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SUBJECT: Documents util presentations & suppls info covered at 900921,1003 & 1105 meetings re activities & accomplishments at plant during past yr.Detailed info re plant operations encl.

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EXECUTIVE VICE PRESIDENT
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161-03655-WFC/DAF

December 18, 1990

Docket Nos. STN 50-528/529/530

U. S. Nuclear Regulatory Commission
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Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, 3
PVNGS Performance Review, 1989-1990
File: 90-056-026

In meetings on September 21, October 3, and November 5, 1990, representatives of the Nuclear Regulatory Commission Staff (NRC) and PVNGS management discussed activities and accomplishments at PVNGS during the past year. Although the meetings have been thorough and productive, it was not possible to discuss every agenda topic in detail. This letter and its more detailed attachment are being submitted both to document the APS presentations and to supplement the information covered in those meetings.

PVNGS performance over the past year represented a significant improvement since the close of the last SALP period; substantial progress has been made in each functional area. APS recognizes the need for further improvement in many aspects of PVNGS operations; a number of significant initiatives are underway to realize that objective. APS is completing its Business Plan which integrates and prioritizes the implementing tasks supporting current and future improvement initiatives. The Business Plan will help PVNGS personnel to better understand their mission and goals and the role their individual efforts play in achieving those goals. The Business Plan will also be used by PVNGS management as a tool for monitoring progress in carrying out the tasks necessary to achieve APS' goals and objectives.

The improvement in PVNGS performance is represented by its improved capacity factor and a reduction in the number of operational events since the last operation period. Unit 1 was restarted (i.e., synchronized to the grid) on July 5, 1990, with NRC concurrence, and has since operated at a capacity factor of 83.5% (through November 30, 1990). Unit 2 operated at a capacity factor of 70.0%

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from November 1, 1989, until the beginning of its second refueling outage on February 23, 1990, and has operated at 89.9% since its restart on July 19, 1990. Unit 3 was restarted December 30, 1989, and operated at a capacity factor of 84.7% (through November 30, 1990). Overall, the capacity factor for the station increased 29.5% over the previous year, and the past four months show an improving trend.

Since November 1, 1989, the units have experienced three unplanned automatic reactor trips, compared to five during the previous SALP period. There was one safety system actuation in the past year compared to four the year before. The number of events requiring submission of LER's also decreased from 41 at the end of 1989 to 25 (through November 30, 1990). In the third quarter of 1990, PVNGS recorded its fewest LER events (five) ever in a single quarter.

The highlights in each functional area are summarized below, and described in greater detail in the attachment.

<u>OPERATIONS:</u> Conservative decision making and greater management involvement in the resolution of operational problems marked operations in the past year. A number of plant events, examples of which are identified in the attachment, lends support to this conclusion. There were events cited in the attachment that highlighted the need for further improvement; however, PVNGS management is devoting concentrated attention to assuring that decisions are consistently conservative and reflect the APS policy that protection of the safety of the public and plant personnel is our highest operational priority.

Although the PVNGS training programs addressed principal National Nuclear Accrediting Board concerns and were removed from probation by the National Academy of Nuclear Training last year, training has continued to receive priority management attention. A Training Advisory Board, composed of senior PVNGS managers, monitors training effectiveness and recommends improvements/changes directly to the Training Manager. Actions to improve the interface between Operations and Training have increased the sense of ownership of training by line management. Self assessment remains a priority within the Training Department and a training change system has been developed which has allowed timely upgrades to the technical training process at the site.

The simulator upgrade project has made substantial progress, and although schedule adjustments have been necessary, APS remains confident that the deadline for certification documentation on the simulator in March 1991 will be met. APS is currently in the pre-contract phase for the purchase of a second simulator, to be placed

in service in the first quarter of 1993. Having two simulators will enhance flexibility in licensed operator training and permit use of a simulator for other activities, such as system engineer training and emergency planning scenarios and drills.

Deficiencies in the control of medical examinations for licensed operators have been resolved by developing a comprehensive system to track the actions required to maintain each operator's license. This process emphasizes to the operators their personal responsibility and accountability for assuring that they fulfill their regulatory obligations, as well as those site support groups which assist the operators in maintaining their license obligations current.

<u>Safety Assessment/Quality Verification:</u> Programmatic changes affecting oversight activities, as described in the attachment, increased the effectiveness of Independent Safety Engineering (ISE) and the Nuclear Safety Group (NSG), increasing the number and depth of their assessments/investigations and improving their ability to assure that identified concerns and recommendations receive timely and adequate responses from line management.

The Technical Specifications were amended, permitting changes to the composition and procedures of the Plant Review Board (PRB). The PRB now includes more senior management, and is able to better focus its efforts on matters of broad operational and potential safety significance.

The Management Review Committee (MRC), which was established to provide additional assurance that Units 1 and 3 were ready for restart, completed its unit restart assignment and was disbanded. APS established an Off-site Safety Review Committee (OSRC) composed of senior management and outside experts to review selected PVNGS events and activities, and advise the Executive Vice President regarding safety performance at PVNGS.

The addition of a number of experienced, technically qualified personnel to the Quality Assurance (QA) organization, including the placement of a permanent Deputy Director, has enhanced QA's ability to assess plant/program performance, as well as compliance. The QA program now includes a performance assessment as part of each audit. The Monitoring Program, which provides a "snapshot" look at ongoing activities, has also demonstrated its ability to contribute to PVNGS performance. Examples of the contributions of audits and monitors are identified in the attachment (see pages 16 and 17). In addition, PVNGS has implemented a graded approach to Quality Control to assure that QC resources are focused on areas of greatest safety significance.

[illegible]

[illegible]

25% [illegible]

The principal deficiency reporting and corrective action programs at PVNGS were substantially revised toward the end of 1989 to improve controls, ensure that deficiencies can be readily documented by all plant personnel, and improve timeliness of dispositions and reportability determinations. The Material Non-conformance Report (MNCR), which is used to document hardware problems, controls operability and reportability determinations, as well as disposition, implementation and close-out of corrective actions, and assures timeliness. The Quality Deficiency Report (QDR) establishes similar controls for non-hardware problems. By establishing these separate mechanisms for reporting deficiencies, significant problems are more readily highlighted to management. In a recent NRC Inspection Report discussing these and other revised deficiency programs it was noted that, "at this time, it appears that these programs, and their implementation, have improved."

A self-initiated Safety System Functional Inspection (SSFI) focused on the diesel generator systems. The SSFI found the systems to be generally satisfactory. Some deficiencies were identified; however, corrective actions are in progress.

Deficiencies in the implementation of PVNGS QA commitments for fire protection systems are being resolved through comprehensive reviews of the QA Program for fire protection system components and other systems important-to-safety.

<u>Maintenance/Surveillance:</u> There was noticeable progress in reducing both the Preventive Maintenance (PM) and Corrective Maintenance (CM) backlogs. Overdue PMs decreased from 9.5% (November 1989) to 2.4% (November 1990). The corrective maintenance backlog (priority 1, 2, 3 CMs greater than 90 days old) decreased from 63.4% (November 1989) to 52.5% (November 1990). The ratio of preventive to total maintenance items has shown an improving trend over the past year. The Business Plan includes a number of tasks aimed at achieving further backlog reductions.

A Motor Operated Valve (MOV) task action plan has been developed which establishes a comprehensive overall schedule for MOV testing and upgrading in accordance with Generic Letter 89-10. The task plan provides for a review of NPRDS information on MOV concerns to determine their applicability to PVNGS, development and maintenance of an MOV performance trending program, and preparation of further guidance for the maintenance and testing of MOVs. Significant progress has been made toward the completion of baseline testing

on safety related and important-to-safety MOVs (67% completed), as well as rotor rewiring (40% completed). The MOV task plan is part of the PVNGS Business Plan.

A Preventive Maintenance Task Force (PMTF) is responsible for a complete evaluation of the PM program and implementing necessary changes. Among their activities, the PMTF is also documenting the bases for PMs. The evaluation methodology for evaluating PM tasks has been developed, as described in the attachment (see page 26), and reviews have been initiated. The development of the PM bases is scheduled to be completed by the end of 1991. The PMTF is also reviewing the existing administrative procedures and Station Information Management System (SIMS) computer programs, which are used to control the PM program, and will recommend changes to increase efficiency and assure that the PM bases are kept current.

Improvements to the work control process include implementation of a writer's guide for procedures and work orders; implementation of a twelve week integrated schedule which facilitates planning, reduces system outages, and allows more efficient use of personnel; and initiation of a model work order development program to improve consistency in planning and to provide standardized guidelines for work package development. These changes have resulted in noticeable improvements. APS is continuing to evaluate the work control process to identify additional measures to improve performance.

<u>Radiation Protection:</u> Several indicators show improvement in the RP area: contamination events decreased from an average of 235 events per unit in 1989 to a projected 137 events per unit in 1990 (Unit 1, 160; Unit 2, 202; Unit 3, 50, based upon data as of October 31, 1990). Occupational radiation exposure decreased from an average of 223 man-rem per unit in 1989 to a projected 169 man-rem per unit in 1990 (Unit 1, 163; Unit 2, 323; Unit 3, 21). The Unit 2 outage also resulted in a reduction of man-rem exposure. These indicators compare favorably with industry averages. The volume of radioactive waste generated has decreased from an average of 12,142 cubic feet per unit (cf/u) in 1989 to a projected 7,621 cf/u (Unit 1, 8,272; Unit 2, 9,629; and Unit 3, 4,962) in 1990. This is somewhat higher than the INPO 1989 industry average of 7,133 cf/u; however, if corrected for a zero release site, PVNGS would be approximately 18% below this average. Efforts are underway to further decrease the volume of radioactive waste, as well as to reduce the number of contamination incidents and the total personnel exposure. In addition, contaminated floor space at PVNGS is well below the site goal of less than 10% per unit; (Unit 1, 3.5%; Unit 2, 1.8%; Unit 3, 1.2%).

Problems in the RP program have shown up in communications within the RP organization and have also been manifested in an increase of employee concerns. The addition of a new position of RP Operations Manager, other personnel changes, improved technician training and the recent period of consistent power operations are expected to improve morale and re-establish good teamwork and communications within the RP organization. APS management is monitoring this area closely to assure that necessary improvements are realized.

APS has modified the Radiation Protection and Chemistry organizations to increase management scrutiny in both areas. A site general manager has been assigned to head each discipline. The site general managers report directly to the Vice President, Nuclear Production. Other changes have been made in the RP organization, as well, to better focus RP management on the needs of each unit.

The attachment also describes other enhancements to the RP and Chemistry programs, including upgrades to the secondary plant online chemistry analyzers and improvements to the radiation monitoring systems.

<u>Security:</u> The attachment identifies many enhancements in the Security area, including the addition of a new, well qualified Manager of Security, a new security contractor organization, revised procedures, and improved equipment. Equipment and personnel performance have improved as a result. Security compensatory manhours have decreased from 4,605 in January 1990 to 606 in November 1990. In addition, one hour reportable events decreased from six in 1989 to three through November 30, 1990. A recent unannounced NRC security inspection (August 1990) closed out all but one open item.

<u>Engineering/Technical Support:</u> The engineering and technical support area benefitted from significant changes in management and organization. The following positions were filled with individuals who came to PVNGS with extensive experience as technical managers in the nuclear industry: Vice President, Nuclear Engineering and Construction; Director, Site Technical Support; and Director, Site Nuclear Engineering and Construction. The Vice President, Nuclear Engineering and Construction is now responsible for all engineering departments.

The System Engineer Program has been strengthened by a reorganization and realignment of responsibilities to provide

closer management direction and better focus the engineers on priority responsibilities. Reporting to the Director, Site Technical Support, are managers of System Engineering, Component and Specialty Engineering, Operations Engineering and Operations Computer Systems. The division between Systems Engineering and Component Engineering focuses the Systems Engineers on monitoring system operation and maintenance, while the Component Engineers are responsible for providing component specific expertise to the System Engineer and Maintenance personnel. Liaison engineers are also assigned to the units to establish a full-time engineering presence in each plant organization and provide increased assurance that Engineering is aware of new developments. Examples identified in the attachment indicate that the revised organization is showing improved results.

The establishment of the Site Nuclear Engineering and Construction organization increases the involvement of Nuclear Engineering in site activities. The group has a key role in coordination of modifications and procurement. Key management positions in the organization have been filled and good progress is being made in staffing.

Implementation of the Engineering Excellence Program is well advanced and a similar program is underway for the Site Technical Support organization. The Site Engineering Excellence Program is now being incorporated into the Business Plan. The EER Backlog Reduction Program is ahead of schedule; a review of planned plant modifications has revealed that many are unnecessary and can be cancelled, allowing better prioritization of significant remaining items. Efforts are also underway to upgrade vendor technical manuals.

APS believes that performance improvement in Engineering/Technical Support demonstrates the effectiveness of the management efforts to strengthen the organization, and that further improvement may be expected.

<u>Emergency Planning:</u> A more aggressive and comprehensive drill schedule, including quarterly full scale drills supplemented by unit and facility functional drills, has contributed to successful integration of relatively new management personnel into the Emergency Response Organization (ERO). There has been a significant reduction in the number of ERO personnel overdue in any month for annual training.

Various facility and hardware enhancements have been made, including upgraded telefax equipment and improvements to the EOF.

The addition of cardreaders and system software modifications have enhanced accountability in the TSC, OSC and Control Room, and have contributed to the two successful assembly and accountability drills in July.

The attachment provides more detailed information on each of these areas, including, where appropriate, supporting data or examples. If you have any questions on any of this information, please do not hesitate to call me.

Sincerely,

WFConway

W. F. Conway

WFC/DAF/pmm

Attachment

cc: J. B. Martin
D. H. Coe
A. C. Gehr
A. H. Gutterman

ATTACHMENT
PLANT OPERATIONS

Unit 1 was restarted (i.e., synchronized to the grid) on July 5, 1990, with NRC concurrence that the restart requirements had been completed, and operated at a capacity factor of 83.5% through November 30, 1990. Unit 2 operated at a capacity factor of 70.0% from November 1, 1989, until the beginning of its second refueling outage on February 23, 1990, and has operated at 89.9% since its restart following that outage on July 19, 1990. Unit 3 was restarted on December 30, 1989, and has operated at a capacity factor of 84.7%. Overall, the capacity factor for the station increased 29.5% from the previous year, and in the past four months there has been an upward trend. All three units restarted after long outages without significant personnel performance problems.

Since November 1, 1989, the units have experienced three unplanned automatic reactor trips, compared to five last year. There was one safety system actuation in the past year compared to four the previous year. The number of events requiring LER's also decreased from 41 for calendar year 1989 to 25 through November 30, 1990. In the third quarter of 1990, PVNGS recorded its fewest number of LER events (five) in a single quarter. Overall, plant performance improved over 1989, although total outage time was more than anticipated.

Management involvement in Operations activities during the past

year was evident in the resolution of operational problems and with the handling of concerns, especially following events at the site. Conservative decision making was also evident. The following plant events are illustrative:

- Management directed Unit 1 to return from mode 3 to mode 5 in order to repair minor steam generator tube leaks. While the leakage was within Technical Specification limits, management decided to fix the leaks before returning Unit 1 to power operations.

- Management drew up an aggressive and conservative plan of action to repair pressurizer safety valves in Unit 1 by getting promptly involved with procurement, QA and replacement of pressurizer safety valves (even confirming ring setting process at Wyle Laboratory). All facets of this event were conducted safely and the replacement proceeded without undue delays.

- Both Unit 1 and Unit 3 were restarted after long outages. Virtually no one in the entire complement of licensed operators in both units had operated a reactor at power since the start of the outage. Consequently, during the preparation for restart, operators were sent to Unit 2 for additional refamiliarization with power operations.

Although these incidents are good indicators of improved performance, APS also recognizes that there were instances in which performance could have been better. Examples of such instances include:

- The transformer fire in December 1989 was incorrectly evaluated as not warranting a notification of an unusual event (NUE) declaration. To prevent a recurrence, the EPIP governing NUE declarations was revised for more specificity.

- In response to inadequacies identified by NRC in the PVNGS spent fuel pool procedures, the procedures were revised to address valve lineups, transfer of pool water between system interfaces, and every evolution of spent fuel pool maneuvers.

- During startup from an outage in Unit 2 during November 1989, the Operators allowed the unit to slightly exceed the heatup rate specified in Technical Specifications. In response to this, all shift supervisors were counselled on attention to detail and management expectations. In addition, a surveillance test procedure change was implemented to require that the heatup rate be graphed at an increased frequency in the control room for better monitoring.

- Unit 3 was restarted on October, 21, 1990 following a post-trip Incident Investigation of the inadvertent actuation of

the Steam Bypass Control System. The investigation team concluded that the event was bounded by previous accident analyses. Subsequently, APS management found that there was inadequate basis for the investigation team's conclusion. As a result, APS is taking steps to augment its post-trip review teams with additional technical expertise.

The Management Observation Program provides valuable management visibility through regularly scheduled plant walkdowns in which managers observe plant conditions and personnel performance and formally document their recommendations. Recommendations were given to the cognizant plant personnel, who were required to assure prompt resolution. These recommendations have resulted in procedure changes and prompt equipment repairs. More importantly; however, the continuous presence of management in the plant increases the communication of management expectations and reinforces management goals and objectives to the plant staff.

Improved procedures for the control of equipment status include a new site-wide procedure governing the conduct of independent verification and the prohibition on the use of uncontrolled marked-up piping and instrumentation diagrams as a means of verifying equipment status in the control room. Operators were briefed on system status errors as they occurred and all operators received additional instruction detailing the requirements for valve manipulations. Since the noted procedural improvements were made,

there have been no operator manipulation errors. To further assess the effectiveness of these actions, an independent assessment of the adequacy and implementation of the System Status Controls Procedure was performed during November. This assessment, performed by the Nuclear Safety Group, included interviews with licensed operators and checks of equipment status documentation. This evaluation confirmed that the System Status Control Procedure had been effective; however, corrective action was required in plant modification statusing as there have been instances where drawings or procedures have not been updated to reflect plant modifications.

The Training Advisory Board was established to monitor the effectiveness of training programs, policies, and procedures, as well as to make recommendations to training management to improve technical training. The Board is composed of the Directors of Plant Operations, Technical Support, and QA, the Managers of Compliance and Training, and the three Plant Managers. Its duties include scheduled observations of simulator training (where performance of crews, instructors, and the simulator are observed). A training single point of management contact has been assigned in all training disciplines to interface directly with training management, conveying plant staff needs and recommendations. Six licensed operators were permanently transferred to Training to increase the on-shift experience level of the training instructors and to enhance the operators' sense of ownership and involvement

in the training program. As a result of these efforts, a more distinct sense of line managers ownership of training programs has been established and changes have been made to training programs to more effectively address discipline specific concerns.

The Simulator Upgrade Program has received extensive management attention. Although there have been some schedule changes, the overall progress has been encouraging. Accomplishments this year include:

- Installing backpanel circuitry on the simulator
- Starting the simulator acceptance testing program
- Receiving computers for new Simulation/Stimulation (SIMSTIM) systems
- Software upgrades

The Simulator Upgrade Program and enhancements are currently on schedule to support submittal of certification documentation by March 26, 1991.

PVNGS is currently in the pre-contract phase for the purchase of a second simulator, so that two Unit 1 plant specific control room simulators will be available for Training. The second simulator,

to be placed in service in the first quarter of 1993, will be used for emergency planning scenarios and drills, in addition to system engineer training. A project manager has been named and a computer services group has been created which will provide support for both simulators. Both simulators will be under the control of the Training Department.

A five-shift operator rotation was adopted at PVNGS in March 1989, when the multiple unit outages required Operations assistance in other areas to support outage activities. Subsequent personnel turnover has required PVNGS to retain a five-shift rotation. APS is training additional licensed operators to enable resumption of the six-shift rotation. There are currently 40 personnel in the Licensed Operator Training Program. The first class of 20 is scheduled for NRC examination in June 1991. This increased initial training program is scheduled to provide an adequate number of licensed operators to achieve the goal of a six-shift rotation by August 1992.

A trip reduction goal of one trip per 7000 hours critical has been incorporated into the Business Plan. A Trip Reduction Task Force has been established to identify potential trip initiators and eliminate them, where possible. The Task Force, which is comprised of key personnel from Operations, Training, Maintenance, Engineering, and Nuclear Fuel Management, meets twice each month. The Task Force is currently evaluating a proposal to enhance the

labeling of trip sensitive components and is developing a detailed scram and turbine trip database to aid trending and analysis. The Task Force will be evaluating potential changes in design, procedures, technical specifications, and training.

The schedule was extended for the station Emergency Operation Procedures (EOPs) upgrade project. The procedures and technical guidelines have been rewritten and verified for technical content by plant review groups; however, validation of the EOPs cannot be accomplished until after the simulator certification.

A Positive Discipline Program has been implemented. This program provides formal consistent guidelines for supervisors in dealing with personnel performance problems. It appears that this program is resulting in more consistent imposition of discipline when appropriate. It is expected that this program will help to minimize personnel errors.

To increase the assurance of strict compliance with procedures, a special variance procedure has been adopted which permits temporary changes, authorized by the Technical Specifications, to be accomplished in a more timely fashion than with the previous change process. Since the PVNGS staff now has the ability to achieve prompt procedure changes, they do not have to work around procedural requirements that are inappropriate to the circumstances.

Other efforts have been completed to increase control room formality, including the designation of specific stations for personnel within the control room and establishment of formal guidelines for control room communications. PVNGS will also require standard attire for control room personnel to maintain a professional atmosphere and for easy identification.

Communication between Operations and other site personnel has been enhanced through the use of electronic mail (E-Mail). The computer terminals are now accessible in the control room, keeping the shift supervisor in closer contact with management. The E-Mail system also provides information on current industry and PVNGS events and a daily plant status report. Daily work packages are also utilized in each unit to implement the plan of the day and to highlight areas requiring particular attention.

SAFETY ASSESSMENT/QUALITY VERIFICATION

The Independent Safety Engineering group (ISE) field evaluation program was revised to include preplanning of the evaluation criteria, scope, and methodology. As a result, the field evaluation reports are more detailed, and include root cause analyses and specific corrective actions. There have been 35 field evaluations or special investigations performed by ISE in 1990. The investigation documentation used in 1989 was less detailed and comprehensive and, as such, should not be compared to the revised 1990 program. The number of assessments done by the Nuclear Safety Group (NSG) increased to 14 in 1990, from five in 1989. At the same time the depth of the assessments and investigations was increased through a more results oriented focus by NSG, short term use of contractors for program assessments, and increased management guidance. Three NSG special assessments were performed at the request of senior management.

Timeliness of resolution of identified ISE/NSG findings, which has been a problem in the past, was improved by program revisions requiring the use of the normal PVNGS deficiency identification process (MNCRs, QDRs, CARs) and the management escalation process to automatically address overdue or unresolved issues findings. ISE/NSG also has been more aggressively following and statusing ISE/NSG recommendations. The status of these items are now included in a combined monthly report to senior management. The

recent upgrading of PVNGS computer tracking systems has increased the visibility of outstanding recommendations to management.

An increase in staffing levels during this period (ISE added two positions, NSG added one position), in conjunction with the programmatic changes also contributed to increased effectiveness of ISE and NSG. However, maintaining adequate staffing levels requires continuing management attention. Examples of improvements resulting from ISE/NSG assessments include:

- 50.59 program to incorporate NSAC 125 guidance, including an extensive two day training program. (This program will be fully implemented by December 1990.)

- Modification program changes to require that all associated training and plant documentation is up to date before modification closeout.

- Procedure changes to more effectively control deboration of refueling pool.

- Charging pump oil storage facility upgrades, including measures to prevent foreign material from entering the charging pump oil containers.

The adequacy of engineering and technical evaluations, in support

of the implementation of corrective actions in response to ISE reports, has been an issue requiring additional management attention. To address these concerns, ISE is devoting increased attention to the engineering and technical evaluations. In-depth discussions with the responsible organization are being stressed as a means to ensure corrective actions fully cover the scope of the ISE recommendation prior to issue closure. ISE continues to have concerns with both the number and lack of specificity in their recommendations.

