CNWRA PROGRAM MANAGER'S PERIODIC REPORT ON ACTIVITIES OF THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

For The Fiscal Reporting Period

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LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
1D, 2D, 3D	1-Dimensional, 2-Dimensional, 3-Dimensional
ACF	Alumina (in excess of alkali feldspar), Calcium oxide, Ferromagnesianoxide
ACNW	Advisory Committee on Nuclear Waste
ACRS	Advanced Computer Review System
AECL	Atomic Energy Canada Limited
AES	Atomic Emission Spectrometry
AGU	American Geophysical Union
AML	Arc Macro Language
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ASU	Arizona State University
ATDT	Automated Technical Data Tracking
CAR	Corrective Action Request
CCDF	Complementary Cumulative Distribution Function
CCL	Commitment Control Log
CCM	Constant Capacitance Model
CDM	Compliance Determination Method
CDROM	Compact Disk Read Only Memory
CDS	Compliance Determination Strategy
CFD	Computational Fluid Dynamics
CM	Configuration Management
CNWRA	Center for Nuclear Waste Regulatory Analyses
COI	Conflict of Interest
COPS	CNWRA Operations
CQAM	CNWRA Quality Assurance Manual
CRWMS	Civilian Radioactive Waste Management System
DAS	Data Acquisition System
DBE	Design Basis Event

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
DCPM	Division of Contracts and Property Management
DECOVALEX	Development of Coupled Models and Their Validation Against Experiments in Nuclear Waste Isolation
DEM	Digital Elevation Model
DFCSS	Division of Fuel Cycle Safety & Safeguards
DHLWM	Division of High-Level Waste Management
DIMNS	Division of Industrial & Medical Nuclear Safety
DLG	Digital Line Graph
DLM	Diffuse Layer Model
DNAG	Decade of North American Geology
DOE	Department of Energy
DRA	Division of Regulatory Applications
EBS	Engineered Barrier System
EBSPAC	Engineered Barrier System Performance Assessment Code
EDO	Office of the Executive Director for Operations
EDS	Energy Dispersive Spectrometry
EDX	Energy Dispersive X-Ray Spectroscopy
EM	Element Manager
EPA	Environmental Protection Agency
EPR	Electrochemical Potentiokinetic Reactivation
EPRI	Electric Power Research Institute
EQA	External Quality Assurance
ESF	Exploratory Studies Facility
FAC	Favorable Condition
FCRG	Format and Content Regulatory Guide
FD&SHA	Fault Displacement and Seismic Hazard Analysis
FEM	Finite Element Method
FIN	Financial Identification Number

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
FTE	Full Time Equivalent
GIS	Geographic Information System
GPS	Global Positioning Satellite
GROA	Geologic Repository Operations Area
GS	Geologic Setting
GWSI	Groundwater System Integration
GWTT	Groundwater Travel Time
HLW	High-Level Waste
HRTEM	High Resolution Transmission Electron Microscopy
ICP-AES	Inductively-Coupled Plasma Atomic Emission Spectrometry
IHLRWM	International High-Level Radioactive Waste Management Conference and Exposition
IM	Intermediate Milestone
IMS	Information Management Systems
INEL	Idaho National Engineering Laboratory
INTRAVAL	International Code Validation
IPA	Iterative Performance Assessment
IRM	Office of Information Resources Management
IVM	Interactive Volume Modeling
IWPE	Integrated Waste Package Experiments
JC	Job Code
JRC	Joint Roughness Coefficient
KTU	Key Technical Uncertainty
LAN	Local Area Network
LANL	Los Alamos National Laboratories
LARP	License Application Review Plan
LBL	Lawrence Berkeley Laboratory
LLNL	Lawrence Livermore National Laboratory

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
LSSA	Licensing Support System Administrator
LWR	Light Water Reactor
MH	Mechanical-hydrological
M&O	Management and Operations
MIT	Massachusetts Institute of Technology
MM	Major Milestone
MPC	Multi-Purpose Canister
MRS	Monitored Retrievable Storage
NAS	National Academy of Science
NCR	Nonconformance Reports
NMSS	Office of Nuclear Material Safety & Safeguards
NRC	Nuclear Regulatory Commission
NRC-NMSS	Nuclear Regulatory Commission—Office of Nuclear Material Safety & Safeguards
NRC-RES	Nuclear Regulatory Commission—Office of Nuclear Regulatory Research
NRC-RES/WMB	Nuclear Regulatory Commission—Office of Nuclear Regulatory Research, Waste Management Branch
NSRRC	Nuclear Safety Research Review Committee
NTS	Nevada Test Site
NWPA	Nuclear Waste Policy Act, as amended
NWTRB	Nuclear Waste Technical Review Board
OBES	Office of Basic Energy Sciences
OGC	Office of General Counsel
OITS	Open Item Tracking System
PA	Performance Assessment
PAAG	Performance Assessment Advisory Group
PAC	Potentially Adverse Condition
PA&HT	Performance Assessment and Hydrologic Transport

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
PASP	Performance Assessment Strategic Plan
PSHA	Probabilistic Seismic Hazard Analysis
PEM	Program Element Manager
PFD	Probabilistic Fault Displacement
PI	Principal Investigator
PMDA	Program Management Decision Analysis Staff
PMPR	Program Manager's Periodic Report
PNL	Pacific Northwest Laboratory
PRA	Probabilistic Risk Assessment
PSAG	Probabilistic System Assessment Group
QA	Quality Assurance
QAP	Quality Assurance Procedure
RDCO	Repository Design, Construction, and Operations
REE	Rare Earth Element
RES	Office of Nuclear Regulatory Research
RFA-ROC	Repository Functional Analysis—Repository Operations Criteria
RIC	Repository Isolation Criteria
RPD	Regulatory Program Database
RRT	Regulatory Requirement Topic
RSRG	Real Space Renormalization Group
SAIC	Science Applications International Corporation
SCA	Site Characterization Analysis
SCC	Substantially Complete Containment
SCCEX	Substantially Complete Containment Example
SCM	Surface Complexation Models
SCP	Site Characterization Plan
SAR	Synthetic Aperture Radar

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
SEM	Scanning Electron Microscopy
SELM	Spectral Element Method
SHE	Standard Hydrogen Electrodes
SKI	Swedish Nuclear Power Inspectorate
SLAR	Side Looking Airborne Radar
SNL	Sandia National Laboratories
SOW	Statement of Work
SRA	Systematic Regulatory Ana[illegible]sis
SRBS	Shafts, Ramps, Boreholes, and their Seals
STP	Staff Technical Position
SUFLAT	Stochastic Analyses of Unsaturated Flow and Transport
SwRI	Southwest Research Institute
TBD	To Be Determined
TDAS	Technical Database Access System
TDI	Technical Document Index
TDOCS	Technical Document Reference Database System
TEM	Transmission Electron Microscopy
THMC	Thermal-Hydrologic-Mechanical-Chemical
TLM	Triple Layer Model
TM	Thematic Mapper
TMH	Thermal-mechanical-hydrological
TOP	Technical Operating Procedure
TPA	Total Performance Assessment
TSPA	Total System Performance Assessment
TSw-Chnv	Topopah Spring-Calico Hills
UA	University of Arizona
UDEC	Universal Distinct Element Code
UNM	University of New Mexico

LIST OF ABBREVIATIONS (cont'd)

ABBREVIATION	DESCRIPTION
U.S.	United States
USGS	United States Geologic Survey
UTM	Universal Transverse Mercator
VCS	Version Control System
VF	Vitrification Facility
WAN	Wide Area Network
WIPP	Waste Isolation Pilot Plant
WMB	Waste Management Branch
WP	Waste Package
WSE&I	Waste Systems Engineering and Integration
WSS	Waste Solidification Systems
WVNS	West Valley Nuclear Services
XPS	X-ray Photoelectron Spectroscopy
XRD	X-ray Diffractometry
YM	Yucca Mountain
YMP	Yucca Mountain Project
YMPO	Yucca Mountain Project Office
YMR	Yucca Mountain Region

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TITLE: Center for Nuclear Waste Regulatory Analyses
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PERIOD OF PERFORMANCE: 10/15/92 - 09/26/97
PERIOD OF THIS REPORT: 01/22/94 - 02/18/94

1. TECHNICAL

1.1 *CNWRA Operations (COPS)*

The NRC and the CNWRA management continued coordination meetings and telephone conferences addressing a range of day-to-day and long-term management topics. CNWRA management staff continued its coordination with specific personnel from the PMDA, DHLWM, RES/WMB, and DCPM, responding to *ad hoc* requests for information addressing management issues affecting the conduct of CNWRA work. These issues included: (i) pursuit of RES-funded projects in Near-Field Environment and Subregional Hydrology beginning in FY94, (ii) clarification of TDOCS/TDI scheduling with that for RPD in the WSE&I Element, (iii) development of change pages to existing operations/project plans, (iv) development of an electronic PMPR, (v) scheduling issue-based topical meetings for CNWRA elements, (vi) utilization of INEL and LLNL Cray computer support funding, and (vii) establishing policies for the CNWRA or SwRI conducting work for other U. S. Government agencies.

As part of the continual development and phased introduction of a different LAN architecture for the CNWRA, the existing LAN server has been replaced, and this replacement has significantly reduced communication and data transmission interruptions, including those with the NRC. The CNWRA has selected specific graphic software for general use by its staff. Several alternative approaches to implementation of an electronic

version of the PMPR are being considered, and a recommendation with be made next fiscal period.

The current status of CNWRA staffing is indicated in Tables 1 and 2. Recruitment efforts and interviews continued for open positions. There have been no additions to the CNWRA core professional staff this period.

Certain changes to specific element/project plans are being made, including revised cost and resource utilization data. The CNWRA will deliver change pages to the current operations/project plans during Period 6.

During this period, Revision 2, Change 6 to the CQAM was approved and issued to the NRC in a controlled distribution process. In other related activities, the CNWRA QA staff performed the following: (i) internal surveillance of laboratory activities, (ii) QA indoctrination of new personnel, (iii) review of QAPs, (iv) assistance in the revision of TOPs, and (v) quality system input to the SRA process. The CNWRA QA Director participated in COI Management Committee meetings and attended meetings regarding safety of CNWRA personnel. All incoming requests-for-proposal to SwRI were reviewed by CNWRA QA staff to preclude any opportunity for an organizational COI through SwRI performing work in violation of the NRC contract. The internal surveillance conducted to assess the implementation of TOP-018 (Configuration Management of Scientific and Engineering Computer Codes) was effected, and eight CNWRA NCRs were generated by QA during the period. The CNWRA EMs and PIs will be addressing the NCRs during the next period. The CNWRA Code Custodian continued work in bringing the identified software codes under configuration management control in accordance with TOP-018.

The DOE, in response to the NRC request for access to their technical databases, has authorized access to such databases via Internet. The NRC has sent to the DOE a list of DHLWM staff who plan to access these databases within 90 days. Moreover, the CNWRA is preparing an External Database Access Plan (IM 5702-155-406) for the Internet access option to DOE databases, along with several other external HLW program databases supported by other participants, and anticipates delivery on April 14, 1994. The CNWRA submitted the TDOCS System Design (IM 5702-155-401), and continued the development of the TDOCS System.

The following activities are expected to occur during the next period. The CNWRA will continue resolution of management issues from the previous NRC/CNWRA Management Meeting, and another meeting is scheduled for Period 6.

Recruitment and interviews will continue for CNWRA core staff.

Change pages to specific element/project plans, including revised cost and resource utilization data, will be delivered in Period 6.

During the next period, the QA staff will: (i) participate in regular COI Management Committee meetings; (ii) conduct QA indoctrinations; (iii) continue depositing and maintaining records in the CNWRA QA records room; and (iv) perform surveillances.

The multiple surveillance reports showing the degree of compliance with TOP-018 for several computer codes resident at the CNWRA will be completed and distributed. In addition, there will be work on the CNWRA task to evaluate QA requirements.

The CNWRA will continue development of the TDOCS System, and it will conduct its first meeting with the TDOCS Advisory Group on March 3, 1994. Over the next several periods, the CNWRA will provide technical advice and support, as appropriate, on NRC requests for technical data from the DOE or other parties. The CNWRA will continue preparation of the plan for technical database access as discussed above.

1.2 *Waste Systems Engineering and Integration (WSE&I)*

There was essentially no activity related to the rulemaking for clarification of siting criteria, and none is expected during the next period. Work so far has been limited to reviewing public comments submitted on the proposed rulemaking to ensure CNWRA staff familiarity with them. Periodic contact is made with the NRC project lead concerning potential CNWRA involvement in this activity.

Essentially no activity related to support for review of the FCRG was undertaken, and none is anticipated in the near future.

There was essentially no activity undertaken in support of NWPA-mandated actions, and none is expected in the period to come.

Relative to CDS development, the CNWRA and NRC staff finalized the manuscript for LARP Revision 0. This manuscript was submitted to the NRC on February 18, 1994. Work continued to complete CDS revisions, specifically format revisions to references for rationales. The NRC concurred in TOP-001-11, Rev 2, Development of Compliance Determination Strategies (IM 5702-221-410). Work continued on preparations for CDS integration.

Significant work took place in the early stage of CDM development. CDM 10.0, Quality Assurance (IM 5702-222-414), which has been concurred in by the NRC staff, has passed final CNWRA review prior to delivery in the next period. The joint NRC/CNWRA team has completed the draft of CDM 1.4, Certification of Safeguards (IM 5702-222-411), and it was forwarded to the NRC project officer for NRC preliminary approval. Initial drafting has begun on the two companion CDMs 1.5, Physical Security Plan (IM 5702-222-412), and 2.7, Nuclear Material Control (IM 5702-222-413). Work continues on generic CDM text for PACs and FACs. Activity continues on development of a Crosswalk of Regulatory/Institutional Uncertainties with Review Plan Topics (IM 5702-222-451). This will become an appendix to the LARP. Work continued on activities in the LARP Development Plan, including definitions of a findings hierarchy, identification of review plan interfaces, and CDS integration.

There was essentially no activity related to WSE&I special projects.

Work is progressing on the implementation of Phase II of the RPD design to develop a generalized report writer. The development team is finalizing approaches to resolve the

remaining technical issues. A parser for the report writer is being prototyped to determine the most effective database input/output formats.

The installation of RPD Version 1.0 on the OS/2 platform is continuing. The DOS/Windows and MacIntosh installations are scheduled following completion and testing of the OS/2 port. A letter was transmitted to the NRC on February 14, 1994 requesting concurrence in the use of Standard Generalized Markup Language for RPD development.

During the next period, the WSE&I Element will direct effort in the following areas: (i) revision of CDSs; (ii) production of CDMs, including those for QA and Certification of Safeguards; (iii) installation of RPD Version 1.0 on various computer platforms; (iv) development of RPD Phase II (Report Writer); (v) initial design of the migration/incorporation of OITS into RPD; (vi) coordination of LARP development activities throughout the CNWRA, including conducting training necessary to support CDM development; (vii) preparation of a Crosswalk of Regulatory/Institutional Uncertainties with Review Plan Topics; (viii) development of an Uncertainty Identification and Resolution Procedure; (ix) CDS integrating activity; and (x) updates to the CNWRA Operations Plans for the DHLWM.

1.3 *External Quality Assurance (EQA)*

During this period, the CNWRA Quality Assurance Specialist was a participant on the NRC team observing the DOE QA audit of the YM Raytheon Services Nevada organization January 24-28, 1994. The CNWRA Observation Audit Report (IM 5702-331-403) was submitted to the NRC, and it will be utilized in the NRC report of this activity.

The CNWRA QA Director attended the NRC/DOE Technical Meeting on the Exploratory Studies Facility in Las Vegas, Nevada February 3, 1994 with the CNWRA RDCO Element Manager and NRC Technical and QA staff.

The CNWRA QA Director held a separate meeting with the NRC EQA Program Element Manager during the NRC/DOE Technical Meeting trip regarding the special tasking for reevaluation of appropriate QA requirements for CNWRA activities. The specific scope and format of this report was better defined because of the discussion.

The NRC EQA PEM and the CNWRA QA Director held planning discussions by telephone during this period on anticipated FY94 EQA work, which can include on-site visits, meetings, and observations of the DOE audits and surveillances. NRC Observation Audit Team work is expected to increase during the spring and summer months, and there may be emphasis to participate in NRC/DOE Technical Meetings so that both NRC and CNWRA QA staff are fully cognizant of YMP plans, site progress, and changes to the ESF.

In the next period, the CNWRA QA Director will continue to coordinate all upcoming NRC audit/surveillance/meeting team work and other EQA activities with the NRC EQA PEM. The CNWRA QA Director will attend the periodic NRC/DOE QA Meeting in

Washington D.C. on February 23, 1994, and a CNWRA QA representative will likely be part of the NRC Observation Audit Team at the EM-343 Audit or the M&O Audit, both of which are scheduled for early March, 1994.

1.4 *Geologic Setting (GS)*

Geology and Geophysics

Work continued for GS staff on the LARP development. The CDM was begun for Review Plan 3.2.1.10—Potentially Adverse Condition-Evidence of Extreme Erosion. CNWRA technical and programmatic review of the CDM for Review Plan 3.2.1.9—Potentially Adverse Condition-Evidence of Igneous Activity was completed, and the authors are resolving comments.

The DOE conducted a 2-day field trip at YM to respond to NRC and CNWRA concerns with the Extreme Erosion Topical Report. The trip was attended by M. Miklas, L. McKague, B. Hill, and A. Watson (Consultant). Nye County conducted a 1-day field trip to point out features of extreme erosion in the YM vicinity and to acquaint the DOE, NRC, CNWRA, state and other counties with colluvial/alluvial sites which display varnished rocks that Nye County believes to be less than 20,000 years old. NRC and CNWRA staff conducted a 2-day field trip to YM and Death Valley to evaluate DOE propositions in the topical report and to investigate regional evidence of extreme erosion in Death Valley.

During this period, work on issues related to tectonics and structural geology focused on development of a 3D Geological Framework Model of Yucca Mountain (MM 5702-425-403). The structure contour maps constructed to define the boundaries between geologic units were reviewed to check for consistency with additional boreholes (in particular, the UZ series boreholes). Transfer of the 3D model from IVM to EarthVision was restarted during the last week of this period and will continue through next period. Additional discussions have been held with IPA staff to determine how to optimize the 3D model for use in flow and transport simulation. Consequently, comparisons have been made between the 3D stratigraphy used by DOE in TSPA-93 and a number of other stratigraphic models. These models include the Sandia 3D thermal-mechanical model; the IPA Phase II model; the physical stratigraphy of Scott and Bonk (1984, Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections); and the composite (Sandia/Scott) model currently used in the CNWRA EarthVision 3D model. In addition, geophysical logs, core descriptions and results of core analyses of selected UZ-series, G-series, and H-series boreholes were reviewed to determine a practical hydrogeologic zonation (correlation) scheme. Preliminary conclusions based on this comparison and review are that: (i) the TSPA-93 and IPA Phase II stratigraphic models could be improved to better represent the in-situ geology, however; (ii) it is not clear how such improvements would affect the flow and transport simulations.

Debugging of SEISM 1.1 code and YM-based seismic input files continued. SEISM 1.1 calculations were made free of computer error messages. However, hazard output did not appear to be reasonable; undocumented input requirements were found to be a cause. Among them is the need for dummy source zones, designed to have little effect on final

calculations, in any radial integration distance band in which no real seismic source zone exists. Telephone conversations were held with B. Davis (LLNL) who was helpful in providing needed information regarding undocumented items. Input data were revised and seismic hazards recalculated. Results, although improved, did not appear to be correct. Analysis of the code with the FORSTRUCT tool was initiated. Extensions of dates for deliverables and bringing SEISM 1.1 under configuration control were requested. During times when source code was being analyzed by J. Menchaca (SwRI), the assigned programmer, R. Hofmann initiated development of rationale for sensitivity analyses of SEISM 1.1 to the introduction of dipping fault planes as source zones and to the reduction of ground motion with depth as a function of spectral frequency.

A paper was prepared and submitted, based on YM early SEISM 1 efforts at CNWRA, for the May 1994 Fifth IHLRWM Conference in Las Vegas, Nevada. A.K. Ibrahim of the NRC is coauthor with R. Hofmann.

Introduction of heterogeneous data sets is continuing for the geologic setting internal use ARC/INFO database.

GPS station location information with seven digits of longitude-latitude precision have been received from J. Davis (Harvard University). Longitude-latitude data with seven digits of precision is required and sufficiently resolved to correctly co-register with meter-scale map data sets.

A sampler CDROM of Synthetic Aperture Radar/Side Looking Airborne Radar (SAR/SLAR) was ordered and received from the EROS Data Center. This sampler CDROM is a USGS experimental demonstration CDROM for delivery of SAR/SLAR mapping mosaics. About one-fourth to one-third of the U.S. has been remote sensed with the SAR/SLAR technology. This sampler CDROM contains five total 1×2 degree SAR/SLAR image mosaics. Two of the five image mosaics fortuitously cover the 1×2 degree quads of Mariposa, California and Las Vegas, Nevada—quads bridging our region of interest.

This sample SAR/SLAR data will be co-registered with vector map coverages of the same 1×2 degree areas for comparison and contrast to known faults, fluvial and eolian features, and other geologic data.

A true four-color ink jet plotter was evaluated for large format-raster map printing/plotting. Several 32-in-wide (drafting E size) maps were produced with the plotter, with a mixture of USGS, CNWRA, and DOE GIS databases. In particular, E-size hypsography and fault maps of the nine-quad area about YM were co-registered with the DOE borehole data set.

During Period 6, hydrogeologic (porosity, permeability) and rock property (density) data will be compiled for 3D gridding in the Topopah Springs unit of the CNWRA model. Work will continue to rebuild the model in EarthVision, and improvements will be made in the faulted areas. Work will also begin on the topical report on Analyses of Coupled Faulting and Magmatic Dike Intrusion (IM 5702-425-402). This report is due May 9,

1994. The report on the review of the DOE Topical Report on Extreme Erosion will be completed in the next period.

Geochemistry, Hydrology, and Climatology

Efforts in Period 5 focused on completing the development of a matrix to identify Data Needs and Methods for CDM development in Hydrology, Geochemistry, and Climatology. The current CDSs were examined for guidance in developing the matrix. An additional source of information for data needs is 10 CFR Part 960, particularly Appendix IV. Existing ARC/INFO coverages were obtained to provide a spatial and interpretive framework for groundwater geochemistry (e.g., political boundaries, lithologic distributions, geologic structures, and topography). Data sources include DOE data and coverages developed as part of the Tectonics and Volcanism research projects at the CNWRA.

Groundwater flow in two geologic scenarios, tuff and granite, has been simulated as part of an analysis to assess the utility of a potential alternative performance measure of the geologic setting. Groundwater flow in two conceptual models, a fractured fully-saturated granite and a saturated/unsaturated tuff/carbonate system, is being simulated as part of this analysis. The effect of heat-generating waste on groundwater flow has been incorporated into all models.

Groundwater flow and the movement of particles through a fully-saturated medium with properties representative of granite have been simulated using PORFLOW. Several discrete fractures have been included in the conceptual model assessed in these simulations.

Groundwater flow through a saturated/unsaturated medium is being simulated with VTOUGH. This medium has properties representative of tuff overlying a carbonate aquifer. The tuff and carbonate units are modeled as composite media. These analyses are ongoing.

During Period 5, CNWRA completed and forwarded to NRC reviews of Study Plans 8.3.1.2.2.8, Fluid Flow in Unsaturated, Fractured Rocks (IM 5702-442-411) and 8.3.1.2.2.9, Site Unsaturated-Zone Modeling and Synthesis (IM 5702-442-411), and the critical review of "The Origin and History of Alteration and Carbonatization of the Yucca Mountain Ignimbrites," Unpublished DOE Report, (IM 5702-442-421).

The matrix for data needs and codes, methods, and analyses will be finished and more in-depth efforts will be made to identify data sources for entry into the GIS database. Groundwater modeling will continue using the two scenarios described above. It is anticipated the modeling results will be finalized and a report prepared. Work will begin on the CDM for Review Plan 3.2.2.5—Potentially Adverse Condition Flooding.

1.5 *Engineered Barrier Systems (EBS)*

The CNWRA staff identified specific caveats in the "Substantially Complete Containment—Example Analysis of a Reference Container," CNWRA Report 94-003, (MM 5702-551-410), to address the extent of applicability of results of the methodology analyses presented in the report. The report is currently under review at the NRC.

