KAJAKAI PROJECT GEOTECHNICAL WORK

Prepared by: Robert A. Joyet **Date of Report:** August, 2006

Project/Action Area: Generation

Project Title: Geotechnical Close - Out Report

Project Initiation Date: April 12, 2004

Original Completion Date: March 31, 2006

Actual Completion Date: August 21, 2006

Under the:

U.S. Agency for International Development - Afghanistan Energy Assistance Program

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MARCH 2006

This publication was produced for review by the United States Agency for International Development. It was prepared by Advanced Engineering Associates International, Inc.

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1.0 Scope of Work

1.1 Original Task

The pertinent Scope of Work as defined in the original Task is as follows:

1. Technical assistance with rehabilitation and/or expansion of small/mini/micro hydro generating plants
2. Other tasks as assigned by the CTO and approved by the CO
3. It is intended that Afghan nationals will take over various duties that may initially be commenced by international experts. Project activities will include technical assistance, oversight of training and some training and procurement.
4. Review of assessments conducted by Acres at Kajakai and Darunta dam/plants combined with on-site reviews
5. Extension of dam safety study performed by Acres International
6. Technical assistance associated with preparation for completion of the spillway
7. Assessments of other small hydro projects (existing and new) as directed by the CTO.

The primary focus was on items 4 through 6 with respect to the Kajakai Hydro Power Project. All three items are broad subjects and from a Geotechnical perspective, they are all related to dam safety issues. The pivotal base document for the performance of much of the work was, “Kajakai Hydroelectric Project Condition Assessment Report”, produced by Acres International Corporation for Louis Berger Group Inc., Afghanistan. Review of this document set the stage for the eventual scope of work.

1.2 Project Description

The Kajakai Hydro Power Project consists of a 90m high impervious core rockfill dam (crest elevation 1050.0m), an Irrigation tunnel with controlled intake and outlet, a power tunnel with controlled inlet and currently two of 3 installed 16.5 Mw Turbines, an ungated spillway with nearly completed concrete ogee section to elevation 1033.6m, on site uninstalled steel radial gates and a partially excavated emergency spillway.

The dam, irrigation outlet, power tunnel with controlled inlet and bulk headed penstock and ungated spillway were constructed by Morrison-Knudsen between 1950 and 1954. The Power house with two of three units was completed as a second phase in 1975. The third phase installation of the concrete ogee, radial gates and separate emergency spillway was aborted in 1980 due to the Soviet invasion of Afghanistan although some continuing work was performed under the Soviet occupation.

Since 1980 and until 2003, and perhaps longer, the project has received little attention and maintenance with regard to all electrical and mechanical equipment and to our knowledge no safety inspections or reviews.

An onsite UNOPS (June, 2003) and offsite Louis Berger Group (September, 2003) assessments were performed to identify potential safety and operational issues for both current and phase 3 project. These assessments did not seem to have the benefit of design drawings and reports and consisted of visual inspections and eye witness and interview accounts.

In April, 2004 a more extensive, “Condition Assessment/Dam Safety Assessment Report was completed by Acres International Corporation for Louis Berger Group Inc. This assessment was a more extensive effort and had the benefit of reviewing available drawings, correspondence, topographic maps, hydrology data, construction contract documents and the Final Design Report by IECO Inc of December 1956.

The latest assessment identified a number of pertinent safety and environmental issues, a severe lack of design and construction drawings and documents for the dam, tunnels and outlet works as well as missing phase 3 documents for the gate installation.

1.3 Project Objectives

The main objectives of the AEAI phase of the work was to assess issues relative to dam safety as well as issues impacted by the eventual and long delayed phase 3 gate installation, which would result in raising the reservoir level to historic levels up to 12m above current levels. The initial focus was to:

- Review the 2004 assessment
- Perform a project site inspection
- Address issues and concerns raised by the assessment to the extent possible with the limited access and tools available
- Raise and address, to the extent possible any other issues or concerns that came up as a result of the review and site investigation
- Attempt to fill in the project information/documentation gap to the maximum extent possible

1.4 Project Objectives Achieved

One of the achieved objectives was to address the following Assessment Report comment regarding the dam monitoring system: “No details of the piezometer installations or monitoring results are available.” The piezometer system is the only and most important remnant monitoring system to enable verification of dam performance and ultimately, its safety.

Other achieved objectives were to:

- Seek, identify and scan pertinent geotechnical design and construction documents
- Support other disciplines in their efforts to obtain design and construction documents and other information including:
    - Design/construction document search, retrieval, cleaning and scanning for archives
    - Air Strip Bridge Location Study for crossing the ungated spillway channel from a proposed fixed wing aircraft runway
- Performed a visual site inspection of the project
- Performed other miscellaneous work

1.5 Constraints and Barriers

The main constraints to any of the work was the unavailability of and access to previously existing information, security issues and the lack of available equipment and vendors to perform investigations at such a remote site.

After decades of occupation, struggles against occupation and civil war, many of the project documents may have been moved around to parts unknown, become totally disorganized and diffused, destroyed or slowly decayed.

Powerhouse documents for instance, appeared to be readily available, though in some disarray. Since the Powerhouse is a continually functioning entity manned by technicians, they both have a need and routine use for the documents themselves, better facilities for storage and preservation and a full appreciation of their value and importance.

On the other hand, the Irrigation House was the repository for the original design and construction documents for the dam, irrigation and power tunnels and associated inlet outlet controls (except power tunnel beyond the original penstock bulkhead). Although the site personnel were very genial, helpful and highly protective of the currently existing documents, they are typically watchmen and caretakers rather than technicians and operators, have less need for the documents except to make seasonal adjustments to the discharge quantity and have very limited facilities for dry and secure storage of such documents. It also appeared that all and any pre-existing formal sets of drawings and reproducibles had long ago been removed from the site. Most of what remained was partial sets and predominantly hard copies.

Security problems limited search to the site facilities, i.e. the Irrigation House. It was suspected that additional documents and/or originals might exist at the District Irrigation Offices in Lashkar Gah, but security concerns on the road between the site and offices, prevented such a search. Similar security concerns prevented looking in Kandahar; although it was doubtful anything of value existed there.

Another limitation was the unavailability or probable prohibitive costs of equipment to perform on site investigations, such as excavation of the dam crest to sample core material and to verify whether or not longitudinal and/or transverse shrinkage cracking had developed in the upper core.

1.6 Lessons Learned

Almost nothing can be counted to be available locally.

Regarding the equipment plugs and outlets, in particular, we had significant problems finding conversions that met the power requirements and would not fail as a result. Similar problems were rampant at the Powerhouse (where various power equipment utilized to perform field modifications to the equipment and materials) where bare wires were connected into outlets for lack of adequate plugs. Similarly where the Irrigation Manager performed both welding and CUTTING with a welding machine, which was also connected into a receptacle with bare wires. It is shameful that site safety and utilitarian requirements were not made a priority at every generation site in dire need of such relief.

It appears that (even same and partnering entities such as AEAI/USAID/IRD) entities involved seldom worked in a coordinated effort, as a team or supported each other with the interdisciplinary resources to optimize the result while minimizing the effort. Inevitably, one had to be a jack of all trades in lieu of benefiting from the depth of variable knowledge and experiences.

1.7 Project Continuity

Much remains to be done regarding dam safety issues.

The functionality of the rehabilitated piezometers remains in question and cannot be fully evaluated without continued system flushing, observation and pressure readings. This work must be performed by someone experienced in dam design and performance and well versed in the operation of the piezometer system.

Documents available at the Irrigation Valve House have been fully exploited. Unfortunately they do not represent a complete set of design and construction documents. The 1955 Design Report, mentioned in the Acres assessment has not been found. Certain irreplaceable documents mentioned in weekly/monthly Construction Reports such as boring logs, including SPT blow counts, of the granular deposits which remain under the dam fill have not been found. The search for such documents should continue as access and security of access allows. Acres International personnel who were at the site and referred to the Design Report should be interviewed by USAID to determine the whereabouts of this referenced document.

1.8 Assignments/Duration and General Activities

The total assignment consisted of three trips to Afghanistan and Stateside work as follows:

- Six week trip, April-May, 2005
    - Review of Acres Assessment report
    - Kajakai Site visit, site inspection, document search, organization and listing
    - Evaluation of piezometer documents and data
- Eight week trip, August-October, 2005
    - Information/progress exchange with John Hazelton of USAID
    - Restart on site (Kajakai Irrigation House) document search, organization, site scanning (A4 size) and preparation of drawings for shipping/scanning in Kabul
    - Begin Construction Narrative document on site
    - On site Bridge Study
    - Inspection of current spillway channel and future emergency spillway channel segment
    - Clean and prepare drawings for scanning then package for shipment back to site
    - Identify vendors and begin piezometer monitoring equipment replacement RFP
- Stateside work, October 2005 through February 2006 for a total of 389 hours
    - Finalize, issue for bids, evaluate bid and award piezometer monitoring equipment replacement RFP
    - Complete Construction Narrative document
    - Respond to Tom Collins and John Hazelton requests for information regarding Intake structure and equipment drawings, 1975-76 Gate drawings and other useful information
    - Miscellaneous support work
- Six week trip, February-April, 2006
    - On site preparation work for installation of piezometer monitoring equipment
    - Expediting of shipping, transfer and transport of piezometer monitoring equipment to Afghanistan and to site
    - On site installation, startup and operation of piezometer monitoring equipment together with Rob King-Mason of Soil Instruments (equipment supplier/installer)
    - Downloading of project documents from my computer and miscellaneous scanning of other documents for incorporation into Closeout Report (files and scans held by Ahmad Omar Ahmadi of AEAI and at AEIC).
- Stateside work, April for a total of 24 hours
    - Beginnings of information organization and Closeout Report

2.0 Hydraulic Piezometers

2.1 Background

The piezometer system is typical of USBR designs of the times and includes sixteen (16) closed-system, double tube, foundation and embankment type hydraulic Piezometers. Piezometer tips are located within the core and the upstream and downstream transition and free draining zones. The tips each have two tubes (5/16 inch O. D. by 1/16 inch wall Saran plastic) which are routed back to the piezometer cabinet at the downstream toe of dam at about el. 973m and each connected to a separate pressure gage measuring feet of pressure. This permits taking two separate readings of the tip pressure.

The condition of the piezometer monitoring equipment can be found in a number of photographs and descriptions in previous reports as well as photographs (in GENERAL ATTACHMENTS, CD 1 and 2, Kajakai Project Photos) herein.

When first inspected (May, 2005) the piezometer cabinet could not be fully opened, the entire plumbing system was leaking, the system had some slight modifications from original and none of the gages appeared to function.

Pertinent piezometer documents found in May, 2005 included:

- Drawings 11-F-3 & 4, Dam Piezometer Installation Sheets 1 & 2 (Scanned Documents Attachments (SDA), CD 6)
- January 1951 Piezometer Manual, Memos & Data and Instructions for Operation and Maintenance (of) Kajakai Dam, Arghandab Dam and Diversion Dam Headworks for Boghra Canal Intake", November, 1955, IEC Inc. (file name instruction-operation manual Nov 1955 (SDA, CD 19)
- Piezometer Readings from March 26, 1953 through November 18, 1960 (SDA, CD 5)

These documents describe the design, installation, location and operation of the piezometer system, piezometer gage readings for the times indicated and problems encountered and their solutions. They did not provide a reduction of the data and evaluation thereof.

The piezometer tip locations in plan, section and by baseline, offset and elevation, and any corrections thereof are shown on Figures 1 and 2 and on Table A respectively. Table A, with one correction to elevation (per construction report), represents the as built location of the piezometer tips and figures 1 and 2 indicate the as built location, which often differed slightly from its design location.

2.2 Readings from March 26, 1953 through November 18, 1960

The Piezometer Readings from March 26, 1953 through November 18, 1960 (SDA, CD 5) were reviewed. After tabulating piezometer reading dates, reservoir level and tailwater level (worksheet "Level vs. Time Date" from excel file "Selected Piezometer Data 1953-1960"), it was noted that many sets of readings had no indication of reservoir and tail water level on the date of readings, rendering the data set somewhat useless. From this tabulation, twenty two sets of data were tabulated and the data reduced to an elevation reading for each piezometer tip (see Tables C – Selected Piezometer Data 1953-1960 and Piez Attachment 1 (excel file on CD 1).

The piezometer data and documents review resulted in the following observations and conclusions:

- Piezometer readings were typically taken as often as 5 times a month, often 3 to 4 times and occasionally once
- There are data gaps as follows:
    - April, August and September 1954
    - September 1955 through April 1956
    - July through October 1956
- Reservoir and tailwater levels were included with all readings through May 1953, after which tailwater was no longer recorded and reservoir level was occasionally not recorded for up to one to two months at a time – The lack of tailwater data is not critical, as it does not vary significantly for the range of reservoir levels that readings were taken, whereas reservoir level is of paramount importance in evaluation of the piezometer tip elevation readings and evaluation of performance
- Each piezometer provides two readings, which should be comparable (within 1.5 meters of head) and if not then they were to be compared, with the master gage
- Many readings differed by more than 1.5 meters but not checked
- Each piezometer (inlet and outlet tube) was to be periodically flushed to verify there was no air in the system resulting in faulty (lower than actual) readings. There is no indication that this was done except on two occasions within the same month on instructions from M-K Afghanistan Headquarters (3/6/54 & 3/14/54, see Scanned Documents Attachments, CD 19, item 2)

- Another memo indicated that air in system was a significant problem and that the use of tailwater (which is significantly aerated by the Jet Valves) should not be used without prior de-airing procedures.
- On the basis of the above, many if not most of the readings are suspect
- Current indications are:
    - Some piezometers read consistently higher than or lower than the plausible maximum and minimum levels
    - Piezometers 1, 2, 3, 6 and 9 give consistent and plausible readings
    - u/s transition piezometer # 14 systematically indicate that the phreatic surface upstream of the core is consistently lower than the lowest tailwater level, which is inconsistent with the nature of reality and indicates defective tip or gages, air in system or both
    - d/s transition piezometer # 13 systematically indicate that the phreatic surface downstream of the core is consistently lower than the lowest tailwater level, which is inconsistent with the nature of reality and indicates defective tip or gages, air in system or both

On the basis of the condition of the monitoring equipment and the above evaluation of readings, it was highly recommended that the monitoring plumbing and gages be completely replaced and modernized with the latest de-airing and flushing equipment.

2.3 Rehabilitation RFP and Procurement

In August of 2005, USAID agreed with the recommendation to rehabilitate the Piezometer monitoring system and authorized AEAI to proceed with procurement of new equipment.

AEAI identified and contacted eight vendors, of which the following three viable vendors agreed to bid on the rehabilitation work:

- Soil Instruments Ltd. – Sussex, England
- Colorado Engineering and Instrumentation – Denver, USA
- RST Instruments Ltd. – British Columbia, Canada

An RFP was prepared (included as Piez Attachment 2 (on CD 1)) and sent to each of the three above vendors. The vendors were provided with Piez Table B – Piezometer Tubing Circuit Volumes, which is a calculation of the minimum volume of de-aired fluid necessary to be flushed from each piezometer system to provide an air free circuit. This provided a basis for vendors to optimize the size of their equipment and is a guide for the minimum flushing volume to assure complete circulation. Because of the possibility of fluid loss out the piezometer tip, the injected quantity should be at least 120% of circuit volume.

Soil Instruments Inc. was the only respondent to the RFP. The Soil Instruments Offer is included as Piez Attachment 3 (on CD 1). An evaluation of their Offer was prepared and is included as Piez Attachment 4 (on CD 1).

2.4 Rehabilitation Installation, Startup and Operation

The equipment and Soils Instrument Installer (Rob King-Mason) arrived on the same morning as the scheduled helicopter flight to the site on March 15, 2006.

Preparatory grading to access the cabinet location, excavation to expose the pipe encased tubing bundle and provide cabinet area drainage, electrical power and water had been provided in the week prior to our arrival with the equipment.

Installation, including a number of field modifications to the equipment, took place between March 15 and 19. Other problems included three piezometer tubes breaking at or below the existing buried pipe collar during tube splicing work, rendering tube splicing impossible. The problem was resolved by some very careful cutting off of the pipe collar threaded sleeve connection. The modifications, cutting and welding were skillfully and with care, performed by Powerhouse and Irrigation Valve House for nominal labor cost.

Individual piezometer circuit flushing with de-aired water began on March 19. Initial progress was three piezometers per day. This rate was improved by finding some clean water receptacles to store de-aired water, which was processed day and night. This improved the rate of flushing. On March 23 a second round of flushing was started. Rob King-Mason was also working on the operation and maintenance manual evenings and when we ran out of de-aired water.

Details of the equipment installation, system startup, flushing and readings can be found in the field notes (Piez Attachment 5 – Installation Field Notes (Piez Attachment CD 1).

Individual piezometer de-aired water flushing quantities (flow in/flow out), post flushing pressure readings and comments from the field notes have been plotted in different ways on Figures D, E1 and E2.. There is no convenient way to look at and try to evaluate the information.

The procedures for properly preparing de-aired water, charging high pressure de-airing unit and flushing piezometers is presented on 4 simplified and illustrative schematic diagrams (Piez Attachment 6) and an accompanying text description (Piez Attachment 7). This process is again described and illustrated with photographs in “Hydraulic Piezometer Operating Manual, Electric and Manual Pumps” (Piez Attachment 8). This same manual details the process of taking readings in conjunction with the flushing process, how to care for the equipment and some insight into trouble shooting and dos and don’ts. Unfortunately, the prime candidates for training in the operation of the equipment either declined at the last minute or arrived on site too late for training, Although the importance of this part of the process had been repeatedly emphasized for months prior to installation, an inadequate pool of candidates were provided and the few that were failed to be trained. **It is highly recommended that this training process be restarted whenever it becomes possible to engage an experienced dam engineer to review the information and continues to flush the systems and take additional readings to fully verify piezometer viability, if any.**

As of the last flushing and reading of all piezometers on April 3, none of the upstream piezometer readings are up to anticipated levels or near previous historic levels (1953-1960). If anything, the current readings should be equivalent or higher, as the phreatic surface of the core, in particular, may not have achieved equilibrium at the time of the early readings. Some of the pressure readings are unbalanced and these same ones tend to return little flush water compared to what is injected. This could mean one of several things we know and perhaps some we do not:

- A pinched or nearly pinched return tube, such that water is going into the formation at the piezometer tip
- A ruptured tube or connection at some point along the circuit
- A blockage of the line by deposition/mineralization/?
- A blockage of the piezometer tip by deposition/mineralization/?
- Other??
- The rupture condition(s) could be natural events or errant pumping with the hand pump in times past, whether by do gooders trying to take measurements, or evil doers sabotaging or playing with the system

Regarding apparent circuit continuity (water sent = water returned) and equivalent but too low pressure readings, this is likely:

- A piezometer tip condition such as blockage/mineralization/?
- Above tip condition and very small tube leakage at some location wherein we are measuring the pressure at the leakage location

- Similar to above, any minor leakage of buried system could be either natural or induced by pumping operation

After installing the negative pressure gage on the last day on site, Tips 4 and 5 indicated pressures compatible with their locations and tailwater conditions. Additional careful readings and additional flushing are necessary to validate these readings, including precise tailwater and reservoir elevation. Such readings need to be done over an entire season and reflect the maximum possible tailwater level variability over that period.

2.5 Monitoring

I believe it is imperative to continue to flush and read all the piezometers as well. This work as well as careful evaluation of results and any trends needs to be performed by an experienced dam engineer. The number of flushes and readings need not be intense, but they should be performed over the seasonal variation of reservoir and tailwater and at reasonably equivalent time intervals.

2.6 Reservoir and Tailwater Levels

AEAI inquired about how and by whom, the reservoir water level was recorded. We were informed that the Irrigation Site Manager measures it at the Irrigation Intake Tower once or twice per week and that Mr. Rasul (Powerhouse Manager) measures it daily.

On Wednesday March 22, the Irrigation Site Manager and I traveled to the Irrigation Tunnel Intake Tower. The purpose of the trip was for him to show me how he measured the reservoir water level.

We first measured the reservoir level by lowering a weighted tape to the reservoir level and measured the distance from water surface to the, “painted X on the curb of the upstream side of concrete gate control tower and the elevation recorded 1050.15 meters” (per Kajakai survey report.txt, Kajakai Dam Survey Report, 3-12-05 to 3-14-05 by surveyors Jerry Holtz and William Matias of USGS, I believe). The distance measured was 17.22 meters after accounting for the wrapped weight on the tape. Reservoir elevation was therefore 1050.15 – 17.22 = 1032.93 meters.

The conditions were windy, which increased my measured distance versus the true vertical distance, thereby giving me a reservoir elevation lower than the true elevation.

The Irrigation Site Manager had a key to a cabinet which housed what used to be an automated water level reader. It consisted of a continuous steel tape between some unknown reference point (pulley or drum mechanism), well below water and the drum in the housing and included a float, which actuated the tape. The tape magnitude at the housing is 68 to 70 some meters. Due to the severe language barrier and limited technical ability of the translator, it was not possible to fully understand the tape anchorage datum, nor the specific reference point for reading the tape. After much discussion, it appeared that at some point in the past, a reservoir elevation was established. Since then, changes in the tape measurement from whatever initial baseline tape reading was established, have been systematically added and deducted from that baseline reading. The reading for this day was established as 1032.45 meters elevation.

This reading is a lower elevation than my measurement (by 45 cm), yet my reading should have been slightly higher due to the wind.

After returning to the Powerhouse, Mr. Rasul took a reading from a pressure gage on the draft tube. His reference elevation or datum is 962.0 meters. The gage vibrates vigorously over a several meter range and an “average” reading was taken as 69.0 meters, yielding a reservoir elevation of 1031.0.