The PVNGS Self-Assessment Group (PSAG), a committee composed of the managers of ISE and NSG, the PRB Chairman and the Director QA/QC, met seven times to develop an integrated schedule of oversight activities to determine appropriateness of scheduled activities and to identify generic management or safety issues warranting senior or executive management attention. The PSAG evaluated the following eight areas:

- 50.59 Program
- Work Control/Work Planning Program
- Administrative Control Program
- Timeliness of Corrective Actions and Commitments
- Use of Vendor Information/Services
- Modifications Turnover Program
- Radiation Monitoring System Reliability
- Post-Installation Test Program

Recommendations for improvement in each of these areas as addressed in the PSAG 1990 semiannual report have been approved by management, and implementation has just begun.

A Corporate Assessment Group (CAG) was established within the Nuclear Safety and Licensing Division in September 1990, to utilize experienced management line personnel to assess performance of selected PVNGS programs and functional areas, to advise PVNGS senior management regarding program effectiveness, and to make recommendations for improvement. The CAG is comprised of functional area managers on rotational (18-30 month) assignments from the following areas: Chemistry, Maintenance, Operations, and Radiation Protection. Their recommendations for plant improvements are tracked and the CAG members are responsible for assuring that recommendations are satisfactorily resolved. The effectiveness of the CAG will be reviewed after more experience is gained in its use.

A Management Review Committee (MRC) was created in the fall of 1989 to assist in oversight of activities preparatory to restart of Units 1 and 3. The MRC ensured that all restart items were adequately addressed before restart. These oversight activities were important in the successful restarts of these units. The MRC then disbanded once their unit restart assignment was accomplished.

The Off-Site Safety Review Committee (OSRC) first met in March 1990. The OSRC reviews selected PVNGS events and activities and advises the Executive Vice President on matters related to nuclear safety. Membership includes the Vice President, Nuclear Safety and Licensing (Chairman); the Vice President, Nuclear Production; the Vice President, Engineering and Construction; and the Director, Quality Assurance. In addition, the Executive Vice President designates outside members with extensive nuclear industry experience. Currently, three outside members are on the committee. The committee has met six times this year and provided independent senior management assessments and recommendations to the Executive Vice President, Nuclear. The actions taken by the OSRC this year include:

- A review of the Incident Investigation Program to determine the responsibility for broad-based issue review, as well as documenting this type of review and tying it to the Incident Investigation Report;

- An evaluation of the oversight group reports for effectiveness as a communication tool and evaluation of resolution tracking for closure;

- With regard to the PVNGS lifted leads policy during the performance of routine maintenance, the Committee suggested that management review this area due to the number of related

lifted lead events.

- With regard to drawing and document control in the security area, the Committee suggested that this area be reviewed to ensure that the appropriate security drawings are under safeguards control.

As a result of a 1989 NSG assessment of the effectiveness of the Plant Review Board (PRB), the Technical Specifications were amended authorizing changes in PRB composition and procedures. The PRB now includes more senior level management and no longer reviews administrative control procedures and changes. The PRB responsibilities were also revised to include the review of additional items designated by the Vice President, Nuclear Production, the Plant Director, or the PRB Chairman. These overall changes to the PRB have resulted in increased PRB attention to the more significant operational issues, and a greater degree of management participation in these safety reviews. However, the effectiveness of the PRB will require further and continuing management attention.

The QA organization continues to be strengthened by the addition of a number of personnel with strong technical qualifications and substantial experience in nuclear plant operations, including three individuals with Professional Engineering Licenses, one individual with a Masters Degree, twelve individuals with Bachelor of Science

Degrees, two STAs, five previously licensed SROs and one RO. These staff additions have added approximately 300 man-years of relevant experience to the organization. In addition, the position of Deputy Director, QA has been filled with an individual with over 17 years experience in the nuclear industry.

Enhancements have been made in the verification processes and deficiency reporting/corrective action processes. For example, increased attention is given by audits to performance issues in addition to the normal compliance assessments. Each audit includes an assessment of whether the activity meets management expectations and a review of compliance with regulatory commitments. To date, eighteen audits have been completed under the enhanced program, resulting in improvements in many areas including:

- Improved program controls for contaminated Measuring & Test Equipment Program (M&TE);
- Improved EP drill evaluation criteria for drill observers;
- Development of procedural guidance for PVNGS operations during mode X (when core is off-loaded);
- Increased management attention on obtaining INPO accreditation of training by RP standards group.

In addition, a revised Monitoring Program was implemented in October 1989. The Monitors address compliance, technical and

performance issues on a real time basis, providing a snapshot of program effectiveness. A specific Monitor Certification Program has been implemented, addressing minimum qualification criteria, on the job training, and written examinations for Monitoring personnel. The goal of the QA Department is for QA Monitoring personnel to perform at least two monitors per day and to spend at least four hours per day in the plant on monitoring activities.

An internal assessment of the Monitoring Program has been performed, using an outside consultant, who identified the following areas as requiring additional attention:

- Establishing a hierarchy of procedures for program implementation.

- Enhancing the administrative and management controls of monitoring activities, including increased participation by managers and supervisors.

- Revising the practice of consolidating deficiencies into one document and instead creating a separate QDR for each deficiency.

- Formalizing training in discipline specific monitoring.

A schedule is being developed for implementation of these

recommendations.

The Monitoring Program has been instrumental in achieving a number of improvements in PVNGS activities, such as improved procedural guidance for receipt inspection of nuclear fuel, enhanced hot particle control for the spent fuel pool, and changes in PM repetitive tasks to reflect changes to equipment classification.

A revised QC Inspection Program was implemented in August of this year. Program enhancements include the initiation of a "Graded Approach" to inspection activities, which takes into consideration the potential safety impact for a failure or malfunction, the complexity or uniqueness of the item, the extent to which functional compliance can be demonstrated by inspection or test, the degree of standardization, and the overall quality history. Quality Engineering has a significantly enlarged role in the inspection planning process, including responsibilities for designating the criterion for selection of work activities to be inspected, the criteria for selecting critical, major and minor attributes, utilization of failure data trending information for inspection planning, and issuance of inspection standards.

The revised inspection program promotes more efficient use of inspection resources, while continuing to comply with applicable regulatory requirements. Similar programs have been successfully used on other nuclear plants. The program has been implemented on

a pilot basis and adjusted based on this experience.

Significant Deficiency Reporting/Corrective Actions are addressed in three ways at PVNGS: Quality Deficiency Reports (QDR) for non-hardware problems; Material Non-conformance Reports (MNCR) for hardware problems; and Corrective Action Reports (CAR) for programmatic problems. Two associated programs are the escalation and stop work programs. These programs were significantly revised or first issued in late 1989, and have been in the implementation, assessment and fine tuning stages during this year. QDRs are validated, logged, tracked, reviewed for potential reportability, verified and closed by Audits and Monitoring. As of November 30, 1990, over 359 QDRs had been initiated over the year and all but 82 had been closed out. The average closeout took 59 days, significantly below the 1990 station goal of 90 days. The MNCR program has been implemented for one year, during which time an internal assessment was made and the program revised. An MNCR can be initiated by anyone and is validated, logged, tracked, controlled, verified and closed by Quality Control. Provisions are made in the program for prompt Operations notification, engineering disposition, tagging, and conditional releases. As of November 30, 1990, 897 MNCRs had been initiated over the year. The goal of dispositioning an MNCR within 30 days was achieved for 628 of the MNCRs. There were 586 MNCRs open as of November 30, 1990, of which approximately 400 were waiting for parts, the next outage, or are in various stages of implementation, while approximately 200 had

not yet been dispositioned.

The CAR program was essentially unchanged for the last year. However, with the implementation of the QDR program, CARs have been used for more significant, generic or programmatic issues. There have been 25 CARs issued to date in 1990, compared to 71 at this date in 1989.

The Escalation Program was implemented in October 1989 and was refined during 1990. Escalations are used to refocus management attention on the resolution of problems when the normal process appears not to be working as well as it should. During 1990, approximately 65 QDRs and CARs were escalated to senior management for resolution. The primary reasons for escalation were (1) an acceptable response was not received within 30 days, (2) committed actions were not timely or satisfactory, or (3) other significant issues required management attention.

The Stop Work Program was implemented in October 1990. Although four Stop Work Notices were prepared in 1990, it was not necessary to issue any of them since in each instance the line organization took appropriate prompt action to stop work until adequate control of the affected activities was established.

A Commitment Management Task Force was initiated to assess and refine the control of commitments and their tracking program. The

objective was to develop a single system to track all commitments ranging from regulatory commitments to individual QDRs. The tracking program will also identify the commitment, its "owner," and "due dates." QA actively participates on this task force since QA commitments and QA deficiency reports are tracked on this system.

QA has established a goal of performing at least one team inspection per year. The first, a Maintenance Vertical Slice Inspection, was performed in August 1989, using an outside contractor as the team lead. Although the inspection indicated that the PVNGS Maintenance Program was being satisfactorily implemented, it identified needed improvements. Nine (9) CARs were issued to address concerns related to such matters as control of vendor technical manuals, EER program and procedure effectiveness, and temporary modification control procedures. The nine CARs were closed out during this SALP period. The second team inspection, completed in August 1990, consisted of an SSFI of the diesel generator systems using another outside contractor as team lead. The inspection concluded that the diesel generator systems were in a satisfactory state of operational readiness; however, some concerns were noted, including:

- Alarm setpoints below vendor limits;

- Timeliness of corrective actions for these setpoints;

- Control of input data used in engineering calculations for diesel fuel oil storage tank volumes; and

- Meteorological conditions that may have exceeded HVAC heat load calculations for the diesel generators.

Resolution of these concerns is in process as QA involvement in engineering activities continue.

On March 19, 1990, QA issued a CAR identifying deficiencies in the timeliness of procedure and other document changes, to implement a decision made by APS in early 1989 to revise the quality classification of the emergency lighting system to Quality Augmented (QAG). At that time, APS did not recognize that UFSAR commitments required that fire protection systems, including emergency lighting, should have been classified QAG. Corrective actions to resolve this concern are described in recent correspondence to the NRC, including the November 15, 1990, response to the Notice of Violation and Proposed Civil Penalty. The corrective actions include implementation of compensatory measures for fire protection QA deficiencies and initiation of a detailed review and revision of various aspects of the Fire Protection QA Program. By February 1991, APS will have thoroughly reassessed the application of the QA Program to Fire Protection, and will submit the description of the revised Fire Protection QA

Program to the NRC.

In addition to the Fire Protection initiatives, a separate task force was developed (October 1990) to evaluate the extent of APS compliance with other important-to-safety QA commitments. The scope of this evaluation includes equipment and activities associated with Radioactive Waste Management, Radiation Protection, Emergency Planning, Security, anticipated transient without scram, post accident monitoring, station blackout, licensing conditions, and non-safety related equipment whose failure could prevent safety functions. This evaluation is currently underway with completion scheduled for February 1991.

Progress has been made in strengthening the QA Department and Programs; however, continued effort will be required to achieve management's expectations. The following activities are being emphasized to further improve and enhance QA Programs:

- Full implementation of the actions resulting from the internal assessment to enhance the QA Monitoring Program;

- Continued implementation of the "Graded Approach" both for inspection activities and other areas of QA as well;

- Continued performance of internal assessments of QA Programs to refine methods and improve effectiveness; and

- Completion of the development, approval, and implementation of the new QA Plan, which will be more operations oriented than the current FSAR and Operations QA Criterion Manual, and will also emphasize individual accountability at all levels of the organization.

MAINTENANCE/SURVEILLANCE

Both the Preventive Maintenance (PM) and Corrective Maintenance (CM) backlogs have been decreased significantly at PVNGS. Overdue PMs have decreased from 9.5% (November 1989) to 2.4% (November 1990). The backlog of CMs (priority 1, 2, 3 CMs greater than 90 days old) decreased from 63.4% (November 1989) to 52.5% (November 1990). Both the PM and CM backlog percentages are currently below the respective industry medians. The ratio of preventive to total maintenance items (the percentage of PM work packages completed divided by the total PM and CM work packages completed) has shown an overall improving trend at PVNGS over the past year.

An MOV Task Action Plan was created establishing a comprehensive overall schedule for MOV testing and upgrading. The scope of the task plan includes a review of NPRDS information on MOV concerns for applicability to PVNGS, developing and maintaining an MOV Performance Trending Program, and developing further guidance for the maintenance and testing of MOVs. Significant progress has been made toward the completion of baseline testing of safety related and important-to-safety MOVs (67% completed), as well as rotor rewiring (40% completed). Calculation methods for determining torque switch setpoints have been standardized and improved. Procedures have also been developed for the assembly and disassembly of MOVs.

Future actions include completion of: (1) the testing and rewiring of the remaining MOVs; (2) MOV procedure reviews and approvals; and (3) torque switch setpoint calculations required by GL 89-10. The results of this MOV Task Action Plan are expected to provide PVNGS with a more comprehensive, consistent, and technically precise MOV Maintenance and Testing Program. The MOV Task Plan is integrated into the PVNGS Business Plan.

The Preventive Maintenance Task Force (PMTF) was established in April 1990, in response to an INPO recommendation that APS review the Preventive Maintenance (PM) activities at PVNGS. The PMTF is responsible for a complete evaluation of the PVNGS PM Program and implementing necessary changes.

The PMTF is evaluating the PM tasks to be performed on each component using a process similar to Reliability Centered Maintenance (RCM) concepts (which employ more analytical methods), but rely more on actual past equipment performance, maintenance history, plant experience and trends rather than theoretical analysis. Recommendations are reviewed and approved by Site Engineering and, where applicable, are compared to those made by the PVNGS RCM analyses which were completed on nine systems. Lessons learned from the comparison are used to refine the analyses.

Systems are being evaluated to ensure that applicable and effective

PM activities are being performed, including the Predictive Maintenance Programs being developed by Site Engineering (e.g., vibration monitoring, oil sampling, non-intrusive check valve inspections, thermography, megger trending, and motor operated valve diagnostic testing).

Evaluation and approval of one system has been completed by the PMTF. Six additional systems have been evaluated, with review and approval of the results now underway, and another system is presently being evaluated. One hundred five (105) systems are scheduled to be completed by December 1991.

The bases for the PM activities is being documented. These bases consist of information (vendor recommendations/regulatory requirements, PMs to be performed and basis/justification) that will support the PM program for each component. The bases are being documented in parallel with the system evaluation discussed above.

As another PMTF initiative, the existing administrative procedures and Station Information Management System (SIMS) computer programs for the control and implementation of the PM program are being revised to streamline the process and improve the program for keeping the PM bases current. The changes identified will result in improved data security and quality within the SIMS Repetitive Maintenance Data Base. They will also facilitate improved resource

utilization and closer management oversight of the effectiveness of the program. The initial changes have been identified and prioritized. The detailed plan for their implementation is being finalized. The initial SIMS changes are scheduled to be implemented by July 1991. The initial procedure changes are scheduled to be completed by March 1991.

The Maintenance Improvement Program includes approximately 40 tasks required to address priority maintenance issues, programs, or projects. These tasks include development of electronic control and tracking of special-use tools, standard equipment specifications for corrective maintenance, and also developing job performance objectives for a maintenance refueling team to improve outage planning, scheduling, and management.

A Work Control Task Force was assembled in May of 1990 to perform a detailed self-assessment of the work control process, make recommendations, and ensure implementation of the required changes. The results that have been realized during this year from these efforts include:

- Implementation of a writer's guide for procedures and work orders.

- Implementation of a 12-week integrated schedule program for the three Units and Central Maintenance, allowing the

organization to plan activities (personnel, parts, schedule) 12 weeks ahead.

- Initiation of a model work order development program was initiated (providing pre-constructed work orders for a particular job) to improve consistency in planning efforts and provide standardized guidelines for work package development. The maintenance goal is to pre-approve 300 such model work orders by the end of 1991. To date, eight have been approved, 65 are in the approval cycle and 155 are under development.

Work Control procedures were also revised to include electronic routing of work orders and clarify tasks, responsibilities, and the line of personnel accountability. The electronic routing of work orders expedites the planning and scheduling process and takes advantage of expanded and parallel work reviews to use site manpower more efficiently.

Parts availability for maintenance has been improved by revising the material requisition guidelines and utilizing the 12-week integrated schedule. A modification to the operation of the protected area warehouse, which will be fully implemented by January 1991, will allow for prestaging parts within the protected area and increase the maintenance effectiveness and productivity by reducing the time it takes to obtain required parts and materials during maintenance activities.

The Maintenance Standards group will be utilized to augment the unit maintenance staff during critical needs and outages. This organizational change also fosters increased cross training between standards and line personnel.

Problems were identified in the last SALP report regarding planning, scheduling, and performance of maintenance activities. To effect improvement, APS has issued further procedural guidance, increased administrative controls, and implemented the 12-week integrated schedule program. Management continues to monitor performance to assure that these, and other initiatives described above, are having the desired effect.

RADIATION PROTECTION/CHEMISTRY

APS has modified the Radiation Protection and Chemistry organizations to improve performance in both areas. The RP and Chemistry groups have been separated to facilitate closer management oversight by providing a site general manager to head each discipline. The Site General Managers report directly to the Vice President, Nuclear Production. An RP manager is assigned to each PVNGS unit. The Unit RP Managers report to the RP Operations Manager who reports to the site RP General Manager. The RP Operations Manager function is expected to enhance consistency and communications between the units. Additional changes to the RP organization include the establishment of unit RP Supervisors, unit RP Technical Coordinators, and a Radioactive Material Control Supervisor.

Radiation Protection:

The PVNGS Radiation Protection (RP) Program has been implemented safely and adequately in 1990. Several indicators show that changes made in the RP area are having an effect. Contamination events have decreased from an average of 235 events per unit in 1989 to a projected 137 events per unit in 1990 (Unit 1, 160; Unit 2, 202; and Unit 3, 50). The 1990 total is thus expected to be significantly lower than the INPO 1989 industry average of 163 events per unit. The number of Unit 1 personnel contaminations is projected to be approximately one-half of its best previous yearly

total.

Occupational radiation exposure has decreased from an average of 223 man-rem per unit in 1989 to a projected 169 man-rem per unit in 1990 (projected unit totals are: Unit 1, 163; Unit 2, 323; and Unit 3, 21). The 1990 total, as well as the 1989 total, would place PVNGS well within the INPO 1987-1989 industry average best quartile of 238 man-rem per unit. The improvement at PVNGS over the 1989 total must be attributed in part to the reduction in outage time in 1990.

The volume of radioactive waste generated decreased from an average of 12,142 cubic feet per unit in 1989 to a projected 7,621 cubic feet per unit in 1990. This is higher than the INPO 1989 industry average of 7,133 cubic feet per unit; however, if corrected for a zero release site (no liquid releases), PVNGS would be approximately 18% below this average. To achieve further decreases in the volume of radioactive waste generated, a Radioactive Waste Minimization Task Team was created and is currently addressing this issue.

There is a variation in the RP indicators among the three units; however, operating history has a major impact on this data. Unit 1 RP dealt with an average of 200 outage days per year from 1987 to 1989 and over 100 days of unplanned outages in 1990. This directly affects the number of maintenance-related man-hours and,

therefore, increases personnel exposure, personnel contaminations, and radioactive waste generated. Unit 1 RP performance, although in need of increased management attention, approached its best year in terms of radiation exposure.

The long outages of 1989 and 1990, coupled with the length and uncertainty of the RP reorganization, appear to have had a negative impact on the morale of RP personnel. This has been manifested in communication problems within the RP organization, as well as an increase in the number of employee concerns. The addition of the RP Operations Manager, other key RP personnel changes, and the recent period of consistent power operations are expected to improve morale and re-establish good teamwork and communications within the RP organization. APS management is monitoring this area closely to assure that necessary improvements are realized.

Management attention to the RP Program was intensified during the past year. The site RP General Manager attends daily staff meetings with the Vice President, Nuclear Production, where radiological problems or concerns are discussed. The RP General Manager also conducts a series of update meetings each quarter in which he meets with the site RP staff in small groups in an open-forum meeting format.

The ALARA committee has been restructured to include permanent members at a higher level of management to ensure that ALARA

concerns receive appropriate attention. In addition, the Corporate Assessment Group, discussed above in the Safety Assessment/Quality Verification (SA/QV) section, includes a line manager from the RP organization, on loan to this group to provide RP Program oversight functions.

The RP organization and organizational responsibilities have been modified to promote a more active RP role in work planning and outage management. Unit RP ALARA/Work Control Supervisors interface directly with the work control/outage planning groups to screen RP tasks for priority/applicability. Staff qualifications also have been improved; the RP staff currently includes four certified health physicists, two of whom have held Senior Reactor Operator Licenses and another who is a National Voluntary Laboratory Accreditation Program (NVLAP) Assessor.

RP training has been improved as shown by the following examples:

- Training content has been enhanced based on feedback from the units.

- Academic training has been developed and is being implemented for new hires.

- Hands-on laboratory training has been developed and is being implemented for RP count room equipment and being

finalized for the Radiological Records and Access Control System (RRACS).

- Hot Particle Training was developed and implemented.

- A more detailed On-The-Job-Training (OTJT) Program for RP personnel has been developed and is being implemented.

- Personnel training at the Instrument Calibration Facility is being enhanced. (Source custodian training is in progress.)

- After-hours instruction and counseling was provided for RP personnel preparing to take this year's National Registry of Radiation Protection Technologists (NRRPT) examination. APS management emphasis on continuing education was responsible, in part, for 36 RP personnel taking the 1990 NRRPT examination while 9 RP personnel took the 1989 NRRPT examination.

Other RP Programs and improvements include:

- The Radiological Controlled Area (RCA) ingress and egress methods have been standardized among the units for ease of use and familiarity.

- The Cobalt Reduction Program has begun locating the cobalt bearing components within plant systems.

- A Quality Circles Task Team was assembled to reduce the frequency of personnel contaminations at PVNGS. The Task Team, consisting of personnel from a range of disciplines, including RP, Central Maintenance, and RP Technical Support made a number of recommendations which are in the process of implementation.

Chemistry:

During the past year, APS has undertaken a major effort to upgrade the secondary plant on-line chemistry analyzers. Monitors on the steam generator blowdown and downcomer lines have been upgraded to include on-line sampling for sodium and cation conductivity, and a computer based data storage and retrieval system for the associated new equipment has been provided. New chart recorders have been installed at the blowdown and condensate demineralizers, and on-line sampling equipment is being replaced in order to ensure proper functioning of the recorders. The temperature control system for the laboratory sample racks has been modified to enhance its effectiveness. The cold labs are scheduled to be remodeled during the next refueling outage for each unit to install new panels and analyzers including an on-line ion chromatograph.

Problems with intrusion of anion and cation impurities have been

reduced but are still under investigation. Currently, a task force consisting of Unit Chemistry, Chemistry Technical Services, Engineering, Operations, and Operations Standards meets on a weekly basis to resolve issues associated with the condensate demineralizers.

Changes also have been made to improve the performance of the Radiation Monitoring System (RMS). A site RMS/effluent supervisor position has been filled, along with Unit RMS/effluent supervisors and technicians. In addition, a group dedicated solely to RMS maintenance has been created and is currently being staffed. The RMS Technician Training Program has been upgraded and implemented and now includes a 13 week class followed by on-the-job (field) training, which mirrors the accredited chemistry training program.

While several RMS design changes have been implemented, several others are required and have been scheduled in order to maintain RMS availability as high as possible. The total availability (functional and on-line) of all radiation monitors has improved from 80% in February 1990, to approximately 95-100% in October 1990. The current technique for calculating availability, uses a daily "snapshot"; however, the site RMS group is developing more precise techniques to trend the percentage availability of all Technical Specification and Non-Technical Specification monitors.

While the number of RMS induced reportable events has been reduced

from 11 in 1989 to 4 thus far in 1990 (and has consistently trended downward from 1985), the number of special reports has increased this year. As maintenance/surveillance activities for RMS have become more frequent and aggressive, the number of special reports submitted by PVNGS increased because the maintenance activities often could not be completed within the 72-hour action statements. In addition, there were more monitors subject to surveillance this year due to the increased operability of the units.

The problems with maintaining nitrogen overpressure in the Steam Generators, first identified by the NRC during the diagnostic evaluation, did not receive sufficiently prompt attention. The reorganization described above; however, should provide a more open line of communication and increased management involvement in the Chemistry Program.

Other areas for improvement and future challenges include completing the design changes for radiation monitors, completing the effluent procedure upgrades before December 31, 1990, and maintaining or improving a chemistry performance index (relative indicator of overall systems impurities) of 0.18 in 1991.