The preliminary compilation of the report entitled, "Role of Colloids in the Release of Radionuclides from Spent Fuel and Vitrified Wasteforms" (IM 5702-523-415), was reviewed by the various authors. Additional input is required from one author before the technical review can be initiated. This report is a joint effort of technical staff at the CNWRA and the NRC, and it is expected to have a revised date of completion.

The available quantitative information and data on engineering components for the Field Engineering Experience for Structural Materials report (IM 5702-551-430) has been collected in rough draft form. The discussions on design process and assessment of areas where improvements in fabrication, design, and inspection can contribute to improved reliability for metallic waste containers have also been drafted. The schedule for completion has been reviewed by the participating NRC staff, and a completion date of March 31, 1994, has been set.

On February 17, 1994, the CNWRA EBS technical staff received CDM development training during a kickoff meeting. The CDM 5.1 (Description of the EBS) is planned for completion this fiscal year, and development of the CDM 5.4 (Assessment of Compliance with the EBS Performance Objectives) will begin this fiscal year. The strategy for development of CDM 5.1 will use other CDMs on "description" review plans currently being developed in other elements as models for development of CDM 5.1.

The CNWRA prepared an annotated outline for a staff position on "substantially complete containment" and submitted it to the NRC on February 8, 1994.

A technical paper titled "Spent Fuel Characterization Relevant to High-Level Waste (HLW) Source Term," coauthored by H. Manaktala, P. Nair, and C. Interrante (NRC) was prepared for presentation at the Fifth IHLRWM Conference to be held in Las Vegas, Nevada, May 22-26, 1994, and it was submitted to the NRC for programmatic review.

In the next period, final input to the report for sections on data for reliability of nuclear components and corrosion case studies will be integrated into the draft. Staffs from CNWRA and NRC will edit the draft to final author form and submit it for CNWRA and editorial review. EBS staff will participate in CDS integration by reviewing pertinent portions of the LARP. Work on the Colloids report and the CNWRA support for the staff position on SCC will continue.

1.6 *Repository Design, Construction, and Operations (RDCO)*

In this reporting period, the RDCO Element concentrated on the following activities: (i) development of CDSs; (ii) development of CDMs on Shafts and Ramps Design, Shafts and Ramps Description, and Surface Facilities Description; (iii) evaluation of computer codes for compliance determination and rock joint model development; (iv) prelicensing interactions; and (v) ESF design reviews.

NRC/CNWRA teleconference meetings regarding CDS integration continued. During this period, the final draft of LARP, Rev. 0 was prepared. This required revision of the CDSs to incorporate NRC OGC's proposed minor changes on CDSs especially on regulatory requirements and some generic text changes based on the new language in CDS development procedure. CNWRA comments were received on the draft "Work Plan for Conducting CDS Integration" that was prepared in Period 4. These comments are being discussed by the Special Working Group that prepared the work plan.

The work on the CDM development included three Regulatory Requirement Topics (RRTs): (i) design of shafts, ramps, boreholes, and theirs seals (SRBS); (ii) description of SRBS; and (iii) description of surface facilities. Drafts on the sections for Protection Against Dynamic Effects of Equipment Failure and Similar Events [60.131(b)(2)], Protection Against Fires and Explosions [60.131(b)(3)], and Inspection, Testing, and Maintenance [60.131(b)(6)] were prepared for CDMs on design of SRBS and transmitted to the NRC team members for their input. The CDM development on design of SRBS for four other sections i.e., Protection Against Natural Phenomena and Environmental Conditions [60.131(b)(1)], Utility Services [60.131(b)(5)], Instrumentation and Control Systems [60.131(b)(8)], and Shaft Conveyances Used in Radioactive Waste Handling [60.131(b)(10)] is at various stages of development. Draft CDMs on description of SRBS and description of surface facilities were prepared and transmitted to the NRC team members for their input.

The development of a rock joint model for simulating dynamic response using the experimental results of the Seismic Rock Mechanics research project continued during this period. Work is in progress to understand the effect of joint surface roughness on rock joint behavior. This is being done through two methods—the theory of fractal geometry and the geostatistical method. The development of the specifications of two problem sets that will be analyzed by computer code ABAQUS in FY94 has been completed. The analysis of these two problem sets by ABAQUS will be a part of further evaluation of the coupled thermal-mechanical-hydrological (TMH) analysis capabilities of ABAQUS.

A. Chowdhury attended the NRC/DOE Technical Meeting on the ESF that was held in Las Vegas, Nevada on February 3, 1994. The purpose of this meeting was to hold discussions on DOE activities related to the ESF design and design control process. The presentations made by DOE indicated improvement on DOE design integration and design control process. Only very limited interaction between the NRC and CNWRA staffs took place during this period regarding DBE Rulemaking.

During the next period, activities within the RDCO Element will include: (i) continued development of the CDMs on Shafts and Ramps Design, Shafts and Ramps Description, and Surface Facilities Description; (ii) integration of CDSs; (iii) development of the rock joint model and evaluation of ABAQUS; (iv) coordination of the DBE rulemaking; (v) participation in prelicensing activities; and (vi) work on ESF Title II Design review.

1.7 *Performance Assessment and Hydrologic Transport (PA&HT)*

The PA&HT Element concentrated on the following activities: (i) review of the EPA draft compliance criteria; (ii) preparation of a background report on the use of expert judgment; (iii) participation in LARP team meetings; (iv) completion of the contribution to the NRC/SKI paper on model validation; (v) preparation of the plan for IPA Phase 3 activities; (vi) completion of the draft PASP; (vii) preparation of user guides for selected TPA modules; (viii) implementation of the software configuration management procedure, TOP-018; and (ix) integration activities.

In accordance with the NRC technical directive of February 10, 1994, work was performed on a review of the EPA Draft Compliance Criteria 40 CFR Part 194. To conduct a thorough review in the limited time, a team was organized consisting of J. Hageman (team lead), W. Patrick, A. DeWispelare, R. Brient, B. Sagar, M. Miklas, E. Tschoepe, and R. Mason (SwRI). The team prepared comments which were included in a letter report entitled "Comments on the January 28, 1994 Draft of EPA 40 CFR Part 194." This report was submitted on February 17, 1994 to fulfill IM 5702-711-403. This work was conducted under the scope described in the PA Element Subtask 1.1 of the FY94-95 Operations Plan.

Work was initiated on preparation of a background report on the use of expert judgment in PA. The report is being prepared in accordance with the outline approved by N. Eisenberg and J. Park (NRC). The principal contributors to this report are: A. DeWispelare and T. Herren (SwRI), and T. Bonano and R. Clemmon (consultants); R. Winkler (consultant) will serve as technical reviewer. In addition, a paper entitled "The Use of Expert Elicitation to Predict Future Climate for the Yucca Mountain Nevada Vicinity" was prepared for presentation at the Fifth IHLRWM Conference in Las Vegas. This work is being conducted under the scope described in the PA Element Subtask 1.2 of the FY94-95 Operations Plan.

R. Bagtzoglou continued participation in the LARP team meetings. The team is currently focusing on developing an approach for the integration/consistency review of CDSs. The team members are setting goals for the review, identifying consistency requirements, and specifying standards of consistency for strategies versus rationales. The aim of this activity is to formulate proposed guidance for the planned in-depth review of all CDSs. This work was conducted under the scope described in the PA Element Subtask 2.1 of the FY94-95 Operations Plan.

An initial contribution was completed to a paper entitled, "Model Validation from a Regulatory Perspective." B. Sagar and G. Wittmeyer authored three chapters of this milestone entitled, "Contribution to NRC/SKI Paper," which was submitted to the NRC on February 10, 1994 to fulfill IM 5702-722-510. This work, which was due on

February 14, 1994, was performed in accordance with the NRC technical directive of January 27, 1994. This work was conducted under the scope described in the PA Element Subtask 2.2 of the FY94-95 Operations Plan.

Planning for the IPA Phase 3 exercise continued with meetings among several members of the CNWRA staff. Proposals received for TPA module development and auxiliary analyses were distributed to CNWRA management for review and comment. The proposals were subsequently modified. Based on discussions with the NRC staff, the CNWRA will take the lead in the preparation of the initial plan for IPA Phase 3. Work continued on the auxiliary analysis on infiltration phenomena at Yucca Mountain; S. Stothoff, B. Gureghian, and A. Nedungadi (SwRI) are collaborating on this task. A technical paper entitled "Sensitivity and Probabilistic Analyses of the Impact of Climatic Conditions on the Infiltration Rate in a Variably Saturated Multi-layered Geologic Medium" was prepared for presentation at the Fifth IHLRWM Conference. This work was conducted under the scope described in the PA Element Subtask 2.3 of the FY94-95 Operations Plan.

A draft of the PASP was completed and submitted to the NRC on February 11, 1994 to fulfill AD 5702-723-410 entitled "Draft of PA Strategic Plan." R. Baca and T. Bonano (Consultant) traveled to Rockville, Maryland, to interact with the NRC staff and complete the draft report; this work also included a trip by R. Baca to Albuquerque, New Mexico. Comments on the current draft were received from J. Park, N. Eisenberg, and R. Neel (NRC). The draft was revised to incorporate these comments and submitted for CNWRA editorial review. The CNWRA final draft of the PASP is expected to be submitted to the NRC by March 7, 1994. This work was conducted under the scope described in the PA Element Substask 2.3 of the FY94-95 Operations Plan.

Preparation of user guides for the DRILLO, SEISMO, and AIRCOM modules of TPA continued. The user guide for the DRILLO module was completed and put through the CNWRA internal review process. Significant progress was made on the SEISMO code user guide. A draft of the AIRCOM user guide was prepared. The DRILLO and SEISMO user guides will fulfill IMs: (i) 5702-723-415, User Guide for DRILLO Modules and (ii) 5702-723-421, User Guide for SEISMO Module. Contributing to this activity were R. Janetzke, V. Kapoor, S. Stothoff, R. Baca, and C. Frietas and A. O'Campo (SwRI). This work was conducted under the scope described in the PA Element Subtask 2.3 of the FY94-95 Operations Plan.

Work continued on placement of appropriate NRC/CNWRA codes under configuration control. A surveillance was performed by the CNWRA QA staff to assess compliance with the Configuration Management Procedure, TOP-018. T. Ratchford (SwRI) and R. Baca prepared responses to QA concerns. In addition, R. Manteufel, R. Janetzke, and A. Lozano (SwRI) traveled to Albuquerque, New Mexico and met with the developers of the CAMCON computer code. In this meeting, the software design and QA aspects of the CAMCON was described by the SNL-WIPP staff. A trip report on this meeting was prepared and transmitted to NRC. This work was conducted under the scope described in PA Element Subtask 2.3 of the FY94-95 Operations Plan.

A series of meetings is being conducted between the PA Element staff and the PIs of the CNWRA research projects. The purpose of these meetings is to achieve technical and programmatic integration of the research projects with the IPA exercises. These meetings are chaired by R. Baca, P. Mackin, and R. Manteufel. In this reporting period, meetings were held with L. McKague, S. Young, and G. Stirewalt of the GS Element to discuss FY94 work on: (i) development of a site-scale hydrostratigraphic model of the YM site and (ii) technical design for a fault module for TPA. Proposals for these two IPA support activities, which were prepared by S. Young and G. Stirewalt, were reviewed, discussed, and finalized. Products of these activities will be added to the FY94-95 Operations Plans.

In the next period, the PA Element will direct its efforts in the following areas: (i) continuing the preparation of the planning document for the IPA Phase 3, (ii) preparing final draft of the PASP, (iii) preparing user guides for TPA modules SEISMO and AIRCOM, (iv) continuing to place the major scientific and engineering codes under configuration control, (vi) continuing work on the auxiliary analyses on infiltration/focused recharge and flow around the waste package, and (vii) conducting integration meetings with PIs working on research projects.

1.8 *Research*

Research Project 1 - Overall Research

The report "NRC High-Level Radioactive Waste Research at CNWRA, July—December 1993," which fulfills milestones for essentially all research projects, was completed and transmitted to NRC February 14, 1994.

The "Call for Papers" announcement for the Workshop on Rock Mechanics Issues in Repository Design and Performance Assessment was prepared in consultation with the NRC-RES and NRC-NMSS staffs. A list of more than 130 individuals from the academic, commercial, and international technical communities, including more than 25 from the DOE and DOE contractors, was also prepared. The announcement will be sent to these individuals during the first week of next period. The workshop is scheduled for September 19-20, 1994, at the Holiday Inn Crowne Plaza, Rockville, Maryland. Invitations to DOE and its contractors will be sent through the NRC.

Planning for the Analogs/Performance Assessment Workshop continued with discussions among CNWRA and NRC Analog and Performance Assessment staff. A meeting has been tentatively scheduled for the week of June 13-17, 1994 in San Antonio, Texas.

Receipt of an SOW for the new Near-Field Environment Research Project is anticipated in the near future; upon receipt of the SOW, work will begin on development of a Project Plan. Planning for the Analogs/Performance Assessment and the Rock Mechanics workshops is anticipated to continue.

Research Project 2 - Geochemistry

Work continued on writing the final report for the Geochemistry Research Project. A peer review of the final topical report for this project was directed by CNWRA

management, and work commenced to plan the review and to make appropriate changes to project budget and schedule. An updated version of EQ3/6 (version 7.2a) was received from LLNL which is compatible with 486, 386, and UNIX environments. Work commenced to operate the software at the CNWRA and bring it under CNWRA configuration management. The paper "Thermodynamics of ion-exchange between clinoptilolite and aqueous solutions of Na^+/K^+ and Na^+/Ca^{2+}" by R.T. Pabalan has been accepted for publication in *Geochimica et Cosmochimica Acta*.

Work will continue on the final report during the next report period and it will be submitted for CNWRA technical, editorial, and programmatic review. Planning for the peer review of the final report will be completed in the next period. The *Geochimica et Cosmochimica Acta* paper by R.T. Pabalan will be revised and returned for publication.

Research Project 3 - Thermohydrology

The Thermohydrology Research Project has been active in several areas during the past reporting period, including: (i) preparation of laboratory-scale experiments, (ii) calculation of hydraulic properties of the test media, (iii) conduct of numerical analyses, and (iv) publication of papers on aspects of dimensional scoping analyses.

Several test containers for the gas-gradient experiments have been prepared using concrete as the test medium. Concrete was selected to provide a medium with a sufficiently low permeability required for a gas gradient to form. A heat load will be imposed upon these test containers to assess whether formation of a gas gradient is feasible. Results from the gas-gradient experiments will be used to assess theories developed through dimensional analysis of heat and mass transfer in unsaturated fractured rock. This work is being conducted by R. Green and S. Svedeman, L. Bishop, and F. Dodge (SwRI).

The hydraulic properties of media used in the laboratory-scale experiments are being characterized. These media include the ceramic to be used in the Test 6/7 series of experiments, concrete being tested for use in the gas-gradient tests, and alumina powders used in several completed experiments. An undergraduate geology student, G. James, was hired to assist in these measurements. The control panel used to conduct measurement of saturated hydraulic conductivity was modified to permit simultaneous measurement of three samples. The former setup, which permitted only one sample to be measured, prohibited timely measurement of samples, particularly those with low permeabilities.

Work continued on numerical analyses of the large-block heater test under construction by the DOE at Fran Ridge using the VTOUGH computer code. A heat load of 3000 watts, double that proposed in the test, has been assessed to evaluate changes in heat and mass transfer when advective gas flow is significant.

Theoretical analysis of these flow mechanisms and identification of simple mathematical models to represent flow in a thermosyphon have continued. Prediction of gas flow through media under the imposition of a heat load has continued. This work is being conducted by R. Manteufel, H. Castellaw, and L. Bishop (SwRI). In relation to this

work, two papers were submitted to the Fifth IHLRWM Conference to be held in Las Vegas, Nevada on May 22-26, 1994: (i) "Thermosyphon Analysis of a Repository: A Simplified Model for Vapor Flow and Heat Transfer" by R. Manteufel and M. Powell and (ii) "Pressure-Driven Flow in Heated, Partially-Saturated Porous Media" by F.T. Dodge and R.T. Green.

In the next period, work will continue in five areas: (i) construction and assessment of test containers and media for use in coupled processes experiments, particularly tests with concrete as the test medium, (ii) conduct of hydraulic property measurement experiments of concrete, ceramic, and alumina, (iii) initiation of the Test 6/7 series with a ceramic and a concrete medium, and (iv) scoping measurements of the preferential flow experiment.

Research Project 4 - Seismic Rock Mechanics

The Seismic Rock Mechanics Research Project has nine tasks. Among these tasks, the first, Focused Literature Search, and the second, Laboratory Characterization of Jointed Rock, are complete. Task 6, YM Scoping Analysis, has been delayed pending the availability of the data associated with YM. Active tasks in FY94 include: Task 3, Assessment of Analytical Models/Computer Codes; Task 4, Rock Dynamics Laboratory and Field Studies; Task 5, Groundwater Hydrology Field Studies; Task 7, Technical Report; Task 8, Semi-Annual Research Reports; and Task 9, DECOVALEX Modeling and Laboratory Studies. In this reporting period, primary effort was devoted to the laboratory study of a small-scale jointed rock mass physical model for Task 4; design of test apparatus for the mechanical-hydrological experimental study for Task 9; preparation of test specimens for mechanical properties determination of Lucky Friday Mine rock for Task 5; and preparation of the Semi-Annual Research Report for Task 8.

The design and construction activities for small-scale model tests of jointed rock mass using a shaking table continued. Casting of rock mass components that are 2 in. by 2 in. in cross section and 2 ft long continued during this period. The casting of more than 300 rock mass components has been completed. Pretest simulation of the small-scale model test using the UDEC computer code continued to develop a preliminary understanding regarding rock mass deformation with an emphasis on the shear displacement and dilation of joints near the excavation. This information is being used for assessing the expected response of the test and has been used to finalize the design of instruments for response measurements. Instruments for measurements of joint normal displacement, excavation closure, and cable loading have been ordered.

The activities associated with the coupled mechanical-hydrological (MH) experiments continued. Work is continuing in the conduct of preliminary MH experiments using the modified apparatus. A preliminary test using nitrogen gas has been completed. The test results are being analyzed to determine the appropriateness of the test design. Preparation of detailed specifications for the MH experiment is close to completion for transmittal to the DECOVALEX Secretariat for use as Test Case #5 problem for DECOVALEX Phase III study. Preparation for a baseline experiment of unsaturated flow through a joint without considering the mechanical effect is under way.

Preparation of specimens for mechanical properties determination of the rock cores collected from the Lucky Friday Mine, Mullan, Idaho continued during this period. About 60 cylindrical specimens have been selected and about 20 of them will be prepared according to ASTM standards for uniaxial compressive tests. About the same number of disk specimens for Brazilian uniaxial tensile tests will also be prepared. The "Report for Groundwater Hydrology Field Studies" (MM 5704-035-094) is being prepared.

A formal announcement for the Workshop on Rock Mechanics Issues in Repository Design and Performance Assessment and a list of potential participants are being finalized. A camera ready copy of the report "Laboratory Characterization of Jointed Rock" (CNWRA Report 93-013), which has been accepted by NRC, is being prepared for publication as a NUREG/CR report.

During the next period, activities within the Seismic Rock Mechanics Research Project will include: (i) casting of rock mass components for the small-scale rock mass dynamic laboratory experiment; (ii) laboratory work on mechanical properties determination of Lucky Friday Mine rock cores and preparation of the Report for Groundwater Hydrology Field Studies (MM 5704-035-094); (iii) DECOVALEX modeling and experiments; (iv) sending invitations for participation of the workshop; and (v) preparation of the "Final Project Report" (MM 5704-037-094) to document the results obtained from the Seismic Rock Mechanics Research Project and making recommendations on use of these results.

Research Project 5 - Integrated Waste Package Experiments (IWPE)

Long-term localized corrosion tests continued into the sixth month. The specimen which was held 100 millivolts above the repassivation potential measured in short-term tests exhibited initiation of crevice corrosion. The specimen held at 100 millivolts below the repassivation potential has not indicated any signs of localized corrosion. The specimens were removed, weighed, and visually examined. The tests will continue.

The controlled tests on the circular crevice cell are still being conducted. The behavior of hydrogen ions in the crevice due to acid addition in the bulk was predictable, at least qualitatively. However, the much slower increase in crevice pH due to caustic additions to the bulk was surprising, even considering the diffusion of hydroxyl ions. Computer simulations of the chemistry and transport in this crevice are being conducted.

U-bend specimens of alloy 825 are being tested in saturated chloride solutions at 95 °C under open circuit and anodic potential conditions. Specimens were examined after 1 month of exposure. Visual examination at 70X exhibited the presence of cracks above the vapor-solution interface, regardless of the level of applied stress. It appears that residual stresses arising from the bending operation are sufficient to induce cracking in the straight legs of the U-bend specimens. These specimens are being tested further.

Slow strain rate tests with intentional crevice devices in the gage section are being conducted using type 316L stainless steel round tensile specimens in concentrated chloride solutions. The crevices are being placed both below and above the solution level.

Specimens of the variously cold-rolled alloy 825 are being prepared for thermal aging. Initially, aging will be performed at temperatures higher than anticipated in the repository. These tests will enable a comparison of the aging kinetics of cold-worked and annealed specimens (which were tested previously).

A report containing a detailed literature review on degradation modes of alternate container materials is being prepared.

The proceedings of the ASTM symposium on Application of Accelerated Corrosion Tests to Service Life Prediction of Materials, co-chaired by G. Cragnolino and N. Sridhar, was published as ASTM Special Technical Publication 1194. A paper titled Prediction of Localized Corrosion Using Modeling and Experimental Techniques, coauthored by N. Sridhar, G. Cragnolino, D. Dunn, and J. Walton (University of Texas at El Paso), is included in the book, among 23 peer-reviewed papers.

The long-term localized and stress corrosion cracking tests will continue. The circular cell for the crevice chemistry experiments will be used for further corrosion tests. Modeling of chemical transport in this cell, without the corrosion reactions, will be completed and compared to experimental results. The specimens for thermal stability will be heat treated, and nitric acid tests will be initiated. The draft report on the alternate materials will be completed and sent for editorial review at the CNWRA.

Research Project 6 - Stochastic Analysis of Large-Scale Flow and Transport in Unsaturated Fractured Rock (Stochastic)

During this reporting period, the research activities focused on the preparation of a technical report on effective hydraulic property calculations with semi-analytical and direct numerical simulation methods. Work conducted by J. Yeh (UA), on the tensorial nature of unsaturated hydraulic conductivity was critically reviewed, has been improved, and is now included as a chapter in the effective properties report.

Two papers were authored and submitted for publication in the Fifth IHLRWM Conference proceedings. The first, authored by A. Bagtzoglou, R. Islam (University of Washington), and M. Muller (SwRI) discusses the Stochastic Unsaturated FLow And Transport (SUFLAT) methodology, and presents some results for a two-layered system. The second, authored by S. Mohanty and A. Bagtzoglou presents the Real Space Renormalization Group method and some verification results. In a third paper, prepared for the tenth International Conference on Computational Methods in Water Resources (CMWR'94), the role of dispersion in determining predictability of solute concentrations levels was examined with the SUFLAT methodology. In a heterogeneous porous medium, it was found that dispersion dramatically increases our ability to confidently predict contaminant concentrations at large times. Further detailed simulations are now being undertaken by V. Kapoor to explore this topic. The effect of greater numerical resolution of variability on our assessment of transport will be found by the fine-scale flow simulation being conducted currently. The grid size in this simulation is half of that employed in the previous simulations, increasing the number of grid-blocks by a factor of eight. Cross-sectional averages of dependent variables are being computed, and mean squared departures from the cross-sectional averages are being evaluated. The ratios of

standard deviations and means, and the variations of this ratio in space and time, will be evaluated.

During the next reporting period, the activities will concentrate on finalizing the report on effective properties.

Research Project 7 - Geochemical Analogs

During Period 5, gamma counting to determine U content of bulk rock samples from Level +00 from the Nopal I deposit was completed. Data from traverse samples radial to the Level +00 exposure of the deposit show general trends of decreasing U content away from the center of the deposit with somewhat higher values where the traverses cross small faults and fractures. Initial tests were begun to investigate the possibility of using a high-resolution, high-sensitivity Canberra gamma spectrometer recently acquired by SwRI for U disequilibria studies. Calibration geometries and standards are being developed. Additions were made to the existing Canberra database to include required U-series isotope peak energies. Results from initial tests show superior resolution at low energies. Successful application of the Canberra Gamma Spectrometer will permit identification of samples which have been deposited during the last one million years.