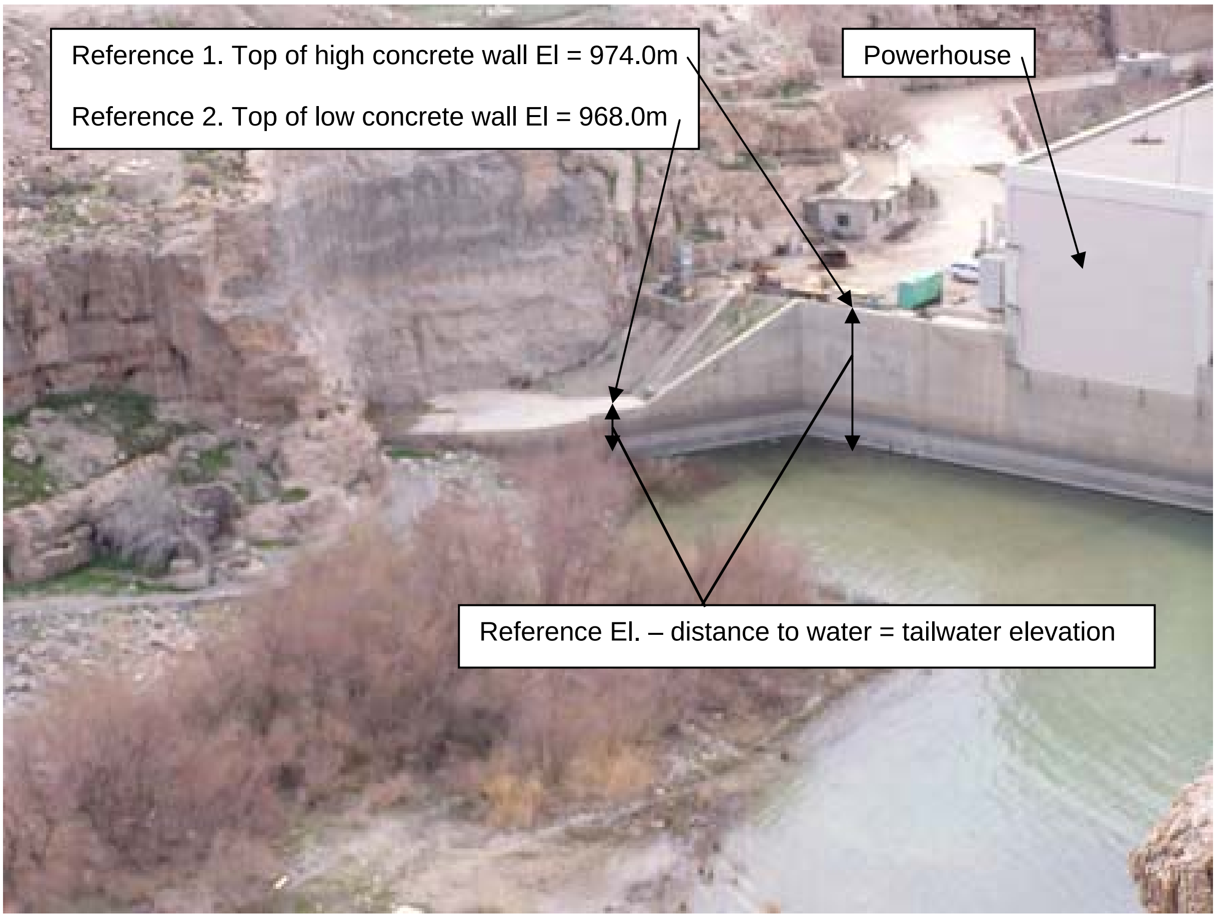
Summary of readings within the same relative time frame and reservoir level were as follows:

Date	Location	Method	Reservoir Elevation (m)
March 22, 2006	Irrigation Intake Tower	Baseline plus/minus increments, by Irrigation Site Manager	1032.45
	Irrigation Intake Tower	Direct tape measurement from reference surveyed elevation, by AEAI	1032.93
	Powerhouse	Datum plus pressure gage reading, by Powerhouse Manager	1031.0

From the above exercise, it is clear that reservoir water levels are consistently measured to be lower than they actually are by between a half and 2 meters or more. If precise reservoir water levels are desirable, it would appear that direct measurement by tape from the surveyed reference point on the Irrigation Intake Tower curb would be preferable until such time as the existing water level reader and method is well understood regarding references, datum and functionality. Once the water level reader methodology is clearly understood, it should be verified by direct and accurate measurement by a good quality tape on a very calm day or calm time of day.

Until such time, the Irrigation Site Manager should be supplied with a good quality tape with weight or “bob” and clear instructions about how and when to take measurements and to avoid errors from wind induced false measurements and water level fluctuations.

Tailwater levels are currently not being measured. Following is a photo which indicates locations from which direct measurements can be taken from known reference elevations to the tailwater surface for this determination. Such measurements may not be needed for routine operation. However, they would be necessary for significant spring/summer spillway overtopping events and when piezometer readings are taken.



Two convenient locations for measuring tailwater elevation on a minimum basis of:

- once per week
- each day of noticeable change, and
- each time piezometers are monitored

The top of the lower wall should be utilized as long as the water level is at or below the top of this wall and the top of the higher wall should be used whenever the water level is above the top of the lower wall. This will provide the most accurate readings possible.

Top of concrete wall elevations and the below tailwater levels were provided by Mr. Rasul, the Powerhouse Manager.

1. Maximum Design flood El = 972.0m
2. Maximum flood of record El = 965.5m
3. Minimum tailwater El = 962.5m

3.0 Document Search and Scanning

The document search began on my first site visit in May, 2005. At that time it became apparent that many documents concerning first phase construction were available at the Valve House. This included a number of piezometer documents which were taken surreptitiously when the otherwise congenial Irrigation Valve House staff, got the order from Lashkar Gah, to not allow any documents offsite for any reason whatsoever. The kept documents were all piezometer related which allowed this important work to proceed. These documents were of course later returned after being scanned and after the reluctance to release documents for scanning in Kabul was lifted.

At this time the following important documents were noted to exist:

- Weekly/Monthly Construction Reports
- Operation/Maintenance Manuals for project including piezometers
- Piezometer readings

- Misc geotechnical specs, memos and consultants reports regarding significant design/construction issues
- Many types of drawings, mostly hard copies

Permission for full access to all documents was finally obtained in September, 2005 and we mobilized to the site to restart the initial sorting and organization of documents and on site scanning of all A4 size material to expedite the work and to put the on site personnel at ease. Drawings were sorted, partially cleaned, drawing lists developed and the best quality prints bundled for shipment to Kabul for scanning.

The greatest obstacle to completing the drawing scanning was the necessary cleaning and patching of prints to make them presentable for efficient and quality scanning. Another issue regarding scanned documents is the establishment of an efficient and logical means of indexing and organizing the scanned files. Documents Search and Scanning (DSS) Attachment 1 – Scanning memo elaborates on this issue and how the scanned files were organized for logical and easy retrieval.

Scanned documents are not included herein as hard copies, but are provided on 19 CDs and the CDs Table of Contents is provided herein as DSS Attachment 2.

One significant and two subsidiary documents were created out of the weekly/monthly Construction Reports. A hard copy of the Construction Narrative, a condensation of the entire construction history of the first phase of the project, was created to present the critical design and construction aspects of the project and is presented as DSS Attachment 3. More condensed versions of the same document, Milestone Events and Pertinent Issues are presented as DSS Attachments 4 and 5 respectively.

4.0 Air Strip Bridge Location Study

On September 19, 2005 Peter Jezek was on site to look for a viable location for a Bailey Bridge type crossing of the Service Spillway Natural Channel. The purpose of the bridge was to permit vehicular traffic between existing Site Facilities and a proposed fixed wing landing strip located northwest of the beginning of the service spillway discharge channel and beyond the gate lay down area. The area had previously been inspected by an Architect who indicated that Bailey Bridge spans up to 40m were viable for this type of traffic.

Visual inspection of the naturally eroded spillway channel indicated a favorable location for such a bridge, as shown on Figure 1 - Bridge Overlay on Photo (2-28m Spans), where the existing access road from the spillway aggregate and concrete batch plant makes a right angle turn toward the spillway ogee (right abutment) and the location of a utility pole (see photo, left abutment).

The approximate location of maximum spillway discharge water level can be seen in the Figure 1 photo as the “white area”, which has been eroded of soil on the right bank and abraded the rock weathering discoloration on the left bank. As can be seen on Figure 2 - Kajakai Spillway Channel Bridge Sketch – Plan & Section, the maximum historic water level would be well below the bridge spans and adequately below the right abutment foundation. The central pier would straddle a natural projection from the right abutment, which would provide pier stability and erosion protection of the lower pier.

Figure 3 - Pier & Left Abutment Overlay on Photo, shows the location of the left abutment foundation on a very stable and massive rock ledge, the pier straddling the natural projection and the bridge location relative to the utility pole.

This bridge location was surveyed by hand level and a 50m tape and angles were estimated. The survey notes and geometry reconciliation (to reconcile the various tape measurements with the estimated angles) are shown on Figure 4 - Field Notes – Survey & Geometry.

This location provides the optimum pier location (with some erosion protection), minimum span lengths of 28m each and in close proximity to the existing road from the aggregate stockpile area and a pioneer road to the existing utility pole on the other bank.

5.0 Zana Khan Dam and Reservoir

In April, 2005, I was asked to review and comment on a trip report inspection of Zana Khan Dam performed by others. My review and comments were based on discussions with the authors and review of numerous photographs taken by same during the April 11, 2005 inspection. Below, find the trip report with my observations and comments incorporated into the original trip report.

MEMORANDUM

Date: April/May, 2005

Log: Zana Khan 041805

To: Tom Hayes, USAID
From: Dennis H. McCandless
Subject: Visit to Zana Khan Dam

The author of this memorandum is a contractor for the U.S. Agency for International Development. Additional input from Robert Joyet, Geotechnical Engineer with MWH (also a contractor for USAID), was incorporated following his review of photographs, the draft memorandum, and verbal discussions with the author.

On April 11, 2005, Dennis McCandless of AEAI joined Michael McGovern of the Louis Berger Group (LBG) on a site visit to the Zana Khan Dam in Ghazni Province. The purpose was to look at the leakage through the dam body and at the outlet valve stems, decide whether there is an imminent danger of dam failure, and propose a course of action to permanently stop the leakage. Travel to the site was by helicopter, with several additional tasks accomplished by other passengers during the day's trip.

History
Zana Khan Dam is a stone masonry gravity structure that was built in stages. It provides irrigation storage for the farmers living downstream. The drainage area above the dam is relatively small, as is the reservoir.

There are no known drawings of the dam or any of the enlargements or improvements made over the years. The dam was rehabilitated during 2003-4 under LBG's contract with USAID. The dam masonry was tuck pointed upstream and downstream, the outlet valves were refurbished, outlet channels for the valves and spillway were also rebuilt, etc.

Present Conditions
Despite the tuck pointing, there is still significant leakage through the central body of the dam and at or near the contact of the masonry and the foundation. This is especially heavy toward the left abutment and the central part of the structure. The upper seepage limit in the central part and left abutment appears to be to the approximate reservoir level at the time of the inspection. The water is clear, but in many places is squirting out of the dam face. This indicates the presence of open seepage paths through the masonry. The site photographs show the extensive nature of the leakage. In some areas, there are white deposits indicative of calcium carbonate leaching of the cement and mortar from the dam masonry joints. Several of these areas are shown on the site photographs.

The leaks in the masonry appear to be concentrated along several horizontal bands that may correspond to the construction joint contacts between old and new construction resulting from the several dam enlargements.

There is heavy leakage around the stems of the two gate valves that control the two outlets from the reservoir. The cause was not clear but the contractor that rehabilitated the valves last year will be asked to investigate.

Initial Safety Assessment

The Zana Khan Dam doesn't appear to be in danger of imminent failure, despite the extensive leakage. The dam may, however, be unstable under extreme loading conditions such as those experienced during an earthquake or during a flood. In particular, the dam parapet wall (about 2.5 meters high) is almost certainly unstable when significant spillway flow occurs. The spillway crest is only about 1.5 m lower than the top of parapet, so when water reaches the spillway crest, there is already about 1 m head on this relatively thin wall.

Though the dam may be safe in the very short term, there are significant problems that should be addressed as soon as possible to avoid accelerated deterioration that could cause failure in the future and to make the dam safe under extreme loads.

Possible Remedial Measures
Several options for solving problems at Zana Khan were discussed during the field visit. These should be considered by the engineering firm selected to do the detailed work:

- Excavation of all loose sediment and other material against the upstream face of the dam to permit inspection and waterproofing of the entire upstream face.

- Installation of an appropriate ultraviolet-resistant synthetic membrane on the upstream face of the dam, recognizing that anchorage and sealing to the foundation contact and crest edge would be an important design issue.

- Adding downstream mass and interface drainage or post tension anchoring the dam into sound foundation rock to improve stability.

Recommendations
In the immediate future, the dam should be visually monitored to detect any significant increase in leakage that might indicate a serious problem is developing.

It would also be wise to work out a system to immediately alert downstream residents if any significant change in conditions is observed.

During the next few months, the dam face should be mapped photographically with the photos showing measured reference station and elevation locations. Leakage measuring points should also be established at practical locations below the dam. (It is not necessary to measure the entire leakage flow, only the amount that is practical.) The leakage observations and photo mapping should be made at different reservoir levels as the water surface declines this summer, and when any significant increase in seepage area or change in seepage flow rate is observed. Each separate survey should document flow rates at the same locations.

It would also be prudent to establish reference points on the dam to monitor movement.

[These points might consist of two continuous lines of grouted steel pins along the top of the parapet wall and along the walkway base of the last dam raise below the parapet wall. Each line would be located and installed in alignment with two similar reference pins (one each on each abutment beyond the influence of any potential dam deflection. The dam pins would be spaced about 25 to 40 m apart (further apart near abutments and closer together within higher dam segments and intervals of maximum height seepage limits). Successive surveys would then be performed immediately after any seismic event, significant spillway flow (once per year), parapet overtopping or significant increased seepage area or flow.]

A dam safety analysis should be completed and repair recommendations and designs developed by an experienced dam engineering firm. Involvement in the surveys, design, and construction process by Afghan counterpart staff is desirable from an institution-building standpoint. Necessary tasks would include:

- Developing basic dam and spillway as-built drawings by survey and direct measurements.
- Core drilling with minimum double- (preferably triple-) tube core barrel and 75 mm diameter core, to investigate the characteristics and condition of the dam masonry material, cemented joints, foundation contact and foundation rock.
- Evaluation of reservoir water chemistry to determine whether acidic water may be accelerating cement joint deterioration.
- Determination of a design flood hydrograph.
- Evaluation of the spillway adequacy from hydrologic and hydraulic standpoints.
- Analyzing the stability of the appropriate dam section(s) under a variety of loading conditions, including earthquake and extreme flood events. This would have to be conducted along several sections and horizontal planes, since different parts of the dam section will have different stability characteristics (horizontal cracking is obvious, so the dam will not act as a single uniform monolith). The parapet wall at the top of the dam will probably not be stable under flood and/or earthquake loads.
- Preparing a remediation plan and designs to control the seepage and correct any deficiencies in spillway capacity and dam stability.
- Establishing a long term monitoring and inspection plan.
- Providing field services during construction to maintain quality control and to address unexpected conditions as they arise during the work.

Action Items

All action items will be undertaken by the Louis Berger Group. They are expected to include:

- Contacting the company that rehabilitated the outlet valves to have them assess the leakage around the stems.
- Comparing any documented pre-rehabilitation seepage surveys and observations to the current seepage observations to determine the efficacy of the 2003-04 rehabilitation work.
- Setting up a monitoring program and a warning system for downstream villagers.
- Working with USAID to define the scope for a dam safety and rehabilitation engineering contract, and proceed with consultant selection.

Dennis H. McCandless
USAID Contractor
Senior Hydroelectric Engineer

cc: Peter Jezek, Philip Durgin, USAID
Michael McGovern, Louis Berger Group
Enclosures: Digital photographs of the dam, jpg format

<u>FIGURES AND TABLES</u>

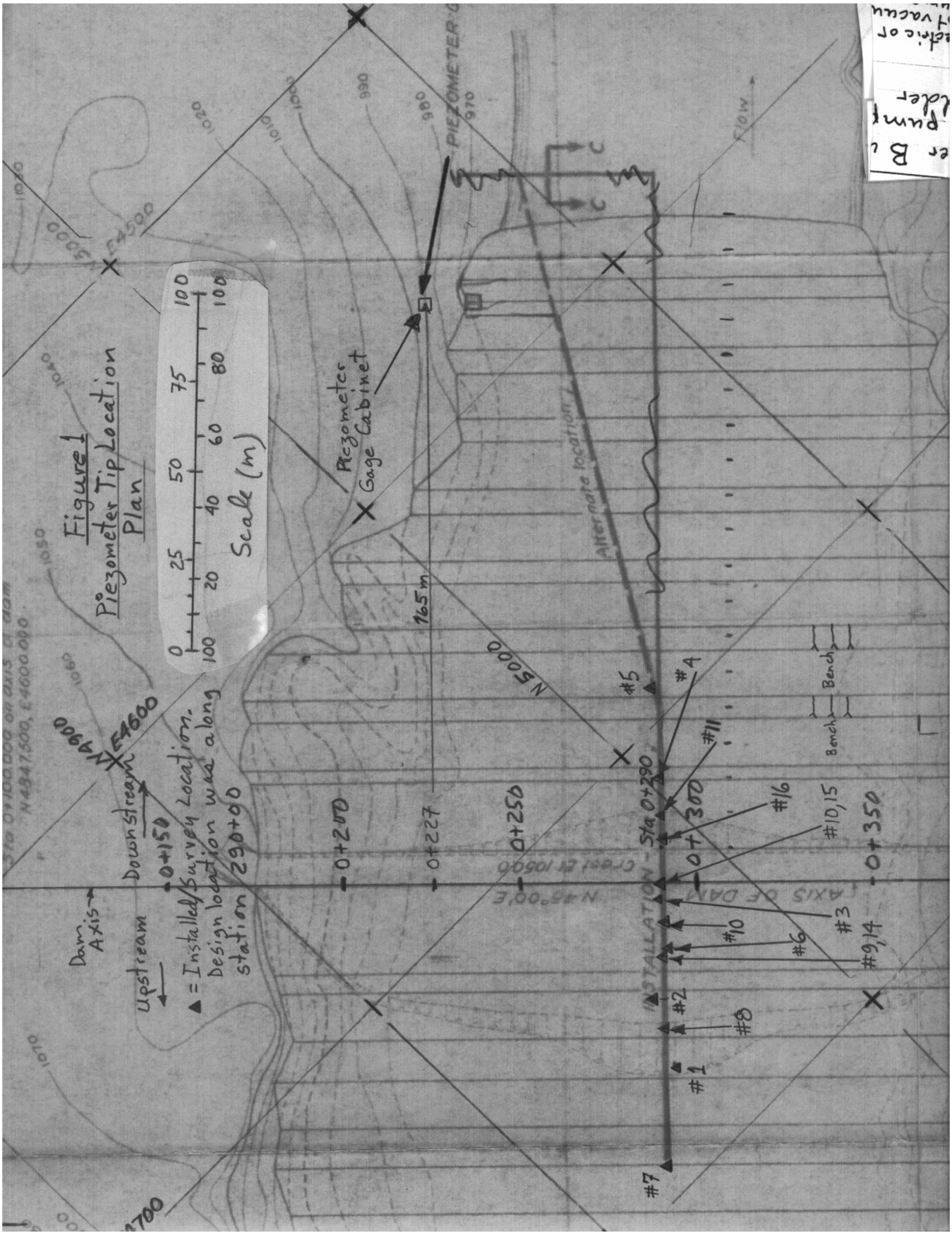


Figure 1
Piezometer Tip Location
Plan

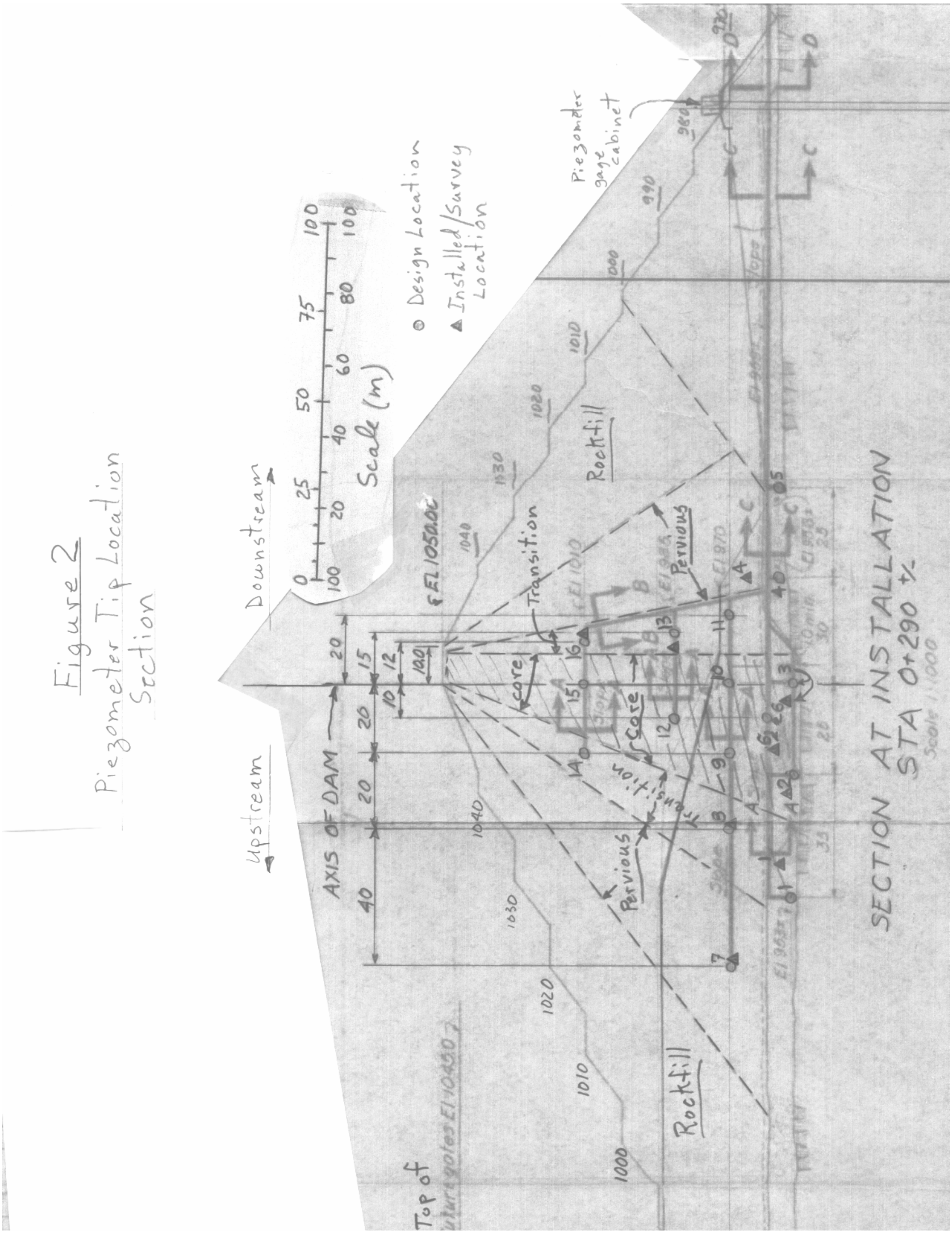


Figure 2
Piezometer Tip Location
Section

Table A

KAJAKAI DAM

LOCATION OF PIEZOMETER TIPS

yes, as corrected RAJ 5/9/2005

checked RAJ 5/9/2005

Tip No.	Type Mat'l.	Location	(m) Station	(m) Offset	(m) Elevation		(feet) Tip Constant Head, Ft.	M.	Volume of Water to Fill One Tube Meas. in 4" Pipe
1	F	u/s	291.5	50.9 Rt.	957.54		+ 51.9	15.82	24 in.
2f	C	core	288.0	31.0 Rt.	953.94		+ 63.7	19.41	20
3f	C	core	289.2	4.0 Rt.	953.66	(1)	+ 64.6	19.69	18
4f	F	d/s	290.0	30.0 Lt.	955.70	965.4	+ 58.0	17.67	16
5f	F	d/s	288.0	55.0 Lt.	956.71		+ 54.6	16.47	13
6	I	core	290.8	18.3 Rt.	957.70		+ 51.4	15.67	19
7	P	u/s	290.0	79.0 Rt.	969.20		+ 13.6	4.14	26
8	T	u/s	"	40.0 Rt.	969.50		+ 12.6	3.84	23
9	I	core	"	20.0 Rt.	969.85		+ 10.3	3.14	21
10	I	core	"	0	970.00		+ 9.8	2.98	19
11	T	d/s	"	20.0 Lt.	969.84		+ 10.0	3.05	19
12	I	core	"	10.0 Rt.	984.72		- 38.5	11.73	21
13	T	d/s	"	10.0 Lt.	984.57		- 38.0	11.58	20
14	T	u/s	"	20.0 Rt.	1010.05		- 121.6	37.06	24
15	I	core	"	0	1009.56		- 120.0	36.57	23
16	T	d/s	"	14.0 Lt.	1010.02		- 121.5	37.03	22