SECURITY

The Security initiatives taken this year have resulted in measurable improvements. For example, security compensatory manhours have decreased from 4,605 in January 1990, to 606 in November 1990. The one-hour reportable events have decreased from six during 1989 (system and human error) to three through November 30, 1990. However, the 24-hour loggable events (system and human error) have increased from 412 in 1989 to 422 through November 30, 1990. This is due, in part, to implementing more conservative reporting/logging criteria than was used in 1989. Further attention is required; however, to effect a reduction in the number of 24-hour loggable events. To strengthen the Security Program, APS took the following actions during the past year:

- In January 1990, the position of Manager, Security, was filled with an individual with more than 19 years of security and law enforcement experience and nine years experience managing successful security programs at various nuclear utilities.

- The Security Department was reorganized in early 1990, by separating it into Operations, Training and Support, Compliance, Badging and Access Control, and Administration and Maintenance. The reorganization identifies more clearly responsibilities and

accountabilities at a senior and supervisory level, with well defined reporting relationships to the new manager.

- The Central Processing Facility which became operational in April 1990, has improved control of processing and exiting site personnel, and improved processing efficiency. The typical processing time for new personnel has been reduced from 21 days in 1989 to five to seven days in 1990.

- APS now performs background screening investigations, instead of relying on an outside contractor. In-house screening minimizes the potential for screening errors and also provides a higher degree of assurance that processing is performed in accordance with regulatory requirements and PVNGS commitments to the NRC.

- Actions to improve intra-department communication include a manager's suggestion box; expanded shift visits by Security supervisors; weekly department bulletins, more frequent meetings among Corporate Security, Security contractors, supervisors and department personnel, and initiation of a department team building project. Effective communication and attention to morale concerns will continue to be a focus of management attention in 1991.

- An on-going Security Incident Review Committee was established to perform incident evaluations and root cause analyses. These assessments are formally documented and identify required Corrective Actions. As a result of these enhancements, the number of door alarms and human errors have decreased. A site-wide Security Awareness Program has been implemented to further reduce human errors, which is one of the primary objectives of the Security organization.

- A program has been initiated to qualify Palo Verde support area Security contractors for duty in the protected and vital areas. Currently, approximately half of the support area security contractor personnel are nuclear qualified and rotated approximately every 60 days from the support area to the protected area to maintain proficiency. As a result, they are available as a ready reserve for unplanned outages and other contingencies. This program is scheduled to be fully implemented by the end of December 1990.

- A program was undertaken to broaden Security force knowledge of nuclear industry security practices through plant visits, seminars, and training. This included 41 Security personnel participating in 40 hours of

supervisory training, as well as contracting an industry leader for conducting quarterly Design Basis Threat Drills.

- To strengthen the escort, Vital Area and Positive Access Control Programs, APS has delineated escort responsibilities through site bulletins, procedural revisions, and monthly unit manager meetings. Special identification is issued to escorts regarding responsibilities while escorting visitors in the protected and vital areas. APS has also implemented a more effective Access Control Program requiring one entry per key card transaction when entering the protected/vital areas.

- A policy of pay incentives for physical agilities, weapon qualification and Designated Armed Response Team (DART) participation has also been implemented.

During 1990, APS engaged a security contract company (Protection Technologies) with previous successful nuclear experience to supplement the proprietary guard force. Protection Technologies turnover rate to date is 3% versus 13.5% by the previous contractor in 1990. A change in security force shifts from 12.5 hours to 8.3 hours has contributed to a reduction of overtime (30.5% during January 1990 versus 7.7% during November 1990). The 1990 attrition

rate for members of both the proprietary and non-proprietary guard force has been reduced from 5% and 60%, respectively, in 1989 to 3.5% and 3% to date in 1990.

Improvements to the Closed Circuit Television (CCTV) system include:

- An additional monitor was installed in both the Central Alarm Station (CAS) and the Secondary Alarm Station (SAS) to allow operators to view two simultaneous alarms.

- Preventive Maintenance tasks for the security cameras have also been enhanced, resulting in significantly improved CCTV performance.

- A long term security system upgrade was begun to replace cameras, realign the security fence, and balance the security lighting (this upgrade is expected to be completed in 1992).

- The security procedure that provides operability requirements for the cameras was enhanced by the addition of camera image/quality criteria.

To reduce the number of spurious perimeter alarms an improved technique was adopted for microwave alignment, utilizing a LASER

device in boresighting; comprehensive microwave bench calibration and field alignment procedures were developed to standardize field setups; and performance and test criteria for microwave equipment were established. These efforts reduced the 1990 perimeter alarm rate (for a 10 month average) to 1.9 alarms/zone/day from the rate of 3.56 over the same period in 1989. A plan was also developed and implemented in September 1990, to reduce the number of spurious intrusion and tamper alarms. The initial results have shown a decrease in alarms; however, it is too soon to assess this program for effectiveness.

Other equipment improvements included microwave equipment upgrades to the newest revisions, camera housing upgrades for better environmental protection, and the cardreader assembly upgrades to eliminate reading errors. Additional cardreaders were installed to facilitate meeting emergency assembly and accountability requirements. A comprehensive computer system performance monitoring package was developed to aid troubleshooting and assess system performance. Software changes were made to eliminate opportunities for human error and improve on past corrective actions for the access control computer. Hardened chains and padlocks were installed to address the vulnerabilities of the personnel access hatches to containment. Finally, the planned upgrade for the roll-up door for Unit 1, which was discussed in the 1989 SALP report, was completed, as was the installation of a shade tarp over the south sallyport.

A comprehensive Preventive Maintenance Program for security equipment has been implemented this past year, and has resulted in improved equipment reliability. Maintenance teams responsible for specific areas of security equipment were established, a comprehensive qualification and training program was initiated for security equipment maintenance technicians, and work scope was evaluated and adjusted to include only security system related tasks. Maintenance procedures, including Preventive Maintenance tasks, associated with Security were reviewed and rewritten and new model work instructions were implemented. Maintenance activities relating to Security included completion of a computer development system and equipment test stands for all system equipment. Timely identification and resolution of technical issues, as well as aggressive resolution of maintenance issues, have been reflected in the improving trend in security compensatory man-hours as well.

Training enhancements that have been realized this SALP period, include more frequent drills on design basis threats, the DART program, classes on hostage negotiation, Security Supervisor Training (40 hours of classes), qualification and training program for maintenance technicians, and participation with the local law enforcement agency and the U. S. military in joint exercises.

APS has designated a single point-of-contact within Security for

daily work planning within the units to assure that there is timely review of the potential security implications of planned temporary modifications and implementation of any necessary security compensatory measures.

Many of the Security improvements described above were reviewed during the recent NRC unannounced inspection (August 1990), during which all but one outstanding inspection item was closed and improvements were identified in the reliability and quality of passive and active security equipment.

ENGINEERING/TECHNICAL SUPPORT

To improve teamwork and coordination between the Nuclear Engineering and Site Technical Support Departments, APS has realigned reporting relationships. The Vice President, Nuclear Engineering and Construction, is now responsible for all engineering departments, including Site Technical Support, Nuclear Engineering and Support Services, and Site Nuclear Engineering and Construction. Having a single officer responsible for all engineering groups is expected to improve the efficiency and effectiveness of technical support of PVNGS operations.

Technical Support

The position of Director, Site Technical Support, was filled in April 1990, by an individual with over 20 years experience in the nuclear industry and extensive experience in technical management. Under the Director are managers of: Systems Engineering; Component and Specialty Engineering; Operations Engineering; and Operations Computer Systems.

The division of responsibilities between Systems Engineering and Component Engineering is intended to make more efficient use of PVNGS technical resources. Systems Engineering focuses on system availability and overall system performance. The systems engineer is responsible for monitoring system performance and identifying actions that should be taken to assure high system reliability and

availability. He monitors the activities affecting his assigned systems to assure that the systems continue to meet design requirements, and maintains overall cognizance of system operation and maintenance. The Component Engineers are maintenance oriented experts on specific components or equipment and the processes that support component operation (e.g., valve packing, pump seals). The Component Engineer assures that assigned components are properly maintained by providing component-specific expertise to the System Engineer and Maintenance Personnel. Component Engineering also monitors equipment performance and maintenance practices and addresses component performance issues across system boundaries.

The new roles of Component and System Engineering have been established to promote a more thorough analysis of component/ systems issues. This restructuring has already shown improved technical support effectiveness. Examples include:

- Development of a new Control Element Drive Mechanism (CEDM) test to reduce the probability of Control Element Assembly (CEA) slip or drop events. This testing revealed previously unknown failure mechanisms for CEAs which were promptly evaluated and rectified.

- During feedwater isolation valve failures, System Engineering made timely evaluations, identified other potentially affected O-ring uses at PVNGS and coordinated prompt resolution (i.e.,

replacement) with Operations and Maintenance personnel.

- Engineering coordination between groups in addressing the auxiliary feedwater overspeed conditions resulted in thorough system evaluations and subsequent system redesigns to maintain piping temperature requirements.

- Engineering stopped Unit 2 refueling to require more lighting based on previous operational experience at another PVNGS unit.

Continued improvement was also noted in the areas of root cause determination. Examples of important root cause determinations made this year include identification of the causes of:

- Tube leaks in Unit 1 Steam Generator.

- Cooling tower degradation and recommendation of sealing coating to extend their life.

- Premature tripping of Unit 1 turbine on overspeed.

- Cathodic protection problems and identification of corrective actions.

- Unit 3 demineralizer B problems (clogged sample line).

To increase day-to-day involvement with plant activities, Technical Support has designated liaison engineers (from Systems Engineering) in each unit, whose functions include communicating the daily concerns associated with plant activities to technical support management. A duty Engineering Manager and supervisor now provide coverage on holidays and weekends as well. These changes, along with the daily unit meetings with Engineering supervisors, weekly technical support groups meetings, and Engineering staff meetings with unit personnel have improved communications between the unit support groups and Engineering.

Engineering

To address the need for Nuclear Engineering to be more involved in plant engineering issues, a Site Nuclear Engineering and Construction organization was established in April 1990. This group provides additional support and site coordination for modifications, design changes, procurement, and nuclear projects. The position of Director was filled in July 1990, by an individual with over 30 years experience in the nuclear industry, including approximately 15 years in technical management. The organization staffing is continuing.

Engineering has developed and implemented a Performance Management Program which assesses engineering performance in many areas (e.g., effectiveness of plant modification processes, timeliness of

commitment resolution, and updating of design documents). Engineering issues monthly reports to management, recommending improvements and changes to engineering methods and practices. Results this year included the development and implementation of a procedure, based on NUMARC guidelines, for evaluation and resolution of open items generated from the Design Basis Program. In addition, a new output Document Change Request Procedure was implemented to provide a more effective mechanism for screening and prioritization of work.

The first five reconstituted design documents (manuals) were issued for use. This long term effort is evaluating approximately 170 systems, structures, and topical issues by reviewing the applicable design and regulatory documents and creating a user friendly comprehensive design document for use when performing modifications, 50.59 evaluations, and related system analyses.

Other initiatives and program improvements include:

- The development of an engineering partnership with Bechtel and Sargent & Lundy. The contractor support organization is familiar with PVNGS and provides a more consistent engineering product.

- Engineering has reviewed the backlog of completed design packages awaiting implementation. This review assessed

the relative priority of design packages and whether the reasons for the design packages are still valid. A number of proposed changes were cancelled. These efforts will optimize manpower utilization and minimize changes to the units.

- A job task analysis has been completed to determine the qualifications required for various functions in Nuclear Engineering. As a result, job requirements have been rewritten and training requirements established to better match engineering tasks with corresponding qualification requirements. This effort will be expanded to include other PVNGS engineering groups.

- In 1989, the EER Backlog Reduction Program defined a scope of work and completion goals for 1990. As of August 31, 1990, the goal for 1990 had been achieved (closure of 5,345 items, approximately 65% of identified scope), and work was continuing to further work off the backlog. During this time; however, the number of total backlog items increased from 7,575 to 8,392. Efforts continue to reduce backlog items accrued during 1990, which are outside of the scope of the 1989 EER Backlog Reduction Program.

There has been substantial progress in implementing the Engineering

Excellence Program. Created to address changing needs and priorities of Engineering, this program has several more specific objectives, including improved configuration management, procedures upgrades, enhanced analytical capabilities, and design basis reconstitution. The program encompasses 153 major tasks, of which 112 have been completed. Results achieved this year include establishment of a Plant Modification Committee (PMC) to evaluate modification priorities and propose changes, to review and upgrade, as necessary, engineering procedures and policies; to assess the need for unitized drawings; and development of a pilot program for evaluation of vendor technical manuals (resulting in a program to upgrade all manuals by December 1992). The Engineering Excellence Program activities shall be integrated into the Business Plan by December 1990. The program will be further refined to incorporate lessons learned as new priorities and issues are identified.

Over a dozen engineering codes have been purchased as part of the Engineering Excellence Program. Training has been provided to the Engineering Department personnel on selected engineering skills and on the use of the engineering codes. These efforts have started to yield tangible results. For example:

- ANSYS (a finite element analysis program) is being used to evaluate several proposed changes to the B04 control room panel and in material restraint analysis. ANSYS has also been used on several problems relating to stress overloads on

various components.

- ME-101 (stress analysis) is being used in the Snubber Reduction Program.

- SETS and CAFTA are being used to address the IPE requirements.

- Easy5 (modeling) was used to solve a heat transfer problem for the nitrogen accumulators on the ADV's.

As more of the codes are installed and qualified, their use is expected to have a significant positive impact on the quality and productivity of the engineering groups.

Areas that require continued management attention include focusing the engineering organization on the needs and priorities of the units, completing staffing within design engineering, and completing the backlog reduction program by 1991. Engineering had initial problems with this years modification to install new emergency lighting and field change requests were required to correct the design problems. The design problems with emergency lighting modifications were rectified and procedure changes are in process to provide more guidance for emergency lighting activities and equipment.

Increased resources were required to address MOV concerns and the

MOV group within engineering added four engineers to better address the MOV Program. Their efforts, including defining the work scope necessary to meet GL 89-10 requirements, were instrumental in the MOV Program improvements detailed above in the Maintenance section.

Engineering also identified problems with the fire rating of diesel generator wall seals. It was later discovered that the scope of the initial evaluation was not broad enough as some seals at lower elevations were missed. As a result of a root cause analysis of this problem the surveillance procedure was revised to include seals at lower elevations and output documents were revised (penetration schedule and location drawings) to reflect actual plant conditions. In addition, a comprehensive program was initiated to verify all fire seals in the plant for functionality.

EMERGENCY PLANNING

A more aggressive and comprehensive drill schedule was implemented in 1990 to increase the level of experience and capability of the Emergency Response Organization (ERO) and enhance its capability. The 1990 schedule provides for quarterly full scale drills supplemented by unit and facility functional drills (compared to the previous year's schedule, which called for one evaluated exercise and one full scale drill). PVNGS expects to retain this new schedule permanently. The 1990 schedule has allowed more personnel, such as alternates and backups, to participate in drills and gain useful experience. In conjunction with this, Emergency Planning tracks personnel participation history in order to assure that the staff receives enough drill experience in the various roles that they may be assigned in a real emergency.

PVNGS Emergency Planning has been involving new management with the Emergency Plan and assimilating them into the ERO. As a result, the ERO positions that have been filled by new management personnel include:

- Radiological Assessment Coordinator
- JENC Utility Spokesperson
- Emergency Coordinator(s)
- Operations Support Coordinator (s)

- Chemistry Coordinator(s)
- Security Director
- Emergency Operations Director(s)
- Emergency Maintenance Coordinator

Emergency Planning full time staffing has also continued to improve. Two of the three positions that were open in late 1989, were filled this year. One was filled with an individual with 15 years RP experience and another individual with an SRO License from another plant and over 20 years experience. Additionally, experienced contract support continues to be available to augment the current Emergency Planning staff.

In order to ensure APS's ability to respond to an emergency in a timely manner, Emergency Planning has implemented unannounced time response studies wherein key facility activation personnel are paged and their response times from their actual locations recorded. The response time reported for each key position is used to determine overall facility activation time. These studies are conducted on backshifts and demonstrate the activation times which are within NUREG guidance. This is a continuing effort which will be used to detect changes in overall response time capability.

The new Fitness For Duty regulations provided new challenges for maintaining an ERO capable of responding at any time, consistent with the new regulations. Consequently, PVNGS established a

rotational duty officer schedule for key TSC, EOF and OSC staffing to ensure ability to respond at any time with qualified personnel meeting Fitness for Duty requirements.

Last year, Emergency Planning identified a concern with the numbers of ERO personnel who were overdue for annual training each month. Due to the number of personnel assigned to each position, PVNGS maintained adequate coverage with qualified personnel at all times; however, the percentage overdue ran as high as 4% last year. Attention to this issue and increased support from the new management team has reduced the overdue percentage to less than .5% this year.

Various facility and hardware enhancements have been made to improve the overall program, including:

- Upgraded telefax equipment in all emergency response facilities.

- Improvements to the EOF facility, including upgraded furnishings and dedicated work stations to improve sense of professionalism, cut down on unnecessary traffic, and reduce noise.

- Planning scenario development and drills.

Management has re-prioritized work items to ensure completion of some long standing hardware modifications to improve the Emergency Response Program. One example is the utilization of ACAD cardreaders. The addition of cardreader installations in the Operations Support Centers and in the Technical Support Center significantly enhanced personnel accountability capability within the protected area. This, coupled with modifications to ACAD system software, facilitated the performance of two successful assembly and accountability drills in July 1990 (one on dayshift and the other on backshift). Both drills conformed with the NUREG-0654 guidance of providing for identification of personnel within the protected area within 30 minutes. At the commencement of the dayshift drill, 1,068 employees were inside the protected area. Of those, 752 non-emergency response personnel exited to the assembly area and 316 manned emergency response positions within the protected area.

As discussed in the Operations section above, during the Unit 3 transformer fire in December 1989, PVNGS did not declare an NUE. APS initiated timely corrective actions to revise EPIP-02, "Emergency Classification," to provide additional specificity on the declaration of an unusual event for fire initiated events.

Two proposed modifications that remain to be addressed are the public address system upgrade and the augmentation of sirens. Resolution of the siren problems depends on a telecommunications cabling upgrade (removing abandoned cable and replacing with new cable). Both of these items will receive continued additional attention by Emergency Planning and are long term issues for resolution. However, there are compensatory measures in place for both the public address and siren problems; a security callout and walkthrough of the affected areas.

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1.0 PURPOSE

Arizona Public Service Company (APS) submits this application pursuant to Arizona Administrative Code R12-1-417.A, for approval to leave in place very low levels of licensed radioactive material on the Palo Verde Nuclear Generating Station (PVNGS) site. The disposal of this material is not currently authorized by the Palo Verde operating license(s). The subject material consists of sludge containing very small quantities of Cobalt-60 (Co-60), Manganese-54 (Mn-54), Cesium-134 (Cs-134) and Cesium-137 (Cs-137). The source of this sludge is from the PVNGS Unit 1 and Unit 3 cooling towers.

2.0 INTRODUCTION

On July 14, 1989, a sample of sludge was taken from the Unit 1 cooling tower inlet canal and analyzed for radioactive isotopes. Very low levels of three non-naturally occurring radionuclides; Co-60, Mn-54 and Cs-137 were detected, Unit 1 and Unit 3 cooling tower sludge had previously been disposed of in the Water Reclamation Facility (WRF) sludge landfill.

A sampling program was initiated the following day to verify the disposal location of the sludge in the WRF sludge landfill and characterize the types and levels of activity present in the cooling tower sludge. In general, cooling tower sludge consists of sand, dirt and debris carried into the towers with the air circulated by the fans and to a lesser extent calcium and magnesium salts precipitated when the cooling water is concentrated before blowdown to the evaporation ponds.

3.0 WASTE STREAM DESCRIPTION

Two primary routes exist for potential low levels of radioactivity to reach the circulating water system (and the cooling water sludge). The first requirement in either case is for an unusual condition, specifically, a primary to secondary leak to occur in the steam generator. Due to the higher pressure of the primary coolant, any small leaks will allow the radioactive coolant water to seep into the secondary system. The plant is designed with radiation monitors on the steam generator blowdown system to identify levels of radiation prior to the contamination in the secondary system becoming a source of offsite release of radiation. In addition, periodic samples are taken of the blowdown from the steam generators and analyzed for radioactivity, as well as chemical contaminants. These samples are more sensitive than the inline monitoring equipment.

Any contamination that does leak into the steam generator secondary side may be carried over in the steam (in very tiny water droplets) to the condenser or as very low levels of contamination left after blowdown. In the condenser, the radioactive material becomes part of the dissolved and suspended materials in the condensate.

The first and probably a minor pathway by which this contamination could reach the circulating water system (and the cooling tower), is by condenser reject to the circulating water system. The normal mode of operation is to reject or makeup water to the condenser from a condensate storage tank in order to control the water level in the hotwell. However, at times the condensate tank may be full when level is still increasing in the hotwell. At these times, the reject line is routed to the circulating water system instead of the condensate storage tank. Due to the very low concentrations of activity in the condenser hotwell water and the infrequency of reject directly to the circulating water, this route is considered as a probable minor pathway.

The second route for the contamination to take in order to reach the circulating system is through the low total dissolved solids (TDS) sump. Regeneration of the condensate demineralizers requires that the resins be transferred from the normal in process vessel to a regeneration skid. The regeneration skid contains three vessels, one cation, one anion, and a remix vessel. The spent resin is first transferred to the cation vessel. In this vessel, the resins are backwashed to remove the suspended solids which were filtered during the run cycle. In addition, the backwash separates the lighter anion resin from the heavier cation resin.

The lighter anion resin is transferred into the anion regeneration vessel and the cation and anion resins are regenerated with nitric acid and sodium hydroxide, respectively. The regenerated resins are then rinsed with demineralized water to remove traces of the regeneration chemicals. Both the regenerant waste and the initial rinse waters are routed through the high TDS sump to the chemical waste neutralizing tank. Both the regenerated anion and cation resins are transferred to the mixed holding vessel, the transfer water acting as a final rinse. This final rinse water is directed to the low TDS sump. The regenerated resins are simply held in the mixed vessel unit until the next inline vessel is exhausted and transferred into the vessel after regeneration of that vessel is started.

The waste water which was routed to the chemical waste neutralizing tank is sampled for chemical parameters and radioactivity prior to discharge to the retention basin. The low TDS sump water is not routinely sampled unless radioactivity may be present as previously indicated by activity in the chemical waste neutralizing tank. The low TDS sump water is transferred to the circulating water system directly.

It is felt that due to the backwash of the insoluble materials off of the resins, plus radioactivity eluding the chemical process of bonding to the resins, this low TDS sump condensate demineralizer regeneration water is the most probable source of the activity in the circulating water system

and hence the cooling tower sludge. Past history of the levels of activity seen in the low TDS sump do not exist. The activity level may have been below our ability to detect or it may have been less than our lower limit and was then concentrated in the cooling towers due to settling and evaporation.

In response to this suspected pathway, PVNGS has instituted a program of sampling for activity in the low TDS sumps if activity is seen in the steam generator blowdown (the location of our best sensitivity). Radioactivity would have to be present in this blowdown to be in the low TDS sump. In addition, a program to require sampling for radioactivity of materials which have a potential to be discharged into the Water Reclamation Facility sludge landfill will be placed into a procedure. PVNGS has also instituted an engineering analysis to determine optional methods of operation or engineering changes.

3.1 Sampling Locations

- Chemical Waste Neutralizing Tank

This was the primary sample location prior to the identification of activity in the Unit 1 cooling tower sludge. It remains a Technical Specification requirement to sample each batch at this location and confirm that concentrations of gamma emitting isotopes are less than 5E-7 μci/ml. Identification of activity above the stated limit requires sampling of all other discharge paths (turbine building sumps, low TDS sump, etc.).

- Retention Basin

This sample location is used for primarily chemical parameter control prior to discharge to the evaporation ponds. Routine radioactivity sampling of the sludge in this location is performed on a quarterly basis.

