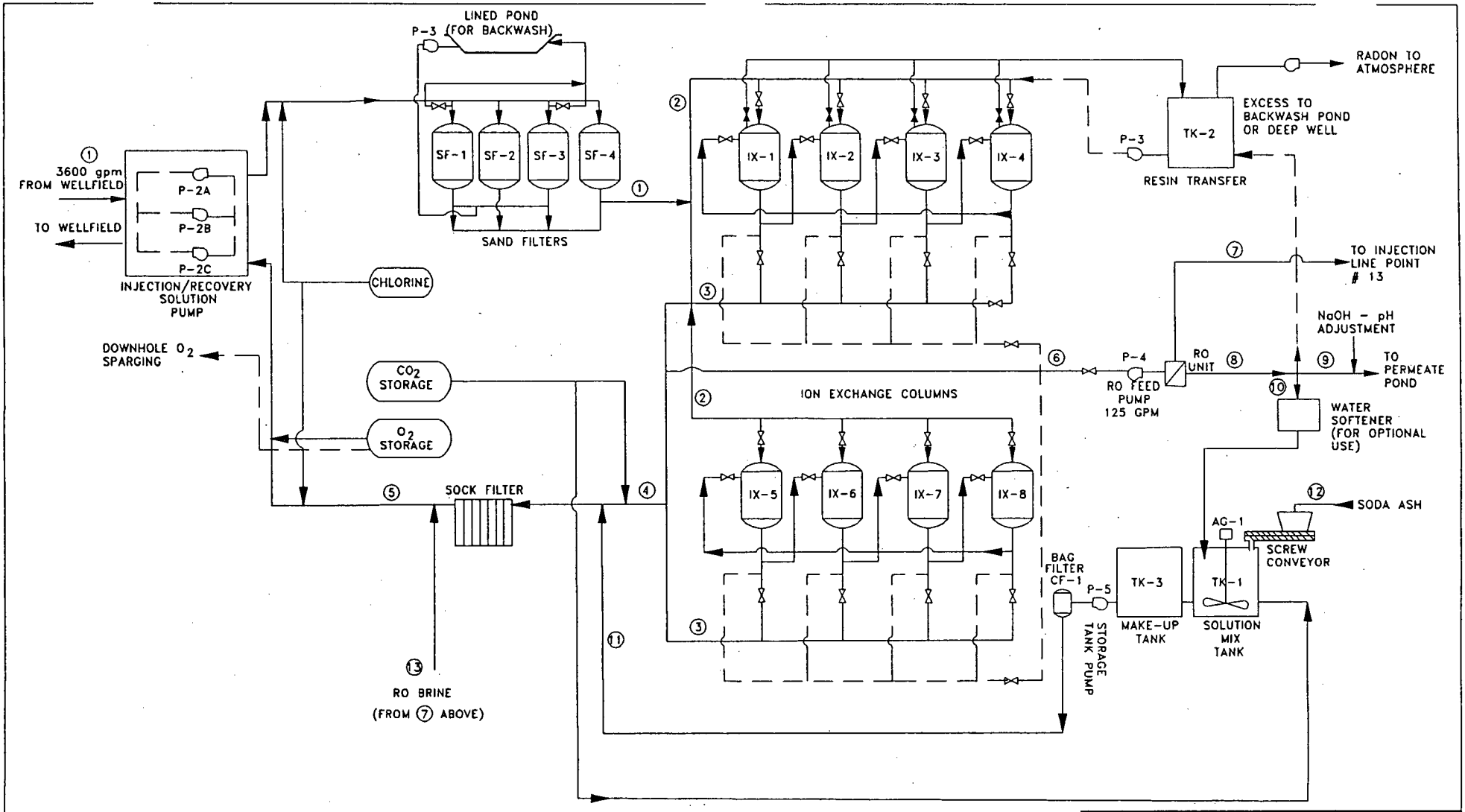
The overall material balance and flowsheet for the satellite extraction process is presented in Figure 3.12. Solutions from the well field first enter the backwash sand filters for removal of any loose sand/sediment particles or debris. Well field solutions are then piped into the four trains of IX columns. Solutions then flow through the IX columns where the uranium is adsorbed onto the resin beads. Loaded resin is shipped to the Irigaray central plant for further processing.

After uranium adsorption and lixiviant makeup, gaseous oxygen and carbon dioxide are added prior to reinjection into the well field. Additional filtering may be required prior to lixiviant injection in the form of cartridge or sand filters and is, therefore, noted as optional.

### 3.4.2.4 Wastewater Management

Two liquid waste streams are produced during the mining operations. The first stream is the 1% bleed taken in the plant for lixiviant control in the well field. The 36 gpm stream consists of the high-quality permeate from the RO unit discussed above in the ion exchange/lixiviant makeup circuit section. The 62.5 gpm of brine (less than two percent of the total injection flow) will be blended with the injection stream prior to well field injection and will not require ponding (options are to pond the brine or dispose of it via deep well injection). The permeate is currently stored in a compacted clay-bottomed pond adjacent to the plant site (a second pond is licensed, but not yet installed). Synthetic liners and leak detection systems are not necessary for the permeate storage ponds due to the good quality of the water; uranium and radium will meet NPDES surface discharge criteria for uranium mines after treatment through the IX systems, reverse osmosis unit and, if necessary, radium removal resin in the plant. Additionally, because the water source is process water, NRC standards in 10 CFR 20, Appendix B, Table 2 values for uranium and radium will be met for discharge into the pond. Anticipated water quality concentration ranges of the permeate storage pond solutions are:

| | (All data in mg/l) |
|---|---|
| Bicarbonate | 35 - 100 |
| Chloride | 15 - 45 |




| ITEM / LINE # | 1 | 2 | 3 | 4 | 5 | 6 | 7 13 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Liquid TPH | 900 | 450 | 450 | 868 | 891 | 31 | 16 | 16 | 9 | 7 | 7 | – |
| S.G. | 1.01 | 1.01 | 1.01 | 1.01 | 1.03 | 1.01 | 1.06 | – | 1.01 | 1.01 | 1.06 | – |
| Flow Rate GP | 3600 | 1800 | 1800 | 3475 | 3564 | 125 | 62.5 | 62.5 | 36 | 26.5 | 26.5 | – |
| U308 lbs/hr | 108 | 54.0 | 0.9 | 1.7 | 1.8 | 0.1 | 0.1 | – | – | – | – | – |
| V lbs/hr | 1.35 | 0.68 | 0.09 | 0.17 | 0.18 | 0.01 | 0.01 | – | – | – | – | – |
| HCO3 lbs/hr | 3,600 | 1,800 | 1,764 | 3,406 | 3,849 | 123 | 123 | 2.5 | 1.4 | 1.0 | 349 | 348 |
| Na lbs/hr | 1,668 | 834 | 817 | 1,578 | 1,784 | 57 | 57 | 1.1 | 0.7 | 0.5 | 161 | – |
| Cl lbs/hr | 288 | 144 | 153 | 295 | 303 | 11 | 10 | 0.2 | 0.1 | 0.1 | 0.1 | – |
| U308 ppm | 60.0 | 1.0 | 1.0 | 1.0 | 2.0 | – | – | – | – | – | – | – |
| V ppm | 0.75 | 0.75 | 0.1 | 0.1 | 0.1 | 0.2 | – | – | – | – | – | – |
| HCO3 ppm | 2000 | 2000 | 1960 | 1960 | 2160 | 1960 | 3920 | 78.4 | 78.4 | 78.4 | 26,226 | – |
| Na ppm | 800 | 800 | 800 | 800 | 800 | 800 | 1568 | 32 | 32 | 32 | 7,181 | – |
| Cl ppm | 160 | 160 | 170 | 170 | 170 | 170 | 333 | 7 | 7 | 7 | 7 | – |

*NOTE:*
*EVAPORATION PONDS ARE EQUIPPED WITH EVAPORATION ENHANCEMENT (TRICKLE SYSTEM)*

Cogema Mining, Inc.

# Christensen Ranch Project

PROCESS FLOW SHEET
SATELLITE EXTRACTION PLAN
CHRISTENSEN RANCH
URANIUM RECOVERY PLANT
(ADSORPTION CIRCUIT)

GEOLOGY:
PROCESS: P. Velasquez
ENVIRON: D. Wichers
SURVEY:
DATA PROC: P. Hague

STATE: WYOMING COUNTY: JOHNSON
DATE: 2/16/95
SCALE: None REVISED: SEPT. 1995
MAP ID:

FIGURE 3.12

| | |
|---|---|
| Sulfate | 1.5 - 10 |
| Sodium | 25 - 75 |
| TDS | 60 - 200 |
| pH | 6.0 - 8.0 |
| Uranium | <0.10 - 2.0 |
| Radium-226 (pCi/l) | <1.0 - 3.0 |

Design criteria for the permeate storage ponds are provided in Section 4.2.

The second stream produced during mining operations consists of sand filter backwash solutions, resin wash water, plant washdown waters and, on occasion, brine from the RO unit. This wastestream ranges from approximately 5 gpm up to 62.5 gpm (very short term basis) and is diverted to the lined brine ponds for evaporation. Currently, two lined brine evaporation ponds are constructed at the Christensen Ranch site. It is anticipated that the remaining two licensed brine ponds will be constructed in 1996. Anticipated waste/brine concentration ranges are:

| | (All data in mg/l) |
|---|---|
| Bicarbonate | 1500 - 7500 |
| Chloride | 150 - 1200 |
| Sulfate | 450 - 12000 |
| Sodium | 800 - 7500 |
| TDS | 2000 - 205000 |
| pH | 6.0 -98.0 |
| Uranium | <0.10 - 15 |
| Radium-226 (pCi/l) | <1.0 - 1500 |

### 3.4.2.5 Satellite Plant Equipment, Instrumentation and Control

A list of the major equipment and instrumentation for the Christensen Ranch satellite plant is given in Table 3.4. The plant operates with minimal operator coverage.

Except for the lixiviant makeup system, the satellite plant has no tanks which can overtop or spill. The flow of solutions through the sand filters and IX columns is controlled by ratio controllers responding to flow elements from the recovery pumps. Flow to the plant is essentially maintained by the downhole submersible pumps in the wellfields, plus booster pumps along the main trunkline. The two recovery booster pumps in the plant are available to boost the solutions through the satellite plant.

The tails solution from the IX columns which is barren of uranium is piped into the inlet of two injection booster pumps which raise the pressure of the solution being injected into the well field. Lixiviant is introduced into the inlet of the booster pump to provide mixing. The lixiviant is piped into the line using a metering pump. Carbon dioxide and gaseous oxygen (or hydrogen peroxide) are added to the injection solution downstream of the injection booster pumps for in-line pH control and oxidation of the uranium ore. A pH probe controls the amount of carbon dioxide gas added to the injection solution.

## TABLE 3.4

## CHRISTENSEN RANCH OPERATIONS EQUIPMENT LIST

| | |
|---|---|
| Plant Capacity: | |
| **Ion Exchange Columns** | 8 |
| Dimensions | 10 Ft.x 9 Ft. (w x h) Rubber coated steel pressure vessels |
| **Sand Filters** | 4 |
| Dimensions | 12 Ft.x 12 Ft. (w x h) Rubber coated steel pressure vessels |
| **Bicarbonate Addition System** | |
| Type | Soda Ash or Casutic Soda/CO2 mixing system with serpentine type mixer |
| Tanks: | 1 - 4' X 4' FRP mix tank with mixer<br>1 - 6' X 6' FRP stock solution tank with submersible pump. |
| **Resin Transfer System** | |
| Tanks: | 16' X 16' Steel tank with mixer - Concrete Bottom - Coated |
| Other: | 3 - 3,500 gallons resin transfer trailers |
| **Reverse Osmosis** | 125 gpm Feed with 2 feed pumps and 2 metering pumps, and 1 wash pump |
| **Chemical Storage Tanks** | 1 - 6' X 10 ' FRP Caustic storage tank<br>1 - 6' X 10 ' FRP Hydrochloric Acid storage tank<br>1 - 6' X 10 ' Steel Sulfuric Acid storage tank<br>1 - 75,000 lb. Soda ash storage tank - exterior<br>1 - 4,000 gal. gasoline storage tank - exterior<br>1 - 4,000 gal. Diesel storage tank - exterior<br>1 - 10,000 gal. propane storage tank - exterior<br>1 - 45 ton CO2 storage tank - exterior<br>1 - 45 ton O2 storage tank - exterior |
| **Pumps** | 2 - 350 hp injection booster pumps - centrifugal with one variable frequency control<br>2- 200 hp recovery booster pump - centrifugal with one variable frequency control<br>2- 10 hp sump pumps<br>1 - 40 hp sandfilter backwash pump with VFC |
| **Filtration - outbound** | 16-Double length bag filters |
| **Other Equipment** | 1 - 10 hp air compressor<br>1 - 75 kW emergency generator<br>1-MCC Power distribution center |
| **Elution System**<br>(Located at Irigaray Central Plant) | |
| Tanks | 1 - 12' X 14' FRP eluant Mix tank with mixer<br>3 - 12' X 14' FRP eluant storage tanks w/o mixer<br>1 - 12' X 8' FRP eluant acid Mix tank w/o mixer<br>1 - 12' X 18' FRP brine generator tanks w/o mixer<br>1 - 12' X 14' FRP caustic storage tank w/o mixer<br>1 - 10' X 14' Rubber coated pressure vessel - elution column<br>1 - 12' X 14' FRP Soda Ash mix tank with mixer, auger and serpentine mixer<br>1 - 12' X 10' FRP Soda Ash water storage tank w/o mixer<br>1 - 125,000 lb. Soda ash storage tank |
| Pumps | 2 - eluant transfer magnetic drive pumps<br>1 - caustic transfer pumps- diaphragm metering<br>2 - eluant transfer magnetic drive pumps |

TABLE 3.4 (cont'd)

CHRISTENSEN RANCH OPERATIONS EQUIPMENT LIST

| | |
|---|---|
| **Precipitation System *** | |
| (Located at Irigaray Central Plant) | |
| Tanks | 4 - 12' X 14' FRP pregnant eluant precipitation tank with mixer and exhaust fan system |
| | 1 - 700 gal. H2O2 aluminum day storage tank |
| | 1 - 7000 gal. H2O2 aluminum storage tank - exterior |
| | 1 - 700 gal. Caustic Soda FRP day storage tank |
| | 2 - 12' X 14' FRP Hydrochloric Acid storage tank - exterior |
| | 1 - 12' X 14' FRP caustic storage tank w/o mixer |
| Pumps | 2 - Filter Press Feed/transfer magnetic drive pumps |
| | 1 - caustic metering pump- centrifugal |
| | 1 - Hydrochloric Acid metering pump- centrifugal |
| | 1 - Hydrogen Peroxide metering pump- centrifugal |
| **Filter Press *** | Shared with the Irigaray circuit |
| (Located at Irigaray Central Plant) | |
| Size | 1425 sq.Ft. |
| Capacity | Approx. 5000 lbs. U3O8 |
| Max. Press | 150 psi |
| Pump | 1 - Progressive cavity SS |
| **Yellow Cake Storage** | |
| (Located at Irigaray Central Plant) | |
| Type | 17' X 14" Epoxy/FRP coated thickener with rake |
| Size | 35,000 gal |
| Pump | Diaphragm, air assisted |

* Common to IR and CR circuits

Operation and instrumentation for the lixiviant makeup system was discussed above in Section 3.4.2.2.

Transfer of resin from the IX columns to the tanker trailers is accomplished by an eductor system and permeate stored in the clean water storage tank inside the plant. Permeate levels in the tank are controlled by a high level controller; when the high level in the tank is reached, a valve in the feed line will close and the permeate will be discharged to the outside storage pond.

All lixiviant makeup activities are performed manually except for the filling of tanks with permeate. In the event of a spill, this solution is collected in the plant sump which discharges to the lined brine evaporation ponds.

Instrumentation in the satellite plant is very simple. The plant is equipped with the following processes:

- high and low pressure indicator and alarm on the recovery and injection lines to and from the well fields
- high/low pressure indicator and alarm on the wastewater output to the lined evaporation ponds
- high pH alarm on the bicarbonate mix system (lixiviant makeup)
- other pH indicators
- tank level indicators
- flow indicators

## 3.5 ACCESS ROADS

### 3.5.1 WELL FIELD ACCESS ROADS

Well field access roads have been established at the Irigaray site since the late 1970's when the well fields were first installed. Accordingly, the majority of the well field access road section will pertain primarily to Christensen Ranch. The construction details of the roads will apply to Irigaray well field access road construction in the future when more well fields are developed at Irigaray.

Approximately 30 acres of well field access roads have been constructed for the Christensen Mine Units 2, 3, 4 and 5. It is estimated that the same approximate acreage will apply for well field access roads in each future development area (North Prong, Heldt Draw and Table Mountain). The well field access road locations existing in Mine Units 2, 3, 4 and 5 are shown on Figure 3.3. Access roads are one of the last facilities to be constructed during well field construction. The roads are located after the boundaries of the well field are established by ore body delineation and well installation. Existing roads are used for well field access roads whenever possible.

The access roads are constructed as needed and will be reclaimed when the well fields they serve have been restored. All suitable topsoil from the access roads will be salvaged prior to construction. For Christensen Ranch, the topsoil salvage depths are determined in the field using the profile descriptions provided in Appendix D7, Soils, and the recommended salvage depths contained in Appendix D7, Table D7-11. For Irigaray, topsoil salvage will be pursuant to the profile descriptions provided in Appendix D7, Soils, of the original application. Estimated topsoil salvage quantities and topsoil stockpile locations are discussed in Section 3.6.

A typical access road cross section is provided in Figure 3.13. The roads are typically 14-foot wide and crowned and surfaced with gravel as shown. Roadside ditches are constructed as shown to provide drainage from the road. Access road ditches are provided with ditch relief drains spaced at intervals not to exceed 1,000 feet to control erosion.

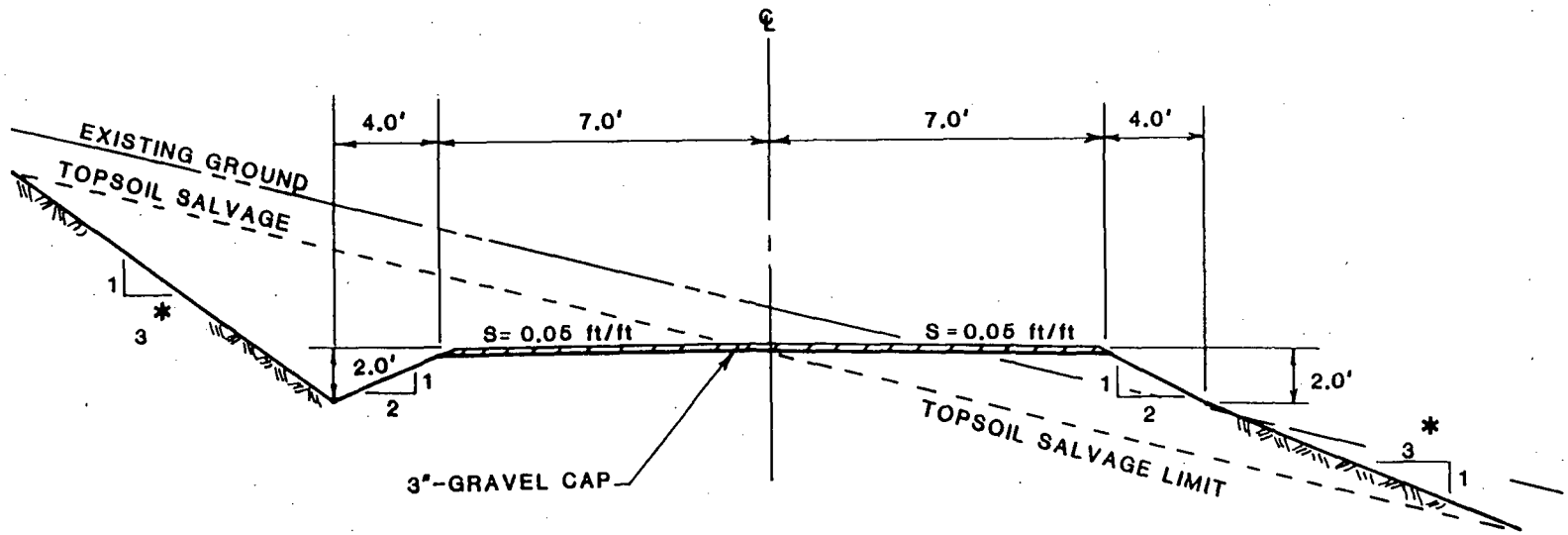
In most areas, where the topography permits, access roads will be constructed at or very near existing grades. Generally, roads will be located along ridges to reduce the potential for blockage by drifting snow. Where drainage crossings are required, the approaches will be maintained at grades not exceeding ten percent and channels will be crossed at right angles, where possible. Ditch relief drainage will be provided to reduce the contribution of sediment from the approach roads to stream channels.

Culverts will be placed in all prominent drainages where low flow crossings are not feasible; existing culvert locations are shown on Figure 3.3. The minimum culvert diameter for cross drainage and relief drainage will be 18 inches. Culverts will be constructed to avoid plugging, collapsing or erosion at the inlets and outlets. Low-flow crossings similar in design to the access road crossing of Willow Creek in Mine Unit 3 and the Willow Creek R & D, now within Christensen Mine Unit 5 (described below) may be used in place of culverts at specific locations. Table 3.5 provides a listing of the culvert locations, drainage basin parameters and recommended minimum culvert sizes for the major drainage crossings within the Willow Creek geographical area (Units 2 through 5) at Christensen Ranch.

#### 3.5.1.1 Christensen Mine Units 3 and 5 Willow Creek Crossings

A low-flow crossing has been constructed in the Christensen Ranch Mine Unit 3 for access to well fields located on the northeast side of Willow Creek. The crossing location is shown on Figure 3.3. Also, a general design for crossings of this type is shown on Figure 3.14 (in pocket). The crossing is designed for the flood calculated to result from the 100-year, 24-hour precipitation event.

An HEC-2 (U.S. Army Corps of Engineers, 1986) flood study was performed using five surveyed cross sections in the vicinity of the proposed crossing location to determine




* NOTE: SLOPES MAY VARY FROM 2.5H:1V TO 3H:1V.

NOT TO SCALE

| | | |
|---|---|---|
| COGEMA Mining, Inc. | | |
| WELLFIELD ACCESS ROAD<br>TYPICAL CROSS SECTION | | |
| | SCALE: NONE | FIGURE: 3.13 |
| DRAWN BY: wwc | DATE: 12-31-87 | |

## TABLE 3.5

## DRAINAGE BASIN PARAMETERS AND RECOMMENDED CULVERT SIZES FOR WELLFIELD ACCESS ROADS

| Culvert No. | Drainage Area (sq. mi.) | Stream Length (miles) | Elev. (ft.) | Curve Number (CN) | Min. Ret. (in/hr) | Recommended CMP (in)[1] |
|---|---|---|---|---|---|---|
| ARC-1 | 0.15 | 0.5 | 120 | 75 | 0.1 | 36 |
| ARC-2 | 0.34 | 1.1 | 260 | 75 | 0.1 | 42 |
| ARC-3 | 1.2 | 2.2 | 203 | 75 | 0.1 | 54 |
| ARC-4 | 3.2 | 3.2 | 365 | 75 | 0.1 | 72 |
| ARC-5 | 1.6 | 2.8 | 388 | 75 | 0.1 | 54 |

[1] Minimum size CMP required to pass the 2-year, 24-hour runoff event with a headwater to depth ration (H/D) = 1 (Bureau of Public Roads "Hydraulic Engineering Circular No. 5", 1965. Chart No. 5).

NOTE: Operator may replace culverts with low-flow crossings depending upon economic conditions at the time of construction. Existing road culvert location are shown on Figure 3.3.

# THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

## THAT CAN BE VIEWED AT THE RECORD TITLED:

## "GENERIC LOW-FLOW STREAM CROSSING DESIGNS." FIGURE 3.14

## WITHIN THIS PACKAGE... OR BY SEARCHING USING THE DOCUMENT/REPORT NO.

**D-05**

the flood elevation for the 100-year, 24-hour precipitation event. Peak discharges for the flood study were determined using the rainfall/runoff computer program TRIHYDRO (WWC, 1985). The drainage basin parameters used as input for the rainfall/runoff program are summarized below:

| | |
|---|---|
| Drainage Area: | 52.36 sq mi |
| Stream Length: | 14.4 mi |
| Elev. Difference: | 1,427 ft |
| Curve Number: | 75 |
| Min. Inf. Loss: | 0.01 iph |
| 100-year, 24-hour Precip.: | 3.8 in |

The peak discharge calculated to result from the 100-year, 24-hour precipitation event is 8,120 cfs. This discharge was used as input for the HEC-2 program along with the surveyed channel cross sections to determine the water surface elevation for the resulting flood. The results of the computerized flood study place the 100-year water surface elevation at 4,586 ft msl or about 12 feet above the channel invert at the proposed crossing location.

The Mine Unit 3 low-flow crossing is similar to the crossing constructed for access to the Willow Creek R & D site, now being used for access to Mine Unit 5. Twin 30-inch diameter culverts were placed in the guide channel and overlain by interlocking concrete blocks to form a stable, flood-resistant roadbed. Upon the completion of mining, the crossing will be reclaimed and the Willow Creek channel returned to its existing configuration.

The two 30-inch culverts have a combined capacity of approximately 54 cfs with an estimated 1.5 feet of cover. This flow capacity enables the culverts to convey frequent low-flow discharges under the crossing thereby reducing the occurrence of overtopping and saturation of the roadbed during low-flow events. The installation of the culverts in the existing guide channel results in minimal channel disturbance and allows the use of the crossing during low-flow conditions in Willow Creek. The inlets and outlets of the culverts are protected from erosion by riprap as shown in the crossing detail on Figure 3.14.

The surface of the crossing is constructed of precast interlocking concrete block. Details of the block design are shown on Figure 3.14. The flood resistance of the block is derived from its ability to interlock with adjacent blocks forming an integrated surface which is not easily displace by the buoyancy or shear forces generated during high flow conditions.

The interlocking blocks were placed on a synthetic filter fabric at the grade of the flood plain. With fill placed only over the low-flow culverts in the guide channel, the low profile of the crossing road surface minimizes hydraulic obstruction during high

flow events. The block extends the length of the crossing to the estimated 100-year flood water surface elevation (elev 4,586). The low profile and high unit weight of the interlocking block (approximately 70 lbs. per interlocking pair) provides a stable and erosion resistant road surface.

### 3.5.1.2 Generic Low Flow Crossing Designs

The low flow crossing designs shown on Figure 3.14 result from several years of field experience with similar stream crossings. Problems have been encountered in the past and were subsequently solved with post construction modifications. The most common modification is to place a veneer of coarse gravel up to about 1-foot thick over the interlocking concrete blocks. This modification is made in response to road bed movement and working which has occasionally been severe enough to break the blocks. By surfacing the crossing with a layer of coarse material, traffic loads are better distributed across the road bed. This treatment is also recommended by the block manufacturer to stabilize the roadbed since the coarse angular gravel works into the spaces between the blocks and locks them together. Together, these two mechanisms allow a gravel veneer to improve the stability of a crossing while minimizing the introduction of material which might contribute to stream sediment loads.

To prevent similar problems from occurring in future crossings, several modifications have been made to the generic interlocking block design. The most significant of these are the continuation of the interlocking block surface course down the upstream and downstream edges of the crossing to extend below the stream scour depth and the encapsulation of select material in geotextile to form a stable subbase. These modifications are shown on Figure 3.14 together with an alternative design which utilizes a cellular confinement system infilled with gravel or concrete for the surface course of the crossing. When utilizing the gravel infill design, select coarse gravel will be used for infill were water velocities below 5.5 feet per second are expected. Where water velocities for the design event exceed 5.5 feet per second, concrete will be used to infill the cells of the confinement system.

Another design modification which may be employed for future low flow crossings is to place the entire length of the crossing at the grade of the stream channel. All stream flow will then pass over the crossing surface course. This design will give the crossing a low profile and, in conjunction with the surface course toe-in described above, reduce the possibility of subbase undercutting and surface course overturning.

Most past problems with the various low-flow crossings are attributable to movement in the subbase. To prevent such movement from occurring in future crossings, the designs depicted on Figure 3.14 provide for at least 15 inches of select fill completely encapsulated in an appropriate geotextile. The select fill material will consist of 2.5-inch minus durable aggregate with less than 8% fines passing a 200 mesh screen.

By placing a geotextile both over and under the subbase aggregate, the potential for fine material invasion into the subbase is greatly reduced. The geotextile will also allow free drainage of the subbase material and provide a considerable amount of reinforcement to the road bed. To enhance this reinforcement effect, all seams will be sown whenever possible. An exception to this subbase design is the gravel infilled cellular confinement option. For this surface course option, the geotextile should be placed under the subbase material only so that the confining grid can move with surface loads and any subgrade settlement.

As mentioned above, the surface course will be toed-in to the original stream channel on both the upstream and downstream sides of the crossing. This feature should prevent any overturning of blocks or cells and will promote smooth flow over the crossing. Wherever possible, the crossing surface should be at the same grade as the channel floor. If culverts under the crossing are specified they will be armored with large riprap sized for the expected flow velocities on both the inlet and outlet ends. Road grades over 10% will be avoided wherever possible.

A site specific crossing design will be produced for each new crossing location. The appropriate surface course will be selected from among the 3 options shown on Figure 3.14. If culverts to pass low flows are deemed desirable, they will be sized to pass the majority of nonflood flows. The expected 100-year high water line will be determined from a detailed hydraulic analysis and the selected surface course extended above this elevation.

### 3.5.2 PRIMARY ACCESS ROAD

The primary access route to the Irigaray central plant was an existing road (Trabing Road) which was upgraded in sections to reach the facility. Approximately 53.44 acres of primary access road are included as part of the WDEQ Irigaray permit boundary. This includes a segment to the north of the original permit boundary (23.44 acres), a segment to the west and south (28.67 acres) and several short segments adjacent to the eastern portion of the permit boundary (1.33 acres). The road was amended into the original permit boundary in 1987 as part of Amendment No. 1. Portions of the access road are shown on Figure 3.1 (in pocket).

The primary access route between the Irigaray central plant and the Christensen Ranch satellite facility is shown on Figure 3.1. The route is also be used to transport loaded ion exchange resin from the Christensen Ranch satellite plant to the Irigaray recovery facility for further processing. The first 7,000 lineal feet of road from the Christensen satellite plant is the only new road construction. This portion of the road connects to existing oil field roads and the existing access road to the Irigaray facility. The existing roads have been upgraded in areas. All suitable topsoil was salvaged prior to the new road construction, and upgrading. Topsoil was stockpiled adjacent to the roads. Topsoil salvage depths were determined as discussed for well field access

roads and in Section 3.6, Construction Considerations.

A typical cross section of the Christensen access road is provided in Figure 3.15. The road has been constructed with a 20-foot topwidth and surfaced with six inches (6") of gravel. Road ditches were constructed as shown to provide drainage from the road surface. Road ditches were provided with ditch relief drains to control erosion and were spaced at intervals not to exceed 1,000 feet. Existing roads to be used as a part of the route, as shown on Figure 3.1, have been upgraded by minor grading to reform the drainage ditches and to provide a smooth travel surface. Graveling has taken place as necessary to provide a safe all-weather road surface.

## 3.6 CONSTRUCTION CONSIDERATIONS

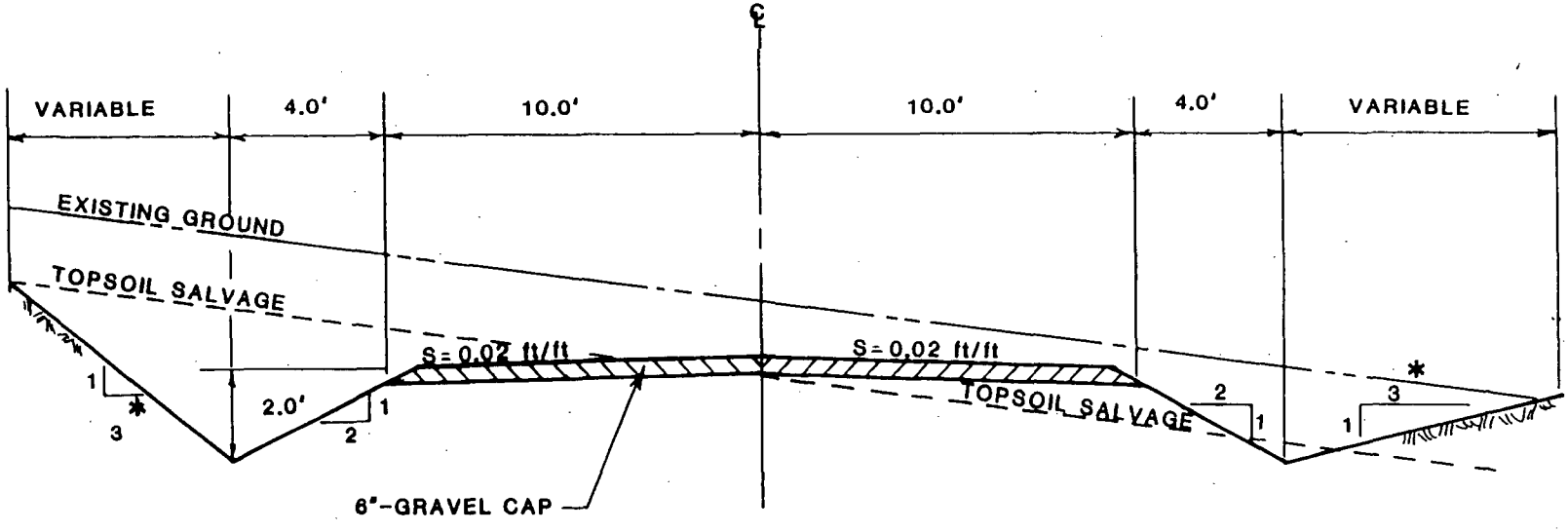
### 3.6.1 TOPSOIL HANDLING TECHNIQUES

Topsoil will be salvaged from areas to be disturbed by the construction of ponds, roads and plant facilities. No topsoil will be salvaged from the well fields since surficial disturbance in those areas should be minimal. Topsoil will be salvaged from building areas within the well fields such as module building locations and booster pump stations. Topsoil salvaged during construction will be based on profile descriptions and recommended salvage depths presented in Appendix D7 of both the Irigaray and Christensen Ranch applications.

Irigaray

For the construction of Irigaray in 1977 through 1980, topsoil was salvaged from pond construction, road cuts, the 517 area and the Units 1-5 restoration building (well field building), and some well field units (6 through 9). Topsoil was not originally salvaged from the plant site location, but some material pushed to the side during construction was retrieved and stockpiled along with topsoil from the construction of Pond E. The following is an accounting of the topsoil material stockpiled at the Irigaray project from past construction activities:

| Stockpile No. | Volume ($yd^3$) | Date Stockpiled | Originating Area |
|---|---|---|---|
| 1 | 1,657 | Nov. 1976 | 517 R & D Area |
| 2 | 267 | Sept. 1978 | Well Field Building |
| 3 | 9,748 | Sept. 1978 | Ponds A, B, C and D |
| 4 | 120 | Oct. 1978 | Road Cuts |
| 5 | 2,248 | Oct. 1978 | Pond E, salvaged material from original plant construction |
| 6 | 9,463 | Aug. 1979 | Ponds RA, RB |




* NOTE: SLOPES WILL VARY FROM 2H:1V TO 3H:1V.

**COGEMA Mining, Inc.**

PRIMARY ACCESS ROAD
TYPICAL CROSS SECTION

| | | |
|---|---|---|
| | SCALE: NONE | FIGURE: 3.15 |
| DRAWN BY: wwc | DATE: 12·31·87 | |

| | | | |
|---|---|---|---|
| 7 | 486 | Apr. 1979 | Road Cuts |
| 7a (addition) | 1,067 | Sept. 1980 | Unit 6 (1 acre) |
| 8 | 630 | Oct. 1979 | Road Cuts |
| 9 | 3,032 | July 1980 | Unit 8 |
| 10 | 3,369 | Aug. 1980 | Units 7 and 9 |
| 11 | 1,444 | Aug. 1980 | Units 7 and 9 |
| 12 | 8,771 | Aug. 1980 | Unit 7 and pond cuts |

Due to rugged terrain, it was found that surface earth moving and contouring became necessary during the Unit 6 through 9 well field installations in 1980. The stripping and salvage of topsoil in the well fields was not a requirement at the time, however, WDEQ felt that topsoil damage and wasting was occurring as a direct result of the surface construction. As a result, a soil erosion control plan was proposed by the company and amended into the WDEQ permit document. The following is a summary of the soil erosion control plan followed for the Irigaray Units 7, 8 and 9 installation:

1. Strip existing topsoil.

    a. Salvage depth of topsoil to be predetermined for each well field by consultation with WDEQ personnel and the applicable area soils map.

    b. Topsoil to be stockpiled and stabilized in such a manner as to minimize wind and water erosion and unnecessary compaction.

2. Contouring of the wellfield to be accomplished once topsoil is removed.

    a. Contour to gentle slopes for easier access, to prevent further erosion and to improve revegetation efforts.

    b. Water bars may be installed to reduce soil erosion.

3. Temporary soil stabilization utilizing an accepted soil binder to be established after contouring and during construction.

4. Well field construction to commence after steps 1-3, above, are completed.

5. Exposed subsoil or topsoil to be seeded with an "interim" seed mixture:

| | |
|---|---|
| Western wheatgrass | 4 lbs./acre |
| Thickspike wheatgrass | 4 lbs./acre |
| Yellow sweet clover | 2 lbs./acre |
| Slender wheatgrass | 2 lbs./acre |
| Total (lbs. PLS) | 12 lbs./acre (drilled) |

a. Seeded ground may be watered with excess permeate, with permission from WDEQ, and an accepted soil binder; hydroseeding or hydromulching may also be used in lieu of a soil binder.

6. After final restoration of a well field, and all surface equipment removal, well plugging, etc., is completed, the well field area will be ripped, stockpiled topsoil will be replaced, and final revegetation will commence.

7. The topsoil in the first six well fields at Irigaray was stabilized mainly by compaction. All compacted areas in Units 1-6 will be ripped prior to seeding.

The above plan was instituted in 1980 for the construction of Units 7, 8 and 9 at Irigaray. Approximately ten inches of topsoil material was stripped and salvaged, after consultation with WDEQ soil scientists. The remainder of the plan was followed.

To date, the areas stripped of topsoil in Units 7, 8 and 9 are still less productive in terms of vegetation growth and overall cover than Units 1 through 6, where topsoil was not stripped. For future construction at Irigaray, including well field installations, it is proposed to follow the topsoil salvage description for Christensen Ranch, as described following. If rugged topography dictates that contouring is necessary, the above plan will be followed.

Christensen Ranch

A large amount of topsoil has been salvaged at the Christensen Ranch operation. The majority of the soil was stripped and salvaged for the plant, ponds and road construction in 1988. In 1993, additional topsoil was salvaged as a result of additional road and well field module building construction in Mine Unit 4. This was also the case in 1995 for the construction of Mine Unit 5. A summary of the topsoil salvaged during past construction activities at Christensen is provided as follows:

| Stockpile No. | Volume ($yd^3$) | Date Stockpiled | Originating Area |
|---|---|---|---|
| 1 | 60,984 | Sep. 1988 | Plant and ponds, Unit 3 |
| 2 | 17,182 | Sep. 1988, 1993 | Plant access road |
| 3 | 14,278 | Oct. 1988 | Access road cuts |
| 4 | 16,779 | Oct. 1988, 1993 | Access road cuts |
| 5 | 6,520 | Mar. 1993 | Unit 2, 4 roads, buildings |
| 6 | 1,680 | Apr. 1993 | Unit 2, 4 roads, buildings |
| 7 | 8,178 | May 1995 | Unit 5 access road, Unit 5 buildings |
| 8 (subsoil) | 4,315 | Jun. 1995 | Willow Creek R & D |
| 9 | 16,822 | Jun. 1995 | Willow Creek R & D, Unit 5 buildings |

For topsoil at Christensen Ranch, the exact salvage depths are determined in the field using the recommended suitable salvage depths provided in Appendix D7, Table D7-11 of the original application. Footnote 8 of Table D7-10.25 provides the definition of "topsoil and subsoil." Wherever these two terms are used within this document, the definitions provided on Table D7-10.25 will apply. Field determinations will be made by checks of soil coloration, rooting depths and soil differences for comparisons with the recommendations in Table D7-11.

In the Christensen Ranch pond areas, the recommended suitable topsoil salvage depths provided in Appendix D7, Table D7-11 were followed. To avoid a significantly excessive disturbance from a borrow area, subsoil was used for embankment construction. The subsoil is protected by a synthetic liner, in the case of the brine evaporation ponds, and by vegetation in the unlined permeate ponds. The clean water stored in the permeate ponds will have no adverse affect on the subsoil characteristics.

In the case of main access roads, topsoil will be salvaged in accordance with the recommended salvage depths in Appendix D7, Tables D7-10 and D7-11, with one exception. Where more than eighteen (18) inches of suitable material is available (topsoil plus subsoil), a minimum of eighteen inches will be salvaged for reclamation purposes. For temporary well field access roads, only the best suitable topsoil material will be salvaged, as recommended in Table D7-10.

All topsoil salvaged during construction will be stored in stockpiles located away from drainages and stabilized from wind and water erosion by the planting of an interim seed mix to provide temporary cover. Topsoil salvaged during construction of access roads will be stockpiled in suitable locations along the road alignments for replacement during reclamation. The stockpiles will be kept out of drainages and will be placed in locations accessible to construction equipment and easily stabilized against erosion. The location of the stockpiles away from drainages and the establishment of vegetation will reduce the potential for topsoil loss and sediment delivery to receiving streams. Topsoil stockpiles will be identified by signs as required by WDEQ regulations. Existing topsoil stockpiles are shown for the Irigaray and Christensen sites on Figures 3.2 and 3.3.

### 3.6.2 SURFACE DRAINAGE

Surface drainage at both the Irigaray and Christensen Ranch facilities will be controlled to the extent necessary to minimize erosion and the contribution of suspended sediment to receiving streams. Runoff control will be accomplished by a variety of methods including interim seeding of disturbed areas to provide temporary cover, the use of drainage ditches (adjacent to ponds and roads) and by locating mine facilities so as to minimize the potential for erosion. Traffic in well field areas will be restricted to established access roads to minimize sources for erosion or sediment production.

Surface runoff will be directed around the evaporation and permeate storage ponds by the use of ditches and berms. Drainage ditches will be constructed as V-shaped channels with slopes designed to be non-erosive. The ditches will minimize surface inflow to the ponds by conveying overland flow around the structures.

Road drainage will be provided by roadside ditches constructed to control surface runoff intercepted by the roads. Culverts or low-flow crossings will be placed in all major drainages and ditch relief drainage will be provided at intervals not exceeding 1,000 feet. The majority of the constructed roads will be located on ridges whenever possible which will reduce the amount of runoff intercepted by them.

As a result of the failure of the Irigaray yellowcake thickener, the surface drainage at both the Irigaray and Christensen facilities was re-evaluated during the summer of 1995. The cause of the thickener failure was wetted soils under the concrete slab, presumably wetted as a result of surface drainage towards the building. As a result of the surface drainage study, some re-work of the ground surface around each plant site will be performed so that drainage is routed away from the buildings.

### 3.6.3 INTERIM SEED MIXTURE

Areas which are disturbed during construction activities will be seeded with an interim seed mixture for stabilization prior to final surface reclamation. Disturbed areas will include topsoil stockpiles, exposed pond berms, plant site perimeters and roadsides. Areas within the well field which are disturbed during drilling activities may be seeded with the interim mixture where necessary. Seeding will be conducted during the first fall or spring season after the disturbances are made, weather permitting.

The interim seed mixture which has been utilized for stabilization of disturbed areas at the Irigaray site was provided above in Section 3.6.1. It is proposed that this mix be replaced by the mix used at the Christensen Ranch site, which has proven to be a successful mixture for the establishment of quick vegetative cover. Accordingly, the interim seed mixture to be used at both Irigaray and Christensen Ranch is given below:

| SPECIES NAME | SEEDING RATE LBS./ACRE PLS * |
|---|---|
| Thickspike wheatgrass | 3 |
| Intermediate wheatgrass | 3 |
| Streambank wheatgrass | 3 |
| Western wheatgrass | 3 |
| Green needlegrass | 2 |
| *PLS-Pure Live Seed | TOTAL PLS 14 LBS. |

Rates are based on drill seeding; rates will be doubled if broadcast seeded.

Additionally, a cover crop of barley, oats or winter wheat is also applied with the above seed mixture at the rate of 5 to 10 pounds per acre.

### 3.6.4 FENCING

At the Irigaray site, an antelope/sheep-tight fence has been constructed around the well fields. The fence is constructed with woven wire from the ground to approximately 4 feet. A single strand of barbed wire is set at approximately the 5 feet level. Around all ponds, an additional three strands of barbed wire are set above the 4 foot woven wire fence at the 5 ft., 6 ft. and 7 ft. levels.

At the Christensen Ranch site, all plant site areas and well fields have been fenced to exclude livestock. The fence has been constructed as the Type III fencing described in WDEQ Guideline No. 10. The lined brine evaporation ponds have been fenced to exclude livestock and wildlife, which consists of an 8-foot high woven wire and barb wire fence type.

In the future, all ponds will continue to be fenced to exclude both livestock and wildlife. Additionally, access to plant areas may be restricted by fencing. However, the need to fence well fields to exclude livestock is not felt to be necessary due to the practice of burying all solution pipelines, electrical and oxygen lines. The well fields may be temporarily isolated after seeding, to establish a stabilizing vegetative growth after initial construction. After vegetation is established, the temporary fencing may be taken down so as to not cause an access obstruction for local livestock.

## 3.7 DEVELOPMENT SCHEDULE

As previously addressed, well field development at the Irigaray site occurred during the late 1970's and early 1980's. Restoration of these well fields is currently ongoing. Continued development at Irigaray is potentially scheduled after the majority of the development at Christensen Ranch is completed.

Initial development of the Christensen Ranch began with the permit approval in 1988, and the installation of Mine Unit 3. This was followed by the development of Mine Unit 2 in 1992, Mine Unit 4 in 1994, and Mine Unit 5 in 1995. Delineation drilling in Mine Unit 6 began in November, 1995. Mine Units 2, and 4 through 5 are currently operating. Mining was completed in Mine Unit 3 in 1995, and is currently in a standby mode pending groundwater restoration in 1996. Mine Unit 1 has never been developed, as Mine Units 2 and 3 actually encompass the originally planned Unit 1.

A mining and restoration timetable has been developed for all current and proposed mine units at the Christensen and Irigaray properties. This timetable is based on the following assumptions:

1. Each mine unit will be mined over a period of 3 to 4 years.

2. A buffer zone may be required between mine units undergoing mining and restoration.

3. Restoration of a specific mine unit will follow the completion of mining by approximately one year and will be accomplished within a two to three year period.

4. Decommissioning of a particular mine unit will commence following regulatory approval of aquifer restoration and stability. Surface reclamation will then be accomplished in the mine unit within the first year after the completion of well abandonment and decommissioning.

Figure 3.16 provides the proposed mining and restoration sequence for Mine Units 2 through 12 at Christensen Ranch and Units 1 through 13 at Irigaray. The schedule accounts for approximately 22 years of mining and restoration; an additional two to three years provides time for the final decommissioning and surface reclamation of the last mine unit and plant site bringing the total mine life to approximately 25 years.

The mining and restoration sequence provided in Figure 3.16 may be affected by various influences. These influences typically involve longer (or shorter) than predicted mining or restoration times, the necessity to increase or curtail production or delays in well field installations. All of these influences interact to cause changes in the predicted mining and restoration sequence. To account for such changes, the mining and restoration schedule is updated each year in the annual report to the WDEQ and USNRC.

## CHRISTENSEN and IRIGARAY
## LIFE OF MINE
## MINING AND RESTORATION SCHEDULE

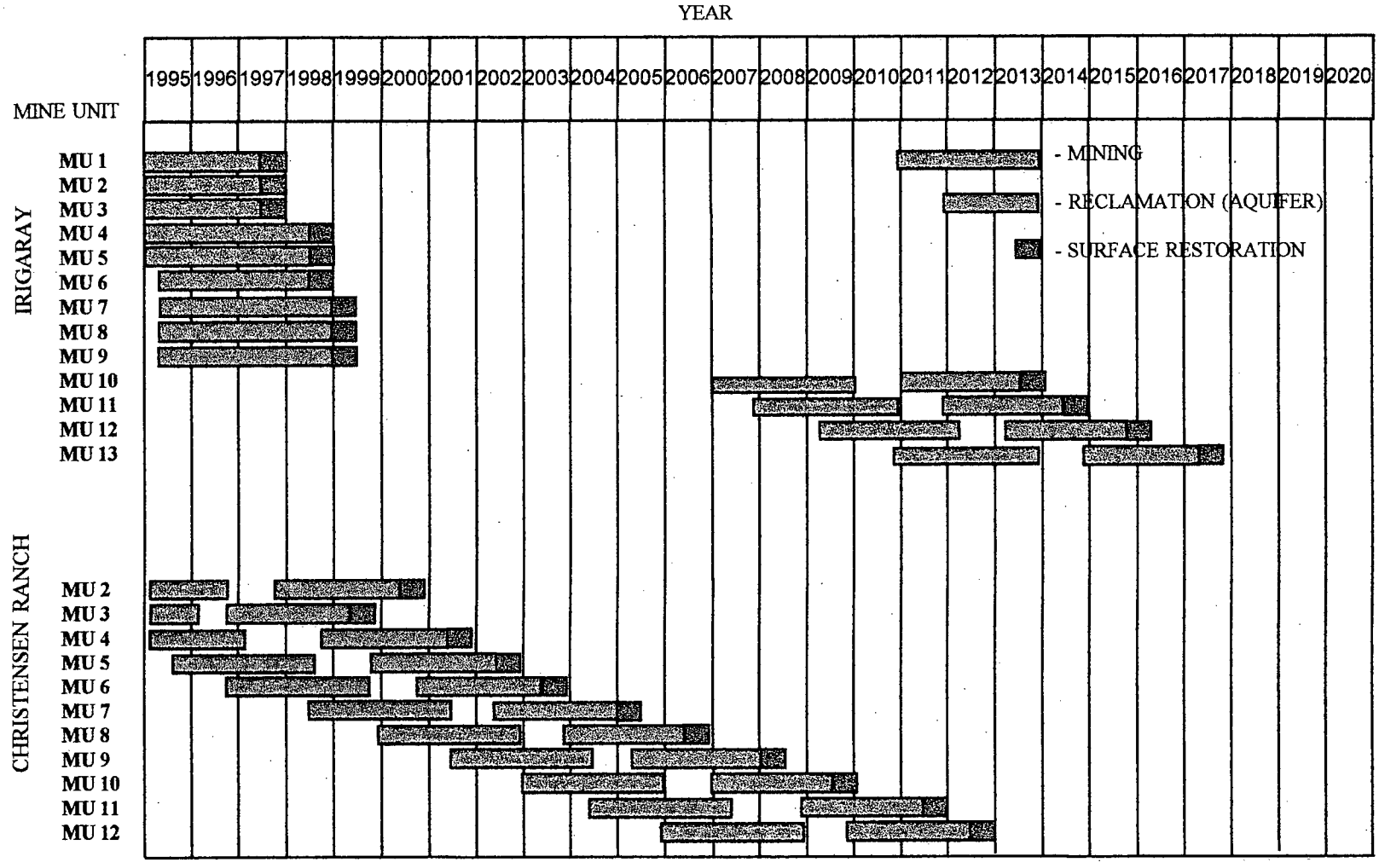



FIGURE 3.16

# 4.0 EFFLUENT CONTROL SYSTEMS

## 4.1 GASEOUS AND AIRBORNE PARTICULATES

Historically, emissions from ISL mining operations are significantly lower than conventional mining and milling operations. The primary source of emissions from ISL operations are from the process plant and associated equipment. Because the Christensen Ranch satellite plant is strictly an ion exchange (IX) facility and will have no precipitation of uranium, the only significant radioactive airborne effluent will be Radon-222 gas. At the Irigaray facility, effluents are limited to the process facility and the drying/packaging unit.

### 4.1.1 CHRISTENSEN RANCH SATELLITE FACILITY

Radon gas is mobilized from the ore zone during the mining process and will be present in the recovery solutions when they enter the plant facility. The majority of the radon gas will remain in solution during the plant process because the IX trains are closed, pressurized systems. A limited amount of radon gas will be released in the lixiviant makeup tanks. These unpressurized tanks will be vented directly to the atmosphere outside of the plant building to minimize personnel exposure.

Another small release of radon gas can occur during the resin transfer from the loaded IX column to the resin tanker trailer. The IX column is vented to the atmosphere directly outside of the plant building to release the radon gas liberated during the transfer process. In addition to the tank ventilation, the plant building is equipped with exhaust fans to further remove radon that is released inside the building, on an as needed basis.

Since the satellite process is entirely a wet process and uranium is not concentrated on-site, there are no uranium particulate effluents from the facility. Spills inside the plant are immediately washed down which eliminates the potential for any buildup of radioactive particulates.

Sources of non-radiological particulate emissions are fugitive dust from vehicular traffic and minor soda ash releases during the filling of the outside storage silo. These emissions are considered minor and insignificant due to the limited traffic (in the case of fugitive dust) and the relatively low usage of soda ash (eight shipments per year).

### 4.1.2 IRIGARAY FACILITY

The primary source of emissions from the Irigaray facility involve fugitive dust from vehicular traffic, release of radon gas from the Irigaray and Christensen Ranch resin processing, release of soda ash particulate from the process facility (when mining operations occur), and the release of yellowcake particulate emissions through the

dryer/packaging system. A total of 92.8 tons per year of air particulates is estimated to be emitted from continuous mining, processing and product drying activities at the Irigaray site. This compares with the previous total of 100 tons estimated in the 1979 WDEQ-AQD air permit application, with the dryer operating only 25% of the time. The 92.8 tons per year is also based on full scale operations; the emissions are far less during the restoration cycle due to fewer vehicles on the roads and limited plant processing.

Fugitive Dust

Potential particulate emissions from fugitive dust were originally estimated at 89.5 tons per year from the Irigaray facility. This included traffic on access roads within the permit boundary (37.9 tons/year) and wellfield roads (51.6 tons/year). Although the number of vehicles used as the basis for the fugitive dust emissions estimate is actually higher than current practice, COGEMA has used the same fugitive dust particulate emission estimate for the purposes of impacts evaluation.

Process Facility

Particulate emissions from the processing facility primarily occur from the lixiviant make-up process (when in use), where soda ash ($Na_2CO_3$) is used to generate the sodium bicarbonate lixiviant. The soda ash is stored in an outside silo adjacent to the plant building, with access for receiving loads of soda ash. The silo is equipped with a baghouse dust collection system which routinely collects over 99% of the product particulate created during the addition of soda ash to the silo. Based on the receipt of eight soda ash shipments per year during mining operations, 75,000 lbs/shipment, and a calculated loss of 500 lbs/shipment, it is estimated that approximately 2 tons/year of soda ash particulate is lost to the atmosphere during loading of the silo.

Radon emissions from resin processing is another source of emissions within the process facilities. The majority of the emissions are from the top of the ion exchange columns, which are covered and vented to the atmosphere outside the plant building. The plant buildings are equipped with exhaust fans to remove radon that is released inside the plant building, on an as needed basis.

The final source of emissions in the process facility is yellowcake particulate emissions from the drying/packaging circuit. When the dryer was first operated in 1980, the unit was operated as a calciner, i.e. high temperature fired. The yellowcake product was dried at approximately 1600° F, in order to "burn-off" contaminants in the yellowcake, such as ammonium and chlorides. Currently, the unit is operated at much lower temperatures, as there are no contaminants to burn-off. The hydrogen peroxide precipitation technique forms a superiorly clean cake, which is again washed in the filter press prior to drying. Few contaminants are present when the yellowcake enters the dryer, which in turn reduces emissions from the dryer.

The drying and packaging unit has three types of emissions: byproducts of combustion, volatilized solution residuals and uranium fines. The byproducts of combustion result from the 1,200,000+ BTU/hour drying unit. The unit is propane fired and is designed for 100% combustion. The air emissions resulting from the byproducts of combustion are $CO_2$, $H_2O$, $O_2$, and $N_2$, i.e., air. Figure 4.1 is a simplified schematic of the drying and packaging unit.

The dryer will operate continuously, for up to 8,760 hours/year, to process uranium from Irigaray, Christensen Ranch and COGEMA's Texas operations. Additionally, in the future, uranium from COGEMA's North Butte facility may be dried at Irigaray. Accordingly, a new MILDOS evaluation was conducted in 1995 for a combined Irigaray/Christensen Ranch operation with a 2,500,000 pound dryer throughput. The results of the MILDOS evaluation are provided in Section 7.3 of this report. The dryer is currently permitted by the WDEQ for up to 2,628,000 pounds per year throughput.

To limit emissions of volatilized solution residuals and uranium fines, the exhaust system in the dryer/packaging area is equipped with a filtration/scrubber system. The filtration/scrubber system consists of two components which are described below.

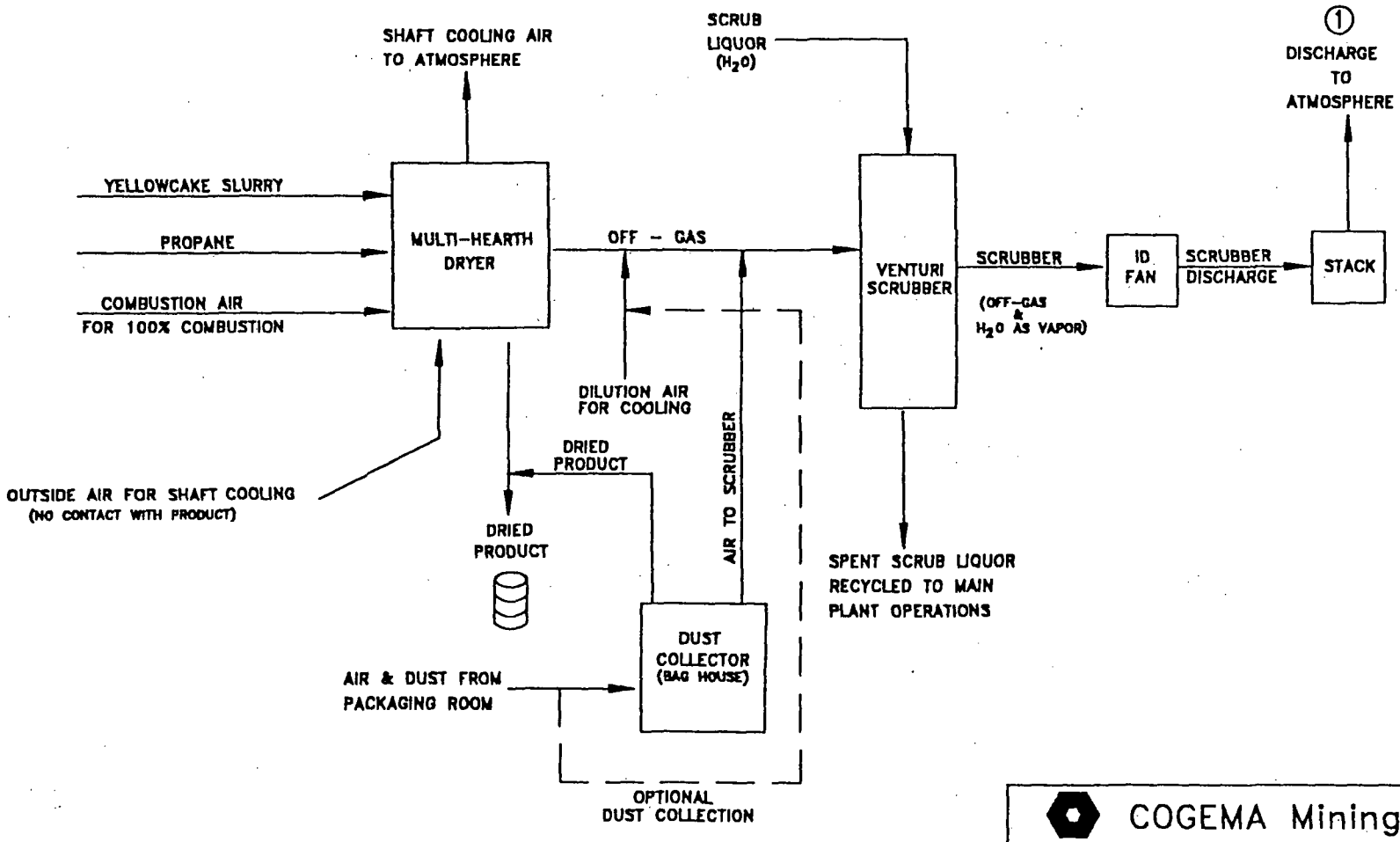
Dryer Off-Gas System

The dryer at the Irigaray Site has an off-gas system that treats the exhaust gases using a wet approach Venturi scrubber. As the off-gases flow from the dryer to the Venturi scrubber, they are cooled in the connecting duct by the addition of ambient air to the duct.

The Venturi scrubber removes all particulates down to the sub-micron size. The cleaned gas exits the top of the separator through an induced draft fan and is discharged to the atmosphere through the stack. The top of the stack is 62 feet above the ground surface and 21 feet above the roof surface. The airflow in the stack is typically in the area of 2300 cfm (at standard temperature and pressure). Spent scrubber liquor is recycled to the main plant operation.

Packaging Dust Control

Uranium fines are generated during the product prying and packaging. Probably 75% to 80% of the uranium fines are generated from the packaging of the materials after drying, rather than from the dryer itself. The yellowcake solids exit the bottom of the dryer and are loaded into drums by a rotary valve. During the drum loading operation, the top of the drum is kept under negative pressure by the use of a drumhood fitted with a suction line. Any fugitive dust generated during the loading operation is captured by the hood and is transported by the suction line to a baghouse dust collector. The filtered air from the baghouse is combined with the dryer off-gas and goes to the Venturi scrubber for further cleaning. The bagfilters in the baghouse are




1 EMISSION POINT FOR DRYING & PACKAGING UNIT

COGEMA Mining Inc.

DRYING/PACKAGING UNIT SCHEMATIC
IRIGARAY PROCESS PLANT

| 02/27/95 | | FIGURE 4.1 |
|---|---|---|

cleaned by an air shock backflush which causes the solids to fall off the bagfilters to the bottom of the baghouse where they are discharged to a drum by a rotary valve.

Stack Emissions Surveys

Emissions from the dryer are monitored on a semi-annual basis through isokinetic stack testing. The WDEQ air permit for the dryer was based on the results of stack testing performed in 1980, when the dryer was initially operated. Recent stack emission surveys performed in 1994 and 1995 show that particulate emissions are anywhere from fifty to seventy-five percent lower that the 1980 results, presumably due to the cleaner peroxide product now produced at Irigaray. The results of the 1980, 1994 and 1995 stack emissions tests are provided in Table 4.1.

## 4.2 LIQUIDS AND SOLIDS

### 4.2.1 CHRISTENSEN RANCH SITE

Liquid effluents from the operation are generated from both the mining and aquifer restoration processes. The restoration process and potential liquid effluents are discussed in Section 6 of this application.

Two liquid effluent streams are produced during the mining operations. The first stream is the typical 1% bleed (up to 36 gpm) taken from the plant process to control lixiviant migration in the wellfield. Several options are available for disposition of the bleed, including the following:

1. Direct injection into the deep disposal well (36 gpm).

2. Processing 125 gpm through the reverse osmosis unit, assuming a split of 50% permeate and 50% brine, with the following disposition: 36 gpm of high quality permeate to the permeate storage pond; 26.5 gpm of permeate to the lixiviant makeup system and reinjection; and 62.5 gpm brine for recirculation back to the injection stream of the process, or to the deep disposal well, or to the evaporation ponds.

3. All or a portion of the bleed may go to the lined evaporation ponds.

The second liquid effluent stream from the process consists of the sand filter backwash solutions, resin transfer wash water, and plant washdown waters. These solutions comprise approximately 5 gpm, on a periodic basis, and are diverted to a lined solar evaporation pond or the deep disposal well after usage.

## TABLE 4.1

## SUMMARY OF STACK EMISSIONS SURVEY RESULTS IRIGARAY DRYER AND PACKAGING CIRCUIT

| Emission | December 1980* | December 1994 | March 1995 | September 1995 |
|---|---|---|---|---|
| Total Particulate (lbs/hr) | 0.30 | 0.074 | 0.149 | 0.167 |
| % Permit Limit (0.30 lbs/hr) | 100 | 24.7 | 49.7 | 55.7 |
| Average Unat Concentration ($\mu$Ci/ml) | 1.62 E-9 | 3.06 E-10 | 7.53 E-10 | 3.37 E-10 |
| $U_3O_8$ Emissions (lbs/hr) | 0.0180 | 0.0047 | 0.0106 | 0.0050 |
| Ra-226 ($\mu$Ci/ml) | -- | 7.75 E-13 | 3.86 E-12 | 9.17 E-13 |
| Th-230 ($\mu$Ci/ml) | --- | 6.7 E-13 | 3.9 E-12 | 1.50 E-12 |
| Pb-210 ($\mu$Ci/ml) | --- | 2.33 E-12 | 3.93 E-12 | 8.7 E-13 |

*Basis for WDEQ-AQD Operating Permit No. OP-254 limits of 0.30 lbs/hr total particulate from the drying and packaging circuit.

Sanitary wastes from the office facility are disposed of by a state approved septic tank/leach field system. Details of liquid effluent retention devices are provided in the following sections.

#### 4.2.1.1 Lined Evaporation Pond Design

The lined solar evaporation ponds were initially designed to provide a surface area and capacity capable of evaporating a 5 gpm process effluent stream. The four pond system, shown on Figure 4.2 (in pocket), was based on two major design considerations. First, the pond system is capable of evaporating the process effluent over a ten year period. Secondly, the pond system is configured to have the capability for totally emptying the contents of one pond into the remaining pond(s). Only two of the four ponds were constructed initially in 1988 and are present today. Plans are to construct the other two ponds in 1996, or on an as-needed basis.

The four lined solar evaporation ponds were designed to meet the requirements of the *U.S. Nuclear Regulatory Commission's Guideline 3.11* in regard to the use of synthetic or natural materials as liners for the construction of evaporation ponds for uranium recovery facilities. As discussed above, the ponds have the capacity to evaporate the process waste stream plus additional, emergency freeboard capacity to allow the dewatering of any one pond into the remaining pond(s). The two existing ponds are currently used to evaporate the process effluent stream, and are used as backwash surge waters for the plant sand filter system.

A computerized operation study was used to evaluate the inflow (process effluent and precipitation) and outflow (evaporation) from the system on a monthly basis for a period of ten years. Precipitation inflow to the ponds was limited to precipitation which falls on the area within the pond dikes since drainage ditches are provided to channel surface runoff around the ponds. Monthly evaporation rates for the area were used to optimize the design of the ponds.

The evaporation pond geometry chosen was necessitated by the gently sloping topography of the satellite plant area. Long, rectangular ponds placed parallel to the contours reduce the need for extremely large cuts or fills and minimize the amount of embankment storage. The four ponds have identical capacities and inside dimensions. The dimensions and pond capacities are shown on Figure 4.2, and are provided as follows:

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## THAT CAN BE VIEWED AT THE RECORD TITLED:

## "CHRISTENSEN RANCH RESERVOIR MAP." FIGURE 4.2

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| POND ID | NO. | SIZE (feet) | DEPTH (feet) | FREE-BOARD (feet) | CAPACITY AT OPERATING LEVEL (Acre-feet) | TOTAL CAPACITY (Acre-feet) |
|---|---|---|---|---|---|---|
| CR-1, CR-2, CR-3 and CR-4 | 4 total | 100 X 400 each | 9.5 | 2 | 5.51 each<br>11.02 - two<br>22.04 - four | 7.68 each<br>15.36 - two<br>30.72 - four |

The design of the evaporation pond liner and leak detection system is shown on Figure 4.3 (in pocket). The liner consists of 36 mil (0.036 inch) reinforced Hypalon which is placed over leak detection media (sand or fine gravel). The sand drains to leak detection piping which consists of 30 inch diameter slotted PVC pipe in gravel-filled trenches at the perimeters of the pond bottoms. The base of the ponds are graded to slope toward the sides to facilitate the drainage of any leakage to the nearest collection pipe. The collection pipes are sloped in approximately 70-foot long sections on each side of the pond to drain the six sumps which serve as collection points for the leak detection system. Taps consisting of 4-inch diameter PVC pipe are installed at each end of the sumps to allow inspection and sampling of the six sumps. The leak detection taps are tested on a weekly basis to check for potential pond leaks.

The use of leak detection sand beneath the Hypalon liners in the two constructed evaporation ponds eliminated the need for constructing vents in the liner material. Any gases produced under the liner are vented through the leak detection media. After construction, water placed in the ponds has prevented billowing or air foil effects.

Should the additional evaporation ponds be necessary, they will be constructed in the same fashion as the original two ponds. All suitable topsoil will be removed and stockpiled prior to pond construction; salvageable depths will be determined in the field but will be based upon the soil descriptions and recommended salvage depths in Appendix D7 of the Christensen Ranch Permit Application. Any organic or vegetative material remaining after topsoil stripping will be removed prior to construction. The ponds will be excavated and graded to the slopes and grades shown on Figure 4.2. Rocks and protruding roots will be removed prior to and during the final grading. The bottom of the ponds will be graded toward the berms, and the trench for the leak detection piping will be dug. The leak detection piping will be installed at the grades and slopes shown in Figure 4.3 and covered with clean, washed gravel.

After the leak detection piping and gravel has been installed, the underdrain system, pond bottom and sides will be covered with clean, washed sand which will be smoothed to the grades and slopes shown. At this point, the Hypalon liner will be

# THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

## THAT CAN BE VIEWED AT THE RECORD TITLED:

## "BRINE EVAPORATION POND DETAIL." FIGURE 4.3

## WITH IN THIS PACKAGE... OR BY SEARCHING USING THE DOCUMENT/REPORT NO.

**D-07**

installed in accordance with the manufacturer's specifications. The reinforced Hypalon liner will be anchored in backfilled trenches three feet from the crest of the berm as shown in Figure 4.3.

Two lined evaporation ponds were located at the Willow Creek R&D site, now encompassed by Mine Unit 5 of the Christensen operations. The ponds have been decommissioned and the area reclaimed. The ponds were originally constructed in 1985, and were approximately 130 ft. by 130 ft., approximately 12 feet deep, and were lined with 36 mil Hypalon liner. Leak detection systems identical to the above design for the brine evaporation ponds were in place for both ponds. The ponds were used for the operation and restoration of the Willow Creek R&D site under WDEQ License 14 RD and USNRC Source Materials License SUA-1331. During the pond decommissioning, performed in May, 1995, no contaminated soils, gravel or piping were found underneath the ponds, or associated with the leak detection systems. Additionally, the pond liners were not contaminated, and were able to be released for un-restricted use. The ponds were still in excellent shape after ten years.

#### 4.2.1.2 Permeate Storage Pond Design

The permeate storage pond system at the Christensen Ranch satellite facility is designed to store high-quality, low-TDS permeate from the reverse osmosis process. The permeate quality will meet NPDES water quality standards for surface discharge from uranium solution mines. Only one of the two ponds has been constructed initially; the other pond will be constructed on an as-needed basis.

As shown on Figure 4.2, two trapezoidal storage ponds have been designed, each with a capacity of approximately 26 acre-feet. Calculations documenting the capacities of the permeate storage ponds are included on Figure 4.2. The maximum embankment capacity impounded in either pond is 19.2 acre-feet. The combined capacity of the two storage ponds is approximately 52 acre-feet. This capacity was designed initially to provide storage for a continuous reverse osmosis bleed stream of approximately 25 gpm for about 1.3 years of plant operation neglecting evaporation. The stored permeate can be utilized during wellfield restoration, or if approved, for land application or surface discharge.

The permeate storage pond system consists of two earthen lined ponds with identical inside dimensions. The ponds do not require synthetic lining or leak detection systems since they are only used to store the reverse osmosis permeate, which meets NPDES water quality limitations. The design of the permeate storage ponds is illustrated on Figure 4.2. Drainage ditches are used where required to channel surface runoff away from the ponds. The storage ponds were designed to have a normal operating depth of 16 feet with an additional 2 feet of freeboard for a total depth of 18 feet. The maximum depth of water storage behind the embankment is 10 feet resulting in a maximum embankment storage capacity of 19.2 acre-feet. The rest of the storage

capacity is created by excavation below grade.

The one existing permeate storage pond was constructed in 1989. In 1992 and 1994, minor settling was observed on the north and east berms. The east berm was repaired in 1992. In November, 1994 and February, 1995, COGEMA contracted two engineering firms to evaluate the settling. The result of the investigations indicated that the permeate pond embankments were experiencing interior slope failure caused by settlement of the lean clay foundation soils. The engineers recommended a remediation plan that involved a flattening of the interior slope from essentially 2H:1V to 5H:1V for the lower half of the interior slope and to 3H:1V for the upper half of the interior slope. To help reduce any seepage from the pond, the pond bottom would be overexcavated by 2 feet in depth and the material replaced and recompacted.

COGEMA began implementation of the remediation plan for the permeate pond in June, 1995. The pond was drained under a WDEQ NPDES permit and allowed to dry during the summer. Subexcavation of the pond bottom began in August and the repairs were completed by November. Use of the pond will begin again after a final inspection is concluded by the contract engineers responsible for the remediation pond design.

#### 4.2.1.3 Spillage Containment System

The Christensen Ranch satellite plant building is constructed with a curbed concrete floor equipped with a floor drain and sump system to control and reclaim spill and washdown water. The sump system is equipped with a pump which delivers liquid contents to the lined evaporation pond system or back into the plant process circuit.

All liquid chemical storage tanks located outside of the plant building, such as for hydrochloric or sulfuric acid, gasoline or diesel fuel storage, are bermed to contain the contents of the tank should the vessel rupture.

#### 4.2.1.4 Other Liquid Effluent Disposal Options

Other liquid effluent disposal options which COGEMA has considered for the Christensen Ranch satellite facility are surface discharge after treatment, deep injection well disposal and land application. Currently, COGEMA maintains a Wyoming NPDES permit for surface discharge of restoration solutions, and temporarily, for surface discharge of permeate while repairs are made to the permeate storage pond (discussed above). COGEMA has also installed one of two licensed deep disposal wells for injection of well field bleed, reverse osmosis brine and other liquid effluents from the process plant. The disposal well is discussed below.

On March 15, 1989, approval was received from WDEQ (permit UIC 88-545) and the USNRC (Condition No. 24 of SUA-1341) for a disposal wellfield for Christensen

Ranch. The Christensen Ranch Disposal Wellfield authorized two injection sites: the Federal Holler Draw 7-B well in the center of NW1/4 Section 7, T44N, R76W (an existing oil well), and the Christensen 18-3 well in the NE1/4 NW 1/4 Section 18, T44N, R76W (a plugged and abandoned oil well) in Johnson County, Wyoming. In June, 1995, the WDEQ permit was modified to allow the construction of a new disposal well at the plant site in lieu of the existing Federal Holler Draw 7-B.

Construction of the new disposal well, COGEMA DW No. 1, was initiated in late July, 1995. The well was completed in late October, 1995. Surface facilities will be constructed in early 1996, with injection capability anticipated by the first quarter of 1996. The permitted injection zone for COGEMA DW No. 1 is the entire thickness of the Teckla, Teapot and Parkman formations, ranging from approximately 7,500 feet below ground surface to a total depth of approximately 8,500 feet below ground surface. The injection zone currently completed is the Teckla, with an 800 foot horizontal completion extending through the Teckla formation. The NRC license was amended in July, 1995 to approve the modifications.

The injection fluid for the two permitted disposal wells is specifically limited to fluids produced at the Irigaray or Christensen Ranch facilities with allowances to accept oil field or other solutions after approval by WDEQ. Based on the results of a step injection test conducted in September, 1995, the surface injection pressure will be limited to 1,840 psi to avoid fracturing of the receiving formation. The resulting injection rate is estimated to be a maximum of 70 gpm, rather than the originally permitted 150 gpm, due to the limitations on operating pressure.

In order to prevent fracturing of the confining strata, injection volume and/or pressure will be controlled and monitored. The injected fluid is analyzed and sampled quarterly for TDS, bicarbonate, carbonate, and total radium. Results of this testing is submitted in a quarterly report to WDEQ. Mechanical integrity tests of the new well have been performed and approved by the WDEQ.

#### 4.2.1.5 Solid Effluents And Waste Disposal

Minor amounts of solid wastes are produced during the satellite operation. Solid residues from the sand filter systems, tank sediments, and sump sediments, as a result of the process effluent stream, will remain in the lined evaporation ponds until final decommissioning. These materials will be designated as byproduct materials and will be disposed of in a USNRC approved disposal area.

Other solid wastes such as trash, spent resin, and contaminated equipment are generated during the mining process. Waste materials and trash which are not contaminated are disposed of in an off-site industrial land fill. Unusable contaminated equipment, spent resin, bag filters or other contaminated materials are stored in a secured area until final disposition in a USNRC approved disposal area.

COGEMA is currently authorized to dispose of byproduct materials in the Pathfinder Mines Corporation Shirley Basin tailings facility. COGEMA maintains a contract with Pathfinder for the disposal of such materials, and is currently shipping byproduct materials to Shirley Basin from both the Christensen Ranch and Irigaray facilities.

### 4.2.2 IRIGARAY FACILITY

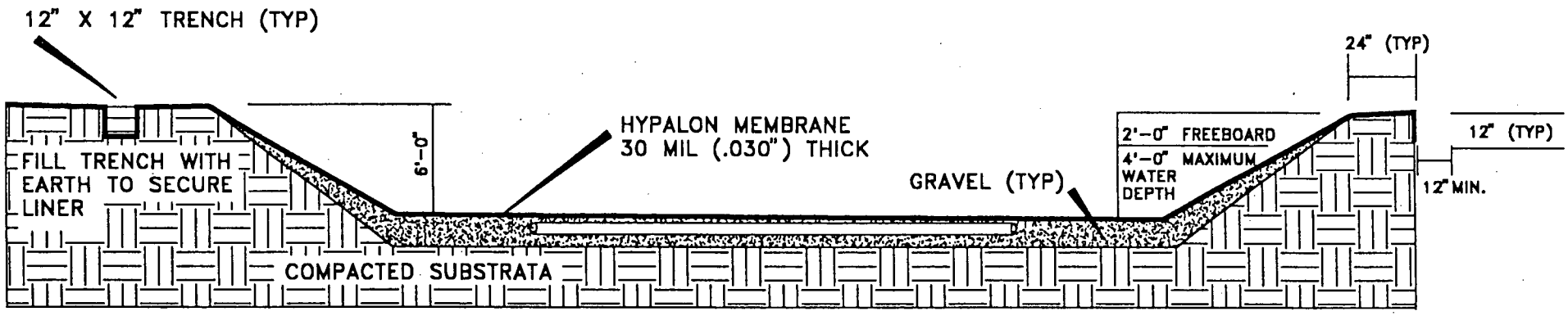
#### 4.2.2.1 Lined Evaporation Pond Design

There are a total of eleven lined ponds at the Irigaray site. These include five lined evaporation ponds, two lined restoration storage ponds, and four lined evaporation ponds located at the 517 R&D site. The five lined evaporation ponds were constructed in 1978 and 1979 under WDEQ Permit to Mine No. 478 and Source Material License SUA-1341, as were the two lined restoration ponds constructed in 1979. The four lined ponds at the 517 R&D site were constructed in 1976 pursuant to License to Explore No. 8 and Source Material License SUA-1204; these ponds were later incorporated into WDEQ Permit to Mine No. 478.

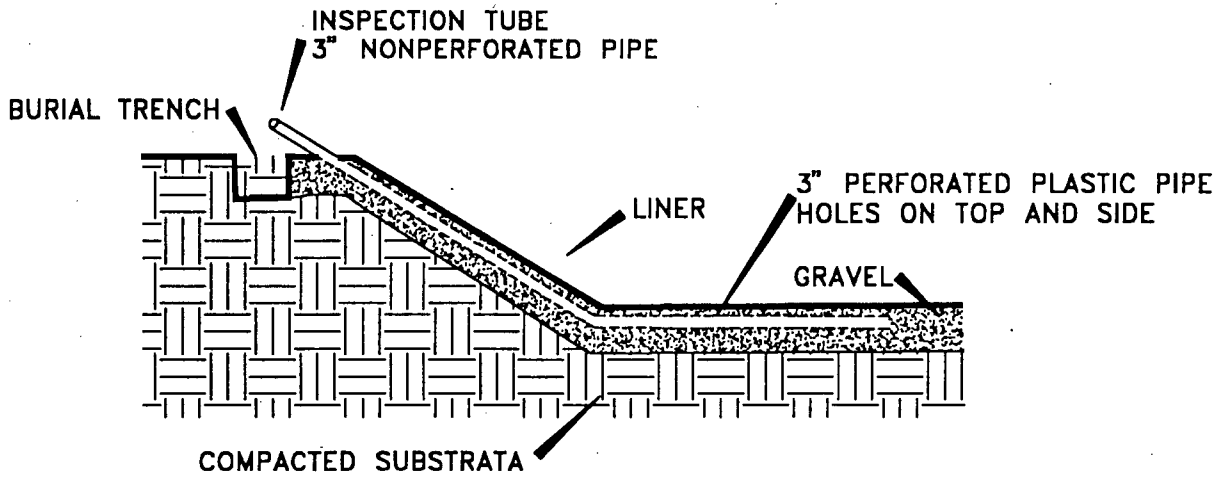
The five lined evaporation ponds were originally designed to accommodate the wellfield and plant bleed streams from an 800 gpm operation. These ponds have been adequate for past operations with higher flow rates, and are capable of evaporating up to 25 gpm on a continuous basis. All ponds are rectangular, earthen-bermed and lined with a 30 mil nylon-reinforced Hypalon liner or equivalent to prevent seepage. Topsoil from areas where the ponds were constructed was stripped to its depth, as determined by the original Soil Survey, and stockpiled and stabilized. Original plans were to use topsoil from pond excavation for berm construction. However, during construction, it became apparent that it would be easier to strip and stockpile the associated topsoil first, them complete pond construction using excavated subsoil for the pond berms.

Pond berms were stabilized by revegetation with interim species. The seeded berms were then stabilized with either native straw mulch, hydromulch, or by use of jute matting. The floor of the ponds is compacted clayey subsoil. Each pond is equipped with a leak detection system that is checked weekly. In addition to waste storage, the ponds are designed for natural evaporation to reduce the volume of the contained waste. The ponds were constructed and operated in such a manner that, should a leak occur, the leaking pond can be safely evacuated into an adjacent pond or ponds while liner repairs are effected. A detailed drawing of the evaporation pond leak detection system is shown in Figure 4.4.

Evaporation ponds already existing in Section 5, T45N, R77W, constructed pursuant to License to Explore No. 8 for the 517 restoration testing, and included within this permit boundary, may be used for development testing, restoration testing, or as alternative ponding for process waste should the need arise. These ponds are




TYPICAL CROSS SECTION




INSPECTION TUBE DETAIL

Cogema Mining, Inc.

# IRIGARAY PROJECT

TYPICAL INSPECTION TUBE DETAIL
OF IRIGARAY EVAPORATION PONDS

| | |
|---|---|
| GEOLOGY: DIVISION & VICKERS | STATE: WYOMING COUNTY: JOHNSON |
| SURVEY: | DATE: December 20, 1993 JOHNSON |
| DATA PROD P. HAGUE | SCALE: NONE REVISED: |
| | MAP ID: FIGURE 4.4 |

identified as numbers 1, 2a, 2b and 3; these correspond to the design designations of pond A (pond 1), pond B (2a and 2b--the pond is divided by a berm, but has a continuous liner and one leak detection system), and pond C (pond 3). These ponds are very shallow, and are lined with a 30 mil CEP liner (chlorinated polyethylene), rather than Hypalon.

The five evaporation ponds at the main Irigaray facility, Ponds A, B, C, D, and E were normally operated with a 2-foot freeboard level. The 2-foot freeboard is adequate to maintain fluid within the pond during a 100 mph wind, and provides a large enough area to accept the contents of an adjacent pond in the event evacuation becomes necessary due to leakage. However, in the event of heavy rains or pond leakage, ponds may be filled to greater capacity, past the normal freeboard level.

Capacities for the five lined evaporation ponds, as well as the four 517 evaporation ponds, are as follows:

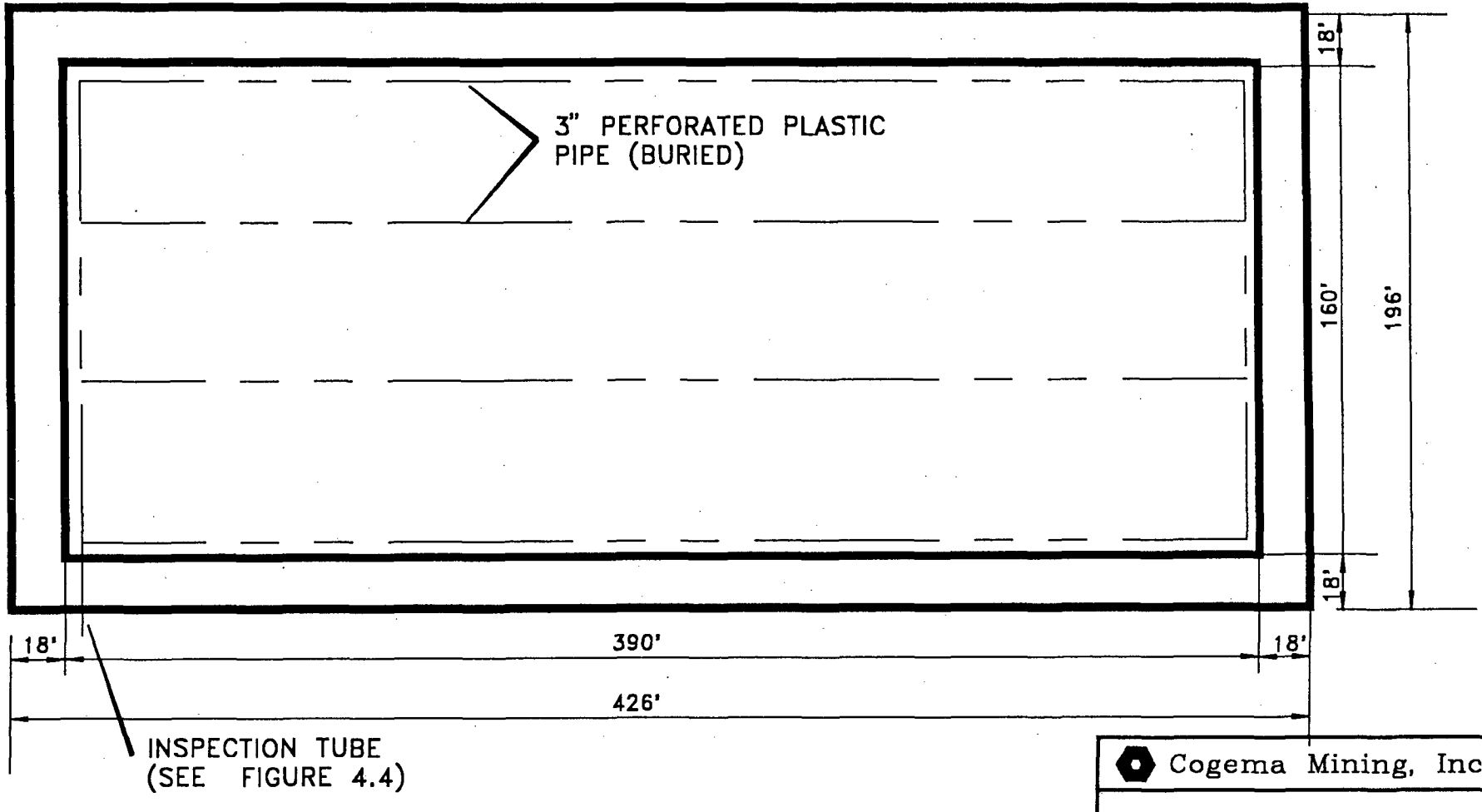
| POND ID | NO. | SIZE | DEPTH (feet) | FREE-BOARD (feet) | FREE-BOARD CAPACITY (Acre/Ft) | TOTAL CAPACITY (Acre/Ft) | EVAP-ORATIVE CAPACITY (Acre/Ft/Yr.) |
|---|---|---|---|---|---|---|---|
| A | 1 | 160X390 | 6 | 2 | 6.3 | 10.0 | 6.12 |
| B | 1 | 250X250 | 6 | 2 | 6.3 | 9.9 | 6.02 |
| C | 1 | 160X390 | 6 | 2 | 6.3 | 10.0 | 6.12 |
| D | 1 | 250X250 | 6 | 2 | 6.3 | 9.9 | 6.02 |
| E | 1 | 100X250 | 6 | 2 | 2.7 | 4.4 | 2.73 |
| 517-1 | 1 | 192X196 | 4 | 2 | 1.31 | 2.90 | - |
| 517-2A | 1 | 96X98 | 4 | 2 | 0.65 | 1.45 | - |
| 517-2B | 1 | 96X98 | 4 | 2 | 0.65 | 1.45 | - |
| 517-3 | 1 | 42X112 | 4 | 2 | 0.07 | 0.24 | - |

Design drawings of ponds A and C, B and D, and E are provided in Figures 4.5, 4.6, and 4.7.

#### 4.2.2.2 Restoration Pond Design

Construction techniques for the two restoration storage ponds were essentially the same as for the lined evaporation ponds. The two restoration storage ponds built for the Irigaray mine operations are currently used for the restoration program, specifically

# MODEL RESERVOIR
## AREA=1.75 ACRES
## CAPACITY=6.3 ACRE FEET



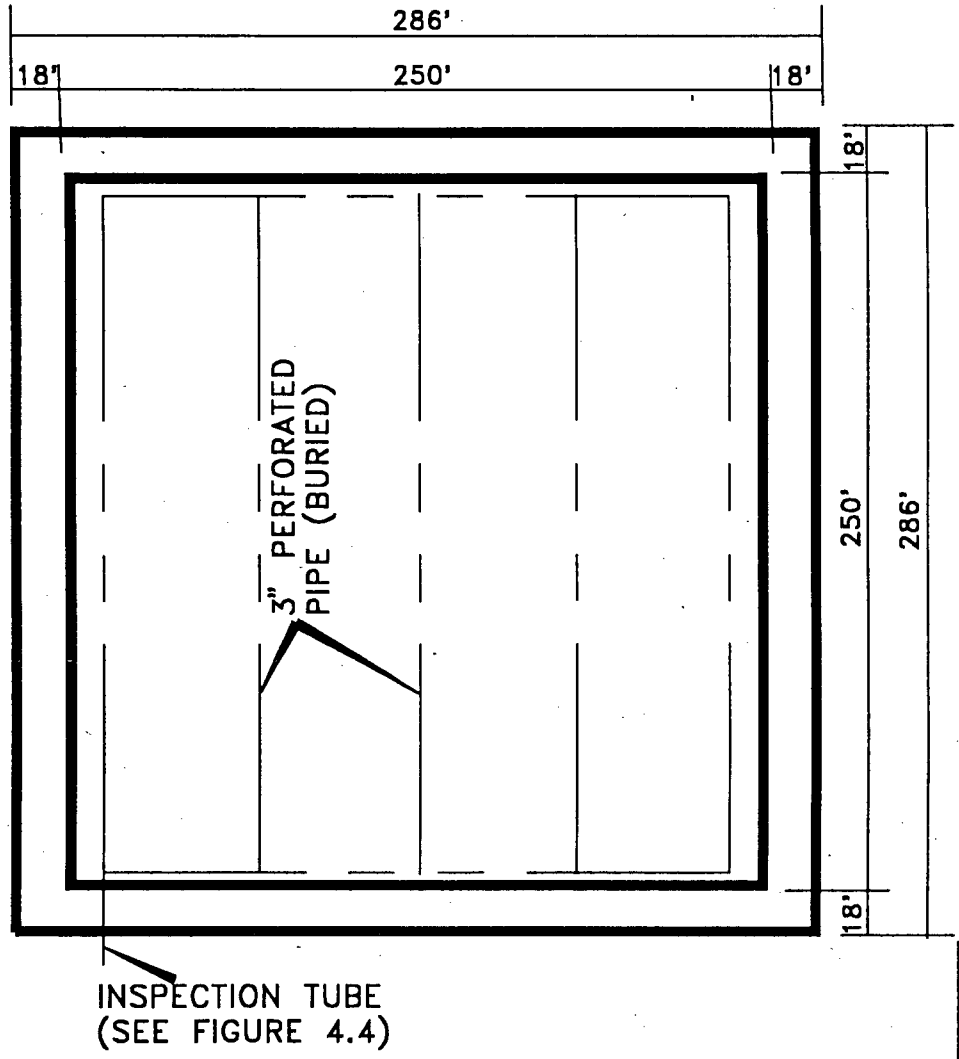

Cogema Mining, Inc.

IRIGARAY PROJECT

DIMENSIONS OF
RECTANGULAR EVAPORATION
PONDS A & C

| | | | |
|---|---|---|---|
| GEOLOGY: ENVIRON. & WICHERS | | STATE WYOMING | COUNTY: JOHNSON |
| SURVEY: | | DATE: SCALE: | REVISED: |
| DATA PROD P. HAGUE | | MAP ID: | FIGURE 4.5 |

# MODEL I SERVOIR
## AREA=1.72 ACRES
## CAPACITY=6.3 ACRE FEET



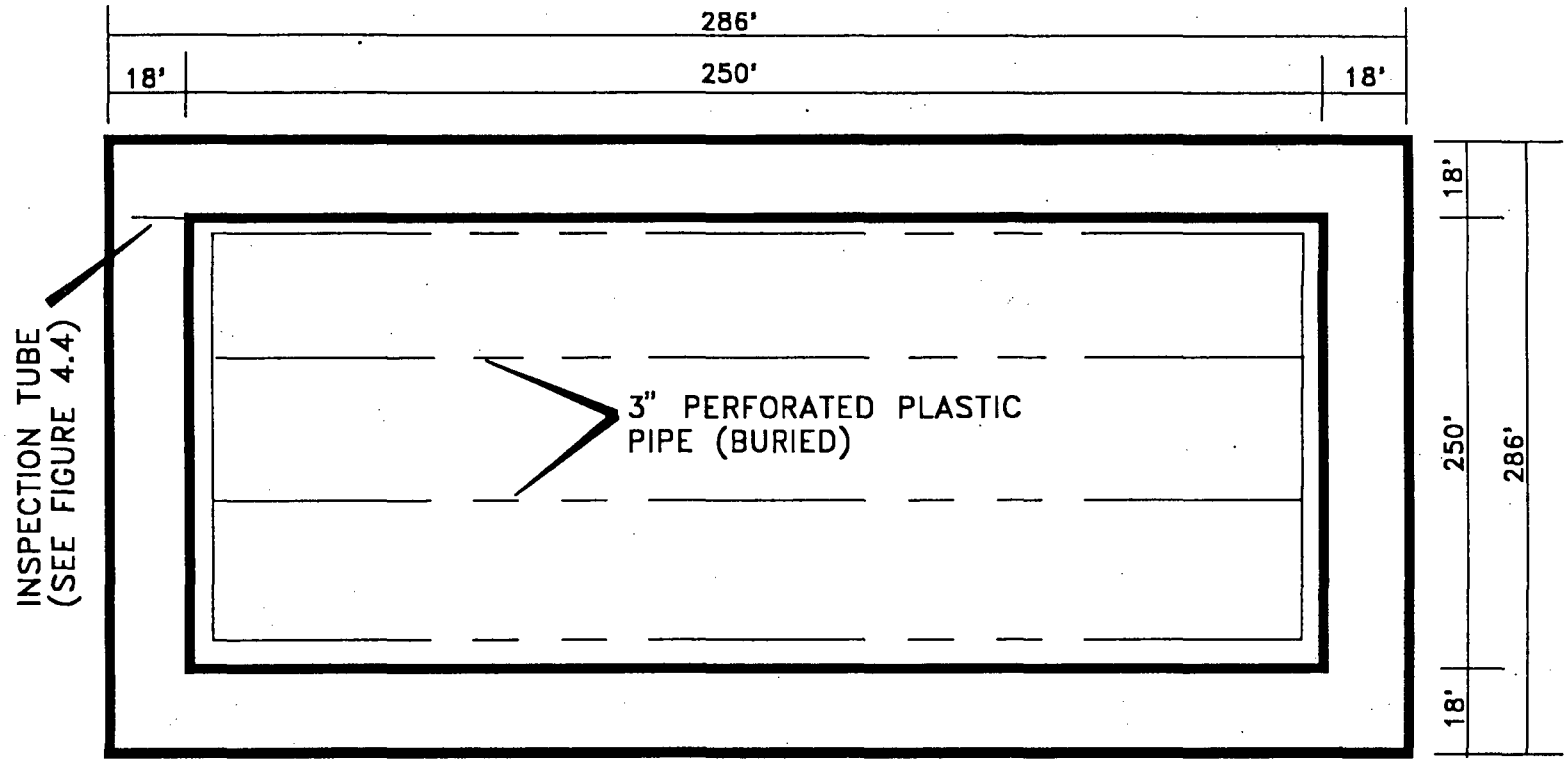

Cogema Mining, Inc.

IRIGARAY PROJECT

DIMENSIONS OF SQUARE EVAPORATION PONDS B & D

| | |
|---|---|
| GEOLOGY: | STATE: WYOMING COUNTY: JOHNSON |
| ENVIRON: L. VICKERS | DATE: |
| SURVEY: | SCALE: REVISED: |
| DATA PROC: | MAP ID: FIGURE 4.6 |

# MODEL RESERVOIR
# ACRE=.078 ACRES
# CAPACITY=2.71 ACRE FEET




Cogema Mining, Inc.

IRIGARAY PROJECT

DIMENSIONS OF
POND E

| | | |
|---|---|---|
| GEOLOGY: ENVIRON: D. VICKERS | STATE WYOMING | COUNTY: JOHNSON |
| SURVEY: | DATE: | |
| DATA PROC: | SCALE: | REVISED: |
| | MAP ID: | FIGURE 4.7 |

for the groundwater sweep and barium chloride treatment for radium-226 removal.

An 8-foot freeboard allowance normally is maintained in each of the restoration ponds (Ponds RA and RB) for the sole purpose of having the capability to transfer the contents of a full restoration pond into the adjacent restoration pond, in the case of leakage. Capacities of these two ponds are as follows:

| POND ID | NO. | SIZE | DEPTH (feet) | FREE-BOARD (feet) | FREE-BOARD CAPACITY (Acre/Ft) | TOTAL CAPACITY (Acre/Ft) | EVAP-ORATIVE CAPACITY (Acre/Ft/Yr.) |
|---|---|---|---|---|---|---|---|
| RA | 1 | Polygonal | 20 | 8 | 19.8 | 39.9 | 6.10 |
| RB | 1 | Polygonal | 20 | 8 | 19.8 | 39.9 | 6.10 |

However, the freeboard of these two ponds may be exceeded as long as the overall capacity at freeboard in the overall pond system (Ponds A, B, C, D, E, 517 ponds, RA and RB) is not exceeded. This will still allow the transfer of the contents of one leaking pond into the other ten ponds.

Design drawings of ponds RA and RA are provided in Figures 4.8 and 4.9.

#### 4.2.2.3 Spillage Containment System

The Irigaray facility building is constructed with a curbed concrete floor equipped with a floor drain and central sump system to control and reclaim spill and washdown water. The sump system is equipped with a pump which delivers liquid contents to the lined evaporation pond system or back into the plant process circuit.

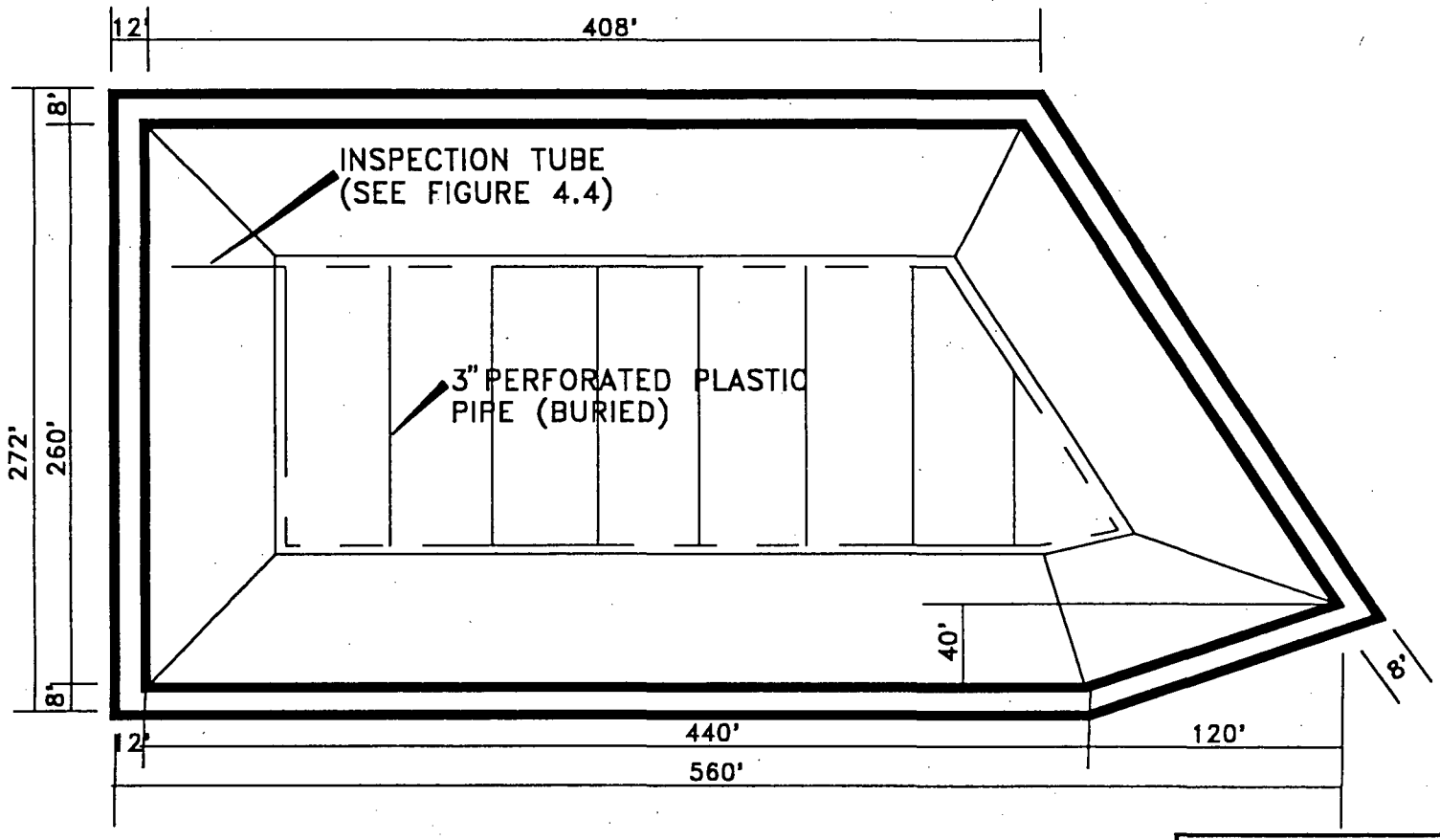
#### 4.2.2.4 Other Liquid Effluent Disposal Options

Another liquid effluent disposal option which COGEMA has considered for the Irigaray site is deep well injection. On May 27, 1992, approval was received from WDEQ (permit UIC-247) and the USNRC (Condition No. 24 of SUA-1341) for a disposal wellfield for the Irigaray site.

The Irigaray Disposal Wellfield also consists of two injection sites, DW-1, located in the W1/2 NW1/4, Section 9, T45N, R77W, and DW-2, located in the E1/2 NE1/4, section 8, T45N, R77W, both in Johnson, County, Wyoming.

The injection fluid for these two wells is specifically limited to fluids produced at the Irigaray or Christensen Ranch facilities, with allowances to accept oil field or other solutions after approval by WDEQ. Specific allowances for certain industrial wastes are contained in the permit.

# MODEL RESERVOIR
# AREA=2.17 ACRES
# CAPACITY=19.8 ACRE FEET

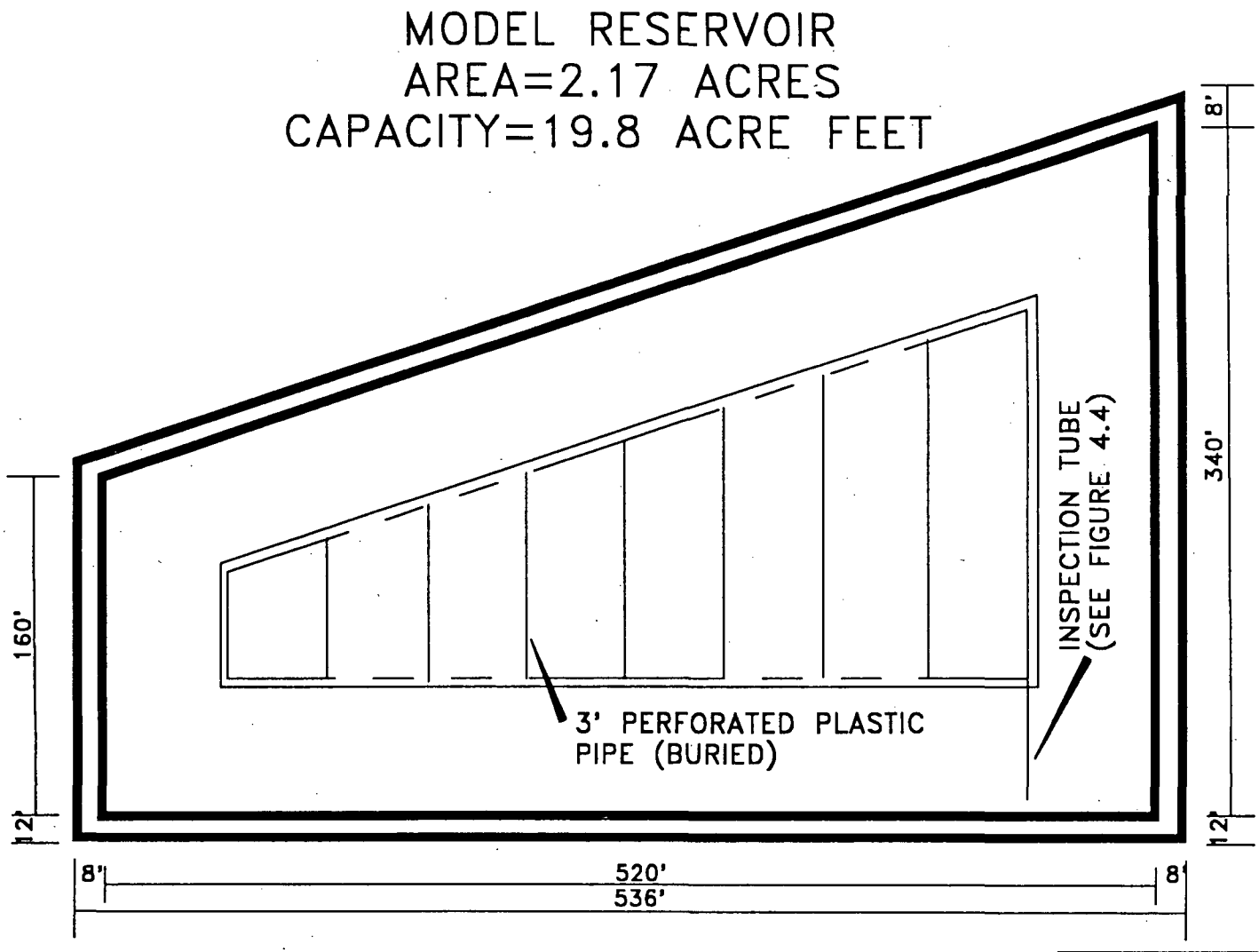



Cogema Mining, Inc.

IRIGARAY PROJECT

DIMENSIONS OF POND RA

| | |
|---|---|
| GEOLOGY: DIVIRON & VICKERS | STATE WYOMING COUNTY JOHNSON |
| SURVEY: | DATED |
| DATA PROD P. HAGUE | SCALE REVISED |
| | MAP ID: FIGURE 4.8 |




Cogema Mining, Inc.

IRIGARAY PROJECT

DIMENSIONS OF PONDS RB

| | |
|---|---|
| GEOLOGY: ENVIRON: B. VICHERS | STATE: WYOMING COUNTY: JOHNSON |
| SURVEY: | DATE: |
| DATA PROC: | SCALE: REVISED: |
| | MAP ID: FIGURE 4.9 |

Injected volume into the two wells as currently permitted is 180 gallons per minute (6,171 barrels per day or 259,182 gallons per day) in each of the two wells.

COGEMA is currently disposing of restoration solutions through evaporation and a Wyoming issued NPDES permit. Solutions are treated with ion exchange, for uranium removal, barium chloride treatment in the ponds for radium-226 removal, and additional treatment through reverse osmosis, if necessary, prior to disposal via surface discharge. The NPDES permit contains limits for uranium, dissolved radium-226, pH, total dissolved solids, total selenium, total suspended solids and total zinc.

#### 4.2.2.5 Solid Effluents And Waste Disposal

During the earlier operations at the Irigaray Site, 1978-1980, significant amounts of calcite solids were generated as a result of the leaching process. The calcite generated during this period was stored in lined 55 gallon drums and subsequently removed to an off site USNRC approved licensed tailings facility in 1981 (Exxon Highland tailings facility).

Dissolved solids from all waste streams will be retained in lined evaporation ponds. The lined settling pond previously designated for calcite storage, Pond E, has essentially been used to store and evaporate waste water solutions from the plant processes, just as the other evaporation ponds. All pond solids will eventually be transported to an off-site licensed tailing facility when final decommissioning is effected. After solid wastes in the evaporation ponds are removed, the Hypalon liners will also be removed to an off-site USNRC approved licensed tailings facility if contaminated. At that time, a gamma survey will be conducted to identify any contaminated surface present. If any contaminated material is found, this also will be removed to an off-site USNRC approved licensed tailing facility prior to final reclamation of the pond sites.

Chemicals separated by conventional water purification techniques, and further concentrated by evaporation, will be generated in the restoration program. Barium sludges will be present in the two lined restoration ponds. Since continuously better water quality is attained as restoration proceeds, a variable amount of waste solids will be generated throughout the restoration operation.

Solid waste from aquifer restoration activities will be contaminated primarily with Radium-226 and Thorium-230. Waste from this source will be stored in evaporation ponds and will also be disposed of according to applicable USNRC regulations in an USNRC approved off site licensed tailing facility.

As previously stated, COGEMA maintains a contract for byproduct materials disposal with Pathfinder Mines Corporation, Shirley Basin tailings facility.

## 4.3 CONTAMINATED EQUIPMENT

The uranium recovery process does not use equipment such as wooden thickener tanks which could become contaminated with radium. Rather, the plant is constructed almost entirely of plastic, fiberglass and stainless steel, all of which can be cleaned of contamination to levels allowable for unrestricted use and removed from the site at the end of the mining activities. Alternately, process equipment may be transferred to another licensed operation site for re-use in similar uranium extraction operations.

Release of equipment and materials from the controlled areas shall be in accordance with *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials, September 1984,* issued by the U.S. Nuclear Regulatory Commission.

# 5.0 OPERATIONS

COGEMA Mining, Inc. (COGEMA) is a subsidiary of COGEMA Resources, Inc., a wholly owned subsidiary of COGEMA, Inc. COGEMA, Inc. is a United States subsidiary of COGEMA, S.A.E. located in France. COGEMA maintains a United States headquarters in Mills, Wyoming where site licensing actions originate. All COGEMA operations, including the Irigaray Mine and Christensen Ranch satellite operations, are conducted in conformance with applicable laws, regulations and requirements of the various regulatory agencies. The responsibilities described below have been designed to both ensure compliance and further implement COGEMA's policy for providing a safe working environment with cost effective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

## 5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

The COGEMA organizational chart, as it pertains to the responsibility for radiation safety and environmental protection at the Christensen Ranch satellite and Irigaray recovery facility is given as Figure 5.1. The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and groundwater monitoring programs, as well as routine and non-routine maintenance activities. Specific responsibilities of the organization are provided below.

### 5.1.1 GENERAL MANAGER, ISL OPERATIONS

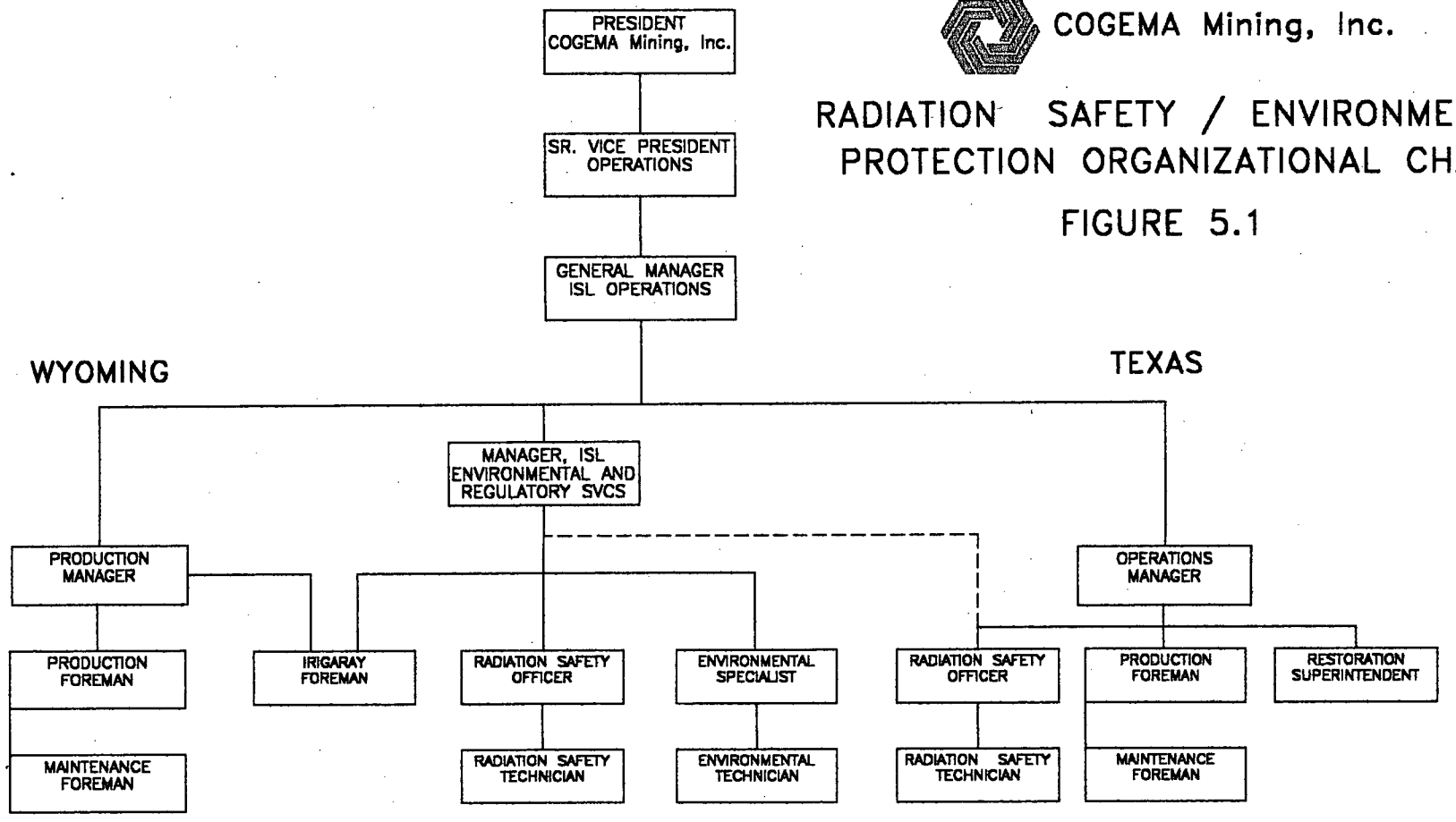
The General Manager, ISL Operations has the overall responsibility for each level of management and the radiation, safety and environmental programs for all of COGEMA's in-situ leach uranium operations, including the Texas operations and the Irigaray and Christensen Ranch projects. The General Manager has responsibility for the mine development, engineering and operational procedures. These responsibilities include the development, review and implementation of all production related operating procedures and the implementation of safety programs, associated quality assurance programs and routine and non-routine maintenance activities. The General Manager has the authority to terminate immediately any or all portion(s) of the project that have been determined to be a threat to health or property as indicated in reports from the Radiation Safety Officer or his designee.

The General Manager works closely with the Manager, ISL Environmental and Regulatory Services, the Radiation Safety Officer, and the Production Manager to assure that all activities at each site are conducted in a safe, prudent and responsible manner in compliance with all applicable regulations. The General Manager reports to the Senior Vice President of Operations in COGEMA's Saskatoon office.

COGEMA Mining, Inc.

# RADIATION SAFETY / ENVIRONMENTAL PROTECTION ORGANIZATIONAL CHART

## FIGURE 5.1




Revised 10/31/1995

### 5.1.2 MANAGER, ISL ENVIRONMENTAL AND REGULATORY SERVICES

The Manager, ISL Environmental and Regulatory Services is responsible for the maintenance of all operational licenses and permits for continued mine operations including modifications, amendments and renewals. This individual also assists and guides the Radiation Safety Officer, if and when necessary, in his routine and special responsibilities. The Manager, ISL Environmental and Regulatory Services has oversight for the development, review, approval, implementation and adherence to radiation safety programs, environmental and groundwater monitoring programs and associated quality assurance programs for the Wyoming sites. The Manager, ISL Environmental and Regulatory Services has both the responsibility and authority to suspend, postpone or modify any work activity that is unsafe or potentially in violation of USNRC's regulations or license conditions, including the ALARA program. The Manager, ISL Environmental and Regulatory Services reports to the General Manager.

### 5.1.3 RADIATION SAFETY OFFICER

The Radiation Safety Officer (RSO) has direct responsibility for the implementation and adherence to radiation safety programs, industrial safety programs, environmental monitoring programs and associated quality assurance programs for the Irigaray and Christensen Ranch Sites.

The RSO is also responsible for the collection and interpretation of employee exposure related monitoring data, and the proper recording and reporting of such. The RSO conducts routine training programs for the supervisors and employees with regard to the proper application of radiation protection and industrial safety procedures. This individual is also responsible for the implementation of and adherence to all regulatory license requirements and fulfillment of reporting requirements. The RSO, with assistance from the RST or Environmental Specialist, or other qualified designee, personally inspects facilities to verify compliance with all applicable health physics and radiation safety requirements. The RSO has both the responsibility and authority to suspend, postpone or modify any work activity that is unsafe or potentially a violation of USNRC's regulations or license conditions, including the ALARA program. The RSO reports directly to the Manager, ISL Environmental and Regulatory Services.

### 5.1.4 RADIATION SAFETY TECHNICIAN (RST)

The Radiation Safety Technician (RST) assists the RSO with his routine radiation safety surveys, employee exposure records keeping, facility inspections, training, and industrial safety responsibilities. The RST reports directly to the RSO.

### 5.1.5 ENVIRONMENTAL SPECIALIST

The Environmental Specialist is responsible for the implementation of all environmental

monitoring programs at both the Irigaray an Christensen Ranch sites. Specific duties include groundwater and surface water sampling, air monitoring and evaporation pond inspections. In addition, the Environmental Specialist has been trained to act as an RST and may assist the RSO with the implementation of the radiological and industrial safety programs. The Environmental Specialist is responsible for the orderly collection and interpretation of all monitoring data. The Environmental Specialist reports directly to the Manager, ISL Environmental and Regulatory Services.

### 5.1.6 RADIATION SAFETY AUDITOR

COGEMA Mining, Inc. utilizes either the Manager, ISL Environmental and Regulatory Services or an outside radiation protection auditing service to provide assurance that all radiation health protection procedures and license condition requirements are being conducted properly at the Irigaray and Christensen Ranch Sites. Any outside service used for this purpose is qualified in radiation safety procedures as well as environmental aspects of solution mining operations.

## 5.2 MANAGEMENT CONTROL PROGRAM

### 5.2.1 OPERATING PROCEDURES

Written standard operating procedures (SOPs) have been developed for all process activities, including those activities involving radioactive materials, for both the Irigaray and Christensen Ranch facilities. Where radioactive materials handling is involved, pertinent radiation safety practices are incorporated into the SOP. Additionally, written SOPs have been developed for non-process activities including environmental monitoring, health physics procedures, emergency procedures, and general safety. Written SOPs have been developed, reviewed and approved by the appropriate supervisors including the RSO and the Manager, ISL Environmental and Regulatory Services. All written SOPs are reviewed for radiological protection aspects and approved by the RSO prior to operations. Additionally, the RSO reviews all SOPs on an annual basis. Applicable current SOPs are referenced throughout this document. SOPs are revised as necessary to meet changing operational and regulatory requirements. Any revisions made to the SOPs are reviewed and approved by the RSO and appropriate supervisor prior to implementation. Written SOPs are kept in the areas of the plant facility where they are used by employees.

For the performance of non-routine work or maintenance activities where the potential for radiation exposure exists and for which written operating procedures have not been prepared, a radiation work permit (RWP) is required. The RWP specifies the necessary radiological safety precautions, equipment or specialized clothing, and radiological surveys required for performing the job. RWPs are issued by the RSO or his designee by way of specialized training.

### 5.2.2 SAFETY AND ENVIRONMENTAL REVIEW PANEL (SERP)

COGEMA is applying for a Performance Based License (PBL) with this renewal application. If a PBL is issued as a result of this renewal application, COGEMA will form a Safety and Environmental Review Panel (SERP) comprised of a minimum of three individuals. The SERP will be responsible for reviewing changes, tests or experiments to determine whether an amendment to the license is required.

One member of the SERP shall have expertise in management and shall be responsible for managerial and financial approval changes; one member shall have expertise in operations and shall have responsibility for implementing any operational changes; and, one member shall be either the Manager, ISL Environmental and Regulatory Services or the Radiation Safety Officer, for the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP as appropriate, to address technical aspects such as health physics, hydrology, engineering or other technical disciplines.

Once the PBL is issued, COGEMA will prepare an SOP to outline the SERP's responsibilities in conducting safety and environmental evaluations of changes to the application, tests or experiments to determine whether an amendment to the license is required.

## 5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAM

The following internal inspections, audits and reports are performed for the Irigaray recovery facility and Christensen Ranch satellite operations:

Weekly

The RSO or a qualified designee conduct a weekly inspection of the process area to observe general radiation safety control practices and make or review required changes in procedures and equipment. Any items of non-compliance or other problems are reviewed with the Production Manager or General Manager.

Monthly

The RSO provides a written summary of the month's radiological activities at the Christensen Ranch and Irigaray facilities. The report includes a review of all monitoring and exposure data for the month, a summary of worker protection activities, a summary of all pertinent radiation survey records, a discussion of any trends in the ALARA program, and a review of adequacy of the implementation of the USNRC license conditions. Recommendations are made for any corrective actions or improvements in the process or safety programs.

Annually

On an annual basis, an audit of the radiation protection and ALARA program is conducted and a written report of the results submitted to corporate management. The audit team consists of either the Manager, ISL Environmental and Regulatory Services and/or the outside radiation safety auditor identified in Section 5.1.6, the RSO and the Production Manager or General Manager. The RSO may accompany the audit team, but may not participate in the conclusions.

The annual ALARA audit report summarizes the following data:

1. Employee exposure records
2. Bioassay results
3. Inspection log entries and summary reports of mine and process inspections
4. Documented training program activities
5. Applicable safety meeting reports
6. Radiological survey and sampling data
7. Reports on any overexposure of workers
8. Operating procedures that were reviewed during this time period

The ALARA audit report specifically discusses the following:

1. Trends in personnel exposures
2. Proper use, maintenance and inspection of equipment used for exposure control
3. Recommendations on ways to further reduce personnel exposures from uranium and its daughters

The ALARA audit report is reviewed by the General Manager with the ALARA audit team. Implementations of the recommendations to further reduce employee exposures, or improvements to the ALARA program, are discussed at that time.

An audit of the Quality Assurance/Quality Control (QA/QC) program is also conducted on an annual basis. The audit is performed by an individual qualified in analytical and monitoring techniques who does not have direct responsibilities in the areas being audited. The results of the QA/QC audit are documented and reported to the Manager, ISL Environmental and Regulatory Services, the RSO and the General Manager. The RSO has the primary responsibility for the implementation of the QA/QC programs at the Irigaray and Christensen Ranch facilities.

## 5.4 QUALIFICATIONS

COGEMA Mining, Inc. project staff are highly experienced in the management of uranium development, mining and operations. The following minimum personnel specifications and qualifications are strictly adhered to.

The minimum qualifications for the Radiation Safety Officer (RSO) are as follows:

1. Education - A Bachelor's Degree or an Associate Degree in the physical sciences, industrial hygiene, environmental technology or engineering from an accredited college or university or an equivalent combination of training and relevant experience in uranium mill/solution mining radiation protection.

2. Health Physics Experience - A minimum of 1 year of work experience relevant to uranium mill/solution mining operations in applied health physics, radiation protection, industrial hygiene or similar work.

3. Specialized Training - A formalized, specialized course(s) in health physics specifically applicable to uranium milling/solution mining operations, of at least 4 weeks duration. The RSO attends refresher training on radiation health physics every two years.

4. Specialized Knowledge - The RSO, through classroom training and on-the-job experience, possesses a thorough knowledge of the proper application and use of all health physics equipment used in the operation, the procedures used for radiological sampling and monitoring, methods used to calculate personnel exposures to uranium and its daughters, and a thorough understanding of the solution mining process and equipment used and how hazards are generated and controlled during the process.

The Radiation Safety Technician (RST) will have the following combinations of education, training and experience:

1. Education - An associate degree or 2 years or more of study in the physical sciences, engineering or a health-related field.

2. Training - At least a total of 4 weeks of generalized training in radiation health protection applicable to uranium mills/solution mining operations.

3. Experience - One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium mill/solution mining operation.

## 5.5 TRAINING

All site employees, and contracted personnel when present, at the Irigaray and Christensen Ranch ISL Project are administered a training program based upon the COGEMA Radiation Safety Training Plan covering radioactive material handling and radiological emergency procedures. This training program is administered in keeping with standard radiological protection guidelines. The technical content of the training program is under the direction of the Manager, ISL Environmental and Regulatory Services. Training is conducted by the RSO.

### 5.5.1 TRAINING PROGRAM CONTENT

Visitors

Visitors to the Irigaray and Christensen Ranch ISL Project receive hazard training on the radiation safety requirements while in the restricted area and survey requirements upon leaving the restricted area.

Contractors

Contractors receive the same hazard training as visitors. In addition, contractors receive additional radiation safety training when applicable to their specific tasks.

Permanent Employees

The COGEMA Radiation Safety Training Program incorporates the following topics discussed in Regulatory Guide 8.31:

1. Fundamentals of health protection;
2. Personal hygiene at uranium mines;
3. Facility-provided protection;
4. Health protection measurements;
5. Mine emergency procedures.

As part of the employee initial training program, COGEMA issues to each new employee the following handouts:

1. Health Physics Manual for radiation training and decontamination procedures;
2. Regulatory Guide 8.29, "Instructions Concerning Risks From Occupational Radiation Exposure";
3. Regulatory Guide 8.13, "Instructions Concerning Prenatal Radiation Exposure"(females only);
4. Uranium-238 Decay Chain table;

5. Standard Operating Procedure HP-1, "Alpha Contamination Monitoring for Release From a Restricted Area";
6. Standard Operating Procedure HP-21, "Respiratory Protection Program" (applicable only to employees who need to be trained to wear a respirator and have been medically certified to do so).

In addition to the training described for all employees, certain employees receive additional training as follows:

Supervisors

Supervisors receive additional annual training relating to their supervisory responsibilities in the area of worker radiation protection.

RSTs

At least one week of generalized classroom training is provided to RSTs by an outside instructor who is a specialist in such training.

### 5.5.2 TESTING REQUIREMENTS

A written test relevant to the principles of radiation safety and health protection in uranium mining is administered at the end of the training course. Employees who fail the test are retested after receiving additional training.

### 5.5.3 ON-THE-JOB TRAINING

RST

On-the-job training is provided to RSTs in radiation exposure monitoring and exposure determination programs, instrument calibration, plant inspections, posting requirements, respirator programs and Health Physics Standard Operating Procedures.