Investigations continued of fracture-filling minerals from the Nopal I analog site to determine the identities of minerals upon which or within which transported U is retained and the positions of the U on or in those minerals. These studies are presently focused on fracture-filling oxides and sulfates. Optical microscopy and XRD analyses show the major minerals to be hematite, goethite, and jarosite. Gamma counting and autoradiographic analyses indicate that the Fe-minerals contain U. However, EDS and Auger spectrometry were unable to detect the presence of U in selected minerals, indicating that U content is below detection limits for these techniques. The possibility of Auger peak overlaps disguising the presence of U is being investigated.

ICP-AES analyses were completed of Cu-rich metal standards (SRM 396 and 871) designed to evaluate techniques for obtaining high quality chemical analyses of microgram quantities of bronze corrosion products collected from artifacts excavated at the Akrotiri analog site. ICP-AES results indicated that such analyses of the available microgram quantities of bronze corrosion products is not practicable. Leaching analyses intended to examine trace metals transported from bronze artifacts into the underlying tuff will be based on EDS analyses and literature-reported analyses of bronze artifacts from elsewhere in the Akrotiri excavation. Leaching experiments were initiated to determine the identities and concentrations of metals on the surfaces of bulk samples of silicic tuff collected as sets in vertical series at locations above which bronze artifacts were discovered.

Measurements continued, in collaboration with the PA Research Project, of saturated hydraulic conductivity and retention curves for tuff matrix samples collected from the Nopal I analog site. The control panel used to conduct saturated hydraulic conductivity measurements was modified to perform up to three simultaneous conductivity measurements; the previous instrument configuration was capable of measuring only a

single sample at a time. The expanded capabilities will permit timely measurement of samples with low permeabilities.

Planning continued for field research at the Nopal I analog site. This effort is anticipated for February 28 through March 4, 1994. Activities are being coordinated with Professor I. Reyes of the *Universidad Autonoma de Chihuahua*.

The Geochemical Natural Analog portion of the CNWRA semi-annual research report was completed with revisions in response to programmatic review and resolution of comments. A revised draft of a manuscript was submitted for publication in the *Journal of Applied Geochemistry* after minor changes in response to external peer-review. Writing began on the "Topical Report on Containment Transport at Peña Blanca" (IM 5704-065-094) describing U transport at the Nopal I analog site. Costs for the Geochemical Natural Analog Research Project were reviewed for CNWRA Mid-Year Operations Plans adjustments; no changes were recommended for the project budget.

During Period 6, activities within the Geochemical Analog Research Project are anticipated to include: (i) field research at the Nopal I analog site, (ii) continued petrographic study of Nopal I samples, (iii) continued Auger spectroscopy of fracture-filling iron oxides and jarosite from Nopal I, (iv) continued leachate analyses of the tuff from the Akrotiri site, and (v) continued writing of the topical report describing U transport at the Nopal I analog site.

Research Project 8 - Sorption Modeling

Experiments on ^{233}U (initial concentration = 50 ppb) sorption on montmorillonite (forward and reverse experiments) were completed. Analysis of uranium concentration using a liquid scintillation analyzer was completed. Results are similar to experiments on clinoptilolite and alpha-alumina, which show strong dependence of uranium sorption on pH. Maximum sorption (100 percent) occurs at a pH about 6.2. Reverse data demonstrate that the sorption reaction is reversible. New experiments were initiated with initial U concentration of 50 ppb, but using a smaller zeolite-mass to solution-volume ratio (0.01 g to 40 ml).

Before starting experiments on the sorption behavior of Np and Pu, radiological safety and operating procedures were drafted and submitted to the SwRI Radiation Health and Safety Committee for approval. Spikes to be used in the experiments (^{237}Np, ^{238}Pu and ^{239}Pu) were ordered from Isotope Products Laboratories, Burbank, California. Isotope activities required are governed by the solubility limits of Np and Pu. Laboratory equipment (e.g., glove bag and HEPA filters) necessary to support the experiments has been identified and ordered.

The Micromeritics zeta potential analyzer has been prepared for use. Work will continue to develop methods to gather reproducible data on the pH_{zpc} (point of zero charge) for geologic materials used in the sorption experiments.

Preparation of a CNWRA perspective (white paper) on the importance of uranium in radionuclide source term and transport studies was initiated.

Modeling of sorption results available from the literature continued with the surface complexation modeling of Th, Am, and Np sorption on SiO_2. These data do not show appreciable desorption at higher pH. Initial modeling results indicate reasonably good agreement between model predictions for the sorption edge and experimental data. Additional modeling has begun for uranium-montmorillonite sorption data available from CNWRA experiments. FITEQL input files are being constructed for determining the binding constants for surface complexation models in the uranium-montmorillonite system.

The manuscript "Approaches to Sorption Modeling for High-Level Waste Performance Assessment" by D. Turner and S. Sassman has been accepted, with minor revision, for publication in the *Journal of Contaminant Hydrology*.

Uranium sorption experiments on montmorillonite will continue. Additional experiments at initial U concentrations of 5 and 500 ppb will be initiated to determine the concentration dependence of U sorption on montmorillonite. Preparation of the Wedron quartz sand to be used in sorption experiments (batch and column) will continue. The white paper covering CNWRA perspectives on the importance of uranium in radionuclide source term and transport studies will be completed.

Modeling efforts will continue to focus on both data available in the literature and the uranium-montmorillonite sorption data and the losses to container walls studied at CNWRA. The *Journal of Contaminant Hydrology* paper will be revised and returned for publication.

Modeling activities during the next period will focus on completing the surface complexation analysis of currently available actinide sorption data for different minerals. When more than one data set is available for analysis, data will be combined to generate a single set of weighted binding constants. Results will be tabulated in a spreadsheet to provide a readily accessible source for the binding constants. Additional effort will focus on applying surface complexation approaches to the limited amount of data that are reported in the literature for actinide sorption in mixtures of minerals.

Research Project 9 - Performance Assessment (PA)

In this reporting period, the technical staff concentrated on: (i) completion of the report on a review of scenario selection methodologies, (ii) conceptual and mathematical models of flow in fractured permeable media, and (iii) analysis of hydraulic properties of the Peña Blanca tuff core samples.

A technical report entitled, "Review of Scenario Selection Approaches for Performance Assessment of High-Level Waste Repositories and Related Issues" (IM 5704-191-094-001) presents a state-of-the-art review of generic scenario selection methodologies. The findings and recommendations of this study are expected to be incorporated in the IPA Phase 3 planning. The report was submitted in advance of the March 31, 1994 due date. This work was conducted under the scope described in Task 1 of the PA Research Project Plan for FY94-95.

Work continued on the conceptual/mathematical model of flow in a fracture with imbibition into the rock matrix. Study of this topic is consistent with the recommendations of IPA Phase 2. V. Kapoor has developed an approach based on a classical fluid mechanics model to examine the water flow in an idealized inclined fracture embedded in a permeable medium. The conceptual/mathematical model, which accounts for the effects of gravity, viscosity, and matrix imbibition, has been implemented in a simple computer code and a series of test runs made. The role of matrix imbibition in controlling the distance water travels in a fracture is being analytically and numerically assessed. In addition, work was performed on documenting the approach. This work will produce a technical report entitled "Study of Water Film Flow in a Fracture with Imbibition" (IM 5704-191-094-002). This activity was conducted under the scope described in Task 1 of the PA Research Project Plan for FY94-95.

Analysis of the unsaturated hydraulic properties of rock samples collected from the Peña Blanca Natural Analog site continued. Preliminary composite moisture retention curves for several samples were compiled. These data, which were obtained using a 5-bar pressure plate extractor for low suction pressures and a water activity meter for higher suction pressures, show that the two techniques are consistent. Parameters for the van Genuchten equation were calculated using the measured moisture retention data. Different analytical relationships between the "n" and "m" coefficients were used to fit the measured data. These calculated parameters, however, have not been finalized. Saturated hydraulic conductivity of the samples are being measured. The apparatus used to perform these measurements was modified to permit as many as three samples to be simultaneously analyzed. This modification will allow timely measurement of the Peña Blanca core samples, particularly the unaltered samples which have low permeabilities requiring long measurement times. This work will be documented in a technical report entitled "Analysis of Hydraulic Characteristics of Hydrothermally-Altered Tuff" (IM 5704-191-094-004). This work is being conducted under the scope described in Task 1 of the PA Research Project Plan for FY94-95.

No work was performed on model validation activities. Per agreement with T. McCartin, (NRC), the major activity on this task will be deferred until the completion of the NRC/SKI model validation paper and PASP by the NRC NMSS staff. This activity was conducted under the scope described in Task 3 of the PA Research Project Plan for FY94-95.

In the next reporting period, work will be directed to the following activities: (i) continue documentation of fracture conceptual/mathematical model, (ii) continue work on determination of fractured tuff properties, and (iii) initiate preparation of a topical report on advanced computational methods in PA.

Research Project 10 - Volcanic Systems

Work continued on compiling additional data into the GIS during this period. This included gathering of age and geographic data on the Springerville volcanic field. Preliminary development of a Markov model for the most probable location of potential eruptions was completed during this period. This model agrees well with nonhomogeneous Poisson models in that it predicts that future volcanism is more likely

to occur in the Crater Flat region than elsewhere. Recurrence rate models, such as those developed for the YMR by C.-H. Ho (University of Nevada, Reno) were tested using data from the Springerville volcanic field during this period. J. Trapp (NRC) participated in testing of the Markov modeling during a staff exchange which took place during this period.

Probability model development will continue during the next period with further testing of the Markov model and of recurrence rate models. Data compilation will continue.

Research Project 11 - Tectonic Processes

During this period, processed data from the initial occupation (1991) of the NRC-funded Death Valley Region GPS was transmitted to the CNWRA in digital form by J. Davis (Harvard University) and was added to the Tectonics Research GIS. Initial planning for field work in the Landers earthquake area was carried out. Compilation of data for cross-section tectonic models of the central Basin and Range region, including the Death Valley-Yucca Mountain area, was initiated. This tectonic modeling project is an integrated effort between Regional Hydrology Research and Regional Tectonics Research. Visualization of earthquake hypocenters in 3D was started during this period. Temporal and spatial clustering of earthquakes is evident from these initial studies, but detailed evaluation of data quality has not yet been performed. The Mesa Butte cinder cone along the Mesa Butte fault in the San Francisco volcanic field (Arizona) was studied using aerial photographs and it appears to be a well-exposed example of the surface manifestation of fault/dike interaction. Therefore, this cinder cone locality has been chosen as a strong candidate for detailed field study.

Compilation of data and planning for cross-section tectonic models of the central Basin and Range and the YM area will continue during the next reporting period. Evaluation of earthquake hypocenters in 3D will continue with emphasis on compressed-time visualization of regional earthquake occurrence. During this period, the Geological Society of America Cordilleran Section meeting will be attended by D. Ferrill and G. Stirewalt. Combined, they will attend 4 field trips: Black Mountains/Death Valley, reconstruction of the Mojave Block, Landers earthquake, and Neogene history of the Garlock fault.

Research Project 12 - Field Volcanism

Field work at Parícutin Volcano, Mexico, was conducted during this period. This field work consisted of sampling active fumaroles for geochemical analysis, studies of soil-gas flux and composition. A total of 30 radon stations were deployed on and around Parícutin. Radon concentrations were as high as 50 picoCuries/liter in areas of active flow. Twenty He, 84 CO_2, and 80 soil Hg samples were also collected and are currently being analyzed. Fumaroles were sampled by the Giggenbach method and condensates were collected for isotopic analysis. In addition, fumarole temperatures were monitored at Parícutin during a 4-day period. Temperatures varied between 180 and 220 °C in the hottest fumaroles during this period.

Similar samples were collected at Jorullo Volcano, Mexico, located 100 km south of Parícutin. It was discovered that fumarole temperatures at Jorullo are about 125 °C. These are regarded as high, since the volcano has not erupted since it was formed 200 years ago.

Samples of pyroclastic rocks were collected at Parícutin from a 2-m pit dug at a distance of 1.1 km from the main cone.

During the coming period, work will focus on the analysis of samples collected at Parícutin and Jorullo volcanoes.

Research Project 13 - Regional Hydrogeologic Processes

Progress was made in Task 2 on the Development of Conceptual Models. In particular, efforts were focused on the development of a regional scale hydrostratigraphic model of the Death Valley region. Compilation of data for cross section tectonic models of the central Basin and Range region and the Yucca Mountain area was initiated during this period. This activity is an integrated effort between the Regional Hydrogeology and Regional Tectonics Research projects. The effort consists of gathering available data and developing interpretations for the pre-Tertiary section with emphasis on the Paleozoic carbonate aquifer. The data and interpretations for the compilation are from outcrop, seismic reflection profiles, water wells, oil and gas wells, and existing geologic cross sections. The data are being compiled in the ARC/INFO database, where appropriate, and will be used to construct additional cross sections which will be modeled using the GEOSEC kinematic balancing program to interpret the regional unconformity at the base of the Tertiary sequence and the top of the Paleozoic carbonate aquifer.

The primary effort during Period 6 will be the compilation of data and planning for cross section tectonic models of the central Basin and Range, Death Valley region and the Yucca Mountain area.

1.9 *Waste Solidification Systems (WSS)*

No significant activity was conducted in WSS this period. The CNWRA received updated information for the Vitrification Facility NRC Readiness Notebook. The review of the vitrification process documents was initiated. Data and information needed on the safety issues related to the potential corrosion of the carbon steel tank, 8D-2 resulting from the formation of nitric acid during the mixing process of PUREX and THOREX wastes are now expected from the DOE in April 1994. The DOE submittals are now 3 months behind planned schedule from that in the WSS Operations Plan. Adjustments to the plan are anticipated.

The review of the additional vitrification documents will be initiated.

1.10 *Monitored Retrievable Storage (MRS)*

During this period, no work assignment was received from the NRC.

The CNWRA will await further work assignment on MRS from the NRC.

2. MANAGEMENT ISSUES

None.

3. MAJOR PROBLEMS

None.

4. SUMMARY OF SCHEDULE CHANGES

Schedule changes that have become necessary are summarized in Table 3. This table provides formal documentation of: (i) schedule changes for IMs that occurred during the preceding period or are anticipated to occur during the subsequent period, and (ii) schedule changes for MMs that are anticipated to occur during subsequent periods. Each item listed has been discussed with the cognizant NRC PEM and other parties, as appropriate. In the case of MMs, the matter has been discussed with the NRC Contracting Officer and/or the designated representative of DCPM.

5. SUMMARY FINANCIAL STATUS

Table 4 indicates the financial status of the CNWRA in the context of authorized funds established by the NRC. Total commitments of the CNWRA are $292,606. Appendix A displays planned and actual costs to date, without allowance for fee, on both a per-period and a cumulative basis. In addition, these data do not include commitments, and variances are shown on both a dollar and percentage basis. Pertinent information is provided for the CNWRA program as a whole, the DHLWM JC, the RES DRA JC, the DIMNS JC, and the DFCSS JC, as well as for each Program Element and Project. This information is provided in both graphical and tabular form.

The actual cost for the fourth period of FY94 in the HLW JC is 9.5 percent below the estimated cost. All of the elements, except GS, show cost underruns, which are explained in the following paragraphs.

The aggregate underspending of 5.1 percent in the COPS Element reflects the accumulation of both the old and new work breakdown structure account numbers (071-076 and 151-155). For FY94 to date, all subtasks are under projected expenditure levels, including both series of work breakdown structure account numbers, except Management Support and Planning (Subtask 151) and DHLWM Computer Systems Support (Subtask 155). It is expected that expenditures for both Subtasks 151 and 155 will continue to exceed estimates for at least one more fiscal period.

The WSE&I Element was 18.4 percent underspent at the end of this period. This represents a 7 percent reduction in underspending from the previous period and reflects the increased use of

additional SwRI staff for RPD development and uncertainty crosswalk preparation. Increased spending is expected in the next period.

Actual costs for EQA are currently 36.4 percent below the estimated spending plan. This underrun in the EQA Element is due to a less-than-expected number of field activities and generally lower costs per activity than originally estimated.

The GS Element is overspent by 8.6 percent. This slight increase in the rate of spending reflects increasing activity in the hydrology/geochemistry/climatology area, as well as an increase in the geology and geophysics site characterization review, resulting from the site visit for extreme erosion. In the next several periods, effort will be transferred from geology/geophysics to IPA resulting in reduced costs in the geology/geophysics area.

The expenditures at the end of this period in the EBS Element are 6.9 percent below the planned costs. Expenditures are expected to increase in the future periods and remain close to planned levels.

Costs incurred to date for RDCO work are 4.0 percent below those planned. Costs will increase as the DBE rulemaking, CDS development, and prelicensing activities continue.

Spending in the PA&HT Element is 21.3 percent under the project amount. This percentage reflects a significant decrease in the cost variance by about 11 percent from the last period. The current underspending is due primarily to: (i) only recent start of work on the expert judgment study, (ii) limited activity on CDSs and CDMs, and (iii) limited NRC tasking on prelicensing interactions and reviews. Work is being accelerated on the expert judgment study and on the auxiliary analyses for infiltration, flow around the waste package, and C-14 transport. This is expected to increase the spending rate and further decrease the variance.

Costs incurred to date for the Overall Research Project were 16 percent above projected costs. The increase in variance from Period 4 largely reflects activity associated with production of the Semi-Annual Research Report (IM 5704-002-205). An adjustment to the project budget is planned to accommodate FY93 charges which were costed to this project during Period 3 of FY94. This adjustment is anticipated to bring future project costs close to projected values.

The Geochemistry Research Project is currently 46 percent above its planned spending, compared to 60 percent last period. An upward adjustment in the project budget will be requested, which will be compensated for by a decrease in the planned budget for the Near-Field Environment Research Project, which is the successor to the current Geochemistry Research Project. The startup of the Near-Field Environment Research Project is delayed because an SOW has not yet been received from NRC. The revised budget will include provision for peer-review, which will be done by external reviewers, of the project final report.

Actual costs for the Thermohydrology Research Project have continued to exceed estimated costs. Actual costs are 9.4 percent over the estimate. This cost variance is about 6 percent smaller than the previous period variance, and reflects efforts to reduce the spending rate. In addition, a letter was received from NRC approving an increase in the budget of $70,000 for the remainder of FY94 to ensure the successful and timely completion of this research project.

Seismic Rock Mechanics Research Project costs incurred are 0.4 percent less than the planned expenditure. Expenditures are expected to remain close to planned levels.

The IWPE Project costs are 17.0 percent less than planned. The underspending was due to the concentration in the SCCEX modeling activities in Periods 3 and 4. Activities in the IWPE Research Project have increased in this reporting period and will continue to be close to the project plan in the future periods.

The Stochastic Research Project is 21.5 percent over the projected costs. The high current spending rate is expected to reduce substantially in subsequent periods. The following actions have been taken already to address the cost variance: (i) two of the project contributors in Task 6 will limit their participation to reviews (since the activities regarding the report on effective properties are winding down); and (ii) two of the contributors in Task 3 will cut their participation by 50 percent.

The Geochemical Natural Analog Research Project is 5 percent below planned costs. Project costs for the remainder of the fiscal year should approximate planned values. Occasional, short-term cost deviations corresponding largely to field research expenses are anticipated.

Spending levels increased slightly for the Sorption Modeling for High-Level Waste Performance Assessment Research Project from the previous period to bring actual costs into close agreement with planned spending.

Currently, the Volcanic Systems Project is underspent by 11.9 percent. Expenditures were lower than expected during this period primarily because considerable effort was expended in Field Volcanism and in reactive work for NMSS.

As of the end of Period 5, the Regional Hydrology Project is approximately 8 percent over budget compared with 15 percent at the close of Period 4. The rate of overspending should continue to decrease during Period 6 due a concerted effort to reduce the overall spending rate.

Cumulatively, the Field Volcanism Project is underspent by 5.5 percent. Project costs are anticipated to remain steady during the next period.

Spending for the Tectonics Project is 46.6 percent over the planned budget. Spending has been significantly reduced during this period. The overage this period is due to travel expenses associated with the Tectonics/Volcanism workshop and to costs for modeling work done during periods 3 and 4. These costs were billed late. Spending will continue to be held down until the project is back on budget.

The PA Research Project is 1.5 percent under the projected amount. This small variance, like that of the previous period, shows efforts to control the spending rate have been very successful. This control was achieved while changing the emphasis of the project to Task 1 topics (e.g., conceptual models, disruptive scenarios) as requested by the NRC project officer.

The expenditures in the WSS Project are 82.7 percent below the planned level. The nature of the tasks in this program element reflect the dependence on several documents to be received from the DOE. As a result, the expenditures are expected to fluctuate. Activities in the review of the

SAR-001 vitrification documents are expected to increase in the next few periods. The DOE is currently planning to send to the NRC, in April 1994, a technical document on the mixing of wastes. A revision in the spending plan for the remaining FY94 activities needs to be made. Significant activities will develop in this project once the draft of the Vitrification SAR is made available by the DOE.

In the MRS Project, no work was assigned to the CNWRA by the NRC resulting in a cost underrun of 98.4 percent. E. Shum (NRC) has indicated that the CNWRA may not receive additional work assignments until an MRS site is identified.