- Steam Generator Blowdown

Since the identification of low level activity in the Unit 1 and Unit 3 cooling tower sludge, the steam generator blowdown sample point has administratively become the indicator point for increased sampling of the low TDS sump, as well as other discharge paths to the evaporation ponds. Since activity in the system is concentrated in the steam generators, activity will be identified at this location before any other waste streams.

- Low TDS Sump

The low TDS sump would normally receive only clean water. However, in the event of a primary to secondary system leak, small amounts of radioactive contamination can be removed by the condensate demineralizers. During the regeneration process for this resin, backwash water, as well as final rinse water, may contain radioactivity and may be sent to the low TDS sump. By keying on the steam generator blowdown sample for indications of leakage, sampling of the low TDS sump can be initiated to minimize activity possibly being discharged to the cooling towers.

- Cooling Tower

Although sampling of the cooling tower circulating water has been a part of the normal sampling program, a requirement for the sampling of the cooling tower sludge for radioactivity prior to disposal has been added to ensure proper disposal, should low levels of activity accumulate in the sludge.

- Evaporation Pond

Sampling of the evaporation pond sludge is now performed on a quarterly basis. This sample point has been added to monitor buildup of activity in the evaporation pond sludge due to low level activity discharges,

4.0 DESCRIPTION OF WASTE

In general, cooling tower sludge consists of sand, dirt and debris carried into the towers with the air circulated by the blowers. Additionally, $CaCO_3$ and magnesium salts are precipitated when the cooling water is concentrated before blowdown to the evaporation ponds. This description compares with the general composition of the Water Reclamation Facility sludge. The composition of the typical sludge produced by the Water Reclamation Facility two-stage lime treatment process is as follows:

When Recalcining Furnace Is Not Operating	When Recalcining Furnace Is Operating
72% Ca as $CaCO_3$	15% Ca as $CaCO_3$
7% Mg as $Mg(OH)_2$	25% Mg as $Mg(OH)_2$
9% $Ca_5(PO)_3$ OH	35% Ca_5 $(PO)_3$ OH
5% Si O_2	16% Si O_2
6% other	9% other
100%	100%

To determine any activity or concentration of radioactive isotopes in the cooling tower sludge previously disposed of in the Water Reclamation Facility sludge landfill, two phases of sampling were initiated. The first phase ("Phase I") (July 15, 1989 through July 17, 1989) was designed to simply verify whether or not the cooling tower sludge deposited in the sludge landfill exhibited any radioactivity. Samples identified by color as cooling tower sludge were taken from selected areas. Cooling tower sludge is considerably darker in color than the Water Reclamation Facility sludge. In addition, samples were taken in a regular grid pattern within and just outside the area of known cooling tower sludge disposal. These samples established the outer boundaries of the area and identified that low levels of activity were present within the disposal area. The data from Phase I are listed in Table 4.0-1. The location of the sampling points is shown on Figure 4.0-1.

The second phase of the program ("Phase II") began on July 18, 1989 and was completed on October 12, 1989. This phase was designed to map the locations of the contaminated cooling tower sludge. Phase II included both surface and subsurface sampling. They are identified on the data table as surface, interface and subbase. The surface sample was taken from 1 to 2 inches. The interface sample was taken from a depth of approximately one foot at the interface between the bottom of the cooling tower sludge and the underlying material. This interface was identified by physical characteristics, usually color. The subbase sample was taken from the surface of the underlying material.

The data from Phase II are listed in Table 4.0-2. Figure 4.0-2 shows the sample locations for the sample analyses listed in Table 4.0-2.

COOLING TOWER SLUDGE SAMPLES FROM WRF LANDFILL
GAMMA SPECTROSCOPY RESULTS
Analyses by PVNGS Unit RP

SAMPLE #	SAMPLE SIZE	DESCRIPTION	DATE	Co-60 (uCi/gm)	Cs-137 (uCi/gm)	Mn-54 (uCi/gm)	Sb-125 (uCi/gm)
1-89-06192	1049 GM	A1 1-89-11256	7-15-89	<6.70E-8	1.16E-07	<4.31E-8	<9.26E-8
1-89-06193	1089 GM	A2 1-89-11256	7-15-89	<8.26E-8	<4.52E-8	<4.57E-8	<8.61E-8
1-89-06194	1061 GM	A3 1-89-11256	7-15-89	<5.50E-8	4.99E-08	<4.19E-8	<1.09E-7
1-89-06206	865 GM	B1 1-89-11256	7-15-89	<7.77E-8	5.72E-08	<4.44E-8	<1.15E-7
1-89-06207	997 GM	B2 1-89-11256	7-15-89	<7.39E-8	<4.55E-8	<3.93E-8	<1.04E-7
1-89-06202	985 GM	B3 1-89-11256	7-15-89	<5.68E-8	<4.99E-8	<3.38E-8	<7.85E-8
1-89-06204	803 GM	C1 1-89-11257	7-15-89	1.49E-06	2.12E-07	3.53E-07	<1.98E-7
1-89-06205	743 GM	C2 1-89-11257	7-15-89	2.52E-06	<9.76E-8	<9.74E-8	<1.82E-7
1-89-06256	884 GM	CC1 1-89-11364	7-16-89	8.96E-07	3.49E-07	2.52E-07	2.52E-07
1-89-06257	449 GM	CC2 1-89-11364	7-16-89	<1.52E-7	2.48E-07	<8.33E-8	<1.84E-7
1-89-06259	922 GM	CC3 1-89-11364	7-16-89	<4.49E-8	<3.57E-8	<2.45E-8	<6.68E-8
1-89-06260	704 GM	CC4 1-89-11364	7-16-89	<8.79E-8	<6.99E-8	<5.96E-8	<1.23E-7
1-89-06262	998 GM	CC5 1-89-11364	7-16-89	<3.59E-8	<2.27E-8	<2.58E-8	<5.60E-8
1-89-06265	1072 GM	CC6 1-89-11364	7-16-89	<3.70E-8	<3.07E-8	<2.26E-8	<6.67E-8
1-89-06266	1131 GM	CC7 1-89-11364	7-16-89	<4.36E-8	<2.50E-8	<3.22E-8	<8.08E-8
1-89-06267	1069 GM	CC8 1-89-11364	7-16-89	<4.19E-8	<2.83E-8	<2.27E-8	<6.96E-8
1-89-06299	1145 GM	OB1 1-89-11443	7-17-89	<6.31E-8	<3.60E-8	<4.59E-8	<8.38E-8
1-89-06300	1000 GM	OB2 1-89-11443	7-17-89	<3.97E-8	<2.73E-8	<2.09E-8	<5.79E-8
1-89-06301	945 GM	OB3 1-89-11443	7-17-89	<3.57E-8	<2.78E-8	<2.21E-8	<6.51E-8
1-89-06302	1133 GM	OB4 1-89-11443	7-17-89	<4.22E-8	<2.91E-8	<2.52E-8	<6.57E-8
1-89-06303	1019 GM	OB5 1-89-11443	7-17-89	<2.58E-8	<2.68E-8	<1.64E-8	<6.55E-8
1-89-06304	1762 GM	OB6 1-89-11443	7-17-89	<5.32E-8	<4.11E-8	<3.94E-8	<8.73E-8

Table 4.0-1

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A surface (a)	07/18/89	<3.1E-7	<1.1E-7	2.59E-6 ±0.07E-6	<1.1E-7	3.97E-7 ±0.33E-7	<2.3E-8	<9.0E-8	<7.4E-8	6.76E-7 ±0.46E-7	<1.0E-7	<1.1E-7	<3.3E-7	<2.7E-7	<1.8E-7	303
Site A interface (b)	07/18/89	<2.6E-7	<8.1E-8	1.08E-6 ±0.05E-6	<8.9E-8	2.39E-7 ±0.27E-7	<1.7E-7	<7.1E-8	<8.2E-8	3.20E-7 ±.033E-7	<8.9E-8	<8.8E-8	<2.4E-7	<2.1E-7	<1.2E-7	494
Site A subbase	07/18/89	<1.7E-7	<5.0E-8	2.7E-7 ±0.2E-7	<4.8E-8	6.1E-8 ±1.3E-8	<1.2E-7	<4.2E-8	<5.6E-8	1.15E-7 ±0.17E-7	<5.6E-8	<5.1E-8	<1.4E-7	<1.3E-7	<8.9E-8	552
Site A-1	07/24/89	<1.9E-7	<5.2E-8	5.03E-7 ±0.27E-7	<7.0E-8	1.04E-7 ±0.16E-7	<1.1E-7	<5.3E-8	<6.2E-8	1.35E-7 ±0.18E-7	<5.4E-8	<5.7E-8	<1.5E-7	<1.5E-8	<8.7E-8	431
Site A-2	07/24/89	<1.5E-7	<4.8E-8	6.83E-7 ±0.25E-7	<5.5E-8	1.22E-7 ±0.14E-7	<1.0E-7	<4.2E-8	<4.7E-8	1.84E-7 ±0.17E-7	<4.6E-8	<5.2E-8	<1.4E-7	<1.3E-7	<7.4E-8	412
Site A-3	07/24/89	<1.7E-7	<6.1E-8	6.69E-7 ±0.33E-7	<6.5E-8	1.82E-7 ±0.20E-7	<1.4E-7	<4.8E-8	<5.4E-8	1.95E-7 ±0.22E-7	<6.0E-8	<6.4E-8	<1.7E-7	<1.9E-7	<9.5E-8	464
Site A-4 (c)	07/24/89	<2.4E-7	<7.8E-8	1.90E-6 ±0.05E-6	<8.1E-8	4.11E-7 ±0.29E-7	<1.6E-7	<6.7E-8	<6.2E-8	5.03E-7 ±0.32E-7	<7.6E-8	<8.4E-8	<2.3E-7	<1.9E-7	<1.3E-7	348
Site A-5 (d)	07/24/89	<2.1E-7	<6.7E-8	1.06E-6 ±0.04E-6	<7.6E-8	2.48E-7 ±0.24E-7	<1.5E-7	<5.4E-8	<7.9E-8	2.62E-7 ±0.26E-7	<7.0E-8	<7.0E-8	<2.0E-7	<1.6E-7	<1.2E-7	484
Site A-6	07/24/89	<1.9E-7	<5.2E-8	3.84E-7 ±0.22E-7	<7.9E-8	5.53E-7 ±0.33E-7	<1.1E-7	<5.2E-8	<6.4E-8	1.08E-7 ±0.15E-7	<5.4E-8	<5.5E-8	<1.7E-7	<1.4E-7	<8.4E-8	486

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-7	07/24/89	<3.2E-7	<1.1E-7	1.58E-6 ±0.07E-6	<1.2E-7	3.22E-7 ±0.38E-7	<2.0E-7	<8.5E-8	<9.7E-8	4.03E-7 ±0.42E-7	<1.2E-7	<1.2E-7	<3.4E-7	<3.1E-7	<1.9E-7	379
Site A-8 surface	07/27/89	<2.7E-7	<6.6E-8	9.05E-7 ±0.35E-7	<6.8E-8	2.0E-7 ±0.2E-7	<1.5E-7	<8.8E-8	<7.4E-8	2.8E-7 ±0.2E-7	<6.7E-8	<6.4E-8	<1.9E-7	<1.9E-7	<1.2E-7	478
Site A-8 interface	07/27/89	<3.8E-7	<1.1E-7	1.47E-6 ±0.06E-6	<1.2E-7	2.1E-7 ±0.3E-7	<2.3E-7	<1.1E-7	<1.1E-7	7.0E-7 ±0.4E-7	<1.2E-7	<9.7E-8	<3.1E-7	<3.0E-7	<1.8E-7	415
Site A-8 subbase	07/27/89	<1.6E-7	<4.6E-8	<7.2E-8	<4.1E-8	<6.0E-8	<1.2E-7	<5.2E-8	<6.5E-8	<5.0E-8	<5.0E-8	<4.2E-8	<1.1E-7	<1.3E-7	<8.7E-8	698
Site A-8	07/24/89	<4.0E-7	<1.1E-7	1.56E-6 ±0.06E-6	4.31E-7 ±0.28E-7	1.67E-6 ±0.08E-6	<2.4E-7	<1.1E-7	<1.1E-7	3.71E-7 ±0.42E-7	<1.1E-7	<1.1E-7	<3.7E-7	<3.0E-7	<2.1E-7	392
Site A-9	07/27/89	<3.1E-7	<8.5E-8	8.59E-7 ±0.43E-7	<9.7E-8	1.1E-7 ±0.2E-7	<1.8E-7	<9.7E-8	<8.9E-8	2.6E-7 ±0.3E-7	<9.1E-8	<9.7E-8	<2.4E-7	<2.7E-7	<1.3E-7	480
Site A-10	07/27/89	<2.8E-7	<7.4E-8	7.87E-7 ±0.41E-7	2.04E-7 ±0.17E-7	8.02E-7 ±0.49E-7	<1.6E-7	<9.1E-8	<7.0E-8	2.0E-7 ±0.2E-7	<8.7E-8	<7.8E-8	<2.2E-7	<1.9E-7	<1.1E-7	481
Site A-11	07/27/89	<3.6E-7	<1.1E-7	2.30E-6 ±0.06E-6	<9.7E-8	3.3E-7 ±0.3E-7	<2.2E-7	<1.2E-7	<1.2E-7	6.1E-7 ±0.4E-7	<1.0E-7	<1.1E-7	<2.9E-7	<2.8E-7	<1.8E-7	352
Site A-12 (e)	07/27/89	<1.9E-7	<6.3E-8	7.8E-7 ±0.3E-7	<6.6E-8	9.5E-8 ±1.7E-8	<1.4E-7	<5.3E-8	<6.6E-8	1.9E-7 ±0.2E-7	<6.9E-8	<6.4E-8	<1.9E-7	<1.6E-7	<1.1E-7	487

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-13	07/27/89	<3.9E-7	<9.3E-8	9.91E-7 ±0.52E-7	<1.0E-7	2.2E-7 ±0.3E-7	<2.1E-7	<1.2E-7	<1.5E-7	2.6E-7 ±0.4E-7	<9.9E-8	<1.4E-7	<2.6E-7	<2.2E-7	<1.6E-7	443
Site A-14	07/27/89	<2.7E-7	<7.0E-8	5.03E-7 ±0.31E-7	<8.0E-8	2.6E-7 ±0.3E-7	<1.5E-7	<8.1E-8	<1.0E-7	1.1E-7 ±0.2E-7	<7.2E-8	<8.0E-8	<1.9E-7	<1.9E-7	<1.2E-7	585
Site A-15 (f)	07/27/89	<2.8E-7	<7.8E-8	1.22E-6 ±0.04E-6	1.9E-7 ±0.1E-7	6.7E-7 ±0.4E-7	<1.5E-7	<9.1E-8	<7.1E-8	2.9E-7 ±0.3E-7	<7.9E-8	<8.4E-8	<2.2E-7	<1.9E-7	<1.3E-7	456
Site A-16	07/27/89	<2.5E-7	<9.5E-8	7.78E-7 ±0.46E-7	<9.2E-8	1.6E-7 ±0.3E-7	<2.1E-7	<7.8E-8	<1.1E-7	1.9E-7 ±0.3E-7	<1.1E-7	<7.5E-8	<2.5E-7	<2.4E-7	<1.5E-7	460
Site A-17	08/03/89	<1.9E-7	<3.8E-8	1.34E-7 ±0.13E-7	<3.9E-8	<4.8E-8	<8.2E-8	<5.3E-8	<6.7E-8	<5.0E-8	<4.4E-8	<4.2E-8	<1.2E-7	<1.1E-7	<6.3E-8	527
Site A-18	08/03/89	<1.9E-7	<4.4E-8	<8.2E-8	<4.9E-8	<5.2E-8	<9.9E-8	<6.7E-8	<6.2E-8	<5.8E-8	<5.2E-8	<4.5E-8	<1.3E-7	<9.6E-8	<8.8E-8	550
Site A-19	08/03/89	<9.4E-8	<3.1E-8	<5.9E-8	<2.9E-8	<3.4E-8	<5.8E-8	<2.7E-8	<3.6E-8	<3.9E-8	<2.8E-8	<2.9E-8	<7.9E-8	<7.0E-8	<4.9E-8	517
Site A-20	08/03/89	<1.1E-7	<3.2E-8	<5.3E-8	<3.2E-8	<3.9E-8	<5.3E-8	<3.1E-8	<3.2E-8	<4.2E-8	<3.4E-8	<2.8E-8	<9.4E-8	<9.2E-8	<5.8E-8	539
Site A-21	08/03/89	<1.4E-7	<3.2E-8	<4.3E-8	<2.9E-8	<3.4E-8	<6.8E-8	<4.4E-8	<5.4E-8	<3.2E-8	<4.0E-8	<3.2E-8	<8.2E-8	<7.5E-8	<5.2E-8	497
Site A-22	08/03/89	<1.1E-7	<3.4E-8	<5.3E-8	<4.3E-8	<4.6E-8	<8.0E-8	<4.1E-8	<6.1E-8	<4.4E-8	<4.3E-8	<3.6E-8	<1.0E-7	<8.6E-8	<5.9E-8	516
Site A-23	08/03/89	<1.5E-7	<4.0E-8	<6.7E-8	<3.3E-8	<4.3E-8	<9.3E-8	<5.8E-8	<5.2E-8	<3.9E-8	<4.7E-8	<4.0E-8	<9.1E-8	<1.3E-7	<7.2E-8	586

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G
Site A-24	08/03/89	<1.3E-7	<3.5E-8	1.9E-7 ±0.1E-7	<3.8E-8	7.2E-8 ±1.1E-8	<7.9E-8	<3.5E-8	<4.5E-8	4.5E-8 ±0.9E-8	<4.1E-8	<4.0E-8	<1.1E-7	<9.7E-8	<6.3E-8	478
Site A-25	08/03/89	<1.2E-7	<3.1E-8	3.0E-7 ±0.2E-7	<3.6E-8	6.5E-8 ±1.0E-8	<7.6E-8	<5.3E-8	<4.0E-8	7.8E-8 ±1.0E-8	<3.5E-8	<3.5E-8	<1.0E-7	<1.0E-7	<6.6E-8	511
Site A-26 (g)	08/03/89	<1.8E-7	<3.8E-8	2.26E-7 ±0.14E-7	<4.6E-8	1.2E-7 ±0.1E-7	<8.7E-8	<4.8E-8	<5.5E-8	8.0E-8 ±1.1E-8	<4.5E-8	<3.5E-8	<1.1E-7	<1.0E-7	<6.7E-8	552
Site A-27	08/03/89	<1.7E-7	<5.1E-8	4.96E-7 ±0.22E-7	<4.8E-8	1.2E-7 ±0.1E-7	<1.0E-7	<5.3E-8	<5.6E-8	1.73E-7 ±.16E-7	<4.5E-8	<4.4E-8	<1.3E-7	<1.1E-7	<7.4E-8	544
Site A-28	08/03/89	<6.9E-8	<2.2E-8	<2.8E-8	<2.0E-8	1.2E-8 ±0.4E-8	<4.9E-8	<2.2E-8	<2.4E-8	<2.1E-8	<2.3E-8	<2.0E-8	<5.5E-8	<5.4E-8	<3.8E-8	599
Site A-29	08/03/89	<1.5E-7	<3.5E-8	1.3E-7 ±0.1E-7	<3.7E-8	<5.4E-8	<9.9E-8	<4.8E-8	<5.2E-8	<5.1E-8	<4.8E-8	<3.8E-8	<1.0E-7	<7.7E-8	<6.4E-8	540
Site A-30	08/03/89	<1.9E-7	<5.1E-8	4.7E-7 ±0.2E-7	<5.5E-8	1.2E-7 ±0.1E-7	<1.1E-7	<6.1E-8	<5.0E-8	1.4E-7 ±0.2E-7	<5.4E-8	<5.7E-8	<1.4E-7	<1.3E-7	<8.8E-8	511
Site A-31	08/03/89	<1.8E-7	<5.2E-8	5.62E-7 ±0.3E-7	<6.7E-8	2.7E-7 ±0.2E-7	<1.3E-7	<6.4E-8	<5.4E-8	1.6E-7 ±0.2E-7	<6.5E-8	<6.3E-8	<1.5E-7	<1.3E-7	<9.9E-8	549
Site A-32	08/03/89	<1.5E-7	<3.6E-8	2.15E-7 ±0.15E-7	<3.5E-8	<5.0E-8	<8.8E-8	<4.7E-8	<5.0E-8	4.6E-8 ±1.1E-8	<4.8E-8	<3.6E-8	<1.0E-7	<9.4E-8	<6.7E-8	556

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-33	08/03/89	<1.6E-7	<4.0E-8	<5.3E-8	<4.0E-8	<4.0E-8	<8.5E-8	<3.8E-8	<5.9E-8	<4.6E-8	<4.4E-8	<4.0E-8	<9.4E-8	<1.2E-7	<7.1E-8	540
Site A-34	08/03/89	<1.6E-7	<4.6E-8	<5.9E-8	<3.4E-8	<4.7E-8	<1.0E-7	<6.1E-8	<7.6E-8	<4.6E-8	<5.2E-8	<4.0E-8	<1.1E-7	<1.1E-7	<7.8E-8	560
Site A-35	08/03/89	<1.5E-7	<3.5E-8	<3.3E-8	<3.5E-8	<3.5E-8	<6.9E-8	<5.0E-8	<5.5E-8	<3.0E-8	<4.0E-8	<2.8E-8	<8.6E-8	<8.4E-8	<5.5E-8	528
Site A-36	08/03/89	<8.7E-8	<2.3E-8	<3.1E-8	<2.7E-8	<3.1E-8	<5.3E-8	<3.9E-8	<3.2E-8	<2.3E-8	<3.0E-8	<2.8E-8	<8.2E-8	<6.3E-8	<5.1E-8	465
Site A-37 (h)	08/03/89	<2.3E-7	<5.7E-8	1.85E-6 ±0.04E-6	<6.5E-8	2.72E-7 ±0.20E-7	<1.4E-7	<7.1E-8	<6.5E-8	4.07E-7 ±0.25E-7	<6.7E-8	<5.7E-8	<1.6E-7	<1.3E-7	<1.0E-7	416
Site A-38	08/09/89	<2.9E-7	<7.5E-8	8.1E-7 ±0.4E-7	1.1E-7 ±0.1E-7	4.7E-7 ±0.3E-7	<1.5E-7	<9.1E-8	<7.9E-8	1.6E-7 ±0.2E-7	<7.7E-8	<7.3E-8	<2.2E-7	<2.2E-7	<1.2E-7	465
Site A-39	08/09/89	<1.2E-7	<3.3E-8	1.34E-7 ±0.13E-7	<3.3E-8	<4.0E-8	<7.5E-7	<4.7E-8	<4.1E-8	<3.9E-8	<4.3E-8	<3.5E-8	<9.0E-8	<8.8E-8	<5.6E-7	453
Site A-40	08/09/89	<2.0E-7	<4.8E-8	2.2E-7 ±0.2E-7	<6.2E-8	1.4E-7 ±0.2E-7	<1.2E-7	<6.0E-8	<5.7E-8	4.6E-8 ±1.3E-8	<5.1E-8	<4.7E-8	<1.4E-7	<1.6E-7	<8.7E-8	518
Site A-41	08/09/89	<2.1E-7	<4.7E-8	2.4E-7 ±0.2E-7	<6.6E-8	1.7E-7 ±0.2E-7	<1.3E-7	<7.9E-8	<6.7E-8	<7.1E-8	<5.6E-8	<6.3E-8	<1.5E-7	<1.2E-7	<8.7E-8	482
Site A-42	08/09/89	<2.0E-7	<6.8E-8	2.7E-7 ±0.3E-7	<5.8E-8	4.3E-8 ±1.4E-8	<1.5E-8	<6.9E-8	<7.1E-8	<9.0E-8	<6.7E-8	<6.0E-8	<1.5E-8	<1.3E-7	<1.1E-7	536
Site A-43	08/09/89	<1.7E-7	<2.6E-8	<5.4E-8	<3.4E-8	<4.8E-8	<8.9E-7	<5.7E-8	<6.6E-8	<3.9E-8	<4.7E-8	<3.4E-8	<9.7E-8	<1.1E-7	<6.2E-8	476