During the first three months of employment the RST receives on-the-job training to conduct the following:

1. Daily facility radiation inspections in accordance with Standard Operating Procedure HP-16;
2. Air surveys for radon daughters and airborne uranium in accordance with Standard Operating Procedures HP-6 and HP-7;
3. Gamma, alpha and equipment release surveys in accordance with Standard Operating Procedures HP-2, HP-3, HP-8 and HP-10;
4. Survey instrument calibration checks and air sampling pump calibrations in accordance with Standard Operating Procedures HP-13, HP-14 and HP-15;

5. Maintenance and inspection of respirators in accordance with Standard Operating Procedure HP-22.

During the second three months of employment the RST receives on-the-job training to conduct the following:

1. Assign Radiation Work Permits in accordance with Standard Operating Procedure HP-11;
2. Calculate and document internal exposures in accordance with Standard Operating Procedure HP-5;
3. Determining radiological posting requirements in accordance with Standard Operating Procedure HP-24.

### 5.5.4 REFRESHER TRAINING

Following initial radiation safety training, all permanent employees receive on-going radiation safety training as part of the routine quarterly safety meetings. This on-going training is used to discuss problems and questions that have arisen in the past quarter, any relevant information or regulations that have changed, exposure trends and other pertinent topics.

### 5.5.5 TRAINING RECORDS

Records of training are kept for a period of five years for all process employees.

## 5.6 SECURITY

### 5.6.1 IRIGARAY SITE SECURITY

Entrances to the Irigaray Site are gravel roads to the north and south of the facility. Each entrance to the site is posted to alert visitors that any building or area within the facility may contain radioactive material and that permission is required prior to entry. In addition, the immediate mine permit area (WDEQ permit boundary) is fenced, with gates on each access route which can be locked. The plant site is within the fenced permit area and properly posted in accordance with 10 CFR § 20.1902 (e) and COGEMA Standard Operating Procedure HP-24, "Radiological Posting Requirements". Posting and warning signs are placed at conspicuous places around the perimeter of the site. All visitors to the Irigaray Site are required to register at the main office and are not permitted inside the plant or wellfield areas without proper authorization. Inexperienced visitors are escorted unless they are frequent visitors who have been instructed regarding areas to be avoided. The process plant, wellfield and related mining activity areas during operations are posted hard-hat and safety glasses areas. Strict adherence to safety rules restricts unauthorized persons from access.

### 5.6.2 CHRISTENSEN RANCH SITE SECURITY

Security for the Christensen Ranch satellite facility is provided by the personnel working at the facility. Security has not been a problem at the facility due to the remote location and private access road. The access to the site is a gravel road to the south of the plant site. The entrance to the facility is posted to alert all visitors that any building or area within the facility may contain radioactive material and that permission is required prior to entry. The plant site is properly posted in accordance with 10 CFR § 20.1902 (e) and COGEMA Standard Operating Procedure HP-24, "Radiological Posting Requirements". Posting and warning signs are placed at conspicuous places around the perimeter of the site. The entrance to the site is equipped with a lockable gate. Pump houses in the wellfields which are near the county road and could be more easily accessed are equipped with a locking door with an access code to prevent access by unauthorized personnel.

All visitors to the Christensen Ranch satellite facility are required to report to the site office where they register and receive proper safety briefings prior to entering any process areas. Inexperienced visitors are escorted unless they are frequent visitors who have been instructed regarding areas to be avoided. The plant, wellfield and related mining activity areas are posted hard-hat and safety glasses areas. Pond areas are fenced and appropriately posted.

## 5.7 RADIATION SAFETY CONTROLS AND MONITORING

COGEMA has a strong corporate commitment to and support for the implementation of the radiological control program at Irigaray and Christensen Ranch. This corporate commitment to ALARA has been incorporated into the radiation safety controls and monitoring programs described in the following sections. This license renewal application contains the results of the radiological control program since 1987. Each area in this section describes the historical program and the results of monitoring since 1987. Where the monitoring results indicate that the program should be modified, proposed changes in the program are also discussed.

### 5.7.1 EFFLUENT CONTROL TECHNIQUES

#### 5.7.1.1 Gaseous And Airborne Particulates

Irigaray Gaseous and Airborne Particulate Control Techniques

Under routine production operations, there are two radioactive effluents at the Irigaray facility:

1. Release of Radon-222 gas from the production solutions;

2. Release of yellowcake through the multi-hearth dryer exhaust system.

The production flow of 2400 gpm is directed to the process building for separation of the uranium. The uranium is separated by passing the recovery solution through pressurized fixed bed downflow ion exchange units. Since the recovered solution is pressurized at all times in the uranium recovery process virtually none of the contained radon is released to the environment. The only radon released to the environment is from the bleed stream that is used for process bleed and for chemical make-up. Radon is also released during the restoration phases of operation, but is significantly reduced due to the lower operational flow rates.

Venting of non-pressurized tanks to the atmosphere outside of the plant building minimizes personnel exposure. The plant buildings are equipped with exhaust fans to remove radon that is released in the plant building, and are used on an as needed basis. No significant personnel exposure to Rn-222 gas has been noted during operation of the Irigaray facility. Results of radon daughter monitoring in the process areas are contained in Section 5.7.3.

The primary source of airborne particulates at the Irigaray facility is the multihearth dryer. The exhaust system for the multi-hearth dryer is equipped with a high intensity Venturi scrubber system to remove contaminants prior to discharge to the atmosphere. This system is designed to remove approximately 90 to 95% of particulates. Further information on the scrubber system was previously discussed in Section 4 of this renewal document. The efficiency of the scrubber system is demonstrated by the uranium concentration measured in the stack effluents. Stack tests conducted in 1994 and 1995 showed that the particulate emissions from the dryer range from 24.7 to 55.7 percent of the standard allowable specified in COGEMA's Permit No. OP-254.

In the event that the yellowcake product is not dried and is stored in existing tanks and shipped as a slurry, the particulate emissions from the dryer are eliminated.

Christensen Ranch Gaseous and Airborne Particulate Control Techniques

The Christensen Ranch satellite facility produces one radioactive airborne effluent, Radon-222 gas, as a result of operations as previously discussed in Section 4. Radon-222 gas primarily remains in solution because the majority of the average 3,600 gpm plant flow is in a pressurized system. A limited amount of radon gas is released as a result of the diversion process bleed stream into the lixiviant makeup circuit. These unpressurized tanks are vented directly to the atmosphere outside of the plant building to minimize personnel exposures. Another potential release of radon gas may occur during the resin transfer from a loaded IX column to the resin tanker trailer. During this process, the IX column is also vented to the atmosphere directly outside of the plant building.

The venting of unpressurized tanks outside of the building minimizes personnel exposures to radon gas. No significant personnel exposure to Rn-222 gas has been noted during operation of the Christensen Ranch facility. Results of radon daughter monitoring in the process areas are contained in Section 5.7.3. As an additional protective measure, the plant building is equipped with area exhaust fans.

There have been no significant increases in the levels of airborne radioactive effluents at the Irigaray recovery facility from the elution Christensen Ranch resin or from the precipitation process.

5.7.1.2 Spill Contingency Plans

Spills as a result of operations at the Irigaray facility were considered in the Final Environmental Impact Statement (NUREG 0481, September 1978). Spills as a result of operations at the Christensen Ranch facility were considered in the Environmental Assessment prepared by the USNRC in consideration of the 1988 license amendment application to allow operations at Christensen Ranch. COGEMA has developed SOPs which provide instructions for spill response. The following spill scenarios and associated engineering and administrative controls apply to operations at the Irigaray and Christensen Ranch facilities.

1. A spill of barren or pregnant lixiviant as a result of surface pipe failures. Leaks would be detected by a loss of injection pressure, direct observation of mine site personnel, or an imbalance in injection/recovery fluids. SOPs provide general instructions for detecting and responding to a spill in the well field. Spillage of leach solution which might result from accidental line ruptures or accidental spills should not degrade the surface soil. Any area affected by such an event would be readily identifiable and decontaminated. In the case that a line rupture or accidental spill does occur which causes the release of a significant amount of pregnant leach solution, dikes, ditches, or other small impoundments would be built by mine site personnel to keep the affected areas as small as possible. Clean-up of the spill consists of pumping the fluids with portable equipment back into the process area for recycle, to the sump system, directly to the ponds, or into a portable tank.

2. A spill from chemical storage tanks. Spills of this type from tanks within the plant buildings would normally be collected by the building sumps and pumped to an appropriate receiving tank. External tanks are diked or bermed to contain the specific tank's capacity. Isolation of the leak or rupture would be performed by closing accessible isolation valves or turning off pumping systems to minimize the volume of the spill.

3. Waste pond leakage. The ponds are lined with hypalon or CPE and are installed with underliner inspection tubes. Weekly inspections are performed and documented. Leaks in ponds are reported in accordance with the SOPs.

4. Failure of a well casing. Such failures would usually occur during initial operation of a newly completed well due to improper completion. All wells undergo mechanical integrity testing following completion and are re-tested every five years of operation. Close monitoring of injection pressure and flow during initial operation would allow early detection of a leak. During normal operations, injection well pressures and flows are monitored and recorded at the manifolds located in the module buildings.

5. Transportation accidents. NUREG 0481 discusses the likelihood of a transportation accident involving shipments of yellowcake. Standard Operating Procedure E-11, "Transportation Accidents Involving Radioactive LSA Material" provides the COGEMA emergency action plan for responding to such an accident. E-11 provides instructions for proper packaging, documentation, driver emergency and accident response procedures and cleanup and recovery actions.

6. Failure of concrete foundation and subsequent tank spill. This is an unlikely occurrence but one which did occur at the Irigaray site in 1994. Moisture buildup underneath the building edge foundation weakened the underlying soils which eventually lost their load bearing capacity. A yellowcake thickener tank leg then punctured the concrete and fell over causing the contents to spill inside and outside of the building. This type of incident will be rectified in the future by re-alignment of the surface drainage around both plant sites, Irigaray and Christensen Ranch.

## 5.7.2 EXTERNAL RADIATION EXPOSURE MONITORING PROGRAM

### 5.7.2.1 Gamma Survey

Program Description

External gamma radiation surveys have been performed routinely on a monthly basis at the Irigaray and Christensen Ranch facilities. Surveys were performed at potential gamma sources such as tanks and filters. During the years of 1987 through 1993, COGEMA maintained an administrative action level of 1.0 mR/hr for gamma surveys. Since the establishment of the new 10 CFR 20, COGEMA has used an administrative action level of 2.0 mR/hr. When the action level was exceeded at any survey location, the survey frequency for areas exceeding the action level was increased to weekly. In any cases of unusual gamma increases, investigations were conducted and records

were maintained of each investigation and the corrective action taken. If the results of a gamma survey identified areas where gamma radiation was in excess of levels that delineate a "radiation area", access to the area was restricted and the area was posted as required in 10 CFR §20.1902 (a).

External gamma surveys were performed with survey equipment which meets the following minimum specifications:

1. Range - Lowest range not to exceed 0.1 milliRoentgens per hour ($\mu$R/hr) full-scale with the highest range to read at least 5 milliRoentgens per hour (mR/hr) full scale;

2. Battery operated and portable;

Examples of satisfactory instrumentation which meets these requirements are the Eberline Instruments Corporation Model E-120 with a HP-270 probe or equivalent. Gamma survey instruments were calibrated every six months and were operated in accordance with the manufacturer's recommendations. Instrument checks were performed each day that an instrument was used.

Historical Program Results

Table 5.1 summarizes the results of external gamma surveys performed since the time of the last license renewal in 1987. The table provides the annual average values for monthly surveys performed at the Irigaray and Christensen Ranch facilities.

The historical data indicates that the average exposure rates have been relatively constant since 1987 with the exception of elevated readings in 1989 at Christensen Ranch during startup operations. Engineering controls instituted at Christensen Ranch since startup have resulted in reduced exposure rates. The data does not show any upwards trend over time. Additional details concerning those periods for which higher values were observed can be found in the semi-annual reports submitted to NRC.

COGEMA has attempted to correlate the gamma exposure rate survey data with the gamma exposure data contained in Section 5.7.2.2. No correlation is evident.

Proposed Gamma Survey Program

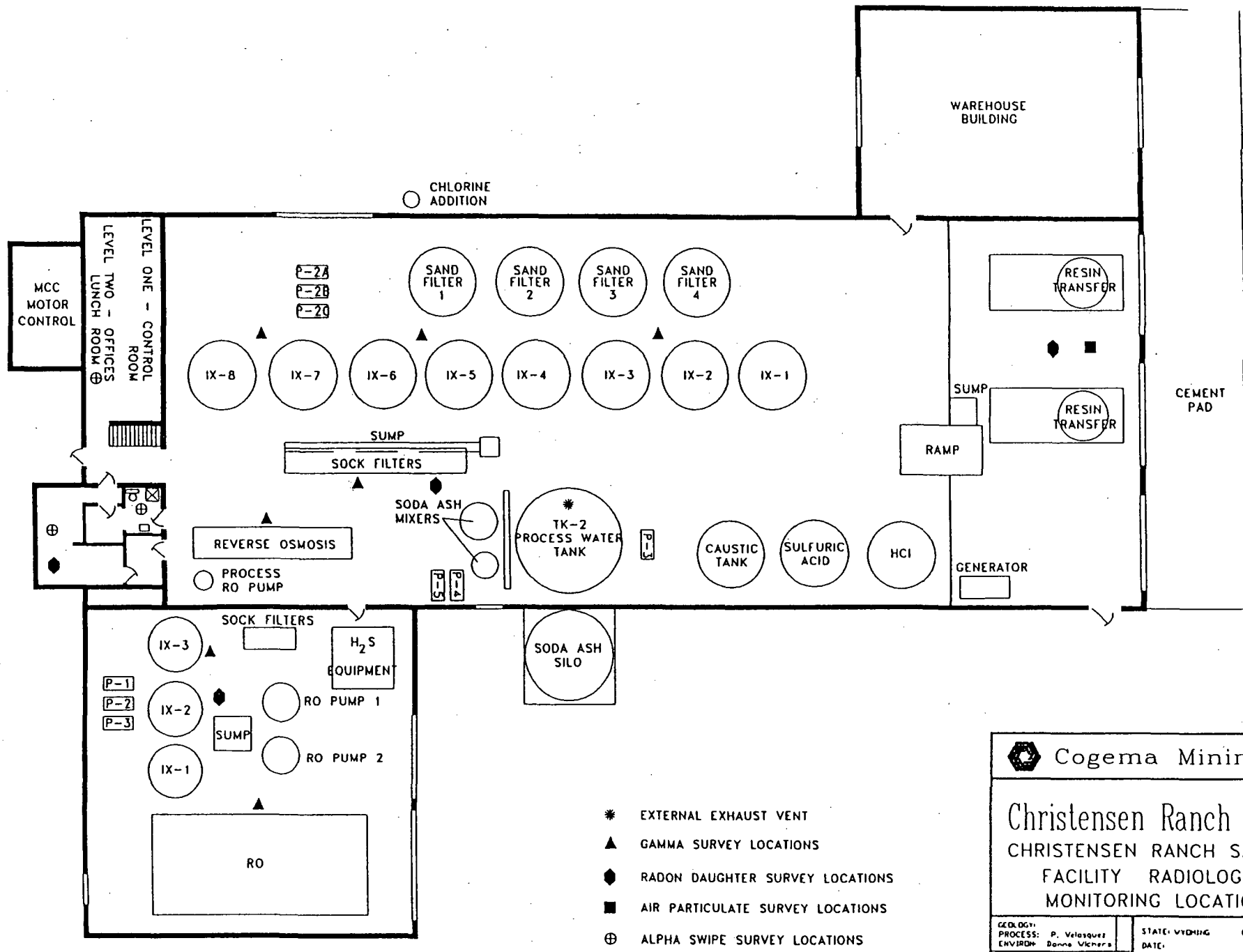
COGEMA proposes to institute the same gamma exposure monitoring program at Irigaray and Christensen Ranch that has been performed to date with the following changes.

- Based upon operating experience, COGEMA proposes to perform gamma exposure rate surveys at the locations shown in Figure 5.2 and Figure 5.3. COGEMA believes that these locations will provide more accurate

## TABLE 5.1
## EXTERNAL GAMMA RADIATION SURVEY RESULTS

| GAMMA MONITORING PERIOD | AVERAGE ANNUAL EXPOSURE RATE (mRem/hr) |
|---|---|
| Third and Fourth Quarter, 1987 - Irigaray | <0.4 |
| Calendar Year 1988 - Irigaray | <0.9 |
| Calendar Year 1989 - Irigaray | <0.5 |
| Calendar Year 1989 - Christensen Ranch | 4.0[1] |
| Calendar Year 1990 - Irigaray | <1.2 |
| Calendar Year 1990 - Christensen Ranch | <0.2 |
| Calendar Year 1991 - Irigaray | <0.2 |
| Calendar Year 1991 - Christensen Ranch | <0.7 |
| Calendar Year 1992 - Irigaray | <0.4 |
| Calendar Year 1992 - Christensen Ranch | <0.9 |
| Calendar Year 1993 - Irigaray | <1.0 |
| Calendar Year 1993 - Christensen Ranch | <0.8 |
| Calendar Year 1994 - Irigaray (through November 1994) | 1.2 |
| Calendar Year 1994 - Christensen Ranch (through November 1994) | <0.9 |

Notes: [1] Christensen Ranch facility began operations in 1989

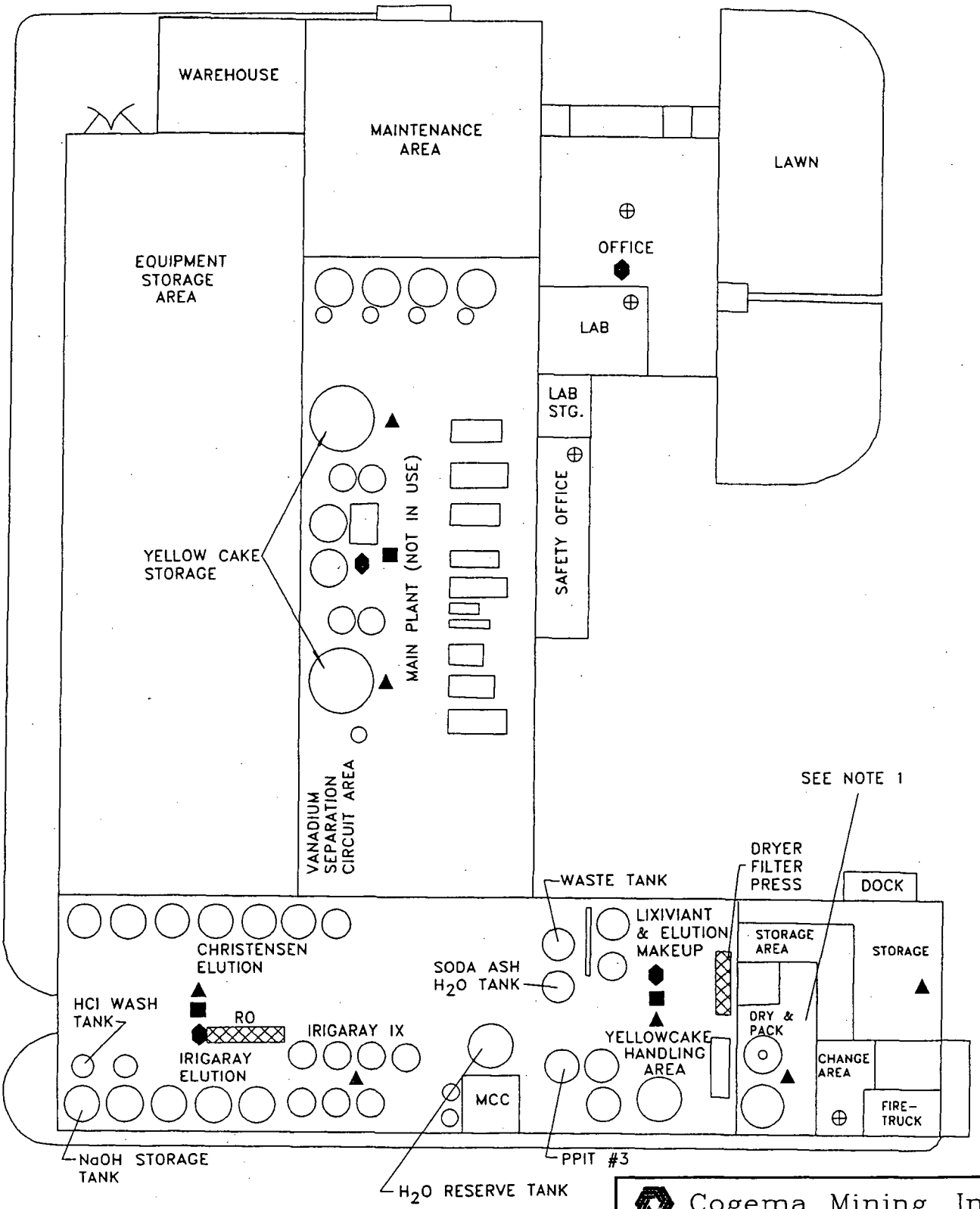



Cogema Mining, Inc.

Christensen Ranch Project

CHRISTENSEN RANCH SATELLITE FACILITY RADIOLOGICAL MONITORING LOCATIONS

| | | |
|---|---|---|
| GEOLOGY: PROCESS: P. Velasquez ENVIRON: Donna Vichera | STATE: WYOMING | COUNTY: JOHNSON |
| SURVEY: | DATE: SCALE: NONE | REVISED: Sept. 1995 |
| DATA PROC: Penny Hague | MAP ID | FIGURE 5.2 |




▲ GAMMA SURVEY LOCATIONS

⬢ RADON DAUGHTER SURVEY LOCATIONS

■ AIR PARTICULATE SURVEY LOCATIONS

⊕ ALPHA SWIPE SURVEY LOCATIONS

⬢ ▲ WELLFIELD AND RESTORATION BUILDINGS (3)
– NOT SHOWN –

NOTE 1: DRYER AREA AIR MONITORING LOCATIONS ARE PROVIDED ON FIGURE 5.4.

Cogema Mining, Inc.

# Irigaray Project

IRIGARAY RECOVERY FACILITY
RADIOLOGICAL MONITORING
LOCATIONS

| | |
|---|---|
| GEOLOGY: | STATE: WYOMING COUNTY: JOHNSON |
| ENVIRON: D. Wichers | DATE: |
| SURVEY: | SCALE: none REVISED: |
| DATA PROC: P. Hague | MAP ID: FIGURE 5.3 |

monitoring of plant radiological conditions than those currently specified.

- The consistency and extent of the survey data available since 1987 indicates that the frequency of surveys can be changed to quarterly for routine surveys and monthly for areas over the 2.0 mRem/hr administrative limit without a reduction in radiological safety. COGEMA believes that this survey frequency schedule is frequent enough to detect changes in conditions. Additionally, these frequencies are more stringent than the schedule recommended in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills". Changes which could affect gamma exposure radiological conditions would be reviewed by the Safety and Environmental Review Panel (SERP) under the proposed Performance Based License. The SERP would recommend any additional monitoring requirements.

Gamma exposure rate surveys will be performed in accordance with the instructions currently contained in Standard Operating Procedure HP-2, "Gamma Exposure Rate Survey". Gamma survey instruments will be checked each day of use in accordance with the instructions currently contained in Standard Operating Procedure HP-14, "Instrument Performance Checks".

### 5.7.2.2 Personnel Dosimetry

Program Description

Since 1987, all employees who were assigned full-time to the Irigaray and Christensen Ranch facilities were issued Thermoluminescent Dosimeters (TLD) for determination of external gamma exposure. TLDs have been provided by TMA Eberline which is accredited by NVLAP of the US Department of Commerce as required in 10 CFR § 20.1501. The TLDs were exchanged and read on a quarterly basis.

Historical Program Results

Table 5.2 contains a summary of the average and maximum annual exposure for all personnel at the Irigaray and Christensen Ranch facilities since 1987. As can be seen in Table 5.2, the average annual exposures at Irigaray and Christensen Ranch are well below 1% of the regulatory limits. The maximum annual individual exposures are well below 10% of the regulatory limit and indicate that exposures at Irigaray and Christensen Ranch are maintained ALARA.

Proposed Personnel Dosimetry Program

10 CFR §20.1502 (a)(1) requires exposure monitoring for "Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits

## TABLE 5.2
## EXTERNAL RADIATION EXPOSURE MONITORING RESULTS

| EXPOSURE MONITORING PERIOD | AVERAGE ANNUAL EXPOSURE (mRem/yr)[3] | MAXIMUM INDIVIDUAL ANNUAL EXPOSURE[1,2] (mRem/yr)[3] |
|---|---|---|
| Third and Fourth Quarter, 1987 | 2.2 | 119 |
| Calendar Year 1988 | 32.8 | 48 |
| Calendar Year 1989 | 18.4 | 38 |
| Calendar Year 1990 | 2.3 | 22 |
| Calendar Year 1991 | 15.3 | 66 |
| Calendar Year 1992 | 32.2 | 245 |
| Calendar Year 1993 | 24.8 | 221 |
| Calendar Year 1994 | 43.5 | 243 |

Notes:

1 Maximum individual exposure values have been corrected to reflect actual values; some higher reported exposures were not recorded following investigation.

2 Annual External Exposure Limit (10 CFR § 20.1201) = 5 rems or 5,000 mRems

3 All data based upon results from Eberline Instrument Corporation; LLD = 10 mRems

in §20.1201 (a)". Ten percent of the dose limit would correspond to a Deep Dose Equivalent (DDE) of 0.500 rem. Maximum individual annual exposures at the Irigaray and Christensen Ranch facilities since 1987 have been well below 10 percent of the limit. COGEMA believes that it is not likely that any employee will exceed 10 percent of the regulatory limit. Although monitoring of external exposure may not be required in accordance with §20.1201(a), COGEMA proposes to continue to issue TLDs to process employees and exchange them on a quarterly basis. COGEMA proposes to discontinue TLD issuance to employees in other work categories.

Results from TLD monitoring will be used to determine individual Deep Dose Equivalent (DDE) for use in determining Total Effective Dose Equivalent (TEDE) in accordance with the instructions currently contained in Standard Operating Procedure HP-5, "Internal and External Occupational Dose Calculations". Process employees will be issued personnel TLDs in accordance with the instructions currently contained in Standard Operating Procedure HP-9, "Personnel TLD Issue".

## 5.7.3 IN-PLANT AIRBORNE RADIATION MONITORING PROGRAM

### 5.7.3.1 In-Plant Airborne Uranium Particulate Monitoring

Program Description

Airborne particulate levels at solution mines which ship slurry yellowcake product are normally very low since the product is wet. At the Christensen Ranch facility, uranium elution, precipitation and slurry activities are absent since these functions are performed at the Irigaray facility. The Irigaray facility shipped slurry yellowcake until December, 1994 when the propane-fired multi-hearth dryer was started.

Monitoring for airborne uranium was performed routinely at Irigaray and Christensen Ranch through the use of area sampling and breathing zone sampling. The monitoring programs are described below.

Area Sampling

Area samples were collected monthly at the specified sample locations. Samples were collected using a glass fiber filter and a regulated air sampler such as an Eberline RAS-1 or equivalent. Sample volume was adequate to achieve the lower limits of detection (LLD) for uranium in air. Samplers were calibrated every six months using a digital mass flowmeter.

Measurement of airborne uranium was performed by gross alpha counting of the air filters using an alpha scaler such as a Ludlum Model 2000 or equivalent. The Maximum Permissible Concentration (MPC) value for natural uranium of 1 E-10 $\mu$Ci/ml from appendix B to 10 CFR §§ 20.1 - 20.601 was applied to the gross alpha counting results. After implementation of the new 10 CFR 20 on January 1, 1994, the Derived Air Concentration (DAC) for soluble (D classification) natural uranium of 5 E-10 $\mu$Ci/ml from appendix B to 10 CFR §§20.1001 - 20.2401 was used. This is a conservative method because the gross alpha results include Uranium-238 and several of its daughters (notably Ra-226 and Th-230) which are alpha emitters. An action level of 25% of the MPC (DAC since 1994) for soluble natural uranium was established at the Irigaray and Christensen Ranch facilities. If an airborne uranium sample exceeded 25% of the MPC (DAC), an investigation was performed and sampling frequency was increased to weekly. The investigation and any corrective action taken was documented.

In addition to the routine airborne uranium sampling, sampling was performed at the Irigaray facility during the operation of the yellowcake dryer and drum packaging system after startup in November, 1994. Continuous sampling in the dry-pack area was performed when the dryer was in operation. Samples were taken from permanently-mounted air sampling inlets connected by a central piping system to a

vacuum pump. The air filters were collected weekly, as a minimum, for analysis. Results were used to determine employee time weighted exposures (TWE).

Breathing Zone Sampling

Breathing zone sampling was performed to determine individual exposure to airborne uranium during certain operations. Sampling was performed with an MSA pump or equivalent. The air filters were counted and compared to the MPC (DAC) using the same method described for area sampling. Air samplers were calibrated at least every six months.

Historical Program Results

Table 5.3 provides the results of monitoring for airborne uranium from the period of 1987 through 1994. Average and maximum airborne gross alpha activity for this period shows a general decline in concentration indicating that engineering controls are effective. All activity levels are well below 25 % of the MPC or DAC.

Proposed In-Plant Airborne Uranium Monitoring Program

COGEMA proposes to institute the same airborne uranium monitoring program at Irigaray and Christensen Ranch that has been performed to date with the following changes.

- Based upon operating experience, COGEMA proposes to perform air sampling at the locations shown in Figure 5.2, Figure 5.3 and Figure 5.4 for the dry-pack area. COGEMA believes that these locations will provide more accurate monitoring of plant radiological conditions than those currently specified.

Airborne sampling will be performed on a monthly basis in accordance with the instructions currently contained in Standard Operating Procedures HP-6, "Airborne Uranium Survey", HP-18, "Use of Breathing Zone Air Samplers" and HP-26, "Airborne Uranium Sampling/Exposure In The Dry-Pack Area." These Standard Operating Procedures implement the guidance contained in USNRC Regulatory Guide 8.25, "Air Sampling in the Workplace." HP-26 requires continuous sampling when the dryer is in operation. Sample frequency will return to monthly grab samples if the dryer is not in operation and final samples taken outside the furnace/drum loading rooms are less than 10% of the DAC for natural uranium.

Sampler calibration will be performed in accordance with the instructions currently contained in Standard Operating Procedure HP-13, "Calibration of Air Sampling Units With 47 mm Sample Filter Heads" and HP-15, "Calibration of Breathing Zone Air Sampling Pumps".

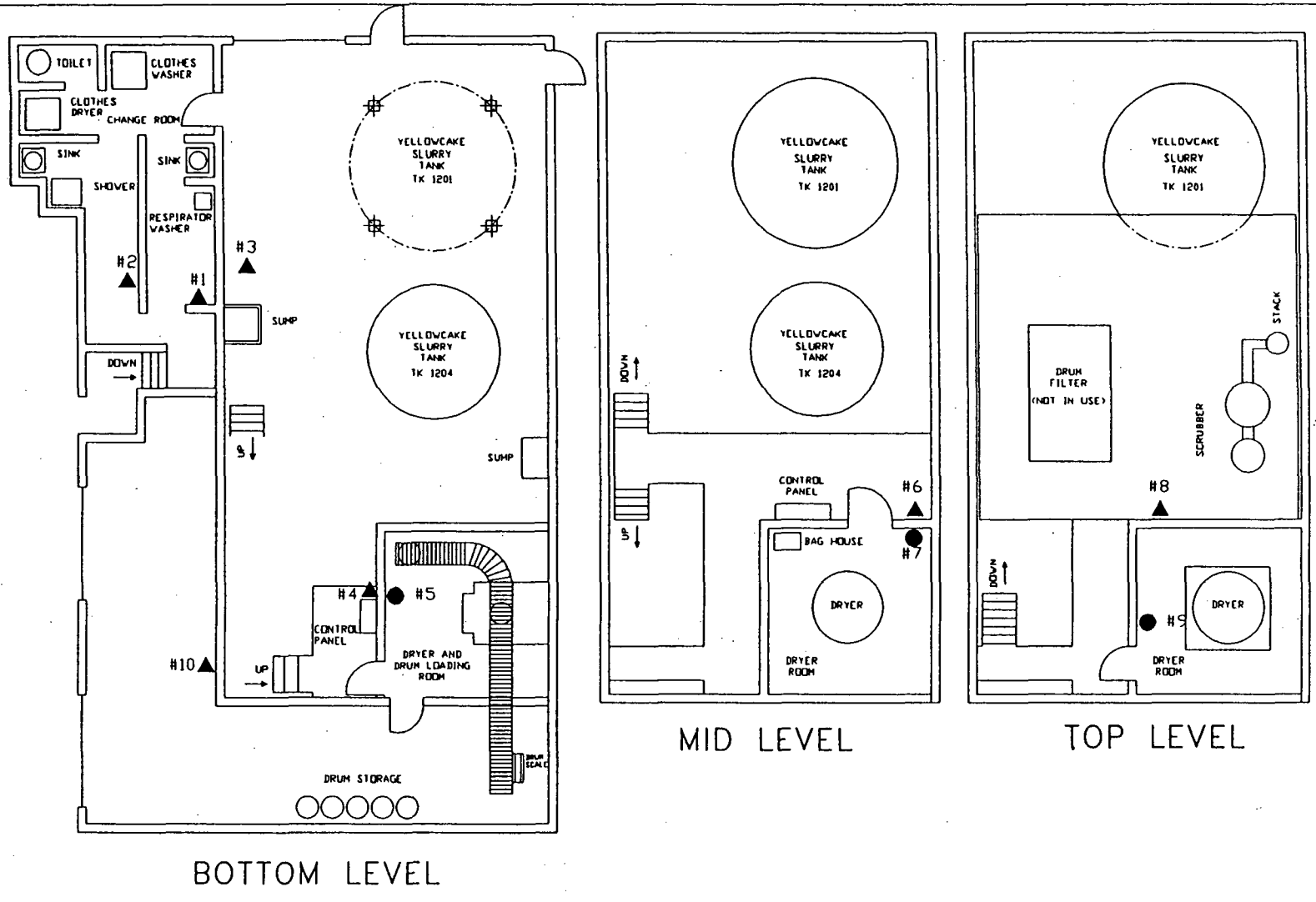
## TABLE 5.3
## INPLANT AIRBORNE URANIUM MONITORING RESULTS

| AIRBORNE URANIUM MONITORING PERIOD | AVERAGE AIRBORNE ACTIVITY μCi/ml gross α (% MPC/% DAC)[1,2] | MAXIMUM AIRBORNE ACTIVITY μCi/ml gross α (% MPC/%DAC)[1,2] |
|---|---|---|
| Third and Fourth Quarter, 1987 - Irigaray | 9.58 E-13 (0.9% MPC) | 6.35 E-12 (6.35% MPC) |
| Calendar Year 1988 - Irigaray | 9.11 E-13 (0.9% MPC) | 1.03 E-11 (10.3% MPC) |
| Calendar Year 1989 - Irigaray | 1.11 E-12 (1.1% MPC) | 2.24 E-11 (22.4% MPC) |
| Calendar Year 1989 - Christensen Ranch | 6.23 E-13 (0.62% MPC) | 1.81 E-12 (1.81% MPC) |
| Calendar Year 1990 - Irigaray | 1.5 E-12 (1.5% MPC) | 8.0 E-12 (8.0% MPC) |
| Calendar Year 1990 - Christensen Ranch | 3.0 E-13 (0.3% MPC) | 8.0 E-13 (0.8% MPC) |
| Calendar Year 1991 - Irigaray | 6.12 E-13 (0.6% MPC) | 8.19 E-12 (8.2% MPC) |
| Calendar Year 1991 - Christensen Ranch | 2.54 E-13 (0.3% MPC) | 6.39 E-13 (0.64% MPC) |
| Calendar Year 1992 - Irigaray | 7.10 E-13 (0.7% MPC) | 5.86 E-12 (5.9% MPC) |
| Calendar Year 1992 - Christensen Ranch | 2.47 E-13 (0.2% MPC) | 4.79 E-13 (0.5% MPC) |
| Calendar Year 1993 - Irigaray | 4.99 E-13 (0.5% MPC) | 1.81 E-12 (1.8% MPC) |
| Calendar Year 1993 - Christensen Ranch | 2.37 E-13 (0.2% MPC) | 6.47 E-13 (0.6% MPC) |
| Calendar Year 1994 - Irigaray | 5.66 E-13 (0.1% DAC) | 6.77 E-12 (1.4% DAC) |
| Calendar Year 1994 - Christensen Ranch | 3.69 E-13 (0.07% DAC) | 1.18 E-12 0.2% DAC) |

Notes:

1 Samples prior to January 1, 1994 compared to MPC where MPC=1 E-10 μCi/ml (10 CFR §§ 20.1 - 20.601 App B) .

2 Samples after January 1, 1994 compared to the DAC where DAC=5 E-10 μCi/ml (10 CFR §§ 20.1001-2401 App B)




COGEMA Mining Inc.

# Irigaray Project

DRY-PACK LEVEL
AIR SAMPLE LOCATIONS

| | | |
|---|---|---|
| GEOLOGY: A. B. Berglund, C. Van Holland | STATE: WYOMING | COUNTY: JOHNSON |
| ENVIRON: B. Vichers | DATE: 6-JUN-94 | |
| SURVEY: R. Shook | SCALE: FIT | REVISED: Sept. 13, 199 |
| DATA PROC: Penny Hagar, R. E. Koehn | MAP ID | FIGURE 5.4 |

### 5.7.3.2 In-Plant Radon Daughter Surveys

Program Description

Since 1987, Radon daughter surveys have been conducted in the operating areas of the Irigaray and Christensen Ranch (since 1989) facilities on a monthly basis at the specified locations. Samples were collected with a low volume air pump and then analyzed with an alpha scaler using the Modified Kusnetz method described in ANSI-N13.8-1973. Air samplers were calibrated at least every six months.

Results of radon daughter sampling are expressed in Working Levels (WL) where one WL is defined as any combination of short-lived Rn-222 daughters in one liter of air, without regard to equilibrium, that emit 1.3 E5 MeV of alpha energy. The MPC limit from appendix B to 10 CFR §§ 20.1 - 20.601 as well as the current DAC limit from appendix B to 10 CFR §§ 20.1001 - 20.2402 for Rn-222 with daughters present is 0.33 WL. COGEMA has established an action level of 25% of the DAC or 0.08 WL. Radon daughter results in excess of the action level resulted in an investigation of the cause and an increase in the sampling frequency to weekly until the radon daughter levels did not exceed the action level.

Historical Program Results

Table 5.4 provides the results of monitoring for radon daughters from the period of 1987 through 1994. The annual average and maximum values are presented. The data shows that the average radon daughter activity concentration at Irigaray and Christensen Ranch was generally less than 5% of the regulatory limit.

Proposed In-Plant Radon Daughter Monitoring Program

COGEMA proposes to institute the same radon daughter monitoring program at Irigaray and Christensen Ranch that has been performed to date with the following changes.

- Based upon operating experience, COGEMA proposes to perform radon daughter sampling at the locations shown in Figure 5.2 and Figure 5.3. COGEMA believes that these locations will provide more accurate monitoring of plant radiological conditions than those currently specified.

Routine radon daughter monitoring will be performed on a monthly basis in accordance with the instructions currently contained in Standard Operating Procedure HP-7, "Radon Daughter Survey." Air sampler calibration will be performed in accordance with the instructions currently contained in Standard Operating Procedure HP-15, "Calibration of Air Sampler - MSA Model S or Equivalent".

## TABLE 5.4
## INPLANT RADON DAUGHTER MONITORING RESULTS

| RADON DAUGHTER MONITORING PERIOD | AVERAGE RADON DAUGHTER ACTIVITY in WL (% MPC/% DAC)[1,2] | MAXIMUM RADON DAUGHTER ACTIVITY in WL (% MPC/%DAC)[1,2] |
|---|---|---|
| Third and Fourth Quarter, 1987 | 0.005 (1.5% MPC) | 0.03 (9.1% MPC) |
| Calendar Year 1988 | 0.018 (5.4% MPC) | 0.461 (140% MPC) |
| Calendar Year 1989 - Irigaray | 0.014 (4.2% MPC) | 0.403 (122% MPC) |
| Calendar Year 1989 - Christensen Ranch | 0.013 (3.9% MPC) | 0.102 (30.9% MPC) |
| Calendar Year 1990 - Irigaray | 0.014 (4.3% MPC) | .0491 (14.9% MPC) |
| Calendar Year 1990 - Christensen Ranch | 0.0043 (1.3% MPC) | 0.0456 (13.8% MPC) |
| Calendar Year 1991 - Irigaray | 0.0079 (2.4% MPC) | 0.0447 (13.5% MPC) |
| Calendar Year 1991 - Christensen Ranch | 0.0057 (1.7% MPC) | 0.0366 (11.1% MPC) |
| Calendar Year 1992 - Irigaray | 0.0099 (3.0% MPC) | 0.0775 (23.5% MPC) |
| Calendar Year 1992 - Christensen Ranch | 0.0084 (2.5% MPC) | 0.0807 (24.5% MPC) |
| Calendar Year 1993 - Irigaray | 0.012 (3.6% MPC) | 0.3396 (103% MPC) |
| Calendar Year 1993 - Christensen Ranch | 0.0096 (2.9% MPC) | 0.0618 (18.7% MPC) |
| Calendar Year 1994 - Irigaray | 0.015 (4.8% DAC) | 0.042 (12.7% DAC) |
| Calendar Year 1994 - Christensen Ranch | 0.007 (2.1% DAC) | 0.072 (21.8% DAC) |

Notes:
1 Samples prior to January 1, 1994 compared to MPC where MPC=0.33 WL (10 CFR §§ 20.1 - 20.601 App B) .
2 Samples after January 1, 1994 compared to the DAC where DAC= 0.33 WL (10 CFR §§ 20.1001-2401 App B)

## 5.7.4 EXPOSURE CALCULATIONS

Employee internal exposure to airborne radioactive materials has been determined at the Irigaray facility since the last license renewal in 1987. Internal exposures at the Christensen Ranch facility began at startup in 1989. Since January 1, 1994 COGEMA has determined internal exposures based upon the requirements of 10 CFR § 20.1204. Prior to January 1, 1994, internal exposure was calculated using the MPC-Hour method based upon 10 CFR § 20.103. Following is a discussion of the exposure calculation methods and results.

### 5.7.4.1 Natural Uranium Exposure

Prior to 1994, exposure calculations for airborne natural uranium were carried out using the MPC-hour method from USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills," Section 2. The number of MPC-hours was calculated using the following equation:

$$I_u = \sum_{i=1}^{n} \frac{Xi * ti}{MPC * PF}$$

where:

| | | |
|---|---|---|
| $I_u$ | = | uranium intake, MPC-hours |
| $t_i$ | = | time that the worker is exposed to concentrations $X_i$ (hr) |
| $X_i$ | = | average concentration of uranium in the air near the worker's breathing zone, $\mu$Ci/ml |
| MPC | = | the concentration value for the radioactive material from appendix B of Part 10 CFR §§20.1 - 20.601, $\mu$Ci/ml |
| PF | = | the respirator protection factor, if applicable |
| n | = | the number of exposure periods during the week or quarter |

The MPC-hours for uranium were calculated on Time Weighted Exposure (TWE) forms and/or RWP Air Sample - Intake Calculation forms. The MPC-hours were totaled and entered onto each employee's Occupational Exposure Record. The regulatory limits were 2,000 MPC-hours per year.

Following implementation of the new 10 CFR 20 on January 1, 1994, internal exposure to airborne uranium has been calculated using the DAC-hours formula:

$$I_u = \sum_{i=1}^{n} \frac{Xi * ti}{DAC * PF}$$

where:

| | | |
|---|---|---|
| $I_u$ | = | uranium intake, DAC-hours |
| $t_i$ | = | time that the worker is exposed to concentrations $X_i$ (hr) |
| $X_i$ | = | average concentration of uranium in the air near the worker's breathing zone, $\mu$Ci/ml |
| DAC | = | the concentration value for the radioactive material from appendix B of Part 10 CFR §§20.1001 - 20.2401, $\mu$Ci/ml |
| PF | = | the respirator protection factor, if applicable |

The DAC-hours for uranium were calculated on Time Weighted Exposure (TWE) forms and/or RWP Air Sample - Intake Calculation forms. The DAC-hours were totaled and entered onto each employee's Occupational Exposure Record. The regulatory limits were 2,000 DAC-hours per year.

The data required to calculate internal exposure to airborne natural uranium was determined as follows:

Time of Exposure Determination

A semi-annual time study was conducted at the Irigaray and Christensen Ranch facilities to determine worker occupied locations and occupancy times. The time studies were documented and were used for the calculation of employee exposures, when actual recorded times were not available.

Airborne Uranium Activity Determination

Airborne uranium activity was determined from surveys performed as described in

Section 5.7.3.1.

In addition to MPC-hour/DAC-hour calculations, a calculation was performed to determine the intake of soluble uranium in milligrams (mg) using the following formula:

$$\text{uranium (mg)} = \frac{X_i * T_i * 1.77\ E9}{PF}$$

where:

| | | |
|---|---|---|
| $X_i$ | = | average concentration of uranium in the air near the worker's breathing zone, $\mu$Ci/ml |
| $t_i$ | = | time that the worker is exposed to concentrations $X_i$ (hr) |
| 1.77 E9 | = | factor equaling the breathing rate (1.2 E6 ml/hr) divided by the specific activity of natural uranium (6.77 E-4 $\mu$Ci/mg) |
| PF | = | the respirator protection factor, if applicable |

The intake limit was 10 milligrams soluble uranium per week which is more restrictive than the DAC-hours limit due to the chemical toxicity of uranium.

Historical Program Results

Table 5.5 summarizes internal exposure results at Irigaray and Christensen Ranch from airborne uranium. The data shows that internal exposure at Irigaray and Christensen Ranch has been maintained ALARA. The maximum individual internal exposure to airborne uranium during the period from 1987 through 1994 was less than 3% of the allowable regulatory limit.

Proposed Airborne Uranium Exposure Monitoring Program

COGEMA proposes to institute the same internal airborne uranium exposure calculation methods at Irigaray and Christensen Ranch that have been used to date and which are currently contained in Standard Operating Procedure HP-5, "Internal and External Occupational Dose Calculations". Exposures to airborne uranium will be compared to the DAC for the natural uranium solubility classification (D, W or Y) that is appropriate for the material. COGEMA produces a very pure hydrogen peroxide precipitate of uranium ($UO_4 \cdot 2\ H_2O$). However, the solubility classifications for natural uranium in Appendix B of 10 CFR 20.1001 - 20.2401 are based on other uranium products such as $UO_2$, $UF_6$, $U_3O_8$, etc. (see uranium-230). Additionally, in

## TABLE 5.5
## ANNUAL AIRBORNE URANIUM EXPOSURE RESULTS

| AIRBORNE URANIUM EXPOSURE MONITORING PERIOD | MAXIMUM AIRBORNE URANIUM EXPOSURE (MPC-HOURS/DAC-HOURS)[1] |
|---|---|
| Calendar Year 1987 | 4.2 MPC-hours |
| Calendar Year 1988 | 56.1 MPC-hours |
| Calendar Year 1989 | < 5.0 MPC-hours |
| Calendar Year 1990 | 0.51 MPC-hours |
| Calendar Year 1991 | 2.817 MPC-hours |
| Calendar Year 1992 | 0.613 MPC-hours |
| Calendar Year 1993 | 5.33 MPC-hours |
| Calendar Year 1994 | 42.55 DAC-hours[2] |

Notes:
[1] The annual regulatory limit prior to 1994 was 2000 MPC-hours. After January 1, 1994 the limit was 2000 DAC hours.
[2] Dry-Pack operations began at Irigaray in November, 1994, and Class Y DACs were used for the dryer area.

Regulatory Guide 8.22 (Bioassay at Uranium Mills, 1988) the NRC makes a distinction between uranium solubility based strictly upon the temperature that the uranium is dried. Essentially, any material that is not dried or is dried at low temperature (defined as less than 400°C, or 752°F) is considered by NRC as soluble (Class D or W).

Product dried at a temperature greater than 400°C, as in the case of our product, is defined as high-fired or calcined yellowcake and is classified as insoluble $U_3O_8$ (Class Y). Even after drying at 540°C (1000° F), the final product has been analyzed by x-ray diffraction and found to be 79% $UO_4 \cdot 2H_2O$, 15% $UO_3$, and 3% $CaCO_3$.

Because of the uncertainty of what solubility classification and corresponding DAC to use for our dried $UO_4 \cdot 2H_2O$ product, COGEMA, in conjunction with Radiation Safety Engineering, Inc. (RSEI, out of Chandler, Arizona), conducted solubility profile testing of the uranium dusts in the Irigaray process plant during the summer of 1995. Breathing zone samples were obtained from all yellowcake process areas within the

plant and submitted to RSEI for the solubility testing. The dissolution rate of the uranium on the air samples was then determined by RSEI over the next 28 days in a simulated lung solution (simulant of the extracellular airway lining fluid), or Gamble's solution. In summary, the results of the testing showed that airborne uranium in the wet process area (filter press) of the plant was highly soluble, with 97% of the uranium dissolving in a 0.3 day half-time, indicative of 97% Class D and 3% Class W material. The airborne uranium in the dryer drum loading and packaging area (where employees have the most potential for exposure) was also highly soluble, with 97% Class D material, and 3% Class W. Air in the control room outside of the dryer exclosure appeared to be a mixture of natural uranium in outside air (due to negative pressure on the dryer) and our dried product, showing 77% Class D and 23% Class W. Exhaust from the drier stack was slightly more insoluble, with approximately 47% Class D and 53% Class W material. No Class Y material ($U_3O_8$) was observed in any of the samples.

A summary of the solubility testing results is provided in Table 5.6. For all areas associated with the dryer (drum packing room, furnace room and exterior control room), an average solubility classification of 85% Class D and 15% Class W could be conservatively calculated. The filter press, a wet uranium process, is obviously 100% Class D. For the stack effluent to unrestricted areas, the classification is essentially 50% Class D and 50% Class W. Because of these results, COGEMA will use the solubility classification and corresponding ALI and DAC provided in Table 5.7 when calculating employee exposure calculations, in lieu of the values currently provided in 10 CFR 20, Appendix B, Table 1. Additionally, a new effluent concentration is provided for use in lieu of the Appendix B, Table 2 air concentration.

## TABLE 5.6

## RESULTS OF URANIUM SOLUBILITY TESTING
## RADIATION SAFETY ENGINEERING, INC.

| Sample Identification | Uranium Activity (Bq) | Sample Volume (L) | Airborne Concentration ($Bq/m^3$) | Fraction in ICRP Class D | Class W | Class Y |
|---|---|---|---|---|---|---|
| Stack 1 | 5.19 | 393 | 13.21 | 44 | 56 | 0 |
| Stack 2 | 6.19 | 405 | 15.29 | 50 | 50 | 0 |
| Average Stack | 5.69 | 399 | 14.25 | 47 | 53 | 0 |
| Control Room 1 | 0.227 | 88,020 | 0.0026 | 77 | 23 | 0 |
| Control Room 2 | 0.806 | 78,930 | 0.010 | 76 | 24 | 0 |
| Average Control | 0.517 | 83,475 | 0.0064 | 77 | 23 | 0 |
| Drum-Pack Room 1 | 12.35 | 1,269 | 9.73 | 98 | 2 | 0 |
| Drum-Pack Room 2 | 1.47 | 6,675 | 0.220 | 97 | 3 | 0 |
| Average Drum | 6.91 | 3,972 | 4.98 | 97 | 3 | 0 |
| Furnace Room 1 | 6.11 | 3,900 | 1.57 | 72 | 28 | 0 |
| Furnace Room 2 | 21.83 | 1,284 | 17.00 | 91 | 9 | 0 |
| Filter Press 1 | 0.669 | 7,170 | 0.0933 | 94 | 6 | 0 |
| Filter Press 2 | 0.410 | 3,000 | 0.137 | 100 | 0 | 0 |
| Average Filter | 0.540 | 5,085 | 0.115 | 97 | 3 | 0 |

**TABLE 5.7**
**PROPOSED URANIUM SOLUBILITY CLASSIFICATIONS AND CORRESPONDING DAC, ALI AND AIRBORNE EFFLUENT CONCENTRATIONS FOR COGEMA YELLOWCAKE PRODUCT**

| PROCESS PLANT AREA | URANIUM-NATURAL SOLUBILITY CLASSIFICATION | OCCUPATIONAL INHALATION VALUES | | EFFLUENT CONCENTRATIONS |
|---|---|---|---|---|
| | | ALI (μCi) | DAC (μCi/ml) | Air (μCi/ml) |
| All processes prior to the dryer | Class D | 1E+0 | 5E-10 | NA |
| Drum Packaging Room, Furnace Areas, Control Room | 85% Class D<br>15% Class W | 1E+0 | 4.7E-10 | NA |
| Stack Discharge - Environmental Air Monitoring Stations | 50% Class D<br>50% Class W | NA | NA | 1.9E-12 |

5.7.4.2 Radon Daughter Exposure

Prior to January 1, 1994, exposure calculations for airborne radon daughters were carried out using the MPC-hour method from USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills," Section 2. The number of MPC-hours was calculated using the following equation:

$$I_r = \sum_{i=1}^{n} \frac{Wi * ti}{MPC * PF}$$

where:

$I_r$ = radon daughter intake, MPC-hours

$t_i$ = time that the worker is exposed to concentrations $W_i$ (hr)

$W_i$ = average number of working levels in the air near the worker's breathing zone during the time ($t_i$)

MPC = the concentration value for the radon daughters from appendix B of Part 20, (0.33 working levels)

| | | |
|---|---|---|
| PF | = | the respirator protection factor, if applicable |
| n | = | the number of exposure periods during the year |

Following implementation of the new 10 CFR 20 in 1994, internal exposure to radon daughters has been calculated using the DAC-hours formula:

$$I_r = \sum_{i=1}^{n} \frac{Wi * ti}{DAC * PF}$$

where:

| | | |
|---|---|---|
| $I_r$ | = | radon daughters intake, DAC-hours |
| $t_i$ | = | time that the worker is exposed to concentrations $W_i$ (hr) |
| $W_i$ | = | average number of working levels in the air near the worker's breathing zone during the time ($t_i$) |
| DAC | = | the concentration value for the radon daughters from Appendix B of Part 20, (0.33 working levels) |
| PF | = | the respirator protection factor, if applicable |

The data required to calculate exposure to radon daughters was determined as follows:

Time of Exposure Determination

A semi-annual time study was conducted at the Irigaray and Christensen Ranch facilities to determine worker occupied locations and occupancy times. The time studies were documented and were used for the calculation of employee exposures, when actual recorded times were not available.

Radon Daughter Concentration Determination

Radon-222 daughter concentrations were determined from surveys performed as described in Section 5.7.3.2. The DAC-hours for radon daughters were calculated on

Time Weighted Exposure (TWE) forms and/or RWP Air Sample - Intake Calculation forms. The DAC-hours were totaled and entered onto each employee's Occupational Exposure Record. The limits were 2,000 DAC-hours per year.

Historical Program Results

Table 5.8 summarizes the results of time weighted radon daughter exposure results at Irigaray and Christensen Ranch since 1987. The data shows that internal exposure due to radon daughters at Irigaray and Christensen Ranch has been maintained ALARA. The maximum individual internal exposure to radon daughters during the period from 1987 through 1994 was in 1989 when Irigaray was in operation and Christensen Ranch was in startup. The maximum exposure for that year was 120.4 MPC-hours or less than 6% of the allowable regulatory limit.

Proposed Radon Daughter Exposure Monitoring Program

COGEMA proposes to institute the same internal radon daughter exposure calculation methods at Irigaray and Christensen Ranch that have been used to date, currently contained in Standard Operating Procedure HP-5, "Internal and External Occupational Dose Calculations". Exposures to radon daughters will be compared to the DAC for radon daughters from appendix B of 10 CFR §§20.1001 - 20.2401 (0.33 WL).

### 5.7.4.3 Total Effective Dose Equivalent

Table 5.9 contains the results of internal and external exposure monitoring for the years of 1990 through 1993, and the Total Effective Dose Equivalent results for 1994 for Irigaray and Christensen Ranch. As can be seen from the data the average exposure was generally less than 2% of the regulatory limit of 5 Rem.

### 5.7.4.4 Respiratory Protection Program

Respiratory protective equipment has been supplied by COGEMA for activities where engineering controls may not be adequate to maintain acceptable levels of airborne radioactive materials or toxic materials. Use of respiratory equipment at Irigaray and Christensen Ranch has been in accordance with the procedures currently set forth in the following Standard Operating Procedures:

- Standard Operating Procedure HP-20, "Respiratory Protection and Respirator Use Program"
- Standard Operating Procedure HP-22, "Respirator Maintenance".

The respirator program was designed to implement the guidance contained in USNRC Regulatory Guide 8.15, "Acceptable Programs For Respiratory Protection". The respirator program is administered by the Radiation Safety Officer (RSO).

## TABLE 5.8
## ANNUAL RADON DAUGHTER EXPOSURE RESULTS

| RADON DAUGHTER EXPOSURE MONITORING PERIOD | MAXIMUM INDIVIDUAL EXPOSURE (MPC-HOURS/DAC-HOURS)[2] |
|---|---|
| Fourth Quarter, 1987 [1,3] | 7.25 MPC-hours |
| Calendar Year 1988[3] | 90.55 MPC-hours |
| Calendar Year 1989[3,4] | 120.4 MPC-hours |
| Calendar Year 1990[5,6] | 23.8 MPC-hours |
| Calendar Year 1991[7,8] | 0.358 MPC-hours |
| Calendar Year 1992[7,8] | 0.124 MPC-hours |
| Calendar Year 1993[3,6] | 3.92 MPC-hours |
| Calendar Year 1994[3,6] | 6.79 DAC-hours |

Notes:
1. 1987 exposure is for the fourth quarter of the year only.
2. The annual limit prior to 1994 was 2000 MPC-hours. After 1994 the limit was 2000 DAC hours.
3. Irigaray in operation
4. Christensen Ranch startup
5. Irigaray in operation one quarter followed by Irigaray restoration
6. Christensen Ranch in operation
7. Irigaray in restoration
8. Christensen Ranch shutdown

### 5.7.5 BIOASSAY PROGRAM

Program Description

COGEMA has implemented a urinalysis bioassay program at the Irigaray and Christensen Ranch facilities that meets the guidelines contained in USNRC Regulatory Guide 8.22, "Bioassay at Uranium Mills." The primary purpose of the program was to detect uranium intake in employees who were regularly exposed to uranium. The bioassay program consisted of the following elements:

1. Prior to assignment to either facility, all new employees were required to submit a baseline urinalysis sample.

2. During operations, urine samples were collected from process area

## TABLE 5.9
## ANNUAL TOTAL EFFECTIVE DOSE EQUIVALENT RESULTS

| EXPOSURE MONITORING PERIOD | | PLANT & WELLFIELD | MAINTE-NANCE | CONST-RUCTION/ DRILLING | OFFICE/ LAB/ SUPER-VISORY |
|---|---|---|---|---|---|
| Calendar Year 1990 | Max # of Employees | 8 | 2 | 3 | 11 |
| | Ave. Exposure(Rem) | 0.025 | 0.014 | 0.008 | 0.0 |
| | Max Exposure(Rem) | 0.060 | 0.027 | 0.012 | 0.0 |
| Calendar Year 1991 | Max # of Employees | 9 | 2 | 3 | 12 |
| | Ave. Exposure(Rem) | 0.041 | 0.013 | 0.019 | 0.001 |
| | Max Exposure(Rem) | 0.066 | 0.023 | 0.040 | 0.011 |
| Calendar Year 1992 | Max # of Employees | 17 | 2 | 3 | 15 |
| | Ave. Exposure(Rem) | 0.080 | <0.001 | 0.020 | 0.003 |
| | Max Exposure(Rem) | 0.246 | 0.001 | 0.059 | 0.013 |
| Calendar Year 1993 | Max # of Employees | 19 | 2 | 5 | 15 |
| | Ave. Exposure(Rem) | 0.055 | 0.009 | <0.001 | <0.001 |
| | Max Exposure(Rem) | 0.221 | 0.016 | 0.001 | 0.002 |
| Calendar Year 1994 | Max # of Employees | 19 | 2 | 5 | 19 |
| | Ave. Exposure(Rem) | 0.105 | 0.085 | 0.043 | 0.005 |
| | Max Exposure(Rem) | 0.309 | 0.146 | 0.152 | 0.034 |

workers on a monthly frequency and analyzed by an outside analytical laboratory for uranium content. Blank and spiked samples were also submitted to the laboratory with monthly employee samples as part of the Quality Assurance program. The measurement sensitivity for the analytical laboratory was 5 $\mu$g/l.

3. Action levels for urinalysis were established based upon Table 1 in USNRC Regulatory Guide 8.22, "Bioassay at Uranium Mills."

4. Documentation was provided to NRC in semi-annual reports anytime an administrative level of 15 $\mu$g/l uranium for urinalysis was exceeded, or anytime an action level of 30 $\mu$g/l for four consecutive specimens or 130 $\mu$g/l for one specimen was reached or exceeded.

Historical Program Results

Following is a summary of the results of the bioassay program since 1987.

1987

An average of forty employees were monitored monthly at the Irigaray facility beginning with baseline sampling in March, April and May of 1987. One bioassay sample exceeded the detection limit of 5 $\mu$g/l with a result of 8.5 $\mu$g/l. A duplicate of that sample was analyzed at less than 5 $\mu$g/l.

1988

An average of 46 employees were monitored monthly at the Irigaray facility throughout 1988 for a total of 552 urinalysis samples. Four samples exceeded the detection limit of 5 $\mu$g/l. The results of those samples were 5.3 $\mu$g/l, 14.4 $\mu$g/l, 17.5 $\mu$g/l and 1625 $\mu$g/l. Repeat samples were submitted on the three samples which originally indicated 14.4 $\mu$g/l, 17.5 $\mu$g/l and 1625 $\mu$g/l. The results of these repeat samples were all less than 5 $\mu$g/l. In accordance with License Condition #48, the USNRC was notified by letter of the bioassay result in excess of 130 $\mu$g/l. The results of the investigation indicated that the elevated uranium level was due to contamination of the sample container.

1989

An average of 56 employees were monitored monthly at the Irigaray and Christensen Ranch facilities throughout 1989 for a total of 690 urinalysis samples. One sample exceeded the detection limit of 5 $\mu$g/l with a result of 10.1 $\mu$g/l which is well below the action level of 15 $\mu$g/l.

1990

An average of 11 employees were monitored monthly at the Irigaray and Christensen Ranch facilities throughout 1990. No samples exceeded the detection limit of 5 $\mu$g/l.

1991

All employees were monitored monthly at the Irigaray and Christensen Ranch facilities throughout 1991. Two samples exceeded the detection limit of 5 $\mu$g/l with results of 7.6 $\mu$g/l and 67.8 $\mu$g/l. A repeat sample of the sample which originally was 67.8 $\mu$g/l was less than the detection limit of 5 $\mu$g/l.

1992

All employees were monitored monthly at the Irigaray and Christensen Ranch facilities throughout 1992. Two samples exceeded the detection limit of 5 $\mu$g/l with results of 8.1 $\mu$g/l and 11.8 $\mu$g/l. Both samples were below the action level of 15 $\mu$g/l.

1993

All employees were monitored monthly at the Irigaray and Christensen Ranch facilities throughout 1993, along with samples from RWP issuances. No samples exceeded the action level of 15 $\mu$g/l. Only three samples were within the 5 to 15 $\mu$g/l range (6.6, 5.6 and 6.3 $\mu$g/l).

1994

All employees were monitored at the Irigaray and Christensen Ranch facilities in 1994. A total of 403 bioassay samples were submitted for analysis. Of this total, 378 were less than 5 $\mu$g/l. 18 samples were within the 5 to 15 $\mu$g/l range. A total of 7 samples were greater than 15 $\mu$g/l as follows:

- One individual involved in cleaning up the yellowcake spill in August, 1994 had an initial result of 87 $\mu$g/l; a repeat sample was 45.9 $\mu$g/l; the next sample for this individual was less than 5 $\mu$g/l.

- One individual involved in cleaning up the yellowcake spill in August, 1994 had an initial result of 16.9 $\mu$g/l; a repeat sample was 7.6 $\mu$g/l; the next sample for this individual was less than 5 $\mu$g/l.

- Four individuals in November, 1994 had initial results of 20.4 $\mu$g/l, 104.6 $\mu$g/l, 18.2 $\mu$g/l and 15.8 $\mu$g/l. All individuals were dry pack operators during initial operations of the dryer in November. Repeat samples were less than 5 $\mu$g/l.

Bioassay Quality Assurance Program Description and Historical Results

Elements of the Quality Assurance requirements for the Bioassay Program were based upon the guidelines contained in USNRC Regulatory Guide 8.22, "Bioassay in Uranium Mills". These elements included the following:

1. Each batch of samples submitted to the analytical laboratory was accompanied by two blind control samples. The control samples were from persons that had not been occupationally exposed and were spiked to a uranium concentration of 10 to 20 $\mu$g/l and 40 to 60 $\mu$g/l. The results of analysis for these samples were required to be within ± 30% of the spiked value. COGEMA has tracked the results of the blind spike analysis since 1987. All analytical results have fallen within the acceptable range with the exception of results received in September, 1994. The results received for samples submitted on September 13, 1994 were 91.1 and 90.4 $\mu$g/l for samples which were spiked to levels of 20 and 50 $\mu$g/l, respectively. Blind samples of the same spike solution were submitted on September 21, 1994 to determine if an error had been made in the preparation of the spike solutions. The results received from the laboratory of these duplicate spikes were 20.5 and 50.6 $\mu$g/l. The cause of the spike analysis which was not within the ±30% was not determined during the investigation and this problem has not been repeated.

2. The analytical laboratory spikes 10 to 30% of all samples received with known concentrations of uranium and the recovery fraction determined. Results were reported to COGEMA. All results have been within ± 30%.

Proposed Bioassay Program

COGEMA proposes to continue to implement the Bioassay Program described in this section in accordance with the guidance contained in USNRC Regulatory Guide 8.22, "Bioassay in Uranium Mills" and with the instructions currently contained in Standard Operating Procedure HP-4, "Bioassay Program".

## 5.7.6 CONTAMINATION CONTROL PROGRAM

COGEMA's contamination control program at Irigaray and Christensen Ranch consists of the following elements:

Surveys For Surface Contamination

COGEMA performed surveys for surface contamination in operating and clean areas

of the Irigaray and Christensen Ranch facilities in accordance with the guidelines contained in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills". Surveys for removable alpha contamination in clean areas such as lunch rooms, change rooms and offices were conducted weekly.

Surveys For Contamination of Skin and Personal Clothing

Condition 49 of License SUA-1341 requires that all employees who do not shower prior to leaving the restricted area monitor themselves with an alpha survey instrument. All personnel leaving the restricted area were required to perform and document alpha contamination monitoring. In addition, personnel who could come in contact with potentially contaminated solutions outside a restricted area such as in the wellfields were required to monitor themselves prior to leaving that worksite. All personnel received training in the performance of surveys for skin and personal contamination. Personnel were also allowed to conduct contamination monitoring of small, hand-carried items as long as all surfaces could be reached with the instrument probe and the item did not originate in yellowcake areas. All other items were surveyed as described in the next section.

As recommended in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills", COGEMA conducted quarterly unannounced spot checks of personnel to verify the effectiveness of the surveys for personnel contamination. A minimum of 25% of the employees assigned to the mine site were surveyed, concentrating on plant operators and maintenance personnel. The purpose of the surveys was to ensure that employees were adequately surveying and decontaminating themselves prior to exiting the restricted areas.

Surveys of Equipment Prior to Release to an Unrestricted Area

Surveys of all items from the restricted areas with the exception of small. hand-carried items described above were performed by the RSO, radiation safety staff or properly trained employees. The release limits are set by "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct or Source Materials", NRC, September 1984. Surveys were performed with the following equipment:

1. Portable alpha count rate meter, Ludlum Model 3 or equivalent.

2. Portable GM survey meter with a beta/gamma probe with an end window thickness of not more than 7 mg/cm$^2$, Eberline Model E-120 with HP-190 probe or equivalent.

3. Swipes for removable contamination surveys as required.

Historical Program Results

Table 5.10 contains the results of the surface contamination monitoring program at the Irigaray and Christensen Ranch facilities since 1987. The table contains the average and maximum results from the weekly surveys. The quarterly spot checks of personnel performed during the period show that the program is effective.

Proposed Contamination Control Program

COGEMA proposes to implement the same Contamination Control program which is currently in use. The program has proven to be effective at controlling contamination of personnel and clean areas. The program will be implemented in accordance with the instructions currently contained in the following Standard Operating Procedures:

- Survey instruments will be calibrated and checked in accordance with the instructions contained in Standard Operating Procedure HP-14, "Instrument Performance Checks".

- Surveys for removable contamination will be performed in accordance with the instructions contained in Standard Operating Procedure HP-3, "Removable Alpha Surveys - Swipes".

- Surveys for alpha and beta/gamma contamination of items prior to release from restricted areas will be performed in accordance with the instructions contained in Standard Operating Procedure HP-10, "Equipment or Material Release to Unrestricted Areas".

- Surveys for removable alpha contamination will be performed in accordance with the instructions contained in Standard Operating Procedure HP-3, "Removable Alpha Surveys".

- Personnel monitoring will be performed in accordance with the instructions contained in Standard Operating Procedure HP-1, "Alpha Contamination Monitoring for Release From a Restricted Area."

## 5.7.7 MONITORING PROGRAM SUMMARY

Section 5.7 of this renewal application has reviewed the radiological monitoring data produced at Irigaray and Christensen Ranch for the years of 1987 through 1994. Each section discussed the historical results of the data with an emphasis on regulatory compliance and trend analysis to determine whether COGEMA's ALARA goals are being met. Where the data indicated that some adjustments in the monitoring program were indicated, COGEMA noted those changes in the "Proposed Program" portion of each section. In order to aid the reviewer in comparing the

**TABLE 5.10**
**SURFACE CONTAMINATION SURVEY RESULTS**

| SURFACE CONTAMINATION MONITORING PERIOD | AVERAGE CONTAMINATION LEVEL ($\alpha$ DPM/100 $cm^2$)[1] | MAXIMUM CONTAMINATION LEVEL ($\alpha$ DPM/100 $cm^2$)[1] |
|---|---|---|
| Third and Fourth Quarter, 1987 - Irigaray | < 5 | 60 |
| Calendar Year 1988 - Irigaray | <16 | 263 |
| Calendar Year 1989 - Both Sites | 65 | 1550 |
| Calendar Year 1990 - Irigaray | <17 | 102 |
| Calendar Year 1990 - Christensen Ranch | <10 | 25 |
| Calendar Year 1991 - Irigaray | 5.4 | 93 |
| Calendar Year 1991 - Christensen Ranch | 4.7 | 22 |
| Calendar Year 1992 - Irigaray | 6.3 | 82 |
| Calendar Year 1992 - Christensen Ranch | 10.1 | 401 |
| Calendar Year 1993 - Irigaray | 13.5 | 526 |
| Calendar Year 1993 - Christensen Ranch | 13.5 | 154 |
| Calendar Year 1994 - Irigaray (through November 1994) | 10.2 | 308 |
| Calendar Year 1994 - Christensen Ranch (through November 1994) | 5.1 | 35 |

Notes: [1] Regulatory limit is 1000 $\alpha$ DPM/100 $cm^2$ for removable contamination as specified in USNRC Regulatory Guide 8.30.

elements of the current monitoring program with those of the proposed program, Table 5.11 provides a tabular summary of both programs as well as the regulatory guidance provided in USNRC Regulatory Guide 8.30, "Health Physics Surveys In Uranium Mills".

## 5.8 ENVIRONMENTAL MONITORING PROGRAMS

### 5.8.1 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

Program Description and Historical Monitoring Results

The airborne effluent and environmental monitoring programs were designed to monitor the release of airborne radioactive effluents from the Irigaray and Christensen Ranch facilities. To evaluate the effectiveness of the effluent control systems, the results of the monitoring program were compared with the background levels and with regulatory limits.

Restricted Areas

COGEMA has established restricted areas to control radioactive materials. At the Christensen Ranch facility, the plant building was designated as the restricted area. At Irigaray, the restricted area was designated as an area approximately 50 meters in diameter from the yellowcake dryer stack. Additionally, ponds were designated as restricted areas. Temporary restricted areas were established as required for areas which contained radioactive material. Changes to the restricted area are discussed under the proposed airborne effluent monitoring program.

Radon

The radon gas effluent released to the environment was monitored at five locations at the Irigaray facility (IR-1, IR-3, IR-4, IR-5 and IR-6) and at four locations at the Christensen Ranch facility (AS-1, AS-5a, AS-5b and AS-6). Monitoring was performed using Track-Etch radon cups provided by Landauer Corporation. The cups were exchanged on a quarterly basis. Standard Operating Procedure ENV-7, "Environmental Radon Detection" currently provides the instructions for radon gas monitoring. In addition to the manufacturer's Quality Assurance program, COGEMA exposed one duplicate radon Track Etch cup per quarter.

In addition to the environmental monitoring performed at the Irigaray and Christensen Ranch, release of radon from process operations was estimated and reported in the semi-annual reports required by 10 CFR § 40.65 and License SUA-1340 Condition Number 14. These estimates were based upon the predicted radon source term calculation provided in the SUA-1341 renewal document (Irigaray) and the Christensen Ranch license application document. The radon source term, or maximum radon release to the environment, for the Irigaray site was calculated to be 1078 Curies per

## TABLE 5.11
## IRIGARAY\CHRISTENSEN RANCH RADIOLOGICAL MONITORING PROGRAM SUMMARY

| Type of Survey | Type of Area | Current Frequency | Proposed Frequency | Reg. Guide 8.30 Recommended Frequency |
|---|---|---|---|---|
| Airborne Uranium | •Airborne radioactivity areas<br>•Other indoor process areas<br>•Special maintenance involving high airborne concentrations of yellowcake | •Weekly grab samples[1]<br>•Monthly grab samples<br>•Extra breathing zone grab samples | •Weekly grab samples[1]<br>•Monthly grab samples<br>•Extra breathing zone grab samples | •Weekly grab samples<br>•Monthly grab samples<br>•Extra breathing zone grab samples |
| Radon daughters | •Areas that exceed 0.08WL<br>•Areas that exceed 0.03WL<br>•Areas below 0.03WL | •Weekly radon daughter grab samples<br>•Monthly radon daughter grab samples<br>•Monthly radon daughter grab samples | •Weekly radon daughter grab samples<br>•Monthly radon daughter grab samples<br>•Monthly radon daughter grab samples | •Weekly radon daughter grab samples<br>•Monthly radon daughter grab samples<br>•Quarterly radon daughter grab samples |
| External radiation: gamma | •Throughout mill<br>•Radiation areas | •Monthly<br>•Weekly[2] | •Quarterly<br>•Monthly[2] | •Semiannually<br>•Quarterly |
| External radiation: beta | •Where workers are in close contact with yellowcake | •Annually | •Annually | •Survey by operation done once plus whenever procedures change |
| Surface contamination | •Yellowcake areas<br>•Eating rooms, change rooms, control rooms, office | •Daily walkthrough<br>•Weekly | •Daily walkthrough<br>•Weekly | •Daily<br>•Weekly |
| Skin and personal clothing | •Yellowcake workers who shower<br>•Yellowcake workers who do not shower | •Each exit from controlled area[3]<br>•Each exit from controlled area[3] | •Each exit from controlled area[3]<br>•Each exit from controlled area[3] | •Quarterly<br>•Each day before leaving |
| Equipment to be released | •Equipment to be released that may be contaminated | •Detailed survey before release | •Detailed survey before release | •Once before release |
| Packages containing yellowcake | •Packages | •Detailed survey before release | •Detailed survey before release | •Spot check before release |

## TABLE 5.11
## IRIGARAY\CHRISTENSEN RANCH RADIOLOGICAL MONITORING PROGRAM SUMMARY

| Type of Survey | Type of Area | Current Frequency | Proposed Frequency | Reg. Guide 8.30 Recommended Frequency |
|---|---|---|---|---|
| Ventilation | •All areas with airborne radioactivity | •Daily walkthrough | •Daily walkthrough | •Daily |
| Respirators | •Respirator face pieces and hoods | •Before reuse | •Before reuse | •Before reuse |

Notes:

1. Increased sampling frequency based upon administrative action level of 25% of the MPC or DAC; Continuous sampling is performed in the dry-pack area during dryer operation
2. Increased gamma survey frequency performed at administrative action level of 2.0 mR\hr
3. All employees required to survey upon exit; Quarterly spot checks of >25% process staff also conducted

year at a flow rate of 1600 gallons per minute (gpm). The radon source term for the Christensen Ranch facility was calculated to be 808 Curies per year at a flow rate of 2500 gpm. The source term for each facility can then be expressed as 0.056 Curies per month per gpm (Irigaray) and 0.027 Curies per month per gpm (Christensen Ranch). Radon release was then calculated on a monthly basis using the average flow rate.

Table 5.12 contains the results of radon monitoring for the Irigaray facility since 1987. Table 5.13 contains similar data for the Christensen Ranch facility since 1988. Table 5.14 contains annual calculated radon releases from both sites since 1987.

Air Particulate

COGEMA performs high volume air particulate sampling at the environmental monitoring stations on a continuous basis during dryer operations. Filters are changed weekly, then composited for quarterly analysis. Since the dryer began operation in November, 1994, the only available environmental monitoring data for environmental air particulate sampling is for the third and fourth quarter of 1994. The results are shown in Table 5.15.

Soil and Vegetation

Soil and vegetation samples from Irigaray and Christensen Ranch were collected on an annual basis at the nine air quality sampling station locations. Sampling was normally performed in July in accordance with Standard Operating Procedure ENV-8, "Soil and Vegetation". The samples were collected at the five air quality monitoring sites at Irigaray (IR-1, IR-3, IR-4, IR-5 and IR-6) and at the four air quality monitoring sites at Christensen Ranch (AS-1, AS-5a, AS-5b and AS-6) using the following procedures:

- Soil — A minimum of two pounds of soil was collected within a ten square foot section surrounding the sample point. The sample consisted of a composite of five to ten individual locations where the sample was taken from the top two inches of the surface. Soil was analyzed for natural uranium, radium-226, thorium-230 and lead-210. The results of annual soil sampling at the Irigaray and Christensen Ranch facilities is presented in Tables 5.16 and 5.17, respectively.

- Vegetation — A minimum of one pound of vegetation was collected at each site. The materials collected were primarily the seed/flower head and leafy portions of grasses and forbes along with young shoots of shrubs. Vegetation was

## TABLE 5.12
## IRIGARAY ENVIRONMENTAL RADON GAS MONITORING RESULTS

| RADON MONITORING PERIOD | IR-1 Downwind of Restricted Area (Ave pCi/l) | IR-3 Upwind of Restricted Area (Ave pCi/l) | IR-4 North Road (517 Test Site) (Ave pCi/l) | IR-5 Irigaray Ranch (Nearest Resident) (Ave pCi/l) | IR-6 Ridge Road SE (Back-ground) (Ave pCi/l) |
|---|---|---|---|---|---|
| Third & Fourth Quarter, 1987 | 1.4 | 1.6 | 1.5 | 0.6 | 1.0 |
| First & Second Quarter, 1988 | 3.0 | 2.2 | 1.7 | 1.3 | 1.2 |
| Third & Fourth Quarter, 1988 | 3.2 | 1.8 | 1.2 | 0.9 | 0.95 |
| First & Second Quarter, 1989 | 1.95 | 1.55 | 1.0 | 0.85 | 1.0 |
| Third & Fourth Quarter, 1989 | 1.15 | 0.9 | 1.65 | 1.0 | 0.85 |
| First & Second Quarter, 1990 | 0.5 | 0.6 | 0.8 | 0.45 | 0.75 |
| Third & Fourth Quarter, 1990 | 0.95 | 0.9 | 1.4 | 0.4 | 0.8 |
| First & Second Quarter, 1991 | 1.1 | 1.15 | 1.05 | 0.8 | 0.95 |
| Third & Fourth Quarter, 1991 | 0.65 | 1.05 | 0.85 | 0.65 | 0.7 |
| First & Second Quarter, 1992 | 1.2 | 1.4 | 1.15 | 0.5 | 1.05 |
| Third & Fourth Quarter, 1992 | 1.75 | 2.0 | 1.05 | 1.65 | 1.05 |
| First & Second Quarter, 1993 | 0.65 | 1.5 | 1.1 | 1.5 | 1.1 |
| Third & Fourth Quarter, 1993 | 0.85 | 1.2 | 1.35 | 1.1 | 1.25 |
| First & Second Quarter, 1994 | 1.3 | 1.4 | 1.7 | 0.8 | 1.0 |
| Third & Fourth Quarter, 1994 | 0.9 | 1.9 | 1.6 | 1.4 | 1.3 |

## TABLE 5.13
## CHRISTENSEN RANCH ENVIRONMENTAL RADON GAS MONITORING RESULTS

| RADON MONITORING PERIOD | AS-1 Table Mountain (Background) (Ave pCi/l) | AS-5a Upwind of Restricted Area (Ave pCi/l) | AS-5b Downwind of Restricted Area (Ave pCi/l) | AS-6 Christensen Ranch (Nearest Resident) (Ave pCi/l) |
|---|---|---|---|---|
| Third & Fourth Quarter, 1988 | 1.1 | 1.1 | 1.1 | 0.8 |
| First & Second Quarter, 1989 | 1.4 | 1.1 | 0.8 | 0.8 |
| Third & Fourth Quarter, 1989 | 1.55 | 1.65 | 1.05 | 0.6 |
| First & Second Quarter, 1990 | 0.45 | 0.5 | 0.35 | 0.6 |
| Third & Fourth Quarter, 1990 | 0.45 | 0.55 | 0.5 | 0.75 |
| First & Second Quarter, 1991 | 1.15 | 0.9 | 1.2 | 0.95 |
| Third & Fourth Quarter, 1991 | 0.75 | 0.8 | 0.75 | 0.7 |
| First & Second Quarter, 1992 | 1.15 | 0.8 | 1.25 | 1.35 |
| Third & Fourth Quarter, 1992 | 1.45 | 1.5 | 2.2 | 1.3 |
| First & Second Quarter, 1993 | 1.05 | 0.9 | 0.7 | 0.9 |
| Third & Fourth Quarter, 1993 | 1.15 | 1.1 | 1.05 | 1.65 |
| First & Second Quarter, 1994 | 1.3 | 1.25 | 0.75 | 1.0 |
| Third & Fourth Quarter, 1994 | 1.3 | 1.9[1] | 1.4 | 1.5 |

[1] The average for AS-5a does not include the results of the fourth quarter, 1994 monitoring which was 19.3 pCi/l. The Track Etch cup was found on the ground at the monitoring station.

## TABLE 5.14
## ENVIRONMENTAL RADON RELEASE CALCULATIONS

| RADON RELEASE CALCULATION PERIOD | IRIGARAY RADON RELEASE[1] (Curies) | CHRISTENSEN RANCH RADON RELEASE[2] (Curies) |
|---|---|---|
| Third and Fourth Quarter, 1987 | 107.02 | n/a |
| Calendar Year 1988 | 895.10 | n/a |
| Calendar Year 1989 | 472 | 239.6 |
| Calendar Year 1990 | 91.8 | 36.7 |
| Calendar Year 1991 | 127.6 | 197.8 |
| Calendar Year 1992 | 170.5 | 471 |
| Calendar Year 1993 | 204.7 | 353.1 |
| Calendar Year 1994 | 268.9 | 308.9 |

Notes:
[1] Irigaray results based on 0.056 Ci/month/gpm
[2] Christensen Ranch results based on 0.027 Ci/month/gpm

## TABLE 5.15
## IRIGARAY ENVIRONMENTAL AIR PARTICULATE MONITORING RESULTS

| MONITORING PERIOD and CONSTITUENT | IR-1 Downwind of Restricted Area | IR-3 Upwind of Restricted Area | IR-13 Employee House Trailer | IR-5 Irigaray Ranch (Nearest Resident) | IR-6 Ridge Road SE (Back-ground) |
|---|---|---|---|---|---|
| Third & Fourth Quarter, 1994 | | | | | |
| Uranium ($\mu$Ci/ml)[a] | 8.02 E-15 | 5.81 E-15 | 4.99 E-15 | 3.28 E-15 | 3.89 E-15 |
| Thorium 230 ($\mu$Ci/ml)[b] | <1.0 E-16 | <1.0 E-16 | <1.0 E-16 | <1.0 E-16 | <1.0 E-16 |
| Radium 226 ($\mu$Ci/ml)[c] | <1.0 E-16 | <1.0 E-16 | <1.0 E-16 | 2.38 E-16 | <1.0 E-16 |
| Lead 210 ($\mu$Ci/ml)[d] | 1.80 E-14 | 1.87 E-14 | 1.77 E-14 | 2.28 E-14 | 1.90 E-14 |

NOTES:

a Effluent limit per new 10 CFR 20: 9.0 E-14 (Y)

b Effluent limit per new 10 CFR 20: 3.0 E-14 (Y)

c Effluent limit per new 10 CFR 20: 9.0 E-13 (W)

d Effluent limit per new 10 CFR 20: 6.0 E-13 (D)

analyzed for natural uranium, radium-226, thorium-230 and lead-210. The results of annual vegetation sampling at the Irigaray and Christensen Ranch facilities is presented in Tables 5.18 and 5.19, respectively.

Tables 5.16, 5.17, 5.18, and 5.19 are organized by sample location with the annual results in order for ease of trend analysis. A detailed review of the data has indicated no trends for any sample locations.

Direct Radiation

Environmental gamma radiation levels were monitored continuously at the nine air quality monitoring stations (see Figure 5.5) in accordance with the instructions currently contained in Standard Operating Procedure ENV-6, "Environmental Gamma Detection." Gamma radiation was monitored through the use of thermoluminescent dosimeters (TLDs) obtained from Eberline Instrument Corporation. TLDs were exchanged on a quarterly basis. In addition to the Quality Assurance performed by Eberline, COGEMA provided one blind duplicate TLD per quarter. Results of the annual gamma radiation monitoring are shown in Tables 5.20 and 5.21.

# THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

## THAT CAN BE VIEWED AT THE RECORD TITLED:

**"Irigaray and Christensen Ranch Environmental Monitoring Station Locations."**
**Figure 5.5**

## WITHIN THIS PACKAGE... OR BY SEARCHING USING THE DOCUMENT/REPORT NO.

**D-08X**

## TABLE 5.16
## IRIGARAY ANNUAL SOIL SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| IR-1 (Downwind from Restricted Area) | Annual Grab | 1987 | < 0.1 | 1.2 | 3.1 | <0.3 |
| | | 1988 | 3.1 | 2.2 ± 0.2 | 2.7 ± 0.2 | 0.7 ± 0.33 |
| | | 1989 | 2.44 | 1.3 ± 0.1 | < 0.02 | <0.10 |
| | | 1990 | 3.6 | 1.3 ± 0.1 | 1.2 ± 0.6 | < 0.2 |
| | | 1991 | 6.4 | 1.4 ± 0.1 | < 0.04 | 0.9 ± 0.5 |
| | | 1992 | 2.3 | 1.4 ± 0.1 | 1.2 ± 1.2 | 1.1 ± 0.4 |
| | | 1993 | 1.7 | 1.2 ± 0.1 | 0.2 ± 0.1 | 0.5 ± 0.2 |
| | | 1994 | 3.4 | 1.1 ± 0.1 | < 0.02 | 0.2 ± 0.2 |
| IR-3 (Upwind from Restricted Area) | Annual Grab | 1987 | < 0.1 | 1.1 | 6.4 | < 0.3 |
| | | 1988 | 2.4 | 1.9 ± 0.1 | 2.2 ± 0.4 | 0.38 ± 0.3 |
| | | 1989 | 5.92 | 1.4 ± 0.1 | 0.4 ± 0.4 | 1.3 ± 0.2 |
| | | 1990 | 5.0 | 0.9 ± 0.1 | 1.0 ± 0.6 | 2.4 ± 0.2 |
| | | 1991 | 37.46[1] | 0.7 ± 0.1 | < 0.04 | 1.1 ± 0.6 |
| | | 1992 | 1.2 | 1.0 ± 0.1 | 1.6 ± 1.2 | 1.0 ± 0.4 |
| | | 1993 | 1.8 | 0.8 ± 0.1 | 0.2 ± 0.1 | 0.3 ± 0.2 |
| | | 1994 | 2.7 | 0.7 ± 0.1 | < 0.02 | < 0.02 |
| IR-4 (North Road 517 Test Site) | Annual Grab | 1987 | 1.8 | 1.3 | 2.9 | 0.8 |
| | | 1988 | 1.1 | 1.7 ± 1.0 | 1.6 ± 0.2 | 0.90 ± 0.35 |
| | | 1989 | 1.61 | 1.5 ± 0.1 | < 0.02 | 1.0 ± 0.2 |

## TABLE 5.16
## IRIGARAY ANNUAL SOIL SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| IR-4 (North Road, 517 Test Site) | Annual Grab | 1990 | 1.1 | 1.1 ± 0.1 | 0.2 ± 0.2 | 0.3 ± 0.3 |
| | | 1991 | 6.04 | 0.9 ± 0.1 | < 0.04 | 0.5 ± 0.5 |
| | | 1992 | 0.04 | 0.7 ± 0.1 | 0.6 ± 0.6 | 1.6 ± 0.4 |
| | | 1993 | 0.2 | 0.9 ± 0.1 | 0.2 ± 0.1 | 0.7 ± 0.2 |
| | | 1994 | 0.8 | 0.7 ± 0.1 | < 0.02 | 0.2 ± 0.2 |
| IR-5 (Irigaray Ranch, Nearest Resident) | Annual Grab | 1987 | < 0.1 | 1.1 | 3.9 | < 0.3 |
| | | 1988 | 0.88 | 1.1 ± 0.2 | 0.75 ± 0.15 | 0.25 ± 0.12 |
| | | 1989 | 1.22 | 0.9 ± 0.1 | 1.1 ± 0.5 | < 0.10 |
| | | 1990 | 0.7 | 0.7 ± 0.1 | 0.3 ± 0.3 | 0.3 ± 0.3 |
| | | 1991 | 0.36 | 0.4 ± 0.1 | < 0.04 | 0.5 ± 0.5 |
| | | 1992 | 2.4 | 3.7 ± 0.1 | 1.2 ± 1.2 | 0.8 ± 0.4 |
| | | 1993 | 0.6 | 0.7 ± 0.1 | < 0.02 | 0.6 ± 0.2 |
| | | 1994 | 0.6 | 2.0 ± 0.2 | < 0.02 | 0.4 ± 0.4 |
| IR-6 (Ridge Road SE, Background) | Annual Grab | 1987 | 0.8 | 2.2 | 4.2 | 1.3 |
| | | 1988 | 1.5 | 1.9 ± 0.1 | 2.1 ± 0.2 | 0.20 ± 0.12 |
| | | 1989 | 2.06 | 2.2 ± 0.1 | 2.8 ± 0.6 | < 0.10 |
| | | 1990 | 1.1 | 0.9 ± 0.1 | 0.2 ± 0.2 | 0.5 ± 0.3 |
| | | 1991 | 5.92 | 0.6 ± 0.1 | < 0.04 | 1.8 ± 0.6 |
| | | 1992 | 1.5 | 0.9 ± 0.1 | 3.1 ± 2.5 | 1.2 ± 0.4 |
| | | 1993 | 0.7 | 1.0 ± 0.1 | 0.9 ± 0.5 | 0.2 ± 0.2 |
| | | 1994 | 0.8 | 0.7 ± 0.1 | < 0.02 | 0.2 ± 0.2 |

[1]Data is questionable and perceived to be a laboratory error. No verification data is available.

## TABLE 5.17
## CHRISTENSEN RANCH ANNUAL SOIL SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| AS-1 (Background) | Annual Grab | 1988 | 1.14 | 1.8 ± 0.3 | 11.8 ± 1.7 | 0.7 ± 0.3 |
| | | 1989 | 1.41 | 2.2 ± 0.3 | 1.6 ± 1.0 | 1.6 ± 0.4 |
| | | 1990 | 0.6 | 0.9 ± 0.1 | 1.0 ± 0.6 | 2.2 ± 1.1 |
| | | 1991 | 0.48 | 0.6 ± 0.1 | < 0.04 | 1.5 ± 0.6 |
| | | 1992 | 8.9 | 7.1 ± 0.2 | 22.2 ± 4.3[1] | 0.8 ± 0.4 |
| | | 1993 | 0.9 | 3.7 ± 0.1 | 0.1 ± 0.1 | 0.5 ± 0.2 |
| | | 1994 | 0.9 | 1.9 ± 0.2 | < 0.02 | 0.6 ± 0.4 |
| AS-6 (Nearest Residence) | Annual Grab | 1988 | 21.4[1] | 1.8 ± 0.3 | 4.2 ± 1.2 | 2.9 ± 0.4 |
| | | 1989 | 2.30 | 2.1 ± 0.3 | 0.8 ± 1.0 | < 1.0 |
| | | 1990 | 1.1 | 1.3 ± 0.1 | 1.0 ± 0.6 | 0.4 ± 0.3 |
| | | 1991 | 0.6 | 0.9 ± 0.1 | < 0.04 | 0.9 ± 0.6 |
| | | 1992 | 1.9 | 3.6 ± 0.1 | 9.2 ± 2.5 | 0.9 ± 0.4 |
| | | 1993 | 0.7 | 0.8 ± 0.1 | 0.1 ± 0.1 | 0.2 ± 0.2 |
| | | 1994 | 1.2 | 1.0 ± 0.1 | 5.2 ± 4.3 | 0.2 ± 0.2 |
| AS-5A (Upwind) | Annual Grab | 1988 | 0.86 | 2.0 ± 0.3 | 4.1 ± 1.2 | 1.3 ± 0.3 |
| | | 1989 | 2.05 | 2.4 ± 0.3 | 5.2 ± 1.2 | <1.0 |
| | | 1990 | 1.1 | 0.9 ± 0.1 | 1.6 ± 0.6 | 0.2 ± 0.2 |
| | | 1991 | 6.53 | 1.1 ± 0.1 | < 0.04 | 0.5 ± 0.5 |
| | | 1992 | 0.5 | 2.5 ± 0.1 | 3.2 ± 1.4 | 1.1 ± 0.4 |
| | | 1993 | 0.5 | 1.4 ± 0.1 | 0.4 ± 0.2 | 0.7 ± 0.2 |

## TABLE 5.17
## CHRISTENSEN RANCH ANNUAL SOIL SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| AS-5A (Upwind) | Annual Grab | 1994 | 1.4 | 1.6 ± 0.2 | < 0.02 | 0.5 ± 0.5 |
| AS-5B (Downwind) | Annual Grab | 1988 | 0.95 | 1.6 ± 0.3 | 3.7 ± 1.1 | 1.5 ± 0.4 |
| | | 1989 | 1.28 | 1.7 ± 0.2 | 3.6 ± 1.2 | 1.0 ± 0.4 |
| | | 1990 | 0.9 | 1.4 ± 0.1 | 0.1 ± 0.1 | 1.8 ± 1.1 |
| | | 1991 | 9.18 | 0.6 ± 0.1 | < 0.04 | 1.4 ± 0.6 |
| | | 1992 | 0.9 | 3.9 ± 0.1 | 5.1 ± 1.5 | 0.6 ± 0.4 |
| | | 1993 | 0.7 | 1.5 ± 0.1 | 0.7 ± 0.4 | 0.9 ± 0.2 |
| | | 1994 | 0.7 | 2.5 ± 0.2 | < 0.02 | 0.8 ± 0.5 |

[1]Data is questionable and perceived to be a laboratory error. No verification data is available.

## TABLE 5.18
## IRIGARAY ANNUAL VEGETATION SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| IR-1 (Downwind from Restricted Area) | Annual Grab | 1987 | 2.6 E-05 | 3.1 E-05 | 9.8 E-05 | 10.5 E-05 |
| | | 1988 | 3.5 E-04 | 1.3 + 0.1 E-04 | 4.1 + 0.8 E-04 | 1.2 + 0.2 E-04 |
| | | 1989 | 3.6 E-05 | 6.0 ± 0.6E-06 | 1.4 ± 1.4 E-06 | 1.8 ± 0.2 E-05 |
| | | 1990 | 1.7 E-05 | 1.8 ± 0.2E-05 | < 5.9 E-07 | 5.5 ± 0.9 E-05 |
| | | 1991 | 1.68 E-05 | 7.28 ± 1.68E-06 | < 5.6 E-07 | 2.35 ± 0.55 E-05 |
| | | 1992 | 2.57 E-05 | 2.02 ± 0.34 E-05 | < 4.6 E-07 | 6.03 ± 0.10 E-05 |
| | | 1993 | 9.5 E-05 | 44 ± 7.2 E-06 | < 3.9 E-07 | 3.8 ± 1.9 E-05 |
| | | 1994 | 8.7 E-04 | 3.5 ± 2.6 E-05 | < 8.1 E-07 | 3.7 ± 4.7 E-05 |
| IR-3 (Upwind from Restricted Area) | Annual Grab | 1987 | 2.1 E-05 | 3.1 E-05 | 6.3 E-05 | 12.8 E-05 |
| | | 1988 | 1.9 E-04 | 5.1 + 0.7 E-05 | 3.0 + 0.7 E-05 | 1.2 + 0.2 E-04 |
| | | 1989 | 7.8 E-06 | 7.2 ± 0.9 E-06 | 1.2 ± 0.7 E-05 | 2.9 ± 0.4 E-05 |
| | | 1990 | 2.3 E-05 | 8.4 ± 1.0 E-06 | < 5.0 E-07 | 2.7 ± 0.6 E-05 |
| | | 1991 | 1.43 E-05 | 1.99 ± 1.99 E-06 | < 8.0 E-07 | 1.23 ± 0.32 E-05 |
| | | 1992 | 2.89 E-05 | 8.21 ± 2.99 E-06 | < 5.0 E-07 | 3.51 ± 1.05 E-05 |
| | | 1993 | 8.9 E-05 | 22 ± 5.5 E-06 | < 4.0 E-07 | 3.5 ± 1.9 E-05 |
| | | 1994 | 2.1 E-04 | 2.1 ± 9.0 E-06 | < 9.9 E-07 | 1.7 ± 4.9 E-05 |

## TABLE 5.18
## IRIGARAY ANNUAL VEGETATION SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| IR-4 (North Road, 517 Test Site) | Annual Grab | 1987 | 4.4 E -05 | 2.6 E-05 | 12.3 E-05 | 12.1 E-05 |
| | | 1988 | 5.3 E-05 | 5.3 + .08 E-05 | 6.3 + 5.8 E-05 | 7.8 + 0.4 E-04 |
| | | 1989 | < 3.8 E-07 | 1.7 ± 0.4 E-06 | < 3.8 E-07 | < 1.9 E-06 |
| | | 1990 | 5.9 E-05 | 8.3 ± 0.4 E-05 | <7.8 E-07 | 1.4 ± 0.1 E-04 |
| | | 1991 | 2.31 E-05 | 3.65 ± 0.51 E-05 | < 1.3 E-06 | 1.59 ± 0.06 E-04 |
| | | 1992 | 2.88 E-05 | 1.56 ± 0.28 E-05 | < 4.0 E-07 | 7.78 ± 1.52 E-05 |
| | | 1993 | 2.8 E-05 | 23 ± 5.9 E-06 | < 4.4 E-07 | 10 ± 2.5 E-05 |
| | | 1994 | 7.6 E-05 | 4.4 ± 3.9 E-05 | < 1.5 E-06 | 4.6 ± 8.0 E-05 |
| IR-5 (Irigaray Ranch, Nearest Resident) | Annual Grab | 1987 | 2.6 E-05 | 3.6 E-05 | 9.9 E-05 | 16.7 E-05 |
| | | 1988 | 2.3 E-05 | 2.6 + 0.5 E-05 | 2.0 + E-04 | 7.2 + 0.2 E-05 |
| | | 1989 | 8.1 E-06 | 5.5 ± 0.6 E-06 | < 3.0 E-07 | 8.9 ± 0.5 E-05 |
| | | 1990 | 5.1 E-06 | 3.9 ± 1.0 E-06 | < 4.9 E-07 | 1.2 ± 0.3 E-05 |
| | | 1991 | 4.63 E-06 | 6.94 ± 2.31 E-06 | < 7.7 E-07 | 2.16 ± 0.31 E-05 |
| | | 1992 | 8.72 E-06 | 1.10 ± 0.37 E-05 | < 6.1 E-07 | 6.04 ± 1.29 E-05 |
| | | 1993 | 3.1 E-07 | 9.1 ± 3.6 E-06 | < 3.1 E-07 | 5.8 ± 1.7 E-05 |
| | | 1994 | 3.5 E-05 | 6.8 ± 4.8 E-05 | < 1.4 E-06 | 2.2 ± 7.1 E-05 |

## TABLE 5.18
## IRIGARAY ANNUAL VEGETATION SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| IR-6 (Ridge Road) | Annual Grab | 1987 | 1.9 E-05 | 2.5 E-05 | 4.8 E-05 | 14.8 E-05 |
| | | 1988 | 6.4 E-05 | 6.9 + 0.9 E-05 | 2.7 + 0.7 E-04 | 7.9 + 1.7 E-05 |
| | | 1989 | 2.8 E-03 | 3.3 ± 0.2E-05 | 1.2 ± 0.2E-04 | 8.8 ± 0.6 E-05 |
| | | 1990 | 2.4 E-05 | 2.5 ± 0.2 E-05 | < 5.6 E-07 | 9.7 ± 0.8 E-05 |
| | | 1991 | 6.48 E-06 | 3.78 ± 2.70 E-06 | < 1.1 E-06 | 4.70 ± 0.43 E-05 |
| | | 1992 | 8.07 E-06 | 2.60 ± 2.60 E-06 | < 5.8 E-07 | 1.79 ± 0.23 E-04 |
| | | 1993 | 4.1 E-05 | 22 ± 6.3 E-06 | < 4.8 E-07 | 17 ± 3.1 E-05 |
| | | 1994 | 6.8 E-05 | 1.1 ± 2.3 E-05 | < 1.7 E-06 | 5.0 ± 9.2 E-05 |

## TABLE 5.19
## CHRISTENSEN RANCH ANNUAL VEGETATION SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| AS-1 (Background) | Annual Grab | 1988 | 9.0 E-05 | 9.4 ± 0.55 E-05 | 1.4 ± 0.61 E-04 | 2.1 ± 8.3 E-06 |
| | | 1989 | 1.6 E-05 | 1.5 ± 0.10 E-05 | < 3.12 E-07 | 1.1 ± 0.10 E-04 |
| | | 1990 | 1.01 E-05 | 1.3 ± 0.1 E-05 | < 3.5 E-07 | 1.7 ± 0.4 E-05 |
| | | 1991 | 3.19 E -06 | 4.79 ± 1.33 E-06 | < 5.3 E-07 | 1.68 ± 0.21 E-05 |
| | | 1992 | 3.58 E-05 | 5.70 ± 1.03 E-05 | < 1.4 E-06 | 3.42 ± 0.53 E-04 |
| | | 1993 | 7.3 E-05 | 14.0 ± 4.21 E-06 | < 3.3 E-07 | 3.8 ± 1.6 E-05 |
| | | 1994 | 7.2 E-05 | 2.4 ± 3.0 E-05 | < 1.6 E-06 | 4.0 ± 8.1 E-05 |
| AS-6 (Nearest Residence) | Annual Grab | 1988 | 2.3 E-05 | 5.0 ± 0.3 E-05 | 6.5 ± 3.06 E-05 | 9.5 ± 4.74 E-06 |
| | | 1989 | 1.7 E-05 | 1.3 ± 0.1 E-05 | 7.7 ± 6.4 E-06 | 1.4 ± 0.1 E-06 |
| | | 1990 | 1.7 E-05 | 1.1 ± 0.1 E-05 | 3.67 ± 3.2 E-06 | 4.8 ± 0.5 E-05 |
| | | 1991 | 4.45 E-06 | 8.52 ± 4.08 E-06 | < 7.4 E-07 | 1.82 ± 0.30 E-05 |
| | | 1992 | 6.53 E-05 | 1.79 ± 1.01 E-05 | < 1.6 E-05 | 4.07 ± 0.60 E-04 |
| | | 1993 | 3.8 E-05 | 8.4 ± 3.7 E-06 | < 3.6 E-07 | 63.0 ± 2.0 E-05 |
| | | 1994 | 5.5 E-05 | 2.7 ± 3.3 E-05 | < 1.7 E-06 | 1.7 ± 7.8 E-05 |
| AS-5A (Upwind) | Annual Grab | 1988 | 1.3 E-04 | 1.1 ± 0.05 E-04 | 1.9 ± 0.53 E-04 | 1.7 ± 0.10 E-04 |
| | | 1989 | 1.3 E-05 | 1.7 ± 0.1 E-05 | 6.1 ± 4.6 E-06 | 1.2 ± 0.1 E-04 |
| | | 1990 | < 2.3 E-07 | 1.7 ± 0.5 E-06 | < 2.3 E-07 | 9.6 ± 0.1 E-06 |
| | | 1991 | 3.6 E-06 | 6.30 ± 1.8 E-06 | < 6.0 E-07 | 1.14 ± 0.21 E-05 |
| | | 1992 | 3.61 E-04 | 4.3 E-06 | < 4.3 E-06 | 1.55 ± 0.17 E-03[1] |
| | | 1993 | 5.5 E-06 | 13.0 ± 4.0 E-06 | < 3.2 E-07 | 2.3 ± 1.5 E-05 |
| | | 1994 | 2.6 E-05 | 1.5 ± 2.1 E-05 | < 1.2 E-06 | 1.9 ± 1.9 E-05 |

## TABLE 5.19

## CHRISTENSEN RANCH ANNUAL VEGETATION SAMPLING PROGRAM RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE PERIOD | U (pCi/g) | Ra-226 (pCi/g) | Th-230 (pCi/g) | Pb-210 (pCi/g) |
|---|---|---|---|---|---|---|
| **AS-5B (Downwind)** | Annual Grab | 1988 | 1.2 E-04 | 2.0 ± 0.08 E-04 | 2.6 ± 0.91 E-04 | 3.1 ± 0.20 E-04 |
| | | 1989 | 7.0 E-07 | 1.3 ± 0.3 E-06 | < 2.96 E-07 | 3.0 ± 1.6 E-06 |
| | | 1990 | 6.0 E-06 | 1.4 ± 0.1 E-05 | 2.0 ± 0.5 E-06 | 2.7 ± 0.4 E-05 |
| | | 1991 | 1.49 E-06 | 4.48 ± 1.47 E-06 | < 5.0 E-07 | 3.98 ± 1.74 E-06 |
| | | 1992 | 8.24 E-05 | 1.32 ± 0.88 E-05 | < 1.5 E-06 | 4.41 ± 0.58 E-04 |
| | | 1993 | 9.1 E-06 | 12.0 ± 4.1 E-06 | < 3.4 E-07 | 87.0 ± 1.5 E-06 |
| | | 1994 | 1.4 E-04 | 4.0 ± 6.9 E-05 | < 2.3 E-06 | 3.5 ± 1.1 E-04 |

[1]Data is questionable and thought to be a laboratory error. No verification data is available.

## TABLE 5.20
## IRIGARAY ENVIRONMENTAL GAMMA SURVEY RESULTS

| GAMMA MONITORING PERIOD | IR-1 Downwind (mRem/day) | IR-3 Upwind (mRem/day) | IR-4 North Road (517 Test Site) (mRem/day) | IR-4 North Road QA (mRem/day) | IR-5 Irigaray Ranch (Nearest Resident) (mRem/day) | IR-6 Ridge Road (Back-ground) (mRem/day) |
|---|---|---|---|---|---|---|
| Third & Fourth Quarter, 1987 | 0.32 | 0.40 | 0.27 | 0.26 | 0.25 | 0.25 |
| First & Second Quarter, 1988 | 0.40 | 0.28 | 0.24 | 0.25 | 0.22 | 0.23 |
| Third & Fourth Quarter, 1988 | 0.37 | 0.33 | 0.25 | 0.24 | 0.23 | 0.23 |
| First & Second Quarter, 1989 | 0.38 | 0.35 | 0.24 | 0.23 | 0.22 | 0.24 |
| Third & Fourth Quarter, 1989 | 0.30 | 0.35 | 0.22 | 0.22 | 0.20 | 0.22 |
| First & Second Quarter, 1990 | 0.30 | 0.25 | 0.22 | 0.23 | 0.21 | 0.22 |
| Third & Fourth Quarter, 1990 | 0.33 | 0.29 | 0.28 | 0.25 | 0.24 | 0.26 |
| First & Second Quarter, 1991 | 0.34 | 0.32 | 0.29 | 0.25 | 0.22 | 0.26 |
| Third & Fourth Quarter, 1991 | 0.43 | 0.43 | 0.32 | 0.28 | 0.29 | 0.32 |
| First & Second Quarter, 1992 | 0.32 | 0.60 | 0.27 | N/A | 0.24 | 0.26 |
| Third & Fourth Quarter, 1992 | 0.40 | 0.65 | 0.35 | N/A | 0.30 | 0.31 |
| First & Second Quarter, 1993 | 0.39 | 0.59 | 0.30 | N/A | 0.24 | 0.31 |
| Third & Fourth Quarter, 1993 | 0.38 | 0.67 | 0.29 | N/A | 0.27 | 0.29 |
| First & Second Quarter, 1994 | 0.36 | 0.68 | 0.30 | N/A | 0.27 | 0.29 |
| Third & Fourth Quarter, 1994 | 0.37 | 0.52 | 0.32 | N/A | 0.27 | 0.33 |

## TABLE 5.21
## CHRISTENSEN RANCH ENVIRONMENTAL GAMMA SURVEY RESULTS

| GAMMA MONITORING PERIOD | AS-1 Table Mountain (Background) (mrem/day) | AS-5a Upwind (mRem/day) | AS-5b Downwind (mRem/day) | AS-6 Christensen Ranch (Nearest Resident) (mRem/day) |
|---|---|---|---|---|
| Third & Fourth Quarter, 1988 | 0.28 | 0.24 | 0.27 | 0.28 |
| First & Second Quarter, 1989 | 0.22 | 0.27 | 0.25 | 0.26 |
| Third & Fourth Quarter, 1989 | 0.22 | 0.24 | 0.24 | 0.24 |
| First & Second Quarter, 1990 | 0.23 | 0.24 | 0.24 | 0.23 |
| Third & Fourth Quarter, 1990 | 0.27 | 0.27 | 0.26 | 0.28 |
| First & Second Quarter, 1991 | 0.26 | 0.24 | 0.27 | 0.27 |
| Third & Fourth Quarter, 1991 | 0.33 | 0.31 | 0.39 | 0.31 |
| First & Second Quarter, 1992 | 0.28 | 0.30 | 0.27 | 0.30 |
| Third & Fourth Quarter, 1992 | 0.32 | 0.36 | 0.34 | 0.34 |
| First & Second Quarter, 1993 | 0.30 | 0.33 | 0.33 | 0.30 |
| Third & Fourth Quarter, 1993 | 0.29 | 0.32 | 0.33 | 0.30 |
| First & Second Quarter, 1994 | 0.28 | 0.31 | 0.31 | 0.31 |
| Third & Fourth Quarter, 1994 | 0.29 | 0.36 | 0.35 | 0.33 |

Proposed Airborne Effluent and Environmental Monitoring Program

COGEMA proposes to continue to implement the Airborne Effluent and Environmental Monitoring Program described in this section with the following proposed changes.

- COGEMA proposes to change the restricted area at the Irigaray facility. The results of monitoring conducted at the facility and modeling indicate that the process portion of the plant building would be the appropriate restricted area boundary for the facility. Approximately two thirds of the fenced storage area adjacent to the plant building will also be maintained as a restricted area for storage purposes. Additionally, temporary restricted areas will be established for any areas which may contain radioactive material or exceed airborne effluent or external radiation limits.

- COGEMA proposes to relocate sample point IR-1 which is currently located approximately ten feet downwind from the plant building. The new proposed location is approximately 50 meters from the building. The proposed new location is in accordance with the guidance contained in NRC Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" and is depicted in Figure 5.5 (in pocket).

- COGEMA proposes to continue sampling at sample location IR-13 and discontinue sampling at location IR-4. Station IR-13 is in accordance with the guidance contained in NRC Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" and is depicted in Figure 5.5.

- Isokinetic sampling of the yellowcake dryer stack will be conducted on a semi-annual basis. The stack sample will be analyzed for Unat.

- A summary of the proposed airborne effluent and environmental monitoring program is provided in Tables 5-22 and 5-23.

## 5.8.2 GROUNDWATER AND SURFACE WATER MONITORING PROGRAM

Program Description

During past operations at the Irigaray and Christensen Ranch facilities, a detailed water sampling program was conducted to identify any potential impacts to water resources of the area. COGEMA's operational water monitoring program included the evaluation of groundwater on a regional basis, groundwater within individual well fields within the permit or licensed area and surface water on a regional and site specific basis. These programs are described in more detail following.

## TABLE 5.22
## CHRISTENSEN RANCH ENVIRONMENTAL AIRBORNE EFFLUENT MONITORING PROGRAM

| | | SAMPLE COLLECTION | | | | SAMPLE ANALYSIS | |
|---|---|---|---|---|---|---|---|
| MONITORED CONSTITUENT | NO. | LOCATION | TYPE | FREQUENCY | METHOD | FREQUENCY | PARAMETER |
| Air (Radon) | 4 | 1. One directly upwind from restricted area boundary, AS5a<br>2. One downwind from restricted area boundary, AS5b<br>3. John Christensen Ranch (nearest residence), AS6<br>4. Table Mountain (remote background), AS1 | Continuous | Quarterly exchange of cups | Terradex Trac-Etch Type F1 Cups or equivalent | Quarterly | Rn-222 |
| Soils and Vegetation | 4 | Same locations as for radon (above) | Grab | Annually | Composite Sample | Annually | Uranium<br>Ra-226<br>Th-230<br>Pb-210 |
| Direct Radiation | 4 | Same locations as for radon (above) | Continuous | Quarterly exchange of dosimeters | Continuous passive integrating dosimeters, Eberline Ruggedized Environmental Spherical or equivalent | Quarterly | External gamma ray exposure rate |

## TABLE 5.23
## IRIGARAY ENVIRONMENTAL AIRBORNE EFFLUENT MONITORING PROGRAM

| | SAMPLE COLLECTION | | | | | SAMPLE ANALYSIS | |
|---|---|---|---|---|---|---|---|
| MONITORED CONSTITUENT | NO. | LOCATION | TYPE | FREQUENCY | METHOD | FREQUENCY | PARAMETER |
| Air (Radon) | 5 | 1. One directly upwind from restricted area boundary, IR-3<br>2. One downwind from restricted area boundary, IR-1<br>3. North Access Road, IR-4 (517 Test Site)<br>4. Irigaray Ranch, IR-5<br>5. Ridge Road Southeast, IR-6 | Continuous | Quarterly exchange of cups | Terradex Trac-Etch Type F1 Cups or equivalent | Quarterly | Rn-222 |
| Air (Particulate) | 5 | Same locations as for radon (above). Employee house trailer, IR-13, may be substituted for IR-4 | Continuous during dryer operation | Weekly | Composite air filter sample | Quarterly | Uranium<br>Ra-226<br>Th-230<br>Pb-210 |
| | 1 | Yellowcake dryer stack | Isokinetic | Semi-Annually | 40 CFR 60 | Semi-Annually | Uranium Release Rates |

## TABLE 5.23
## IRIGARAY ENVIRONMENTAL AIRBORNE EFFLUENT MONITORING PROGRAM

| | SAMPLE COLLECTION | | | | | SAMPLE ANALYSIS | |
|---|---|---|---|---|---|---|---|
| MONITORED CONSTITUENT | NO. | LOCATION | TYPE | FREQUENCY | METHOD | FREQUENCY | PARAMETER |
| Soils and Vegetation | 5 | Same locations as for radon (above) | Grab | Annually | Composite Sample | Annually | Uranium<br>Ra-226<br>Th-230<br>Pb-210 |
| Direct Radiation | 5 | Same locations as for radon (above) | Continuous | Quarterly exchange of dosimeters | Continuous passive integrating dosimeters, Eberline Ruggedized Environmental Spherical or equivalent | Quarterly | External gamma ray exposure rate |

### 5.8.2.1 Regional Groundwater Monitoring

Historical Results

Approximately six (6) stock watering and domestic water wells are located within two kilometers of the Christensen Ranch mining area and one well is located near Irigaray. Baseline data from these wells were collected prior to mining for reference to operational sampling results. Grab samples of groundwater from these wells were collected on a quarterly frequency when the wells were operational, with the exception of Willow No. 2 at Irigaray, where there is only a semi-annual sampling requirement. Groundwater monitoring results were submitted in the semi-annual activity and monitoring reports submitted to NRC. A summary table of regional groundwater monitoring results for Irigaray and Christensen Ranch since 1987 can be found in Table 5.24. As can be seen from Table 5.24, no variances are seen which can be attributed to the mining operations.

Proposed Program

COGEMA proposes to institute the same regional groundwater monitoring program during future operations, with the exception that only four of the six Christensen Ranch regional wells will be sampled. This is because the Middle Artesian No. 2 and Del Gulch Well No. 3 are old windmills and normally inoperative. Table 5.25 summarizes the proposed regional groundwater sampling program.

### 5.8.2.2 Mine Unit Groundwater Monitoring

Historical Results

At both the Irigaray and Christensen Ranch sites, monitor wells are completed in a minimum of three different stratigraphic horizons for monitoring the containment of mining solutions in the wellfields during operations. At Irigaray, monitor wells are completed in the overlying aquifer (Unit 1 Sand), the underlying aquifer (deep zone), and in the ore zone (Upper Irigaray Sandstone). Additionally, ore zone trend wells were installed at Irigaray in 1978 and 1979 and are located between the wellfield and the monitor well ring. And, trend wells are located in the coal zone, a strata overlying the production zone. The coal zone was the original overlying monitor zone at Irigaray, but due to hydrologic connections to the ore zone, the coal zone was incorporated into the production zone in 1980. The original coal zone monitor wells have since been treated as overlying trend wells for the ore zone. Installed monitor well spacing and frequency existing at Irigaray is as follows:

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| Willow No. 2 (Irigaray) | Semi-Annual Grab | 7/19/88 | 0.0074 | 1.8 ± 1.0 | < 0.2 | < 1.0 | < 1.0 |
| | | 5/10/89 | 0.0049 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 11/28/89 | 0.0010 | 0.7 ± 0.3 | < 0.2 | < 1.0 | 8.8 ± 1.2 |
| | | 5/23/90 | < 0.0003 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 11/20/90 | < 0.0003 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 5/22/91 | < 0.0010 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 11/22/91 | 0.008 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 5/15/92 | < 0.0003 | 1.7 ± 3.0 | < 0.2 | 6.1 ± 8.0 | < 1.0 |
| | | 11/13/92 | < 0.0003 | < 0.2 | < 0.2 | 3.0 ± 0.8 | < 1.0 |
| | | 5/20/93 | < 0.0003 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 11/19/93 | < 0.0003 | 0.3 ± 0.2 | < 0.2 | 1.4 ± 0.5 | < 1.0 |
| | | 5/12/94 | <0.003 | < 2.0 | < 2.0 | < 1.0 | < 1.0 |
| | | 12/7/94 | < 0.0003 | < 0.2 | < 0.2 | 1.8 | < 1.0 |
| Christensen Ranch House No. 3 | Quarterly Grab | 4th Quarter 1988 | 0.0215 | 0.7 ± 0.3 | 1.9 ± 2.4 | 1.2 ± 1.8 | 1.1 ± 1.0 |
| | | 1st and 2nd Quarter 1989 | 0.0173 | 1.35 | 0.75 | 2.05 | 2.95 |
| | | 3rd and 4th Quarter 1989 | 0.0182 | 5.45 | 2.95 | 6.15 | 1.85 |
| | | 1st and 2nd Quarter 1990 | 0.0174 | 0.6 | 0.2 | 2.05 | 1.0 |

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| Christensen Ranch House No. 3 (cont'd) | Quarterly Grab | 3rd and 4th Quarter 1990 | 0.0242 | 0.85 | 0.2 | 3.05 | 2.25 |
| | | 1st and 2nd Quarter 1991 | 0.0156 | 0.6 | 0.2 | 1.0 | 1.0 |
| | | 3rd and 4th Quarter 1991 | 0.0139 | 1.95 | 0.2 | 1.9 | 1.0 |
| | | 1st and 2nd Quarter 1992 | 0.0650 | 2.0 | 0.2 | 1.35 | 3.75 |
| | | 3rd and 4th Quarter 1992 | 0.0150 | 1.1 | 0.2 | 2.75 | 1.0 |
| | | 1st and 2nd Quarter 1993 | 0.0140 | 0.8 | 0.2 | 2.35 | 1.0 |
| | | 3rd and 4th Quarter 1993 | 0.0145 | 1.125 | 0.2 | 3.1 | 1.0 |
| | | 1st and 2nd Quarter 1994 | 0.0185 | 4.3 | 0.2 | 2.6 | 1.4 |
| | | 3rd and 4th Quarter 1994 | 0.0165 | 1.35 | 0.2 | 1.0 | 1.0 |

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| Ellendale No .4 (Christensen) | Quarterly Grab | 4th Quarter 1988 | < 0.0003 | < 0.2 | 0.6 | < 1.0 | 2.8 |
| | | 1st and 2nd Quarter 1989 | 0.0006 | 0.4 | 0.2 | 1.0 | 1.0 |
| | | 3rd and 4th Quarter 1989 | 0.0003 | 4.3 | 2.6 | 4.6 | 1.7 |
| | | 1st and 2nd Quarter 1990 | 0.0176 | 0.2 | 0.2 | 1.0 | 5.45 |
| | | 3rd and 4th Quarter 1990 | 0.0049 | 0.2 | 0.2 | 1.45 | 1.45 |
| | | 1st and 2nd Quarter 1991 | 0.0007 | 0.2 | 0.2 | 1.0 | 1.0 |
| | | 3rd and 4th Quarter 1991 | 0.0035 | 0.2 | 0.2 | 1.0 | 1.0 |
| | | 1st and 2nd Quarter 1992 | 0.0003 | 0.2 | 0.2 | 1.0 | 1.0 |

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| Ellendale No. 4 (Christensen) (cont'd) | Quarterly Grab | 2nd and 3rd Quarter 1992 | 0.0003 | 0.2 | 0.2 | 1.9 | 1.0 |
| | | 1st and 2nd Quarter 1993 | 0.0055 | 0.25 | 0.2 | 1.45 | 1.0 |
| | | 3rd and 4th Quarter 1993 | 0.0020 | 0.3 | 0.2 | 1.05 | 1.4 |
| | | 1st and 2nd Quarter 1994 | 0.0015 | 0.2 | 0.2 | 2.45 | 1.35 |
| | | 3rd and 4th Quarter 1994 | 0.0015 | 1.85 | 0.2 | 1.0 | 1.0 |
| Willow Corral No. 32 (Christensen) | Quarterly Grab | 4th Quarter 1988 | 0.0007 | 0.6 | 5.1 | < 1.0 | < 1.0 |
| | | 1st and 2nd Quarter 1989 | 0.0004 | 0.45 | 1.45 | 1.0 | 1.05 |
| | | 3rd and 4th Quarter 1989 | 0.0003 | 1.4 | 0.2 | 4.15 | 1.0 |
| | | 2nd Quarter 1990 | < 0.0003 | < 0.2 | < 0.2 | 7.2 ± 2.7 | < 1.0 |

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| Willow Corral No. 32 (Christensen) (cont'd) | Quarterly Grab | 3rd and 4th Quarter 1990 | 0.0030 | 0.2 | 0.2 | 1.0 | 1.65 |
| | | 1st and 2nd Quarter 1991 | 0.0003 | 0.2 | 0.2 | 1.0 | 1.0 |
| | | 3rd and 4th Quarter 1991 | 0.0017 | 0.2 | 0.2 | 13.9 | 1.0 |
| | | 1st and 2nd Quarter 1992 | 0.0003 | 1.6 | 0.2 | 1.0 | 1.0 |
| | | 3rd and 4th Quarter 1992 | 0.0003 | 1.6 | 0.2 | 1.55 | 1.0 |
| | | 1st and 2nd Quarter 1993 | 0.0003 | 0.3 | 0.2 | 2.65 | 1.0 |
| Willow Corral No. 2 (Christensen) | Quarterly Grab | 3rd and 4th Quarter 1993 | 0.0023 | 0.35 | 0.2 | 1.1 | 1.0 |
| | | 1st and 2nd Quarter 1994 | 0.0003 | 1.1 | 1.1 | 1.0 | 1.0 |
| | | 3rd and 4th Quarter 1994 | 0.0007 | 0.2 | 0.2 | 2.15 | 1.0 |

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| First Artesian No. 1 (Christensen) | Quarterly Grab | 4th Quarter 1988 | < 0.0003 | < 0.2 | 3.2 ± 2.5 | 2.3 ± 1.9 | < 1.0 |
| | | 1st and 2nd Quarter 1989 | 0.0007 | 0.5 | 0.75 | 1.0 | 1.05 |
| | | 3rd and 4th Quarter 1989 | 0.0003 | 2.15 | 1.1 | 1.55 | 1.7 |
| | | 1st and 2nd Quarter 1990 | 0.0005 | 0.5 | 0.2 | 7.25 | 3.75 |
| | | 3rd and 4th Quarter 1990 | 0.0021 | 0.2 | 0.2 | 1.0 | 1.0 |
| | | 1st and 2nd Quarter 1991 | 0.0003 | 0.2 | 0.2 | 2.15 | 1.0 |
| | | 3rd and 4th Quarter 1991 | 0.0037 | 0.2 | 0.2 | 1.0 | 1.0 |
| | | 1st Quarter 1992 | < 0.0003 | 0.6 | < 0.2 | < 1.0 | < 1.0 |

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| First Artesian No. 1 (Christensen) (cont'd) | Quarterly Grab | 3rd and 4th Quarter 1992 | 0.0012 | 0.25 | 0.2 | 2.35 | 1.0 |
| | | 1st and 2nd Quarter 1993 | 0.0012 | 0.2 | 0.2 | 3.7 | 1.1 |
| | | 3rd and 4th Quarter 1993 | 0.0070 | 0.55 | 0.2 | 1.0 | 1.0 |
| | | 1st and 2nd Quarter 1994 | 0.007 | 1.1 | 1.1 | 2.6 | 1.0 |
| | | 3rd and 4th Quarter 1994 | 0.0035 | 0.8 | 0.2 | 1.0 | 1.4 |
| Middle Artesian No. 2 (Christensen) | Quarterly Grab | 4th Quarter 1988 | 0.0277 | 0.2 | < 0.2 | 5.5 | < 1.0 |
| | | 1st and 2nd Quarter 1989 | 0.0208 | 0.85 | 1.95 | 2.1 | 1.0 |
| | | 3rd and 4th Quarter 1989 | 0.0207 | 1.65 | 0.2 | 2.75 | 5.95 |
| | | 1st and 2nd Quarter 1990 | 0.0264 | 0.2 | 0.2 | 6.35 | 2.9 |

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| Middle Artesian No. 2 (Christensen) (cont'd) | Quarterly Grab | 3rd and 4th Quarter 1990 | 0.0226 | 0.2 | 0.2 | 1.0 | 1.65 |
| | | 1st and 2nd Quarter 1991 | 0.0169 | 0.35 | 0.2 | 1.0 | 1.0 |
| | | 3rd and 4th Quarter 1991 | 0.0239 | 0.4 | 0.2 | 10.0 | 2.25 |
| | | 1st and 2nd Quarter 1992 | 0.0110 | 1.35 | 0.2 | 1.0 | 1.0 |
| | | 3rd and 4th Quarter 1992 | 0.0102 | 0.2 | 0.2 | 3.2 | 1.05 |
| | | 1st Quarter 1993 | 0.0024 | 0.4 | < 0.2 | 2.4 | 2.2 |
| | | 3rd and 4th Quarter 1993 | N/A | N/A | N/A | N/A | 1.0 |
| | | 1st and 2nd Quarter 1994 | N/A | N/A | N/A | N/A | N/A |
| Del Gulch No. 3 (Christensen) | Quarterly Grab | 4th Quarter 1988 | 0.0047 | 1.2 | 0.6 | 20.8 | 14.12 |

## TABLE 5.24
## REGIONAL GROUNDWATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| Del Gulch No. 3 (Christensen) (cont'd) | Quarterly Grab | 1st and 2nd Quarter 1989 | N/A | N/A | N/A | N/A | N/A |
| | | 4th Quarter 1989 | 0.0020 | 0.9 | 1.1 | < 1.0 | 3.5 |
| | | 1st Quarter 1990 | 0.003 | < 0.2 | < 0.2 | < 1.0 | 11.4 |

Notes: Analysis performed by Energy Laboratories, Incorporated (ELI), Casper, Wyoming.
ELI Detection Limit: U (mg/l) = 0.0003
Ra-226 (pCi/l) = 0.20
Th-230 (pCi/l) = 0.20
Pb-210 (pCi/l) = 1.0
Po-210 (pCi/l) = 1.0

Missing Data: There are several quarters for which data is not supplied. The cause was generally an inoperative pump or an inoperative windmill. There is no data available for the Del Gulch monitoring well after the 1st Quarter of 1990 due to an inoperative windmill.