TABLE 1. CNWRA CORE STAFF - HIRING PROFILE AND STATUS (02/18/94)

EXPERTISE/EXPERIENCE	FISCAL YEAR (PLANNED)								OPEN THIS YEAR
	FY93				FY94	FY95	FY96	FY97	
	1Q	2Q	3Q	4Q					
ADMINISTRATION	5	5	5	5	5	5	5	5	0
CODE ANALYSIS/DEVELOPMENT	2	2	2	2	2	2	2	2	0
DATABASE MANAGEMENT & DATA PROCESSING	2	2	2	2	2	2	2	2	0
ELECTROCHEMISTRY	1	1	1	1	1	1	1	1	0
ENGINEERING GEOLOGY/GEOLOGICAL ENGNG			1	1	1	1	1	1	0
ENVIRONMENTAL SCIENCES	1	1	1	1	1	1	1	1	0
GEOCHEMISTRY	5	5	5	5	5	5	5	5	0
GEOHYDROLOGY/HYDROGEOLOGY	5	5	5	5	5	5	5	5	0
GEOLOGY	2	2	2	2	2	2	2	2	0
HEALTH PHYSICS	1	1	1	1	1	1	1	1	0
INFORMATION MANAGEMENT SYSTEMS	2	2	2	2	2	2	2	2	0
MATERIAL SCIENCES	4	4	4	4	4	4	4	4	0
MECHANICAL, INCLUDING DESIGN & FABRICATION	1	1	1	1	1	1	1	1	0
MINING ENGINEERING	1	1	1	1	1	1	1	1	0
NUCLEAR ENGINEERING	1	1	1	1	1	1	1	1	0
NUMERICAL MODELING/HP (e)			1	1	1	1	1	1	1
PERFORMANCE ASSESSMENT	4	4	4	4	4	4	4	4	0
QUALITY ASSURANCE	2	2	2	2	2	2	2	2	0
RADIOISOTOPE GEOCHEMISTRY (a)	1	1	1	1	1	1	1	1	1
REGULATORY ANALYSIS	1	1	1	1	1	1	1	1	0
ROCK MECHANICS	3	3	3	3	3	3	3	3	0
SEISMOLOGY	1	1	1	1	1	1	1	1	0
SOURCE-TERM/SPENT FUEL DEGRAD.	1	1	1	1	1	1	1	1	0
STRUCTURAL GEOLOGY/SEISMO-TECTONICS	3	3	3	3	3	3	3	3	0
SYSTEMS ENGINEERING	1	1	1	1	1	1	1	1	0
VOLCANOLOGY/IGNEOUS PROCESSES	1	1	1	2	2	2	2	2	0
TOTAL CORE STAFF PLANNED	51	51	53	54	54	54	54	54	2

Staffing Summary

	Professional	Support	Total
Current	52	16	68
Limited Term	1	0	1
Offers Made	0	0	0
Planned This Date	54	16	70
Planned End of FY94	54	16	70

(a) Interview scheduled next period
(b) Resumes being solicited
(c) Offer made
(d) Offer pending
(e) Offer accepted

TABLE 2. CNWRA CORE STAFF - CURRENT PROFILE (02/18/94)

EXPERTISE/EXPERIENCE	
ADMINISTRATION	J.LATZ, W.PATRICK, H.GARCIA, P.MACKIN, J. RUSSELL, B. SAGAR
CODE ANALYST	R.JANETZKE, R.MARTIN
DATABASE MANAGEMENT AND DATA PROCESS	A.JOHNSON
ELECTROCHEMISTRY	G.CRAGNOLINO
ENGINEERING GEOLOGY/GEOLOGICAL ENGNG	G.OFOEGBU
ENVIRONMENTAL SCIENCES	P.LaPLANTE
GEOCHEMISTRY	W.MURPHY, R.PABALAN, E.PEARCY, J.PRIKRYL, D.TURNER, P.BERTETTI*
GEOHYDROLOGY/HYDROGEOLOGY	A.BAGTZOGLOU, R.GREEN, S.STOTHOFF, G.WITTMEYER, V.KAPOOR, S.MOHANTY
GEOLOGY	L.McKAGUE, M.MIKLAS
HEALTH PHYSICS	J.HAGEMAN
INFORMATION MANAGEMENT SYSTEMS	R.JOHNSON, R.MARSHALL
MATERIAL SCIENCES	P.NAIR, H.MANAKTALA, N.SRIDHAR, D.DUNN
MECHANICAL, INCLUDING DESIGN & FABRICATION	C.TSCHOEPE
MINING ENGINEERING	S-M.HSIUNG
NUCLEAR ENGINEERING	H.KARIMI
NUMERICAL MODELING/SIMULATION	
PERFORMANCE ASSESSMENT	R.BACA, A.B.GUREGHIAN, R.MANTEUFEL
QUALITY ASSURANCE	B.MABRITO, R.BRIENT
RADIOISOTOPE GEOCHEMISTRY	
REGULATORY ANALYSIS	S.SPECTOR (law)
ROCK MECHANICS	A.CHOWDHURY, M.AHOLA, A.GHOSH
SEISMOLOGY	R.HOFMANN
SOURCE-TERM/SPENT FUEL DEGRAD	P.LICHTNER
STRUCTURAL GEOLOGY/SEISMO-TECTONICS	G.STIREWALT, S.YOUNG, D.FERRILL
SYSTEMS ENGINEERING	A.DeWISPELARE
VOLCANOLOGY/IGNEOUS PROCESSES	C.CONNOR, B.HILL

*LIMITED TERM

TABLE 3. SUMMARY OF SCHEDULE CHANGES

Milestone Number	Type	Description	Original Date	Revised Date	Rationale for Change
5720-441-406	IM	Test Analysis SEISM I Code	08/31/93	08/31/94	Continuing Technical Difficulties in Code Transfer
5706-003-100	IM	Tank Material Mixing Review Report	03/25/94	08/12/94	Awaiting DOE Documents
5702-711-403	IM	Review of EPA Draft Compliance Criteria	02/17/94		Added per NRC Technical Directive

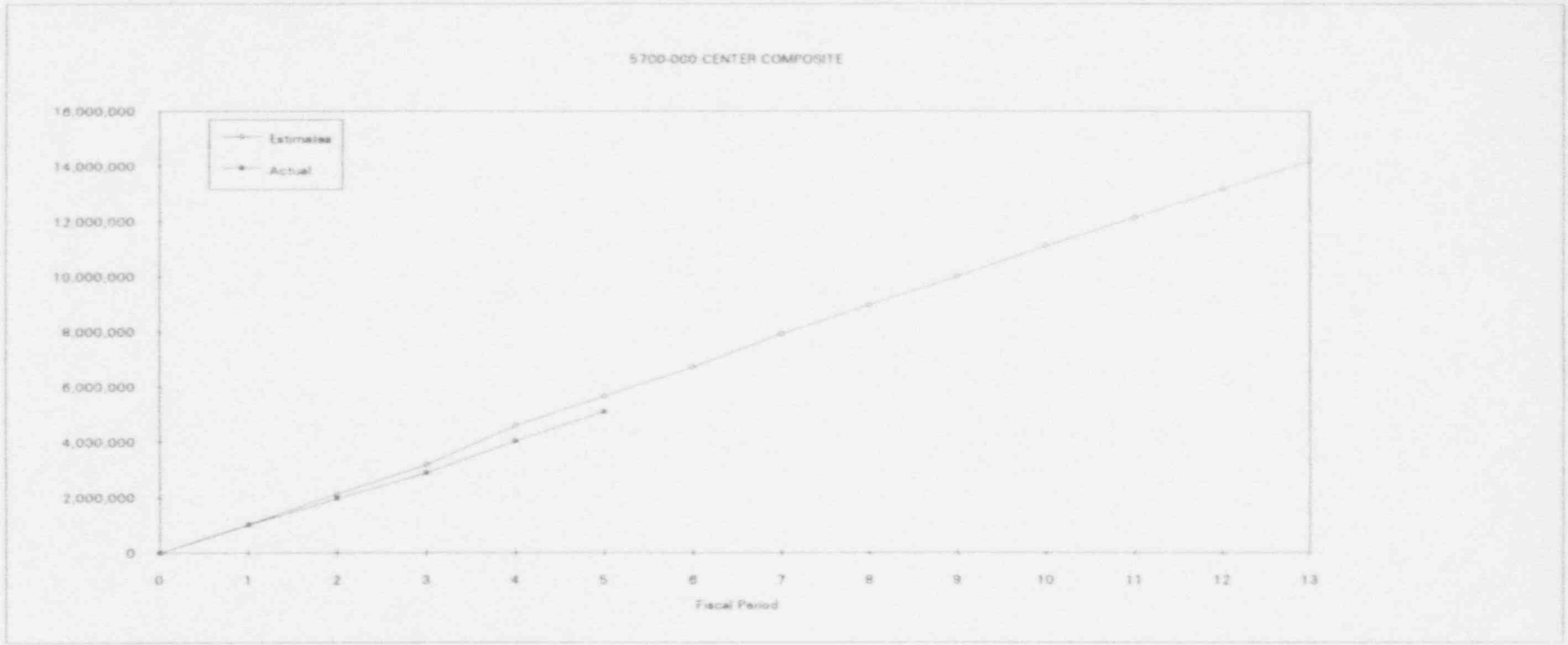
TABLE 4. FINANCIAL STATUS

	Funds Authorized*	Funds Costed to Date**	Funds Uncosted	Commitments
GS	3,567,399	1,678,565.08	1,888,834	9,315
EBS	2,376,992	1,039,410.39	1,337,582	11,314
RDCO	1,206,199	1,379,197.56	(172,999)	15,332
WSEI	2,582,731	1,736,139.63	846,591	25,321
EQA	1,284,454	137,283.07	1,147,171	800
PA	2,480,853	1,833,847.91	647,005	124,669
COPS	4,329,800	2,988,394.50	1,341,406	8,767
HLW	17,828,428	10,792,838.14	7,035,590	195,517
OVERALL	466,856	296,776.22	170,080	3,507
GEOCHEM	388,410	318,351.38	70,059	0
THERMO	924,236	543,327.08	380,909	1,950
SEISMIC	1,208,067	658,231.35	549,836	32,326
IWPE	1,377,499	731,915.42	645,584	1,954
STOCH	510,727	368,603.22	142,124	2,025
ANALOGS	1,069,663	557,598.64	512,064	9,992
SORPTION	996,066	534,848.29	461,218	6,032
RES PA	795,113	724,594.70	70,518	13,128
VOLCAN (R)	427,348	385,783.40	41,565	201
VOLCAN (FLD)	774,382	268,339.45	506,043	11,093
REG HYDRO	774,545	167,089.52	607,455	0
TECTONIC	1,236,738	432,424.22	804,314	14,882
RES	10,949,650	5,987,882.89	4,961,767	97,089
WSS	235,392	112,248.10	123,144	0
MRS	56,231	14,274.63	41,956	0
TOTAL	29,069,701	16,907,243.76	12,162,457	292,606

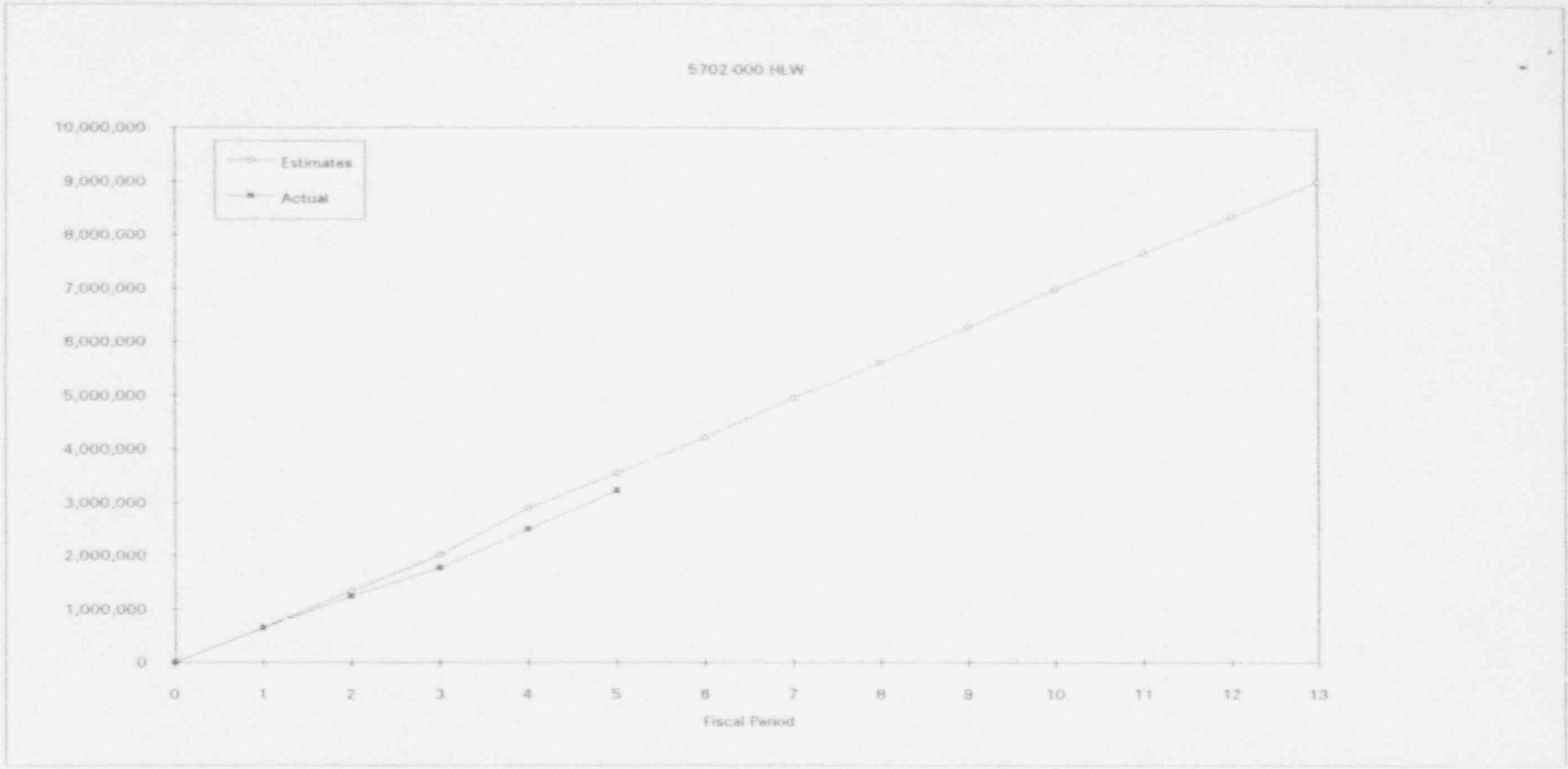
* Additional Authorized Funds of $2,576,788 for HLW and $314,325 for RES have not been allocated.
** Costed to Date includes 3 percent Base Fee. Additional fee awarded (Award Fee Pool 11) of 4.2 percent is not included.
Amount authorized includes carryover.

APPENDIX A

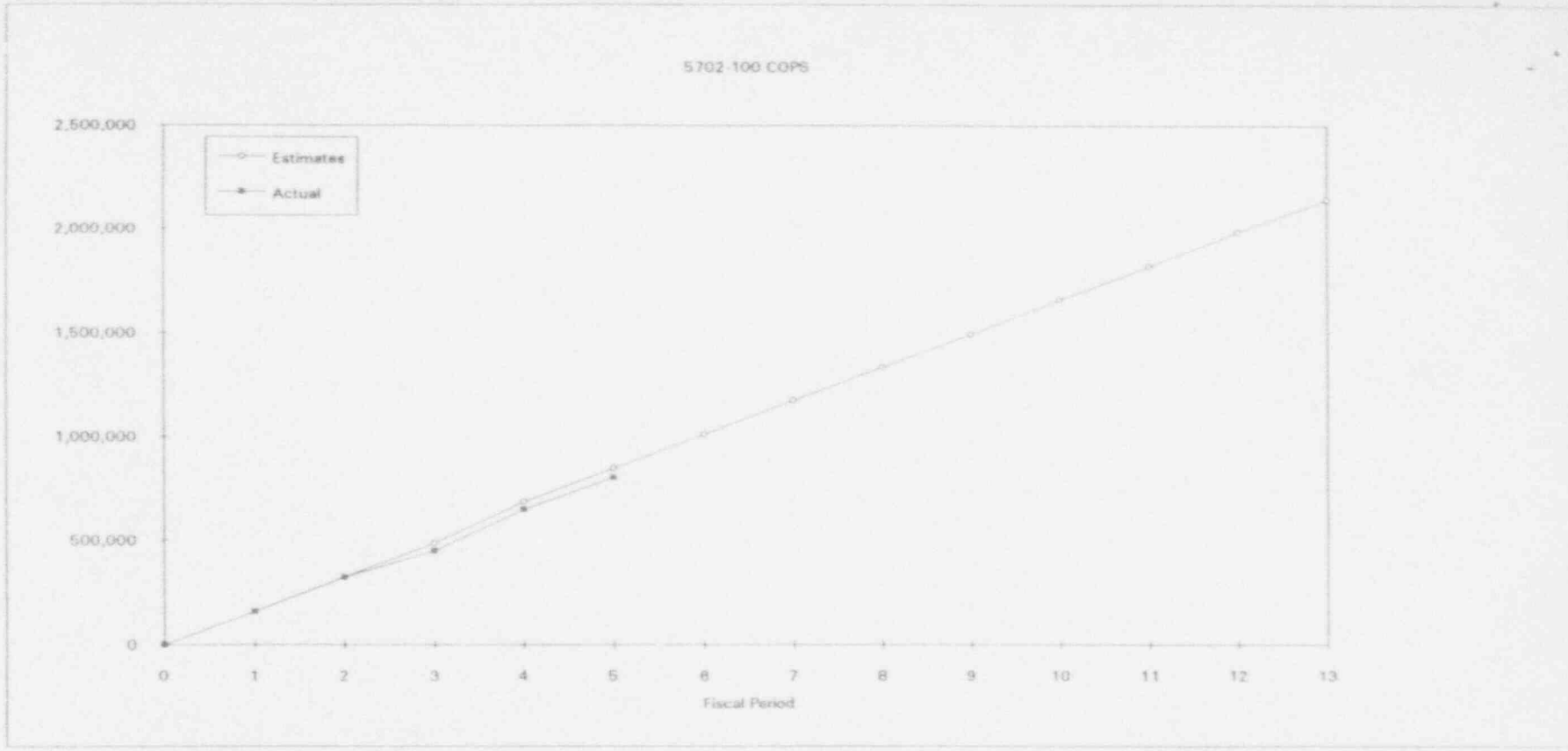
PLANNED AND ACTUAL COSTS, AND COST VARIANCES



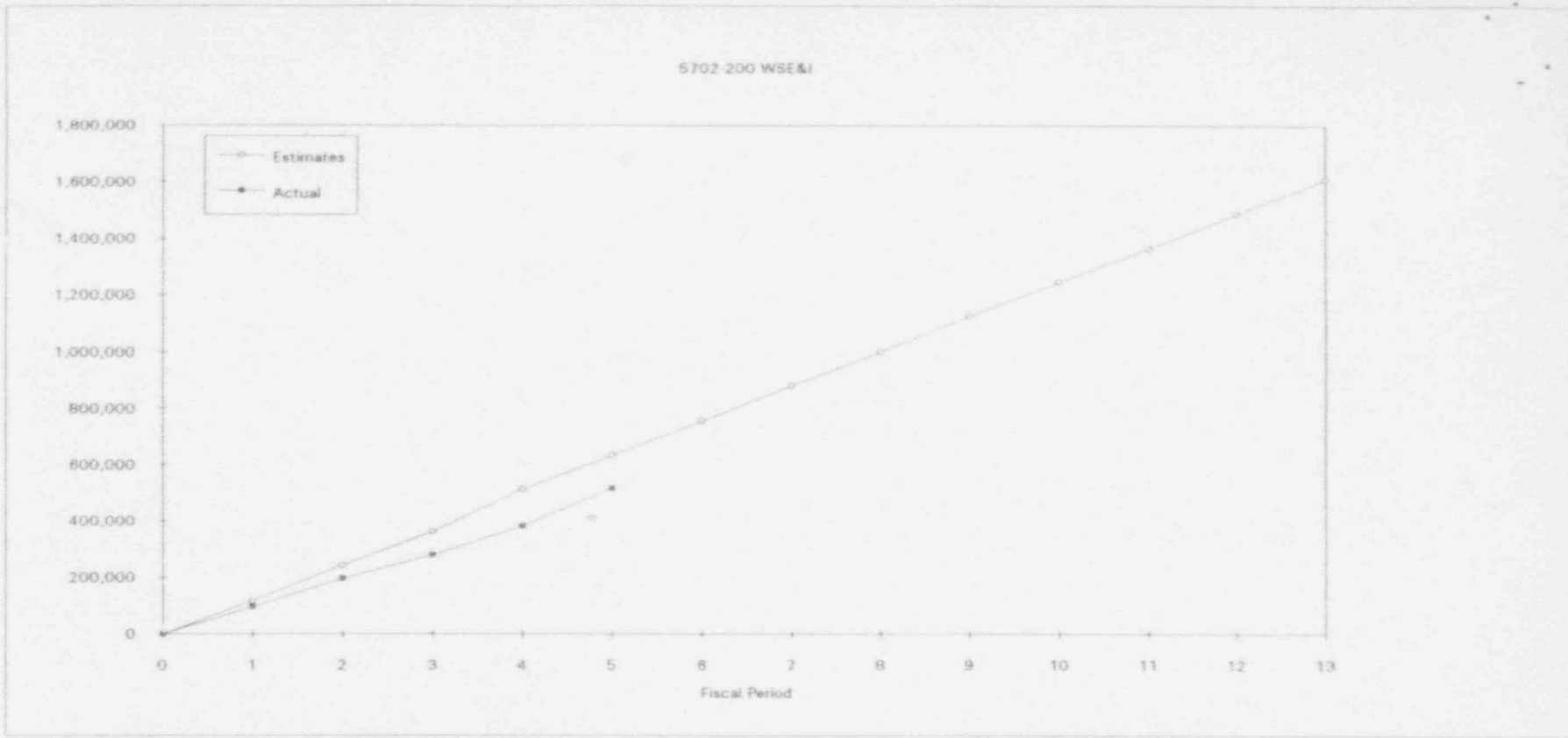
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	1,036,290	1,078,569	1,058,971	1,413,692	1,076,350	1,070,034	1,199,665	1,029,595	1,040,534	1,104,920	1,025,749	1,044,462	1,006,753	5,663,882
ACT. PERIOD COST	988,990	968,936	933,225	1,128,970	1,078,151	0	0	0	0	0	0	0	0	5,084,954
VARIANCE, $	47,300	109,633	125,746	284,722	(1,801)	0	0	0	0	0	0	0	0	578,928
VARIANCE, %	4.6%	10.2%	11.9%	20.1%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.2%
EST. FY CUMUL	1,036,290	2,114,859	3,173,840	4,587,532	5,663,882	6,733,916	7,933,581	8,963,176	10,003,710	11,108,630	12,134,379	13,178,841	14,185,574	
ACTUAL FY CUMUL	988,990	1,957,925	2,891,160	4,020,130	5,098,281	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	7.0%	13.8%	20.4%	28.3%	35.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	47,300	156,934	282,680	567,402	565,601	0	0	0	0	0	0	0	0	
VARIANCE, %	4.6%	7.4%	8.9%	12.4%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



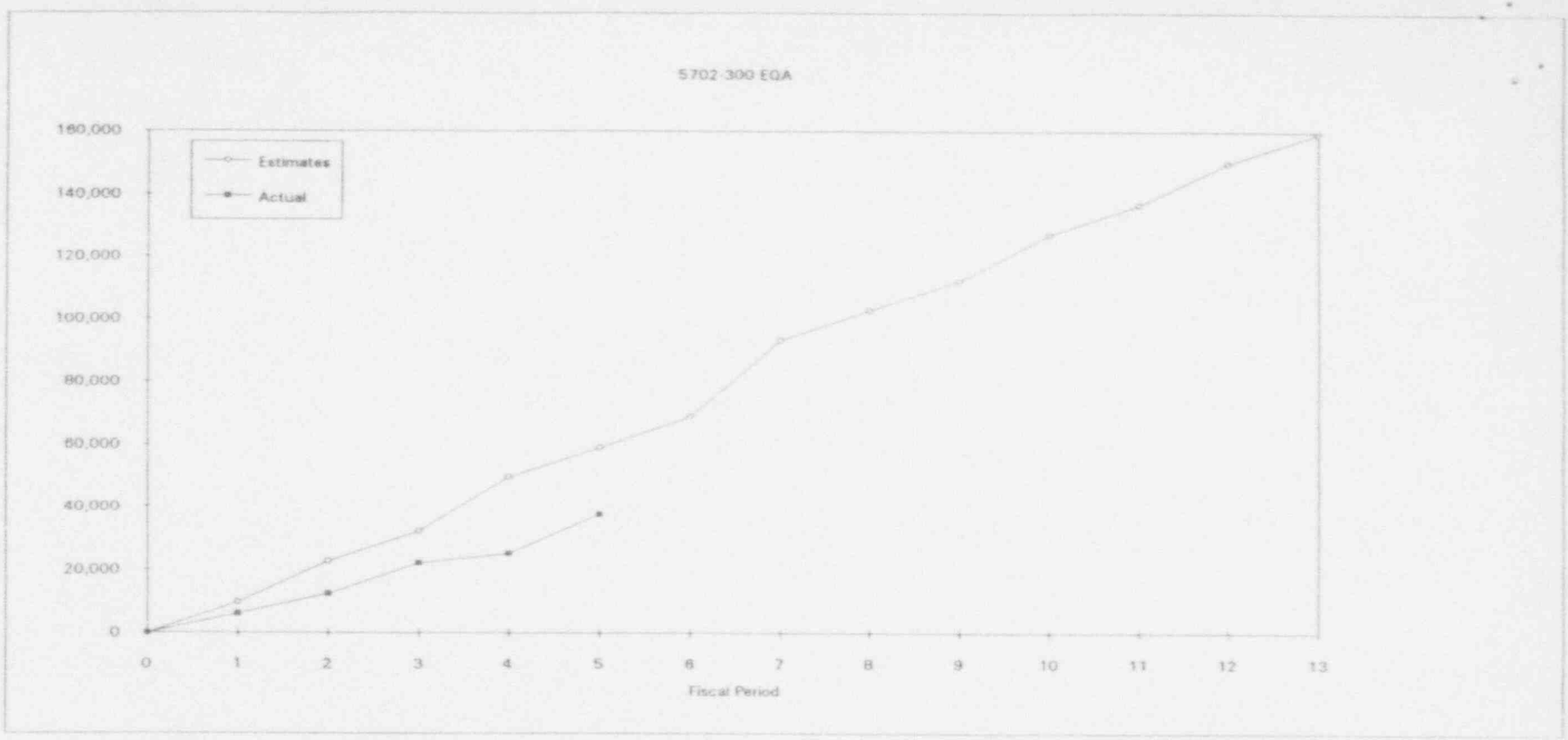
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	657,942	683,096	672,919	876,325	669,874	663,879	732,369	656,577	674,429	714,033	672,919	683,096	662,079	3,559,956
ACT. PERIOD COST	644,178	600,899	531,606	721,653	723,345	0	0	0	0	0	0	0	0	3,221,681
VARIANCE, $	13,764	82,197	141,313	154,672	(53,671)	0	0	0	0	0	0	0	0	338,275
VARIANCE, %	2.1%	12.0%	21.0%	17.7%	-8.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.5%
EST. FY CUMUL	657,942	1,341,038	2,013,957	2,890,282	3,559,956	4,223,835	4,956,004	5,612,581	6,287,010	7,001,043	7,673,962	8,357,058	9,019,137	
ACTUAL FY CUMUL	644,178	1,245,077	1,776,683	2,498,336	3,221,681	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	7.1%	13.8%	19.7%	27.7%	35.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	13,764	95,961	237,274	391,948	338,275	0	0	0	0	0	0	0	0	
VARIANCE, %	2.1%	7.2%	11.8%	13.6%	9.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