PIEZOMETER GAUGES

				EL. (m)
227 m	165 m Lt.	~~973.56~~	Average elevation of gauges 1 - 8	973.6
		~~972.98~~	" " " " 9 - 16	973.2

RAJ 5/9/2005

Tips are embankment type except those marked f, which are foundation type

Type Material: **F, foundation (river gravels); I, impervious; T, transition; P, pervious; C, connecting pipe landed on concrete that caps joint at bottom of core trench, for measuring seepage (pressure) along contact.**

(1) pe Construction Report w/e 12/14/51, see page 3c of scanned report

Piez Table A

Location of Piezometer Tips

Table B - Piezometer Tubing Circuit Flushing Volumes							
Piez #	Tip el.	offset dist (m)	dist. To plan Alternate location(m)	Alt. location distance (m)	total length (m)	double tube volume in liters	Minimum Flushing Volume in liters
1	**957.5**	15.5	116	150	281.5	10.0	**12**
2	**953.94**	9.5	81	150	240.5	8.6	**10.5**
3	**953.66**	1.2	56	150	207.2	7.4	**9**
4	**955.7**	9.1	25	150	184.1	6.6	**8**
5	**956.71**	16.8	2	150	168.8	6.0	**7**
6	**957.7**	5.6	66	150	221.6	7.9	**9.5**
7	**969.2**	24	144	150	318	11.3	**14**
8	**969.5**	12.2	104	150	266.2	9.5	**11.5**
9	**969.85**	6.1	84	150	240.1	8.6	**10.5**
10	**970**	0	79	150	229	8.2	**10**
11	**969.84**	6.1	45	150	201.1	7.2	**9**
12	**984.72**	3	87	150	240	8.5	**10.5**
13	**984.57**	3	63	150	216	7.7	**9.5**
14	**1010.05**	6.1	118	150	274.1	9.8	**12**
15	**1009.56**	0	98	150	248	8.8	**10.5**
16	**1010.02**	4.3	87	150	241.3	8.6	**10.5**

	gage #s	gage el.
Inlet	1 to 8	974.1
Inlet	9 to 16	973.65
Outlet	1 to 8	973.25
Outlet	9 to 16	972.85

1) max current reservoir el. = 1039 m, Max future reservoir el. = 1048 m
2) spring runoff max tailwater to 972 m & probably higher with updated PMF and future raised reservoir
3) all tubing 5/16" OD x 1/16 " wall Saran - radius = 3/32" = 0.1875" = 0.2381cm

Piez Table C - Selected Piezometer Data - February 26, 1953

Kajakai Dam

Reservoir Level **989.8**

Tailwater Level **963 (a)**

Tip No.	Tip El.	Type	tip position relative to: tubing	gages	core	material zone	Tip No.	Tip El.	gage (ft H_2O) inlet	outlet	Piezometric Level[1] (m) inlet	outlet	avg.	Piez tip constant[3] (m) inlet	outlet	avg.	Expected Level [2]	Actual Reading Comment
1	957.5	foundation			u/s	alluvium	**1**	957.5	52	52	989.9	989.1	989.5	16.5	15.7	16.1	reservoir level	same as reservoir
2	954.0						**2**	953.9	37	37	988.8	988.1	988.5	20.0	19.3	19.7	slightly < or > reserevoir & trailing	
3	953.7	embankment			core	core	**3**	953.7	7	7	979.9	979.1	979.5	20.3	19.5	19.9	< piez 2	
4	955.7						**4**	955.7	2	2	976.4	975.6	976.0	18.3	17.5	17.9	close to Tailwater	> tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	0	0	974.8	974.0	974.4	17.3	16.5	16.9	tailwater or nearly so	> tailwater
6	957.7				core	core	**6**	957.7	4	10	975.0	976.0	975.5	16.3	15.5	15.9	< piez 2, > piez 3	
7	969.2					free draining	**7**	969.2	52	56	978.2	978.6	978.4	4.8	4.0	4.4	reservoir level	< reservoir, lagging
8	969.5				u/s	transition	**8**	969.5	31	40	971.5	973.4	972.4	4.5	3.7	4.1	same as or trailing reservoir level	
9	969.9						**9**	969.9	0	0	961.2	960.4	960.8	3.7	2.9	3.3	slightly < resrevoir & trailing	
10	970.0				core	core	**10**	970.0	0	0	961.1	960.3	960.7	3.6	2.8	3.2	< piez 9	
11	969.8		below	below	d/s	transition	**11**	969.8	0	0	961.3	960.5	960.9	3.8	3.0	3.4	< core, higher than tailwater	
12	984.7				core	core	**12**	984.7	30	15	955.5	950.2	952.9	-11.1	-11.9	-11.5	slightly < resrevoir & trailing	
13	984.6				d/s		**13**	984.6	0	5	946.5	947.2	946.9	-11.0	-11.8	-11.4	< core, higher than tailwater	< lowest tailwater
14	1010.1				u/s	transition	**14**	1010.1	17	30	926.2	929.3	927.8	-36.5	-37.3	-36.9	same as or trailing reservoir	< lowest reservoir
15	1009.6				core	core	**15**	1009.6	17	30	926.7	929.8	928.3	-36.0	-36.8	-36.4	< and trailing reservoir	
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	22	12	927.8	924.0	925.9	-36.4	-37.2	-36.8	< core, higher than tailwater	
							Date		**26-Feb-53**									

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - June 11, 1953

		Kajakai Dam					11-Jun-53		Reservoir Leve		1031.5							
								Tailwater Level			963.5							
			tip position relative to						gage (ft H_2O)		Piezometric Level[1] (m)			Piez tip constant[3] (m)				
Tip No.	Tip El.	Type	tubing	gages	core	material zone	Tip No.	Tip El.	inlet	outlet	inlet	outlet	avg.	inlet	outlet	avg.	Expected Level [2]	Actual Reading Comment
1	957.5	foundation			u/s	alluvium	1	957.5	195	200	1033.5	1034.2	1033.8	16.5	15.7	16.1	reservoir level	reads higher than highest reservoir to date
2	954.0						2	953.9	150	155	1023.2	1024.1	1023.7	20.0	19.3	19.7	slightly < or > reserevoir & trailing	
3	953.7	embankment			core	core	3	953.7	62	62	996.7	995.9	996.3	20.3	19.5	19.9	< piez 2	
4	955.7						4	955.7	-12	-12	972.1	971.3	971.7	18.3	17.5	17.9	close to Tailwater	reads higher than highest tailwater
5	956.7	foundation			d/s	alluvium	5	956.7	-5	-20	973.3	967.9	970.6	17.3	16.5	16.9	tailwater or nearly so	reads higher than highest tailwater
6	957.7				core	core	6	957.7	97	105	1003.4	1005.0	1004.2	16.3	15.5	15.9	< piez 2, > piez 3	
7	969.2					free draining	7	969.2	180	177	1017.2	1015.5	1016.3	4.8	4.0	4.4	reservoir level	sign. Lag of reservoir
8	969.5				u/s	transition	8	969.5	170	175	1013.8	1014.6	1014.2	4.5	3.7	4.1	same as or trailing reservoir level	
9	969.9						9	969.9	115	124	996.3	998.2	997.2	3.7	2.9	3.3	slightly < resrevoir & trailing	
10	970.0				core	core	10	970.0	15	20	965.7	966.4	966.0	3.6	2.8	3.2	< piez 9	
11	969.8		below	below	d/s	transition	11	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater	
12	984.7				core	core	12	984.7	17	30	951.6	954.7	953.2	-11.1	-11.9	-11.5	slightly < resrevoir & trailing	
13	984.6				d/s		13	984.6	10	40	949.5	957.9	953.7	-11.0	-11.8	-11.4	< core, higher than tailwater	
14	1010.1				u/s	transition	14	1010.1	52	105	936.9	952.2	944.5	-36.5	-37.3	-36.9	same as or trailing reservoir	
15	1009.6				core	core	15	1009.6	57	25	938.9	928.3	933.6	-36.0	-36.8	-36.4	< and trailing reservoir	
16	1010.0	embankment	above	above	d/s	transition	16	1010.0	25	120	928.7	956.9	942.8	-36.4	-37.2	-36.8	< core, higher than tailwater	

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

Piez Table C - Selected Piezometer Data - July 16, 1953																		
		Kajakai Dam				**16-Jul-53**		**Reservoir Level**			**1027.4**							
								Tailwater Level			**963.5**							
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**				
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**	**Actual Reading Comment**
1	957.5	foundation			u/s	alluvium	**1**	957.5	182	185	1029.5	1029.6	1029.5	16.5	15.7	16.1	reservoir level	lagging reservoir drop
2	954.0						**2**	953.9	142	147	1020.8	1021.6	1021.3	20.0	19.3	19.7	slightly < or > reserevoir & trailing	
3	953.7	embankment			core	core	**3**	953.7	62	62	996.7	995.9	996.3	20.3	19.5	19.9	< piez 2	
4	955.7						**4**	955.7	-22	-12	969.1	971.3	970.2	18.3	17.5	17.9	close to Tailwater	reads higher than highest tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-2	-15	974.2	969.4	971.8	17.3	16.5	16.9	tailwater or nearly so	reads higher than highest tailwater
6	957.7				core	core	**6**	957.7	94	105	1002.5	1005.0	1003.7	16.3	15.5	15.9	< piez 2, > piez 3	
7	969.2					free draining	**7**	969.2	170	165	1014.1	1011.8	1013.0	4.8	4.0	4.4	reservoir level	< reservoir
8	969.5				u/s	transition	**8**	969.5	163	167	1011.7	1012.1	1011.9	4.5	3.7	4.1	same as or trailing reservoir level	
9	969.9						**9**	969.9	115	115	996.3	995.5	995.9	3.7	2.9	3.3	slightly < resrevoir & trailing	
10	970.0				core	core	**10**	970.0	25	30	968.7	969.4	969.1	3.6	2.8	3.2	< piez 9	
11	969.8		below	below	d/s	transition	**11**	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater	< tailwater
12	984.7				core	core	**12**	984.7	57	45	963.8	959.3	961.5	-11.1	-11.9	-11.5	slightly < resrevoir & trailing	
13	984.6				d/s		**13**	984.6	45	25	960.2	953.3	956.8	-11.0	-11.8	-11.4	< core, higher than tailwater	< tailwater
14	1010.1				u/s	transition	**14**	1010.1	77	105	944.5	952.2	948.3	-36.5	-37.3	-36.9	same as or trailing reservoir	< lowest reservoir
15	1009.6				core	core	**15**	1009.6	57	77	938.9	944.2	941.5	-36.0	-36.8	-36.4	< and trailing reservoir	
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	15	120	925.7	956.9	941.3	-36.4	-37.2	-36.8	< core, higher than tailwater	< tailwater

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(pink) will not hold pressure, line leaks

Piez Table C - Selected Piezometer Data - Decermber 17, 1953																		
		Kajakai Dam						**Reservoir Level**			**1004.5**							
								Tailwater Level			**963.8**							
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**				
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**	**Actual Reading Comment**
1	957.5	foundation			u/s	alluvium	**1**	957.5	105	110	1006.0	1006.7	1006.4	16.5	15.7	16.1	reservoir level	> reservoir
2	954.0						**2**	953.9	87	92	1004.0	1004.8	1004.5	20.0	19.3	19.7	slightly < or > reserevoir & trailing	
3	953.7	embankment			core	core	**3**	953.7	40	40	990.0	989.2	989.6	20.3	19.5	19.9	< piez 2	
4	955.7						**4**	955.7	-22	-12	969.1	971.3	970.2	18.3	17.5	17.9	close to Tailwater	> tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	0	-15	974.8	969.4	972.1	17.3	16.5	16.9	tailwater or nearly so	> tailwater
6	957.7				core	core	**6**	957.7	55	63	990.6	992.2	991.4	16.3	15.5	15.9	< piez 2, > piez 3	
7	969.2					free draining	**7**	969.2	100	105	992.8	993.5	993.2	4.8	4.0	4.4	reservoir level	< reservoir, should be > to lag
8	969.5				u/s	transition	**8**	969.5	98	102	991.9	992.3	992.1	4.5	3.7	4.1	same as or trailing reservoir level	
9	969.9						**9**	969.9	58	77	978.9	983.9	981.4	3.7	2.9	3.3	slightly < resrevoir & trailing	
10	970.0				core	core	**10**	970.0	33	35	971.2	971.0	971.1	3.6	2.8	3.2	< piez 9	
11	969.8		below	below	d/s	transition	**11**	969.8	2	-10	961.9	957.5	959.7	3.8	3.0	3.4	< core, higher than tailwater	
12	984.7				core	core	**12**	984.7	62	60	965.3	963.9	964.6	-11.1	-11.9	-11.5	slightly < resrevoir & trailing	
13	984.6				d/s		**13**	984.6	30	10	955.6	948.7	952.2	-11.0	-11.8	-11.4	< core, higher than tailwater	< lowest tailwater
14	1010.1				u/s	transition	**14**	1010.1	50	92	936.2	948.2	942.2	-36.5	-37.3	-36.9	same as or trailing reservoir	< lowest reservoir
15	1009.6				core	core	**15**	1009.6	67	60	941.9	939.0	940.5	-36.0	-36.8	-36.4	< and trailing reservoir	
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	25	112	928.7	954.4	941.6	-36.4	-37.2	-36.8	< core, higher than tailwater	
							Date			**17-Dec-53**								

[1] individual and average readings for comparison of widely variable readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	March 6, 1954 - Before Flushing							**Reservoir Level**			**1007.0 (a)**						
		Kajakai Dam						**Tailwater Level**			**963.5 (a)**						
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	114	118	1008.8	1009.2	1009.0	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	93	98	1005.9	1006.7	1006.3	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	43	43	990.9	990.1	990.5	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-22	-12	969.1	971.3	970.2	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	0	-17	974.8	968.8	971.8	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	60	68	992.1	993.7	992.9	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	111	115	996.1	996.6	996.4	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	105	109	994.0	994.4	994.2	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	80	76	985.6	983.6	984.6	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	32	35	970.9	971.0	970.9	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	3	-10	962.2	957.5	959.8	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	58	35	964.1	956.3	960.2	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	28	23	955.0	952.7	953.9	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	42	52	933.8	936.1	934.9	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	65	50	941.3	935.9	938.6	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	25	110	928.7	953.8	941.3	-36.4	-37.2	-36.8	< core, higher than tailwater

[1] individual and average readings for comparison of widely variable readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) approximated

	March 6, 1954 - After Flushing							**Reservoir Level**			**1007.0 (a)**						
		Kajakai Dam						**Tailwater Level**			**963.5 (a)**						
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	115	118	1009.1	1009.2	1009.1	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	93	98	1005.9	1006.7	1006.3	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	38	42	989.4	989.8	989.6	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-23	-23	968.8	968.0	968.4	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	24	14	982.1	978.3	980.2	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	59	66	991.8	993.1	992.5	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	113	116	996.8	996.9	996.8	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	101	99	992.8	991.4	992.1	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	80	76	985.6	983.6	984.6	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	33	35	971.2	970.0	971.1	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	2	-9	961.9	957.8	959.8	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	58	34	964.1	956.0	960.0	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	28	22	955.0	952.4	953.7	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	43	52	934.1	936.1	935.1	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	62	50	940.4	935.9	938.2	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	25	110	928.7	953.8	941.3	-36.4	-37.2	-36.8	< core, higher than tailwater

[1] individual and average readings for comparison of widely variable readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) approximated

Piez Table C - Selected Piezometer Data - May 7, 1954

		Kajakai Dam						**Reservoir Level**			**1035.7**						
								Tailwater Level			**>967 (a)**						
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	210	215	1038.0	1038.7	1038.4	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	167	173	1028.4	1029.5	1029.0	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	76	82	1001.0	1002.0	1001.5	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-15	-15	971.2	970.4	970.8	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-2	-20	974.2	967.9	971.0	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	114	122	1008.6	1010.2	1009.4	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	207	216	1025.4	1027.4	1026.4	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	190	190	1019.9	1019.1	1019.5	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	142	137	1004.5	1002.2	1003.3	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	40	44	973.3	973.7	973.5	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	-2	-10	960.7	957.5	959.1	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	50	31	961.6	955.1	958.3	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	37	58	957.8	963.4	960.6	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	48	40	935.6	932.4	934.0	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	105	85	953.5	946.6	950.1	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	35	120	931.8	956.9	944.3	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date			**7-May-54**							

[1] individual and average readings for comparison of widely variable readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

Piez Table C - Selected Piezometer Data - September 16, 1954

		Kajakai Dam						**Reservoir Level**			**1027.3**						
								Tailwater Level			**963.5 (a)**						
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	184	189	1030.1	1030.8	1030.5	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	150	154	1023.2	1023.8	1023.5	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	65	70	997.6	998.3	998.0	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-20	-20	969.7	968.9	969.3	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-5	-24	973.3	966.7	970.0	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	100	110	1004.3	1006.5	1005.4	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	179	189	1016.9	1019.1	1018.0	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	170	170	1013.8	1013.0	1013.4	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	130	125	1000.8	998.5	999.7	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	55	55	977.9	977.1	977.5	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	-5	-10	959.8	957.5	958.6	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	80	60	970.8	963.9	967.3	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	51	20	962.0	951.8	956.9	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	65	90	940.8	947.6	944.2	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	105	75	953.5	943.6	948.5	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	50	120	936.3	956.9	946.6	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date			**16-Sep-54**							

(1) individual and average readings for comparison of widely varaible readings

(2) for normal reservoir fluctuations (no drawdown scenario)

(3) adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - March 9, 1955

		Kajakai Dam				**9-Mar-55**		**Reservoir Level**			**1008.3**						
							Tailwater Level				**963.5 (a)**						
Tip No.	**Tip El.**	**Type**	**tip position relative to tubing**	**tip position relative to gages**	**tip position relative to core**	**material zone**	**Tip No.**	**Tip El.**	**gage ($ft\ H_2O$) inlet**	**gage ($ft\ H_2O$) outlet**	**Piezometric Level[1] (m) inlet**	**Piezometric Level[1] (m) outlet**	**Piezometric Level[1] (m) avg.**	**Piez tip constant[3] (m) inlet**	**Piez tip constant[3] (m) outlet**	**Piez tip constant[3] (m) avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	128	130	1013.0	1012.8	1012.9	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	103	110	1008.9	1010.3	1009.7	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	50	50	993.0	992.2	992.6	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-19	-17	970.0	969.8	969.9	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	0	-20	974.8	967.9	971.4	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	72	80	995.8	997.4	996.6	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	125		1000.4			4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	120	118	998.6	997.2	997.9	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	95	90	990.2	987.8	989.0	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	46	50	975.1	975.5	975.3	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	-2	-9	960.7	957.8	959.2	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	107	69	979.0	966.6	972.8	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	46	15	960.5	950.3	955.4	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	63	80	940.2	944.6	942.4	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	118	80	957.5	945.1	951.3	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	44	130	934.5	959.9	947.2	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date			**9-Mar-55**							

[1] individual and average readings for comparison of widely variable readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - July 14, 1955

Kajakai Dam

Reservoir Level **1034.1**

Tailwater Level **963.5 (a)**

Tip No.	Tip El.	Type	tip position relative to tubing	gages	core	material zone	Tip No.	Tip El.	gage (ft H_2O) inlet	outlet	Piezometric Level[1] (m) inlet	outlet	avg.	Piez tip constant[3] (m) inlet	outlet	avg.	Expected Level [2]
1	957.5	foundation			u/s	alluvium	**1**	957.5	209	213	1037.7	1038.1	1037.9	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	165	173	1027.8	1029.5	1028.7	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	77	81	1001.3	1001.7	1001.5	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-18	-20	970.3	968.9	969.6	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	2	-13	975.4	970.0	972.7	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	117	125	1009.5	1011.1	1010.3	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	201	212	1023.6	1026.1	1024.9	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	190	190	1019.9	1019.1	1019.5	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	146	140	1005.7	1003.1	1004.4	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	58	62	978.8	979.2	979.0	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	-2	-9	960.7	957.8	959.2	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	91	85	974.1	971.5	972.8	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	56	26	963.6	953.6	958.6	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	66	105	941.1	952.2	946.7	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	148	165	966.6	971.0	968.8	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	52	148	937.0	965.4	951.2	-36.4	-37.2	-36.8	< core, higher than tailwater