# TABLE 5.25
# IRIGARAY AND CHRISTENSEN RANCH ENVIRONMENTAL GROUNDWATER AND SURFACE WATER MONITORING PROGRAMS

| | SAMPLE COLLECTION | | | SAMPLE ANALYSIS | | |
|---|---|---|---|---|---|---|
| CONSTITUENT | LOCATION | TYPE | FREQUENCY | METHOD | FREQUENCY | PARAMETER |
| Regional Groundwater | Christensen Ranch<br>1. Christensen Ranch House No. 3<br>2. Ellendale No. 4<br>3. Willow Corral No. 32<br>4. First Artesian No. 1<br><br>Irigaray<br>1. Willow No. 2 | Grab | Quarterly | Pumped or bailed; downhole submersible pump or windmill | Quarterly | Uranium, Ra-226, Th-230, Pb-210, Po-210, Water levels |
| Groundwater | Monitor Wells:<br>Ore Zone Perimeter<br>Upper Aquifer<br>Lower Aquifer | BASELINE<br>Grab | 4 samples each spaced two weeks apart | Downhole submersible pump | 4 samples each spaced two weeks apart | One sample - Assay Suite A[1]<br>Three samples Assay Suite B[2]<br>Water levels |
| | Monitor Wells:<br>Ore Zone Perimeter<br>Upper Aquifer<br>Lower Aquifer | OPERATIONAL MONITORING<br>Grab | Twice per month | Downhole submersible pump | Twice per month | Assay Suite C[3]<br>Water levels |
| | Mine Unit Baseline Wells (For definition of restoration goals) | BASELINE<br>Grab | 4 samples each spaced two weeks apart | Downhole submersible pump | 4 samples each spaced two weeks apart | Two samples - Assay Suite A[1]<br>Two samples - Assay Suite B[2]<br>Water levels |

1. Assay Suite A = Ca, Mg, Na, K, $CO_3$, $HCO_3$, $SO_4$, Cl, $NH_4$ (as N), $NO_2$ + $NO_3$ (as N), F, Si, TDS, Conductivity, Total Alkalinity (as $CaCO_3$), pH, Al, As, Ba, Bo, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, V, Zn, U, Ra-226.
2. Assay Suite B = TDS, $SO_4$, Cl, Conductivity, Total Alkalinity, pH, As, Se, U, Ra-226
3. Assay Suite C = Excursion parameters: Cl, Conductivity, Total Alkalinity

# TABLE 5.25
# IRIGARAY AND CHRISTENSEN RANCH ENVIRONMENTAL GROUNDWATER AND SURFACE WATER MONITORING PROGRAMS

| | SAMPLE COLLECTION | | | | SAMPLE ANALYSIS | |
|---|---|---|---|---|---|---|
| CONSTITUENT | LOCATION | TYPE | FREQUENCY | METHOD | FREQUENCY | PARAMETER |
| Surface Water | Christensen Ranch<br>1. CG-05: Upstream Willow Creek<br>2. GS-1: Downstream Willow Creek<br>3. GS-03: 250 yds downstream of PU-3 in Willow Creek<br><br>*Irigaray*<br>1. IR-5: Powder River at Irigaray Ranch<br>2. IR-9: Downstream Willow Creek<br>3. IR-14: Upstream Willow Creek<br>4. IR-17: 200 ft. east of Unit 1 | Grab | Quarterly on runoff event basis | Grab | Quarterly | Assay Suite B[2], Th-230, Pb-210, Po-210 and estimated flow rate |

1. Assay Suite A = Ca, Mg, Na, K, $CO_3$, $HCO_3$, $SO_4$, Cl, $NH_4$ (as N), $NO_2$ + $NO_3$ (as N), F, Si, TDS, Conductivity, Total Alkalinity (as $CaCO_3$), pH, Al, As, Ba, Bo, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, V, Zn, U, Ra-226.
2. Assay Suite B = TDS, $SO_4$, Cl, Conductivity, Total Alkalinity, pH, As, Se, U, Ra-226
3. Assay Suite C = Excursion parameters: Cl, Conductivity, Total Alkalinity

| | Distance From Wellfield (feet) | Spacing Between Monitoring Wells(feet) |
|---|---|---|
| Ore Zone Perimeter Monitor Wells | 400 | 400 to 600 |
| Ore Zone Trend Wells | 200 | 200 to 400 |
| Overlying Monitor Wells (Unit 1 Sand) | Two to three wells per mine unit | |
| Overlying Coal Zone Trend Wells | One to two wells per acre of wellfield | |
| Underlying Monitor Wells (Deep Zone) | Two wells per mine unit | |

At Christensen Ranch, monitor wells have been completed in three different stratigraphic horizons for monitoring the containment of mining solutions in the well fields during operations. The ore zone wells have the same completed ore zone interval within the host sandstone (K sandstone) as the adjacent production and injection wells so as to intercept and detect any migration of mining solutions. In addition, monitor wells are completed in the overlying and underlying aquifers directly above and below the ore zone sandstone for detection of any vertical migration of mining solutions. Installed monitor well spacing and frequency at Christensen is as follows:

| | Distance From Well Field (feet) | Spacing Between Monitoring Wells (feet) |
|---|---|---|
| Ore Zone, Downgradient | 300 | 300 |
| Ore Zone, Sides | 500 | 500 |
| Ore Zone, Upgradient | 500 | 500 |
| Overlying Monitor Wells | One well per 3.5 acres of well field pattern area | |
| Underlying Monitor Wells | One well per 3.5 acres of well field pattern area | |

Monitor Well Baseline Water Quality

After delineation of the mine unit boundaries, monitor wells have been installed according to the previously noted spacing and frequency. After completion, wells were washed out and developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appeared stable and consistent with the anticipated quality of the area. After development, wells were sampled to obtain baseline water quality.

At Irigaray, monitor wells were sampled for baseline water quality three times, with sample events spaced two weeks apart. In Units 6 through 9, as many as five baseline samples were collected; the extra two samples were to verify older baseline data. At Christensen Ranch, four baseline samples have been collected, with sample events spaced two weeks apart. For baseline sampling, a minimum of two casing displacements was evacuated prior to sample collections. Samples were analyzed for

one full suite analysis and three short list analyses (see Table 5.25). The reason for the differences between Irigaray and Christensen is that Irigaray was permitted in 1978, and Christensen was permitted ten years later in 1988.

Mine Unit Baseline Water Quality

Baseline water quality was established for the mineralized zones to be mined within the host sandstone. As a basis for determining the groundwater quality restoration goals for a particular mine unit, COGEMA collected samples from representative injection or production wells at a density of one well for every acre of well field pattern area. At Irigaray, a baseline "fence" was used in several well fields, which amounted to a density of approximately two wells for each acre of well field. The wells chosen for baseline were evenly distributed over the well field area, with the exception of the Irigaray "fence", where the line of baseline wells extended across the well field. Baseline water quality was established by collecting four samples from each well on two week intervals and analyzing the samples for two full suite analyses and two short list analyses, as identified in Table 5.25. Water quality baseline sampling procedures were the same as those discussed for monitor wells.

Baseline water quality for a particular mine unit is established by combining the sample results from all mineralized zone wells within that mine unit and calculating an arithmetic average. Outliers are removed from the data base as described in the following section. The overall average baseline water quality results for a mine unit are used to define the restoration water quality target values for that particular mine unit.

Removal of Outliers from the Water Quality Data Base

Prior to any calculations for baseline mean, other statistics, or upper control limits, the water quality data base will be screened for outliers. Outliers are anomalously high or low values relative to the other values, which can compromise a data base. Outliers are typically caused by one of the following conditions:

- Transcription errors, either in the laboratory or in-house
- Analytical errors (multiplication errors, etc.)
- Incorrect units of measurements
- Sampling error

However, it is possible that the outlier is a true value, being caused by natural water quality variability, or geologic differences within the sampled aquifer. For this reason, the following procedures will be followed when analyzing the water quality data base for outliers:

- The data will first be screened visually, to identify obvious outliers, if present.

- The data will then be screened using a statistical analysis. COGEMA has used, and will continue to use, the tolerance-limit formula (Loftis, et al., 1987) as its method for outlier screening. This method is currently approved in the WDEQ Permit to Mine, NRC license, and is recommended in the WDEQ Guideline No. 4 for In Situ Mining. The tolerance-limit method used by COGEMA is as follows:

$\bar{X} \pm Ks$

Where:

$\bar{X}$ = sample mean

K = tolerance factor, corresponding to $\gamma = 0.99$ and $\alpha = 0.001$

s = sample standard deviation

- Once an outlier is identified, either by the visual screening, or by the tolerance-limit method, reasons for the outlier will be investigated. The analyzing laboratory will be contacted to see if the outlier could be a result of a calculation error, transcription error, or unit of measurement error. Errors in sampling will also be investigated. Hopefully, the error will be detected and the data point corrected. However, if no explanation for the outlier can be reasonably found, the data point will be excluded if it fails the tolerance limit statistical screening.

The tolerance limit screening method is also useful with identifying separate water quality populations, such as found on occasion in the Christensen Ranch shallow monitor zones. In this case, separate upper control limits are set for these particular wells instead of the group upper control limit.

Operational Monitoring

Operational monitoring at both Irigaray and Christensen Ranch in the past has consisted of sampling the monitor wells on a twice per month basis and analyzing the samples for the excursion indicators chloride, conductivity and total alkalinity. Additionally, trend wells are sampled and analyzed at the operator's discretion. Typically, trend wells are sampled every two weeks, as monitor wells are, and analyzed for chloride. A discussion of the upper control limit calculations, as well as excursion verification procedures follows.

Proposed Program

Table 5.25 provides the groundwater sampling program proposed for ongoing mining operations at Irigaray and Christensen Ranch, including baseline and operational monitoring. The program is consistent with the currently Christensen Ranch program, which has worked well in the past. One change in the program is proposed regarding the mine unit baseline program. In the past, baseline was obtained from the ore zone within the mine unit for a minimum of one well per acre of wellfield. This practice has occurred at Irigaray in all mine units (30 acres), as well as Christensen Ranch mine units (up to 75 acres of installed well field). COGEMA proposes to change the current one well per acre frequency to one well per four acres of installed pattern area, which is consistent with the WDEQ Guideline No. 4 for In Situ Mining, and other in situ operator's permit conditions.

### 5.8.2.3 Upper Control Limits and Excursion Monitoring

After baseline water quality was established for the monitor wells for a particular mine unit, upper control limits (UCLs) were set for certain chemical constituents which would be indicative of a migration of lixiviant from the well field. The constituents chosen for indicators of lixiviant migration at both Irigaray and Christensen Ranch, and for which UCLs were set, are chloride, conductivity and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations may be affected during an excursion as bicarbonate is the major constituent added to the lixiviant.

Due to the different licensing and permitting times, upper control limits have been set using different criteria for the Irigaray and Christensen Ranch monitor wells. The following methods were followed for calculating upper control limits at each site:

Irigaray: Upper control limits were set for each individual monitor well. The UCLs were calculated as follows:

| | |
|---|---|
| Chloride - | baseline mean (average of three or five samples) plus 5 mg/l |
| Total Alkalinity - | baseline mean plus 15% |
| Conductivity - | baseline mean plus 10% |

At Irigaray, action limits were set for chloride only in trend wells based on existing water quality analyses during pre-startup in 1987, plus 20 mg/l.

Christensen:

- For each mine unit, the results from the baseline samples from all monitor wells in the same stratigraphic horizon were combined as a group and averaged arithmetically (sample mean). Average baseline concentrations were established separately for each stratigraphic monitor zone (perimeter ore zone, interior overlying and underlying aquifers). The average baseline values were then used to calculate upper control limits for the monitor zones associated with that mine unit. In other words, each monitor well within a particular stratigraphic zone has the same upper control limit concentrations.

- The above method of calculating group upper control limits was chosen for the Christensen Ranch mining areas due to the relatively small variability seen in baseline water quality results obtained in the Willow Creek R & D program and the Christensen baseline program especially in chloride and conductivity levels. Prior to upper control limit calculation, outliers were removed from the data set by using visual screening, and the tolerance limit method discussed above. Any data point which did not fall within the tolerance limits set by the test was considered suspect and was eliminated for use in upper control limit calculation if no explanation could be found for the anomolous value.

  If all four baseline sample results from an individual well would be eliminated by the tolerance limit process, the well would have its own set of UCLs based upon the average results of the four samples.

- Upper control limits were then calculated as follows:

| | | |
|---|---|---|
| Chloride | - | Baseline mean plus five (5) standard deviations |
| Conductivity | - | Baseline mean plus five (5) standard deviations |
| Total Alkalinity | - | Baseline mean plus five (5) standard deviations |

- After operations in Mine Unit 3 and 4 it became obvious that the upper control limit calculation for chloride (baseline mean plus five standard deviations) provided an upper control limit that was too restrictive, due to the relatively small variability in baseline chloride values. For Mine Unit 5, the chloride upper control limit was calculated as the baseline mean plus 15 mg/l. Control limits for conductivity and total alkalinity remained the same. This practice was approved by both the WDEQ and NRC for Mine Unit 5.

- Trend well action limits are set the same as for monitor well upper control limits.

Irigaray and Christensen Ranch monitor wells and their respective upper control limits are provided in Tables 5.26 and 5.27.

Excursion Verification and Corrective Action

During routine sampling, if two of the three UCL values were exceeded in a monitor well, the well was resampled within two days of the first sample and analyzed for the excursion indicators. If the second sample did not exceed two out of three UCLs, a third sample was taken within two days from the second sample. If neither the second or third sample results exceeded two of the three UCLs, the first sample was considered in error.

If the second or third sample verified an exceedance of two out of the three UCLs, the well in question was placed on excursion status. Upon verification of the excursion, the WDEQ and USNRC were notified by telephone within 24 hours and notified in writing within 7 days.

When an excursion was verified, the following methods of corrective action were instituted (not necessarily in the order given; dependent upon the circumstances):

- A preliminary investigation was completed to determine the probable cause.

- Production and/or injection rates in the vicinity of the monitor well were adjusted as necessary to increase the net overrecovery, thus forming a hydraulic gradient toward the production zone.

- Individual injection wells were pumped to enhance recovery of mining solutions.

- Injection into the well field area adjacent to the monitor well was suspended. Recovery operations continued thus increasing the overall bleed rate and the recovery of well field solutions.

In addition to the above corrective actions, sampling frequency of the monitor well on excursion status was increased to weekly. Uranium and pH were added to the routine

## TABLE 5.26

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS IRIGARAY RANCH

Monitor Wells

| Well No. | Location | Upper Control Limit | | | Well No. | Location | Upper Control Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Perimeter Ore Zone | | | | | | | | | |
| M2 | Mine Unit 2 | 18.0 | 685 | 131.1 | M26 | Mine Unit 7 | 14.6 | 596 | 113.9 |
| M4 | Mine Unit 2 | 18.1 | 671 | 100.4 | M27 | Mine Unit 7 | 15.2 | 625 | 105.8 |
| M7 | Mine Unit 1 | 17.5 | 679 | 109.8 | M28 | Mine Unit 8 | 15.5 | 715 | 110.9 |
| M10 | Mine Unit 4 | 17.5 | 701 | 132.3 | M29 | Mine Unit 8 | 16.1 | 702 | 109.8 |
| M17 | Mine Unit 1 | 17.1 | 724 | 111.7 | M30 | Mine Unit 9 | 15.2 | 704 | 105.5 |
| M18 | Mine Unit 1 | 17.0 | 719 | 109.8 | M31 | Mine Unit 9 | 15.6 | 690 | 107.2 |
| M19 | Mine Unit 3 | 17.0 | 651 | 116.7 | M32 | Mine Unit 9 | 16.1 | 707 | 107.4 |
| M23 | Mine Unit 5 | 17.0 | 614 | 106.6 | M33 | Mine Unit 9 | 15.9 | 686 | 112.0 |
| M24 | Mine Unit 6 | 14.5 | 632 | 119.4 | RS27 | Mine Unit 5 | 16.9 | 646 | 101.2 |
| M25 | Mine Unit 6 | 15.5 | 692 | 111.9 | 16-151 | Mine Unit 9 | 16.0 | 702 | 110.2 |
| | | | | | T31 | Mine Unit 1 | 21.8 | 779 | 106.1 |
| Shallow Sand | | | | | | | | | |
| SSM2 | Mine Unit 1 | 20.3 | 2075 | 128.4 | SSM19 | Mine Unit 8 | 13.7 | 1636 | 114.1 |
| SSM3 | Mine Unit 2 | 38.5 | 1451 | 219.1 | SSM34 | Mine Unit 9 | 13.2 | 1698 | 110.4 |
| SSM4 | Mine Unit 2 | 23.5 | 883 | 275.5 | SSM35 | Mine Unit 9 | 14.4 | 1688 | 132.7 |
| SSM5 | Mine Unit 3 | 21.5 | 825 | 254.9 | SSM36 | Mine Unit 9 | 13.7 | 1565 | 119.6 |
| SSM6 | Mine Unit 4 | 16.3 | 2445 | 122.2 | SSM37 | Mine Unit 7 | 14.3 | 1813 | 120.0 |
| SSM7 | Mine Unit 5 | 17.1 | 2604 | 119.4 | SSM38 | Mine Unit 7 | 16.2 | 2800 | 118.8 |
| SSM8 | Mine Unit 5 | 16.6 | 2389 | 112.2 | SSM39 | Mine Unit 7 | 14.5 | 2071 | 104.4 |
| SSM9 | Mine Unit 6 | 15.0 | 2008 | 117.8 | SSM40 | Mine Unit 8 | 13.6 | 1672 | 109.2 |
| SSM10 | Mine Unit 6 | 15.5 | 1955 | 177.4 | SSM41 | Mine Unit 4 | 24.9 | 2566 | 126.8 |
| SSM11 | Mine Unit 6 | 16.2 | 2784 | 122.9 | SSM42 | Mine Unit 3 | 23.3 | 1571 | 213.2 |
| SSM18 | Mine Unit 8 | 14.7 | 1849 | 119.4 | SSM43 | Mine Unit 1 | 25.6 | 1456 | 170.4 |

## TABLE 5.26

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS IRIGARAY RANCH

Monitor Wells - cont'd

| Well No. | Location | Upper Control Limit | | | Well No. | Location | Upper Control Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Deep Sand | | | | | | | | | |
| DM1 | Mine Unit 1 | 16.2 | 609 | 207.4 | DM14 | Mine Unit 8 | 15.5 | 619 | 109.5 |
| DM2 | Mine Unit 1 | 15.1 | 757 | 187.1 | DM15 | Mine Unit 9 | 15.1 | 618 | 110.6 |
| DM3 | Mine Unit 2 | 15.8 | 677 | 240.9 | DM16 | Mine Unit 9 | 15.7 | 646 | 111.0 |
| DM4 | Mine Unit 4 | 14.4 | 603 | 117.6 | DM17 | Mine Unit 5 | 15.0 | 618 | 108.2 |
| DM5 | Mine Unit 2 | 15.7 | 675 | 206.0 | DM18 | Mine Unit 4 | 14.5 | 598 | 105.6 |
| DM9 | Mine Unit 5 | 16.3 | 647 | 132.7 | DM19 | Mine Unit 3 | 31.7 | 1207 | 245.3 |
| DM10 | Mine Unit 6 | 16.4 | 606 | 107.5 | DM20 | Mine Unit 3 | 17.5 | 609 | 135.6 |
| DM11 | Mine Unit 7 | 15.0 | 607 | 104.7 | DM21 | Mine Unit 7 | 15.6 | 628 | 126.7 |
| DM13 | Mine Unit 8 | 15.1 | 624 | 113.5 | DM22 | Mine Unit 6 | 15.1 | 654 | 117.0 |

## TABLE 5.26

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS IRIGARAY RANCH

Trend Wells - cont'd

| Well No. | Location | Action Limit | | | Well No. | Location | Action Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Perimeter Ore Zone | | | | | | | | | |
| E118 | Mine Unit 2 | 85.2 | | | T39 | Mine Unit 7 | 20.6 | | |
| M1 | Mine Unit 1 | 22.8 | | | T40 | Mine Unit 7 | 20.8 | | |
| M12 | Mine Unit 6 | 23.6 | | | T41 | Mine Unit 7 | 20.4 | | |
| M14 | Mine Unit 1 | 22.2 | | | T42 | Mine Unit 7 | 21.0 | | |
| M15 | Mine Unit 5 | 27.2 | | | T43 | Mine Unit 7 | 20.8 | | |
| RS26 | Mine Unit 4 | 23.0 | | | T44 | Mine Unit 7 | 21.4 | | |
| T3 | Mine Unit 1 | 93.4 | | | T45 | Mine Unit 7 | 20.6 | | |
| T8 | Mine Unit 1 | 90.2 | | | T46 | Mine Unit 7 | 21.2 | | |
| T12 | Mine Unit 2 | 23.8 | | | T47 | Mine Unit 8 | 21.2 | | |
| T17 | Mine Unit 4 | 27.0 | | | T48 | Mine Unit 8 | 22.4 | | |
| T18 | Mine Unit 3 | 25.2 | | | T49 | Mine Unit 8 | 21.4 | | |
| T23 | Mine Unit 5 | 24.2 | | | T50 | Mine Unit 8 | 21.0 | | |
| T24 | Mine Unit 3 | 26.0 | | | T51 | Mine Unit 8 | 21.4 | | |
| T25 | Mine Unit 2 | 27.4 | | | T52 | Mine Unit 9 | 21.4 | | |
| T27 | Mine Unit 4 | 26.4 | | | T53 | Mine Unit 9 | 21.4 | | |
| T29 | Mine Unit 5 | 20.2 | | | T54 | Mine Unit 9 | 21.4 | | |
| T32 | Mine Unit 1 | 33.4 | | | T55 | Mine Unit 9 | 21.0 | | |
| T33 | Mine Unit 1 | 22.8 | | | T56 | Mine Unit 9 | 22.2 | | |
| T34 | Mine Unit 6 | 21.2 | | | T57 | Mine Unit 9 | 21.0 | | |
| T35 | Mine Unit 5 | 27.0 | | | T58 | Mine Unit 9 | 21.4 | | |
| T36 | Mine Unit 6 | 21.0 | | | T59 | Mine Unit 9 | 21.4 | | |
| T37 | Mine Unit 6 | 21.0 | | | T60 | Mine Unit 9 | 22.0 | | |
| T38 | Mine Unit 6 | 20.8 | | | T61 | Mine Unit 9 | 21.6 | | |
| | | | | | T62 | Mine Unit 9 | 22.4 | | |

## TABLE 5.26

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS IRIGARAY RANCH

Trend Wells - cont'd

| Well No. | Location | Action Limit | | | Well No. | Location | Action Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Interior Coal Zone | | | | | | | | | |
| RS19 | Mine Unit 3 | 56.0 | | | SM15 | Mine Unit 6 | 56.0 | | |
| RS34 | Mine Unit 2 | 56.0 | | | SM16 | Mine Unit 6 | 56.0 | | |
| RS39 | Mine Unit 3 | 56.0 | | | SM17 | Mine Unit 5 | 56.0 | | |
| RS84 | Mine Unit 4 | 56.0 | | | SM18 | Mine Unit 7 | 56.0 | | |
| SM1 | Mine Unit 1 | 56.0 | | | SM19 | Mine Unit 7 | 56.0 | | |
| SM2 | Mine Unit 1 | 56.0 | | | SM23 | Mine Unit 8 | 56.0 | | |
| SM4 | Mine Unit 4 | 56.0 | | | SM24 | Mine Unit 8 | 56.0 | | |
| SM7 | Mine Unit 2 | 56.0 | | | SM25 | Mine Unit 8 | 56.0 | | |
| SM9 | Mine Unit 5 | 56.0 | | | SM26 | Mine Unit 9 | 56.0 | | |
| SM10 | Mine Unit 6 | 56.0 | | | SM27 | Mine Unit 9 | | | |
| SM11 | Mine Unit 7 | 56.0 | | | SM28 | Mine Unit 9 | 56.0 | | |

Units 1 through 3: Operational Status Restored
Sampling Frequency Once every two months

Units 4 through 9: Operational Status In Restoration
Sampling Frequency Monthly

TAB. .27

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS CHRISTENSEN RANCH

Monitor Wells

| Well No. | Location | Upper Control Limit | | | Well No. | Location | Upper Control Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Perimeter Ore Zone | | | | | | | | | |
| MW17-2 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW77 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW18 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW78 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW19 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW79 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW20 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW80 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW23 | Mine Unit 3 | 13.4 | 777 | 116.3 | MW81 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW24 | Mine Unit 3 | 13.4 | 777 | 116.3 | MW82 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW25 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW83 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW26 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW84 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW27 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW85 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW28 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW86 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW29 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW87 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW30 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW88 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW31 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW89 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW32 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW90 | Mine Unit 2 | 13.6 | 823 | 121.3 |
| MW35 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW101 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW36 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW102 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW37 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW103 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW38 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW104 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW39 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW105 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW40 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW106 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW41 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW107 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW42 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW108 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW43 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW109 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW44 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW110 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW45 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW111 | Mine Unit 2 | 11.6 | 778 | 124.6 |
| MW62 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW114 | Mine Unit 2 | 13.4 | 777 | 129.7 |
| MW63 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW115 | Mine Unit 2 | 13.4 | 777 | 129.7 |
| MW64 | Mine Unit 3 | 13.4 | 777 | 129.7 | MW116 | Mine Unit 2 | 13.4 | 777 | 129.7 |
| MW73 | Mine Unit 2 | 13.6 | 823 | 121.3 | 4MW-1 | Mine Unit 4 | 11.1 | 825 | 116.9 |
| MW74 | Mine Unit 2 | 13.6 | 823 | 121.3 | 4MW-2 | Mine Unit 4 | 11.1 | 825 | 116.9 |
| MW75 | Mine Unit 2 | 13.6 | 823 | 121.3 | 4MW-3 | Mine Unit 4 | 11.1 | 825 | 116.9 |
| [illegible] | Mine Unit 2 | 13.6 | 823 | 121.3 | 4MW-4 | Mine Unit 4 | 11.1 | 825 | 116.9 |

TAB. ).27

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS CHRISTENSEN RANCH

Monitor Well - cont'd

| Well No. | Location | Upper Control Limit | | | Well No. | Location | Upper Control Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Perimeter Ore Zone (cont.) | | | | | | | | | |
| 4MW-5 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW16 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-6 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW18 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-7 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW20 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-8 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW30A | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-9 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW31 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-10 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW32A | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-11 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW33 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-12 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW34 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-13 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW35A | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-14 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW36 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-15 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW37 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-16 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW38 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-17 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW39A | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-18 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW40 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-19 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW41A | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-20 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW42 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-21 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW43 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-22 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW44 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-23 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW46 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-24 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW47B | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 4MW-25 | Mine Unit 4 | 11.1 | 825 | 116.9 | 5MW48 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW1 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW49 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW2 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW50 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW3 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW51 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW4 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW52 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW5 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW53 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW6 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW54 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW7 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW55 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW8 | Mine Unit 5 | 23.0 | 1423 | 122.5 | 5MW56 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW10 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW57 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW12 | Mine Unit 5 | 22.8 | 1725 | 145.4 | 5MW58 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| [illegible] | [illegible] | 22.7 | 1004 | 134.3 | 5MW59 | Mine Unit 5 | 22.7 | 1004 | 134.3 |

TAB. .27

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS CHRISTENSEN RANCH

Monitor Well - cont'd

| Well No. | Location | Upper Control Limit | | | Well No. | Location | Upper Control Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Perimeter Ore Zone (cont'd) | | | | | | | | | |
| 5MW60 | Mine Unit 5 | 23.7 | 779 | 191.3 | 5MW65 | Mine Unit 5 | 24.9 | 734 | 128.1 |
| 5MW61 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW66 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW62 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW67 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW63 | Mine Unit 5 | 22.7 | 1004 | 134.3 | 5MW69 | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5MW64 | Mine Unit 5 | 22.7 | 1004 | 134.3 | | | | | |
| Shallow Sand | | | | | | | | | |
| MW46S | Mine Unit 3 | 13.5 | 1087 | 184.4 | MW98S | Mine Unit 2 | 63.4 | 21365 | 5861.3 |
| MW48S | Mine Unit 3 | 22.2 | 1775 | 268.3 | MW100S | Mine Unit 2 | 23.5 | 3560 | 304.0 |
| MW50S | Mine Unit 3 | 22.2 | 1775 | 268.3 | MW112S | Mine Unit 2 | 63.4 | 21365 | 5861.3 |
| MW52S | Mine Unit 3 | 22.2 | 1775 | 268.3 | MW117S | Mine Unit 2 | 13.6 | 768 | 144.5 |
| MW54S | Mine Unit 3 | 22.2 | 1775 | 268.3 | 4SM-1 | Mine Unit 4 | 8.8 | 1570 | 142.7 |
| MW56S | Mine Unit 3 | 13.5 | 1087 | 184.4 | 4SM-4 | Mine Unit 4 | 8.8 | 1570 | 142.7 |
| MW58S | Mine Unit 3 | 13.5 | 1087 | 184.4 | 4SM-8 | Mine Unit 4 | 8.8 | 1570 | 142.7 |
| MW66S-2 | Mine Unit 3 | 22.2 | 1775 | 129.7 | 4SRM-07 | Mine Unit 4 | 19.4 | 1175 | 447.1 |
| MW68S | Mine Unit 2 | 23.5 | 3560 | 304.0 | 5SM1 | Mine Unit 5 | 22.1 | 2922 | 316.6 |
| MW70S | Mine Unit 2 | 63.4 | 21365 | 5861.3 | 5SM2 | Mine Unit 5 | 22.1 | 2922 | 316.6 |
| MW72S | Mine Unit 2 | 63.4 | 21365 | 5861.3 | 5SM3 | Mine Unit 5 | 22.1 | 2922 | 316.6 |
| MW92S | Mine Unit 2 | 23.5 | 3560 | 304.0 | 5SM5 | Mine Unit 5 | 22.1 | 2922 | 316.6 |
| MW94S | Mine Unit 2 | 23.5 | 3560 | 304.0 | 5SM6 | Mine Unit 5 | 22.1 | 2922 | 316.6 |
| MW96S | Mine Unit 2 | 23.5 | 3560 | 304.0 | 5SM7 | Mine Unit 5 | 22.1 | 2922 | 316.6 |

TAB. .27

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS CHRISTENSEN RANCH

Monitor Well - cont'd

| Well No. | Location | Upper Control Limit | | | Well No. | Location | Upper Control Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Deep Sand | | | | | | | | | |
| MW45D | Mine Unit 3 | 13.7 | 753 | 153.3 | MW97D | Mine Unit 2 | 13.8 | 723 | 143.3 |
| MW47D | Mine Unit 3 | 13.7 | 753 | 153.5 | MW99D | Mine Unit 2 | 13.8 | 723 | 143.3 |
| MW49D | Mine Unit 3 | 13.7 | 753 | 153.5 | MW113D | Mine Unit 2 | 13.8 | 723 | 143.3 |
| MW51D | Mine Unit 3 | 13.7 | 753 | 153.3 | 4DM-1 | Mine Unit 4 | 14.1 | 712 | 189.2 |
| MW53D | Mine Unit 3 | 13.7 | 753 | 153.3 | 4DM-4 | Mine Unit 4 | 14.1 | 712 | 189.2 |
| MW55D | Mine Unit 3 | 13.7 | 753 | 153.3 | 4DM-8 | Mine Unit 4 | 14.1 | 712 | 189.2 |
| MW57D | Mine Unit 3 | 13.7 | 753 | 153.3 | 4DRM-07 | Mine Unit 4 | 14.1 | 712 | 189.2 |
| MW65D | Mine Unit 3 | 13.7 | 753 | 129.7 | 5DM1A | Mine Unit 5 | 22.8 | 1017 | 420.9 |
| MW67D | Mine Unit 2 | 12.9 | 789 | 134.0 | 5DM2 | Mine Unit 5 | 22.8 | 1017 | 420.9 |
| MW69D | Mine Unit 2 | 12.9 | 789 | 134.0 | 5DM3 | Mine Unit 5 | 22.8 | 1017 | 420.9 |
| MW71D | Mine Unit 2 | 12.9 | 789 | 134.0 | 5DM4 | Mine Unit 5 | 22.8 | 1017 | 420.9 |
| MW91D | Mine Unit 2 | 12.9 | 789 | 134.0 | 5DM5 | Mine Unit 5 | 22.8 | 1017 | 420.9 |
| MW93D | Mine Unit 2 | 12.9 | 789 | 134.0 | 5DM7 | Mine Unit 5 | 22.8 | 1017 | 420.9 |
| MW95D | Mine Unit 2 | 12.9 | 789 | 134.0 | 5DM8T | Mine Unit 5 | 22.7 | 1004 | 134.3 |
| 5DM9T | Mine Unit 5 | NOT BASELINED | | | | | | | |

TAB. .27

## INDIVIDUAL MONITOR WELL UPPER CONTROL LIMITS and TREND WELL ACTION LIMITS CHRISTENSEN RANCH

Trend Wells - cont'd

| Well No. | Location | Upper Control Limit | | | Well No. | Location | Upper Control Limit | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cl | Cond | Alk | | | Cl | Cond | Alk |
| Perimeter Ore Zone | | | | | | | | | |
| MW78T | Mine Unit 2 | 13.6 | 823 | 121.3 | MW87T | Mine Unit 2 | 13.6 | 823 | 121.3 |
| 5TW-1 | Mine Unit 5 | NOT BASELINED | | | | | | | |

Units 2, 4 and 5: Operational Status Active
Sampling Frequency Every 2 Weeks

Unit 3: Operational Status Standby
Sampling Frequency Every 2 Weeks

analytical list of chloride, conductivity and total alkalinity. An excursion was considered concluded when the concentrations of excursion indicators did not exceed the criteria defining an excursion for three consecutive one-week samples.

Proposed Excursion Verification and Monitoring Program

The proposed excursion verification and monitoring program for both the Irigaray and Christensen Ranch sites is the same as noted above for Christensen Ranch, except that upper control limits for all monitor wells at the Irigaray and Christensen Ranch sites will be calculated as follows:

| | |
|---|---|
| Chloride - | baseline mean plus 15 mg/l |
| Total Alkalinity - | baseline mean plus 5 standard deviations |
| Conductivity - | baseline mean plus 5 standard deviations |

Group upper control limits for each stratigraphic unit within each mine unit will continue to be calculated as well. The method for removal of outliers from the water quality data base will also be the same as noted above.

### 5.8.2.4 Surface Water Monitoring

Program Description and Historic Results

The pre-operational water quality monitoring program assessed water quality and quantity for the Willow Creek drainage and tributaries within and immediately adjacent to the Irigaray and Christensen Ranch boundaries. During operations, COGEMA sampled four surface water locations at Irigaray and three at Christensen Ranch. Quarterly grab samples were taken from upstream (IR-14) and downstream (IR-9) Willow Creek monitoring stations at Irigaray. Additionally, a sample was collected quarterly at station IR-17, adjacent to the operating well fields. Annually, samples were also collected from the Powder River at the Irigaray Ranch, downstream from the confluence with Willow Creek (IR-5). At Christensen, samples were collected downstream from the well field operations (GS-01), upstream from the operations (CG-05) and adjacent to Mine Unit 3 (GS-03). Samples from all locations except IR-5 were obtained quarterly on a runoff event basis as Willow Creek is an ephemeral stream. IR-5 is obtained annually. Surface monitoring results are submitted in the semi-annual activity and monitoring reports submitted to the WDEQ and NRC. A summary of the past regional surface water monitoring results is given in Table 5.28.

Proposed Surface Water Monitoring Program

No changes to the current surface water monitoring program are recommended. A summary of the proposed program is given in Table 5.25.

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| IR-5 (Irigaray - Powder River at the Irigaray Ranch) | Annual Grab | 8/19/87 | 0.0056 | 1.4 ± 0.4 | 12.1 ± 3.6 | 3.9 ± 1.9 | 10.6 ± 1.7 |
| | | 6/21/88 | 0.0103 | 3.2 ± 1.1 | 8.4 ± 5.0 | 3.7 ± 4.4 | < 1.0 |
| | | 8/17/89 | 0.0091 | 13.5 ± 1.0[1] | < 0.2 | 23.1 ±2.4 | < 1.0 |
| | | 8/21/90 | 0.0038 | 0.3 ± 0.3 | 0.5 ± 0.5 | < 1.0 | < 1.0 |
| | | 1991 | 0.001 | < 0.2 | < 0.2 | 7.5 ± 0.8 | 1.7 ± 0.5 |
| | | 7/10/92 | | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 7/2/93 | 0.009 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 7/2/94 | < 0.009 | < 0.2 | < 0.2 | <1.0 | <1.0 |
| IR-9 (Irigaray - Downstream Willow Creek) | Quarterly Grab | 3rd and 4th Quarter 1987 | 0.0386 | 3.7 | 3.95 | 3.45 | 6.1 |
| | | 1st and 2nd Quarter 1988 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1988 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1988 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1988 | No Flow | No Flow | No Flow | No Flow | No Flow |

[1] Data is perceived to be a laboratory error. No verification data are available.

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| IR-9 (Irigaray-Downstream Willow Creek) (cont'd) | Quarterly Grab | 1st and 2nd Quarter 1989 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1989 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1990 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1990 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1991 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1991 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1992 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1992 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | | | | | | |

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| IR-9 (Irigaray-Downstream Willow Creek) (cont'd) | Quarterly Grab | 1st and 2nd Quarter 1993 | 0.032 | 0.4 | < 0.2 | 2.7 | < 1.0 |
| | | 3rd and 4th Quarter 1993 | 0.023 | < 0.2 | < 1.0 | < 1.0 | 3.4 |
| | | 1st and 2nd Quarter 1994 | 0.020 | < 2.0 | < 2.0 | 4.0 | < 1.0 |
| | | 3rd and 4th Quarter 1994 | No Flow | No Flow | No Flow | No Flow | No Flow |
| IR-14 (Irigaray-Upstream Willow Creek) | Quarterly Grab | 3rd and 4th Quarter 1987 | 0.0162 | 3.85 | 0.95 | 1.0 | 4.05 |
| | | 1st and 2nd Quarter 1988 | 0.0404 | 35.7[1] | 4.8 | 4.0 | < 1.0 |
| | | 3rd and 4th Quarter 1988 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1989 | No Flow | No Flow | No Flow | No Flow | No Flow |

[1] Data is perceived to be a laboratory error. No verification data are available.

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| IR-14 (Irigaray-Upstream Willow Creek) (cont'd) | Quarterly Grab | 3rd and 4th Quarter 1989 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1990 | 0.0245 | 1.4 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1990 | 0.0170 | 0.2 | 0.2 | 1.6 | 1.0 |
| | | 1st and 2nd Quarter 1991 | 0.007 | 0.3 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1991 | 0.0140 | 0.3 | 0.2 | 1.0 | 3.0 |
| | | 1st and 2nd Quarter 1992 | 0.0035 | 0.6 | 0.2 | 1.35 | 1.0 |
| | | 3rd and 4th Quarter 1992 | 0.0170 | < 0.2 | < 0.2 | < 0.1 | 2.1 ± 0.2 |
| | | 1st and 2nd Quarter 1993 | 0.0300 | 0.3 | < 0.2 | 1.4 | < 1.0 |

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| IR- 14 (Irigaray-Upstream Willow Creek) (cont'd) | Quarterly Grab | 3rd and 4th Quarter 1993 | 0.0115 | 0.25 | 1.0 | 1.0 | 2.95 |
| | | 1st and 2nd Quarter 1994 | 0.0805 | 5.5 | 1.1 | 2.75 | 1.4 |
| | | 3rd and 4th Quarter 1994 | 0.0144 | 0.2 | 0.2 | 1.0 | 1.0 |
| IR-17 (Irigaray - 200' East of Unit 1) | Quarterly Grab | 3rd and 4th Quarter 1988 | 0.0273 | 10.55[1] | 2.65 | 1.8 | 1.0 |
| | | 1st and 2nd Quarter 1989 | 0.0227 | 0.4 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1989 | 0.0239 | 2.1 | 1.4 | 4.1 | 1.0 |
| | | 1st and 2nd Quarter 1990 | 0.0252 | < 0.2 | < 0.2 | 1.0 | 4.6 |
| | | 3rd and 4th Quarter 1990 | 0.0223 | 0.35 | 0.2 | 6.85 | 1.0 |

[1] Data is perceived to be a laboratory error. No verification data are available.

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| IR-17 (Irigaray-200' East of Unit 1) (cont'd) | Quarterly Grab | 1st and 2nd Quarter 1991 | 0.0130 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1991 | 0.0076 | 0.2 | 0.2 | 1.6 | 1.8 |
| | | 1st and 2nd Quarter 1992 | 0.0120 | 0.2 | 0.2 | 1.05 | 1.0 |
| | | 3rd and 4th Quarter 1992 | 0.0200 | 0.4 | < 0.2 | < 1.0 | 2.5 |
| | | 1st and 2nd Quarter 1993 | 0.2700 | < 0.2 | < 0.2 | 1.4 ± 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1993 | 0.0280 | 0.2 | 1.0 | 1.0 | 1.0 |
| | | 1st and 2nd Quarter 1994 | 0.018 | 2.1 | 1.1 | 2.75 | 1.05 |
| | | 3rd and 4th Quarter 1994 | 0.023 | 0.25 | 0.2 | 1.0 | 1.0 |

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| CG-05 (Willow Creek Upstream Christensen) | Quarterly Grab | 3rd and 4th Quarter 1988 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1989 | 0.0140 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1989 | 0.0273 | 0.2 | 5.7 | 1.7 | 8.1 |
| | | 1st and 2nd Quarter 1990 | 0.0176 | 0.9 | < 0.2 | < 1.0 | 1.1 |
| | | 3rd and 4th Quarter 1990 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1991 | 0.005 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1991 | 0.0190 | < 0.2 | < 0.2 | < 1.0 | 1.2 |
| | | 1st and 2nd Quarter 1992 | 0.0085 | 0.5 | 0.2 | 1.0 | 1.0 |

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| CG-05 (Willow Creek Upstream Christensen) (cont'd) | Quarterly Grab | 3rd and 4th Quarter 1992 | 0.0100 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 1st and 2nd Quarter 1993 | 0.0150 | 0.2 | < 0.2 | 1.8 | < 1.0 |
| | | 3rd and 4th Quarter 1993 | 0.0170 | 0.2 | 0.6 | 7.7 | 1.4 |
| | | 1st and 2nd Quarter 1994 | 0.019 | 1.8 | 1.1 | 3.9 | 1.0 |
| | | 3rd and 4th Quarter 1994 | 0.010 | < 0.2 | < 0.2 | < 1.0 | 2.4 |
| GS-01 (Willow Creek Down-stream-Christensen) | Quarterly Grab | 3rd and 4th Quarter 1988 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1989 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1989 | 0.0147 | 0.2 | 6.1 | < 1.0 | < 1.0 |

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| GS-01 (Willow Creek Down-stream-Christensen) (cont'd) | Quarterly Grab | 1st and 2nd Quarter 1990 | 0.0887 | < 0.2 | < 0.2 | 4.4 | 3.5 |
| | | 3rd and 4th Quarter 1990 | 0.0169 | < 0.2 | < 0.2 | 7.8 | < 1.0 |
| | | 1st and 2nd Quarter 1991 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1991 | 0.0168 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 1st and 2nd Quarter 1992 | 0.0310 | 0.2 | 0.2 | 1.0 | 2.0 |
| | | 3rd and 4th Quarter 1992 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1993 | 0.5400[1] | 0.4 | < 0.2 | 2.4 | < 1.0 |
| | | 3rd and 4th Quarter 1993 | 0.0525 | 0.45 | 0.6 | 13.5 | 1.25 |

[1] Data perceived to be a laboratory error. No verification data are available.

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| GS-01 (Willow Creek Down-stream-Christensen) (cont'd) | Quarterly Grab | 1st and 2nd Quarter 1994 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 3rd and 4th Quarter 1994 | 0.018 | 0.6 | < 0.2 | < 1.0 | 1.6 |
| GS-03 (Willow Creek 250 yds Downstream from MU-3 - Christensen) | Quarterly Grab | 2nd Quarter 1989 | 3.0240[1] | 0.6 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1989 | 1.709[1] | 5.8 | 9.6 | 8.2 | 5.6 |
| | | 1st and 2nd Quarter 1990 | 0.4370 | < 0.2 | < 0.2 | 1.9 | 6.4 |
| | | 3rd and 4th Quarter 1990 | No Flow | No Flow | No Flow | No Flow | No Flow |
| | | 1st and 2nd Quarter 1991 | 0.3550 | 0.4 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1991 | No Flow | No Flow | No Flow | No Flow | No Flow |

[1] Data perceived to be a laboratory error. No verification data are available.

## TABLE 5.28
## REGIONAL SURFACE WATER MONITORING RESULTS

| STATION NUMBER | SAMPLING FREQUENCY AND METHOD | SAMPLE DATE | U (mg/l) | Ra-226 (pCi/l) | Th-230 (pCi/l) | Pb-210 (pCi/l) | Po-210 (pCi/l) |
|---|---|---|---|---|---|---|---|
| GS-03 (Willow Creek 250 yds Downstream from MU-3-Christensen) (cont'd) | Quarterly Grab | 1st and 2nd Quarter 1992 | 0.3550 | 0.4 | 0.2 | 1.0 | 1.1 |
| | | 3rd and 4th Quarter 1992 | 0.0200 | < 0.2 | < 0.2 | < 1.0 | < 1.0 |
| | | 1st and 2nd Quarter 1993 | 0.1310 | 0.7 | < 0.2 | < 1.0 | < 1.0 |
| | | 3rd and 4th Quarter 1993 | 0.2850 | 0.35 | 0.6 | 10.5 | 1.25 |
| | | 1st and 2nd Quarter 1994 | 0.0385 | 2.25 | 1.1 | 2.2 | 1.25 |
| | | 3rd and 4th Quarter 1994 | 0.0885 | 0.5 | 0.2 | 1.0 | 1.2 |

Notes: Analysis performed by Energy Laboratories, Incorporated (ELI), Casper, Wyoming.

ELI Detection Limit:
U (mg/l) = 0.0003
Ra-226 (pCi/l) = 0.20
Th-230 (pCi/l) = 0.2 to 1.0
Pb-210 (pCi/l) = 1.0
Po-210 (pCi/l) = 1.0

### 5.8.3 EVAPORATION POND LEAK DETECTION MONITORING

The brine evaporation and restoration ponds at both Irigaray and Christensen Ranch are lined and equipped with a leak detection system. During operations, the leak detection standpipes are checked for evidence of leakage on a weekly frequency. Visual inspection of the pond embankments, fences and liners and the measurement of pond freeboard are performed on the same frequency. Anytime six (6) inches or more of fluid is detected in a leak detection system standpipe, a sample of the solution is obtained and analyzed for chloride, conductivity, pH and uranium. Should the analyses indicate that the pond is leaking (by comparison to chemical analyses of pond water), the following actions are taken:

- The WDEQ and USNRC are notified by telephone within 48 hours of leak verification.

- The level of the leaking pond is lowered by transferring its contents into an adjacent pond, or a pond within the pond system. While lowering the water level in the pond, inspections of the liner are made to determine the cause and location of the leakage. The area of investigation first centers around the pond area specific for the particular standpipe which contains fluid. Each lined pond has six leak detection standpipes. Therefore, the area of leakage is readily identifiable.

- Once the source of the leakage is found, the liner is repaired and water is reintroduced to the pond to check the adequacy of the repair. Water in the leak detection standpipes is monitored on a daily basis while refilling the pond.

- A written report is submitted to the WDEQ and USNRC within 30 days of correcting the leakage. The report includes analytical data and describes the cause of the leakage, corrective actions taken and the results of those actions.

Because the permeate storage ponds are unlined and will contain water which meets NPDES surface discharge criteria, leak detection systems are not installed. Water quality in the permeate storage ponds is sampled on a quarterly frequency and analyzed for uranium, radium-226 (dissolved), pH, TDS, chloride, conductivity and zinc. Water quality in the brine evaporation ponds is sampled on a quarterly basis and analyzed for uranium, radium-226, pH, TDS, chloride, conductivity, sulfate, ammonium (NH4), nitrate (NO3) and zinc. Results of the quarterly assays are reported to the WDEQ and NRC in the semi-annual reports.

## 5.9 QUALITY ASSURANCE PROGRAM

A quality assurance program has been in place at Irigaray and Christensen Ranch for all relevant operational monitoring and analytical procedures. The objective of the program has been to identify any deficiencies in the sampling techniques and measurement processes so that corrective action could be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program provided assurance to both regulatory agencies and the public that the monitoring results were valid.

The QA program has addressed the following:

- Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports was provided.

- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program.

- Written procedures for QA activities. These procedures include activities involving sample collection, sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting.

- Quality control (QC) in the laboratory. Procedures cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs. Outside laboratory QA/QC programs are included.

- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.

The Standard Operating Procedures developed by COGEMA are a critical step to insuring that quality assurance objectives are met. Current SOP's exist for a variety of areas, including but not limited to:

1. Environmental monitoring procedures.
2. Testing procedures.
3. Exposure procedures.
4. Equipment operation and maintenance procedures.
5. Employee health and safety procedures.
6. Incident response procedures.
7. Laboratory procedures.

Routine monitor well samples, pond samples and some radiological survey samples are analyzed at the Irigaray laboratory. In 1996, the laboratory at Irigaray will be moved to the new office building at Christensen Ranch. The quality assurance plan for this laboratory is detailed in Standard Operating Procedure ENV-22, "Laboratory Quality Assurance Program, Irigaray Mine Site."

## 5.10 REPORTING PROCEDURES

### 5.10.1 ROUTINE REPORTS

Routine reports and data submittals to the WDEQ and USNRC are described as follows.

#### 5.10.1.1 Semi-Annual Report

Pursuant to 10 CFR 40, Section 40.64, a report will be submitted to the USNRC on a semi-annual basis outlining the results of the effluent and environmental monitoring programs described in Sections 5.8 and any other information required by license condition.

A report will also be submitted to the WDEQ on a semi-annual basis that will address the results of the operational groundwater monitoring program (monitor and trend well sample analyses and water levels in tabular form), summaries of the well integrity testing program, and an accounting of the total gallons injected and recovered. If practical, the WDEQ semi-annual report will be combined with the USNRC semi-annual report.

#### 5.10.1.2 Annual Report

As required by W.S. 35-11-411, COGEMA will submit an annual report to the WDEQ. The report shall contain the following information:

1. Maps showing locations of all wells installed in conjunction with the mining activity and areas where groundwater restoration has been achieved or is taking place or planned to take place within the next year. The map should also show areas where mining is expected to commence during the next year.

2. The total quantity of recovery fluid injected and the total quantity of recovery fluid extracted during the annual reporting period for each mine unit including a description of how these quantities were determined.

3. Water quality monitoring program results including a map and description of excursions, if any occurred during the period, their location and extent.

4. An updated potentiometric surface map for all aquifers that are or may be affected by the mining operation.

In addition to the above information, COGEMA will use the annual report as the mechanism to update or revise the mine plan as operations progress. The annual report will contain the bond estimate for surface and aquifer restoration for the current and following year's operations. The USNRC will receive a copy of the WDEQ annual report.

An annual report will also be submitted to the USNRC which outlines any changes made to the operations and approved by the SERP, under the performance based license, during the past year. The annual report will include a summary of the changes and recommendations approved by the SERP, as well as copies of any pages of this application which are revised by the SERP. The annual report may be included with semi-annual report, or may be combined with the WDEQ annual report.

5.10.1.3 Mine Unit Data Submittals

Prior to the commencement of lixiviant injection into a new mine unit, certain baseline information will be collected. This information will be summarized in a baseline data package for submittal to the WDEQ for their approval of operations in the new mine unit. The package will not formally be submitted to the USNRC under the new performance based license, but will instead be evaluated by the SERP and will be available for review during an inspection.

COGEMA will establish baseline groundwater quality for each mine unit as previously discussed. Baseline data collection for each mine unit will begin as soon as the boundaries of a new unit are defined and monitor wells are installed. The mine unit baseline water quality will be submitted to the WDEQ as supplemental information to the original mine permit.

The data package submitted to the WDEQ for a particular mine unit will include:

1. Baseline water quality for the ore zone monitor wells, the overlying aquifer monitor wells, underlying aquifer monitor wells and the ore zone itself within the well field boundaries.

2. Results of a pumping test to demonstrate that the perimeter ore zone monitor wells are in communication with the mine unit ore zone wells.

3. Potentiometric surface maps for the ore zone, the overlying aquifer and the underlying aquifer as developed from pre-mining water levels.

4. Monitor well upper control limits.

5. Location and completion details for monitor wells and ore zone baseline water quality wells.

6. Average mine unit baseline water quality and proposed restoration target values.

7. If a mine unit is in an area where no previous baseline hydrologic data is available, the results of a multi-well aquifer test will be submitted. The test will define the aquifer properties within the affected area including average and directional transmissivity, permeabilities, hydrologic boundary conditions, and vertical confinement of the mining zone. An analysis of whether an excursion can be retrieved from a monitor well within the 60-day regulatory timeframe will be conducted, if the aquifer properties are significantly different than others identified in previous mine units.

### 5.10.2 NON-ROUTINE REPORTS

In the event that a report of a non-routine incident becomes necessary, COGEMA will follow specific reporting procedures for that incident as identified by the particular regulatory agency. In most cases, both the WDEQ and NRC are notified by telephone within 24 to 48 hours of verified monitor well excursions, pond leakage, significant spills, tank ruptures, or any other incidents that would trigger the reporting requirements provided in 10 CFR 20, Subpart M. Written reports will follow such telephone reports within the timeframes discussed in this application, or by other requirements imposed by the regulatory agency.

# 6.0 RESTORATION AND RECLAMATION PLANS

## 6.1 GROUNDWATER RESTORATION

### 6.1.1 TARGET RESTORATION VALUES

COGEMA's primary goal for restoration will be to return the quality of groundwater at the Irigaray and Christensen Ranch sites to baseline concentrations, using the best practicable technology and economic reasonableness. If the primary goal cannot be achieved, the groundwater will, at a minimum, be returned to the pre-mining use category.

Details of the establishment of baseline water quality in a particular mine unit were previously given in Section 5.8 of this application. In summary, groundwater baseline water quality is established for a mine unit by collecting samples from representative injection or recovery wells within that unit and arithmetically averaging the sample results, after outlier removal. The overall average result will be used as the baseline concentration.

Because of the number of sample results used for the average baseline determination, the spatial distance over which the samples were distributed, and the variability between sample results, the final restoration concentration achieved for a particular chemical constituent should be a function of the average baseline and the variability found between sample results used for baseline determination. Accordingly, the target restoration values will be a function of the average baseline, the range of results found in the baseline samples and the variability between sample results. The target values for the majority of chemical constituents should fall between tolerance limits calculated with the mine unit baseline data base, using the same tolerance limit method previously provided in Section 5.8 under upper control limit calculations.

Target restoration values for the Irigaray site restoration program which are currently approved are provided for the reader's convenience in Table 6.1 of this report. From previous restoration efforts at Irigaray (E-Field and 517), it is known that certain parameters are returned to values above baseline during restoration, yet they are still within the quality of use. For these parameters, target restoration values other than baseline were set and approved by the regulatory agencies, in the case of the Irigaray restoration program. Please note that the target value for ammonia is only applicable to Irigaray Units 1 through 5. The pre-mining use category has been established by the Water Quality Division, WDEQ with the approval of each Unit's baseline data package. The use category is essentially Class I (Domestic Use) for the ore zone, with some localized exceptions such as Class II (Agriculture) and Class III (Livestock), based on an individual well's water quality characteristics. The Unit 1 Sand (overlying monitor zone) has been classified as Class III (Livestock).

TABLE 6.1
IRIGARAY TARGET RESTORATION VALUES
(OUT OF PERMIT TO MINE NO. 478, AMENDMENT NO. 2)

| PARAMETER | BASELINE RANGE | CLASS STANDARDS[b] DOMESTIC | CLASS STANDARDS[b] LIVESTOCK | TARGET RESTORATION VALUES |
|---|---|---|---|---|
| | | 0.5[d] | | |
| Ammonia ($NH_4$) | - <0.5d | 0.05 | 0.2 | 50[c] |
| Arsenic (As) | <0.01 - 0.105 | 1.0 | 0.2 | Baseline |
| Barium (Ba) | <0.01 - 0.08 | | | Baseline |
| Bicarbonate ($HCO_3$) | 14.2 - 133.6 | | | 295[c] |
| Boron (B) | <0.01 - 0.225 | 0.75 | 5.0 | Baseline |
| Cadmium (Cd) | <0.002 - 0.006 | 0.01 | 0.05 | Baseline |
| Calcium (Ca) | 1.6 - 27.1 | | | Baseline |
| Chloride (Cl) | 7.8 - 15.1 | 250.0 | 2000.0 | 56[c] |
| Chromium (Cr) | <0.002 - 0.024 | 0.05 | 0.05 | Baseline |
| Copper (Cu) | <0.005 - 0.051 | 1.0 | 0.5 | Baseline |
| Fluoride (F) | 0.2 - 0.68 | 1.4 - 2.4 | | Baseline |
| Iron (Fe) | 0.2 - 6.88 | 0.3 | | Baseline |
| Lead (Pb) | <0.002 - 0.014 | 0.05 | 0.1 | Baseline |
| Magnesium (Mg) | <0.1 - 7.1 | | | Baseline |
| Manganese (Mn) | <0.005 - 0.058 | 0.05 | | Baseline |
| Mercury (Hg) | - <0.0002 | 0.002 | 0.00005 | Baseline |
| Molybdenum (Mo) | <0.02 - 0.05 | | | Baseline |
| Nickel (Ni) | - <0.2 | | | Baseline |
| Nitrate ($NO_2$) | 0.2 - 1.0 | 10.0 | | Baseline |
| Potassium (K) | 1.4 - 5.3 | | | Baseline |
| Selenium (Se) | <0.01 - 0.322 | 0.01 | 0.05 | Baseline |
| Sodium (Na) | 99.7 - 164.0 | | | Baseline |
| Sulfate ($SO_4$) | 140 - 300 | 250.0 | 3000.0 | Baseline |
| Total Dissolved Solids | 271 - 555 | 500.0 | 5000.0 | Baseline |

## TABLE 6.1 (cont'd)
## IRIGARAY TARGET RESTORATION VALUES
## (OUT OF PERMIT TO MINE NO. 478, AMENDMENT NO. 2)

| PARAMETER | BASELINE RANGE | CLASS STANDARDS[b] DOMESTIC | CLASS STANDARDS[b] LIVESTOCK | TARGET RESTORATION VALUES |
|---|---|---|---|---|
| Uranium (U) | 0.01 - 18.6 | 5.0 | 5.0 | 2.09 [c,e] |
| Vanadium (V) | <0.0 5 - 0.55 | | 0.1 | Baseline |
| Zinc (Zn) | <0.02 - 0.17 | 5.0 | 25.0 | Baseline |
| pH (Units) | 8.0 - 10.4 | 6.5 - 9.0 | 6.5 - 8.5 | Baseline |
| Radium-226 (pci/l) | 2.5 - 210 | 5.0 | 5.0 | Baseline |

a) Ranges were compiled using average baseline data from 30 production zone wells located in Production Units 1 through 6 (Average baseline = average results from three baseline samples). The wells are: AP-3, AP-4, AP-10, DI-4, DI-12, DI-21, DI-27, EI-15, EI-16, EI-17, EI-18, EI-34, EI-54, EI-68, FI-60, FI-62, FI-64, FI-66, FI-67, GI-76, GI-82, GI-105, HI-57, HI-62, HP-59, HP-87, and GI-122. Baseline ranges may change as mining progresses.

b) Taken from Wyoming Department of Environmental Quality, Water Quality Rules and Regulations, Chapter VIII, "Quality Standards for Wyoming Groundwaters", Table 1; April 1980.

c) Target values presented are based on results achieved during research and development tests at the Irigaray Site, the use of best practicable technology and economic reasonableness. The target restoration value for $NH_4$ applies only to Units 1-5 where ammonium bicarbonate lixiviant was used. Target values for bicarbonate, chloride, and uranium are based upon the final 360-day E Field stabilization values (mean plus two standard deviations).

d) Wyoming standards are expressed in terms of ammonia ($NH_3$).

e) Target values may have to be adjusted as necessary as restoration proceeds, however, in no case the value be greater than 5 mg/l (Class of Use).

Target restoration values for the Christensen Ranch restoration program have been established in each individual baseline data package for Mine Units 2, 3, 4 and 5 submitted to and approved by the regulatory agencies. Target values were set as the baseline mean with an acceptable range provided by tolerance limits, to account for the baseline variability. This is necessary because we know that the exact average baseline value for a particular constituent will probably not be met at restoration, therefore the restored concentration should fall within a range of acceptable values around the mean baseline value. This range has been calculated with tolerance limits. For non-detectable values, the target is to restore to the same proportion of non-detectable values.

Secondary restoration target values are a function of the pre-mining use suitability criteria as established by the WDEQ. Most of the ore zone groundwater at Christensen Ranch has been classified by WDEQ as Class I Domestic, with the exception of radium-226 in some areas. Other classifications at Christensen range from Class I, II, III and IV in the shallow zones, to Class I in the deep zones.

Target values for each individual Mine Unit at Christensen Ranch can be found in the individual baseline data packages for each mine unit, submitted to the WDEQ and NRC on or about the following dates:

| | | |
|---|---|---|
| Mine Unit 2 North | - | November, 1992 |
| Mine Unit 2 South | - | April, 1992 |
| Mine Unit 3 | - | December, 1988 |
| Mine Unit 3 expansion | - | June 18, 1991 |
| Mine Unit 3, Modules 2 and 4A | - | October, 1993 |
| Mine Unit 4 | - | April, 1994 |
| Mine Unit 5 | - | February, 1995 |

### 6.1.2 RESTORATION PROCESSES

The restoration programs conducted in the past, and planned for the future involve essentially three phases of restoration processes. They are as follows:

1: Groundwater Sweep
2: Reverse Osmosis with Permeate Injection (includes metals reduction)
3: Groundwater Recirculation
4: Stabilization Monitoring

These phases of restoration have been shown to be effective in previous restoration efforts, including the 517 R & D site, the Irigaray E-Field restoration, Christensen Ranch Willow Creek R & D site, and the Irigaray Units 1 through 3. The first three phases are active restoration processes. The last phase of restoration is the stability monitoring phase, where the groundwater is monitored for a minimum of nine months

to assure that the restored concentrations are stable. A description of each restoration process is provided below.

#### 6.1.2.1 Groundwater Sweep

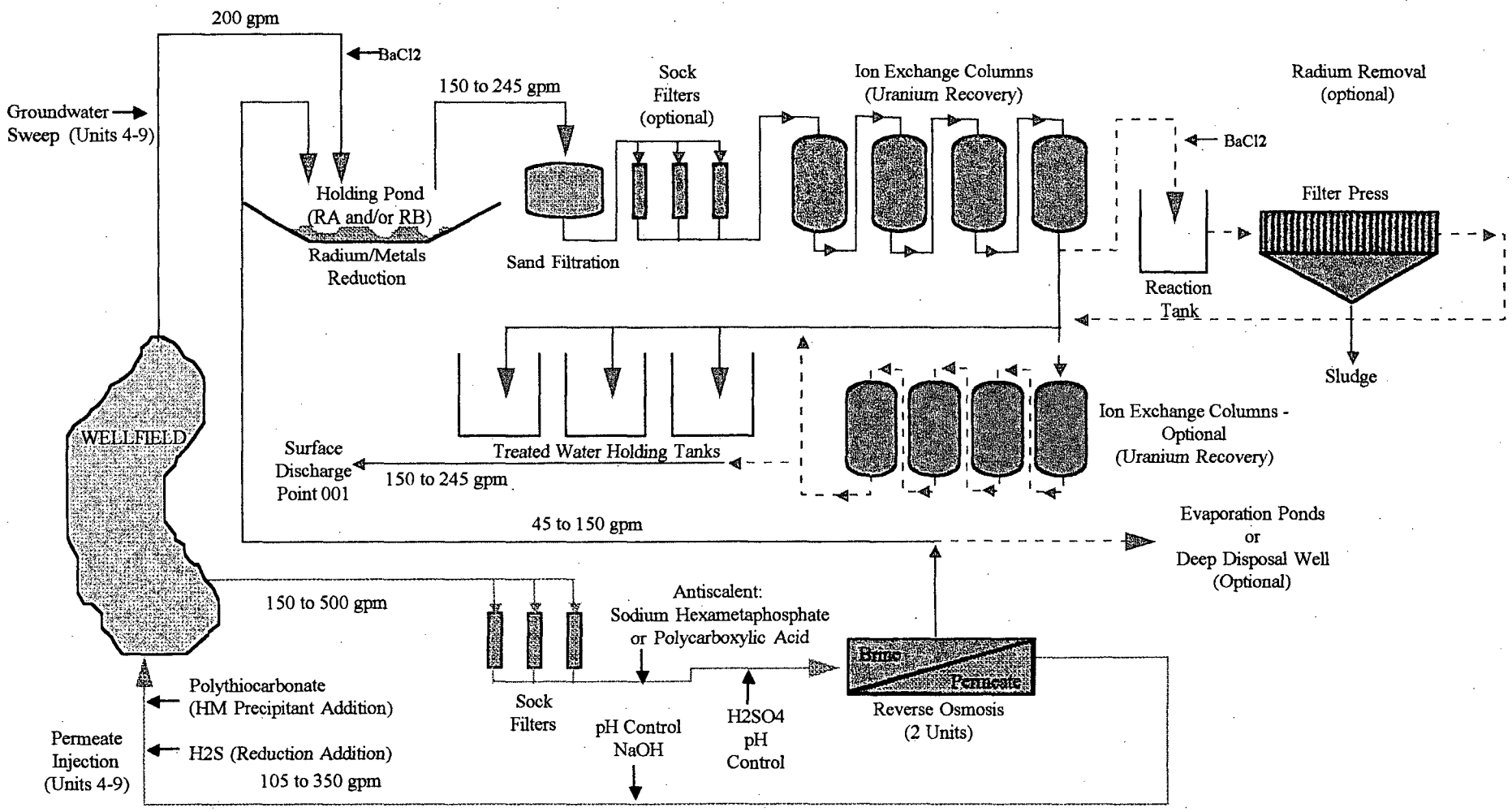
The first step in the restoration process is to recall the mining solution from the periphery of the wellfields which has been affected by horizontal flaring. This process is termed groundwater sweep because the voids created within the ore zone aquifer during the removal of mining solutions are swept and filled with native groundwater. The goal of the groundwater sweep phase is to achieve an approximate 25% reduction in the conductivity (total dissolved solids indicator) of the composite wellfield groundwater, and return all mining solutions back to the wellfield.

Groundwater sweep is accomplished by pumping the recovery and injection wells within the wellfield with no reinjection of solutions (total water withdrawal). Wells used for the recovery may be varied during the pumping to achieve maximum flow distribution throughout the wellfield. Flow rates during groundwater sweep are dependent upon the sustainable yield of the ore zone aquifer, and will fluctuate as the program progresses.

All solutions recovered from the wellfield during the groundwater sweep phase are treated and surface discharged under the appropriate Wyoming NPDES Permit. The solutions are treated for uranium, radium-226, and total suspended solids removal prior to discharge.

A typical groundwater sweep treatment process is shown in Figure 6.1 (Irigaray Restoration Process Flow Diagram for Units 4 through 9). Although this process is tailored somewhat for the Irigaray Units 4 through 9, the processes are the same as those to be used in future restorations at Irigaray and Christensen Ranch. The process involves routing the recovered groundwater sweep solutions from the wellfields to a holding pond(s), where barium chloride will be added. Treatment with barium chloride will remove approximately 95% of the total radium-226 content by a reaction forming a barium sulfate/radium-226 co-precipitate. The barium treatment also assists with other metals reduction, although high metal concentrations are not a problem in the Irigaray wellfields. Solutions in the holding pond will then be routed to the main processing plant for further treatment.

Within the process plant, the groundwater solutions from the pond will be filtered (total suspended solids removal) and then sent through the ion exchange columns for recovery of uranium. After the primary uranium removal, the solutions are sent to the treated water holding tanks, or to two optional circuits which are available to further reduce uranium and radium-226 concentrations as necessary to meet the requirements of the NPDES permits. These optional circuits include additional barium chloride




Groundwater Sweep and Treatment for Surface Discharge; Includes Brine from Reverse Osmosis Treatment

Reverse Osmosis / Permeate Injection

| COGEMA Mining, Inc. | |
|---|---|
| IRIGARAY PROJECT<br>TYPICAL RESTORATION PROCESS FLOW DIAGRAM PRODUCTION UNITS 4-9 | |
| DATE: 12/27/95 | FIGURE 6.1 |

treatment and filtration through a filter press, and additional ion exchange treatment. Solutions stored in the treated water holding tanks are then released by pipeline to surface discharge.

Flow rates during groundwater sweep will vary, depending upon the aquifer properties. Flow rates typically begin around 200 to 300 gpm, then will decrease during the program due to the 100% consumptive removal.

#### 6.1.2.2 Reverse Osmosis/Permeate Injection Phase

After the groundwater sweep phase is completed, the reverse osmosis/permeate injection phase will be initiated. In this phase, the groundwater is recovered from the well fields and treated in a reverse osmosis (RO) unit. The RO unit removes chemical constituents from the groundwater through a pressurized semi-permeable membrane system that yields a cleanwater product (permeate) and a product made up of concentrated ions (brine). All permeate produced from the RO process will be injected back into the wellfields. Brine solutions produced will be routed to holding ponds for treatment and surface discharge, or routed to other on-site ponds for evaporation or to a disposal well. It is anticipated that 70% of the incoming flow will be processed into permeate, with 30% rejected as brine. Water quality in the holding ponds will be routinely monitored to assure that solutions do not exceed the NPDES limits for TDS of 5,000 mg/l for surface discharge. If, during the latter stages of the restoration program, the TDS concentrations approach this limit, brine solutions may be routed to the on-site evaporation ponds or disposed of by deep injection.

The goals of the RO/permeate injection phase are:

a) To reduce the total dissolved solids within the well field to baseline conditions;
b) To reduce trace metals and uranium concentrations to baseline conditions;
c) To return the aquifer pH to the baseline level of approximately 9.0.

During operation of the wellfield, solutions will be removed by way of the recovery wells and the permeate injected by way of the injection wells. Pattern changes may be made to accommodate better coverage in the wellfield (previous recovery wells converted to injectors, or injectors converted to recovery wells). A general wellfield overrecovery of approximately 30% will take place during this phase due to the rejection of 30% of the RO product water sent to the ponds as brine. The generalized overrecovery will be beneficial to the restoration as it will draw native unaffected groundwater into the wellfield area.

Figure 6.1 also shows a typical process flow diagram for the RO/permeate injection phase. The solutions incoming from the wellfield are routed directly to the RO units. The reverse osmosis units will typically be designed to accommodate a 500 gpm feed

rate. As the RO unit has proven to be efficient at removing approximately 95% of all ions, additional uranium and radium-226 removal is not thought to be necessary. Wellfield flow rates during the RO/permeate injection phase will again vary based upon aquifer properties, but are expected to range from 200 to 500 gpm depending upon the size of the area undergoing restoration.

Operation of the RO unit requires chemical additions before and after processing. Prior to processing, antiscalants such as sodium hexametaphosphate or polycarboxylic acid are required to prevent fouling of the RO membranes. Additionally, pH control is required prior to the RO unit (sulfuric acid is added to create an acidic condition for processing), and after processing to raise the pH to baseline wellfield pH levels (addition of sodium hydroxide). Other additions to the permeate will consist of the addition of hydrogen sulfide gas for metals reduction underground, or the use of another heavy metal precipitant such as polythiocarbonate, if necessary (allowed for pilot use only in the Irigaray well fields). As the pH control of the injected permeate and metals reduction are key elements for the success of the restoration program, these will be discussed in more detail following.

Control of Permeate Injection pH

In some mine units, the baseline groundwater pH approaches 9.0 standard units. In order to achieve this baseline value, adjustment of the permeate pH level prior to injection must be accomplished. Sodium hydroxide (caustic soda) will be used to adjust the pH of the permeate stream to a pH of 9.5 prior to injection. The higher pH level for the permeate will not only bring the groundwater back to the baseline pH range, but could also in itself create a more reducing environment underground for chemical precipitation.

Metals Reduction

Probably the most important step of the restoration process is to return the underground conditions to baseline, which includes the oxidation/reduction state. If the aquifer is left highly oxidized (which occurs during mining), metals and other constituents will continue to leach and remain at higher than desired levels during and after restoration. Accordingly, it is necessary to attempt to reduce the oxygenated environment as much as possible during restoration, which entails the addition of reducing agents during the permeate injection phase.

The addition of an oxygen scavenger, or reducing agent, will occur after the first PVD of permeate injection. In the case of Irigaray Units 4 through 9, approximately 44,000 pounds of hydrogen sulfide ($H_2S$) gas are planned to be injected into Units 4 through 9 during the second PVD of RO/permeate injection. The basis for the 44,000 pounds is previous field experience in Irigaray Units 1 through 3, where approximately half this amount was used (one

truck load). The concentration will be adjusted to approximately 200 mg/l in the permeate stream, until clear breakthrough of the gas is seen in the recovery wells. Injection of the $H_2S$ will continue until Eh (oxidation potential) or dissolved oxygen readings indicate that the oxidation potential has been reduced. In mine units at Christensen Ranch or future units at Irigaray, the amount of $H_2S$ gas to be used will ultimately be dependent upon the Eh of the wellfield at the time of the addition.

The $H_2S$ gas will be delivered to the site in an insulated tanker trailer. The liquid $H_2S$ will be extracted from the bottom of the tank and vaporized in a series of stainless steel coils submerged in water. The vaporized $H_2S$ will be metered and injected into the permeate stream flowing into the wellfield. The gas generates sufficient pressure as it vaporizes to overcome injection line pressure; however, a series of controls will be installed in the $H_2S$ line that will shut the system down in the event of pressure/flow losses in the permeate stream, or the detection of a pre-determined concentration of the gas in the wellfield or plant areas.

In April, 1991, a hydrogen sulfide safety program was submitted to the WDEQ and NRC for the Units 1 through 5 approved restoration plan. The program was approved by NRC through Condition No. 38 of SUA-1341. The same safety plan be followed for the restoration program, with the exception that the particular brand of detection equipment identified in the plan may not be available. However, equivalent equipment will be used. Standard operating procedures will be developed according to the April, 1991 plan, and as new technology dictates.

It is anticipated that all metals will be reduced to baseline levels or target restoration values through the use of the $H_2S$ gas. However, in the remote case that this does not occur, the addition of a heavy metal precipitant may be necessary. The heavy metals precipitant proposed for use in the Irigaray 4 through 9 program (only if necessary) during the permeate stream is "Thio-Red II", a liquid organo-sulfur polymer (polythiocarbonate). Thio-Red II has no hazardous ingredients or breakdown products; its affinity for heavy metals is a characteristic of the polythiocarbonate, which will not react with other cations. The product is used by industry for heavy metals recovery from underground waters, waste oils, general wastewater treatment operations, and is used as a polishing agent for removing heavy metals for effluent discharge compliance.

Bench scale testing of the Thio-Red II product was conducted at the Irigaray laboratory in 1990. No adverse reactions were noted either during introduction to lixiviant or permeate. However, when WDEQ and NRC approved the restoration plan for Units 1 through 5, the use of Thio-Red II was restricted to the southern half of Mine Unit 1. Prior to full-scale utilization of the precipitant, a report describing the test and results was to be submitted to NRC and WDEQ

for review and approval. As the heavy metal precipitant was never needed during the Units 1, 2 and 3 restoration effort, the product was never tested in the southern half of Mine Unit 1.

If the use of the heavy metals precipitant is deemed necessary during the restoration efforts in Units 4 through 9, the use of Thio-Red II would again be limited to one mine unit prior to full scale usage in all units, subject to regulatory approval. The unit identified for testing would be chosen by COGEMA based upon water quality analysis.

#### 6.1.2.3 Recirculation

At the completion of the permeate injection phase, the water quality in the vicinity of the injection wells will have the characteristics of the injected permeate. In order to homogenize the aquifer, the wellfield will be operated by withdrawing from the recovery wells and injecting the recovered solutions into the injections wells. No treatment of the circulated water would be performed with the exception that a small amount of reductant may be added to insure the depletion of oxygen during the process.

The recirculation phase may be operated for up to one pore volume. Minimal water discharges are planned to be produced during the recirculation, as the wellfield flow rates will be maintained in a balanced mode. The active restoration period will be completed at the end of the recirculation phase.

#### 6.1.2.4 Stabilization Monitoring

A post-restoration stabilization monitoring period of nine months is typically instituted at the end of restoration. Within this time frame, the designated restoration wells are sampled at the beginning, then at the end of every three month period, providing a total of four samples during the nine month period of stability monitoring. The samples are analyzed for a full suite of chemical and radiological analyses. As the aquifer requires time to equilibrate after the active restoration, more frequent sampling of these wells is not recommended.

Monitor wells are typically sampled on a quarterly basis during the post-restoration stability period. Analyses include the three excursion parameters.

### 6.1.3 PROPOSED RESTORATION PROGRAM

The proposed restoration program for future mining activities at both Christensen Ranch and Irigaray is essentially identical to that approved for the Irigaray Units 4 through 9, *"Aquifer Restoration and Wellfield Decommissioning, Units 4 through 9, March, 1995"*. Anticipated flow and volumes given below are considered typical and will vary depending upon local aquifer properties and the area undergoing restoration:

| | |
|---|---|
| Treatment: | Groundwater Sweep |
| Flowrate: | Up to 300 gpm |
| Volume: | 1 PVD |
| | Bleed to treatment, surface discharge, deep injection well, ponds, or other wastewater management practices approved in the future. Sweep solutions may be treated, stored and reinjected into other mine units undergoing restoration to minimize overall groundwater consumption and wastewater disposal volumes. |

| | |
|---|---|
| Treatment: | RO/permeate injection |
| Flowrate: | Up to 500 gpm |
| Volume: | 5 PVD |
| | Brine to deep well injection, lined ponds, treatment and surface discharge or reinjection into another unit undergoing restoration, or other wastewater management practices approved in the future. |

| | |
|---|---|
| Treatment: | Recirculation |
| Flowrate: | Up to 500 gpm |
| Volume: | 1 PVD |

| | |
|---|---|
| Treatment: | Stabilization Monitoring |
| Flowrate: | None |
| Time Period: | Minimum of 9 months |

Groundwater volumes produced during restoration will depend upon the size of the mine unit and corresponding pore volume. As an example, volumes expected to be generated during the restoration of Irigaray Units 4 through 9, using the above program in combination with the May, 1990 approved program for Units 1 through 5, are as follows:

<u>Production Units 4 and 5</u>

| | |
|---|---|
| Treatment: | RO/permeate injection |
| Flowrate: | 150 gpm |
| Volume: | 3 PVD (May, 1990 approved plan) |
| RO split: | 70% permeate (reinjection); 30% brine (holding ponds) |

| | | |
|---|---|---|
| 1 PVD | = | $10.5 \times 10^6$ gallons |
| 1 PVD | = | 48.6 days @ 150 gpm |
| 3 PVD | = | 145.8 days (4.9 months) |
| | = | $31.5 \times 10^6$ gallons |
| @ 70% | = | $22.0 \times 10^6$ gallons permeate injection |
| @ 30% | = | $9.5 \times 10^6$ gallons brine to holding pond, treatment and surface discharge |

Production Units 6 through 9

| | |
|---|---|
| Treatment: | Groundwater Sweep |
| Flowrate: | 200 gpm |
| Volume: | 1 PVD (March, 1995 plan) |

| | | |
|---|---|---|
| 1 PVD | = | $39.5 \times 10^6$ gallons |
| 1 PVD | = | 137 days @ 200 gpm (4.6 months) |
| | = | 39.5 x 106 gallons to holding pond, treatment and surface discharge |

Production Units 4 through 9

| | |
|---|---|
| Treatment: | RO/permeate injection |
| Flowrate: | 500 gpm |
| Volume: | 5 PVD |

| | | |
|---|---|---|
| 1 PVD | = | $50.0 \times 10^6$ gallons |
| 1 PVD | = | 69.4 days @ 500 gpm |
| 5 PVD | = | 347 days (11.6 months) = $250.0 \times 10^6$ gallons |
| @ 70% | = | $175.0 \times 10^6$ gallons permeate injection |
| @ 30% | = | $75.0 \times 10^6$ gallons brine to holding pond, treatment and surface discharge; or, directly to evaporation ponds or deep injection well for disposal. |

| | |
|---|---|
| Treatment: | Recirculation |
| Flowrate: | 500 gpm |
| Volume: | up to 1 PVD |

| | | |
|---|---|---|
| 1 PVD | = | $50.0 \times 10^6$ gallons |
| 1 PVD | = | 69.4 days @ 500 gpm |
| | = | Minimal discharge, recirculation only up to 69.4 days. |

### 6.1.3.1 Restoration Schedule

It is anticipated that mining in a particular unit will be completed in a three year period. Restoration of a mine unit will typically follow completion of mining by approximately one year. If the mine unit is located adjacent to an active mining area, restoration may be delayed until the mining is accomplished in the adjacent unit. At that time, the mine unit in which production was just completed may serve as a buffer zone between the unit ready for restoration and another mine unit in a production mode. Restoration of each mine unit is designed to be accomplished within a two to three year period to keep up with the mining schedules. Mining and reclamation timetables for the Christensen Ranch area were previously discussed in Section 3.6.

#### 6.1.3.2 Monitoring During Restoration

The proposed schedule for monitoring various recovery streams, designated restoration wells, and monitor wells for the well fields undergoing restoration is provided in Table 6.2. This schedule is currently in place for the Irigaray Units 4 through 9 restoration program.

#### 6.1.3.3 Determination of Restoration Success

After the restoration in an area has been achieved, and the post-restoration stabilization monitoring program is completed, a report will be completed summarizing the results of the restoration program. The restoration results will be compared with the restoration target values (discussed in Section 6.1.1 above). The report will also provide the results of the stability monitoring program. The report will be submitted to the regulatory agencies for their review and approval. The acceptance of the well field restoration and stability success will be based on the ability to meet the goals of the restoration program and the lack of significant increasing trends during the stability monitoring period.

After concurrence from the WDEQ and USNRC that the restoration goals have been achieved and stability criteria have been met, decommissioning and surface reclamation of the restored area will be initiated as described in Sections 6.2 and 6.3.

### 6.1.4 IRIGARAY RESTORATION HISTORY

The mining history of the Irigaray site is very important in order to understand the complexity of the groundwater restoration history. Research and development efforts began at the Irigaray site in 1975 with the 517 and USMT pilot scale operations. The 517 site consisted of three five spot patterns and the USMT site was one five spot pattern. Portable plant equipment was present for the processing, and four lined evaporation ponds were constructed. The 517 site was mined with ammonium bicarbonate lixiviant, and a "natural lixiviant" was used at the USMT site (essentially calcium bicarbonate and $CO_2$). The USMT pattern was restored in 1977, and a portion of the 517 site was restored as a demonstration to obtain a commercial ISL license in 1978. Restoration was later completed in the 517 area in 1987.

At the same time that activities were ongoing at the 517 site (Section 5, T45N, R78W), a 100 gpm pilot scale plant was operating in Section 9, T45N, R78W, in the area of the current Mine Unit 1 at Irigaray. This was called the A-Well Field, which operated with ammonium bicarbonate lixiviant during 1977. When the commercial license was issued in 1978, operations continued in the A-Well Field, plus construction and operation of the B, C, D, F, and G well fields were initiated from 1978 through 1980. These well fields comprise what is today's Units 1 through 5 at Irigaray. In 1979, the company at the time, Westinghouse, realized that continued operation with ammonium bicarbonate was not a possibility due to the restoration standards for

# TABLE 6.2
# RESTORATION GROUNDWATER MONITORING SCHEDULE AND ANALYSES

| RESTORATION PHASE | SAMPLE ORIGIN | FREQUENCY | ANALYTICAL PARAMETERS |
|---|---|---|---|
| Post-Mining | Designated Restoration Wells<br>*Ore Zone* | Once | WDEQ Guideline 8* |
| | Monitor and Trend Wells<br>Ore Zone Monitors<br>Ore Zone Trends (if present)<br>Coal Zone Trends (Irigaray only)<br>Deep Zone<br>Shallow Zone | Biweekly | Chloride, Conductivity, Total Alkalinity (monitor wells)<br>Chloride (trend wells) |
| Restoration | Recovery Stream Composite | Weekly<br>As Needed<br>End of Each Pore Volume Displacement | $HCO_3/CO_3$, $SO_4$, Cl, Conductivity, pH, $U_3O_8$<br>Add Na, Ca, $NH_4$, TDS, etc.<br>WDEQ Guideline 8* |
| | Designated Restoration Wells<br>Ore Zone | End of Each Restoration Phase | WDEQ Guideline 8* |
| | Monitor Wells<br>Ore Zone<br>Deep Zone<br>Shallow Zone | Monthly | Chloride, Conductivity, Total Alkalinity |
| | Trend Wells<br>Coal Zone Trends (Irigaray only)<br>Ore Zone Trends (if present) | Monthly<br>(Groundwater Sweep Only) | Chloride |
| Post-Restoration Stability | Designated Restoration Wells<br>*Ore Zone* | Four Times<br>*(Beginning, quarterly, and the end)* | WDEQ Guideline 8* |
| | Monitor Wells<br>Ore Zone<br>Deep Zone<br>Shallow Zone | Quarterly | Chloride, Conductivity, Total Alkalinity |

* WDEQ Guideline 8 analysis consists of Ca, Mg, Na, K, $CO_3$, $HCO_3$, $SO_4$, Cl, $NH_4$ (N), $NO_2$ + $NO_3$, F, Si, TDS, Cond., Total Alk., Al, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, V, Zn, U, and Ra-226.

ammonium. Westinghouse then operated another well field, the E-Well Field, with a sodium bicarbonate lixiviant to demonstrate restoration achievability with the sodium lixiviant. After mining, the E-Well Field was restored and accepted by the regulatory agencies in 1986.

Although Units 1 through 5 were initially operated with an ammonium bicarbonate lixiviant, Westinghouse received regulatory approvals to switch to the sodium bicarbonate lixiviant in 1980. Operations in Units 1 through 5 continued operation with the sodium lixiviant through early 1982, when all operations went into a standby mode pending an improvement in the uranium market.

In 1987, Malapai Resources Company purchased the Irigaray property and resumed operations in Mine Units 1 through 5, and initiated the first operations in Units 6 through 9. Mining continued in these units until February, 1990 when operations again went on standby pending another sale of the property. In April, 1990 a plan for the groundwater restoration of Units 1 through 5 was submitted to the NRC and WDEQ, and groundwater restoration commenced in May, 1990. In September, 1990, Total Minerals Corporation became the operator of the Irigaray site and continued the restoration program initiated by Malapai in Irigaray Units 1 through 5, with Units 6 through 9 remaining in a standby mode pending further production. Restoration was completed in Units 1 through 3 in late 1992. Stabilization monitoring of Units 1 through 3 was completed in late 1993. The groundwater sweep phase of restoration in Unit 4 and 5, as described in the approved plans for Units 1 through 5, was essentially completed by September, 1993, when the decision was made to continue operations in Units 6 through 9. Permission was received from the regulatory agencies to temporarily cease restoration in Units 4 and 5 until mining was completed in the adjacent Units 6 through 9.

In July, 1993 COGEMA Resources, Inc. purchased Total Mineral Corporations interest in the Irigaray project. In November, 1993, the name of Total Minerals Corporation changed to COGEMA Mining, Inc.

In November, 1993, the restoration of Units 4 and 5 was temporarily suspended in order to recover the remaining reserves in Units 6 through 9. Production operations commenced at that time and were completed in Units 6 through 9 one year later, in November, 1994. By submittal dated March 6, 1995, COGEMA provided to the NRC and WDEQ a detailed plan for the restoration of groundwater in Units 4 through 9. Although the restoration plan for Units 4 and 5 was already approved, the new plan incorporated the reverse osmosis phase of restoration into the plan for Units 6 through 9.

Approval to begin the groundwater sweep phase of restoration in Units 6 through 9 was provided to COGEMA by WDEQ and NRC in April, 1995. Accordingly, groundwater sweep operations began on April 16, 1995. Continuation of restoration

in Units 4 and 5 began in October, 1995 with the startup of the reverse osmosis phase of restoration. Upon completion of groundwater sweep in Units 6 through 9 (scheduled for April or May, 1996), all units (4 through 9) will be incorporated into the reverse osmosis phase of restoration, discussed in more detail below.

#### 6.1.4.1 Irigaray Units 1 through 9 Restoration Program

Estimate of Affected Area

The affected area for the restoration program was defined as the ore production zone plus any monitoring zones exhibiting excursion status during the mining operations. The affected area for Units 1 through 5 were the ore production zone, the coal zone (part of the production zone), and the Unit 1 Sand (shallow monitor zone). For Units 6 through 9, the affected area has been determined to be the ore production zone, as well as small portions of the coal zone, the Unit 1 sand, and the deep monitor zone.

Initial mining operations in Units 1 through 5 during the period of 1978 through 1981 are known to have caused lixiviant migrations to the original upper monitor zone via improperly sealed exploration boreholes and faulty injection well casings. Due to the inability to totally isolate the coal zone from mining solutions, the coal monitor zone was incorporated into the production zone for Units 1 through 9 via license amendments with both the USNRC and WDEQ. As such, the coal zone has been used as a "trend" zone in Units 1 through 9 during operations, as an early warning for Unit 1 Sand excursion control (new shallow zone monitor zone).

After the coal zone was designated as part of the production zone, another upper stratigraphic zone, the Unit 1 Sand, was then designated for monitoring purposes. Some lixiviant contamination was discovered in the Unit 1 Sand in Production Units 1 through 5 in 1980 and some of the monitor wells in this sand have been troublesome during operations.

The deep monitor zone within Production Units 1 through 5 remains unaffected by mining operations and has not been included with the affected area estimate. The deep monitor zone in Units 6 through 9 is unaffected with one exception, well DM-10 in Unit 6.

Perimeter ore zone monitor wells for Production Units 1 through 9 have remained unaffected throughout previous mining operations. These areas are not considered as part of the affected area. Several of the ore zone trend wells have been affected by mining solutions.

Irigaray Baseline Water Quality

Baseline water quality was established for the Irigaray Production Units 1 through 5 during the years of 1976 through 1979. Baseline water quality for Units 6 through 9 was established in 1979, 1980, and 1987. Some of the initial baseline sampling was conducted by Westinghouse during the development of the units. Malapai later conducted additional baseline water sampling to confirm and augment the existing baseline established by Westinghouse. Individual baseline water quality packages were submitted to and approved by the regulatory agencies for Units 6 through 9.

Analyses typically followed the WDEQ Guideline 8 list of parameters for uranium mines. The individual chemical analyses for each monitor or baseline water quality (restoration) well in Units 1 through 5 are contained in *"Appendix I of the Aquifer Restoration and Decommissioning Plan for Units 1 Through 5, May, 1990"*. Individual analysis for wells in Units 6 through 9 are contained in *"Appendix 2 of the Aquifer Restoration and Decommissioning Plan for Units 4 Through 9, March, 1995"*.

As previously stated, the coal zone within Units 1 through 9 is part of the production zone and wells completed in the coal are used as "trend wells" for the overlying Unit 1 Sand monitor zone. Baseline water quality in the coal zone was calculated using baseline water quality data from seven monitor wells in Units 1 through 5 and nine monitor wells in Units 6 through 9. Complete data from Units 1 through 5 is presented in *"Appendix I of the Units 1 Through 5 Restoration Report, May, 1990"*. The data from Units 6 through 9 is presented in *"Appendix 2 of the Units 4 Through 9 Restoration and Decommissioning Plan, March, 1995"*.

Program Details

In the May, 1990 restoration plan for Irigaray Units 1 through 5, the following treatment sequence was called for:

| | | |
|---|---|---|
| 1: | Groundwater Sweep | - 3 Pore Volume Displacements (PVD) |
| 2: | RO/Permeate Injection | - 3 PVD |
| 3: | Recirculation | - 1 PVD |

Units 1 through 3 were restored with the above method, and Units 4 and 5 have undergone the first phase (3 PVD of groundwater sweep). However, for Units 6 through 9 restoration program, the following sequence will be followed:

| | | |
|---|---|---|
| 1: | Groundwater Sweep | - 1 PVD |
| 2: | RO/Permeate Injection | - 5 PVD |
| 3: | Recirculation | - 1 PVD |

Essentially the changes involve shortening the groundwater sweep phase and expanding the RO treatment phase. COGEMA believes that the same amount of groundwater sweep is necessary to recall mining solutions from the periphery of the wellfield. However, once these solutions are recalled, we believe that continued groundwater sweep is inefficient and that more effort should be placed on treating the groundwater within the wellfield.

Groundwater volumes anticipated for the above program were provided in Section 6.1.2, above. As also indicated above, restoration efforts for Units 4 and 5 will continue under the currently approved Unit 1 through 5 Restoration Plan, until these units can be incorporated into the RO/permeate injection phase of the Unit 6 through 9 restoration. In other words, RO/permeate injection will be ongoing in Units 4 and 5 while groundwater sweep commences in Units 6 through 9. Recent approval was received from the WDEQ and USNRC to process the groundwater sweep solutions from Units 6 through 9 and reinject the permeate into Units 4 and 5. This has helped to raise the piezometric head levels in Units 4 and 5, which were very reduced due to groundwater sweep operations in Units 6 through 9. It has also saved on groundwater disposal costs by reducing the volumes to be treated and surface discharged by 70%.

As stated, the flows from Units 4 and 5 will be combined with the flows from Units 6 through 9 for the RO/permeate injection treatment. Units 4 and 5 will, in fact, see more RO/permeate injection treatment than the currently approved restoration plan calls for. This will also allow all units to be treated with the $H_2S$ reductant at the same time, which is prudent with regards to the industrial safety aspects of $H_2S$ usage.

#### 6.1.4.2 Results of the Irigaray Units 1 through 3 Restoration

Active aquifer restoration was completed in Units 1 through 3 in December, 1992. The final stabilization monitoring samples were collected from these units in September, 1993.

Although the plan for restoration called for 3 PVD of groundwater sweep, 3 PVD of reverse osmosis and 1 PVD of recirculation, a total of 16 PVDs were processed for the overall restoration effort in Units 1 through 3. The 16 PVDs consisted of 3 PVDs of groundwater sweep, 12 PVDs of reverse osmosis permeate injection and 1 PVD of recirculation. Hydrogen sulfide gas was injected during the sixth PVD for the reduction of metals.

COGEMA believes the reason restoration required more effort in Units 1 through 3 is due to the extensive mining history in these units, the use of several lixiviants (ammonium bicarbonate, sodium bicarbonate, and $CO_2$), the periods of standby without production or restoration, and the fact that the area was the first commercial ISL uranium well field in Wyoming (experimentation occurred).

Table 6.3 outlines the results of the Units 1 through 3 water quality progress through restoration stabilization. As can be seen from Table 6.3, restoration in the ore zone was achieved to a level above baseline for total dissolved solids, due to parameters such as sodium and bicarbonate. The remainder of the major parameters met the approved restoration targets. All trace metals, uranium and radium-226 were restored to baseline, or within the baseline range, with the exception of manganese.

Although baseline, and class of use in the case of total dissolved solids (TDS) was not met for all parameters, COGEMA believes that Best Practicable Technology (BPT) was used. as well as an extraordinary effort to achieve the restoration goals by treatment with 16 PVDs. It was felt at the time restoration ended that continued restoration efforts would not have provided a reasonable cost benefit ratio.

Shallow Zones Restoration

In the Irigaray Permit to Mine No. 478, the following commitment was made in 1986:

"In the event that the background water quality of the shallow monitoring zones is degraded by the mining process, restoration of the zones will be attempted where water yields are sufficient to allow clean-up of contaminants; observations indicate that some restoration will naturally occur in an affected shallow zone during the restoration of the underlying production zone via any remaining connecting pathways which originally caused the degradation. Therefore, restoration of shallow monitor zones in each affected wellfield will occur simultaneously with the restoration of that particular wellfield. In the case that the water quality constituents of an affected shallow zone remain above baseline after restoration of the underlying production zone, best practicable technology (BPT) procedures to be used in the restoration of the shallow zones will be similar to those chosen for the restoration of the respective production wellfield where possible. However, the restoration procedures used will ultimately be dependent upon the water yielding characteristics of the particular zone. Previous restoration attempts in a shallow zone, the coal zone, have demonstrated this feasibility. It is recognized that should certain constituent values remain above baseline but below the original water use category, BPT may well be merely to allow natural restoration to take place."

Two shallow zone monitor wells, SSM-42 and SSM-43, remain on excursion status in the restored Units 1 through 3. These wells exceed their chloride and conductivity upper control limits by only a few parts per million (or $\mu$mhos/cm). COGEMA believes that BPT has already been applied for these wells by the 16 PVDs of restoration in the ore zone. COGEMA and WDEQ are currently assessing this particular situation to determine if baseline has been met in this zone, and if BPT has been demonstrated.

# TA 6.3
# IRIGARAY UNITS 1 - 3 GROUNDWATER QUALITY CONCENTRATIONS

| | BASELINE MEAN 1,f | MINING COMPOSITE 2,f | POST-MINING 3,f | RESTOR-ATION 4,f1 | STABIL-IZATION MEAN 4,f | ALL STABILI-ZATION ROUNDS 4,f | RESTORATION VALUES BASELINE RANGE a | | | WYOMING GROUNDWATER STANDARDS b | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N = 13 to 65 1976-1979 | COMPOSITE 3/16/89 | 5/18/90 5/21/90 | 12/92 | 9/93 | 2/93 - 9/93 | MIN | MAX | TARGET | CLASS I DOMESTIC | CLASS II AGRICULTURE | CLASS III LIVESTOCK |
| **MAJOR IONS (mg/l)** | | | | | | | | | | | | |
| Ca | 6.9 | 192 | 147.2 | 34.9 | 33.5 | 32.6 | 1.6 | 27.1 | Baseline | --- | --- | --- |
| Mg | 0.86 | 45.6 | 37.8 | 9.0 | 7.8 | 6.3 | < 0.1 | 7.1 | Baseline | --- | --- | --- |
| Na | 115 | 604 | 552 | 196 | 187 | 201 | 99.7 | 164 | Baseline | --- | --- | --- |
| K | 2.4 | 9.5 | 10.5 | 5.0 | 3.0 | 3.1 | 1.4 | 5.3 | Baseline | --- | --- | --- |
| $CO_3$ | 19.5 | 0 | 0 | 0 | 0 | 0 | | | | --- | --- | --- |
| $HCO_3$ | 78.2 | 1183 | 1140 | 451 | 402 | 450 | 14.2 | 133.6 | 295 c | --- | --- | --- |
| $SO_4$ | 179 | 609 | 512 | 183 | 184 | 182 | 140 | 300 | Baseline | 250 | 200 | 3000 |
| Cl | 12.1 | 395 | 340 | 64.8 | 56.4 | 60.9 | 7.8 | 15.1 | 56 c | 250 | 100 | 2000 |
| $NH_4$ (N) | 0.20 | 60.0 | 53.4 | 29.1 | 27.7 | 27.5 | | < 0.5 | 50 c,d | 0.5 | --- | --- |
| $NO_2$ (N) | 0.04 | 2.3 | 0.14 | 0.23 f2 | < 0.10 | < = 0.12 | 0.2 | 1 | Baseline | 1.0 | --- | 10.0 |
| $NO_3$ (N) | 0.86 | 26.0 | 4.4 | 1.33 | 0.08 f2 | < = 0.11 | | | | 10.0 | --- | --- |
| F | 0.31 | <0.10 | 0.11 | 0.28 | 0.14 | < = 0.17 | 0.2 | 0.69 | Baseline | 1.4 - 2.4 | --- | --- |
| $SiO_2$ | 8.0 | 10.5 | 10.8 | 5.9 | 5.5 | 5.1 | | | | --- | --- | --- |
| TDS @ 180 C | 378 | 2588 | 2088 | 758 | 714 | 741 | 271 | 555 | Baseline | 500 | 2000 | 5000 |
| Cond. (uhmo/cm) | 637 | 3974 | 3700 | 1182 | 1400 | 1364 | | | | --- | --- | --- |
| Alk. (as $CaCO_3$) | 121 | 970 | 934 | 369 | 330 | 369 | | | | --- | --- | --- |
| ph (Units) | 9.2 | 7.3 | 7.17 | 7.79 | 7.42 | 7.61 | 8 | 10.4 | Baseline | 6.5 - 9.0 | 4.5 - 9.0 | 6.5 - 8.5 |
| **TRACE METALS (mg/l)** | | | | | | | | | | | | |
| Al | 0.40 | 0.20 | 0.10 | 0.10 | < 0.10 | < 0.10 | | | | --- | 5.0 | 5.0 |
| As | 0.014 | 0.001 | 0.01 | 0.002 f1 | 0.004 f2 | < = 0.004 | < 0.01 | 0.105 | Baseline | 0.05 | 0.1 | 0.20 |
| Ba | 0.04 | <0.10 | <0.10 | 0.06 | 0.05 | < = 0.05 | < 0.01 | 0.08 | Baseline | 1.0 | --- | --- |
| B | 0.06 | <0.10 | 0.10 | 0.05 f1 | 0.01 | < = 0.05 | < 0.01 | 0.225 | Baseline | 0.75 | 0.75 | 5.0 |
| Cd | 0.002 | <0.01 | <0.01 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | 0.006 | Baseline | 0.01 | 0.01 | 0.05 |
| Cr | 0.005 | <0.05 | <0.05 | < 0.005 | < 0.005 | < = 0.005 | < 0.002 | 0.024 | Baseline | 0.05 | 0.10 | 0.05 |
| Cu | 0.015 | <0.01 | 0.01 | 0.01 | < 0.01 | < = 0.01 | < 0.005 | 0.051 | Baseline | 1.0 | 0.20 | 0.50 |
| Fe | 0.43 | <0.05 | 1.19 | < 0.05 | 0.93 f2 | < = 0.12 | 0.2 | 6.88 | Baseline | 0.3 | 5.0 | --- |
| Pb | 0.005 | <0.05 | <0.05 | < 0.001 | < 0.001 | < = 0.001 | < 0.002 | 0.014 | Baseline | 0.05 | 5.0 | 0.1 |
| Mn | 0.017 | 1.07 | 1.08 | 0.20 | 0.19 | 0.22 | < 0.005 | < 0.058 | Baseline | 0.05 | 0.20 | --- |
| Hg | < 0.0002 | <0.001 | <0.001 | < 0.0002 | < 0.002 | < 0.0002 | | < 0.002 | Baseline | 0.002 | --- | 0.00005 |
| Mo | 0.04 | <0.10 | <0.10 | < 0.04 | < 0.04 | < = 0.04 | < 0.02 | 0.05 | Baseline | --- | --- | --- |
| Ni | 0.16 | <0.05 | <0.05 | < 0.05 | < 0.05 | < 0.05 | | < 0.2 | Baseline | --- | 0.20 | --- |
| Se | 0.07 | 0.147 | 0.276 | 0.086 | 0.008 | < = 0.026 | < 0.01 | 0.322 | Baseline | 0.01 | 0.02 | 0.05 |
| V | 0.07 | <0.10 | <0.10 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.55 | Baseline | --- | 0.10 | 0.10 |
| Zn | 0.02 | 0.03 | 0.06 | < 0.01 | 0.01 | < = 0.01 | < 0.02 | 0.17 | Baseline | 5.0 | 2.0 | 25.0 |

# TABLE (cont'd)
# IRIGARAY UNITS 1 - 3 GROUNDWATER QUALITY CONCENTRATIONS

| | BASELINE MEAN 1,f | MINING COMPOSITE 2,f | POST-MINING 3,f | RESTOR-ATION 4,f1 | STABIL-IZATION MEAN 4,f | ALL STABILI-ZATION ROUNDS 4,f | RESTORATION VALUES BASELINE RANGE a | | | WYOMING GROUNDWATER STANDARDS b | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N=13 to 65 1976-1979 | COMPOSITE 3/16/89 | 5/18/90 5/21/90 | 12/92 | 9/93 | 2/93 - 9/93 | MIN | MAX | TARGET | CLASS I DOMESTIC | CLASS II AGRICULTURE | CLASS III LIVESTOCK |
| RADIOMETRIC (pCi/l) | | | | | | | | | | | | |
| U (mg/l) | 1.22 | 15.16 | 7.18 | 5.09 | 1.81 | 2.60 | 0.01 | 18.6 | 2.09 c,e | 5.0 | 5.0 | 5.0 |
| Ra-226 | 39.3 | 342 | 160.7 | 181.6 | 157.8 | 140.7 | 2.5 | 210 | Baseline | 60. | 6.0 | 6.0 |
| Ra-228 +/- | | 5.8 | 4.8 | 5.4 | 4.3 | 3.5 | | | | | | |

Footnotes to Table 6.2

1: Samples taken from wells AP-3, AP-4, AP-5, AP-10, DI-4, DI-12, DI-21, DI-27, DP-7, EI-34, FI-60, FI-62, FI-64, FI-66, FI-67, GI-76, GI-82, GI-105, GI-122

2: Samples taken from wells AP-4, BP-4, CP-10, DP-2, DI-4(90), DI-27, DP-29, FP-5, FI-62, FI-67(132), GI-76, GI-82, GP-9, GI-134.

3: Samples taken from Unit 1 - 3 designated restoration wells AP-4, BP-4, DI-27, DI-90, DP-2, DP-29, FP-5

4: Samples taken from Unit 1 - 3 designated restoration wells AP-4, BP-4, CI-17, DI-27, DI-90, DP-2(B), DP-29, FP-5

a: Ranges were compiled using average baseline data from 30 production zone wells located in Production Units 1 through 6 (Average baseline - average results from three samples). The 30 production zone wells are : AP-3, AP-4, AP-5, AP-10,DI-4, DI-12, DI-21, DI-27, EI-25, EI-16, EI-17, EI-18, EI-34, EI-54, EI-68, FI-60, FI-62, FI-64, FI-66, FI-67, GI-76, GI-82, GI-105, HI-57, HI-62, HP-59, HP-87, and GI-122.

b: Taken from Wyoming Department of Environmental Quality, Water Quality Rules and Regulations, Chapter VIII, *"Quality Standards for Wyoming Groundwater"*, Table 1: April 9, 1990.

c: Target values presented are based are based on results achieved during research and development tests at the Irigaray site, the use of best practicable technology and economic reasonableness. The target restoration values for $NH_4$ applies only to Units 1 through 5 where ammonium bicarbonate lixiviant was used. Target values for bicarbonate, chloride, and uranium are based upon the final 360 day E-field stabilization values (mean plus two standard deviations.).

d: Wyoming standards are expressed in terms of ammonia ($NH_3$).

e: Target value may have to be achieved as necessary as restoration proceeds, however, in no case the value be greater than 5 mg/l (Class of Use).

f: Arithmetic mean calculated to establish mean

f1: Mean Calculated using Documentation OSWER-9950.1, *"A Statistical Procedure For Analyzing Interim Status Detection Monitoring Data: Methodology And Application"*.

f2: Calculation does not work when large variances occur.

## 6.1.5 CHRISTENSEN RANCH RESTORATION HISTORY

### 6.1.5.1 Willow Creek R & D

The ability to mine and restore the Christensen Ranch orebody has been demonstrated by the operation of the Willow Creek R & D in-situ operation. This successful demonstration provided the basis for the design of the commercial scale groundwater restoration plan for the Christensen Ranch, and the Irigaray Units 4 through 9 program.

The Willow Creek R & D was located in Sections 17 and 20, Township 44 North, Range 76 West, and now is encompassed by Mine Unit 5 of the Christensen operations. The mining phase of the R & D operation was conducted in two adjacent 25' x 25' five-spot well field patterns, from September, 1986 through December, 1986. The lixiviant used was sodium bicarbonate, at a concentration of approximately 2 grams per liter, with gaseous oxygen as the oxidant.

The restoration process for the Willow Creek R & D was conducted during the time period from February, 1987 through July, 1987. The process incorporated four restoration methods, namely groundwater sweep, reverse osmosis permeate injection, reductant usage and final well field recirculation. Approximately 13 pore volume displacements (PVDs) were processed for the groundwater restoration, assuming that horizontal flaring affected an area 30 feet outside the well field perimeter.

The first phase of restoration was a groundwater sweep operation with surface discharge of the groundwater after treatment for uranium and radium removal. Approximately seven (7) PVDs were produced and surface discharged during the initial groundwater sweep phase.

The second phase of the restoration program involved the processing of well field solutions through a reverse osmosis (RO) unit and the injection of the resultant cleanwater fraction, or permeate, back into the well field. The concentrated impurities from the RO unit, or brine, were routed to the evaporation pond for disposal. The effect of the permeate injection was to significantly reduce the total dissolved solids (TDS) concentrations of the groundwater within the well field perimeter. Approximately three (3) PVDs were processed during the permeate injection phase.

The third phase of the restoration program involved the injection of a reducing agent. Concentrations of some trace metals, notably arsenic and selenium, were still elevated at the end of the permeate injection phase; it was determined that chemical reduction would be the most effective and timely method for lowering the concentrations of these metals. Prior to the use of the reductant, groundwater sweep was conducted for an additional 0.38 PVDs to draw in surrounding native groundwater.

The reducing agent chosen for the process was hydrogen sulfide ($H_2S$) gas. During $H_2S$ usage, the well field was strictly circulated with no bleed taken. The gas was introduced into the injection stream and circulated through the well field for approximately one (1) PVD. The concentrations of arsenic and selenium had been reduced by approximately 90% at the end of the reductant usage.

Some increase in total dissolved solids concentrations was noted following the reductant usage. An additional 1.05 PVD of groundwater sweep and 0.34 PVD of permeate injection were processed to further reduce the total dissolved solids concentrations. The final step of groundwater restoration, or well field recirculation, was initiated at the end of the permeate injection. The effect of the recirculation was to equally distribute the injected permeate and to homogenize the well field solutions. Recirculation of the well field was conducted for 0.38 PVD.

Table 6.4 summarizes the water quality concentrations for the well field pre-mining baseline, post-mining, restoration and post-restoration stability phases (obtained to date). The results indicate that the groundwater at the Willow Creek site was restored to baseline concentrations for the majority of the chemical constituents and to the quality of pre-mining use for all parameters. Parameters which did not meet baseline concentrations at the end of restoration are bicarbonate, total alkalinity, arsenic, selenium, vanadium, uranium and radium. An explanation of each parameter is as follows.

1. Bicarbonate - Bicarbonate is the major chemical added during the mining process, therefore, it will constitute the highest concentration of all chemicals at the time of restoration. Bicarbonate levels were substantially reduced during the restoration process. The restored levels of bicarbonate, although slightly above baseline levels, do not exceed any known water quality standards. Further efforts to reduce the bicarbonate levels would not result in any significant benefit to the overall quality of the groundwater and the cost of the effort would be substantial.

2. Total Alkalinity - Alkalinity is a function of the bicarbonate levels in the groundwater, therefore, the above explanation applies.

3. Arsenic - The final restoration value for arsenic exceeds baseline, however, is within the Class I Domestic Standard of 0.05 mg/l. Arsenic values are expected to decline during the stability monitoring period, as evidenced by the September and October, 1987 data in Table 6.4. Arsenic was one of the metals for which the reductant phase of the restoration was conducted. The reduced condition of the aquifer should continue to lower the concentrations of elements such as arsenic, which will precipitate under mild reducing conditions.

# TAI 3.4
# WILLOW CREEK WELLFIELD GROUN ATER QUALITY CONCENTRATIONS

| | BASE-LINE | POST-MINING | RESTORATION | | | | | | | POST RESTORATION STABILITY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAJOR IONS (mg/l) | N=52 to 55 4/86 | N=7 12/10/86 2/5/87 | N=3 2/25/87 | N=9 3/24/87 | N=5 4/16/87 | N=5 5/13/87 | N=4 6/22/87 | N=7 7/14/87 | N=5 7/23/87 | N=5 8/24/87 ENERGY LAB | N=5 8/31/87 WAMCO | N=5 9/24/87 ENERGY LAB | N=5 10/26/87 ENERGY LAB | N=3 11/11/87 ENERGY LAB | CLASS I STAND-ARDS |
| Ca | 8.6 | 90.2 | 52.5 | 42.2 | 20.9 | 3.2 | 18.1 | 7.59 | 7.8 | 13.8 | 9.6 | 12.0 | 12.9 | 13.3 | |
| Mg | 1.2 | 14.0 | 8.1 | 7.1 | 3.3 | 0.51 | 2.3 | 1.19 | 1.20 | 1.98 | 4.2 | 1.8 | 1.6 | 1.57 | |
| Na | 136 | 780.4 | 382.3 | 383.3 | 252.2 | 84.96 | 228.3 | 140.2 | 123.6 | 148.4 | 134.2 | 142.2 | 144.6 | 142 | |
| K | 2.6 | 5.4 | 4.1 | 3.6 | 2.5 | 0.83 | 2.0 | 1.41 | 1.76 | 1.8 | 1.6 | 1.7 | 1.5 | 1.7 | |
| CO3 | 7.32 | 0 | 0 | 0 | 0 | 4.62 | 0 | 0 | 0.42 | 0 | 0 | 0 | 0 | 0 | |
| HCO3 | 118 | 1701.3 | 775.7 | 675.7 | 383.2 | 161.2 | 348.2 | 232.7 | 188.12 | 180.2 | 201.2 | 195.2 | 209.4 | 191.0 | |
| SO4 | 194.8 | 387.3 | 270.3 | 265.2 | 221.4 | 41.6 | 225.3 | 118.8 | 109.2 | 198.0 | 151.4 | 159.4 | 163.8 | 177.0 | 250 |
| Cl | 7.2 | 152.3 | 66.0 | 66.1 | 27.1 | 5.7 | 19.5 | 12.3 | 11.2 | 10.6 | 13.2 | 11.3 | 10.9 | 10.4 | 250 |
| NH4 | <0.05 | 0.11 | 0.06 | 0.09 | 0.17 | 0.11 | 0.28 | <0.07 | <0.06 | <0.07 | 0.16 | 0.086 | <0.05 | <0.06 | 0.5 |
| NO2 (N) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 | 1.0 |
| NO3 (N) | <0.06 | 0.22 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.06 | <0.03 | 0.02 | 0.02 | 0.05 | 10.0 |
| F | 0.171 | <0.11 | 0.18 | 0.24 | 0.23 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.13 | <0.11 | <0.12 | <0.10 | 1.4-2.4 |
| SiO2 | 9.11 | 22.0 | 13.5 | 10.5 | 9.7 | 6.5 | 6.6 | 12.7 | 9.3 | 11.8 | | 12.9 | 12.6 | 12.8 | |
| TDS | 425 | 2406.3 | 1328.7 | 1237.3 | 776.4 | 239.6 | 673.0 | 418.9 | 356.8 | 457.6 | 452.4 | 448 | 435.6 | 432.7 | 500 |
| Cond | 653 | 3457.1 | 1823.0 | 1709 | 1165.8 | 402.6 | 1113.0 | 657.6 | 581.4 | 753.6 | 705 | 698.8 | 714.2 | 764.3 | |
| Alk | 109.4 | 1447.5 | 636.0 | 553.3 | 313.8 | 140.8 | 285.5 | 190.7 | 154.9 | 147.6 | 165 | 159.9 | 168.4 | 156.7 | |
| pH | 8.87 | 7.4 | 8.0 | 7.84 | 8.06 | 8.52 | 7.53 | 7.98 | 7.86 | 7.32 | 7.77 | 7.986 | 751 | 7.59 | 6.5-9.0 |
| TRACE METALS (mg/l) | | | | | | | | | | | | | | | |
| Al | <0.10 | 0.66 | 0.81 | 0.47 | 0.26 | <0.12 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | |
| As | <0.0025 | 0.148 | 0.068 | 0.223 | 0.198 | 0.088 | 0.074 | 0.097 | 0.045 | 0.031 | 0.009 | 0.027 | 0.0298 | 0.0227 | 0.05 |
| Ba | <0.10 | 0.12 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | 1.0 |
| B | <0.11 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.014 | <0.10 | <0.10 | <0.10 | 0.75 |
| Cd | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.002 | <0.01 | <0.01 | <0.01 | 0.01 |
| Co | <0.01 | <0.02 | <0.01 | | | | | | <0.01 | | | | | | |
| Cr | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.01 | <0.05 | <0.05 | <0.05 | 0.05 |
| Cu | <0.01 | 0.05 | 0.09 | 0.04 | <0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 1.0 |
| Fe | <0.06 | 0.12 | 0.16 | 0.07 | <0.076 | <0.052 | <0.058 | <0.057 | <0.05 | 0.36 | 0.22 | 0.22 | 0.22 | 0.24 | 0.3 |
| Pb | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.05 |
| Mn | <0.02 | 0.09 | 0.05 | 0.04 | <0.02 | <0.01 | 0.028 | <0.017 | 0.012 | 0.04 | 0.04 | 0.04 | 0.03 | <0.03 | 0.05 |
| Hg | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.0002 | <0.001 | <0.001 | <0.001 | 0.002 |
| Mo | <0.1 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | |
| Ni | <0.05 | <0.05 | <0.07 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.02 | <0.05 | <0.05 | <0.05 | |
| Se | <0.001 | 3.094 | 1.846 | 2.544 | 1.475 | 0.405 | 0.044 | 0.073 | 0.061 | <0.011 | <0.022 | <0.014 | <0.0088 | <0.015 | 0.01 |
| V | <0.1 | 2.61 | 2.66 | 9.03 | 6.48 | 2.86 | 0.93 | 0.91 | 0.36 | <0.021 | <0.10 | <0.11 | <0.18 | <0.10 | |
| Zn | <0.01 | 0.11 | 0.02 | <0.02 | 0.04 | 0.01 | <0.02 | <0.011 | <0.01 | <0.01 | <0.007 | <0.012 | <0.01 | <0.01 | 5.0 |
| RADIO (pCi/l) | | | | | | | | | | | | | | | |
| U (mg/l) | 0.0354 | 36.4 | 53.9 | 22.9 | 9.80 | 2.36 | 4.46 | 2.42 | 1.802 | 1.17 | 1.321 | 1.35 | 1.52 | 1.359 | 5.0 |
| Ra-226 | 73.2 | 1225.7 | 515.3 | 473.9 | 207.3 | 59.2 | 133.6 | 94.9 | 93.4 | 147.52 | 41.2 | 120.18 | 132.1 | | 5.0 |

N = Number of samples (data points) used for arithemetic average. Samples taken from wells RW-01, RW-02, WCPW-21, IW-01, IW-02, IW-03, IW-04, IW-06, and IW-07.

4. Selenium - The final restoration value for selenium exceeds baseline and the Class I Domestic Standard of 0.01 mg/l. Selenium concentrations are also expected to decrease during the stability period due to the reducing effects remaining in the well field. As indicated in Table 6.4, selenium concentrations have significantly declined during the stability and should continue the decreasing trend.

5. Vanadium - Vanadium concentrations at the end of restoration exceed the baseline. Vanadium concentrations have continued to decrease during the stability period. The most recent results shown in Table 6.4 are essentially at baseline values.

6. Uranium - Uranium concentrations at the end of restoration are above baseline but well within the Domestic Class I Standard of 5.0 mg/l. The final uranium concentration in the groundwater will be a function of the liquid-solid equilibrium and the Eh and pH characteristics of the mining zone. It is expected that uranium values may continue to decrease during the stability period until an equilibrium concentration is reached.

7. Radium - Radium concentrations at the end of restoration are above baseline and exceed the Class I Standard of 5.0 pCi/l. Radium levels at baseline also significantly exceeded the Class I Standard. The final restoration results are, however, within one standard deviation of the mean baseline concentration and are well within the range of baseline radium concentrations. The stability monitoring period data for radium indicate that although the radium has increased somewhat, the results are still within the range of baseline values and fall within two standard deviations of the mean baseline concentration.

The conclusions reached for the restoration effort at the Willow Creek site are:

1. The final restoration sample analyses dated July 23, 1987 indicate that the restoration efforts were successfully completed and that further restoration operations would not necessarily be technically practical or economically feasible.

2. Water quality should continue to improve during the post-restoration monitoring period and should stabilize when the Eh (redox potential) equilibrates at a fixed level.

3. The concentrations of parameters which exceed baseline should have no impact on present or future water uses, or the environment, as they do not effect the overall use suitability criteria.

The experience gained from the Willow Creek R & D indicates that groundwater after mining at Christensen Ranch can be restored to essentially baseline water quality and to a quality of use consistent with the use(s) for which the water was suitable prior to the mining operations. The results of the Willow Creek mining and restoration program, which include extensive analytical data, are given in the report entitled "*Malapai Resources Company, Aquifer Restoration Efforts and Results, Willow Creek R & D, Christensen Ranch, Wyoming, October 26, 1987.*"

#### 6.1.5.2 Christensen Ranch Restoration Program

The planned restoration program for Christensen Ranch will be as that described in Section 6.1.2, above. The program will be tailored to meet the individual characteristics of each mine unit, but will essentially follow Section 6.1.2.

## 6.2 DECONTAMINATION AND DECOMMISSIONING

The following sections address the final decommissioning of process facilities, evaporation ponds, well fields and equipment which will be used on the Irigaray and Christensen Ranch site. It discusses general procedures to be used, both during final decommissioning, as well as the decommissioning of a particular mine unit area.

Decommissioning of well fields and process facilities, once their usefulness has been completed in an area, will be scheduled within one year after agency approval of groundwater restoration and stability. It will be accomplished in accordance with an approved decommissioning plan and the most current applicable Wyoming Department of Environmental Quality and USNRC rules and regulations, permit and license stipulations and amendments in effect at the time of the decommissioning activity.

Landowner involvement in the final disposition of non-process related equipment and acceptable final site conditions may alter final decommissioning plans at the actual time decommissioning takes place.

The following is a list of general decommissioning activities:

1: Plug and abandon all wells as detailed per Section 3.0.

2: Radiological surveys and sampling of all facilities, process related equipment and materials presently on site to determine their degree of

contamination and identify the potential for personnel exposure during decommissioning.

3: Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation.

4: Decontamination of items to be released for unrestricted use to levels consistent with the requirements of U.S. Nuclear Regulatory Commission "*Guidelines for Decontamination of Facilities and Equipment ..., September, 1984*".

5: Survey excavated areas for earthen contamination and remove same to a licensed disposal facility.

6: Backfill and recontour all disturbed areas.

7: Perform final site soil radiation background surveys.

8: Establish permanent revegetation on all disturbed areas.

The following sections describe in general terms the planned decommissioning activities and procedures for the Irigaray and Christensen Ranch facilities. COGEMA will, prior to final decommissioning, submit to the USNRC and WDEQ a detailed plan for their review and approval.

### 6.2.1 PROCESS BUILDINGS AND EQUIPMENT

Prior to process plant decommissioning, a preliminary radiological survey will be conducted to identify any potential hazards. The survey will also support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. The majority of the process equipment in the process building will be reusable, as well as the building itself. Alternatives for the disposition of the building and equipment are discussed below.

#### 6.2.1.1 Removal and Disposal Alternatives

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., will be inventoried, listed and designated for one of the following removal alternatives:

1: Removal to a new location within the Irigaray/Christensen Ranch site for further use or storage.

2: Removal to another licensed facility for either use or permanent disposal.

3: Decontamination to meet unrestricted use criteria for release, sale or other non-restricted use by the landowner and others.

It is most likely that process buildings will be dismantled and moved to another location on the site or to a permanent licensed disposal facility. Cement foundation pads and footing will be broken up and trucked to disposal site or a licensed facility if contaminated. The landowner, however, could request that a building or other structures be left on site for his use. In this case, the building will be decontaminated to meet unrestricted use criteria.

Disposal at a Licensed Facility

If a piece of process equipment is to be moved to another licensed area the following procedures may be used.

1: Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce interior contamination as necessary for safe handling.

2: The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be contaminated the equipment will be washed down and decontaminated to permit safe handling.

3: The equipment will be disassembled only to the degree necessary for transportation. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the plant building.

4: Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in plastic lined covered dump trucks or drummed in barrels for delivery to the receiving facility.

5: Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.

6: All other miscellaneous contaminated material will be transported to a licensed disposal facility.

Disposal To Unrestricted Use

If a piece of equipment is to be released for unrestricted use it will be appropriately surveyed before leaving the licensed area. Both interior and exterior surfaces will be

surveyed to detect potential contamination. Appropriate decontamination procedures will be used to clean any contaminated areas and the equipment resurveyed and documentation of the final survey retained to show that unrestricted use criteria were met prior to releasing the equipment or materials from the site. Criteria to be used for release to unrestricted use will be USNRC's *"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials, September 1984"*, or the most current standards for decontamination at that time.

If a process building is left on site for landowner unrestricted use, the following basic decontamination procedures will be used. Actual corrective procedures will be determined by field requirements as defined by radiological surveys.

1: After the building has been emptied, the interior floors, ceiling and walls of the building and exterior surfaces at vent and stack locations will be checked for contamination. Any remaining removable contamination will be removed by washing. Areas where contamination was noted will be resurveyed to ensure removal of all contamination to appropriate levels.

2: Process floor sump and drains will be washed out and decontaminated using water and, if necessary, acid solutions. If the appropriate decontamination levels cannot be achieved, it may be necessary to remove portions of the sump and floor to disposal.

3: Excavations necessary to remove trunklines or drains will be surveyed for contaminated earthen material. Earthen material that is found to be contaminated will be removed to a licensed disposal facility prior to backfilling the excavated areas.

4: The parking and storage areas around the building will be surveyed for surface contamination after all equipment has been removed.

Decontamination of these areas will be conducted as necessary to meet the standards for unrestricted use.

## 6.2.2 EVAPORATION POND DECOMMISSIONING

### 6.2.2.1 Disposal of Pond Water

The volume of water remaining in the lined evaporation ponds after restoration as well as its chemical and radiological characteristics will be considered to determine the most practical disposal program. Disposal options for the pond liquid include evaporation, treatment and disposal, treatment and used for reinjection during restoration, or transportation to another licensed facility or disposal site. The pond

water from the later stages of groundwater restoration may be treatable to within discharge limits; if this can be accomplished, the water will be treated and discharged under an appropriate NPDES permit. Evaporation of the remaining water may be enhanced by use of sprinkler systems, etc. The pond waste may also be disposed of in a deep disposal well.

#### 6.2.2.2 Pond Sludge and Sediments

Pond sludges and sediments will contain mining process chemicals and radionuclides. Wind blown sand grains and dust blown into the ponds during their active life also add to the bulk of sludges. This material will be contained within the pond bottom and kept in a dampened condition, especially during the handling and removal operation to prevent the spread of airborne contamination and potential worker exposure through inhalation. Dust abatement techniques will be used as necessary. The sludge will be removed from the ponds and loaded into plastic lined dump trucks or drums and transported to a USNRC licensed disposal facility. All equipment and personnel working on sludge and liner removal will be checked prior to leaving the work area to prevent the tracking of sludge into uncontaminated locations.

#### 6.2.2.3 Disposal of Pond Liners and Leak Detection Systems

Pond liners will be kept washed down and intact as much as practical during sludge removal so as to confine sludges and sediments to the pond bottom.

Pond liners will be cut into strips and transported to a USNRC licensed disposal facility or will be decontaminated for release to an unrestricted area. After removal of the pond liners, the pond leak detection system piping will be removed. Materials involved in the leak detection system will be surveyed and released for unrestricted use if not contaminated or transported to a USNRC licensed facility for disposal. The earthen material in the pond bottom and leak detection system trenches will be surveyed for soil contamination; any contaminated soil in excess of limits defined in 10 CFR 40, Appendix A, will be removed.

Following the removal of all pond materials and the disposal of any contaminated soils, surface preparation will take place prior to reclamation. Pond surface reclamation will be performed in accordance with the surface reclamation plan, Section 6.3. An additional radiation background survey will be conducted on the recontoured area prior to topsoiling.

#### 6.2.2.4 On Site Burial

At the present time, on site burial of radioactive contaminants is not anticipated. However, depending upon the availability of a USNRC licensed disposal site at the time of decommissioning, on site burial may become a potential alternative. Should

this occur, pond locations would be considered initially as the on site disposal locations for contaminated materials. Appropriate licensing with the regulatory agencies would be obtained prior to any on site burial of contaminated wastes.

### 6.2.3 WELL FIELD DECOMMISSIONING

Well field decommissioning will consist of the following steps:

1: The first step of the well field decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, electrical conduit at Irigaray, well boxes, and wellhead equipment. Well head equipment such as valves, meters or control fixtures will be salvaged.

2: Removal of buried well field piping, or surface piping as is the case in Irigaray Units 1 - 5.

3: Wells will be plugged and abandoned according to the procedures described below.

4: The well field area may be recontoured, if necessary, and a final background gamma survey conducted over the entire well field area to identify any contaminated earthen materials requiring removal to disposal.

5: Final surface reclamation of the well field areas will be conducted according to the surface reclamation plan described in Section 6.3.