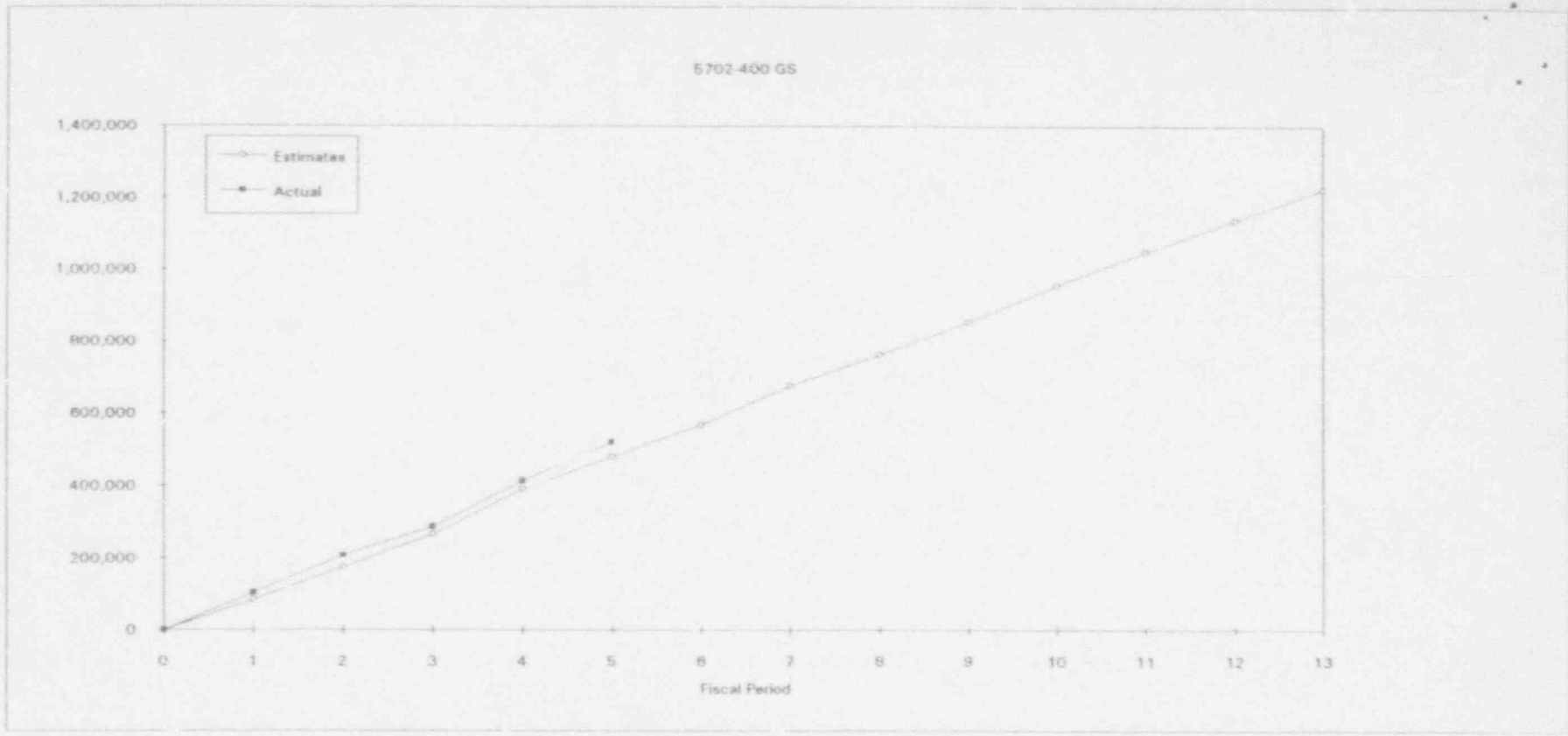
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	158,237	166,818	158,580	204,039	160,927	161,388	162,255	160,473	160,461	184,454	158,580	166,818	158,892	848,601
ACT. PERIOD COST	160,035	161,950	125,227	202,472	155,313	0	0	0	0	0	0	0	0	804,996
VARIANCE, $	(1,798)	4,868	33,353	1,567	5,614	0	0	0	0	0	0	0	0	43,605
VARIANCE, %	-1.1%	2.9%	21.0%	0.8%	3.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.1%
EST. FY CUMUL	158,237	325,055	483,635	687,674	848,601	1,009,989	1,172,244	1,332,717	1,493,178	1,857,632	1,916,212	1,983,030	2,141,922	
ACTUAL FY CUMUL	160,035	321,985	447,211	649,683	804,996	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	7.5%	15.0%	20.9%	30.3%	37.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(1,796)	3,070	38,424	37,991	43,605	0	0	0	0	0	0	0	0	
VARIANCE, %	-1.1%	0.9%	7.5%	5.5%	5.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



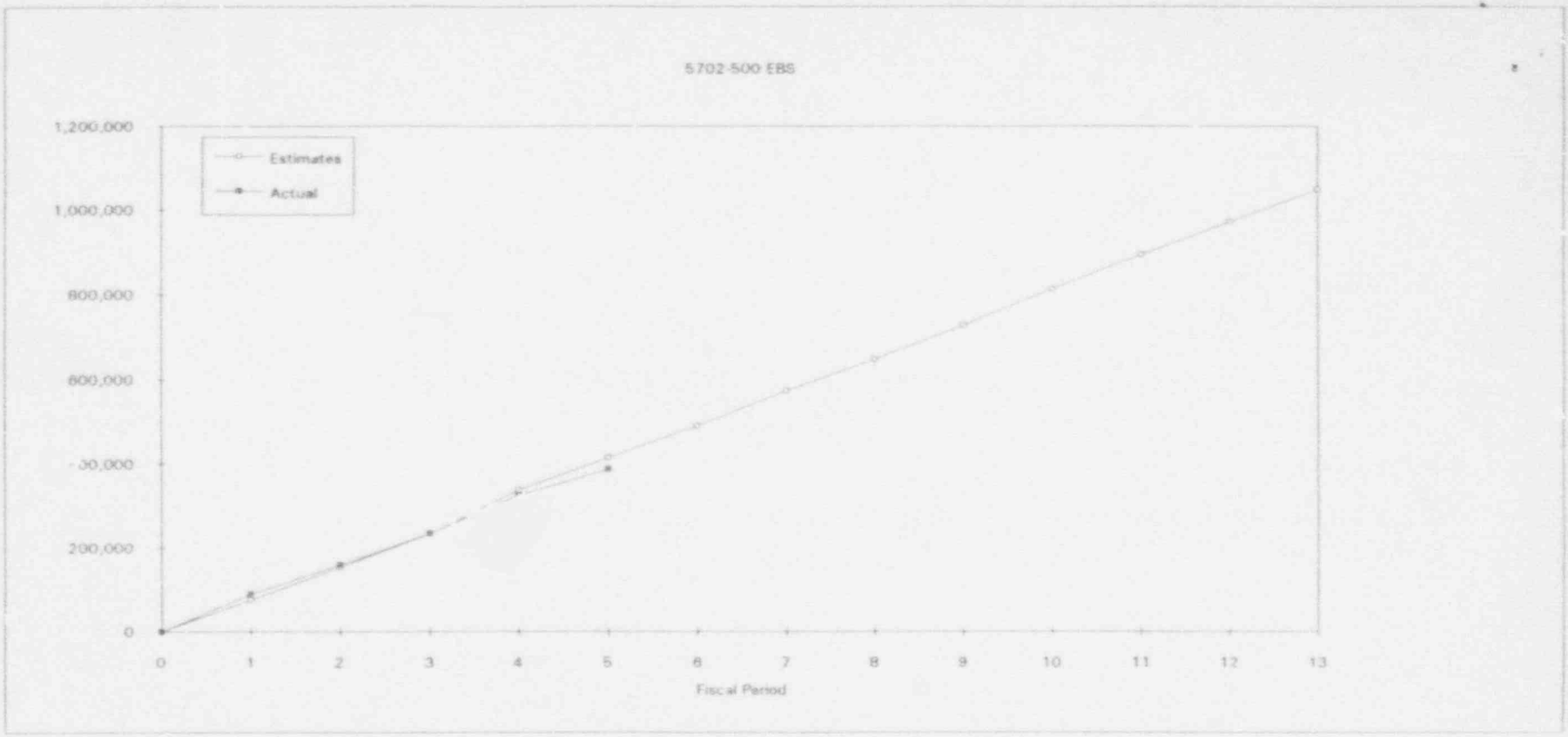
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	119,827	123,640	118,376	151,465	121,502	121,740	124,765	120,538	123,042	122,550	118,376	123,640	120,551	634,810
ACT. PERIOD COST	98,078	98,795	83,026	102,918	135,074	0	0	0	0	0	0	0	0	517,891
VARIANCE, $	21,749	24,845	35,350	48,547	(13,572)	0	0	0	0	0	0	0	0	116,919
VARIANCE, %	18.1%	20.1%	29.9%	32.1%	-11.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	18.4%
EST. FY CUMUL	119,827	243,467	361,843	513,308	634,810	756,550	881,315	1,001,851	1,124,893	1,247,443	1,365,819	1,489,459	1,610,010	
ACTUAL FY CUMUL	98,078	196,874	279,900	382,818	517,891	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	6.1%	12.2%	17.4%	23.8%	32.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	21,749	46,593	81,943	130,490	116,919	0	0	0	0	0	0	0	0	
VARIANCE, %	18.1%	19.1%	22.6%	25.4%	18.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



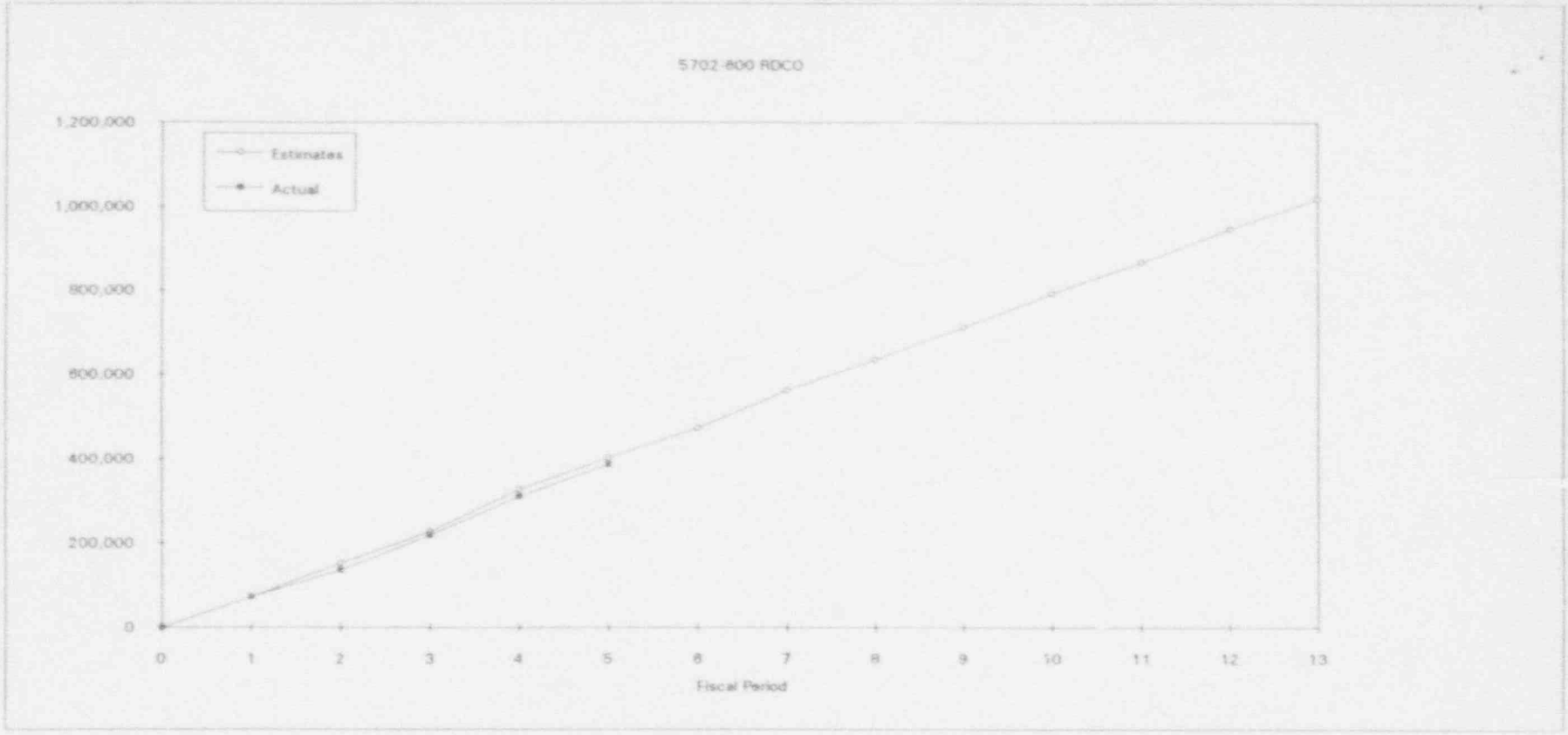
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	9,472	13,130	9,619	17,387	9,419	9,745	24,398	9,543	9,395	15,020	9,619	13,130	9,543	59,027
ACT. PERIOD COST	5,931	6,296	9,795	3,003	12,542	0	0	0	0	0	0	0	0	37,567
VARIANCE, $	3,541	6,834	(176)	14,384	(3,123)	0	0	0	0	0	0	0	0	21,460
VARIANCE, %	37.4%	52.0%	-1.8%	82.7%	-33.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	36.4%
EST. FY CUMUL	9,472	22,602	32,221	49,608	59,027	68,772	93,170	102,713	112,108	127,128	136,747	149,877	159,420	
ACTUAL FY CUMUL	5,931	12,227	22,022	25,025	37,567	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	3.7%	7.7%	13.8%	15.7%	23.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	3,541	10,375	10,199	24,583	21,460	0	0	0	0	0	0	0	0	
VARIANCE, %	37.4%	45.9%	31.7%	49.6%	36.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



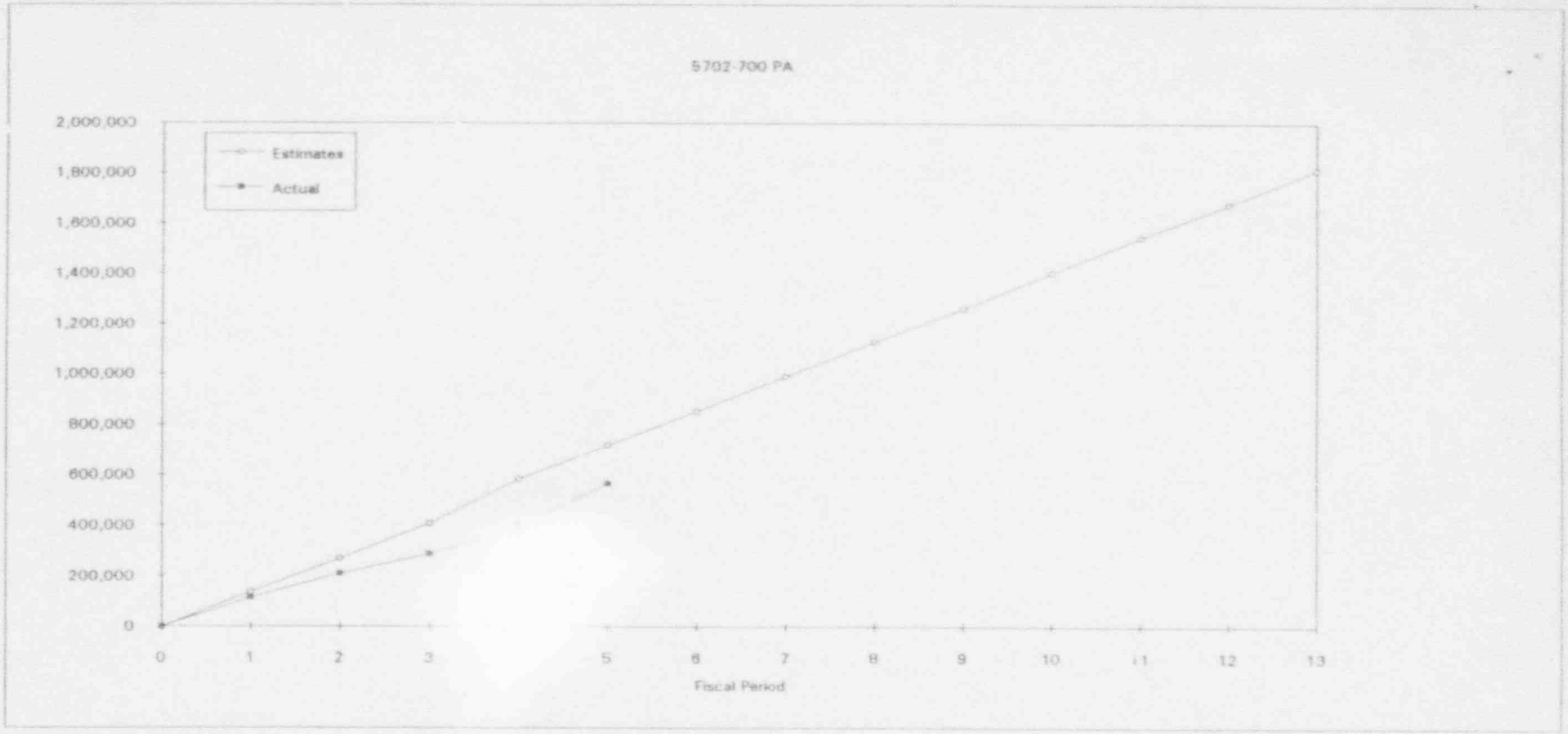
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	85,199	89,533	91,769	124,740	88,111	88,442	110,505	85,654	89,510	103,095	91,769	89,533	88,270	479,352
ACT. PERIOD COST	103,969	104,642	78,820	126,025	107,488	0	0	0	0	0	0	0	0	520,745
VARIANCE, $	(18,770)	(15,109)	13,149	(1,285)	(19,377)	0	0	0	0	0	0	0	0	(41,393)
VARIANCE, %	-22.0%	-16.9%	14.3%	-1.0%	-22.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-8.6%
EST. FY CUMUL	85,199	174,732	266,501	391,241	479,352	567,794	678,299	763,953	853,463	956,558	1,048,327	1,137,860	1,224,130	
ACTUAL FY CUMUL	103,969	208,611	287,232	413,257	520,745	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	8.5%	17.0%	23.5%	33.8%	42.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(18,770)	(33,879)	(20,731)	(22,016)	(41,393)	0	0	0	0	0	0	0	0	
VARIANCE, %	-22.0%	-19.4%	-7.8%	-5.6%	-8.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



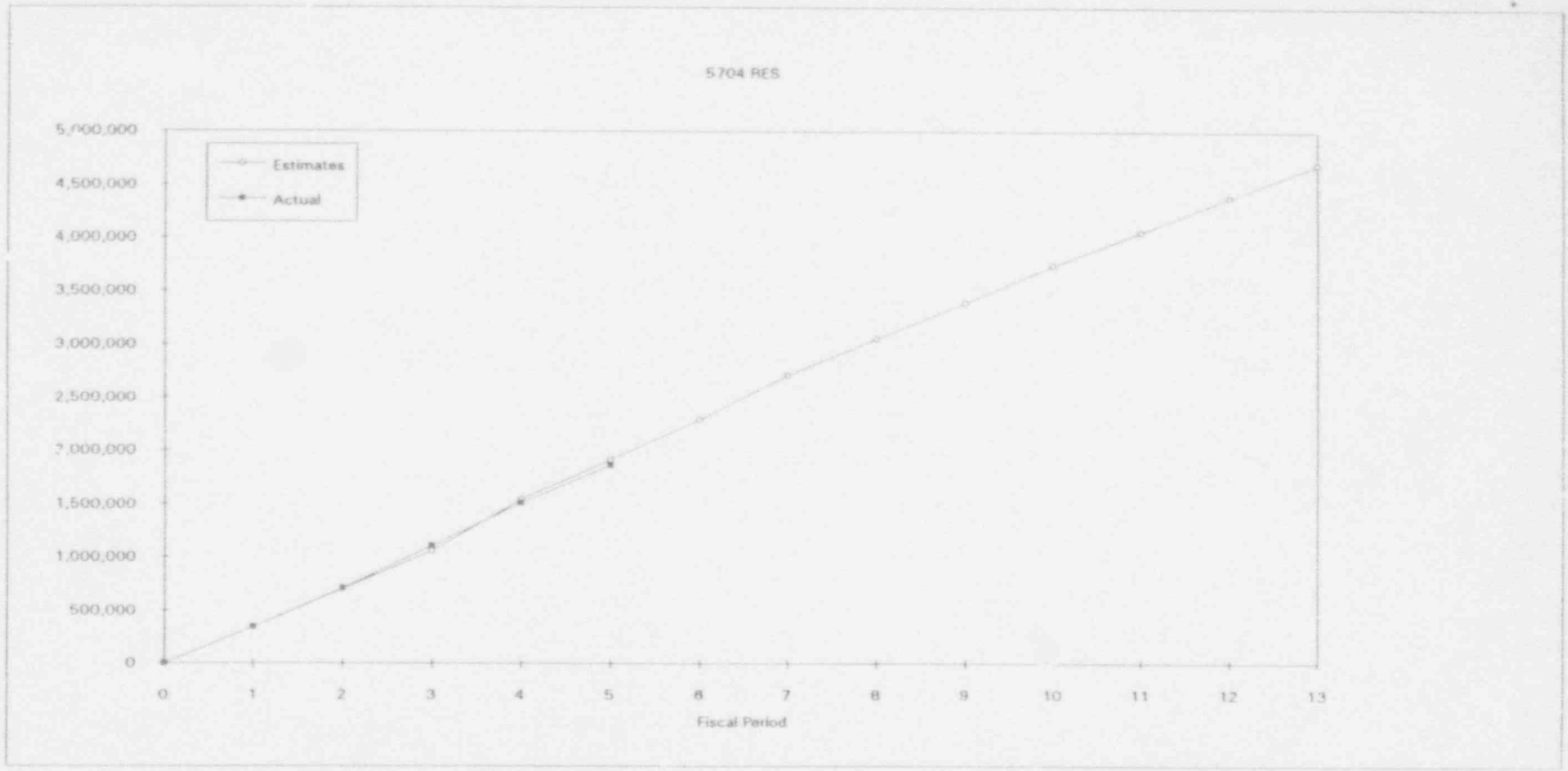
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	76,356	76,588	81,729	103,641	77,970	75,207	84,037	74,775	79,096	84,670	81,729	76,588	76,675	416,284
ACT. PERIOD COST	89,924	68,848	76,194	90,429	62,146	0	0	0	0	0	0	0	0	387,542
VARIANCE, $	(13,568)	7,740	5,535	13,212	15,824	0	0	0	0	0	0	0	0	28,742
VARIANCE, %	-17.8%	10.1%	6.8%	12.7%	20.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.9%
EST. FY CUMUL	76,356	152,944	234,673	338,314	416,284	491,491	575,528	650,303	729,399	814,069	895,798	972,386	1,049,061	
ACTUAL FY CUMUL	89,924	158,773	234,967	325,396	387,542	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	8.6%	15.1%	22.4%	31.0%	36.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(13,568)	(5,829)	(294)	12,918	28,742	0	0	0	0	0	0	0	0	
VARIANCE, %	-17.8%	-3.8%	-0.1%	3.8%	6.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