7/14/1955 Date

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - August 11, 1955

		Kajakai Dam					**Reservoir Level**			**1031.5**							
							Tailwater Level			**963.5 (a)**							
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	200	205	1035.0	1035.7	1035.3	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	160	166	1026.3	1027.4	1026.9	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	75	76	1000.7	1000.2	1000.4	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-20	-21	969.7	968.6	969.2	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-1	-17	974.5	968.8	971.7	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	119	120	1010.1	1009.6	1009.8	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	195	205	1021.8	1024.0	1022.9	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	184	184	1018.1	1017.3	1017.7	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	144	136	1005.1	1001.9	1003.5	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	60	65	979.4	980.1	979.8	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	-2	-10	960.7	957.5	959.1	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	95	86	975.4	971.8	973.6	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	57	26	963.9	953.6	958.8	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	68	113	941.7	954.7	948.2	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	152	148	967.8	965.8	966.8	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	55	149	937.9	965.7	951.8	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date			**11-Aug-55**							

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - August 2, 1956

Kajakai Dam — **Reservoir Level** 1034.1 — **Tailwater Level** 963.5 (a)

Tip No.	Tip El.	Type	tip position relative to: tubing	gages	core	material zone	Tip No.	Tip El.	gage (ft H_2O): inlet	outlet	Piezometric Level[1] (m): inlet	outlet	avg.	Piez tip constant[3] (m): inlet	outlet	avg.	Expected Level [2]
1	957.5	foundation			u/s	alluvium	**1**	957.5	210	213	1038.0	1038.1	1038.1	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	165	169	1027.8	1028.3	1028.1	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	73	80	1000.1	1001.4	1000.7	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-18	-20	970.3	968.9	969.6	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-3	-18	973.9	968.5	971.2	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	116	122	1009.2	1010.2	1009.7	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	200	205	1023.3	1024.0	1023.6	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	190	191	1019.9	1019.4	1019.7	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	165	140	1011.5	1003.1	1007.3	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	62	66	980.0	980.4	980.2	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	101	98	977.2	975.5	976.3	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	60	25	964.8	953.3	959.1	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	73	150	943.3	965.9	954.6	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	125	150	959.6	966.4	963.0	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	61	152	939.7	966.6	953.2	-36.4	-37.2	-36.8	< core, higher than tailwater

Date **2-Aug-56**

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - May 9, 1957

Kajakai Dam

Reservoir Level **1036.9**

Tailwater Level **963.5 (a)**

Tip No.	Tip El.	Type	tip position relative to: tubing	gages	core	material zone	Tip No.	Tip El.	gage ($ft\ H_2O$): inlet	outlet	Piezometric Level[1] (m): inlet	outlet	avg.	Piez tip constant[3] (m): inlet	outlet	avg.	Expected Level [2]
1	957.5	foundation			u/s	alluvium	**1**	957.5	217	222	1040.2	1040.9	1040.5	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	168	176	1028.7	1030.5	1029.6	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	70	75	999.1	999.9	999.5	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-12	-15	972.1	970.4	971.3	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-5	-20	973.3	967.9	970.6	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	115	126	1008.9	1011.4	1010.1	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	205	210	1024.8	1025.5	1025.2	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	195	197	1021.5	1021.3	1021.4	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	145	136	1005.4	1001.9	1003.6	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	56	55	978.2	977.1	977.6	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	94	70	975.1	966.9	971.0	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	51	25	962.0	953.3	957.7	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	67	146	941.4	964.7	953.1	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	117	155	957.2	968.0	962.6	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	49	152	936.0	966.6	951.3	-36.4	-37.2	-36.8	< core, higher than tailwater

Date **9-May-57**

(1) individual and average readings for comparison of widely varaible readings

(2) for normal reservoir fluctuations (no drawdown scenario)

(3) adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - July 11, 1957

Reservoir Level **1033.8**

Tailwater Level **963.5 (a)**

Tip No.	Tip El.	Type	tip position relative to: tubing	gages	core	material zone	Tip No.	Tip El.	gage (ft H_2O): inlet	outlet	Piezometric Level[1] (m): inlet	outlet	avg.	Piez tip constant[3] (m): inlet	outlet	avg.	Expected Level [2]
1	957.5	foundation			u/s	alluvium	**1**	957.5	209	214	1037.7	1038.4	1038.1	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	163	170	1027.2	1028.6	1028.0	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	70	72	999.1	999.0	999.0	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-16	-20	970.9	968.9	969.9	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-4	-19	973.6	968.2	970.9	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	119	125	1010.1	1011.1	1010.6	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	198	207	1022.7	1024.6	1023.6	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	191	192	1020.2	1019.7	1020.0	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	145	140	1005.4	1003.1	1004.2	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	62	66	980.0	980.4	980.2	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-9	961.3	957.8	959.5	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	100	77	976.9	969.1	973.0	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	60	26	964.8	953.6	959.2	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	76	152	944.2	966.5	955.4	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	126	163	959.9	970.4	965.2	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	60	157	939.4	968.2	953.8	-36.4	-37.2	-36.8	< core, higher than tailwater

Date **11-Jul-57**

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) approximation

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - February 27, 1958

		Kajakai Dam						**Reservoir Level**		**1020.3**							
								Tailwater Level		**963.5 (a)**							
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	163	168	1023.7	1024.4	1024.1	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	127	136	1016.2	1018.3	1017.3	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	55	55	994.6	993.8	994.2	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-20	-20	969.7	968.9	969.3	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-5	-20	973.3	967.9	970.6	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	99	102	1004.0	1004.1	1004.0	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	155	161	1009.6	1010.6	1010.1	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	150	149	1007.7	1006.6	1007.2	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	118	110	997.2	993.9	995.6	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	55	60	977.9	978.6	978.2	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-9	961.3	957.8	959.5	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	97	75	976.0	968.5	972.2	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	54	20	963.0	951.8	957.4	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	70	150	942.3	965.9	954.1	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	123	159	959.0	969.2	964.1	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	55	158	937.9	968.5	953.2	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date		**27-Feb-58**								

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - May 1, 1958

Kajakai Dam — **Reservoir Level** 1035.2 — **Tailwater Level** 963.5 (a)

Tip No.	Tip El.	Type	tip position relative to: tubing	gages	core	material zone	Tip No.	Tip El.	gage (ft H_2O): inlet	outlet	Piezometric Level[1] (m): inlet	outlet	avg.	Piez tip constant[3] (m): inlet	outlet	avg.	Expected Level [2]
1	957.5	foundation			u/s	alluvium	**1**	957.5	210	217	1038.0	1039.4	1038.7	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	164	171	1027.5	1028.9	1028.3	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	75	80	1000.7	1001.4	1001.0	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-18	-17	970.3	969.8	970.1	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-5	-17	973.3	968.8	971.0	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	116	123	1009.2	1010.5	1009.8	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	206	208	1025.1	1024.9	1025.0	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	190	191	1019.9	1019.4	1019.7	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	147	175	1006.0	1013.8	1009.9	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	56	60	978.2	978.6	978.4	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	-1	-9	961.0	957.8	959.4	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	101	87	977.2	972.1	974.7	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	55	26	963.3	953.6	958.4	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	68	153	941.7	966.8	954.3	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	121	60	958.4	939.0	948.7	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	60	160	939.4	969.1	954.2	-36.4	-37.2	-36.8	< core, higher than tailwater

Date **1-May-58**

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - June 26, 1958

		Kajakai Dam						**Reservoir Level**			**1032.8**						
								Tailwater Level			**963.5 (a)**						
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	204	208	1036.2	1036.6	1036.4	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	155	169	1024.8	1028.3	1026.6	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	63	64	997.0	996.5	996.8	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	-20	-20	969.7	968.9	969.3	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-5	-20	973.3	967.9	970.6	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	107	118	1006.4	1009.0	1007.7	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	193	199	1021.1	1022.2	1021.7	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	184	182	1018.1	1016.7	1017.4	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	130	174	1000.8	1013.4	1007.1	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	55	59	977.9	978.3	978.1	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	99	75	976.6	968.5	972.5	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	54	21	963.0	952.1	957.5	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	68	151	941.7	966.2	954.0	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	121	159	958.4	969.2	963.8	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	60	159	939.4	968.8	954.1	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date			**26-Jun-58**							

(1) individual and average readings for comparison of widely varaible readings

(2) for normal reservoir fluctuations (no drawdown scenario)

(3) adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - January 23, 1959

		Kajakai Dam						**Reservoir Level**		**1002.8**							
								Tailwater Level		**963.5 (a)**							
			tip position relative to						**gage (ft H_2O)**		**Piezometric Level[1] (m)**			**Piez tip constant[3] (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	110	110	1007.5	1006.7	1007.1	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	83	89	1002.8	1003.9	1003.4	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	39	35	989.7	987.7	988.7	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	5	-20	977.3	968.9	973.1	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-5	-20	973.3	967.9	970.6	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	74	75	996.4	995.9	996.1	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	100	104	992.8	993.2	993.0	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	105	105	994.0	993.2	993.6	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	87	81	987.7	985.1	986.4	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	45	49	974.8	975.2	975.0	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	93	70	974.8	966.9	970.8	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	48	10	961.1	948.7	954.9	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	66	165	941.1	970.5	955.8	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	117	150	957.2	966.4	961.8	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	110	168	954.6	971.5	963.1	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date			**23-Jan-59**							

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

	el.
inlet gages 1-8	974.0
inlet gages 9-16	973.6
outlet gages 1-8	973.2
outlet gages 9-16	972.8
avg. in/out 1-8	973.6
avg. in/out 9-16	973.2

Piez Table C - Selected Piezometer Data - April 24, 1959

		Kajakai Dam						**Reservoir Level**			**1035.2**						
								Tailwater Level			**963.5 (a)**						
			tip position relative to						**gage reading**		**Piezometric Level (1) (m)**			**Piez tip constant (3) (m)**			
Tip No.	**Tip El.**	**Type**	**tubing**	**gage**	**core**	**material zone**	**Tip No.**	**Tip El.**	**inlet**	**outlet**	**inlet**	**outlet**	**avg.**	**inlet**	**outlet**	**avg.**	**Expected Level (2)**
1	957.5	foundation			u/s	alluvium	**1**	957.5	214	215	1039.2	1038.7	1039.0	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	162	170	1026.9	1028.6	1027.8	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	64	66	997.3	997.1	997.2	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	7	-20	977.9	968.9	973.4	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-5	-20	973.3	967.9	970.6	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	110	118	1007.3	1009.0	1008.2	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	203	201	1024.2	1022.8	1023.5	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	184	191	1018.1	1019.4	1018.8	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	128	125	1000.2	998.5	999.4	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	50	53	976.3	976.5	976.4	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	90	76	973.8	968.8	971.3	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	47	19	960.8	951.5	956.2	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	91	146	948.7	964.7	956.7	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	117	133	957.2	961.2	959.2	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	108	168	954.0	971.5	962.8	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date			**24-Apr-59**							

(1) individual and average readings for comparison of widely variable readings

(2) for normal reservoir fluctuations (no drawdown scenario)

(3) adjustment due to gage location above (-) or (+) below tip

(a) assumed

Piez Table C - Selected Piezometer Data - June 26, 1959

Tip No.	Tip El.	Type	tip position relative to: tubing	gages	core	material zone	Tip No.	Tip El.	gage (ft H_2O) inlet	outlet	Piezometric Level[1] (m) inlet	outlet	avg.	Piez tip constant[3] (m) inlet	outlet	avg.	Expected Level [2]
		Kajakai Dam						**Reservoir Level**			**1032.1**						
								Tailwater Level			**963.5 (a)**						
1	957.5	foundation			u/s	alluvium	**1**	957.5	204	209	1036.2	1036.9	1036.6	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	155	165	1024.8	1027.1	1026.0	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	66	65	997.9	996.8	997.4	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	5	-20	977.3	968.9	973.1	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-5	-21	973.3	967.6	970.4	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	115	124	1008.9	1010.8	1009.8	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	188	195	1019.6	1021.0	1020.3	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	190	190	1019.9	1019.1	1019.5	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	143	137	1004.8	1002.2	1003.5	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	55	57	977.9	977.7	977.8	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	93	70	974.8	966.9	970.8	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	50	25	961.7	953.3	957.5	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	85	143	946.9	963.8	955.4	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	119	123	957.8	958.2	958.0	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	111	164	954.9	970.3	962.6	-36.4	-37.2	-36.8	< core, higher than tailwater
							Date		**26-Jun-59**								

[1] individual and average readings for comparison of widely variable readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

Piez Table C - Selected Piezometer Data - February 12, 1960

Kajakai Dam

Reservoir Leve **999.8**

Tailwater Level **963.5 (a)**

Tip No.	**Tip El.**	**Type**	**tip position relative: tubing**	**gages**	**core**	**material zone**	**Tip No.**	**Tip El.**	**gage (ft H_2O): inlet**	**outlet**	**Piezometric Level[1] (m): inlet**	**outlet**	**avg.**	**Piez tip constant (m): inlet**	**outlet**	**avg.**	**Expected Level [2]**
1	957.5	foundation			u/s	alluvium	**1**	957.5	99	100	1004.2	1003.7	1003.9	16.5	15.7	16.1	reservoir level
2	954.0						**2**	953.9	75	80	1000.4	1001.2	1000.8	20.0	19.3	19.7	slightly < or > reserevoir & trailing
3	953.7	embankment			core	core	**3**	953.7	36	31	988.8	986.5	987.6	20.3	19.5	19.9	< piez 2
4	955.7						**4**	955.7	5	-20	977.3	968.9	973.1	18.3	17.5	17.9	close to Tailwater
5	956.7	foundation			d/s	alluvium	**5**	956.7	-6	-23	973.0	967.0	970.0	17.3	16.5	16.9	tailwater or nearly so
6	957.7				core	core	**6**	957.7	67	66	994.2	993.1	993.7	16.3	15.5	15.9	< piez 2, > piez 3
7	969.2					free draining	**7**	969.2	90	91	989.7	989.2	989.5	4.8	4.0	4.4	reservoir level
8	969.5				u/s	transition	**8**	969.5	96	95	991.3	990.2	990.7	4.5	3.7	4.1	same as or trailing reservoir level
9	969.9						**9**	969.9	82	76	986.2	983.6	984.9	3.7	2.9	3.3	slightly < resrevoir & trailing
10	970.0				core	core	**10**	970.0	41	45	973.6	974.0	973.8	3.6	2.8	3.2	< piez 9
11	969.8		below	below	d/s	transition	**11**	969.8	0	-10	961.3	957.5	959.4	3.8	3.0	3.4	< core, higher than tailwater
12	984.7				core	core	**12**	984.7	92	67	974.4	966.0	970.2	-11.1	-11.9	-11.5	slightly < resrevoir & trailing
13	984.6				d/s		**13**	984.6	45	10	960.2	948.7	954.5	-11.0	-11.8	-11.4	< core, higher than tailwater
14	1010.1				u/s	transition	**14**	1010.1	66	127	941.1	958.9	950.0	-36.5	-37.3	-36.9	same as or trailing reservoir
15	1009.6				core	core	**15**	1009.6	113	123	956.0	958.2	957.1	-36.0	-36.8	-36.4	< and trailing reservoir
16	1010.0	embankment	above	above	d/s	transition	**16**	1010.0	105	155	953.1	967.6	960.3	-36.4	-37.2	-36.8	< core, higher than tailwater

Date **12-Feb-60**

[1] individual and average readings for comparison of widely varaible readings

[2] for normal reservoir fluctuations (no drawdown scenario)

[3] adjustment due to gage location above (-) or (+) below tip

(a) assumed

year	Month	Date	Reservoir Water Level (m)	Tailwater Level (m)	Comments/Notes
1953	February	2/26/1953	989.8	963	done
	March	3/5/1953	992.3	963	
		3/14/1953	1002.3	963.1	
		3/19/1953	1004.3	963.1	
		3/26/1953	1009.8	963.2	
	April	4/4/1953	1013.8	963.2	
		4/9/1953	1016.0	963.3	
		4/16/1953	1020.6	963.3	
		4/23/1953	1023.6	963.3	
		4/30/1953	1026.0	963.3	
	May	5/7/1953	1028.1	963.5	
		5/14/1953	1029.5	963.6	
		5/21/1953	1030.1	963.5	
		5/28/1953	1030.6	963.5	
	June	6/4/1953	1031.3	963.5	
		6/11/1953	1031.5	963.5	done
		6/18/1953	1031.1	963.5	
		6/25/1953	1030.4	963.5	
	July	7/2/1953	1029.5	963.5	
		7/9/1953	1028.7	963.5	#16 installed, I drop/second coming out of inlet si
		7/16/1953	1027.4	963.5	done
		7/23/1953	1025.9	963.5	
		7/30/1953	1024.3	963.4	
	August	8/6/1953	1022.6	963.8	
		8/13/1953	1020.8	963.8	
		8/20/1953	1019.0	963.8	
		8/27/1953	1017.2	963.8	
	September	9/3/1953	1015.3	963.8	
		9/10/1953	1013.3	963.8	
		9/17/1953	1011.8	963.8	
		9/24/1953	1010.8	964	
	October	10/1/1953	1010.6	964	
		10/8/1953	1009.7	964	
		10/15/1953	1008.8	964	
		10/22/1953	1008.0	964	
		10/29/1953	1007.2	964	
	November	11/5/1953	1006.6	961.2	
		11/12/1953	1006.6	961.2	
		11/19/1953	1006.4	963.8	
		11/26/1953	1005.7	963.8	
	December	12/3/1953	1005.3	963.8	
		12/10/1953	1005.3	963.8	
		12/17/1953	1004.5	963.8	done
		12/26/1953	1005.5	961.2	

max seasonal level
minimum seasonal level
piezometer evaluation

year	Month	Date	Reservoir Water Level (m)	Tailwater Level (m)	Comments/Notes
1954	January	1/7/1954	1008.2	963.8	
		1/21/1954	1008.9	963.8	
	February	2/4/1954	1006.7	963.6	
		2/15/1954			not done Piezometers flushed
		2/11/1954	1005.7	963.6	
		2/18/1954	1007.1	963.6	
		2/25/1954	1007.2	963.6	
	March	3/14/1954	same as 2/25/1954	same as 2/25/1954	[illegible] reading, air indicated), March 14 (three sets of readings), March 15 (day after flushing)
	May	5/7/1954	1035.7	967	Done
		5/23/1954	1034.7		
	June	6/12/1954	1034		
		6/29/1954	1032.7		
	July	9/9/1954	1028		
		9/16/1954	1027.3		done
		9/23/1954	1026.6		
		9/30/1954	1026.2		
	October	10/7/1954	1025.8		
		10/14/1954	1025.4		
		10/21/1954	1025.1		
		10/26/1954	1024.8		
	November	11/3/1954			
		11/10/1954	1024.6		
		11/17/1954	1024.4		
		11/24/1954	1024		
	December	12/1/1954			
		12/8/1954			
		12/15/1954			
		12/29/1954			
		12/22/1954			

year	Month	Date	Reservoir Water Level (m)	Tailwater Level (m)	Comments/Notes
1955	January	1/5/1955	1020.4		
		1/12/1955	1019		
		1/19/1955	1017.7		
		1/26/1955	1016.4		
	February	2/2/1955	1015.1		
		2/2/1955	1013.8		
		2/16/1955	1012.4		
		2/23/1955	1010.9		
	March	3/2/1955	1009.5		
		3/9/1955	1008.3		done
		3/16/1955	1013.1		
		3/23/1955	1017		
		3/31/1955	1019.3		
	April	4/2/1955	1021.5		
		4/14/1955	1023.9		
		4/21/1955	1025.1		
		4/28/1955	1026.3		
	May	5/5/1955	1028.3		
		5/12/1955	1031.5		
		5/19/1955	1032.8		
		5/26/1955	1033.8		
	June	6/2/1955			
		6/9/1955			
		6/16/1955			
		6/23/1955			
		6/30/1955			
	July	7/7/1955			
		7/14/1955	1034.1		done
		7/21/1955			
		7/28/1955			
	August	8/4/1955			
		8/11/1955	1031.5		done
		8/18/1955			
		8/25/1955			

year	Month	Date	Reservoir Water Level (m)	Tailwater Level (m)	Comments/Notes
1956	May	5/3/1956	1035.7		
		5/10/1956			
		5/17/1956	1034.7		
		5/24/1956	1034.3		
		5/31/1956	1034		
	June	6/7/1956	1034.3		
		6/14/1956	1034.3		
		6/21/1956	1034.2		
		6/28/1956	1034.2		
	July	7/5/1956	1034.2		
		7/12/1956	1034.1		
		7/19/1956	1034.5		
		7/26/1956	1034.7		
	August	8/2/1956	1034.1		done
		8/9/1956	1033.1		
		8/16/1956	1031.8		
		8/23/1956	1030.4		
		8/30/1956	1029		
	September	9/6/1956			
		9/13/1956			
		9/20/1956			
		9/27/1956			
	October	10/3/1956	1023.4		
		10/10/1956	1022		
		10/17/1956	1021.9		
		10/24/1956	1022.6		
		10/31/1956	1022.8		
	November	11/7/1956	1022.4		
		11/14/1956	1021.9		
		11/21/1956	1021.4		
		11/28/1956	1020.8		
	December	12/6/1956	1020.1		
		12/13/1956			
		12/20/1956			
		12/27/1956	1018.3		

year	Month	Date	Reservoir Water Level (m)	Tailwater Level (m)	Comments/Notes
1957	January	1/3/1957	1017.4		
		1/10/1956	1016.4		
		1/17/1957	1015.5		
		1/24/1957	1014.2		
		1/31/1957	1014.5		
	February	2/7/1957			
		2/14/1957	1012.8		
		2/21/1957	1012.1		not done
		2/28/1957			
	March	3/7/1957			
		3/14/1957			
		3/21/1957	1023.6		
		3/28/1957			
	April	4/4/1957	1032.5		
		4/11/1957	1036.1		
		4/18/1957	1036.7		
		4/25/1957	1036.6		
	May	5/2/1957	1036.7		
		5/9/1957	1036.9		done
		5/16/1957	1036.5		
		5/23/1957	1036.1		
		5/30/1957	1035.7		
	June	6/6/1957	1035.5		
		6/13/1957	1035.1		
		6/20/1957	1034.7		
		6/27/1957	1034.3		
	July	7/4/1957	1034		
		7/11/1957	1033.8		done
		7/18/1957	1033.5		
		7/25/1956			
	August	8/1/1957	1032.5		
		8/8/1957	1031.7		
		8/16/1957	1031.4		
		8/23/1957	1031.3		
		8/29/1957	1030.4		
	September	9/5/1957			
		9/12/1957			
		9/19/1957			
		9/26/1957			
	October	10/3/1957			
		10/10/1957			
		10/17/1957			
		10/24/1957			
		10/31/1957			
	November	11/7/1957			
		11/14/1957	1021.1		
		10/21/1957	1022.1		
		11/28/1957	1022.8		
	December	12/5/1957			
		12/12/1957	1024.1		
		12/19/1957			
		12/26/1957	1023.2		