6: All piping, boxes and well head equipment will be surveyed for contamination prior to release in accordance with the USNRC guidelines for decommissioning.

Based upon previous experience, it is estimated that over 90% of the equipment will meet releasable limits which will allow disposal at an unrestricted area landfill. Other materials which are contaminated will be acid washed or cleansed with other methods until they are releasable. If the equipment still does not meet releasable limits, it will be disposed of at a facility licensed to accept by-product material. Much of the equipment could be reused by COGEMA in other production areas.

Well field decommissioning will be an independent ongoing operation throughout the mining sequence. Once a mine unit has been mined out and groundwater restoration and stability have been accepted by the regulatory agencies, the well field will be scheduled for decommissioning and surface reclamation.

### 6.2.3.1 Well Plugging and Abandonment

All wells no longer useful to continued mining or restoration operations will be abandoned. These include all injection and recovery wells, monitor wells and any other wells within the mine unit used for the collection of hydrologic or water quality data or incidental monitoring purposes. The only known exception at this time may be a well which could be transferred to the landowner for domestic or livestock use.

The objective of COGEMA's well abandonment program is to seal and abandon all wells in such a manner as to assure the groundwater supply is protected and to eliminate any potential physical hazard. The abandonment procedures contained herein are designed to comply with Wyoming Statute 35-11-404 and applicable regulations of the Department of Environmental Quality, Land and Water Quality Divisions and the Wyoming State Engineer's Office.

Two abandonment methods may be used, depending upon costs at the time of decommissioning. The first, use an acceptable bentonitic abandonment fluid to seal wells at the Irigaray/Christensen Ranch site. The criteria of a 10 minute gel strength of at least 20 pounds per 100 square feet and filtrate volume not to exceed 13.5 cubic centimeters (or the most current standard at the time of abandonment) will be followed for preparation of the abandonment fluid. Cement will be added to the top of the bentonite column to bring the level of total abandonment materials in the casing up to the level at which it will be cut off or approximately two feet below ground surface. A permanent tag showing well name and any other pertinent information will be affixed to the top of the cement plug. The hole where the surface casing was removed will be backfilled to the surface using local surface material. Surface reclamation procedures described in Section 6.3 will then be implemented.

The second method involves the placement of bentonite chips in the bottom 75 feet and upper 30 feet of the well with the intermediate volume filled with gravel. This method is currently used in the financial surety estimate for reclamation. A cement cone with metal marker is then placed two feet below the surface, surface casing is removed, and then hole is backfilled.

Records of abandoned wells will be tabulated and reported to the appropriate agencies after decommissioning. The tabulation will include the well name, permit number, total depth, aquifer or zone of completion, casing type and date and method of abandonment.

### 6.2.3.2 Buried Trunklines, Pipes and Equipment

Buried process related piping such as injection and recovery lines will be removed from the mine unit undergoing decommissioning. Salvageable lines will be held for use in ongoing mining operations. Lines that are not reusable may either be assumed to be

contaminated and disposed of at a licensed disposal site or may be surveyed and, if suitable for release to an unrestricted area, may be sent to a sanitary landfill. If on site burial is an option in the future, lines may be disposed of on site according to conditions of the appropriate licenses/permits.

### 6.2.4 SOIL DECONTAMINATION

After all surface equipment is removed and all wells are properly plugged and abandoned, a gamma survey of the well field surfaces will be conducted. Any areas with elevated gamma readings which indicate radium-226 levels in excess of limits in 10 CFR 40, Appendix A, will be resurveyed. Soil samples will be collected from confirmed contaminated locations for the analysis of radium-226 and uranium. Based upon the soil sampling and additional gamma radiation readings, contaminated soil will be removed and transferred to a site licensed to accept by-product materials. Gamma survey results and soil sampling results will be submitted to the USNRC for their review, approval and opportunity to split soil samples. After approval of the soil contamination removal program, revegetation will commence.

Baseline radiation background studies which included gamma radiation background measurements and accompanying surface soil sampling have been collected at both Irigaray and Christensen Ranch. This information will be used to compare pre-mining radiological background conditions with existing conditions at the time a mine unit or plant facility is decommissioned. The baseline information will be used to identify areas contaminated by mining activities, if they exist, and provide valid clean up criteria and action levels.

#### 6.2.4.1 Surface Soil Background Surveys

Procedures used for the soils radiation background study and details of results for Christensen Ranch are provided in *"Appendix D10 of the WDEQ Christensen Ranch Amendment Application"*. Information on Irigaray is contained in *"Appendix D of the WDEQ Application"*. For Irigaray, the original survey included ten sample points. Background radium levels ranged between 0.29 pCi/gm to 0.89 pCi/g. For Christensen Ranch surface soil surveys were conducted over the areas where uranium ore is known to exist in minable quantities or potential future well field areas and the satellite plant site. The surveys were conducted using a portable gamma scintillometer by walking transacts and recording surface gamma readings every 100 meters. Soil samples were taken for laboratory analysis every 300 meters. The results of the study show background gamma readings from 11-19 ur/hr averaging about 13 ur/hr. Laboratory analytical results of surface soil samples taken show background levels of radium in the soil ranging from 1.1 pCi/gm to 6.8 pCi/gm and averaging 3.7 pCi/gm.

#### 6.2.4.2 Soil Surveys

The objective of site soil surveys during decommissioning will be to identify and remove to a licensed disposal facility any earthen materials which exceed EPA 40 CFR Part 192.32 standards or other applicable standards at the time of decommissioning. These standards presently require that radium concentrations in surface soils, averaged over areas of 100 square meters, do not exceed background levels by more than 5 pCi/g averaged over the first 15 cm below the surface and 15 pCi/g averaged over any 15 cm thick layer more than 15 cm below the surface.

Three general types of site soil surveys will be conducted on the site during decommissioning:

1: Areas of potential surface contamination will be identified using a gross gamma survey on an adequately spaced grid.

2: Spot checks of areas around the site of potentially contaminated areas.

3: The final soil background survey on areas which have been prepared for surface reclamation using a grid spacing adequate for confirming clean up to applicable standards.

Contaminated soils which are removed from site surfaces will be transported to a licensed disposal site. The primary areas for potential soil contamination include well field surfaces, evaporation pond bottoms and berms, process building areas, storage yards and transportation routes over which product or contaminants have been moved.

### 6.2.5 DECOMMISSIONING HEALTH PHYSICS AND RADIATION SAFETY

The health physics and radiation safety program for decommissioning will document decommissioning processes and ensure that occupational radiation exposure levels are kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee by way of specialized training, will be on site during any decommissioning activities where a potential radiation exposure hazard exists.

#### 6.2.5.1 Special Training

All workers employed during decommissioning whether contractor employees or COGEMA mine employees will be given specialized training for minimizing radiological exposures during decommissioning activities. Written operating procedures will be prepared for all decommissioning activities involving the handling of radioactive materials.

#### 6.2.5.2 Health Physics Surveys

Health physics survey conducted during decommissioning will be guided by applicable sections of 10 CFR 20 and USNRC Regulatory Guide No. 8.30 entitled "*Health Physics Surveys in Uranium Mills*" or other applicable standards at the time.

#### 6.2.5.3 Equipment and Materials Surveys

Any site equipment to be released for unrestricted use will be surveyed for alpha contamination and beta gamma as necessary to document levels for release, according to USNRC *"Guidelines for Decontamination of Facilities for Byproduct or Source Materials", Uranium Recovery Field Office Region IV, Denver, Colorado, September 1984,* or the most current standards for decontamination at that time.

#### 6.2.5.4 Transportation Equipment Surveys

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation and U.S. Nuclear Regulatory Commission Regulations (49 CFR 173.389)(10 CFR 71).

#### 6.2.5.5 Records and Reporting Procedures

At the conclusion of site decommissioning and surface reclamation, a report containing all applicable documentation will be submitted to the U.S. Nuclear Regulatory Commission and the Wyoming Department of Environmental Quality. Records of all contaminated materials transported to a licensed disposal site will be maintained for a period of five years or as otherwise required by applicable regulations at the time of decommissioning. A well abandonment report consistent with the requirements of Wyoming Statute 35-11-404(e) will be filed with the Administrator of the Land Quality Division and the State Engineer's Office upon completion of the decommissioning of all well fields.

## 6.3 SURFACE RECLAMATION

The following reclamation plan provides procedural techniques for surface reclamation of all disturbances contained in COGEMA's Irigaray/Christensen Ranch mine plan. Provided are reclamation procedures for the process plant facilities, brine evaporation ponds, permeate storage ponds, mine units, and access roads. Reclamation techniques and procedures for subsequent facilities not yet constructed will follow the same concepts as presented below. Reclamation schedules for mine units are dependent upon the progress of mining and the successful completion of groundwater restoration. Cost estimates for bonding calculations include all activities which are

anticipated to complete groundwater restoration, decontamination, decommissioning and surface reclamation of well field and plant facilities installed to operate for one year of mining activity.

The principal objective of the surface reclamation plan is to return disturbed lands to production, compatible with the post mining land use, of equal or better quality than its premining condition. The reclaimed lands should therefore be capable of supporting livestock grazing and provided stable habitat for native wildlife species. Soils, vegetation, wildlife and radiological baseline data will be used as guidelines for the design, completion and evaluation of surface reclamation. Final surface reclamation will blend affected areas with adjacent undisturbed lands so as to re-establish original slope and topography and present a natural appearance. Surface reclamation efforts will strive to limit soil erosion by wind and water, sedimentation and re-establish natural through drainage patterns. Landowner input regarding the proposed reclamation plans will be given consideration in keeping with W.S. 35-11-406(b)(xi).

### 6.3.1 POST MINING LAND USE

All lands disturbed by COGEMA's Irigaray/Christensen Ranch uranium solution mining activities will be reclaimed to their historical premining land use which is primarily domestic livestock grazing of cattle and sheep with incidental use by native wildlife.

The area was used more commonly for sheep pasture prior to the 1970's than it is today as about 94% of the land in the Powder River Basin is classified as rangeland. The Irigaray site is used for both sheep and cattle grazing. There are still some sheep pastures in the southwestern portion of the Christensen Ranch area which are owned and operated by the Streeter family. There are no plans at present to disturb them. The Christensen Ranch is used for year-round cattle grazing. Pastures are rotated using a deferred system of management with a supplemental winter feeding program. The number of animals grazed varies from year to year, depending upon the management rotation cycle, market price, weather conditions and forage produced. Carrying capacity for range cattle in the vicinity ranges from .24 to .33 animal units per acres per month (AUM), averaging around .28 AUM according to U.S. Soil Conservation personnel in the Gillette office. Dry weight forage production in the area has been estimated to be 1,200 to 1,300 lbs per acre per year using the U.S. Soil Conservation Service range site guide. A more conservative method used by BLM estimate the production to be closer to 800 pounds per acre per year. According to information provided in *"Appendix D8 of the Christensen Ranch Amendment Application"*, the latter estimate equates to about 5 to 6 acres per AUM with slightly higher production in areas further removed from water sources. The original Environmental Impact Statement for Irigaray, NUREG-0481, estimated that Irigaray could support 9 acres per AUM.

Big game wildlife use of the site surrounding areas includes antelope and mule deer. According to wildlife data reported in *"Appendix D9 of the Christensen Ranch Amendment Application"*, the maximum antelope density observed was 3.5 animals per square mile. Mule deer density was estimated to be a minimum of 1.8 deer per square mile. Although these figures do not necessarily relate to the areas carrying capacity for these species, they do provide an indication of present use. It should be noted that the antelope density figure is a maximum observed. The maximum observed deer numbers are considered a minimum density figure and may be extremely variable due to the inherent difficulties in censusing the deer population accurately. Other species present include the sage grouse, desert cottontail rabbit, mourning dove and numerous non-game species that use the area either permanently or seasonally. Similar results were found in the data contained in *"Appendix D of the WDEQ Application for Irigaray"*, although specific densities are not identified.

Other present-day uses of the area include intermittent uranium exploration which began during the early 1950's and more recently the production of oil and gas.

### 6.3.2 PROCESS FACILITIES RECLAMATION

Removal of process equipment, disposal of buildings and facilities and the disposition of process and other waste generated at the satellite plant site areas are described in Section 6.2, Decontamination and Decommissioning. This section of the reclamation plan describes the procedures which will be used to reclaim the surface of the decommissioned and decontaminated disturbances.

#### 6.3.2.1 Subsoil and Topsoil Replacement Methods and Handling Techniques

Subsoils and stockpiled topsoils will be replaced on the disturbances from which they were removed during construction, within practical limits. Areas to be backfilled will be scarified or ripped prior to backfilling to create an uneven surface for application of backfill. This will provide a more cohesive surface to eliminate slipping and slumping. The less suitable subsoils and unsuitable topsoils, if any, will be backfilled first so as to place them in the deepest part of the excavation to be covered with more suitable reclamation materials. Subsoils will be replaced using paddle wheel scrapers, push-cats or other appropriate equipment to transfer the earth from stockpile locations or areas of use and to spread it evenly on the ripped disturbances. Grader blades may be used to even the spread of backfill materials. Backfill compaction will be accomplished by movement of the equipment over the fill area. Topsoil replacement will commence as soon as practical after a given disturbed surface has been prepared. Topsoils will be picked up from storage locations by paddle wheel scrapers or other appropriate equipment and distributed evenly over the disturbed areas. The final grading of topsoil materials will be done so as to establish adequate drainage and the final prepared surface will be left in a roughened condition. There will be no topsoils used for construction of any kind; topsoils will have been salvaged and stockpiled.

#### 6.3.2.2 Estimated Volumes and Replacement Depths

Topsoil was never stripped from the well field surfaces in Irigaray Production Units 1 through 5 thus no topsoil replacement will occur there. Stripping did occur for Units 6 through 9, as well as the evaporation pond sites. Topsoil materials have been and will be salvaged from construction areas for the brine and permeate pond system, roads and plant facility on the Christensen Ranch site.

According to mine plan estimates and baseline soils study data, there is sufficient suitable topsoil material to cover all disturbed areas with a minimum of twelve inches of topsoil material. The one potential exception to this is where road construction is completed along ridge tops, which generally have very shallow topsoil.

Subsoil materials excavated during pond or road installation may be temporarily used for construction purposes. An excess of subsoil material for stockpiling is not anticipated.

#### 6.3.2.3 Contouring of Affected Areas

Due to the relatively minor nature of disturbances created by in-situ mining, there are only a few areas disturbed to the extent to which subsoils and geologic materials are removed causing significant topographic changes which need backfilling and recontouring. Generally speaking, solar evaporation pond construction results in redistribution of sufficient amounts of subsurface materials which requires replacement and contour blending during reclamation. Given the dissected nature of the landscape and slope extremes on the Irigaray/Christensen Ranch area, other installations which will require minor backfilling and recontouring include cut and fill areas to level process plant and equipment locations, cut and fill areas where access roads cross drainages, well field areas which may need to be terraced due to unworkable natural slope conditions and berm materials used around outside storage tanks and chemical storage areas. The existing contours will only be interrupted in small localized areas; because approximate original contours will be achieved during final surface reclamation, no post mining contour maps have been included in this application.

#### 6.3.2.4 Surface Configuration

Changes in the surface configuration caused by construction and installation of operating facilities will be only temporary, during the operating period. These changes will be caused by topsoil removal and storage along with the relocation of subsoil materials used for construction purposes. Restoration of the original land surface, which is consistent with the pre- and post-mining land use, the blending of affected areas with adjacent topography to approximate original contours and re-establishment of drainage patterns will be accomplished by returning the earthen materials moved during construction to their approximate original locations.

### 6.3.2.5 Re-Establishment of Through Drainage

Drainage channels which have been modified by the mine plan for operational purposes such as road crossings will be re-established by removing fill materials, culverts and reshaping to as close to pre-operational conditions as practical. Surface drainage of disturbed areas which have been located on terrain with varying degrees of slope will be accomplished by final grading and contouring appropriate to each location so as to allow for controlled surface run off and eliminate depressions where water could accumulate.

### 6.3.2.6 Erosion Control Practices

Slope conditions vary considerably within the Irigaray/Christensen Ranch area. Replaced topsoils will be protected from wind and water erosion by respreading and discing along the contour in areas where slopes exceed ten percent or perpendicular to prevailing winds on more moderate slopes. Final prepared seed beds will be left in a roughened condition to abate erosion and aid in retention of soil moisture. Native hay or straw mulch will be added to aid against erosion. Cover crop mulch of cereal grains may be considered on some areas if seeding can be done prior to June 1. The seeding rate would be 30 lbs/acre. Mulch will be applied to all prepared surfaces at a minimum rate of two tons per acre. Slopes exceeding twenty percent over a distance of 140 feet will be mulched at the rate of three tons per acre in keeping with the requirements of Chapter II, Section 2.(b)(iii)(c) of the LQD rules and regulations. The mulch will be anchored by discing along the contour. Weed free native hay will be used in preference to domestic straw mulch in order to reduce introduction of weeds and promote introduction of desirable native species. In addition to application of mulch, water erosion will be controlled by installation of water breaks and water bars as necessary to slow and control surface run off. If necessary in steeper areas, the water breaks will be interrupted with rip rap to slow run off flow and reduce sedimentation until a suitable stand of vegetation is established.

### 6.3.2.7 Surface Preparation For Seeding

All compacted areas from which topsoils have been removed such as parking and storage areas, primary access and well field road beds, etc., will be ripped, putting them in a roughened but contoured condition for topsoiling. Ripping to a depth of one to two feet on compacted areas will improve water infiltration and root penetration of the seedlings by breaking up impervious layers. Final contouring and blending will be done with topsoil application. Large rocks encountered while moving soils and earthen materials will be used to construct random piles in the elevated portions of the reclaimed areas to increase habitat diversity for wildlife. This will not be done on private lands if the landowner objects to leaving the rock piles on the surface.

Surface preparation for seeding will be accomplished using a combination of the various farming techniques described above under subsoil and topsoil replacement methods, handling techniques and erosion control procedures. If a disturbed area is finished for seeding and is left fallow for a period exceeding 60 days, additional ripping, rediscing and, in some cases where there is evidence of gullying, recutting of water bars may be accomplished just prior to seeding. The addition of soil amendments and/or fertilizer will be considered by reviewing baseline soils data and visual inspection of the topsoil once it has been replaced. Additives such as nitrogen, phosphorus and potassium may be applied to the topsoiled areas prior to discing and mulching. Additional laboratory testing may be necessary to establish the need or form of these fertilizers in some cases and, if applied, the application will follow rates, time of application and methods suggested by the U.S. Soil Conservation Service for range land applications.

### 6.3.3 REVEGETATION PRACTICES

The objective of COGEMA's revegetation plan is to establish a post-mining native plant community that will meet the reclamation success standard stated in Section 6.3.3.9 and provide long term ecological stability. Some interim cover crop techniques will be utilized during operations, however, revegetation will strive to re-establish native species consistent with the post-mining land use goals.

The Irigaray/Christensen Ranch area is a large site and the disturbances necessary for mining will not be made at the same time but more on a sequential basis. COGEMA recognizes that the area is a mixture of private and public land, BLM and state lands. The responsibility to provide adequate seed mixtures to satisfy the requirements of different landowners and still meet adequate reclamation standards in keeping with post-mining land use has been considered. Although the primary goal of surface reclamation on all lands is livestock grazing, seed mixes have been adjusted to allow for each landowners desires.

The inclusion of sagebrush is the primary point of difference anticipated. Private landowners usually ask that this species be eliminated while public land managers such as BLM generally require its replacement because of its value to wildlife. Other considerations in developing seed mixtures are post-mining topographic features, additional landowner desires, exposure and position of the post-mining landscape and seed availability at the time reclamation is anticipated.

No introduced plant species, such as Crested wheatgrass, will be used that might adversely affect the re-establishment of native grasses. All seeding will be done using species native to the area unless the landowner or other special considerations require adjustments. Discussion with and prior approval from the Department of Environmental Quality will be conducted before seeding any non-native species.

#### 6.3.3.1 Irigaray Site Characteristics

Detailed information regarding baseline vegetation for the Irigaray site can be found in *"Attachment 6 to Appendix D if the WDEQ Application for Irigaray"*. Quantative baseline data including cover, production density, species composition and frequency information is included. The information was derived from a study of approximately 4,700 acres in the mine area. In general, the Irigaray site vegetative cover consists of a series of interdigitating sagebrush and sagebrush-grass complexes.

#### 6.3.3.2 Christensen Ranch Site Characteristics

Data obtained from the pre-mining vegetation study has been considered during the development of the revegetation plan, *"Appendix D8 of the Christensen Ranch Amendment Application"*. The pre-mining study identified eight distinct vegetation mapping units. They include agricultural, disturbed, pine break, cheatgrass, bottomland sagebrush, grassland, riparian and upland sagebrush grassland units. Pine break and agricultural units were not considered for reclamation because they will not be disturbed and represent a very small percentage of the area. The cheatgrass unit was not considered for reclamation because it is of little value in the re-establishment of an ecologically sound plant community and is not consistent with the post-mining reclamation uses and goals. Although the cheatgrasses are ubiquitous throughout the permit area, pure stands of these species (Bromus tectorum and Bromus japonicus) usually occur on disturbed and overused areas where plant succession has been interrupted or set back.

The four plant communities considered during reclamation planning are the bottomland sagebrush, grassland, riparian and upland sagebrush grassland. These four mapping units represent 96.7% of the Christensen Ranch area. The degree of disturbance to each type is anticipated to be roughly the same percentage as their occurrence in the area, which are 28% bottomland sagebrush, 5.4% grassland, 1.6% riparian and 61.7% upland sagebrush/grassland. The remaining 3.3% includes the other four mapping units discussed initially.

#### 6.3.3.3 Irigaray Seed Mixtures

Suggested permanent seed mixes for privately owned uplands, public uplands and riparian plant communities for the Christensen Ranch area are provided in Table 6-5. Nine species of native grasses and five species of native shrubs have been selected for final revegetation of the Irigaray site. The selection of these grasses and shrub species was based on their palatability to livestock, suitability for wildlife habitat, drought resistance, and applicability to the Irigaray site.

## TABLE 6.5
## SUGGESTED SEED MIXES FOR PERMANENT RECLAMATION
## IRIGARAY SITE

| Life Form and Species | Pounds of Pure Live Seed Per Acre | Plants Per Acre |
|---|---|---|
| **Grasses** | | |
| Agropyron smithii | | |
| Western wheatgrass | 3.6 | - |
| Agropyron trachycaulum | | |
| Slender wheatgrass | 1.8 | - |
| Agropyron dasystachyum | | |
| Thickspike wheatgrass | 1.8 | - |
| Agropyron spicatum | | |
| Bluebunch wheatgrass | 1.8 | - |
| Bouteloua gracilis | | |
| Blue gramma | 3.6 | - |
| Calamovilfa longifolia | | |
| Prairie sand-reed | 1.2 | - |
| Sporobolus cryptandrus | | |
| Sand dropseed | 1.2 | - |
| Stipa viridula | | |
| Green needle grass | 1.8 | - |
| Oryzopsis hymendoides | | |
| Indian rice grass | 1.2 | - |
| **Shrubs** | | |
| Artimisia tridentata | | |
| Big sagebrush | - | 90 |
| Artimisia cana | | |
| Silver sage | - | 60 |

## TABLE 6.5 (cont'd)
## SUGGESTED SEED MIXES FOR PERMANENT RECLAMATION
## IRIGARAY SITE

| Life Form and Species | Pounds of Pure Live Seed Per Acre | Plants Per Acre |
|---|---|---|
| Eurotia Ceratoides lanata | | |
| Winterfat | 1.0 | - |
| Chrysothamnus nauseosus | | |
| Rubber rabbitbrush | | 60 |
| Rhus trilobata | | |
| Skunkbrush | | 60 |
| Minimum Total Mix | 19 | 270 |

Notes:

Species that are indicated "Plants Per Acre" will be placed by direct planting as opposed to drilling or broadcast seeding.

The use of shrub species offers several advantages to enhance the success of the revegetation program, especially with respect to wildlife. Shrub seedlings with an established root system can withstand grazing pressure sooner than if started from seed. Also, establishment of some shrubs, notably big sagebrush, is poor from direct seeding. Since grasses are dominant over shrubs in early stages, direct planting of seedlings gives shrubs a competitive advantage that greatly increases establishment of a diverse cover.

#### 6.3.3.4 Christensen Ranch Seed Mixtures

The private landowner for Christensen Ranch has requested that yellow sweet clover, Melilotus officinalis, be eliminated from seed mixes used on private lands whether temporary or permanent (see Attachment 6.1 at the end of Section 6.0).

Suggested permanent seed mixes for privately owned uplands, public uplands and riparian plant communities for the Christensen Ranch area are provided in Table 6-6. Development of the seed mixes was accomplished by first considering the dominant plant species present in the pre-mining plant communities. This list of dominants was combined with a list of species recommended for reclamation by the vegetation baseline study contractor. A table was developed which listed some 35 plant species and the characteristics of each which included growth form, growth season, forge quality for cattle, deer, antelope, commercial seed availability and revegetation potential where information was available. Other considerations listed included flood, salt and drought tolerance of each species. Since one of the objectives of the reclamation plan is to reclaim disturbance areas with native plants, all species considered for inclusion in seed mixes were checked against the baseline plant species list. Plants not found during the pre-mining baseline survey were eliminated from consideration in seed mixes, therefore, while all species considered for reclamation may not be native in a true sense, they were found in the pre-mining plant community.

The pre-mining plant community is rich in forb species; some 165 individuals were identified. Many of these plants are weeds not necessarily useful to the reclamation goals of the project with the exception of adding diversity. There are four species of forbs listed for consideration in the seed mixes and at least one of these, preferably a legume, will be included in each seed mix if no objection precludes their use. Many of the forbs on the undisturbed areas will be re-established on reclaimed areas as volunteers. The shrub and sub-shrubs included in the seed mixes to replace dominant pre-mining species are species of the greatest value to the post-mining land uses. No consideration has been given to seeding any tree species because few if any will be destroyed by the mining operation. Forage value for all seed mix species are either preferred or desirable for cattle grazing and wildlife. Shrub species selected will aid in seed mix diversity as well as providing forage and cover for wildlife.

## TABLE 6.6
## SUGGESTED SEED MIXES FOR PERMANENT RECLAMATION
## CHRISTENSEN RANCH SITE

**Seed mixes and rates in pounds per acre of Pure Live Seed (PLS)**

| Life Form and Species | Private[e] Uplands | Public[f] Uplands | Riparian[g] Uplands |
|---|---|---|---|
| Grasses[a] | | | |
| Agropyron dasystahyum | | | |
| Thickspike wheatgrass | 3 | 3 | 3 |
| Agropyron ripariam | | | |
| Streambank wheatgrass | 2 | 2 | 3 |
| Agropyron smithii | | | |
| Western wheatgrass | 3 | 3 | 2 |
| Agropyron spicatum inerme | | | |
| Beardless bluebunch wheatgrass | 1 | 1 | - |
| Agropyron trachycaulum | | | |
| Slender wheatgrass | 2 | 2 | 3 |
| Elymus junceus | | | |
| Russian wildrye | .5 | .5 | - |
| Orgzopsis hymenoides | | | |
| Indian ricegrass | .5 | .5 | - |
| Phylum pratense | | | |
| Common timothy | - | - | 1 |
| Poa pratensis | | | |
| Kentucky bluegrass | - | - | 1 |
| Poa secunda | | | |
| Sandberg bluegrass | 1 | 1 | - |

## TABLE 6.6
## SUGGESTED SEED MIXES FOR PERMANENT RECLAMATION
## CHRISTENSEN RANCH SITE

**Seed mixes and rates in pounds per acre of Pure Live Seed (PLS)**

| Life Form and Species | Private[a] Uplands | Public[f] Uplands | Riparian[g] Uplands |
|---|---|---|---|
| Stipa viridula | | | |
| Green needlegrass | 1 | 1 | 1 |
| **Forbs[b]** | | | |
| Medicago sativa | | | |
| Alfalfa | .25-.50 | - | - |
| Melilotus officinalis | | | |
| Yellow sweetclover | - | .25 | - |
| Vicia americana | | | |
| American vetch | .25-.50 | .25-.50 | .25-.50 |
| Penstemon sp | | | |
| Penstemon | .25-.50 | .25-.50 | - |
| **Sub-shrubs[c]** | | | |
| Artemisia ludoviciana | | | |
| Louisiana sagewort | .5 | .5 | - |
| Artemisia frigida | | | |
| Fringed sagewort | .5 | .5 | - |
| Atriplex gardneri | | | |
| Gardner saltbrush | .5 | .5 | - |
| Ceratoides | | | |
| Common winterfat | .5 | .5 | - |

## TABLE 6.6
## SUGGESTED SEED MIXES FOR PERMANENT RECLAMATION
## CHRISTENSEN RANCH SITE

Seed mixes and rates in pounds per acre of Pure Live Seed (PLS)

| Life Form and Species | Private[e] Uplands | Public[f] Uplands | Riparian[g] Uplands |
|---|---|---|---|
| **Shrubs[d]** | | | |
| Artemisia cana | | | |
| Silver sagebrush | - | - | .25 |
| Artemisia tridentata | | | |
| Big sagebrush | - | .25 | - |
| Atriplex canescens | | | |
| Fourwing saltbrush | .5 | .5 | - |
| Chrysothamnus nauseosus | | | |
| Rubber rabbitbush | .25-.50 | .25-.50 | - |
| Chrysothamnus viscidiflourus | | | |
| Douglas rabbitbush | .25-.50 | .25-.50 | - |
| Prunus virginiana | | | |
| Common chokecherry | - | - | .25 |
| Ribes aureum | | | |
| Golden current | - | - | .25 |
| Rosa woodsii | | | |
| Woods rose | - | - | .25 |
| Salix amygdeloides | | | |
| Peach-leaf willow | - | - | .25 |
| Salix exigua | | | |

## TABLE 6.6
## SUGGESTED SEED MIXES FOR PERMANENT RECLAMATION
## CHRISTENSEN RANCH SITE

**Seed mixes and rates in pounds per acre of Pure Live Seed (PLS)**

| Life Form and Species | Private[e] Uplands | Public[f] Uplands | Riparian[g] Uplands |
|---|---|---|---|
| Coyote willow | - | - | .25 |
| **MINIMUM SEED MIX SUMMARY** | | | |
| Grasses[a] | 14.0 | 14.0 | 14.0 |
| Forbs[b] (if acceptable) | .5 | .5 | .5 |
| Sub-shrubs[c] | 1.0 | 1.0 | 0.0 |
| Shrubs[d] | 1.0 | 1.0 | 1.0 |
| Minimum Total Mix | 16.5 | 16.5 | 15.5 |

Notes

a) Each seed mix will contain 14 lbs/acre PLS grasses

b) Each seed mix will contain .5 lbs/acre of one or more forb species acceptable to the landowner. A legume species is preferred.

c) Each upland seed mix will contain 1 lb/acre PLS or more sub-shrubs; Winterfat and Gardner saltbrush at .5 lbs each are preferred, plus .5 lbs of one Sagewort species.

d) Each seed mix will contain a minimum of two shrub species with a minimum of 1 lb/acre PLS.

e) Private upland seed mix contain .5 lbs/ acre PLS each of Fourwing saltbrush and a rabbitbrush; Rubber rabbitbrush will be preferred.

f) Public upland seed mix will contain .25 lbs/acre PLS of Big sagebrush plus shrub species described in (e) above.

g) Riparian seed mix will contain .25 lbs/acre PLS of Silver sagebrush, .25 lbs/acre Woods rose, .25 lbs either Common chokecherry or Golden current, and .25 lbs of a Willow species.

### 6.3.3.5 Reseeding Methods

Seeding will be done using a combination of drilling, broadcasting and direct planting depending upon the size of the area, slope, time of planting, species seeded and other factors. A range drill will be used for seeding grasses, forbs and shrub species along the contours on larger areas where slope conditions are less than thirty percent. All seed mixtures drilled will be applied at the rate tabulated in Table 6.5 or Table 6.6 and drilled to a depth of 1/4" to 1/2". Broadcast seeding will be used on areas with steep slopes (over thirty percent) and for seeding additional shrubs if necessary. Harrowing or raking will follow broadcast seeding whenever possible. The seed rate for a given seed mixture will be doubled for areas where seeds are broadcast.

The pre-mining plant communities are dominated by cool-season grasses and final reclamation seed mixes are composed of cool-season grasses. Shrub species will initially be planted with the grasses. There are no present plans to use a two-stage seeding program and, due to the nature of the mining disturbance, opportunities for using live topsoil are not likely except in the well fields. If early evaluation of initially seeded areas indicates poor establishment of shrubs and low species diversity, an interseeding program may be considered. If interseeding becomes necessary, consideration will be given to the addition of dominant warm-season grasses, hand-broadcasting of shrub species in drainage bottoms, along side slopes and in the lee of rock piles and outcrops to add diversity to the habitats. This would increase cover and edge effect as well as shrub density. If adequate shrub densities are not established using the above methods, additional direct planting of shrub pads or tublings in low density clusters will be considered.

Seeding will be done either during the fall after October 15 and prior to the ground freezing or during early spring before April 15. Spring seeding may be extended into May in some years depending on site weather and soil conditions. Fall seeding will be preferred in most cases to take advantage of the soil moisture conditions and avoid the use of machinery during the spring when soils tend to be saturated with moisture.

### 6.3.3.6 Management of Newly Seeded Areas

Post-mining management practices will include the protection of newly seeded areas from livestock grazing by fencing the livestock out until the newly established plant community is capable of maintaining itself under normal management practices. No major attempt will be made to exclude wildlife; type III livestock fencing will be used. The Land Quality Division, COGEMA and the landowner will work together to develop an acceptable grazing plan to reintroduce domestic livestock to the various reclaimed areas.

No irrigation of reclaimed areas is planned. If any significant stands of noxious weeds are noted, they will be controlled by either physical or chemical means as suggested

by the county weed-control staff.

### 6.3.3.7 General Reclamation Schedules

A general schedule for reclamation given in Section 3.6.

### 6.3.3.8 Exception To Surface Reclamation Plans

Alternative final reclamation plans may be proposed for approval prior to final reclamation. Reasons for considering changes to the present plan include input from the landowners at the time COGEMA is prepared to undertake final decommissioning and surface reclamation. The landowners could be interested in retaining a building, suitable water well or portion of a road which would benefit his livestock operation. Amended plans to include such alternatives will be submitted for approval assuming that the facility retained could be decontaminated to the standards required for unrestricted use.

### 6.3.3.9 Evaluation of Reclamation Success

The basis for evaluation of reclamation success on disturbances created by COGEMA mining activities are those goals defined in the Department of Environmental Quality, Land Quality Division, Rules and Regulations. They are to achieve post-mining cover and production equal to pre-mining conditions, species composition and diversity capable of supporting the post-mining land use, the ability of the reclaimed plant community to sustain grazing pressure at least equal to pre-mining grazing pressure and all of the above must be attained for the last two consecutive years immediately prior to final bond release.

A post-seeding monitoring program will be conducted on reclaimed areas beginning the first spring after reseeding has taken place. The purpose of the initial inspection of newly seeded areas will be to check for successful germination, ground cover in relation to potential erosion and to identify any other potential problem areas. Subsequent inspections will serve to record the progress of the development of the reseeded plant community. As the reseeded area develops, additional data will be recorded to aid in determining when the reseeded area will be ready for implementation of the post-mining grazing program and final evaluation of reclamation success.

Reseeded areas will be monitored periodically during the growing season and the field reconnaissance will include development of species lists to monitor and document diversity and composition.

The reclamation methods and seed mixes selected by COGEMA should enhance wildlife habitat in keeping with the requirement of LQD Rules and Regulations by

re-establishing native species and the inclusion of sub-shrub and woody species. In addition to seed mix diversity, plant species diversity and life forms on the reclaimed areas should be increased through invading and volunteer species from adjoining undisturbed areas as the new plant communities develop. The relatively small, often narrow and irregularly shaped nature of most of the disturbance associated with the project should increase the potential for invasion of additional native species.

Reference Areas

During the vegetation baseline study at Christensen Ranch, a composite reference area that represented the various vegetation types, topography, slope and aspect of the area to be affected was selected to serve as the benchmark for the revegetation success parameters *("Appendix D-8 of the Christensen Ranch Amendment Application").* The single large composite reference area incorporated the range of vegetation types to be disturbed, therefore, eliminating the need for a separate reference or control area for each vegetation type. Also eliminated was the need to stratify the reclaimed areas into the various vegetation types for evaluation purposes. When an area is ready to be evaluated for revegetation success, it will be sampled as one unit and parameters will be compared to the composite reference area also sampled as one unit. The assumption that the vegetation on the reference area and reclaimed area will respond similarly to climatic variation is unchanged from the normal use of reference areas for evaluating reclamation success. The composite reference area will not be disturbed by mining activities.

At Irigaray, the vegetation baseline study included 3 control plots, approximately 2 to 3 acres in size, situated each of the 3 major vegetation types (bottomland sagebrush, upland sagebrush, and grassland). These plots were located away from mining activities. Each control plot was sampled for production and cover data.

Cover and Productivity Evaluation

Quantitative data on the cover and productivity of vegetation on the reclaimed area will be gathered during each of two consecutive years prior to bond release and compared to data from the composite reference or control area gathered during the same periods. The same procedures used to obtain the cover and productivity data during the baseline studies at Christensen Ranch random sampling, point intercept transacts, productivity from unprotected plots, sampling adequacy as defined in WDEQ Guideline No. 2) will be used to sample both the reclaimed area and the reference area.

Reclamation will be considered adequate for percent vegetation cover, percent total ground cover and total production if those parameters on the reclaimed area exceed or are equivalent to the parameters on the reference area (80% confidence with 0.2) as determined by the following formula:

$$x - x + z_{0.8}\ S x^2 + S x^2\ 0$$

Where: x = mean of parameter from reclaimed area
x = goal of parameter from composite reference area
S = variance of respective mean
$z_{0.8}$ = Z value for 80% confidence

(all of the above from WDEQ Guideline No. 2)

Species Composition and Diversity Evaluation

Species composition and species diversity of the reclaimed area will be evaluated based on vegetation species data gathered during the quantitative cover and production sampling and qualitative vegetation species composition surveys to be conducted on the reclaimed areas. Species diversity evaluations will consider both components, variety and equitability. A discussion of the major species (species having relative cover of 2% or greater) on the reclaimed area will be prepared. The discussion will address the ability of the various species to support and maintain the post-mining land use of livestock grazing and incidental wildlife use. A discussion of the various species, role in secondary succession will also be provided. A qualitative comparison of the species composition on the reclaimed area with the composite reference area community will be included in the discussion. In addition, a comparison of the life forms on the reclaimed and composite reference area communities will be provided using the Motyka similarity index (Mueller-Dombois and Ellenberg 1974):

$$IS_m o = \frac{2w}{a+b} \times 100 = \%\ similarity$$

Where: w = sum of the lesser value for each component pair from areas A and B.
a = sum of the values for area A.
b = sum of the values for area B.

The index of similarity will be based on vegetation cover of the following life forms:

1: Perennial native grass
2: Annual grass
3: Perennial forb
4: Annual forb
5: Deciduous shrub
6: Evergreen shrub

The Land Quality Division has proposed an index of similarity of 80% between reclaimed and pre-mining communities (Boles 1983). COGEMA will calculate the index for the reclaimed area and composite reference area and use it as a basis for discussion; however, the index will not constitute the sole criterion for evaluation of species diversity and inability to obtain 80% similarity will not in and of itself be grounds for rejecting reclamation success relative to species composition.

During at least the two years prior to bond release and while the vegetation success studies are being conducted, livestock and wildlife will be allowed to graze on the reclaimed area per the agreed re-introduction plans developed as stated in Section 6.3.4.6. Quantitative data on vegetation cover and production and qualitative data on vegetation species composition gathered during the reclamation success studies will be evaluated and reported relative to the ability of the area to support grazing. A discussion of the shrubs on the reclaimed area, including quantitative estimates of the areal extent of shrub dominated areas, species of shrubs and approximate densities will be provided along with a discussion of the wildlife habitat provided by shrubs.

Reclamation Bond Release Report

In addition to the specific items discussed above, the reports submitted to the Land Quality Division in support of reclamation success will include a discussion of the reclamation practices, seed mix, methods to establish shrubs, husbandry practice and land management used on the reclaimed area. Procedures used to define the boundaries of the reclaimed area and discussion of the age of the reclaimed area will also be included.

Reclamation Conducted To-Date

The decommissioning of the Christensen Ranch Willow Creek R&D site began on March 21, 1995. Authorization for this project was initially granted by NRC during discussions held in mid-March, 1995 in Denver (at the NRC/industry TOT meetings), and was later formalized by Amendment No. 37 dated April 19, 1995. Removal of the R&D ponds, soil stockpiles, septic tank and fencing were necessary in order to develop the new Mine Unit 5 at Christensen Ranch.

Decommissioning commenced with the two evaporation ponds by first transferring all remaining pond water and sediments to the lined ponds located at the CR satellite plant. This was accomplished by pumping through a temporary surface line run from the R&D ponds to the satellite plant. After all the water and sediments had been removed from the ponds, decontamination of the liners began through the use of a high pressure steam cleaner. After the liners were cleaned, surveyed, and removed, a grid system was laid out on the underlying gravel, leak detection systems, and soil in preparation for radiological surveying and sampling. Guidelines from NUREG-5849, "Manual for Conducting Radiological Surveys in Support of License Termination", were

followed for the radiological surveys, and NRC's "Guideline For Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials", September, 1994, was used for determining releasable limits for all materials.

Radiological surveys (alpha and beta/gamma) performed of the pond gravel leak detection systems and underlying soils indicated background levels of radiation, with no indication of any contamination. Extensive gravel and soils sampling and analysis further verified that no contamination existed under the liners of the evaporation ponds.

Other decommissioning activities involved the removal of the septic tank, removal of all fencing surrounding the R&D area, additional soil sampling in areas where the process trailers had once been located (no contaminated soils were found), and the relocation of remaining topsoil and subsoil not used in the pond reclamation (remaining from construction of the access road). The soil stockpiles are now located immediately south of the R&D site, south of the Mine Unit 5 boundary.

After all aspects of the R&D site had been surveyed and released, reclamation of the site commenced. Subsoil and topsoil were replaced on the site to the original depth and grade. Seed was applied in the fall of 1995.

## 6.4 BONDING ASSESSMENT

### 6.4.1 BOND CALCULATIONS

An up-to-date estimate for the restoration, decommissioning and surface reclamation at the Irigaray and Christensen Ranch sites is provided as Attachment 6.2. The cost assessment includes groundwater restoration, decontamination and decommissioning and surface reclamation costs for all areas affected to date by the installation and operation of the proposed mine plan through 1996. The detailed calculation utilized in determining the bonding requirements for the Irigaray/Christensen Ranch project are enclosed on Attachment 6.2.

### 6.4.2 FINAL SURETY ARRANGEMENTS

COGEMA currently maintains an irrevocable letter of credit number 93/832 issued by the Credit Commercial de France of New York in favor of the State of Wyoming in the amount of $10,423,465.00 for the purpose of complying with 10 CFR 40, Appendix A, Criterion 9 regarding restoration and reclamation costs. The bank has been asked to raise the level of the letter of credit to $11,384,319.00 for the 1995-1996 bonding period. The increase is expected to be received by mid-January, 1996.

# ATTACHMENT 6.1

## LANDOWNER REVEGETATION REQUEST

March 31, 1988

Ms. Donna L. Wichers
Manager - Licensing, Safety and Environmental Services
Malapai Resources Company
P.O. Box 9950
Casper, Wyoming 82609

Dear Ms. Wichers:

In regards to the seed mixture for final reclamation on Christensen Ranch lands which will be affected by Malapai Resources Company's commercial mining operations, I specifically have two requests. First, I request that sagebrush be eliminated from the final reclamation seed mix. Secondly, I request that yellow sweet clover be eliminated from any final or temporary cover seed mixes used for reclamation.

Sincerely,

John O. Christensen

John O. Christensen

CHRISTENSEN RANCH
S-475, Savageton Route
Gillette, Wyoming 82716

JOC:dw

# ATTACHMENT 6.2

## RESTORATION, DECOMMISSIONING AND RECLAMATION ESTIMATE

# COGEMA Mining, Inc.

## 1995-1996
## Decommissioning and Reclamation Cost Estimate
## Irigaray and Christensen Ranch Projects

## PERMIT TO MINE NO. 478

Originally Submitted August 17, 1995
Revised November 3, 1995

COGEMA Mining, Inc.
SUMMARY OF RECLAMATION/RESTORATION BOND ESTIMATE
WDEQ PERMIT NO. 478/USNRC LICENSE SUA-1341
TABLE 1
D:\DONNA\WYBOND\WYWKTAB1.WK4

| | | |
|---|---|---|
| I GROUNDWATER RESTORATION - Worksheet 1: | | $5,029,754 |
| II DECOMMISSIONING AND SURFACE RECLAMATION: | | |
| A. Process Plant(s) Equipment Removal and Disposal Worksheet 2 | | $111,220 |
| B. Plant Building(s) Demolition and Disposal Worksheet 3 | | $516,227 |
| C. Process Pond Sludge and Liner Handling Worksheet 4 | | $1,886,406 |
| D. Well Abandonment Worksheet 5 | | $650,381 |
| E. Wellfield Equipment Removal and Disposal Worksheet 6 | | $892,467 |
| F. Topsoil Replacement and Revegation Worksheet 7 | | $499,470 |
| G. Miscellaneous Reclamation Activities Worksheet 8 | | $119,377 |
| Sub Total - Decommissioning and Surface Reclamation | | $4,675,548 |
| SUBTOTAL RESTORATION AND RECLAMATION | | $9,705,302 |
| Contingency | | |
| Project Design | 2% | |
| Contractor Profit & Mobilization | 4% | |
| Project Management | 3% | |
| Site Security & Liability Assurance | 1% | |
| Unknowns | 5% | |
| TOTAL CONTINGENCY | 15% | $1,455,795 |
| SUBTOTAL | | $11,161,097 |
| 2% Inflation Factor to 1995 $ | | $223,222 |
| TOTAL RESTORATION AND RECLAMATION | | $11,384,319 |

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| OUNDWATER RESTORATION | Irigaray Mine Unit(s) #1 Thru #5 | Irigaray Mine Unit(s) #6 Thru #9 | Christensen Mine Unit #2 | Christensen Mine Unit #3 | Christensen Mine Unit #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 |
|---|---|---|---|---|---|---|---|
| Technical Assumptions: | | | | | | | |
| Wellfield Area (Ft²) | 522720 | 784080 | 890000 | 798944 | 510088 | 1100386 | 1100386 |
| Wellfield Area (Acres) | 12.00 | 18.00 | 20.43 | 18.34 | 11.71 | 25.26 | 25.26 |
| Affected Ore Zone Area (Ft²) | 522720 | 784080 | 890000 | 798944 | 550193 | 1100386 | 1100386 |
| Avg Completed Thickness (Ft) | 15.0 | 18.0 | 11.0 | 10.0 | 12.7 | 13.0 | 13.0 |
| Affected Volume: | | | | | | | |
| Factor For Vertical Flare | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| Factor For Horizontal Flare | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| Total Volume (Ft³) | 11290752 | 20323354 | 14097600 | 11504794 | 10061930 | 20599226 | 20599226 |
| Porosity | 26.0% | 26.0% | 26.0% | 26.0% | 26.0% | 26.0% | 26.0% |
| Gallons Per Cubic Foot | 7.48 | 7.48 | 7.48 | 7.48 | 7.48 | 7.48 | 7.48 |
| Gallons Per Pore Volume | 21958254 | 39524858 | 27417012 | 22374523 | 19568441 | 40061375 | 40061375 |
| Number of Wells in Unit(s) | | | | | | | |
| Production Wells | 150 | 274 | 153 | 185 | 105 | 220 | 220 |
| Injection Wells | 310 | 330 | 173 | 277 | 128 | 260 | 260 |
| Monitor Wells | 150 | 165 | 50 | 46 | 44 | 80 | 80 |
| Average Well Spacing (Ft) | 35 | 35 | 85 | 70 | 85 | 85 | 85 |
| Average Well Depth (Ft) | 250 | 250 | 345 | 300 | 430 | 450 | 510 |
| I GROUNDWATER SWEEP | | | | | | | |
| A. PLANT & OFFICE | | | | | | | |
| Operating Assumptions: | | | | | | | |
| Flowrate (gpm) | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| PV's Required | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Total Gallons For Treatment | 87833018 | 158099432 | 109668050 | 89498090 | 78273763 | 160245498 | 160245498 |
| Total KGals for Treatment | 87833 | 158099 | 109668 | 89498 | 78274 | 160245 | 160245 |
| Cost Assumptions: | | | | | | | |
| Power | | | | | | | |
| Avg Connected Hp | 50.00 | 50.00 | 51.30 | 51.30 | 51.30 | 51.30 | 51.30 |
| Kwh's/Hp | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $/Kwh | $0.051 | $0.051 | $0.048 | $0.048 | $0.048 | $0.048 | $0.048 |
| Gallons Per Minute | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| Gallons Per Hour | 12000 | 12000 | 12000 | 12000 | 12000 | 12000 | 12000 |
| Cost Per Hour | 2.53 | 2.53 | 2.46 | 2.46 | 2.46 | 2.46 | 2.46 |
| Cost Per Gallon | 0.00021 | 0.00021 | 0.00021 | 0.00021 | 0.00021 | 0.00021 | 0.00021 |
| Cost Per KGal ($) | $0.211 | $0.211 | $0.205 | $0.205 | $0.205 | $0.205 | $0.205 |
| Chemicals | | | | | | | |
| Barium Chloride ($/KGals) | $0.041 | $0.041 | $0.041 | $0.041 | $0.041 | $0.041 | $0.041 |
| Elution ($/KGals) | $0.099 | $0.099 | $0.099 | $0.099 | $0.099 | $0.099 | $0.099 |
| Repair & Maintenance ($/KGals) | $0.061 | $0.061 | $0.061 | $0.061 | $0.061 | $0.061 | $0.061 |
| Analysis ($/KGals) | $0.164 | $0.091 | $0.091 | $0.161 | $0.092 | $0.094 | $0.094 |
| Total Cost Per KGal | $0.576 | $0.503 | $0.498 | $0.567 | $0.499 | $0.501 | $0.501 |
| Total Treatment Cost | $50,602 | $79,564 | $54,577 | $50,788 | $39,026 | $80,215 | $80,215 |
| Utilities | | | | | | | |
| Power ($/Month) | $1,840 | $1,840 | $1,840 | $1,840 | $1,840 | $1,840 | $1,840 |
| Propane ($/Month | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 |
| Time For Treatment | | | | | | | |
| Minutes For Treatment | 439165 | 790497 | 548340 | 447490 | 391369 | 801227 | 801227 |
| Hours For Treatment | 7319 | 13175 | 9139 | 7458 | 6523 | 13354 | 13354 |
| Days For Treatment | 305 | 549 | 381 | 311 | 272 | 556 | 556 |
| Average Days Per Month | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 |
| Months For Treatment | 10.0 | 18.0 | 12.5 | 10.2 | 8.9 | 18.3 | 18.3 |
| Utilities Cost ($) | $28,478 | $51,261 | $35,558 | $29,018 | $25,379 | $51,957 | $51,957 |
| TOTAL PLANT & OFFICE COST | $79,080 | $130,825 | $90,135 | $79,806 | $64,404 | $132,172 | $132,172 |

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| ROUNDWATER RESTORATION | Irigaray Mine Unit(s) #1 Thru #5 | Irigaray Mine Unit(s) #6 Thru #9 | Christensen Mine Unit #2 | Christensen Mine Unit #3 | Christensen Mine Unit #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 |
|---|---|---|---|---|---|---|---|
| I GROUNDWATER SWEEP (Continued) | | | | | | | |
| B. WELLFIELD | | | | | | | |
| Cost Assumptions: | | | | | | | |
| Power | | | | | | | |
| Avg Flow/Pump (gpm) | 3.86 | 3.86 | 8.02 | 8.02 | 8.02 | 8.02 | 8.02 |
| Avg Hp/Pump | 1.50 | 1.50 | 3.00 | 3.00 | 3.00 | 3.00 | 3 |
| Avg # of Pumps Required | 51.9 | 51.9 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| Avg Connected Hp | 77.8 | 77.8 | 74.9 | 74.9 | 74.9 | 74.9 | 74.9 |
| Kwh's/Hp | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| $/Kwh | $0.051 | $0.051 | $0.048 | $0.048 | $0.048 | $0.048 | $0.048 |
| Gallons Per Minute | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| Gallons Per Hour | 12000 | 12000 | 12000 | 12000 | 12000 | 12000 | 12000 |
| Cost Per Hour ($) | $3.94 | $3.94 | $3.59 | $3.59 | $3.59 | $3.59 | $3.59 |
| Cost Per Gallon ($) | $0.0003 | $0.0003 | $0.0003 | $0.0003 | $0.0003 | $0.0003 | $0.0003 |
| Cost Per KGal ($) | 0.328 | 0.328 | 0.299 | 0.299 | 0.299 | 0.299 | 0.299 |
| Repair & Maintenance ($/KGals) | $0.016 | $0.016 | $0.016 | $0.016 | $0.016 | $0.016 | $0.016 |
| Total Cost Per KGal | $0.345 | $0.345 | $0.316 | $0.316 | $0.316 | $0.316 | $0.316 |
| TOTAL WELLFIELD COST | $30,263 | $54,473 | $34,650 | $28,277 | $24,731 | $50,630 | $50,630 |
| TOTAL GROUND WATER SWEEP COST | $109,343 | $185,298 | $124,785 | $108,083 | $89,135 | $182,802 | $182,802 |
| II REVERSE OSMOSIS | | | | | | | |
| A. PLANT & OFFICE | | | | | | | |
| Operating Assumptions: | | | | | | | |
| Flowrate (gpm) | 300 | 300 | 500 | 500 | 500 | 500 | 500 |
| PV's Required | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Total Gallons For Treatment | 65874763 | 118574574 | 82251037 | 67123568 | 58705322 | 120184124 | 120184124 |
| Total KGals for Treatment | 65874.763 | 118574.57 | 82251.037 | 67123.568 | 58705.322 | 120184.12 | 120184.12 |
| Feed to RO (gpm) | 300 | 300 | 500 | 500 | 500 | 500 | 500 |
| Permeate Flow (gpm) | 240 | 240 | 400 | 400 | 400 | 400 | 400 |
| Brine Flow (gpm) | 60 | 60 | 100 | 100 | 100 | 100 | 100 |
| Average RO Recovery | 80.0% | 80.0% | 80.0% | 80.0% | 80.0% | 80.0% | 80.0% |
| Cost Assumptions: | | | | | | | |
| Power | | | | | | | |
| Avg Connected Hp | 120.00 | 120.00 | 180.00 | 180.00 | 180.00 | 180.00 | 180.00 |
| Kwh's/Hp | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| $/Kwh | $0.051 | $0.051 | $0.048 | $0.048 | $0.048 | $0.048 | $0.048 |
| Gallons Per Minute | 300 | 300 | 500 | 500 | 500 | 500 | 500 |
| Gallons Per Hour | 18000 | 18000 | 30000 | 30000 | 30000 | 30000 | 30000 |
| Cost Per Hour ($) | $6.07 | $6.07 | $8.64 | $8.64 | $8.64 | $8.64 | $8.64 |
| Cost Per Gallon ($) | $0.00034 | $0.00034 | $0.00029 | $0.00029 | $0.00029 | $0.00029 | $0.00029 |
| Cost Per KGal ($) | $0.337 | $0.337 | $0.288 | $0.288 | $0.288 | $0.288 | $0.288 |
| Chemicals | | | | | | | |
| Sulfuric Acid ($/KGals) | $0.076 | $0.076 | $0.076 | $0.076 | $0.076 | $0.076 | $0.076 |
| Caustic Soda ($/KGals) | $0.111 | $0.111 | $0.111 | $0.111 | $0.111 | $0.111 | $0.111 |
| Hydrochloric Acid ($/KGals) | $0.009 | $0.009 | $0.009 | $0.009 | $0.009 | $0.009 | $0.009 |
| Hydrogen Sulfide ($/KGals) | $0.304 | $0.304 | $0.304 | $0.304 | $0.304 | $0.304 | $0.304 |
| Repair & Maintenance ($/KGals) | $0.279 | $0.279 | $0.279 | $0.279 | $0.279 | $0.279 | $0.279 |
| Sampling & Analysis ($/KGals) | $0.164 | $0.091 | $0.091 | $0.161 | $0.092 | $0.094 | $0.094 |
| Total Cost Per KGal ($) | $1.279 | $1.207 | $1.157 | $1.227 | $1.158 | $1.160 | $1.160 |
| Total Pumping Cost ($) | $84,280 | $143,064 | $95,186 | $82,366 | $67,991 | $139,435 | $139,435 |
| Utilities | | | | | | | |
| Power ($/Month) | $1,840 | $1,840 | $1,840 | $1,840 | $1,840 | $1,840 | $1,840 |
| Propane ($/Month | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 |
| Time For Treatment | | | | | | | |
| Minutes For Treatment | 219582.54 | 395248.58 | 164502.07 | 134247.14 | 117410.64 | 240368.25 | 240368.25 |
| Hours For Treatment | 3659.7091 | 6587.4763 | 2741.7012 | 2237.4523 | 1956.8441 | 4006.1375 | 4006.1375 |
| Days For Treatment | 152.48788 | 274.47818 | 114.23755 | 93.227177 | 81.535169 | 166.92239 | 166.92239 |
| Average Days Per Month | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 |
| Months For Treatment | 5.0 | 9.0 | 3.8 | 3.1 | 2.7 | 5.5 | 5.5 |
| Utilities Cost ($) | $14,201 | $25,562 | $10,793 | $8,805 | $7,669 | $15,621 | $15,621 |
| TOTAL PLANT & OFFICE COST | $98,481 | $168,627 | $105,979 | $91,170 | $75,660 | $155,056 | $155,056 |

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WORKSHEET 1
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| GROUNDWATER RESTORATION | Irigaray Mine Unit(s) #1 Thru #5 | Irigaray Mine Unit(s) #6 Thru #9 | Christensen Mine Unit #2 | Christensen Mine Unit #3 | Christensen Mine Unit #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 |
|---|---|---|---|---|---|---|---|
| II REVERSE OSMOSIS (Continued) | | | | | | | |
| 8. WELLFIELD | | | | | | | |
| Cost Assumptions: | | | | | | | |
| Power | | | | | | | |
| Avg Flow/Pump (gpm) | 3.86 | 3.86 | 8.02 | 8.02 | 8.02 | 8.02 | 8.02 |
| Avg Hp/Pump | 1.50 | 1.50 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Avg # of Pumps Required | 77.8 | 77.8 | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 |
| Avg Connected Hp | 116.7 | 116.7 | 187.1 | 187.1 | 187.1 | 187.1 | 187.1 |
| Kwh's/Hp | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| $/Kwh | $0.051 | $0.051 | $0.048 | $0.048 | $0.048 | $0.048 | $0.048 |
| Gallons Per Minute | 300 | 300 | 500 | 500 | 500 | 500 | 500 |
| Gallons Per Hour | 18000 | 18000 | 30000 | 30000 | 30000 | 30000 | 30000 |
| Cost Per Hour ($) | $5.91 | $5.91 | $8.98 | $8.98 | $8.98 | $8.98 | $8.98 |
| Cost Per Gallon ($) | $0.0003 | $0.0003 | $0.0003 | $0.0003 | $0.0003 | $0.0003 | $0.0003 |
| Cost Per KGal ($) | $0.328 | $0.328 | $0.299 | $0.299 | $0.299 | $0.299 | $0.299 |
| Repair & Maintenance ($/KGals) | $0.016 | $0.016 | $0.016 | $0.016 | $0.016 | $0.016 | $0.016 |
| Total Cost Per KGal | $0.345 | $0.345 | $0.316 | $0.316 | $0.316 | $0.316 | $0.316 |
| TOTAL WELLFIELD COST | $22,697 | $40,855 | $25,987 | $21,208 | $18,548 | $37,972 | $37,972 |
| TOTAL REVERSE OSMOSIS COST | $121,179 | $209,482 | $131,966 | $112,378 | $94,208 | $193,029 | $193,029 |
| III WASTE DISPOSAL WELL | | | | | | | |
| Operating Assumptions: | | | | | | | |
| Annual Evaporation Capacity (Gals) | 10512000 | 10512000 | 1917611.9 | 1917611.9 | 1917611.9 | 1917611.9 | 1917611.9 |
| Avg. Monthly Evap. Capacity (Gals) | 876000 | 876000 | 159801 | 159801 | 159801 | 159801 | 159801 |
| Total Disposal Requirement | | | | | | | |
| RO Brine Total Gallons | 13174953 | 23714915 | 16450207 | 13424714 | 11741064 | 24036825 | 24036825 |
| Months of RO Operation | 5.0 | 9.0 | 3.8 | 3.1 | 2.7 | 5.5 | 5.5 |
| Average Monthly Reqm't (Gallons) | 2634990.5 | 2634990.5 | 4329002 | 4330552.8 | 4348542.4 | 4370331.8 | 4370331.8 |
| Monthly Balance for DDW (Gals) | 1758990.5 | 1758990.5 | 4169201 | 4170751.8 | 4188741.4 | 4210530.8 | 4210530.8 |
| Total WDW Disposal (Gallons) | 8794952.7 | 15830915 | 15842964 | 12929330 | 11309602 | 23157919 | 23157919 |
| Total WDW Disposal (KGals) | 8794.9527 | 15830.915 | 15842.964 | 12929.33 | 11309.602 | 23157.919 | 23157.919 |
| Cost Assumptions: | | | | | | | |
| Power | | | | | | | |
| Avg Connected Hp | 75.00 | 75.00 | 167.00 | 167.00 | 167.00 | 167.00 | 167.00 |
| Kwh's/Hp | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| $/Kwh | $0.051 | $0.051 | $0.048 | $0.048 | $0.048 | $0.048 | $0.048 |
| Gallons Per Minute | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Gallons Per Hour | 9000 | 9000 | 9000 | 9000 | 9000 | 9000 | 9000 |
| Cost Per Hour ($) | $3.80 | $3.80 | $8.02 | $8.02 | $8.02 | $8.02 | $8.02 |
| Cost Per Gallon ($) | $0.0004 | $0.0004 | $0.0009 | $0.0009 | $0.0009 | $0.0009 | $0.0009 |
| Cost Per KGal ($) | $0.422 | $0.422 | $0.891 | $0.891 | $0.891 | $0.891 | $0.891 |
| Chemicals ($/Kgals) | | | | | | | |
| Corrosion Inhibitor | $0.217 | $0.217 | $0.217 | $0.217 | $0.217 | $0.217 | $0.217 |
| Algacide | $0.052 | $0.052 | $0.052 | $0.052 | $0.052 | $0.052 | $0.052 |
| Other | $0.080 | $0.080 | $0.080 | $0.080 | $0.080 | $0.080 | $0.080 |
| Repair & Maint ($/Kgals) | $0.230 | $0.230 | $0.230 | $0.230 | $0.230 | $0.230 | $0.230 |
| Total Cost Per KGal | $1.001 | $1.001 | $1.470 | $1.470 | $1.470 | $1.470 | $1.470 |
| TOTAL WASTE DISPOSAL WELL COST | $8,802 | $15,844 | $23,290 | $19,006 | $16,625 | $34,043 | $34,043 |
| IV STABILIZATION MONITORING | | | | | | | |
| Operating Assumptions: | | | | | | | |
| Time of Stabilization (mos) | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Frequency of Analysis (mos) | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Total Sets of Analysis | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Cost Assumptions: | | | | | | | |
| Power ($/Month) | $0 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 |
| Total Power Cost | $0 | $9,000 | $9,000 | $9,000 | $9,000 | $9,000 | $9,000 |
| Sampling & Analysis (each set) | $3,600 | $3,600 | $3,600 | $3,600 | $3,600 | $3,600 | $3,600 |
| Total Sampling & Analysis Cost ($) | $10,800 | $10,800 | $10,800 | $10,800 | $10,800 | $10,800 | $10,800 |
| Utilities ($/Month) | $0 | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 |
| Total Utilities Cost ($) | $0 | $18,000 | $18,000 | $18,000 | $18,000 | $18,000 | $18,000 |
| TOTAL STABILIZATION COST | $10,800 | $37,800 | $37,800 | $37,800 | $37,800 | $37,800 | $37,800 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
WORKSHEET 1
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ROUNDWATER RESTORATION

| | Irigaray Mine Unit(s) #1 Thru #5 | Irigaray Mine Unit(s) #6 Thru #9 | Christensen Mine Unit #2 | Christensen Mine Unit #3 | Christensen Mine Unit #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 |
|---|---|---|---|---|---|---|---|

| V LABOR (Irigaray and Christensen Combined) | | | |
|---|---|---|---|
| Cost Assumptions | Cost/Hour | Hours/Year | Cost |
| Crew: | | | |
| 1 Supervisor | $20.00 | 2080 | $41,600 |
| 4 Operators | $15.00 | 2080 | $124,800 |
| 2 Maintenance | $15.00 | 2080 | $62,400 |
| 2 Vehicles | $10.00 | 2080 | $41,600 |
| Cost per Year | | | $270,400 |
| Time Required - Years (See Figure 1) | 6.1 | | |
| TOTAL RESTORATION LABOR COST | $1,649,440 | | |

| | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Unit #2 Thru #4 | Total Christensen & Irigaray |
|---|---|---|---|
| VI RESTORATION CAPITAL REQUIREMENTS | | | |
| I Deep Disposal Well(s) | $353,540 | $0 | $353,540 |
| II Plug and Abandon DDW | $100,000 | $100,000 | $200,000 |
| III 500 GPM Reverse Osmosis Unit | | $400,000 | $400,000 |
| Total | $453,540 | $500,000 | $953,540 |

| | Irigaray Mine Unit(s) #1 Thru #5 | Irigaray Mine Unit(s) #6 Thru #9 | Christensen Mine Unit #2 | Christensen Mine Unit #3 | Christensen Mine Unit #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | TOTAL |
|---|---|---|---|---|---|---|---|---|
| SUMMARY: | | | | | | | | |
| I GROUNDWATER SWEEP | $109,343 | $185,298 | $124,785 | $108,083 | $89,135 | $182,802 | $182,802 | |
| II REVERSE OSMOSIS | $121,179 | $209,482 | $131,966 | $112,378 | $94,208 | $193,029 | $193,029 | |
| III WASTE DISPOSAL WELL | $8,802 | $15,844 | $23,290 | $19,006 | $16,625 | $34,043 | $34,043 | |
| IV STABILIZATION | $10,800 | $37,800 | $37,800 | $37,800 | $37,800 | $37,800 | $37,800 | |
| SUB TOTAL | $250,124 | $448,424 | $317,841 | $277,268 | $237,769 | $447,674 | $447,674 | $2,426,774 |
| V LABOR | | | | | | | | $1,649,440 |
| VI CAPITAL | | | | | | | | $953,540 |
| TAL GROUNDWATER RESTORATION COST | | | | | | | | $5,029,754 |

COGEM/ g, Inc.
Restoratio. ..d Reclamation Costs
Wyoming Operations
WORKSHEET 2
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| PLANT EQUIPMENT REMOVAL AND DISPOSAL | Irigaray | | | | | | Christensen | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Maint Area & Laboratory | Main Process Building | Expansion Building | Dry Pack Area | Restoration Building | Sub Total | Satellite Plant | Restoration Extension | Wellfield Modules | Sub Total |
| Volume (Yds³) | 40 | 200 | 180 | 40 | 40 | | 91 | 42 | 55 | |
| Quantity Per Truck Load (Yds³) | 20 | 20 | 20 | 20 | 20 | | 20 | 20 | 20 | |
| Number of Truck Loads | 2.0 | 10.0 | 9.0 | 2.0 | 2.0 | | 4.55 | 2.1 | 2.8 | |
| I Decontamination Cost | | | | | | | | | | |
| Decontamination Cost ($/Load) | $462 | $462 | $462 | $462 | $462 | | $462 | $462 | $462 | |
| Percent Requiring Decontamination | 20.0% | 100.0% | 100.0% | 100.0% | 100.0% | | 100.0% | 100.0% | 100.0% | |
| Total Cost | $185 | $4,617 | $4,155 | $923 | $923 | $10,804 | $2,102 | $970 | $1,294 | $4,366 |
| II Dismantle and Loading Cost | | | | | | | | | | |
| Cost Per Truck Load ($) | $600 | $600 | $600 | $600 | $600 | | $600 | $600 | $600 | |
| Total Cost | $1,200 | $6,000 | $5,400 | $1,200 | $1,200 | $15,000 | $2,730 | $1,260 | $1,680 | $5,670 |
| III Oversize Charges | | | | | | | | | | |
| Percent Requiring Permits | 40.0% | 40.0% | 40.0% | 60.0% | 40.0% | | 40.0% | 40.0% | 0.0% | |
| Cost Per Truck Load ($) | $326 | $326 | $326 | $326 | $326 | | $326 | $326 | $326 | |
| Total Cost | $261 | $1,306 | $1,175 | $392 | $261 | $3,395 | $593 | $274 | $0 | $867 |
| IV Transportation & Disposal | | | | | | | | | | |
| A. Landfill | | | | | | | | | | |
| Percent To Be Shipped | 80.0% | 80.0% | 80.0% | 50.0% | 80.0% | | 80.0% | 80.0% | 80.0% | |
| Distance (Miles) | 100 | 100 | 100 | 100 | 100 | | 100 | 100 | 100 | |
| Cost Per Mile ($) | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | | $2.58 | $2.58 | $2.58 | |
| Transportation Cost | $412 | $2,060 | $1,854 | $258 | $412 | | $939 | $433 | $578 | |
| Disposal Fee Per Cubic Yard | $3.09 | $3.09 | $3.09 | $3.09 | $3.09 | | $3.09 | $3.09 | $3.09 | |
| Disposal Cost ($) | $99 | $494 | $445 | $62 | $99 | | $225 | $104 | $138 | |
| Total Cost | $511 | $2,554 | $2,299 | $319 | $511 | | $1,164 | $537 | $716 | |
| B. Licensed Site | | | | | | | | | | |
| Percent To Be Shipped | 20.0% | 20.0% | 20.0% | 50.0% | 20.0% | | 20.0% | 20.0% | 20.0% | |
| Distance (Miles) | 200 | 200 | 200 | 200 | 200 | | 200 | 200 | 200 | |
| Cost Per Mile ($) | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | | $2.58 | $2.58 | $2.58 | |
| Transportation Cost | $206 | $1,030 | $927 | $515 | $206 | | $470 | $217 | $289 | |
| Disposal Cost Per Cubic Foot ($) | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | | $14.50 | $14.50 | $14.50 | |
| Quantity Per Truck Load (Yds³) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | | 20.0 | 20.0 | 20.0 | |
| Quantity Per Truck Load (Ft³) | 540 | 540 | 540 | 540 | 540 | | 540 | 540 | 540 | |
| Disposal Cost | $3,132 | $15,660 | $14,094 | $7,830 | $3,132 | | $7,125 | $3,289 | $4,385 | |
| Total Cost | $3,338 | $16,690 | $15,021 | $8,345 | $3,338 | | $7,595 | $3,505 | $4,674 | |
| Total Cost | $3,849 | $19,244 | $17,320 | $8,664 | $3,849 | $52,926 | $8,759 | $4,043 | $5,390 | $18,192 |
| TOTAL COST | $5,495 | $31,167 | $28,050 | $11,179 | $6,233 | $82,125 | $14,184 | $6,547 | $8,364 | $29,095 |
| TOTAL COST - IRIGARAY AND CHRISTENSEN | | | | | | | | | | $111,220 |

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Restoration a, .nation Costs
Wyoming Operations
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| | Irigaray | | | | | | | Christensen | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maint Area & Laboratory | Warehouse & Offices | Main Process Building | Expansion Building | Dry Pack Area | Restoration Building | Sub Total | Satellite Plant | Wellfield Modules | Booster Pump Bldgs. | Restoration Extension | Office Building | Warehouse | Sub Total |
| **BUILDING DEMOLITION AND DISPOSAL** | | | | | | | | | | | | | | |
| Structural Character | 1 Story Steel Frame | 1 Story Steel Frame | 1 Story Steel Frame | 1 Story Steel Frame | 3 Story Steel/Masonry | 1 Story Steel Frame | | 2 Story Steel Frame | 1 Story Pre Fab (23) | 1 Story Pre Fab (4) | 2 Story Steel Frame | 1 Story Pre-Fab | 1 Story Steel Frame | |
| Demolition Volume ($Ft^3$) | 179400 | 108720 | 430400 | 386400 | 126000 | 69640 | | 192000 | 94640 | 24000 | 72000 | 64800 | 11000 | |
| Cost of Demolition Per $Ft^3$ | $0.110 | $0.110 | $0.110 | $0.110 | $0.110 | $0.110 | | $0.110 | $0.110 | $0.110 | $0.110 | $0.110 | $0.110 | |
| Demolition Cost ($) | $19,734 | $11,959 | $47,344 | $42,504 | $13,860 | $7,660 | $143,061 | $21,120 | $10,410 | $2,640 | $7,920 | $7,128 | $1,210 | $50,428 |
| Factor For Gutting | 15.0% | 10.0% | 30.0% | 10.0% | 20.0% | 10.0% | | 20.0% | 0.0% | 0.0% | 20.0% | 10.0% | 10.0% | |
| Cost For Gutting ($) | $2,960 | $1,196 | $14,203 | $4,250 | $2,772 | $766 | $26,147 | $4,224 | $0 | $0 | $1,584 | $713 | $121 | $6,642 |
| Weight (pounds) | 158761 | 96212 | 380885 | 341947 | 111504 | 61628 | | 169912 | 56784 | 14400 | 63717 | 38802 | 9735 | |
| Weight per Truckload | 40000 | 40000 | 40000 | 40000 | 40000 | 40000 | | 40000 | 40000 | 40000 | 40000 | 40000 | 40000 | |
| Number of Truckloads | 4.0 | 2.4 | 9.5 | 8.5 | 2.8 | 1.5 | | 4.3 | 1.4 | 0.4 | 1.6 | 1.0 | 0.2 | |
| Distance to Landfill | 100 | 100 | 100 | 100 | 100 | 100 | | 100 | 100 | 100 | 100 | 100 | 100 | |
| Cost per Mile | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost | $1,022 | $619 | $2,452 | $2,201 | $718 | $397 | $7,409 | $1,109 | $361 | $103 | $413 | $258 | $52 | $2,296 |
| Disposal Cost per Ton | $18.00 | $18.00 | $18.00 | $18.00 | $18.00 | $18.00 | | $18.00 | $18.00 | $18.00 | $18.00 | $18.00 | $18.00 | |
| Disposal Cost | $1,429 | $866 | $3,428 | $3,078 | $1,004 | $555 | $10,360 | $1,530 | $511 | $130 | $573 | $349 | $88 | $3,181 |
| TOTAL COST | $25,145 | $14,640 | $67,427 | $52,033 | $18,354 | $9,378 | $186,977 | $27,983 | $11,282 | $2,873 | $10,490 | $8,448 | $1,471 | $62,547 |
| TOTAL COST IRIGARAY AND CHRISTENSEN | | | | | | | | | | | | | | $249,524 |
| **CONCRETE DECONTAMINATION, DEMOLITION & DISPOSAL** | | | | | | | | | | | | | | |
| Area ($Ft^2$) | 8020 | 7100 | 17600 | 18400 | 5600 | 3600 | | 9600 | 0 | 0 | 3600 | 0 | 1000 | |
| Average Thickness (Ft) | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 0.5 | | 0.5 | 0.0 | 0.0 | 0.5 | 0.0 | 0.5 | |
| Volume ($Ft^3$) | 4010 | 3550 | 8800 | 9200 | 5600 | 1800 | | 4800 | 0 | 0 | 1800 | 0 | 500 | |
| Percent Requiring Decontamination | 0.0% | 0.0% | 100.0% | 100.0% | 100.0% | 100.0% | | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | |
| Percent Decontaminated | 0.0% | 0.0% | 75.0% | 75.0% | 40.0% | 75.0% | | 75.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | |
| Decontamination ($/$Ft^2$) | $0.143 | $0.143 | $0.143 | $0.143 | $0.143 | $0.143 | | $0.143 | $0.000 | $0.143 | $0.143 | $0.143 | $0.143 | |
| Decontamination Cost | $0 | $0 | $1,881 | $1,967 | $319 | $385 | | $1,373 | $0 | $0 | $515 | $0 | $0 | |
| Demolition ($/$Ft^2$) | $1.584 | $1.584 | $1.584 | $1.584 | $1.584 | $1.584 | | $1.584 | $1.584 | $1.584 | $1.584 | $1.584 | $1.584 | |
| Demolition Cost | $12,704 | $11,246 | $27,878 | $29,146 | $8,870 | $5,702 | $95,546 | $15,206 | $0 | $0 | $5,702 | $0 | $1,584 | $22,493 |
| Transportation & Disposal | | | | | | | | | | | | | | |
| A. Onsite Disposal | | | | | | | | | | | | | | |
| Percent to be Disposed Onsite | 100% | 100% | 75% | 75% | 40% | 75% | | 75% | 0% | 0% | 100% | 0% | 100% | |
| Transportation Cost | $0 | $0 | $0 | $0 | $0 | $0 | | $0 | $0 | $0 | $0 | $0 | $0 | |
| Disposal Cost per Cubic Foot | $0.049 | $0.049 | $0.049 | $0.049 | $0.049 | $0.049 | | $0.049 | $0.049 | $0.049 | $0.049 | $0.049 | $0.049 | |
| Disposal Cost ($) | $196 | $174 | $323 | $338 | $110 | $66 | $1,208 | $176 | $0 | $0 | $88 | $0 | $25 | |
| B. Licensed Site | | | | | | | | | | | | | | |
| Percent to be Shipped | 0% | 0% | 25% | 25% | 60% | 25% | | 25% | 100% | 100% | 0% | 100% | 0% | |
| Distance (Miles) | 200 | 200 | 200 | 200 | 200 | 200 | | 200 | 200 | 200 | 200 | 200 | 200 | |
| Cost per Mile ($) | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost | $0 | $0 | $2,098 | $2,194 | $3,204 | $429 | $7,925 | $1,147 | $0 | $0 | $0 | $0 | $0 | |
| Disposal Cost per Cubic Foot | $5.00 | $5.00 | $5.00 | $5.00 | $5.00 | $5.00 | | $5.00 | $5.00 | $5.00 | $5.00 | $5.00 | $5.00 | |
| Quantity Per Truck Load ($Yds^3$) | 20 | 20 | 20 | 20 | 20 | 20 | | 20 | 20 | 20 | 20 | 20 | 20 | |
| Quantity Per Truck Load ($Ft^3$) | 540 | 540 | 540 | 540 | 540 | 540 | | 540 | 540 | 540 | 540 | 540 | 540 | |
| Disposal Cost ($) | $0 | $0 | $11,000 | $11,500 | $16,800 | $2,250 | $41,550 | $6,000 | $0 | $0 | $0 | $0 | $0 | |
| TOTAL COST | $12,900 | $11,420 | $43,180 | $45,144 | $29,304 | $8,832 | $150,780 | $23,902 | $0 | $0 | $6,305 | $0 | $1,609 | $31,816 |
| TOTAL COST IRIGARAY AND CHRISTENSEN | | | | | | | | | | | | | | $182,596 |

COGEMA Mi
Restoration an .umation Costs
Wyoming Operations
WORKSHEET 3
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| | Irigaray | | | | | | | Christensen | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maint Area & Laboratory | Warehouse & Offices | Main Process Building | Expansion Building | Dry Pack Area | Restoration Building | Sub Total | Satellite Plant | Wellfield Modules | Booster Pump Bldgs. | Restoration Extension | Office Building | Warehouse | Sub Total |
| SOIL REMOVAL & DISPOSAL | | | | | | | | | | | | | | |
| Assume removal of 3" of Contaminated Soil under Primary Areas, Disposal at a Licensed facility. | | | | | | | | | | | | | | |
| Removal, Front End Loader ($50/hr) | $0 | $0 | $815 | $852 | $259 | $167 | $2,093 | $444 | $0 | $0 | $0 | $0 | $0 | |
| Quantity to be Shipped (Ft³) | 0 | 0 | 4400 | 4600 | 1400 | 900 | | 2400 | 0 | 0 | 0 | 0 | 0 | |
| Distance (Miles) | 200 | 200 | 200 | 200 | 200 | 200 | | 200 | 200 | 200 | 200 | 200 | 200 | |
| Cost Per Mile ($) | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $0 | $0 | $4,196 | $4,387 | $1,335 | $858 | $10,777 | $2,293 | $0 | $0 | $0 | $0 | $0 | |
| Disposal fee Per Cubic Foot($) | $5.00 | $5.00 | $5.00 | $5.00 | $5.00 | $5.00 | | $5.00 | $5.00 | $5.00 | $5.00 | $5.00 | $5.00 | |
| Quantity per Truckload (Ft³) | 540 | 540 | 540 | 540 | 540 | 540 | | 540 | 540 | 540 | 540 | 540 | 540 | |
| Disposal Cost ($) | $0 | $0 | $22,000 | $23,000 | $7,000 | $4,500 | $56,500 | $12,000 | $0 | $0 | $0 | $0 | $0 | |
| Total Cost | $0 | $0 | $27,011 | $28,239 | $8,594 | $5,525 | $69,370 | $14,737 | $0 | $0 | $0 | $0 | $0 | |
| TOTAL COST | $0 | $0 | $27,011 | $28,239 | $8,594 | $5,525 | $69,370 | $14,737 | $0 | $0 | $0 | $0 | $0 | $14,737 |
| TOTAL COST IRIGARAY AND CHRISTENSEN | | | | | | | | | | | | | | $84,107 |
| TOTAL COST | $38,045 | $26,060 | $137,618 | $125,416 | $56,252 | $23,735 | $407,128 | $66,622 | $11,282 | $2,873 | $16,795 | $8,448 | $3,080 | $109,100 |
| TOTAL COST IRIGARAY AND CHRISTENSEN | | | | | | | | | | | | | | $516,227 |

COGEMA Mir.
Restoration an... ...nation Costs
Wyoming Operations
WORKSHEET 4
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| POND RECLAMATION COST | Irigaray | | | | | | | 5I7 | | | | Christensen | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pond A | Pond B | Pond C | Pond D | Pond E | Pond RA | Pond RB | Pond 1 | Pond 2A | Pond 2B | Pond 2C | Brine Pond 1 | Brine Pond 2 | Brine Pond 3 | Brine Pond 4 | Permeate Pond | |
| POND SLUDGE: | | | | | | | | | | | | | | | | | |
| Average Sludge Depth (Ft) | 0.250 | 0.080 | 0.250 | 0.170 | 0.020 | 0.600 | 0.020 | 0.080 | 0.170 | 0.080 | 0.250 | 0.010 | 0.010 | 0.010 | 0.010 | 0.000 | |
| Average Area of Sludge ($Ft^2$) | 64044 | 63450 | 64044 | 63529 | 25650 | 54000 | 54000 | 24975 | 20012 | 10125 | 2160 | 21600 | 21600 | 21600 | 21600 | 0 | |
| Volume of Sludge ($Ft^3$) | 16011 | 5076 | 16011 | 10800 | 513 | 32400 | 1080 | 1998 | 3402 | 810 | 540 | 216 | 216 | 216 | 216 | 0 | |
| Volume of Sludge ($Yds^3$) | 593 | 188 | 593 | 400 | 19 | 1,200 | 40 | 74 | 126 | 30 | 20 | 8 | 8 | 8 | 8 | 0 | |
| Volume of Sludge Per Truck Load ($Yds^3$) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| # of Truck Loads of Sludge | 29.7 | 9.4 | 29.7 | 20.0 | 1.0 | 60.0 | 2.0 | 3.7 | 6.3 | 1.5 | 1.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.0 | |
| Sludge Handling Cost Per Load ($) | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | $200.00 | |
| Total Sludge Handling Cost ($) | $5,940 | $1,880 | $5,940 | $4,000 | $200 | $12,000 | $400 | $740 | $1,260 | $300 | $200 | $80 | $80 | $80 | $80 | $0 | |
| Transportation & Disposal | | | | | | | | | | | | | | | | | |
| Percent To Be Shipped | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | |
| Distance (Miles) | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | |
| Cost Per Mile ($) | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $15,296 | $4,841 | $15,296 | $10,300 | $515 | $30,900 | $1,030 | $1,906 | $3,245 | $773 | $515 | $206 | $206 | $206 | $206 | $0 | |
| Disposal Cost Per Cubic Foot ($) | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | |
| Quantity Per Truck Load ($Yds^3$) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Quantity Per Truck Load ($Ft^3$) | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | |
| Disposal Cost ($) | $232,551 | $73,602 | $232,551 | $156,600 | $7,830 | $469,800 | $15,660 | $28,971 | $49,329 | $11,745 | $7,830 | $3,132 | $3,132 | $3,132 | $3,132 | $0 | |
| Total Transportation & Disposal ($) | $247,847 | $78,443 | $247,847 | $166,900 | $8,345 | $500,700 | $16,690 | $30,877 | $52,574 | $12,518 | $8,345 | $3,338 | $3,338 | $3,338 | $3,338 | $0 | |
| TOTAL SLUDGE COST ($) | $253,787 | $80,323 | $253,787 | $170,900 | $8,545 | $512,700 | $17,090 | $31,617 | $53,834 | $12,818 | $8,545 | $3,418 | $3,418 | $3,418 | $3,418 | $0 | $1,417,618 |
| POND LINER: | | | | | | | | | | | | | | | | | |
| Total Pond Area (Acres) | 1.75 | 1.72 | 1.75 | 1.72 | 0.78 | 2.17 | 2.17 | 0.85 | 0.43 | 0.43 | 0.11 | 1.10 | 1.10 | 1.10 | 1.10 | 0.00 | |
| Total Pond Area ($Ft^2$) | 76230 | 74923.2 | 76230 | 74923.2 | 33976.8 | 94525.2 | 94525.2 | 37026 | 18730.8 | 18730.8 | 4791.6 | 47916 | 47916 | 47916 | 47916 | 0 | |
| Factor For Sloping Sides | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | |
| Total Liner Area ($Ft^2$) | 91476 | 89908 | 91476 | 89908 | 40772 | 113430 | 113430 | 44431 | 22477 | 22477 | 5750 | 57499 | 57499 | 57499 | 57499 | 0 | |
| Liner Thickness (Millimeters) | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | |
| Liner Thickness (Inches) | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | 0.1181 | |
| Liner Thickness (Ft) | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | 0.0098 | |
| "Swell" Factor | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | 25.0% | |
| Liner Volume ($Ft^3$) | 1121 | 1101 | 1121 | 1101 | 499 | 1390 | 1390 | 544 | 275 | 275 | 70 | 704 | 704 | 704 | 704 | 0 | |
| Truck Loads of Liner | 2.1 | 2.0 | 2.1 | 2.0 | 0.9 | 2.6 | 2.6 | 1.0 | 0.5 | 0.5 | 0.1 | 1.3 | 1.3 | 1.3 | 1.3 | 0.0 | |
| Liner Handling Cost ($) | | | | | | | | | | | | | | | | | |
| Labor Crew Cost per Hour ($) | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | $100 | |
| Hours per Load | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | |
| Liner Handling Cost Per Load ($) | $420.00 | $400.00 | $420.00 | $400.00 | $160.00 | $520.00 | $520.00 | $200.00 | $100.00 | $100.00 | $20.00 | $260.00 | $260.00 | $260.00 | $260.00 | $0.00 | |
| Total Liner Handling Cost ($) | $882 | $800 | $882 | $800 | $162 | $1,352 | $1,352 | $200 | $50 | $50 | $2 | $338 | $338 | $338 | $338 | $0 | |
| Transportation & Disposal | | | | | | | | | | | | | | | | | |
| Percent To Be Shipped | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | |
| Distance (Miles) | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | |
| Cost Per Mile ($) | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $1,082 | $1,030 | $1,082 | $1,030 | $464 | $1,339 | $1,339 | $516 | $258 | $258 | $52 | $670 | $670 | $670 | $670 | $0 | |
| Disposal Cost Per Cubic Foot ($) | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | $14.50 | |
| Quantity Per Truck Load ($Ft^3$) | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | 540 | |
| Disposal Cost ($) | $16,443 | $15,660 | $16,443 | $15,660 | $7,047 | $20,358 | $20,358 | $7,830 | $3,915 | $3,915 | $783 | $10,179 | $10,179 | $10,179 | $10,179 | $0 | |
| Total Transportation & Disposal ($) | $17,525 | $16,690 | $17,525 | $16,690 | $7,511 | $21,697 | $21,697 | $8,345 | $4,173 | $4,173 | $835 | $10,849 | $10,849 | $10,849 | $10,849 | $0 | |
| TOTAL LINER COST ($) | $18,407 | $17,490 | $18,407 | $17,490 | $7,673 | $23,049 | $23,049 | $8,545 | $4,223 | $4,223 | $837 | $11,187 | $11,187 | $11,187 | $11,187 | $0 | $188,141 |
| POND BACKFILL: | | | | | | | | | | | | | | | | | |
| Backfill required ($Yds^3$) | 8740 | 8580 | 8740 | 8580 | 2517 | 14617 | 16319 | 2345 | 1837 | 1537 | 163 | 9048 | 9048 | 9048 | 9048 | 18070 | |
| Backfill Cost ($/Yd^3$) | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | $1.00 | |
| TOTAL BACKFILL COST ($) | $8,740 | $8,580 | $8,740 | $8,580 | $2,517 | $14,617 | $16,319 | $2,345 | $1,837 | $1,537 | $163 | $9,048 | $9,048 | $9,048 | $9,048 | $18,070 | $128,237 |

COGEMA Min.
Restoration and ....mation Costs
Wyoming Operations
WORKSHEET 4
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| POND RECLAMATION COST | Irigaray | | | | | | | 517 | | | | Christensen | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pond A | Pond B | Pond C | Pond D | Pond E | Pond RA | Pond RB | Pond 1 | Pond 2A | Pond 2B | Pond 2C | Brine Pond 1 | Brine Pond 2 | Brine Pond 3 | Brine Pond 4 | Permeate Pond | |
| LEAK DETECTION SYSTEM REMOVAL | | | | | | | | | | | | | | | | | |
| Volume of Gravel and Piping (Yd³) (Assume 3") | | | 531 | 513 | | | | | | | | | | | | | |
| Quantity per Truckload (Ft³) | | | 540 | 540 | | | | | | | | | | | | | |
| Quantity to be Shipped | | | 100 | 100 | | | | | | | | | | | | | |
| Distance (Miles) | | | 200 | 200 | | | | | | | | | | | | | |
| Cost per Mile ($) | | | $2.58 | $2.58 | | | | | | | | | | | | | |
| Transportation Cost ($) | | | $515 | $515 | | | | | | | | | | | | | |
| Handling Cost ($200/Load) | | | $5,310 | $5,130 | | | | | | | | | | | | | |
| Disposal Fee per Cubic Foot ($) | | | $5.00 | $5.00 | | | | | | | | | | | | | |
| Disposal Cost ($) | | | $71,685 | $69,255 | | | | | | | | | | | | | |
| TOTAL LEAK DETECTION SYSTEM REMOVAL | $0 | $0 | $77,510 | $74,900 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $152,410 |
| TOTAL POND RECLAMATION COST | $280,934 | $106,393 | $358,444 | $271,870 | $18,735 | $550,388 | $58,458 | $42,507 | $59,894 | $18,578 | $9,545 | $23,653 | $23,653 | $23,653 | $23,653 | $18,070 | $1,886,406 |

SUMMARY - IRIGARAY:

| | |
|---|---|
| TOTAL SLUDGE COST ($) | $1,403,946 |
| TOTAL LINER COST ($) | $143,393 |
| TOTAL BACKFILL COST ($) | $73,975 |
| LEAK DETECTION SYSTEM REMOVAL | $152,410 |
| TOTAL POND RECLAMATION COST | $1,773,724 |

SUMMARY - CHRISTENSEN:

| | |
|---|---|
| TOTAL SLUDGE COST ($) | $13,672 |
| TOTAL LINER COST ($) | $44,748 |
| TOTAL BACKFILL COST ($) | $54,262 |
| LEAK DETECTION SYSTEM REMOVAL | $0 |
| TOTAL POND RECLAMATION COST | $112,682 |
| TOTAL PROJECT COST - CR and IR ($) | $1,886,406 |

COGEM/ ıg, Inc.
Restoration and Reclamation Costs
Wyoming Operations
WORKSHEET 5
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| WELL PLUGGING & ABANDONMENT | Irigaray | | | | Christensen | | | |
|---|---|---|---|---|---|---|---|---|
| | Mine Units #1 Thru #9 | 5I7 USMT Test Sites | Monitor/ Trend | Sub Total | Mine Units #2 Thru #6 | Monitor/ Trend | Misc. Regional | Sub Total |
| Number of Wells | 1064 | 24 | 315 | 1403 | 1981 | 291 | 118 | 2390 |
| Average Depth | 250 | 250 | 250 | | 410 | 410 | 410 | |
| Average Diameter | 4.5 | 4.5 | 4.5 | | 4.5 | 4.5 | 4.5 | |
| Materials | | | | | | | | |
| Bentonite Chips Required ($Ft^3$/Well) | 11.6 | 11.6 | 11.6 | | 11.6 | 11.6 | 11.6 | |
| Bags of Chips Required/Well | 15.0 | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 | |
| Cost Per Bag ($) | $4.00 | $4.00 | $4.00 | | $4.00 | $4.00 | $4.00 | |
| Cost/Well Bentonite Chips ($) | $60.00 | $60.00 | $60.00 | | $60.00 | $60.00 | $60.00 | |
| Gravel Fill Required ($Ft^3$/Well) | 15.7 | 15.7 | 15.7 | | 33.6 | 33.6 | 33.6 | |
| Gravel Fill Required ($Yd^3$/Well) | 0.6 | 0.6 | 0.6 | | 1.24 | 1.24 | 1.24 | |
| Cost of Gravel/$Yd^3$ ($) | $17.53 | $17.53 | $17.53 | | $17.53 | $17.53 | $17.53 | |
| Cost/Well Gravel Fill ($) | $10.19 | $10.19 | $10.19 | | $21.74 | $21.74 | $21.74 | |
| Cement Cone/Markers Req'd/Well | 1.0 | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 | |
| Cost of Cement Cones/Markers ($) | $4.00 | $4.00 | $4.00 | | $4.00 | $4.00 | $4.00 | |
| Total Materials Cost per Well | $74.19 | $74.19 | $74.19 | | $85.74 | $85.74 | $85.74 | |
| Labor | | | | | | | | |
| Hours Required per Well | 1.0 | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 | |
| Labor Cost per Hour | $60.00 | $60.00 | $60.00 | | $60.00 | $60.00 | $60.00 | |
| Total Labor Cost per Well ($) | $60.00 | $60.00 | $60.00 | | $60.00 | $60.00 | $60.00 | |
| Equipment Rental | | | | | | | | |
| Hours Required per Well | 1.0 | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 | |
| Backhoe w/Operator Cost/Hr ($) | $30.00 | $30.00 | $30.00 | | $30.00 | $30.00 | $30.00 | |
| Total Equipment Cost per Well ($) | $30.00 | $30.00 | $30.00 | | $30.00 | $30.00 | $30.00 | |
| Total Cost per Well ($) | $164.19 | $164.19 | $164.19 | | $175.74 | $175.74 | $175.74 | |
| TOTAL WELL ABANDONMENT COST ($) | $174,702 | $3,941 | $51,721 | $230,363 | $348,141 | $51,140 | $20,737 | $420,018 |

| | |
|---|---|
| GRAND TOTAL IRIGARAY AND CHRISTENSEN | $650,381 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
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\10_07_94.WK4

| WELLFIELD EQUIPMENT REMOVAL & DISPOSAL | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|
| I Wellfield Piping | | | | | |
| A. Removal | | | | | |
| Length/Well (Ft) | 100 | 300 | 300 | 300 | |
| Total Number of Wells | 1064 | 1021 | 480 | 480 | |
| Total Quantity (Ft) | 106400 | 306300 | 144000 | 144000 | |
| Cost of Removal ($/Ft) | $0.162 | $0.162 | $0.162 | $0.162 | |
| Cost of Removal ($) | $17,221 | $49,575 | $23,306 | $23,306 | $113,408 |
| Average OD (Inches) | 3.0 | 3.0 | 3.0 | 3.0 | |
| Chipped Volume Reduction ($Ft^3$/Ft) | 0.016 | 0.016 | 0.016 | 0.016 | |
| Chipped Volume ($Ft^3$) | 1,702 | 4,901 | 2,304 | 2,304 | |
| Quantity Per Truck Load ($Ft^3$) | 540 | 540 | 540 | 540 | |
| Total Number of Truck Loads | 3.2 | 9.1 | 4.3 | 4.3 | |
| B. Survey & Decontamination | | | | | |
| Percent Requiring Decontamination | 0% | 0% | 0% | 0% | |
| Loads for Decontamination | 0.0 | 0.0 | 0.0 | 0.0 | |
| Cost for Decontamination ($/Load) | $461.70 | $461.70 | $461.70 | $461.70 | |
| Cost for Decontamination ($) | $0 | $0 | $0 | $0 | $0 |
| C. Transport & Disposal | | | | | |
| 1.) Landfill | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped | 0.0% | 0.0% | 0.0% | 0.0% | |
| Loads To Be Shipped | 0.0 | 0.0 | 0.0 | 0.0 | |
| Distance (Miles) | 100 | 100 | 100 | 100 | |
| Transportation Cost ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $0 | $0 | $0 | $0 | $0 |
| b. Disposal | | | | | |
| Disposal Fee Per $Yd^3$ | $3.09 | $3.09 | $3.09 | $3.09 | |
| $Yds^3$ Per Load | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $0 | $0 | $0 | $0 | |
| Total Cost - Landfill | $0 | $0 | $0 | $0 | $0 |
| 2.) Licensed Site | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped | 100.0% | 100.0% | 100.0% | 100.0% | |
| Loads To Be Shipped | 3.2 | 9.1 | 4.3 | 4.3 | |
| Distance (Miles) | 200 | 200 | 200 | 200 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $1,624 | $4,687 | $2,215 | $2,215 | $10,740 |
| b. Disposal | | | | | |
| Disposal Cost Per $Ft^3$ | $14.50 | $14.50 | $14.50 | $14.50 | |
| Disposal Fee Per $Yd^3$ | $391.50 | $391.50 | $391.50 | $391.50 | |
| Quantity Per Truck Load ($Yds^3$) | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $24,685 | $71,253 | $33,669 | $33,669 | $163,275 |
| Total Cost - Licensed Site | $26,308 | $75,940 | $35,884 | $35,884 | |
| Total Cost - Transport & Disposal | $26,308 | $75,940 | $35,884 | $35,884 | |
| Total Cost - WF Piping Removal & Disposal | $43,529 | $125,515 | $59,190 | $59,190 | $287,423 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
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| WELLFIELD EQUIPMENT REMOVAL & DISPOSAL | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|
| II Production Well Pumps | | | | | |
| A. Pump and Tubing Removal | | | | | |
| Number of Production Wells | 424 | 443 | 220 | 220 | |
| Cost of Removal ($/well) | $18.00 | $18.00 | $18.00 | $18.00 | |
| Cost of Removal ($) | $7,632 | $7,974 | $3,960 | $3,960 | $23,526 |
| Number of Pumps Per Truck Load | 180 | 180 | 180 | 180 | |
| Number of Truck Loads (Pumps) | 2.4 | 2.5 | 1.2 | 1.2 | |
| B. Survey & Decontamination (Pumps) | | | | | |
| Percent Requiring Decontamination | 50.0% | 50.0% | 50.0% | 50.0% | |
| Loads for Decontamination | 1.2 | 1.3 | 0.6 | 0.6 | |
| Cost for Decontamination ($/Load) | $461.70 | $461.70 | $461.70 | $461.70 | |
| Cost for Decontamination ($) | $554 | $600 | $277 | $277 | $1,708 |
| C. Tubing Volume Reduction & Loading | | | | | |
| Length per Well (Ft) | 100 | 300 | 300 | 490 | |
| Total Quantity | 42,400 | 132,900 | 66,000 | 107,800 | |
| Cost of Removal ($/Ft) | $0.02 | $0.02 | $0.02 | $0.02 | |
| Cost of Removal ($) | $848 | $2,658 | $1,320 | $2,156 | $6,982 |
| Average OD (Inches) | 3.0 | 3.0 | 3.0 | 3.0 | |
| Chipped Volume Reduction ($Ft^3$/Ft) | 0.016 | 0.016 | 0.016 | 0.016 | |
| Chipped Volume ($Ft^3$) | 678 | 2,126 | 1,056 | 1,725 | |
| Quantity per Truckload ($Ft^3$) | 540 | 540 | 540 | 540 | |
| Number of Truck Loads | 1.3 | 3.9 | 2.0 | 3.2 | |
| D. Transport & Disposal | | | | | |
| 1.) Landfill | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped (Pumps) | 50.0% | 50.0% | 50.0% | 50.0% | |
| Loads To Be Shipped | 1.2 | 1.3 | 0.6 | 0.6 | |
| Distance (Miles) | 100 | 100 | 100 | 100 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $309 | $335 | $155 | $155 | $954 |
| b. Disposal | | | | | |
| Disposal Fee Per $Yd^3$ | $3.09 | $3.09 | $3.09 | $3.09 | |
| $Yds^3$ Per Load | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $74 | $80 | $37 | $37 | $228 |
| Total Cost - Landfill | $383 | $415 | $192 | $192 | |
| 2.) Licensed Site | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped (Pumps) | 50.0% | 50.0% | 50.0% | 50.0% | |
| Percent To Be Shipped (Tubing) | 100.0% | 100.0% | 100.0% | 100.0% | |
| Loads To Be Shipped | 2.5 | 5.2 | 2.6 | 3.8 | |
| Distance (Miles) | 200 | 200 | 200 | 200 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $1,265 | $2,697 | $1,316 | $1,961 | $7,239 |
| b. Disposal | | | | | |
| Disposal Cost Per $Ft^3$ | $14.50 | $14.50 | $14.50 | $14.50 | |
| Disposal Fee Per $Yd^3$ | $391.50 | $391.50 | $391.50 | $391.50 | |
| Quantity Per Truck Load ($Yds^3$) | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $19,233 | $41,012 | $20,010 | $29,754 | $110,009 |
| Total Cost - Licensed Site | $20,498 | $43,709 | $21,326 | $31,715 | |
| Total Cost - Transport & Disposal | $20,881 | $44,124 | $21,518 | $31,907 | |
| Total Cost - Pump Removal & Disposal | $29,915 | $55,357 | $27,075 | $38,300 | $150,647 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
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| WELLFIELD EQUIPMENT REMOVAL & DISPOSAL | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|
| III Surface Trunkline Piping | | | | | |
| A. Removal | | | | | |
| Total Quantity (Ft) | 44700 | 0 | 0 | 0 | |
| Cost of Removal ($/Ft) | $0.120 | $0.120 | $0.120 | $0.120 | |
| Cost of Removal ($) | $5,364 | $0 | $0 | $0 | $5,364 |
| Average OD (Inches) | 8.750 | 8.750 | 0.000 | 0.000 | |
| Chipped Volume Reduction ($Ft^3$/Ft) | 0.088 | 0.088 | 0.088 | 0.088 | |
| Chipped Volume ($Ft^3$) | 3911.25 | 0 | 0 | 0 | |
| Quantity Per Truck Load ($Ft^3$) | 540 | 540 | 540 | 540 | |
| Total Number of Truck Loads | 7.2 | 0.0 | 0.0 | 0.0 | |
| B. Survey & Decontamination | | | | | |
| Percent Requiring Decontamination | 0.0% | 0.0% | 0.0% | 0.0% | |
| Loads for Decontamination | 0.0 | 0.0 | 0.0 | 0.0 | |
| Cost for Decontamination ($/Load) | $461.70 | $461.70 | $461.70 | $461.70 | |
| Cost for Decontamination ($) | $0 | $0 | $0 | $0 | $0 |
| C. Transport & Disposal | | | | | |
| 1.) Landfill | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped | 0.0% | 0.0% | 0.0% | 0.0% | |
| Loads To Be Shipped | 0.0 | 0.0 | 0.0 | 0.0 | |
| Distance (Miles) | 100 | 100 | 100 | 100 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $0 | $0 | $0 | $0 | $0 |
| b. Disposal | | | | | |
| Disposal Fee Per $Yd^3$ | $3.09 | $3.09 | $3.09 | $3.09 | |
| $Yds^3$ Per Load | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $0 | $0 | $0 | $0 | $0 |
| Total Cost - Landfill | $0 | $0 | $0 | $0 | |
| 2.) Licensed Site | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped | 100.0% | 100.0% | 100.0% | 100.0% | |
| Loads To Be Shipped | 7.2 | 0.0 | 0.0 | 0.0 | |
| Distance (Miles) | 200 | 200 | 200 | 200 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $3,730 | $0 | $0 | $0 | $3,730 |
| b. Disposal | | | | | |
| Disposal Cost Per $Ft^3$ | $14.50 | $14.50 | $14.50 | $14.50 | |
| Disposal Fee Per $Yd^3$ | $391.50 | $391.50 | $391.50 | $391.50 | |
| Quantity Per Truck Load ($Yds^3$) | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $56,713 | $0 | $0 | $0 | $56,713 |
| Total Cost - Licensed Site | $60,443 | $0 | $0 | $0 | |
| Total Cost - Transport & Disposal | $60,443 | $0 | $0 | $0 | |
| Total Cost - Surface Trunkline Removal & Disposal | $65,807 | $0 | $0 | $0 | $65,807 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
'ORKSHEET 6
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| WELLFIELD EQUIPMENT REMOVAL & DISPOSAL | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|
| IV. Buried Trunkline | | | | | |
| A. Removal | | | | | |
| Total Quantity (Ft) | 7300 | 11565 | 24500 | 47000 | |
| Cost of Removal ($/Ft) | $2.35 | $2.35 | $2.35 | $2.35 | |
| Cost of Removal ($) | $17,155 | $27,178 | $57,575 | $110,450 | $212,358 |
| Average OD (Inches) | 8.750 | 8.750 | 8.750 | 12.000 | |
| Chipped Volume Reduction ($Ft^3$/Ft) | 0.088 | 0.088 | 0.088 | 0.130 | |
| Chipped Volume ($Ft^3$) | 638.75 | 1011.9375 | 2156 | 6110 | |
| Quantity Per Truck Load ($Ft^3$) | 540 | 540 | 540 | 540 | |
| Number of Truck Loads | 1.2 | 1.9 | 4.0 | 11.3 | |
| B. Survey & Decontamination | | | | | |
| Percent Requiring Decontamination | 0.0% | 0.0% | 0.0% | 0.0% | |
| Loads for Decontamination | 0.0 | 0.0 | 0.0 | 0.0 | |
| Cost for Decontamination. ($/Load) | $461.70 | $461.70 | $461.70 | $461.70 | |
| Cost for Decontamination. ($) | $0 | $0 | $0 | $0 | $0 |
| C. Transport & Disposal | | | | | |
| 1.) Landfill | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped | 0.0% | 0.0% | 0.0% | 0.0% | |
| Loads To Be Shipped | 0.0 | 0.0 | 0.0 | 0.0 | |
| Distance (Miles) | 100 | 100 | 100 | 100 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $0 | $0 | $0 | $0 | $0 |
| b. Disposal | | | | | |
| Disposal Fee Per $Yd^3$ | $3.09 | $3.09 | $3.09 | $3.09 | |
| $Yds^3$ Per Load | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $0 | $0 | $0 | $0 | $0 |
| Total Cost - Landfill | $0 | $0 | $0 | $0 | |
| 2.) Licensed Site | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped | 100.0% | 100.0% | 100.0% | 100.0% | |
| Loads To Be Shipped | 1.2 | 1.9 | 4.2 | 11.3 | |
| Distance (Miles) | 200 | 200 | 200 | 200 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $618 | $979 | $2,064 | $5,830 | $9,491 |
| b. Disposal | | | | | |
| Disposal Cost Per $Ft^3$ | $14.50 | $14.50 | $14.50 | $14.50 | |
| Disposal Fee Per $Yd^3$ | $391.50 | $391.50 | $391.50 | $391.50 | |
| Quantity Per Truck Load ($Yds^3$) | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $9,396 | $14,877 | $31,320 | $88,479 | $144,072 |
| Total Cost - Licensed Site | $10,014 | $15,856 | $33,384 | $94,309 | |
| Total Cost - Transport & Disposal | $10,014 | $15,856 | $33,384 | $94,309 | |
| Total Cost - Buried Trunkline Removal & Disposal | $27,169 | $43,033 | $90,959 | $204,759 | $365,920 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
'ORKSHEET 6
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| WELLFIELD EQUIPMENT REMOVAL & DISPOSAL | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|
| V Manholes | | | | | |
| A. Removal | | | | | |
| Total Quantity | 5 | 8 | 5 | 6 | |
| Cost of Removal ($ Each) | $110.00 | $110.00 | $110.00 | $110.00 | |
| Cost of Removal ($) | $550 | $880 | $550 | $660 | $2,640 |
| Quantity Per Truck Load | 10 | 10 | 10 | 10 | |
| Number of Truck Loads | 0.5 | 0.8 | 0.5 | 0.6 | |
| B. Survey & Decontamination | | | | | |
| Percent Requiring Decontamination | 0.0% | 0.0% | 0.0% | 0.0% | |
| Loads for Decontamination | 0.0 | 0.0 | 0.0 | 0.0 | |
| Cost for Decontamination ($/Load) | $461.70 | $461.70 | $461.70 | $461.70 | |
| Cost for Decontamination ($) | $0 | $0 | $0 | $0 | $0 |
| C. Transport & Disposal | | | | | |
| 1.) Landfill | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped | 0.0% | 0.0% | 0.0% | 0.0% | |
| Loads To Be Shipped | 0.0 | 0.0 | 0.0 | 0.0 | |
| Distance (Miles) | 100 | 100 | 100 | 100 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $0 | $0 | $0 | $0 | $0 |
| b. Disposal | | | | | |
| Disposal Fee Per Yd³ ($) | $3.09 | $3.09 | $3.09 | $3.09 | |
| Yds³ Per Load | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $0 | $0 | $0 | $0 | $0 |
| Total Cost - Landfill | $0 | $0 | $0 | $0 | |
| 2.) Licensed Site | | | | | |
| a. Transportation | | | | | |
| Percent To Be Shipped | 100.0% | 100.0% | 100.0% | 100.0% | |
| Loads To Be Shipped | 0.5 | 0.8 | 0.5 | 0.6 | |
| Distance (Miles) | 200 | 200 | 200 | 200 | |
| Cost Per Mile ($/mile) | $2.58 | $2.58 | $2.58 | $2.58 | |
| Transportation Cost ($) | $258 | $412 | $258 | $310 | $1,238 |
| b. Disposal | | | | | |
| Disposal Cost Per Ft³ | $14.50 | $14.50 | $14.50 | $14.50 | |
| Disposal Fee Per Yd³ | $391.50 | $391.50 | $391.50 | $391.50 | |
| Quantity Per Truck Load (Yds³) | 20 | 20 | 20 | 20 | |
| Disposal Cost ($) | $3,915 | $6,264 | $3,915 | $4,698 | $18,792 |
| Total Cost - Licensed Site | $4,173 | $6,676 | $4,173 | $5,008 | |
| Total Cost - Transport & Disposal | $4,173 | $6,676 | $4,173 | $5,008 | |
| Total Cost Manhole Removal & Disposal | $4,723 | $7,556 | $4,723 | $5,668 | $22,670 |
| TOTAL COST - WELLFIELD EQUIP REMOVAL & DISP | $171,143 | $231,461 | $181,947 | $307,917 | $892,467 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
WORKSHEET 7
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TOPSOIL REPLACEMENT & REVEGETATION

| | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|
| I Process Plant and Office Building | | | | | |
| A. Topsoil Handling & Grading | | | | | |
| Affected Area (Acres) | 5.0 | 2.5 | 0.0 | 0.0 | |
| Average Affected Thickness (Ins) | 12.0 | 12.0 | 0.0 | 0.0 | |
| Topsoil Volume (Yds³) | 8067 | 4033 | 0 | 0 | |
| Unit Cost - Haul/Place ($/Yd³) | $1.00 | $1.00 | $1.00 | $1.00 | |
| Topsoil Handling Cost ($) | $8,067 | $4,033 | $0 | $0 | |
| Unit Cost - Grading ($/Ac) | $50.00 | $50.00 | $50.00 | $50.00 | |
| Grading Cost ($) | $250 | $125 | $0 | $0 | |
| Sub Total - Topsoil | $8,317 | $4,158 | $0 | $0 | $12,475 |
| B. Radiation Survey & Soil Analysis | | | | | |
| Unit Cost ($/Ac) | $75.00 | $75.00 | $75.00 | $75.00 | |
| Sub Total - Survey & Analysis | $375 | $188 | $0 | $0 | $563 |
| C. Revegetation | | | | | |
| Fertilizer ($/Ac) | $46.49 | $46.49 | $46.49 | $46.49 | |
| Seeding Prep & Seeding ($/Ac) | $168.68 | $168.68 | $168.68 | $168.68 | |
| Mulching & Crimping ($/Ac) | $276.54 | $276.54 | $276.54 | $276.54 | |
| Sub Total Cost/Acre | $491.71 | $491.71 | $491.71 | $491.71 | |
| Sub Total - Revegation | $2,459 | $1,229 | $0 | $0 | $3,688 |
| Sub Total - Process Plant and Office Bldg. | $11,150 | $5,575 | $0 | $0 | $16,725 |
| II Ponds | | | | | |
| A. Topsoil Handling & Grading | | | | | |
| Affected Area (Acres) | 20.0 | 12.0 | 0.0 | 0.0 | |
| Average Affected Thickness (Ins) | 12 | 12 | 0 | 0 | |
| Topsoil Volume (Yds³) | 32267 | 19360 | 0 | 0 | |
| Unit Cost - Haul/Place ($/Yd³) | $1.00 | $1.00 | $1.00 | $1.00 | |
| Topsoil Handling Cost ($) | $32,267 | $19,360 | $0 | $0 | |
| Unit Cost - Grading ($/Ac) | $50.00 | $50.00 | $50.00 | $50.00 | |
| Grading Cost ($) | $1,000 | $600 | $0 | $0 | |
| Sub Total - Topsoil | $33,267 | $19,960 | $0 | $0 | $53,227 |
| B. Radiation Survey & Soil Analysis | | | | | |
| Unit Cost ($/Ac) | $75.00 | $75.00 | $75.00 | $75.00 | |
| Sub Total - Survey & Analysis | $1,500 | $900 | $0 | $0 | $2,400 |
| C. Revegation | | | | | |
| Fertilizer ($/Ac) | $46.49 | $46.49 | $46.49 | $46.49 | |
| Seeding Prep & Seeding ($/Ac) | $168.68 | $168.68 | $168.68 | $168.68 | |
| Mulching & Crimping ($/Ac) | $276.54 | $276.54 | $276.54 | $276.54 | |
| Sub Total Cost/Acre | $491.71 | $491.71 | $491.71 | $491.71 | |
| Sub Total - Revegation | $9,834 | $5,901 | $0 | $0 | $15,735 |
| Sub Total - Ponds | $44,601 | $26,761 | $0 | $0 | $71,362 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
WORKSHEET 7
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TOPSOIL REPLACEMENT & REVEGETATION

| | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|
| III Wellfields | | | | | |
| A. Topsoil Handling & Grading | | | | | |
| Affected Area (Acres) | 40.0 | 55.0 | 30.0 | 30.0 | |
| Average Affected Thickness (Ins) | 3.5 | 0.0 | 0.0 | 0.0 | |
| Topsoil Volume (Yds³) | 18822 | 0 | 0 | 0 | |
| Unit Cost - Haul/Place ($/Yd³) | $1.00 | $1.00 | $1.00 | $1.00 | |
| Topsoil Handling Cost ($) | $18,822 | $0 | $0 | $0 | |
| Unit Cost - Grading ($/Ac) | $50.00 | $50.00 | $50.00 | $50.00 | |
| Grading Cost ($) | $2,000 | $2,750 | $1,500 | $1,500 | |
| Sub Total - Topsoil | $20,822 | $2,750 | $1,500 | $1,500 | $26,572 |
| B. Radiation Survey & Soil Analysis | | | | | |
| Unit Cost ($/Ac) | $75.00 | $75.00 | $75.00 | $75.00 | |
| Sub Total - Survey & Analysis | $3,000 | $4,125 | $2,250 | $2,250 | $11,625 |
| C. Revegation | | | | | |
| Fertilizer ($/Ac) | $46.49 | $46.49 | $46.49 | $46.49 | |
| Seeding Prep & Seeding ($/Ac) | $168.68 | $168.68 | $168.68 | $168.68 | |
| Mulching & Crimping ($/Ac) | $276.54 | $276.54 | $276.54 | $276.54 | |
| Sub Total Cost/Acre | $491.71 | $491.71 | $491.71 | $491.71 | |
| Sub Total - Revegation | $19,668 | $27,044 | $14,751 | $14,751 | $76,214 |
| Sub Total - Wellfields ($) | $43,490 | $33,919 | $18,501 | $18,501 | $114,411 |
| IV Roads | | | | | |
| A. Topsoil Handling & Grading | | | | | |
| Affected Area (Acres) | 25.0 | 20.0 | 15.0 | 21.0 | |
| Average Affected Thickness (Ins) | 12 | 12 | 12 | 12 | |
| Topsoil Volume (Yds³) | 40333 | 32267 | 24200 | 33880 | |
| Unit Cost - Haul/Place ($/Yd³) | $1.00 | $1.00 | $1.00 | $1.00 | |
| Topsoil Handling Cost ($) | $40,333 | $32,267 | $24,200 | $33,880 | |
| Unit Cost - Grading ($/Ac) | $50.00 | $50.00 | $50.00 | $50.00 | |
| Grading Cost ($) | $1,250 | $1,000 | $750 | $1,050 | |
| Sub Total - Topsoil | $41,583 | $33,267 | $24,950 | $34,930 | $134,730 |
| B. Radiation Survey & Soil Analysis | | | | | |
| Unit Cost ($/Ac) | $75.00 | $75.00 | $75.00 | $75.00 | |
| Sub Total - Survey & Analysis | $1,875 | $1,500 | $1,125 | $1,575 | $6,075 |
| C. Revegation | | | | | |
| Fertilizer ($/Ac) | $46.49 | $46.49 | $46.49 | $46.49 | |
| Seeding Prep & Seeding ($/Ac) | $168.68 | $168.68 | $168.68 | $168.68 | |
| Mulching & Crimping ($/Ac) | $276.54 | $276.54 | $276.54 | $276.54 | |
| Sub Total Cost/Acre | $491.71 | $491.71 | $491.71 | $491.71 | |
| Sub Total - Revegation | $12,293 | $9,834 | $7,376 | $10,326 | $39,829 |
| Sub Total - Roads ($) | $55,751 | $44,601 | $33,451 | $46,831 | $180,634 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
VORKSHEET 7
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TOPSOIL REPLACEMENT & REVEGETATION

| | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|
| **V Other** | | | | | |
| A. Topsoil Handling & Grading | | | | | |
| Affected Area (Acres) | 41.0 | 19.0 | 5.0 | 5.0 | |
| Average Affected Thickness (Ins) | 0.0 | 0.0 | 0 | 0 | |
| Topsoil Volume (Yds³) | 0 | 0 | 0 | 0 | |
| Unit Cost - Haul/Place ($/Yd³) | $1.00 | $1.00 | $1.00 | $1.00 | |
| Topsoil Handling Cost ($) | $0 | $0 | $0 | $0 | |
| Unit Cost - Grading ($/Ac) | $50.00 | $50.00 | $50.00 | $50.00 | |
| Grading Cost ($) | $2,050 | $950 | $250 | $250 | |
| Sub Total - Topsoil | $2,050 | $950 | $250 | $250 | $3,500 |
| B. Radiation Survey & Soil Analysis | | | | | |
| Unit Cost ($/Ac) | $75.00 | $75.00 | $75.00 | $75.00 | |
| Sub Total - Survey & Analysis | $3,075 | $1,425 | $375 | $375 | $5,250 |
| C. Revegation | | | | | |
| Fertilizer ($/Ac) | $46.49 | $46.49 | $46.49 | $46.49 | |
| Seeding Prep & Seeding ($/Ac) | $168.68 | $168.68 | $168.68 | $168.68 | |
| Mulching & Crimping ($/Ac) | $276.54 | $276.54 | $276.54 | $276.54 | |
| Sub Total Cost/Acre | $491.71 | $491.71 | $491.71 | $491.71 | |
| Sub Total - Revegation | $20,160 | $9,343 | $2,459 | $2,459 | $34,421 |
| Sub Total - Other | $25,285 | $11,718 | $3,084 | $3,084 | $43,171 |
| **VI Remedial Action** | | | | | |
| A. Topsoil Handling & Grading | | | | | |
| Affected Area (Acres) | 65.5 | 54.3 | 14.5 | 14.5 | |
| Average Affected Thickness (Ins) | 0.0 | 0.0 | 0.0 | 0.0 | |
| Topsoil Volume (Yds³) | 0 | 0 | 0 | 0 | |
| Unit Cost - Haul/Place ($/Yd³) | $1.00 | $1.00 | $1.00 | $1.00 | |
| Topsoil Handling Cost ($) | $0 | $0 | $0 | $0 | |
| Unit Cost - Grading ($/Ac) | $0.00 | $0.00 | $0.00 | $0.00 | |
| Grading Cost ($) | $0 | $0 | $0 | $0 | |
| Sub Total - Topsoil | $0 | $0 | $0 | $0 | $0 |
| B. Radiation Survey & Soil Analysis | | | | | |
| Unit Cost ($/Ac) | $0.00 | $0.00 | $0.00 | $0.00 | |
| Sub Total - Survey & Analysis | $0 | $0 | $0 | $0 | $0 |
| C. Revegation | | | | | |
| Fertilizer ($/Ac) | $46.49 | $46.49 | $46.49 | $46.49 | |
| Seeding Prep & Seeding ($/Ac) | $168.68 | $168.68 | $168.68 | $168.68 | |
| Mulching & Crimping ($/Ac) | $276.54 | $276.54 | $276.54 | $276.54 | |
| Sub Total Cost/Acre | $491.71 | $491.71 | $491.71 | $491.71 | |
| Sub Total - Revegation | $32,207 | $26,700 | $7,130 | $7,130 | $73,167 |
| Sub Total - Remedial Action | $32,207 | $26,700 | $7,130 | $7,130 | $73,167 |
| TOTAL COST - TOPSOIL & REVEGETATION | $212,484 | $149,274 | $62,166 | $75,546 | $499,470 |

COGEMA Mining, Inc.
Restoration and Reclamation Costs
Wyoming Operations
WORKSHEET 8
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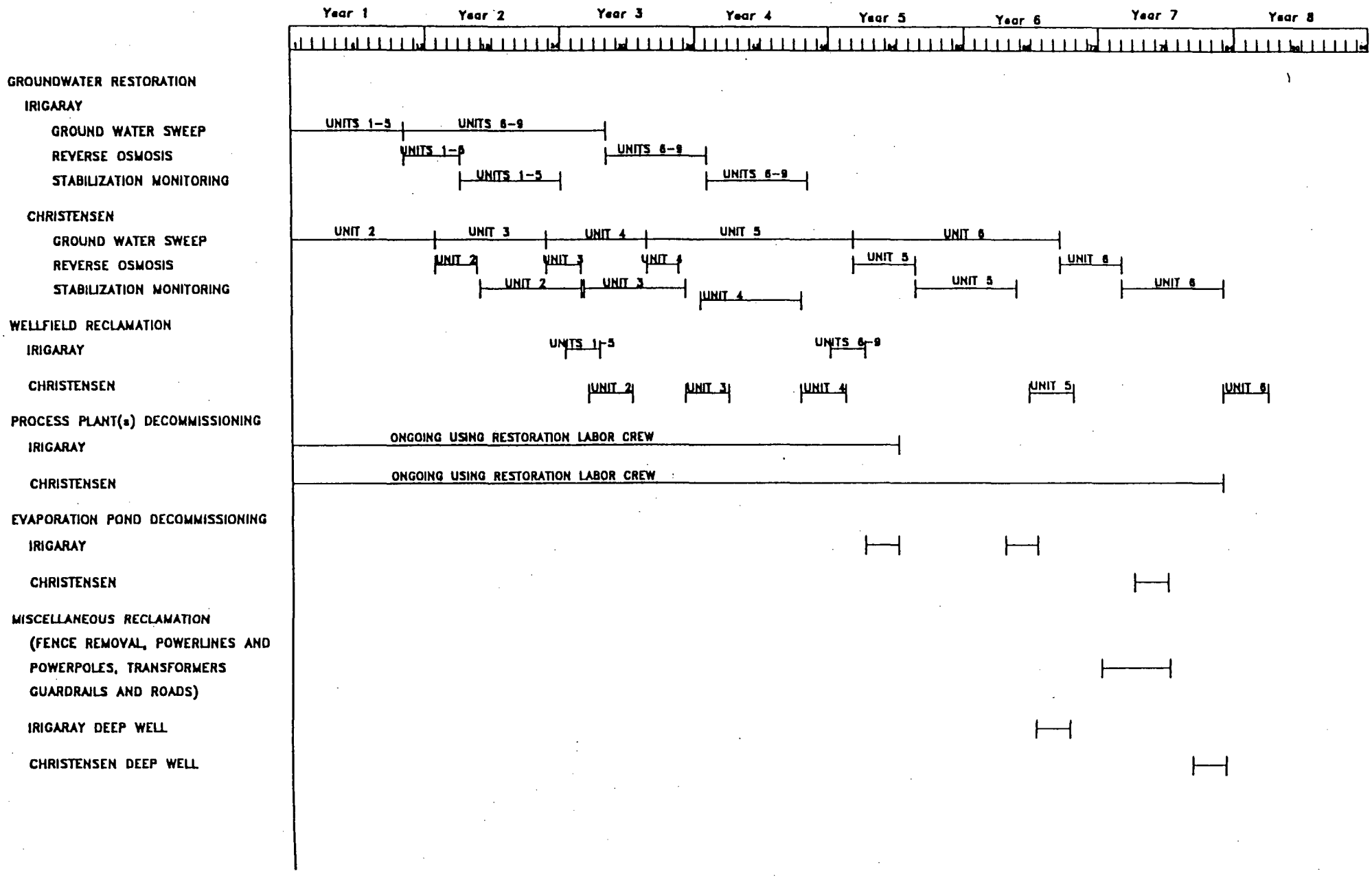
MISCELLANEOUS RECLAMATION

| | | Irigaray Mine Unit(s) #1 Thru #9 | Christensen Mine Units #2 Thru #4 | Christensen Mine Unit #5 | Christensen Mine Unit #6 | Total Christensen & Irigaray |
|---|---|---|---|---|---|---|
| I | Fence Removal & Disposal | | | | | |
| | Quantity (Feet) | 15240 | 35260 | 20000 | 20000 | |
| | Cost of Removal/Disposal ($/Ft) | $0.49 | $0.49 | $0.49 | $0.49 | |
| | Cost of Removal/Disposal ($) | $7,547 | $17,348 | $9,800 | $9,800 | $44,495 |
| II | Powerline Removal & Disposal | | | | | |
| | Quantity (Feet) | 9450 | 10565 | 18000 | 18000 | |
| | Cost of Removal/Disposal ($/Ft) | $0.00 | $0.00 | $0.00 | $0.00 | |
| | Cost of Removal/Disposal ($) | $0 | $0 | $0 | $0 | $0 |
| III | Powerpole Removal & Disposal | | | | | |
| | Quantity | 25 | 30 | 60 | 60 | |
| | Cost of Removal/Disposal ($/Each) | $0.00 | $0.00 | $0.00 | $0.00 | |
| | Cost of Removal/Disposal ($) | $0 | $0 | $0 | $0 | $0 |
| IV | Transformer Removal & Disposal | | | | | |
| | Quantity | 3 | 1 | 0 | 0 | |
| | Cost of Removal/Disposal ($/Each) | $2,040 | $2,040 | $2,040 | $2,040 | |
| | Cost of Removal/Disposal ($) | $6,120 | $2,040 | $0 | $0 | $8,160 |
| V | Booster Pump Assembly Removal & Disposal | | | | | |
| | Quantity | 0 | 6 | 5 | 5 | |
| | Cost of Removal/Disposal ($/Each) | $250 | $250 | $250 | $250 | |
| | Cost of Removal/Disposal ($) | $0 | $1,500 | $1,250 | $1,250 | $4,000 |
| VI | Culvert Removal & Disposal | | | | | |
| | Quantity (Feet) | 150 | 1200 | 1000 | 1000 | |
| | Cost of Removal/Disposal ($/Ft) | $2.86 | $2.86 | $2.86 | $2.86 | |
| | Cost of Removal/Disposal ($) | $429 | $3,433 | $2,860 | $2,860 | $9,582 |
| VII | Guardrail Removal | | | | | |
| | Quantity (Feet) | 200 | 3000 | 0 | 0 | |
| | Cost of Removal/Disposal ($/Ft) | $5.20 | $5.20 | $5.20 | $5.20 | |
| | Cost of Removal/Disposal ($) | $1,040 | $15,600 | $0 | $0 | $16,640 |
| VIII | Low Water Stream Crossing | | | | | |
| | Quantity | 0 | 1 | 1 | 0 | |
| | Cost of Removal/Disposal ($/Each) | $7,000 | $7,000 | $7,000 | $7,000 | |
| | Cost of Removal/Disposal ($) | $0 | $7,000 | $7,000 | $0 | $14,000 |
| IX | Utilities Cost | | | | | |
| | Quantity (Mos) | 4 | 8 | 4 | 4 | |
| | Cost Per Month ($/Month) | $2,000 | $1,000 | $1,000 | $1,000 | |
| | Total Cost ($) | $8,000 | $8,000 | $4,000 | $4,000 | $24,000 |
| | TOTAL MISCELLANEOUS COST | $23,136 | $53,421 | $24,910 | $17,910 | $119,377 |

# FIGURE 1
## Restoration and Reclamation Plan
## Schedule of Events



# Explanation of Changes to the August 17, 1995 and November 3, 1995 Original and Revised Estimates

COGEMA Mining, Inc.