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-44	08/09/89	<1.6E-7	<4.1E-8	3.36E-7 ±0.19E-7	<4.6E-8	4.6E-8 ±1.1E-8	<1.0E-7	<5.2E-8	<6.3E-8	4.9E-8 ±1.1E-8	<4.6E-8	<4.5E-8	<1.2E-7	<1.1E-7	<7.8E-8	472
Site A-45	08/09/89	<2.0E-7	<4.1E-8	<7.3E-8	<4.8E-8	<5.8E-8	<1.3E-7	<6.2E-8	<5.7E-8	<6.0E-8	<5.3E-8	<4.9E-8	<1.3E-7	<9.1E-8	<6.6E-8	514
Site A-46	08/15/89	<1.2E-7	<2.5E-8	<2.9E-8	<2.9E-8	<3.7E-8	<6.3E-8	<3.5E-8	<4.7E-8	<3.2E-8	<3.0E-8	<2.7E-8	<8.9E-8	<8.6E-8	<5.6E-8	509
Site A-47	08/15/89	<1.4E-7	<4.1E-8	<4.5E-8	<3.9E-8	<4.2E-8	<8.6E-8	<3.7E-8	<7.0E-8	<3.9E-8	<4.9E-8	<3.7E-8	<1.1E-7	<1.1E-7	<9.0E-8	544
Site A-48	08/15/89	<1.5E-7	<3.9E-8	<4.1E-8	<4.0E-8	<4.1E-8	<8.7E-8	<4.7E-8	<5.7E-8	<4.6E-8	<4.3E-8	<4.0E-8	<1.1E-7	<1.2E-7	<7.8E-8	531
Site A-49	08/15/89	<1.1E-7	<3.2E-8	1.2E-7 ±0.1E-7	<4.1E-8	<5.7E-8	<9.6E-8	<3.9E-8	<4.9E-8	<5.1E-8	<4.3E-8	<4.3E-8	<1.1E-7	<1.3E-7	<6.6E-8	599
Site A-50	08/15/89	<1.8E-7	<4.7E-8	4.93E-7 ±0.26E-7	<6.0E-8	1.2E-7 ±0.2E-7	<1.3E-7	<4.8E-8	<5.3E-8	1.2E-7 ±0.2E-7	<5.0E-8	<5.6E-8	<1.5E-7	<4.6E-8	<1.5E-7	514
Site A-51	08/15/89	<1.7E-7	<4.6E-8	<7.8E-8	<4.8E-8	<5.3E-8	<8.7E-8	<4.3E-8	<5.6E-8	<5.5E-8	<4.8E-8	<4.1E-8	<1.2E-7	<1.3E-7	<7.3E-8	605
Site A-52	08/15/89	<2.6E-7	<7.3E-8	1.15E-6 ±0.04E-6	1.3E-7 ±0.1E-7	5.2E-7 ±0.4E-7	<1.5E-7	<6.9E-8	<8.2E-8	3.3E-7 ±0.3E-7	<8.0E-8	<9.5E-8	<2.3E-7	<2.1E-7	<1.4E-7	503
Site A-53	08/15/89	<1.4E-7	<3.6E-8	1.2E-7 ±0.1E-7	<4.4E-8	<4.9E-8	<8.6E-8	<3.8E-8	<4.1E-8	<5.7E-8	<3.9E-8	<3.8E-8	<1.2E-7	<1.3E-7	<7.0E-8	525
Site A-54	08/15/89	<1.5E-7	<4.2E-8	<4.3E-8	<3.8E-8	<4.7E-8	<1.1E-7	<4.2E-8	<5.5E-8	<5.1E-8	<5.4E-8	<4.1E-8	<1.2E-7	<1.4E-7	<9.3E-8	582
Site A-55	08/15/89	<1.6E-7	<4.0E-8	<5.3E-8	<3.7E-8	<4.7E-8	<9.0E-8	<4.5E-8	<5.8E-8	<4.9E-8	<4.5E-8	<3.2E-8	<1.2E-7	<1.0E-7	<7.9E-8	525

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-56	08/15/89	<1.1E-7	<3.0E-8	<3.8E-8	<2.8E-8	<3.7E-8	<6.4E-8	<3.2E-8	<2.5E-8	<3.1E-8	<3.5E-8	<2.9E-8	<7.8E-8	<7.6E-8	<5.8E-8	540
Site A-57	08/15/89	<1.4E-7	<3.4E-8	1.78E-7 ±0.13E-7	<4.0E-8	<5.3E-8	<9.2E-8	<3.9E-8	<5.6E-8	<5.1E-8	<4.5E-8	<4.0E-8	<1.2E-7	<1.1E-7	<6.4E-8	529
Site A-58	08/15/89	<1.9E-7	<4.5E-8	<1.2E-7	<5.9E-8	<7.6E-8	<1.1E-7	<4.6E-8	<5.6E-8	<7.4E-8	<6.1E-8	<5.0E-8	<1.5E-7	<1.2E-7	<9.1E-8	515
Site A-59	08/15/89	<1.7E-7	<4.8E-8	<6.5E-8	<4.5E-8	<5.1E-8	<1.0E-7	<4.5E-8	<5.1E-8	<4.6E-8	<4.3E-8	<4.4E-8	<1.1E-7	<1.5E-7	<7.7E-8	580
Site A-60	08/15/89	<2.2E-7	<7.1E-8	8.41E-7 ±0.37E-7	<9.2E-8	1.7E-7 ±0.2E-7	<1.4E-7	<6.1E-8	<5.5E-8	1.4E-7 ±0.2E-7	<6.2E-8	<6.9E-8	<1.9E-7	<1.9E-7	<9.9E-8	489
Site A-61	08/15/89	<8.1E-8	<2.3E-8	<3.2E-8	<2.4E-8	<2.9E-8	<5.7E-8	<2.5E-8	<3.1E-8	<2.6E-8	<2.5E-8	<2.3E-8	<7.4E-8	<5.5E-8	<4.1E-8	514
Site A-62	08/15/89	<1.6E-7	<4.2E-8	<6.4E-8	<4.2E-8	<5.2E-8	<7.6E-8	<5.0E-8	<7.4E-8	<4.9E-8	<5.1E-8	<3.7E-8	<1.2E-7	<1.0E-7	<7.7E-8	502
Site A-63	08/15/89	<1.0E-7	<3.2E-8	<3.1E-8	<2.7E-8	<3.2E-8	<4.6E-8	<3.9E-8	<3.2E-8	<2.8E-8	<3.9E-8	<2.9E-8	<8.9E-8	<6.6E-8	<5.0E-8	467
Site A-64	08/15/89	<1.5E-7	<4.7E-8	<5.3E-8	<5.2E-8	<5.5E-8	<7.2E-8	<4.0E-8	<5.4E-8	<4.1E-8	<5.0E-8	<3.7E-8	<1.1E-7	<1.1E-7	<6.7E-8	507
Site A-65	08/15/89	<1.0E-7	<2.7E-8	<2.9E-8	<2.5E-8	<2.8E-8	<4.6E-8	<3.2E-8	<4.4E-8	<2.3E-8	<3.5E-8	<2.6E-8	<6.9E-8	<7.7E-8	<5.1E-8	462
Site A-66	08/15/89	<1.1E-7	<2.9E-8	<4.6E-8	<3.0E-8	<3.0E-8	<5.9E-8	<3.6E-8	<4.2E-8	<3.2E-8	<3.7E-8	<3.1E-8	<8.2E-8	<7.3E-8	<5.8E-8	483
Site A-67	08/15/89	<1.6E-7	<5.1E-8	2.0E-7 ±0.2E-7	<6.7E-8	2.1E-7 ±0.2E-7	<1.1E-7	<5.6E-8	<7.7E-8	<7.7E-8	<5.4E-8	<6.4E-8	<1.6E-7	<1.7E-7	<8.5E-8	517

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-68	08/15/89	<2.5E-7	<6.0E-8	5.56E-7 ±0.31E-7	<6.8E-8	1.1E-7 ±0.2E-7	<1.3E-7	<6.4E-8	<7.4E-8	1.4E-7 ±0.2E-7	<7.3E-8	<6.1E-8	<1.8E-7	<1.6E-7	<1.1E-7	477
Site A-69	08/15/89	<1.6E-7	<4.1E-8	3.99E-7 ±0.20E-7	<4.4E-8	8.3E-8 ±1.2E-8	<9.1E-8	<4.7E-8	<5.3E-8	1.1E-7 ±0.1E-7	<4.7E-8	<4.0E-8	<1.2E-7	<1.1E-7	<6.9E-8	475
Site A-70	08/15/89	<1.5E-7	<5.7E-8	2.26E-7 ±0.20E-7	<5.0E-8	<7.5E-8	<1.3E-7	<4.0E-8	<4.9E-8	<6.7E-8	<5.7E-8	<5.0E-8	<1.4E-7	<1.3E-7	<8.9E-8	563
Site A-71	08/22/89	<1.9E-7	<5.0E-8	<6.4E-8	<4.5E-8	<5.2E-8	<1.1E-7	<6.6E-8	<8.9E-8	<4.6E-8	<4.7E-8	<4.3E-8	<1.2E-8	<1.4E-7	<9.8E-8	549
Site A-72	08/22/89	<1.7E-7	<4.0E-8	<4.9E-8	<3.6E-8	<4.8E-8	<8.5E-8	<5.6E-8	<4.8E-8	<3.9E-8	<4.3E-8	<3.3E-8	<1.1E-7	<9.7E-8	<7.5E-8	590
Site A-73	08/22/89	<1.7E-7	<3.8E-8	<6.1E-8	<3.5E-8	<4.3E-8	<9.5E-8	<5.6E-8	<5.4E-8	<4.4E-8	<4.9E-8	<3.4E-8	<1.0E-7	<1.1E-7	<7.0E-8	552
Site A-74	08/22/89	<2.3E-7	<4.2E-8	<7.3E-8	<5.7E-8	<7.2E-8	<1.3E-7	<6.3E-8	<8.9E-8	<5.6E-8	<6.3E-8	<4.6E-8	<1.3E-7	<1.6E-7	<9.9E-8	550
Site A-75	08/22/89	<2.4E-7	<6.2E-8	<4.5E-8	<4.8E-8	<6.3E-8	<1.5E-7	<8.2E-8	<8.5E-8	<5.0E-8	<6.1E-8	<4.4E-8	<1.3E-7	<1.6E-7	<1.1E-7	574
Site A-76	08/22/89	<2.3E-7	<6.1E-8	<5.6E-8	<5.4E-8	<6.6E-8	<1.4E-7	<8.2E-8	<1.0E-7	<5.9E-8	<7.4E-8	<4.2E-8	<1.3E-7	<1.7E-7	<7.9E-8	629
Site A-77	08/22/89	<2.0E-7	<4.5E-8	<9.1E-8	<4.7E-8	<5.6E-8	<1.1E-7	<6.0E-8	<6.6E-8	<6.1E-8	<5.5E-8	<4.6E-8	<1.1E-7	<1.3E-7	<9.8E-8	522
Site A-78	08/22/89	<2.2E-7	<4.2E-8	1.1E-7 ±0.1E-7	<5.5E-8	<6.3E-8	<1.2E-7	<7.0E-8	<5.2E-8	<6.0E-8	<6.1E-8	<5.2E-8	<1.4E-7	<1.4E-7	<1.0E-7	556
Site A-79	08/22/89	<1.6E-7	<3.6E-8	<5.1E-8	<3.2E-8	<4.6E-8	<8.8E-8	<4.3E-8	<4.9E-8	<3.6E-8	<3.7E-8	<3.5E-8	<1.1E-7	<1.4E-7	<6.6E-8	479

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-80	08/22/89	<2.0E-7	<4.4E-8	<7.5E-8	<4.4E-8	<5.5E-8	<8.6E-8	<5.4E-8	<7.2E-8	<3.7E-8	<4.9E-8	<4.5E-8	<1.2E-7	<1.1E-7	<6.8E-8	476
Site A-81	08/22/89	<1.4E-7	<3.2E-8	<4.1E-8	<3.7E-8	<4.2E-8	<7.1E-8	<4.2E-8	<4.4E-8	<3.8E-8	<4.7E-8	<3.4E-8	<9.0E-8	<1.1E-7	<6.3E-8	484
Site A-82	08/22/89	<1.4E-7	<3.9E-8	<6.1E-8	<4.5E-8	<5.1E-8	<6.4E-8	<4.6E-8	<4.8E-8	<4.7E-8	<4.0E-8	<4.2E-8	<1.1E-7	<1.0E-7	<6.8E-8	496
Site A-83	08/22/89	<1.0E-7	<2.6E-8	<3.6E-8	<2.6E-8	<3.6E-8	<4.7E-8	<3.3E-8	<4.1E-8	<2.3E-8	<2.5E-8	<2.4E-8	<7.3E-8	<6.2E-8	<4.3E-8	421
Site A-84	08/22/89	<1.2E-7	<3.2E-8	<2.7E-8	<2.3E-8	<3.2E-8	<6.0E-8	<4.7E-8	<3.7E-8	<2.9E-8	<3.0E-8	<2.5E-8	<7.4E-8	<6.7E-8	<4.7E-8	533
Site A-85	08/22/89	<1.1E-7	<2.8E-8	<2.7E-8	<3.0E-8	<4.1E-8	<4.7E-8	<3.5E-8	<3.6E-8	<3.2E-8	<3.5E-8	<2.9E-8	<9.1E-8	<7.2E-8	<5.3E-8	468
Site A-86	08/22/89	<1.1E-7	<3.0E-8	<3.9E-8	<3.2E-8	<3.7E-8	<6.3E-8	<4.1E-8	<5.3E-8	<3.3E-8	<4.1E-8	<3.2E-8	<1.0E-7	<5.6E-8	<6.3E-8	508
Site A-87	08/22/89	<1.4E-7	<3.0E-8	<4.8E-8	<3.0E-8	2.2E-8 ±0.7E-8	<7.2E-8	<5.1E-8	<4.6E-8	<3.2E-8	<3.2E-8	<3.0E-8	<7.7E-8	<6.7E-8	<4.6E-8	450
Site A-88	08/22/89	<1.1E-7	<2.7E-8	<3.2E-8	<2.7E-8	<4.1E-8	<6.7E-8	<3.8E-8	<5.4E-8	<2.8E-8	<2.8E-8	<2.5E-8	<8.6E-8	<5.1E-8	<5.4E-8	507
Site A-89	08/30/89	<3.3E-7	<4.3E-8	<4.4E-8	<3.3E-8	<4.4E-8	<8.2E-8	<1.8E-7	<1.2E-7	<4.0E-8	<4.9E-8	<4.1E-8	<9.6E-8	<8.2E-8	<7.6E-8	550
Site A-90	08/30/89	<2.9E-7	<4.8E-8	<4.2E-8	<3.4E-8	<4.7E-8	<1.2E-7	<1.3E-7	<1.5E-7	<4.2E-8	<5.6E-8	<4.1E-8	<1.2E-7	<1.4E-7	<7.7E-8	606
Site A-91	08/30/89	<2.3E-7	<3.3E-8	<3.0E-8	<2.8E-8	<3.5E-8	<8.1E-8	<1.3E-7	<5.9E-8	<3.6E-8	<4.1E-8	<3.4E-8	<7.8E-8	<8.1E-8	<6.1E-8	456
Site A-92	08/30/89	<2.6E-7	<4.1E-8	<3.4E-8	<3.3E-8	<3.7E-8	<8.5E-8	<1.2E-7	<9.9E-8	<3.9E-8	<5.1E-8	<3.7E-8	<9.4E-8	<8.7E-8	<6.4E-8	481
Site A-93	08/30/89	<3.3E-7	<4.7E-8	<6.6E-8	<4.1E-8	<3.9E-8	<9.3E-8	<1.3E-7	<1.1E-7	<3.1E-8	<5.0E-8	<4.3E-8	<1.1E-7	<9.8E-8	<7.3E-8	471

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-94	08/30/89	<3.0E-7	<4.7E-8	<7.2E-8	<4.8E-8	<5.0E-8	<1.0E-7	<1.6E-7	<1.5E-7	<4.4E-8	<5.9E-8	<4.9E-8	<1.2E-7	<1.2E-7	<9.3E-8	472
Site A-95	08/30/89	<1.8E-7	<3.0E-8	<4.4E-8	<2.7E-8	<3.2E-8	<7.4E-8	<1.0E-7	<7.2E-8	2.5E-8 ±0.7E-8	<4.3E-8	<3.3E-8	<8.0E-8	<6.9E-8	<5.8E-8	472
Site A-96	08/30/89	<1.1E-7	<3.1E-8	<4.4E-8	<2.5E-8	<3.2E-8	<6.8E-8	<4.3E-8	<4.4E-8	<3.4E-8	<3.5E-8	<2.7E-8	<7.1E-8	<7.5E-8	<5.2E-8	582
Site A-97	08/30/89	<1.7E-7	<3.2E-8	<3.4E-8	<3.0E-8	<3.6E-8	<6.0E-8	<5.4E-8	<4.9E-8	<3.2E-8	<3.6E-8	<3.0E-8	<9.2E-8	<6.3E-8	<5.7E-8	478
Site A-98	08/30/89	<1.2E-7	<2.5E-8	<2.6E-8	<2.3E-8	<3.1E-8	<5.3E-8	<4.2E-8	<3.7E-8	<2.5E-8	<3.0E-8	<2.3E-8	<5.7E-8	<6.2E-8	<4.8E-8	463
Site A-99	08/30/89	<3.1E-7	<4.3E-8	<4.9E-8	<4.1E-8	<5.0E-8	<1.2E-7	<1.5E-7	<7.7E-8	<4.3E-8	<5.9E-8	<3.9E-8	<1.1E-7	<9.2E-8	<7.0E-8	467
Site A-100	08/30/89	<2.3E-7	<3.1E-8	<3.3E-8	<2.9E-8	<3.0E-8	<6.7E-8	<1.2E-7	<8.4E-8	<2.8E-8	<4.1E-8	<3.4E-8	<8.3E-8	<6.3E-8	<5.5E-8	492
Site A-101	08/30/89	<2.7E-7	<3.7E-8	<6.2E-8	<3.5E-8	<4.0E-8	<9.9E-8	<1.4E-7	<1.1E-7	<4.4E-8	<5.8E-8	<4.1E-8	<1.0E-7	<9.1E-8	<8.6E-8	492
Site A-102	08/30/89	<2.0E-7	<3.7E-8	<5.6E-8	<3.0E-8	<3.9E-8	<8.9E-8	<7.1E-8	<6.6E-8	<4.4E-8	<4.5E-8	<3.6E-8	<9.7E-8	<8.4E-8	<6.4E-8	499
Site A-103	08/30/89	<1.5E-7	<2.4E-8	<3.1E-8	<2.5E-8	<2.9E-8	<4.9E-8	<6.8E-8	<4.4E-8	<2.5E-8	<3.5E-8	<2.7E-8	<7.7E-8	<6.5E-8	<4.7E-8	434
Site A-104	08/30/89	<1.1E-7	<2.0E-8	<2.1E-8	<1.8E-8	<2.3E-8	<4.1E-8	<3.9E-8	<2.8E-8	<2.4E-8	<2.6E-8	<1.9E-8	<6.0E-8	<4.6E-8	<3.8E-8	485
Site A-105	08/30/89	<9.7E-8	<2.8E-8	<4.2E-8	<2.9E-8	<3.7E-8	<6.2E-8	<3.4E-8	<4.5E-8	<2.6E-8	<3.2E-8	<3.1E-8	<7.8E-8	<7.4E-8	<5.3E-8	444
Site A-106	08/30/89	<1.8E-7	<3.8E-8	<4.9E-8	<3.2E-8	<3.9E-8	<7.4E-8	<4.8E-8	<5.7E-8	<4.3E-8	<3.8E-8	<3.7E-8	<8.6E-8	<7.9E-8	<5.7E-8	482

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-107	08/30/89	<1.6E-7	<4.3E-8	<4.2E-8	<3.3E-8	<4.3E-8	<7.1E-8	<5.8E-8	<7.2E-8	<3.5E-8	<4.7E-8	<3.8E-8	<8.8E-8	<8.7E-8	<6.3E-8	463
Site A-108	08/30/89	<1.8E-7	<3.8E-8	<5.9E-8	<3.5E-8	<4.8E-8	<9.6E-8	<6.8E-8	<6.2E-8	<4.2E-8	<5.1E-8	<3.7E-8	<9.0E-8	<1.0E-7	<7.6E-8	657
Site A-109	08/30/89	<1.5E-7	<4.0E-8	<4.9E-8	<3.2E-8	<4.3E-8	<8.6E-8	<5.4E-8	<6.1E-8	<4.1E-8	<5.0E-8	<3.3E-8	<9.7E-8	<8.9E-8	<5.9E-8	551
Site A-110	08/30/89	<1.6E-7	<2.9E-8	<3.5E-8	<2.0E-8	2.0E-8 ±0.5E-8	<7.0E-8	<6.7E-8	<5.3E-8	<2.8E-8	<3.5E-8	<2.4E-8	<6.5E-8	<5.9E-8	<5.0E-8	695
Site A-111	08/30/89	<4.0E-7	<5.9E-8	1.3E-7 ±0.2E-7	<6.3E-8	<7.6E-8	<1.5E-8	<2.0E-7	<1.8E-7	<8.4E-8	<7.9E-8	<6.8E-8	<1.4E-7	<1.4E-7	<1.0E-7	565
Site A-112	08/30/89	<1.9E-7	<3.8E-8	<6.5E-8	<3.5E-8	<4.9E-8	<1.0E-8	<7.3E-8	<7.2E-8	<4.4E-8	<4.9E-8	<3.7E-8	<1.1E-7	<9.4E-8	<7.7E-8	506
Site A-113	08/30/89	<1.3E-7	<2.2E-8	<2.6E-8	<2.0E-8	<2.3E-8	<5.5E-8	<5.9E-8	<3.8E-8	<2.2E-8	<2.6E-8	<2.2E-8	<5.6E-8	<5.4E-8	<4.2E-8	531
Site A-114	08/30/89	<1.2E-7	<2.4E-8	<3.2E-8	<2.2E-8	<3.1E-8	<6.3E-8	<5.2E-8	<4.7E-8	<2.7E-8	<2.9E-8	<2.5E-8	<6.8E-8	<6.1E-8	<4.3E-8	489
Site A-115	10/12/89	<4.4E-7	<5.5E-8	<5.6E-8	<4.6E-8	<5.0E-8	<1.1E-7	<2.7E-7	<2.2E-6	<4.9E-8	<6.5E-8	<5.0E-8	<1.4E-7	<1.4E-7	<1.2E-7	557
Site A-116	10/12/89	<3.4E-7	<4.0E-8	<4.1E-8	<2.8E-8	<3.4E-8	<9.6E-8	<1.9E-7	<9.6E-8	<3.3E-8	<4.8E-8	<3.4E-8	<7.6E-8	<8.7E-8	<6.8E-8	604
Site A-117	10/12/89	<3.7E-7	<4.4E-8	<5.1E-8	<3.4E-8	<3.9E-8	<1.2E-7	<1.9E-7	<1.2E-7	<3.9E-8	<5.6E-8	<4.1E-8	<9.7E-8	<1.2E-7	<7.2E-8	666
Site A-118	10/12/89	<3.4E-7	<4.0E-8	<3.5E-8	<2.9E-8	<3.5E-8	<9.3E-8	<1.7E-7	<1.2E-7	<3.5E-8	<5.5E-8	<3.8E-8	<7.5E-8	<8.3E-8	<7.3E-8	649
Site A-119	10/12/89	<4.4E-7	<4.0E-8	<4.2E-8	<4.3E-8	<4.8E-8	<8.3E-8	<2.0E-7	<1.8E-7	<3.2E-8	<6.0E-8	<5.3E-8	<1.2E-7	<1.2E-7	<8.5E-8	506