year	Month	Date	Reservoir Water Level (m)	Tailwater Level (m)	Comments/Notes
1958	January	1/2/1958	1022.6		
		1/9/1958	1021.8		
		1/16/1958	1021.4		
		1/23/1958	1021		
		1/30/1958	1020.6		
	February	2/6/1958	1020.8		
		2/13/1958	1020.9		
		2/20/1958	1020.5		
		2/27/1958	1020.3		done
	March	3/6/1958	1020.3		
		3/13/1958	1021.2		
		3/20/1958	1022.8		
		3/26/1958	1025.3		
	April	4/3/1958	1028.4		
		4/10/1958	1031.8		
		4/17/1958	1034.3		
		4/24/1958	1035.2		
	May	5/1/1958	1035.2		done
		5/8/1958	1034.8		
		5/15/1958	1034.4		
		5/27/1958	1034.2		
		5/29/1958	1034.1		
	June	6/5/1958	1033.8		
		6/12/1958	1033.6		
		6/19/1958	1033.3		
		6/26/1958	1032.8		done
	September	9/24/1958	1015.8		
	November	11/7/1958			
		11/14/1958			
		11/21/1958			
		11/28/1958			
	December	12/5/1958			
		12/12/1958	1004		
		12/19/1958			
		12/26/1958			

year	Month	Date	Reservoir Water Level (m)	Tailwater Level (m)	Comments/Notes
1959	January	1/2/1959	1004.2		
		1/9/1959	1004		
		1/16/1959	1003.4		
		1/23/1959	1002.8		done
		1/30/1959	1003.4		
	February	2/6/1959			
		2/13/1959			
		2/20/1959			
		2/27/1959			
	March	3/6/1959	1008.7		
		3/13/1959	1014.1		
		3/20/1959	1017.9		
		3/27/1959	1023.2		
	April	4/3/1959	1027.1		
		4/10/1959	1030.6		
		4/17/1959	1034.4		
		4/24/1959	1035.2		done
	May	5/1/1959	1034.8		
		5/8/1959	1034.6		
		5/15/1959	1034.3		
		5/22/1959	1034.4		
		5/29/1959	1034.1		
	June	6/5/1959	1033.9		
		6/12/1959	1033.6		
		6/19/1959	1033		
		6/26/1959	1032.1		done
	July	7/3/1959	1031.1		
		7/10/1959	1029.9		
		7/17/1959	1028.7		
		7/24/1959	1027.4		
		7/31/1959	1025.9		
	August	8/14/1959	1022.7		
		8/21/1959	1021		
		8/28/1959	1019.2		
	September	9/11/1959	1015.9		
		9/18/1959	1014.2		
		9/25/1959	1012.8		
	October	10/2/1959	1011.9		
		10/9/1959			
		10/16/1959	1010.3		
		10/24/1959			
		10/30/1959	1008.8		
	November	11/6/1959	1008.3		
		11/13/1959	1008.1		
		11/20/1959	1008		
		11/26/1959	1008		
	December	12/4/1959	1008.4		
		12/11/1959	1008.3		
		12/18/1959	1006.8		
		12/25/1959	1005.2		

year	Month	Date	Reservoir Water Level (m)	Tailwater Level (m)	Comments/Notes
1960	January	1/1/1960	1003.9		
		1/8/1960	1001.7		
		1/15/1960	1001.6		
		1/22/1960	1001.4		
		1/29/1960	1000.6		
	February	2/5/1960	1000.1		
		2/12/1960	999.8		done
		2/19/1960	1000.3		
		2/26/1960	1001		
	March	3/4/1960	1001.5		
		3/11/1960	1003.1		
		3/18/1960	1004.3		
		3/25/1960	1007.2		
	April	4/1/1960	1009.6		
		4/8/1960	1012.5		
		4/15/1960	1016.2		
		4/22/1960	1022.4		
		4/27/1960	1022.4		
		4/29/1960	1026.9		
	November	11/18/1960	1022.8		

Kajakai Dam, Afghanistan
Hydraulic Piezometer Rehabilitation
Mar 2006
Piez Table D - De-airing Details

		De-airing pressures (mH2O)		Volumes (l)		Reading after (mH2O)			Reading 23/3/06 mH2O		Reading 24/3/06 mH2O		Reading 25/3/06 mH2O	
Piezo No.	Date	Send Line	Return Line	Sent	Returned	Left	Right	Comments	Left	Right	Left	Right	Left	Right
1	19-Mar	60	-2	11	10.8			Initially reading 18.0 then dropping to zero	9.5	9.8				
2	19-Mar	60	-2	9.5	9.5	32	32	OK	31.6	31.4				
3	19-Mar	40	-2	5.5	2.4	0	0	Negative Pressure?	0.0	0.0				
3	20-Mar	60	-4	3	2	0	0	OK	-	-				
4	20-Mar	60	-4	7.2	5.5	0	0	Negative Pressure?	0.0	0.0				
5	20-Mar	60	-4	8	7.7	0	0	Negative Pressure?	0.0	0.0				
6	20-Mar	60	-4	10	8.2	17	17	OK	15.5	16.5				
7	21-Mar	60	-3	13	3.1	3	16	OK	3.0	15.7				
8	21-Mar	60	-4	11.9	7.4	9	9	OK	10.5	10.7				
9	21-Mar	60	-4	9.3	0.5	0.75	3.75		1.0	3.7				
9	22-Mar	60	-4	2	0.1			Send line very fast. No leak at cabinet. Little return flow	-	-				
10	22-Mar	44	-4	9.2	3.5				3.6	3.7				
11	22-Mar	40	-4	8	5.1				4.3	4.3				
12	22-Mar	64	-4	10.4	0.3	30	0	Slow send. Little return flow	23.3	0.8				
13	22-Mar	60	-3	8.7	0.3	12.5	2	Little return flow	11.5	3.0				
14	22-Mar	60	0	11.4	1	6	12.5	Black air/water return. Then circulated water OK	11.5	11.7				
15	22-Mar	60	0	5	0			Zero reaction on return line. Flow= 2 min/litre	31.6	0.0				
15	22-Mar	0	80	0.5	0	31.8	0	Send water on return line. Upto 80mH2O. Little flow	-	-				
16	23-Mar	76	0	6	0			Zero reaction on return line. Flow= 7 min/litre	0.0	11.5				
16	23-Mar	0	76	5	0	0	11.5	Send water on return line. Flow rate= 1m:40s /litre	-	-				
2	23-Mar	60	-3	2	2			Circulated 2 litres						
2	23-Mar	60	Closed	5	-	3	5	Then closed return to pressurise core. Tube blown. Inaccessible.						
6	23-Mar	60	-4	9	7.5	13.8	15	No return bubbles noticed						
7	23-Mar	60	-3	12.8	4.5	3	15.75	No return bubbles noticed						
8	23-Mar	60	-4	10.5	7.7	11.5	10.5	No return bubbles noticed						
12	24-Mar	50	0	5.5	0.1			1 litre in 4.25 mins. Little return flow						
12	24-Mar	Closed	40	5	-	25.5	16	1 litre in 4.25 mins. Sent on return limb						
13	24-Mar	40	0	7.5	0.1			1 litre in 2.5 mins. Little return flow						
13	24-Mar	Closed	40	4.6	-	18.3	27	1 litre in 5 mins. Sent on return limb						
1	24-Mar	70	-4	11.2	11	27.5	27.5	No return bubbles noticed						
9	24-Mar	50	0	5.5	0.1			1 litre in 25 secs						
9	24-Mar	0	50	5	0	0	3.8	1 litre in 2 mins. No reaction from return line						
10	24-Mar	44	-4	10.2	4.1	4.1	4.1	H2S air / gas returning. Last 1.5 litres water						
11	25-Mar	40	-4	8.2	5.7	9.2	9.2	A few bubbles at 5.5 litres sent. Pressure drops to 4.5mH2O in 7hrs						
3	25-Mar	30	-5	8.6	6.1	0	0	Some bubbles at 1.3 litres sent						
4	25-Mar	30	-5	3.2	1.5			1 hour circulating. 1 litre in 18.8 min. No bubbles						
4	25-Mar	50	-5	4.6	1.8	0	0	1 litre in 11.7 min. No bubbles						
5	25-Mar	50	-5	8.4	8.3	0	0	No bubbles						
1	25-Mar	70	-4	12.5	11.3	28	28	No bubbles						
1	26-Mar	60	-4	11.2	11	25.5	26	No bubbles						

Kajakai Dam, Afghanistan

Piez Table E1 - Deairing Results

March - April, 2006

		Initial Flushing							Subsequent Flushing and Readings													
Piezo No.		De-airing pressures mH2O		Volume H2O (l)		Reading mH2O			Reading 23/3/06 mH2O		After Reflush 23/03/06		Reading 24/03/06		After Reflush 24/03/06		Reading 25/03/06		After Reflush 25/03/06		Rea 26/0
	Date	Send	Return	Send	Return	In	Out	Comments	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In
1	19-Mar	60	-2	11	10.8			Initially reading 18.0 then dropping to zero	9.5	9.8			7.4	7.3	28.0	27.5	22.3	22.3			24.8
2	19-Mar	60	-2	9.5	9.5	32	32		31.6	31.4	3.0	5.0	5.3	6.8			4.8	6.5			2.9
3	19-Mar	40	-2	5.5	2.4	0	0	Negative Pressure?	0.0	0.0			0	0.0			0	0	?	?	0.0
3	20-Mar	60	-4	3	2	0	0		-	-											
4	20-Mar	60	-4	7.2	5.5	0	0	Negative Pressure?	0.0	0.0			0	0.0			-ve	-ve	?	?	-ve
5	20-Mar	60	-4	8	7.7	0	0	Negative Pressure?	0.0	0.0			0	0.0			--ve	--ve	?	?	--ve
6	20-Mar	60	-4	10	8.2	17	17		15.5	16.5	13.8	15.0	13.2	14.8			14.6	15.9			12.9
7	21-Mar	60	-3	13	3.1	3	16		3.0	15.7	3.0	15.8	3.1	15.8			3.2	15.8			1.6
8	21-Mar	60	-4	11.9	7.4	9	9		10.5	10.7	11.5	10.5	21.1	11.4			12.0	11.4			10.5
9	21-Mar	60	-4	9.3	0.5	0.75	3.75		1.0	3.7			1.15	3.8	34.5	34.5	1.8	4.2			-ve
9	22-Mar	60	-4	2	0.1			Send line very fast. No leak at cabinet. Little return flow	-	-											
10	22-Mar	44	-4	9.2	3.5				3.6	3.7			3.8	3.8	4.1	4.1	4.0	4.0			2.3
11	22-Mar	40	-4	8	5.1				4.3	4.3			4.6	4.3			4.4	4.4	9.2	9.2	3.0
12	22-Mar	64	-4	10.4	0.3	30	0	Slow send. Little return flow	23.3	0.8			23.4	0.8	25.5	16.0	23.8	12.1			21.4
13	22-Mar	60	-3	8.7	0.3	12.5	2	Little return flow	11.5	3.0			11.6	2.9	18.3	27.0	12.1	24.0			12.4
14	22-Mar	60	0	11.4	1	6	12.5	Black air/water return/Then circulated water OK	11.5	11.7			11.6	11.7			12.1	12.6			12.0
15	22-Mar	60	0	5	0			Zero reaction on return line. Flow= 2 min/litre	31.6	0.0			31.4	0.0			23	--ve			23.0
15	22-Mar	0	80	0.5	0	31.75	0	Send water on return line/To 80mH2O/Little flow	-	-											
16	23-Mar	76	0	6	0			Zero reaction on return line. Flow= 7 min/litre	0.0	11.5			0	11.6			-ve	11.9			-ve
16	23-Mar	0	76	5	0	0	11.5	Send water on return line/Flow rate= 1m:40s /litre	-	-											

Kajakai Dam, Afghanistan

Piez Table E2 - Deairing Results

March - April, 2006

Piezo No.		Initial Flushing: De-airing pressures mH2O		Volume H2O (l)		Reading mH2O			Subsequent Flushing and Readings: Reading 30/3/06 mH2O		Reading 2/4 mH2O		After Reflush 2/4		Reading 3/4 (neg press gage installed)		flushed 3/4, no readings	
	Date	Send	Return	Send	Return	In	Out	Comments	In	Out	In	Out	In	Out	In	Out		
1	19-Mar	60	-2	11	10.8			Initially reading 18.0 then dropping to zero	15.0	15.0	16.0	15.9			16.2	16.2		
2	19-Mar	60	-2	9.5	9.5	32	32		2.8	4.5	2.8	4.5			2.8	4.5		
3	19-Mar	40	-2	5.5	2.4	0	0	Negative Pressure?	0.0	0.0	0.0	0.0			0.4	0.4		
3	20-Mar	60	-4	3	2	0	0		-	-	-	-			-	-		
4	20-Mar	60	-4	7.2	5.5	0	0	Negative Pressure?	vac	vac	vac	vac			-5.6	-6.1		
5	20-Mar	60	-4	8	7.7	0	0	Negative Pressure?	vac	vac	vac	vac			-7	-7		
6	20-Mar	60	-4	10	8.2	17	17		11.2	12.9	11.0	12.5	22.5	22.5	22.4	22.7		
7	21-Mar	60	-3	13	3.1	3	16		1.5	14.2	1.5	14.3			1.7	14.2		
8	21-Mar	60	-4	11.9	7.4	9	9		10.0	9.5	9.9	9.5	14.0	13.3	13.4	12.3		
9	21-Mar	60	-4	9.3	0.5	0.75	3.75		vac	2.3	vac	2.3			-3.1	2.2		
9	22-Mar	60	-4	2	0.1			Send line very fast. No leak at cabinet. Little return flow	-	-	-	-			-	-		
10	22-Mar	44	-4	9.2	3.5				2.3	2.4	2.4	2.4	no	reading	2.4	2.4		
11	22-Mar	40	-4	8	5.1				3.0	3.0	3.0	3.0			2.9	2.9	X	X
12	22-Mar	64	-4	10.4	0.3	30	0	Slow send. Little return flow	21.5	12.0	21.6	12.0			21.5	12.0		
13	22-Mar	60	-3	8.7	0.3	12.5	2	Little return flow	11.2	22.0	11.0	22.0			11.0	22.0		
14	22-Mar	60	0	11.4	1	6	12.5	Black air/water return/Then circulated water OK	10.7	10.9	10.7	11.0			10.5	10.9	X	X
15	22-Mar	60	0	5	0			Zero reaction on return line. Flow= 2 min/litre	14.3	vac	14.3	vac			14.7	-6.3		
15	22-Mar	0	80	0.5	0	31.75	0	Send water on return line/To 80mH2O/Little flow	-	-	-	-			-	-		
16	23-Mar	76	0	6	0			Zero reaction on return line. Flow= 7 min/litre	vac	10.9	vac	10.6			-4.4	11.2		
16	23-Mar	0	76	5	0	0	11.5	Send water on return line/Flow rate= 1m:40s /litre	-	-	-	-			-	-		

ATTACHMENTS

Piez Attachments (all other attachments on Piez Attachments CD 1)

6. High Pressure De-airing Unit Schematics – 2 pages

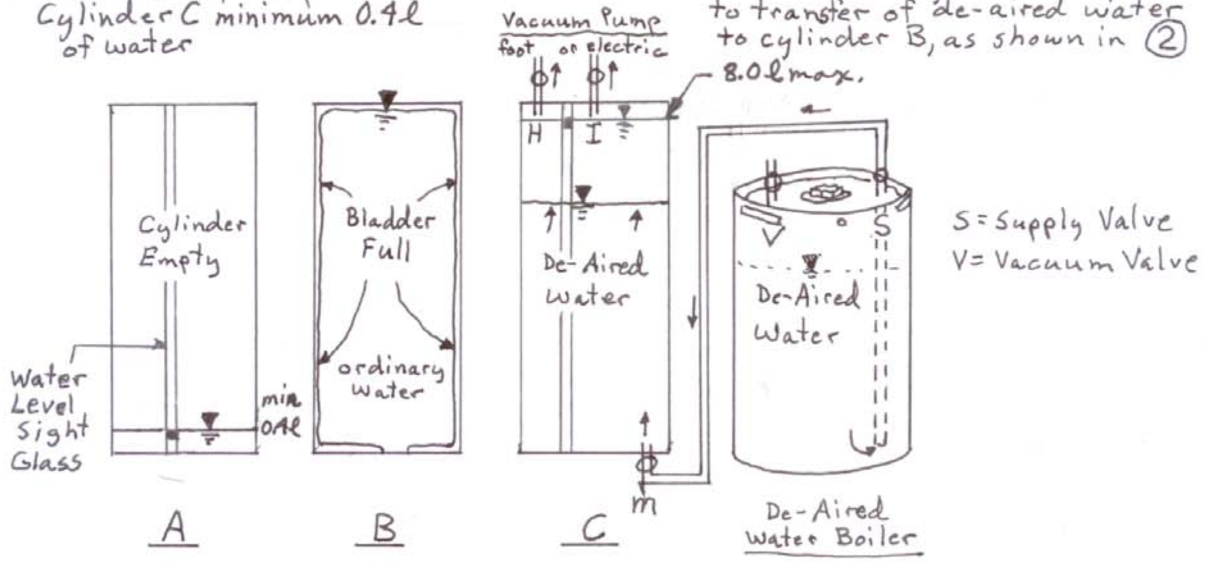
7. High Pressure De-airing Unit Text – 1 page

8. Hydraulic Piezometer Operating Manual Electric Pumps and Manual Pumps

High Pressure De-Airing Unit

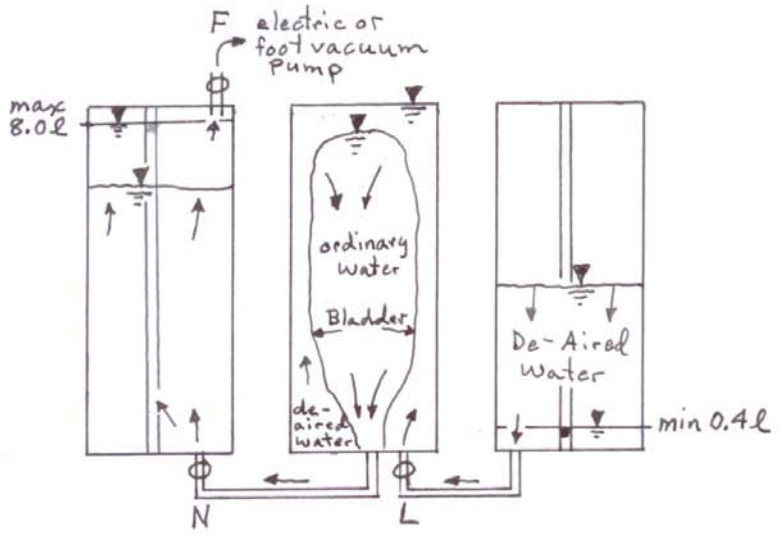
① Fill cylinder C with de-aired water using vacuum pump
Cylinder C minimum 0.4ℓ of water

Do not completely fill cylinder C with de-aired water. Hold a vacuum on the cylinder C prior to transfer of de-aired water to cylinder B, as shown in ②



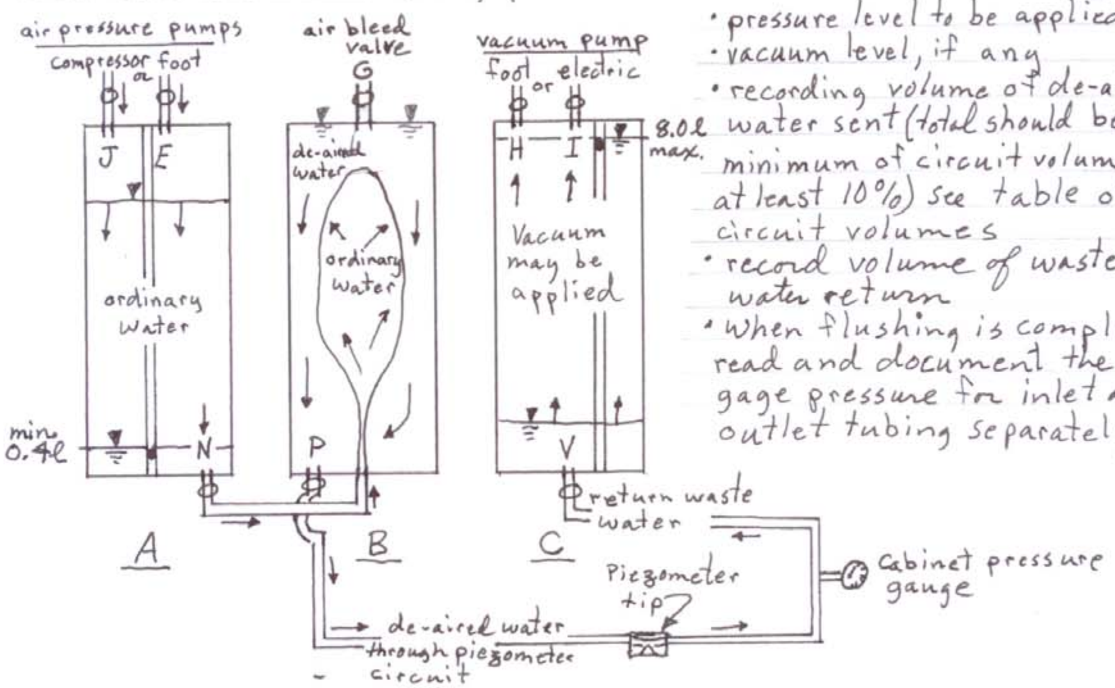
Note: Be carefull to shut off inlet valve M befre de-aired water is drawn into vacuum pump

② Fill cylinder B with de-aired water from cylinder C by using vacuum pump on valve F to pull the ordinary water from the bladder in cylinder B and into cylinder A

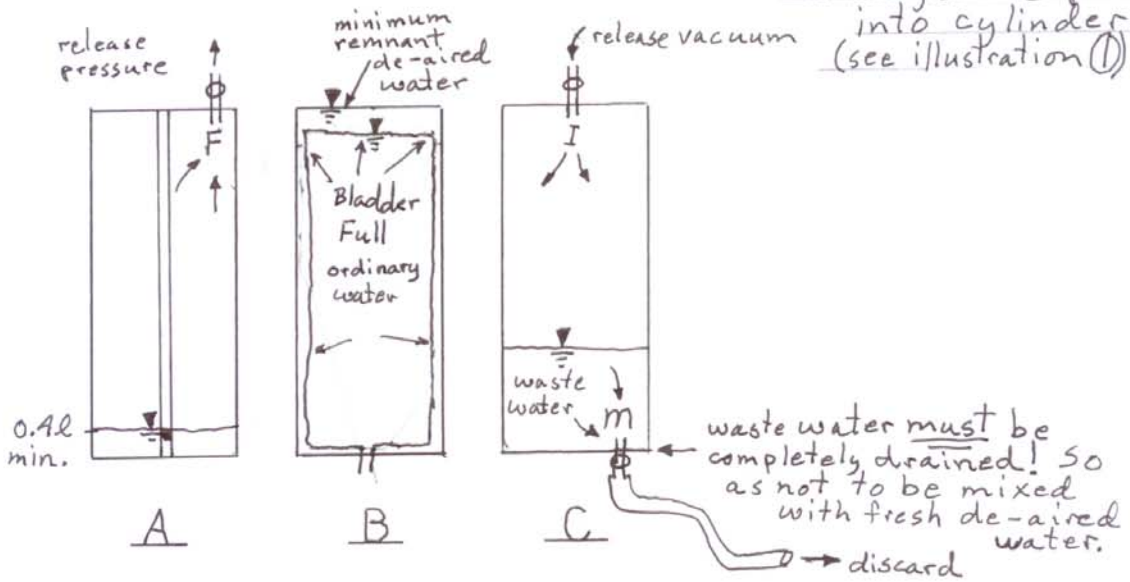


(3) Flushing piezometer circuit with de-aired water by applying air pressure at cylinder A and usually vacuum at cylinder B. Documentation and flushing parameters includes the following:

- pressure level to be applied
- vacuum level, if any
- recording volume of de-aired water sent (total should be minimum of circuit volume + at least 10%) see table of circuit volumes
- record volume of waste water return
- when flushing is complete, read and document the gage pressure for inlet and outlet tubing separately



(4) Drain waste water from cylinder C by releasing vacuum by opening valve I, hooking hose to M and opening valve M. Slowly release pressure from cylinder A by slight opening of valve F. Once waste water is drained, fresh de-aired water can again be pulled into cylinder C (see illustration (1))



Attachment 7 - High Pressure De-Airing Unit – Page 1 of 1

The high pressure de-airing system is utilized to flush each piezometer circuit with freshly de-aired water to remove any air from the piezometer tip or circuit, which has come out of solution and is affecting the transmission of correct pressure readings between the piezometer tip and pressure gage. The flushing is done within a closed circuit under pressure at the injection or inflow end (green tape) and usually a small vacuum at the return end (blue tape). Several intermediate steps are necessary between injection cycles (of about 8 liters) to load de-aired water and later discharge waste return water.