# REVISIONS TO THE

# 1995-1996
# Decommissioning and Reclamation Cost Estimate
# Irigaray and Christensen Ranch ISL Projects
# dated August 17, 1995

NRC License SUA-1341
and
DEQ Permit to Mine No. 478

November 3, 1995

**COGEMA Mining, Inc.**
**Revisions to the 1995-1996**
**Decommissioning and Reclamation Cost Estimate**
**Irigaray and Christensen Ranch Projects**

## Descriptions of Revisions

In late September, the Board of Directors approved COGEMA Mining, Inc.'s proposed budget for 1996. Several activities pertaining to Christensen Ranch were approved by the board that were not considered in the 1995-1996 Decommissioning and Reclamation Cost Estimate submitted to the Wyoming Department of Environmental Quality (DEQ) and the U.S. Nuclear Regulatory Commission (NRC) on August 17, 1995. These activities include the following:

- Addition of an 60' x 108' office building to the Christensen Ranch Satellite Plant site.

- Addition of a 25' x 40' warehouse to the Christensen Ranch plant building.

- Addition of a 40' extension to the Christensen Ranch plant building, to house two additional ion exchange vessels and one sand filter. This equipment is necessary to accommodate solutions from the remainder of Mine Unit 5, and to assist with a flow increase from the current 2500 gpm plant capacity to 3600 gpm.

- Addition of a 60' x 60' extension to the Christensen Ranch plant building to house restoration equipment. Restoration is expected to commence in Mine Unit 3 during 1996. The building will house process equipment specific for restoration activities.

- Construction of two additional brine evaporation ponds (already permitted) at Christensen Ranch. These ponds are identical to the two existing brine ponds, and will be situated to the east of the existing brine ponds as permitted in the Christensen Ranch mine permit/license application document. The ponds will be used to evaporate wellfield bleed associated with the plant flow increase to 3600 gpm, and restoration activities.

The purpose of this submittal is to increase the August 17, 1995 decommissioning cost estimate to account for the above activities, planned for construction during the 1995-1996 bonding period. The increase in the 1995-1996 Decommissioning and Reclamation Cost Estimate from the above additions amounts to $118,458.00, including the 15% contingency and 2% for inflation. Detailed changes made to the individual worksheets of the cost estimate are explained following, and copies of the affected and revised worksheets are attached to this explanation. These should be incorporated into your August 17, 1995 submittal. Additionally, Figure 3.9 from the Irigaray/Christensen Ranch license renewal supplement, in progress, is attached to show the locations of the various plant building expansions. The office building, not shown, is tentatively planned for construction along the access road to the south of the existing evaporation pond area.

**Changes Made to Cost Estimate Worksheets:**

Changes to individual worksheets and the summary table, which comprise the 1995-1996 Decommissioning and Reclamation Cost Estimate, are explained below.

Summary of Reclamation/Restoration Estimate

1. Worksheets 2, 3, 4 and 7 have been revised to account for reclamation costs of the above structures. These cost revisions have been reflected in the summary table.

2. The net change in amount from the August 17, 1995 estimate is an increase of $118,458.00, bringing the grand total to $11,384,319.00.

Worksheet 2 - Plant Equipment Removal and Disposal

1. The volume of equipment to be removed and disposed of at the Christensen Ranch satellite has been increased from 80 $yd^3$ in the existing plant to 91 $yd^3$ for the addition of two ion exchange columns and one sand filter. Additionally, the oxygen saturator has been removed from the plant; the 91 $yd^3$ takes this into account.

2. A new column has been added under Christensen Ranch called Restoration Extension. This is the 60' x 60' building extension to be added on the southwest corner of the existing satellite plant to house restoration equipment. The new column addresses the removal and disposal of the restoration equipment, which amounts to 42 $yd^3$.

3. The addition of 11 $yd^3$ of material in the satellite plant and 42 $yd^3$ of material from the restoration building results in a $8,787 increase to Worksheet 2. The new Worksheet 2 total is now $111,220.

Worksheet 3 - Building and Concrete Demolition and Disposal

1. As noted above, a 40' extension is planned for the existing Christensen Satellite Plant building to house the two additional ion exchange vessels and sand filter. The building demolition volume has, therefore, been increased accordingly to 192,000 $ft^3$ from the original 144,000 $ft^3$. Additionally, the volume of foundation concrete has been adjusted from 3600 $ft^3$ to 4800 $ft^3$. The increased foundation area of the building was also used to calculate the potential volume of contaminated soil that may require removal after the plant is decommissioned.

2. Three new columns have been added to Worksheet 3. These are the Restoration Extension to the satellite plant; the new office building; and the warehouse. These are discussed in detail as follows:

   - The restoration extension is a 60' x 60' two story steel frame building to be

added on the southwest corner of the existing satellite plant. The materials of construction will be the same as the satellite plant. Worksheet 3 has been revised to add the building and foundation demolition and disposal costs. As this building will be used strictly for restoration, contaminated concrete, or soils under the foundation, are not expected and have not been accounted for in Worksheet 3.

- The office building will be placed on the west side of the entrance road to the plant, south of the existing fenced pond area. The building will consist of up to nine 12' by 60' modular units, set on a steel frame. There is no concrete foundation. The building is expected to be 60' x 108' at the largest (there is a possibility that only 8 modular units will be necessary, reducing the size to 60' x 96'). Worksheet 3 has been revised to account for the building demolition and disposal cost of a 60' x 108' one story, pre-fabricated building.

- The warehouse building will consist of a one story, steel frame building placed on the north side of the existing satellite plant. The building will extend 25' to the north, and run 40' along the north side of the plant. The roof will slope from 12' to 10', giving an average roof height of 11'. Worksheet 3 has been revised to account for the building demolition and disposal cost for the 25' x 40' building.

3. The net increase to Worksheet 3 from the above activities is $16,931, bringing the new total for building and concrete demolition and disposal to $516,227.

Worksheet 4 - Pond Reclamation Cost

1. Worksheet 4 of the August 17, 1995 estimate includes reclamation costs for the two existing lined brine ponds and the one permeate storage pond at Christensen Ranch. Worksheet 4 has now been updated to add two additional lined brine ponds, scheduled for construction during the spring/summer season of 1996. The ponds (Brine Ponds 3 and 4) will complete the four-pond system (lined ponds) originally approved for construction in 1988 by WDEQ and NRC in the original mine permit/license application for Christensen Ranch.

2. The net increase to Worksheet 4 from the addition of the two new brine ponds is $47,306, bringing the new total of Worksheet 4 to $1,886,406. The cost estimate per pond used for the two new ponds is identical to that for the two existing ponds.

Worksheet 7 - Topsoil Replacement & Revegetation

1. Section I, Process Plant, has been revised to add the topsoil handling, grading and revegetation costs for the office building (Section I is now entitled Process Plant and Office Building). An area of 0.5 acres was estimated to be disturbed for the office building area, and was added to the existing 2 acre area of the plant site. No additional

costs were added for the 40' plant extension, the 60' x 60' restoration building extension, nor the 25' x 40' warehouse, as this area is already encompassed by the 2 acre plant site. In summary, the affected area for Section I, Process Plant and Office Building, has been increased from 2 acres to 2.5 acres.

2. Section II, Ponds, has not been revised. This is because the 12 acres of affected area already in the cost estimate encompasses the entire fenced pond area at Christensen Ranch. The two new brine ponds will be constructed inside the existing fenced pond area, as originally planned in the permit applications.

3. Section VI, Remedial Action, has been revised to assume that 50% of the office building acreage (0.5 acres) will require remedial revegetation action. The estimate of acreage requiring remedial action in the August 17, 1995 estimate was 57.3 acres. This acreage figure was in error, and should have been 54 acres (50% of the total acreage listed in Sections I through V). With the addition of the 0.3 acres for the office building, the new total is 54.3 acres. This correction actually provides a savings of $1,475 for the category of remedial action.

4. The net effect of the office building addition to Section I, and the corrections made in Section VI, is a net decrease of $362 in the Worksheet 4 total. The new total is now $499,470.

COGEMA Mining, Inc.

# 1995-1996
# Decommissioning and Reclamation Cost Estimate
# Irigaray and Christensen Ranch ISL Projects

NRC License SUA-1341
and
WDEQ Permit to Mine No. 478

August 17, 1995

COGEMA Mining, Inc.
1995-1996
Decommissioning and Reclamation Cost Estimate
Irigaray and Christensen Ranch Projects

## 1995-1996 Cost Estimate Assumptions

The 1995-1996 decommissioning and reclamation cost estimate is based on the estimate provided in the last annual surety update provided to NRC and WDEQ, submittal dated April 21, 1995. Several areas have been updated within this approved estimate, to account for next year's planned activities. The assumptions which have been used for the update are as follows:

1. Irigaray Project - No changes have been made to the previously approved estimate. Although groundwater restoration has been completed in Mine Units 1,2 and 3, the restoration has not yet been submitted for approval from the regulatory agencies. Restoration has commenced in Mine Units 4 through 9.

   WDEQ has recently requested that a restoration plan for monitor wells on excursion status be submitted, and costs for such a plan incorporated into the bond estimate. No costs have been incorporated at this time pending completion of the plan. COGEMA will meet with the WDEQ on August 29 to discuss considerations for the plan. It is premature at this time to incorporate costs for such a plan.

   In summary, no changes in the bond estimate have been made for the Irigaray Project for the 1995-1996 term.

2. Christensen Ranch Project

   - Christensen Ranch (CR) Mine Units 2, 4 and 5 will continue to operate during the remainder of 1995 and through 1996. Portions of Unit 2 will be turned off during 1996 as areas are mined out.

   - Construction of CR Mine Unit 6 will commence in 1996. Environmental reconnaissance for CR Unit 6 will begin as early as October, 1995. Operations in CR Mine Unit 6 may commence by mid-1996 (after regulatory approvals are obtained).

   - CR Mine Unit 3 will go into restoration during the first quarter of 1996.

   Changes to the bond estimate for the 1995-1996 term involve the addition of CR Mine Unit 6 groundwater restoration, decommissioning and reclamation (affects most worksheets), the updating of several CR Mine Unit 5 categories with "as-built" numbers, and the deletion of the majority of the costs associated with the Willow Creek R & D

facilities due to the decommissioning and reclamation of the site in April and May, 1995. Worksheet 9 has been completed deleted, with remaining R & D costs (well sealing, road decommissioning and Willow Creek crossing decommissioning) being incorporated into CR Mine Unit 5 cost estimates.

## Changes Made to Cost Estimate Worksheets

The surety estimate is comprised of eight worksheets and a table which summarizes the costs. An explanation of all changes made to the estimate, by individual worksheet, is provided as follows:

### General

WDEQ, in their June 30, 1995 review of the currently approved surety estimate, recommended that COGEMA should pursue an on-site landfill for disposal of non-byproduct materials because the Casper or Campbell County (Gillette, WY) landfills would not accept out-of-county waste. COGEMA is currently sending our non-byproduct material waste (office trash, demolition materials, etc.) to the industrial landfill at Midwest/Edgerton. The cost to dispose of such materials at that site (a new site) is $18.00/ton. The site is only 53 miles from our projects, rather than the 100 miles to Casper. Accordingly, throughout the worksheet documents, the cost of $17/ton for disposal has been changed to $18/ton for disposal at an industrial landfill. However, the $3.09/cubic yard charge has not been changed. We have estimated our current cost for disposal is $1.67/cubic yard from the prices Midwest/Edgerton have charged us: approximately $50 per each 30 yard dumpster. We also did not change the 100 miles for transportation to the industrial landfill, assuming a round trip to Midwest/Edgerton.

In summary, the only change made to the landfill transportation and disposal category in each worksheet was from $17/ton (where used) to $18/ton.

### Summary of Reclamation/Restoration Estimate

1. Revised Worksheet costs have been incorporated into the summary. See individual worksheet changes listed below.

2. The 15% contingency has been broken down into categories required by WDEQ. No contingency has been added for monitoring (included) or preconstruction investigation (with annual reports and bond updates, this should not be necessary).

3. A 2% inflation factor has been added to update the estimate to 1995$.

4. The overall change in amount from the 1994-1995 estimate is a net increase of

$1,159,468, largely due to the incorporation of the new Mine Unit 6 at Christensen Ranch, proposed for construction during 1996.

Worksheet 1 - Groundwater Restoration

1. Costs associated with the groundwater restoration of CR Mine Unit 6 have been incorporated into Worksheet 1. It has been assumed that CR Mine Unit 6 will essentially be the same size as CR Mine Unit 5. Accordingly, the same costs for CR Mine Unit 5 have been used for the costs for CR Mine Unit 6. One difference is that the ore zone is approximately 60 feet deeper in the CR Mine Unit 6 area, due to topography. This has no effect on Worksheet 1. Categories I, II, III and IV were changed to incorporate CR Mine Unit 6.

2. Category V, Labor, was also increased to account for additional time for groundwater restoration of CR Mine Unit 6. The time estimate is shown on the revised Figure 1, attached to the back of the worksheets. The new time estimate to complete restoration is now 6.1 years as compared to the previous 5.3 years (up through CR Mine Unit 5).

3. Category VI was decreased to delete the cost to install a deep disposal well at Christensen Ranch. Construction of the well began the last week in July, 1995 and will continue through the fourth quarter of 1995. The well may be operational by November, 1995.

4. The impact to Worksheet 1 from the addition of CR Mine Unit 6 costs and the deletion of the construction costs of a disposal well was a net increase of $310,454.

Worksheet 2 - Process Plant(s) Equipment Removal and Disposal

1. Approximately 15 cubic yards of equipment were added for six new wellfield module buildings at the CR Mine Unit 6, bring the total from 40 cubic yards up to 55 cubic yards. All costs were increased accordingly.

2. Landfill charges did not change (see general category above).

3. The impact to Worksheet 2 from the addition of CR Mine Unit 6 costs was a net increase of $1,870.

Worksheet 3 - Plant Building(s) Demolition and Disposal

1. Worksheet 3 was revised to add 6 wellfield module buildings for CR Mine Unit 6. Accordingly, the total number of CR wellfield module buildings was increased to 23, from 17. Each building is 12' by 36', and 10' tall, for a total of 4,320 $ft^3$ each.

2. Four booster pump stations are present on the Christensen Ranch site. These have never been incorporated into the surety estimate. These buildings house booster pump assemblies for boosting the flow in the trunklines to the main satellite plant. The buildings are of the same pre-fabricated construction as wellfield module buildings, without concrete floors. The four buildings, and their dimensions, are provided as follows:

| | | |
|---|---|---|
| CR Mine Unit 2 | 18' x 40' x 10' | = 7,200 $ft^3$ |
| CR Mine Unit 4 | 18' x 24' x 10' | = 4,320 $ft^3$ |
| CR Mine Unit 5 | 26' x 24' x 10' | = 6,240 $ft^3$ |
| CR Mine Unit 6 | 26' x 24' x 10' | = 6,240 $ft^3$ |

3. Disposal costs at a landfill were revised from $17/ton to $18/ton, as discussed under general, above.

4. The impact to Worksheet 3 from the above changes was a net increase of $6,623.

Worksheet 4 - Process Pond Sludge and Liner Handling

1. No changes have been made to this worksheet. Observations of pond sludge levels indicate no substantive changes.

Worksheet 5 - Well Plugging and Abandonment

1. Changes to incorporate CR Mine Unit 6 into Worksheet 5 include:

   - Addition of 220 recovery wells
   - Addition of 260 injection wells
   - Addition of 80 monitor/trend wells
   - Addition of 20 hydrology test wells (listed as miscellaneous regional)

2. An additional 48 wells from the Willow Creek R & D site (previous Worksheet 9) were incorporated into CR Mine Unit 5, and added to the miscellaneous regional category. Many wells from the Willow Creek R & D have been incorporated into CR Mine Unit 5 activities. The remaining 48 wells will not be used for CR Mine Unit 5 activities and will be plugged and abandoned during the next year. Once they are properly abandoned, they will be deleted from the surety estimate.

3. The overall average depth of wells in CR Mine Unit 6 is 510'. Using a weighted average for each CR mine unit and respective average depth, the overall average depth for all Christensen Ranch wells is 410', rather than the previous 378'. This new depth increased the volumes for abandonment materials. Overall, the cost per well for plugging and abandonment increased by $2.39/well, for a total of $175.74 per well.

4. The effect to Worksheet 5 from the above changes was a net increase of $114,579.

Worksheet 6 - Wellfield Equipment Removal and Disposal

1. Category 1, Wellfield Piping, was revised to include costs for CR Mine Unit 6. The same costs as CR Mine Unit 5 were used for CR Mine Unit 6.

2. Category II, Production Well Pumps, was revised to include costs for CR Mine Unit 6. One difference was made in Part C, Tubing Volume, to note the deeper pump setting depths that will be used in CR Mine Unit 6. The length of tubing per well increased from 300' in other CR Mine Units to 490' for CR Mine Unit 6.

3. Category IV, Buried Trunkline, was revised to reflect the as-built trunkline in CR Mine Unit 5 (addition of 9,000 feet), and an estimated 47,000 feet of trunkline within CR Mine Unit 6 and connecting CR Mine Unit 6 to the satellite plant (the 47,000 feet of piping is actually two runs of pipe in a 23,500' trench). The piping for CR Mine Unit 6 will also be 12 inch O.D. pipe, and the chipped volume reduction has been increased accordingly.

4. Category V, Manholes, was revised to show 6 manholes in the trunkline for Christensen CR Mine Unit 6, and the as-built number of manholes for the CR Mine Unit 5 trunkline (now 5, down from 8).

5. The effect to Worksheet 6 from the above changes is a net increase of $338,756.

Worksheet 7 - Topsoil Replacement and Revegetation

1. Category III, Wellfields, was revised to include CR Mine Unit 6. The same wellfield affected acreage (30) as CR Mine Unit 5 was used for CR Mine Unit 6 costs.

2. Category IV, Roads, was revised to include 21 acres of roads for CR Mine Unit 6 (within the wellfield and the main road from the wellfield to the Christensen satellite plant). The road acreage for CR Mine Unit 5 was also increased from 4 to 15 acres, based on as-built roads and the addition of the Willow Creek R & D access road into the CR Mine Unit 5 road acreage.

3. Categories V, Other, and VI, Remedial Action, were also revised to incorporate CR Mine Unit 6, using the same estimates used for CR Mine Unit 5.

4. The overall effect to Worksheet 7 from the above changes was a net increase of $100,077.

Worksheet 8 - Miscellaneous Reclamation Activities

1. Fence Removal and Disposal has been revised to increase the quantity of fence in CR Mine Unit 5 to the estimated as-built quantity of 20,000 feet. And, the fence requirement for CR Mine Unit 6 has been estimated at 20,000 feet based on CR Mine Unit 5.

2. Powerline Removal and Disposal has been revised to increase the quantity of powerline in CR Mine Unit 5 to the as-built estimate of 18,000 feet, and the same quantity was used for CR Mine Unit 6. No costs are associated with the powerline as it is owned by Sheridan-Johnson County REA.

3. Powerpole Removal and Disposal has been revised to increase the number of powerpoles associated with the powerline in CR Mine Unit 5 to the as-built estimate of 60. The same quantity has been used for CR Mine Unit 6. The poles are also owned by REA.

4. Transformer Removal and Disposal has been revised to indicate the as-built and proposed estimates for CR Mine Units 5 and 6, respectively. There are no large transformers at either mine unit.

5. A new category, Booster Pump Assembly Removal and Disposal, has been added to Worksheet 8. Within each booster pump building are from three to five 125 gallon per minute pumps connected to the main trunklines which send production flow to the plant. Associated with each booster pump is approximately 30 feet of 12" pipe. The cost for removal and disposal of each booster pump assembly (pump plus piping) is $250 each. This cost was derived from a cost estimate to remove and dispose of all 16 assemblies, and includes piping volume reduction, surveys and decontamination, pump dismantling cost and transportation and disposal.

6. Low Water Stream Crossing has been revised to incorporate the reclamation of the Willow Creek R & D stream crossing (tri-lock block) within CR Mine Unit 5. This also eliminates the cost from last year's Worksheet 9.

7. Utilities Cost during reclamation activities has been revised to add four months for CR Mine Unit 6, consistent with the estimate for CR Mine Unit 5.

8. The overall effect of the above changes to Worksheet 8 result in a net increase of $24,752.

Worksheet 9 - Willow Creek R & D Site Decommissioning

As previously noted, the Willow Creek R & D site was decommissioned in April and May of this year. The decommissioning included the removal and reclamation of the two evaporation

ponds, remaining septic tank, fence removal and topsoil and subsoil stockpile removals. Topsoil and subsoil not used during the reclamation has been relocated to the south of the CR Mine Unit 5 wellfield area. Remaining structures were incorporated into the following worksheets: wells - Worksheet 5; access road - Worksheet 7; low water crossing - Worksheet 8; miscellaneous - Worksheet 7 (whole area incorporated into CR Mine Unit 5). Accordingly, Worksheet 9 has been deleted from the surety estimate.

## 7.0 ENVIRONMENTAL EFFECTS

The objective of the mining and environmental monitoring program is to conduct an operation that is viable and environmentally responsible. The environmental monitoring programs are used to ensure that the potential sources of land, water and air pollution are controlled and monitored were presented in Section 5.O, Operations.

This section discusses and describes the degree of unavoidable environmental change, the short term and long term impacts due to the operation, and the consequences of possible accidents at the Irigaray and Christensen Ranch sites.

### 7.1 SITE PREPARATION AND CONSTRUCTION

All major facilities have been constructed at the Irigaray site including the process plant, ponds, roads and nine production well fields. Additional well fields may be constructed within the current permit boundary, and in the long term, outside of the permitted area. Other construction at Irigaray may include the installation of a deep disposal well.

The Christensen Ranch satellite plant and most of the support facilities have already been constructed, including three out of six permitted ponds, and the deep injection well for wastewater disposal. Four mine units are currently constructed and in production (Mine Unit 3 is mined out), with a fifth undergoing construction at the time of this submittal. Additionally, future mine units will be constructed in the Heldt Draw, North Prong, and Table Mountain areas. The original application for Christensen Ranch called for satellite plants at each of these areas. However, after seven years of operational experience, COGEMA plans to operate only the existing satellite plant, using buried pipelines to connect with the future well field areas. Other potential construction planned for Christensen Ranch are roads to the new mine units, and the installation of the three remaining ponds for wastewater disposal.

Soils and vegetation will be affected by the construction and installation of the remaining lined evaporation and permeate storage impoundments at Christensen Ranch, as well as the installation of new mine units and construction of access routes at both Irigaray and Christensen Ranch. Construction of these facilities will have the primary effect of changing the present land use from cattle grazing and incidental wildlife use to a temporary mining use in the areas of potential disturbance. These facilities will create relatively small disturbances which are temporary in nature and which will be reclaimed to the original land use characteristics according to the Reclamation Plan. Increased sedimentation during construction will be temporary and will be minimized by the stabilization of the disturbed areas with seeding of an interim seed mix. Stabilization of the areas disturbed during ongoing operations is discussed in Section 3. Consequently, while the disturbances associated with the mining operations are unavoidable, there will be no long term irreversible effects from the

preparation and construction of the various components of the mining operation. It is probable that the irregular and often narrow well field disturbances may, in some cases, enhance wildlife habitat for certain species by creating an increased edge effect along the perimeter and by adding temporary diversity to the area. Domestic livestock grazing may be temporarily interrupted on the operating areas.

### 7.1.1 PROCESS FACILITIES AND POND CONSTRUCTION

The Irigaray/Christensen Ranch terrain will be disturbed temporarily where the ponds and plant facilities are placed, along sections of newly constructed access roads and where buried process lines are installed. Estimates and actual acreage of disturbance are provided for Irigaray and Christensen Ranch sites in Section 3.0. After groundwater restoration has been accomplished, the facilities will be decommissioned as described in Section 6.2 and the surface disturbances reclaimed according to the reclamation plan, Section 6.3.

### 7.1.2 WELL FIELD DISTURBANCES

Well field installations at the Irigaray site consist of 30 acres of production well fields, and a small area associated with the 517 R&D site (less than one acre of well field area). Within the current permit area, two to three additional mine units may be feasible; Production Unit Ten is planned for installation at the 517 site.

Well field installations at the Christensen Ranch site will cause the majority of the surface disturbance created during mining. Well field mine units will, however, be disturbed to a lesser degree than other installations and will be withdrawn from grazing for a shorter period of time than other facilities. The surface disturbance of well field mining units will be reclaimed and returned to grazing use sequentially once the groundwater restoration has been approved. Mine units will continue to be installed to achieve and maintain the plant recovery rate (annual average of 3,600 gpm at Christensen). When the initial mine unit is depleted (mined out), restoration will commence and will continue sequentially as areas are mined out. The mining sequence will continue through the completion of mining, with the mine units being rotated back to various stages of restoration, and surface reclamation returning them to livestock production.

The total area disturbed by well fields at any given time will vary according to the mining schedule and the size of the mine units in operation. The amount of disturbance in a given well field will depend on surface relief and the degree of disturbance necessary for efficient installation and operation of the mine unit.

Each unit will be disturbed for three to six years before surface reclamation is conducted. This time includes approximately three years for mining, and up to three years for groundwater restoration and stability monitoring. After surface reclamation has been achieved, the areas will be returned to grazing use.

## 7.2 OPERATIONAL EFFECTS

### 7.2.1 AIR QUALITY IMPACTS

The impacts of operations at the Irigaray site upon the air quality in the area are minimal. Fugitive dust will be released during travel on access roads to the site and within the well field areas. The amount of fugitive dust released during operations at the Irigaray recovery facility, where traffic in the past was greater than that for the current Christensen operations, was calculated to be 89.5 tons/year (particle size < 30 $\mu$m) within the permit boundary. (Reference: *Section M2, WDEQ Application for Permit to Mine, No. 478*). This estimate can be used as a worst-case estimate for the Christensen Ranch operations because of the small number of employees commuting to the site and the limited scope of the process operations and requirements. Computer modeling conducted in 1978 of the Irigaray particulate emissions showed that the maximum total predicted concentrations due to all influences, including fugitive dust and uranium particulate from the Irigaray dryer, was only 32 g/m$^3$ (includes a background of 20 g/m$^3$). This is well below the most restrictive secondary National Ambient Air Quality Standard of 60 g/m$^3$. The Christensen Ranch total particulate emissions should be well below the Irigaray estimates. Efforts to reduce fugitive dust are made when it becomes apparent that it is a problem. This has been accomplished by applying dust control media (only water to date) to the access roads.

Installation of future facilities at the Christensen Ranch plant site will contribute some amount of fugitive dust to the atmosphere during the construction period. This contribution will be localized and temporary, therefore, should not significantly affect air quality in the region. The release of diesel emissions from drilling and construction equipment will be minor and of short duration.

Air quality at the site and surrounding areas has not been impacted by operational activities. There have been no atmospheric emissions from the facility other than fugitive dust, some soda ash emissions during loading of the silo and radon gas, which will be discussed in Section 7.3 following. The following table estimates the total emissions from the Irigaray facility assuming dryer operations at 8,760 hours per year.

| | **1979 CT-223 Permit Application Estimates (tons/year)** | **1994 Updated Permit Application Estimates (tons/year)** |
|---|---|---|
| **Fugitive Dust** | 89.5 | 89.5 |
| **Process Plant** | 60.55 | 2.0 |
| **Drying and Packaging** | 5.8 | 1.3 |
| **TOTAL** | **155.85** | **92.8** |

Actual dryer stack emissions testing has shown that the 1.3 tons/year estimate for total particulate is in fact high, with true emissions averaging less than half that amount (0.56 tons/year).

### 7.2.2 LAND USE DISTURBANCE IMPACTS

At the Irigaray site, the primary impact has been the loss of grazing capacity during the life of the project, which is still a minimal impact. A total of seven animal unit months has been removed from use, a loss of grazing capacity that would support approximately five cows per year. With successful reclamation, this grazing land should be returned to its original capacity.

The primary unavoidable impact caused by operation of the Christensen Ranch project is the removal of up to a total of 1,000 acres of rangeland out of livestock grazing use over a period of 25 to 30 years. Of the total acres of potential disturbance within all mining areas, only approximately 50% may be disturbed at any one time. All of the impacts are considered temporary and reversible by returning the land to its former grazing use through post-mining surface reclamation.

The overall long term effects of the in-situ mining operation at the Irigaray and Christensen Ranch sites are minimal as compared to conventional uranium mining methods because there is no long term stability of uranium ore tailings and waste required. There should has been no conflict with, or impacts to, other mineral resources in the area.

### 7.2.3 IMPACTS TO WATER RESOURCES

Potential impacts to water resources from mining and restoration operations include: 1) groundwater consumption; 2) declines in groundwater quality; 3) impacts to surface water from construction or decommissioning activities; and 4) impacts to surface water from accidents. These potential impacts to water resources in the area of the Irigaray/Christensen Ranch area are expected to be minimal, as summarized in the following sections. Impacts to water resources are described in detail in *Appendix D6, Hydrology* of both the *Irigaray WDEQ Application* and the *Christensen Ranch Amendment Application*.

#### 7.2.3.1 Groundwater Consumption

Groundwater consumption at Irigaray was originally estimated at approximately 1,000 acre-feet. As this withdrawal of groundwater occurred over a long period of time, and given the limited groundwater data due to the complex geology present, the impact of this pumpage is difficult to determine. Potential impacts however could include: 1) temporary lowering of water levels in wells located in the ore zone aquifer in the immediate vicinity of the well fields and 2) the lowering of water levels in wells

located in the alluvium overlying the Wasatch Formation, if leakage from the alluvium into the Wasatch Formation occurs as a result of pumping.

At Christensen Ranch, the maximum total consumptive use of groundwater as a result of mining and restoration of one mine unit is estimated to range from 70 million gallons to 150 million gallons or 215 to 460 acre-feet. In the original Christensen Ranch amendment application, it was estimated that this number would range from 212 to 224 acre-feet of water over the 25 year mine life, for a total of 8,480 acre-feet to 8,960 acre-feet to be consumptively used for mining and restoration of all mine units. The water withdrawn from the ore zone aquifer consists of bleed water from the mining operation for lixiviant migration control and bleed water from the restoration process. Although the number and size of mine units has been decreased since the original application, the potential consumption has remained essentially the same because the estimate to complete mining in a unit has now increased to up to three years per mine unit.

Impact from the consumptive uses are considered to be temporary and should be mitigated by the withdrawal of the groundwater over the extended period of approximately twenty five years. The primary potential impact will be the temporary lowering of water levels in wells completed in the production zone aquifer in the immediate vicinity of the well fields. Water levels will be monitored during both mining and restoration to assess the amount of drawdown in surrounding wells. Additionally, COGEMA will attempt to minimize the groundwater consumption during restoration, when the majority of the water is withdrawn, by utilizing state of the art technology.

7.2.3.2 Groundwater Quality

Impacts to groundwater are associated with consumptive use and temporary degradation of water quality. Potential groundwater quality impacts from operations at Irigaray and Christensen Ranch are associated with 1) uncontrolled excursions, 2) liner failures in the evaporation ponds, 3) accidental leaks or spills of process solutions, and 4) improper or incomplete groundwater restoration. Additionally, local groundwater quality will be temporarily lowered by the mining process in the vicinity of the well fields. Potential impacts to groundwater quality are discussed:

Excursions

Migrations of lixiviant from the well fields, or excursions, occur during the mining operations due to varying aquifer properties and fluctuations in well field operations. The monitoring systems described in Section 5.0 ensure that any excursion from the well field are detected before lixiviant migrates a significant distance from the production zone. Operations at the Irigaray and Christensen Ranch sites have demonstrated that this type of monitoring system is effective and that excursions can be controlled. Excursions within the ore zone are typically identified and controlled

within a several week (and sometimes days) period.

Excursions to an upper monitor zone have proven to be more difficult to totally withdraw back to the original baseline water quality levels. At Irigaray, a history of excursions to the shallow monitor zone is present. In the early days of mining, initial excursions of lixiviant to the shallow monitor zones were caused by faulty injection well casings and unplugged, or improperly plugged, exploration holes within the well field areas. The mining occurred in the late 1970's and early 1980's before there was a requirement to test the integrity of injection well casings.

As a result of the first excursions, three shallow monitor wells remain on excursion status today, with two wells located in previously restored areas (Units 1 and 3). The third shallow well is located in Unit 8, currently undergoing restoration. A fourth excursion is present in a deep monitor well, and is thought to be caused by a connection with the production zone. This well is located in Unit 6, currently undergoing restoration.

The impact of the excursions at Irigaray to the local groundwater is considered by COGEMA as insignificant. Several parameters exceed baseline values (chloride, total alkalinity, conductivity), but are well within use classification standards. A summary of the excursion history since 1987 is provided later in this section.

At Christensen Ranch, several excursions to the ore zone have occurred and have all been controlled. Two excursions to the shallow monitor well in Mine Unit 3 occurred, but have been controlled and returned to baseline values. Due to COGEMA's well casing integrity testing program and our practice of sealing exploration holes within well fields, we do not anticipate large scale problems with shallow excursions.

A history of the excursions at both Irigaray and Christensen Ranch since 1987 (last permit update and license renewal) is provided as follows:

<u>1987</u>

DM-20 (deep monitor well, IR Unit 3) was confirmed to exceed the Upper Control Limits for all excursion parameters on November 24, 1987. The excursion was determined to be caused by a poor cement bond in the annulus of the monitor well. DM-20 was abandoned and replaced with DM-20C. Sampling of DM-20C began on December 21, 1987. No further problems were encountered with the well.

<u>1988</u>

No wells were reported on excursion status during this period.

1989

M-7 and M-18 (perimeter ore zone monitor wells, IR Unit 1) were reported on excursion status on January 27, 1989, and April 21, 1989, respectively. The problem in both wells was elevated sulfate concentrations which directly influence the excursion parameter conductivity. The elevated sulfates were thought to be caused by the well being located in the Willow Creek flood plain instead of the Irigaray wellfield. In March and April, 1989, the company requested that the Land Quality Division approve a redefinition of the excursion criteria which would alleviate the problem with M-7 and M-18. As a result, M-7 and M-18 were both reported off excursion status in November of 1989.

SSM-34 (shallow monitor well, IR Unit 9) was reported on excursion status on February 2, 1989. The well exceeded the Upper Control Limits for chloride and alkalinity. Corrective action consisted of re-entering and cementing an improperly plugged exploration hole adjacent to SSM-34. SSM-34 remained stable after replugging the adjacent exploration well. SSM-34 was reported off excursion status on October 19, 1989.

SSM-18 (shallow monitor well, IR Unit 8) was reported on excursion status on July 5, 1995. The well exceeded the Upper Control Limits for chloride and alkalinity. Corrective action consisted of over recovery in the area. SSM-18 was reported off excursion on April 19, 1991.

DM-10 (deep monitor well, IR Unit 6) was reported on excursion status on July 5, 1989. Corrective action consisted of pumping wells adjacent to DM-10 and over recovery in the area. DM-10 was reported off excursion on December 21, 1992.

SSM-43 (shallow monitor well, IR Unit 1) was reported on excursion status on October 13, 1989. The well exceeded two of three Upper Control Limits. Initially, over recovery in the area was utilized in an attempt to correct the situation until over recovery was ceased with permission of WDEQ. SSM-43 remains on excursion status at this time.

1990

SSM-39 (shallow monitor well, IR Unit 1) was reported on excursion status during December of 1990. The well exceeded the Upper Control Limits for chloride and alkalinity. Restoration of Units 1 through 5 was in progress at this time. SSM-39 was reported off excursion status on June 1, 1992.

SSM-42 (shallow monitor well, IR Unit 3) was reported on excursion status during October 10, 1990. The well exceeded the Upper Control Limits for chloride and conductivity. Restoration of Unit 1 through 5 was in progress when the well was reported on excursion. SSM-42 remains on excursion at this time.

MW19 (ore zone monitor well, CR Unit 3) was reported on excursion status on January 5, 1990. The well exceeded the Upper Control Limits for chloride and alkalinity. Corrective action consisted of over recovery in the area. MW19 was reported off excursion on April 2, 1990.

1991

M-2 (ore zone monitor, IR Unit 2) was reported on excursion status in January of 1991. The well exceeded the Upper Control Limits for chloride and conductivity. Corrective action consisted of pumping trend wells in the surrounding area. M-2 was reported off excursion status on March 8, 1993.

MW48S (shallow monitor well, CR Unit 3) was reported on excursion status on December 3, 1991. The well exceeded the Upper Control Limits for chloride and alkalinity. Integrity failure of injection well 3R27-1 was determined to be the cause of the excursion. MW48S was reported off excursion status on January 2, 1992.

MW19 (ore zone monitor well, CR Unit 3) was again reported on excursion status on November 19, 1991. The well exceeded the Upper Control Limits for chloride and conductivity. Corrective action consisted of over recovery in the area. MW19 was reported off excursion status on February 8, 1993.

1992

MW48S (shallow monitor well, CR Unit 3) was reported on excursion status on March 27, 1992 and again on June 19, 1992. The well exceeded the Upper Control Limits for chloride and alkalinity. Various corrective actions have been attempted to control this well. MW48S was reported off excursion status on August 29, 1995.

4E6-1 (ore zone monitor well, CR Unit 3) was reported on excursion status on September 10, 1992. The well had exceeded all three excursion parameters. 4E6-1 was reported off excursion status on April 30, 1993.

1993

MW46S (shallow monitor well, CR Unit 3) was reported on excursion status on March 10, 1993. The well had exceeded the Upper Control Limits for chloride and alkalinity. Corrective action consisted of over recovery in the area. MW46S was reported off excursion status on August 29, 1995.

1994

DM-10 (deep monitor well, IR Unit 6) was reported on excursion status on February 2, 1994. The well had exceeded all three Upper Control Limits. Corrective action has consisted of pumping recovery wells HI-53 and HP-22, and active restoration in Mine

Unit 6. DM-10 remains on excursion status at this time, although the well is very close to being off excursion status.

SSM-39 (shallow monitor well, IR Unit 7) was reported on excursion status on March 15, 1994. The well had exceeded the Upper Control Limits for conductivity and alkalinity. The exceedances were not identified at the time of the excursion and was later reported as a self-identified deviation from permit requirements. This well is currently on normal status.

SSM-40 (shallow monitor well, IR Unit 8) was reported on excursion status on March 6, 1994. The well exceeded the Upper Control Limits for chloride and conductivity. Corrective action consisted of shutting down various injection wells in the area. SSM-40 remains on excursion status at this time.

1995

SSM-3 (shallow monitor well, IR Unit 2) was reported on excursion status on June 14, 1995. The well exceeded the Upper Control Limits for chloride and conductivity. The well is located in a restored well field. SSM-3 was reported off excursion status on August 29, 1995.

SSM-18 (shallow monitor well, IR Unit 8) was reported on excursion status on June 14, 1995. The well exceeded the Upper Control Limits for chloride and conductivity. A groundwater sweep was occurring when the well was reported to be on excursion. Corrective action consisted of the pumping of well KI-78. SSM-18 was reported off excursion status on August 29, 1995.

M-2 (ore zone monitor well, IR Unit 2) was reported to be on excursion status on June 14, 1995. The well exceeded all three Upper Control Limits. Corrective action consisted of pumping trend wells T-10 and T-11. M-2 was reported off excursion status on August 29, 1995.

MW108 (ore zone monitor well, CR Unit 2) was reported on excursion status on January 9, 1995. The well had exceeded the Upper Control Limits for chloride and alkalinity. Corrective action consisted of over recovery in the area. MW108 was declared off excursion status on February 9, 1995.

4MW15 (ore zone monitor well, CR Unit 4) was reported on excursion status on June 8, 1995. The well exceeded the Upper Control Limits for chloride and alkalinity. Corrective action consisted of shutting off numerous injection wells and over recovery in the area. 4MW15 was taken off excursion status effective December 5, 1995.

In summary, the wells that remain on excursion status as of this submittal are all located at the Irigaray site, and include three shallow monitor wells (SSM-40, SSM-42 and SSM-43) and one deep monitor well (DM-10).

Waste Disposal Ponds

Liquid and solid wastes are temporarily stored in lined solar evaporation ponds. A leak detection system installed under the ponds ensures that any failure in the lining will be detected before solutions migrate significant distances from the pond area. At both the Irigaray and Christensen Ranch areas, the impact of pond leakage, should it occur, is expected to be small because of the dry strata beneath the ponds and the large vertical distances to groundwater.

Two lined evaporation ponds have experienced leakage at the Irigaray site in the past. In 1979 and 1980, water in the leak detection of Pond C at Irigaray was discovered during routine pond inspections. The source of the water in the leak detection system was never identified; after dye studies and inspections of the pond liner (after evacuation of all water), the source was thought to be from an outside influence (a small sandstone outcrop next to the pond). The water in the detection system has not been noted since that time. In 1992, a leak was detected in Pond D at Irigaray. The pond contents were emptied into another pond and a 2' X 2' tear in the liner was repaired. The pond was refilled and has not experienced further problems.

No leakage has been detected in the Christensen Ranch brine ponds. Some seepage was felt to be occurring from the one existing permeate storage pond at Christensen in 1994. The seepage was apparently causing failure of the interior slopes of the pond (see Section 4.0 of this document). The pond has since been repaired. No impact to groundwater or surface water quality from the seepage occurred as the permeate was of very high quality and easily met NPDES surface discharge criteria for uranium mines. During the repair of the permeate pond, the existing water was discharged under the Christensen NPDES permit. Further seepage from the permeate pond will not cause impacts to water quality in the area due to the excellent quality of the permeate produced, and COGEMA's monitoring programs to ensure this.

Accidental Leaks or Spills

Accidental leaks or spills of process chemicals could potentially infiltrate shallow aquifers and locally reduce groundwater quality. Any leaks or spills would probably not be of a sufficient volume to significantly degrade near surface groundwater quality. The potential for these chemicals to migrate into deeper strata is also considered very low due to the large vertical distance between the near surface aquifers and the lower aquifers.

Spills within the well field areas do occur on occasion. The spills are typically a result of an injection line separation inside or adjacent to the mine unit module buildings, as these lines are pressurized and have connections to other piping or valves at the surface. Spills of injection solution are barren of uranium, but do contain radium-226. Spill locations are mapped and soil samples collected when a spill occurs. Soil analyses from past spills indicate that radium-226 does not tend to adsorb in the soil,

and the soils have otherwise been unaffected.

Restoration

Should groundwater restoration be incomplete, groundwater quality could be locally degraded. Previous restoration conducted at the Willow Creek R & D site, Irigaray E-Field, Irigaray Units 1-3 and the 517 test site has shown that the return of groundwater quality to near baseline conditions is feasible. A few chemical parameters such as TDS, chloride, carbonates, and uranium may not be reduced to exactly baseline values. In most cases, these areas were restored to values within pre-mining use classifications (Class I, Domestic). The exception to this was TDS in the Irigaray Units 1-3. The concentration of TDS over baseline, and the Class I use category, is due to the concentration of sodium bicarbonate remaining in the groundwater after restoration, which in turn affects the TDS. All metals were returned to baseline. It is anticipated that during the restoration of future well fields these parameters will be reduced to either baseline, or near baseline, and pre-mining use classification standards. Therefore, the impacts of a properly implemented restoration program on the local groundwater quality of the production zone will be minimal.

### 7.2.3.3 Construction and Operations Impacts to Surface Water

The activities that could potentially impact surface water in the Irigaray/Christensen Ranch area include construction and operation of the well fields, pipelines, process plants and access roads. Other operational impacts could include accidental occurrences such as leaks or breaks in pipelines, spills or an evaporation pond overtopping.

Construction Impacts

Normal construction activities within the well fields, process plants and along the pipeline courses and roads may increase the sediment yield of the areas so disturbed. However, the relative sizes of these disturbances are minor compared to the size of the permitted areas and to the size of the watersheds. Most of the disturbed areas are revegetated with an interim seed mixture following the completion of construction. Thus, the effects of increased sediment yield will be short term.

Operational Impacts

The process plants are equipped with a spillage containment system. The curbed plant foundation and pumpable sumps will ensure that leaks or spills within the plants do not leave the plant area. Monitoring of evaporation ponds ensures that the ponds are not overfilled and that leaks, eroded areas, liner damage, or other potential problems, are detected.

Accidental spills of mining solutions, chemicals, fuels or loaded resin are mitigated by

immediate remedial action such as containment within earthen berms (where possible) or retrieving the solutions with pumping units. The immediate surface water in the area of both Irigaray and Christensen Ranch, Willow Creek, is an ephemeral stream as is its tributaries. If a spill occurred which reached Willow Creek during a period of flow, the spilled material would be diluted and dispersed. Also, the soils of the licensed area are generally dry and have a high specific retention capacity. Spills to the soil are rapidly absorbed and the dry streambed will not enhance the transport of the solids or liquids. Thus, the impact of any occurrence is likely to remain in close proximity to the site and make remedial action easier.

Spills that have occurred over the past years have not impacted Willow Creek.

Decommissioning and Reclamation

Sediment yields and total runoff will increase for a very short period of time during and immediately following decommissioning and reclamation activities. The relative area of such disturbances to the area of the watersheds is quite small. In addition, well field decommissioning and reclamation will be on-going throughout the operational life, thus reducing the amount of area to be reclaimed at the end of final operations. Thus, the impacts to surface waters within and adjacent to the licensed area will not be significant because of their short duration and the limited areal extent of the disturbance.

### 7.2.4 ECOLOGICAL IMPACTS

Principal impacts on terrestrial biota will be caused by the disturbance of soils and vegetation during construction of the facilities. The greatest effect created by this disturbance will be the setting back of plant succession within the area of disturbance. This impact is only temporary and disturbances will be reclaimed using state of the art surface reclamation practices to re-establish the native plant community giving consideration to forage production, ground cover and species diversity.

## 7.3 RADIOLOGICAL EFFECTS

General

This section discusses radiological impacts of continuing operations at the Christensen Ranch and Irigaray in situ leach site. Impacts both to humans and to non-human biota are discussed. All investigations presented in this section pertaining to radiological impacts were performed in 1995 based on current models and compared to current regulations.

Radiological Regulations

Currently (1995) there are three sets of regulations promulgated by two agencies governing radiation doses to the public from uranium in situ leach operations with dryers: EPA's 40 CFR 190, radiation protection standards governing all nuclear fuel cycle operation; EPA's 40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAPs); and NRC's 10 CFR 20, radiation protection standards. 40 CFR 190 stipulates that operations be conducted to provide reasonable assurance that annual dose equivalent to the whole body of 25 mrem per year (excluding radon) is not exceeded for any member of the public. 40 CFR 61, Subpart I requires that radionuclide emissions from a regulated facility shall not exceed amounts causing any member of the public to receive an effective dose equivalent of 10 mrem per year. (The total effective dose equivalent (TEDE) is the sum of the dose equivalents from both external and internal sources with units of rem or sieverts. For internal doses the dose equivalents in individual organs are weighted by an organ-weighting factor, which is derived based on the risk coefficient determined for that tissue or organ. 10 CFR 20 requires that licensees shall conduct operations to limit total effective dose equivalent to individual members of the public to 0.1 rem (100 mrem) per year.

Radiological Background

Natural background radiation is derived from a number of sources including the sun and naturally occurring radiation sources on the earth's surface. The dose resulting from exposure to naturally occurring radon levels in the Western Great Plains has been estimated at 560 mrem/year (USNRC, 1979a). However, according to a more recent evaluation by the U.S. Nuclear Regulatory Commission, the average natural background concentration of radon-222 is 0.62 pCi/l which is expected to produce a dose of 625 mrem/yr to the bronchial epithelium with an annual dose equivalent to the whole body of 212 mrem (NRC, 1992). In addition, the NRC determined that the general internal background dose due to inhaled and ingested radionuclides to the whole body is 174 mrem/yr for the Wyoming Basin (NRC, 1992).

Summary of Radiological Impacts from the Christensen Ranch and Irigaray Site.

Detailed radiological modeling was performed in 1995 based on the source terms given in Attachment 7.3(A) and weather data, with details presented in the following sections. The primary sources of exposure from this operation include radon and its decay products and emissions from the thermal dryer at the Irigaray site. Results from NRC specified MILDOS-AREA modeling, including radon, indicated a total annual effective committed dose to an adult at the nearest resident to Christensen Ranch of no more than 0.59 mrem/yr; and to an adult at the nearest ranch to Irigaray a total annual effective committed dose of no more than 0.40 mrem/yr as a result of continuing in situ leach and drying operations at the Site. A total of 48 receptors were evaluated with the maximum effective dose predicted by the MILDOS-AREA model being 20.8 mrem/yr (including radon and its decay products) or 20.8% of the standard of 100 mrem/yr to the general public. With radon and its decay products excluded the maximum predicted dose at any receptor was 0.599 mrem/yr which is less than the standards of 25 mrem/yr and 10 mrem/yr as per 40 CFR 190 and 40 CFR 61 respectively. Hence, it can be concluded that continuation of operations at the Site is unlikely to result in subjecting any member of the general public to radiation that exceeds any regulatory standard.

## 7.3.1 EXPOSURE PATHWAYS

The potential pathways for radiation exposure of humans as a result of emissions from the Christensen Ranch and Irigaray Site include airborne releases of radionuclides from the thermal dryer, and radon-222 releases from the well fields; ingestion of vegetation, milk and meat used for gardens and beef ranches in the vicinity of the Site; immersion in a cloud of radioactive gas or particulates; and ingestion of contaminated water primarily as a result of permitted discharges of water into surface water drainages. The above airborne pathways for radiation exposure are depicted in Figure 7.3-1. The NRC-specified MILDOS-AREA computer code (ANL/ES-161, 1989) was used to assess the possible radiation exposure to humans from airborne emissions. This code calculated the concentrations of radionuclides at specific receptors and the dose at the receptors given in Table 7.1. Receptors 1 through 4 and 23 through 27 are the air monitoring stations for Christensen Ranch and Irigaray. These are shown on Figure 5.5, Section 5. Results of the MILDOS-AREA modeling are detailed below.

## 7.3.2 EXPOSURES FROM WATER PATHWAYS

Groundwater

Four domestic groundwater wells in the Site area are sampled quarterly with an additional well samples semi-annually for radiological analyses of uranium, radium-226, thorium-230, lead-210 and polonium-210. These same wells were included as part of the baseline sampling for the Christensen Ranch license application, with the

# TABLE 7.1
# INDIVIDUAL RECEPTOR LOCATION DATA
# MILDOS-AREA (03/89)

| | LOCATION | X (KM) | Y (KM) | Z (M) | DIST (KM) | TYPE |
|---|---|---|---|---|---|---|
| Christensen Ranch | | | | | | |
| 1 | AS-1 | -3.66 | -0.46 | 0.00 | 3.69 | 0 |
| 2 | AS-5A | 0.01 | -0.05 | 0.00 | 0.06 | 0 |
| 3 | AS-5B | -0.01 | 0.01 | 0.00 | 0.02 | 0 |
| 4 | AS-6 | 3.51 | -3.73 | 0.00 | 5.12 | 0 |
| 5 | 100M NORTH | 0.00 | 0.10 | 0.00 | 0.10 | 0 |
| 6 | 100M EAST | 0.10 | 0.00 | 0.00 | 0.10 | 0 |
| 7 | 100M SOUTH | 0.00 | -0.10 | 0.00 | 0.10 | 0 |
| 8 | 100M WEST | -0.10 | 0.00 | 0.00 | 0.10 | 0 |
| 9 | 100M UPWIND | 0.07 | -0.07 | 0.00 | 0.10 | 0 |
| 10 | 100M DOWNWIND | -0.07 | 0.07 | 0.00 | 0.10 | 0 |
| 11 | 200M NORTH | 0.00 | 0.20 | 0.00 | 0.20 | 0 |
| 12 | 200M EAST | 0.20 | 0.00 | 0.00 | 0.20 | 0 |
| 13 | 200M SOUTH | 0.00 | -0.20 | 0.00 | 0.20 | 0 |
| 14 | 200M WEST | -0.20 | 0.00 | 0.00 | 0.20 | 0 |
| 15 | 200M UPWIND | 0.14 | -0.14 | 0.00 | 0.20 | 0 |
| 16 | 200M DOWNWIND | -0.14 | 0.14 | 0.00 | 0.20 | 0 |
| 17 | 240 DEG @725M | -0.72 | -0.38 | 0.00 | 0.82 | 0 |
| 18 | 270 DEG @ 5500M | -5.49 | 0.00 | 0.00 | 5.49 | 0 |
| 19 | 330 DEG @ 5100M | -4.00 | 3.05 | 0.00 | 5.03 | 0 |
| 20 | 345 DEG @ 2050M | -0.84 | 1.83 | 0.00 | 2.01 | 0 |
| 21 | 45 DEG @ 3350M | 2.36 | 2.29 | 0.00 | 3.29 | 0 |
| 22 | 80 DEG @ 4725M | 4.57 | 1.22 | 0.00 | 4.73 | 0 |
| Irigaray Ranch | | | | | | |
| 23 | IR-1 | -7.18 | 9.28 | 0.00 | 11.73 | 0 |
| 24 | IR-3 | -7.05 | 9.22 | 0.00 | 11.61 | 0 |
| 25 | IR-4 | -7.09 | 10.06 | 0.00 | 12.30 | 0 |
| 26 | IR-5 | -9.22 | 15.09 | 0.00 | 17.68 | 0 |
| 27 | IR-6 | -6.02 | 8.50 | 0.00 | 10.41 | 0 |
| 28 | 50M NORTH TO TD | -7.09 | 9.27 | 0.00 | 11.67 | 0 |
| 29 | 50M EAST OF TD | -7.04 | 9.22 | 0.00 | 11.60 | 0 |
| 30 | 50M SOUTH OF TD | -7.09 | 9.17 | 0.00 | 11.59 | 0 |
| 31 | 50M WEST OF TD | -7.14 | 9.22 | 0.00 | 11.66 | 0 |
| 32 | 50M UPWIND OF TD | -7.05 | 9.19 | 0.00 | 11.58 | 0 |
| 33 | 50M DOWNWIND OF TD | -7.13 | 9.26 | 0.00 | 11.68 | 0 |
| 34 | 100M NORTH OF TD | -7.09 | 9.32 | 0.00 | 11.71 | 0 |
| 35 | 100M EAST OF TD | -6.99 | 9.22 | 0.00 | 11.57 | 0 |
| 36 | 100M SOUTH OF TD | -7.09 | 9.12 | 0.00 | 11.55 | 0 |
| 37 | 100M WEST OF TD | -7.19 | 9.22 | 0.00 | 11.69 | 0 |
| 38 | 100M UPWIND OF TD | -7.02 | 9.15 | 0.00 | 11.53 | 0 |
| 39 | 100M DOWNWIND OF TD | -7.16 | 9.29 | 0.00 | 11.73 | 0 |
| 40 | 200M NORTH OF TD | -7.09 | 9.42 | 0.00 | 11.79 | 0 |
| 41 | 200M EAST OF TD | -6.89 | 9.22 | 0.00 | 11.51 | 0 |
| 42 | 200M SOUTH OF TD | -7.09 | 9.02 | 0.00 | 11.47 | 0 |
| 43 | 200M WEST OF TD | -7.29 | 9.22 | 0.00 | 11.75 | 0 |
| 44 | 200M UPWIND OF TD | -6.95 | 9.08 | 0.00 | 11.43 | 0 |
| 45 | 200M DOWNWIND OF TD | -7.23 | 9.36 | 0.00 | 11.83 | 0 |
| 46 | 500M NORTH OF TD | -7.09 | 9.72 | 0.00 | 12.03 | 0 |
| 47 | 500M EAST OF TD | -6.59 | 9.22 | 0.00 | 11.33 | 0 |
| 48 | 500M SOUTH OF TD | -7.09 | 8.72 | 0.00 | 11.24 | 0 |

TD - Thermal Dryer

exception of evaluation of the data for 1994 indicates that the radiological concentrations in the wells are within one standard deviation of the concentrations determined for baseline. Table 7.2 depicts these concentrations. As with the baseline concentrations, the operational sampling concentrations are within the expected ranges for naturally occurring background as reported by the Environmental Protection Agency (EPA 520/5-85-008, 1985). Radiological impact, if any, to humans from the groundwater will therefore be negligible.

TABLE 7.2
RADIOLOGICAL CONCENTRATIONS IN DOMESTIC GROUNDWATER WELLS

| Location | Uranium mg/l | Ra-226 pCi/l | Th-230 pCi/l | Pb-210 pCi/l | Po-210 pCi/l |
|---|---|---|---|---|---|
| Willow #2 | < 0.0003 | < 0.20 | < 0.20 | 1.4 | < 1.0 |
| Baseline | | | | | |
| Christensen Ranch House | 0.017 | 2.8 ± 3.2 | < 0.20 | 1.8 ± 1.35 | < 1.2 |
| Baseline | 0.017 | 1.1 | 2.1 | < 1.0 | < 1.0 |
| Ellendale #4 | 0.0015 ± 0.00058 | <1.0 ±1.65 | < 0.20 | <1.7± 1.35 | 1.2±0.35 |
| Baseline | 0.0009 | 0.4 | < 0.20 | < 1.0 | < 1.0 |
| 1st Artesian | <0.0046 ± 0.0047 | < 0.50 | < 0.20 | < 1.8 ± 1.0 | < 1.2 |
| Baseline | < 0.0003 | 1.4 | 4.2 | < 1.0 | < 1.0 |

Surface Water

Six surface water locations are samples quarterly with one location sampled annually with the samples analyzed for uranium, radium-226, thorium-230, lead-210 and polonium-210. Some of these same sample locations were included as part of the baseline sampling for the Christensen Ranch license application. Evaluation of the data for 1994 indicates that the radiological concentrations at the surface water sampling location CG-05 during operations are well below those reported for baseline. The other surface water sampling locations sampled during operations have concentrations within the range of surface water values as determined for baseline. Table 7.3 depicts these concentrations. As with the baseline concentrations, the operational sampling concentrations are within the expected ranges for naturally occurring background as reported by the United Nations Scientific Committee, 1977. Radiological impact, if any, to humans from the surface water concentrations will therefore be negligible.

## TABLE 7.3
## RADIOLOGICAL CONCENTRATIONS AT SURFACE WATER SAMPLING LOCATIONS

| Location | Uranium mg/l | Ra-226 pCi/l | Th-230 pCi/l | Pb-210 pCi/l | Po-210 pCi/l |
|---|---|---|---|---|---|
| Irigaray | | | | | |
| IR-5 | < 0.009 | < 0.20 | < 0.20 | < 1.0 | < 1.0 |
| IR-9 | 0.019 | < 0.20 | < 0.20 | 4.0 ± 4.0 | < 1.0 |
| IR-14 | 0.046 ± 0.07 | < 0.32 ± 0.42 | < 0.20 | < 1.88 ± 1.75 | < 1.2 ± 0.40 |
| IR-17 | 0.021 ± 0.003 | 0.32 ± 0.09 | < 0.20 | < 1.88 ± 1.10 | < 1.0 ± 0.05 |
| Christensen Ranch | | | | | |
| CG-05 | 0.0097 ± 0.0035 | 0.25 ± 0.08 | < 0.20 | 2.93 ± 3.35 | < 1.50 ± 0.81 |
| Baseline | 0.03 | 0.7 | 7.10 | 3.30 | < 1.0 |
| GS-01 | 0.018 | 0.6 | < 0.20 | < 1.0 | 1.6 |
| GS-03 | 0.06 ± 0.05 | 0.45 ± 0.17 | < 0.20 | 1.6 ± 0.73 | 1.20 ± 0.30 |

### 7.3.3 EXPOSURES FROM AIR PATHWAYS

An assessment of the radiological effects of Site operations includes the annual release of radioactive particulate materials and radon from the facility, the resulting concentrations at various significant receptor locations, and the resulting dose commitments to nearby individuals and populations within 80 km of the Site. The calculated results are compared below to natural background exposures for the area and to applicable regulations. A summary of the source terms and assumptions used to calculate the potential annual airborne releases of radioactive material from the Christensen Ranch and Irigaray Site is presented in Attachment 7.3(A).

Airborne Concentrations

Table 7.4 gives the predicted airborne concentrations of radionuclides at the nearest residents (Christensen and Irigaray ranches) and at the receptor with the highest predicted concentrations. These are compared to the effluent concentrations as given in 10 CFR 20. All of the predicted concentrations are less than 3% of the effluent release limits, with most being negligible.

**TABLE 7.4**
**PREDICTED AIRBORNE CONCENTRATIONS, pCi/m³**

| Location | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| Christensen Ranch, pCi/m³ | 4.3E-6 | 1.0E-8 | 1.2E-8 | 3.5E-8 |
| Irigaray Ranch, pCi/m³ | 4.2E-5 | 9.7E-8 | 1.1E-7 | 3.4E-7 |
| 200m South of Thermal Dryer | 1.3E-3 | 2.9E-6 | 3.4E-6 | 1.0E-5 |
| Effluent Limits, pCi/m³ | 6.0E-2 | 3.0E-2 | 9.0E-1 | 6.0E-1 |

Nearest Residents

The pathways evaluated by the MILDOS-AREA code resulting from airborne emissions include inhalation, exposure from ground concentrations of radionuclides, ingestion of milk, meat and vegetation which may be impacted by airborne emission, and immersion in a cloud of radioactive materials. The total doses predicted by the code at the nearest residents are 0.59 mrem/yr for the effective committed dose equivalent and 9.16 mrem/yr to the bronchi at Christensen Ranch. At the Irigaray Ranch, where the thermal dryer is located, the model predicted a total effective dose of 0.4 mrem/yr and a dose to the bronchi of 5.05 mrem/yr. These doses are 0.59% and 0.4% of the standard to the general public of 100 mrem/yr as promulgated by the NRC. The doses predicted by the model, excluding that from radon, were 0.0067 mrem/yr effective dose and 0.0000025 mrem/yr to the bronchi at Christensen Ranch and 0.0645 mrem/yr effective dose and 0.000025 mrem/yr to the bronchi at Irigaray Ranch which are well below the standards of 25 mrem/yr and 10 mrem/yr to any organ (excluding radon) by the EPA. The above doses are presented in Table 7.5.

**TABLE 7.5**
**PREDICTED DOSES AT NEAREST RESIDENTS, mrem/yr**

| Location | Effective | Bronchi |
|---|---|---|
| Including Radon | | |
| Christensen Ranch | 0.59 | 9.16 |
| Irigaray Ranch | 0.40 | 5.05 |
| NRC Limit | 100.00 | |
| Excluding Radon | | |
| Christensen Ranch | 0.0067 | 0.0000025 |
| Irigaray Ranch | 0.0645 | 0.000025 |
| EPA Limit | 25.0 (10.0) | 25.0 (10.0) |

Area Receptors

In addition to the modelled receptors at the nearest residents, receptor locations were modelled at the air sampling stations for Christensen Ranch and Irigaray, as well as 100 and 200 meters in the four cardinal directions from Christensen Ranch and 50, 100 and 200 meters in the four cardinal directions from the thermal dryer at Irigaray, including upwind and downwind directions from the thermal dryer at the above distances.

The highest doses were predicted at 500 meters east of the thermal dryer. The total effective dose at this receptor to an adult was estimated at 20.8 mrem/yr (20.8% of the NRC standard) including the dose from radon and decay products and 0.60 mrem/yr for uranium particulate only (2.4% of the EPA 25 mrem/yr standard which excludes the dose associated with radon).

The range of total effective doses was from 0.25 mrem/yr to 20.8 mrem/yr with a range of total doses to the bronchi of from 3.67 to 334 mrem/yr. The range of effective doses, excluding the contribution from radon, was from 0.0068 mrem/yr to 0.60 mrem/yr with that to the bronchi ranging from 0.000003 mrem/yr to 0.00023 mrem/yr. The above values are presented in Table 7.6 The largest predicted bronchi dose is approximately one half of that predicted by the NRC as resulting from natural background (NRC, 1992).

**TABLE 7.6**
**RANGE OF PREDICTED DOSES FOR COMPLIANCE AS PER NRC AND EPA REQUIREMENTS**

| Location | Requirement | Effective | Bronchi |
|---|---|---|---|
| 80 deg @ 4725m | NRC Requirements | 0.25 | 3.67 |
| | EPA Requirements | 0.0068 | 0.000003 |
| 500 m east of TD | NRC Requirements | 20.8 | 334.0 |
| | EPA Requirements | 0.6 | 0.00023 |

Deposition of Radioactive Materials on Food Crops

The equations used in Section 7.3.6 are applicable to doses to humans ingesting food crops grown and cattle pastured locally where the vegetation may be contaminated by ground concentrations of radionuclides released into the air.

The maximum dose to cattle grazing full time on forage where the ground concentrations of U-238, Th-230, Ra-226 and Pb-210 were 243 pCi/m$^2$, 0.57 pCi/m$^2$,

0.66 pCi/m², and 0.66 pCi/m² respectively was 0.124 mrem/yr. Given that a person in the area would not be consuming as much vegetation as the cattle, and the vegetation consumed would not be grown in the same area, the dose to people from consumption of food crops with deposited radionuclides is expected to be negligible. Section 7.3.6 also addresses and gives the equations used to assess the dose to a coyote from consumption of meat, where the cattle had been grazing on forage with the above ground concentrations. The dose to the coyote was 0.00027 mrem/yr assuming one pound of meat consumed each day. Again it is unlikely that a person in the area would only consume meat from those cattle grazing in a specific area. The dose to humans from ingestion of meat and milk is also expected to be negligible.

### 7.3.4 EXPOSURES FROM EXTERNAL RADIATION

External gamma radiation exposure measurements have been collected quarterly at the Christensen Ranch /Irigaray site over the past several years during operations at 3 air particulate sampling locations (receptors 2, 3, and 24) and 6 other locations. At these locations, the external exposure has ranged from 87.6 mrem/yr to 220 mrem/yr during 1994 with one of the upwind locations, receptor 24, consistently showing the greatest external gamma exposure. The average annual external exposure for this time period was 123.5 mrem/yr. This average external exposure is consistent with the background for the western high plateau region of the United States as given by the National Council on Radiation Protection (report #94) and is within the range of background reported in 1986-1987. It is not anticipated that continuation of operations at the Christensen Ranch/Irigaray Site will increase the external exposure levels in the area.

### 7.3.5 RADIATION DOSE COMMITMENTS TO POPULATIONS RESULTING FROM AIRBORNE RELEASES

Table 7.7 depict the estimated doses in person rem-year to people within 80 kilometers and for all populations as a result of operation at the Christensen Ranch/Irigaray Site. Doses are annual population dose commitments and are given for the effective whole body, the bone, the average lung and the bronchial epithelium for one year of operation. The pathways considered include inhalation, ground concentrations, immersion in a cloud, ingestion of vegetation, milk and meat and radon. As can be seen from Table 7.7, the major dose occurs to the bronchi, primarily as a result of radon and its decay products. The maximum doses estimated to populations as a results of releases from the Christensen Ranch/Irigaray facility are less than one percent of that which people are exposed to as a result of natural background radiation.

**TABLE 7.7**
**POPULATION DOSES RECEIVED AS A RESULT OF OPERATIONS AT THE CHRISTENSEN RANCH/IRIGARAY FACILITY PERSON REM/YEAR (23517 PERSONS)**

| Location | Effective | Bone | Ave. Lung | Bronchi |
|---|---|---|---|---|
| Within 80 km | 0.2948 | 2.499 | 0.391 | 6.011 |
| Beyond 80 km | 11.95 | 160.3 | 2.734 | 83.32 |
| Total | 12.25 | 162.8 | 3.125 | 89.33 |

## 7.3.6 EXPOSURES TO FLORA AND FAUNA

The radiological impact of the Christensen Ranch/Irigaray in situ leach uranium operation on biota other than humans is evaluated in this subsection. This section presents the model used to predict radiological effects of the in situ leach operation, the resulting of air and ground concentrations from the model, and the corresponding concentrations in plants and animals (per NRC Regulatory Guide 3.46, 1982).

### 7.3.6.1 Exposure Pathways

The major pathways for doses to biota other than humans include inhalation, ingestion of meat and ingestion of vegetation. The latter two pathways will depend upon the type of animal - herbivore (plant-eater), carnivore (meat-eater) or omnivore (eats both plants and meat). An additional pathway is ingestion of water. There are authorized discharge points into surface waters at the Christensen Ranch/Irigaray site with limits established under an NPDES permit. Discharge at the discharge points is not continuous and therefore the pathway of consumption of water is considered negligible. In addition, routine consumption of pond fluid by large animals is unlikely, since either the areas around the ponds or the individual ponds are fenced. There is the very unlikely possibility of consumption of water released as a result of failure of the ponds; however, every attempt is made to reduce the possibility of unexpected pond failure with weekly inspections of the ponds, and every attempt will be made to contain fluids in the event of an accident.

Ingestion of Vegetation

At the base of the food chain are the flora of the area. Sections 2 and 6 outline the various floral species predominant in the area. There are two mechanisms by which vegetation can accumulate radionuclides in the environment. These include air deposition and root uptake. It is generally assumed, however, that the major concentrations of radionuclides associated with flora will be from deposition on the

plants (Dressen and Marple, 1979; Ibrahim and Whicker, 1988a, 1988b; McDowell-Boyer and others, 1979; and Rayno and others, 1980).

The NRC specified model, MILDOS-AREA (Argonne National Laboratory [ANL], ANL/ES-161, 1989) was used to estimate radiological concentrations and effects from the in situ leach operation. The MILDOS-AREA model evaluated total radionuclide air concentrations and ground surface concentrations for forty-eight receptors in the vicinity of the site. The highest predicted concentrations occurred at the receptor 200 m south of the thermal dryer, receptor 42. These concentrations were used in the evaluation of exposures to biota other than humans.

The radionuclide ground concentrations at receptor 42 for U-238 was 24.31 pCi/m², for Ra-226 was 0.6581 pCi/m², for Th-230 was 0.5673 pCi/m² and for Pb-210 was 0.6581 pCi/m². The airborne concentrations for the above radionuclides at receptor 42 were 1.258E-3 pCi/m³ for U-238, 3.404E-6 pCi/m³ for Ra-226, 2.935E-6 pCi/m³ for Th-230 and 1.02E-5 pCi/m³ for Pb-210.

The following equation (NRC, 1992) was used to determine the radiological concentrations in vegetation:

$$C_{vi} = D_i E_r E_v \frac{(1-e^{-\lambda_w t_v})}{Y_v \lambda_w} + C_{gi} (B_{vi}/P)$$

Where:

| | | |
|---|---|---|
| $C_{vi}$ | = | Concentration of radionuclide, i, on vegetation, pCi/kg |
| $D_i$ | = | Total deposition rate, pCi/m²-s [Cair in pCi/m³ for PTSZ, 3 $\mu$, x deposition velocity (1cm/sec)] |
| $E_r$ | = | Fraction of total deposition retained on plant surface = 0.2 |
| $E_v$ | = | Fraction of foliar deposition reaching edible portions of vegetation, = 1.0 |
| $\lambda_w$ | = | Decay constant for weathering loss, 5.73 x $10^{-7}$/sec |
| $t_v$ | = | Assumed duration of exposure while growing for vegetation. 60 days (5.184 x $10^6$ sec) |
| $Y_v$ | = | Assumed yield density of vegetation, 2.0 kg/m² |
| $C_{gi}$ | = | Ground concentrations from MILDOS, pCi/m² |
| $B_v$ | = | Soil-to-plant transfer factor - edible above ground: 2.5 x $10^{-3}$ U, 4.2 x $10^{-3}$ Th, 1.4 x $10^{-2}$ Ra, 4.0 x $10^{-3}$ Pb |
| P | = | Assumed areal soil density for surface mixing, 240kg/m² |

This equation was used by the NRC in preparing a 1992 Environmental Assessment for the Sweetwater Uranium Project; the values used for deposition velocity, $E_r$, $E_v$, $\lambda_w$, $t_v$, $Y_v$, $B_{vi}$, and P were the same as those used by the NRC. The soil-to-plant transfer factor, $B_{vi}$, is given for each radionuclide in Table 7.8. The MILDOS-predicted air and

ground concentrations for each radionuclide listed above at receptor 42 were used in the equation. Resulting uranium-238, thorium-230, radium-226 and lead-210 in vegetation are given in Table 7.9, and correspond to estimated conditions at the receptor 200 m south of the thermal dryer, the receptor indicating the greatest total airborne and ground concentrations at the CR/IR site.

TABLE 7.8
ENVIRONMENTAL TRANSFER COEFFICIENTS

| Coefficient | Uranium-238 | Thorium-230 | Radium-226 | Lead-210 |
|---|---|---|---|---|
| Plant/Soil, $B_v$ | $2.5 \times 10^{-3}$ | $4.2 \times 10^{-3}$ | $1.4 \times 10^{-2}$ | $4.0 \times 10^{-3}$ |
| Beef/feed, $F_b$ | $3.4 \times 10^{-4}$ | $2.0 \times 10^{-4}$ | $5.1 \times 10^{-4}$ | $7.1 \times 10^{-4}$ |
| Effective Decay Constant, $\lambda_{eff}$, 1/days | 0.693/100 | 0.693/57000 | 0.693/9000 | 0.693/1200 |

TABLE 7.9
VEGETATION CONCENTRATIONS AT RECEPTOR 42

| Coefficient | Uranium-238 | Thorium-230 | Radium-226 | Lead-210 |
|---|---|---|---|---|
| $C_{vi}$, pCi/kg | 2.08 | 4.86E-3 | 5.6E-3 | 1.7E-2 |

Ingestion of vegetation by herbivores is a pathway for radionuclides. Concentrations of radionuclides in herbivore meat resulting from consumption of vegetation was calculated based on the conservative assumption that the herbivore eats only vegetation at the site of receptor 42. This is conservative for cattle and sheep because livestock in the region may be shipped to feeder lots for the winter or have supplemental feed delivered to them and because only radionuclide concentrations at the downwind boundaries were considered.

The following equation was used to calculate radionuclide concentrations in the meat of cattle grazing on vegetation, and was also used by the NRC in the 1992 Sweetwater site Environmental Assessment (NRC, 1992):

$$C_{bi} = Q \times F_{bi} \times C_{vi}$$

Where:

$C_{bi}$ = Concentration of radionuclide, i, in herbivore meat, pCi/kg

$Q$ = Consumption of vegetation by herbivore, 10 kg/day dry

$F_{bi}$ = Transfer coefficient: ratio of concentration in dry weight of vegetation consumed to concentration deposited in meat, pCi/kg per pCi/day

$C_{vi}$ = Concentration of radionuclide, i, in vegetation, pCi/kg

The values for $F_{bi}$ were the same as those used by the NRC in the 1992 Sweetwater site Environmental Assessment; values of $F_{bi}$ for each radionuclide are listed in Table 7.8. The daily consumption rate, Q, for cattle was selected from an NRC document (NRC, 1979a). Resulting radiological concentrations in herbivore meat (cattle) are provided in Table 7.10. Concentrations for Pronghorn antelope and deer will be lower than for cattle because antelope and deer consume less vegetation than cattle.

TABLE 7.10
RADIOLOGICAL CONCENTRATIONS IN HERBIVORE MEAT

| Coefficient | Uranium-238 | Thorium-230 | Radium-226 | Lead-210 |
|---|---|---|---|---|
| $C_{bi}$, pCi/kg | 7.0E-3 | 1.0E-5 | 2.9E-5 | 1.2E-4 |

Ingestion of Meat

Ingestion of meat from those animals grazing on vegetation is another pathway of exposure. The following equation was used to calculate concentrations in carnivore meat:

$$C_{ci} = Q\ K_{bi}\ C_{bi}(1-e^{-\lambda_{eff}\ 365})/\lambda_{eff}$$

Where:

| | | |
|---|---|---|
| $C_{ci}$ | = | Concentration of radionuclide, i, in carnivore meat, pCi in whole body after one year |
| Q | = | Consumption of meat by carnivore |
| $K_{bi}$ | = | Fraction of intake going to the blood of the carnivore |
| $C_{bi}$ | = | Concentration of radionuclide, i, in herbivore meat, pCi/kg |
| $\lambda_{eff}$ | = | Effective decay constant, 0.693 divided by half-life in days |

The equation calculates the amount of radioactivity concentrating in the whole body of a carnivore over a one-year period. The term, $(1-e^{-\lambda t}/\lambda_{eff}$, accounts for the buildup and release throughout the year of radionuclides ingested daily. Radiological concentrations were calculated for coyotes, which are the only carnivore, other than man, in the region which may prey on cattle, assuming a 1 pound/day rate of meat consumption (Caras, 1967). The fraction of intake going to blood for each radionuclide is provided in Table 7.8 International Commission on Radiological Protection, 1978). Corresponding results for carnivore concentrations are given in Table 7.11.

## TABLE 7.11
## RADIOLOGICAL CONCENTRATIONS IN CARNIVORE MEAT

| Coefficient | Uranium-238 | Thorium-230 | Radium-226 | Lead-210 |
|---|---|---|---|---|
| $C_{ci}$, pCi/kg | 8.44E-4 | 3.3E-7 | 8.4E-4 | 1.4E-3 |

The values in the above tables were used to calculate the doses estimated for herbivores and carnivores. For herbivores the following assumptions were used to calculate the dose to cattle grazing on the above vegetation:

1. Assumed 10 kg/d dry for herbivores and 454 g/d for carnivores based on NUREG/CR-0574, pg 48
2. Fraction of intake to blood: Ra-0.2; U-0.002, Th-0.0002, Pb-0.08 (ICRP 30)
3. Decay equation from ICRP #2
4. Assumed cow is 942 lbs (Odum, 1971)
5. Assumed coyote is 40 lbs (Odum, 1971)

Equation: pCi/kg ($C_{vi,bi}$) x 10 kg/d (454g/d) x fraction to blood = pCi/d
pCi/d x $(1-e^{-\lambda_{eff} 365})/\lambda_{eff}$ = pCi in whole body after one year
pCi x 2.22 d/m-pCi x Mev/d x 1.6021 x $10^{-6}$ ergs/Mev x 1 rem-g/100ergs
x 1/whole body weight,g x $5.256 \times 10^5$ m/yr x $10^3$ mrem/rem = mrem

$\lambda$ eff Ra-226 = .693/900 d; Mev = 220 (includes daughters, QF)
$\lambda$ eff Th-230 = $.693/5.7 \times 10^4$ d: Mev = 96 (includes daughters, QF)
$\lambda$ eff U-238 = .693/100 d: Mev = 86 (includes daughters, QF)
$\lambda$ eff Pb-210 = $.693/1.2 \times 10^3$ d: Mev = 5.2 (includes daughters, QF)

## TABLE 7.12
## DOSE TO CATTLE GRAZING ON CONTAMINATED VEGETATION, mrem/yr

| Uranium-238 | Thorium-230 | Radium-226 | Lead-210 | Total |
|---|---|---|---|---|
| 0.02 | 0.003 | 0.10 | 0.001 | 0.124 |

**TABLE 7.13**
**DOSE TO CARNIVORES (COYOTES) FEEDING ON CATTLE GRAZING ON CONTAMINATED VEGETATION, mrem/yr**

| Uranium-238 | Thorium-230 | Radium-226 | Lead-210 | Total |
|---|---|---|---|---|
| 7.5E-5 | 3.3E-8 | 1.9E-4 | 8.0E-6 | 2.7E-4 |

The total doses from ingestion by herbivores and carnivores are 0.124 and 2.7E-4 mrem/yr respectively at the location with the greatest ground concentration of radionuclides, receptor 42.

Inhalation is another pathway of exposure to biota other than humans. The airborne concentrations for U-238, Th-230, Ra-226 and Pb-210, in pCi/m$^3$, predicted by the MILDOS-AREA model at receptor 42 were used in this evaluation. The airborne concentrations for each radionuclide were compared to the effluent concentrations given in 10 CFR 20 (revised) representing 50 mrem/year to the general public. The following Table 7.14 gives the airborne concentrations as predicted by the model, the effluent concentrations as per 10 CFR 20, and the predicted dose from inhalation at receptor 42.

**TABLE 7.14**
**INHALATION DOSE TO BIOTA OTHER THAN HUMANS**

| | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| Model Concentration, uCi/ml | 1.3E-15 | 2.9E-18 | 3.4E-18 | 1.0E-17 |
| 10 CFR 20 Limits, uCi/ml | 9.0E-14 | 3.0E-14 | 9.0E-13 | 6.0E-13 |
| Inhalation dose at receptor 42 | 0.72 | 9.7E-5 | 1.9E-4 | 8.3E-4 |

The total predicted dose from inhalation of the above airborne particulate concentrations is 0.72 mrem/yr. Evaluating the dose from radon, the Rn-222 concentration and radon daughter concentration in Working Level units were used to determine that the equilibrium fraction at receptor 42 is 0.2. Using ICRP #50, the Rn-222 concentration at receptor 42 of 0.06 pCi/l with an equilibrium factor of 0.2 equates to a dose of 5.28 mrem/yr. Therefore, the total inhalation dose to biota other than humans is approximately 6.0 mrem/yr.

The dose from the pathways of ingestion of vegetation, and inhalation of particulates and radon decay products to herbivores is thus 6.124 mrem/yr at the receptor which was predicted to have the greatest ground and airborne concentrations. The dose from ingestion and inhalation for carnivores at the same location is 6.0 mrem/yr.

### 7.3.7 REFERENCES

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## 7.4 NON-RADIOLOGICAL EFFECTS

The in-situ solution mine is by design a self-contained mining circuit. Wastes generated by the facility are contained and eventually removed to disposal elsewhere. The potential non-radiological effects of the operation include the possibility of lixiviant excursion, evaporation pond leakage and temporary disturbance of the land during site

preparation, construction and operations. The effects of these possible occurrences are considered small as discussed in Section 7.2 above. The environmental monitoring programs given in Section 5.8 are designed to quickly identify any adverse conditions that may result during operations. No long term irreversible effects are anticipated.

## 7.5 EFFECTS OF ACCIDENTS

Accidents involving human safety associated with the in-situ uranium mining technology typically have far less severe consequences than accidents associated with underground and open pit mining methods. In-situ mining provides a higher level of safety for personnel and neighboring communities when compared to conventional mining methods or other energy related industries. Accidents that may occur are minor and are not catastrophic as would be the case for explosions at oil refineries or in equipment malfunctions or human error in the public transportation industries. Radiological accidents at the Irigaray/Christensen Ranch site, if they occur, would typically manifest themselves slowly and are, therefore, detectable in sufficient time to be safely and methodically corrected. The remote location of the site and the low level of radioactivity associated with the process both decrease the potential hazard of an accident to the general public.

### 7.5.1 ACCIDENTS INVOLVING RADIOACTIVITY

#### 7.5.1.1 Tank Failure

Process fluids are contained in vessels and piping circuits within the process plant or in bermed outside storage tanks. The process plants have been designed to control and confine liquid spills should they occur. The plant building structure and concrete curb will contain liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sumps are equipped with a pump to transfer any spilled solutions back into the plant process or to the lined evaporation pond system. Consequently, the accident would be of short duration and the remedial procedure is incorporated into the process plant design.

All tanks in the process plant(s) are made of fiberglass or steel. Instantaneous failure is highly unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to below the leakage level and repaired. Procedures to be followed in the event of an uncontrolled liquid release in the plant area are described in *Standard Operating Procedure E-1, Plant Solution Spills.*

Yellowcake Thickener Tank Collapse

On August 1, 1994, the thickener tank which is used to store yellowcake product within the Irigaray plant collapsed. When it collapsed, it caught the end of the filter

press and tore through the back wall of the plant building. The anchor bolts for a column of the pre-engineered plant building structure were torn out of its footer, and the column itself was severely damaged.

At the time of the collapse, it was estimated that the thickener contained approximately 110,000 pounds of $U_3O_8$ equivalent. It was estimated that approximately 23,095 pounds of yellowcake material spilled inside and outside of the building. Additional estimates were that approximately 90% of this material was recovered for normal processing. Contaminated soils were excavated and shipped to a disposal facility accounting for the remaining product.

Subsequent investigations revealed that the cause of the collapse was not due to a tank failure, but rather, was due to a classic puncture shear of the steel legs supporting the tank through the concrete slab floor. It is assumed that the slab failure was due to the loss of load bearing characteristics of the soil foundation underlying the concrete slab.

The final assessment by COGEMA was this event was most likely an isolated occurrence. In addition, the USNRC concluded that the environmental impact of this accident was negligible, and that COGEMA followed all appropriate procedures and regulations in their response and mitigation efforts.

Precautions that have been taken by COGEMA to avoid such an occurrence in the future are:

- An engineering study of the surface drainage around the Irigaray and Christensen Ranch plant facilities was undertaken. As a result, a re-grading plan was designed to assure drainage away from all plant facilities.

- Pressure grouting through, and underneath, the concrete slab was conducted for all tanks constructed similarly to the yellowcake thickener tank.

- When replaced, the yellowcake thickener tank was placed on a one-foot thick reinforced concrete mat, with pressure grouting through engineered holes in the mat to emplace as much concrete under the mat as possible.

- Elevations surveys are routinely conducted to observe any movement in tanks containing yellowcake material.

#### 7.5.1.2 Pipe Failure

The rupture of a pipeline within the process plant is easily visible and can be repaired quickly. The maintenance equipment within the satellite process plant will be adequate to handle this type of problem.

The rupture of an injection or recovery line between the plant and well field will result in either barren or pregnant leach solution contaminating the ground near the break. A large and sudden rupture will be detected by a drop in pressure in the system and interruptions in the flow of liquids. A small break will be detected visually during routine inspection of the lines. Any ground contamination will be removed to disposal. Procedures to be followed in the event of an uncontrolled liquid release in a well field are described in *Standard Operating Procedure E-2, Well Field Solution Spills.*

In 1988, the primary injection trunkline at Irigaray continued to fail at a joint directly outside of the central plant facility. The line is of 12" HDPE construction, and the joint was a butt fused elbow, allowing the line to come straight out from the plant, then angle over towards the well fields. After two or three breaks and spills, the joint was replaced with stainless steel from the plant out the elbow, the elbow is stainless steel, and then HDPE pipe from there on. It was discovered that the fused HDPE elbow joint was only rated for 150 psi, rather than the normally rated 300 psi HDPE pipe. The installation of the short stainless steel run from the plant, through the elbow, corrected the problem of continual breakage at the joint. Pressure ratings of field installed joints are now investigated carefully.

#### 7.5.1.3 Lined Evaporation Ponds

An accident involving a leak in a solar evaporation pond is detectable via the leak detection system placed beneath the pond liner. If a pond leak does occur, the effects of the seepage will be mitigated by the natural clay content of the soils underlying the liner. The clays will absorb radium and other constituents contained in the seepage. Seepage from a pond leak should not affect the local groundwater system due to the large distance from ground surface to the water table. A breach in a pond berm is unlikely because of the design requirements which are incorporated to avoid such an occurrence.

Leaks detected in site evaporation ponds have been discussed earlier in this section.

#### 7.5.1.4 Lixiviant Excursion

Pre-mining hydraulic testing has defined the aquifer characteristics for the receiving strata or production zone at the site. The ore-bearing strata is physically and hydraulically separate from overlying and underlying aquifers. The well completion procedures used and the mechanical integrity testing for each injection well performed

prior to leach solution injection ensure that injected solutions are contained within the well and are transmitted to the target production zone. The monitoring program for overlying and underlying aquifers is a backup check to ensure that the injection is controlled in this manner. Should an excursion occur, the excursion correction procedures outlined in Section 3 of this document will be instituted immediately.

Excursion parameter upper control limits for all aquifers are extremely close to baseline concentrations so that the slightest perturbation in water quality is detected and precautionary measures are taken. Because of the chemically conservative nature of the excursion parameters used, it would be extremely unlikely that at the time excursion correction procedures are instituted that any chemical parameter other than the excursion indicators will be different from baseline values. As such, no radiologic groundwater degradation should result when a well is in excursion status.

In the event that an excursion does occur and is accidentally undetected, concentrations of metals such as uranium, arsenic, selenium and radium-226 are likely to be low due to natural precipitation and adsorption onto clays. This phenomenon occurs because the metals, which are mobilized in the oxidized environment of the production zone, are selectively removed from solution via precipitation or adsorption as they move into the reduced environment outside of the production zone.

Section 7.2.3.2 discussed the impacts of excursions to local groundwater, and provides a history of past excursions at each operation since 1987.

### 7.5.2 TRANSPORTATION ACCIDENTS

Transportation of materials to and from the Irigaray/Christensen Ranch site can be categorized as follows: 1) shipments of yellowcake, 2) shipments of uranium-laden resin to the Irigaray recovery facility from Christensen Ranch; 3) shipments of barren, eluted resin from the Irigaray facility; 4) shipments of process chemicals or fuel from suppliers to the sites; and 5) shipments of radioactive waste from the sites to a licensed disposal facility. Accidents involving these transportation occurrences are discussed below.

#### 7.5.2.1 Accidents Involving Yellowcake Shipments

Accidents involving yellowcake shipments can take two forms. The first would involve a shipment of dried yellowcake product being shipped from the Irigaray facility after processing. The second would involve a shipment of uranium oxide or yellowcake slurry, which could be product that is being shipped from COGEMA's Texas operations to Irigaray for processing, or slurry being shipped from Irigaray to another processing location in the event that the dryer at Irigaray is not operational.

The dried yellowcake that is produced at the Irigaray Recovery facility will be shipped

to a uranium hexafluoride conversion plant. The dried yellowcake product is generally packaged in 0.208 $m^3$ (55-gal), 18 gauge drums holding an average of 364 kg (800 lb) and classified by the Department of Transportation as Type A packaging (49 CFR Parts 171-189 and 10 CFR Part 71). It is shipped by truck to a conversion plant, which will transform the yellowcake to uranium hexafluoride for the enrichment step of the light water-cooled reactor fuel cycle. An average truck shipment contains approximately 45 drums, or 16 metric tons (17.5 tons) of dried yellowcake.

In the case of the slurry shipments, each shipment will contain approximately 14,000 pounds of $U_3O_8$. Shipments are made in COGEMA owned, exclusive use slurry transport trailers.

From published statistics, the probability of a truck accident is in the range of $1.0 \times 10^{-6}$ to $1.6 \times 10^{-6}$ per kilometer ($1.6 \times 10^{-6}$ to $2.6 \times 10^{-6}$ per mile). Truck accident statistics include three categories of traffic accidents: collisions, noncollisions, and other events. Collisions involve interactions of the transport vehicle with other objects, whether moving vehicles or fixed objects. Noncollisions are accidents in which the transport vehicle leaves the transport path or deviates from normal operation in some way, such as by rolling over on its top and side. Accidents classified as other events include personal injuries suffered on the vehicle, records of persons falling from or being thrown against a standing vehicle, cases of stolen vehicles, and fires occurring in a standing vehicle.

The ability of materials and structures in the shipping package to resist the combined physical forces arising from impact, puncture, crush, vibration, and fire depends on the magnitude of the forces. These magnitudes vary with the severity of the accident, as does the frequency with which they occur. A generalized evaluation of accident risks by the USNRC classifies accidents into eight categories, depending upon the combined stresses of impact, puncture, crush, and fire. On the basis of this classification scheme, conditional probabilities (i.e., given an accident, the probabilities that the accident is of a certain magnitude) of the occurrence of the eight accident severities were developed. In order to assess the risk of a transportation accident, it is necessary to know the fraction of radioactive material that is released when involved in an accident of a given severity. Two models have been developed for this analysis. Model I assumes complete loss of the drum contents. Model II, based upon actual tests, assumes partial loss of the drum contents. The packaging is assumed to be Type A drums containing low specific activity (LSA) radioactive materials.

For Model I and Model II, the quantity of yellowcake in its dried form released to the atmosphere in the event of a truck accident is estimated to be approximately 7,400 kg (16,200 lb) and 500 kg (1,100 lb) respectively. Most of the yellowcake released from the container would be deposited directly on the ground in the immediate vicinity of the accident. Some fraction of the released material, however, would be dispersed into the atmosphere. Additional details on this modeling can be found in the *Irigaray*

*Environmental Impact Statement, NUREG-0481.* Slurry shipments, there would be no dust dispersion considerations as the uranium is contained on the slurry, thus the wet mixture creates no dust.

*Standard Operating Procedure E-11, Transportation Accidents Involving Radioactive LSA Material,* details procedures to be followed in the event of an emergency.

7.5.2.2 Accidents Involving Resin Transfers

COGEMA anticipates that two tanker truckloads of uranium-laden resin and two tanker truckloads of barren, eluted resin could be transported on a daily basis to Irigaray from the Christensen Ranch satellite plant. The resin is transported in a specially designed, low profile, 2,500 gallon capacity tanker trailers.

The worst case accident involving the resin transfer would involve the total wreckage of the transport truck and tanker trailer when carrying uranium laden resin and where all of the tank contents were spilled. Because the uranium adheres to the resin and the resin is in a wet condition during shipment, the radiological and environmental impacts of such a spill should be relatively minimal. The radiological or environmental impact of a similar accident with barren, eluted resin would be very minor. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

In the event of a transportation accident involving the resin transfer operation from Christensen Ranch to Irigaray, COGEMA will institute its emergency response plan for transportation accidents. To minimize the impacts from such an accident, the following procedures will be followed:

1. Each resin hauling truck will be equipped with a radio which can communicate with either the Irigaray recovery facility or the Christensen Ranch satellite plant. In the event of an accident and spill, the driver can radio to both sites to obtain help.

2. A check-in and check-out procedure will be instituted where the driver will call the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, a crew would respond and search for the vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.

3. Each resin transport vehicle will be equipped with an emergency contingency package whereby the driver could use the contained equipment to begin containment of any spilled material.

4. Both the Irigaray and Christensen facilities will be equipped with emergency response packages to quickly respond to a transportation accident.

5. Personnel at both the Irigaray and Christensen facilities, as well as the designated truck drivers, will have specialized training to handle an emergency response to a transportation accident.

#### 7.5.2.3 Accidents Involving Shipments of Process Chemicals

The probability of an accident involving the transfer of resin or any shipment of process chemicals is very low. Chemicals which will be shipped to the Irigaray/Christensen Ranch site may include soda ash, hydrochloric acid, sulfuric acid, sodium bicarbonate, carbon dioxide gas, gaseous oxygen, propane, diesel fuel and gasoline. An accident involving a supplier of any of the above chemicals would be handled according to the same emergency response plan as yellowcake or resin transfer accidents. Specialized training will be provided to employees as to the various precautions regarding the different chemicals which could be spilled. The impacts of such accidents should be relatively minor due to the mitigation provided by the emergency response plan.

#### 7.5.2.4 Accidents Involving Radioactive Wastes

Radioactive solid byproduct material or unusable contaminated equipment generated during the operations will be transported to a licensed disposal site as needed and at the time of decommissioning. Because of the low radioactive concentrations involved, these shipments are considered to have minimum potential for significant impacts as a result of transportation accidents. The effects of an accident during the transportation of such waste will be mitigated by the emergency response plan for transportation accidents.

### 7.5.3 OTHER ACCIDENTS

Other potential accidents involving non-radiological materials are associated with the various chemical and fuel storage tanks maintained outside the process facilities. Each of the liquid chemical storage tanks will be surrounded by earthen berms. Each tank will be labeled to identify the solution within the tanks. In the event that a tank should instantaneously rupture, the solutions will be retained by the surrounding earthen berm placed around the tank for that purpose.

Fuel storage tanks will be placed in an area remote from the building to avoid fire damage to the building or injury to workers in the unlikely event of combustion of the fuel.

A spill prevention, control and countermeasure (SPCC) plan is in place for the Irigaray and Christensen Ranch sites. Although EPA only requires this plan for oil or raw petroleum fuel products, COGEMA has expanded our plan to include all stored chemicals. The plan is addressed in *Standard Operating Procedures SPCC-1, Inspection of Facilities, and SPCC-2, Spill Response*.

## ATTACHMENT 7.3(A)

## USNRC ATTACHMENT A

## TABLE 7.3(A)-1

## SITE SPECIFIC INFORMATION
## CHRISTENSEN RANCH

| PARAMETER | VALUE |
|---|---|
| Average ore quality, $U_3O_8$, in ore body | 0.094% |
| Ore Radon-222 activity, assuming equilibrium with U-238 | 265 pCi/g |
| Operating days per year (plant factor) | 365 days |
| Dimensions of ore body | |
| Area per year to be mined | 40 acres |
| Average thickness of body | 12.0 feet (3.7 meters) |
| Average production flow rate | 3600 gpm |
| Formation porosity | 28% |
| Process recovery | 95% |
| Leaching efficiency | 60% |
| Rock density | 1.91 g/cm$^3$ |
| Restoration flow rate | 500 gpm |
| Production cell parameters | |
| Residence time (Production) | 8.7 days |
| Residence time (Restoration) | 30 days |
| Type of cell pattern | Mixture of 5 spots |
| Average cell area | 5,000 ft$^2$ |
| Average cell flow rate | 38 lpm |
| Annual Rn-222 emission from production | 1471 Ci/yr |
| Annual Rn-222 emission from restoration | 280 Ci/yr |
| Annual Rn-222 emission from start-up | 44 Ci/yr |
| Source stack description (Radon) | plant vent |
| Stack height | 23.0 ft (7.0 meters) |
| Stack diameter | 0.25 ft (0.80 meters) |
| Stack exit velocity | 218 m/sec |

## TABLE 7.3(A)-2

## SOURCE AND RECEPTOR COORDINATES
## CHRISTENSEN RANCH

| Source Name | X (km) | Y (km) | Z (km) | |
|---|---|---|---|---|
| MU 3 | 0.15 | -0.08 | 1.00 | |
| MU 4 | 0.65 | -2.10 | 1.00 | |
| MU 5A | 2.13 | -2.93 | 1.00 | |
| MU 5B | 1.79 | -2.67 | 1.00 | |
| Plant | 0.00 | 0.00 | 7.01 | |
| **Receptor Name** | **X (km)** | **Y (km)** | **Z (km)** | **Distance (km)** |
| AS-1 | -3.66 | -0.46 | 0.00 | 3.69 |
| AS-5A | 0.01 | -0.05 | 0.00 | 0.06 |
| AS-5B | -0.01 | 0.01 | 0.00 | 0.02 |
| AS-6 | 3.51 | -3.73 | 0.00 | 5.12 |
| 100m North | 0.00 | 0.10 | 0.00 | 0.10 |
| 100m East | 0.10 | 0.00 | 0.00 | 0.10 |
| 100m South | 0.00 | -0.10 | 0.00 | 0.10 |
| 100m West | -0.10 | 0.00 | 0.00 | 0.10 |
| 100m Upwind | 0.07 | -0.07 | 0.00 | 0.10 |
| 100m Downwind | -0.07 | 0.07 | 0.00 | 0.10 |
| 200m North | 0.00 | 0.20 | 0.00 | 0.20 |
| 200m East | 0.20 | 0.00 | 0.00 | 0.20 |
| 200m South | 0.00 | -0.20 | 0.00 | 0.20 |
| 200m West | -0.20 | 0.00 | 0.00 | 0.20 |
| 200m Upwind | 0.14 | -0.14 | 0.00 | 0.20 |
| 200m Downwind | -0.14 | 0.14 | 0.00 | 0.20 |
| 240 deg @ 725m | -0.72 | -0.38 | 0.00 | 0.82 |
| 270 deg @ 5500m | -5.49 | 0.00 | 0.00 | 5.49 |
| 330 deg @ 5100m | -4.00 | 3.05 | 0.00 | 5.03 |
| 345 deg @ 2050m | -0.84 | 1.83 | 0.00 | 2.01 |
| 45 deg @ 3350m | 2.36 | 2.29 | 0.00 | 3.29 |
| 80 deg @ 4725m | 4.57 | 1.22 | 0.00 | 4.73 |

## TABLE 7.3(A)-3

## CALCULATION OF ANNUAL RADON EMISSIONS
## CHRISTENSEN RANCH

1) To calculate Radon release from leaching assuming that U-238 is in equilibrium with all its decay products:

$Ci/m^3$ = 265 pCi/g ore x 1.91 $g/cm^3$ x 0.2 x 0.72/0.28 x $10^{-6}$
= 2.60 x $10^{-4}$ $Ci/m^3$

Where:
0.2 = Emanating Power
0.72 = 1 - Porosity
0.28 = Porosity

The yearly release is then:

2.60 x $10^{-4}$ $Ci/m^3$ x 13626 lpm x (0.79) x 365 d/yr x 1.44 = 1471 Ci/yr

Where:
13626 = liters per minute
0.79 = $\epsilon = 1 - e^{-(\lambda\tau)}$
= $\epsilon = 1 - e^{-(0.1812)(8.7\ \text{days})}$
= $\epsilon = 1 - 0.21$
1.44 = constant

2) The Radon release from start-up is given by:

2.60 x $10^{-4}$ $Ci/m^3$ x 40 acres x 4074 $m^2$/acre x 3.7 m x 0.28 = 44 Ci/yr

Where:
4074 = $m^2$/acre
3.7 = Thickness of orebody in meters
0.28 = Porosity

The total release of Radon from the start-up solution and production lixiviant solution is:

| | |
|---|---|
| Start-up solution | 44 Ci/yr |
| Production | 1471 Ci/yr |
| | 1515 Ci/yr |

3) The Radon release from restoration is given by:

2.60 x $10^{-4}$ $Ci/m^3$ x 1893 lpm x 365 d/yr x (0.996) x 1.44 = 258 Ci/yr

258 Ci/yr + 22 (start-up) = 280 Ci/yr total release

| | | | |
|---|---|---|---|
| Where: | 3785 | = | Restoration flow in liter per minute |
| | 0.996 | = | $\epsilon = 1 - e^{-(\lambda t)}$ |
| | | = | $\epsilon = 1 - e^{-(0.1812)(30\ \text{days})}$ |
| | | = | $\epsilon = 1 - 0.004$ |
| | 1.44 | = | constant |

The total release from this 40 acre in-situ mining operation is then:

| | |
|---|---|
| Production | 1471 Ci/yr |
| Start-up | 44 Ci/yr |
| Restoration (Includes Start-up) | 280 Ci/yr |
| | 1795 Ci/yr |

4) Actual Radon Release to the Environment

4.1) Production

The average annual flow at Christensen Ranch will be 3600 gpm during production. During production the 3600 gpm of recovery solution will be processed using a pressurized fixed bed ion exchange process to remove the uranium. A worst case bleed stream of 125 gpm will be processed by reverse osmosis and approximately 60 gpm of this bleed will be sent to the evaporation pond or disposal well and approximately 65 gpm will be sent to chemical make-up and will be reinjected into the formation. Radon losses to the environment will be minimal on the processing of the 3600 gpm since the recovered solution will be pressurized at all times above ground. The only Radon released to the environment should be from the 125 gpm bleed stream which will be at atmospheric conditions. This loss will be 3.5% of the Radon Source Term of 1515 Ci/yr or 53 Ci/yr.

Approximately 25% of the total Radon could be released during reinjection of the process solution. This Radon may be released in venting of the injection wells. The total source term for Radon from production is 1515 Ci/yr (including start-up) and 25% of that will be 379 Ci/yr. The two mine units closest to the nearest resident are Mine Units 4 and 5. For example, the 25% could be derived from Mine Unit 4 operating at 1600 gpm, from which 168 Ci/yr of Radon will be released, and Mine Unit 5 operating at 2000 gpm, where 211 Ci/yr will be released. After completion of mining in Mine Units 4 and 5 mining will be initiated in Mine Units 6 and 7 and will proceed as per the Mine Plan.

4.2) Restoration

The maximum restoration flow will be 500 gpm. Initially restoration will be conducted in Mine Unit 3 and the maximum dose to the nearest resident is expected to occur at this time. This assumes ongoing production in Mine Units 4 and 5, with restoration in Mine Unit 3. The total Radon produced in restoration will be 280 Ci/yr and 25% of this total (70 Ci/yr) could be released in the wellfield and 75% (210 Ci/yr) could be released in the plant. It is not certain that 75% of the Radon will be released at the plant, but for purposes of this evaluation a 75% release will be conservatively estimated.

A summary of the actual Radon releases to the environment during the time of maximum dose to the nearest resident follows:

Process Building

| | |
|---|---|
| Production Release | 53 Ci/yr |
| Restoration Release | 210 Ci/yr |

Wellfields

| | |
|---|---|
| Mine Unit #4 | 168 Ci/yr |
| Mine Unit #5 | 211 Ci/yr |
| Mine Unit #2 (Restoration) | 70 Ci/yr |

## TABLE 7.3(A)-4

## MISCELLANEOUS DATA
## CHRISTENSEN RANCH

| | |
|---|---|
| Fraction of year during which cattle graze locally | Est. 33% |
| Fraction of cattle feed obtained by grazing | Est. 90% |
| Fraction of stored cattle feed grown locally | Est. 90% |
| Acreage required to graze 1 animal unit (450 kg) for one month (AUM) | 3.5 ha |
| Length of growing season | 4 mo/yr |
| Fraction of locally produced vegetables consumed locally | Est. 100% |
| Fraction of locally produced meat consumed locally | Est. < 5% |
| Fraction of locally produced milk consumed locally | Est. 100% |

## TABLE 7.3(A)-5

## SITE SPECIFIC INFORMATION
## IRIGARAY

| PARAMETER | VALUE |
|---|---|
| Average ore quality, $U_3O_8$, in ore body | 0.12% |
| Ore Radon-222 activity, assuming equilibrium with U-238 | 338 pCi/g |
| Operating days per year (plant factor) | 365 days |
| Dimensions of ore body | |
| Area per year to be mined | 28 acres |
| Average thickness of body | 12.0 feet (3.7 meters) |
| Average production flow rate | 2400 gpm |
| Formation porosity | 27% |
| Process recovery | 95% |
| Leaching efficiency | 60% |
| Rock density | 1.93 g/cm$^3$ |
| Restoration flow rate | 500 gpm |
| Production cell parameters | |
| Residence time (Production) | 8.4 days |
| Residence time (Restoration) | 40 days |
| Type of cell pattern | Variable |
| Average cell area | 5,000 ft$^2$ |
| Average cell flow rate | 38 lpm |
| Annual Rn-222 emission from production | 1355 Ci/yr |
| Annual Rn-222 emission from restoration | 391 Ci/yr |
| Annual Rn-222 emission from start-up | 40 Ci/yr |
| Source stack description (Radon) | plant vent |
| Stack height | 25.0 ft (7.6 meters) |
| Stack diameter | 0.25 ft (0.80 meters) |
| Stack exit velocity | 218 m/sec |

## TABLE 7.3(A)-6

## SOURCE AND RECEPTOR COORDINATES
## IRIGARAY

| Source Name | X (km) | Y (km) | Z (km) | |
|---|---|---|---|---|
| MU 4-9 | -6.44 | 7.85 | 1.00 | |
| MU 10 | -6.71 | 9.22 | 1.00 | |
| MU 11-12 | -7.24 | 9.91 | 1.00 | |
| Plant | -7.11 | 9.22 | 7.62 | |
| Thermal Dryer | -7.09 | 9.22 | 18.90 | |
| **Receptor Name** | **X (km)** | **Y (km)** | **Z (km)** | **Distance (km)** |
| IR-1 | -7.18 | 9.28 | 0.00 | 11.73 |
| IR-3 | -7.05 | 9.22 | 0.00 | 11.61 |
| IR-4 | -7.09 | 10.06 | 0.00 | 12.30 |
| IR-5 | -9.22 | 15.09 | 0.00 | 17.68 |
| IR-6 | -6.02 | 8.50 | 0.00 | 10.41 |
| 50m North of TD | -7.09 | 9.27 | 0.00 | 11.67 |
| 50m East of TD | -7.04 | 9.22 | 0.00 | 11.60 |
| 50m South of TD | -7.09 | 9.17 | 0.00 | 11.59 |
| 50m West of TD | -7.14 | 9.22 | 0.00 | 11.66 |
| 50m Upwind of TD | -7.05 | 9.19 | 0.00 | 11.58 |
| 50m Downwind of TD | -7.13 | 9.26 | 0.00 | 11.68 |
| 100m North of TD | -7.09 | 9.32 | 0.00 | 11.71 |
| 100m East of TD | -6.99 | 9.22 | 0.00 | 11.57 |
| 100m South of TD | -7.09 | 9.12 | 0.00 | 11.55 |
| 100m West of TD | -7.19 | 9.22 | 0.00 | 11.69 |
| 100m Upwind of TD | -7.02 | 9.15 | 0.00 | 11.53 |
| 100m Downwind of TD | -7.16 | 9.29 | 0.00 | 11.73 |
| 200m North of TD | -7.09 | 9.42 | 0.00 | 11.79 |
| 200m East of TD | -6.89 | 9.22 | 0.00 | 11.51 |

| Receptor Name | X (km) | Y (km) | Z (km) | Distance (km) |
|---|---|---|---|---|
| 200m South of TD | -7.09 | 9.02 | 0.00 | 11.47 |
| 200m West of TD | -7.29 | 9.22 | 0.00 | 11.75 |
| 200m Upwind of TD | -6.95 | 9.08 | 0.00 | 11.43 |
| 200m Downwind of TD | -7.23 | 9.36 | 0.00 | 11.83 |
| 500m North of TD | -7.09 | 9.72 | 0.00 | 12.03 |
| 500m East of TD | -6.59 | 9.22 | 0.00 | 11.33 |
| 500m South of TD | -7.09 | 8.72 | 0.00 | 11.24 |

## TABLE 7.3(A)-7

## CALCULATION OF ANNUAL RADON EMISSIONS
## IRIGARAY

1) To calculate Radon release from leaching assuming that U-238 is in equilibrium with all its decay products:

$Ci/m^3$ = 338 pCi/g ore x 1.93 $g/cm^3$ x 0.2 x 0.73/0.27 x $10^{-6}$
= $3.53 \times 10^{-4}$ $Ci/m^3$

Where:
0.2 = Emanating Power
0.73 = 1 - Porosity
0.27 = Porosity

The yearly release is then:

$3.53 \times 10^{-4}$ $Ci/m^3$ x 9084 lpm x (0.78) x 365 d/yr x 1.44 = 1315 Ci/yr

Where:
9084 = liters per minute
0.78 = $\epsilon = 1 - e^{-(\lambda\tau)}$
= $\epsilon = 1 - e^{-(0.1812)(8.4\ \text{days})}$
= $\epsilon = 1 - 0.22$
1.44 = constant

2) The Radon release from start-up is given by:

$3.530 \times 10^{-4}$ $Ci/m^3$ x 28 acres x 4074 $m^2$/acre x 3.66 m x 0.27 = 40 Ci/yr

Where:
4074 = $m^2$/acre
3.66 = Thickness of orebody in meters
0.27 = Porosity

The total release of Radon from the start-up solution and production lixiviant solution is:

| | |
|---|---|
| Start-up solution | 40 Ci/yr |
| Production | 1315 Ci/yr |
| | 1355 Ci/yr |

3) The Radon release from restoration is given by:

$3.53 \times 10^{-4}$ $Ci/m^3$ x 1893 lpm x 365 d/yr x 1.00 x 1.44 = 351 Ci/yr
351 Ci/yr + 20 (start-up) = 371 Ci/yr total release

| | | | |
|---|---|---|---|
| Where: | 1893 | = | Restoration flow in liter per minute |
| | 1.0 | = | $\epsilon = 1 - e^{-\lambda t}$ |
| | | = | $\epsilon = 1 - e^{-(0.1812)(40\ \text{days})}$ |
| | | = | $\epsilon = 1.0$ |
| | 1.44 | = | constant |

The total release from this 28 acre in-situ mining operation is then:

| | |
|---|---|
| Production | 1355 Ci/yr |
| Start-up | 40 Ci/yr |
| Restoration (Includes Start-up) | 371 Ci/yr |
| | 1766 Ci/yr |

4) Actual Radon Release to the Environment

4.1) Production

The production flow rate at the Irigaray Site will be 2400 gpm and the total source term for Radon will be 1355 Ci/yr. Approximately 25% of the total Radon will be released in the wellfield due to venting and the 25% will be equal to 339 Ci/yr. It is anticipated that the wellfield release will be equally distributed over Mine Unit 10 and a combination of Mine Units 11 and 12, in future development areas to the north of the current Irigaray plant site.

The production flow of 2400 gpm will report to the process building for separation of the uranium. The uranium will be separated by passing the recovery solution through pressurized fixed bed downflow ion exchange units. Since the recovered solution will be pressurized at all times in the uranium recovery process virtually none of the contained Radon will be released to the environment. The only Radon that will be released to the environment will be for the up to 125 gpm bleed stream (worst case) that is used for the process bleed and for chemical make-up. The up to 125 gpm bleed will be 5.2% of the production flow and therefore 5.2% of the production source term of 1355 Ci/yr could potentially be released to the environment. The actual Radon release from the plant would then be 70 Ci/yr.

4.2) Restoration

The maximum restoration flow will be 500 gpm. Initially restoration activities will be conducted in Mine Units 4 through 9. The total restoration source term for 500 gpm will be 391 Ci/yr and it is estimated that 25% (93 Ci/yr) of the source term will be released in the wellfield by venting and 75% (278 Ci/yr) of the source term will potentially be released at the process plant. It is not certain that 75% of the Radon will be released at the process plant, but for purposes

of this evaluation a 75% release will be conservatively estimated.

A summary of the worst case Radon releases to the environment, in future development areas, follows:

Process Building

| | |
|---|---|
| Production Release | 70 Ci/yr |
| Restoration Release | 278 Ci/yr |

Wellfields

| | |
|---|---|
| Mine Unit #10 | 170 Ci/yr |
| Mine Units #11,#12 | 170 Ci/yr |
| Mine Units #4-9 (Restoration) | 93 Ci/yr |

## TABLE 7.3(A)-8

## YELLOWCAKE DRYING AND PROCESSING EMISSIONS IRIGARAY

| PARAMETER | VALUE |
|---|---|
| Processing Rates for dry/pack | 285 lbs/hr |
| Estimated annual production | 2,500,000 lbs/yr |
| Estimated production purity, % $UO_3/UO_4$ by weight[1] | 95% |
| Airborne effluent concentrations | 9900 uci U-238 per year[2]<br>26.8 uci Ra-226 per year<br>80.5 uci Pb-210 per year<br>23.1 uci Th-230 per year |
| Dry/pack stack height (above ground) | 62 feet (18.9 m) |
| Stack diameter | 1.33 feet (0.41 m) |
| Airflow | 2322 SCFM (65.76 $m^3$/min) |
| Stack velocity | 12.3 m/sec |

1. COGEMA performed x-ray diffraction studies on the bulk product from the drying operation and the composition of the product was determined to be 83.7% $UO_4.2H_2O$ and 16.3% $UO_3$. Samples of the scrubber water were also analyzed and the uranium in the scrubber water was determined to be 99.5% $UO_3$. Therefore stack effluents will be considered to be primarily $UO_3$.

2. Airborne effluents are based on a stack emissions survey conducted at the Irigaray site in December 1994. U-natural, Ra-226, Th-230 and Pb-210 were measured on the stack samples collected. The average $U_3O_8$-natural released on three tests was 40.9 lbs/yr with a standard deviation of 18.2 lbs/yr. For modeling purposes the average plus two standard deviations was used and this value is 77.3 lbs/yr. The pounds $U_3O_8$/yr was converted to uCi/yr using the following calculation:

$$(77.3 \text{ lbs } U_3O_8/\text{yr})\times(0.848\ U/U_3O_8)\times(454 \text{ g/lb})\times(3.33\times10^{-7} \text{ Ci/g})\times(1\times10^{6} \text{ uCi/Ci}) = 9910 \text{ uCi/yr}$$

The values for Ra-226, Th-230 and Pb-210 were calculated using the respective effluent data.

## TABLE 7.3(A)-9

## MISCELLANEOUS DATA
## IRIGARAY

| | |
|---|---|
| Fraction of year during which cattle graze locally | Est. 33% |
| Fraction of cattle feed obtained by grazing | Est. 90% |
| Fraction of stored cattle feed grown locally | Est. 90% |
| Acreage required to graze 1 animal unit (450 kg) for one month (AUM) | 3.5 ha |
| Length of growing season | 4 mo/yr |
| Fraction of locally produced vegetables consumed locally | Est. 100% |
| Fraction of locally produced meat consumed locally | Est. < 5% |
| Fraction of locally produced milk consumed locally | Est. 100% |

## 8.0 ALTERNATIVES TO PROPOSED ACTION

The alternatives applicable to the Irigaray/Christensen Ranch site are: to mine by in situ methods using an alternative lixiviant chemistry; to dispose of liquid wastes by methods other than using the solar evaporation ponds; to dispose of solid radioactive wastes on site rather than off site; to add the uranium elution and precipitation processes to the satellite facilities, thereby eliminating the resin haul to the Irigaray Recovery facility; to mine the ore body by conventional methods; or to not mine the property at all.

### 8.1 ALTERNATIVE LIXIVIANT CHEMISTRY

The Irigaray and Christensen Ranch ore bodies are currently being mined with sodium bicarbonate as the lixiviant. Another cation based lixiviant has been tested at the 517 test site on the Irigaray property. If this lixiviant proves to be desirable and acceptable to the regulatory agencies as a lixiviant, its use may be proposed in the future for the Irigaray/Christensen Ranch wellfields.

### 8.2 WASTE MANAGEMENT ALTERNATIVES

Lined solar evaporation ponds, unlined cleanwater storage ponds, surface discharge and deep well injection are used for the storage and disposal of waste water solutions from the mining and restoration operations at both Irigaray and Christensen Ranch. COGEMA is currently conducting a wastewater management engineering study which is designed to identify the most efficient, cost effective and environmentally acceptable method for wastewater disposal at Irigaray and Christensen Ranch. It is possible that alternative methods for wastewater disposal will be identified that COGEMA may apply for. These methods could include mechanical evaporation (multiple effect evaporators, vapor recompression systems, etc.), land application, electrodialysis reversal, treatment and aquifer recharge (during mining) through wells or recharge basins, and constructed wetlands (metals removal).

COGEMA intends to transport all solid radioactive wastes off-site to a USNRC licensed disposal facility when final decommissioning occurs. Currently a contract is in place with Pathfinder Mines Corporation, Shirley Basin Tailings Facility for byproduct waste disposal. Should a USNRC licensed disposal facility not be available to COGEMA at the time of decommissioning, the alternative of on-site burial may be necessary. This alternative could incur long term monitoring requirements and more expensive reclamation costs, however, it may be the only alternative available to COGEMA at that time.

## 8.3 URANIUM RECOVERY PROCESS ALTERNATIVES

At present, there is no uranium elution or precipitation capability proposed for the Christensen Ranch satellite facility. This capability may become desirable in the future when mining activities expand or a plant expansion becomes necessary at the Irigaray Recovery facility. The economics of placing the elution and precipitation circuits at Christensen Ranch may be more favorable than those associated with an expansion of the Irigaray facility combined with the increase in the number of resin hauls and associated expense. It is also conceivable that the drying unit at Irigaray could be moved to Christensen Ranch as well.

Although the uranium recovery process, non-ammonium lixiviant and current wellfield installation are the most suitable for the Irigaray/Christensen Ranch Site, changes in the environmental, technical, economic and regulatory climate may necessitate changes within the solution mining alternative established at Irigaray/Christensen Ranch. Should these changes become necessary, proper notification will be made to the regulatory agencies.

## 8.4 MINING ALTERNATIVES

Because the Irigaray/Christensen Ranch property is now an established commercial solution mining site, there are no viable alternatives to the mining methods at this time. The current low price of uranium makes an established solution mining process very attractive and perhaps the only economical method of mining uranium at this time. The use of conventional mining methods (open pit or underground) for the Irigaray/Christensen Ranch site is presently considered not economically feasible. Generally, open pit mining is used for relatively moderate grade ore deposits close to the ground surface. The overburden to ore ratio under present economic conditions precludes the mining of the Christensen Ranch site using open pit methods. Underground mining is generally used for deeper, higher grade deposits. Due to the large capital investments and higher operating costs required for underground mining and open pit mining, as well as environmental disadvantages, neither method is considered to be economically feasible.

Environmental and socioeconomic advantages of the in situ leaching mining method as compared with underground or open pit methods are:

1. minimal surface disturbance,
2. less solid waste production, no mill tailings,
3. less air pollution,
4. smaller radiological releases to the environment, short and long term,
5. ability to mine a lower grade of ore,
6. a modest capital investment,

7. less risk to personnel,
8. lower manpower requirements,
9. ability to return groundwater to pre-mining conditions.

## 8.5 ALTERNATIVE TO NO LICENSING ACTION

If the NRC chooses to deny the renewal of License SUA-1341 for production on a commercial scale, COGEMA would be forced to decommission and reclaim the site, leaving a valuable mineral unmined. This denial would also result in the loss of large investments incurred to date by COGEMA for the rights to and development of the Irigaray/Christensen Ranch site. COGEMA currently has contracts for the sale of uranium to be used as fuel in nuclear reactors; the denial of the application will impair COGEMA's ability to deliver on their contracts.

# 9.0 BENEFIT-COST SUMMARY

## 9.1 GENERAL

The general need for uranium is subsumed in the operation of nuclear power reactors. In reactor licensing evaluations, the benefits of the energy produced are weighed against related environmental costs, including a prorated share of the environmental costs of the uranium fuel cycle. These incremental impacts in the fuel cycle are justified in terms of the benefits of energy generation. However, it is appropriate the review the specific site-related benefits and costs of an individual fuel-cycle facility such as Irigaray/Christensen Ranch.

## 9.2 QUANTIFIABLE BENEFITS AND COSTS

The operation of the Irigaray/Christensen Ranch project will accrue monetary benefits to the surrounding communities from local expenditures and state and local taxes paid by the project. The project operation will add employment to the local communities, which are currently experiencing an economic slump due to the depressed energy, farming and ranching industries.

Environmental impacts of the project are and will be minimal. Groundwater impact, radiological impact and the disturbance of the land are the three potential uncompensated environmental costs associated with the project. The groundwater will be restored to pre-mining usage quality, as demonstrated by the Willow Creek R&D and the Irigaray restoration to date; the radiological impacts of the project are small as no tailings are produced and waste materials will be transported off-site; the disturbance of the land is also a very small impact which should be mitigated by the proposed surface reclamation techniques to bring the land back to its pre-mining condition. Interim reclamation efforts have demonstrated that this goal is achievable. The benefits involved with the production of uranium and the power generated as a result are considered to offset the small risk that the above environmental impacts may be more severe than anticipated.

## 10.0 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

As discussed in Section 1.0, this is a renewal application for WDEQ Permit to Mine No. 478 and USNRC License SUA-1341, originally issued in November 1978, and renewed in 1987. All other required permits for the project were obtained prior to commencement of activities. A summary of the relevant permits is given below:

| Permit or License | Granting Authority |
|---|---|
| Source Material License No. SUA-1341 (Amendment 40) | USNRC |
| Wyoming Permit to Mine No. 478 (Amendment 2) | WDEQ - LQD and WQD |
| Permit to Appropriate Groundwater (Well fields and monitor wells) | SEO |
| Permit to Construct Impoundments | SEO and WDEQ-WQD |
| Permit to Construct Sanitary Leach Field | WDEQ-WQD and Johnson County |
| NPDES Surface Discharge Permit<br>Irigaray: WY-0028801<br>Christensen: WY-0033642 | WDEQ-WQD |
| Air Quality Permit to Construct<br>Air Quality Permit to Operate<br>Permit No. OP-254 | WDEQ-AQD |
| UIC 95-241, Class I<br>Christensen Ranch Disposal Wellfield<br>UIC 91-247, Class I<br>Irigaray Disposal Wellfield | WDEQ-WQD |

USNRC: United States Nuclear Regulatory Commission, Rockville, Maryland.

WDEQ: LQD, WQD, AQD - Wyoming Department of Environmental Quality, Land Quality Division (LQD), Water Quality Division (WQD) and Air Quality Division (AQD), Cheyenne, Wyoming.

SEO: Wyoming State Engineers Office, Cheyenne, Wyoming.