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site A-120	10/12/89	<3.3E-7	<4.3E-8	<3.6E-8	<3.5E-8	<3.2E-8	<9.0E-8	<1.9E-7	<1.1E-7	<3.4E-8	<5.1E-8	<3.7E-8	<7.5E-8	<6.2E-8	<6.0E-8	483
Site A-121	10/12/89	<3.2E-7	<4.6E-8	<5.7E-8	<3.4E-8	<4.4E-8	<8.4E-8	<1.6E-7	<9.7E-8	<3.9E-8	<6.7E-8	<4.6E-8	<9.0E-8	<1.0E-7	<8.5E-8	544
Site A-122	10/12/89	<4.4E-7	<4.6E-8	<4.1E-8	<4.2E-8	<3.6E-8	<1.1E-7	<1.8E-7	<6.3E-8	<4.9E-8	<7.2E-8	<5.3E-8	<1.3E-7	<1.1E-7	<9.1E-8	492
Site A-123	10/12/89	<2.6E-7	<3.7E-8	<4.0E-8	<2.7E-8	<3.6E-8	<8.4E-8	<1.6E-7	<1.1E-7	<3.3E-8	<4.8E-8	<3.4E-8	<9.2E-8	<8.9E-8	<4.3E-8	537
Site B surface	07/18/89	<1.5E-7	<3.6E-8	<6.0E-8	<4.1E-8	<5.2E-8	<9.9E-7	<4.4E-8	<5.0E-8	<4.6E-8	<4.9E-8	<3.3E-8	<1.1E-7	<1.2E-7	<6.9E-8	409
Site B interface	07/18/89	<9.9E-8	<3.1E-8	<3.3E-8	<2.9E-8	<3.1E-8	<6.3E-8	<2.7E-8	<3.2E-8	<3.0E-8	<3.4E-8	<2.9E-7	<7.8E-7	<8.6E-8	<4.6E-8	575
Site B subbase	07/18/89	<7.4E-8	<1.8E-8	<2.5E-8	<2.3E-8	<2.5E-8	<4.1E-8	<2.9E-8	<2.3E-8	<2.4E-8	<2.7E-8	<2.2E-8	<6.1E-8	<4.4E-8	<3.8E-8	550
Site B-1	07/24/89	<1.1E-7	<3.8E-8	<5.4E-8	<3.4E-8	<4.0E-8	<6.4E-8	<3.3E-8	<3.9E-8	<2.9E-8	<3.7E-8	<3.2E-8	<1.0E-7	<8.4E-8	<6.1E-8	467
Site B-2	07/24/89	<9.9E-8	<2.8E-8	<2.9E-8	<2.9E-8	<3.1E-8	<5.6E-8	<2.8E-8	<4.7E-8	<3.2E-8	<3.3E-8	<2.8E-8	<7.8E-8	<5.2E-8	<4.8E-8	490
Site B-3	07/24/89	<8.3E-8	<2.2E-8	8.7E-8 ±0.7E-8	<2.2E-8	<3.1E-8	<4.9E-8	<2.6E-8	<2.5E-8	3.0E-8 ±0.6E-8	<2.6E-8	<2.1E-8	<7.2E-8	<6.0E-8	<4.1E-8	509
Site B-3 (second sample)	08/30/89	<4.6E-7	<5.7E-8	<8.2E-8	<5.4E-8	<6.1E-8	<1.5E-7	<2.1E-7	<1.9E-7	<6.3E-8	<8.2E-8	<2.9E-8	<1.2E-7	<1.0E-7	<9.4E-8	464

TABLE 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site B-4	07/24/89	<1.1E-7	<3.4E-8	<3.4E-8	<3.1E-8	<4.3E-8	<7.6E-8	<4.2E-8	<4.4E-8	<3.2E-8	<3.7E-8	<3.1E-8	<8.9E-8	<7.6E-8	<6.1E-8	482
Site B-5	07/24/89	<2.4E-7	<6.7E-8	<1.2E-7	<6.8E-8	9.3E-8 ±2.0E-8	<1.4E-7	<6.1E-8	<1.0E-7	<7.5E-8	<6.0E-8	<7.0E-8	<1.7E-7	<1.6E-8	<9.2E-8	415
Site B-6 (i)	07/24/89	<2.9E-7	<9.6E-8	<1.0E-7	<1.1E-7	1.51E-7 ±0.27E-7	<1.7E-7	<8.7E-8	<1.1E-7	<8.3E-8	<8.4E-8	<8.7E-8	<2.5E-7	<2.0E-7	<1.7E-7	330
Site B-7 (j)	07/24/89	<1.7E-7	<5.0E-8	<6.2E-8	<5.0E-8	8.6E-8 ±1.4E-8	<1.0E-7	<5.6E-8	<7.3E-8	<4.3E-8	<5.4E-8	<4.9E-8	<1.4E-7	<1.0E-7	<9.6E-8	402
Site B-8 (k)	07/24/89	<1.4E-7	<3.5E-8	<5.5E-8	<3.7E-8	7.8E-8 ±1.0E-8	<8.4E-8	<4.6E-8	<5.4E-8	<3.4E-8	<4.1E-8	<3.6E-8	<9.8E-8	<8.9E-8	<6.2E-8	426
Site B-9	08/30/89	<1.4E-7	<3.0E-8	<4.8E-8	<3.6E-8	<4.6E-8	<7.7E-8	<4.3E-8	<4.8E-8	<3.1E-8	<5.9E-8	<4.1E-8	<1.1E-7	<7.8E-8	<6.3E-8	421
Site B-10	08/30/89	<1.6E-7	<4.4E-8	<4.4E-8	<3.2E-8	<5.3E-8	<6.1E-8	<4.5E-8	<6.0E-8	<4.3E-8	<4.6E-8	<4.1E-8	<1.1E-7	<1.1E-7	<6.8E-8	451
Site B-11	08/30/89	<1.5E-7	<4.2E-8	<3.9E-8	<3.6E-8	<4.5E-8	<7.0E-8	<4.9E-8	<6.7E-8	<4.4E-8	<4.3E-8	<4.0E-8	<1.1E-7	<7.7E-8	<8.0E-8	437
Site B-12	08/30/89	<1.3E-7	<3.9E-8	<3.9E-8	<3.8E-8	<3.4E-8	<5.2E-8	<4.0E-8	<6.2E-8	<4.0E-8	<4.3E-8	<3.8E-8	<1.2E-7	<1.0E-7	<5.1E-8	461
Site B-13	08/30/89	<1.8E-7	<5.1E-8	<7.0E-8	<5.1E-8	<6.3E-8	<8.9E-8	<5.2E-8	<6.5E-8	<5.0E-8	<4.5E-8	<3.9E-8	<1.3E-7	<1.3E-7	<7.5E-8	424
Site B-14	08/30/89	<1.4E-7	<3.4E-8	<5.0E-8	<4.2E-8	<4.4E-8	<6.8E-8	<4.7E-8	<5.1E-8	<4.3E-8	<4.7E-8	<4.2E-8	<1.2E-7	<9.3E-8	<7.0E-8	483
Site B-15	08/30/89	<1.6E-7	<4.5E-8	<5.8E-8	<3.9E-8	<5.0E-8	<8.8E-8	<4.8E-8	<6.1E-8	<5.3E-8	<5.0E-8	<4.3E-8	<1.2E-7	<9.0E-8	<7.9E-8	441

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site B-16	08/30/89	<7.8E-8	<2.6E-8	<3.7E-8	<3.1E-8	<3.2E-8	<5.5E-8	<2.9E-8	<4.0E-8	<2.4E-8	<3.0E-8	<2.9E-8	<7.1E-8	<6.4E-8	<5.4E-8	456
Site B-17	08/30/89	<1.9E-7	<4.2E-8	<7.2E-8	<6.0E-8	<8.1E-8	<1.2E-7	<6.2E-8	<7.8E-8	<5.8E-8	<5.5E-8	<5.4E-8	<1.4E-7	<1.6E-7	<9.6E-8	439
Site C surface	07/18/89	<2.3E-7	<5.5E-8	<7.6E-8	<7.1E-8	1.1E-7 ±0.2E-7	<1.2E-7	<6.5E-8	<8.7E-8	<5.6E-8	<6.4E-8	<6.2E-8	<1.6E-7	<1.5E-7	<9.9E-8	364
Site C interface	07/18/89	<1.8E-7	<4.6E-8	<5.3E-7	<4.1E-8	<5.2E-8	<1.0E-7	<6.3E-8	<7.7E-8	<4.7E-8	<5.7E-8	<4.0E-8	<9.6E-8	<1.1E-7	<8.1E-8	572
Site C subbase	07/18/89	<9.4E-8	<2.1E-8	<2.7E-8	<1.9E-8	<2.7E-8	<4.0E-8	<2.4E-8	<2.6E-8	<2.1E-8	<2.5E-8	<2.2E-8	<6.5E-8	<5.8E-8	<4.0E-8	588
Site C-1	07/24/89	<1.9E-7	<5.0E-8	<6.4E-8	<4.8E-8	<6.7E-8	<1.2E-7	<5.9E-8	<6.9E-8	<4.7E-8	<6.1E-8	<4.2E-8	<1.4E-8	<1.3E-8	<9.6E-8	526
Site C-2	07/24/89	<1.6E-7	<4.1E-8	<5.3E-8	<4.2E-8	<6.0E-8	<8.1E-8	<5.3E-8	<7.7E-8	<4.6E-8	<5.4E-8	<4.3E-8	<1.2E-7	<1.1E-7	<1.0E-7	500
Site C-3 (l)	07/24/89	<1.5E-7	<4.5E-8	<4.2E-8	<4.3E-8	<4.9E-8	<8.9E-8	<5.1E-8	<5.4E-8	<4.0E-8	<5.2E-8	<4.0E-8	<1.2E-8	<9.7E-8	<7.0E-8	425
Site C-4	07/24/89	<1.8E-7	<4.9E-8	<6.4E-8	<4.7E-8	7.5E-8 ±1.4E-8	<8.6E-8	<5.5E-8	<6.7E-8	<4.7E-8	<5.2E-8	<4.4E-8	<1.2E-7	<1.2E-7	<8.0E-7	416
Site C-5	07/24/89	<2.1E-7	<7.1E-8	<1.0E-7	<7.3E-8	<1.1E-7	<1.6E-7	<7.0E-8	<7.7E-8	<8.2E-8	<7.8E-8	<6.4E-8	<1.7E-7	<1.3E-7	<1.2E-7	458
Site C-6	07/24/89	<1.6E-7	<4.2E-8	<4.7E-8	<3.6E-8	<4.2E-8	<8.9E-8	<5.0E-8	<6.6E-8	<3.6E-8	<4.7E-8	<3.5E-8	<1.2E-7	<1.3E-7	<7.8E-8	445
Site C-7	07/24/89	<1.6E-7	<3.5E-8	<5.2E-8	<5.2E-8	<5.4E-8	<1.2E-7	<5.3E-8	<5.3E-8	<4.1E-8	<4.4E-8	<4.1E-8	<1.2E-7	<1.1E-7	<8.6E-8	457

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G
Site C-8	07/24/89	<2.0E-7	<4.7E-8	<5.3E-8	<5.0E-8	<6.7E-8	<1.2E-7	<4.9E-8	<6.7E-8	<4.8E-8	<6.2E-8	<4.8E-8	<1.2E-7	<1.1E-7	<8.4E-8	444
Site D	07/18/89	<1.9E-7	<6.7E-8	<9.3E-8	<7.6E-8	1.34E-7 ±0.21E-7	<1.6E-7	<6.3E-8	<1.0E-8	<7.3E-8	<8.9E-8	<7.1E-8	<1.8E-7	<2.1E-7	<1.5E-7	400
Site E	07/18/89	<2.0E-7	<6.6E-8	<7.8E-8	<6.7E-8	1.16E-7 ±0.16E-7	<1.5E-7	<6.0E-8	<8.1E-8	<6.4E-8	<7.1E-8	<6.3E-8	<1.6E-7	<1.8E-7	<1.1E-7	434
Site E (second sample)	07/20/89	<1.6E-7	<4.8E-8	<6.8E-8	<5.1E-8	1.0E-7 ±0.1E-7	<1.3E-7	<4.7E-8	<6.3E-8	<5.6E-8	<5.7E-8	<4.2E-8	<1.2E-7	<1.4E-7	<9.4E-8	482
Site F	07/18/89	<1.8E-7	<4.0E-7	<4.2E-8	<3.9E-8	<4.7E-8	<9.3E-8	<6.5E-8	<6.4E-8	<4.1E-1	<4.5E-8	<2.5E-7	<1.1E-7	<1.1E-7	<6.9E-8	528
Site F-1	07/24/89	<1.3E-7	<3.2E-8	<4.9E-8	<3.3E-8	<4.7E-8	<7.6E-8	<3.3E-8	<3.7E-8	<3.4E-8	<4.6E-8	<3.7E-8	<8.6E-8	<9.5E-8	<5.9E-8	464
Site F-2	07/24/89	<1.4E-7	<3.7E-8	<4.9E-8	<3.9E-8	<6.2E-8	<8.4E-8	<3.8E-8	<6.1E-8	<3.8E-8	<4.2E-8	<3.8E-8	<1.1E-7	<1.3E-7	<7.4E-8	542
Site F-3	07/24/89	<1.1E-7	<2.9E-8	<4.0E-8	<3.0E-8	3.6E-8 ±0.8E-8	<7.6E-8	<3.4E-8	<3.9E-8	<3.4E-8	<3.4E-8	<2.8E-8	<8.8E-8	<7.8E-8	<5.0E-8	558
Site F-4	07/24/89	<1.4E-7	<4.0E-8	<5.0E-8	<3.6E-8	<5.8E-8	<7.7E-8	<4.3E-8	<5.6E-8	<4.4E-8	<5.2E-8	<3.6E-8	<1.2E-7	<1.2E-7	<6.6E-8	526
Site F-5	07/24/89	<1.8E-8	<4.9E-8	<5.6E-8	<4.7E-8	<7.8E-8	<1.1E-7	<4.7E-8	<7.5E-8	<5.0E-8	<5.1E-8	<4.6E-8	<1.3E-7	<1.2E-7	<9.1E-8	469
Site F-6	07/24/89	<1.5E-7	<4.3E-8	<5.0E-8	<3.7E-8	9.4E-8 ±1.1E-8	<8.7E-8	<4.9E-8	<3.8E-8	<3.7E-8	<4.4E-8	<3.6E-8	<1.1E-7	<1.1E-7	<7.0E-8	488

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site F-7	07/24/89	<1.4E-7	<4.3E-8	<5.6E-8	<3.3E-8	4.9E-8 ±0.9E-8	<7.4E-8	<4.2E-8	<4.2E-8	<4.0E-8	<4.2E-8	<3.5E-8	<9.8E-8	<8.6E-8	<6.8E-8	488
Site F-8	07/24/89	<1.5E-7	<4.2E-8	<5.5E-8	<4.1E-8	8.1E-8 ±1.2E-8	<9.0E-8	<4.1E-8	<3.7E-8	<4.1E-8	<4.3E-8	<4.1E-8	<1.1E-7	<1.2E-7	<7.6E-8	428
Site G	07/18/89	<2.6E-7	<7.4E-8	<8.9E-8	<6.9E-8	1.58E-7 ±0.24E-7	<1.9E-7	<8.9E-8	<1.4E-7	<7.5E-8	<8.6E-8	<6.4E-7	<1.9E-7	<2.3E-7	<1.2E-7	416
Site H-1	07/27/89	<1.6E-7	<4.6E-8	<5.0E-8	<3.7E-8	5.4E-8 ±1.3E-8	<9.5E-8	<5.9E-8	<7.2E-8	<4.8E-8	<5.7E-8	<4.3E-8	<1.1E-8	<1.1E-8	<8.0E-8	484
Site H-2	07/27/89	<1.4E-7	<4.1E-8	<5.1E-8	<4.0E-8	<5.6E-8	<8.2E-8	<3.6E-8	<5.3E-8	<3.7E-8	<5.0E-8	<4.3E-8	<9.9E-8	<9.1E-8	<7.3E-8	506
Site H-3	07/27/89	<1.9E-7	<5.9E-9	<6.1E-8	<4.8E-8	<6.5E-8	<1.2E-7	<6.7E-7	<8.7E-8	<5.6E-8	<7.2E-8	<4.7E-8	<1.3E-7	<1.4E-7	<9.7E-8	506
Site H-4	07/27/89	<1.7E-7	<4.6E-8	<4.0E-8	<4.1E-8	<5.5E-8	<1.1E-7	<5.2E-8	<5.7E-8	<4.5E-8	<4.5E-8	<4.4E-8	<1.1E-7	<9.2E-8	<8.5E-8	488
Site H-5	07/27/89	<1.5E-7	<3.8E-8	<4.2E-8	<3.3E-8	<5.2E-8	<8.3E-8	<5.2E-8	<5.8E-8	<3.9E-8	<3.8E-8	<3.3E-8	<9.4E-8	<1.1E-8	<4.6E-8	530
Site H-6	07/27/89	<2.1E-7	<5.6E-8	<6.2E-8	<5.6E-8	<5.7E-8	<1.2E-7	<6.4E-8	<8.2E-8	<5.0E-8	<5.6E-8	<3.7E-8	<1.1E-7	<1.1E-7	<9.7E-8	522
Site H-7	07/27/89	<1.5E-7	<3.5E-8	<4.0E-8	<3.3E-8	<4.3E-8	<8.1E-8	<4.9E-8	<7.0E-8	<2.7E-8	<4.0E-8	<3.3E-8	<9.6E-8	<9.2E-8	<6.7E-8	557
Site H-8	07/27/89	<2.7E-7	<5.7E-8	<7.0E-8	<5.6E-8	<6.9E-8	<1.2E-7	<7.8E-8	<6.9E-8	<4.8E-8	<7.0E-8	<5.4E-8	<1.4E-7	<1.2E-7	<9.1E-8	485
Site H-9	07/27/89	<1.7E-7	<4.4E-8	<3.9E-8	<4.8E-8	<5.8E-8	<6.7E-8	<6.3E-8	<7.4E-8	<4.0E-8	<5.0E-8	<4.4E-8	<1.1E-7	<1.2E-7	<7.2E-8	572

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
Site H-10	07/27/89	<2.3E-7	<3.8E-8	<6.2E-8	<5.5E-8	<6.4E-8	<1.3E-7	<6.5E-8	<6.7E-8	<5.7E-8	<5.4E-8	<5.5E-8	<1.3E-7	<1.1E-7	<9.9E-8	413
Site H-11	07/27/89	<1.3E-7	<3.3E-8	<4.3E-8	<2.9E-8	<3.4E-8	<6.1E-8	<4.7E-8	<3.6E-8	<3.5E-8	<3.8E-8	<2.9E-8	<7.7E-8	<7.9E-8	<5.4E-8	481
Site H-12	07/27/89	<1.5E-7	<2.4E-8	<3.7E-8	<3.9E-8	<3.5E-8	<5.6E-8	<4.8E-8	<5.3E-8	<3.7E-8	<4.4E-8	<3.7E-8	<9.6E-8	<8.1E-8	<7.0E-8	595
Site H-13	07/27/89	<1.4E-7	<3.1E-8	<3.1E-8	<3.1E-8	<3.3E-8	<6.7E-8	<4.6E-8	<3.8E-8	<3.2E-8	<3.7E-8	<3.5E-8	<9.5E-8	<8.7E-8	<5.7E-8	480
Site H-14	07/27/89	<7.4E-8	<2.3E-8	<2.3E-8	<2.4E-8	<2.7E-8	<5.1E-8	<2.8E-8	<3.4E-8	<2.7E-8	<2.7E-8	<2.3E-8	<5.9E-8	<6.1E-8	<3.9E-8	505
Site H-15	07/27/89	<1.7E-7	<4.7E-8	<6.6E-8	<4.7E-8	<6.1E-8	<1.1E-7	<5.1E-8	<6.7E-8	<4.6E-8	<5.3E-8	<4.2E-8	<1.2E-7	<1.2E-7	<8.4E-8	493
Site H-16	07/27/89	<2.2E-7	<5.7E-8	<7.1E-8	<5.8E-8	<5.0E-8	<1.1E-7	<6.8E-8	<7.8E-8	<4.5E-8	<5.4E-8	<5.2E-8	<1.4E-7	<1.6E-7	<7.9E-8	463
Site H-17	07/27/89	<1.4E-7	<3.0E-8	<3.9E-8	<3.5E-8	<5.3E-8	<7.6E-8	<6.2E-8	<6.3E-8	<3.7E-8	<4.8E-8	<3.4E-8	<1.1E-7	<1.1E-7	<7.5E-8	514
Site H-18	07/27/89	<8.3E-8	<3.0E-8	<2.9E-8	<2.5E-8	<3.7E-8	<5.6E-8	<2.7E-8	<3.9E-8	<2.8E-8	<3.1E-8	<2.5E-8	<6.9E-8	<7.8E-8	<4.3E-8	536
Site H-19	07/27/89	<1.7E-7	<3.9E-8	<5.3E-8	<3.5E-8	<4.8E-8	<8.4E-8	<5.8E-8	<6.8E-8	<4.2E-8	<5.1E-8	<3.9E-8	<1.2E-7	<1.0E-7	<8.2E-8	482
Site H-20	07/27/89	<1.8E-7	<4.6E-8	<5.4E-8	<5.1E-8	<6.1E-8	<8.6E-8	<6.1E-8	<6.8E-8	<5.0E-8	<4.3E-8	<4.9E-8	<1.2E-7	<1.3E-7	<8.5E-8	479
Site H-21	08/03/89	<2.0E-7	<5.1E-8	<6.5E-8	<4.9E-8	<7.2E-8	<1.1E-7	<6.0E-8	<6.3E-8	<5.2E-8	<5.6E-8	<4.8E-8	<1.1E-7	<1.1E-7	<7.5E-8	414
Site H-22 *	08/03/89	<2.2E-7	<6.3E-8	<7.6E-8	<6.6E-8	1.7E-7 ±0.2E-7	<1.2E-7	<7.4E-8	<8.0E-8	<6.4E-8	<6.5E-8	<6.1E-8	<1.6E-7	<1.7E-7	<1.1E-7	286
Site H-23	08/03/89	<1.3E-7	<4.2E-8	<4.2E-8	<3.1E-8	<4.4E-8	<7.4E-8	<4.2E-8	<4.2E-8	<3.5E-8	<4.0E-8	<3.4E-8	<9.0E-8	<7.8E-8	<6.3E-8	502

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G
Site H-24	08/03/89	<1.2E-7	<3.5E-8	<4.0E-8	<2.6E-8	1.9E-8 ±0.7E-8	<6.4E-8	<4.2E-8	<4.5E-8	<2.6E-8	<3.4E-8	<2.8E-8	<8.4E-8	<8.4E-8	<5.5E-8	526
Site H-25	08/03/89	<1.3E-7	<3.1E-8	<4.2E-8	<3.1E-8	<3.9E-8	<8.1E-8	<4.0E-8	<4.2E-8	<3.1E-8	<3.9E-8	<3.0E-8	<8.4E-8	<8.0E-8	<6.4E-8	573
Site H-26	08/03/89	<1.3E-7	<3.0E-8	<3.9E-8	<3.2E-8	<4.1E-8	<7.7E-8	<4.3E-8	<5.2E-8	<2.9E-8	<3.9E-8	<3.3E-8	<8.5E-8	<9.3E-8	<6.1E-8	528
Site H-27	08/03/89	<1.8E-7	<4.7E-8	<5.2E-8	<4.5E-8	<5.0E-8	<9.0E-8	<5.6E-8	<8.0E-8	<4.4E-8	<4.8E-8	<4.5E-8	<1.1E-7	<1.0E-7	<6.9E-8	551
Site H-28	08/03/89	<1.4E-7	<4.0E-8	<4.4E-8	<3.0E-8	<5.4E-8	<8.4E-8	<5.2E-8	<5.6E-8	<3.4E-8	<3.8E-8	<3.1E-8	<1.0E-7	<9.7E-8	<7.2E-8	501
Site H-29	08/03/89	<1.5E-7	<4.7E-8	<3.8E-8	<4.1E-8	<4.5E-8	<8.8E-8	<6.0E-8	<3.9E-8	<4.0E-8	<4.5E-8	<3.9E-8	<1.1E-7	<8.4E-8	<7.4E-8	531
Site H-30	08/09/89	<1.9E-7	<4.5E-8	<6.0E-8	<5.2E-8	<6.1E-8	<9.6E-8	<5.3E-8	<5.5E-8	<5.4E-8	<5.1E-8	<4.8E-8	<1.3E-7	<1.3E-7	<7.1E-8	498
Site H-31	08/09/89	<1.5E-7	<5.1E-8	<6.3E-8	<5.3E-8	<7.3E-8	<1.2E-7	<5.8E-8	<8.1E-8	<5.2E-8	<6.1E-8	<5.1E-8	<1.2E-7	<1.5E-7	<8.2E-8	457
Site H-32	08/09/89	<1.2E-7	<4.0E-8	<4.7E-8	<3.6E-8	<4.5E-8	<7.0E-8	<4.2E-8	<4.1E-8	<3.1E-8	<4.6E-8	<3.9E-8	<1.0E-7	<1.0E-7	<7.0E-8	482
Site H-33	08/09/89	<1.2E-7	<3.2E-8	<3.7E-8	<3.0E-8	<3.7E-8	<6.5E-8	<4.0E-8	<4.2E-8	<3.5E-8	<3.8E-8	<3.3E-8	<9.2E-8	<8.8E-8	<5.0E-8	519
Site H-34	08/09/89	<1.6E-7	<5.0E-8	<3.9E-8	<4.0E-8	<4.8E-8	<8.4E-8	<5.2E-8	<4.2E-8	<4.3E-8	<4.8E-8	<3.5E-8	<1.0E-7	<1.2E-7	<6.0E-8	554
Site H-35	08/09/89	<1.6E-7	<3.7E-8	<4.1E-8	<4.1E-8	<3.9E-8	<9.6E-8	<5.1E-8	<6.8E-8	<5.2E-8	<4.8E-8	<4.1E-8	<1.0E-7	<9.7E-8	<8.2E-8	514