The de-airing unit consists of three cylinders:

Cylinder A is filled with ordinary water which is pressurized to fill the bladder in cylinder B, pressurize and circulate de-aired water and flush each piezometer circuit. Ordinary water is later “pulled back” into cylinder A, to ”recharge” cylinder B with de-aired water for additional “flushing” of piezometer circuits.

Cylinder B is utilized to inject or circulate de-aired water to each piezometer circuit by first “pulling” de-aired water into cylinder B by vacuum transfer of the ordinary water from inside of the bladder in B, to cylinder A and then later circulating de-aired water from B by refilling the bladder under air pressure applied to cylinder A and usually a small vacuum applied to (flushing return water) cylinder C.

Cylinder C is utilized as the point of de—aired water entry to recharge the de-airing unit from the boiler. The water is then transferred to injection or flushing cylinder B. Cylinder C is also the return cylinder for waste water from the flushing and injection of de-aired water into each piezometer circuit. A vacuum may be applied to this cylinder during circulation to encourage the return of the waste water and air.

The following illustrated steps (1-4) describe each of these steps to correctly:

1. & 2. Load or re-charge the de-airing unit with freshly de-aired water from the boiler

3. Flush each piezometer circuit with de-aired water by circulating under pressure and vacuum

4. Disposing of the waste or return water and preparation of the unit for loading or re-charging with de-aired water to continue flushing each piezometer circuit

The flushing of piezometer circuits with freshly de-aired water is necessary to maintain the system free of air bubbles and pockets which are compressible and prevent the transmission of the actual hydraulic pressure between the piezometer tip, within the dam, and the pressure gage in the cabinet. Air bubbles and pockets result from water pressure and temperature changes and the small exchange of dissolved air-rich reservoir water at the piezometer tip. Air in the system results in pressure gage readings which are lower than actual pressures.

Soil Instruments Ltd

HYDRAULIC PIEZOMETER OPERATING MANUAL ELECTRIC PUMPS AND MANUAL PUMPS

Kajakai Dam, Helmand, Afghanistan

Man 104	3	21/03/2006	Rob King-Mason	RKM	RKM
Manual No.	**Revision**	**Date**	**Originator**	**Checked**	**Authorised for Issue**

Contents

General Information

Refer to Drawing No. A3/2074-013.

The de-airing unit consists essentially of pressure, supply and return tanks (A, B and C) and gauges to measure water pressure and vacuum during circulation of de-aired water. All these components are mounted on a frame or panel complete with valves and connecting pipe-work. Pressure and vacuum pumps are used to operate the equipment.
Pressure is applied to the de-aired water in supply tank B by forcing water from the pressure tank A into the inside of a flexible bladder in B. Water from the supply tank may then be circulated through hydraulic piezometer tubes back to the return tank C. The volume changes measured in both the return and pressure tanks A and C indicate the quantity of water circulated through the system. The object is to completely replace the water in the piezometer tubes with freshly de-aired water.
The equipment has been fully tested to the operating pressure and vacuum before despatch. However, it is possible that movements during transit may disturb the cylinders, pipe-work or valves sufficiently to cause small leaks when the equipment is operated. If any leaks are observed during operation they should be eliminated by gently tightening the appropriate component.

Never modify the arrangement without the full written approval of SOIL INSTRUMENTS LTD as unauthorized modifications may bypass the safety system.

It is advisable to drain water from the equipment during cold weather to prevent damage to the cylinders due to freezing.

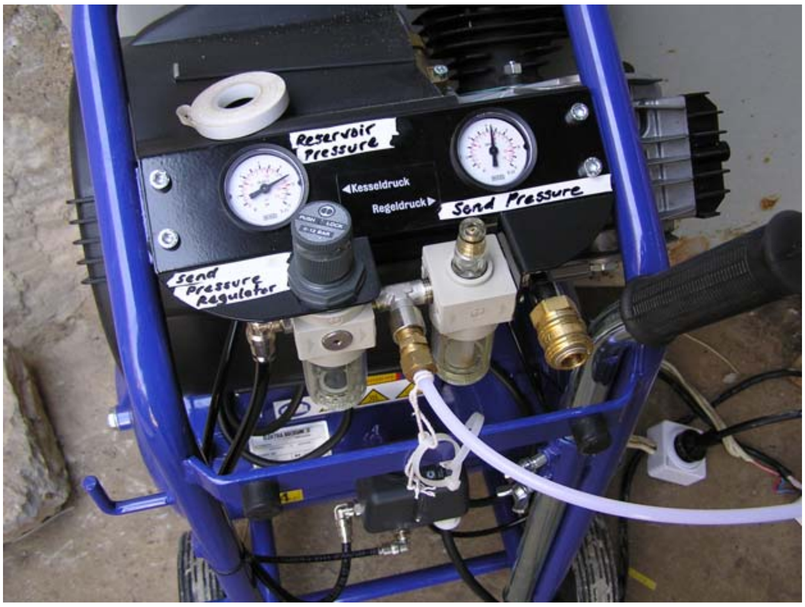
1. Nine litter capacity, triple cylinder De-Airing unit

Positioning Of The Portable De-Airing Unit

The unit should be positioned on level ground and close to the terminal panels. The manifolds on the piezometer terminal panels should be connected to the busbar tee-piece connections on the de-airing panel. Blank-off the other side of the tee-pieces with the stop-end fittings provided.

Place the vacuum pump to the right of the unit, the pressure pump to the left-hand side. The pressure pump (Foot Type) connects to the Schrader fitting on valve K, for standby use in the event of electric power failure.

2. The complete assembly of required components for maintaining, operating and reading the Hydraulic piezometers at Kajakai Dam, Afghanistan.



3. Electric Pressure Pump & reservoir


4. Electric De-aired Water Boiler


5. Electric Vacuum Pump

Preparation, Setting Up and Initial Charging

Note: Items 3.1 to 3.5 have been completed by the Soil Instruments engineer on site during system commissioning and will not be required unless the de-airing system is drained for servicing. The section should be read and understood however, as it forms an essential part of the system understanding.
It is essential to operate the valves in the order stated. Initially all the valves should be closed.
Valve handles not used in every day operation of the de-airing unit, have been removed to render the system less confusing to operate. These can be easily refitted for carrying out the operation described in 3.1 to 3.4 below, or for back flushing of piezometers.

Valves are closed when their operating handles are at 90° to the valve body and open when parallel to the body, as indicated in the photos 6 & 7 below, 6 of the de-airing unit, 7 of the piezometer gauge boards.
Photo 6 also shows the two black pressure regulator rotary knobs, the lower (arrowed) supplying controlled pressure to the 'send' cylinder, the upper to the return cylinder, should a back pressure be required. The knobs are screwed in clockwise to increase supply pressure, which is indicated by the gauge in the photo, showing 58 mH20 of send pressure.
The connection tube to the electric compressor is shown connecting at the T piece between the two rotary regulator knobs.

6. The 2 yellow handle valves are closed

7. Left hand valve is closed, 2 right-hand are Open

3.1 To completely evacuate the bladder and partly fill the pressure tank with clean water.
Attach the vacuum pump with the hose supplied to valve F. Open valves G, F and N and apply vacuum until the bladder is completely evacuated.
Close all valves.
3.2 Immerse one end of a rubber tube into a container of clean water and attach the other end to valve K at the base of the pressure tank A. Open valves K and F and operate the vacuum pump drawing the water into A. When this tank is seven-eighths full close valves K and F. Remove the hose from F, open valve F to release the vacuum, and then close.
The de-airing unit is normally operated with two electric pumps and a boiler, photos 3,4 & 5, all of which require a 220v a/c electric supply (see separate sheet Drg.No. A4/145-000M): Boiler 13 Amp, Compressor 10 Amp and Vacuum pump 1.5 Amp loadings. Vacuum and pressure foot pumps are also supplied, as a standby should electrical power fail.
The electric compressor, photo 3, is connected to the pressure regulators via the tee piece between the regulators with the nylon tube provided, shown in photo 6 above.
The electric vacuum pump, photo 5, is connected to either valves F, G or H as required during operation.
The water boiler, photo 4, is positioned on the floor near tank C.

3.3 Prepare some de-aired water in the de-airing boiler, allowing it to cool at least 18 hours. Connect valve S on the boiler to valve M on tank C using a length of rubber hose. Attach the vacuum pump to valve H, open valves H and M and release the vacuum from the boiler by opening valve V (on the boiler). Open valve S and by operating the vacuum pump draw the de-aired water into tank C until it is three-quarters full. Close valves M and H.

3.4 Remove the vacuum hose and open valve H to release the vacuum. Open valves G and L, attach the vacuum hose to G and draw the de-aired water from C into tank B by operating the vacuum pump until tank C water level is just above the red mark on the level sight tube. Close all valves. To fill B completely it is necessary to repeat the operation but only half-filling C with de-aired water. When tank is almost full close all valves. Remove the vacuum hose from G.

3.5 Attach the air line leading to the de-airing unit, cylinder pressure regulators to the fitting on the compressor, as shown in photo 3 and plug in and switch on the compressor and allow it to build its reservoir pressure until it cuts out automatically. Screw in the compressor's Send pressure regulator until 1 bar shows on the cylinder A (Send) pressure gauge.

Open valve J and slowly screw in the lower regulator to bring the pressure in A to 5-10mH20. Open valve N and slowly open valve G thereby inflating the bladder, displacing the de-aired water in B and forcing out any remaining air. (If the air were to be removed by applying a vacuum at G there is a risk of damaging the pump by drawing water into it).
It is important that cylinder B is completely filled with de-aired water and all air excluded. Release pressure from A by switching off compressor, unscrewing the regulator and slowly opening open valve F. Close all valves.

3.6 Attach the vacuum hose to F, open valves F, N, L and H and by evacuating A, water is drawn from inside the bladder in B to A, and thus drawing de-aired water from C into B. When the bladder is fully deflated the tank A will again be seven-eighths full of water. Close valves F, N, L and H. Remove the vacuum hose from F and release the vacuum in A by opening F. Close all valves.

3.7 Open valves H and M to drain the water from tank C. Close all valves.

The panel is now fully charged with de-aired water and ready for operation.

Operation and Recharging

If the de-airing unit is already charged with de-aired water, then go to paragraph 4.5.
If the unit requires recharging with fresh de-aired water, continue as follows:

4.1 Connect the rubber drain hose to valve M at the base of cylinder C and open it.
If the cylinder contains any returned waste-water, drain it away.
You will need to open cylinder C to atmosphere by opening valve I to allow the water to drain.
Once drained, connect the free end of this hose to valve S of the de-aired water boiler, open valve V slowly to release any vacuum in the boiler and then open valve S.

4.2 Connect the vacuum pump hose to valve I and apply a vacuum, thereby drawing de-aired water into cylinder C.
Stop the flow by closing valve M, when the water level reaches a maximum level at 8000 cc (less if less is required to refill cylinder A), but continue to vacuum cylinder C for 30 seconds to assist further air removal.
Close valve I and leave the water under vacuum for 5 minutes to further de-air.

4.3 Disconnect the vacuum hose from valve I and push it on to valve F. After the 5 minutes wait, slowly release the vacuum in C by opening valve I. Leave open.
Open valve F and valve L at the base of cylinder B and apply a vacuum to cylinder A via valve F.
This will draw the aired water back into cylinder A, creating a vacuum in cylinder B which will then draw the fresh de-aired water into cylinder B from cylinder C.

4.4 Once the water level in cylinder A reaches 8000 cc, the flow will stop as B's internal bladder fully collapses. At the same time, make sure the water level in tank C doesn't drop below the level of the sight glass, as unwanted air would be drawn into cylinder B.
Close valve L and remove the vacuum hose from F, releasing the vacuum in cylinder A.
Close valve F and fit the vacuum hose again to valve I.

4.5 Connect cylinder A air pressurization line to the compressor, as in photo 3. Tie the line’s retaining cord to the compressor body, in case of accidental pressurized line release.
Plug the compressor into electric supply and switch on the compressor. The compressor will start and build up its reservoir pressure to a set amount before automatically cutting out. As compressed air is used, the reservoir pressure will drop. The compressor will again automatically cut in and re-charge the reservoir.

4.6 Screw down the pressure regulator valve on the compressor until the required de-airing Send pressure is achieved, indicated by the compressor’s Send pressure gauge (1Bar=10mH2O).
At the de-airing unit, slowly open valve J on cylinder A and screw in the lower de-airing unit pressure regulator (photo 6) until the required Send pressure is achieved here.
Now apply any required vacuum in cylinder C via valve I, indicated by the de-airing unit’s vacuum gauge.
Mark A and C cylinder sight tubes with colored tape at the ‘start’ water levels, indicated by the red sight-glass floats.
The de-airing unit is ready to circulate water.

4.7 Make sure all valves from the bus bars to each piezometer limb and the Master Gauge panel are closed.
Open the valves connecting the piezometer limbs to be de-aired to the bus bars, making sure the valves connecting through to the piezometer gauge are closed.
Simultaneously, open valves P and V of the de-airing unit to circulate water.
A waste water returns, occasionally boost any required vacuum pressure in cylinder C by running the vacuum pump for 30 seconds.

4.8 Control the water volume sent via cylinder A’s sight-glass. Stop when the level in cylinder A reaches 500 cc.
If the de-airing unit needs to be re-charged with de-aired water to complete circulation of a piezometer circuit, close valves P and V to stop the water flow.
Note the sent and returned water volumes.
Close valve J to stop the compressed air supply and very slowly open F to lose the Send pressure.
At the same time, lose the vacuum in cylinder C and dispose of any waste-water and recharge the de-airing unit as described in 4.1 to 4.4 above.

4.9 Slowly reopen valve J to re-pressurise cylinder A.
Reapply the vacuum to cylinder C.
Reopen valves P and V to continue flushing.

4.10 If the piezometer is fully flushed, close its bus bar valves and again note sent and returned water volumes.
Select another piezometer, adjust the Send pressure via cylinder A’s regulator, mark the ‘start’ water levels on the sight -glasses and open the selected piezometer bus-bar valves.
Continue as 4.7 and 4.8 above.

4.10 If all piezometer de-airing is complete, flush through all bus-bar lines to the Master and Vacuum gauges and the gauge zeroing tube.
Then close all valves, including valve J.
Very slowly, open valve F to evacuate the A cylinder Send pressure
Switch off the compressor and unplug from the electricity.
Unscrew the pressure regulators of the de-airing unit and the compressor until all pressure is relieved from the connecting tubing lines.
Undo the air-line’s brass fitting at the compressor until free and untie the security string from the chassis.

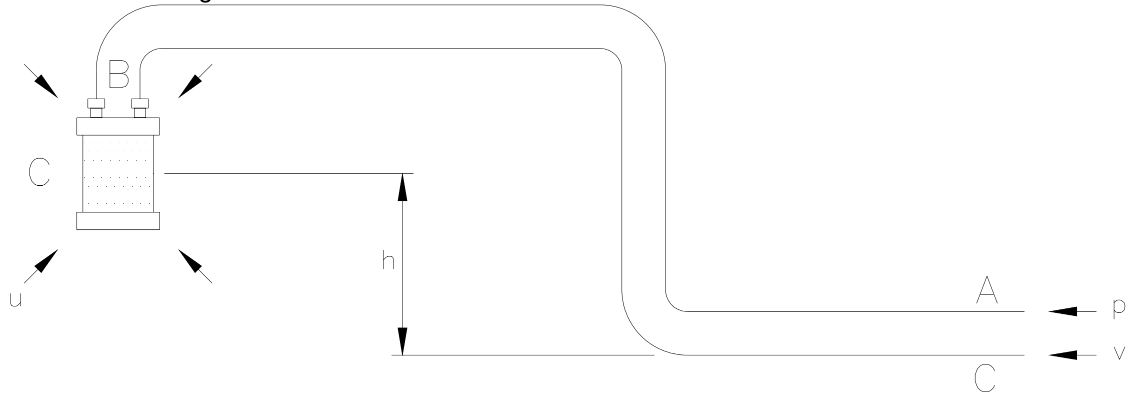
Applying Back Pressure To Return Cylinder C

On some occasions it may be necessary to apply a controlled back-pressure to the return cylinder to maintain equilibrium of pressure at the piezometer tip when circulating de-aired water. This procedure is used to minimize the effect of forcing water into the soil surrounding the piezometer.

To apply the required back pressure to cylinder C close Valves H and R, open valves Q and S. Adjust pressure applied to cylinder C by operating the top regulator until the required back-pressure is obtained.

On completion of the de-airing operation ensure that top regulator is fully unscrewed and valves I and S are closed.

Calculation Of De-Airing Pressures



Consider a piezometer tip in the soil during the de-airing process as follows:

u = pore pressure in the fill at the tip.
p = pressure on the pressure side of the de-airing apparatus.
v = pressure on the vacuum side of the de-airing apparatus.
h = difference in head between the tip and the pressure and vacuum gauges on the de-airing apparatus.

fAB and
fBC = friction losses in the piezometer tube

All pressures are measured with respect to atmospheric pressure.
For Equilibrium:-

$p = h + u = fAB$

$v = h + u - fBD$

Since AB = BC, and if no water flows in or out of the tip the velocity will be the same throughout the system then:-

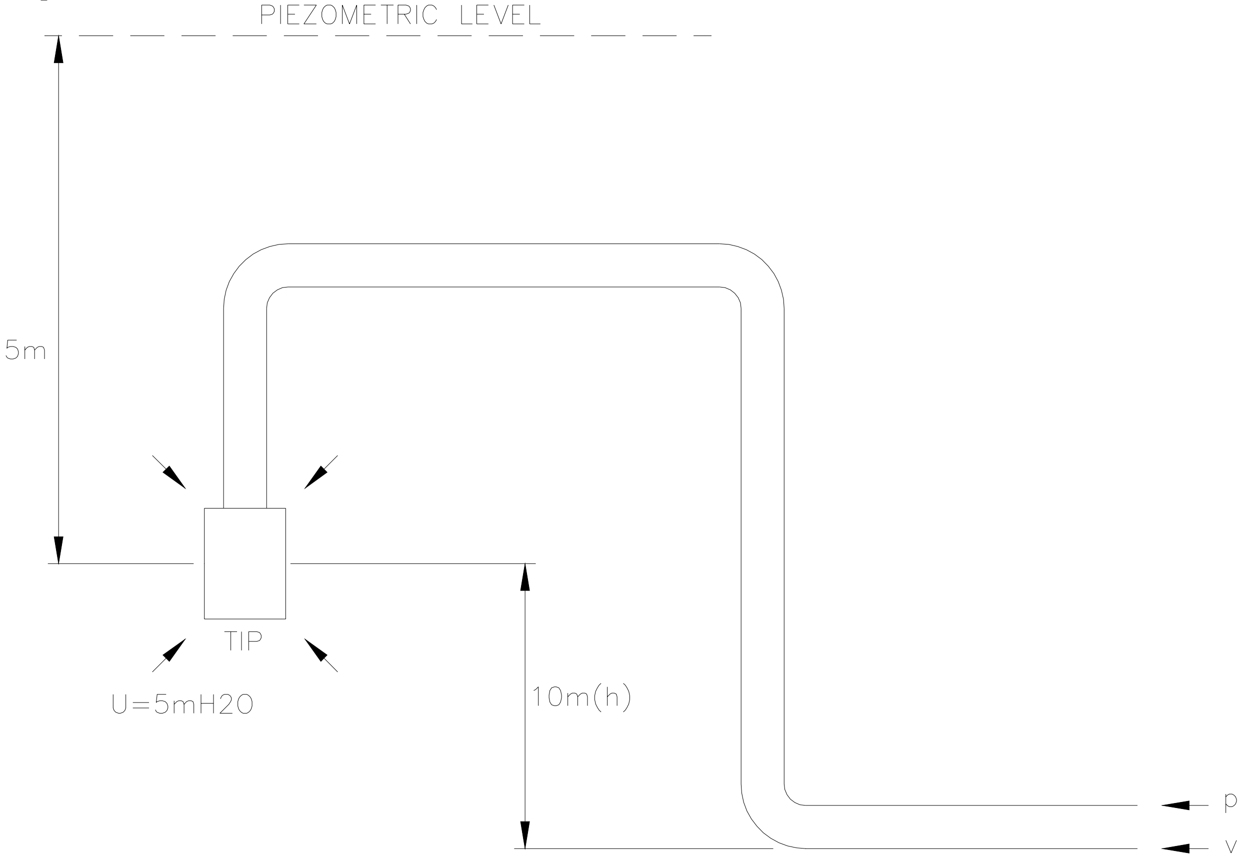
$fAB = fBC$

$p = 2(h + u) - v$

In a piezometer installation h is known, v can be maintained at a known value, and u for each tip can be estimated using previous pore pressure reading. In this way p can be calculated for each piezometer and de-airing carried out at the appropriate pressure. If the piezometer lies below the readout point, the term h, the difference in head between the tip and pressure and vacuum gauges on the de-airing apparatus, changes sign and becomes negative.