# MILDOS MODELING

## 10 CFR 20 Requirements

REGION: IRIGARY/CHRISTSEN RANCH CODE: MILDOS-AREA (03/89) PAGE 2
METSET: IRIGARY DATA DATA: crin.dat 02/22/95

JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS=0.26830,0.28680,0.20920,0.16930,0.05240,0.01220

| MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ABILITY CLASS 1 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.3600 | 0.3300 | 0.3100 | 0.2300 | 0.2000 | 0.1200 | 0.2600 | 0.1900 | 0.4700 | 0.2900 | 0.4800 | 0.3600 | 0.4700 | 0.3400 | 0.3300 | 0.3600 | 5.1000 |
| 5.5 | 0.5600 | 0.3300 | 0.3000 | 0.1400 | 0.0500 | 0.1000 | 0.1600 | 0.2400 | 0.2700 | 0.3100 | 0.3600 | 0.1600 | 0.2600 | 0.1300 | 0.3500 | 0.5500 | 4.2700 |
| 10.0 | 0.3000 | 0.1300 | 0.0200 | 0.0100 | 0.0100 | 0.0100 | 0.0800 | 0.0700 | 0.0500 | 0.0800 | 0.1500 | 0.0800 | 0.0300 | 0.0000 | 0.0100 | 0.1000 | 1.1300 |
| 15.5 | 0.0200 | 0.0000 | 0.0100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.0100 | 0.0000 | 0.0100 | 0.0700 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 1.2400 | 0.7900 | 0.6400 | 0.3800 | 0.2600 | 0.2300 | 0.5000 | 0.5000 | 0.7900 | 0.6800 | 0.9900 | 0.6000 | 0.7800 | 0.4800 | 0.6900 | 1.0200 | 10.5700 |
| STABILITY CLASS 2 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.0600 | 0.0700 | 0.0200 | 0.0500 | 0.0800 | 0.0800 | 0.0800 | 0.1200 | 0.0900 | 0.1300 | 0.2000 | 0.0600 | 0.1500 | 0.0900 | 0.1700 | 0.0500 | 1.5000 |
| 5.5 | 0.3000 | 0.1400 | 0.0700 | 0.0100 | 0.0700 | 0.0300 | 0.1000 | 0.1500 | 0.3100 | 0.3400 | 0.2800 | 0.1200 | 0.0800 | 0.1400 | 0.1700 | 0.2100 | 2.5200 |
| 10.0 | 0.3400 | 0.1600 | 0.1000 | 0.0100 | 0.0300 | 0.0300 | 0.1200 | 0.1200 | 0.1900 | 0.2700 | 0.1900 | 0.1300 | 0.0700 | 0.0700 | 0.0800 | 0.2800 | 2.1900 |
| 15.5 | 0.1300 | 0.0500 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0100 | 0.0000 | 0.0300 | 0.0500 | 0.0100 | 0.0000 | 0.0000 | 0.0200 | 0.3000 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 0.8300 | 0.4200 | 0.1900 | 0.0700 | 0.1800 | 0.1400 | 0.3000 | 0.3900 | 0.6000 | 0.7400 | 0.7000 | 0.3600 | 0.3100 | 0.3000 | 0.4200 | 0.5600 | 6.5100 |
| STABILITY CLASS 3 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.0500 | 0.0500 | 0.0700 | 0.0300 | 0.1200 | 0.1600 | 0.1500 | 0.0700 | 0.0300 | 0.0700 | 0.0300 | 0.0200 | 0.0600 | 0.0500 | 0.0500 | 0.0900 | 1.1000 |
| 5.5 | 0.1400 | 0.0800 | 0.0800 | 0.0100 | 0.0500 | 0.0800 | 0.1300 | 0.1200 | 0.2400 | 0.4300 | 0.2300 | 0.0800 | 0.1400 | 0.1000 | 0.1500 | 0.1400 | 2.2000 |
| 10.0 | 0.6500 | 0.1500 | 0.0600 | 0.0800 | 0.0300 | 0.0700 | 0.1500 | 0.1700 | 0.4300 | 0.2700 | 0.2000 | 0.0900 | 0.0800 | 0.0300 | 0.1200 | 0.4100 | 2.9900 |
| 15.5 | 0.3500 | 0.0300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0300 | 0.0100 | 0.0200 | 0.0500 | 0.0700 | 0.0800 | 0.0200 | 0.0200 | 0.0200 | 0.0500 | 0.7500 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 1.1900 | 0.3100 | 0.2100 | 0.1200 | 0.2000 | 0.3100 | 0.4600 | 0.3700 | 0.7200 | 0.8200 | 0.5300 | 0.2700 | 0.3000 | 0.2000 | 0.3400 | 0.6900 | 7.0400 |
| BILITY CLASS 4 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.1400 | 0.1000 | 0.1600 | 0.0700 | 0.2300 | 1.3800 | 0.8700 | 0.0900 | 0.0600 | 0.0100 | 0.0900 | 0.1000 | 0.2200 | 0.1300 | 0.2400 | 0.1400 | 4.0300 |
| 5.5 | 0.6100 | 0.2800 | 0.2600 | 0.0800 | 0.4300 | 2.0000 | 2.0500 | 0.6300 | 0.5700 | 0.6900 | 0.4000 | 0.1600 | 0.1700 | 0.1500 | 0.3600 | 0.6700 | 9.5100 |
| 10.0 | 1.2900 | 0.3700 | 0.2100 | 0.2000 | 0.2600 | 0.2800 | 0.8300 | 0.9100 | 0.9500 | 0.8800 | 0.5500 | 0.1500 | 0.1400 | 0.0600 | 0.3500 | 1.0500 | 8.4800 |
| 15.5 | 1.6200 | 0.3100 | 0.2000 | 0.1400 | 0.0500 | 0.4300 | 1.2300 | 1.3000 | 1.9700 | 2.4600 | 0.8700 | 0.3100 | 0.4900 | 0.1400 | 0.7900 | 2.6200 | 14.9300 |
| 21.5 | 0.4900 | 0.0200 | 0.0100 | 0.0100 | 0.0000 | 0.1200 | 0.7100 | 0.3100 | 0.5200 | 0.8800 | 0.6900 | 0.1500 | 0.1000 | 0.0000 | 0.2400 | 0.9900 | 5.2400 |
| 28.0 | 0.0300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1500 | 0.3500 | 0.0100 | 0.0100 | 0.0600 | 0.1000 | 0.1200 | 0.0500 | 0.0000 | 0.0500 | 0.2900 | 1.2200 |
| ALL | 4.1800 | 1.0800 | 0.8400 | 0.5000 | 0.9700 | 4.3600 | 6.0400 | 3.2500 | 4.0800 | 4.9800 | 2.7000 | 0.9900 | 1.1700 | 0.4800 | 2.0300 | 5.7600 | 43.4100 |
| STABILITY CLASS 5 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.1900 | 0.2200 | 0.0900 | 0.1000 | 0.3600 | 1.2100 | 1.0200 | 0.1700 | 0.1500 | 0.1700 | 0.1300 | 0.0500 | 0.2800 | 0.2900 | 0.2100 | 0.1900 | 4.8300 |
| 5.5 | 0.2700 | 0.2800 | 0.0800 | 0.1200 | 0.2400 | 1.8000 | 1.6100 | 0.5500 | 0.3300 | 0.4900 | 0.2000 | 0.2000 | 0.2300 | 0.1300 | 0.3400 | 0.4700 | 7.3400 |
| 10.0 | 0.3000 | 0.1900 | 0.1600 | 0.1300 | 0.0900 | 0.3700 | 0.9800 | 0.7000 | 0.6600 | 0.9000 | 0.2100 | 0.0700 | 0.0700 | 0.0600 | 0.2000 | 0.9100 | 6.0000 |
| 15.5 | 0.0100 | 0.0000 | 0.0200 | 0.0000 | 0.0000 | 0.0100 | 0.0900 | 0.0200 | 0.1000 | 0.2300 | 0.0700 | 0.0100 | 0.0100 | 0.0000 | 0.0700 | 0.1600 | 0.8000 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 0.7700 | 0.6900 | 0.3500 | 0.3500 | 0.6900 | 3.3900 | 3.7000 | 1.4400 | 1.2400 | 1.7900 | 0.6100 | 0.3300 | 0.5900 | 0.4800 | 0.8200 | 1.7300 | 18.9700 |
| STABILITY CLASS 6 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.3800 | 0.3700 | 0.2800 | 0.2400 | 0.5400 | 1.4300 | 2.1300 | 0.9800 | 0.5400 | 0.4500 | 0.5700 | 0.3500 | 0.4500 | 0.5000 | 0.4900 | 0.5700 | 10.2700 |
| 5.5 | 0.1000 | 0.0500 | 0.0300 | 0.0200 | 0.1000 | 0.4000 | 0.6100 | 0.3100 | 0.2400 | 0.2700 | 0.2200 | 0.0800 | 0.0900 | 0.0900 | 0.1000 | 0.1300 | 2.8400 |
| 10.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.0100 | 0.0000 | 0.0000 | 0.0700 | 0.0000 | 0.0100 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.1300 |
| 15.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.0100 | 0.0000 | 0.0300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0100 | 0.0100 | 0.0800 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 0.4800 | 0.4200 | 0.3100 | 0.2600 | 0.6400 | 1.8500 | 2.7700 | 1.3000 | 0.7800 | 0.8200 | 0.7900 | 0.4400 | 0.5400 | 0.5900 | 0.6000 | 0.7300 | 13.3200 |
| | 8.6900 | 3.7100 | 2.5400 | 1.6800 | 2.9400 | 10.2800 | 13.7700 | 7.2500 | 8.2100 | 9.8300 | 6.3200 | 2.9900 | 3.6900 | 2.5300 | 4.9000 | 10.4900 | 99.8200 |

JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS=0.26830,0.28680,0.20920,0.16930,0.05240,0.01220

| MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STABILITY CLASS 1 | | | | | | | | | | | | | | | | | |
| .5 | 0.3600 | 0.3300 | 0.3100 | 0.2300 | 0.2000 | 0.1200 | 0.2600 | 0.1900 | 0.4700 | 0.2900 | 0.4800 | 0.3600 | 0.4700 | 0.3400 | 0.3300 | 0.3600 | |
| 5.5 | 0.5600 | 0.3300 | 0.3000 | 0.1400 | 0.0500 | 0.1000 | 0.1600 | 0.2400 | 0.2700 | 0.3100 | 0.3600 | 0.1600 | 0.2600 | 0.1300 | 0.3500 | 0.5500 | 4.2700 |
| .0 | 0.3000 | 0.1300 | 0.0200 | 0.0100 | 0.0100 | 0.0100 | 0.0800 | 0.0700 | 0.0500 | 0.0800 | 0.1500 | 0.0800 | 0.0300 | 0.0000 | 0.0100 | 0.1000 | 1.1300 |
| .5 | 0.0200 | 0.0000 | 0.0100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.0100 | 0.0000 | 0.0100 | 0.0700 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| L | 1.2400 | 0.7900 | 0.6400 | 0.3800 | 0.2600 | 0.2300 | 0.5000 | 0.5000 | 0.7900 | 0.6800 | 0.9900 | 0.6000 | 0.7800 | 0.4800 | 0.6900 | 1.0200 | 10.5700 |
| STABILITY CLASS 2 | | | | | | | | | | | | | | | | | |
| .5 | 0.0600 | 0.0700 | 0.0200 | 0.0500 | 0.0800 | 0.0800 | 0.0800 | 0.1200 | 0.0900 | 0.1300 | 0.2000 | 0.0600 | 0.1500 | 0.0900 | 0.1700 | 0.0500 | 1.5000 |
| .5 | 0.3000 | 0.1400 | 0.0700 | 0.0100 | 0.0700 | 0.0300 | 0.1000 | 0.1500 | 0.3100 | 0.3400 | 0.2800 | 0.1200 | 0.0800 | 0.1400 | 0.1700 | 0.2100 | 2.5200 |
| 10.0 | 0.3400 | 0.1600 | 0.1000 | 0.0100 | 0.0300 | 0.0300 | 0.1200 | 0.1200 | 0.1900 | 0.2700 | 0.1900 | 0.1300 | 0.0700 | 0.0700 | 0.0800 | 0.2800 | 2.1900 |
| 15.5 | 0.1300 | 0.0500 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0100 | 0.0000 | 0.0300 | 0.0500 | 0.0100 | 0.0000 | 0.0000 | 0.0200 | 0.3000 |
| .5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| .0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 0.8300 | 0.4200 | 0.1900 | 0.0700 | 0.1800 | 0.1400 | 0.3000 | 0.3900 | 0.6000 | 0.7400 | 0.7000 | 0.3600 | 0.3100 | 0.3000 | 0.4200 | 0.5600 | 6.5100 |
| STABILITY CLASS 3 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.0500 | 0.0500 | 0.0700 | 0.0300 | 0.1200 | 0.1600 | 0.1500 | 0.0700 | 0.0300 | 0.0700 | 0.0300 | 0.0200 | 0.0600 | 0.0500 | 0.0500 | 0.0900 | 1.1000 |
| 5.5 | 0.1400 | 0.0800 | 0.0800 | 0.0100 | 0.0500 | 0.0800 | 0.1300 | 0.1200 | 0.2400 | 0.4300 | 0.2300 | 0.0800 | 0.1400 | 0.1000 | 0.1500 | 0.1400 | 2.2000 |
| 1 .0 | 0.6500 | 0.1500 | 0.0600 | 0.0800 | 0.0300 | 0.0700 | 0.1500 | 0.1700 | 0.4300 | 0.2700 | 0.2000 | 0.0900 | 0.0800 | 0.0300 | 0.1200 | 0.4100 | 2.9900 |
| 1 .5 | 0.3500 | 0.0300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0300 | 0.0100 | 0.0200 | 0.0500 | 0.0700 | 0.0800 | 0.0200 | 0.0200 | 0.0200 | 0.0500 | 0.7500 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 .0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| A | 1.1900 | 0.3100 | 0.2100 | 0.1200 | 0.2000 | 0.3100 | 0.4600 | 0.3700 | 0.7200 | 0.8200 | 0.5300 | 0.2700 | 0.3000 | 0.2000 | 0.3400 | 0.6900 | 7.0400 |

INDIVIDUAL RECEPTOR LOCATION DATA, 48 LOCATIONS INPUT THIS RUN

| I | LOCATION NAMES | X(KM) | Y(KM) | Z(M) | DIST(KM) | TYPE | I | LOCATION NAMES | X(KM) | Y(KM) | Z(M) | DIST(KM) | TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-AS-1 | -3.66 | -0.46 | 0.00 | 3.69 | 0 | 25 | 25-IR-4 | -7.09 | 10.06 | 0.00 | 12.30 | 0 |
| 2 | 2-AS-5A | 0.01 | -0.05 | 0.00 | 0.06 | 0 | 26 | 26-IR-5 | -9.22 | 15.09 | 0.00 | 17.68 | 0 |
| 3 | 3-AS-5B | -0.01 | 0.01 | 0.00 | 0.02 | 0 | 27 | 27-IR-6 | -6.02 | 8.50 | 0.00 | 10.41 | 0 |
| 4 | 4-AS-6 | 3.51 | -3.73 | 0.00 | 5.12 | 0 | 28 | 28-50M NORTH OF TD | -7.09 | 9.27 | 0.00 | 11.67 | 0 |
| 5 | 5-100M NORTH | 0.00 | 0.10 | 0.00 | 0.10 | 0 | 29 | 29-50M EAST OF TD | -7.04 | 9.22 | 0.00 | 11.60 | 0 |
| 6 | 6-100M EAST | 0.10 | 0.00 | 0.00 | 0.10 | 0 | 30 | 30-50M SOUTH OF TD | -7.09 | 9.17 | 0.00 | 11.59 | 0 |
| 7 | 7-100M SOUTH | 0.00 | -0.10 | 0.00 | 0.10 | 0 | 31 | 31-50M WEST OF TD | -7.14 | 9.22 | 0.00 | 11.66 | 0 |
| 8 | 8-100M WEST | -0.10 | 0.00 | 0.00 | 0.10 | 0 | 32 | 32-50M UPWIND OF TD | -7.05 | 9.19 | 0.00 | 11.58 | 0 |
| 9 | 9-100M UPWIND | 0.07 | -0.07 | 0.00 | 0.10 | 0 | 33 | 33-50M DOWNWIND OF T | -7.13 | 9.26 | 0.00 | 11.68 | 0 |
| 10 | 10-100M DOWNWIND | -0.07 | 0.07 | 0.00 | 0.10 | 0 | 34 | 34-100M NORTH OF TD | -7.09 | 9.32 | 0.00 | 11.71 | 0 |
| 11 | 11-200M NORTH | 0.00 | 0.20 | 0.00 | 0.20 | 0 | 35 | 35-100M EAST OF TD | -6.99 | 9.22 | 0.00 | 11.57 | 0 |
| 12 | 12-200M EAST | 0.20 | 0.00 | 0.00 | 0.20 | 0 | 36 | 36-100M SOUTH OF TD | -7.09 | 9.12 | 0.00 | 11.55 | 0 |
| 13 | 13-200M SOUTH | 0.00 | -0.20 | 0.00 | 0.20 | 0 | 37 | 37-100M WEST OF TD | -7.19 | 9.22 | 0.00 | 11.69 | 0 |
| 14 | 14-200M WEST | -0.20 | 0.00 | 0.00 | 0.20 | 0 | 38 | 38-100M UPWIND OF TD | -7.02 | 9.15 | 0.00 | 11.53 | 0 |
| 15 | 15-200M UPWIND | 0.14 | -0.14 | 0.00 | 0.20 | 0 | 39 | 39-100M DOWNWIND OF | -7.16 | 9.29 | 0.00 | 11.73 | 0 |
| 16 | 16-200M DOWNWIND | -0.14 | 0.14 | 0.00 | 0.20 | 0 | 40 | 40-200M NORTH OF TD | -7.09 | 9.42 | 0.00 | 11.79 | 0 |
| 17 | 17-240 DEG @ 725M | -0.72 | -0.38 | 0.00 | 0.82 | 0 | 41 | 41-200M EAST OF TD | -6.89 | 9.22 | 0.00 | 11.51 | 0 |
| 18 | 18-270 DEG @ 5500M | -5.49 | 0.00 | 0.00 | 5.49 | 0 | 42 | 42-200M SOUTH OF TD | -7.09 | 9.02 | 0.00 | 11.47 | 0 |
| 19 | 19-330 DEG @ 5100M | -4.00 | 3.05 | 0.00 | 5.03 | 0 | 43 | 43-200M WEST OF TD | -7.29 | 9.22 | 0.00 | 11.75 | 0 |
| 20 | 20-345 DEG @ 2050M | -0.84 | 1.83 | 0.00 | 2.01 | 0 | 44 | 44-200M UPWIND OF TD | -6.95 | 9.08 | 0.00 | 11.43 | 0 |
| 21 | 21- 45 DEG @ 3350M | 2.36 | 2.29 | 0.00 | 3.29 | 0 | 45 | 45-200M DOWNWIND OF | -7.23 | 9.36 | 0.00 | 11.83 | 0 |
| 22 | 22- 80 DEG @ 4725M | 4.57 | 1.22 | 0.00 | 4.73 | 0 | 46 | 46-500M NORTH OF TD | -7.09 | 9.72 | 0.00 | 12.03 | 0 |
| 23 | 23-IR-1 | -7.18 | 9.28 | 0.00 | 11.73 | 0 | 47 | 47-500M EAST OF TD | -6.59 | 9.22 | 0.00 | 11.33 | 0 |
| 24 | 24-IR-3 | -7.05 | 9.22 | 0.00 | 11.61 | 0 | 48 | 48-500M SOUTH OF TD | -7.09 | 8.72 | 0.00 | 11.24 | 0 |

MISCELLANEOUS INPUTABLE PARAMETER VALUES

| DMM | DMA | TSTART | FFORI | FHAYI | FFORP | FHAYP | FPR(1) | FPR(2) | FPR(3) | ACTRAT |
|---|---|---|---|---|---|---|---|---|---|---|
| 800.0 | 1300.0 | 1995.00 | 0.33 | 0.90 | 0.33 | 0.90 | 370.00 | 790.00 | 600.00 | 2.50 |

IFACT EQUALS 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,

JC EQUALS 0, 0, 1, 1, 0, 1, 1, 1, 1, 0

| TIME STEP DATA.... | STEP NAMES | LENGTH, YRS | IFTODO |
|---|---|---|---|
| 1 | 1-YEAR PERIOD | 1.00 | 1 |

XRHO EQUALS 1.5, 2.5, 3.5, 4.5, 7.5, 15.0, 25.0, 35.0, 45.0, 55.0, 65.0, 75.0,

HDP EQUALS 50.0

METSET: IRIGARY DATA DATA: crin.dat 02/22/95

POPULATION DISTRIBUTION

| KILOMETERS | N 0.0 | NNE 22.5 | NE 45.0 | ENE 67.5 | E 90.0 | ESE 112.5 | SE 135.0 | SSE 157.5 | S 180.0 | SSW 202.5 | SW 225.0 | WSW 247.5 | W 270.0 | WNW 292.5 | NW 315.0 | NNW 337 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0- 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.0- 3.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.0- 4.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4.0- 5.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5.0-10.0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0-20.0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 11 | 3 | 6 | 0 |
| 20.0-30.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 134 | 111 | 0 | 0 | 0 | 0 |
| 30.0-40.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40.0-50.0 | 0 | 0 | 0 | 0 | 1236 | 0 | 0 | 0 | 0 | 247 | 495 | 0 | 0 | 0 | 0 | 0 |
| 50.0-60.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 256 | 0 | 0 | 0 |
| 60.0-70.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70.0-80.0 | 0 | 17635 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3358 | [illegible] |
| 1.0-80.0 | 0 | 17635 | 3 | 6 | 1236 | 0 | 0 | 16 | 0 | 247 | 629 | 111 | 267 | 3 | 3364 | 0 |

TOTAL 1-80 KM POPULATION IS 23517 PERSONS

NUMBER OF SOURCES=10

| NO. | KM X | KM Y | M Z | KM2 AREA | CI/YEAR U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | ID | PSIZE SET | M/SEC EXIT VEL | SOURCE NAME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.15 | -0.08 | 1.00 | 0.1115 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.00E+01 | 1001 | 2 | 1.00E-02 | CR MU 3 |
| 2 | 0.65 | -2.10 | 1.00 | 0.1665 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.68E+02 | 1002 | 2 | 1.00E-02 | CR MU 4 |
| 3 | 2.13 | -2.93 | 1.00 | 0.1165 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.06E+02 | 1003 | 2 | 1.00E-02 | CR MU 5A |
| 4 | 1.79 | -2.67 | 1.00 | 0.1486 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.06E+02 | 1004 | 2 | 1.00E-02 | CR MU5B |
| 5 | 0.00 | 0.00 | 7.01 | 0.0000 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.63E+02 | 1005 | 2 | 2.14E+02 | CR PLANT |
| 6 | -6.44 | 7.85 | 1.00 | 0.2780 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.30E+01 | 1006 | 2 | 1.00E-02 | IR MU 4-9 |
| 7 | -6.71 | 9.22 | 1.00 | 0.0590 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.70E+02 | 1007 | 2 | 1.00E-02 | IR MU 10 |
| 8 | -7.24 | 9.91 | 1.00 | 0.0450 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.70E+02 | 1008 | 2 | 1.00E-02 | IR MU 11-12 |
| 9 | -7.11 | 9.22 | 7.62 | 0.0000 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.48E+02 | 1009 | 2 | 1.04E+02 | IR PLANT |
| 10 | -7.09 | 9.22 | 18.90 | 0.0000 | 9.90E-03 | 2.31E-05 | 2.68E-05 | 8.05E-05 | 0.00E+00 | 1010 | 2 | 1.23E+01 | IR THERMAL DRYER |

INPUT TAILS ACTIVITIES, PCI/G

| SET | URANIUM | THORIUM | RADIUM | LEAD |
|---|---|---|---|---|
| 1 | 1.00E+02 | 1.00E+02 | 1.00E+02 | 1.00E+02 |
| 2 | 1.00E+02 | 1.00E+02 | 1.00E+02 | 1.00E+02 |
| 3 | 1.00E+02 | 1.00E+02 | 1.00E+02 | 1.00E+02 |

AMAD AND FRACTIONAL DISTRIBUTION

| SET | 1.5 | 3.0 | 7.7 | 54.0 |
|---|---|---|---|---|
| 1 | 0.000 | 1.000 | 0.000 | 0.000 |
| 2 | 1.000 | 0.000 | 0.000 | 0.000 |
| 3 | 0.000 | 0.000 | 0.300 | 0.700 |

PARTICULATE SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 1 TIME STEP(S) USED FOR THIS RUN

| SOURCE NUMBER | TSTEP 1 1.00YRS | TSTEP 2 0.00YRS | TSTEP 3 0.00YRS | TSTEP 4 0.00YRS | TSTEP 5 0.00YRS | TSTEP 6 0.00YRS | TSTEP 7 0.00YRS | TSTEP 8 0.00YRS | TSTEP 9 0.00YRS | TSTEP10 0.00YRS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 2 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 3 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 4 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 5 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 6 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 7 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 8 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 9 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 10 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |

RADON SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 1 TIME STEP(S) USED FOR THIS RUN

| SOURCE NUMBER | TSTEP 1 1.00YRS | TSTEP 2 0.00YRS | TSTEP 3 0.00YRS | TSTEP 4 0.00YRS | TSTEP 5 0.00YRS | TSTEP 6 0.00YRS | TSTEP 7 0.00YRS | TSTEP 8 0.00YRS | TSTEP 9 0.00YRS | TSTEP10 0.00YRS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 2 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 3 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 4 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 5 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 6 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 7 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 8 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 9 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 10 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF INFANT

| AMAD= 1.5 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 3.42E+03 | 3.85E+03 | 4.68E+03 | 6.49E+02 | 1.74E+02 | 4.10E+00 | 8.80E+02 |
| BONE | 4.84E+01 | 5.41E+01 | 2.17E+04 | 5.92E+02 | 5.47E+02 | 7.03E-02 | 2.10E+02 |
| AVG.LUNG | 2.69E+04 | 3.08E+04 | 3.10E+04 | 4.17E+03 | 5.07E+01 | 5.96E+01 | 3.36E+03 |
| LIVER | 3.51E-01 | 3.23E-01 | 1.16E+02 | 4.42E+01 | 2.83E+03 | 1.32E+00 | 2.54E+02 |
| KIDNEY | 4.67E+01 | 5.23E+01 | 1.21E+01 | 1.68E+01 | 1.08E+03 | 3.48E+01 | 1.32E+03 |

| AMAD= 3.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 2.08E+03 | 2.33E+03 | 3.05E+03 | 4.63E+02 | 1.90E+02 | 3.25E+00 | 7.26E+02 |
| BONE | 3.56E+01 | 3.98E+01 | 1.57E+04 | 6.64E+02 | 5.94E+02 | 8.98E-02 | 2.37E+02 |
| AVG.LUNG | 1.70E+04 | 1.94E+04 | 1.96E+04 | 2.63E+03 | 5.51E+01 | 3.77E+01 | 2.12E+03 |
| LIVER | 2.48E-01 | 2.38E-01 | 8.41E+01 | 4.95E+01 | 3.08E+03 | 1.69E+00 | 2.88E+02 |
| KIDNEY | 3.44E+01 | 3.86E+01 | 8.73E+00 | 1.88E+01 | 1.16E+03 | 4.13E+01 | 1.49E+03 |

| AMAD= 7.7 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.11E+03 | 1.25E+03 | 1.85E+03 | 3.08E+02 | 2.28E+02 | 2.91E+00 | 7.61E+02 |
| BONE | 3.60E+01 | 4.02E+01 | 1.18E+04 | 8.37E+02 | 7.46E+02 | 1.27E-01 | 3.00E+02 |
| AVG.LUNG | 7.50E+03 | 8.38E+03 | 8.46E+03 | 1.14E+03 | 6.67E+01 | 1.78E+01 | 9.16E+02 |
| LIVER | 2.30E-01 | 2.47E-01 | 7.57E+01 | 6.37E+01 | 3.71E+03 | 2.30E+00 | 3.52E+02 |
| KIDNEY | 3.71E+01 | 4.20E+01 | 7.71E+00 | 2.51E+01 | 1.39E+03 | 5.34E+01 | 1.85E+03 |

| AMAD=54.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-2. |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 2.49E+00 | 2.74E+00 | 5.25E+02 | 1.45E+02 | 2.17E+02 | 1.82E+00 | 4.98E+02 |
| BONE | 2.04E+01 | 2.28E+01 | 6.11E+03 | 7.79E+02 | 7.13E+02 | 1.40E-01 | 2.66E+02 |
| AVG.LUNG | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.38E+01 | 0.00E+00 | 0.00E+00 |
| LIVER | 1.09E-01 | 1.40E-01 | 3.92E+01 | 5.93E+01 | 3.55E+03 | 2.53E+00 | 3.12E+02 |
| KIDNEY | 2.10E+01 | 2.38E+01 | 3.99E+00 | 2.34E+01 | 1.32E+03 | 4.75E+01 | 1.64E+03 |

| AMAD= 0.3 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 6.97E+03 | 7.81E+03 | 9.06E+03 | 1.18E+03 | 1.75E+02 | 6.52E+00 | 1.30E+03 |
| BONE | 8.37E+01 | 9.35E+01 | 4.21E+04 | 5.42E+02 | 5.39E+02 | 4.04E-02 | 1.75E+02 |
| AVG.LUNG | 5.84E+04 | 6.67E+04 | 6.73E+04 | 9.03E+03 | 5.00E+01 | 1.21E+02 | 7.29E+03 |
| LIVER | 6.15E-01 | 5.35E-01 | 2.06E+02 | 3.64E+01 | 2.80E+03 | 7.62E-01 | 1.98E+02 |
| KIDNEY | 7.63E+01 | 8.55E+01 | 2.12E+01 | 1.43E+01 | 1.09E+03 | 2.51E+01 | 1.10E+03 |

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF CHILD

| Al i µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.64E+03 | 1.84E+03 | 2.58E+03 | 1.62E+02 | 8.37E+01 | 1.97E+00 | 2.05E+02 |
| BONE | 3.23E+01 | 3.60E+01 | 1.91E+04 | 1.86E+02 | 4.00E+02 | 5.14E-02 | 2.27E+01 |
| AVG.LUNG | 1.32E+04 | 1.47E+04 | 1.49E+04 | 1.18E+03 | 2.30E+01 | 2.70E+01 | 9.53E+02 |
| LIVER | 1.62E-01 | 1.46E-01 | 6.50E+01 | 9.12E+00 | 1.18E+03 | 5.53E-01 | 6.00E+01 |
| KIDNEY | 2.04E+01 | 2.29E+01 | 7.00E+00 | 4.42E+00 | 4.98E+02 | 1.61E+01 | 3.19E+02 |

| AD= 3.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 9.97E+02 | 1.12E+03 | 1.68E+03 | 1.16E+02 | 9.11E+01 | 1.56E+00 | 1.69E+02 |
| BONE | 2.38E+01 | 2.66E+01 | 1.38E+04 | 2.09E+02 | 4.35E+02 | 6.57E-02 | 2.57E+01 |
| AVG.LUNG | 8.32E+03 | 9.31E+03 | 9.39E+03 | 7.45E+02 | 2.50E+01 | 1.71E+01 | 6.01E+02 |
| LIVER | 1.14E-01 | 1.08E-01 | 4.70E+01 | 1.02E+01 | 1.29E+03 | 7.07E-01 | 6.78E+01 |
| KIDNEY | 1.51E+01 | 1.69E+01 | 5.07E+00 | 4.95E+00 | 5.37E+02 | 1.91E+01 | 3.61E+02 |

| AMAD= 7.7 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 5.33E+02 | 5.97E+02 | 9.93E+02 | 6.72E+01 | 1.10E+02 | 1.40E+00 | 1.56E+02 |
| BONE | 1.46E+01 | 1.51E+01 | 8.90E+03 | 2.43E+02 | 4.88E+02 | 8.34E-02 | 3.00E+01 |
| AVG.LUNG | 3.59E+03 | 4.02E+03 | 4.05E+03 | 3.22E+02 | 2.76E+01 | 7.36E+00 | 2.60E+02 |
| LIVER | 7.77E-02 | 8.02E-02 | 3.31E+01 | 1.24E+01 | 1.47E+03 | 9.15E-01 | 7.97E+01 |
| KIDNEY | 1.14E+01 | 1.28E+01 | 3.59E+00 | 5.99E+00 | 6.14E+02 | 2.35E+01 | 4.26E+02 |

| AMAD=[illegible] 0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.19E+00 | 1.31E+00 | 2.81E+02 | 3.15E+01 | 1.04E+02 | 8.77E-01 | 1.02E+02 |
| BONE | 8.28E+00 | 8.54E+00 | 4.61E+03 | 2.26E+02 | 4.67E+02 | 9.15E-02 | 2.66E+01 |
| AVG.LUNG | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.64E+01 | 0.00E+00 | 0.00E+00 |
| LIVER | 3.67E-02 | 4.54E-02 | 1.71E+01 | 1.15E+01 | 1.41E+03 | 1.00E+00 | 7.07E+01 |
| KIDNEY | 6.46E+00 | 7.24E+00 | 1.86E+00 | 5.58E+00 | 5.82E+02 | 2.09E+01 | 3.78E+02 |

| AD= 0.3 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 3.34E+03 | 3.74E+03 | 5.00E+03 | 3.06E+02 | 8.76E+01 | 3.26E+00 | 3.24E+02 |
| BONE | 6.17E+01 | 6.89E+01 | 3.71E+04 | 1.77E+02 | 4.09E+02 | 3.06E-02 | 2.01E+01 |
| AVG.LUNG | 2.86E+04 | 3.20E+04 | 3.22E+04 | 2.56E+03 | 2.33E+01 | 5.66E+01 | 2.07E+03 |
| LIVER | 3.07E-01 | 2.68E-01 | 1.26E+02 | 8.39E+00 | 1.24E+03 | 3.39E-01 | 5.29E+01 |
| KIDNEY | 3.91E+01 | 4.38E+01 | 1.36E+01 | 3.92E+00 | 5.12E+02 | 1.18E+01 | 2.80E+02 |

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF TEENAGE

| AMAD= 1.5 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 8.55E+02 | 9.62E+02 | 1.77E+03 | 9.20E+01 | 9.06E+01 | 2.13E+00 | 9.38E+01 |
| BONE | 4.15E+01 | 4.63E+01 | 1.97E+04 | 7.02E+02 | 9.58E+02 | 1.23E-01 | 1.46E+01 |
| AVG.LUNG | 6.88E+03 | 7.69E+03 | 7.76E+03 | 5.21E+02 | 9.51E+00 | 1.12E+01 | 4.20E+02 |
| LIVER | 8.43E-02 | 7.30E-02 | 3.76E+01 | 5.30E+00 | 5.07E+02 | 2.37E-01 | 2.73E+01 |
| KIDNEY | 1.17E+01 | 1.31E+01 | 4.28E+00 | 5.89E+00 | 2.39E+02 | 7.74E+00 | 1.65E+02 |

| AMAD= 3.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 5.20E+02 | 5.83E+02 | 1.16E+03 | 6.56E+01 | 9.87E+01 | 1.69E+00 | 7.74E+01 |
| BONE | 3.06E+01 | 3.41E+01 | 1.43E+04 | 7.87E+02 | 1.04E+03 | 1.57E-01 | 1.65E+01 |
| AVG.LUNG | 4.34E+03 | 4.85E+03 | 4.90E+03 | 3.29E+02 | 1.03E+01 | 7.06E+00 | 2.65E+02 |
| LIVER | 5.95E-02 | 5.38E-02 | 2.72E+01 | 5.94E+00 | 5.51E+02 | 3.03E-01 | 3.08E+01 |
| KIDNEY | 8.61E+00 | 9.64E+00 | 3.10E+00 | 6.60E+00 | 2.58E+02 | 9.18E+00 | 1.87E+02 |

| AMAD= 7.7 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 2.78E+02 | 3.12E+02 | 6.62E+02 | 5.88E+01 | 1.10E+02 | 1.40E+00 | 7.18E+01 |
| BONE | 2.47E+01 | 2.77E+01 | 9.08E+03 | 9.49E+02 | 1.22E+03 | 2.08E-01 | 2.03E+01 |
| AVG.LUNG | 1.87E+03 | 2.09E+03 | 2.11E+03 | 1.42E+02 | 1.24E+01 | 3.30E+00 | 1.15E+02 |
| LIVER | 3.89E-02 | 3.86E-02 | 1.73E+01 | 7.11E+00 | 6.61E+02 | 4.10E-01 | 3.75E+01 |
| KIDNEY | 6.18E+00 | 6.92E+00 | 1.97E+00 | 8.61E+00 | 3.07E+02 | 1.18E+01 | 2.27E+02 |

| AMAD=54.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-21 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 6.22E-01 | 6.85E-01 | 1.88E+02 | 2.76E+01 | 1.04E+02 | 8.77E-01 | 4.70E+01 |
| BONE | 1.40E+01 | 1.57E+01 | 4.70E+03 | 8.83E+02 | 1.17E+03 | 2.29E-01 | 1.80E+01 |
| AVG.LUNG | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.18E+01 | 0.00E+00 | 0.00E+00 |
| LIVER | 1.83E-02 | 2.19E-02 | 8.98E+00 | 6.62E+00 | 6.32E+02 | 4.50E-01 | 3.33E+01 |
| KIDNEY | 3.50E+00 | 3.92E+00 | 1.02E+00 | 8.02E+00 | 2.91E+02 | 1.05E+01 | 2.02E+02 |

| AMAD= 0.3 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.74E+03 | 1.95E+03 | 3.44E+03 | 1.58E+02 | 8.76E+01 | 3.26E+00 | 1.48E+02 |
| BONE | 7.49E+01 | 8.37E+01 | 3.83E+04 | 6.46E+02 | 1.01E+03 | 7.54E-02 | 1.27E+01 |
| AVG.LUNG | 1.49E+04 | 1.67E+04 | 1.68E+04 | 1.13E+03 | 9.99E+00 | 2.42E+01 | 9.11E+02 |
| LIVER | 1.54E-01 | 1.28E-01 | 6.64E+01 | 4.76E+00 | 5.33E+02 | 1.45E-01 | 2.48E+01 |
| KIDNEY | 2.05E+01 | 2.29E+01 | 7.56E+00 | 4.76E+00 | 2.56E+02 | 5.91E+00 | 1.50E+02 |

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF ADULT

| AMAD= 1.5 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 7.13E+02 | 8.02E+02 | 1.61E+03 | 5.41E+01 | 6.97E+01 | 1.64E+00 | 5.87E+01 |
| BONE | 2.30E+01 | 2.57E+01 | 1.97E+04 | 2.19E+02 | 5.64E+02 | 7.24E-02 | 5.82E+00 |
| AVG.LUNG | 5.73E+03 | 6.41E+03 | 6.47E+03 | 3.47E+02 | 7.92E+00 | 9.32E+00 | 2.80E+02 |
| LIVER | 7.03E-02 | 6.09E-02 | 3.42E+01 | 2.94E+00 | 4.23E+02 | 1.97E-01 | 1.82E+01 |
| KIDNEY | 9.73E+00 | 1.09E+01 | 3.89E+00 | 2.94E+00 | 1.99E+02 | 6.45E+00 | 1.10E+02 |

| AMAD= 3.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 4.34E+02 | 4.85E+02 | 1.05E+03 | 3.86E+01 | 7.59E+01 | 1.30E+00 | 4.84E+01 |
| BONE | 1.70E+01 | 1.90E+01 | 1.43E+04 | 2.46E+02 | 6.12E+02 | 9.26E-02 | 6.58E+00 |
| AVG.LUNG | 3.62E+03 | 4.05E+03 | 4.08E+03 | 2.19E+02 | 8.61E+00 | 5.88E+00 | 1.77E+02 |
| LIVER | 4.96E-02 | 4.48E-02 | 2.47E+01 | 3.30E+00 | 4.59E+02 | 2.52E-01 | 2.05E+01 |
| KIDNEY | 7.17E+00 | 8.03E+00 | 2.81E+00 | 3.30E+00 | 2.15E+02 | 7.65E+00 | 1.25E+02 |

| AMAD= 7.7 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 2.32E+02 | 2.60E+02 | 6.62E+02 | 2.80E+01 | 8.45E+01 | 1.08E+00 | 4.23E+01 |
| BONE | 1.12E+01 | 1.26E+01 | 9.08E+03 | 2.79E+02 | 6.78E+02 | 1.16E-01 | 7.51E+00 |
| AVG.LUNG | 1.56E+03 | 1.75E+03 | 1.76E+03 | 9.46E+01 | 9.53E+00 | 2.54E+00 | 7.63E+01 |
| LIVER | 2.99E-02 | 2.97E-02 | 1.58E+01 | 3.74E+00 | 5.08E+02 | 3.16E-01 | 2.34E+01 |
| KIDNEY | 4.75E+00 | 5.32E+00 | 1.79E+00 | 3.74E+00 | 2.36E+02 | 9.04E+00 | 1.42E+02 |

| µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 5.18E-01 | 5.71E-01 | 1.88E+02 | 1.31E+01 | 8.03E+01 | 6.75E-01 | 2.77E+01 |
| BONE | 6.37E+00 | 7.12E+00 | 4.70E+03 | 2.60E+02 | 6.48E+02 | 1.27E-01 | 6.66E+00 |
| AVG.LUNG | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.11E+00 | 0.00E+00 | 0.00E+00 |
| LIVER | 1.41E-02 | 1.68E-02 | 8.16E+00 | 3.49E+00 | 4.86E+02 | 3.46E-01 | 2.08E+01 |
| KIDNEY | 2.69E+00 | 3.01E+00 | 9.29E-01 | 3.49E+00 | 2.24E+02 | 8.05E+00 | 1.26E+02 |

| AMAD= 0.3 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.45E+03 | 1.63E+03 | 3.12E+03 | 9.86E+01 | 7.30E+01 | 2.72E+00 | 9.27E+01 |
| BONE | 4.41E+01 | 4.92E+01 | 3.83E+04 | 2.09E+02 | 5.92E+02 | 4.44E-02 | 5.29E+00 |
| AVG.LUNG | 1.24E+04 | 1.39E+04 | 1.40E+04 | 7.53E+02 | 8.33E+00 | 2.02E+01 | 6.07E+02 |
| LIVER | 1.40E-01 | 1.16E-01 | 6.64E+01 | 2.80E+00 | 4.44E+02 | 1.21E-01 | 1.65E+01 |
| KIDNEY | 1.86E+01 | 2.08E+01 | 7.56E+00 | 2.80E+00 | 2.13E+02 | 4.93E+00 | 1.00E+02 |

EXTERNAL WHOLE BODY DOSE CONVERSION FACTORS

| | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 |
|---|---|---|---|---|---|---|---|---|
| , MR/YR PER PCI/M2 | 3.70E-06 | 6.12E-07 | 9.47E-07 | 2.27E-06 | 5.03E-08 | 1.10E-08 | 3.16E-05 | 1.85E-04 |
| MR/YR PER PCI/M3 | 1.23E-04 | 3.59E-06 | 4.90E-05 | 1.43E-05 | 2.83E-06 | 6.34E-07 | 1.67E-03 | 1.16E-02 |
| NG LEVEL CONCENTRATION FACTORS, WL PER PCI/M3 | ..... | ..... | ..... | 1.03E-06 | 5.07E-06 | 3.73E-06 | | |

## INGESTION DOSE CONVERSION FACTORS, MREM PER PCI INGESTED

| AGE GROUP | TISSUE | U-238 | U-234 | Th-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po |
|---|---|---|---|---|---|---|---|---|---|
| INFANT | EFFECTIV | 1.61E-02 | 1.79E-02 | 8.57E-04 | 2.51E-02 | 2.11E-02 | 3.11E-02 | 3.88E-05 | 7.95E-02 |
| INFANT | BONE | 4.49E-02 | 5.43E-02 | 9.24E-07 | 4.39E-02 | 1.09E-01 | 1.86E-01 | 6.00E-07 | 3.29E-02 |
| INFANT | LIVER | 2.72E-04 | 3.15E-04 | 4.93E-07 | 3.74E-03 | 8.48E-03 | 3.62E-01 | 7.52E-06 | 4.48E-02 |
| INFANT | KIDNEY | 4.93E-02 | 5.71E-02 | 4.38E-07 | 3.53E-04 | 3.32E-03 | 1.35E-01 | 2.86E-04 | 2.23E-01 |
| CHILD | EFFECTIV | 9.95E-04 | 1.14E-03 | 5.30E-05 | 1.53E-03 | 2.38E-03 | 8.67E-03 | 1.08E-05 | 9.12E-03 |
| CHILD | BONE | 4.86E-03 | 5.43E-03 | 1.00E-07 | 3.32E-03 | 2.50E-02 | 7.86E-02 | 2.53E-07 | 2.07E-03 |
| CHILD | LIVER | 3.74E-05 | 4.20E-05 | 6.78E-08 | 1.45E-04 | 1.32E-03 | 8.81E-02 | 1.83E-06 | 6.88E-03 |
| CHILD | KIDNEY | 6.01E-03 | 6.75E-03 | 5.34E-08 | 1.54E-05 | 6.44E-04 | 3.54E-02 | 7.48E-05 | 3.44E-02 |
| TEENAGE | EFFECTIV | 7.90E-04 | 8.80E-04 | 4.22E-05 | 1.20E-03 | 4.22E-03 | 1.12E-02 | 1.40E-05 | 4.85E-03 |
| TEENAGE | BONE | 1.83E-02 | 2.05E-02 | 3.77E-07 | 3.32E-03 | 1.09E-01 | 2.35E-01 | 7.57E-07 | 1.65E-03 |
| TEENAGE | LIVER | 2.13E-05 | 2.39E-05 | 3.85E-08 | 5.94E-05 | 8.14E-04 | 4.75E-02 | 9.87E-07 | 3.68E-03 |
| TEENAGE | KIDNEY | 3.85E-03 | 4.33E-03 | 3.43E-08 | 6.80E-06 | 1.02E-03 | 2.18E-02 | 4.62E-05 | 2.04E-02 |
| ADULT | EFFECTIV | 2.55E-04 | 2.84E-04 | 1.36E-05 | 5.46E-04 | 1.32E-03 | 5.10E-03 | 6.36E-06 | 1.94E-03 |
| ADULT | BONE | 3.74E-03 | 4.18E-03 | 7.70E-08 | 1.33E-03 | 2.53E-02 | 8.10E-02 | 2.61E-07 | 4.22E-04 |
| ADULT | LIVER | 8.51E-06 | 9.55E-06 | 1.54E-08 | 2.20E-05 | 3.39E-04 | 2.26E-02 | 4.70E-07 | 1.60E-03 |
| ADULT | KIDNEY | 1.54E-03 | 1.73E-03 | 1.37E-08 | 2.52E-06 | 3.39E-04 | 1.04E-02 | 2.20E-05 | 9.29E-03 |

## ENVIRONMENTAL CONCENTRATION FACTORS

| CONCENTRATION FACTOR | FOOD TYPE | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|
| BIV, DIMENSIONLESS | ED.ABG. | 2.50E-03 | 4.20E-03 | 1.40E-02 | 4.00E-03 |
| BIV, DIMENSIONLESS | POTATO | 2.50E-03 | 4.20E-03 | 3.00E-03 | 4.00E-03 |
| BIV, DIMENSIONLESS | BELOW G. | 2.50E-03 | 4.20E-03 | 1.40E-02 | 4.00E-03 |
| BIV, DIMENSIONLESS | FORAGE | 2.50E-03 | 4.20E-03 | 1.80E-02 | 2.80E-02 |
| BIV, DIMENSIONLESS | ST. FEED | 2.50E-03 | 4.20E-03 | 8.20E-02 | 3.60E-02 |
| FBI, PCI/KG PER PCI/DAY | MEAT | 3.40E-04 | 2.00E-04 | 5.10E-04 | 7.10E-04 |
| FMI, PCI/L PER PCI/DAY | MILK | 6.10E-04 | 5.00E-06 | 5.90E-04 | 1.20E-04 |
| FRACTION IN ED PORTION | ED.ABG. | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 |
| FRACTION IN ED PORTION | POTATO | 1.00E-01 | 1.00E-01 | 1.00E-01 | 1.00E-01 |
| FRACTION IN ED PORTION | BELOW G. | 1.00E-01 | 1.00E-01 | 1.00E-01 | 1.00E-01 |
| FRACTION IN ED PORTION | FORAGE | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 |
| FRACTION IN ED PORTION | ST. FEED | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 |

## TIME STEP DEPENDENT VARIABLES

| NO. | TIME STEP NAME | PAJUST | GFACT U-238 | GFACT Th-230 | GFACT Ra-226 | GFACT Pb-210 | TFACT U-238 | TFACT Th-230 | TFACT Ra-226 | TFACT Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-YEAR PERIOD | 1.000E+00 | 3.134E+07 | 3.134E+07 | 3.134E+07 | 3.086E+07 | 1.621E+00 | 1.621E+00 | 1.621E+00 | 1.618E+00 |

XPFACT=2.640E+02 GPFACT(4)=1.707E+09 1.707E+09 1.679E+09 6.943E+08 TPFACT(4)=1.638E+00 1.638E+00 1.638E+00 1.624E+00

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE N DIRECTION, THETA EQUALS 0.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|
| 9.940E-06 | 2.319E-08 | 2.691E-08 | 8.064E-08 | 9.291E+00 | 8.706E+00 | 5.467E+00 | 3.922E+00 | 1.540E-05 | 5.131E-05 |
| 1.067E-05 | 2.489E-08 | 2.888E-08 | 8.655E-08 | 5.672E+00 | 5.508E+00 | 3.898E+00 | 3.075E+00 | 1.457E-05 | 3.690E-05 |
| 1.200E-05 | 2.799E-08 | 3.248E-08 | 9.733E-08 | 4.300E+00 | 4.243E+00 | 3.240E+00 | 2.702E+00 | 1.473E-05 | 3.088E-05 |
| 1.295E-05 | 3.022E-08 | 3.505E-08 | 1.051E-07 | 3.581E+00 | 3.559E+00 | 2.862E+00 | 2.464E+00 | 1.491E-05 | 2.737E-05 |
| 1.556E-05 | 3.630E-08 | 4.211E-08 | 1.262E-07 | 2.624E+00 | 2.622E+00 | 2.294E+00 | 2.054E+00 | 1.466E-05 | 2.199E-05 |
| 1.219E-05 | 2.844E-08 | 3.299E-08 | 9.887E-08 | 1.554E+00 | 1.554E+00 | 1.372E+00 | 1.228E+00 | 1.324E-05 | 1.314E-05 |
| 5.726E-06 | 1.336E-08 | 1.550E-08 | 4.645E-08 | 8.247E-01 | 8.252E-01 | 7.584E-01 | 6.848E-01 | 1.203E-05 | 7.249E-06 |
| 2.503E-06 | 5.840E-09 | 6.776E-09 | 2.031E-08 | 4.799E-01 | 4.802E-01 | 4.645E-01 | 4.414E-01 | 1.148E-05 | 4.496E-06 |
| 1.361E-06 | 3.176E-09 | 3.685E-09 | 1.104E-08 | 3.197E-01 | 3.199E-01 | 3.160E-01 | 3.081E-01 | 1.089E-05 | 3.081E-06 |
| 8.528E-07 | 1.990E-09 | 2.308E-09 | 6.918E-09 | 2.318E-01 | 2.319E-01 | 2.312E-01 | 2.284E-01 | 1.033E-05 | 2.263E-06 |
| 5.847E-07 | 1.364E-09 | 1.583E-09 | 4.743E-09 | 1.779E-01 | 1.780E-01 | 1.782E-01 | 1.773E-01 | 9.838E-06 | 1.748E-06 |
| 4.262E-07 | 9.945E-10 | 1.154E-09 | 3.458E-09 | 1.419E-01 | 1.420E-01 | 1.424E-01 | 1.423E-01 | 9.403E-06 | 1.399E-06 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.922E+00 | 4.484E-03 | 5.201E-03 | 5.201E-03 | 0.000E+00 | 6.900E+00 | 6.900E+00 | 6.900E+00 | 1.426E+00 |
| 2.5 | 2.062E+00 | 4.812E-03 | 5.582E-03 | 5.582E-03 | 0.000E+00 | 4.368E+00 | 4.368E+00 | 4.368E+00 | 1.349E+00 |
| 3.5 | 2.319E+00 | 5.412E-03 | 6.277E-03 | 6.277E-03 | 0.000E+00 | 3.367E+00 | 3.367E+00 | 3.367E+00 | 1.364E+00 |
| 4.5 | 2.503E+00 | 5.841E-03 | 6.775E-03 | 6.775E-03 | 0.000E+00 | 2.825E+00 | 2.825E+00 | 2.825E+00 | 1.380E+00 |
| 7.5 | 3.007E+00 | 7.017E-03 | 8.139E-03 | 8.139E-03 | 0.000E+00 | 2.085E+00 | 2.085E+00 | 2.085E+00 | 1.357E+00 |
| 15.0 | 2.356E+00 | 5.498E-03 | 6.377E-03 | 6.377E-03 | 0.000E+00 | 1.237E+00 | 1.237E+00 | 1.237E+00 | 1.226E+00 |
| [illegible] | 1.107E+00 | 2.583E-03 | 2.996E-03 | 2.996E-03 | 0.000E+00 | 6.566E-01 | 6.566E-01 | 6.566E-01 | 1.114E+00 |
| [illegible] | 4.839E-01 | 1.129E-03 | 1.310E-03 | 1.310E-03 | 0.000E+00 | 3.816E-01 | 3.816E-01 | 3.816E-01 | 1.063E+00 |
| [illegible] | 2.631E-01 | 6.140E-04 | 7.122E-04 | 7.122E-04 | 0.000E+00 | 2.541E-01 | 2.541E-01 | 2.541E-01 | 1.008E+00 |
| 55.0 | 1.649E-01 | 3.847E-04 | 4.462E-04 | 4.462E-04 | 0.000E+00 | 1.842E-01 | 1.842E-01 | 1.842E-01 | 9.559E-01 |
| 65.0 | 1.130E-01 | 2.638E-04 | 3.059E-04 | 3.059E-04 | 0.000E+00 | 1.413E-01 | 1.413E-01 | 1.413E-01 | 9.109E-01 |
| 75.0 | 8.240E-02 | 1.923E-04 | 2.230E-04 | 2.230E-04 | 0.000E+00 | 1.127E-01 | 1.127E-01 | 1.127E-01 | 8.706E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 9.940E-08 | 2.319E-10 | 2.691E-10 | 4.700E-08 |
| 2.5 | 1.067E-07 | 2.489E-10 | 2.888E-10 | 4.457E-08 |
| 3.5 | 1.200E-07 | 2.799E-10 | 3.248E-10 | 4.517E-08 |
| 4.5 | 1.295E-07 | 3.022E-10 | 3.505E-10 | 4.578E-08 |
| 7.5 | 1.556E-07 | 3.630E-10 | 4.211E-10 | 4.524E-08 |
| 15.0 | 1.219E-07 | 2.844E-10 | 3.299E-10 | 4.070E-08 |
| 25.0 | 5.726E-08 | 1.336E-10 | 1.550E-10 | 3.657E-08 |
| 35.0 | 2.503E-08 | 5.840E-11 | 6.776E-11 | 3.465E-08 |
| 45.0 | 1.361E-08 | 3.176E-11 | 3.685E-11 | 3.278E-08 |
| 55.0 | 8.528E-09 | 1.990E-11 | 2.308E-11 | 3.104E-08 |
| 65.0 | 5.847E-09 | 1.364E-11 | 1.583E-11 | 2.956E-08 |
| 75.0 | 4.262E-09 | 9.945E-12 | 1.154E-11 | 2.824E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE E DIRECTION, THETA EQUALS 90.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 6.620E-06 | 1.545E-08 | 1.792E-08 | 5.370E-08 | 1.073E+01 | 1.023E+01 | 5.690E+00 | 3.376E+00 | 1.084E-05 | 5.197E-05 |
| 2.5 | 5.567E-06 | 1.299E-08 | 1.507E-08 | 4.516E-08 | 6.984E+00 | 6.755E+00 | 4.229E+00 | 2.820E+00 | 1.053E-05 | 3.892E-05 |
| 3.5 | 4.857E-06 | 1.133E-08 | 1.315E-08 | 3.940E-08 | 4.913E+00 | 4.811E+00 | 3.355E+00 | 2.479E+00 | 1.106E-05 | 3.121E-05 |
| 4.5 | 4.198E-06 | 9.796E-09 | 1.137E-08 | 3.406E-08 | 3.552E+00 | 3.513E+00 | 2.720E+00 | 2.189E+00 | 1.168E-05 | 2.557E-05 |
| 7.5 | 2.638E-06 | 6.155E-09 | 7.141E-09 | 2.140E-08 | 1.529E+00 | 1.527E+00 | 1.382E+00 | 1.268E+00 | 1.182E-05 | 1.331E-05 |
| 15.0 | 8.587E-07 | 2.004E-09 | 2.324E-09 | 6.966E-09 | 6.523E-01 | 6.527E-01 | 6.372E-01 | 6.198E-01 | 1.205E-05 | 6.215E-06 |
| 25.0 | 4.587E-07 | 1.070E-09 | 1.242E-09 | 3.721E-09 | 3.615E-01 | 3.618E-01 | 3.598E-01 | 3.562E-01 | 1.165E-05 | 3.525E-06 |
| 35.0 | 2.976E-07 | 6.944E-10 | 8.056E-10 | 2.414E-09 | 2.392E-01 | 2.394E-01 | 2.395E-01 | 2.386E-01 | 1.102E-05 | 2.351E-06 |
| 45.0 | 2.111E-07 | 4.926E-10 | 5.715E-10 | 1.713E-09 | 1.729E-01 | 1.730E-01 | 1.735E-01 | 1.734E-01 | 1.041E-05 | 1.705E-06 |
| 55.0 | 1.587E-07 | 3.702E-10 | 4.295E-10 | 1.287E-09 | 1.321E-01 | 1.321E-01 | 1.327E-01 | 1.328E-01 | 9.862E-06 | 1.304E-06 |
| 65.0 | 1.240E-07 | 2.894E-10 | 3.358E-10 | 1.006E-09 | 1.048E-01 | 1.049E-01 | 1.053E-01 | 1.056E-01 | 9.383E-06 | 1.036E-06 |
| 75.0 | 9.982E-08 | 2.329E-10 | 2.702E-10 | 8.098E-10 | 8.551E-02 | 8.556E-02 | 8.597E-02 | 8.623E-02 | 8.958E-06 | 8.457E-07 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.280E+00 | 2.986E-03 | 3.464E-03 | 3.464E-03 | 0.000E+00 | 8.106E+00 | 8.106E+00 | 8.106E+00 | 1.004E+00 |
| 2.5 | 1.076E+00 | 2.511E-03 | 2.913E-03 | 2.913E-03 | 0.000E+00 | 5.353E+00 | 5.353E+00 | 5.353E+00 | 9.750E-01 |
| 3.5 | 9.389E-01 | 2.191E-03 | 2.541E-03 | 2.541E-03 | 0.000E+00 | 3.813E+00 | 3.813E+00 | 3.813E+00 | 1.024E+00 |
| 4.5 | 8.116E-01 | 1.894E-03 | 2.197E-03 | 2.197E-03 | 0.000E+00 | 2.785E+00 | 2.785E+00 | 2.785E+00 | 1.081E+0[illegible] |
| 7.5 | 5.100E-01 | 1.190E-03 | 1.380E-03 | 1.380E-03 | 0.000E+00 | 1.211E+00 | 1.211E+00 | 1.211E+00 | 1.095E[illegible] |
| 15.0 | 1.660E-01 | 3.873E-04 | 4.493E-04 | 4.493E-04 | 0.000E+00 | 5.174E-01 | 5.174E-01 | 5.174E-01 | 1.116E+[illegible] |
| 25.0 | 8.867E-02 | 2.069E-04 | 2.400E-04 | 2.400E-04 | 0.000E+00 | 2.868E-01 | 2.868E-01 | 2.868E-01 | 1.078E+00 |
| 35.0 | 5.753E-02 | 1.342E-04 | 1.557E-04 | 1.557E-04 | 0.000E+00 | 1.898E-01 | 1.898E-01 | 1.898E-01 | 1.020E+00 |
| 45.0 | 4.081E-02 | 9.522E-05 | 1.105E-04 | 1.105E-04 | 0.000E+00 | 1.371E-01 | 1.371E-01 | 1.371E-01 | 9.634E-01 |
| 55.0 | 3.067E-02 | 7.157E-05 | 8.302E-05 | 8.302E-05 | 0.000E+00 | 1.047E-01 | 1.047E-01 | 1.047E-01 | 9.130E-01 |
| 65.0 | 2.398E-02 | 5.595E-05 | 6.490E-05 | 6.490E-05 | 0.000E+00 | 8.311E-02 | 8.311E-02 | 8.311E-02 | 8.687E-01 |
| 75.0 | 1.930E-02 | 4.503E-05 | 5.223E-05 | 5.223E-05 | 0.000E+00 | 6.782E-02 | 6.782E-02 | 6.782E-02 | 8.294E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 6.620E-08 | 1.545E-10 | 1.792E-10 | 3.307E-08 |
| 2.5 | 5.567E-08 | 1.299E-10 | 1.507E-10 | 3.205E-08 |
| 3.5 | 4.857E-08 | 1.133E-10 | 1.315E-10 | 3.357E-08 |
| 4.5 | 4.198E-08 | 9.796E-11 | 1.137E-10 | 3.537E-08 |
| 7.5 | 2.638E-08 | 6.155E-11 | 7.141E-11 | 3.568E-08 |
| 15.0 | 8.587E-09 | 2.004E-11 | 2.324E-11 | 3.623E-08 |
| 25.0 | 4.587E-09 | 1.070E-11 | 1.242E-11 | 3.498E-08 |
| 35.0 | 2.976E-09 | 6.944E-12 | 8.056E-12 | 3.307E-08 |
| 45.0 | 2.111E-09 | 4.926E-12 | 5.715E-12 | 3.124E-08 |
| 55.0 | 1.587E-09 | 3.702E-12 | 4.295E-12 | 2.960E-08 |
| 65.0 | 1.240E-09 | 2.894E-12 | 3.358E-12 | 2.816E-08 |
| 75.0 | 9.982E-10 | 2.329E-12 | 2.702E-12 | 2.688E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE SSE DIRECTION, THETA EQUALS 157.5 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|
| 8.070E-06 | 1.883E-08 | 2.185E-08 | 6.547E-08 | 5.260E+01 | 4.632E+01 | 1.749E+01 | 7.495E+00 | 1.356E-05 | 1.643E-04 |
| 7.141E-06 | 1.666E-08 | 1.933E-08 | 5.793E-08 | 7.720E+01 | 6.586E+01 | 1.902E+01 | 6.050E+00 | 1.041E-05 | 1.868E-04 |
| 6.350E-06 | 1.482E-08 | 1.719E-08 | 5.151E-08 | 2.304E+01 | 2.081E+01 | 7.350E+00 | 2.794E+00 | 9.006E-06 | 6.912E-05 |
| 5.675E-06 | 1.324E-08 | 1.536E-08 | 4.604E-08 | 1.275E+01 | 1.186E+01 | 5.758E+00 | 3.008E+00 | 1.027E-05 | 5.262E-05 |
| 4.175E-06 | 9.742E-09 | 1.130E-08 | 3.387E-08 | 3.581E+00 | 3.542E+00 | 2.600E+00 | 2.074E+00 | 1.301E-05 | 2.456E-05 |
| 2.289E-06 | 5.342E-09 | 6.197E-09 | 1.857E-08 | 1.165E+00 | 1.165E+00 | 1.040E+00 | 9.306E-01 | 1.383E-05 | 9.945E-06 |
| 1.298E-06 | 3.029E-09 | 3.514E-09 | 1.053E-08 | 5.798E-01 | 5.802E-01 | 5.558E-01 | 5.239E-01 | 1.297E-05 | 5.369E-06 |
| 8.484E-07 | 1.980E-09 | 2.297E-09 | 6.882E-09 | 3.718E-01 | 3.720E-01 | 3.656E-01 | 3.544E-01 | 1.216E-05 | 3.558E-06 |
| 6.019E-07 | 1.404E-09 | 1.629E-09 | 4.883E-09 | 2.667E-01 | 2.669E-01 | 2.652E-01 | 2.609E-01 | 1.149E-05 | 2.593E-06 |
| 4.506E-07 | 1.051E-09 | 1.220E-09 | 3.656E-09 | 2.038E-01 | 2.039E-01 | 2.037E-01 | 2.021E-01 | 1.091E-05 | 1.996E-06 |
| 3.506E-07 | 8.180E-10 | 9.489E-10 | 2.844E-09 | 1.623E-01 | 1.624E-01 | 1.627E-01 | 1.622E-01 | 1.042E-05 | 1.598E-06 |
| 2.807E-07 | 6.550E-10 | 7.599E-10 | 2.277E-09 | 1.333E-01 | 1.334E-01 | 1.338E-01 | 1.338E-01 | 9.982E-06 | 1.315E-06 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.560E+00 | 3.640E-03 | 4.222E-03 | 4.222E-03 | 0.000E+00 | 3.669E+01 | 3.669E+01 | 3.669E+01 | 1.255E+00 |
| 2.5 | 1.381E+00 | 3.221E-03 | 3.736E-03 | 3.736E-03 | 0.000E+00 | 5.217E+01 | 5.217E+01 | 5.217E+01 | 9.633E-01 |
| 3.5 | 1.228E+00 | 2.864E-03 | 3.322E-03 | 3.322E-03 | 0.000E+00 | 1.649E+01 | 1.649E+01 | 1.649E+01 | 8.338E-01 |
| 4.5 | 1.097E+00 | 2.560E-03 | 2.969E-03 | 2.969E-03 | 0.000E+00 | 9.394E+00 | 9.394E+00 | 9.394E+00 | 9.511E-01 |
| 7.5 | 8.072E-01 | 1.883E-03 | 2.185E-03 | 2.185E-03 | 0.000E+00 | 2.807E+00 | 2.807E+00 | 2.807E+00 | 1.204E+00 |
| 15.0 | 4.426E-01 | 1.033E-03 | 1.198E-03 | 1.198E-03 | 0.000E+00 | 9.240E-01 | 9.240E-01 | 9.240E-01 | 1.281E+00 |
| 25.0 | 2.509E-01 | 5.855E-04 | 6.792E-04 | 6.792E-04 | 0.000E+00 | 4.602E-01 | 4.602E-01 | 4.602E-01 | 1.200E+00 |
| [illegible] | 1.640E-01 | 3.827E-04 | 4.439E-04 | 4.439E-04 | 0.000E+00 | 2.951E-01 | 2.951E-01 | 2.951E-01 | 1.125E+00 |
| 45.0 | 1.164E-01 | 2.715E-04 | 3.149E-04 | 3.149E-04 | 0.000E+00 | 2.117E-01 | 2.117E-01 | 2.117E-01 | 1.064E+00 |
| 55.0 | 8.711E-02 | 2.033E-04 | 2.358E-04 | 2.358E-04 | 0.000E+00 | 1.617E-01 | 1.617E-01 | 1.617E-01 | 1.010E+00 |
| 65.0 | 6.777E-02 | 1.581E-04 | 1.834E-04 | 1.834E-04 | 0.000E+00 | 1.288E-01 | 1.288E-01 | 1.288E-01 | 9.643E-01 |
| 75.0 | 5.427E-02 | 1.266E-04 | 1.469E-04 | 1.469E-04 | 0.000E+00 | 1.058E-01 | 1.058E-01 | 1.058E-01 | 9.242E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 8.070E-08 | 1.883E-10 | 2.185E-10 | 4.133E-08 |
| 2.5 | 7.141E-08 | 1.666E-10 | 1.933E-10 | 3.179E-08 |
| 3.5 | 6.350E-08 | 1.482E-10 | 1.719E-10 | 2.753E-08 |
| 4.5 | 5.675E-08 | 1.324E-10 | 1.536E-10 | 3.128E-08 |
| 7.5 | 4.175E-08 | 9.742E-11 | 1.130E-10 | 3.936E-08 |
| 15.0 | 2.289E-08 | 5.342E-11 | 6.197E-11 | 4.169E-08 |
| 25.0 | 1.298E-08 | 3.029E-11 | 3.514E-11 | 3.900E-08 |
| 35.0 | 8.484E-09 | 1.980E-11 | 2.297E-11 | 3.654E-08 |
| 45.0 | 6.019E-09 | 1.404E-11 | 1.629E-11 | 3.451E-08 |
| 55.0 | 4.506E-09 | 1.051E-11 | 1.220E-11 | 3.277E-08 |
| 65.0 | 3.506E-09 | 8.180E-12 | 9.489E-12 | 3.127E-08 |
| 75.0 | 2.807E-09 | 6.550E-12 | 7.599E-12 | 2.997E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE S DIRECTION, THETA EQUALS 180.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 8.888E-06 | 2.074E-08 | 2.406E-08 | 7.210E-08 | 5.923E+01 | 5.510E+01 | 2.189E+01 | 9.054E+00 | 1.523E-05 | 2.015E-04 |
| 2.5 | 8.203E-06 | 1.914E-08 | 2.220E-08 | 6.654E-08 | 2.167E+01 | 2.050E+01 | 9.221E+00 | 4.409E+00 | 1.106E-05 | 8.431E-05 |
| 3.5 | 7.524E-06 | 1.755E-08 | 2.037E-08 | 6.103E-08 | 8.788E+00 | 8.440E+00 | 4.680E+00 | 2.613E+00 | 9.568E-06 | 4.217E-05 |
| 4.5 | 6.882E-06 | 1.606E-08 | 1.863E-08 | 5.583E-08 | 5.045E+00 | 4.941E+00 | 3.273E+00 | 2.222E+00 | 1.006E-05 | 2.997E-05 |
| 7.5 | 5.381E-06 | 1.256E-08 | 1.457E-08 | 4.366E-08 | 2.371E+00 | 2.365E+00 | 1.925E+00 | 1.620E+00 | 1.187E-05 | 1.824E-05 |
| 15.0 | 2.689E-06 | 6.274E-09 | 7.279E-09 | 2.181E-08 | 9.226E-01 | 9.230E-01 | 8.460E-01 | 7.689E-01 | 1.184E-05 | 8.108E-06 |
| 25.0 | 1.396E-06 | 3.257E-09 | 3.778E-09 | 1.132E-08 | 4.669E-01 | 4.672E-01 | 4.519E-01 | 4.300E-01 | 1.075E-05 | 4.376E-06 |
| 35.0 | 8.584E-07 | 2.003E-09 | 2.324E-09 | 6.963E-09 | 2.966E-01 | 2.968E-01 | 2.930E-01 | 2.857E-01 | 9.876E-06 | 2.857E-06 |
| 45.0 | 5.849E-07 | 1.365E-09 | 1.583E-09 | 4.745E-09 | 2.099E-01 | 2.100E-01 | 2.092E-01 | 2.066E-01 | 9.180E-06 | 2.048E-06 |
| 55.0 | 4.264E-07 | 9.948E-10 | 1.154E-09 | 3.459E-09 | 1.584E-01 | 1.585E-01 | 1.585E-01 | 1.577E-01 | 8.612E-06 | 1.555E-06 |
| 65.0 | 3.258E-07 | 7.603E-10 | 8.820E-10 | 2.643E-09 | 1.249E-01 | 1.250E-01 | 1.253E-01 | 1.251E-01 | 8.145E-06 | 1.231E-06 |
| 75.0 | 2.579E-07 | 6.018E-10 | 6.982E-10 | 2.092E-09 | 1.016E-01 | 1.017E-01 | 1.021E-01 | 1.021E-01 | 7.747E-06 | 1.003E-06 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.718E+00 | 4.009E-03 | 4.650E-03 | 4.650E-03 | 0.000E+00 | 4.365E+01 | 4.365E+01 | 4.365E+01 | 1.410E+00 |
| 2.5 | 1.586E+00 | 3.700E-03 | 4.292E-03 | 4.292E-03 | 0.000E+00 | 1.624E+01 | 1.624E+01 | 1.624E+01 | 1.024E+00 |
| 3.5 | 1.454E+00 | 3.394E-03 | 3.936E-03 | 3.936E-03 | 0.000E+00 | 6.689E+00 | 6.689E+00 | 6.689E+00 | 8.859E-01 |
| 4.5 | 1.330E+00 | 3.104E-03 | 3.601E-03 | 3.601E-03 | 0.000E+00 | 3.917E+00 | 3.917E+00 | 3.917E+00 | 9.313E-01 |
| 7.5 | 1.040E+00 | 2.427E-03 | 2.816E-03 | 2.816E-03 | 0.000E+00 | 1.876E+00 | 1.876E+00 | 1.876E+00 | 1.099E+0 |
| 15.0 | 5.198E-01 | 1.213E-03 | 1.407E-03 | 1.407E-03 | 0.000E+00 | 7.325E-01 | 7.325E-01 | 7.325E-01 | 1.096E+00 |
| 25.0 | 2.698E-01 | 6.296E-04 | 7.303E-04 | 7.303E-04 | 0.000E+00 | 3.708E-01 | 3.708E-01 | 3.708E-01 | 9.956E-01 |
| 35.0 | 1.659E-01 | 3.872E-04 | 4.491E-04 | 4.491E-04 | 0.000E+00 | 2.355E-01 | 2.355E-01 | 2.355E-01 | 9.144E-01 |
| 45.0 | 1.131E-01 | 2.638E-04 | 3.060E-04 | 3.060E-04 | 0.000E+00 | 1.666E-01 | 1.666E-01 | 1.666E-01 | 8.499E-01 |
| 55.0 | 8.242E-02 | 1.923E-04 | 2.231E-04 | 2.231E-04 | 0.000E+00 | 1.257E-01 | 1.257E-01 | 1.257E-01 | 7.973E-01 |
| 65.0 | 6.299E-02 | 1.470E-04 | 1.705E-04 | 1.705E-04 | 0.000E+00 | 9.915E-02 | 9.915E-02 | 9.915E-02 | 7.541E-01 |
| 75.0 | 4.986E-02 | 1.163E-04 | 1.349E-04 | 1.349E-04 | 0.000E+00 | 8.066E-02 | 8.066E-02 | 8.066E-02 | 7.172E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 8.888E-08 | 2.074E-10 | 2.406E-10 | 4.641E-08 |
| 2.5 | 8.203E-08 | 1.914E-10 | 2.220E-10 | 3.386E-08 |
| 3.5 | 7.524E-08 | 1.755E-10 | 2.037E-10 | 2.932E-08 |
| 4.5 | 6.882E-08 | 1.606E-10 | 1.863E-10 | 3.074E-08 |
| 7.5 | 5.381E-08 | 1.256E-10 | 1.457E-10 | 3.606E-08 |
| 15.0 | 2.689E-08 | 6.274E-11 | 7.279E-11 | 3.572E-08 |
| 25.0 | 1.396E-08 | 3.257E-11 | 3.778E-11 | 3.237E-08 |
| 35.0 | 8.584E-09 | 2.003E-11 | 2.324E-11 | 2.970E-08 |
| 45.0 | 5.849E-09 | 1.365E-11 | 1.583E-11 | 2.759E-08 |
| 55.0 | 4.264E-09 | 9.948E-12 | 1.154E-11 | 2.587E-08 |
| 65.0 | 3.258E-09 | 7.603E-12 | 8.820E-12 | 2.446E-08 |
| 75.0 | 2.579E-09 | 6.018E-12 | 6.982E-12 | 2.326E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE W DIRECTION, THETA EQUALS 270.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|
| 1.322E-05 | 3.084E-08 | 3.578E-08 | 1.072E-07 | 1.771E+01 | 1.753E+01 | 1.248E+01 | 8.844E+00 | 2.568E-05 | 1.143E-04 |
| 1.551E-05 | 3.619E-08 | 4.199E-08 | 1.258E-07 | 1.188E+01 | 1.183E+01 | 9.455E+00 | 7.486E+00 | 2.729E-05 | 8.805E-05 |
| 1.724E-05 | 4.024E-08 | 4.668E-08 | 1.399E-07 | 8.896E+00 | 8.885E+00 | 7.494E+00 | 6.309E+00 | 2.826E-05 | 7.068E-05 |
| 1.781E-05 | 4.155E-08 | 4.820E-08 | 1.445E-07 | 7.001E+00 | 6.998E+00 | 6.093E+00 | 5.319E+00 | 2.860E-05 | 5.794E-05 |
| 1.397E-05 | 3.260E-08 | 3.782E-08 | 1.133E-07 | 3.518E+00 | 3.519E+00 | 3.186E+00 | 2.902E+00 | 2.353E-05 | 3.060E-05 |
| 3.872E-06 | 9.034E-09 | 1.048E-08 | 3.141E-08 | 1.205E+00 | 1.206E+00 | 1.171E+00 | 1.127E+00 | 1.755E-05 | 1.138E-05 |
| 9.201E-07 | 2.147E-09 | 2.491E-09 | 7.464E-09 | 4.946E-01 | 4.949E-01 | 4.918E-01 | 4.852E-01 | 1.332E-05 | 4.813E-06 |
| 4.334E-07 | 1.011E-09 | 1.173E-09 | 3.516E-09 | 3.032E-01 | 3.034E-01 | 3.038E-01 | 3.029E-01 | 1.205E-05 | 2.982E-06 |
| 2.828E-07 | 6.598E-10 | 7.655E-10 | 2.294E-09 | 2.191E-01 | 2.192E-01 | 2.201E-01 | 2.203E-01 | 1.161E-05 | 2.163E-06 |
| 1.915E-07 | 4.469E-10 | 5.185E-10 | 1.554E-09 | 1.649E-01 | 1.650E-01 | 1.658E-01 | 1.663E-01 | 1.106E-05 | 1.631E-06 |
| 1.371E-07 | 3.199E-10 | 3.712E-10 | 1.112E-09 | 1.288E-01 | 1.289E-01 | 1.296E-01 | 1.300E-01 | 1.053E-05 | 1.275E-06 |
| 1.025E-07 | 2.392E-10 | 2.775E-10 | 8.316E-10 | 1.036E-01 | 1.037E-01 | 1.043E-01 | 1.046E-01 | 1.004E-05 | 1.026E-06 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 2.555E+00 | 5.961E-03 | 6.915E-03 | 6.915E-03 | 0.000E+00 | 1.389E+01 | 1.389E+01 | 1.389E+01 | 2.377E+00 |
| 2.5 | 2.998E+00 | 6.996E-03 | 8.115E-03 | 8.115E-03 | 0.000E+00 | 9.382E+00 | 9.382E+00 | 9.382E+00 | 2.527E+00 |
| 3.5 | 3.334E+00 | 7.779E-03 | 9.023E-03 | 9.023E-03 | 0.000E+00 | 7.046E+00 | 7.046E+00 | 7.046E+00 | 2.617E+00 |
| 4.5 | 3.442E+00 | 8.032E-03 | 9.317E-03 | 9.317E-03 | 0.000E+00 | 5.552E+00 | 5.552E+00 | 5.552E+00 | 2.648E+00 |
| 7.5 | 2.701E+00 | 6.302E-03 | 7.310E-03 | 7.310E-03 | 0.000E+00 | 2.794E+00 | 2.794E+00 | 2.794E+00 | 2.178E+00 |
| 15.0 | 7.484E-01 | 1.746E-03 | 2.026E-03 | 2.026E-03 | 0.000E+00 | 9.573E-01 | 9.573E-01 | 9.573E-01 | 1.625E+00 |
| 25.0 | 1.779E-01 | 4.150E-04 | 4.814E-04 | 4.814E-04 | 0.000E+00 | 3.925E-01 | 3.925E-01 | 3.925E-01 | 1.233E+00 |
| | 8.379E-02 | 1.955E-04 | 2.268E-04 | 2.268E-04 | 0.000E+00 | 2.405E-01 | 2.405E-01 | 2.405E-01 | 1.116E+00 |
| | 5.467E-02 | 1.276E-04 | 1.480E-04 | 1.480E-04 | 0.000E+00 | 1.738E-01 | 1.738E-01 | 1.738E-01 | 1.075E+00 |
| 55.0 | 3.703E-02 | 8.640E-05 | 1.002E-04 | 1.002E-04 | 0.000E+00 | 1.308E-01 | 1.308E-01 | 1.308E-01 | 1.024E+00 |
| 65.0 | 2.651E-02 | 6.185E-05 | 7.174E-05 | 7.174E-05 | 0.000E+00 | 1.022E-01 | 1.022E-01 | 1.022E-01 | 9.748E-01 |
| 75.0 | 1.982E-02 | 4.624E-05 | 5.363E-05 | 5.363E-05 | 0.000E+00 | 8.220E-02 | 8.220E-02 | 8.220E-02 | 9.298E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 1.322E-07 | 3.084E-10 | 3.578E-10 | 7.810E-08 |
| 2.5 | 1.551E-07 | 3.619E-10 | 4.199E-10 | 8.314E-08 |
| 3.5 | 1.724E-07 | 4.024E-10 | 4.668E-10 | 8.619E-08 |
| 4.5 | 1.781E-07 | 4.155E-10 | 4.820E-10 | 8.723E-08 |
| 7.5 | 1.397E-07 | 3.260E-10 | 3.782E-10 | 7.171E-08 |
| 15.0 | 3.872E-08 | 9.034E-11 | 1.048E-10 | 5.297E-08 |
| 25.0 | 9.201E-09 | 2.147E-11 | 2.491E-11 | 4.003E-08 |
| 35.0 | 4.334E-09 | 1.011E-11 | 1.173E-11 | 3.620E-08 |
| 45.0 | 2.828E-09 | 6.598E-12 | 7.655E-12 | 3.484E-08 |
| 55.0 | 1.915E-09 | 4.469E-12 | 5.185E-12 | 3.319E-08 |
| 65.0 | 1.371E-09 | 3.199E-12 | 3.712E-12 | 3.160E-08 |
| 75.0 | 1.025E-09 | 2.392E-12 | 2.775E-12 | 3.014E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.153E-02 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.298E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.958E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.337E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.749E-05 | 0.000E+00 | 5.387E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.105E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.326E-04 | 0.000E+00 | 4.495E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.010E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 7.881E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.816E-04 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.100E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.860E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.261E-02 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 3.907E-02 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| TION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.220E-02 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.302E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.641E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 7.646E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.662E-05 | 0.000E+00 | 1.011E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.232E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.485E-04 | 0.000E+00 | 1.999E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.194E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.187E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.682E-03 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.346E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.720E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 7.701E-02 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 1.836E-01 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS AVG.LUNG

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| D ECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.334E-02 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.213E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.931E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.293E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.763E-04 | 0.000E+00 | 3.354E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.297E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.241E-03 | 0.000E+00 | 1.667E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.112E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.194E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.231E-04 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.784E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.474E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.624E-02 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 1.352E-01 PERSON-REM/YR

METSET: IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS AVG.LUNG

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.334E-02 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.213E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.931E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.293E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.763E-04 | 0.000E+00 | 3.354E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.297E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.241E-03 | 0.000E+00 | 1.667E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.112E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.194E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.231E-04 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.784E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.474E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.624E-02 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 1.352E-01 PERSON-REM/YR

IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS BRONCHI

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| ECTION | IRHO 1.5 | IRHO 2.5 | IRHO 3.5 | IRHO 4.5 | IRHO 7.5 | IRHO 15.0 | IRHO 25.0 | IRHO 35.0 | IRHO 45.0 | IRHO 55.0 | IRHO 65.0 | IRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| R | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.063E+00 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.244E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.201E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.671E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.377E-02 | 0.000E+00 | 1.747E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.088E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.741E-02 | 0.000E+00 | 7.822E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.968E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.657E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.278E-02 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.189E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.729E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.948E+00 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 5.755E+00 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS GROUND EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.784E-04 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.787E-07 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.382E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.267E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.736E-06 | 0.000E+00 | 2.026E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.194E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.628E-06 | 0.000E+00 | 9.536E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.708E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.940E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.504E-06 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.583E-07 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.073E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.446E-04 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 7.124E-04 PERSON-REM/YR

SET: IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS CLOUD EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.689E-02 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.529E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.664E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.347E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.470E-04 | 0.000E+00 | 1.241E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.452E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.060E-04 | 0.000E+00 | 6.868E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.397E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.364E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.659E-04 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.582E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.019E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.718E-02 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 4.985E-02 PERSON-REM/YR

METSET: IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS VEG. ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | IRHO 1.5 | IRHO 2.5 | IRHO 3.5 | IRHO 4.5 | IRHO 7.5 | IRHO 15.0 | IRHO 25.0 | IRHO 35.0 | IRHO 45.0 | IRHO 55.0 | IRHO 65.0 | IRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 8.719E-06 | 1.410E-05 | 2.041E-05 | 2.696E-05 | 2.326E-04 | 8.094E-04 | 1.080E-03 | 1.329E-03 | 1.571E-03 | 1.794E-03 | 2.005E-03 | 2.199E-03 |
| NNE | 7.376E-06 | 1.230E-05 | 1.750E-05 | 2.234E-05 | 1.833E-04 | 5.386E-04 | 9.326E-04 | 1.232E-03 | 1.469E-03 | 1.679E-03 | 1.871E-03 | 2.048E-03 |
| NE | 6.754E-06 | 1.131E-05 | 1.589E-05 | 2.029E-05 | 1.664E-04 | 6.156E-04 | 8.071E-04 | 1.052E-03 | 1.340E-03 | 1.596E-03 | 1.828E-03 | 2.041E-03 |
| ENE | 6.265E-06 | 1.022E-05 | 1.466E-05 | 1.925E-05 | 1.560E-04 | 5.684E-04 | 8.113E-04 | 9.870E-04 | 1.136E-03 | 1.267E-03 | 1.385E-03 | 1.494E-03 |
| E | 6.078E-06 | 9.605E-06 | 1.373E-05 | 1.819E-05 | 1.469E-04 | 5.689E-04 | 9.066E-04 | 1.194E-03 | 1.447E-03 | 1.674E-03 | 1.881E-03 | 2.070E-03 |
| ESE | 5.912E-06 | 8.933E-06 | 1.252E-05 | 1.665E-05 | 1.619E-04 | 6.343E-04 | 9.555E-04 | 1.226E-03 | 1.465E-03 | 1.680E-03 | 1.877E-03 | 2.058E-03 |
| SE | 6.408E-06 | 8.778E-06 | 1.186E-05 | 1.694E-05 | 1.616E-04 | 6.368E-04 | 9.582E-04 | 1.233E-03 | 1.477E-03 | 1.700E-03 | 1.907E-03 | 2.100E-03 |
| SSE | 7.565E-06 | 9.939E-06 | 1.210E-05 | 1.698E-05 | 1.669E-04 | 6.744E-04 | 1.031E-03 | 1.338E-03 | 1.616E-03 | 1.869E-03 | 2.103E-03 | 2.321E-03 |
| S | 8.468E-06 | 1.073E-05 | 1.315E-05 | 1.728E-05 | 1.588E-04 | 5.890E-04 | 8.635E-04 | 1.093E-03 | 1.297E-03 | 1.480E-03 | 1.648E-03 | 1.804E-03 |
| SSW | 9.871E-06 | 1.288E-05 | 1.470E-05 | 1.845E-05 | 1.469E-04 | 5.093E-04 | 7.561E-04 | 9.782E-04 | 1.174E-03 | 1.350E-03 | 1.510E-03 | 1.657E-03 |
| SW | 1.128E-05 | 1.642E-05 | 1.922E-05 | 2.106E-05 | 1.411E-04 | 4.509E-04 | 6.378E-04 | 8.049E-04 | 9.485E-04 | 1.075E-03 | 1.190E-03 | 1.294E-03 |
| WSW | 1.259E-05 | 2.228E-05 | 2.727E-05 | 3.187E-05 | 1.776E-04 | 5.045E-04 | 6.180E-04 | 7.216E-04 | 8.301E-04 | 9.259E-04 | 1.013E-03 | 1.092E-03 |
| W | 1.399E-05 | 2.519E-05 | 3.695E-05 | 4.826E-05 | 3.282E-04 | 8.715E-04 | 1.047E-03 | 1.311E-03 | 1.617E-03 | 1.878E-03 | 2.111E-03 | 2.320E-03 |
| WNW | 1.414E-05 | 2.789E-05 | 4.254E-05 | 5.807E-05 | 4.875E-04 | 1.450E-03 | 2.495E-03 | 3.784E-03 | 4.793E-03 | 5.654E-03 | 6.416E-03 | 7.100E-03 |
| NW | 1.249E-05 | 2.439E-05 | 3.849E-05 | 5.486E-05 | 6.515E-04 | 5.268E-03 | 4.604E-03 | 5.491E-03 | 6.445E-03 | 7.342E-03 | 8.172E-03 | 8.936E-03 |
| NNW | 1.040E-05 | 1.852E-05 | 2.673E-05 | 3.614E-05 | 3.469E-04 | 1.697E-03 | 1.657E-03 | 2.036E-03 | 2.416E-03 | 2.771E-03 | 3.108E-03 | 3.421E-03 |

TOTAL DOSE COMMITMENT IS 2.181E-01 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS VEG. ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 1.005E-04 | 1.634E-04 | 2.378E-04 | 3.151E-04 | 2.748E-03 | 9.488E-03 | 1.230E-02 | 1.482E-02 | 1.737E-02 | 1.975E-02 | 2.202E-02 | 2.412E-02 |
| NNE | 8.512E-05 | 1.422E-04 | 2.021E-04 | 2.573E-04 | 2.105E-03 | 6.048E-03 | 1.036E-02 | 1.360E-02 | 1.618E-02 | 1.846E-02 | 2.053E-02 | 2.245E-02 |
| NE | 7.796E-05 | 1.300E-04 | 1.819E-04 | 2.310E-04 | 1.873E-03 | 6.839E-03 | 8.879E-03 | 1.155E-02 | 1.469E-02 | 1.748E-02 | 2.001E-02 | 2.233E-02 |
| ENE | 7.212E-05 | 1.171E-04 | 1.669E-04 | 2.178E-04 | 1.738E-03 | 6.281E-03 | 8.918E-03 | 1.082E-02 | 1.244E-02 | 1.386E-02 | 1.515E-02 | 1.633E-02 |
| E | 6.988E-05 | 1.098E-04 | 1.560E-04 | 2.053E-04 | 1.639E-03 | 6.256E-03 | 9.936E-03 | 1.307E-02 | 1.583E-02 | 1.831E-02 | 2.056E-02 | 2.262E-02 |
| ESE | 6.824E-05 | 1.024E-04 | 1.423E-04 | 1.880E-04 | 1.802E-03 | 6.984E-03 | 1.048E-02 | 1.341E-02 | 1.602E-02 | 1.836E-02 | 2.051E-02 | 2.248E-02 |
| SE | 7.392E-05 | 1.014E-04 | 1.362E-04 | 1.923E-04 | 1.805E-03 | 7.027E-03 | 1.052E-02 | 1.351E-02 | 1.617E-02 | 1.860E-02 | 2.086E-02 | 2.295E-02 |
| SSE | 8.690E-05 | 1.149E-04 | 1.400E-04 | 1.945E-04 | 1.877E-03 | 7.483E-03 | 1.137E-02 | 1.471E-02 | 1.774E-02 | 2.049E-02 | 2.304E-02 | 2.541E-02 |
| S | 9.720E-05 | 1.245E-04 | 1.530E-04 | 1.997E-04 | 1.805E-03 | 6.573E-03 | 9.550E-03 | 1.204E-02 | 1.425E-02 | 1.623E-02 | 1.807E-02 | 1.976E-02 |
| SSW | 1.130E-04 | 1.491E-04 | 1.717E-04 | 2.150E-04 | 1.683E-03 | 5.695E-03 | 8.358E-03 | 1.076E-02 | 1.288E-02 | 1.479E-02 | 1.653E-02 | 1.813E-02 |
| SW | 1.290E-04 | 1.892E-04 | 2.234E-04 | 2.459E-04 | 1.633E-03 | 5.061E-03 | 7.029E-03 | 8.838E-03 | 1.040E-02 | 1.177E-02 | 1.302E-02 | 1.415E-02 |
| WSW | 1.440E-04 | 2.551E-04 | 3.145E-04 | 3.685E-04 | 2.053E-03 | 5.643E-03 | 6.818E-03 | 7.923E-03 | 9.097E-03 | 1.014E-02 | 1.108E-02 | 1.194E-02 |
| W | 1.598E-04 | 2.888E-04 | 4.249E-04 | 5.553E-04 | 3.769E-03 | 9.720E-03 | 1.152E-02 | 1.436E-02 | 1.769E-02 | 2.054E-02 | 2.307E-02 | 2.535E-02 |
| WNW | 1.617E-04 | 3.197E-04 | 4.907E-04 | 6.745E-04 | 5.700E-03 | 1.624E-02 | 2.752E-02 | 4.159E-02 | 5.252E-02 | 6.186E-02 | 7.014E-02 | 7.759E-02 |
| NW | 1.434E-04 | 2.810E-04 | 4.465E-04 | 6.429E-04 | 8.067E-03 | 6.833E-02 | 5.213E-02 | 6.064E-02 | 7.075E-02 | 8.041E-02 | 8.940E-02 | 9.770E-02 |
| NNW | 1.198E-04 | 2.142E-04 | 3.103E-04 | 4.242E-04 | 4.230E-03 | 2.163E-02 | 1.882E-02 | 2.256E-02 | 2.658E-02 | 3.040E-02 | 3.404E-02 | 3.744E-02 |

TOTAL DOSE COMMITMENT IS 2.413E+00 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MEAT ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 2.138E-06 | 3.417E-06 | 4.897E-06 | 6.425E-06 | 5.419E-05 | 1.916E-04 | 2.712E-04 | 3.471E-04 | 4.169E-04 | 4.797E-04 | 5.381E-04 | 5.919E-04 |
| NNE | 1.804E-06 | 2.999E-06 | 4.272E-06 | 5.486E-06 | 4.525E-05 | 1.389E-04 | 2.452E-04 | 3.275E-04 | 3.924E-04 | 4.501E-04 | 5.027E-04 | 5.512E-04 |
| NE | 1.651E-06 | 2.788E-06 | 3.947E-06 | 5.094E-06 | 4.272E-05 | 1.619E-04 | 2.160E-04 | 2.830E-04 | 3.611E-04 | 4.306E-04 | 4.937E-04 | 5.516E-04 |
| ENE | 1.540E-06 | 2.533E-06 | 3.679E-06 | 4.892E-06 | 4.081E-05 | 1.509E-04 | 2.174E-04 | 2.657E-04 | 3.063E-04 | 3.421E-04 | 3.745E-04 | 4.041E-04 |
| E | 1.497E-06 | 2.393E-06 | 3.467E-06 | 4.647E-06 | 3.835E-05 | 1.524E-04 | 2.442E-04 | 3.225E-04 | 3.913E-04 | 4.530E-04 | 5.091E-04 | 5.605E-04 |
| ESE | 1.445E-06 | 2.214E-06 | 3.154E-06 | 4.247E-06 | 4.243E-05 | 1.695E-04 | 2.573E-04 | 3.309E-04 | 3.961E-04 | 4.547E-04 | 5.082E-04 | 5.574E-04 |
| SE | 1.569E-06 | 2.142E-06 | 2.933E-06 | 4.281E-06 | 4.207E-05 | 1.695E-04 | 2.572E-04 | 3.320E-04 | 3.988E-04 | 4.595E-04 | 5.159E-04 | 5.682E-04 |
| SSE | 1.868E-06 | 2.424E-06 | 2.944E-06 | 4.217E-06 | 4.288E-05 | 1.777E-04 | 2.747E-04 | 3.584E-04 | 4.344E-04 | 5.034E-04 | 5.671E-04 | 6.264E-04 |
| S | 2.094E-06 | 2.599E-06 | 3.167E-06 | 4.215E-06 | 4.000E-05 | 1.536E-04 | 2.290E-04 | 2.921E-04 | 3.478E-04 | 3.978E-04 | 4.440E-04 | 4.866E-04 |
| SSW | 2.452E-06 | 3.130E-06 | 3.505E-06 | 4.425E-06 | 3.644E-05 | 1.324E-04 | 2.006E-04 | 2.619E-04 | 3.156E-04 | 3.637E-04 | 4.076E-04 | 4.477E-04 |
| SW | 2.807E-06 | 4.025E-06 | 4.632E-06 | 5.025E-06 | 3.433E-05 | 1.164E-04 | 1.702E-04 | 2.161E-04 | 2.555E-04 | 2.902E-04 | 3.215E-04 | 3.499E-04 |
| WSW | 3.137E-06 | 5.537E-06 | 6.680E-06 | 7.763E-06 | 4.331E-05 | 1.311E-04 | 1.645E-04 | 1.938E-04 | 2.236E-04 | 2.499E-04 | 2.737E-04 | 2.953E-04 |
| W | 3.492E-06 | 6.241E-06 | 9.103E-06 | 1.187E-05 | 8.102E-05 | 2.276E-04 | 2.807E-04 | 3.534E-04 | 4.367E-04 | 5.080E-04 | 5.713E-04 | 6.283E-04 |
| WNW | 3.524E-06 | 6.915E-06 | 1.041E-05 | 1.402E-05 | 1.160E-04 | 3.760E-04 | 6.650E-04 | 1.014E-03 | 1.292E-03 | 1.527E-03 | 1.736E-03 | 1.922E-03 |
| NW | 3.084E-06 | 5.983E-06 | 9.316E-06 | 1.300E-05 | 1.359E-04 | 9.659E-04 | 1.169E-03 | 1.459E-03 | 1.732E-03 | 1.980E-03 | 2.208E-03 | 2.418E-03 |
| NNW | 2.549E-06 | 4.514E-06 | 6.458E-06 | 8.535E-06 | 7.517E-05 | 3.278E-04 | 4.177E-04 | 5.379E-04 | 6.464E-04 | 7.454E-04 | 8.381E-04 | 9.242E-04 |

TOTAL DOSE COMMITMENT IS 5.779E-02 PERSON-REM/YR

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TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MEAT ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| TION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2.484E-05 | 3.984E-05 | 5.725E-05 | 7.526E-05 | 6.388E-04 | 2.249E-03 | 3.131E-03 | 3.966E-03 | 4.743E-03 | 5.448E-03 | 6.105E-03 | 6.710E-03 |
| E | 2.098E-05 | 3.491E-05 | 4.970E-05 | 6.372E-05 | 5.248E-04 | 1.592E-03 | 2.797E-03 | 3.724E-03 | 4.458E-03 | 5.108E-03 | 5.702E-03 | 6.249E-03 |
| NE | 1.920E-05 | 3.235E-05 | 4.570E-05 | 5.881E-05 | 4.904E-04 | 1.846E-03 | 2.452E-03 | 3.209E-03 | 4.093E-03 | 4.879E-03 | 5.593E-03 | 6.247E-03 |
| ENE | 1.788E-05 | 2.934E-05 | 4.248E-05 | 5.630E-05 | 4.661E-04 | 1.717E-03 | 2.468E-03 | 3.012E-03 | 3.471E-03 | 3.875E-03 | 4.241E-03 | 4.575E-03 |
| | 1.738E-05 | 2.769E-05 | 3.997E-05 | 5.340E-05 | 4.382E-04 | 1.730E-03 | 2.768E-03 | 3.653E-03 | 4.431E-03 | 5.129E-03 | 5.764E-03 | 6.345E-03 |
| E | 1.681E-05 | 2.566E-05 | 3.638E-05 | 4.883E-05 | 4.843E-04 | 1.925E-03 | 2.916E-03 | 3.749E-03 | 4.485E-03 | 5.148E-03 | 5.753E-03 | 6.309E-03 |
| SE | 1.824E-05 | 2.493E-05 | 3.400E-05 | 4.934E-05 | 4.811E-04 | 1.927E-03 | 2.918E-03 | 3.764E-03 | 4.518E-03 | 5.204E-03 | 5.842E-03 | 6.433E-03 |
| E | 2.166E-05 | 2.821E-05 | 3.428E-05 | 4.883E-05 | 4.921E-04 | 2.026E-03 | 3.122E-03 | 4.068E-03 | 4.926E-03 | 5.706E-03 | 6.427E-03 | 7.097E-03 |
| | 2.428E-05 | 3.031E-05 | 3.699E-05 | 4.905E-05 | 4.614E-04 | 1.756E-03 | 2.606E-03 | 3.318E-03 | 3.946E-03 | 4.512E-03 | 5.033E-03 | 5.514E-03 |
| SSW | 2.839E-05 | 3.646E-05 | 4.105E-05 | 5.174E-05 | 4.221E-04 | 1.514E-03 | 2.283E-03 | 2.973E-03 | 3.579E-03 | 4.123E-03 | 4.617E-03 | 5.071E-03 |
| SW | 3.249E-05 | 4.678E-05 | 5.408E-05 | 5.884E-05 | 3.998E-04 | 1.334E-03 | 1.933E-03 | 2.452E-03 | 2.896E-03 | 3.288E-03 | 3.641E-03 | 3.962E-03 |
| W | 3.630E-05 | 6.411E-05 | 7.765E-05 | 9.038E-05 | 5.041E-04 | 1.500E-03 | 1.871E-03 | 2.198E-03 | 2.535E-03 | 2.831E-03 | 3.099E-03 | 3.344E-03 |
| | 4.038E-05 | 7.232E-05 | 1.056E-04 | 1.378E-04 | 9.398E-04 | 2.601E-03 | 3.186E-03 | 4.005E-03 | 4.947E-03 | 5.753E-03 | 6.468E-03 | 7.112E-03 |
| WNW | 4.077E-05 | 8.012E-05 | 1.211E-04 | 1.636E-04 | 1.359E-03 | 4.305E-03 | 7.559E-03 | 1.151E-02 | 1.464E-02 | 1.730E-02 | 1.965E-02 | 2.176E-02 |
| | 3.577E-05 | 6.952E-05 | 1.086E-04 | 1.525E-04 | 1.655E-03 | 1.226E-02 | 1.346E-02 | 1.660E-02 | 1.964E-02 | 2.244E-02 | 2.501E-02 | 2.737E-02 |
| NW | 2.963E-05 | 5.254E-05 | 7.535E-05 | 1.002E-04 | 9.051E-04 | 4.090E-03 | 4.817E-03 | 6.127E-03 | 7.340E-03 | 8.453E-03 | 9.497E-03 | 1.047E-02 |

TOTAL DOSE COMMITMENT IS 6.578E-01 PERSON-REM/YR

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TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MILK ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 8.767E-07 | 1.493E-06 | 2.260E-06 | 3.068E-06 | 2.884E-05 | 9.441E-05 | 9.643E-05 | 9.263E-05 | 9.711E-05 | 1.042E-04 | 1.121E-04 | 1.202E-04 |
| NNE | 7.495E-07 | 1.272E-06 | 1.795E-06 | 2.231E-06 | 1.784E-05 | 4.101E-05 | 6.204E-05 | 7.483E-05 | 8.585E-05 | 9.514E-05 | 1.036E-04 | 1.115E-04 |
| NE | 6.889E-07 | 1.109E-06 | 1.497E-06 | 1.810E-06 | 1.304E-05 | 4.088E-05 | 4.639E-05 | 5.789E-05 | 7.250E-05 | 8.515E-05 | 9.654E-05 | 1.070E-04 |
| ENE | 6.225E-07 | 9.743E-07 | 1.308E-06 | 1.603E-06 | 1.076E-05 | 3.497E-05 | 4.603E-05 | 5.384E-05 | 6.067E-05 | 6.682E-05 | 7.245E-05 | 7.763E-05 |
| E | 5.975E-07 | 8.924E-07 | 1.190E-06 | 1.471E-06 | 1.030E-05 | 3.244E-05 | 4.903E-05 | 6.323E-05 | 7.570E-05 | 8.691E-05 | 9.712E-05 | 1.065E-04 |
| ESE | 6.023E-07 | 8.518E-07 | 1.094E-06 | 1.357E-06 | 1.103E-05 | 3.697E-05 | 5.194E-05 | 6.476E-05 | 7.630E-05 | 8.680E-05 | 9.645E-05 | 1.054E-04 |
| SE | 6.491E-07 | 9.015E-07 | 1.146E-06 | 1.461E-06 | 1.153E-05 | 3.842E-05 | 5.358E-05 | 6.662E-05 | 7.838E-05 | 8.916E-05 | 9.925E-05 | 1.087E-04 |
| SSE | 7.362E-07 | 1.025E-06 | 1.261E-06 | 1.605E-06 | 1.300E-05 | 4.405E-05 | 6.144E-05 | 7.610E-05 | 8.936E-05 | 1.014E-04 | 1.126E-04 | 1.231E-04 |
| S | 8.177E-07 | 1.143E-06 | 1.435E-06 | 1.779E-06 | 1.392E-05 | 4.150E-05 | 5.374E-05 | 6.389E-05 | 7.304E-05 | 8.141E-05 | 8.926E-05 | 9.657E-05 |
| SSW | 9.318E-07 | 1.348E-06 | 1.667E-06 | 2.046E-06 | 1.396E-05 | 3.681E-05 | 4.672E-05 | 5.612E-05 | 6.475E-05 | 7.274E-05 | 8.017E-05 | 8.708E-05 |
| SW | 1.052E-06 | 1.650E-06 | 2.088E-06 | 2.382E-06 | 1.469E-05 | 3.415E-05 | 3.767E-05 | 4.492E-05 | 5.137E-05 | 5.722E-05 | 6.259E-05 | 6.754E-05 |
| WSW | 1.171E-06 | 2.097E-06 | 2.756E-06 | 3.301E-06 | 1.832E-05 | 3.659E-05 | 3.713E-05 | 4.023E-05 | 4.485E-05 | 4.912E-05 | 5.311E-05 | 5.682E-05 |
| W | 1.286E-06 | 2.407E-06 | 3.632E-06 | 4.782E-06 | 3.191E-05 | 6.094E-05 | 5.952E-05 | 7.049E-05 | 8.518E-05 | 9.772E-05 | 1.089E-04 | 1.191E-04 |
| WNW | 1.315E-06 | 2.657E-06 | 4.308E-06 | 6.263E-06 | 5.570E-05 | 1.066E-04 | 1.487E-04 | 2.142E-04 | 2.583E-04 | 2.974E-04 | 3.331E-04 | 3.657E-04 |
| NW | 1.212E-06 | 2.444E-06 | 4.103E-06 | 6.386E-06 | 1.113E-04 | 1.154E-03 | 3.857E-04 | 3.350E-04 | 3.577E-04 | 3.924E-04 | 4.286E-04 | 4.636E-04 |
| NNW | 1.045E-06 | 1.916E-06 | 2.870E-06 | 4.260E-06 | 5.385E-05 | 3.401E-04 | 1.445E-04 | 1.304E-04 | 1.390E-04 | 1.521E-04 | 1.663E-04 | 1.803E-04 |

TOTAL DOSE COMMITMENT IS 1.364E-02 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MILK ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| CTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 8.756E-06 | 1.495E-05 | 2.269E-05 | 3.084E-05 | 2.910E-04 | 9.500E-04 | 9.565E-04 | 9.028E-04 | 9.367E-04 | 9.987E-04 | 1.071E-03 | 1.145E-03 |
| NE | 7.490E-06 | 1.272E-05 | 1.794E-05 | 2.227E-05 | 1.778E-04 | 4.024E-04 | 6.023E-04 | 7.207E-04 | 8.237E-04 | 9.100E-04 | 9.889E-04 | 1.063E-03 |
| E | 6.886E-06 | 1.106E-05 | 1.490E-05 | 1.795E-05 | 1.282E-04 | 3.969E-04 | 4.444E-04 | 5.520E-04 | 6.902E-04 | 8.094E-04 | 9.167E-04 | 1.015E-03 |
| ENE | 6.214E-06 | 9.702E-06 | 1.298E-05 | 1.583E-05 | 1.048E-04 | 3.372E-04 | 4.404E-04 | 5.130E-04 | 5.768E-04 | 6.343E-04 | 6.871E-04 | 7.358E-04 |
| | 5.960E-06 | 8.873E-06 | 1.179E-05 | 1.449E-05 | 1.005E-04 | 3.105E-04 | 4.668E-04 | 6.005E-04 | 7.180E-04 | 8.236E-04 | 9.198E-04 | 1.008E-03 |
| SE | 6.020E-06 | 8.483E-06 | 1.084E-05 | 1.338E-05 | 1.073E-04 | 3.547E-04 | 4.947E-04 | 6.149E-04 | 7.234E-04 | 8.222E-04 | 9.131E-04 | 9.969E-04 |
| SE | 6.485E-06 | 9.014E-06 | 1.142E-05 | 1.445E-05 | 1.126E-04 | 3.698E-04 | 5.118E-04 | 6.341E-04 | 7.445E-04 | 8.459E-04 | 9.408E-04 | 1.030E-03 |
| SSE | 7.340E-06 | 1.025E-05 | 1.262E-05 | 1.597E-05 | 1.278E-04 | 4.270E-04 | 5.907E-04 | 7.282E-04 | 8.526E-04 | 9.659E-04 | 1.071E-03 | 1.169E-03 |
| | 8.149E-06 | 1.145E-05 | 1.439E-05 | 1.779E-05 | 1.379E-04 | 4.049E-04 | 5.187E-04 | 6.130E-04 | 6.982E-04 | 7.764E-04 | 8.498E-04 | 9.182E-04 |
| SSW | 9.273E-06 | 1.350E-05 | 1.675E-05 | 2.054E-05 | 1.390E-04 | 3.598E-04 | 4.507E-04 | 5.375E-04 | 6.177E-04 | 6.921E-04 | 7.616E-04 | 8.264E-04 |
| SW | 1.047E-05 | 1.648E-05 | 2.094E-05 | 2.393E-05 | 1.470E-04 | 3.350E-04 | 3.618E-04 | 4.290E-04 | 4.891E-04 | 5.437E-04 | 5.941E-04 | 6.405E-04 |
| SW | 1.164E-05 | 2.087E-05 | 2.753E-05 | 3.302E-05 | 1.833E-04 | 3.578E-04 | 3.573E-04 | 3.842E-04 | 4.268E-04 | 4.666E-04 | 5.039E-04 | 5.387E-04 |
| | 1.278E-05 | 2.397E-05 | 3.623E-05 | 4.772E-05 | 3.181E-04 | 5.941E-04 | 5.695E-04 | 6.706E-04 | 8.086E-04 | 9.263E-04 | 1.032E-03 | 1.128E-03 |
| WNW | 1.308E-05 | 2.646E-05 | 4.305E-05 | 6.278E-05 | 5.600E-04 | 1.043E-03 | 1.430E-03 | 2.048E-03 | 2.458E-03 | 2.823E-03 | 3.157E-03 | 3.463E-03 |
| W | 1.209E-05 | 2.441E-05 | 4.111E-05 | 6.426E-05 | 1.136E-03 | 1.187E-02 | 3.811E-03 | 3.227E-03 | 3.414E-03 | 3.730E-03 | 4.066E-03 | 4.393E-03 |
| NW | 1.044E-05 | 1.916E-05 | 2.876E-05 | 4.289E-05 | 5.481E-04 | 3.489E-03 | 1.431E-03 | 1.262E-03 | 1.331E-03 | 1.450E-03 | 1.581E-03 | 1.712E-03 |

TOTAL DOSE COMMITMENT IS 1.317E-01 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

METSET: IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

SUMMARY PRINT OF POPULATION DOSES COMPUTED FOR TSTEP 1--DOSES SHOWN ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DOSES RECEIVED BY PEOPLE WITHIN 80 KILOMETERS

| PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|
| INHAL. | 3.907E-02 | 1.836E-01 | 1.352E-01 | 1.369E-01 | 6.609E-02 | 5.755E+00 |
| GROUND | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 |
| CLOUD | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 |
| VEG. ING | 1.908E-01 | 2.111E+00 | 1.908E-01 | 6.961E-01 | 5.942E-01 | 1.908E-01 |
| MEAT ING | 8.797E-03 | 1.001E-01 | 8.797E-03 | 3.155E-02 | 2.615E-02 | 8.797E-03 |
| MILK ING | 5.559E-03 | 5.369E-02 | 5.559E-03 | 1.657E-02 | 1.906E-02 | 5.559E-03 |
| RNPLUS50 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| TOTALS | 2.948E-01 | 2.499E+00 | 3.910E-01 | 9.317E-01 | 7.561E-01 | 6.011E+00 |

DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS

| PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|
| INHAL. | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| GROUND | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| CLOUD | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| VEG. ING | 2.730E-02 | 3.020E-01 | 2.730E-02 | 9.959E-02 | 8.501E-02 | 2.730E-02 |
| MEAT ING | 4.899E-02 | 5.577E-01 | 4.899E-02 | 1.757E-01 | 1.457E-01 | 4.899E-02 |
| MILK ING | 8.084E-03 | 7.806E-02 | 8.084E-03 | 2.409E-02 | 2.771E-02 | 8.084E-03 |
| RNPLUS50 | 1.187E+01 | 1.594E+02 | 2.650E+00 | 1.187E+01 | 1.187E+01 | 8.323E+01 |
| TOTALS | 1.195E+01 | 1.603E+02 | 2.734E+00 | 1.217E+01 | 1.213E+01 | 8.332E+01 |

TOTAL DOSES COMPUTED OVER ALL POPULATIONS

| PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|
| INHAL. | 3.907E-02 | 1.836E-01 | 1.352E-01 | 1.369E-01 | 6.609E-02 | 5.755E+00 |
| GROUND | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 |
| CLOUD | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 |
| VEG. ING | 2.181E-01 | 2.413E+00 | 2.181E-01 | 7.957E-01 | 6.792E-01 | 2.181E-01 |
| MEAT ING | 5.779E-02 | 6.578E-01 | 5.779E-02 | 2.072E-01 | 1.718E-01 | 5.779E-02 |
| MILK ING | 1.364E-02 | 1.317E-01 | 1.364E-02 | 4.067E-02 | 4.677E-02 | 1.364E-02 |
| RNPLUS50 | 1.187E+01 | 1.594E+02 | 2.650E+00 | 1.187E+01 | 1.187E+01 | 8.323E+01 |
| TOTALS | 1.225E+01 | 1.628E+02 | 3.125E+00 | 1.310E+01 | 1.288E+01 | 8.933E+01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| -AS-1 | 1 | 1.599E-05 | 3.731E-08 | 4.328E-08 | 1.297E-07 | 3.091E+00 | 7.212E-03 | 8.365E-03 | 8.365E-03 |
| -AS-1 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 1-AS-1 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| -AS-1 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ONCENTRATION TOTALS | | 1.599E-05 | 3.731E-08 | 4.328E-08 | 1.297E-07 | 3.091E+00 | 7.212E-03 | 8.365E-03 | 8.365E-03 |
| 2-AS-5A | 1 | 9.721E-06 | 2.268E-08 | 2.632E-08 | 7.886E-08 | 1.879E+00 | 4.385E-03 | 5.086E-03 | 5.086E-03 |
| 2-AS-5A | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 2-AS-5A | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 2-AS-5A | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ONCENTRATION TOTALS | | 9.721E-06 | 2.268E-08 | 2.632E-08 | 7.886E-08 | 1.879E+00 | 4.385E-03 | 5.086E-03 | 5.086E-03 |
| 3-AS-5B | 1 | 9.801E-06 | 2.287E-08 | 2.653E-08 | 7.951E-08 | 1.895E+00 | 4.421E-03 | 5.128E-03 | 5.128E-03 |
| 3-AS-5B | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3-AS-5B | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3-AS-5B | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ONCENTRATION TOTALS | | 9.801E-06 | 2.287E-08 | 2.653E-08 | 7.951E-08 | 1.895E+00 | 4.421E-03 | 5.128E-03 | 5.128E-03 |
| 4-AS-6 | 1 | 4.299E-06 | 1.003E-08 | 1.164E-08 | 3.487E-08 | 8.310E-01 | 1.939E-03 | 2.249E-03 | 2.249E-03 |
| 4-AS-6 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 4-AS-6 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 4-AS-6 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| CONCENTRATION TOTALS | | 4.299E-06 | 1.003E-08 | 1.164E-08 | 3.487E-08 | 8.310E-01 | 1.939E-03 | 2.249E-03 | 2.249E-03 |
| 5-100M NORTH | 1 | 9.809E-06 | 2.289E-08 | 2.655E-08 | 7.958E-08 | 1.896E+00 | 4.425E-03 | 5.132E-03 | 5.132E-03 |
| 5-100M NORTH | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 5-100M NORTH | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 5-100M NORTH | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| CONCENTRATION TOTALS | | 9.809E-06 | 2.289E-08 | 2.655E-08 | 7.958E-08 | 1.896E+00 | 4.425E-03 | 5.132E-03 | 5.132E-03 |
| 6-100M EAST | 1 | 9.545E-06 | 2.227E-08 | 2.584E-08 | 7.743E-08 | 1.845E+00 | 4.305E-03 | 4.994E-03 | 4.994E-03 |
| 6-100M EAST | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 6-100M EAST | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 6-100M EAST | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| CONCENTRATION TOTALS | | 9.545E-06 | 2.227E-08 | 2.584E-08 | 7.743E-08 | 1.845E+00 | 4.305E-03 | 4.994E-03 | 4.994E-03 |
| 7-100M SOUTH | 1 | 9.720E-06 | 2.268E-08 | 2.631E-08 | 7.885E-08 | 1.879E+00 | 4.385E-03 | 5.086E-03 | 5.086E-03 |
| 7-100M SOUTH | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 7-100M SOUTH | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 7-100M SOUTH | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| CONCENTRATION TOTALS | | 9.720E-06 | 2.268E-08 | 2.631E-08 | 7.885E-08 | 1.879E+00 | 4.385E-03 | 5.086E-03 | 5.086E-03 |
| 8-100M WEST | 1 | 9.989E-06 | 2.331E-08 | 2.704E-08 | 8.104E-08 | 1.931E+00 | 4.506E-03 | 5.226E-03 | 5.226E-03 |
| 8-100M WEST | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 8-100M WEST | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 8-100M WEST | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| CONCENTRATION TOTALS | | 9.989E-06 | 2.331E-08 | 2.704E-08 | 8.104E-08 | 1.931E+00 | 4.506E-03 | 5.226E-03 | 5.226E-03 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| | | | AIRBORNE CONCENTRATIONS, PCI/M3 | | | | GROUND CONCENTRATIONS, PCI/M2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NAME | PTSZ | U-238 | Th-230 | Ra-226 | Pb-210 | U-238 | Th-230 | Ra-226 | Pb-210 |
| | 100M UPWIND | 1 | 9.582E-06 | 2.236E-08 | 2.594E-08 | 7.773E-08 | 1.852E+00 | 4.322E-03 | 5.013E-03 | 5.013E-03 |
| | -100M UPWIND | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 9 | 9-100M UPWIND | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 9 | 9-100M UPWIND | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.582E-06 | 2.236E-08 | 2.594E-08 | 7.773E-08 | 1.852E+00 | 4.322E-03 | 5.013E-03 | 5.013E-03 |
| 10 | 10-100M DOWNWIND | 1 | 9.955E-06 | 2.323E-08 | 2.695E-08 | 8.076E-08 | 1.925E+00 | 4.491E-03 | 5.209E-03 | 5.209E-03 |
| 10 | 10-100M DOWNWIND | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 10 | 10-100M DOWNWIND | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 10 | 10-100M DOWNWIND | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.955E-06 | 2.323E-08 | 2.695E-08 | 8.076E-08 | 1.925E+00 | 4.491E-03 | 5.209E-03 | 5.209E-03 |
| 11 | 11-200M NORTH | 1 | 9.849E-06 | 2.298E-08 | 2.666E-08 | 7.990E-08 | 1.904E+00 | 4.443E-03 | 5.153E-03 | 5.153E-03 |
| 11 | 11-200M NORTH | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 11 | 11-200M NORTH | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 11 | 11-200M NORTH | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.849E-06 | 2.298E-08 | 2.666E-08 | 7.990E-08 | 1.904E+00 | 4.443E-03 | 5.153E-03 | 5.153E-03 |
| 12 | 12-200M EAST | 1 | 9.324E-06 | 2.176E-08 | 2.524E-08 | 7.564E-08 | 1.803E+00 | 4.206E-03 | 4.879E-03 | 4.879E-03 |
| 12 | 12-200M EAST | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 12 | 12-200M EAST | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 12 | 12-200M EAST | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.324E-06 | 2.176E-08 | 2.524E-08 | 7.564E-08 | 1.803E+00 | 4.206E-03 | 4.879E-03 | 4.879E-03 |
| 13 | 200M SOUTH | 1 | 9.672E-06 | 2.257E-08 | 2.618E-08 | 7.846E-08 | 1.870E+00 | 4.363E-03 | 5.060E-03 | 5.060E-03 |
| | 00M SOUTH | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 13 | 200M SOUTH | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 13 | 13-200M SOUTH | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.672E-06 | 2.257E-08 | 2.618E-08 | 7.846E-08 | 1.870E+00 | 4.363E-03 | 5.060E-03 | 5.060E-03 |
| 14 | 14-200M WEST | 1 | 1.021E-05 | 2.383E-08 | 2.765E-08 | 8.286E-08 | 1.974E+00 | 4.607E-03 | 5.344E-03 | 5.344E-03 |
| 14 | 14-200M WEST | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 14 | 14-200M WEST | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 14 | 14-200M WEST | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.021E-05 | 2.383E-08 | 2.765E-08 | 8.286E-08 | 1.974E+00 | 4.607E-03 | 5.344E-03 | 5.344E-03 |
| 15 | 15-200M UPWIND | 1 | 9.400E-06 | 2.193E-08 | 2.544E-08 | 7.625E-08 | 1.817E+00 | 4.240E-03 | 4.918E-03 | 4.918E-03 |
| 15 | 15-200M UPWIND | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 15 | 15-200M UPWIND | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 15 | 15-200M UPWIND | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.400E-06 | 2.193E-08 | 2.544E-08 | 7.625E-08 | 1.817E+00 | 4.240E-03 | 4.918E-03 | 4.918E-03 |
| 16 | 16-200M DOWNWIND | 1 | 1.015E-05 | 2.369E-08 | 2.748E-08 | 8.236E-08 | 1.963E+00 | 4.579E-03 | 5.312E-03 | 5.312E-03 |
| 16 | 16-200M DOWNWIND | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 16 | 16-200M DOWNWIND | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 16 | 16-200M DOWNWIND | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.015E-05 | 2.369E-08 | 2.748E-08 | 8.236E-08 | 1.963E+00 | 4.579E-03 | 5.312E-03 | 5.312E-03 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|
| 17 | 17-240 DEG @ 725M | 1 | 1.106E-05 | 2.582E-08 | 2.995E-08 | 8.976E-08 | 2.139E+00 | 4.991E-03 | 5.789E-03 | 5.789E-03 |
| 17 | 17-240 DEG @ 725M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 17 | 17-240 DEG @ 725M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 17 | 17-240 DEG @ 725M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.106E-05 | 2.582E-08 | 2.995E-08 | 8.976E-08 | 2.139E+00 | 4.991E-03 | 5.789E-03 | 5.789E-03 |
| 18 | 18-270 DEG @ 5500M | 1 | 1.732E-05 | 4.040E-08 | 4.687E-08 | 1.405E-07 | 3.348E+00 | 7.811E-03 | 9.060E-03 | 9.060E-03 |
| 18 | 18-270 DEG @ 5500M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 18 | 18-270 DEG @ 5500M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 18 | 18-270 DEG @ 5500M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.732E-05 | 4.040E-08 | 4.687E-08 | 1.405E-07 | 3.348E+00 | 7.811E-03 | 9.060E-03 | 9.060E-03 |
| 19 | 19-330 DEG @ 5100M | 1 | 3.236E-05 | 7.551E-08 | 8.760E-08 | 2.625E-07 | 6.256E+00 | 1.460E-02 | 1.693E-02 | 1.693E-02 |
| 19 | 19-330 DEG @ 5100M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 19 | 19-330 DEG @ 5100M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 19 | 19-330 DEG @ 5100M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 3.236E-05 | 7.551E-08 | 8.760E-08 | 2.625E-07 | 6.256E+00 | 1.460E-02 | 1.693E-02 | 1.693E-02 |
| 20 | 20-345 DEG @ 2050M | 1 | 1.289E-05 | 3.009E-08 | 3.490E-08 | 1.046E-07 | 2.493E+00 | 5.816E-03 | 6.746E-03 | 6.746E-03 |
| 20 | 20-345 DEG @ 2050M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 20 | 20-345 DEG @ 2050M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 20 | 20-345 DEG @ 2050M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.289E-05 | 3.009E-08 | 3.490E-08 | 1.046E-07 | 2.493E+00 | 5.816E-03 | 6.746E-03 | 6 3 |
| 21 | 21- 45 DEG @ 3350M | 1 | 6.865E-06 | 1.602E-08 | 1.858E-08 | 5.569E-08 | 1.327E+00 | 3.097E-03 | 3.592E-03 | 3.592E-03 |
| 21 | 21- 45 DEG @ 3350M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 21 | 21- 45 DEG @ 3350M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 21 | 21- 45 DEG @ 3350M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 6.865E-06 | 1.602E-08 | 1.858E-08 | 5.569E-08 | 1.327E+00 | 3.097E-03 | 3.592E-03 | 3.592E-03 |
| 22 | 22- 80 DEG @ 4725M | 1 | 4.386E-06 | 1.023E-08 | 1.187E-08 | 3.558E-08 | 8.479E-01 | 1.978E-03 | 2.295E-03 | 2.295E-03 |
| 22 | 22- 80 DEG @ 4725M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 22 | 22- 80 DEG @ 4725M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 22 | 22- 80 DEG @ 4725M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 4.386E-06 | 1.023E-08 | 1.187E-08 | 3.558E-08 | 8.479E-01 | 1.978E-03 | 2.295E-03 | 2.295E-03 |
| 23 | 23-IR-1 | 1 | 1.319E-04 | 3.077E-07 | 3.570E-07 | 1.070E-06 | 2.549E+01 | 5.949E-02 | 6.900E-02 | 6.900E-02 |
| 23 | 23-IR-1 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 23 | 23-IR-1 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 23 | 23-IR-1 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.319E-04 | 3.077E-07 | 3.570E-07 | 1.070E-06 | 2.549E+01 | 5.949E-02 | 6.900E-02 | 6.900E-02 |
| 24 | 24-IR-3 | 1 | 1.370E-06 | 3.196E-09 | 3.708E-09 | 1.111E-08 | 2.648E-01 | 6.179E-04 | 7.167E-04 | 7.167E-04 |
| 24 | 24-IR-3 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 24 | 24-IR-3 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 24 | 24-IR-3 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.370E-06 | 3.196E-09 | 3.708E-09 | 1.111E-08 | 2.648E-01 | 6.179E-04 | 7.167E-04 | 7.167E-04 |

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 25-IR-4 | 1 | 4.620E-04 | 1.078E-06 | 1.251E-06 | 3.748E-06 | 8.931E+01 | 2.084E-01 | 2.417E-01 | 2.417E-0 |
| 25 | 25-IR-4 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 25 | 25-IR-4 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 25 | 25-IR-4 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 4.620E-04 | 1.078E-06 | 1.251E-06 | 3.748E-06 | 8.931E+01 | 2.084E-01 | 2.417E-01 | 2.417E-0 |
| 26 | 26-IR-5 | 1 | 4.156E-05 | 9.697E-08 | 1.125E-07 | 3.372E-07 | 8.034E+00 | 1.875E-02 | 2.174E-02 | 2.174E-0 |
| 26 | 26-IR-5 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 26 | 26-IR-5 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 26 | 26-IR-5 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 4.156E-05 | 9.697E-08 | 1.125E-07 | 3.372E-07 | 8.034E+00 | 1.875E-02 | 2.174E-02 | 2.174E-0 |
| 27 | 27-IR-6 | 1 | 1.580E-04 | 3.687E-07 | 4.277E-07 | 1.282E-06 | 3.055E+01 | 7.128E-02 | 8.268E-02 | 8.268E-0 |
| 27 | 27-IR-6 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 27 | 27-IR-6 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 27 | 27-IR-6 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 1.580E-04 | 3.687E-07 | 4.277E-07 | 1.282E-06 | 3.055E+01 | 7.128E-02 | 8.268E-02 | 8.268E-02 |
| 28 | 28-50M NORTH OF TD | 1 | 8.815E-06 | 2.057E-08 | 2.386E-08 | 7.151E-08 | 1.704E+00 | 3.976E-03 | 4.612E-03 | 4.612E-03 |
| 28 | 28-50M NORTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 28 | 28-50M NORTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 28 | 28-50M NORTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 8.815E-06 | 2.057E-08 | 2.386E-08 | 7.151E-08 | 1.704E+00 | 3.976E-03 | 4.612E-03 | 4.612E-03 |
| | 29-50M EAST OF TD | 1 | 8.381E-06 | 1.956E-08 | 2.269E-08 | 6.799E-08 | 1.620E+00 | 3.780E-03 | 4.385E-03 | 4.385E-03 |
| | 29-50M EAST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 29 | 29-50M EAST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 29 | 29-50M EAST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 8.381E-06 | 1.956E-08 | 2.269E-08 | 6.799E-08 | 1.620E+00 | 3.780E-03 | 4.385E-03 | 4.385E-03 |
| 30 | 30-50M SOUTH OF TD | 1 | 2.970E-05 | 6.930E-08 | 8.040E-08 | 2.409E-07 | 5.742E+00 | 1.340E-02 | 1.554E-02 | 1.554E-02 |
| 30 | 30-50M SOUTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 30 | 30-50M SOUTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 30 | 30-50M SOUTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 2.970E-05 | 6.930E-08 | 8.040E-08 | 2.409E-07 | 5.742E+00 | 1.340E-02 | 1.554E-02 | 1.554E-02 |
| 31 | 31-50M WEST OF TD | 1 | 1.654E-06 | 3.859E-09 | 4.477E-09 | 1.342E-08 | 3.197E-01 | 7.460E-04 | 8.653E-04 | 8.653E-04 |
| 31 | 31-50M WEST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 31 | 31-50M WEST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 31 | 31-50M WEST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.654E-06 | 3.859E-09 | 4.477E-09 | 1.342E-08 | 3.197E-01 | 7.460E-04 | 8.653E-04 | 8.653E-04 |
| 32 | 32-50M UPWIND OF TD | 1 | 7.308E-06 | 1.705E-08 | 1.978E-08 | 5.929E-08 | 1.413E+00 | 3.297E-03 | 3.824E-03 | 3.824E-03 |
| 32 | 32-50M UPWIND OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 32 | 32-50M UPWIND OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 32 | 32-50M UPWIND OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 7.308E-06 | 1.705E-08 | 1.978E-08 | 5.929E-08 | 1.413E+00 | 3.297E-03 | 3.824E-03 | 3.824E-03 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 3 50M DOWNWIND OF T | 1 | 7.117E-06 | 1.661E-08 | 1.927E-08 | 5.774E-08 | 1.376E+00 | 3.210E-03 | 3.724E-03 | 3.724E-03 |
| 3 50M DOWNWIND OF T | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 33-50M DOWNWIND OF T | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 50M DOWNWIND OF T | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 0 ENTRATION TOTALS | | 7.117E-06 | 1.661E-08 | 1.927E-08 | 5.774E-08 | 1.376E+00 | 3.210E-03 | 3.724E-03 | 3.724E-03 |
| 34-100M NORTH OF TD | 1 | 3.081E-04 | 7.190E-07 | 8.341E-07 | 2.500E-06 | 5.957E+01 | 1.390E-01 | 1.612E-01 | 1.612E-01 |
| 3 100M NORTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 100M NORTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 34-100M NORTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 0 ENTRATION TOTALS | | 3.081E-04 | 7.190E-07 | 8.341E-07 | 2.500E-06 | 5.957E+01 | 1.390E-01 | 1.612E-01 | 1.612E-01 |
| 35-100M EAST OF TD | 1 | 2.181E-04 | 5.089E-07 | 5.903E-07 | 1.769E-06 | 4.216E+01 | 9.837E-02 | 1.141E-01 | 1.141E-01 |
| 35-100M EAST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 100M EAST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 35-100M EAST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ONCENTRATION TOTALS | | 2.181E-04 | 5.089E-07 | 5.903E-07 | 1.769E-06 | 4.216E+01 | 9.837E-02 | 1.141E-01 | 1.141E-01 |
| 3 100M SOUTH OF TD | 1 | 6.361E-04 | 1.484E-06 | 1.722E-06 | 5.160E-06 | 1.230E+02 | 2.869E-01 | 3.328E-01 | 3.328E-01 |
| 36-100M SOUTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 100M SOUTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 100M SOUTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ONCENTRATION TOTALS | | 6.361E-04 | 1.484E-06 | 1.722E-06 | 5.160E-06 | 1.230E+02 | 2.869E-01 | 3.328E-01 | 3.328E-01 |
| 3 100M WEST OF TD | 1 | 6.321E-05 | 1.475E-07 | 1.711E-07 | 5.128E-07 | 1.222E+01 | 2.851E-02 | 3.307E-02 | 3.307E-02 |
| 37-100M WEST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 37-100M WEST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 100M WEST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 0 ENTRATION TOTALS | | 6.321E-05 | 1.475E-07 | 1.711E-07 | 5.128E-07 | 1.222E+01 | 2.851E-02 | 3.307E-02 | 3.307E-02 |
| 3 100M UPWIND OF TD | 1 | 2.633E-04 | 6.144E-07 | 7.128E-07 | 2.136E-06 | 5.090E+01 | 1.188E-01 | 1.378E-01 | 1.378E-01 |
| 3 100M UPWIND OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 38-100M UPWIND OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 38-100M UPWIND OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 0 ENTRATION TOTALS | | 2.633E-04 | 6.144E-07 | 7.128E-07 | 2.136E-06 | 5.090E+01 | 1.188E-01 | 1.378E-01 | 1.378E-01 |
| 39-100M DOWNWIND OF | 1 | 1.861E-04 | 4.342E-07 | 5.038E-07 | 1.510E-06 | 3.598E+01 | 8.394E-02 | 9.737E-02 | 9.737E-02 |
| 3 100M DOWNWIND OF | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 100M DOWNWIND OF | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 39-100M DOWNWIND OF | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 0 ENTRATION TOTALS | | 1.861E-04 | 4.342E-07 | 5.038E-07 | 1.510E-06 | 3.598E+01 | 8.394E-02 | 9.737E-02 | 9.737E-02 |
| 40-200M NORTH OF TD | 1 | 9.918E-04 | 2.314E-06 | 2.685E-06 | 8.046E-06 | 1.917E+02 | 4.474E-01 | 5.189E-01 | 5.189E-01 |
| 40-200M NORTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 4 200M NORTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 40-200M NORTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ONCENTRATION TOTALS | | 9.918E-04 | 2.314E-06 | 2.685E-06 | 8.046E-06 | 1.917E+02 | 4.474E-01 | 5.189E-01 | 5.189E-01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 41 | 41-200M EAST OF TD | 1 | 6.556E-04 | 1.530E-06 | 1.775E-06 | 5.318E-06 | 1.267E+02 | 2.957E-01 | 3.430E-01 | 3.430E-01 |
| 41 | 41-200M EAST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 41 | 41-200M EAST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 41 | 41-200M EAST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 6.556E-04 | 1.530E-06 | 1.775E-06 | 5.318E-06 | 1.267E+02 | 2.957E-01 | 3.430E-01 | 3.430E-01 |
| 42 | 42-200M SOUTH OF TD | 1 | 1.258E-03 | 2.935E-06 | 3.405E-06 | 1.020E-05 | 2.431E+02 | 5.673E-01 | 6.581E-01 | 6.581E-01 |
| 42 | 42-200M SOUTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 42 | 42-200M SOUTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 42 | 42-200M SOUTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.258E-03 | 2.935E-06 | 3.405E-06 | 1.020E-05 | 2.431E+02 | 5.673E-01 | 6.581E-01 | 6.581E-01 |
| 43 | 43-200M WEST OF TD | 1 | 2.724E-04 | 6.356E-07 | 7.373E-07 | 2.210E-06 | 5.266E+01 | 1.229E-01 | 1.425E-01 | 1.425E-01 |
| 43 | 43-200M WEST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 43 | 43-200M WEST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 43 | 43-200M WEST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 2.724E-04 | 6.356E-07 | 7.373E-07 | 2.210E-06 | 5.266E+01 | 1.229E-01 | 1.425E-01 | 1.425E-01 |
| 44 | 44-200M UPWIND OF TD | 1 | 6.730E-04 | 1.570E-06 | 1.822E-06 | 5.460E-06 | 1.301E+02 | 3.036E-01 | 3.521E-01 | 3.521E-01 |
| 44 | 44-200M UPWIND OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 44 | 44-200M UPWIND OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 44 | 44-200M UPWIND OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CENTRATION TOTALS | | 6.730E-04 | 1.570E-06 | 1.822E-06 | 5.460E-06 | 1.301E+02 | 3.036E-01 | 3.521E-01 | 3.521E-01 |
| 45 | 45-200M DOWNWIND OF | 1 | 6.157E-04 | 1.437E-06 | 1.667E-06 | 4.995E-06 | 1.190E+02 | 2.777E-01 | 3.222E-01 | 3.222E-01 |
| 45 | 45-200M DOWNWIND OF | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 45 | 45-200M DOWNWIND OF | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 45 | 45-200M DOWNWIND OF | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 6.157E-04 | 1.437E-06 | 1.667E-06 | 4.995E-06 | 1.190E+02 | 2.777E-01 | 3.222E-01 | 3.222E-01 |
| 46 | 46-500M NORTH OF TD | 1 | 7.993E-04 | 1.865E-06 | 2.164E-06 | 6.485E-06 | 1.545E+02 | 3.606E-01 | 4.182E-01 | 4.182E-01 |
| 46 | 46-500M NORTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 46 | 46-500M NORTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 46 | 46-500M NORTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 7.993E-04 | 1.865E-06 | 2.164E-06 | 6.485E-06 | 1.545E+02 | 3.606E-01 | 4.182E-01 | 4.182E-01 |
| 47 | 47-500M EAST OF TD | 1 | 3.858E-04 | 9.002E-07 | 1.044E-06 | 3.130E-06 | 7.458E+01 | 1.740E-01 | 2.019E-01 | 2.019E-01 |
| 47 | 47-500M EAST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 47 | 47-500M EAST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 47 | 47-500M EAST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 3.858E-04 | 9.002E-07 | 1.044E-06 | 3.130E-06 | 7.458E+01 | 1.740E-01 | 2.019E-01 | 2.019E-01 |
| 48 | 48-500M SOUTH OF TD | 1 | 8.301E-04 | 1.937E-06 | 2.247E-06 | 6.734E-06 | 1.605E+02 | 3.744E-01 | 4.343E-01 | 4.343E-01 |
| 48 | 48-500M SOUTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 48 | 48-500M SOUTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 48 | 48-500M SOUTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 8.301E-04 | 1.937E-06 | 2.247E-06 | 6.734E-06 | 1.605E+02 | 3.744E-01 | 4.343E-01 | 4.343E-01 |