Table 4.0-2

SLUDGE SAMPLES FROM WRF LANDFILL

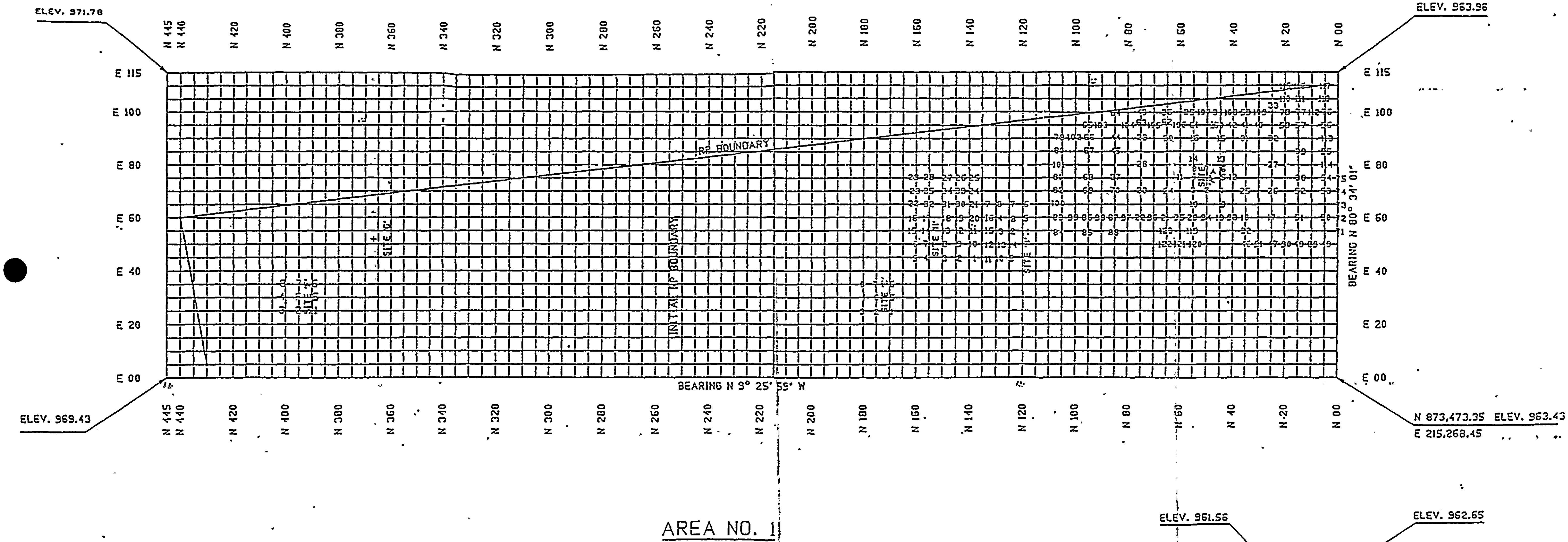
GAMMA SPECTROSCOPY RESULTS in uCi/G

Second Interim Report

Sample Collected	Date	Ba-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	La-140	Mn-54	Nb-95	Sb-124	Sb-125	Zn-65	Zr-95	Sample Size (G)
ARRA/PVNGS #1	08/30/89	<4.7E-7	<6.3E-8	6.27E-7 ±0.29E-7	<5.9E-8	1.4E-7 ±0.2E-7	<1.6E-7	<2.3E-7	<1.7E-7	2.0E-7 ±0.2E-7	<7.7E-8	<6.6E-8	<1.4E-7	<1.5E-7	<1.3E-7	448
ARRA/PVNGS #2 (m)	08/30/89	<7.3E-7	<1.1E-7	1.50E-6 ±0.05E-6	<9.6E-8	2.4E-7 ±0.3E-7	<2.6E-7	<3.6E-7	<2.2E-7	3.2E-7 ±0.3E-7	<1.2E-7	<1.1E-7	<2.5E-7	<2.3E-7	<1.8E-7	397
ARRA/PVNGS #3	08/30/89	<6.9E-7	<1.1E-7	1.32E-6 ±0.05E-6	<9.5E-8	2.9E-7 ±0.3E-7	<2.6E-7	<3.6E-7	<2.2E-7	3.1E-7 ±0.3E-7	<1.1E-7	<1.0E-7	<2.2E-7	<2.0E-7	<1.6E-7	447
ARRA/PVNGS #4	08/30/89	<5.1E-7	<5.9E-8	8.66E-7 ±0.32E-7	<5.9E-8	1.7E-7 ±0.2E-7	<1.5E-7	<2.4E-7	<1.2E-7	2.0E-7 ±0.2E-7	<6.8E-8	<6.9E-8	<1.5E-7	<1.7E-7	<1.1E-7	439

(a) Site contains: Be-7 9.8E-7 ± 1.7E-7
(b) Site contains: Be-7 2.66E-7 ± 1.15E-7
(c) Site contains: Be-7 8.39E-7 ± 1.26E-7
(d) Site contains: Be-7 6.23E-7 ± 1.11E-7
(e) Site contains: Ce-144 1.8E-7 ± 0.6EE-7
(f) Site contains: Be-7 4.9E-7 ± 1.2E-7
(g) Site contains: Cd-109 3.6E-7 ± 1.3EE-7
(h) Site contains: Be-7 6.1E-7 ± 0.9E-7
(i) Site contains: Be-7 6.12E-7 ± 1.7E-7
(j) Site contains: Be-7 4.3E-7 ± 1.0E-7
(k) Site contains: Be-7 4.3E-7 ± 0.7E-7
(l) Site contains: Be-7 2.8E-7 ± 0.8E-7
(m) Site contains: Be-7 7.3E-7 ± 1.5E-7
* Geometry Invalid due to the low density of the sample.

Table 4.0-2



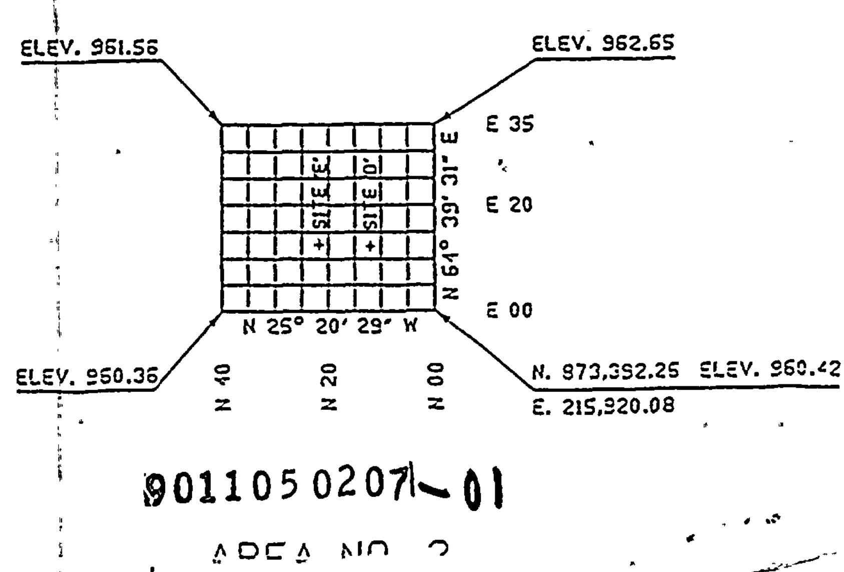
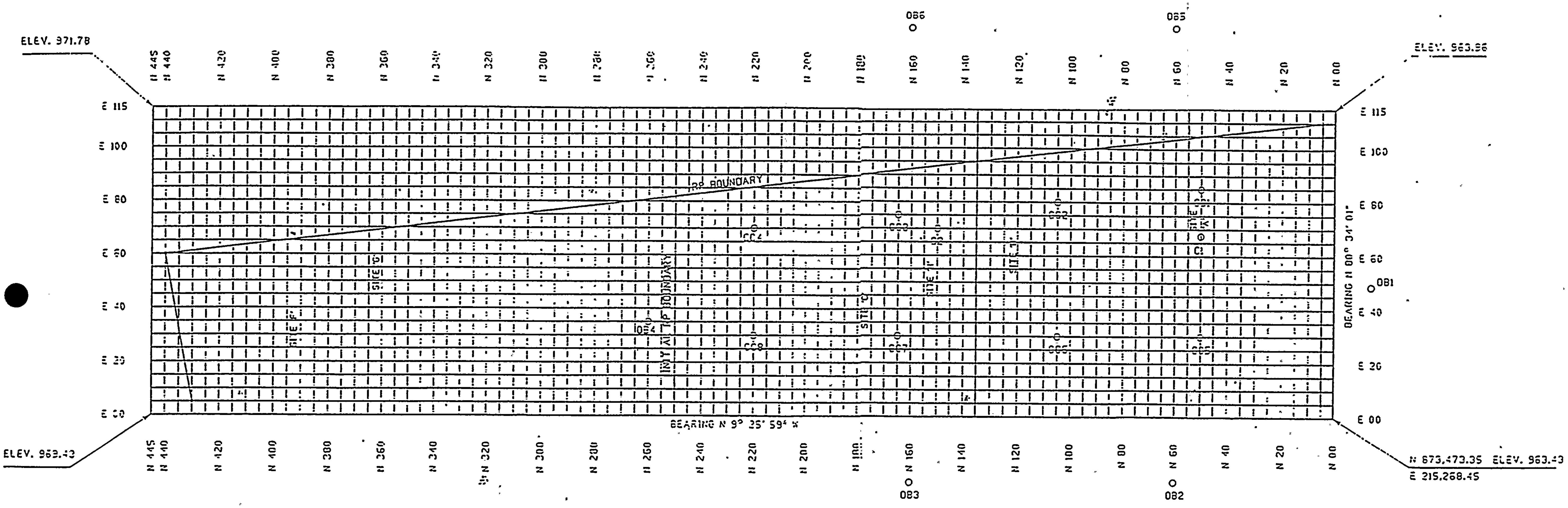


Figure 4.0-1

ASU
COOLING TOWER SLUDGE
SAMPLE LOCATIONS
AT LIME SLUDGE LANDFILL
WRF

9011050207-01



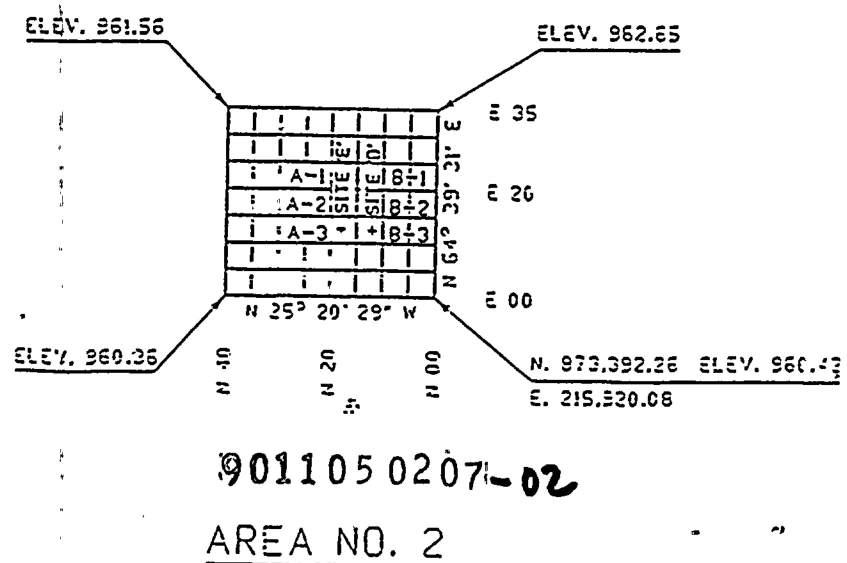


Figure 4.0-2

UNIT RP
COOLING TOWER SLUDGE
SAMPLING LOCATIONS
AT LIME SLUDGE LANDFILL
WRF

9011050207-02

4.1 SAMPLING AND ANALYTICAL METHODS:

All samples were collected using a shovel to excavate the sample material. The material to be analyzed was then placed in a plastic bag, labeled and sent to the laboratory for analysis.

The analyses were performed using a Germanium Gamma Spectrometer used for environmental samples. This equipment is capable of completing analyses at very low levels of detectability.

The analyses for Phase I of the sampling program were performed by PVNGS Unit Radiation Protection Laboratory (Unit RP). The samples for Phase II were performed by Arizona State University (ASU). Both laboratories have similar equipment.

4.2 SAMPLE ANALYSIS RESULTS:

The data collected to date are listed in Tables 4.0-1 and 4.0-2. The results are reported in microcurie per gram (μCi/gm). Analytical results which are positive (that is a value greater than the lower limit of detection (LLD)) are expressed in the tables with an uncertainty of $\pm$ 1 sigma. The LLD values are indicated by "<" preceding the listing on the table. A reported LLD value means that the radionuclide in question for a specific sample cannot be positively identified as being present at the level of the LLD. The implication is that if the radionuclide is present, its concentration will not exceed the LLD value.

The Phase I landfill samples analyzed by the Unit RP have shown positive Mn-54, Co-60 and Cs-137 values at sample points C1 and CC-1 (see Figure 4.0-1). A positive indication of Co-60 was found at sample point C2. A positive indication of Sb-125 was found at CC-1. However, no positive Sb-125 results have been found in the Phase II samples analyzed by ASU. The positive Cs-137 values found in the Phase I samples correspond to background Cs-137 activity levels (Table 4.2-1).

TABLE 4.2-1
PREOPERATIONAL BACKGROUND MONITORING RESULTS
AT PVNGS FOR Cs-137

Survey Year	# Samples Collected	Average Of Samples (pCi/kg)	Standard Deviation (pCi/kg)
1976[1]	19	168	167
1984[2]	19	160	117

[1]Source: Preconstruction Radiological Analysis on Palo Verde Site Soil, Controls for Environmental Pollution, Inc., Sante Fe, New Mexico, August 30, 1976.

[2]Source: Preoperational Radiological Analysis on Palo Verde Nuclear Generating Station and Vicinity Soil, Controls for Environmental Pollution, Inc., Sante Fe, New Mexico.

A total of 210 landfill samples collected in Phase II were analyzed by ASU. The results from those analyses are given in Table 4.0-2. These samples were taken from eight locations (Sites A through H) within areas 1 and 2 mentioned above.

Site A was the only location identified by Phase II that exhibited radioactivity levels above background. The radionuclides identified at Site A were Mn-54, Co-60, Cs-134 and Cs-137. Samples from all of the other sites showed LLD values for Mn-54, Co-60 and Cs-134; the positive Cs-137 values found in these samples correspond to background levels of Cs-137.

Within Site A, 130 samples were collected to establish its radiological boundary and the ranges of radioactivity values for each radionuclide present. Of the 130 analyses, 50 gave positive indications of power plant derived radionuclides. The identity of the radionuclides detected and their corresponding concentrations for the 50 positive samples are summarized in Table 4.2-2. Of these 50 samples, 36 showed positive for all three isotopes, Mn-54, Co-60 and Cs-137. The maximum concentrations for Mn-54, Co-60 and Cs-137 are 7.0E-7, 2.6E-6 and 1.7E-6 μCi/gm, respectively. In addition, 5 samples also contain Cs-134 with a maximum concentration of 4.3E-7 μCi/gm. The rest showed positive for one or two of these isotopes.

Site A Sludge Samples from Area 1 of the Sludge Landfill
Gamma Spectroscopic Results above LLD in uCi/gm

Sample #	Mn-54	Co-60	Cs-134	Cs-137
A surface	6.8E-7	2.6E-6		4.0E-7
A interface	3.2E-7	1.1E-6		2.4E-7
A subbase	1.2E-7	2.7E-7		6.1E-8
A-1	1.4E-7	5.0E-7		1.0E-7
A-2	1.8E-7	6.8E-7		1.2E-7
A-3	2.0E-7	6.7E-7		1.8E-7
A-4	5.0E-7	1.9E-6		4.1E-7
A-5	2.6E-7	1.1E-6		2.5E-7
A-6	1.1E-7	3.8E-7		5.5E-7
A-7	4.0E-7	1.6E-6		3.2E-7
A-8	3.7E-7	1.6E-6	4.3E-7	1.7E-6
A-8 surface	2.8E-7	9.0E-7		2.0E-7
A-8 interface	7.0E-7	1.5E-6		2.1E-7
A-9	1.6E-7	8.6E-7		1.1E-7
A-10	2.0E-7	1.9E-7	2.0E-7	8.0E-7
A-11	6.1E-7	2.3E-6		3.3E-7
A-12	1.9E-7	7.8E-7		9.5E-8
A-13	2.6E-7	9.9E-7		2.2E-7
A-14	1.1E-7	5.0E-7		2.6E-7
A-15	2.9E-7	1.2E-6	1.9E-7	6.7E-7
A-16	1.9E-7	7.8E-7		1.6E-7
A-17		1.3E-7		
A-24	4.5E-8	1.9E-7		7.2E-8
A-25	7.8E-8	3.0E-7		6.5E-8
A-26	8.0E-8	2.3E-7		1.2E-7
A-27	1.7E-7	5.0E-7		1.2E-7
A-28				1.2E-7
A-29		1.3E-7		
A-30	1.4E-7	4.7E-7		1.2E-7
A-31	1.6E-7	5.6E-7		2.7E-7
A-32	4.6E-8	2.2E-7		
A-37	4.1E-7	1.9E-6		2.7E-7
A-38	1.6E-7	8.1E-7	1.1E-7	4.7E-7
A-39		1.3E-7		
A-40	4.6E-8	2.2E-7		1.4E-7
A-41		2.4E-7		1.7E-7
A-42		2.7E-7		4.3E-8
A-44	4.9E-8	3.4E-7		4.6E-8
A-49		1.2E-7		
A-50	1.2E-7	4.9E-7		1.2E-7
A-52	3.3E-7	1.2E-6	1.3E-7	5.2E-7
A-53		1.2E-7		
A-57		1.8E-7		
A-60	1.4E-7	8.4E-7		1.7E-7
A-67		2.0E-7		2.1E-7
A-68	1.4E-7	5.6E-7		1.1E-7
A-69	1.1E-7	4.0E-7		8.3E-8
A-70		2.3E-7		
A-78		1.1E-7		
A-87				2.2E-8
A-95	2.5E-8			
A-110				2.0E-8

Table 4.2-2

To put the radiocesium data in perspective, the PVNGS 1986 Annual Radiological Environmental Operating Report prepared by ASU reported positive soil background values of Cs-137 that range from a low of 1E-8 7.4E-7 µCi/gm. These soil samples were taken at 59 environmental thermoluminescent dosimeter (TLD) sites maintained by ASU for PVNGS. In comparison, the values for Cs-137 reported above the LLD by the Phase II sampling program range from 1.9E-8 to 1.7E-6 µCi/gm. It is also important to note that these levels of radioactivity pose no risk to human health and the environment because of their very low levels of radioactivity.

The Cs-134 found in 5 samples confirms the presence of power plant radiocesium in the cooling tower sludge. Although it is not clear why so few samples show Cs-134, its absence supports the position that the Cs-137 found in nearly all of the positive samples can be attributed to background Cs-137. The highest Cs-137 concentration is given in Table 4.0-2 for sample A-8 as 1.7E-6 µCi/gm, which is outside background Cs-137 levels. However, Cs-134 was also found in this sample, which infers the presence of power plant Cs-137, and hence, this may explain the higher value for Cs-137 reported for this sample.

On August 30, 1989, 4 samples were taken in cooperation with Arizona Radiation Regulatory Agency at 4 locations within Site A for the purpose of an interlaboratory gamma spectroscopy comparison. The results of the analyses of these 4 samples performed at ASU and ARRA are presented in Table 4.2-3. A comparison of the results provided in Table 4.2-3 shows a difference that is generally less than a factor of two, which is within acceptable expectations given differences in techniques used at each facility, e.g., sample geometry and size.

ASU[a] and ARRA[b] Inter-laboratory Comparison

Site A Sludge Samples from Area 1 of Sludge Landfill

Gamma Spectroscopic Results in uCi/gm

Sample ARRA/PVNGS	Mn-54		Co-60		Cs-137	
	ASU	ARRA	ASU	ARRA	ASU	ARRA
#1	2.0E-7	9.9E-8	6.3E-7	3.6E-7	1.4E-7	1.4E-7
#2	3.2E-7	2.1E-7	1.5E-6	8.6E-7	2.4E-7	2.0E-7
#3	3.1E-7	2.2E-7	1.3E-6	8.8E-7	2.9E-7	1.7E-7
#4	2.0E-7	1.1E-6	8.7E-7	4.4E-7	1.7E-7	1.4E-7

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[a] Values from Table 4.0-2.

[b] Letter from Norman Pratt, ARRA, to Walter Bouchard, APS dated September 18, 1989.

Table 4.2-3

4.3 ESTIMATED VOLUME OF WASTE

The volume of material disposed at the Water Reclamation Facility sludge disposal landfill from the WRF two stage lime treatment process is 50,000 tons per year. The volumes of sludge generated at Units 1 and 3 cooling towers and disposed of in the Water Reclamation Facility sludge landfill was approximately 400 tons (approximately 450 cy). Compared to the expected volume from the Water Reclamation Facility, the contribution from the cooling tower sludge was very small.

4.4 REVIEW OF POTENTIAL GROUNDWATER IMPACTS:

The Water Reclamation Facility sludge disposal landfill is labeled facility No. 6 (Figure 4.4-1), and is located at coordinates 33°23'57" N, 112°50'50" W. The major geologic units below the site are the Upper Alluvial Unit, the Upper Middle Fine-Grained Unit, the Middle Fine-Grained Unit (Palo Verde Clay) and the Lower Coarse Grained Unit (see Section 8 for a more detailed description).

The PVNGS site is located in an area that was historically used for irrigated agriculture between 1950 and late 1975. Groundwater recharge, primarily from excess irrigation water, formed a perched groundwater mound under the site. Where the perched system exists beneath the PVNGS site, the depths to water range from less than 10 feet to more than 90 feet below land surface. Available geologic data indicate the perched groundwater system exists primarily within the Upper Alluvial Unit. The Upper Alluvial Unit consists of silty and gravelly sands of varying thickness with interlayered, discontinuous lenses of clays and silty clays. The lower boundary of the perched groundwater system is an aquitard, referred to as the Upper Middle Fine-Grained Unit.

The upper portion of the Middle Fine-Grained Unit consists of massive, continuous layers of clays and silty clays, interbedded with thinner layers and scattered lenses of clayey silt, clayey sand and silty sand. In the vicinity of the plant site, the lower portion of the Middle Fine-Grained Unit is referred to as the Palo Verde Clay. The Palo Verde Clay varies in

thickness from 20 to more than 120 feet. Laboratory tests indicate that the hydraulic conductivity of the Palo Verde Clay is approximately 5.0 X 10^{-8} cm/sec. The Palo Verde Clay acts as an aquitard for the regional aquifer, contained in the Lower Coarse-Grained Unit, as evidenced by localized artesian conditions in wells which penetrate the regional aquifer system.