When a piezometer has accumulated a lot of air, care should be taken to apply sufficient pressure to drive water at least as far as the tip before applying a vacuum to other lead, as the friction loss in the return tube Carrying air is much less than in one carrying water and air will be drawn in through the tip from the fill.

Example 1.

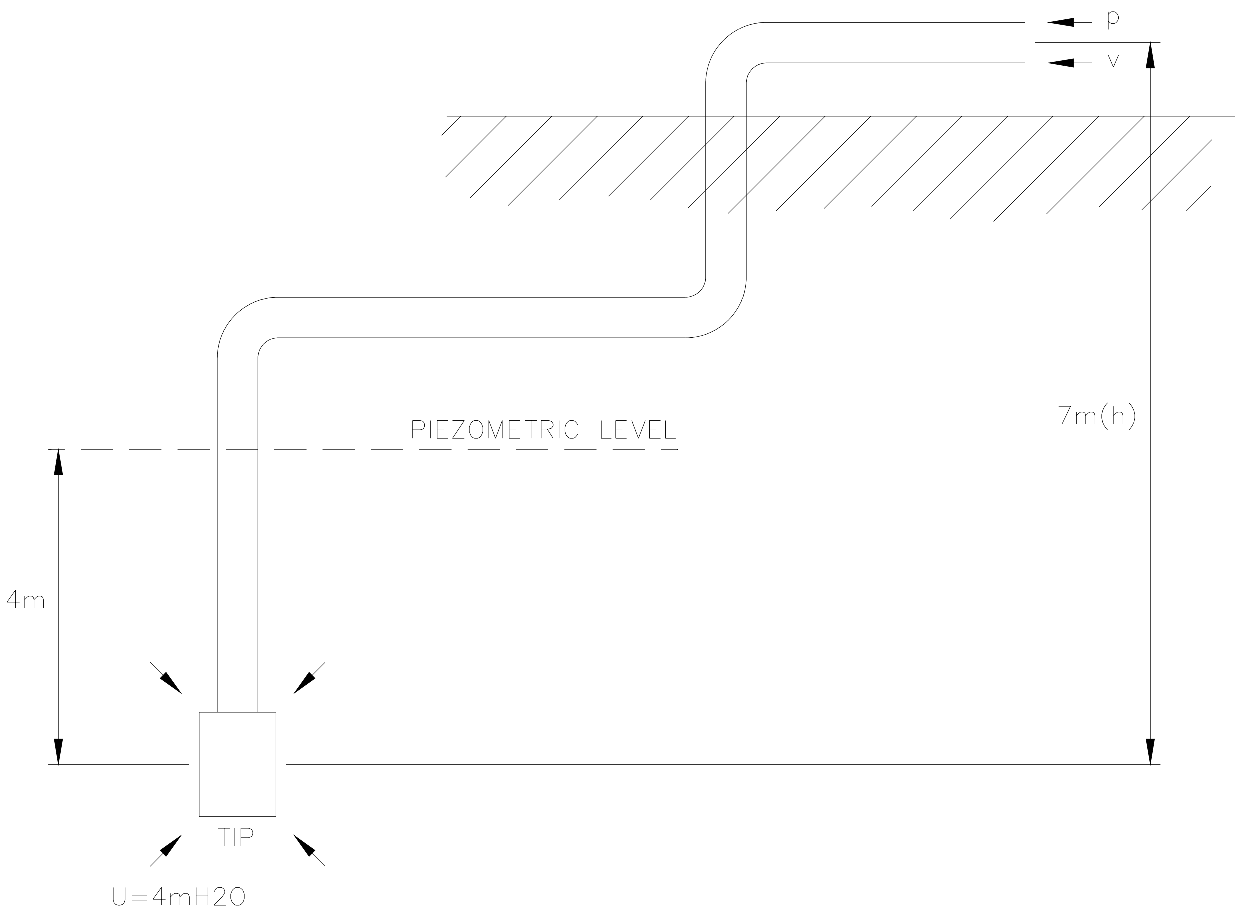


Where, p = 2(h + u) -v
p = 2(10 + 5) –v
p = 30 - v
Therefore for, v = o
p = 30 mH20

For, v = -5 mH20
p = 35 mH20

For v = -10 mH20
p = 40 mH20

Example 2.



p = 2 (h + u) -v
p = 2 (-7 + 4) -v
p = -6 -v

Therefore for v = o
p = -6 mH20

for v = -5 mH20
p = -1 mH20

for v = -10 mH20
p = 4 mH20

The De-Aired Water Boiler

Refer to Drawing No. 145-000M.

Up to 27 litters of the de-aired water can be prepared in the boiler at one filling. An integral immersion coil heats the water to boiling thus expelling any air or gases in solution. By sealing the boiler and allowing it to cool, the steam and water vapor above the water condense thus creating a partial vacuum inside the boiler. This prevents further solution of air or gases.

6.1 Remove the central filler-cap using a Stilton type wrench. Open valves V and S.

6.2 Pour in clean water to within 100mm of the top.

6.3 Connect the electrical cable to a suitable AC mains supply having checked the voltage of the unit and the supply, switch on at the mains. Coming to the boil will take approximately 2 hours. Bring to the boil and allow boiling for fifteen minutes. Switch off at the mains supply.

6.4 Close valves V and S, replace the central filler-cap and tighten. Allow to cool.

WARNING:- Although the cap is fitted with a pressure relief valve, never boil with the filler-cap on.

NOTE:- With a partial vacuum inside the boiler, never open valve S before opening valve V, as this will draw air into the de-aired water.

SAFETY REQUIREMENTS:-

The 4 psi Pressure Relief Valve in centre of filler cap must be checked at intervals not exceeding 12 months by a competent person.

POWER SUPPLY:-

The 240 volt unit requires 240V, 50Hz, 15 Amps per heater element.
The units must always be earthed.

Pump Maintenance

General:

Always store all pumps in dry and dust free conditions. Operate each pump at least once per month to avoid mechanism seizure.

Electric Compressor:

A separate manual is supplied describing routine compressor maintenance, but most important is to check the crankcase oil level at the start of each operating day and adjust if necessary.

The oil level should remain within the notch at the tip of the dipstick (photo 8).

Occasionally drain the pressure reservoir and the filter moisture trap of moisture.

Electric Vacuum Pump:

During operation, it is advised to not to allow water to be drawn through the pump in error. If this happens, immediately remove the source of water and allow the pump to run with a through flow of air to evacuate and dry the pump of water.

Apply a few drops of oil to the air inlet port on the pump and operate the pump in pulses to distribute the oil internally.

Should the pump 'stick' or not operate when connected to the mains, make sure the pump is disconnected from the mains, and carefully remove the rear fan guard (photo 9).

Rotate the fan blade clockwise by hand until it is freed off.

Carefully and correctly replace the fan guard and operate as normally.

Foot pumps:

Vacuum and pressure foot pumps (photo 10) are supplied and may be used in the event of electrical failure.

The vacuum pump will be applied to the same points on the De-Airing Unit as the electric vacuum pump.

The pressure pump will be applied to valve E for pressurising cylinder A.

The foot pumps will require occasional lubrication of the piston rods for efficient use.

Again, avoid water entry into the vacuum pump.

The pumps can be fairly easily dismantled for internal cleaning and lubrication.

Photo 8.
Fan guard removed from electric vacuum pump

Photo 9.
Electric compressor oil level dipstick

Photo 10. Foot Pumps: Pressure to the right, Vacuum to the left

Taking Piezometer Readings

Individual Gauges:

With all valves closed to the Send and Return bus bar flushing lines, switch each piezometer limb through to its reading gauge in turn, to get both piezometer readings.
Tap the gauge glass gently with your knuckle to settle the needle. Note each reading and later enter into a computer spreadsheet for processing and graphing.
Obtain the reservoir level at the same time as the piezometer readings for later correlation.

Master Gauge and Vacuum Gauge:

Make sure the bus bars are thoroughly de-aired through to the Master and Vacuum Gauges and zeroing tube, through applying pressure (say 10mH2O) to the bus bar Send line and returning to cylinder C and operating valves X, Y and Z, and through to the zeroing tube via valve W, on the Master Gauge panel.

Close off the De-Airing Unit valves P & V.

Check the Master Gauge zero by opening the gauge through to the zeroing tube via valves W and X, then isolating again by closing.

Switch through individually, in turn, each piezometer limb to the Master Gauge.
Piezometer limbs showing negative pressure should be switched through to the Vacuum Gauge located on the Master Gauge board.
Tap the gauge as before to settle the gauge needle and note the reading once stable.
Close the piezometer limb valve and open the next valve through, etc.

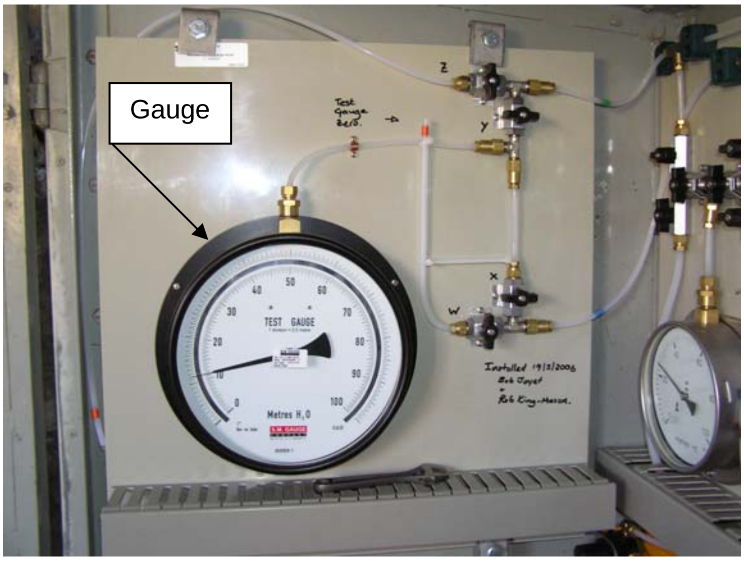
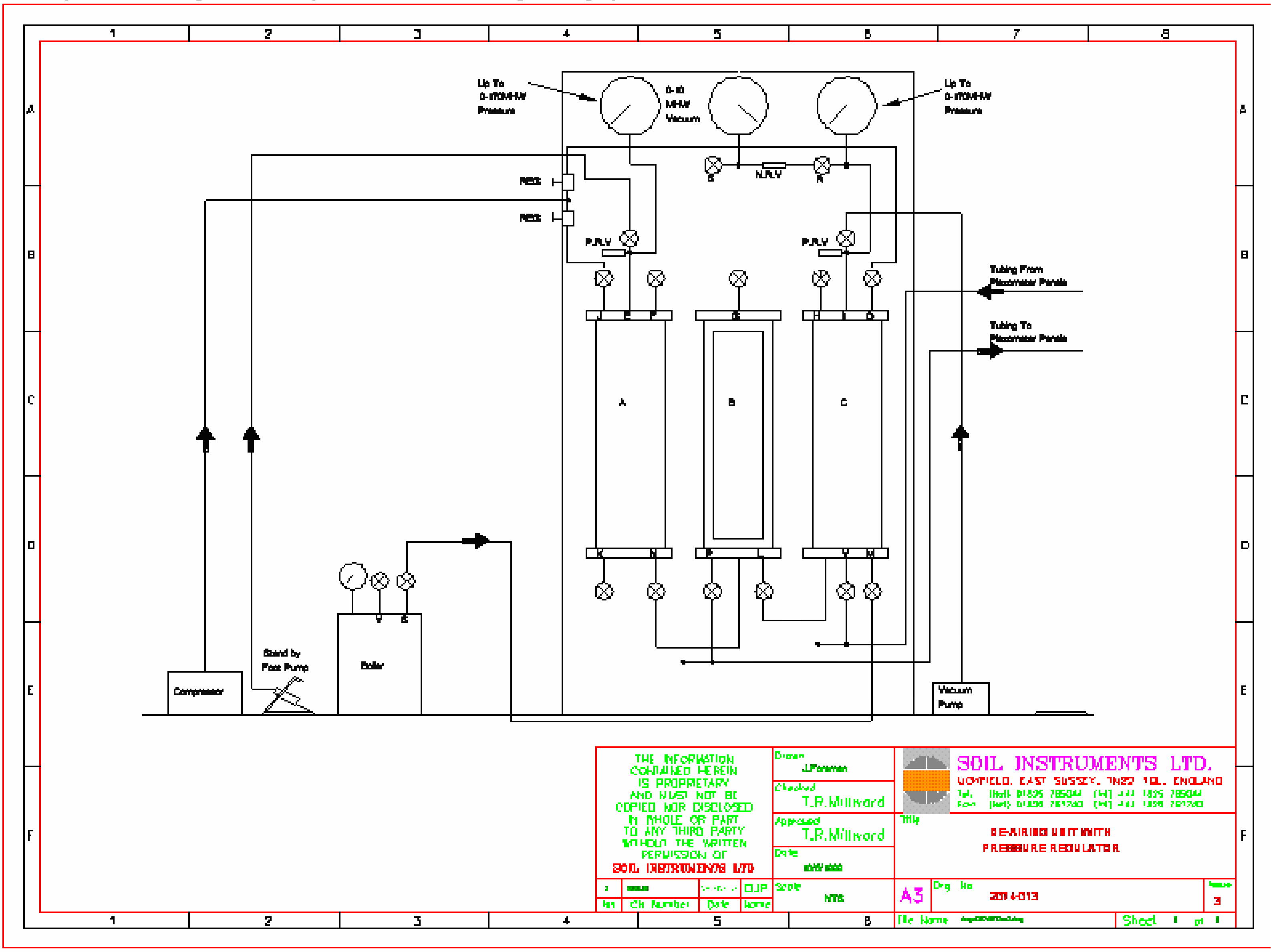


Photo 11. Master Gauge Panel. All valves closed

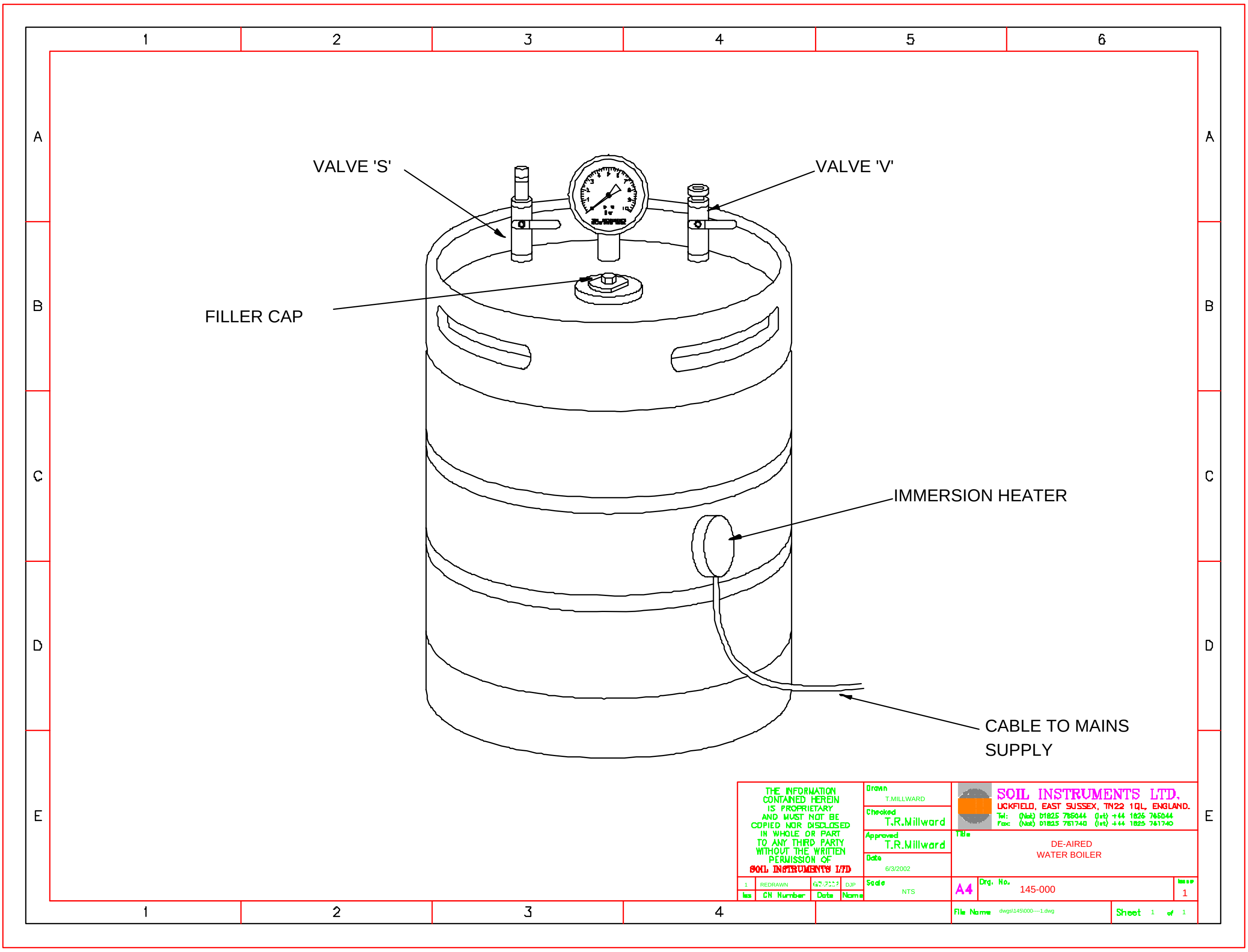
Photo 12. Individual gauges,
Left limb reading on gauge, 13.5mH2O

System Diagram (A3/2074-013)

Kajakai Dam, Afghanistan: Hydraulic Piezometer Operating System



27 Litre De-Aired Water Boiler (A4/145-00M)



Kajakai Dam, Afghanistan: Hydraulic Piezometer Operating System

Document Search and Scanning Attachments

1. **Scanning Memo**
2. **Scanned Documents – Table of Contents Only, (The Scanned Documents are contained on 19 CDs)**
3. **Kajikai Dam Construction Narrative (also as hard copy)**
4. **Construction Narrative Milestone Events (also as hard copy)**
5. **Construction Narrative Pertinent Issues (also as hard copy)**

Attachment 1- Scanning Memo

September 28, 2005

All (sent to USAID/IRD/AEAI),

I would like to indulge you regarding several items.

Regarding the already scanned Selected Site Drawings and Hollow Jet Valve and the next to be scanned rotovalve; I assume there will be great interest and need in having a set of hard copies available for tabletop viewing etc. How many copies of such prints are reasonably necessary? Please discuss and let me know, as a coordinated effort between scanning and prints would work best so we do not all of a sudden ask for a set of prints down the road (or worse, several entities ask for sets at different times).

Keep in mind that I am working with prints that vary in size as follows:

- 95 x 140 cm black prints and similar size true "blueprints"
- Occasional 65 x 85 prints
- Many 60 x 92 cm black or true "blueprints"
- Some 45 x 70 cm negatives
- Some 45 x 60 black prints
- Many approx. A3 size black and "blueprints"
- Even some A4 size "blueprints"

Due to the legibility or partial legibility of the multiple copies/sizes and for the additional convenience of having both the large and more typical sizes available for portability, I sometimes make or have to make multiple format copies of the same drawing. The multiple copies/multiple format size issue is principally related to the Rotovalve.

I would think it reasonable to make the following sets available:

- One for site
- One for John and USAID
- One for Paul and IRD
- One for AEAI

Each of these sets can later be turned over to the appropriate entity or authority following any of our demobilizations.

Another pressing issue (prior to scanning) is indexing/cataloging of the drawings in particular and all other documents in general. I imagine the same issue is true for all other plants or projects, whether hydro, fossil fuel or whatever. Thus far and for Kajakai, I have been involved and responsible with the finding and scanning of the following documents or document types:

- Piezometer data, memoranda, procedures and maintenance and operation documents
- Instructions for Operation and Maintenance (of) Kajakai Dam, Arghandab Dam and Diversion Dam Headworks for Boghra Canal Intake
- Weekly and monthly Construction Records 1950-54
- Hollow jet valve and Rotovalve 3-ring binder which included:
    - Jet valve text and schematic for 7 cases for opening & closing valve under different operational scenarios
    - Misc. Rotovalve drawings
    - 2nd copy of, "Instructions for Operation and Maintenance (of) Kajakai Dam, Arghandab Dam and Diversion Dam Headworks for Boghra Canal Intake"
    - Rotovalve and oil sump description and Instructions, plus misc. drawings
    - 75 ton Intake tunnel Berger Crane w/ drawings
    - Jet Valve Control Drawings
- Intake Crane and Stoplog problem description and resolution
- Design Memos, Specs and Consultant Reports
- Daily Discharge Data for 1948, 49 and 53
- Irrigation Valve Operation & Maintenance Log Book
- Drawings including the following sets:
    - Jet valve

    - Rotovalve
    - 10, 11, 21 & 31-F-Series - Civil Drawings
    - 13-F-Series - Concrete & Reinforcement
    - 15-F-Series - Equipment including fixed wheel Gate and stoplog
    - 17-F-Series - Electrical
    - 27-Series - Site Drawings including: borrow, borings, special treatment, grouting, portals, bridges and field changes
    - Intake Tunnel 75 Ton Berger Crane
    - Intake Tower Access Bridge
    - Miscellaneous file sets of Topography, Foundation grouting and Special Treatment, Soil Testing – Kajakai and Soil testing Arghandab
    - Hitachi Gate Series (only 5, all sepias)
    - Few other misc. dwgs.
- Harza 1976 Gate Drawings (from 1977 Bid Package)

I struggled a little bit regarding how to arrange folders, files and their respective names or headings. I was tweaking my system, even as the initial drawings were being scanned. Although a couple of mistakes occurred and I made indexing/file name format changes as scanning was performed, the resulting indexing and file names was well done and can be fixed without much work, as the number of drawings for each set and resulting CD was small.