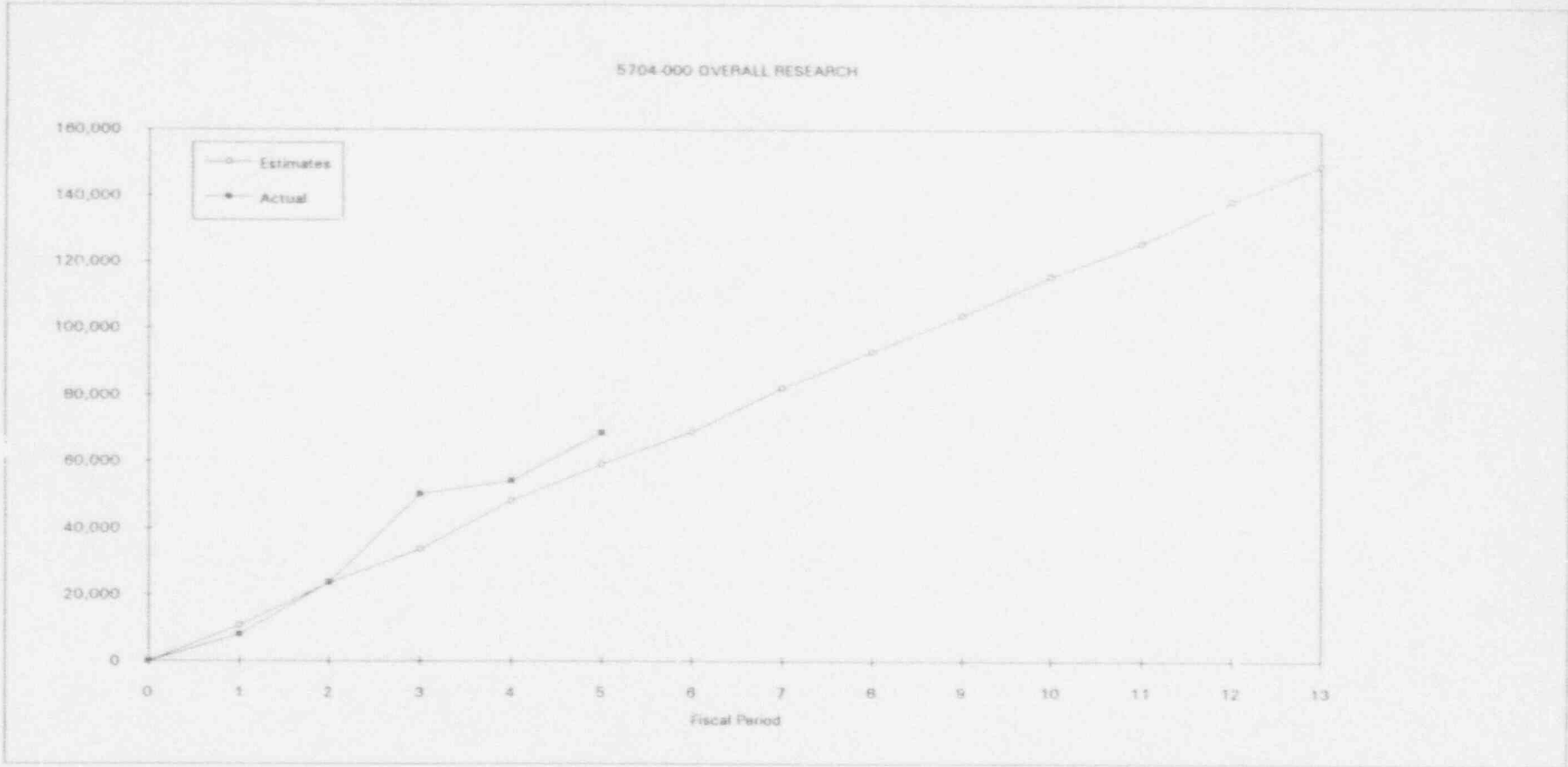
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	72,727	80,430	73,222	99,846	76,147	72,059	88,781	71,569	77,020	81,328	73,222	80,430	73,060	402,372
ACT. PERIOD COST	72,067	64,548	81,312	92,428	76,019	0	0	0	0	0	0	0	0	386,374
VARIANCE, $	660	15,882	(8,090)	7,418	128	0	0	0	0	0	0	0	0	15,998
VARIANCE, %	0.9%	19.7%	-11.0%	7.4%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%
EST. FY CUMUL	72,727	153,157	226,379	326,225	402,372	474,431	563,192	634,761	711,781	793,110	866,332	946,762	1,019,822	
ACTUAL FY CUMUL	72,067	136,615	217,927	310,355	386,374	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	7.1%	13.4%	21.4%	30.4%	37.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	660	16,542	8,452	15,870	15,998	0	0	0	0	0	0	0	0	
VARIANCE, %	0.9%	10.8%	3.7%	4.9%	4.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



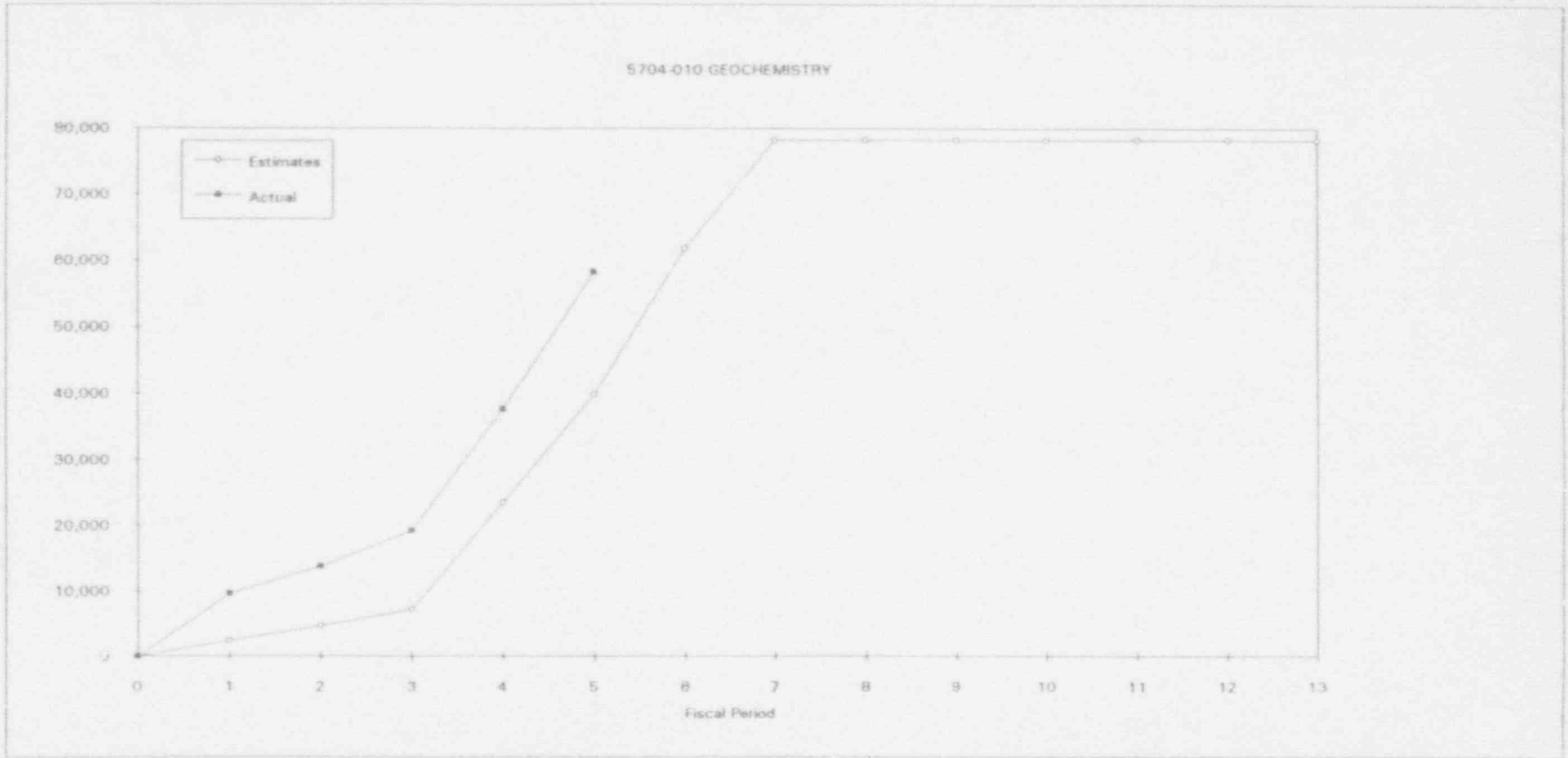
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	136,124	132,957	139,624	175,207	135,598	135,098	137,648	134,027	135,905	142,915	139,624	132,957	137,088	719,510
ACT. PERIOD COST	114,173	95,819	77,432	104,378	174,783	0	0	0	0	0	0	0	0	566,585
VARIANCE, $	21,951	37,138	62,192	70,829	(39,185)	0	0	0	0	0	0	0	0	152,945
VARIANCE, %	16.1%	27.9%	44.5%	40.4%	-28.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21.3%
EST. FY CUMUL	136,124	268,081	408,705	583,912	719,510	854,608	992,256	1,126,283	1,262,188	1,405,103	1,544,727	1,677,684	1,814,772	
ACTUAL FY CUMUL	114,173	209,992	287,424	391,802	566,585	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	6.3%	11.6%	15.8%	21.6%	31.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	21,951	59,089	121,281	192,110	152,945	0	0	0	0	0	0	0	0	
VARIANCE, %	16.1%	22.0%	29.7%	32.9%	21.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



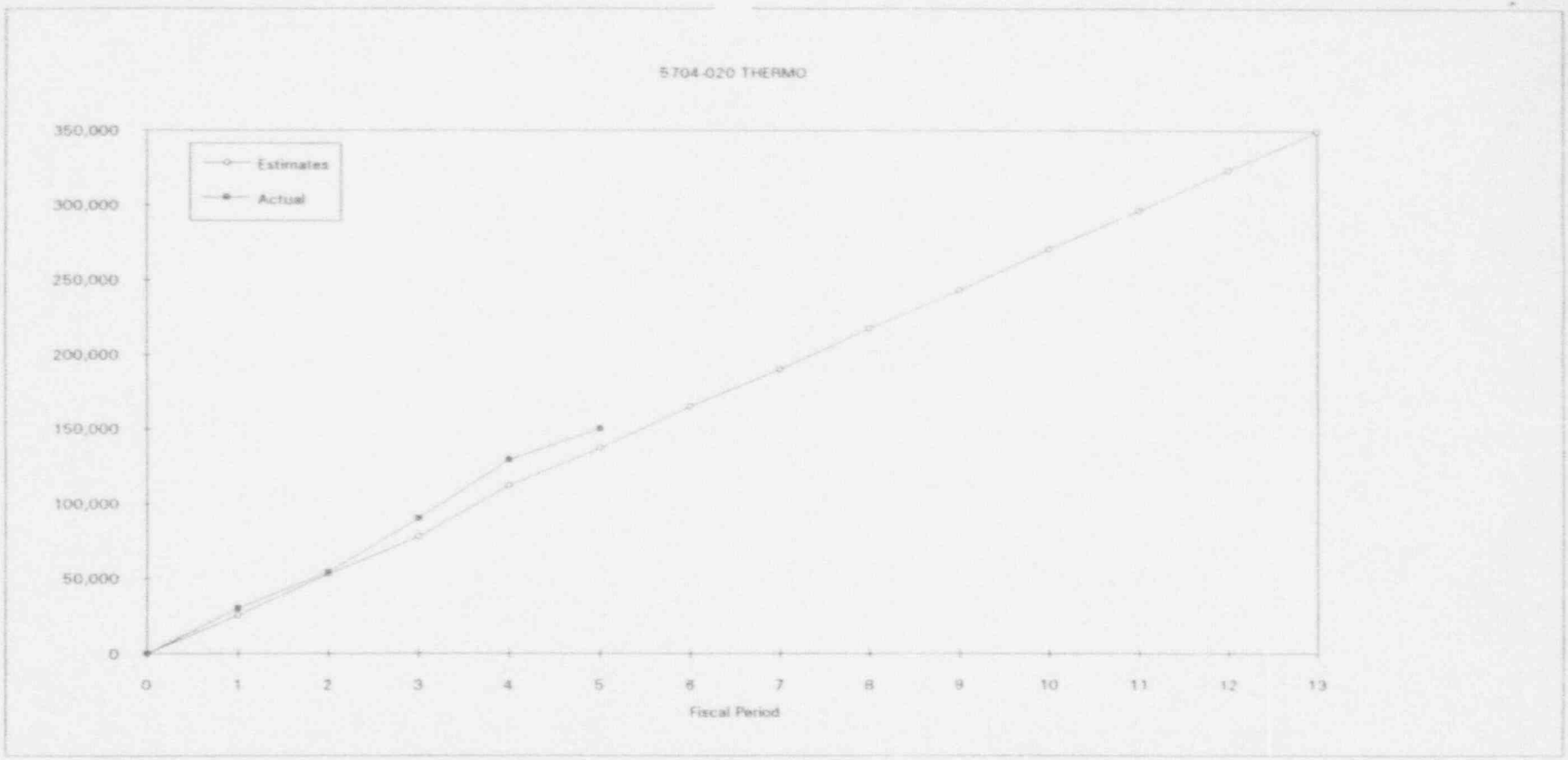
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	345,035	360,635	350,761	489,525	371,772	373,801	426,362	341,618	329,843	351,895	317,529	326,528	311,226	1,917,728
ACT. PERIOD COST	342,323	364,760	399,889	404,182	350,424	0	0	0	0	0	0	0	0	1,881,578
VARIANCE, $	2,712	(4,125)	(49,128)	85,343	21,348	0	0	0	0	0	0	0	0	58,150
VARIANCE, %	0.8%	-1.1%	-14.0%	17.4%	5.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.9%
EST. FY CUMUL	345,035	705,670	1,056,431	1,545,956	1,917,728	2,291,529	2,717,891	3,059,509	3,389,352	3,741,247	4,058,776	4,385,304	4,696,530	
ACTUAL FY CUMUL	342,323	707,083	1,106,972	1,511,154	1,861,578	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	7.3%	15.1%	23.6%	32.2%	39.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	2,712	(1,413)	(50,541)	34,802	56,150	0	0	0	0	0	0	0	0	
VARIANCE, %	0.8%	-0.2%	-4.8%	2.3%	2.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



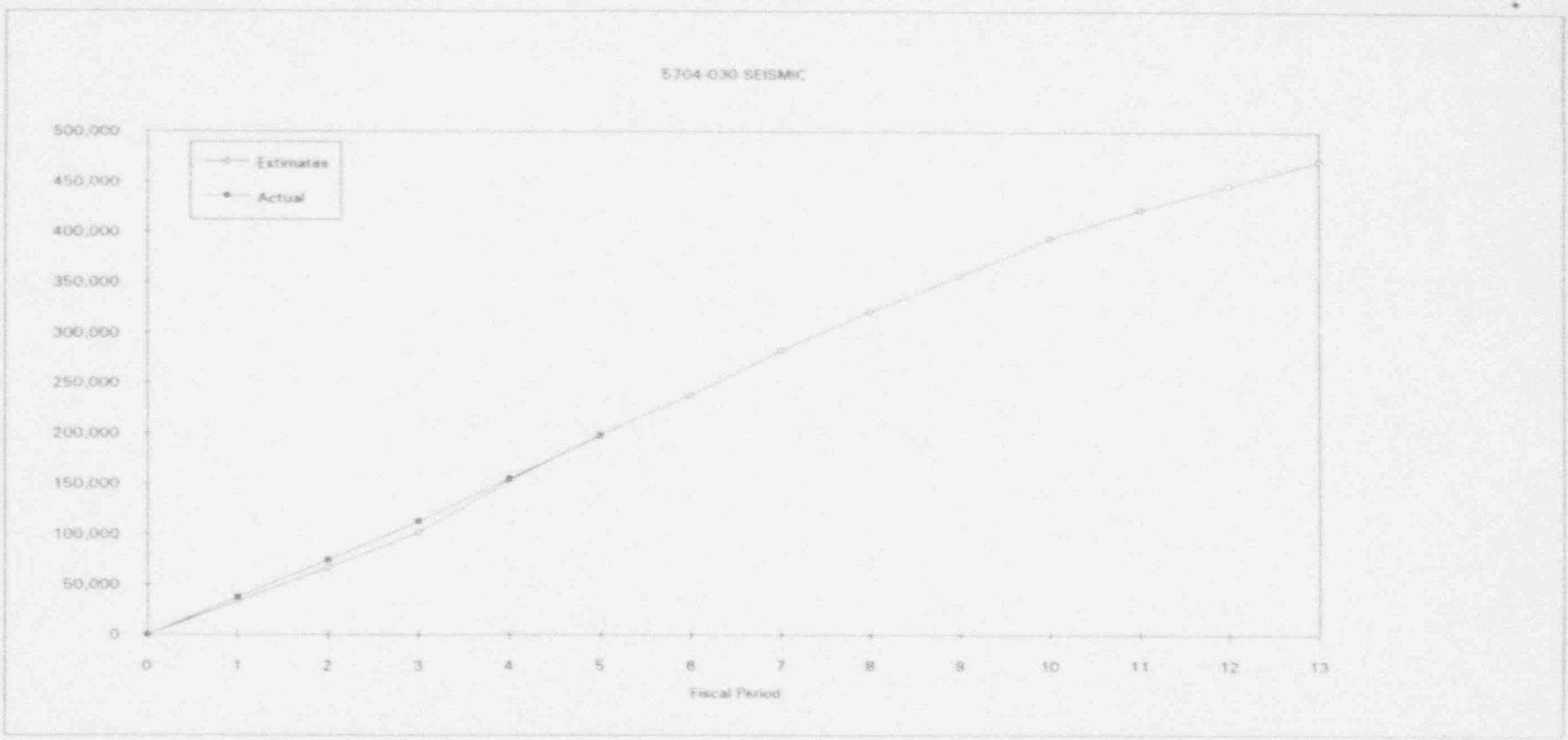
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	10,705	12,830	10,214	14,093	10,754	9,785	13,300	10,935	10,778	11,680	10,214	12,830	10,802	59,098
ACT. PERIOD COST	8,084	15,838	28,636	3,894	14,289	0	0	0	0	0	0	0	0	68,541
VARIANCE, $	2,621	(2,808)	(18,422)	10,699	(3,535)	0	0	0	0	0	0	0	0	(9,445)
VARIANCE, %	24.5%	-21.9%	-180.8%	73.3%	-32.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-16.0%
EST. FY CUM'L	10,705	23,535	33,749	48,342	59,096	68,881	82,181	93,116	103,894	115,574	125,788	138,618	149,420	
ACTUAL FY CUMUL	8,084	23,721	50,357	54,252	68,541	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	5.4%	15.9%	33.7%	36.3%	45.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	2,621	(186)	(18,608)	(5,910)	(9,445)	0	0	0	0	0	0	0	0	
VARIANCE, %	24.5%	-0.8%	-49.2%	-12.2%	-16.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



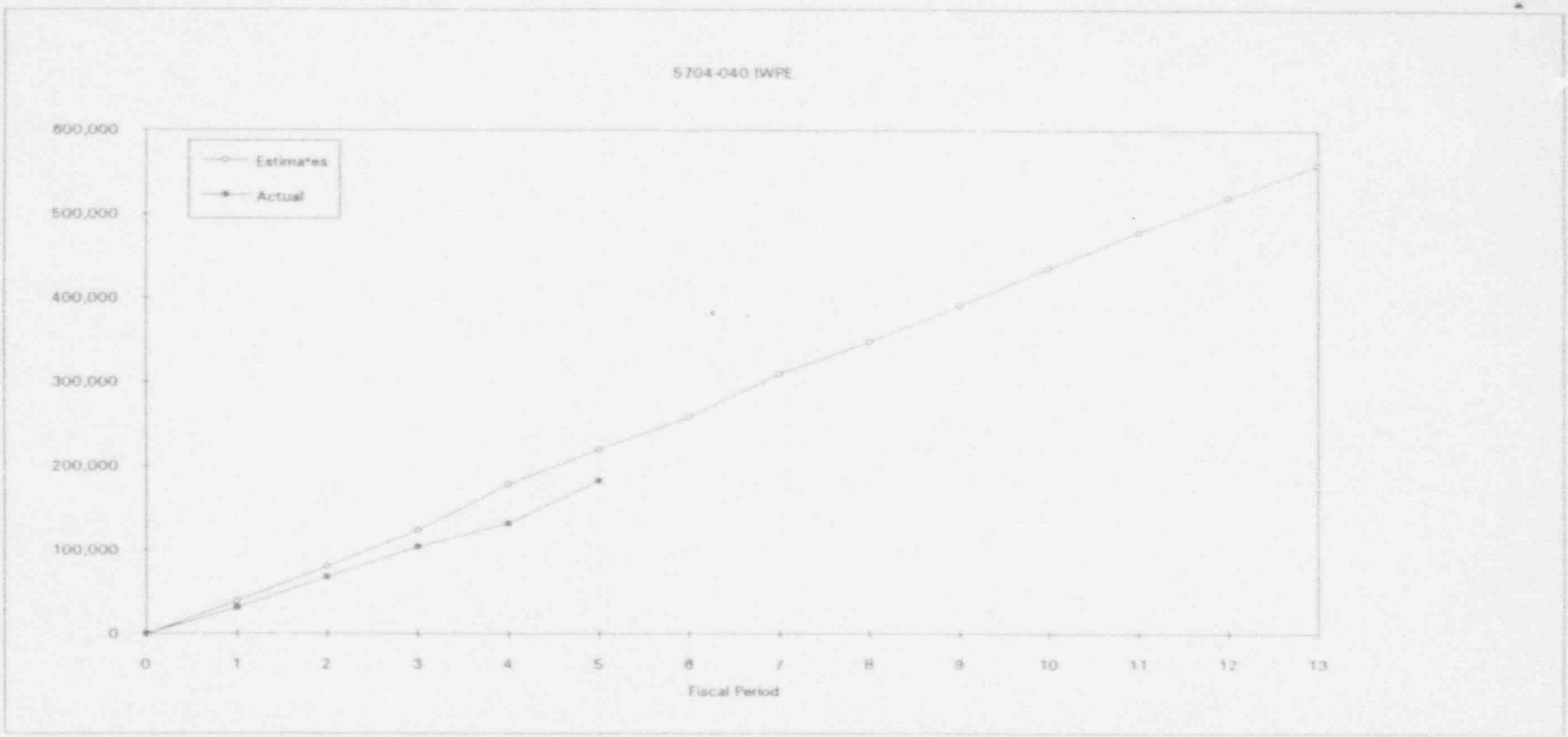
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	2,381	2,292	2,502	16,354	16,354	21,997	16,343	0	0	0	0	0	0	39,883
ACT. PERIOD COST	9,570	4,153	5,451	18,497	20,566	0	0	0	0	0	0	0	0	58,238
VARIANCE, $	(7,189)	(1,861)	(2,949)	(2,143)	(4,212)	0	0	0	0	0	0	0	0	(18,355)
VARIANCE, %	-301.9%	-81.2%	-117.9%	-13.1%	-25.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	46.0%
EST. FY CUMUL	2,381	4,673	7,175	23,529	39,883	61,880	78,223	78,223	78,223	78,223	78,223	78,223	78,223	
ACTUAL FY CUMUL	9,570	13,723	19,174	37,671	58,238	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	12.2%	17.5%	24.5%	48.2%	74.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(7,189)	(9,050)	(11,999)	(14,142)	(18,355)	0	0	0	0	0	0	0	0	
VARIANCE, %	-301.9%	-193.7%	-167.2%	-60.1%	-46.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