INDIVIDUAL RECEPTOR RADON AND RADON DAUGHTER CONCENTRATIONS

| | AIRBORNE CONCENTRATIONS, PCI/M3 | | | | | | | | GROUND CONCENTRATIONS, PCI/M2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO. | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | Bi-210 | Po-210 | WL | Po-218 | Pb-214 | Bi-214 | Pb-210 |
| 1 | 7.937E+00 | 7.931E+00 | 6.761E+00 | 5.739E+00 | 2.659E-05 | 1.437E-07 | 2.362E-11 | 6.385E-05 | 6.281E+00 | 6.281E+00 | 6.281E+00 | 2.462E+00 |
| 2 | 9.814E+01 | 5.243E+01 | 1.069E+01 | 5.634E+00 | 1.583E-05 | 9.215E-08 | 2.072E-11 | 1.292E-04 | 4.153E+01 | 4.153E+01 | 4.153E+01 | 1.466E+00 |
| 3 | 7.841E+01 | 5.092E+01 | 1.109E+01 | 5.623E+00 | 1.592E-05 | 9.224E-08 | 2.051E-11 | 1.297E-04 | 4.033E+01 | 4.033E+01 | 4.033E+01 | 1.474E+00 |
| 4 | 7.298E+00 | 7.154E+00 | 4.553E+00 | 2.830E+00 | 1.096E-05 | 1.191E-07 | 4.491E-11 | 4.101E-05 | 5.666E+00 | 5.666E+00 | 5.666E+00 | 1.015E+00 |
| 5 | 6.471E+01 | 4.654E+01 | 1.079E+01 | 5.416E+00 | 1.574E-05 | 9.182E-08 | 2.030E-11 | 1.228E-04 | 3.686E+01 | 3.686E+01 | 3.686E+01 | 1.457E+00 |
| 6 | 1.157E+02 | 5.594E+01 | 9.628E+00 | 5.118E+00 | 1.513E-05 | 9.090E-08 | 2.068E-11 | 1.255E-04 | 4.431E+01 | 4.431E+01 | 4.431E+01 | 1.401E+00 |
| 7 | 8.999E+01 | 4.848E+01 | 1.066E+01 | 5.759E+00 | 1.594E-05 | 9.238E-08 | 2.084E-11 | 1.255E-04 | 3.840E+01 | 3.840E+01 | 3.840E+01 | 1.475E+00 |
| 8 | 5.742E+01 | 4.438E+01 | 1.178E+01 | 6.036E+00 | 1.657E-05 | 9.343E-08 | 2.046E-11 | 1.280E-04 | 3.515E+01 | 3.515E+01 | 3.515E+01 | 1.534E+00 |
| 9 | 1.152E+02 | 5.526E+01 | 9.958E+00 | 5.388E+00 | 1.541E-05 | 9.145E-08 | 2.084E-11 | 1.275E-04 | 4.377E+01 | 4.377E+01 | 4.377E+01 | 1.427E+00 |
| 10 | 6.293E+01 | 4.787E+01 | 1.177E+01 | 5.808E+00 | 1.628E-05 | 9.284E-08 | 2.030E-11 | 1.306E-04 | 3.792E+01 | 3.792E+01 | 3.792E+01 | 1.508E+00 |
| 11 | 5.685E+01 | 4.275E+01 | 1.065E+01 | 5.270E+00 | 1.563E-05 | 9.152E-08 | 2.004E-11 | 1.177E-04 | 3.386E+01 | 3.386E+01 | 3.386E+01 | 1.447E+00 |
| 12 | 1.070E+02 | 4.833E+01 | 8.591E+00 | 4.818E+00 | 1.458E-05 | 8.994E-08 | 2.082E-11 | 1.113E-04 | 3.828E+01 | 3.828E+01 | 3.828E+01 | 1.350E+00 |
| 13 | 3.541E+01 | 2.542E+01 | 9.964E+00 | 5.953E+00 | 1.602E-05 | 9.263E-08 | 2.111E-11 | 9.891E-05 | 2.013E+01 | 2.013E+01 | 2.013E+01 | 1.483E+00 |
| 14 | 5.307E+01 | 4.346E+01 | 1.286E+01 | 6.512E+00 | 1.733E-05 | 9.486E-08 | 2.037E-11 | 1.343E-04 | 3.442E+01 | 3.442E+01 | 3.442E+01 | 1.604E+00 |
| 15 | 1.144E+02 | 4.944E+01 | 9.275E+00 | 5.249E+00 | 1.499E-05 | 9.085E-08 | 2.113E-11 | 1.175E-04 | 3.916E+01 | 3.916E+01 | 3.916E+01 | 1.388E+00 |
| 16 | 5.787E+01 | 4.680E+01 | 1.269E+01 | 6.080E+00 | 1.675E-05 | 9.365E-08 | 2.005E-11 | 1.352E-04 | 3.706E+01 | 3.706E+01 | 3.706E+01 | 1.551E+00 |
| 17 | 2.168E+01 | 2.114E+01 | 1.321E+01 | 8.418E+00 | 2.108E-05 | 1.034E-07 | 2.104E-11 | 1.202E-04 | 1.674E+01 | 1.674E+01 | 1.674E+01 | 1.951E+00 |
| 18 | 5.216E+00 | 5.215E+00 | 4.611E+00 | 4.104E+00 | 2.594E-05 | 1.667E-07 | 2.871E-11 | 4.406E-05 | 4.130E+00 | 4.130E+00 | 4.130E+00 | 2.402E+00 |
| 19 | 7.918E+00 | 7.895E+00 | 6.585E+00 | 5.708E+00 | 3.331E-05 | 2.002E-07 | 3.228E-11 | 6.281E-05 | 6.253E+00 | 6.253E+00 | 6.253E+00 | 3.084E+00 |
| 20 | 9.619E+00 | 9.392E+00 | 6.684E+00 | 5.027E+00 | 1.952E-05 | 1.019E-07 | 1.677E-11 | 6.231E-05 | 7.439E+00 | 7.439E+00 | 7.439E+00 | 1.808E+00 |
| 21 | 4.163E+00 | 4.090E+00 | 2.921E+00 | 2.305E+00 | 1.225E-05 | 9.111E-08 | 2.113E-11 | 2.762E-05 | 3.239E+00 | 3.239E+00 | 3.239E+00 | 1.134E+00 |
| 22 | 2.921E+00 | 2.899E+00 | 2.311E+00 | 1.941E+00 | 1.207E-05 | 1.095E-07 | 3.181E-11 | 2.194E-05 | 2.296E+00 | 2.296E+00 | 2.296E+00 | 1.117E+00 |
| 23 | 1.139E+02 | 9.413E+01 | 1.996E+01 | 5.329E+00 | 2.359E-05 | 2.909E-07 | 9.788E-11 | 2.180E-04 | 7.456E+01 | 7.456E+01 | 7.456E+01 | 2.184E+00 |
| 24 | 1.394E+02 | 1.064E+02 | 1.834E+01 | 4.753E+00 | 2.312E-05 | 2.849E-07 | 9.491E-11 | 2.203E-04 | 8.425E+01 | 8.425E+01 | 8.425E+01 | 2.141E+00 |
| 25 | 1.473E+02 | 9.281E+01 | 1.638E+01 | 5.049E+00 | 2.248E-05 | 2.821E-07 | 9.868E-11 | 1.975E-04 | 7.351E+01 | 7.351E+01 | 7.351E+01 | 2.081E+00 |
| 26 | 4.013E+00 | 4.005E+00 | 3.365E+00 | 2.932E+00 | 2.742E-05 | 3.875E-07 | 1.740E-10 | 3.212E-05 | 3.172E+00 | 3.172E+00 | 3.172E+00 | 2.539E+00 |
| 27 | 2.936E+01 | 2.593E+01 | 9.922E+00 | 4.426E+00 | 2.235E-05 | 2.428E-07 | 7.280E-11 | 9.352E-05 | 2.054E+01 | 2.054E+01 | 2.054E+01 | 2.069E+00 |
| 28 | 1.395E+02 | 1.103E+02 | 2.011E+01 | 5.041E+00 | 2.322E-05 | 2.866E-07 | 9.595E-11 | 2.343E-04 | 8.732E+01 | 8.732E+01 | 8.732E+01 | 2.150E+00 |
| 29 | 1.427E+02 | 1.081E+02 | 1.836E+01 | 4.738E+00 | 2.310E-05 | 2.845E-07 | 9.474E-11 | 2.221E-04 | 8.564E+01 | 8.564E+01 | 8.564E+01 | 2.138E+00 |
| 30 | 1.012E+02 | 8.042E+01 | 1.611E+01 | 4.649E+00 | 2.333E-05 | 2.871E-07 | 9.559E-11 | 1.818E-04 | 6.369E+01 | 6.369E+01 | 6.369E+01 | 2.160E+00 |
| 31 | 1.089E+02 | 8.860E+01 | 1.819E+01 | 4.989E+00 | 2.347E-05 | 2.892E-07 | 9.680E-11 | 2.021E-04 | 7.018E+01 | 7.018E+01 | 7.018E+01 | 2.172E+00 |
| 32 | 1.200E+02 | 9.217E+01 | 1.677E+01 | 4.626E+00 | 2.319E-05 | 2.854E-07 | 9.493E-11 | 1.972E-04 | 7.300E+01 | 7.300E+01 | 7.300E+01 | 2.147E+00 |
| 33 | 1.240E+02 | 9.991E+01 | 1.949E+01 | 5.081E+00 | 2.337E-05 | 2.883E-07 | 9.662E-11 | 2.207E-04 | 7.913E+01 | 7.913E+01 | 7.913E+01 | 2.164E+00 |
| 34 | 1.553E+02 | 1.230E+02 | 2.214E+01 | 5.276E+00 | 2.318E-05 | 2.863E-07 | 9.613E-11 | 2.586E-04 | 9.743E+01 | 9.743E+01 | 9.743E+01 | 2.146E+00 |
| 35 | 1.651E+02 | 1.189E+02 | 1.827E+01 | 4.627E+00 | 2.293E-05 | 2.821E-07 | 9.372E-11 | 2.323E-04 | 9.415E+01 | 9.415E+01 | 9.415E+01 | 2.123E+00 |
| 36 | 8.250E+01 | 6.653E+01 | 1.454E+01 | 4.538E+00 | 2.341E-05 | 2.874E-07 | 9.541E-11 | 1.592E-04 | 5.269E+01 | 5.269E+01 | 5.269E+01 | 2.167E+00 |
| 37 | 9.680E+01 | 8.080E+01 | 1.816E+01 | 5.173E+00 | 2.369E-05 | 2.916E-07 | 9.784E-11 | 1.946E-04 | 6.399E+01 | 6.399E+01 | 6.399E+01 | 2.194E+00 |
| 38 | 1.173E+02 | 8.712E+01 | 1.550E+01 | 4.473E+00 | 2.313E-05 | 2.839E-07 | 9.406E-11 | 1.850E-04 | 6.901E+01 | 6.901E+01 | 6.901E+01 | 2.142E+00 |
| 39 | 1.237E+02 | 1.013E+02 | 2.065E+01 | 5.342E+00 | 2.349E-05 | 2.898E-07 | 9.750E-11 | 2.290E-04 | 8.026E+01 | 8.026E+01 | 8.026E+01 | 2.175E+00 |
| 40 | 1.745E+02 | 1.382E+02 | 2.507E+01 | 5.681E+00 | 2.312E-05 | 2.857E-07 | 9.649E-11 | 2.906E-04 | 1.095E+02 | 1.095E+02 | 1.095E+02 | 2.141E+00 |
| 41 | 2.119E+02 | 1.316E+02 | 1.623E+01 | 4.181E+00 | 2.254E-05 | 2.774E-07 | 9.170E-11 | 2.334E-04 | 1.043E+02 | 1.043E+02 | 1.043E+02 | 2.087E+00 |
| 42 | 6.142E+01 | 4.897E+01 | 1.267E+01 | 4.467E+00 | 2.362E-05 | 2.881E-07 | 9.505E-11 | 1.313E-04 | 3.878E+01 | 3.878E+01 | 3.878E+01 | 2.186E+00 |
| 43 | 7.775E+01 | 6.724E+01 | 1.768E+01 | 5.480E+00 | 2.418E-05 | 2.965E-07 | 9.994E-11 | 1.794E-04 | 5.326E+01 | 5.326E+01 | 5.326E+01 | 2.238E+00 |
| 44 | 1.043E+02 | 7.350E+01 | 1.348E+01 | 4.291E+00 | 2.305E-05 | 2.811E-07 | 9.239E-11 | 1.601E-04 | 5.821E+01 | 5.821E+01 | 5.821E+01 | 2.134E+00 |
| 45 | 1.259E+02 | 1.043E+02 | 2.290E+01 | 5.946E+00 | 2.380E-05 | 2.928E-07 | 9.922E-11 | 2.457E-04 | 8.260E+01 | 8.260E+01 | 8.260E+01 | 2.203E+00 |
| 46 | 1.967E+02 | 1.378E+02 | 2.381E+01 | 5.800E+00 | 2.287E-05 | 2.841E-07 | 9.756E-11 | 2.843E-04 | 1.092E+02 | 1.092E+02 | 1.092E+02 | 2.118E+00 |
| 47 | 2.686E+02 | 1.013E+02 | 1.142E+01 | 3.662E+00 | 2.166E-05 | 2.635E-07 | 8.577E-11 | 1.759E-04 | 8.027E+01 | 8.027E+01 | 8.027E+01 | 2.005E+00 |
| 48 | 4.814E+01 | 3.951E+01 | 1.268E+01 | 4.827E+00 | 2.429E-05 | 2.900E-07 | 9.395E-11 | 1.230E-04 | 3.129E+01 | 3.129E+01 | 3.129E+01 | 2.249E+00 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

ER 1 NAME=1-AS-1 X= -3.7KM, Y= -0.5KM, Z= 0.0M, DIST= 3.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.60E-05 | 1.60E-05 | 3.73E-08 | 4.33E-08 | 6.39E-05 | 2.67E-05 | 2.73E-07 | 1.30E-07 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 3.20E-06 | 4.00E-06 | 4.66E-07 | 2.16E-08 | 1.92E-03 | 6.68E-06 | 1.37E-09 | 1.85E-08 |

SUM OF FRACTIONS EQUALS 1.93E-03

ER 2 NAME=2-AS-5A X= 0.0KM, Y= -0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.72E-06 | 9.72E-06 | 2.27E-08 | 2.63E-08 | 1.29E-04 | 1.59E-05 | 1.71E-07 | 7.89E-08 |
| MPC. PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| ON OF MPC | 1.94E-06 | 2.43E-06 | 2.84E-07 | 1.32E-08 | 3.88E-03 | 3.98E-06 | 8.55E-10 | 1.13E-08 |

SUM OF FRACTIONS EQUALS 3.89E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

UMBER 3 NAME=3-AS-5B X= 0.0KM, Y= 0.0KM, Z= 0.0M, DIST= 0.0KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.80E-06 | 9.80E-06 | 2.29E-08 | 2.65E-08 | 1.30E-04 | 1.60E-05 | 1.72E-07 | 7.95E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.96E-06 | 2.45E-06 | 2.86E-07 | 1.33E-08 | 3.89E-03 | 4.00E-06 | 8.59E-10 | 1.14E-08 |

SUM OF FRACTIONS EQUALS 3.90E-03

UMBER 4 NAME=4-AS-6 X= 3.5KM, Y= -3.7KM, Z= 0.0M, DIST= 5.1KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 4.30E-06 | 4.30E-06 | 1.00E-08 | 1.16E-08 | 4.10E-05 | 1.10E-05 | 1.54E-07 | 3.49E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 8.60E-07 | 1.07E-06 | 1.25E-07 | 5.82E-09 | 1.23E-03 | 2.75E-06 | 7.70E-10 | 4.99E-09 |

SUM OF FRACTIONS EQUALS 1.24E-03

ET: IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

UMBER 5 NAME=5-100M NORTH X= 0.0KM, Y= 0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.81E-06 | 9.81E-06 | 2.29E-08 | 2.66E-08 | 1.23E-04 | 1.58E-05 | 1.71E-07 | 7.96E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.96E-06 | 2.45E-06 | 2.86E-07 | 1.33E-08 | 3.69E-03 | 3.95E-06 | 8.57E-10 | 1.14E-08 |

SUM OF FRACTIONS EQUALS 3.70E-03

UMBER 6 NAME=6-100M EAST X= 0.1KM, Y= 0.0KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.54E-06 | 9.54E-06 | 2.23E-08 | 2.58E-08 | 1.26E-04 | 1.52E-05 | 1.68E-07 | 7.74E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| ION OF MPC | 1.91E-06 | 2.39E-06 | 2.78E-07 | 1.29E-08 | 3.77E-03 | 3.80E-06 | 8.42E-10 | 1.11E-08 |

SUM OF FRACTIONS EQUALS 3.78E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

UMBER 7 NAME=7-100M SOUTH X= 0.0KM, Y= -0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.72E-06 | 9.72E-06 | 2.27E-08 | 2.63E-08 | 1.25E-04 | 1.60E-05 | 1.71E-07 | 7.89E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.94E-06 | 2.43E-06 | 2.84E-07 | 1.32E-08 | 3.77E-03 | 4.00E-06 | 8.56E-10 | 1.13E-08 |

SUM OF FRACTIONS EQUALS 3.78E-03

UMBER 8 NAME=8-100M WEST X= -0.1KM, Y= 0.0KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.99E-06 | 9.99E-06 | 2.33E-08 | 2.70E-08 | 1.28E-04 | 1.67E-05 | 1.74E-07 | 8.11E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 2.00E-06 | 2.50E-06 | 2.91E-07 | 1.35E-08 | 3.84E-03 | 4.16E-06 | 8.72E-10 | 1.16E-08 |

SUM OF FRACTIONS EQUALS 3.85E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 9 NAME=9-100M UPWIND X= 0.1KM, Y= -0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.58E-06 | 9.58E-06 | 2.24E-08 | 2.59E-08 | 1.28E-04 | 1.55E-05 | 1.69E-07 | 7.78E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.92E-06 | 2.40E-06 | 2.79E-07 | 1.30E-08 | 3.83E-03 | 3.87E-06 | 8.46E-10 | 1.11E-08 |

SUM OF FRACTIONS EQUALS 3.84E-03

NUMBER 10 NAME=10-100M DOWNWIND X= -0.1KM, Y= 0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.96E-06 | 9.96E-06 | 2.32E-08 | 2.69E-08 | 1.31E-04 | 1.64E-05 | 1.74E-07 | 8.08E-08 |
| C, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| RACTION OF MPC | 1.99E-06 | 2.49E-06 | 2.90E-07 | 1.35E-08 | 3.92E-03 | 4.09E-06 | 8.68E-10 | 1.15E-08 |

SUM OF FRACTIONS EQUALS 3.93E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 11 NAME=11-200M NORTH X= 0.0KM, Y= 0.2KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.85E-06 | 9.85E-06 | 2.30E-08 | 2.67E-08 | 1.18E-04 | 1.57E-05 | 1.71E-07 | 7.99E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.97E-06 | 2.46E-06 | 2.87E-07 | 1.33E-08 | 3.53E-03 | 3.93E-06 | 8.57E-10 | 1.14E-08 |

SUM OF FRACTIONS EQUALS 3.54E-03

NUMBER 12 NAME=12-200M EAST X= 0.2KM, Y= 0.0KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.32E-06 | 9.32E-06 | 2.18E-08 | 2.52E-08 | 1.11E-04 | 1.47E-05 | 1.66E-07 | 7.57E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.86E-06 | 2.33E-06 | 2.72E-07 | 1.26E-08 | 3.34E-03 | 3.66E-06 | 8.28E-10 | 1.08E-08 |

SUM OF FRACTIONS EQUALS 3.35E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NR 13 NAME=13-200M SOUTH X= 0.0KM, Y= -0.2KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.67E-06 | 9.67E-06 | 2.26E-08 | 2.62E-08 | 9.89E-05 | 1.61E-05 | 1.71E-07 | 7.85E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.93E-06 | 2.42E-06 | 2.82E-07 | 1.31E-08 | 2.97E-03 | 4.02E-06 | 8.55E-10 | 1.12E-08 |

SUM OF FRACTIONS EQUALS 2.98E-03

NUMBER 14 NAME=14-200M WEST X= -0.2KM, Y= 0.0KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.02E-05 | 1.02E-05 | 2.38E-08 | 2.76E-08 | 1.34E-04 | 1.74E-05 | 1.78E-07 | 8.29E-08 |
| PC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 2.04E-06 | 2.55E-06 | 2.98E-07 | 1.38E-08 | 4.03E-03 | 4.35E-06 | 8.89E-10 | 1.18E-08 |

SUM OF FRACTIONS EQUALS 4.04E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 15 NAME=15-200M UPWIND X= 0.1KM, Y= -0.1KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.40E-06 | 9.40E-06 | 2.19E-08 | 2.54E-08 | 1.18E-04 | 1.51E-05 | 1.67E-07 | 7.63E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.88E-06 | 2.35E-06 | 2.74E-07 | 1.27E-08 | 3.53E-03 | 3.77E-06 | 8.36E-10 | 1.09E-08 |

SUM OF FRACTIONS EQUALS 3.54E-03

NUMBER 16 NAME=16-200M DOWNWIND X= -0.1KM, Y= 0.1KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.02E-05 | 1.02E-05 | 2.37E-08 | 2.75E-08 | 1.35E-04 | 1.68E-05 | 1.76E-07 | 8.24E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 2.03E-06 | 2.54E-06 | 2.96E-07 | 1.37E-08 | 4.06E-03 | 4.21E-06 | 8.80E-10 | 1.18E-08 |

SUM OF FRACTIONS EQUALS 4.07E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 17 NAME=17-240 DEG @ 725M X= -0.7KM, Y= -0.4KM, Z= 0.0M, DIST= 0.8KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.11E-05 | 1.11E-05 | 2.58E-08 | 3.00E-08 | 1.20E-04 | 2.12E-05 | 1.93E-07 | 8.98E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 2.21E-06 | 2.77E-06 | 3.23E-07 | 1.50E-08 | 3.61E-03 | 5.29E-06 | 9.66E-10 | 1.28E-08 |

SUM OF FRACTIONS EQUALS 3.62E-03

NUMBER 18 NAME=18-270 DEG @ 5500M X= -5.5KM, Y= 0.0KM, Z= 0.0M, DIST= 5.5KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.73E-05 | 1.73E-05 | 4.04E-08 | 4.69E-08 | 4.41E-05 | 2.61E-05 | 3.07E-07 | 1.41E-07 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 3.46E-06 | 4.33E-06 | 5.05E-07 | 2.34E-08 | 1.32E-03 | 6.52E-06 | 1.54E-09 | 2.01E-08 |

SUM OF FRACTIONS EQUALS 1.34E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 19 NAME=19-330 DEG @ 5100M X= -4.0KM, Y= 3.0KM, Z= 0.0M, DIST= 5.0KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 3.24E-05 | 3.24E-05 | 7.55E-08 | 8.76E-08 | 6.28E-05 | 3.36E-05 | 4.63E-07 | 2.63E-07 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 6.47E-06 | 8.09E-06 | 9.44E-07 | 4.38E-08 | 1.89E-03 | 8.39E-06 | 2.31E-09 | 3.75E-08 |

SUM OF FRACTIONS EQUALS 1.91E-03

NUMBER 20 NAME=20-345 DEG @ 2050M X= -0.8KM, Y= 1.8KM, Z= 0.0M, DIST= 2.0KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.29E-05 | 1.29E-05 | 3.01E-08 | 3.49E-08 | 6.23E-05 | 1.96E-05 | 2.07E-07 | 1.05E-07 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 2.58E-06 | 3.22E-06 | 3.76E-07 | 1.75E-08 | 1.87E-03 | 4.91E-06 | 1.03E-09 | 1.49E-08 |

SUM OF FRACTIONS EQUALS 1.88E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

1 NAME=21- 45 DEG @ 3350M X= 2.4KM, Y= 2.3KM, Z= 0.0M, DIST= 3.3KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 6.87E-06 | 6.87E-06 | 1.60E-08 | 1.86E-08 | 2.76E-05 | 1.23E-05 | 1.47E-07 | 5.57E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.37E-06 | 1.72E-06 | 2.00E-07 | 9.29E-09 | 8.29E-04 | 3.08E-06 | 7.34E-10 | 7.96E-09 |

SUM OF FRACTIONS EQUALS 8.36E-04

UMBER 22 NAME=22- 80 DEG @ 4725M X= 4.6KM, Y= 1.2KM, Z= 0.0M, DIST= 4.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 4.39E-06 | 4.39E-06 | 1.02E-08 | 1.19E-08 | 2.19E-05 | 1.21E-05 | 1.45E-07 | 3.56E-08 |
| , PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 8.77E-07 | 1.10E-06 | 1.28E-07 | 5.94E-09 | 6.59E-04 | 3.03E-06 | 7.25E-10 | 5.09E-09 |

SUM OF FRACTIONS EQUALS 6.64E-04

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 23 NAME=23-IR-1 X= -7.2KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.32E-04 | 1.32E-04 | 3.08E-07 | 3.57E-07 | 2.18E-04 | 2.47E-05 | 1.36E-06 | 1.07E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 2.64E-05 | 3.30E-05 | 3.85E-06 | 1.78E-07 | 6.55E-03 | 6.17E-06 | 6.80E-09 | 1.53E-07 |

SUM OF FRACTIONS EQUALS 6.62E-03

NUMBER 24 NAME=24-IR-3 X= -7.0KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.37E-06 | 1.37E-06 | 3.20E-09 | 3.71E-09 | 2.20E-04 | 2.31E-05 | 2.96E-07 | 1.12E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 2.74E-07 | 3.42E-07 | 4.00E-08 | 1.85E-09 | 6.62E-03 | 5.78E-06 | 1.48E-09 | 1.60E-09 |

SUM OF FRACTIONS EQUALS 6.62E-03

REGION: IRIGARY/CRIN

DATASET: IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 25 NAME=25-IR-4 X= -7.1KM, Y= 10.1KM, Z= 0.0M, DIST= 12.3KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 4.62E-04 | 4.62E-04 | 1.08E-06 | 1.25E-06 | 1.97E-04 | 2.62E-05 | 4.03E-06 | 3.75E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 9.24E-05 | 1.15E-04 | 1.35E-05 | 6.25E-07 | 5.93E-03 | 6.56E-06 | 2.02E-08 | 5.35E-07 |

SUM OF FRACTIONS EQUALS 6.16E-03

NUMBER 26 NAME=26-IR-5 X= -9.2KM, Y= 15.1KM, Z= 0.0M, DIST= 17.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 4.16E-05 | 4.16E-05 | 9.70E-08 | 1.13E-07 | 3.21E-05 | 2.78E-05 | 7.25E-07 | 3.37E-07 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| ACTION OF MPC | 8.31E-06 | 1.04E-05 | 1.21E-06 | 5.63E-08 | 9.65E-04 | 6.94E-06 | 3.62E-09 | 4.82E-08 |

SUM OF FRACTIONS EQUALS 9.92E-04

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

ER 27 NAME=27-IR-6 X= -6.0KM, Y= 8.5KM, Z= 0.0M, DIST= 10.4KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.58E-04 | 1.58E-04 | 3.69E-07 | 4.28E-07 | 9.35E-05 | 2.36E-05 | 1.52E-06 | 1.28E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 3.16E-05 | 3.95E-05 | 4.61E-06 | 2.14E-07 | 2.81E-03 | 5.91E-06 | 7.62E-09 | 1.83E-07 |

SUM OF FRACTIONS EQUALS 2.89E-03

ER 28 NAME=28-50M NORTH OF TD X= -7.1KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 8.81E-06 | 8.81E-06 | 2.06E-08 | 2.39E-08 | 2.34E-04 | 2.33E-05 | 3.58E-07 | 7.16E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.76E-06 | 2.20E-06 | 2.57E-07 | 1.19E-08 | 7.04E-03 | 5.82E-06 | 1.79E-09 | 1.02E-08 |

SUM OF FRACTIONS EQUALS 7.05E-03

REGION: IRIGARY/CHRISTSEN RANCH CODE: [illegible]

SET: IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 29 NAME=29-50M EAST OF TD X= -7.0KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 8.38E-06 | 8.38E-06 | 1.96E-08 | 2.27E-08 | 2.22E-04 | 2.32E-05 | 3.52E-07 | 6.81E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.68E-06 | 2.10E-06 | 2.44E-07 | 1.13E-08 | 6.67E-03 | 5.79E-06 | 1.76E-09 | 9.73E-09 |

SUM OF FRACTIONS EQUALS 6.68E-03

NUMBER 30 NAME=30-50M SOUTH OF TD X= -7.1KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 2.97E-05 | 2.97E-05 | 6.93E-08 | 8.04E-08 | 1.82E-04 | 2.36E-05 | 5.28E-07 | 2.41E-07 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 5.94E-06 | 7.42E-06 | 8.66E-07 | 4.02E-08 | 5.46E-03 | 5.89E-06 | 2.64E-09 | 3.44E-08 |

SUM OF FRACTIONS EQUALS 5.48E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

U ER 31 NAME=31-50M WEST OF TD X= -7.1KM, Y= 9.2KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.65E-06 | 1.65E-06 | 3.86E-09 | 4.48E-09 | 2.02E-04 | 2.35E-05 | 3.03E-07 | 1.35E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 3.31E-07 | 4.13E-07 | 4.82E-08 | 2.24E-09 | 6.07E-03 | 5.87E-06 | 1.51E-09 | 1.93E-09 |

SUM OF FRACTIONS EQUALS 6.08E-03

C ER 32 NAME=32-50M UPWIND OF TD X= -7.1KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 7.31E-06 | 7.31E-06 | 1.71E-08 | 1.98E-08 | 1.97E-04 | 2.32E-05 | 3.45E-07 | 5.94E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.46E-06 | 1.83E-06 | 2.13E-07 | 9.89E-09 | 5.92E-03 | 5.81E-06 | 1.72E-09 | 8.48E-09 |

SUM OF FRACTIONS EQUALS 5.93E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 33 NAME=33-50M DOWNWIND OF T X= -7.1KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 7.12E-06 | 7.12E-06 | 1.66E-08 | 1.93E-08 | 2.21E-04 | 2.34E-05 | 3.46E-07 | 5.78E-08 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.42E-06 | 1.78E-06 | 2.08E-07 | 9.63E-09 | 6.63E-03 | 5.86E-06 | 1.73E-09 | 8.26E-09 |

SUM OF FRACTIONS EQUALS 6.64E-03

NUMBER 34 NAME=34-100M NORTH OF TD X= -7.1KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 3.08E-04 | 3.08E-04 | 7.19E-07 | 8.34E-07 | 2.59E-04 | 2.57E-05 | 2.79E-06 | 2.50E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| ION OF MPC | 6.16E-05 | 7.70E-05 | 8.99E-06 | 4.17E-07 | 7.77E-03 | 6.42E-06 | 1.39E-08 | 3.57E-07 |

SUM OF FRACTIONS EQUALS 7.92E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

ER 35 NAME=35-100M EAST OF TD X= -7.0KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 2.18E-04 | 2.18E-04 | 5.09E-07 | 5.90E-07 | 2.32E-04 | 2.47E-05 | 2.05E-06 | 1.77E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 4.36E-05 | 5.45E-05 | 6.36E-06 | 2.95E-07 | 6.98E-03 | 6.17E-06 | 1.03E-08 | 2.53E-07 |

SUM OF FRACTIONS EQUALS 7.09E-03

ER 36 NAME=36-100M SOUTH OF TD X= -7.1KM, Y= 9.1KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 6.36E-04 | 6.36E-04 | 1.48E-06 | 1.72E-06 | 1.59E-04 | 2.86E-05 | 5.45E-06 | 5.16E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.27E-04 | 1.59E-04 | 1.86E-05 | 8.61E-07 | 4.78E-03 | 7.14E-06 | 2.72E-08 | 7.37E-07 |

SUM OF FRACTIONS EQUALS 5.09E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NAME=37-100M WEST OF TD X= -7.2KM, Y= 9.2KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 6.32E-05 | 6.32E-05 | 1.47E-07 | 1.71E-07 | 1.95E-04 | 2.42E-05 | 8.04E-07 | 5.13E-07 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.26E-05 | 1.58E-05 | 1.84E-06 | 8.56E-08 | 5.84E-03 | 6.05E-06 | 4.02E-09 | 7.33E-08 |

SUM OF FRACTIONS EQUALS 5.88E-03

NUMBER 38 NAME=38-100M UPWIND OF TD X= -7.0KM, Y= 9.1KM, Z= 0.0M, DIST= 11.5KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 2.63E-04 | 2.63E-04 | 6.14E-07 | 7.13E-07 | 1.85E-04 | 2.53E-05 | 2.42E-06 | 2.14E-06 |
| PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 5.27E-05 | 6.58E-05 | 7.68E-06 | 3.56E-07 | 5.56E-03 | 6.32E-06 | 1.21E-08 | 3.05E-07 |

SUM OF FRACTIONS EQUALS 5.69E-03

REGION: IRIGARY/CHRISTISEN RANCH CODE: [illegible]

SHEET: IRIGARY DATA DATA: crin.dat 02/22/95

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 39 NAME=39-100M DOWNWIND OF X= -7.2KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.86E-04 | 1.86E-04 | 4.34E-07 | 5.04E-07 | 2.29E-04 | 2.50E-05 | 1.80E-06 | 1.51E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 3.72E-05 | 4.65E-05 | 5.43E-06 | 2.52E-07 | 6.88E-03 | 6.25E-06 | 9.00E-09 | 2.16E-07 |

SUM OF FRACTIONS EQUALS 6.97E-03

NUMBER 40 NAME=40-200M NORTH OF TD X= -7.1KM, Y= 9.4KM, Z= 0.0M, DIST= 11.8KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 9.92E-04 | 9.92E-04 | 2.31E-06 | 2.68E-06 | 2.91E-04 | 3.12E-05 | 8.33E-06 | 8.05E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.98E-04 | 2.48E-04 | 2.89E-05 | 1.34E-06 | 8.73E-03 | 7.79E-06 | 4.17E-08 | 1.15E-06 |

SUM OF FRACTIONS EQUALS 9.21E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

MBER 41 NAME=41-200M EAST OF TD X= -6.9KM, Y= 9.2KM, Z= 0.0M, DIST= 11.5KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 6.56E-04 | 6.56E-04 | 1.53E-06 | 1.77E-06 | 2.33E-04 | 2.79E-05 | 5.60E-06 | 5.32E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.31E-04 | 1.64E-04 | 1.91E-05 | 8.87E-07 | 7.01E-03 | 6.96E-06 | 2.80E-08 | 7.60E-07 |

SUM OF FRACTIONS EQUALS 7.33E-03

MBER 42 NAME=42-200M SOUTH OF TD X= -7.1KM, Y= 9.0KM, Z= 0.0M, DIST= 11.5KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 1.26E-03 | 1.26E-03 | 2.93E-06 | 3.40E-06 | 1.31E-04 | 3.38E-05 | 1.05E-05 | 1.02E-05 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| TION OF MPC | 2.52E-04 | 3.14E-04 | 3.67E-05 | 1.70E-06 | 3.94E-03 | 8.45E-06 | 5.25E-08 | 1.46E-06 |

SUM OF FRACTIONS EQUALS 4.56E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

II ER 43 NAME=43-200M WEST OF TD X= -7.3KM, Y= 9.2KM, Z= 0.0M, DIST= 11.8KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 2.72E-04 | 2.72E-04 | 6.36E-07 | 7.37E-07 | 1.79E-04 | 2.64E-05 | 2.51E-06 | 2.21E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 5.45E-05 | 6.81E-05 | 7.94E-06 | 3.69E-07 | 5.39E-03 | 6.60E-06 | 1.25E-08 | 3.16E-07 |

SUM OF FRACTIONS EQUALS 5.52E-03

N BER 44 NAME=44-200M UPWIND OF TD X= -6.9KM, Y= 9.1KM, Z= 0.0M, DIST= 11.4KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 6.73E-04 | 6.73E-04 | 1.57E-06 | 1.82E-06 | 1.60E-04 | 2.85E-05 | 5.74E-06 | 5.46E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.35E-04 | 1.68E-04 | 1.96E-05 | 9.11E-07 | 4.81E-03 | 7.13E-06 | 2.87E-08 | 7.80E-07 |

SUM OF FRACTIONS EQUALS 5.14E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 45 NAME=45-200M DOWNWIND OF X= -7.2KM, Y= 9.4KM, Z= 0.0M, DIST= 11.8KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 6.16E-04 | 6.16E-04 | 1.44E-06 | 1.67E-06 | 2.46E-04 | 2.88E-05 | 5.29E-06 | 5.00E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.23E-04 | 1.54E-04 | 1.80E-05 | 8.33E-07 | 7.38E-03 | 7.20E-06 | 2.64E-08 | 7.14E-07 |

SUM OF FRACTIONS EQUALS 7.68E-03

NUMBER 46 NAME=46-500M NORTH OF TD X= -7.1KM, Y= 9.7KM, Z= 0.0M, DIST= 12.0KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 7.99E-04 | 7.99E-04 | 1.87E-06 | 2.16E-06 | 2.84E-04 | 2.94E-05 | 6.77E-06 | 6.48E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| ICTION OF MPC | 1.60E-04 | 2.00E-04 | 2.33E-05 | 1.08E-06 | 8.54E-03 | 7.34E-06 | 3.38E-08 | 9.26E-07 |

SUM OF FRACTIONS EQUALS 8.93E-03

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

R 47 NAME=47-500M EAST OF TD X= -6.6KM, Y= 9.2KM, Z= 0.0M, DIST= 11.3KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 3.86E-04 | 3.86E-04 | 9.00E-07 | 1.04E-06 | 1.76E-04 | 2.48E-05 | 3.39E-06 | 3.13E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 7.72E-05 | 9.64E-05 | 1.13E-05 | 5.22E-07 | 5.28E-03 | 6.20E-06 | 1.70E-08 | 4.47E-07 |

SUM OF FRACTIONS EQUALS 5.48E-03

R 48 NAME=48-500M SOUTH OF TD X= -7.1KM, Y= 8.7KM, Z= 0.0M, DIST= 11.2KM, IRTYPE= 0

RESULTS OF MPC CHECK AT THIS LOCATION

| | U-238 | U-234 | Th-230 | Ra-226 | Rn-222(WL) | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|
| CONC., PCI/M3 | 8.30E-04 | 8.30E-04 | 1.94E-06 | 2.25E-06 | 1.23E-04 | 3.10E-05 | 7.02E-06 | 6.73E-06 |
| MPC, PCI/M3 | 5.00E+00 | 4.00E+00 | 8.00E-02 | 2.00E+00 | 3.33E-02 | 4.00E+00 | 2.00E+02 | 7.00E+00 |
| FRACTION OF MPC | 1.66E-04 | 2.08E-04 | 2.42E-05 | 1.12E-06 | 3.69E-03 | 7.76E-06 | 3.51E-08 | 9.62E-07 |

SUM OF FRACTIONS EQUALS 4.10E-03

# MILDOS MODELING

## 40 CFR 190 Requirements

REGION: IRIGARY/CHRISTSEN RANCH CODE: MILDOS-AREA (03/89) PAGE 2
METSET: IRIGARY DATA DATA: 40cfr.in 02/22/95
JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS=0.26830,0.28680,0.20920,0.16930,0.05240,0.01220

| MPH | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STABILITY CLASS 1 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.3600 | 0.3300 | 0.3100 | 0.2300 | 0.2000 | 0.1200 | 0.2600 | 0.1900 | 0.4700 | 0.2900 | 0.4800 | 0.3600 | 0.4700 | 0.3400 | 0.3300 | 0.3600 | 5.1000 |
| 5.5 | 0.5600 | 0.3300 | 0.3000 | 0.1400 | 0.0500 | 0.1000 | 0.1600 | 0.2400 | 0.2700 | 0.3100 | 0.3600 | 0.1600 | 0.2600 | 0.1300 | 0.3500 | 0.5500 | 4.2700 |
| 10.0 | 0.3000 | 0.1300 | 0.0200 | 0.0100 | 0.0100 | 0.0100 | 0.0800 | 0.0700 | 0.0500 | 0.0800 | 0.1500 | 0.0800 | 0.0300 | 0.0000 | 0.0100 | 0.1000 | 1.1300 |
| 15.5 | 0.0200 | 0.0000 | 0.0100 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.0100 | 0.0000 | 0.0100 | 0.0700 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 1.2400 | 0.7900 | 0.6400 | 0.3800 | 0.2600 | 0.2300 | 0.5000 | 0.5000 | 0.7900 | 0.6800 | 0.9900 | 0.6000 | 0.7800 | 0.4800 | 0.6900 | 1.0200 | 10.5700 |
| STABILITY CLASS 2 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.0600 | 0.0700 | 0.0200 | 0.0500 | 0.0800 | 0.0800 | 0.0800 | 0.1200 | 0.0900 | 0.1300 | 0.2000 | 0.0600 | 0.1500 | 0.0900 | 0.1700 | 0.0500 | 1.5000 |
| 5.5 | 0.3000 | 0.1400 | 0.0700 | 0.0100 | 0.0700 | 0.0300 | 0.1000 | 0.1500 | 0.3100 | 0.3400 | 0.2800 | 0.1200 | 0.0800 | 0.1400 | 0.1700 | 0.2100 | 2.5200 |
| 10.0 | 0.3400 | 0.1600 | 0.1000 | 0.0100 | 0.0300 | 0.0300 | 0.1200 | 0.1200 | 0.1900 | 0.2700 | 0.1900 | 0.1300 | 0.0700 | 0.0700 | 0.0800 | 0.2800 | 2.1900 |
| 15.5 | 0.1300 | 0.0500 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0100 | 0.0000 | 0.0300 | 0.0500 | 0.0100 | 0.0000 | 0.0000 | 0.0200 | 0.3000 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 0.8300 | 0.4200 | 0.1900 | 0.0700 | 0.1800 | 0.1400 | 0.3000 | 0.3900 | 0.6000 | 0.7400 | 0.7000 | 0.3600 | 0.3100 | 0.3000 | 0.4200 | 0.5600 | 6.5100 |
| STABILITY CLASS 3 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.0500 | 0.0500 | 0.0700 | 0.0300 | 0.1200 | 0.1600 | 0.1500 | 0.0700 | 0.0300 | 0.0700 | 0.0300 | 0.0200 | 0.0600 | 0.0500 | 0.0500 | 0.0900 | 1.1000 |
| 5.5 | 0.1400 | 0.0800 | 0.0800 | 0.0100 | 0.0500 | 0.0800 | 0.1300 | 0.1200 | 0.2400 | 0.4300 | 0.2300 | 0.0800 | 0.1400 | 0.1000 | 0.1500 | 0.1400 | 2.2000 |
| 10.0 | 0.6500 | 0.1500 | 0.0600 | 0.0800 | 0.0300 | 0.0700 | 0.1500 | 0.1700 | 0.4300 | 0.2700 | 0.2000 | 0.0900 | 0.0800 | 0.0300 | 0.1200 | 0.4100 | 2.9900 |
| 15.5 | 0.3500 | 0.0300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0300 | 0.0100 | 0.0200 | 0.0500 | 0.0700 | 0.0800 | 0.0200 | 0.0200 | 0.0200 | 0.0500 | 0.7500 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 1.1900 | 0.3100 | 0.2100 | 0.1200 | 0.2000 | 0.3100 | 0.4600 | 0.3700 | 0.7200 | 0.8200 | 0.5300 | 0.2700 | 0.3000 | 0.2000 | 0.3400 | 0.6900 | 7.0400 |
| STABILITY CLASS 4 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.1400 | 0.1000 | 0.1600 | 0.0700 | 0.2300 | 1.3800 | 0.8700 | 0.0900 | 0.0600 | 0.0100 | 0.0900 | 0.1000 | 0.2200 | 0.1300 | 0.2400 | 0.1400 | 4.0300 |
| 5.5 | 0.6100 | 0.2800 | 0.2600 | 0.0800 | 0.4300 | 2.0000 | 2.0500 | 0.6300 | 0.5700 | 0.6900 | 0.4000 | 0.1600 | 0.1700 | 0.1500 | 0.3600 | 0.6700 | 9.5100 |
| 10.0 | 1.2900 | 0.3700 | 0.2100 | 0.2000 | 0.2600 | 0.2800 | 0.8300 | 0.9100 | 0.9500 | 0.8800 | 0.5500 | 0.1500 | 0.1400 | 0.0600 | 0.3500 | 1.0500 | 8.4800 |
| 15.5 | 1.6200 | 0.3100 | 0.2000 | 0.1400 | 0.0500 | 0.4300 | 1.2300 | 1.3000 | 1.9700 | 2.4600 | 0.8700 | 0.3100 | 0.4900 | 0.1400 | 0.7900 | 2.6200 | 14.9300 |
| 21.5 | 0.4900 | 0.0200 | 0.0100 | 0.0100 | 0.0000 | 0.1200 | 0.7100 | 0.3100 | 0.5200 | 0.8800 | 0.6900 | 0.1500 | 0.1000 | 0.0000 | 0.2400 | 0.9900 | 5.2400 |
| 28.0 | 0.0300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1500 | 0.3500 | 0.0100 | 0.0100 | 0.0600 | 0.1000 | 0.1200 | 0.0500 | 0.0000 | 0.0500 | 0.2900 | 1.2200 |
| ALL | 4.1800 | 1.0800 | 0.8400 | 0.5000 | 0.9700 | 4.3600 | 6.0400 | 3.2500 | 4.0800 | 4.9800 | 2.7000 | 0.9900 | 1.1700 | 0.4800 | 2.0300 | 5.7600 | 43.4100 |
| STABILITY CLASS 5 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.1900 | 0.2200 | 0.0900 | 0.1000 | 0.3600 | 1.2100 | 1.0200 | 0.1700 | 0.1500 | 0.1700 | 0.1300 | 0.0500 | 0.2800 | 0.2900 | 0.2100 | 0.1900 | 4.8300 |
| 5.5 | 0.2700 | 0.2800 | 0.0800 | 0.1200 | 0.2400 | 1.8000 | 1.6100 | 0.5500 | 0.3300 | 0.4900 | 0.2000 | 0.2000 | 0.2300 | 0.1300 | 0.3400 | 0.4700 | 7.3400 |
| 10.0 | 0.3000 | 0.1900 | 0.1600 | 0.1300 | 0.0900 | 0.3700 | 0.9800 | 0.7000 | 0.6600 | 0.9000 | 0.2100 | 0.0700 | 0.0700 | 0.0600 | 0.2000 | 0.9100 | 6.0000 |
| 15.5 | 0.0100 | 0.0000 | 0.0200 | 0.0000 | 0.0000 | 0.0100 | 0.0900 | 0.0200 | 0.1000 | 0.2300 | 0.0700 | 0.0100 | 0.0100 | 0.0000 | 0.0700 | 0.1600 | 0.8000 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 0.7700 | 0.6900 | 0.3500 | 0.3500 | 0.6900 | 3.3900 | 3.7000 | 1.4400 | 1.2400 | 1.7900 | 0.6100 | 0.3300 | 0.5900 | 0.4800 | 0.8200 | 1.7300 | 18.9700 |
| STABILITY CLASS 6 | | | | | | | | | | | | | | | | | |
| 1.5 | 0.3800 | 0.3700 | 0.2800 | 0.2400 | 0.5400 | 1.4300 | 2.1300 | 0.9800 | 0.5400 | 0.4500 | 0.5700 | 0.3500 | 0.4500 | 0.5000 | 0.4900 | 0.5700 | 10.2700 |
| 5.5 | 0.1000 | 0.0500 | 0.0300 | 0.0200 | 0.1000 | 0.4000 | 0.6100 | 0.3100 | 0.2400 | 0.2700 | 0.2200 | 0.0800 | 0.0900 | 0.0900 | 0.1000 | 0.1300 | 2.8400 |
| 10.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.0100 | 0.0000 | 0.0000 | 0.0700 | 0.0000 | 0.0100 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.1300 |
| 15.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0200 | 0.0100 | 0.0000 | 0.0300 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0100 | 0.0100 | 0.0800 |
| 21.5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 28.0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ALL | 0.4800 | 0.4200 | 0.3100 | 0.2600 | 0.6400 | 1.8500 | 2.7700 | 1.2000 | 0.7800 | 0.8200 | 0.7900 | 0.4400 | 0.5400 | 0.5900 | 0.6000 | 0.7300 | 13.3200 |

INDIVIDUAL RECEPTOR LOCATION DATA, 48 LOCATIONS INPUT THIS RUN

| I | LOCATION NAMES | X(KM) | Y(KM) | Z(M) | DIST(KM) | TYPE | I | LOCATION NAMES | X(KM) | Y(KM) | Z(M) | DIST(KM) | TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-AS-1 | -3.66 | -0.46 | 0.00 | 3.69 | 1 | 25 | 25-IR-4 | -7.09 | 10.06 | 0.00 | 12.30 | 1 |
| 2 | 2-AS-5A | 0.01 | -0.05 | 0.00 | 0.06 | 1 | 26 | 26-IR-5 | -9.22 | 15.09 | 0.00 | 17.68 | 1 |
| 3 | 3-AS-5B | -0.01 | 0.01 | 0.00 | 0.02 | 1 | 27 | 27-IR-6 | -6.02 | 8.50 | 0.00 | 10.41 | 1 |
| 4 | 4-AS-6 | 3.51 | -3.73 | 0.00 | 5.12 | 1 | 28 | 28-50M NORTH OF TD | -7.09 | 9.27 | 0.00 | 11.67 | 1 |
| 5 | 5-100M NORTH | 0.00 | 0.10 | 0.00 | 0.10 | 1 | 29 | 29-50M EAST OF TD | -7.04 | 9.22 | 0.00 | 11.60 | 1 |
| 6 | 6-100M EAST | 0.10 | 0.00 | 0.00 | 0.10 | 1 | 30 | 30-50M SOUTH OF TD | -7.09 | 9.17 | 0.00 | 11.59 | 1 |
| 7 | 7-100M SOUTH | 0.00 | -0.10 | 0.00 | 0.10 | 1 | 31 | 31-50M WEST OF TD | -7.14 | 9.22 | 0.00 | 11.66 | 1 |
| 8 | 8-100M WEST | -0.10 | 0.00 | 0.00 | 0.10 | 1 | 32 | 32-50M UPWIND OF TD | -7.05 | 9.19 | 0.00 | 11.58 | 1 |
| 9 | 9-100M UPWIND | 0.07 | -0.07 | 0.00 | 0.10 | 1 | 33 | 33-50M DOWNWIND OF T | -7.13 | 9.26 | 0.00 | 11.68 | 1 |
| 10 | 10-100M DOWNWIND | -0.07 | 0.07 | 0.00 | 0.10 | 1 | 34 | 34-100M NORTH OF TD | -7.09 | 9.32 | 0.00 | 11.71 | 1 |
| 11 | 11-200M NORTH | 0.00 | 0.20 | 0.00 | 0.20 | 1 | 35 | 35-100M EAST OF TD | -6.99 | 9.22 | 0.00 | 11.57 | 1 |
| 12 | 12-200M EAST | 0.20 | 0.00 | 0.00 | 0.20 | 1 | 36 | 36-100M SOUTH OF TD | -7.09 | 9.12 | 0.00 | 11.55 | 1 |
| 13 | 13-200M SOUTH | 0.00 | -0.20 | 0.00 | 0.20 | 1 | 37 | 37-100M WEST OF TD | -7.19 | 9.22 | 0.00 | 11.69 | 1 |
| 14 | 14-200M WEST | -0.20 | 0.00 | 0.00 | 0.20 | 1 | 38 | 38-100M UPWIND OF TD | -7.02 | 9.15 | 0.00 | 11.53 | 1 |
| 15 | 15-200M UPWIND | 0.14 | -0.14 | 0.00 | 0.20 | 1 | 39 | 39-100M DOWNWIND OF | -7.16 | 9.29 | 0.00 | 11.73 | 1 |
| 16 | 16-200M DOWNWIND | -0.14 | 0.14 | 0.00 | 0.20 | 1 | 40 | 40-200M NORTH OF TD | -7.09 | 9.42 | 0.00 | 11.79 | 1 |
| 17 | 17-240 DEG @ 725M | -0.72 | -0.38 | 0.00 | 0.82 | 1 | 41 | 41-200M EAST OF TD | -6.89 | 9.22 | 0.00 | 11.51 | 1 |
| 18 | 18-270 DEG @ 5500M | -5.49 | 0.00 | 0.00 | 5.49 | 1 | 42 | 42-200M SOUTH OF TD | -7.09 | 9.02 | 0.00 | 11.47 | 1 |
| 19 | 19-330 DEG @ 5100M | -4.00 | 3.05 | 0.00 | 5.03 | 1 | 43 | 43-200M WEST OF TD | -7.29 | 9.22 | 0.00 | 11.75 | 1 |
| 20 | 20-345 DEG @ 2050M | -0.84 | 1.83 | 0.00 | 2.01 | 1 | 44 | 44-200M UPWIND OF TD | -6.95 | 9.08 | 0.00 | 11.43 | 1 |
| 21 | 21- 45 DEG @ 3350M | 2.36 | 2.29 | 0.00 | 3.29 | 1 | 45 | 45-200M DOWNWIND OF | -7.23 | 9.36 | 0.00 | 11.83 | 1 |
| 22 | 22- 80 DEG @ 4725M | 4.57 | 1.22 | 0.00 | 4.73 | 1 | 46 | 46-500M NORTH OF TD | -7.09 | 9.72 | 0.00 | 12.03 | 1 |
| 23 | 23-IR-1 | -7.18 | 9.28 | 0.00 | 11.73 | 1 | 47 | 47-500M EAST OF TD | -6.59 | 9.22 | 0.00 | 11.33 | 1 |
| 24 | 24-IR-3 | -7.05 | 9.22 | 0.00 | 11.61 | 1 | 48 | 48-500M SOUTH OF TD | -7.09 | 8.72 | 0.00 | 11.24 | 1 |

MISCELLANEOUS INPUTABLE PARAMETER VALUES

| DMM | DMA | TSTART | FFORI | FHAYI | FFORP | FHAYP | FPR(1) | FPR(2) | FPR(3) | ACTRAT |
|---|---|---|---|---|---|---|---|---|---|---|
| 800.0 | 1300.0 | 1995.00 | 0.33 | 0.90 | 0.33 | 0.90 | 370.00 | 790.00 | 600.00 | 2.50 |

IPACT EQUALS 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,

JC EQUALS 0, 0, 1, 1, 0, 1, 1, 1, 1, 0

| TIME STEP DATA.... | STEP NAMES | LENGTH, YRS | IFTODO |
|---|---|---|---|
| 1 | 1-YEAR PERIOD | 1.00 | 1 |

XRHO EQUALS 1.5, 2.5, 3.5, 4.5, 7.5, 15.0, 25.0, 35.0, 45.0, 55.0, 65.0, 75.0,

HDP EQUALS 50.0

POPULATION DISTRIBUTION

| KILOMETERS | N 0.0 | NNE 22.5 | NE 45.0 | ENE 67.5 | E 90.0 | ESE 112.5 | SE 135.0 | SSE 157.5 | S 180.0 | SSW 202.5 | SW 225.0 | WSW 247.5 | W 270.0 | WNW 292.5 | NW 315.0 | NNW 337.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0- 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.0- 3.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.0- 4.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4.0- 5.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5.0-10.0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0-20.0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 11 | 3 | 6 | 0 |
| 20.0-30.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 134 | 111 | 0 | 0 | 0 | 0 |
| 30.0-40.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40.0-50.0 | 0 | 0 | 0 | 0 | 1236 | 0 | 0 | 0 | 0 | 247 | 495 | 0 | 0 | 0 | 0 | 0 |
| 50.0-60.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 256 | 0 | 0 | 0 |
| 60.0-70.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70.0-80.0 | 0 | 17635 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3358 | 0 |
| 1.0-80.0 | 0 | 17635 | 3 | 6 | 1236 | 0 | 0 | 16 | 0 | 247 | 629 | 111 | 267 | 3 | 3364 | 0 |

TOTAL 1-80 KM POPULATION IS 23517 PERSONS

NUMBER OF SOURCES=10

| NO. | KM X | KM Y | M Z | KM2 AREA | U-238 | Th-230 | CI/YEAR Ra-226 | Pb-210 | Rn-222 | ID | PSIZE SET | M/SEC EXIT VEL | SOURCE NAME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.15 | -0.08 | 1.00 | 0.1115 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.00E+01 | 1001 | 2 | 1.00E-02 | CR MU 3 |
| 2 | 0.65 | -2.10 | 1.00 | 0.1665 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.68E+02 | 1002 | 2 | 1.00E-02 | CR MU 4 |
| 3 | 2.13 | -2.93 | 1.00 | 0.1165 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.06E+02 | 1003 | 2 | 1.00E-02 | CR MU 5A |
| 4 | 1.79 | -2.67 | 1.00 | 0.1486 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.06E+02 | 1004 | 2 | 1.00E-02 | CR MU5B |
| 5 | 0.00 | 0.00 | 7.01 | 0.0000 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.63E+02 | 1005 | 2 | 2.14E+02 | CR PLANT |
| 6 | -6.44 | 7.85 | 1.00 | 0.2780 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.30E+01 | 1006 | 2 | 1.00E-02 | IR MU 4-9 |
| 7 | -6.71 | 9.22 | 1.00 | 0.0590 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.70E+02 | 1007 | 2 | 1.00E-02 | IR MU 10 |
| 8 | -7.24 | 9.91 | 1.00 | 0.0450 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.70E+02 | 1008 | 2 | 1.00E-02 | IR MU 11-12 |
| 9 | -7.11 | 9.22 | 7.62 | 0.0000 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.48E+02 | 1009 | 2 | 1.04E+02 | IR PLANT |
| 10 | -7.09 | 9.22 | 18.90 | 0.0000 | 9.90E-03 | 2.31E-05 | 2.68E-05 | 8.05E-05 | 0.00E+00 | 1010 | 2 | 1.23E+01 | IR THERMAL DRYER |

INPUT TAILS ACTIVITIES, PCI/G

| SET | URANIUM | THORIUM | RADIUM | LEAD |
|---|---|---|---|---|
| 1 | 1.00E+02 | 1.00E+02 | 1.00E+02 | 1.00E+02 |
| 2 | 1.00E+02 | 1.00E+02 | 1.00E+02 | 1.00E+02 |
| 3 | 1.00E+02 | 1.00E+02 | 1.00E+02 | 1.00E+02 |

AMAD AND FRACTIONAL DISTRIBUTION

| SET | 1.5 | 3.0 | 7.7 | 54.0 |
|---|---|---|---|---|
| 1 | 0.000 | 1.000 | 0.000 | 0.000 |
| 2 | 1.000 | 0.000 | 0.000 | 0.000 |
| 3 | 0.000 | 0.000 | 0.300 | 0.700 |

PARTICULATE SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 1 TIME STEP(S) USED FOR THIS RUN

| SOURCE NUMBER | TSTEP 1 1.00YRS | TSTEP 2 0.00YRS | TSTEP 3 0.00YRS | TSTEP 4 0.00YRS | TSTEP 5 0.00YRS | TSTEP 6 0.00YRS | TSTEP 7 0.00YRS | TSTEP 8 0.00YRS | TSTEP 9 0.00YRS | TSTEP10 0.00YRS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 2 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 3 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 4 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 5 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 6 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 7 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 8 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 9 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 10 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |

RADON SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 1 TIME STEP(S) USED FOR THIS RUN

| SOURCE NUMBER | TSTEP 1 1.00YRS | TSTEP 2 0.00YRS | TSTEP 3 0.00YRS | TSTEP 4 0.00YRS | TSTEP 5 0.00YRS | TSTEP 6 0.00YRS | TSTEP 7 0.00YRS | TSTEP 8 0.00YRS | TSTEP 9 0.00YRS | TSTEP10 0.00YRS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 2 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 3 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 4 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 5 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 6 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 7 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 8 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 9 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |
| 10 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 | 1.000E+00 |

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF INFANT

| AMAD= 1.5 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 3.42E+03 | 3.85E+03 | 4.68E+03 | 6.49E+02 | 1.74E+02 | 4.10E+00 | 8.80E+02 |
| BONE | 4.84E+01 | 5.41E+01 | 2.17E+04 | 5.92E+02 | 5.47E+02 | 7.03E-02 | 2.10E+02 |
| AVG.LUNG | 2.69E+04 | 3.08E+04 | 3.10E+04 | 4.17E+03 | 5.07E+01 | 5.96E+01 | 3.36E+03 |
| LIVER | 3.51E-01 | 3.23E-01 | 1.16E+02 | 4.42E+01 | 2.83E+03 | 1.32E+00 | 2.54E+02 |
| KIDNEY | 4.67E+01 | 5.23E+01 | 1.21E+01 | 1.68E+01 | 1.08E+03 | 3.48E+01 | 1.32E+03 |

| AMAD= 3.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 2.08E+03 | 2.33E+03 | 3.05E+03 | 4.63E+02 | 1.90E+02 | 3.25E+00 | 7.26E+02 |
| BONE | 3.56E+01 | 3.98E+01 | 1.57E+04 | 6.64E+02 | 5.94E+02 | 8.98E-02 | 2.37E+02 |
| AVG.LUNG | 1.70E+04 | 1.94E+04 | 1.96E+04 | 2.63E+03 | 5.51E+01 | 3.77E+01 | 2.12E+03 |
| LIVER | 2.48E-01 | 2.38E-01 | 8.41E+01 | 4.95E+01 | 3.08E+03 | 1.69E+00 | 2.88E+02 |
| KIDNEY | 3.44E+01 | 3.86E+01 | 8.73E+00 | 1.88E+01 | 1.16E+03 | 4.13E+01 | 1.49E+03 |

| AMAD= 7.7 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.11E+03 | 1.25E+03 | 1.85E+03 | 3.08E+02 | 2.28E+02 | 2.91E+00 | 7.61E+02 |
| BONE | 3.60E+01 | 4.02E+01 | 1.18E+04 | 8.37E+02 | 7.46E+02 | 1.27E-01 | 3.00E+02 |
| AVG.LUNG | 7.50E+03 | 8.38E+03 | 8.46E+03 | 1.14E+03 | 6.67E+01 | 1.78E+01 | 9.16E+02 |
| LIVER | 2.30E-01 | 2.47E-01 | 7.57E+01 | 6.37E+01 | 3.71E+03 | 2.30E+00 | 3.52E+02 |
| KIDNEY | 3.71E+01 | 4.20E+01 | 7.71E+00 | 2.51E+01 | 1.39E+03 | 5.34E+01 | 1.85E+03 |

| AMAD=54.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 2.49E+00 | 2.74E+00 | 5.25E+02 | 1.45E+02 | 2.17E+02 | 1.82E+00 | 4.98E+02 |
| BONE | 2.04E+01 | 2.28E+01 | 6.11E+03 | 7.79E+02 | 7.13E+02 | 1.40E-01 | 2.66E+02 |
| AVG.LUNG | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.38E+01 | 0.00E+00 | 0.00E+00 |
| LIVER | 1.09E-01 | 1.40E-01 | 3.92E+01 | 5.93E+01 | 3.55E+03 | 2.53E+00 | 3.12E+02 |
| KIDNEY | 2.10E+01 | 2.38E+01 | 3.99E+00 | 2.34E+01 | 1.32E+03 | 4.75E+01 | 1.64E+03 |

| AMAD= 0.3 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 6.97E+03 | 7.81E+03 | 9.06E+03 | 1.18E+03 | 1.75E+02 | 6.52E+00 | 1.30E+03 |
| BONE | 8.37E+01 | 9.35E+01 | 4.21E+04 | 5.42E+02 | 5.39E+02 | 4.04E-02 | 1.75E+02 |
| AVG.LUNG | 5.84E+04 | 6.67E+04 | 6.73E+04 | 9.03E+03 | 5.00E+01 | 1.21E+02 | 7.29E+03 |
| LIVER | 6.15E-01 | 5.35E-01 | 2.06E+02 | 3.64E+01 | 2.80E+03 | 7.62E-01 | 1.98E+02 |
| KIDNEY | 7.63E+01 | 8.55E+01 | 2.12E+01 | 1.43E+01 | 1.09E+03 | 2.51E+01 | 1.10E+03 |

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF CHILD

| AMAD= 1.5 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.64E+03 | 1.84E+03 | 2.58E+03 | 1.62E+02 | 8.37E+01 | 1.97E+00 | 2.05E+02 |
| BONE | 3.23E+01 | 3.60E+01 | 1.91E+04 | 1.86E+02 | 4.00E+02 | 5.14E-02 | 2.27E+01 |
| AVG.LUNG | 1.32E+04 | 1.47E+04 | 1.49E+04 | 1.18E+03 | 2.30E+01 | 2.70E+01 | 9.53E+02 |
| LIVER | 1.62E-01 | 1.46E-01 | 6.50E+01 | 9.12E+00 | 1.18E+03 | 5.53E-01 | 6.00E+01 |
| KIDNEY | 2.04E+01 | 2.29E+01 | 7.00E+00 | 4.42E+00 | 4.98E+02 | 1.61E+01 | 3.19E+02 |

| AMAD= 3.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 9.97E+02 | 1.12E+03 | 1.68E+03 | 1.16E+02 | 9.11E+01 | 1.56E+00 | 1.69E+02 |
| BONE | 2.38E+01 | 2.66E+01 | 1.38E+04 | 2.09E+02 | 4.35E+02 | 6.57E-02 | 2.57E+01 |
| AVG.LUNG | 8.32E+03 | 9.31E+03 | 9.39E+03 | 7.45E+02 | 2.50E+01 | 1.71E+01 | 6.01E+02 |
| LIVER | 1.14E-01 | 1.08E-01 | 4.70E+01 | 1.02E+01 | 1.29E+03 | 7.07E-01 | 6.78E+01 |
| KIDNEY | 1.51E+01 | 1.69E+01 | 5.07E+00 | 4.95E+00 | 5.37E+02 | 1.91E+01 | 3.61E+02 |

| AMAD= 7.7 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 5.33E+02 | 5.97E+02 | 9.93E+02 | 6.72E+01 | 1.10E+02 | 1.40E+00 | 1.56E+02 |
| BONE | 1.46E+01 | 1.51E+01 | 8.90E+03 | 2.43E+02 | 4.88E+02 | 8.34E-02 | 3.00E+01 |
| AVG.LUNG | 3.59E+03 | 4.02E+03 | 4.05E+03 | 3.22E+02 | 2.76E+01 | 7.36E+00 | 2.60E+02 |
| LIVER | 7.77E-02 | 8.02E-02 | 3.31E+01 | 1.24E+01 | 1.47E+03 | 9.15E-01 | 7.97E+01 |
| KIDNEY | 1.14E+01 | 1.28E+01 | 3.59E+00 | 5.99E+00 | 6.14E+02 | 2.35E+01 | 4.26E+02 |

| AMAD=54.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.19E+00 | 1.31E+00 | 2.81E+02 | 3.15E+01 | 1.04E+02 | 8.77E-01 | 1.02E+02 |
| BONE | 8.28E+00 | 8.54E+00 | 4.61E+03 | 2.26E+02 | 4.67E+02 | 9.15E-02 | 2.66E+01 |
| AVG.LUNG | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.64E+01 | 0.00E+00 | 0.00E+00 |
| LIVER | 3.67E-02 | 4.54E-02 | 1.71E+01 | 1.15E+01 | 1.41E+03 | 1.00E+00 | 7.07E+01 |
| KIDNEY | 6.46E+00 | 7.24E+00 | 1.86E+00 | 5.58E+00 | 5.82E+02 | 2.09E+01 | 3.78E+02 |

| AMAD= 0.3 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 3.34E+03 | 3.74E+03 | 5.00E+03 | 3.06E+02 | 8.76E+01 | 3.26E+00 | 3.24E+02 |
| BONE | 6.17E+01 | 6.89E+01 | 3.71E+04 | 1.77E+02 | 4.09E+02 | 3.06E-02 | 2.01E+01 |
| AVG.LUNG | 2.86E+04 | 3.20E+04 | 3.22E+04 | 2.56E+03 | 2.33E+01 | 5.66E+01 | 2.07E+03 |
| LIVER | 3.07E-01 | 2.68E-01 | 1.26E+02 | 8.39E+00 | 1.24E+03 | 3.39E-01 | 5.29E+01 |
| KIDNEY | 3.91E+01 | 4.38E+01 | 1.36E+01 | 3.92E+00 | 5.12E+02 | 1.18E+01 | 2.80E+02 |

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF TEENAGE

| AMAD= 1.5 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 8.55E+02 | 9.62E+02 | 1.77E+03 | 9.20E+01 | 9.06E+01 | 2.13E+00 | 9.38E+01 |
| BONE | 4.15E+01 | 4.63E+01 | 1.97E+04 | 7.02E+02 | 9.58E+02 | 1.23E-01 | 1.46E+01 |
| AVG.LUNG | 6.88E+03 | 7.69E+03 | 7.76E+03 | 5.21E+02 | 9.51E+00 | 1.12E+01 | 4.20E+02 |
| LIVER | 8.43E-02 | 7.30E-02 | 3.76E+01 | 5.30E+00 | 5.07E+02 | 2.37E-01 | 2.73E+01 |
| KIDNEY | 1.17E+01 | 1.31E+01 | 4.28E+00 | 5.89E+00 | 2.39E+02 | 7.74E+00 | 1.65E+02 |

| AMAD= 3.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 5.20E+02 | 5.83E+02 | 1.16E+03 | 6.56E+01 | 9.87E+01 | 1.69E+00 | 7.74E+01 |
| BONE | 3.06E+01 | 3.41E+01 | 1.43E+04 | 7.87E+02 | 1.04E+03 | 1.57E-01 | 1.65E+01 |
| AVG.LUNG | 4.34E+03 | 4.85E+03 | 4.90E+03 | 3.29E+02 | 1.03E+01 | 7.06E+00 | 2.65E+02 |
| LIVER | 5.95E-02 | 5.38E-02 | 2.72E+01 | 5.94E+00 | 5.51E+02 | 3.03E-01 | 3.08E+01 |
| KIDNEY | 8.61E+00 | 9.64E+00 | 3.10E+00 | 6.60E+00 | 2.58E+02 | 9.18E+00 | 1.87E+02 |

| AMAD= 7.7 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 2.78E+02 | 3.12E+02 | 6.62E+02 | 5.88E+01 | 1.10E+02 | 1.40E+00 | 7.18E+01 |
| BONE | 2.47E+01 | 2.77E+01 | 9.08E+03 | 9.49E+02 | 1.22E+03 | 2.08E-01 | 2.03E+01 |
| AVG.LUNG | 1.87E+03 | 2.09E+03 | 2.11E+03 | 1.42E+02 | 1.24E+01 | 3.30E+00 | 1.15E+02 |
| LIVER | 3.89E-02 | 3.86E-02 | 1.73E+01 | 7.11E+00 | 6.61E+02 | 4.10E-01 | 3.75E+01 |
| KIDNEY | 6.18E+00 | 6.92E+00 | 1.97E+00 | 8.61E+00 | 3.07E+02 | 1.18E+01 | 2.27E+02 |

| AMAD=54.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 6.22E-01 | 6.85E-01 | 1.88E+02 | 2.76E+01 | 1.04E+02 | 8.77E-01 | 4.70E+01 |
| BONE | 1.40E+01 | 1.57E+01 | 4.70E+03 | 8.83E+02 | 1.17E+03 | 2.29E-01 | 1.80E+01 |
| AVG.LUNG | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.18E+01 | 0.00E+00 | 0.00E+00 |
| LIVER | 1.83E-02 | 2.19E-02 | 8.98E+00 | 6.62E+00 | 6.32E+02 | 4.50E-01 | 3.33E+01 |
| KIDNEY | 3.50E+00 | 3.92E+00 | 1.02E+00 | 8.02E+00 | 2.91E+02 | 1.05E+01 | 2.02E+02 |

| AMAD= 0.3 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.74E+03 | 1.95E+03 | 3.44E+03 | 1.58E+02 | 8.76E+01 | 3.26E+00 | 1.48E+02 |
| BONE | 7.49E+01 | 8.37E+01 | 3.83E+04 | 6.46E+02 | 1.01E+03 | 7.54E-02 | 1.27E+01 |
| AVG.LUNG | 1.49E+04 | 1.67E+04 | 1.68E+04 | 1.13E+03 | 9.99E+00 | 2.42E+01 | 9.11E+02 |
| LIVER | 1.54E-01 | 1.28E-01 | 6.64E+01 | 4.76E+00 | 5.33E+02 | 1.45E-01 | 2.48E+01 |
| KIDNEY | 2.05E+01 | 2.29E+01 | 7.56E+00 | 4.76E+00 | 2.56E+02 | 5.91E+00 | 1.50E+02 |

INHALATION DOSE CONVERSION FACTORS, MREM/YR PER PCI/M3, FOR AGE GROUP OF ADULT

| AMAD= 1.5 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 7.13E+02 | 8.02E+02 | 1.61E+03 | 5.41E+01 | 6.97E+01 | 1.64E+00 | 5.87E+01 |
| BONE | 2.30E+01 | 2.57E+01 | 1.97E+04 | 2.19E+02 | 5.64E+02 | 7.24E-02 | 5.82E+00 |
| AVG.LUNG | 5.73E+03 | 6.41E+03 | 6.47E+03 | 3.47E+02 | 7.92E+00 | 9.32E+00 | 2.80E+02 |
| LIVER | 7.03E-02 | 6.09E-02 | 3.42E+01 | 2.94E+00 | 4.23E+02 | 1.97E-01 | 1.82E+01 |
| KIDNEY | 9.73E+00 | 1.09E+01 | 3.89E+00 | 2.94E+00 | 1.99E+02 | 6.45E+00 | 1.10E+02 |

| AMAD= 3.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 4.34E+02 | 4.85E+02 | 1.05E+03 | 3.86E+01 | 7.59E+01 | 1.30E+00 | 4.84E+01 |
| BONE | 1.70E+01 | 1.90E+01 | 1.43E+04 | 2.46E+02 | 6.12E+02 | 9.26E-02 | 6.58E+00 |
| AVG.LUNG | 3.62E+03 | 4.05E+03 | 4.08E+03 | 2.19E+02 | 8.61E+00 | 5.88E+00 | 1.77E+02 |
| LIVER | 4.96E-02 | 4.48E-02 | 2.47E+01 | 3.30E+00 | 4.59E+02 | 2.52E-01 | 2.05E+01 |
| KIDNEY | 7.17E+00 | 8.03E+00 | 2.81E+00 | 3.30E+00 | 2.15E+02 | 7.65E+00 | 1.25E+02 |

| AMAD= 7.7 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 2.32E+02 | 2.60E+02 | 6.62E+02 | 2.80E+01 | 8.45E+01 | 1.08E+00 | 4.23E+01 |
| BONE | 1.12E+01 | 1.26E+01 | 9.08E+03 | 2.79E+02 | 6.78E+02 | 1.16E-01 | 7.51E+00 |
| AVG.LUNG | 1.56E+03 | 1.75E+03 | 1.76E+03 | 9.46E+01 | 9.53E+00 | 2.54E+00 | 7.63E+01 |
| LIVER | 2.99E-02 | 2.97E-02 | 1.58E+01 | 3.74E+00 | 5.08E+02 | 3.16E-01 | 2.34E+01 |
| KIDNEY | 4.75E+00 | 5.32E+00 | 1.79E+00 | 3.74E+00 | 2.36E+02 | 9.04E+00 | 1.42E+02 |

| AMAD=54.0 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 5.18E-01 | 5.71E-01 | 1.88E+02 | 1.31E+01 | 8.03E+01 | 6.75E-01 | 2.77E+01 |
| BONE | 6.37E+00 | 7.12E+00 | 4.70E+03 | 2.60E+02 | 6.48E+02 | 1.27E-01 | 6.66E+00 |
| AVG.LUNG | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.11E+00 | 0.00E+00 | 0.00E+00 |
| LIVER | 1.41E-02 | 1.68E-02 | 8.16E+00 | 3.49E+00 | 4.86E+02 | 3.46E-01 | 2.08E+01 |
| KIDNEY | 2.69E+00 | 3.01E+00 | 9.29E-01 | 3.49E+00 | 2.24E+02 | 8.05E+00 | 1.26E+02 |

| AMAD= 0.3 µm | U-238 | U-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|
| EFFECTIV | 1.45E+03 | 1.63E+03 | 3.12E+03 | 9.86E+01 | 7.30E+01 | 2.72E+00 | 9.27E+01 |
| BONE | 4.41E+01 | 4.92E+01 | 3.83E+04 | 2.09E+02 | 5.92E+02 | 4.44E-02 | 5.29E+00 |
| AVG.LUNG | 1.24E+04 | 1.39E+04 | 1.40E+04 | 7.53E+02 | 8.33E+00 | 2.02E+01 | 6.07E+02 |
| LIVER | 1.40E-01 | 1.16E-01 | 6.64E+01 | 2.80E+00 | 4.44E+02 | 1.21E-01 | 1.65E+01 |
| KIDNEY | 1.86E+01 | 2.08E+01 | 7.56E+00 | 2.80E+00 | 2.13E+02 | 4.93E+00 | 1.00E+02 |

EXTERNAL WHOLE BODY DOSE CONVERSION FACTORS

| | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 |
|---|---|---|---|---|---|---|---|---|
| GROUND, MR/YR PER PCI/M2 | 3.70E-06 | 6.12E-07 | 9.47E-07 | 2.27E-06 | 5.03E-08 | 1.10E-08 | 3.16E-05 | 1.85E-04 |
| CLOUD, MR/YR PER PCI/M3 | 1.23E-04 | 3.59E-06 | 4.90E-05 | 1.43E-05 | 2.83E-06 | 6.34E-07 | 1.67E-03 | 1.16E-02 |
| WORKING LEVEL CONCENTRATION FACTORS, WL PER PCI/M3 | | ..... | ..... | ..... | ..... | 1.03E-06 | 5.07E-06 | 3.73E-06 |

## INGESTION DOSE CONVERSION FACTORS, MREM PER PCI INGESTED

| AGE GROUP | TISSUE | U-238 | U-234 | Th-234 | Th-230 | Ra-226 | Pb-210 | Bi-210 | Po-210 |
|---|---|---|---|---|---|---|---|---|---|
| INFANT | EFFECTIV | 1.61E-02 | 1.79E-02 | 8.57E-04 | 2.51E-02 | 2.11E-02 | 3.11E-02 | 3.88E-05 | 7.95E-02 |
| INFANT | BONE | 4.49E-02 | 5.43E-02 | 9.24E-07 | 4.39E-02 | 1.09E-01 | 1.86E-01 | 6.00E-07 | 3.29E-02 |
| INFANT | LIVER | 2.72E-04 | 3.15E-04 | 4.93E-07 | 3.74E-03 | 8.48E-03 | 3.62E-01 | 7.52E-06 | 4.48E-02 |
| INFANT | KIDNEY | 4.93E-02 | 5.71E-02 | 4.38E-07 | 3.53E-04 | 3.32E-03 | 1.35E-01 | 2.86E-04 | 2.23E-01 |
| CHILD | EFFECTIV | 9.95E-04 | 1.14E-03 | 5.30E-05 | 1.53E-03 | 2.38E-03 | 8.67E-03 | 1.08E-05 | 9.12E-03 |
| CHILD | BONE | 4.86E-03 | 5.43E-03 | 1.00E-07 | 3.32E-03 | 2.50E-02 | 7.86E-02 | 2.53E-07 | 2.07E-03 |
| CHILD | LIVER | 3.74E-05 | 4.20E-05 | 6.78E-08 | 1.45E-04 | 1.32E-03 | 8.81E-02 | 1.83E-06 | 6.88E-03 |
| CHILD | KIDNEY | 6.01E-03 | 6.75E-03 | 5.34E-08 | 1.54E-05 | 6.44E-04 | 3.54E-02 | 7.48E-05 | 3.44E-02 |
| TEENAGE | EFFECTIV | 7.90E-04 | 8.80E-04 | 4.22E-05 | 1.20E-03 | 4.22E-03 | 1.12E-02 | 1.40E-05 | 4.85E-03 |
| TEENAGE | BONE | 1.83E-02 | 2.05E-02 | 3.77E-07 | 3.32E-03 | 1.09E-01 | 2.35E-01 | 7.57E-07 | 1.65E-03 |
| TEENAGE | LIVER | 2.13E-05 | 2.39E-05 | 3.85E-08 | 5.94E-05 | 8.14E-04 | 4.75E-02 | 9.87E-07 | 3.68E-03 |
| TEENAGE | KIDNEY | 3.85E-03 | 4.33E-03 | 3.43E-08 | 6.80E-06 | 1.02E-03 | 2.18E-02 | 4.62E-05 | 2.04E-02 |
| ADULT | EFFECTIV | 2.55E-04 | 2.84E-04 | 1.36E-05 | 5.46E-04 | 1.32E-03 | 5.10E-03 | 6.36E-06 | 1.94E-03 |
| ADULT | BONE | 3.74E-03 | 4.18E-03 | 7.70E-08 | 1.33E-03 | 2.53E-02 | 8.10E-02 | 2.61E-07 | 4.22E-04 |
| ADULT | LIVER | 8.51E-06 | 9.55E-06 | 1.54E-08 | 2.20E-05 | 3.39E-04 | 2.26E-02 | 4.70E-07 | 1.60E-03 |
| ADULT | KIDNEY | 1.54E-03 | 1.73E-03 | 1.37E-08 | 2.52E-06 | 3.39E-04 | 1.04E-02 | 2.20E-05 | 9.29E-03 |

## ENVIRONMENTAL CONCENTRATION FACTORS

| CONCENTRATION FACTOR | FOOD TYPE | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|
| BIV, DIMENSIONLESS | ED.ABG. | 2.50E-03 | 4.20E-03 | 1.40E-02 | 4.00E-03 |
| BIV, DIMENSIONLESS | POTATO | 2.50E-03 | 4.20E-03 | 3.00E-03 | 4.00E-03 |
| BIV, DIMENSIONLESS | BELOW G. | 2.50E-03 | 4.20E-03 | 1.40E-02 | 4.00E-03 |
| BIV, DIMENSIONLESS | FORAGE | 2.50E-03 | 4.20E-03 | 1.80E-02 | 2.80E-02 |
| BIV, DIMENSIONLESS | ST. FEED | 2.50E-03 | 4.20E-03 | 8.20E-02 | 3.60E-02 |
| FBI, PCI/KG PER PCI/DAY | MEAT | 3.40E-04 | 2.00E-04 | 5.10E-04 | 7.10E-04 |
| FMI, PCI/L PER PCI/DAY | MILK | 6.10E-04 | 5.00E-06 | 5.90E-04 | 1.20E-04 |
| FRACTION IN ED PORTION | ED.ABG. | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 |
| FRACTION IN ED PORTION | POTATO | 1.00E-01 | 1.00E-01 | 1.00E-01 | 1.00E-01 |
| FRACTION IN ED PORTION | BELOW G. | 1.00E-01 | 1.00E-01 | 1.00E-01 | 1.00E-01 |
| FRACTION IN ED PORTION | FORAGE | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 |
| FRACTION IN ED PORTION | ST. FEED | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 |

## TIME STEP DEPENDENT VARIABLES

| NO. | TIME STEP NAME | PAJUST | GFACT U-238 | GFACT Th-230 | GFACT Ra-226 | GFACT Pb-210 | TFACT U-238 | TFACT Th-230 | TFACT Ra-226 | TFACT Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-YEAR PERIOD | 1.000E+00 | 3.134E+07 | 3.134E+07 | 3.134E+07 | 3.086E+07 | 1.621E+00 | 1.621E+00 | 1.621E+00 | 1.618E+00 |

IPFACT=2.640E+02 GPFACT(4)=1.707E+09 1.707E+09 1.679E+09 6.943E+08 TPFACT(4)=1.638E+00 1.638E+00 1.638E+00 1.624E+00

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE N DIRECTION, THETA EQUALS 0.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 9.940E-06 | 2.319E-08 | 2.691E-08 | 8.064E-08 | 9.291E+00 | 8.706E+00 | 5.467E+00 | 3.922E+00 | 1.540E-05 | 5.131E-05 |
| 2.5 | 1.067E-05 | 2.489E-08 | 2.888E-08 | 8.655E-08 | 5.672E+00 | 5.508E+00 | 3.898E+00 | 3.075E+00 | 1.457E-05 | 3.690E-05 |
| 3.5 | 1.200E-05 | 2.799E-08 | 3.248E-08 | 9.733E-08 | 4.300E+00 | 4.243E+00 | 3.240E+00 | 2.702E+00 | 1.473E-05 | 3.088E-05 |
| 4.5 | 1.295E-05 | 3.022E-08 | 3.505E-08 | 1.051E-07 | 3.581E+00 | 3.559E+00 | 2.862E+00 | 2.464E+00 | 1.491E-05 | 2.737E-05 |
| 7.5 | 1.556E-05 | 3.630E-08 | 4.211E-08 | 1.262E-07 | 2.624E+00 | 2.622E+00 | 2.294E+00 | 2.054E+00 | 1.466E-05 | 2.199E-05 |
| 15.0 | 1.219E-05 | 2.844E-08 | 3.299E-08 | 9.887E-08 | 1.554E+00 | 1.554E+00 | 1.372E+00 | 1.228E+00 | 1.324E-05 | 1.314E-05 |
| 25.0 | 5.726E-06 | 1.336E-08 | 1.550E-08 | 4.645E-08 | 8.247E-01 | 8.252E-01 | 7.584E-01 | 6.848E-01 | 1.203E-05 | 7.249E-06 |
| 35.0 | 2.503E-06 | 5.840E-09 | 6.776E-09 | 2.031E-08 | 4.799E-01 | 4.802E-01 | 4.645E-01 | 4.414E-01 | 1.148E-05 | 4.496E-06 |
| 45.0 | 1.361E-06 | 3.176E-09 | 3.685E-09 | 1.104E-08 | 3.197E-01 | 3.199E-01 | 3.160E-01 | 3.081E-01 | 1.089E-05 | 3.081E-06 |
| 55.0 | 8.528E-07 | 1.990E-09 | 2.308E-09 | 6.918E-09 | 2.318E-01 | 2.319E-01 | 2.312E-01 | 2.284E-01 | 1.033E-05 | 2.263E-06 |
| 65.0 | 5.847E-07 | 1.364E-09 | 1.583E-09 | 4.743E-09 | 1.779E-01 | 1.780E-01 | 1.782E-01 | 1.773E-01 | 9.838E-06 | 1.748E-06 |
| 75.0 | 4.262E-07 | 9.945E-10 | 1.154E-09 | 3.458E-09 | 1.419E-01 | 1.420E-01 | 1.424E-01 | 1.423E-01 | 9.403E-06 | 1.399E-06 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.922E+00 | 4.484E-03 | 5.201E-03 | 5.201E-03 | 0.000E+00 | 6.900E+00 | 6.900E+00 | 6.900E+00 | 1.426E+00 |
| 2.5 | 2.062E+00 | 4.812E-03 | 5.582E-03 | 5.582E-03 | 0.000E+00 | 4.368E+00 | 4.368E+00 | 4.368E+00 | 1.349E+00 |
| 3.5 | 2.319E+00 | 5.412E-03 | 6.277E-03 | 6.277E-03 | 0.000E+00 | 3.367E+00 | 3.367E+00 | 3.367E+00 | 1.364E+00 |
| 4.5 | 2.503E+00 | 5.841E-03 | 6.775E-03 | 6.775E-03 | 0.000E+00 | 2.825E+00 | 2.825E+00 | 2.825E+00 | 1.380E+00 |
| 7.5 | 3.007E+00 | 7.017E-03 | 8.139E-03 | 8.139E-03 | 0.000E+00 | 2.085E+00 | 2.085E+00 | 2.085E+00 | 1.357E+00 |
| 15.0 | 2.356E+00 | 5.498E-03 | 6.377E-03 | 6.377E-03 | 0.000E+00 | 1.237E+00 | 1.237E+00 | 1.237E+00 | 1.226E+00 |
| 25.0 | 1.107E+00 | 2.583E-03 | 2.996E-03 | 2.996E-03 | 0.000E+00 | 6.566E-01 | 6.566E-01 | 6.566E-01 | 1.114E+00 |
| 35.0 | 4.839E-01 | 1.129E-03 | 1.310E-03 | 1.310E-03 | 0.000E+00 | 3.816E-01 | 3.816E-01 | 3.816E-01 | 1.063E+00 |
| 45.0 | 2.631E-01 | 6.140E-04 | 7.122E-04 | 7.122E-04 | 0.000E+00 | 2.541E-01 | 2.541E-01 | 2.541E-01 | 1.008E+00 |
| 55.0 | 1.649E-01 | 3.847E-04 | 4.462E-04 | 4.462E-04 | 0.000E+00 | 1.842E-01 | 1.842E-01 | 1.842E-01 | 9.559E-01 |
| 65.0 | 1.130E-01 | 2.638E-04 | 3.059E-04 | 3.059E-04 | 0.000E+00 | 1.413E-01 | 1.413E-01 | 1.413E-01 | 9.109E-01 |
| 75.0 | 8.240E-02 | 1.923E-04 | 2.230E-04 | 2.230E-04 | 0.000E+00 | 1.127E-01 | 1.127E-01 | 1.127E-01 | 8.706E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 9.940E-08 | 2.319E-10 | 2.691E-10 | 4.700E-08 |
| 2.5 | 1.067E-07 | 2.489E-10 | 2.888E-10 | 4.457E-08 |
| 3.5 | 1.200E-07 | 2.799E-10 | 3.248E-10 | 4.517E-08 |
| 4.5 | 1.295E-07 | 3.022E-10 | 3.505E-10 | 4.578E-08 |
| 7.5 | 1.556E-07 | 3.630E-10 | 4.211E-10 | 4.524E-08 |
| 15.0 | 1.219E-07 | 2.844E-10 | 3.299E-10 | 4.070E-08 |
| 25.0 | 5.726E-08 | 1.336E-10 | 1.550E-10 | 3.657E-08 |
| 35.0 | 2.503E-08 | 5.840E-11 | 6.776E-11 | 3.465E-08 |
| 45.0 | 1.361E-08 | 3.176E-11 | 3.685E-11 | 3.278E-08 |
| 55.0 | 8.528E-09 | 1.990E-11 | 2.308E-11 | 3.104E-08 |
| 65.0 | 5.847E-09 | 1.364E-11 | 1.583E-11 | 2.956E-08 |
| 75.0 | 4.262E-09 | 9.945E-12 | 1.154E-11 | 2.824E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE E DIRECTION, THETA EQUALS 90.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 6.620E-06 | 1.545E-08 | 1.792E-08 | 5.370E-08 | 1.073E+01 | 1.023E+01 | 5.690E+00 | 3.376E+00 | 1.084E-05 | 5.197E-05 |
| 2.5 | 5.567E-06 | 1.299E-08 | 1.507E-08 | 4.516E-08 | 6.984E+00 | 6.755E+00 | 4.229E+00 | 2.820E+00 | 1.053E-05 | 3.892E-05 |
| 3.5 | 4.857E-06 | 1.133E-08 | 1.315E-08 | 3.940E-08 | 4.913E+00 | 4.811E+00 | 3.355E+00 | 2.479E+00 | 1.106E-05 | 3.121E-05 |
| 4.5 | 4.198E-06 | 9.796E-09 | 1.137E-08 | 3.406E-08 | 3.552E+00 | 3.513E+00 | 2.720E+00 | 2.189E+00 | 1.168E-05 | 2.557E-05 |
| 7.5 | 2.638E-06 | 6.155E-09 | 7.141E-09 | 2.140E-08 | 1.529E+00 | 1.527E+00 | 1.382E+00 | 1.268E+00 | 1.182E-05 | 1.331E-05 |
| 15.0 | 8.587E-07 | 2.004E-09 | 2.324E-09 | 6.966E-09 | 6.523E-01 | 6.527E-01 | 6.372E-01 | 6.198E-01 | 1.205E-05 | 6.215E-06 |
| 25.0 | 4.587E-07 | 1.070E-09 | 1.242E-09 | 3.721E-09 | 3.615E-01 | 3.618E-01 | 3.598E-01 | 3.562E-01 | 1.165E-05 | 3.525E-06 |
| 35.0 | 2.976E-07 | 6.944E-10 | 8.056E-10 | 2.414E-09 | 2.392E-01 | 2.394E-01 | 2.395E-01 | 2.386E-01 | 1.102E-05 | 2.351E-06 |
| 45.0 | 2.111E-07 | 4.926E-10 | 5.715E-10 | 1.713E-09 | 1.729E-01 | 1.730E-01 | 1.735E-01 | 1.734E-01 | 1.041E-05 | 1.705E-06 |
| 55.0 | 1.587E-07 | 3.702E-10 | 4.295E-10 | 1.287E-09 | 1.321E-01 | 1.321E-01 | 1.327E-01 | 1.328E-01 | 9.862E-06 | 1.304E-06 |
| 65.0 | 1.240E-07 | 2.894E-10 | 3.358E-10 | 1.006E-09 | 1.048E-01 | 1.049E-01 | 1.053E-01 | 1.056E-01 | 9.383E-06 | 1.036E-06 |
| 75.0 | 9.982E-08 | 2.329E-10 | 2.702E-10 | 8.098E-10 | 8.551E-02 | 8.556E-02 | 8.597E-02 | 8.623E-02 | 8.958E-06 | 8.457E-07 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.280E+00 | 2.986E-03 | 3.464E-03 | 3.464E-03 | 0.000E+00 | 8.106E+00 | 8.106E+00 | 8.106E+00 | 1.004E+00 |
| 2.5 | 1.076E+00 | 2.511E-03 | 2.913E-03 | 2.913E-03 | 0.000E+00 | 5.353E+00 | 5.353E+00 | 5.353E+00 | 9.750E-01 |
| 3.5 | 9.389E-01 | 2.191E-03 | 2.541E-03 | 2.541E-03 | 0.000E+00 | 3.813E+00 | 3.813E+00 | 3.813E+00 | 1.024E+00 |
| 4.5 | 8.116E-01 | 1.894E-03 | 2.197E-03 | 2.197E-03 | 0.000E+00 | 2.785E+00 | 2.785E+00 | 2.785E+00 | 1.081E+00 |
| 7.5 | 5.100E-01 | 1.190E-03 | 1.380E-03 | 1.380E-03 | 0.000E+00 | 1.211E+00 | 1.211E+00 | 1.211E+00 | 1.[illegible]E+00 |
| 15.0 | 1.660E-01 | 3.873E-04 | 4.493E-04 | 4.493E-04 | 0.000E+00 | 5.174E-01 | 5.174E-01 | 5.174E-01 | 1.[illegible]E+00 |
| 25.0 | 8.867E-02 | 2.069E-04 | 2.400E-04 | 2.400E-04 | 0.000E+00 | 2.868E-01 | 2.868E-01 | 2.868E-01 | 1.078E+00 |
| 35.0 | 5.753E-02 | 1.342E-04 | 1.557E-04 | 1.557E-04 | 0.000E+00 | 1.898E-01 | 1.898E-01 | 1.898E-01 | 1.020E+00 |
| 45.0 | 4.081E-02 | 9.522E-05 | 1.105E-04 | 1.105E-04 | 0.000E+00 | 1.371E-01 | 1.371E-01 | 1.371E-01 | 9.634E-01 |
| 55.0 | 3.067E-02 | 7.157E-05 | 8.302E-05 | 8.302E-05 | 0.000E+00 | 1.047E-01 | 1.047E-01 | 1.047E-01 | 9.130E-01 |
| 65.0 | 2.398E-02 | 5.595E-05 | 6.490E-05 | 6.490E-05 | 0.000E+00 | 8.311E-02 | 8.311E-02 | 8.311E-02 | 8.687E-01 |
| 75.0 | 1.930E-02 | 4.503E-05 | 5.223E-05 | 5.223E-05 | 0.000E+00 | 6.782E-02 | 6.782E-02 | 6.782E-02 | 8.294E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 6.620E-08 | 1.545E-10 | 1.792E-10 | 3.307E-08 |
| 2.5 | 5.567E-08 | 1.299E-10 | 1.507E-10 | 3.205E-08 |
| 3.5 | 4.857E-08 | 1.133E-10 | 1.315E-10 | 3.357E-08 |
| 4.5 | 4.198E-08 | 9.796E-11 | 1.137E-10 | 3.537E-08 |
| 7.5 | 2.638E-08 | 6.155E-11 | 7.141E-11 | 3.568E-08 |
| 15.0 | 8.587E-09 | 2.004E-11 | 2.324E-11 | 3.623E-08 |
| 25.0 | 4.587E-09 | 1.070E-11 | 1.242E-11 | 3.498E-08 |
| 35.0 | 2.976E-09 | 6.944E-12 | 8.056E-12 | 3.307E-08 |
| 45.0 | 2.111E-09 | 4.926E-12 | 5.715E-12 | 3.124E-08 |
| 55.0 | 1.587E-09 | 3.702E-12 | 4.295E-12 | 2.960E-08 |
| 65.0 | 1.240E-09 | 2.894E-12 | 3.358E-12 | 2.816E-08 |
| 75.0 | 9.982E-10 | 2.329E-12 | 2.702E-12 | 2.688E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE SSE DIRECTION, THETA EQUALS 157.5 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 8.070E-06 | 1.883E-08 | 2.185E-08 | 6.547E-08 | 5.260E+01 | 4.632E+01 | 1.749E+01 | 7.495E+00 | 1.356E-05 | 1.643E-04 |
| 2.5 | 7.141E-06 | 1.666E-08 | 1.933E-08 | 5.793E-08 | 7.720E+01 | 6.586E+01 | 1.902E+01 | 6.050E+00 | 1.041E-05 | 1.868E-04 |
| 3.5 | 6.350E-06 | 1.482E-08 | 1.719E-08 | 5.151E-08 | 2.304E+01 | 2.081E+01 | 7.350E+00 | 2.794E+00 | 9.006E-06 | 6.912E-05 |
| 4.5 | 5.675E-06 | 1.324E-08 | 1.536E-08 | 4.604E-08 | 1.275E+01 | 1.186E+01 | 5.758E+00 | 3.008E+00 | 1.027E-05 | 5.262E-05 |
| 7.5 | 4.175E-06 | 9.742E-09 | 1.130E-08 | 3.387E-08 | 3.581E+00 | 3.542E+00 | 2.600E+00 | 2.074E+00 | 1.301E-05 | 2.456E-05 |
| 15.0 | 2.289E-06 | 5.342E-09 | 6.197E-09 | 1.857E-08 | 1.165E+00 | 1.165E+00 | 1.040E+00 | 9.306E-01 | 1.383E-05 | 9.945E-06 |
| 25.0 | 1.298E-06 | 3.029E-09 | 3.514E-09 | 1.053E-08 | 5.798E-01 | 5.802E-01 | 5.558E-01 | 5.239E-01 | 1.297E-05 | 5.369E-06 |
| 35.0 | 8.484E-07 | 1.980E-09 | 2.297E-09 | 6.882E-09 | 3.718E-01 | 3.720E-01 | 3.656E-01 | 3.544E-01 | 1.216E-05 | 3.558E-06 |
| 45.0 | 6.019E-07 | 1.404E-09 | 1.629E-09 | 4.883E-09 | 2.667E-01 | 2.669E-01 | 2.652E-01 | 2.609E-01 | 1.149E-05 | 2.593E-06 |
| 55.0 | 4.506E-07 | 1.051E-09 | 1.220E-09 | 3.656E-09 | 2.038E-01 | 2.039E-01 | 2.037E-01 | 2.021E-01 | 1.091E-05 | 1.996E-06 |
| 65.0 | 3.506E-07 | 8.180E-10 | 9.489E-10 | 2.844E-09 | 1.623E-01 | 1.624E-01 | 1.627E-01 | 1.622E-01 | 1.042E-05 | 1.598E-06 |
| 75.0 | 2.807E-07 | 6.550E-10 | 7.599E-10 | 2.277E-09 | 1.333E-01 | 1.334E-01 | 1.338E-01 | 1.338E-01 | 9.982E-06 | 1.315E-06 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.560E+00 | 3.640E-03 | 4.222E-03 | 4.222E-03 | 0.000E+00 | 3.669E+01 | 3.669E+01 | 3.669E+01 | 1.255E+00 |
| 2.5 | 1.381E+00 | 3.221E-03 | 3.736E-03 | 3.736E-03 | 0.000E+00 | 5.217E+01 | 5.217E+01 | 5.217E+01 | 9.633E-01 |
| 3.5 | 1.228E+00 | 2.864E-03 | 3.322E-03 | 3.322E-03 | 0.000E+00 | 1.649E+01 | 1.649E+01 | 1.649E+01 | 8.338E-01 |
| 4.5 | 1.097E+00 | 2.560E-03 | 2.969E-03 | 2.969E-03 | 0.000E+00 | 9.394E+00 | 9.394E+00 | 9.394E+00 | 9.511E-01 |
| 7.5 | 8.072E-01 | 1.883E-03 | 2.185E-03 | 2.185E-03 | 0.000E+00 | 2.807E+00 | 2.807E+00 | 2.807E+00 | 1.204E+00 |
| 15.0 | 4.426E-01 | 1.033E-03 | 1.198E-03 | 1.198E-03 | 0.000E+00 | 9.240E-01 | 9.240E-01 | 9.240E-01 | 1.281E+00 |
| 25.0 | 2.509E-01 | 5.855E-04 | 6.792E-04 | 6.792E-04 | 0.000E+00 | 4.602E-01 | 4.602E-01 | 4.602E-01 | 1.200E+00 |
| 35.0 | 1.640E-01 | 3.827E-04 | 4.439E-04 | 4.439E-04 | 0.000E+00 | 2.951E-01 | 2.951E-01 | 2.951E-01 | 1.125E+00 |
| 45.0 | 1.164E-01 | 2.715E-04 | 3.149E-04 | 3.149E-04 | 0.000E+00 | 2.117E-01 | 2.117E-01 | 2.117E-01 | 1.064E+00 |
| 55.0 | 8.711E-02 | 2.033E-04 | 2.358E-04 | 2.358E-04 | 0.000E+00 | 1.617E-01 | 1.617E-01 | 1.617E-01 | 1.010E+00 |
| 65.0 | 6.777E-02 | 1.581E-04 | 1.834E-04 | 1.834E-04 | 0.000E+00 | 1.288E-01 | 1.288E-01 | 1.288E-01 | 9.643E-01 |
| 75.0 | 5.427E-02 | 1.266E-04 | 1.469E-04 | 1.469E-04 | 0.000E+00 | 1.058E-01 | 1.058E-01 | 1.058E-01 | 9.242E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 8.070E-08 | 1.883E-10 | 2.185E-10 | 4.133E-08 |
| 2.5 | 7.141E-08 | 1.666E-10 | 1.933E-10 | 3.179E-08 |
| 3.5 | 6.350E-08 | 1.482E-10 | 1.719E-10 | 2.753E-08 |
| 4.5 | 5.675E-08 | 1.324E-10 | 1.536E-10 | 3.128E-08 |
| 7.5 | 4.175E-08 | 9.742E-11 | 1.130E-10 | 3.936E-08 |
| 15.0 | 2.289E-08 | 5.342E-11 | 6.197E-11 | 4.169E-08 |
| 25.0 | 1.298E-08 | 3.029E-11 | 3.514E-11 | 3.900E-08 |
| 35.0 | 8.484E-09 | 1.980E-11 | 2.297E-11 | 3.654E-08 |
| 45.0 | 6.019E-09 | 1.404E-11 | 1.629E-11 | 3.451E-08 |
| 55.0 | 4.506E-09 | 1.051E-11 | 1.220E-11 | 3.277E-08 |
| 65.0 | 3.506E-09 | 8.180E-12 | 9.489E-12 | 3.127E-08 |
| 75.0 | 2.807E-09 | 6.550E-12 | 7.599E-12 | 2.997E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE S DIRECTION, THETA EQUALS 180.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 8.888E-06 | 2.074E-08 | 2.406E-08 | 7.210E-08 | 5.923E+01 | 5.510E+01 | 2.189E+01 | 9.054E+00 | 1.523E-05 | 2.015E-04 |
| 2.5 | 8.203E-06 | 1.914E-08 | 2.220E-08 | 6.654E-08 | 2.167E+01 | 2.050E+01 | 9.221E+00 | 4.409E+00 | 1.106E-05 | 8.431E-05 |
| 3.5 | 7.524E-06 | 1.755E-08 | 2.037E-08 | 6.103E-08 | 8.788E+00 | 8.440E+00 | 4.680E+00 | 2.613E+00 | 9.568E-06 | 4.217E-05 |
| 4.5 | 6.882E-06 | 1.606E-08 | 1.863E-08 | 5.583E-08 | 5.045E+00 | 4.941E+00 | 3.273E+00 | 2.222E+00 | 1.006E-05 | 2.997E-05 |
| 7.5 | 5.381E-06 | 1.256E-08 | 1.457E-08 | 4.366E-08 | 2.371E+00 | 2.365E+00 | 1.925E+00 | 1.620E+00 | 1.187E-05 | 1.824E-05 |
| 15.0 | 2.689E-06 | 6.274E-09 | 7.279E-09 | 2.181E-08 | 9.226E-01 | 9.230E-01 | 8.460E-01 | 7.689E-01 | 1.184E-05 | 8.108E-06 |
| 25.0 | 1.396E-06 | 3.257E-09 | 3.778E-09 | 1.132E-08 | 4.669E-01 | 4.672E-01 | 4.519E-01 | 4.300E-01 | 1.075E-05 | 4.376E-06 |
| 35.0 | 8.584E-07 | 2.003E-09 | 2.324E-09 | 6.963E-09 | 2.966E-01 | 2.968E-01 | 2.930E-01 | 2.857E-01 | 9.876E-06 | 2.857E-06 |
| 45.0 | 5.849E-07 | 1.365E-09 | 1.583E-09 | 4.745E-09 | 2.099E-01 | 2.100E-01 | 2.092E-01 | 2.066E-01 | 9.180E-06 | 2.048E-06 |
| 55.0 | 4.264E-07 | 9.948E-10 | 1.154E-09 | 3.459E-09 | 1.584E-01 | 1.585E-01 | 1.585E-01 | 1.577E-01 | 8.612E-06 | 1.555E-06 |
| 65.0 | 3.258E-07 | 7.603E-10 | 8.820E-10 | 2.643E-09 | 1.249E-01 | 1.250E-01 | 1.253E-01 | 1.251E-01 | 8.145E-06 | 1.231E-06 |
| 75.0 | 2.579E-07 | 6.018E-10 | 6.982E-10 | 2.092E-09 | 1.016E-01 | 1.017E-01 | 1.021E-01 | 1.021E-01 | 7.747E-06 | 1.003E-06 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.718E+00 | 4.009E-03 | 4.650E-03 | 4.650E-03 | 0.000E+00 | 4.365E+01 | 4.365E+01 | 4.365E+01 | 1.410E+00 |
| 2.5 | 1.586E+00 | 3.700E-03 | 4.292E-03 | 4.292E-03 | 0.000E+00 | 1.624E+01 | 1.624E+01 | 1.624E+01 | 1.024E+00 |
| 3.5 | 1.454E+00 | 3.394E-03 | 3.936E-03 | 3.936E-03 | 0.000E+00 | 6.689E+00 | 6.689E+00 | 6.689E+00 | 8.859E-01 |
| 4.5 | 1.330E+00 | 3.104E-03 | 3.601E-03 | 3.601E-03 | 0.000E+00 | 3.917E+00 | 3.917E+00 | 3.917E+00 | 9.313E-01 |
| 7.5 | 1.040E+00 | 2.427E-03 | 2.816E-03 | 2.816E-03 | 0.000E+00 | 1.876E+00 | 1.876E+00 | 1.876E+00 | 1.099E+00 |
| 15.0 | 5.198E-01 | 1.213E-03 | 1.407E-03 | 1.407E-03 | 0.000E+00 | 7.325E-01 | 7.325E-01 | 7.325E-01 | 1.096E+00 |
| 25.0 | 2.698E-01 | 6.296E-04 | 7.303E-04 | 7.303E-04 | 0.000E+00 | 3.708E-01 | 3.708E-01 | 3.708E-01 | 9.956E-01 |
| 35.0 | 1.659E-01 | 3.872E-04 | 4.491E-04 | 4.491E-04 | 0.000E+00 | 2.355E-01 | 2.355E-01 | 2.355E-01 | 9.144E-01 |
| 45.0 | 1.131E-01 | 2.638E-04 | 3.060E-04 | 3.060E-04 | 0.000E+00 | 1.666E-01 | 1.666E-01 | 1.666E-01 | 8.499E-01 |
| 55.0 | 8.242E-02 | 1.923E-04 | 2.231E-04 | 2.231E-04 | 0.000E+00 | 1.257E-01 | 1.257E-01 | 1.257E-01 | 7.973E-01 |
| 65.0 | 6.299E-02 | 1.470E-04 | 1.705E-04 | 1.705E-04 | 0.000E+00 | 9.915E-02 | 9.915E-02 | 9.915E-02 | 7.541E-01 |
| 75.0 | 4.986E-02 | 1.163E-04 | 1.349E-04 | 1.349E-04 | 0.000E+00 | 8.066E-02 | 8.066E-02 | 8.066E-02 | 7.172E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 8.888E-08 | 2.074E-10 | 2.406E-10 | 4.641E-08 |
| 2.5 | 8.203E-08 | 1.914E-10 | 2.220E-10 | 3.386E-08 |
| 3.5 | 7.524E-08 | 1.755E-10 | 2.037E-10 | 2.932E-08 |
| 4.5 | 6.882E-08 | 1.606E-10 | 1.863E-10 | 3.074E-08 |
| 7.5 | 5.381E-08 | 1.256E-10 | 1.457E-10 | 3.606E-08 |
| 15.0 | 2.689E-08 | 6.274E-11 | 7.279E-11 | 3.572E-08 |
| 25.0 | 1.396E-08 | 3.257E-11 | 3.778E-11 | 3.237E-08 |
| 35.0 | 8.584E-09 | 2.003E-11 | 2.324E-11 | 2.970E-08 |
| 45.0 | 5.849E-09 | 1.365E-11 | 1.583E-11 | 2.759E-08 |
| 55.0 | 4.264E-09 | 9.948E-12 | 1.154E-11 | 2.587E-08 |
| 65.0 | 3.258E-09 | 7.603E-12 | 8.820E-12 | 2.446E-08 |
| 75.0 | 2.579E-09 | 6.018E-12 | 6.982E-12 | 2.326E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE W DIRECTION, THETA EQUALS 270.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

| KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | WL |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 1.322E-05 | 3.084E-08 | 3.578E-08 | 1.072E-07 | 1.771E+01 | 1.753E+01 | 1.248E+01 | 8.844E+00 | 2.568E-05 | 1.143E-04 |
| 5 | 1.551E-05 | 3.619E-08 | 4.199E-08 | 1.258E-07 | 1.188E+01 | 1.183E+01 | 9.455E+00 | 7.486E+00 | 2.729E-05 | 8.805E-05 |
| 5 | 1.724E-05 | 4.024E-08 | 4.668E-08 | 1.399E-07 | 8.896E+00 | 8.885E+00 | 7.494E+00 | 6.309E+00 | 2.826E-05 | 7.068E-05 |
| 5 | 1.781E-05 | 4.155E-08 | 4.820E-08 | 1.445E-07 | 7.001E+00 | 6.998E+00 | 6.093E+00 | 5.319E+00 | 2.860E-05 | 5.794E-05 |
| 5 | 1.397E-05 | 3.260E-08 | 3.782E-08 | 1.133E-07 | 3.518E+00 | 3.519E+00 | 3.186E+00 | 2.902E+00 | 2.353E-05 | 3.060E-05 |
| 0 | 3.872E-06 | 9.034E-09 | 1.048E-08 | 3.141E-08 | 1.205E+00 | 1.206E+00 | 1.171E+00 | 1.127E+00 | 1.755E-05 | 1.138E-05 |
| 0 | 9.201E-07 | 2.147E-09 | 2.491E-09 | 7.464E-09 | 4.946E-01 | 4.949E-01 | 4.918E-01 | 4.852E-01 | 1.332E-05 | 4.813E-06 |
| 0 | 4.334E-07 | 1.011E-09 | 1.173E-09 | 3.516E-09 | 3.032E-01 | 3.034E-01 | 3.038E-01 | 3.029E-01 | 1.205E-05 | 2.982E-06 |
| 0 | 2.828E-07 | 6.598E-10 | 7.655E-10 | 2.294E-09 | 2.191E-01 | 2.192E-01 | 2.201E-01 | 2.203E-01 | 1.161E-05 | 2.163E-06 |
| 0 | 1.915E-07 | 4.469E-10 | 5.185E-10 | 1.554E-09 | 1.649E-01 | 1.650E-01 | 1.658E-01 | 1.663E-01 | 1.106E-05 | 1.631E-06 |
| 0 | 1.371E-07 | 3.199E-10 | 3.712E-10 | 1.112E-09 | 1.288E-01 | 1.289E-01 | 1.296E-01 | 1.300E-01 | 1.053E-05 | 1.275E-06 |
| 0 | 1.025E-07 | 2.392E-10 | 2.775E-10 | 8.316E-10 | 1.036E-01 | 1.037E-01 | 1.043E-01 | 1.046E-01 | 1.004E-05 | 1.026E-06 |

GROUND SURFACE CONCENTRATIONS, PCI/M2

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 | Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 2.555E+00 | 5.961E-03 | 6.915E-03 | 6.915E-03 | 0.000E+00 | 1.389E+01 | 1.389E+01 | 1.389E+01 | 2.377E+00 |
| 2.5 | 2.998E+00 | 6.996E-03 | 8.115E-03 | 8.115E-03 | 0.000E+00 | 9.382E+00 | 9.382E+00 | 9.382E+00 | 2.527E+00 |
| 3.5 | 3.334E+00 | 7.779E-03 | 9.023E-03 | 9.023E-03 | 0.000E+00 | 7.046E+00 | 7.046E+00 | 7.046E+00 | 2.617E+00 |
| 4.5 | 3.442E+00 | 8.032E-03 | 9.317E-03 | 9.317E-03 | 0.000E+00 | 5.552E+00 | 5.552E+00 | 5.552E+00 | 2.648E+00 |
| 7.5 | 2.701E+00 | 6.302E-03 | 7.310E-03 | 7.310E-03 | 0.000E+00 | 2.794E+00 | 2.794E+00 | 2.794E+00 | 2.178E+00 |
| 15.0 | 7.484E-01 | 1.746E-03 | 2.026E-03 | 2.026E-03 | 0.000E+00 | 9.573E-01 | 9.573E-01 | 9.573E-01 | 1.625E+00 |
| 25.0 | 1.779E-01 | 4.150E-04 | 4.814E-04 | 4.814E-04 | 0.000E+00 | 3.925E-01 | 3.925E-01 | 3.925E-01 | 1.233E+00 |
| 35.0 | 8.379E-02 | 1.955E-04 | 2.268E-04 | 2.268E-04 | 0.000E+00 | 2.405E-01 | 2.405E-01 | 2.405E-01 | 1.116E+00 |
| 45.0 | 5.467E-02 | 1.276E-04 | 1.480E-04 | 1.480E-04 | 0.000E+00 | 1.738E-01 | 1.738E-01 | 1.738E-01 | 1.075E+00 |
| 55.0 | 3.703E-02 | 8.640E-05 | 1.002E-04 | 1.002E-04 | 0.000E+00 | 1.308E-01 | 1.308E-01 | 1.308E-01 | 1.024E+00 |
| 65.0 | 2.651E-02 | 6.185E-05 | 7.174E-05 | 7.174E-05 | 0.000E+00 | 1.022E-01 | 1.022E-01 | 1.022E-01 | 9.748E-01 |
| 75.0 | 1.982E-02 | 4.624E-05 | 5.363E-05 | 5.363E-05 | 0.000E+00 | 8.220E-02 | 8.220E-02 | 8.220E-02 | 9.298E-01 |

TOTAL DEPOSITION RATES, PCI/M2-SEC

| XRHO, KM | U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|
| 1.5 | 1.322E-07 | 3.084E-10 | 3.578E-10 | 7.810E-08 |
| 2.5 | 1.551E-07 | 3.619E-10 | 4.199E-10 | 8.314E-08 |
| 3.5 | 1.724E-07 | 4.024E-10 | 4.668E-10 | 8.619E-08 |
| 4.5 | 1.781E-07 | 4.155E-10 | 4.820E-10 | 8.723E-08 |
| 7.5 | 1.397E-07 | 3.260E-10 | 3.782E-10 | 7.171E-08 |
| 15.0 | 3.872E-08 | 9.034E-11 | 1.048E-10 | 5.297E-08 |
| 25.0 | 9.201E-09 | 2.147E-11 | 2.491E-11 | 4.003E-08 |
| 35.0 | 4.334E-09 | 1.011E-11 | 1.173E-11 | 3.620E-08 |
| 45.0 | 2.828E-09 | 6.598E-12 | 7.655E-12 | 3.484E-08 |
| 55.0 | 1.915E-09 | 4.469E-12 | 5.185E-12 | 3.319E-08 |
| 65.0 | 1.371E-09 | 3.199E-12 | 3.712E-12 | 3.160E-08 |
| 75.0 | 1.025E-09 | 2.392E-12 | 2.775E-12 | 3.014E-08 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.153E-02 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.298E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.958E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.337E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.749E-05 | 0.000E+00 | 5.387E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.105E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.326E-04 | 0.000E+00 | 4.495E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.010E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 7.881E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.816E-04 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.100E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.860E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.261E-02 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 3.907E-02 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.220E-02 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.302E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.641E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 7.646E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.662E-05 | 0.000E+00 | 1.011E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.232E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.485E-04 | 0.000E+00 | 1.999E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.194E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.187E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.682E-03 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.346E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.720E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 7.701E-02 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 1.836E-01 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS AVG.LUNG

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.334E-02 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.213E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.931E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.293E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.763E-04 | 0.000E+00 | 3.354E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.297E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.241E-03 | 0.000E+00 | 1.667E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.112E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.194E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.231E-04 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.784E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.474E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.624E-02 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 1.352E-01 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS BRONCHI

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | IRHO 1.5 | IRHO 2.5 | IRHO 3.5 | IRHO 4.5 | IRHO 7.5 | IRHO 15.0 | IRHO 25.0 | IRHO 35.0 | IRHO 45.0 | IRHO 55.0 | IRHO 65.0 | IRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.063E+00 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.244E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.201E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.671E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.377E-02 | 0.000E+00 | 1.747E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.088E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.741E-02 | 0.000E+00 | 7.822E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.968E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.657E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.278E-02 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.189E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.729E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.948E+00 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 5.755E+00 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS GROUND EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NNE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.784E-04 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.787E-07 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ENE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.382E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.267E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| ESE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.736E-06 | 0.000E+00 | 2.026E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| S | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.194E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.628E-06 | 0.000E+00 | 9.536E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| WSW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.708E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.940E-06 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.504E-06 | 0.000E+00 | 0.000E+00 |
| WNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.583E-07 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.073E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.446E-04 |
| NNW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 7.124E-04 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD  DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS CLOUD  EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| CTION | IRHO 1.5 | IRHO 2.5 | IRHO 3.5 | IRHO 4.5 | IRHO 7.5 | IRHO 15.0 | IRHO 25.0 | IRHO 35.0 | IRHO 45.0 | IRHO 55.0 | IRHO 65.0 | IRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.689E-02 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.529E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| NE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.664E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.347E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| E | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SE | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.470E-04 | 0.000E+00 | 1.241E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.452E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.060E-04 | 0.000E+00 | 6.868E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| SW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 3.397E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.364E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.659E-04 | 0.000E+00 | 0.000E+00 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.582E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| W | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 5.019E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.718E-02 |
| NW | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |

TOTAL DOSE COMMITMENT IS 4.985E-02 PERSON-REM/YR

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS VEG. ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | IRHO 1.5 | IRHO 2.5 | IRHO 3.5 | IRHO 4.5 | IRHO 7.5 | IRHO 15.0 | IRHO 25.0 | IRHO 35.0 | IRHO 45.0 | IRHO 55.0 | IRHO 65.0 | IRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 8.719E-06 | 1.410E-05 | 2.041E-05 | 2.696E-05 | 2.326E-04 | 8.094E-04 | 1.080E-03 | 1.329E-03 | 1.571E-03 | 1.794E-03 | 2.005E-03 | 2.199E-03 |
| NNE | 7.376E-06 | 1.230E-05 | 1.750E-05 | 2.234E-05 | 1.833E-04 | 5.386E-04 | 9.326E-04 | 1.232E-03 | 1.469E-03 | 1.679E-03 | 1.871E-03 | 2.048E-03 |
| NE | 6.754E-06 | 1.131E-05 | 1.589E-05 | 2.029E-05 | 1.664E-04 | 6.156E-04 | 8.071E-04 | 1.052E-03 | 1.340E-03 | 1.596E-03 | 1.828E-03 | 2.041E-03 |
| ENE | 6.265E-06 | 1.022E-05 | 1.466E-05 | 1.925E-05 | 1.560E-04 | 5.684E-04 | 8.113E-04 | 9.870E-04 | 1.136E-03 | 1.267E-03 | 1.385E-03 | 1.494E-03 |
| E | 6.078E-06 | 9.605E-06 | 1.373E-05 | 1.819E-05 | 1.469E-04 | 5.689E-04 | 9.066E-04 | 1.194E-03 | 1.447E-03 | 1.674E-03 | 1.881E-03 | 2.070E-03 |
| ESE | 5.912E-06 | 8.933E-06 | 1.252E-05 | 1.665E-05 | 1.619E-04 | 6.343E-04 | 9.555E-04 | 1.226E-03 | 1.465E-03 | 1.680E-03 | 1.877E-03 | 2.058E-03 |
| SE | 6.408E-06 | 8.778E-06 | 1.186E-05 | 1.694E-05 | 1.616E-04 | 6.368E-04 | 9.582E-04 | 1.233E-03 | 1.477E-03 | 1.700E-03 | 1.907E-03 | 2.100E-03 |
| SSE | 7.565E-06 | 9.939E-06 | 1.210E-05 | 1.698E-05 | 1.669E-04 | 6.744E-04 | 1.031E-03 | 1.338E-03 | 1.616E-03 | 1.869E-03 | 2.103E-03 | 2.321E-03 |
| S | 8.468E-06 | 1.073E-05 | 1.315E-05 | 1.728E-05 | 1.588E-04 | 5.890E-04 | 8.635E-04 | 1.093E-03 | 1.297E-03 | 1.480E-03 | 1.648E-03 | 1.804E-03 |
| SSW | 9.871E-06 | 1.288E-05 | 1.470E-05 | 1.845E-05 | 1.469E-04 | 5.093E-04 | 7.561E-04 | 9.782E-04 | 1.174E-03 | 1.350E-03 | 1.510E-03 | 1.657E-03 |
| SW | 1.128E-05 | 1.642E-05 | 1.922E-05 | 2.106E-05 | 1.411E-04 | 4.509E-04 | 6.378E-04 | 8.049E-04 | 9.485E-04 | 1.075E-03 | 1.190E-03 | 1.294E-03 |
| WSW | 1.259E-05 | 2.228E-05 | 2.727E-05 | 3.187E-05 | 1.776E-04 | 5.045E-04 | 6.180E-04 | 7.216E-04 | 8.301E-04 | 9.259E-04 | 1.013E-03 | 1.092E-03 |
| W | 1.399E-05 | 2.519E-05 | 3.695E-05 | 4.826E-05 | 3.282E-04 | 8.715E-04 | 1.047E-03 | 1.311E-03 | 1.617E-03 | 1.878E-03 | 2.111E-03 | 2.320E-03 |
| WNW | 1.414E-05 | 2.789E-05 | 4.254E-05 | 5.807E-05 | 4.875E-04 | 1.450E-03 | 2.495E-03 | 3.784E-03 | 4.793E-03 | 5.654E-03 | 6.416E-03 | 7.100E-03 |
| NW | 1.249E-05 | 2.439E-05 | 3.849E-05 | 5.486E-05 | 6.515E-04 | 5.268E-03 | 4.604E-03 | 5.491E-03 | 6.445E-03 | 7.342E-03 | 8.172E-03 | 8.936E-03 |
| NNW | 1.040E-05 | 1.852E-05 | 2.673E-05 | 3.614E-05 | 3.469E-04 | 1.697E-03 | 1.657E-03 | 2.036E-03 | 2.416E-03 | 2.771E-03 | 3.108E-03 | 3.421E-03 |