Table 4.4-1 shows the November, 1988 water level contours for the perched groundwater system beneath the site. The data show that the perched system does not extend beneath the sludge landfill. Monitor wells PV-207A and PV-207B, each 100 feet deep, are dry (Table 4.4-1). Figure 4.4-2 shows the elevation of the top of the Middle Fine-Grained Unit and the Palo Verde Clay and the thickness of the Palo Verde Clay. The thickness of the Palo Verde Clay below the Sludge Landfill is 80 to 100 feet. The thickness of the Upper Middle Fine-Grained Unit is 190 to 200 feet. Data from wells PV-207A and PV-207B indicate that the depth to the top of the Middle Fine-Grained Unit is 27 feet (see Figure 4.4-3 for geologic log of wells PV-207A and PV-207B).

As stated above, water in the perched groundwater system is found within the Upper Alluvial Unit and the upper portion of the Middle Fine-Grained Unit. Wells PV-207A and PV-207B show that the perched system does not exist in the vicinity of the sludge landfill. Although the geologic conditions are the same at the sludge landfill as those elsewhere at the site, the perched system was not formed because there was no historic irrigation to provide a source of water.

The leachability of the cooling tower sludge is low. As described in section 2, the major components of the cooling tower sludge are dirt and sand carried into the tower by the blowers. The calcium and magnesium salts are not highly soluble either.

PVNGS CONTAINMENT/DISPOSAL FACILITIES*

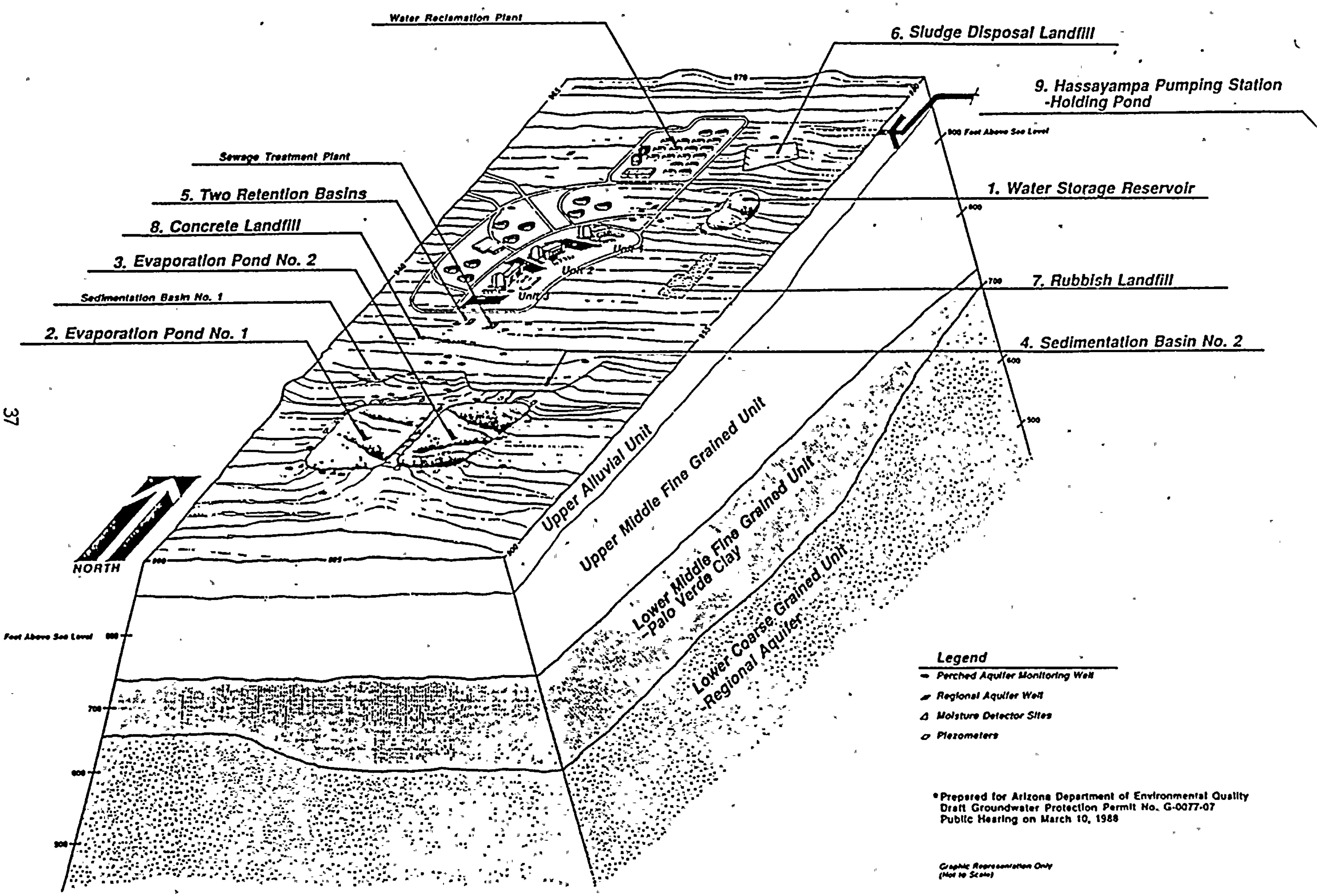


Figure 4.4-1

Very little water is expected to move through the sludge disposal landfill due to the basic operation and design of the landfill. The sludge from the Water Reclamation Facility, which constitutes the majority of material disposed in the landfill, is dewatered prior to disposal. The material is piled on the land surface to a maximum height of 6 feet. The landfill is also graded to prevent standing water on the landfill.

If any substantial discharge were to occur at the landfill this water would be detected by the PV-207 wells. In addition, any discharge from the facility would have to move vertically downward through approximately 190 to 200 feet of the Upper Middle Fine-Grained Unit and 80 to 100 feet of Palo Verde Clay before impacting the regional groundwater system.

P[illegible]S GROUNDWATER MONITORING PROGRAM
WATER LEVEL MEASUREMENTS DATA
VALUES IN FEET - BASED ON REFERENCE ELEVATIONS
APS ENVIRONMENTAL DEPARTMENT 02/15/90
CODES: A=NORMAL D=DRY WELL N=NO SAMPLE TAKEN

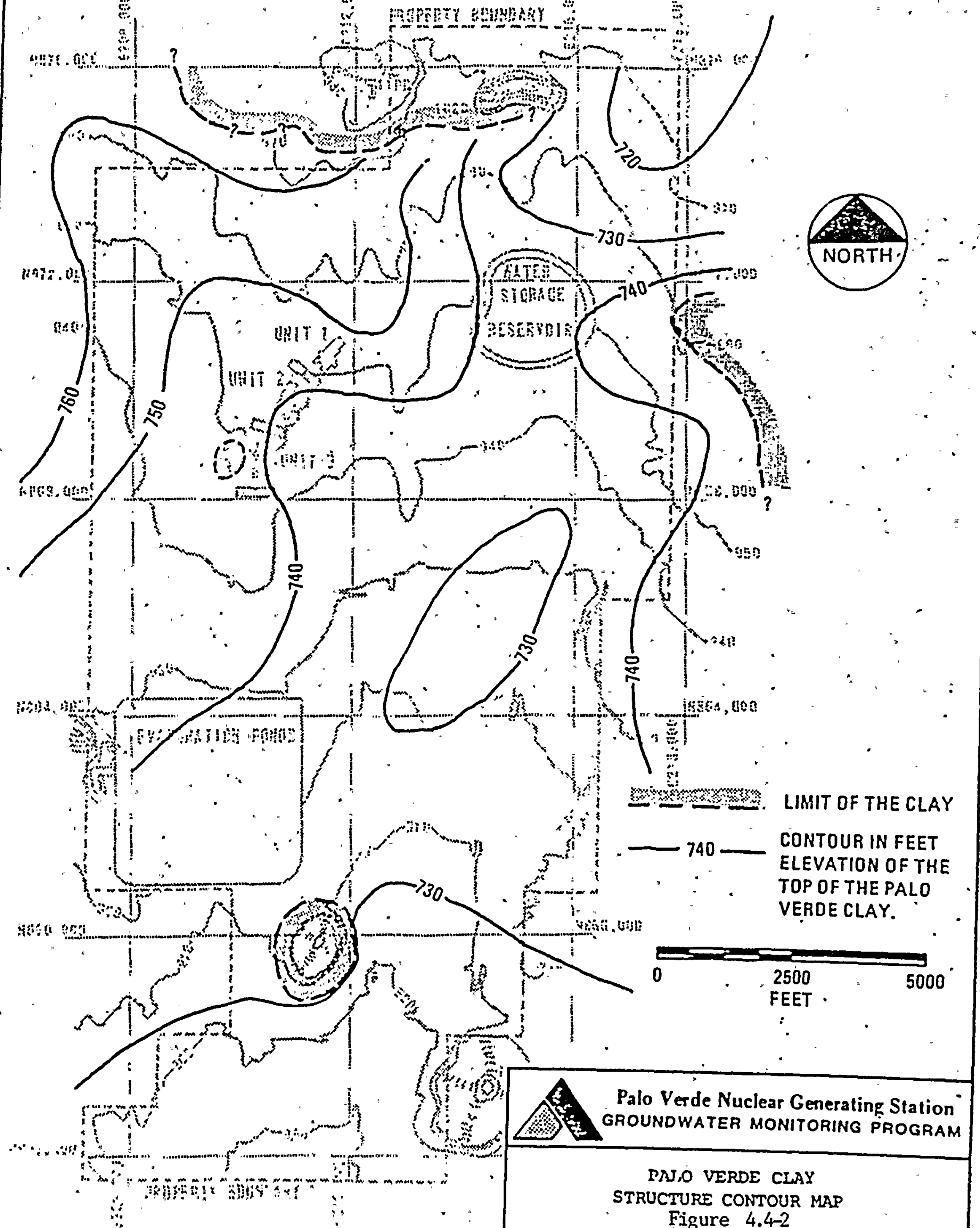
WELL NAME	QTR	YEAR	DATE	CODE	REFERENCE ELEVATION	GROUNDWATER ELEVATION	DEPTH TO WATER	COMMENT
WELL PV-206B								
PV-206B	1	88	880123	N	947.57	.	.	NOT ABLE TO REMOVE WELL CAP
PV-206B	1	88	880308	A	947.57	898.15	49.42	
PV-206B	2	88	880606	A	947.68	898.50	49.18	NEW REF. ELEV.--INSTALL PUMP
PV-206B	3	88	880823	A	947.68	896.96	50.72	
PV-206B	3	88	880915	A	947.68	896.37	51.31	
PV-206B	4	88	881020	A	947.68	896.05	51.63	
PV-206B	4	88	881109	A	947.68	895.71	51.97	
PV-206B	4	88	881209	A	947.68	895.61	52.07	
PV-206B	4	88	881217	A	947.68	895.43	52.25	
PV-206B	4	88	881222	A	947.68	895.34	52.34	
PV-206B	1	89	890117	A	947.68	895.22	52.46	
PV-206B	1	89	890201	A	947.68	895.08	52.60	
PV-206B	1	89	890314	A	947.68	894.98	52.70	
PV-206B	2	89	890412	A	947.68	894.53	53.15	
PV-206B	2	89	890502	A	947.68	894.45	53.23	
PV-206B	2	89	890626	A	947.68	894.13	53.55	
PV-206B	3	89	890717	A	947.68	894.03	53.65	
PV-206B	3	89	890801	A	947.68	893.83	53.85	
PV-206B	3	89	890922	A	947.68	893.18	54.50	
PV-206B	4	89	891017	A	947.68	893.38	54.30	
PV-206B	4	89	891104	A	947.68	893.35	54.33	
PV-206B	4	89	891218	A	947.68	893.18	54.50	
WELL PV-207A								
PV-207A	1	88	880123	N	967.24	.	.	
PV-207A	1	88	880308	D	967.24	.	.	DRY
PV-207A	3	88	880823	N	967.24	.	.	
PV-207A	3	88	880930	D	967.24	.	.	DRY
PV-207A	4	88	881027	D	967.24	.	.	DRY @101.72
PV-207A	4	88	881108	D	967.24	.	.	DRY
PV-207A	4	88	881209	D	967.24	.	.	
PV-207A	4	88	881217	D	967.24	.	.	
PV-207A	4	88	881222	D	967.24	.	.	
PV-207A	1	89	890117	D	967.24	.	.	
PV-207A	1	89	890201	D	967.24	.	.	
PV-207A	1	89	890314	D	967.24	.	.	
PV-207A	2	89	890412	D	967.24	.	.	
PV-207A	2	89	890503	D	967.24	.	.	
PV-207A	2	89	890626	D	967.24	.	.	
PV-207A	3	89	890717	D	967.24	.	.	
PV-207A	3	89	890803	D	967.24	.	.	
PV-207A	3	89	890922	D	967.24	.	.	
PV-207A	4	89	891017	D	967.24	.	.	

Table 4.4-1
(Sheet 1 of 2)

PVNGS GROUNDWATER MONITORING PROGRAM
WATER LEVEL MEASUREMENTS DATA
VALUES IN FEET - BASED ON REFERENCE ELEVATIONS
APS ENVIRONMENTAL DEPARTMENT 02/15/90
CODES: A=NORMAL D=DRY WELL N=NO SAMPLE TAKEN

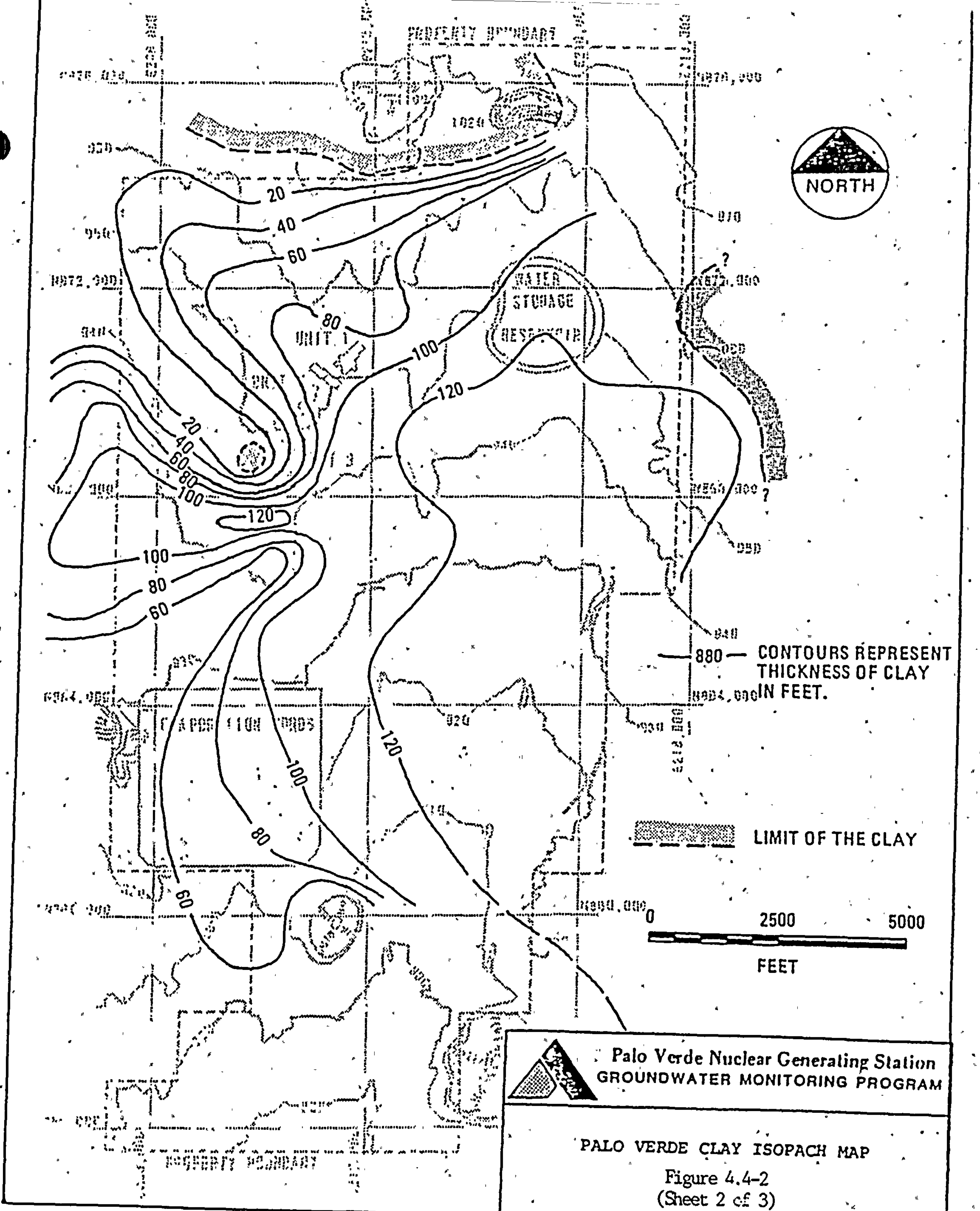
WELL NAME	QTR	YEAR	DATE	CODE	REFERENCE ELEVATION	GROUNDWATER ELEVATION	DEPTH TO WATER	COMMENT
PV-207A	4	89	891102	D	967.24	.	.	
PV-207A	4	89	891218	D	967.24	.	.	
					WELL PV-207B			
PV-207B	1	88	880123	N	967.94	.	.	
PV-207B	1	88	880308	D	967.94	.	.	DRY
PV-207B	3	88	880823	N	967.94	.	.	
PV-207B	3	88	880930	D	967.94	.	.	DRY
PV-207B	4	88	881027	D	967.94	.	.	DRY
PV-207B	4	88	881108	D	967.94	.	.	DRY
PV-207B	4	88	881209	D	967.94	.	.	
PV-207B	4	88	881217	D	967.94	.	.	
PV-207B	4	88	881222	D	967.94	.	.	
PV-207B	1	89	890117	D	967.94	.	.	
PV-207B	1	89	890201	D	967.94	.	.	
PV-207B	1	89	890314	D	967.94	.	.	
PV-207B	2	89	890412	D	967.94	.	.	
PV-207B	2	89	890503	D	967.94	.	.	
PV-207B	2	89	890626	D	967.94	.	.	
PV-207B	3	89	890717	D	967.94	.	.	
PV-207B	3	89	890803	D	967.94	.	.	
PV-207B	3	89	890922	D	967.94	.	.	
PV-207B	4	89	891017	D	967.94	.	.	
PV-207B	4	89	891102	D	967.94	.	.	
PV-207B	4	89	891218	D	967.94	.	.	
					WELL PV-208C			
PV-208C	2	88	880425	A	942.37	935.81	6.56	
PV-208C	2	88	880518	A	942.37	936.32	6.05	
PV-208C	3	88	880718	A	942.37	937.62	4.75	
PV-208C	3	88	880728	A	942.37	920.70	21.67	EVACUATED PIEZ. W/SANDPIPER PUMP
PV-208C	3	88	880801	A	942.37	925.24	17.13	
PV-208C	3	88	880802	A	942.37	925.83	16.54	
PV-208C	3	88	880803	A	942.37	926.02	16.35	
PV-208C	3	88	880809	A	942.37	928.42	13.95	
PV-208C	3	88	880810	A	942.37	928.82	13.55	
PV-208C	3	88	880811	A	942.37	929.27	13.10	
PV-208C	3	88	880812	A	942.37	929.67	12.70	
PV-208C	3	88	880815	A	942.37	930.67	11.70	
PV-208C	3	88	880816	A	942.37	931.02	11.35	
PV-208C	3	88	880817	A	942.37	931.22	11.15	
PV-208C	3	88	880818	A	942.37	931.52	10.85	
PV-208C	3	88	880819	A	942.37	931.82	10.55	
PV-208C	3	88	880822	A	942.37	932.62	9.75	
PV-208C	3	88	880823	A	942.37	932.64	9.73	

Table 4.4-1
(Sheet 2 of 2)



Palo Verde Nuclear Generating Station
GROUNDWATER MONITORING PROGRAM

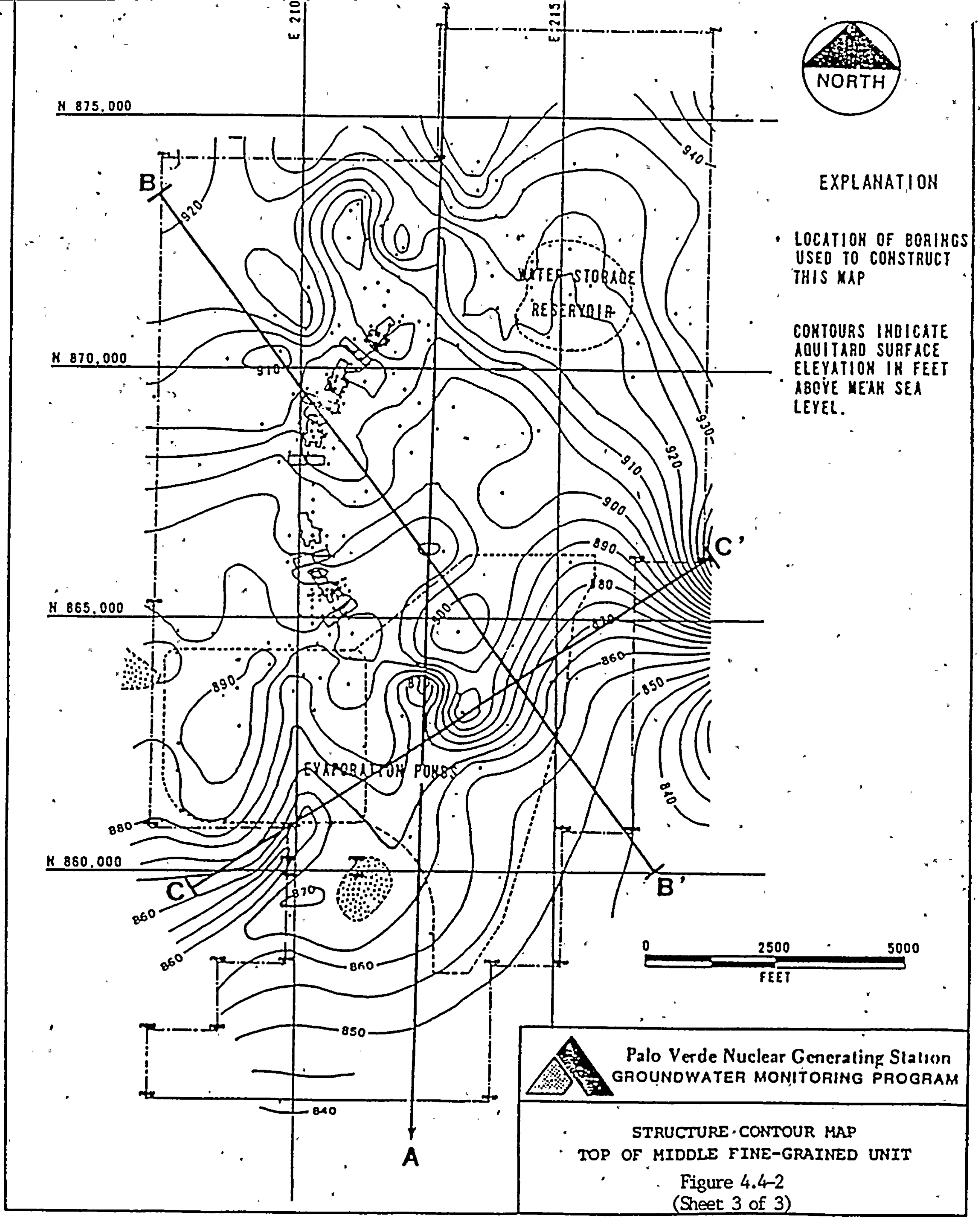
PALO VERDE CLAY
STRUCTURE CONTOUR MAP
Figure 4.4-2
(Sheet 1 of 3)



Palo Verde Nuclear Generating Station
GROUNDWATER MONITORING PROGRAM

PALO VERDE CLAY ISOPACH MAP

Figure 4.4-2
(Sheet 2 of 3)



Palo Verde Nuclear Generating Station
GROUNDWATER MONITORING PROGRAM

STRUCTURE-CONTOUR MAP
TOP OF MIDDLE FINE-GRAINED UNIT

Figure 4.4-2
(Sheet 3 of 3)