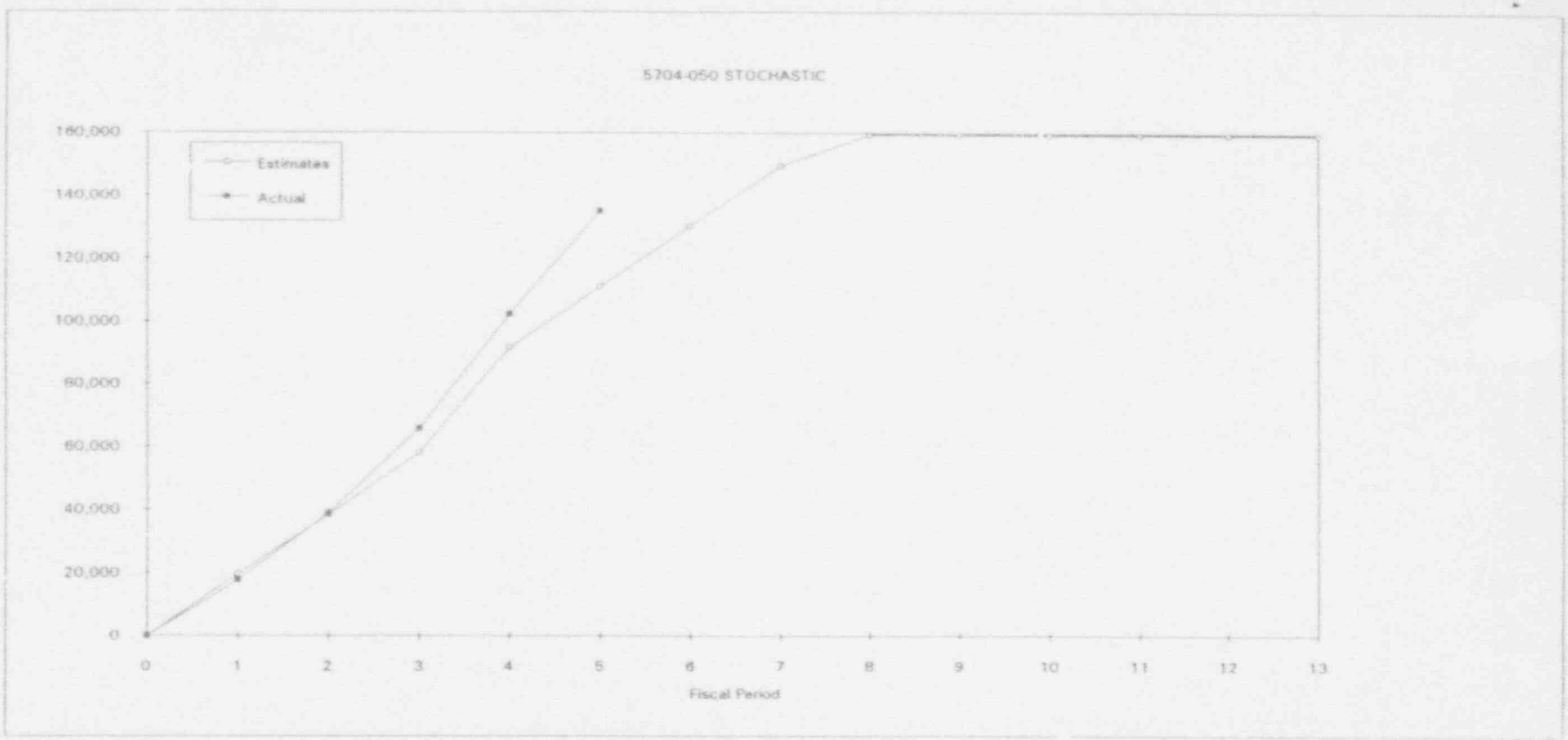
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	25,828	27,200	25,454	33,994	24,997	27,909	25,142	27,512	25,543	27,507	25,454	27,200	25,688	137,473
ACT. PERIOD COST	30,464	24,159	35,990	39,219	20,817	0	0	0	0	0	0	0	0	150,449
VARIANCE, $	(4,636)	3,041	(10,536)	(5,225)	4,380	0	0	0	0	0	0	0	0	(12,976)
VARIANCE, %	-18.0%	11.2%	-41.4%	-15.4%	17.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.4%
EST. FY CUMUL	25,828	53,028	78,482	112,476	137,473	165,382	190,524	218,036	243,579	271,086	296,540	323,740	349,428	
ACTUAL FY CUMUL	30,464	54,623	90,613	129,832	150,449	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	8.7%	15.6%	25.9%	37.2%	43.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(4,636)	(1,595)	(12,131)	(17,356)	(12,976)	0	0	0	0	0	0	0	0	
VARIANCE, %	-18.0%	3.0%	-15.5%	-15.4%	-9.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



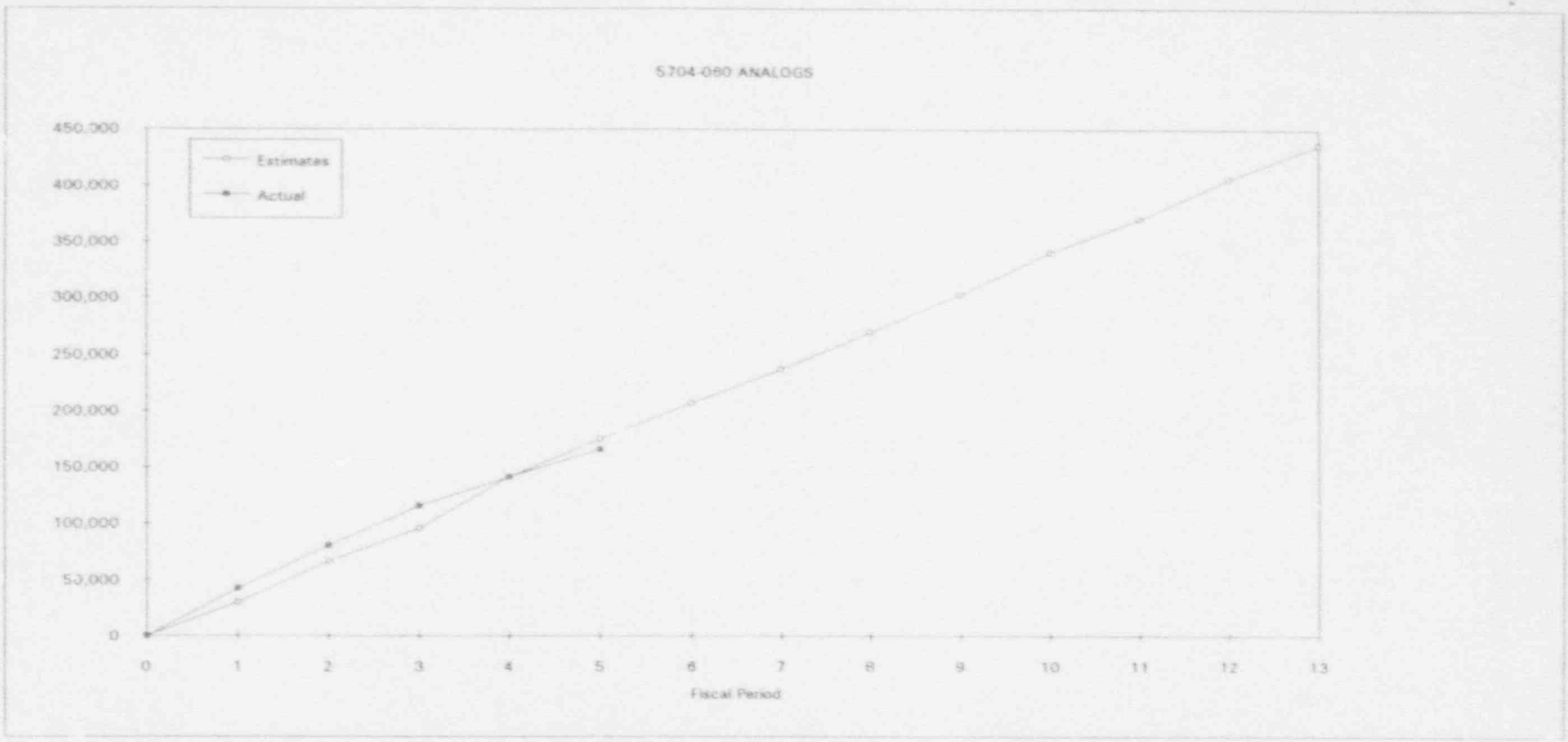
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	33,620	33,071	34,673	51,576	45,221	39,222	45,223	39,024	34,812	37,974	27,879	24,375	24,774	198,181
ACT. PERIOD COST	37,662	36,655	38,201	42,511	42,271	0	0	0	0	0	0	0	0	197,299
VARIANCE, $	(4,042)	(3,584)	(3,528)	9,065	2,950	0	0	0	0	0	0	0	0	882
VARIANCE, %	-12.0%	-10.8%	-10.2%	17.6%	6.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
EST. FY CUMUL	33,620	66,691	101,364	152,940	198,161	237,383	282,606	321,630	356,442	394,416	422,295	446,670	471,444	
ACTUAL FY CUMUL	37,662	74,317	112,518	155,028	197,299	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	8.0%	15.8%	23.9%	32.9%	41.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(4,042)	(7,626)	(11,154)	(2,088)	862	0	0	0	0	0	0	0	0	
VARIANCE, %	-12.0%	-11.4%	-11.0%	-1.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



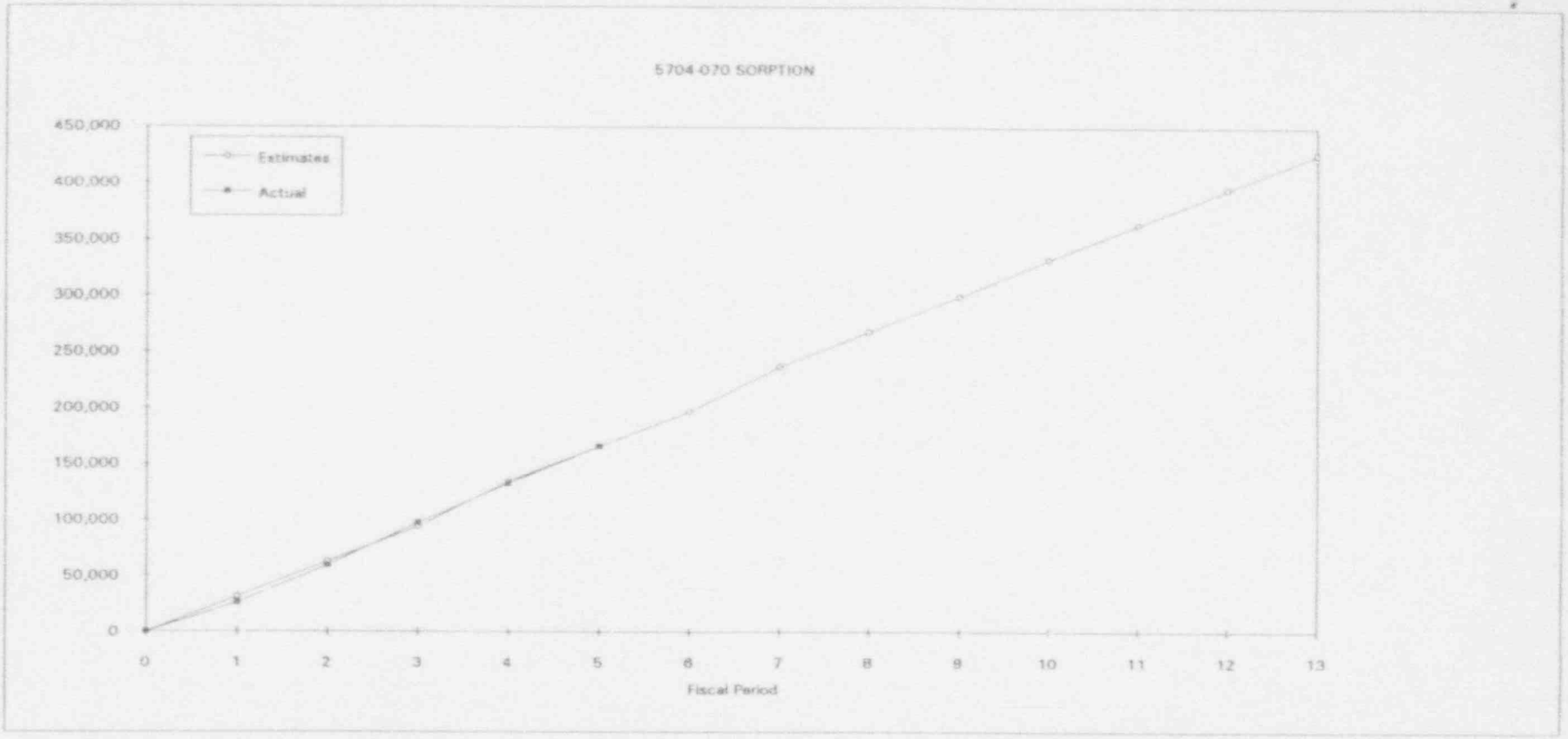
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	39,128	41,310	43,232	54,738	41,852	38,840	50,842	38,848	42,487	44,300	43,232	41,310	39,257	220,056
ACT. PERIOD COST	31,353	36,368	35,843	28,347	50,892	0	0	0	0	0	0	0	0	182,603
VARIANCE, $	7,773	4,942	7,389	26,389	(9,040)	0	0	0	0	0	0	0	0	37,453
VARIANCE, %	19.9%	12.0%	17.1%	48.2%	-21.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	17.0%
EST. FY CUMUL	39,128	80,438	123,668	178,404	220,056	258,896	309,738	348,586	391,073	435,373	478,605	519,915	559,172	
ACTUAL FY CUMUL	31,353	67,721	103,564	131,911	182,603	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	5.6%	12.1%	18.5%	23.6%	32.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	7,773	12,715	20,104	46,493	37,453	0	0	0	0	0	0	0	0	
VARIANCE, %	19.9%	15.8%	16.3%	26.1%	17.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



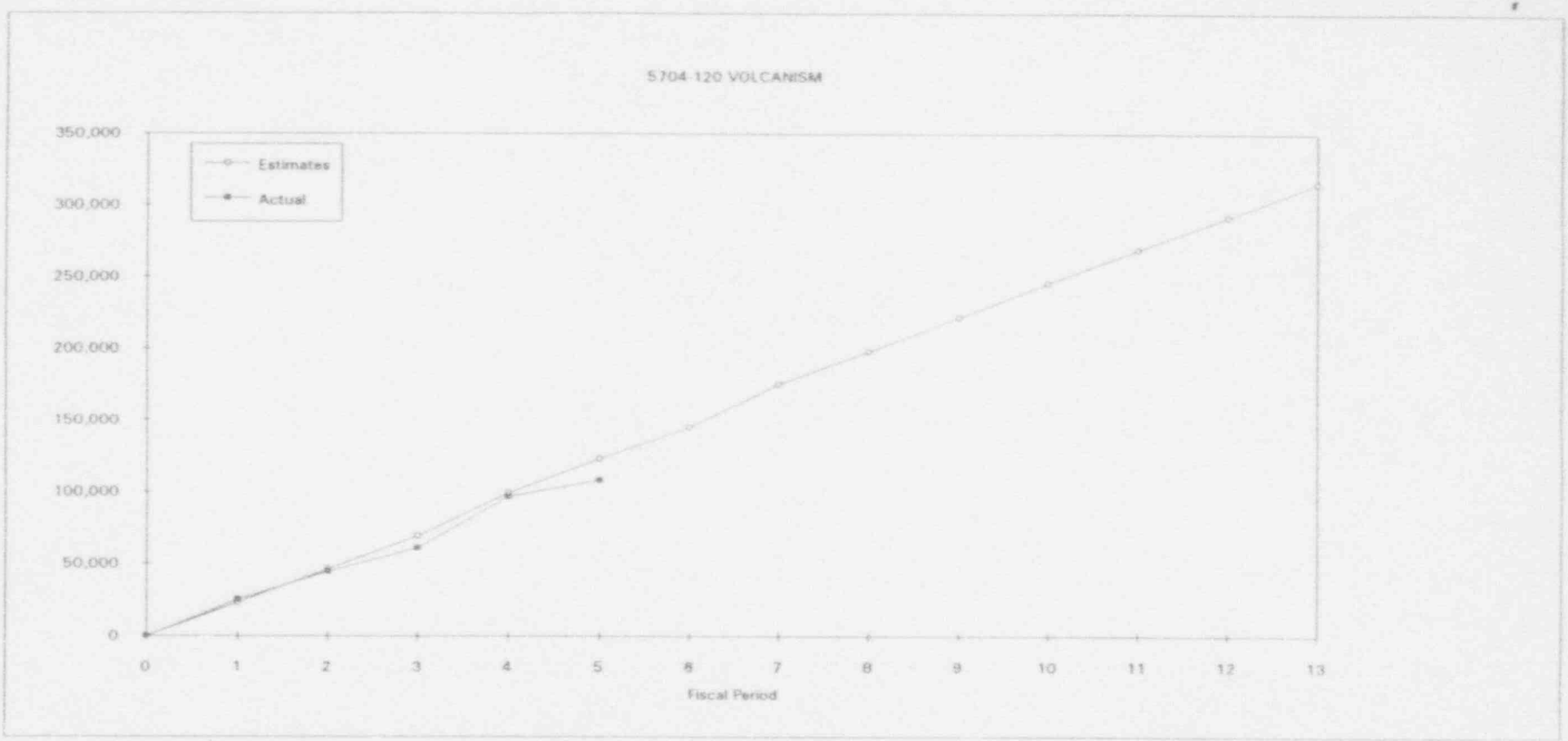
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	19,575	18,792	19,609	33,801	19,404	19,049	19,318	9,823	0	0	0	0	0	111,181
ACT. PERIOD COST	17,707	21,171	26,806	38,731	32,648	0	0	0	0	0	0	0	0	135,062
VARIANCE, $	1,868	(2,379)	(7,197)	(2,930)	(13,242)	0	0	0	0	0	0	0	0	(23,881)
VARIANCE, %	9.5%	-12.7%	-36.7%	-8.7%	-68.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21.5%
EST. FY CUMUL	19,575	38,367	57,976	91,777	111,181	130,230	149,548	159,369	159,369	159,369	159,369	159,369	159,369	
ACTUAL FY CUMUL	17,707	38,878	65,684	102,415	135,062	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	11.1%	24.4%	41.2%	64.3%	84.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	1,868	(511)	(7,708)	(10,638)	(23,881)	0	0	0	0	0	0	0	0	
VARIANCE, %	9.5%	-1.3%	-13.3%	-11.6%	-21.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



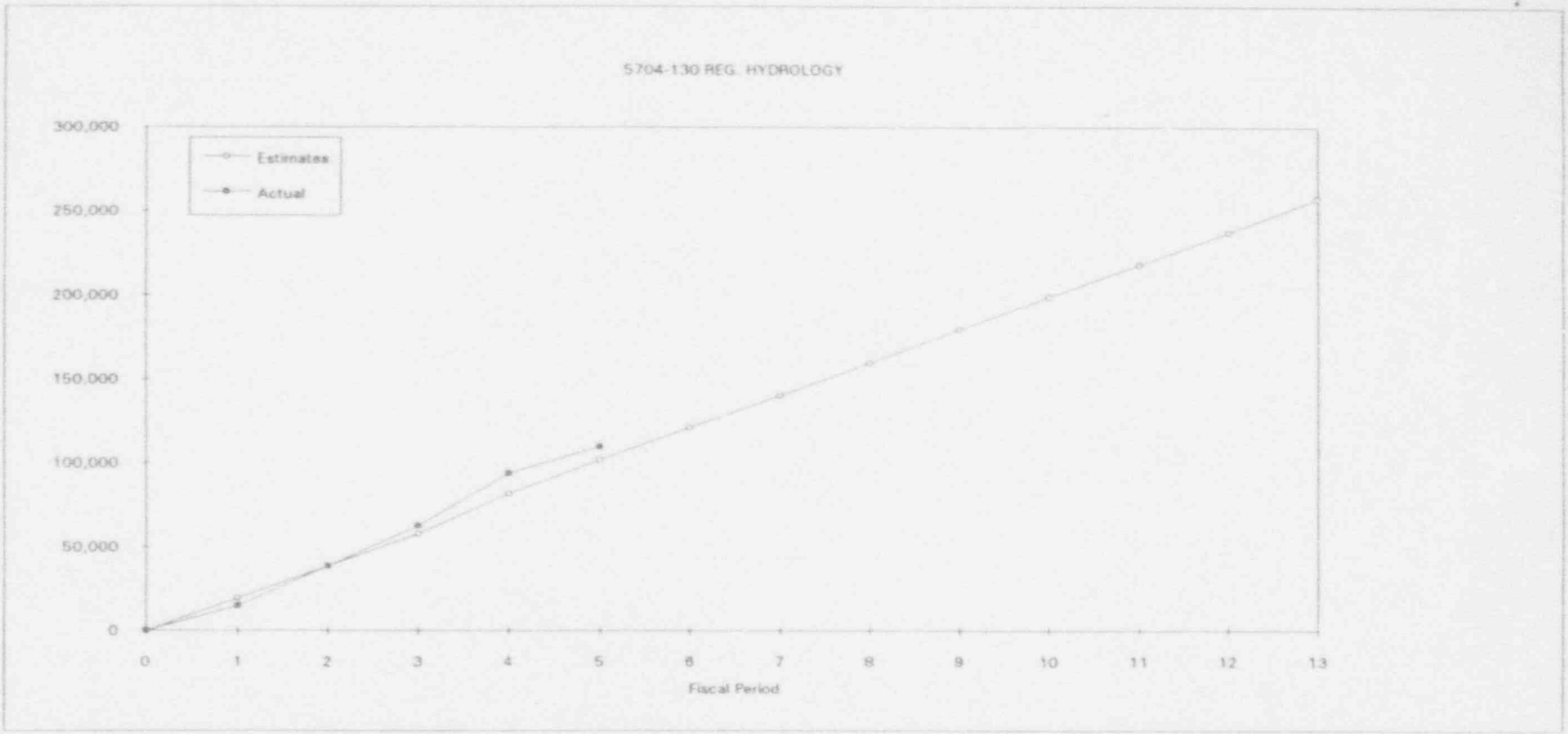
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	30,461	35,818	29,787	45,607	33,067	32,420	30,090	32,352	33,199	38,045	29,787	35,818	29,926	174,740
ACT. PERIOD COST	42,564	37,938	35,408	25,782	24,303	0	0	0	0	0	0	0	0	165,992
VARIANCE, $	(12,103)	(2,120)	(5,619)	19,825	8,764	0	0	0	0	0	0	0	0	8,748
VARIANCE, %	-39.7%	5.8%	-18.8%	43.5%	26.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%
EST. FY CUMUL	30,461	66,279	96,066	141,673	174,740	207,160	237,250	269,602	302,801	340,846	370,633	406,451	436,377	
ACTUAL FY CUMUL	42,564	80,502	115,908	141,690	165,992	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	9.8%	18.4%	26.6%	32.5%	38.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(12,103)	(14,223)	(19,842)	(17)	8,748	0	0	0	0	0	0	0	0	
VARIANCE, %	-39.7%	-21.5%	-20.7%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