TOTAL DOSE COMMITMENT IS 2.181E-01 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS VEG. ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 1.005E-04 | 1.634E-04 | 2.378E-04 | 3.151E-04 | 2.748E-03 | 9.488E-03 | 1.230E-02 | 1.482E-02 | 1.737E-02 | 1.975E-02 | 2.202E-02 | 2.412E-02 |
| NNE | 8.512E-05 | 1.422E-04 | 2.021E-04 | 2.573E-04 | 2.105E-03 | 6.048E-03 | 1.036E-02 | 1.360E-02 | 1.618E-02 | 1.846E-02 | 2.053E-02 | 2.245E-02 |
| NE | 7.796E-05 | 1.300E-04 | 1.819E-04 | 2.310E-04 | 1.873E-03 | 6.839E-03 | 8.879E-03 | 1.155E-02 | 1.469E-02 | 1.748E-02 | 2.001E-02 | 2.233E-02 |
| ENE | 7.212E-05 | 1.171E-04 | 1.669E-04 | 2.178E-04 | 1.738E-03 | 6.281E-03 | 8.918E-03 | 1.082E-02 | 1.244E-02 | 1.386E-02 | 1.515E-02 | 1.633E-02 |
| E | 6.988E-05 | 1.098E-04 | 1.560E-04 | 2.053E-04 | 1.639E-03 | 6.256E-03 | 9.936E-03 | 1.307E-02 | 1.583E-02 | 1.831E-02 | 2.056E-02 | 2.262E-02 |
| ESE | 6.824E-05 | 1.024E-04 | 1.423E-04 | 1.880E-04 | 1.802E-03 | 6.984E-03 | 1.048E-02 | 1.341E-02 | 1.602E-02 | 1.836E-02 | 2.051E-02 | 2.248E-02 |
| SE | 7.392E-05 | 1.014E-04 | 1.362E-04 | 1.923E-04 | 1.805E-03 | 7.027E-03 | 1.052E-02 | 1.351E-02 | 1.617E-02 | 1.860E-02 | 2.086E-02 | 2.295E-02 |
| SSE | 8.690E-05 | 1.149E-04 | 1.400E-04 | 1.945E-04 | 1.877E-03 | 7.483E-03 | 1.137E-02 | 1.471E-02 | 1.774E-02 | 2.049E-02 | 2.304E-02 | 2.541E-02 |
| S | 9.720E-05 | 1.245E-04 | 1.530E-04 | 1.997E-04 | 1.805E-03 | 6.573E-03 | 9.550E-03 | 1.204E-02 | 1.425E-02 | 1.623E-02 | 1.807E-02 | 1.976E-02 |
| SSW | 1.130E-04 | 1.491E-04 | 1.717E-04 | 2.150E-04 | 1.683E-03 | 5.695E-03 | 8.358E-03 | 1.076E-02 | 1.288E-02 | 1.479E-02 | 1.653E-02 | 1.813E-02 |
| SW | 1.290E-04 | 1.892E-04 | 2.234E-04 | 2.459E-04 | 1.633E-03 | 5.061E-03 | 7.029E-03 | 8.838E-03 | 1.040E-02 | 1.177E-02 | 1.302E-02 | 1.415E-02 |
| WSW | 1.440E-04 | 2.551E-04 | 3.145E-04 | 3.685E-04 | 2.053E-03 | 5.643E-03 | 6.818E-03 | 7.923E-03 | 9.097E-03 | 1.014E-02 | 1.108E-02 | 1.194E-02 |
| W | 1.598E-04 | 2.888E-04 | 4.249E-04 | 5.553E-04 | 3.769E-03 | 9.720E-03 | 1.152E-02 | 1.436E-02 | 1.769E-02 | 2.054E-02 | 2.307E-02 | 2.535E-02 |
| WNW | 1.617E-04 | 3.197E-04 | 4.907E-04 | 6.745E-04 | 5.700E-03 | 1.624E-02 | 2.752E-02 | 4.159E-02 | 5.252E-02 | 6.186E-02 | 7.014E-02 | 7.759E-02 |
| NW | 1.434E-04 | 2.810E-04 | 4.465E-04 | 6.429E-04 | 8.067E-03 | 6.833E-02 | 5.213E-02 | 6.064E-02 | 7.075E-02 | 8.041E-02 | 8.940E-02 | 9.770E-02 |
| NNW | 1.198E-04 | 2.142E-04 | 3.103E-04 | 4.242E-04 | 4.230E-03 | 2.163E-02 | 1.882E-02 | 2.256E-02 | 2.658E-02 | 3.040E-02 | 3.404E-02 | 3.744E-02 |

TOTAL DOSE COMMITMENT IS 2.413E+00 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MEAT ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 2.138E-06 | 3.417E-06 | 4.897E-06 | 6.425E-06 | 5.419E-05 | 1.916E-04 | 2.712E-04 | 3.471E-04 | 4.169E-04 | 4.797E-04 | 5.381E-04 | 5.919E-04 |
| NNE | 1.804E-06 | 2.999E-06 | 4.272E-06 | 5.486E-06 | 4.525E-05 | 1.389E-04 | 2.452E-04 | 3.275E-04 | 3.924E-04 | 4.501E-04 | 5.027E-04 | 5.512E-04 |
| NE | 1.651E-06 | 2.788E-06 | 3.947E-06 | 5.094E-06 | 4.272E-05 | 1.619E-04 | 2.160E-04 | 2.830E-04 | 3.611E-04 | 4.306E-04 | 4.937E-04 | 5.516E-04 |
| ENE | 1.540E-06 | 2.533E-06 | 3.679E-06 | 4.892E-06 | 4.081E-05 | 1.509E-04 | 2.174E-04 | 2.657E-04 | 3.063E-04 | 3.421E-04 | 3.745E-04 | 4.041E-04 |
| E | 1.497E-06 | 2.393E-06 | 3.467E-06 | 4.647E-06 | 3.835E-05 | 1.524E-04 | 2.442E-04 | 3.225E-04 | 3.913E-04 | 4.530E-04 | 5.091E-04 | 5.605E-04 |
| ESE | 1.445E-06 | 2.214E-06 | 3.154E-06 | 4.247E-06 | 4.243E-05 | 1.695E-04 | 2.573E-04 | 3.309E-04 | 3.961E-04 | 4.547E-04 | 5.082E-04 | 5.574E-04 |
| SE | 1.569E-06 | 2.142E-06 | 2.933E-06 | 4.281E-06 | 4.207E-05 | 1.695E-04 | 2.572E-04 | 3.320E-04 | 3.988E-04 | 4.595E-04 | 5.159E-04 | 5.682E-04 |
| SSE | 1.868E-06 | 2.424E-06 | 2.944E-06 | 4.217E-06 | 4.288E-05 | 1.777E-04 | 2.747E-04 | 3.584E-04 | 4.344E-04 | 5.034E-04 | 5.671E-04 | 6.264E-04 |
| S | 2.094E-06 | 2.599E-06 | 3.167E-06 | 4.215E-06 | 4.000E-05 | 1.536E-04 | 2.290E-04 | 2.921E-04 | 3.478E-04 | 3.978E-04 | 4.440E-04 | 4.866E-04 |
| SSW | 2.452E-06 | 3.130E-06 | 3.505E-06 | 4.425E-06 | 3.644E-05 | 1.324E-04 | 2.006E-04 | 2.619E-04 | 3.156E-04 | 3.637E-04 | 4.076E-04 | 4.477E-04 |
| SW | 2.807E-06 | 4.025E-06 | 4.632E-06 | 5.025E-06 | 3.433E-05 | 1.164E-04 | 1.702E-04 | 2.161E-04 | 2.555E-04 | 2.902E-04 | 3.215E-04 | 3.499E-04 |
| WSW | 3.137E-06 | 5.537E-06 | 6.680E-06 | 7.763E-06 | 4.331E-05 | 1.311E-04 | 1.645E-04 | 1.938E-04 | 2.236E-04 | 2.499E-04 | 2.737E-04 | 2.953E-04 |
| W | 3.492E-06 | 6.241E-06 | 9.103E-06 | 1.187E-05 | 8.102E-05 | 2.276E-04 | 2.807E-04 | 3.534E-04 | 4.367E-04 | 5.080E-04 | 5.713E-04 | 6.283E-04 |
| WNW | 3.524E-06 | 6.915E-06 | 1.041E-05 | 1.402E-05 | 1.160E-04 | 3.760E-04 | 6.650E-04 | 1.014E-03 | 1.292E-03 | 1.527E-03 | 1.736E-03 | 1.922E-03 |
| NW | 3.084E-06 | 5.983E-06 | 9.316E-06 | 1.300E-05 | 1.359E-04 | 9.659E-04 | 1.169E-03 | 1.459E-03 | 1.732E-03 | 1.980E-03 | 2.208E-03 | 2.418E-03 |
| NNW | 2.549E-06 | 4.514E-06 | 6.458E-06 | 8.535E-06 | 7.517E-05 | 3.278E-04 | 4.177E-04 | 5.379E-04 | 6.464E-04 | 7.454E-04 | 8.381E-04 | 9.242E-04 |

TOTAL DOSE COMMITMENT IS 5.779E-02 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MEAT ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 2.484E-05 | 3.984E-05 | 5.725E-05 | 7.526E-05 | 6.388E-04 | 2.249E-03 | 3.131E-03 | 3.966E-03 | 4.743E-03 | 5.448E-03 | 6.105E-03 | 6.710E-03 |
| NNE | 2.098E-05 | 3.491E-05 | 4.970E-05 | 6.372E-05 | 5.248E-04 | 1.592E-03 | 2.797E-03 | 3.724E-03 | 4.458E-03 | 5.108E-03 | 5.702E-03 | 6.249E-03 |
| NE | 1.920E-05 | 3.235E-05 | 4.570E-05 | 5.881E-05 | 4.904E-04 | 1.846E-03 | 2.452E-03 | 3.209E-03 | 4.093E-03 | 4.879E-03 | 5.593E-03 | 6.247E-03 |
| ENE | 1.788E-05 | 2.934E-05 | 4.248E-05 | 5.630E-05 | 4.661E-04 | 1.717E-03 | 2.468E-03 | 3.012E-03 | 3.471E-03 | 3.875E-03 | 4.241E-03 | 4.575E-03 |
| E | 1.738E-05 | 2.769E-05 | 3.997E-05 | 5.340E-05 | 4.382E-04 | 1.730E-03 | 2.768E-03 | 3.653E-03 | 4.431E-03 | 5.129E-03 | 5.764E-03 | 6.345E-03 |
| ESE | 1.681E-05 | 2.566E-05 | 3.638E-05 | 4.883E-05 | 4.843E-04 | 1.925E-03 | 2.916E-03 | 3.749E-03 | 4.485E-03 | 5.148E-03 | 5.753E-03 | 6.309E-03 |
| SE | 1.824E-05 | 2.493E-05 | 3.400E-05 | 4.934E-05 | 4.811E-04 | 1.927E-03 | 2.918E-03 | 3.764E-03 | 4.518E-03 | 5.204E-03 | 5.842E-03 | 6.433E-03 |
| SSE | 2.166E-05 | 2.821E-05 | 3.428E-05 | 4.883E-05 | 4.921E-04 | 2.026E-03 | 3.122E-03 | 4.068E-03 | 4.926E-03 | 5.706E-03 | 6.427E-03 | 7.097E-03 |
| S | 2.428E-05 | 3.031E-05 | 3.699E-05 | 4.905E-05 | 4.614E-04 | 1.756E-03 | 2.606E-03 | 3.318E-03 | 3.946E-03 | 4.512E-03 | 5.033E-03 | 5.514E-03 |
| SSW | 2.839E-05 | 3.646E-05 | 4.105E-05 | 5.174E-05 | 4.221E-04 | 1.514E-03 | 2.283E-03 | 2.973E-03 | 3.579E-03 | 4.123E-03 | 4.617E-03 | 5.071E-03 |
| SW | 3.249E-05 | 4.678E-05 | 5.408E-05 | 5.884E-05 | 3.998E-04 | 1.334E-03 | 1.933E-03 | 2.452E-03 | 2.896E-03 | 3.288E-03 | 3.641E-03 | 3.962E-03 |
| WSW | 3.630E-05 | 6.411E-05 | 7.765E-05 | 9.038E-05 | 5.041E-04 | 1.500E-03 | 1.871E-03 | 2.198E-03 | 2.535E-03 | 2.831E-03 | 3.099E-03 | 3.344E-03 |
| W | 4.038E-05 | 7.232E-05 | 1.056E-04 | 1.378E-04 | 9.398E-04 | 2.601E-03 | 3.186E-03 | 4.005E-03 | 4.947E-03 | 5.753E-03 | 6.468E-03 | 7.112E-03 |
| WNW | 4.077E-05 | 8.012E-05 | 1.211E-04 | 1.636E-04 | 1.359E-03 | 4.305E-03 | 7.559E-03 | 1.151E-02 | 1.464E-02 | 1.730E-02 | 1.965E-02 | 2.176E-02 |
| NW | 3.577E-05 | 6.952E-05 | 1.086E-04 | 1.525E-04 | 1.655E-03 | 1.226E-02 | 1.346E-02 | 1.660E-02 | 1.964E-02 | 2.244E-02 | 2.501E-02 | 2.737E-02 |
| NNW | 2.963E-05 | 5.254E-05 | 7.535E-05 | 1.002E-04 | 9.051E-04 | 4.090E-03 | 4.817E-03 | 6.127E-03 | 7.340E-03 | 8.453E-03 | 9.497E-03 | 1.047E-02 |

TOTAL DOSE COMMITMENT IS 6.578E-01 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MILK ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | IRHO 1.5 | IRHO 2.5 | IRHO 3.5 | IRHO 4.5 | IRHO 7.5 | IRHO 15.0 | IRHO 25.0 | IRHO 35.0 | IRHO 45.0 | IRHO 55.0 | IRHO 65.0 | IRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 8.767E-07 | 1.493E-06 | 2.260E-06 | 3.068E-06 | 2.884E-05 | 9.441E-05 | 9.643E-05 | 9.263E-05 | 9.711E-05 | 1.042E-04 | 1.121E-04 | 1.202E-04 |
| NNE | 7.495E-07 | 1.272E-06 | 1.795E-06 | 2.231E-06 | 1.784E-05 | 4.101E-05 | 6.204E-05 | 7.483E-05 | 8.585E-05 | 9.514E-05 | 1.036E-04 | 1.115E-04 |
| NE | 6.889E-07 | 1.109E-06 | 1.497E-06 | 1.810E-06 | 1.304E-05 | 4.088E-05 | 4.639E-05 | 5.789E-05 | 7.250E-05 | 8.515E-05 | 9.654E-05 | 1.070E-04 |
| ENE | 6.225E-07 | 9.743E-07 | 1.308E-06 | 1.603E-06 | 1.076E-05 | 3.497E-05 | 4.603E-05 | 5.384E-05 | 6.067E-05 | 6.682E-05 | 7.245E-05 | 7.763E-05 |
| E | 5.975E-07 | 8.924E-07 | 1.190E-06 | 1.471E-06 | 1.030E-05 | 3.244E-05 | 4.903E-05 | 6.323E-05 | 7.570E-05 | 8.691E-05 | 9.712E-05 | 1.065E-04 |
| ESE | 6.023E-07 | 8.518E-07 | 1.094E-06 | 1.357E-06 | 1.103E-05 | 3.697E-05 | 5.194E-05 | 6.476E-05 | 7.630E-05 | 8.680E-05 | 9.645E-05 | 1.054E-04 |
| SE | 6.491E-07 | 9.015E-07 | 1.146E-06 | 1.461E-06 | 1.153E-05 | 3.842E-05 | 5.358E-05 | 6.662E-05 | 7.838E-05 | 8.916E-05 | 9.925E-05 | 1.087E-04 |
| SSE | 7.362E-07 | 1.025E-06 | 1.261E-06 | 1.605E-06 | 1.300E-05 | 4.405E-05 | 6.144E-05 | 7.610E-05 | 8.936E-05 | 1.014E-04 | 1.126E-04 | 1.231E-04 |
| S | 8.177E-07 | 1.143E-06 | 1.435E-06 | 1.779E-06 | 1.392E-05 | 4.150E-05 | 5.374E-05 | 6.389E-05 | 7.304E-05 | 8.141E-05 | 8.926E-05 | 9.657E-05 |
| SSW | 9.318E-07 | 1.348E-06 | 1.667E-06 | 2.046E-06 | 1.396E-05 | 3.681E-05 | 4.672E-05 | 5.612E-05 | 6.475E-05 | 7.274E-05 | 8.017E-05 | 8.708E-05 |
| SW | 1.052E-06 | 1.650E-06 | 2.088E-06 | 2.382E-06 | 1.469E-05 | 3.415E-05 | 3.767E-05 | 4.492E-05 | 5.137E-05 | 5.722E-05 | 6.259E-05 | 6.754E-05 |
| WSW | 1.171E-06 | 2.097E-06 | 2.756E-06 | 3.301E-06 | 1.832E-05 | 3.659E-05 | 3.713E-05 | 4.023E-05 | 4.485E-05 | 4.912E-05 | 5.311E-05 | 5.682E-05 |
| W | 1.286E-06 | 2.407E-06 | 3.632E-06 | 4.782E-06 | 3.191E-05 | 6.094E-05 | 5.952E-05 | 7.049E-05 | 8.518E-05 | 9.772E-05 | 1.089E-04 | 1.191E-04 |
| WNW | 1.315E-06 | 2.657E-06 | 4.308E-06 | 6.263E-06 | 5.570E-05 | 1.066E-04 | 1.487E-04 | 2.142E-04 | 2.583E-04 | 2.974E-04 | 3.331E-04 | 3.657E-04 |
| NW | 1.212E-06 | 2.444E-06 | 4.103E-06 | 6.386E-06 | 1.113E-04 | 1.154E-03 | 3.857E-04 | 3.350E-04 | 3.577E-04 | 3.924E-04 | 4.286E-04 | 4.636E-04 |
| NNW | 1.045E-06 | 1.916E-06 | 2.870E-06 | 4.260E-06 | 5.385E-05 | 3.401E-04 | 1.445E-04 | 1.304E-04 | 1.390E-04 | 1.521E-04 | 1.663E-04 | 1.803E-04 |

TOTAL DOSE COMMITMENT IS 1.364E-02 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MILK ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

| DIRECTION | XRHO 1.5 | XRHO 2.5 | XRHO 3.5 | XRHO 4.5 | XRHO 7.5 | XRHO 15.0 | XRHO 25.0 | XRHO 35.0 | XRHO 45.0 | XRHO 55.0 | XRHO 65.0 | XRHO 75.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 8.756E-06 | 1.495E-05 | 2.269E-05 | 3.084E-05 | 2.910E-04 | 9.500E-04 | 9.565E-04 | 9.028E-04 | 9.367E-04 | 9.987E-04 | 1.071E-03 | 1.145E-03 |
| NNE | 7.490E-06 | 1.272E-05 | 1.794E-05 | 2.227E-05 | 1.778E-04 | 4.024E-04 | 6.023E-04 | 7.207E-04 | 8.237E-04 | 9.100E-04 | 9.889E-04 | 1.063E-03 |
| NE | 6.886E-06 | 1.106E-05 | 1.490E-05 | 1.795E-05 | 1.282E-04 | 3.969E-04 | 4.444E-04 | 5.520E-04 | 6.902E-04 | 8.094E-04 | 9.167E-04 | 1.015E-03 |
| ENE | 6.214E-06 | 9.702E-06 | 1.298E-05 | 1.583E-05 | 1.048E-04 | 3.372E-04 | 4.404E-04 | 5.130E-04 | 5.768E-04 | 6.343E-04 | 6.871E-04 | 7.358E-04 |
| E | 5.960E-06 | 8.873E-06 | 1.179E-05 | 1.449E-05 | 1.005E-04 | 3.105E-04 | 4.668E-04 | 6.005E-04 | 7.180E-04 | 8.236E-04 | 9.198E-04 | 1.008E-03 |
| ESE | 6.020E-06 | 8.483E-06 | 1.084E-05 | 1.338E-05 | 1.073E-04 | 3.547E-04 | 4.947E-04 | 6.149E-04 | 7.234E-04 | 8.222E-04 | 9.131E-04 | 9.969E-04 |
| SE | 6.485E-06 | 9.014E-06 | 1.142E-05 | 1.445E-05 | 1.126E-04 | 3.698E-04 | 5.118E-04 | 6.341E-04 | 7.445E-04 | 8.459E-04 | 9.408E-04 | 1.030E-03 |
| SSE | 7.340E-06 | 1.025E-05 | 1.262E-05 | 1.597E-05 | 1.278E-04 | 4.270E-04 | 5.907E-04 | 7.282E-04 | 8.526E-04 | 9.659E-04 | 1.071E-03 | 1.169E-03 |
| S | 8.149E-06 | 1.145E-05 | 1.439E-05 | 1.779E-05 | 1.379E-04 | 4.049E-04 | 5.187E-04 | 6.130E-04 | 6.982E-04 | 7.764E-04 | 8.498E-04 | 9.182E-04 |
| SSW | 9.273E-06 | 1.350E-05 | 1.675E-05 | 2.054E-05 | 1.390E-04 | 3.598E-04 | 4.507E-04 | 5.375E-04 | 6.177E-04 | 6.921E-04 | 7.616E-04 | 8.264E-04 |
| SW | 1.047E-05 | 1.648E-05 | 2.094E-05 | 2.393E-05 | 1.470E-04 | 3.350E-04 | 3.618E-04 | 4.290E-04 | 4.891E-04 | 5.437E-04 | 5.941E-04 | 6.405E-04 |
| WSW | 1.164E-05 | 2.087E-05 | 2.753E-05 | 3.302E-05 | 1.833E-04 | 3.578E-04 | 3.573E-04 | 3.842E-04 | 4.268E-04 | 4.666E-04 | 5.039E-04 | 5.387E-04 |
| W | 1.278E-05 | 2.397E-05 | 3.623E-05 | 4.772E-05 | 3.181E-04 | 5.941E-04 | 5.695E-04 | 6.706E-04 | 8.086E-04 | 9.263E-04 | 1.032E-03 | 1.128E-03 |
| WNW | 1.308E-05 | 2.646E-05 | 4.305E-05 | 6.278E-05 | 5.600E-04 | 1.043E-03 | 1.430E-03 | 2.048E-03 | 2.458E-03 | 2.823E-03 | 3.157E-03 | 3.463E-03 |
| NW | 1.209E-05 | 2.441E-05 | 4.111E-05 | 6.426E-05 | 1.136E-03 | 1.187E-02 | 3.811E-03 | 3.227E-03 | 3.414E-03 | 3.730E-03 | 4.066E-03 | 4.393E-03 |
| NNW | 1.044E-05 | 1.916E-05 | 2.876E-05 | 4.289E-05 | 5.481E-04 | 3.489E-03 | 1.431E-03 | 1.262E-03 | 1.331E-03 | 1.450E-03 | 1.581E-03 | 1.712E-03 |

TOTAL DOSE COMMITMENT IS 1.317E-01 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

SUMMARY PRINT OF POPULATION DOSES COMPUTED FOR TSTEP 1--DOSES SHOWN ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DOSES RECEIVED BY PEOPLE WITHIN 80 KILOMETERS

| PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|
| INHAL. | 3.907E-02 | 1.836E-01 | 1.352E-01 | 1.369E-01 | 6.609E-02 | 5.755E+00 |
| GROUND | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 |
| CLOUD | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 |
| VEG. ING | 1.908E-01 | 2.111E+00 | 1.908E-01 | 6.961E-01 | 5.942E-01 | 1.908E-01 |
| MEAT ING | 8.797E-03 | 1.001E-01 | 8.797E-03 | 3.155E-02 | 2.615E-02 | 8.797E-03 |
| MILK ING | 5.559E-03 | 5.369E-02 | 5.559E-03 | 1.657E-02 | 1.906E-02 | 5.559E-03 |
| RNPLUS50 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| TOTALS | 2.948E-01 | 2.499E+00 | 3.910E-01 | 9.317E-01 | 7.561E-01 | 6.011E+00 |

DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS

| PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|
| INHAL. | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| GROUND | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| CLOUD | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| VEG. ING | 2.730E-02 | 3.020E-01 | 2.730E-02 | 9.959E-02 | 8.501E-02 | 2.730E-02 |
| MEAT ING | 4.899E-02 | 5.577E-01 | 4.899E-02 | 1.757E-01 | 1.457E-01 | 4.899E-02 |
| MILK ING | 8.084E-03 | 7.806E-02 | 8.084E-03 | 2.409E-02 | 2.771E-02 | 8.084E-03 |
| RNPLUS50 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| TOTALS | 8.438E-02 | 9.378E-01 | 8.438E-02 | 2.994E-01 | 2.584E-01 | 8.438E-02 |

TOTAL DOSES COMPUTED OVER ALL POPULATIONS

| PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|
| INHAL. | 3.907E-02 | 1.836E-01 | 1.352E-01 | 1.369E-01 | 6.609E-02 | 5.755E+00 |
| GROUND | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 | 7.124E-04 |
| CLOUD | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 | 4.985E-02 |
| VEG. ING | 2.181E-01 | 2.413E+00 | 2.181E-01 | 7.957E-01 | 6.792E-01 | 2.181E-01 |
| MEAT ING | 5.779E-02 | 6.578E-01 | 5.779E-02 | 2.072E-01 | 1.718E-01 | 5.779E-02 |
| MILK ING | 1.364E-02 | 1.317E-01 | 1.364E-02 | 4.067E-02 | 4.677E-02 | 1.364E-02 |
| RNPLUS50 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| TOTALS | 3.792E-01 | 3.437E+00 | 4.753E-01 | 1.231E+00 | 1.014E+00 | 6.095E+00 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1-AS-1 | 1 | 1.599E-05 | 3.731E-08 | 4.328E-08 | 1.297E-07 | 3.091E+00 | 7.212E-03 | 8.365E-03 | 8.365E-03 |
| 1 | 1-AS-1 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 1 | 1-AS-1 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 1 | 1-AS-1 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.599E-05 | 3.731E-08 | 4.328E-08 | 1.297E-07 | 3.091E+00 | 7.212E-03 | 8.365E-03 | 8.365E-03 |
| 2 | 2-AS-5A | 1 | 9.721E-06 | 2.268E-08 | 2.632E-08 | 7.886E-08 | 1.879E+00 | 4.385E-03 | 5.086E-03 | 5.086E-03 |
| 2 | 2-AS-5A | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 2 | 2-AS-5A | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 2 | 2-AS-5A | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.721E-06 | 2.268E-08 | 2.632E-08 | 7.886E-08 | 1.879E+00 | 4.385E-03 | 5.086E-03 | 5.086E-03 |
| 3 | 3-AS-5B | 1 | 9.801E-06 | 2.287E-08 | 2.653E-08 | 7.951E-08 | 1.895E+00 | 4.421E-03 | 5.128E-03 | 5.128E-03 |
| 3 | 3-AS-5B | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 | 3-AS-5B | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 3 | 3-AS-5B | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.801E-06 | 2.287E-08 | 2.653E-08 | 7.951E-08 | 1.895E+00 | 4.421E-03 | 5.128E-03 | 5.128E-03 |
| 4 | 4-AS-6 | 1 | 4.299E-06 | 1.003E-08 | 1.164E-08 | 3.487E-08 | 8.310E-01 | 1.939E-03 | 2.249E-03 | 2.249E-03 |
| 4 | 4-AS-6 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 4 | 4-AS-6 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 4 | 4-AS-6 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 4.299E-06 | 1.003E-08 | 1.164E-08 | 3.487E-08 | 8.310E-01 | 1.939E-03 | 2.249E-03 | 2.249E-03 |
| 5 | 5-100M NORTH | 1 | 9.809E-06 | 2.289E-08 | 2.655E-08 | 7.958E-08 | 1.896E+00 | 4.425E-03 | 5.132E-03 | 5.132E-03 |
| 5 | 5-100M NORTH | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 5 | 5-100M NORTH | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 5 | 5-100M NORTH | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.809E-06 | 2.289E-08 | 2.655E-08 | 7.958E-08 | 1.896E+00 | 4.425E-03 | 5.132E-03 | 5.132E-03 |
| 6 | 6-100M EAST | 1 | 9.545E-06 | 2.227E-08 | 2.584E-08 | 7.743E-08 | 1.845E+00 | 4.305E-03 | 4.994E-03 | 4.994E-03 |
| 6 | 6-100M EAST | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 6 | 6-100M EAST | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 6 | 6-100M EAST | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.545E-06 | 2.227E-08 | 2.584E-08 | 7.743E-08 | 1.845E+00 | 4.305E-03 | 4.994E-03 | 4.994E-03 |
| 7 | 7-100M SOUTH | 1 | 9.720E-06 | 2.268E-08 | 2.631E-08 | 7.885E-08 | 1.879E+00 | 4.385E-03 | 5.086E-03 | 5.086E-03 |
| 7 | 7-100M SOUTH | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 7 | 7-100M SOUTH | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 7 | 7-100M SOUTH | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.720E-06 | 2.268E-08 | 2.631E-08 | 7.885E-08 | 1.879E+00 | 4.385E-03 | 5.086E-03 | 5.086E-03 |
| 8 | 8-100M WEST | 1 | 9.989E-06 | 2.331E-08 | 2.704E-08 | 8.104E-08 | 1.931E+00 | 4.506E-03 | 5.226E-03 | 5.226E-03 |
| 8 | 8-100M WEST | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 8 | 8-100M WEST | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 8 | 8-100M WEST | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.989E-06 | 2.331E-08 | 2.704E-08 | 8.104E-08 | 1.931E+00 | 4.506E-03 | 5.226E-03 | 5.226E-03 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 9-100M UPWIND | 1 | 9.582E-06 | 2.236E-08 | 2.594E-08 | 7.773E-08 | 1.852E+00 | 4.322E-03 | 5.013E-03 | 5.013E-03 |
| 9 | 9-100M UPWIND | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 9 | 9-100M UPWIND | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 9 | 9-100M UPWIND | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.582E-06 | 2.236E-08 | 2.594E-08 | 7.773E-08 | 1.852E+00 | 4.322E-03 | 5.013E-03 | 5.013E-03 |
| 10 | 10-100M DOWNWIND | 1 | 9.955E-06 | 2.323E-08 | 2.695E-08 | 8.076E-08 | 1.925E+00 | 4.491E-03 | 5.209E-03 | 5.209E-03 |
| 10 | 10-100M DOWNWIND | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 10 | 10-100M DOWNWIND | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 10 | 10-100M DOWNWIND | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.955E-06 | 2.323E-08 | 2.695E-08 | 8.076E-08 | 1.925E+00 | 4.491E-03 | 5.209E-03 | 5.209E-03 |
| 11 | 11-200M NORTH | 1 | 9.849E-06 | 2.298E-08 | 2.666E-08 | 7.990E-08 | 1.904E+00 | 4.443E-03 | 5.153E-03 | 5.153E-03 |
| 11 | 11-200M NORTH | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 11 | 11-200M NORTH | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 11 | 11-200M NORTH | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.849E-06 | 2.298E-08 | 2.666E-08 | 7.990E-08 | 1.904E+00 | 4.443E-03 | 5.153E-03 | 5.153E-03 |
| 12 | 12-200M EAST | 1 | 9.324E-06 | 2.176E-08 | 2.524E-08 | 7.564E-08 | 1.803E+00 | 4.206E-03 | 4.879E-03 | 4.879E-03 |
| 12 | 12-200M EAST | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 12 | 12-200M EAST | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 12 | 12-200M EAST | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.324E-06 | 2.176E-08 | 2.524E-08 | 7.564E-08 | 1.803E+00 | 4.206E-03 | 4.879E-03 | 4.879E-03 |
| 13 | 13-200M SOUTH | 1 | 9.672E-06 | 2.257E-08 | 2.618E-08 | 7.846E-08 | 1.870E+00 | 4.363E-03 | 5.060E-03 | 5.060E-03 |
| 13 | 13-200M SOUTH | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 13 | 13-200M SOUTH | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 13 | 13-200M SOUTH | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.672E-06 | 2.257E-08 | 2.618E-08 | 7.846E-08 | 1.870E+00 | 4.363E-03 | 5.060E-03 | 5.060E-03 |
| 14 | 14-200M WEST | 1 | 1.021E-05 | 2.383E-08 | 2.765E-08 | 8.286E-08 | 1.974E+00 | 4.607E-03 | 5.344E-03 | 5.344E-03 |
| 14 | 14-200M WEST | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 14 | 14-200M WEST | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 14 | 14-200M WEST | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.021E-05 | 2.383E-08 | 2.765E-08 | 8.286E-08 | 1.974E+00 | 4.607E-03 | 5.344E-03 | 5.344E-03 |
| 15 | 15-200M UPWIND | 1 | 9.400E-06 | 2.193E-08 | 2.544E-08 | 7.625E-08 | 1.817E+00 | 4.240E-03 | 4.918E-03 | 4.918E-03 |
| 15 | 15-200M UPWIND | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 15 | 15-200M UPWIND | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 15 | 15-200M UPWIND | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.400E-06 | 2.193E-08 | 2.544E-08 | 7.625E-08 | 1.817E+00 | 4.240E-03 | 4.918E-03 | 4.918E-03 |
| 16 | 16-200M DOWNWIND | 1 | 1.015E-05 | 2.369E-08 | 2.748E-08 | 8.236E-08 | 1.963E+00 | 4.579E-03 | 5.312E-03 | 5.312E-03 |
| 16 | 16-200M DOWNWIND | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 16 | 16-200M DOWNWIND | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 16 | 16-200M DOWNWIND | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.015E-05 | 2.369E-08 | 2.748E-08 | 8.236E-08 | 1.963E+00 | 4.579E-03 | 5.312E-03 | 5.312E-03 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 17 | 17-240 DEG @ 725M | 1 | 1.106E-05 | 2.582E-08 | 2.995E-08 | 8.976E-08 | 2.139E+00 | 4.991E-03 | 5.789E-03 | 5.789E-03 |
| 17 | 17-240 DEG @ 725M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 17 | 17-240 DEG @ 725M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 17 | 17-240 DEG @ 725M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.106E-05 | 2.582E-08 | 2.995E-08 | 8.976E-08 | 2.139E+00 | 4.991E-03 | 5.789E-03 | 5.789E-03 |
| 18 | 18-270 DEG @ 5500M | 1 | 1.732E-05 | 4.040E-08 | 4.687E-08 | 1.405E-07 | 3.348E+00 | 7.811E-03 | 9.060E-03 | 9.060E-03 |
| 18 | 18-270 DEG @ 5500M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 18 | 18-270 DEG @ 5500M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 18 | 18-270 DEG @ 5500M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.732E-05 | 4.040E-08 | 4.687E-08 | 1.405E-07 | 3.348E+00 | 7.811E-03 | 9.060E-03 | 9.060E-03 |
| 19 | 19-330 DEG @ 5100M | 1 | 3.236E-05 | 7.551E-08 | 8.760E-08 | 2.625E-07 | 6.256E+00 | 1.460E-02 | 1.693E-02 | 1.693E-02 |
| 19 | 19-330 DEG @ 5100M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 19 | 19-330 DEG @ 5100M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 19 | 19-330 DEG @ 5100M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 3.236E-05 | 7.551E-08 | 8.760E-08 | 2.625E-07 | 6.256E+00 | 1.460E-02 | 1.693E-02 | 1.693E-02 |
| 20 | 20-345 DEG @ 2050M | 1 | 1.289E-05 | 3.009E-08 | 3.490E-08 | 1.046E-07 | 2.493E+00 | 5.816E-03 | 6.746E-03 | 6.746E-03 |
| 20 | 20-345 DEG @ 2050M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 20 | 20-345 DEG @ 2050M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 20 | 20-345 DEG @ 2050M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.289E-05 | 3.009E-08 | 3.490E-08 | 1.046E-07 | 2.493E+00 | 5.816E-03 | 6.746E-03 | 6.746E-03 |
| 21 | 21- 45 DEG @ 3350M | 1 | 6.865E-06 | 1.602E-08 | 1.858E-08 | 5.569E-08 | 1.327E+00 | 3.097E-03 | 3.592E-03 | 3.592E-03 |
| 21 | 21- 45 DEG @ 3350M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 21 | 21- 45 DEG @ 3350M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 21 | 21- 45 DEG @ 3350M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 6.865E-06 | 1.602E-08 | 1.858E-08 | 5.569E-08 | 1.327E+00 | 3.097E-03 | 3.592E-03 | 3.592E-03 |
| 22 | 22- 80 DEG @ 4725M | 1 | 4.386E-06 | 1.023E-08 | 1.187E-08 | 3.558E-08 | 8.479E-01 | 1.978E-03 | 2.295E-03 | 2.295E-03 |
| 22 | 22- 80 DEG @ 4725M | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 22 | 22- 80 DEG @ 4725M | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 22 | 22- 80 DEG @ 4725M | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 4.386E-06 | 1.023E-08 | 1.187E-08 | 3.558E-08 | 8.479E-01 | 1.978E-03 | 2.295E-03 | 2.295E-03 |
| 23 | 23-IR-1 | 1 | 1.319E-04 | 3.077E-07 | 3.570E-07 | 1.070E-06 | 2.549E+01 | 5.949E-02 | 6.900E-02 | 6.900E-02 |
| 23 | 23-IR-1 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 23 | 23-IR-1 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 23 | 23-IR-1 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.319E-04 | 3.077E-07 | 3.570E-07 | 1.070E-06 | 2.549E+01 | 5.949E-02 | 6.900E-02 | 6.900E-02 |
| 24 | 24-IR-3 | 1 | 1.370E-06 | 3.196E-09 | 3.708E-09 | 1.111E-08 | 2.648E-01 | 6.179E-04 | 7.167E-04 | 7.167E-04 |
| 24 | 24-IR-3 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 24 | 24-IR-3 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 24 | 24-IR-3 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.370E-06 | 3.196E-09 | 3.708E-09 | 1.111E-08 | 2.648E-01 | 6.179E-04 | 7.167E-04 | 7.167E-04 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 25-IR-4 | 1 | 4.620E-04 | 1.078E-06 | 1.251E-06 | 3.748E-06 | 8.931E+01 | 2.084E-01 | 2.417E-01 | 2.417E-01 |
| 25 | 25-IR-4 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 25 | 25-IR-4 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 25 | 25-IR-4 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 4.620E-04 | 1.078E-06 | 1.251E-06 | 3.748E-06 | 8.931E+01 | 2.084E-01 | 2.417E-01 | 2.417E-01 |
| 26 | 26-IR-5 | 1 | 4.156E-05 | 9.697E-08 | 1.125E-07 | 3.372E-07 | 8.034E+00 | 1.875E-02 | 2.174E-02 | 2.174E-02 |
| 26 | 26-IR-5 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 26 | 26-IR-5 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 26 | 26-IR-5 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 4.156E-05 | 9.697E-08 | 1.125E-07 | 3.372E-07 | 8.034E+00 | 1.875E-02 | 2.174E-02 | 2.174E-02 |
| 27 | 27-IR-6 | 1 | 1.580E-04 | 3.687E-07 | 4.277E-07 | 1.282E-06 | 3.055E+01 | 7.128E-02 | 8.268E-02 | 8.268E-02 |
| 27 | 27-IR-6 | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 27 | 27-IR-6 | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 27 | 27-IR-6 | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.580E-04 | 3.687E-07 | 4.277E-07 | 1.282E-06 | 3.055E+01 | 7.128E-02 | 8.268E-02 | 8.268E-02 |
| 28 | 28-50M NORTH OF TD | 1 | 8.815E-06 | 2.057E-08 | 2.386E-08 | 7.151E-08 | 1.704E+00 | 3.976E-03 | 4.612E-03 | 4.612E-03 |
| 28 | 28-50M NORTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 28 | 28-50M NORTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 28 | 28-50M NORTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 8.815E-06 | 2.057E-08 | 2.386E-08 | 7.151E-08 | 1.704E+00 | 3.976E-03 | 4.612E-03 | 4.612E-03 |
| 29 | 29-50M EAST OF TD | 1 | 8.381E-06 | 1.956E-08 | 2.269E-08 | 6.799E-08 | 1.620E+00 | 3.780E-03 | 4.385E-03 | 4.385E-03 |
| 29 | 29-50M EAST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 29 | 29-50M EAST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 29 | 29-50M EAST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 8.381E-06 | 1.956E-08 | 2.269E-08 | 6.799E-08 | 1.620E+00 | 3.780E-03 | 4.385E-03 | 4.385E-03 |
| 30 | 30-50M SOUTH OF TD | 1 | 2.970E-05 | 6.930E-08 | 8.040E-08 | 2.409E-07 | 5.742E+00 | 1.340E-02 | 1.554E-02 | 1.554E-02 |
| 30 | 30-50M SOUTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 30 | 30-50M SOUTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 30 | 30-50M SOUTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 2.970E-05 | 6.930E-08 | 8.040E-08 | 2.409E-07 | 5.742E+00 | 1.340E-02 | 1.554E-02 | 1.554E-02 |
| 31 | 31-50M WEST OF TD | 1 | 1.654E-06 | 3.859E-09 | 4.477E-09 | 1.342E-08 | 3.197E-01 | 7.460E-04 | 8.653E-04 | 8.653E-04 |
| 31 | 31-50M WEST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 31 | 31-50M WEST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 31 | 31-50M WEST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.654E-06 | 3.859E-09 | 4.477E-09 | 1.342E-08 | 3.197E-01 | 7.460E-04 | 8.653E-04 | 8.653E-04 |
| 32 | 32-50M UPWIND OF TD | 1 | 7.308E-06 | 1.705E-08 | 1.978E-08 | 5.929E-08 | 1.413E+00 | 3.297E-03 | 3.824E-03 | 3.824E-03 |
| 32 | 32-50M UPWIND OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 32 | 32-50M UPWIND OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 32 | 32-50M UPWIND OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 7.308E-06 | 1.705E-08 | 1.978E-08 | 5.929E-08 | 1.413E+00 | 3.297E-03 | 3.824E-03 | 3.824E-03 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-210 |
|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 33-50M DOWNWIND OF T | 1 | 7.117E-06 | 1.661E-08 | 1.927E-08 | 5.774E-08 | 1.376E+00 | 3.210E-03 | 3.724E-03 | 3.724E-03 |
| 33 | 33-50M DOWNWIND OF T | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 33 | 33-50M DOWNWIND OF T | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 33 | 33-50M DOWNWIND OF T | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 7.117E-06 | 1.661E-08 | 1.927E-08 | 5.774E-08 | 1.376E+00 | 3.210E-03 | 3.724E-03 | 3.724E-03 |
| 34 | 34-100M NORTH OF TD | 1 | 3.081E-04 | 7.190E-07 | 8.341E-07 | 2.500E-06 | 5.957E+01 | 1.390E-01 | 1.612E-01 | 1.612E-01 |
| 34 | 34-100M NORTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 34 | 34-100M NORTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 34 | 34-100M NORTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 3.081E-04 | 7.190E-07 | 8.341E-07 | 2.500E-06 | 5.957E+01 | 1.390E-01 | 1.612E-01 | 1.612E-01 |
| 35 | 35-100M EAST OF TD | 1 | 2.181E-04 | 5.089E-07 | 5.903E-07 | 1.769E-06 | 4.216E+01 | 9.837E-02 | 1.141E-01 | 1.141E-01 |
| 35 | 35-100M EAST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 35 | 35-100M EAST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 35 | 35-100M EAST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 2.181E-04 | 5.089E-07 | 5.903E-07 | 1.769E-06 | 4.216E+01 | 9.837E-02 | 1.141E-01 | 1.141E-01 |
| 36 | 36-100M SOUTH OF TD | 1 | 6.361E-04 | 1.484E-06 | 1.722E-06 | 5.160E-06 | 1.230E+02 | 2.869E-01 | 3.328E-01 | 3.328E-01 |
| 36 | 36-100M SOUTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 36 | 36-100M SOUTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 36 | 36-100M SOUTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 6.361E-04 | 1.484E-06 | 1.722E-06 | 5.160E-06 | 1.230E+02 | 2.869E-01 | 3.328E-01 | 3.328E- |
| 37 | 37-100M WEST OF TD | 1 | 6.321E-05 | 1.475E-07 | 1.711E-07 | 5.128E-07 | 1.222E+01 | 2.851E-02 | 3.307E-02 | 3.307E-02 |
| 37 | 37-100M WEST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 37 | 37-100M WEST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 37 | 37-100M WEST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 6.321E-05 | 1.475E-07 | 1.711E-07 | 5.128E-07 | 1.222E+01 | 2.851E-02 | 3.307E-02 | 3.307E-02 |
| 38 | 38-100M UPWIND OF TD | 1 | 2.633E-04 | 6.144E-07 | 7.128E-07 | 2.136E-06 | 5.090E+01 | 1.188E-01 | 1.378E-01 | 1.378E-01 |
| 38 | 38-100M UPWIND OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 38 | 38-100M UPWIND OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 38 | 38-100M UPWIND OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 2.633E-04 | 6.144E-07 | 7.128E-07 | 2.136E-06 | 5.090E+01 | 1.188E-01 | 1.378E-01 | 1.378E-01 |
| 39 | 39-100M DOWNWIND OF | 1 | 1.861E-04 | 4.342E-07 | 5.038E-07 | 1.510E-06 | 3.598E+01 | 8.394E-02 | 9.737E-02 | 9.737E-02 |
| 39 | 39-100M DOWNWIND OF | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 39 | 39-100M DOWNWIND OF | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 39 | 39-100M DOWNWIND OF | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 1.861E-04 | 4.342E-07 | 5.038E-07 | 1.510E-06 | 3.598E+01 | 8.394E-02 | 9.737E-02 | 9.737E-02 |
| 40 | 40-200M NORTH OF TD | 1 | 9.918E-04 | 2.314E-06 | 2.685E-06 | 8.046E-06 | 1.917E+02 | 4.474E-01 | 5.189E-01 | 5.189E-01 |
| 40 | 40-200M NORTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 40 | 40-200M NORTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| 40 | 40-200M NORTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| | CONCENTRATION TOTALS | | 9.918E-04 | 2.314E-06 | 2.685E-06 | 8.046E-06 | 1.917E+02 | 4.474E-01 | 5.189E-01 | 5.189E-01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR PARTICULATE CONCENTRATIONS

| NO. | NAME | PTSZ | AIRBORNE CONCENTRATIONS, PCI/M3 U-238 | Th-230 | Ra-226 | Pb-210 | GROUND CONCENTRATIONS, PCI/M2 U-238 | Th-230 | Ra-226 | Pb-21( |
|---|---|---|---|---|---|---|---|---|---|---|
| 41 | 41-200M EAST OF TD | 1 | 6.556E-04 | 1.530E-06 | 1.775E-06 | 5.318E-06 | 1.267E+02 | 2.957E-01 | 3.430E-01 | 3.430E-0 |
| 41 | 41-200M EAST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 41 | 41-200M EAST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 41 | 41-200M EAST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 6.556E-04 | 1.530E-06 | 1.775E-06 | 5.318E-06 | 1.267E+02 | 2.957E-01 | 3.430E-01 | 3.430E-0 |
| 42 | 42-200M SOUTH OF TD | 1 | 1.258E-03 | 2.935E-06 | 3.405E-06 | 1.020E-05 | 2.431E+02 | 5.673E-01 | 6.581E-01 | 6.581E-0 |
| 42 | 42-200M SOUTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 42 | 42-200M SOUTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 42 | 42-200M SOUTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 1.258E-03 | 2.935E-06 | 3.405E-06 | 1.020E-05 | 2.431E+02 | 5.673E-01 | 6.581E-01 | 6.581E-0 |
| 43 | 43-200M WEST OF TD | 1 | 2.724E-04 | 6.356E-07 | 7.373E-07 | 2.210E-06 | 5.266E+01 | 1.229E-01 | 1.425E-01 | 1.425E-0 |
| 43 | 43-200M WEST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 43 | 43-200M WEST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 43 | 43-200M WEST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 2.724E-04 | 6.356E-07 | 7.373E-07 | 2.210E-06 | 5.266E+01 | 1.229E-01 | 1.425E-01 | 1.425E-0 |
| 44 | 44-200M UPWIND OF TD | 1 | 6.730E-04 | 1.570E-06 | 1.822E-06 | 5.460E-06 | 1.301E+02 | 3.036E-01 | 3.521E-01 | 3.521E-0 |
| 44 | 44-200M UPWIND OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 44 | 44-200M UPWIND OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 44 | 44-200M UPWIND OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 6.730E-04 | 1.570E-06 | 1.822E-06 | 5.460E-06 | 1.301E+02 | 3.036E-01 | 3.521E-01 | 3.521E-0 |
| 45 | 45-200M DOWNWIND OF | 1 | 6.157E-04 | 1.437E-06 | 1.667E-06 | 4.995E-06 | 1.190E+02 | 2.777E-01 | 3.222E-01 | 3.222E-0 |
| 45 | 45-200M DOWNWIND OF | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 45 | 45-200M DOWNWIND OF | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 45 | 45-200M DOWNWIND OF | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 6.157E-04 | 1.437E-06 | 1.667E-06 | 4.995E-06 | 1.190E+02 | 2.777E-01 | 3.222E-01 | 3.222E-0 |
| 46 | 46-500M NORTH OF TD | 1 | 7.993E-04 | 1.865E-06 | 2.164E-06 | 6.485E-06 | 1.545E+02 | 3.606E-01 | 4.182E-01 | 4.182E-0 |
| 46 | 46-500M NORTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 46 | 46-500M NORTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 46 | 46-500M NORTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 7.993E-04 | 1.865E-06 | 2.164E-06 | 6.485E-06 | 1.545E+02 | 3.606E-01 | 4.182E-01 | 4.182E-0 |
| 47 | 47-500M EAST OF TD | 1 | 3.858E-04 | 9.002E-07 | 1.044E-06 | 3.130E-06 | 7.458E+01 | 1.740E-01 | 2.019E-01 | 2.019E-0 |
| 47 | 47-500M EAST OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 47 | 47-500M EAST OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 47 | 47-500M EAST OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 3.858E-04 | 9.002E-07 | 1.044E-06 | 3.130E-06 | 7.458E+01 | 1.740E-01 | 2.019E-01 | 2.019E-0 |
| 48 | 48-500M SOUTH OF TD | 1 | 8.301E-04 | 1.937E-06 | 2.247E-06 | 6.734E-06 | 1.605E+02 | 3.744E-01 | 4.343E-01 | 4.343E-0 |
| 48 | 48-500M SOUTH OF TD | 2 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 48 | 48-500M SOUTH OF TD | 3 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| 48 | 48-500M SOUTH OF TD | 4 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+0 |
| | CONCENTRATION TOTALS | | 8.301E-04 | 1.937E-06 | 2.247E-06 | 6.734E-06 | 1.605E+02 | 3.744E-01 | 4.343E-01 | 4.343E-0 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

INDIVIDUAL RECEPTOR RADON AND RADON DAUGHTER CONCENTRATIONS

| AIRBORNE CONCENTRATIONS, PCI/M3 | | | | | | | | GROUND CONCENTRATIONS, PCI/M2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rn-222 | Po-218 | Pb-214 | Bi-214 | Pb-210 | Bi-210 | Po-210 | WL | Po-218 | Pb-214 | Bi-214 | Pb-210 |
| 7.937E+00 | 7.931E+00 | 6.761E+00 | 5.739E+00 | 2.659E-05 | 1.437E-07 | 2.362E-11 | 6.385E-05 | 6.281E+00 | 6.281E+00 | 6.281E+00 | 2.462E+00 |
| 9.814E+01 | 5.243E+01 | 1.069E+01 | 5.634E+00 | 1.583E-05 | 9.215E-08 | 2.072E-11 | 1.292E-04 | 4.153E+01 | 4.153E+01 | 4.153E+01 | 1.466E+00 |
| 7.841E+01 | 5.092E+01 | 1.109E+01 | 5.623E+00 | 1.592E-05 | 9.224E-08 | 2.051E-11 | 1.297E-04 | 4.033E+01 | 4.033E+01 | 4.033E+01 | 1.474E+00 |
| 7.298E+00 | 7.154E+00 | 4.553E+00 | 2.830E+00 | 1.096E-05 | 1.191E-07 | 4.491E-11 | 4.101E-05 | 5.666E+00 | 5.666E+00 | 5.666E+00 | 1.015E+00 |
| 6.471E+01 | 4.654E+01 | 1.079E+01 | 5.416E+00 | 1.574E-05 | 9.182E-08 | 2.030E-11 | 1.228E-04 | 3.686E+01 | 3.686E+01 | 3.686E+01 | 1.457E+00 |
| 1.157E+02 | 5.594E+01 | 9.628E+00 | 5.118E+00 | 1.513E-05 | 9.090E-08 | 2.068E-11 | 1.255E-04 | 4.431E+01 | 4.431E+01 | 4.431E+01 | 1.401E+00 |
| 8.999E+01 | 4.848E+01 | 1.066E+01 | 5.759E+00 | 1.594E-05 | 9.238E-08 | 2.084E-11 | 1.255E-04 | 3.840E+01 | 3.840E+01 | 3.840E+01 | 1.475E+00 |
| 5.742E+01 | 4.438E+01 | 1.178E+01 | 6.036E+00 | 1.657E-05 | 9.343E-08 | 2.046E-11 | 1.280E-04 | 3.515E+01 | 3.515E+01 | 3.515E+01 | 1.534E+00 |
| 1.152E+02 | 5.526E+01 | 9.958E+00 | 5.388E+00 | 1.541E-05 | 9.145E-08 | 2.084E-11 | 1.275E-04 | 4.377E+01 | 4.377E+01 | 4.377E+01 | 1.427E+00 |
| 6.293E+01 | 4.787E+01 | 1.177E+01 | 5.808E+00 | 1.628E-05 | 9.284E-08 | 2.030E-11 | 1.306E-04 | 3.792E+01 | 3.792E+01 | 3.792E+01 | 1.508E+00 |
| 5.685E+01 | 4.275E+01 | 1.065E+01 | 5.270E+00 | 1.563E-05 | 9.152E-08 | 2.004E-11 | 1.177E-04 | 3.386E+01 | 3.386E+01 | 3.386E+01 | 1.447E+00 |
| 1.070E+02 | 4.833E+01 | 8.591E+00 | 4.818E+00 | 1.458E-05 | 8.994E-08 | 2.082E-11 | 1.113E-04 | 3.828E+01 | 3.828E+01 | 3.828E+01 | 1.350E+00 |
| 3.541E+01 | 2.542E+01 | 9.964E+00 | 5.953E+00 | 1.602E-05 | 9.263E-08 | 2.111E-11 | 9.891E-05 | 2.013E+01 | 2.013E+01 | 2.013E+01 | 1.483E+00 |
| 5.307E+01 | 4.346E+01 | 1.286E+01 | 6.512E+00 | 1.733E-05 | 9.486E-08 | 2.037E-11 | 1.343E-04 | 3.442E+01 | 3.442E+01 | 3.442E+01 | 1.604E+00 |
| 1.144E+02 | 4.944E+01 | 9.275E+00 | 5.249E+00 | 1.499E-05 | 9.085E-08 | 2.113E-11 | 1.175E-04 | 3.916E+01 | 3.916E+01 | 3.916E+01 | 1.388E+00 |
| 5.787E+01 | 4.680E+01 | 1.269E+01 | 6.080E+00 | 1.675E-05 | 9.365E-08 | 2.005E-11 | 1.352E-04 | 3.706E+01 | 3.706E+01 | 3.706E+01 | 1.551E+00 |
| 2.168E+01 | 2.114E+01 | 1.321E+01 | 8.418E+00 | 2.108E-05 | 1.034E-07 | 2.104E-11 | 1.202E-04 | 1.674E+01 | 1.674E+01 | 1.674E+01 | 1.951E+00 |
| 5.216E+00 | 5.215E+00 | 4.611E+00 | 4.104E+00 | 2.594E-05 | 1.667E-07 | 2.871E-11 | 4.406E-05 | 4.130E+00 | 4.130E+00 | 4.130E+00 | 2.402E+00 |
| 7.918E+00 | 7.895E+00 | 6.585E+00 | 5.708E+00 | 3.331E-05 | 2.002E-07 | 3.228E-11 | 6.281E-05 | 6.253E+00 | 6.253E+00 | 6.253E+00 | 3.084E+00 |
| 9.619E+00 | 9.392E+00 | 6.684E+00 | 5.027E+00 | 1.952E-05 | 1.019E-07 | 1.677E-11 | 6.231E-05 | 7.439E+00 | 7.439E+00 | 7.439E+00 | 1.808E+00 |
| 4.163E+00 | 4.090E+00 | 2.921E+00 | 2.305E+00 | 1.225E-05 | 9.111E-08 | 2.113E-11 | 2.762E-05 | 3.239E+00 | 3.239E+00 | 3.239E+00 | 1.134E+00 |
| 2.921E+00 | 2.899E+00 | 2.311E+00 | 1.941E+00 | 1.207E-05 | 1.095E-07 | 3.181E-11 | 2.194E-05 | 2.296E+00 | 2.296E+00 | 2.296E+00 | 1.117E+00 |
| 1.139E+02 | 9.413E+01 | 1.996E+01 | 5.329E+00 | 2.359E-05 | 2.909E-07 | 9.788E-11 | 2.180E-04 | 7.456E+01 | 7.456E+01 | 7.456E+01 | 2.184E+00 |
| 1.394E+02 | 1.064E+02 | 1.834E+01 | 4.753E+00 | 2.312E-05 | 2.849E-07 | 9.491E-11 | 2.203E-04 | 8.425E+01 | 8.425E+01 | 8.425E+01 | 2.141E+00 |
| 1.473E+02 | 9.281E+01 | 1.638E+01 | 5.049E+00 | 2.248E-05 | 2.821E-07 | 9.868E-11 | 1.975E-04 | 7.351E+01 | 7.351E+01 | 7.351E+01 | 2.081E+00 |
| 4.013E+00 | 4.005E+00 | 3.365E+00 | 2.932E+00 | 2.742E-05 | 3.875E-07 | 1.740E-10 | 3.212E-05 | 3.172E+00 | 3.172E+00 | 3.172E+00 | 2.539E+00 |
| 2.936E+01 | 2.593E+01 | 9.922E+00 | 4.426E+00 | 2.235E-05 | 2.428E-07 | 7.280E-11 | 9.352E-05 | 2.054E+01 | 2.054E+01 | 2.054E+01 | 2.069E+00 |
| 1.395E+02 | 1.103E+02 | 2.011E+01 | 5.041E+00 | 2.322E-05 | 2.866E-07 | 9.595E-11 | 2.343E-04 | 8.732E+01 | 8.732E+01 | 8.732E+01 | 2.150E+00 |
| 1.427E+02 | 1.081E+02 | 1.836E+01 | 4.738E+00 | 2.310E-05 | 2.845E-07 | 9.474E-11 | 2.221E-04 | 8.564E+01 | 8.564E+01 | 8.564E+01 | 2.138E+00 |
| 1.012E+02 | 8.042E+01 | 1.611E+01 | 4.649E+00 | 2.333E-05 | 2.871E-07 | 9.559E-11 | 1.818E-04 | 6.369E+01 | 6.369E+01 | 6.369E+01 | 2.160E+00 |
| 1.089E+02 | 8.860E+01 | 1.819E+01 | 4.989E+00 | 2.347E-05 | 2.892E-07 | 9.680E-11 | 2.021E-04 | 7.018E+01 | 7.018E+01 | 7.018E+01 | 2.172E+00 |
| 1.200E+02 | 9.217E+01 | 1.677E+01 | 4.626E+00 | 2.319E-05 | 2.854E-07 | 9.493E-11 | 1.972E-04 | 7.300E+01 | 7.300E+01 | 7.300E+01 | 2.147E+00 |
| 1.240E+02 | 9.991E+01 | 1.949E+01 | 5.081E+00 | 2.337E-05 | 2.883E-07 | 9.662E-11 | 2.207E-04 | 7.913E+01 | 7.913E+01 | 7.913E+01 | 2.164E+00 |
| 1.553E+02 | 1.230E+02 | 2.214E+01 | 5.276E+00 | 2.318E-05 | 2.863E-07 | 9.613E-11 | 2.586E-04 | 9.743E+01 | 9.743E+01 | 9.743E+01 | 2.146E+00 |
| 1.651E+02 | 1.189E+02 | 1.827E+01 | 4.627E+00 | 2.293E-05 | 2.821E-07 | 9.372E-11 | 2.323E-04 | 9.415E+01 | 9.415E+01 | 9.415E+01 | 2.123E+00 |
| 8.250E+01 | 6.653E+01 | 1.454E+01 | 4.538E+00 | 2.341E-05 | 2.874E-07 | 9.541E-11 | 1.592E-04 | 5.269E+01 | 5.269E+01 | 5.269E+01 | 2.167E+00 |
| 9.680E+01 | 8.080E+01 | 1.816E+01 | 5.173E+00 | 2.369E-05 | 2.916E-07 | 9.784E-11 | 1.946E-04 | 6.399E+01 | 6.399E+01 | 6.399E+01 | 2.194E+00 |
| 1.173E+02 | 8.712E+01 | 1.550E+01 | 4.473E+00 | 2.313E-05 | 2.839E-07 | 9.406E-11 | 1.850E-04 | 6.901E+01 | 6.901E+01 | 6.901E+01 | 2.142E+00 |
| 1.237E+02 | 1.013E+02 | 2.065E+01 | 5.342E+00 | 2.349E-05 | 2.898E-07 | 9.750E-11 | 2.290E-04 | 8.026E+01 | 8.026E+01 | 8.026E+01 | 2.175E+00 |
| 1.745E+02 | 1.382E+02 | 2.507E+01 | 5.681E+00 | 2.312E-05 | 2.857E-07 | 9.649E-11 | 2.906E-04 | 1.095E+02 | 1.095E+02 | 1.095E+02 | 2.141E+00 |
| 2.119E+02 | 1.316E+02 | 1.623E+01 | 4.181E+00 | 2.254E-05 | 2.774E-07 | 9.170E-11 | 2.334E-04 | 1.043E+02 | 1.043E+02 | 1.043E+02 | 2.087E+00 |
| 6.142E+01 | 4.897E+01 | 1.267E+01 | 4.467E+00 | 2.362E-05 | 2.881E-07 | 9.505E-11 | 1.313E-04 | 3.878E+01 | 3.878E+01 | 3.878E+01 | 2.186E+00 |
| 7.775E+01 | 6.724E+01 | 1.768E+01 | 5.480E+00 | 2.418E-05 | 2.965E-07 | 9.994E-11 | 1.794E-04 | 5.326E+01 | 5.326E+01 | 5.326E+01 | 2.238E+00 |
| 1.043E+02 | 7.350E+01 | 1.348E+01 | 4.291E+00 | 2.305E-05 | 2.811E-07 | 9.239E-11 | 1.601E-04 | 5.821E+01 | 5.821E+01 | 5.821E+01 | 2.134E+00 |
| 1.259E+02 | 1.043E+02 | 2.290E+01 | 5.946E+00 | 2.380E-05 | 2.928E-07 | 9.922E-11 | 2.457E-04 | 8.260E+01 | 8.260E+01 | 8.260E+01 | 2.203E+00 |
| 1.967E+02 | 1.378E+02 | 2.381E+01 | 5.800E+00 | 2.287E-05 | 2.841E-07 | 9.756E-11 | 2.843E-04 | 1.092E+02 | 1.092E+02 | 1.092E+02 | 2.118E+00 |
| 2.686E+02 | 1.013E+02 | 1.142E+01 | 3.662E+00 | 2.166E-05 | 2.635E-07 | 8.577E-11 | 1.759E-04 | 8.027E+01 | 8.027E+01 | 8.027E+01 | 2.005E+00 |
| 4.814E+01 | 3.951E+01 | 1.268E+01 | 4.827E+00 | 2.429E-05 | 2.900E-07 | 9.395E-11 | 1.230E-04 | 3.129E+01 | 3.129E+01 | 3.129E+01 | 2.249E+00 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 1 NAME=1-AS-1 X= -3.7KM, Y= -0.5KM, Z= 0.0M, DIST= 3.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.26E-01 | 2.97E-02 | 9.25E-01 | 7.70E-04 | 3.10E-02 | 9.46E-06 |
| CHILD | TOTALS | 5.71E-02 | 7.93E-03 | 4.47E-01 | 5.06E-04 | 8.17E-03 | 9.46E-06 |
| TEENAGE | TOTALS | 3.06E-02 | 3.47E-02 | 2.34E-01 | 3.60E-04 | 7.20E-03 | 9.46E-06 |
| ADULT | TOTALS | 2.48E-02 | 8.85E-03 | 1.95E-01 | 2.37E-04 | 3.26E-03 | 9.46E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.94E-01 | 1.15E-01 | 1.00E+00 | 1.52E-01 | 1.35E-01 | 9.99E+00 |
| CHILD | TOTALS | 7.23E-01 | 9.90E-02 | 5.31E-01 | 1.16E-01 | 1.00E-01 | 9.99E+00 |
| TEENAGE | TOTALS | 6.98E-01 | 1.95E-01 | 3.14E-01 | 9.48E-02 | 9.17E-02 | 9.99E+00 |
| ADULT | TOTALS | 6.90E-01 | 1.21E-01 | 2.70E-01 | 8.68E-02 | 8.19E-02 | 9.99E+00 |

NUMBER 2 NAME=2-AS-5A X= 0.0KM, Y= -0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.67E-02 | 1.81E-02 | 5.62E-01 | 4.68E-04 | 1.88E-02 | 5.75E-06 |
| CHILD | TOTALS | 3.47E-02 | 4.82E-03 | 2.72E-01 | 3.08E-04 | 4.97E-03 | 5.75E-06 |
| TEENAGE | TOTALS | 1.86E-02 | 2.11E-02 | 1.42E-01 | 2.19E-04 | 4.38E-03 | 5.75E-06 |
| ADULT | TOTALS | 1.51E-02 | 5.38E-03 | 1.18E-01 | 1.44E-04 | 1.98E-03 | 5.75E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.52E+00 | 1.06E-01 | 6.46E-01 | 1.28E-01 | 1.18E-01 | 1.23E+02 |
| CHILD | TOTALS | 7.48E+00 | 9.64E-02 | 3.59E-01 | 1.07E-01 | 9.70E-02 | 1.23E+02 |
| TEENAGE | TOTALS | 7.46E+00 | 1.54E-01 | 2.27E-01 | 9.38E-02 | 9.21E-02 | 1.23E+02 |
| ADULT | TOTALS | 7.45E+00 | 1.10E-01 | 2.00E-01 | 8.91E-02 | 8.62E-02 | 1.23E+02 |

3 NAME=3-AS-5B X= 0.0KM, Y= 0.0KM, Z= 0.0M, DIST= 0.0KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.73E-02 | 1.82E-02 | 5.67E-01 | 4.72E-04 | 1.90E-02 | 5.80E-06 |
| CHILD | TOTALS | 3.50E-02 | 4.86E-03 | 2.74E-01 | 3.10E-04 | 5.01E-03 | 5.80E-06 |
| TEENAGE | TOTALS | 1.88E-02 | 2.13E-02 | 1.43E-01 | 2.21E-04 | 4.41E-03 | 5.80E-06 |
| ADULT | TOTALS | 1.52E-02 | 5.42E-03 | 1.19E-01 | 1.45E-04 | 2.00E-03 | 5.80E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 6.04E+00 | 1.07E-01 | 6.51E-01 | 1.28E-01 | 1.19E-01 | 9.81E+01 |
| CHILD | TOTALS | 6.00E+00 | 9.67E-02 | 3.62E-01 | 1.07E-01 | 9.73E-02 | 9.81E+01 |
| TEENAGE | TOTALS | 5.98E+00 | 1.55E-01 | 2.29E-01 | 9.41E-02 | 9.24E-02 | 9.81E+01 |
| ADULT | TOTALS | 5.98E+00 | 1.10E-01 | 2.01E-01 | 8.93E-02 | 8.65E-02 | 9.81E+01 |

4 NAME=4-AS-6 X= 3.5KM, Y= -3.7KM, Z= 0.0M, DIST= 5.1KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 3.39E-02 | 7.99E-03 | 2.49E-01 | 2.07E-04 | 8.33E-03 | 2.54E-06 |
| CHILD | TOTALS | 1.54E-02 | 2.13E-03 | 1.20E-01 | 1.36E-04 | 2.20E-03 | 2.54E-06 |
| TEENAGE | TOTALS | 8.23E-03 | 9.33E-03 | 6.28E-02 | 9.69E-05 | 1.94E-03 | 2.54E-06 |
| ADULT | TOTALS | 6.67E-03 | 2.38E-03 | 5.23E-02 | 6.37E-05 | 8.76E-04 | 2.54E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 6.19E-01 | 5.08E-02 | 2.88E-01 | 6.98E-02 | 5.87E-02 | 9.16E+00 |
| CHILD | TOTALS | 5.99E-01 | 4.71E-02 | 1.62E-01 | 5.53E-02 | 4.75E-02 | 9.16E+00 |
| TEENAGE | TOTALS | 5.93E-01 | 8.30E-02 | 1.03E-01 | 4.64E-02 | 4.42E-02 | 9.16E+00 |
| ADULT | TOTALS | 5.90E-01 | 5.62E-02 | 9.06E-02 | 4.32E-02 | 4.07E-02 | 9.16E+00 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 5 NAME=5-100M NORTH X= 0.0KM, Y= 0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.74E-02 | 1.82E-02 | 5.67E-01 | 4.72E-04 | 1.90E-02 | 5.81E-06 |
| CHILD | TOTALS | 3.50E-02 | 4.87E-03 | 2.75E-01 | 3.11E-04 | 5.01E-03 | 5.81E-06 |
| TEENAGE | TOTALS | 1.88E-02 | 2.13E-02 | 1.43E-01 | 2.21E-04 | 4.42E-03 | 5.81E-06 |
| ADULT | TOTALS | 1.52E-02 | 5.43E-03 | 1.19E-01 | 1.45E-04 | 2.00E-03 | 5.81E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 5.01E+00 | 1.04E-01 | 6.48E-01 | 1.25E-01 | 1.15E-01 | 8.10E+01 |
| CHILD | TOTALS | 4.97E+00 | 9.35E-02 | 3.59E-01 | 1.04E-01 | 9.41E-02 | 8.10E+01 |
| TEENAGE | TOTALS | 4.95E+00 | 1.51E-01 | 2.26E-01 | 9.08E-02 | 8.92E-02 | 8.10E+01 |
| ADULT | TOTALS | 4.94E+00 | 1.07E-01 | 1.98E-01 | 8.61E-02 | 8.33E-02 | 8.10E+01 |

NUMBER 6 NAME=6-100M EAST X= 0.1KM, Y= 0.0KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.53E-02 | 1.77E-02 | 5.52E-01 | 4.60E-04 | 1.85E-02 | 5.65E-06 |
| CHILD | TOTALS | 3.41E-02 | 4.74E-03 | 2.67E-01 | 3.02E-04 | 4.88E-03 | 5.65E-06 |
| TEENAGE | TOTALS | 1.83E-02 | 2.07E-02 | 1.39E-01 | 2.15E-04 | 4.30E-03 | 5.65E-06 |
| ADULT | TOTALS | 1.48E-02 | 5.28E-03 | 1.16E-01 | 1.41E-04 | 1.94E-03 | 5.65E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.82E+00 | 9.98E-02 | 6.29E-01 | 1.20E-01 | 1.11E-01 | 1.45E+02 |
| CHILD | TOTALS | 8.78E+00 | 8.98E-02 | 3.48E-01 | 9.95E-02 | 9.04E-02 | 1.45E+02 |
| TEENAGE | TOTALS | 8.77E+00 | 1.45E-01 | 2.18E-01 | 8.72E-02 | 8.56E-02 | 1.45E+02 |
| ADULT | TOTALS | 8.76E+00 | 1.03E-01 | 1.92E-01 | 8.26E-02 | 8.00E-02 | 1.45E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

7 NAME=7-100M SOUTH X= 0.0KM, Y= -0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.67E-02 | 1.81E-02 | 5.62E-01 | 4.68E-04 | 1.88E-02 | 5.75E-06 |
| CHILD | TOTALS | 3.47E-02 | 4.82E-03 | 2.72E-01 | 3.08E-04 | 4.97E-03 | 5.75E-06 |
| TEENAGE | TOTALS | 1.86E-02 | 2.11E-02 | 1.42E-01 | 2.19E-04 | 4.38E-03 | 5.75E-06 |
| ADULT | TOTALS | 1.51E-02 | 5.38E-03 | 1.18E-01 | 1.44E-04 | 1.98E-03 | 5.75E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 6.91E+00 | 1.07E-01 | 6.46E-01 | 1.29E-01 | 1.19E-01 | 1.13E+02 |
| CHILD | TOTALS | 6.86E+00 | 9.71E-02 | 3.60E-01 | 1.07E-01 | 9.77E-02 | 1.13E+02 |
| TEENAGE | TOTALS | 6.85E+00 | 1.55E-01 | 2.28E-01 | 9.45E-02 | 9.27E-02 | 1.13E+02 |
| ADULT | TOTALS | 6.84E+00 | 1.11E-01 | 2.01E-01 | 8.97E-02 | 8.68E-02 | 1.13E+02 |

3 NAME=8-100M WEST X= -0.1KM, Y= 0.0KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.88E-02 | 1.86E-02 | 5.78E-01 | 4.81E-04 | 1.94E-02 | 5.91E-06 |
| CHILD | TOTALS | 3.57E-02 | 4.96E-03 | 2.80E-01 | 3.16E-04 | 5.11E-03 | 5.91E-06 |
| TEENAGE | TOTALS | 1.91E-02 | 2.17E-02 | 1.46E-01 | 2.25E-04 | 4.50E-03 | 5.91E-06 |
| ADULT | TOTALS | 1.55E-02 | 5.53E-03 | 1.22E-01 | 1.48E-04 | 2.04E-03 | 5.91E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 4.47E+00 | 1.12E-01 | 6.66E-01 | 1.34E-01 | 1.24E-01 | 7.19E+01 |
| CHILD | TOTALS | 4.43E+00 | 1.01E-01 | 3.71E-01 | 1.12E-01 | 1.02E-01 | 7.19E+01 |
| TEENAGE | TOTALS | 4.41E+00 | 1.62E-01 | 2.36E-01 | 9.87E-02 | 9.68E-02 | 7.19E+01 |
| ADULT | TOTALS | 4.41E+00 | 1.15E-01 | 2.08E-01 | 9.38E-02 | 9.08E-02 | 7.19E+01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 9 NAME=9-100M UPWIND X= 0.1KM, Y= -0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.56E-02 | 1.78E-02 | 5.54E-01 | 4.61E-04 | 1.86E-02 | 5.67E-06 |
| CHILD | TOTALS | 3.42E-02 | 4.75E-03 | 2.68E-01 | 3.03E-04 | 4.90E-03 | 5.67E-06 |
| TEENAGE | TOTALS | 1.83E-02 | 2.08E-02 | 1.40E-01 | 2.16E-04 | 4.31E-03 | 5.67E-06 |
| ADULT | TOTALS | 1.49E-02 | 5.30E-03 | 1.17E-01 | 1.42E-04 | 1.95E-03 | 5.67E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.80E+00 | 1.03E-01 | 6.35E-01 | 1.23E-01 | 1.14E-01 | 1.44E+02 |
| CHILD | TOTALS | 8.75E+00 | 9.30E-02 | 3.52E-01 | 1.03E-01 | 9.36E-02 | 1.44E+02 |
| TEENAGE | TOTALS | 8.74E+00 | 1.49E-01 | 2.22E-01 | 9.04E-02 | 8.88E-02 | 1.44E+02 |
| ADULT | TOTALS | 8.73E+00 | 1.06E-01 | 1.96E-01 | 8.58E-02 | 8.31E-02 | 1.44E+02 |

NUMBER 10 NAME=10-100M DOWNWIND X= -0.1KM, Y= 0.1KM, Z= 0.0M, DIST= 0.1KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.85E-02 | 1.85E-02 | 5.76E-01 | 4.79E-04 | 1.93E-02 | 5.89E-06 |
| CHILD | TOTALS | 3.56E-02 | 4.94E-03 | 2.79E-01 | 3.15E-04 | 5.09E-03 | 5.89E-06 |
| TEENAGE | TOTALS | 1.91E-02 | 2.16E-02 | 1.45E-01 | 2.24E-04 | 4.48E-03 | 5.89E-06 |
| ADULT | TOTALS | 1.55E-02 | 5.51E-03 | 1.21E-01 | 1.48E-04 | 2.03E-03 | 5.89E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 4.88E+00 | 1.10E-01 | 6.62E-01 | 1.32E-01 | 1.22E-01 | 7.87E+01 |
| CHILD | TOTALS | 4.84E+00 | 9.94E-02 | 3.68E-01 | 1.10E-01 | 1.00E-01 | 7.87E+01 |
| TEENAGE | TOTALS | 4.82E+00 | 1.59E-01 | 2.33E-01 | 9.67E-02 | 9.49E-02 | 7.87E+01 |
| ADULT | TOTALS | 4.82E+00 | 1.13E-01 | 2.06E-01 | 9.18E-02 | 8.89E-02 | 7.87E+01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

11 NAME=11-200M NORTH X= 0.0KM, Y= 0.2KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.77E-02 | 1.83E-02 | 5.70E-01 | 4.74E-04 | 1.91E-02 | 5.83E-06 |
| CHILD | TOTALS | 3.52E-02 | 4.89E-03 | 2.76E-01 | 3.12E-04 | 5.03E-03 | 5.83E-06 |
| TEENAGE | TOTALS | 1.89E-02 | 2.14E-02 | 1.44E-01 | 2.22E-04 | 4.43E-03 | 5.83E-06 |
| ADULT | TOTALS | 1.53E-02 | 5.45E-03 | 1.20E-01 | 1.46E-04 | 2.01E-03 | 5.83E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 4.42E+00 | 1.02E-01 | 6.48E-01 | 1.22E-01 | 1.13E-01 | 7.11E+01 |
| CHILD | TOTALS | 4.37E+00 | 9.13E-02 | 3.58E-01 | 1.01E-01 | 9.19E-02 | 7.11E+01 |
| TEENAGE | TOTALS | 4.36E+00 | 1.49E-01 | 2.24E-01 | 8.86E-02 | 8.70E-02 | 7.11E+01 |
| ADULT | TOTALS | 4.35E+00 | 1.05E-01 | 1.97E-01 | 8.39E-02 | 8.11E-02 | 7.11E+01 |

12 NAME=12-200M EAST X= 0.2KM, Y= 0.0KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.35E-02 | 1.73E-02 | 5.39E-01 | 4.49E-04 | 1.81E-02 | 5.52E-06 |
| CHILD | TOTALS | 3.33E-02 | 4.63E-03 | 2.61E-01 | 2.95E-04 | 4.77E-03 | 5.52E-06 |
| TEENAGE | TOTALS | 1.79E-02 | 2.02E-02 | 1.36E-01 | 2.10E-04 | 4.20E-03 | 5.52E-06 |
| ADULT | TOTALS | 1.45E-02 | 5.16E-03 | 1.13E-01 | 1.38E-04 | 1.90E-03 | 5.52E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.17E+00 | 9.35E-02 | 6.11E-01 | 1.12E-01 | 1.04E-01 | 1.34E+02 |
| CHILD | TOTALS | 8.13E+00 | 8.38E-02 | 3.36E-01 | 9.31E-02 | 8.43E-02 | 1.34E+02 |
| TEENAGE | TOTALS | 8.11E+00 | 1.38E-01 | 2.10E-01 | 8.12E-02 | 7.97E-02 | 1.34E+02 |
| ADULT | TOTALS | 8.11E+00 | 9.61E-02 | 1.84E-01 | 7.68E-02 | 7.43E-02 | 1.34E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 13 NAME=13-200M SOUTH X= 0.0KM, Y= -0.2KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.63E-02 | 1.80E-02 | 5.59E-01 | 4.66E-04 | 1.87E-02 | 5.72E-06 |
| CHILD | TOTALS | 3.46E-02 | 4.80E-03 | 2.71E-01 | 3.06E-04 | 4.94E-03 | 5.72E-06 |
| TEENAGE | TOTALS | 1.85E-02 | 2.10E-02 | 1.41E-01 | 2.18E-04 | 4.35E-03 | 5.72E-06 |
| ADULT | TOTALS | 1.50E-02 | 5.35E-03 | 1.18E-01 | 1.43E-04 | 1.97E-03 | 5.72E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.81E+00 | 1.05E-01 | 6.41E-01 | 1.26E-01 | 1.16E-01 | 4.43E+01 |
| CHILD | TOTALS | 2.77E+00 | 9.47E-02 | 3.56E-01 | 1.05E-01 | 9.53E-02 | 4.43E+01 |
| TEENAGE | TOTALS | 2.75E+00 | 1.53E-01 | 2.25E-01 | 9.21E-02 | 9.02E-02 | 4.43E+01 |
| ADULT | TOTALS | 2.75E+00 | 1.08E-01 | 1.98E-01 | 8.73E-02 | 8.44E-02 | 4.43E+01 |

NUMBER 14 NAME=14-200M WEST X= -0.2KM, Y= 0.0KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.06E-02 | 1.90E-02 | 5.91E-01 | 4.92E-04 | 1.98E-02 | 6.04E-06 |
| CHILD | TOTALS | 3.65E-02 | 5.07E-03 | 2.86E-01 | 3.23E-04 | 5.22E-03 | 6.04E-06 |
| TEENAGE | TOTALS | 1.96E-02 | 2.22E-02 | 1.49E-01 | 2.30E-04 | 4.60E-03 | 6.04E-06 |
| ADULT | TOTALS | 1.59E-02 | 5.65E-03 | 1.24E-01 | 1.51E-04 | 2.08E-03 | 6.04E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 4.15E+00 | 1.19E-01 | 6.85E-01 | 1.43E-01 | 1.31E-01 | 6.64E+01 |
| CHILD | TOTALS | 4.11E+00 | 1.08E-01 | 3.84E-01 | 1.20E-01 | 1.09E-01 | 6.64E+01 |
| TEENAGE | TOTALS | 4.09E+00 | 1.71E-01 | 2.45E-01 | 1.05E-01 | 1.03E-01 | 6.64E+01 |
| ADULT | TOTALS | 4.09E+00 | 1.23E-01 | 2.17E-01 | 1.00E-01 | 9.71E-02 | 6.64E+01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

5 NAME=15-200M UPWIND X= 0.1KM, Y= -0.1KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.41E-02 | 1.75E-02 | 5.44E-01 | 4.53E-04 | 1.82E-02 | 5.56E-06 |
| CHILD | TOTALS | 3.36E-02 | 4.66E-03 | 2.63E-01 | 2.98E-04 | 4.80E-03 | 5.56E-06 |
| TEENAGE | TOTALS | 1.80E-02 | 2.04E-02 | 1.37E-01 | 2.12E-04 | 4.23E-03 | 5.56E-06 |
| ADULT | TOTALS | 1.46E-02 | 5.20E-03 | 1.14E-01 | 1.39E-04 | 1.92E-03 | 5.56E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.73E+00 | 9.92E-02 | 6.21E-01 | 1.19E-01 | 1.10E-01 | 1.43E+02 |
| CHILD | TOTALS | 8.69E+00 | 8.94E-02 | 3.44E-01 | 9.91E-02 | 9.00E-02 | 1.43E+02 |
| TEENAGE | TOTALS | 8.67E+00 | 1.44E-01 | 2.16E-01 | 8.69E-02 | 8.53E-02 | 1.43E+02 |
| ADULT | TOTALS | 8.67E+00 | 1.02E-01 | 1.90E-01 | 8.24E-02 | 7.97E-02 | 1.43E+02 |

16 NAME=16-200M DOWNWIND X= -0.1KM, Y= 0.1KM, Z= 0.0M, DIST= 0.2KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.01E-02 | 1.89E-02 | 5.87E-01 | 4.89E-04 | 1.97E-02 | 6.01E-06 |
| CHILD | TOTALS | 3.63E-02 | 5.04E-03 | 2.84E-01 | 3.21E-04 | 5.19E-03 | 6.01E-06 |
| TEENAGE | TOTALS | 1.94E-02 | 2.20E-02 | 1.48E-01 | 2.29E-04 | 4.57E-03 | 6.01E-06 |
| ADULT | TOTALS | 1.58E-02 | 5.62E-03 | 1.24E-01 | 1.50E-04 | 2.07E-03 | 6.01E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 4.51E+00 | 1.14E-01 | 6.77E-01 | 1.37E-01 | 1.27E-01 | 7.24E+01 |
| CHILD | TOTALS | 4.46E+00 | 1.04E-01 | 3.78E-01 | 1.15E-01 | 1.04E-01 | 7.24E+01 |
| TEENAGE | TOTALS | 4.45E+00 | 1.65E-01 | 2.40E-01 | 1.01E-01 | 9.91E-02 | 7.24E+01 |
| ADULT | TOTALS | 4.44E+00 | 1.18E-01 | 2.12E-01 | 9.59E-02 | 9.29E-02 | 7.24E+01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 17 NAME=17-240 DEG @ 725M X= -0.7KM, Y= -0.4KM, Z= 0.0M, DIST= 0.8KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.73E-02 | 2.06E-02 | 6.40E-01 | 5.33E-04 | 2.14E-02 | 6.55E-06 |
| CHILD | TOTALS | 3.95E-02 | 5.49E-03 | 3.10E-01 | 3.50E-04 | 5.66E-03 | 6.55E-06 |
| TEENAGE | TOTALS | 2.12E-02 | 2.40E-02 | 1.62E-01 | 2.49E-04 | 4.98E-03 | 6.55E-06 |
| ADULT | TOTALS | 1.72E-02 | 6.12E-03 | 1.35E-01 | 1.64E-04 | 2.25E-03 | 6.55E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.82E+00 | 1.38E-01 | 7.51E-01 | 1.70E-01 | 1.54E-01 | 2.72E+01 |
| CHILD | TOTALS | 1.77E+00 | 1.28E-01 | 4.26E-01 | 1.42E-01 | 1.28E-01 | 2.72E+01 |
| TEENAGE | TOTALS | 1.75E+00 | 2.01E-01 | 2.75E-01 | 1.25E-01 | 1.22E-01 | 2.72E+01 |
| ADULT | TOTALS | 1.75E+00 | 1.45E-01 | 2.44E-01 | 1.19E-01 | 1.15E-01 | 2.72E+01 |

NUMBER 18 NAME=18-270 DEG @ 5500M X= -5.5KM, Y= 0.0KM, Z= 0.0M, DIST= 5.5KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.37E-01 | 3.22E-02 | 1.00E+00 | 8.34E-04 | 3.36E-02 | 1.02E-05 |
| CHILD | TOTALS | 6.19E-02 | 8.59E-03 | 4.85E-01 | 5.48E-04 | 8.85E-03 | 1.02E-05 |
| TEENAGE | TOTALS | 3.32E-02 | 3.76E-02 | 2.53E-01 | 3.90E-04 | 7.79E-03 | 1.02E-05 |
| ADULT | TOTALS | 2.69E-02 | 9.58E-03 | 2.11E-01 | 2.57E-04 | 3.53E-03 | 1.02E-05 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 5.82E-01 | 9.84E-02 | 1.06E+00 | 1.31E-01 | 1.18E-01 | 6.57E+00 |
| CHILD | TOTALS | 5.05E-01 | 8.00E-02 | 5.49E-01 | 9.62E-02 | 8.10E-02 | 6.57E+00 |
| TEENAGE | TOTALS | 4.78E-01 | 1.77E-01 | 3.14E-01 | 7.51E-02 | 7.28E-02 | 6.57E+00 |
| ADULT | TOTALS | 4.69E-01 | 1.02E-01 | 2.66E-01 | 6.73E-02 | 6.29E-02 | 6.57E+00 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

19 NAME=19-330 DEG @ 5100M X= -4.0KM, Y= 3.0KM, Z= 0.0M, DIST= 5.0KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.55E-01 | 6.02E-02 | 1.87E+00 | 1.56E-03 | 6.27E-02 | 1.92E-05 |
| CHILD | TOTALS | 1.16E-01 | 1.61E-02 | 9.06E-01 | 1.02E-03 | 1.65E-02 | 1.92E-05 |
| TEENAGE | TOTALS | 6.20E-02 | 7.02E-02 | 4.73E-01 | 7.29E-04 | 1.46E-02 | 1.92E-05 |
| ADULT | TOTALS | 5.02E-02 | 1.79E-02 | 3.94E-01 | 4.80E-04 | 6.59E-03 | 1.92E-05 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 9.24E-01 | 1.50E-01 | 1.95E+00 | 1.73E-01 | 1.76E-01 | 9.96E+00 |
| CHILD | TOTALS | 7.81E-01 | 1.13E-01 | 9.93E-01 | 1.29E-01 | 1.14E-01 | 9.96E+00 |
| TEENAGE | TOTALS | 7.29E-01 | 2.55E-01 | 5.56E-01 | 1.02E-01 | 1.03E-01 | 9.96E+00 |
| ADULT | TOTALS | 7.15E-01 | 1.42E-01 | 4.71E-01 | 9.18E-02 | 8.81E-02 | 9.96E+00 |

20 NAME=20-345 DEG @ 2050M X= -0.8KM, Y= 1.8KM, Z= 0.0M, DIST= 2.0KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.02E-01 | 2.40E-02 | 7.46E-01 | 6.21E-04 | 2.50E-02 | 7.63E-06 |
| CHILD | TOTALS | 4.61E-02 | 6.40E-03 | 3.61E-01 | 4.08E-04 | 6.59E-03 | 7.63E-06 |
| TEENAGE | TOTALS | 2.47E-02 | 2.80E-02 | 1.88E-01 | 2.91E-04 | 5.80E-03 | 7.63E-06 |
| ADULT | TOTALS | 2.00E-02 | 7.13E-03 | 1.57E-01 | 1.91E-04 | 2.63E-03 | 7.63E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.87E-01 | 9.76E-02 | 8.13E-01 | 1.22E-01 | 1.12E-01 | 1.21E+01 |
| CHILD | TOTALS | 8.30E-01 | 8.39E-02 | 4.33E-01 | 9.62E-02 | 8.47E-02 | 1.21E+01 |
| TEENAGE | TOTALS | 8.10E-01 | 1.57E-01 | 2.58E-01 | 8.03E-02 | 7.85E-02 | 1.21E+01 |
| ADULT | TOTALS | 8.04E-01 | 1.00E-01 | 2.23E-01 | 7.44E-02 | 7.11E-02 | 1.21E+01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 21 NAME=21- 45 DEG @ 3350M X= 2.4KM, Y= 2.3KM, Z= 0.0M, DIST= 3.3KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 5.41E-02 | 1.28E-02 | 3.97E-01 | 3.31E-04 | 1.33E-02 | 4.06E-06 |
| CHILD | TOTALS | 2.45E-02 | 3.41E-03 | 1.92E-01 | 2.17E-04 | 3.51E-03 | 4.06E-06 |
| TEENAGE | TOTALS | 1.31E-02 | 1.49E-02 | 1.00E-01 | 1.55E-04 | 3.09E-03 | 4.06E-06 |
| ADULT | TOTALS | 1.07E-02 | 3.80E-03 | 8.35E-02 | 1.02E-04 | 1.40E-03 | 4.06E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 3.97E-01 | 4.88E-02 | 4.29E-01 | 6.64E-02 | 5.78E-02 | 5.23E+00 |
| CHILD | TOTALS | 3.66E-01 | 4.19E-02 | 2.27E-01 | 5.02E-02 | 4.24E-02 | 5.23E+00 |
| TEENAGE | TOTALS | 3.55E-01 | 8.55E-02 | 1.34E-01 | 4.02E-02 | 3.86E-02 | 5.23E+00 |
| ADULT | TOTALS | 3.52E-01 | 5.22E-02 | 1.15E-01 | 3.65E-02 | 3.42E-02 | 5.23E+00 |

NUMBER 22 NAME=22- 80 DEG @ 4725M X= 4.6KM, Y= 1.2KM, Z= 0.0M, DIST= 4.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 3.46E-02 | 8.16E-03 | 2.54E-01 | 2.11E-04 | 8.50E-03 | 2.60E-06 |
| CHILD | TOTALS | 1.57E-02 | 2.18E-03 | 1.23E-01 | 1.39E-04 | 2.24E-03 | 2.60E-06 |
| TEENAGE | TOTALS | 8.40E-03 | 9.52E-03 | 6.41E-02 | 9.88E-05 | 1.97E-03 | 2.60E-06 |
| ADULT | TOTALS | 6.81E-03 | 2.43E-03 | 5.34E-02 | 6.50E-05 | 8.94E-04 | 2.60E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.79E-01 | 3.95E-02 | 2.81E-01 | 6.12E-02 | 4.82E-02 | 3.67E+00 |
| CHILD | TOTALS | 2.59E-01 | 3.60E-02 | 1.53E-01 | 4.52E-02 | 3.64E-02 | 3.67E+00 |
| TEENAGE | TOTALS | 2.53E-01 | 7.50E-02 | 9.31E-02 | 3.54E-02 | 3.28E-02 | 3.67E+00 |
| ADULT | TOTALS | 2.50E-01 | 4.60E-02 | 7.99E-02 | 3.18E-02 | 2.91E-02 | 3.67E+00 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 23 NAME=23-IR-1 X= -7.2KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.04E+00 | 2.45E-01 | 7.63E+00 | 6.35E-03 | 2.56E-01 | 7.80E-05 |
| CHILD | TOTALS | 4.71E-01 | 6.54E-02 | 3.69E+00 | 4.18E-03 | 6.74E-02 | 7.80E-05 |
| TEENAGE | TOTALS | 2.53E-01 | 2.86E-01 | 1.93E+00 | 2.97E-03 | 5.94E-02 | 7.80E-05 |
| ADULT | TOTALS | 2.05E-01 | 7.30E-02 | 1.60E+00 | 1.95E-03 | 2.69E-02 | 7.80E-05 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 9.69E+00 | 3.55E-01 | 7.73E+00 | 1.74E-01 | 3.82E-01 | 1.43E+02 |
| CHILD | TOTALS | 9.11E+00 | 1.80E-01 | 3.80E+00 | 1.41E-01 | 1.83E-01 | 1.43E+02 |
| TEENAGE | TOTALS | 8.90E+00 | 4.63E-01 | 2.03E+00 | 1.21E-01 | 1.68E-01 | 1.43E+02 |
| ADULT | TOTALS | 8.85E+00 | 2.07E-01 | 1.71E+00 | 1.13E-01 | 1.31E-01 | 1.43E+02 |

NUMBER 24 NAME=24-IR-3 X= -7.0KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.08E-02 | 2.55E-03 | 7.92E-02 | 6.60E-05 | 2.66E-03 | 8.11E-07 |
| CHILD | TOTALS | 4.89E-03 | 6.80E-04 | 3.83E-02 | 4.34E-05 | 7.00E-04 | 8.11E-07 |
| TEENAGE | TOTALS | 2.62E-03 | 2.97E-03 | 2.00E-02 | 3.09E-05 | 6.17E-04 | 8.11E-07 |
| ADULT | TOTALS | 2.13E-03 | 7.58E-04 | 1.67E-02 | 2.03E-05 | 2.79E-04 | 8.11E-07 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.06E+01 | 1.06E-01 | 1.76E-01 | 1.61E-01 | 1.23E-01 | 1.74E+02 |
| CHILD | TOTALS | 1.06E+01 | 1.09E-01 | 1.40E-01 | 1.30E-01 | 1.10E-01 | 1.74E+02 |
| TEENAGE | TOTALS | 1.05E+01 | 1.72E-01 | 1.19E-01 | 1.11E-01 | 1.03E-01 | 1.74E+02 |
| ADULT | TOTALS | 1.05E+01 | 1.28E-01 | 1.11E-01 | 1.05E-01 | 9.80E-02 | 1.74E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 25 NAME=25-IR-4 X= -7.1KM, Y= 10.1KM, Z= 0.0M, DIST= 12.3KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 3.64E+00 | 8.59E-01 | 2.67E+01 | 2.22E-02 | 8.95E-01 | 2.73E-04 |
| CHILD | TOTALS | 1.65E+00 | 2.29E-01 | 1.29E+01 | 1.46E-02 | 2.36E-01 | 2.73E-04 |
| TEENAGE | TOTALS | 8.85E-01 | 1.00E+00 | 6.75E+00 | 1.04E-02 | 2.08E-01 | 2.73E-04 |
| ADULT | TOTALS | 7.17E-01 | 2.56E-01 | 5.62E+00 | 6.85E-03 | 9.41E-02 | 2.73E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.48E+01 | 9.61E-01 | 2.68E+01 | 1.79E-01 | 1.01E+00 | 1.84E+02 |
| CHILD | TOTALS | 1.28E+01 | 3.35E-01 | 1.30E+01 | 1.42E-01 | 3.43E-01 | 1.84E+02 |
| TEENAGE | TOTALS | 1.20E+01 | 1.17E+00 | 6.85E+00 | 1.19E-01 | 3.09E-01 | 1.84E+02 |
| ADULT | TOTALS | 1.19E+01 | 3.80E-01 | 5.71E+00 | 1.09E-01 | 1.90E-01 | 1.84E+02 |

NUMBER 26 NAME=26-IR-5 X= -9.2KM, Y= 15.1KM, Z= 0.0M, DIST= 17.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 3.28E-01 | 7.73E-02 | 2.40E+00 | 2.00E-03 | 8.06E-02 | 2.46E-05 |
| CHILD | TOTALS | 1.48E-01 | 2.06E-02 | 1.16E+00 | 1.32E-03 | 2.12E-02 | 2.46E-05 |
| TEENAGE | TOTALS | 7.96E-02 | 9.02E-02 | 6.07E-01 | 9.36E-04 | 1.87E-02 | 2.46E-05 |
| ADULT | TOTALS | 6.45E-02 | 2.30E-02 | 5.06E-01 | 6.16E-04 | 8.47E-03 | 2.46E-05 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 6.70E-01 | 1.31E-01 | 2.45E+00 | 1.23E-01 | 1.54E-01 | 5.05E+00 |
| CHILD | TOTALS | 4.88E-01 | 8.04E-02 | 1.22E+00 | 8.67E-02 | 8.18E-02 | 5.05E+00 |
| TEENAGE | TOTALS | 4.21E-01 | 2.22E-01 | 6.56E-01 | 6.41E-02 | 7.17E-02 | 5.05E+00 |
| ADULT | TOTALS | 4.04E-01 | 1.05E-01 | 5.49E-01 | 5.57E-02 | 5.54E-02 | 5.05E+00 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 27 NAME=27-IR-6 X= -6.0KM, Y= 8.5KM, Z= 0.0M, DIST= 10.4KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.25E+00 | 2.94E-01 | 9.14E+00 | 7.61E-03 | 3.06E-01 | 9.35E-05 |
| CHILD | TOTALS | 5.65E-01 | 7.84E-02 | 4.42E+00 | 5.00E-03 | 8.08E-02 | 9.35E-05 |
| TEENAGE | TOTALS | 3.03E-01 | 3.43E-01 | 2.31E+00 | 3.56E-03 | 7.11E-02 | 9.35E-05 |
| ADULT | TOTALS | 2.45E-01 | 8.74E-02 | 1.92E+00 | 2.34E-03 | 3.22E-02 | 9.35E-05 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 3.51E+00 | 3.71E-01 | 9.21E+00 | 1.39E-01 | 3.99E-01 | 3.68E+01 |
| CHILD | TOTALS | 2.83E+00 | 1.60E-01 | 4.50E+00 | 1.07E-01 | 1.63E-01 | 3.68E+01 |
| TEENAGE | TOTALS | 2.57E+00 | 4.83E-01 | 2.38E+00 | 8.77E-02 | 1.47E-01 | 3.68E+01 |
| ADULT | TOTALS | 2.51E+00 | 1.87E-01 | 1.99E+00 | 7.99E-02 | 1.03E-01 | 3.68E+01 |

NUMBER 28 NAME=28-50M NORTH OF TD X= -7.1KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 6.95E-02 | 1.64E-02 | 5.10E-01 | 4.25E-04 | 1.71E-02 | 5.22E-06 |
| CHILD | TOTALS | 3.15E-02 | 4.37E-03 | 2.47E-01 | 2.79E-04 | 4.51E-03 | 5.22E-06 |
| TEENAGE | TOTALS | 1.69E-02 | 1.91E-02 | 1.29E-01 | 1.99E-04 | 3.97E-03 | 5.22E-06 |
| ADULT | TOTALS | 1.37E-02 | 4.88E-03 | 1.07E-01 | 1.31E-04 | 1.80E-03 | 5.22E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.06E+01 | 1.26E-01 | 6.13E-01 | 1.67E-01 | 1.43E-01 | 1.74E+02 |
| CHILD | TOTALS | 1.06E+01 | 1.19E-01 | 3.54E-01 | 1.36E-01 | 1.20E-01 | 1.74E+02 |
| TEENAGE | TOTALS | 1.06E+01 | 1.94E-01 | 2.34E-01 | 1.17E-01 | 1.13E-01 | 1.74E+02 |
| ADULT | TOTALS | 1.06E+01 | 1.38E-01 | 2.08E-01 | 1.11E-01 | 1.05E-01 | 1.74E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 29 NAME=29-50M EAST OF TD X= -7.0KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 6.61E-02 | 1.56E-02 | 4.85E-01 | 4.04E-04 | 1.62E-02 | 4.96E-06 |
| CHILD | TOTALS | 2.99E-02 | 4.16E-03 | 2.35E-01 | 2.65E-04 | 4.28E-03 | 4.96E-06 |
| TEENAGE | TOTALS | 1.60E-02 | 1.82E-02 | 1.22E-01 | 1.89E-04 | 3.77E-03 | 4.96E-06 |
| ADULT | TOTALS | 1.30E-02 | 4.64E-03 | 1.02E-01 | 1.24E-04 | 1.71E-03 | 4.96E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.09E+01 | 1.20E-01 | 5.82E-01 | 1.61E-01 | 1.36E-01 | 1.78E+02 |
| CHILD | TOTALS | 1.08E+01 | 1.13E-01 | 3.37E-01 | 1.30E-01 | 1.14E-01 | 1.78E+02 |
| TEENAGE | TOTALS | 1.08E+01 | 1.87E-01 | 2.22E-01 | 1.12E-01 | 1.07E-01 | 1.78E+02 |
| ADULT | TOTALS | 1.08E+01 | 1.32E-01 | 1.97E-01 | 1.05E-01 | 9.96E-02 | 1.78E+02 |

NUMBER 30 NAME=30-50M SOUTH OF TD X= -7.1KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.34E-01 | 5.52E-02 | 1.72E+00 | 1.43E-03 | 5.76E-02 | 1.76E-05 |
| CHILD | TOTALS | 1.06E-01 | 1.47E-02 | 8.31E-01 | 9.40E-04 | 1.52E-02 | 1.76E-05 |
| TEENAGE | TOTALS | 5.69E-02 | 6.44E-02 | 4.34E-01 | 6.69E-04 | 1.34E-02 | 1.76E-05 |
| ADULT | TOTALS | 4.61E-02 | 1.64E-02 | 3.61E-01 | 4.40E-04 | 6.05E-03 | 1.76E-05 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.91E+00 | 1.51E-01 | 1.81E+00 | 1.55E-01 | 1.70E-01 | 1.27E+02 |
| CHILD | TOTALS | 7.78E+00 | 1.16E-01 | 9.25E-01 | 1.24E-01 | 1.17E-01 | 1.27E+02 |
| TEENAGE | TOTALS | 7.73E+00 | 2.26E-01 | 5.25E-01 | 1.04E-01 | 1.08E-01 | 1.27E+02 |
| ADULT | TOTALS | 7.72E+00 | 1.36E-01 | 4.48E-01 | 9.73E-02 | 9.61E-02 | 1.27E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 31 NAME=31-50M WEST OF TD X= -7.1KM, Y= 9.2KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.30E-02 | 3.08E-03 | 9.56E-02 | 7.97E-05 | 3.21E-03 | 9.79E-07 |
| CHILD | TOTALS | 5.91E-03 | 8.21E-04 | 4.63E-02 | 5.24E-05 | 8.45E-04 | 9.79E-07 |
| TEENAGE | TOTALS | 3.17E-03 | 3.59E-03 | 2.42E-02 | 3.73E-05 | 7.44E-04 | 9.79E-07 |
| ADULT | TOTALS | 2.57E-03 | 9.15E-04 | 2.01E-02 | 2.45E-05 | 3.37E-04 | 9.79E-07 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.27E+00 | 1.07E-01 | 1.92E-01 | 1.61E-01 | 1.23E-01 | 1.36E+02 |
| CHILD | TOTALS | 8.26E+00 | 1.09E-01 | 1.48E-01 | 1.30E-01 | 1.10E-01 | 1.36E+02 |
| TEENAGE | TOTALS | 8.26E+00 | 1.73E-01 | 1.23E-01 | 1.11E-01 | 1.03E-01 | 1.36E+02 |
| ADULT | TOTALS | 8.26E+00 | 1.28E-01 | 1.14E-01 | 1.04E-01 | 9.77E-02 | 1.36E+02 |

NUMBER 32 NAME=32-50M UPWIND OF TD X= -7.1KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 5.76E-02 | 1.36E-02 | 4.23E-01 | 3.52E-04 | 1.42E-02 | 4.33E-06 |
| CHILD | TOTALS | 2.61E-02 | 3.63E-03 | 2.05E-01 | 2.31E-04 | 3.74E-03 | 4.33E-06 |
| TEENAGE | TOTALS | 1.40E-02 | 1.59E-02 | 1.07E-01 | 1.65E-04 | 3.29E-03 | 4.33E-06 |
| ADULT | TOTALS | 1.13E-02 | 4.04E-03 | 8.89E-02 | 1.08E-04 | 1.49E-03 | 4.33E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 9.14E+00 | 1.12E-01 | 5.14E-01 | 1.56E-01 | 1.29E-01 | 1.50E+02 |
| CHILD | TOTALS | 9.11E+00 | 1.07E-01 | 3.01E-01 | 1.25E-01 | 1.08E-01 | 1.50E+02 |
| TEENAGE | TOTALS | 9.10E+00 | 1.80E-01 | 2.01E-01 | 1.06E-01 | 1.01E-01 | 1.50E+02 |
| ADULT | TOTALS | 9.09E+00 | 1.26E-01 | 1.78E-01 | 9.93E-02 | 9.38E-02 | 1.50E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 33 NAME=33-50M DOWNWIND OF T X= -7.1KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 5.61E-02 | 1.32E-02 | 4.12E-01 | 3.43E-04 | 1.38E-02 | 4.21E-06 |
| CHILD | TOTALS | 2.54E-02 | 3.53E-03 | 1.99E-01 | 2.25E-04 | 3.64E-03 | 4.21E-06 |
| TEENAGE | TOTALS | 1.36E-02 | 1.54E-02 | 1.04E-01 | 1.60E-04 | 3.20E-03 | 4.21E-06 |
| ADULT | TOTALS | 1.10E-02 | 3.94E-03 | 8.66E-02 | 1.05E-04 | 1.45E-03 | 4.21E-06 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 9.45E+00 | 1.21E-01 | 5.12E-01 | 1.65E-01 | 1.38E-01 | 1.55E+02 |
| CHILD | TOTALS | 9.42E+00 | 1.16E-01 | 3.05E-01 | 1.35E-01 | 1.17E-01 | 1.55E+02 |
| TEENAGE | TOTALS | 9.41E+00 | 1.89E-01 | 2.07E-01 | 1.16E-01 | 1.10E-01 | 1.55E+02 |
| ADULT | TOTALS | 9.41E+00 | 1.35E-01 | 1.85E-01 | 1.09E-01 | 1.03E-01 | 1.55E+02 |

NUMBER 34 NAME=34-100M NORTH OF TD X= -7.1KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.43E+00 | 5.73E-01 | 1.78E+01 | 1.48E-02 | 5.97E-01 | 1.82E-04 |
| CHILD | TOTALS | 1.10E+00 | 1.53E-01 | 8.62E+00 | 9.76E-03 | 1.58E-01 | 1.82E-04 |
| TEENAGE | TOTALS | 5.90E-01 | 6.69E-01 | 4.50E+00 | 6.94E-03 | 1.39E-01 | 1.82E-04 |
| ADULT | TOTALS | 4.78E-01 | 1.70E-01 | 3.75E+00 | 4.57E-03 | 6.28E-02 | 1.82E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.42E+01 | 6.90E-01 | 1.79E+01 | 1.88E-01 | 7.30E-01 | 1.94E+02 |
| CHILD | TOTALS | 1.29E+01 | 2.74E-01 | 8.74E+00 | 1.53E-01 | 2.79E-01 | 1.94E+02 |
| TEENAGE | TOTALS | 1.23E+01 | 8.51E-01 | 4.61E+00 | 1.31E-01 | 2.54E-01 | 1.94E+02 |
| ADULT | TOTALS | 1.22E+01 | 3.10E-01 | 3.86E+00 | 1.22E-01 | 1.73E-01 | 1.94E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

35 NAME=35-100M EAST OF TD X= -7.0KM, Y= 9.2KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.72E+00 | 4.06E-01 | 1.26E+01 | 1.05E-02 | 4.23E-01 | 1.29E-04 |
| CHILD | TOTALS | 7.79E-01 | 1.08E-01 | 6.10E+00 | 6.91E-03 | 1.11E-01 | 1.29E-04 |
| TEENAGE | TOTALS | 4.18E-01 | 4.73E-01 | 3.19E+00 | 4.91E-03 | 9.82E-02 | 1.29E-04 |
| ADULT | TOTALS | 3.38E-01 | 1.21E-01 | 2.65E+00 | 3.23E-03 | 4.44E-02 | 1.29E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.42E+01 | 5.10E-01 | 1.27E+01 | 1.71E-01 | 5.43E-01 | 2.06E+02 |
| CHILD | TOTALS | 1.33E+01 | 2.17E-01 | 6.21E+00 | 1.37E-01 | 2.21E-01 | 2.06E+02 |
| TEENAGE | TOTALS | 1.29E+01 | 6.42E-01 | 3.29E+00 | 1.17E-01 | 2.01E-01 | 2.06E+02 |
| ADULT | TOTALS | 1.28E+01 | 2.48E-01 | 2.75E+00 | 1.08E-01 | 1.43E-01 | 2.06E+02 |

36 NAME=36-100M SOUTH OF TD X= -7.1KM, Y= 9.1KM, Z= 0.0M, DIST= 11.6KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 5.02E+00 | 1.18E+00 | 3.68E+01 | 3.06E-02 | 1.23E+00 | 3.76E-04 |
| CHILD | TOTALS | 2.27E+00 | 3.16E-01 | 1.78E+01 | 2.01E-02 | 3.25E-01 | 3.76E-04 |
| TEENAGE | TOTALS | 1.22E+00 | 1.38E+00 | 9.29E+00 | 1.43E-02 | 2.86E-01 | 3.76E-04 |
| ADULT | TOTALS | 9.87E-01 | 3.52E-01 | 7.74E+00 | 9.42E-03 | 1.30E-01 | 3.76E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.13E+01 | 1.27E+00 | 3.69E+01 | 1.79E-01 | 1.34E+00 | 1.03E+02 |
| CHILD | TOTALS | 8.54E+00 | 4.11E-01 | 1.79E+01 | 1.38E-01 | 4.22E-01 | 1.03E+02 |
| TEENAGE | TOTALS | 7.49E+00 | 1.54E+00 | 9.38E+00 | 1.13E-01 | 3.76E-01 | 1.03E+02 |
| ADULT | TOTALS | 7.25E+00 | 4.67E-01 | 7.82E+00 | 1.01E-01 | 2.14E-01 | 1.03E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 37 NAME=37-100M WEST OF TD X= -7.2KM, Y= 9.2KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 4.99E-01 | 1.18E-01 | 3.66E+00 | 3.04E-03 | 1.23E-01 | 3.74E-05 |
| CHILD | TOTALS | 2.26E-01 | 3.14E-02 | 1.77E+00 | 2.00E-03 | 3.23E-02 | 3.74E-05 |
| TEENAGE | TOTALS | 1.21E-01 | 1.37E-01 | 9.23E-01 | 1.42E-03 | 2.85E-02 | 3.74E-05 |
| ADULT | TOTALS | 9.81E-02 | 3.50E-02 | 7.69E-01 | 9.37E-04 | 1.29E-02 | 3.74E-05 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.85E+00 | 2.22E-01 | 3.75E+00 | 1.65E-01 | 2.43E-01 | 1.21E+02 |
| CHILD | TOTALS | 7.58E+00 | 1.40E-01 | 1.87E+00 | 1.33E-01 | 1.42E-01 | 1.21E+02 |
| TEENAGE | TOTALS | 7.47E+00 | 3.08E-01 | 1.02E+00 | 1.14E-01 | 1.32E-01 | 1.21E+02 |
| ADULT | TOTALS | 7.45E+00 | 1.63E-01 | 8.64E-01 | 1.06E-01 | 1.11E-01 | 1.21E+02 |

NUMBER 38 NAME=38-100M UPWIND OF TD X= -7.0KM, Y= 9.1KM, Z= 0.0M, DIST= 11.5KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.08E+00 | 4.90E-01 | 1.52E+01 | 1.27E-02 | 5.10E-01 | 1.56E-04 |
| CHILD | TOTALS | 9.41E-01 | 1.31E-01 | 7.37E+00 | 8.34E-03 | 1.35E-01 | 1.56E-04 |
| TEENAGE | TOTALS | 5.04E-01 | 5.71E-01 | 3.85E+00 | 5.93E-03 | 1.19E-01 | 1.56E-04 |
| ADULT | TOTALS | 4.09E-01 | 1.46E-01 | 3.20E+00 | 3.90E-03 | 5.37E-02 | 1.56E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.10E+01 | 5.84E-01 | 1.53E+01 | 1.64E-01 | 6.21E-01 | 1.47E+02 |
| CHILD | TOTALS | 9.82E+00 | 2.30E-01 | 7.46E+00 | 1.29E-01 | 2.34E-01 | 1.47E+02 |
| TEENAGE | TOTALS | 9.38E+00 | 7.31E-01 | 3.94E+00 | 1.08E-01 | 2.12E-01 | 1.47E+02 |
| ADULT | TOTALS | 9.28E+00 | 2.64E-01 | 3.29E+00 | 9.91E-02 | 1.42E-01 | 1.47E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 39 NAME=39-100M DOWNWIND OF X= -7.2KM, Y= 9.3KM, Z= 0.0M, DIST= 11.7KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.47E+00 | 3.46E-01 | 1.08E+01 | 8.96E-03 | 3.61E-01 | 1.10E-04 |
| CHILD | TOTALS | 6.65E-01 | 9.23E-02 | 5.21E+00 | 5.89E-03 | 9.51E-02 | 1.10E-04 |
| TEENAGE | TOTALS | 3.56E-01 | 4.04E-01 | 2.72E+00 | 4.19E-03 | 8.38E-02 | 1.10E-04 |
| ADULT | TOTALS | 2.89E-01 | 1.03E-01 | 2.26E+00 | 2.76E-03 | 3.79E-02 | 1.10E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.08E+01 | 4.58E-01 | 1.09E+01 | 1.79E-01 | 4.89E-01 | 1.55E+02 |
| CHILD | TOTALS | 1.00E+01 | 2.09E-01 | 5.32E+00 | 1.45E-01 | 2.13E-01 | 1.55E+02 |
| TEENAGE | TOTALS | 9.74E+00 | 5.82E-01 | 2.83E+00 | 1.24E-01 | 1.95E-01 | 1.55E+02 |
| ADULT | TOTALS | 9.67E+00 | 2.39E-01 | 2.37E+00 | 1.16E-01 | 1.44E-01 | 1.55E+02 |

NUMBER 40 NAME=40-200M NORTH OF TD X= -7.1KM, Y= 9.4KM, Z= 0.0M, DIST= 11.8KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 7.82E+00 | 1.84E+00 | 5.74E+01 | 4.78E-02 | 1.92E+00 | 5.87E-04 |
| CHILD | TOTALS | 3.54E+00 | 4.92E-01 | 2.78E+01 | 3.14E-02 | 5.07E-01 | 5.87E-04 |
| TEENAGE | TOTALS | 1.90E+00 | 2.15E+00 | 1.45E+01 | 2.23E-02 | 4.46E-01 | 5.87E-04 |
| ADULT | TOTALS | 1.54E+00 | 5.49E-01 | 1.21E+01 | 1.47E-02 | 2.02E-01 | 5.87E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.10E+01 | 1.97E+00 | 5.75E+01 | 2.31E-01 | 2.07E+00 | 2.18E+02 |
| CHILD | TOTALS | 1.67E+01 | 6.23E-01 | 2.79E+01 | 1.84E-01 | 6.39E-01 | 2.18E+02 |
| TEENAGE | TOTALS | 1.51E+01 | 2.34E+00 | 1.46E+01 | 1.57E-01 | 5.72E-01 | 2.18E+02 |
| ADULT | TOTALS | 1.47E+01 | 6.99E-01 | 1.22E+01 | 1.42E-01 | 3.23E-01 | 2.18E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 41 NAME=41-200M EAST OF TD X= -6.9KM, Y= 9.2KM, Z= 0.0M, DIST= 11.5KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 5.17E+00 | 1.22E+00 | 3.79E+01 | 3.16E-02 | 1.27E+00 | 3.88E-04 |
| CHILD | TOTALS | 2.34E+00 | 3.25E-01 | 1.83E+01 | 2.08E-02 | 3.35E-01 | 3.88E-04 |
| TEENAGE | TOTALS | 1.26E+00 | 1.42E+00 | 9.58E+00 | 1.48E-02 | 2.95E-01 | 3.88E-04 |
| ADULT | TOTALS | 1.02E+00 | 3.63E-01 | 7.98E+00 | 9.71E-03 | 1.34E-01 | 3.88E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.11E+01 | 1.32E+00 | 3.80E+01 | 1.86E-01 | 1.39E+00 | 2.65E+02 |
| CHILD | TOTALS | 1.83E+01 | 4.29E-01 | 1.84E+01 | 1.45E-01 | 4.39E-01 | 2.65E+02 |
| TEENAGE | TOTALS | 1.72E+01 | 1.58E+00 | 9.67E+00 | 1.21E-01 | 3.93E-01 | 2.65E+02 |
| ADULT | TOTALS | 1.70E+01 | 4.84E-01 | 8.07E+00 | 1.09E-01 | 2.26E-01 | 2.65E+02 |

NUMBER 42 NAME=42-200M SOUTH OF TD X= -7.1KM, Y= 9.0KM, Z= 0.0M, DIST= 11.5KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 9.92E+00 | 2.34E+00 | 7.27E+01 | 6.06E-02 | 2.44E+00 | 7.44E-04 |
| CHILD | TOTALS | 4.49E+00 | 6.24E-01 | 3.52E+01 | 3.98E-02 | 6.43E-01 | 7.44E-04 |
| TEENAGE | TOTALS | 2.41E+00 | 2.73E+00 | 1.84E+01 | 2.83E-02 | 5.66E-01 | 7.44E-04 |
| ADULT | TOTALS | 1.95E+00 | 6.96E-01 | 1.53E+01 | 1.86E-02 | 2.56E-01 | 7.44E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.46E+01 | 2.42E+00 | 7.28E+01 | 2.04E-01 | 2.54E+00 | 7.68E+01 |
| CHILD | TOTALS | 9.17E+00 | 7.14E-01 | 3.53E+01 | 1.52E-01 | 7.34E-01 | 7.68E+01 |
| TEENAGE | TOTALS | 7.09E+00 | 2.88E+00 | 1.85E+01 | 1.22E-01 | 6.51E-01 | 7.68E+01 |
| ADULT | TOTALS | 6.63E+00 | 8.05E-01 | 1.54E+01 | 1.05E-01 | 3.36E-01 | 7.68E+01 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 43 NAME=43-200M WEST OF TD X= -7.3KM, Y= 9.2KM, Z= 0.0M, DIST= 11.8KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.15E+00 | 5.06E-01 | 1.58E+01 | 1.31E-02 | 5.28E-01 | 1.61E-04 |
| CHILD | TOTALS | 9.73E-01 | 1.35E-01 | 7.62E+00 | 8.62E-03 | 1.39E-01 | 1.61E-04 |
| TEENAGE | TOTALS | 5.22E-01 | 5.91E-01 | 3.98E+00 | 6.14E-03 | 1.23E-01 | 1.61E-04 |
| ADULT | TOTALS | 4.23E-01 | 1.51E-01 | 3.31E+00 | 4.04E-03 | 5.55E-02 | 1.61E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 8.07E+00 | 6.12E-01 | 1.58E+01 | 1.77E-01 | 6.50E-01 | 9.73E+01 |
| CHILD | TOTALS | 6.90E+00 | 2.45E-01 | 7.73E+00 | 1.41E-01 | 2.50E-01 | 9.73E+01 |
| TEENAGE | TOTALS | 6.45E+00 | 7.64E-01 | 4.08E+00 | 1.19E-01 | 2.27E-01 | 9.73E+01 |
| ADULT | TOTALS | 6.35E+00 | 2.80E-01 | 3.41E+00 | 1.10E-01 | 1.54E-01 | 9.73E+01 |

NUMBER 44 NAME=44-200M UPWIND OF TD X= -6.9KM, Y= 9.1KM, Z= 0.0M, DIST= 11.4KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 5.31E+00 | 1.25E+00 | 3.89E+01 | 3.24E-02 | 1.30E+00 | 3.98E-04 |
| CHILD | TOTALS | 2.40E+00 | 3.34E-01 | 1.88E+01 | 2.13E-02 | 3.44E-01 | 3.98E-04 |
| TEENAGE | TOTALS | 1.29E+00 | 1.46E+00 | 9.83E+00 | 1.52E-02 | 3.03E-01 | 3.98E-04 |
| ADULT | TOTALS | 1.04E+00 | 3.72E-01 | 8.19E+00 | 9.97E-03 | 1.37E-01 | 3.98E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.32E+01 | 1.34E+00 | 3.90E+01 | 1.77E-01 | 1.41E+00 | 1.30E+02 |
| CHILD | TOTALS | 1.03E+01 | 4.27E-01 | 1.89E+01 | 1.35E-01 | 4.37E-01 | 1.30E+02 |
| TEENAGE | TOTALS | 9.19E+00 | 1.61E+00 | 9.91E+00 | 1.11E-01 | 3.90E-01 | 1.30E+02 |
| ADULT | TOTALS | 8.94E+00 | 4.84E-01 | 8.27E+00 | 9.87E-02 | 2.19E-01 | 1.30E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 45 NAME=45-200M DOWNWIND OF X= -7.2KM, Y= 9.4KM, Z= 0.0M, DIST= 11.8KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 4.86E+00 | 1.14E+00 | 3.56E+01 | 2.97E-02 | 1.19E+00 | 3.64E-04 |
| CHILD | TOTALS | 2.20E+00 | 3.05E-01 | 1.72E+01 | 1.95E-02 | 3.15E-01 | 3.64E-04 |
| TEENAGE | TOTALS | 1.18E+00 | 1.34E+00 | 8.99E+00 | 1.39E-02 | 2.77E-01 | 3.64E-04 |
| ADULT | TOTALS | 9.56E-01 | 3.41E-01 | 7.49E+00 | 9.12E-03 | 1.25E-01 | 3.64E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.44E+01 | 1.27E+00 | 3.57E+01 | 2.10E-01 | 1.33E+00 | 1.57E+02 |
| CHILD | TOTALS | 1.18E+01 | 4.32E-01 | 1.74E+01 | 1.68E-01 | 4.42E-01 | 1.57E+02 |
| TEENAGE | TOTALS | 1.07E+01 | 1.52E+00 | 9.11E+00 | 1.43E-01 | 3.98E-01 | 1.57E+02 |
| ADULT | TOTALS | 1.05E+01 | 4.87E-01 | 7.60E+00 | 1.32E-01 | 2.41E-01 | 1.57E+02 |

NUMBER 46 NAME=46-500M NORTH OF TD X= -7.1KM, Y= 9.7KM, Z= 0.0M, DIST= 12.0KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 6.30E+00 | 1.49E+00 | 4.62E+01 | 3.85E-02 | 1.55E+00 | 4.73E-04 |
| CHILD | TOTALS | 2.86E+00 | 3.97E-01 | 2.24E+01 | 2.53E-02 | 4.09E-01 | 4.73E-04 |
| TEENAGE | TOTALS | 1.53E+00 | 1.73E+00 | 1.17E+01 | 1.80E-02 | 3.60E-01 | 4.73E-04 |
| ADULT | TOTALS | 1.24E+00 | 4.42E-01 | 9.73E+00 | 1.18E-02 | 1.63E-01 | 4.73E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.12E+01 | 1.61E+00 | 4.63E+01 | 2.20E-01 | 1.69E+00 | 2.46E+02 |
| CHILD | TOTALS | 1.77E+01 | 5.27E-01 | 2.25E+01 | 1.77E-01 | 5.40E-01 | 2.46E+02 |
| TEENAGE | TOTALS | 1.64E+01 | 1.92E+00 | 1.18E+01 | 1.51E-01 | 4.85E-01 | 2.46E+02 |
| ADULT | TOTALS | 1.61E+01 | 5.91E-01 | 9.84E+00 | 1.38E-01 | 2.83E-01 | 2.46E+02 |

TIME STEP NUMBER 1, 1-YEAR PERIOD DURATION IN YRS IS... 1.0

NUMBER 47 NAME=47-500M EAST OF TD X= -6.6KM, Y= 9.2KM, Z= 0.0M, DIST= 11.3KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 3.04E+00 | 7.17E-01 | 2.23E+01 | 1.86E-02 | 7.48E-01 | 2.28E-04 |
| CHILD | TOTALS | 1.38E+00 | 1.91E-01 | 1.08E+01 | 1.22E-02 | 1.97E-01 | 2.28E-04 |
| TEENAGE | TOTALS | 7.39E-01 | 8.37E-01 | 5.64E+00 | 8.69E-03 | 1.74E-01 | 2.28E-04 |
| ADULT | TOTALS | 5.99E-01 | 2.13E-01 | 4.69E+00 | 5.72E-03 | 7.86E-02 | 2.28E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 2.33E+01 | 8.00E-01 | 2.24E+01 | 1.54E-01 | 8.45E-01 | 3.36E+02 |
| CHILD | TOTALS | 2.16E+01 | 2.78E-01 | 1.09E+01 | 1.19E-01 | 2.85E-01 | 3.36E+02 |
| TEENAGE | TOTALS | 2.10E+01 | 9.81E-01 | 5.71E+00 | 9.82E-02 | 2.55E-01 | 3.36E+02 |
| ADULT | TOTALS | 2.08E+01 | 3.18E-01 | 4.77E+00 | 8.88E-02 | 1.55E-01 | 3.36E+02 |

NUMBER 48 NAME=48-500M SOUTH OF TD X= -7.1KM, Y= 8.7KM, Z= 0.0M, DIST= 11.2KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 6.55E+00 | 1.54E+00 | 4.80E+01 | 4.00E-02 | 1.61E+00 | 4.91E-04 |
| CHILD | TOTALS | 2.97E+00 | 4.12E-01 | 2.32E+01 | 2.63E-02 | 4.24E-01 | 4.91E-04 |
| TEENAGE | TOTALS | 1.59E+00 | 1.80E+00 | 1.21E+01 | 1.87E-02 | 3.74E-01 | 4.91E-04 |
| ADULT | TOTALS | 1.29E+00 | 4.59E-01 | 1.01E+01 | 1.23E-02 | 1.69E-01 | 4.91E-04 |

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

| AGE | PATHWAY | EFFECTIV | BONE | AVG.LUNG | LIVER | KIDNEY | BRONCHI |
|---|---|---|---|---|---|---|---|
| INFANT | TOTALS | 1.02E+01 | 1.63E+00 | 4.81E+01 | 1.88E-01 | 1.71E+00 | 6.02E+01 |
| CHILD | TOTALS | 6.65E+00 | 5.05E-01 | 2.33E+01 | 1.42E-01 | 5.18E-01 | 6.02E+01 |
| TEENAGE | TOTALS | 5.28E+00 | 1.96E+00 | 1.22E+01 | 1.15E-01 | 4.61E-01 | 6.02E+01 |
| ADULT | TOTALS | 4.97E+00 | 5.72E-01 | 1.02E+01 | 1.01E-01 | 2.51E-01 | 6.02E+01 |