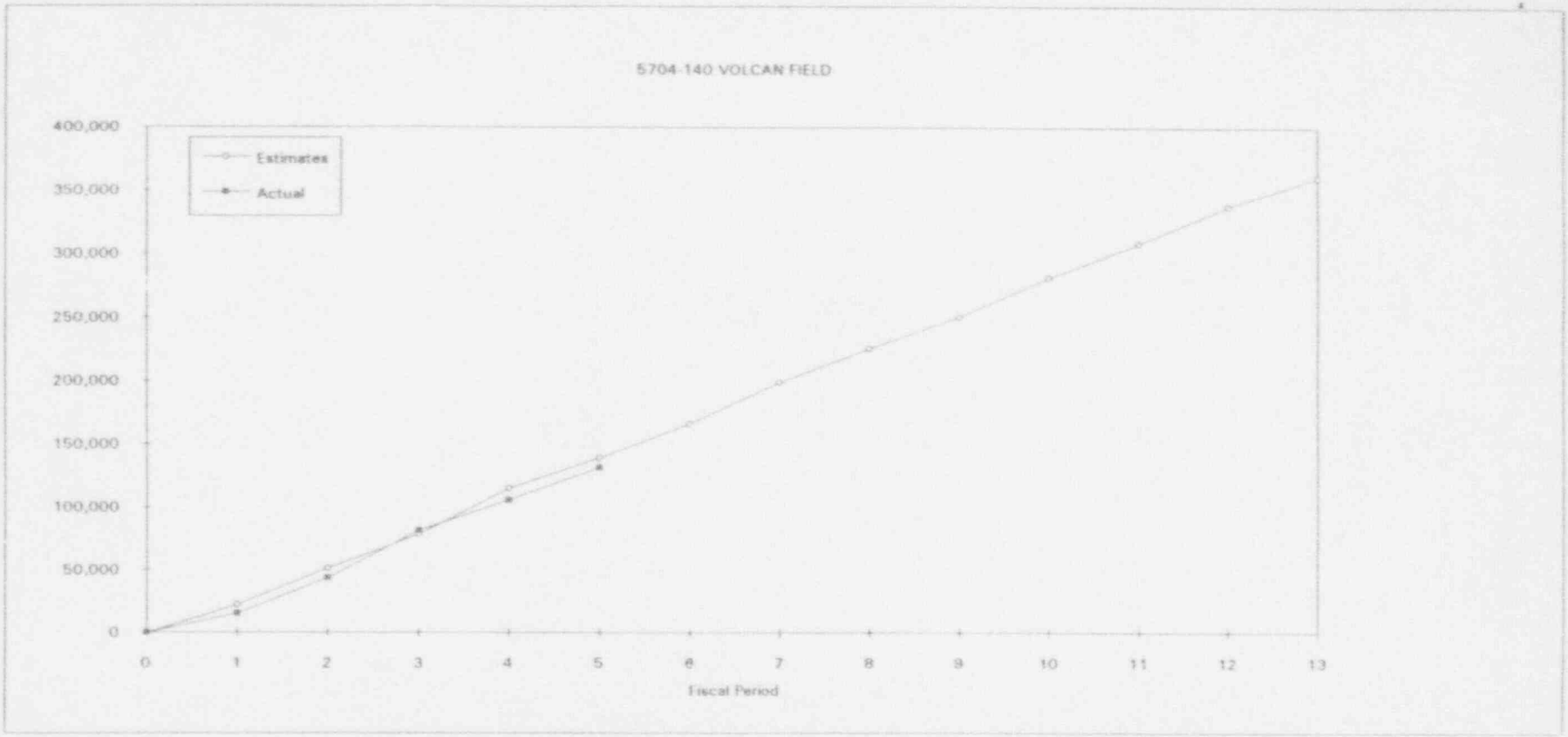
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	31,291	31,043	31,271	41,047	30,992	31,141	40,497	30,861	31,318	33,078	31,271	31,043	31,323	165,844
ACT. PERIOD COST	25,722	33,108	38,493	35,263	33,063	0	0	0	0	0	0	0	0	165,849
VARIANCE, $	5,569	(2,065)	(7,222)	5,784	(2,071)	0	0	0	0	0	0	0	0	(5)
VARIANCE, %	17.8%	-6.7%	-23.1%	14.1%	-6.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
EST. FY CUMUL	31,291	62,334	93,605	134,652	165,644	196,785	237,282	268,143	299,461	332,539	363,810	394,853	426,178	
ACTUAL FY CUMUL	25,722	58,830	97,323	132,586	165,649	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	6.0%	13.9%	22.8%	31.1%	38.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	5,569	3,504	(3,718)	2,066	(5)	0	0	0	0	0	0	0	0	
VARIANCE, %	17.8%	5.8%	-4.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



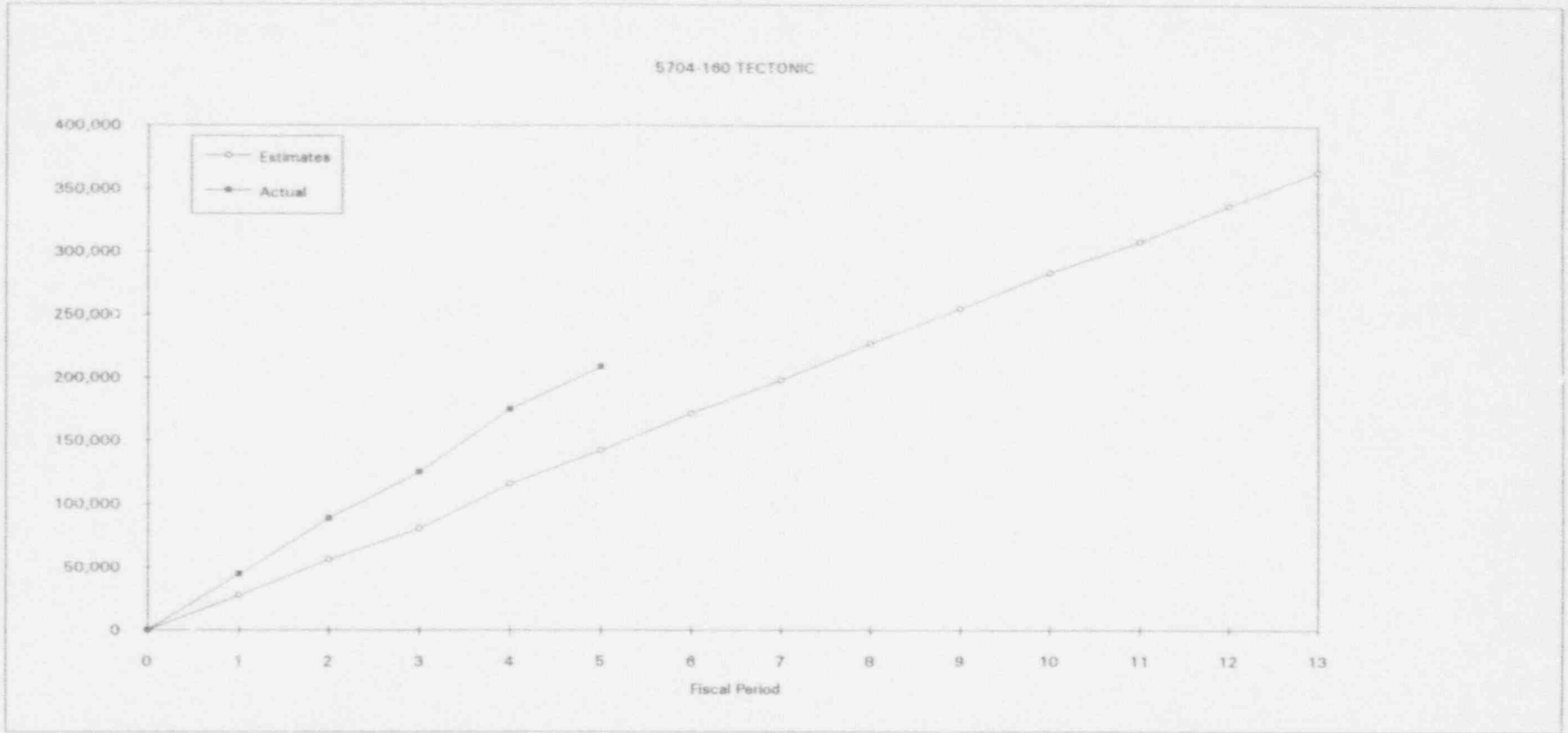
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	23,268	22,781	23,376	29,743	23,388	22,798	30,452	22,477	23,875	23,844	23,376	22,781	23,613	122,556
ACT. PERIOD COST	25,206	19,156	16,566	35,830	11,197	0	0	0	0	0	0	0	0	107,955
VARIANCE, $	(1,938)	3,625	6,810	(6,087)	12,191	0	0	0	0	0	0	0	0	14,601
VARIANCE, %	-8.3%	15.9%	29.1%	-20.5%	52.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.9%
EST. FY CUMUL	23,268	46,049	69,425	99,168	122,556	145,354	175,808	198,283	222,158	246,002	269,378	292,159	315,772	
ACTUAL FY CUMUL	25,206	44,363	60,928	96,758	107,955	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	8.0%	14.0%	19.3%	30.6%	34.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(1,938)	1,686	8,497	2,410	14,601	0	0	0	0	0	0	0	0	
VARIANCE, %	-8.3%	3.7%	12.2%	2.4%	11.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



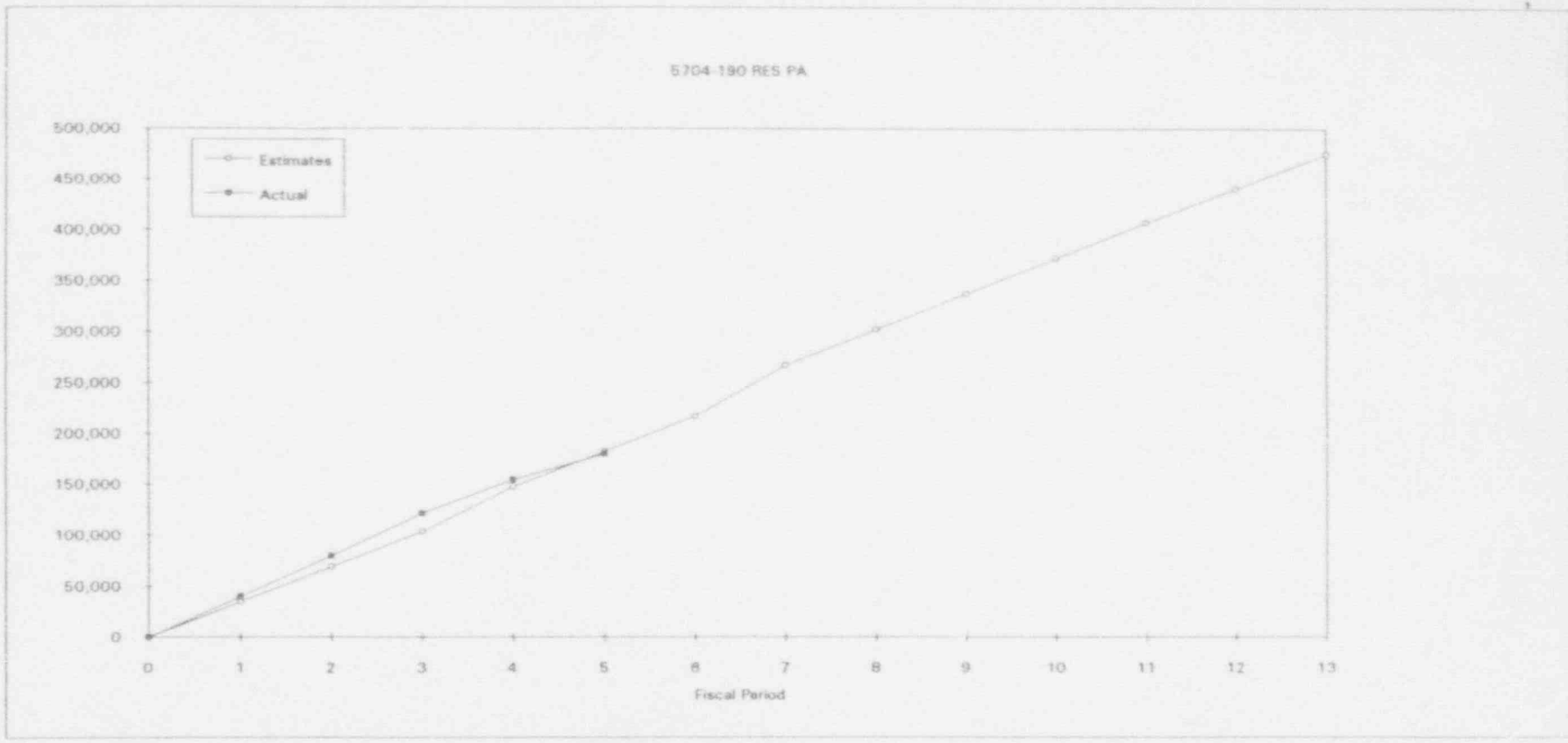
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	19,414	19,303	19,200	23,909	19,954	13,506	19,073	19,405	20,071	19,209	19,200	19,303	19,956	101,780
ACT. PERIOD COST	14,792	23,858	24,066	31,288	15,783	0	0	0	0	0	0	0	0	109,787
VARIANCE, $	4,622	(4,555)	(4,866)	(7,379)	4,171	0	0	0	0	0	0	0	0	(8,007)
VARIANCE, %	23.8%	-23.6%	-25.3%	-30.9%	20.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-7.9%
EST. FY CUMUL	19,414	38,717	57,917	81,826	101,780	121,286	140,359	159,764	179,835	199,044	218,244	237,547	257,503	
ACTUAL FY CUMUL	14,792	38,650	62,716	94,004	109,787	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	5.7%	15.0%	24.4%	36.5%	42.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	4,622	67	(4,799)	(12,178)	(8,007)	0	0	0	0	0	0	0	0	
VARIANCE, %	23.8%	0.2%	-8.3%	-14.9%	-7.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



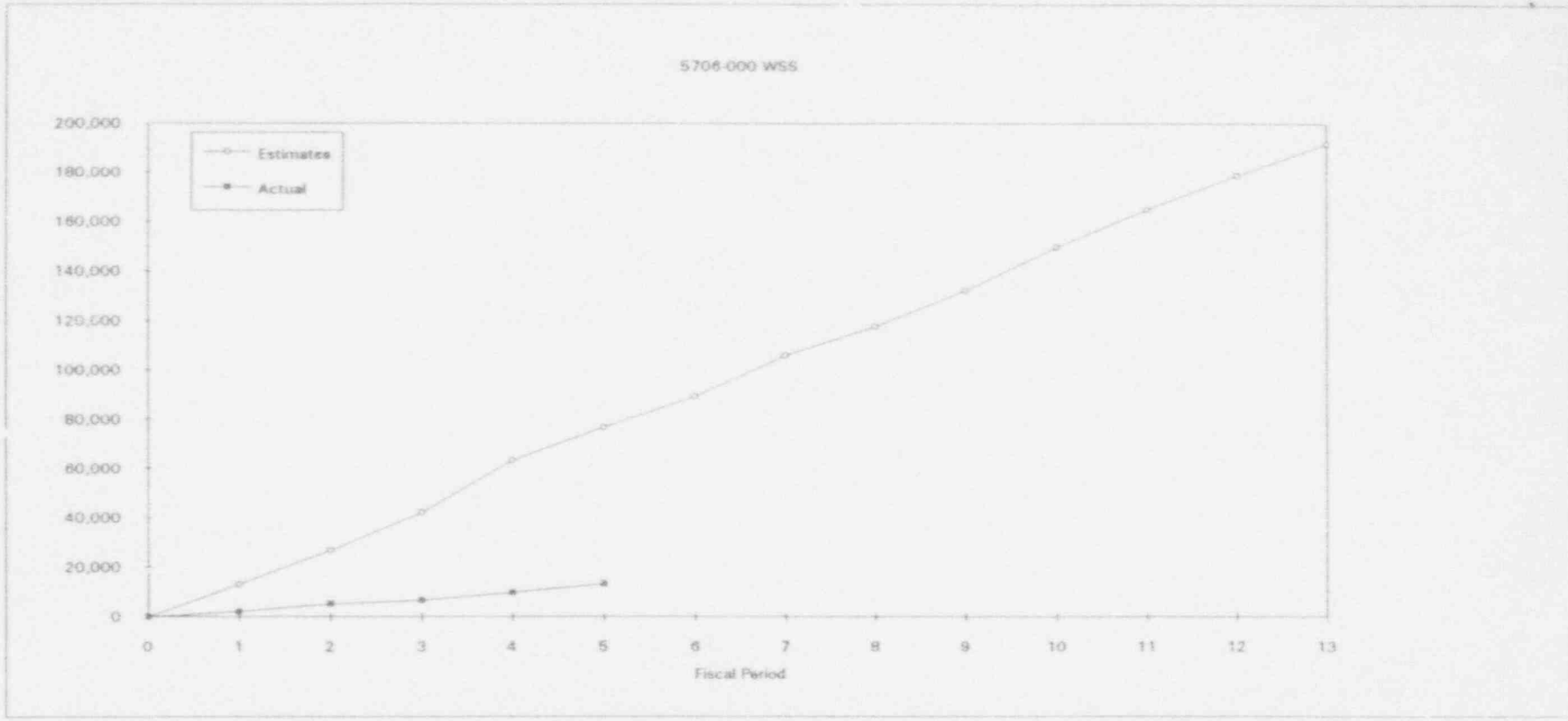
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	22,328	28,954	27,015	36,634	24,212	27,078	33,096	26,536	24,704	31,069	27,015	28,954	22,602	139,141
ACT. PERIOD COST	15,217	28,385	37,962	24,061	25,858	0	0	0	0	0	0	0	0	131,483
VARIANCE, $	7,109	569	(10,947)	12,574	(1,646)	0	0	0	0	0	0	0	0	7,658
VARIANCE, %	31.8%	2.0%	-40.5%	34.3%	-6.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.5%
EST. FY CUMUL	22,328	51,280	78,295	114,929	139,141	166,219	199,315	225,851	250,555	281,624	308,639	337,593	360,195	
ACTUAL FY CUMUL	15,217	43,602	81,564	105,625	131,483	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	4.2%	12.1%	22.6%	29.3%	36.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	7,109	7,678	(3,269)	9,304	7,658	0	0	0	0	0	0	0	0	
VARIANCE, %	31.8%	15.0%	-4.2%	8.1%	5.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



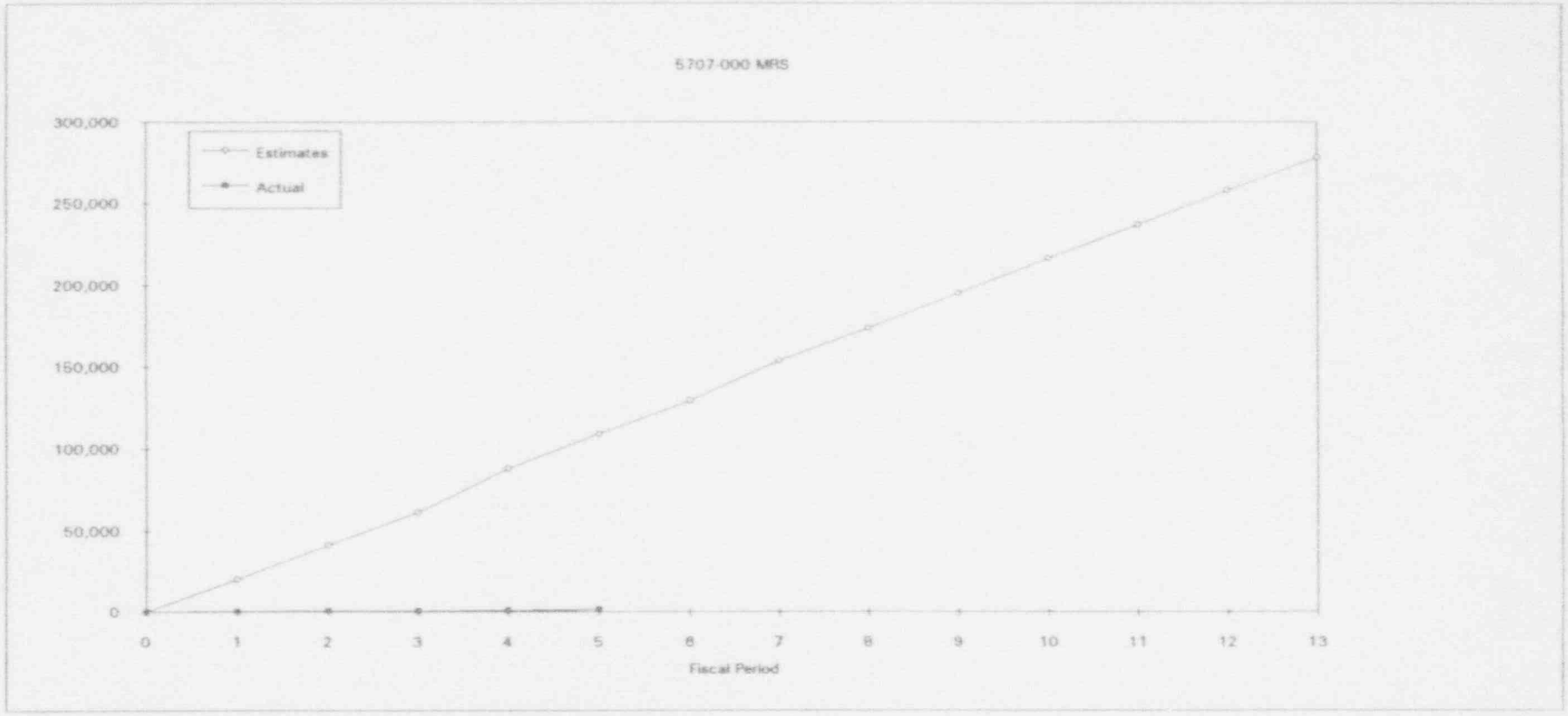
ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST. PERIOD COST	27,357	28,497	24,920	35,059	28,639	28,942	27,238	28,756	27,300	28,372	24,920	28,497	27,417	142,472
ACT. PERIOD COST	44,248	44,712	36,034	49,680	34,211	0	0	0	0	0	0	0	0	208,884
VARIANCE, $	(16,891)	(16,215)	(11,114)	(14,621)	(7,572)	0	0	0	0	0	0	0	0	(66,412)
VARIANCE, %	-61.7%	-58.9%	-44.6%	-41.7%	-28.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-46.6%
EST. FY CUMUL	27,357	55,854	80,774	115,833	142,472	171,414	198,652	227,408	254,708	283,080	308,000	336,497	363,914	
ACTUAL FY CUMUL	44,248	88,960	124,994	174,673	208,884	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	12.2%	24.4%	34.3%	48.0%	57.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(16,891)	(33,106)	(44,220)	(58,840)	(66,412)	0	0	0	0	0	0	0	0	
VARIANCE, %	-61.7%	-59.3%	-54.7%	-50.8%	-46.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	34,787	33,902	34,824	44,272	34,787	34,597	50,394	34,514	34,972	35,164	34,624	33,902	36,170	182,352
ACT. PERIOD COST	39,733	39,459	42,436	33,080	24,928	0	0	0	0	0	0	0	0	179,835
VARIANCE, $	(4,946)	(5,557)	(7,812)	11,192	9,839	0	0	0	0	0	0	0	0	2,717
VARIANCE, %	-14.2%	-16.4%	-22.6%	25.3%	28.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%
EST. FY CUMUL	34,787	68,689	103,313	147,585	182,352	216,949	267,343	301,857	336,829	371,993	406,617	440,519	475,689	
ACTUAL FY CUMUL	39,733	79,192	121,627	154,708	179,635	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	8.4%	16.6%	25.6%	32.5%	37.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	(4,946)	(10,503)	(18,314)	(7,123)	2,717	0	0	0	0	0	0	0	0	
VARIANCE, %	-14.2%	-15.3%	-17.7%	-4.8%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	13,038	13,732	15,343	21,070	13,720	12,282	16,748	11,731	14,498	17,559	15,343	13,732	13,085	76,903
ACT. PERIOD COST	2,192	2,956	1,534	3,099	3,547	0	0	0	0	0	0	0	0	13,327
VARIANCE, $	10,846	10,776	13,809	17,971	10,173	0	0	0	0	0	0	0	0	63,576
VARIANCE, %	83.2%	78.5%	90.0%	85.3%	74.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	82.7%
EST. FY CUMUL	13,038	26,770	42,113	63,183	76,903	89,185	105,933	117,664	132,162	149,721	165,064	178,796	191,881	
ACTUAL FY CUMUL	2,192	5,148	6,682	9,780	13,327	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	1.1%	2.7%	3.5%	5.1%	6.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	10,846	21,622	35,431	53,403	63,576	0	0	0	0	0	0	0	0	
VARIANCE, %	83.2%	80.8%	84.1%	84.5%	82.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	



ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
EST PERIOD COST	20,275	21,106	19,958	26,772	21,184	20,272	24,186	19,669	21,764	21,433	19,958	21,106	20,333	109,295
ACT. PERIOD COST	297	321	206	37	835	0	0	0	0	0	0	0	0	1,696
VARIANCE, $	19,978	20,785	19,752	26,736	20,349	0	0	0	0	0	0	0	0	107,599
VARIANCE, %	98.5%	98.5%	99.0%	99.9%	96.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.4%
EST. FY CUMUL	20,275	41,381	61,338	88,111	109,295	129,567	153,753	173,422	195,186	216,619	236,577	257,683	278,016	
ACTUAL FY CUMUL	297	618	824	860	1,696	0	0	0	0	0	0	0	0	
PERCENT COMPLETE	0.1%	0.2%	0.3%	0.3%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
VARIANCE, $	19,978	40,763	60,515	87,251	107,599	0	0	0	0	0	0	0	0	
VARIANCE, %	98.5%	98.5%	98.7%	99.0%	98.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	