At the same time, have been deliberating with respect to the need for a database wide system of indexing and file naming etc., which should really be done ahead of rather than following the scanning. I therefore present a couple of rough ideas with a sequence of 4 Sheets (attached to end of memo) as follows:

- Sheet 1 – General Project subfolders for Kajakai Dam
- Sheet 2 – Drawing Folder and subfolders for Kajakai Dam: This is an approach where all drawings are within a single folder and then sequenced in subfolders by the several phases of construction or time frames or both. An alternative could be to have a folder for each Phase of construction which would contain all subfolders for that phase, including a subfolder with only those particular drawings.
- Sheet 3 – Shows how I intend to index/catalog and assign drawing file names to maintain drawing sequence, within each drawing set or folder. Note that I intend to include a drawing list as the first file of each successive CD within any drawing set, so that an index of the included drawings is readily available whenever a CD is opened.
- Sheet 4 – Shows how we already indexed and selected file names for the Construction Reports

I strongly recommend that someone begins to develop and organize an indexing/cataloging framework and some kind of logical protocol for this library or database. Otherwise we may end up with all of the necessary information at our fingertips, but without knowing what is there, what it consists of and how to find it.

As I reviewed what we did and write this, I am reminded that there can or should be another step in the above Sheet 4 process or for other more often used or referred to text documents. All documents have been scanned one page at a time, with each page being a single file. It would make a lot of sense for certain documents that are often referred to or need to be hard copied from time to time to be combined into a single file for convenience of both reading and printing. Currently, the following text documents come to mind:

- "Instructions for Operation and Maintenance (of) Kajakai Dam, Arghandab Dam and Diversion Dam Headworks for Boghra Canal Intake"
- Hollow jet valve and Rotovalve 3-ring binder

Regarding the Construction Reports, which are extensive, it is necessary that they be reviewed from start to finish to cull any of the important information which address design issues and concerns and which contain test data or insights into construction or equipment installation and testing. Towards that end I have begun a construction narrative to note significant events and the above type of information. This process is absolutely necessary to the Geotechnical work to gather all pertinent data and information towards resolving and addressing current issues (extent and adequacy of grouting and foundation treatment, nature and engineering properties of the dam zoning materials) and concerns that have been expressed within project assessment reports. I imagine it will also have relevance regarding other disciplines and design and operation issues

Where important information is contained in or attached to the report, I will incorporate the file or scan of that information into the narrative. This will provide a summary reference document limited to the significant events, data and design issues. Any reader can then refer directly to the original reports for additional information or within the location and time frame of the issue(s) of interest. For this reason I do not consider it important to spend the time to combine the Construction Reports into a single file document.

Another purpose of the scanning and review effort of found documents is to provide a set of pertinent reference documents to the eventual design consultant which will be selected to design the Gate Installation Project.

Regarding further scanning, there are apparently ongoing problems with the scanner performance and maintenance. The information center is looking at possibilities of renting a scanner from some other entity in Kabul to provide continuity of scanning for this and other projects.

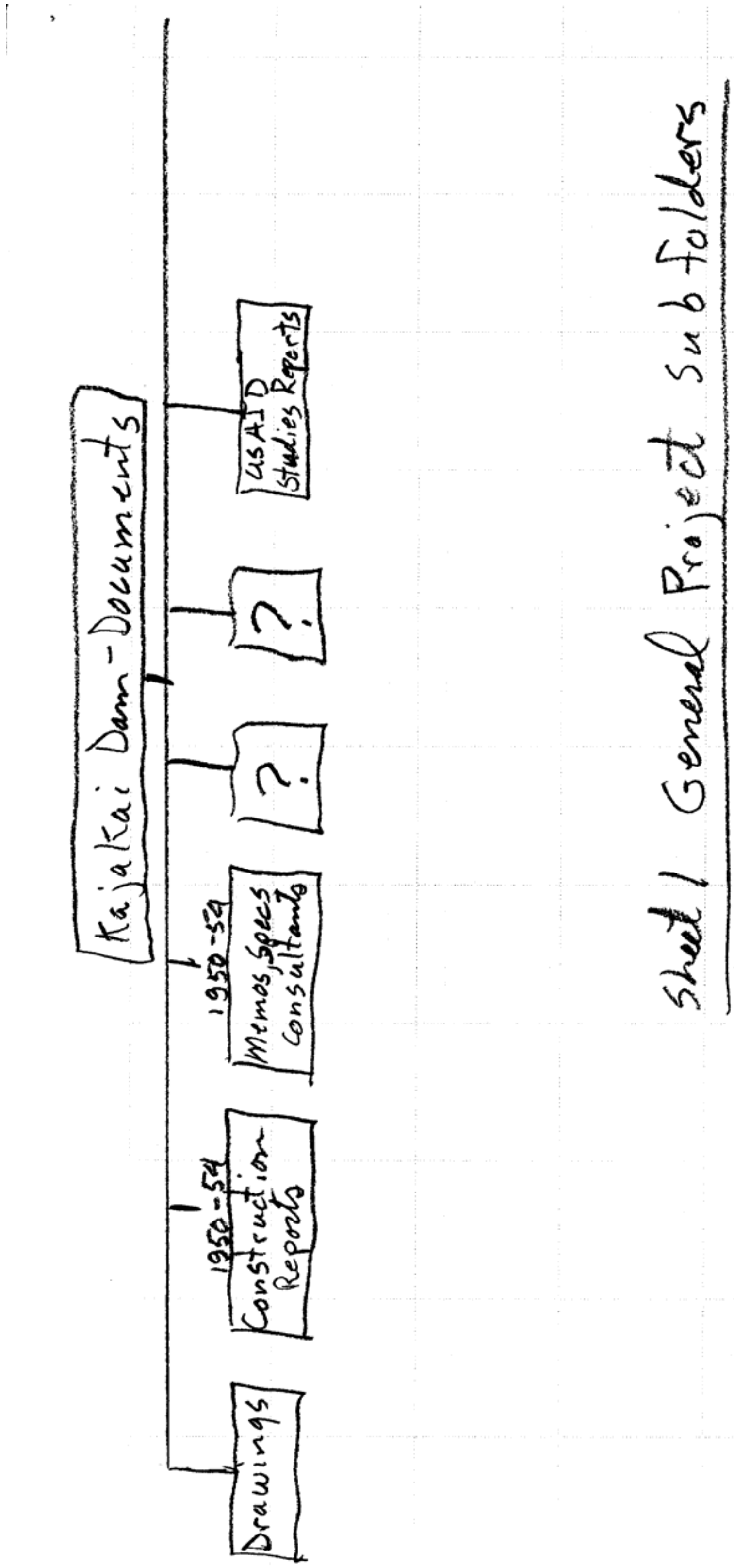
The rotovalve package preparation and detailed drawing list should be ready by tomorrow and consists of about 82 drawings of the various sizes mentioned.

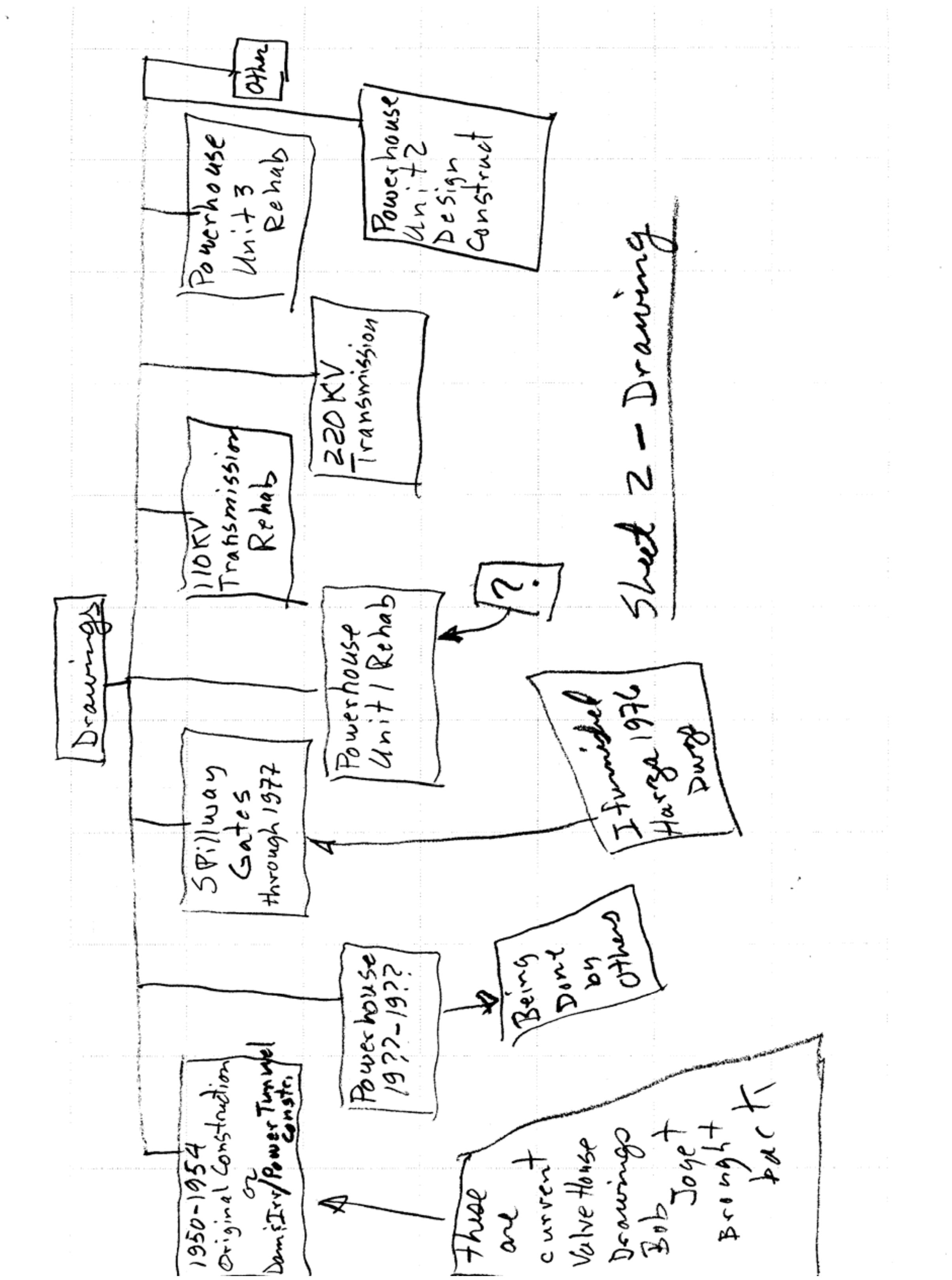
Also regarding the current Kajakai drawings to be scanned, I would like to get them completed within the next two weeks and send the original prints back to the valve house as they are completed. We have committed to returning them and after much thought on the subject it appears that on-site has always been the best and most secure location to assure their long term preservation (even in less than ideal locations and environment) and availability. Beyond the Rotovalve package, I envision about 250 more drawings.

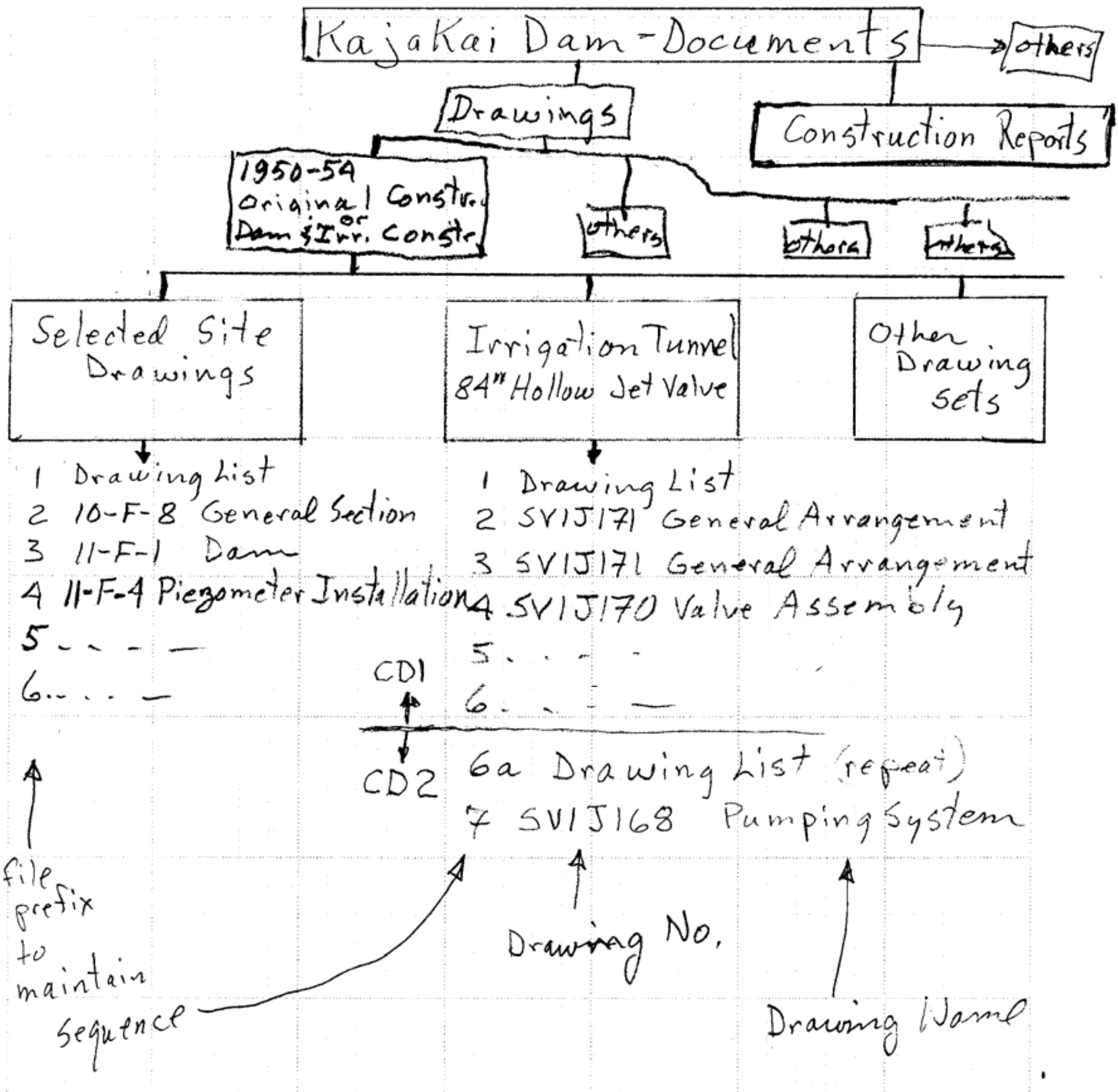
Please give me some feedback and/or direction regarding the database/library indexing cataloging, as I want to make sure that regardless of the eventual and overall system, that whatever I do with the Kajakai documents, will be as seamless as possible when incorporated into the overall system.

Best Regards,
Bob joyet

Sheets 1-4 Follow

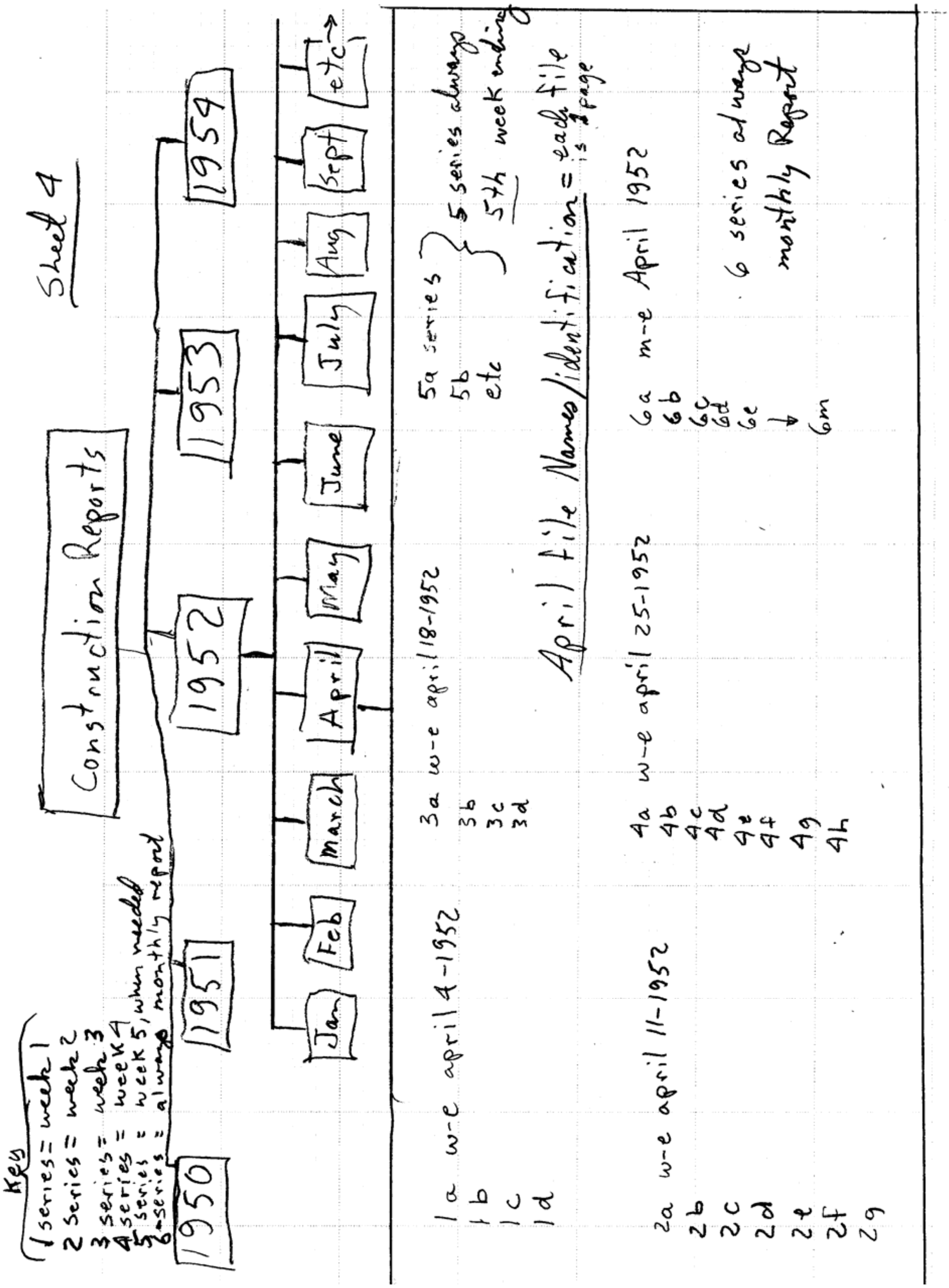

Kajakai Dam - Documents
Drawings
1950-54
Construction Reports
1950-59
Memos, Specs
Consultants
?
?
USAID
Studies Reports
Sheet 1 General Project Sub folders


Drawings
1950-1954 Original Construction or Dam & Irr/Power Tunnel Constr.
Powerhouse 19??-19??
Spillway Gates through 1977
Powerhouse Unit 1 Rehab
110KV Transmission Rehab
220 KV Transmission
Powerhouse Unit 3 Rehab
Other
Powerhouse Unit 2 Design Construct
these are current Valve House Drawings Bob Joye brought back
Being Done by Others
I furnished Harza 1976 Dwgs
?
Sheet 2 – Drawing



Sheet 3 - 1950-54

Original Construction Dwgs
or
Dam & Irrigation / Power Tunnel Constr.


Sheet 4
Construction Reports
1950
1951
1952
1953
1954
Jan
Feb
March
April
May
June
July
Aug
Sept
etc
Key
1 series = week 1
2 series = week 2
3 series = week 3
4 series = week 4
5 series = week 5, when needed
6 series = always monthly report
April File Names/identification = each file is 1 page
1a w-e april 4-1952
1b
1c
1d
2a w-e april 11-1952
2b
2c
2d
2e
2f
2g
3a w-e april 18-1952
3b
3c
3d
4a w-e april 25-1952
4b
4c
4d
4e
4f
4g
4h
5a series
5b
etc
5 series
5 series always 5th week ending
6a m-e April 1952
6b
6c
6d
6e
6m
6 series always monthly Report

Attachment 2 - Scanned Documents

Table of Contents Only

(The Scanned Documents are contained on 19 CDs)

CD 1

Construction Weekly and Monthly Reports for 1950 and 1951

CD 2

Construction Weekly and Monthly Reports for 1952

CD 3

Construction Weekly and Monthly Reports for 1953 and 1954

CD 4

A - Jet and Rotovalve – 3-Ring Binder

1 - Operation Instruction 84" Hollow Jet Valve (scan page files 1-23, 6 cases)

2 - Miscellaneous Drawings – Rotovalve (scan page files 24-35)

3 - Instructions for Operation and Maintenance – Kajakai Dam, Arghandab Dam and Diversion Dam and Headworks for Boghra Canal Intake – (scan page files 36-70 - 3 page tables of content and 32 pages of text. There were Appendix A-H cover sheets (no content or title), therefore the cover sheets were not scanned.

4 - Content lists and service bulletins – appear to be Rotovalve related (scan page files 72-91)

5 - 75 Ton Berger Crane Operation and maintenance Instructions (scan page files 92-121)

6 - Jet Valve Control Drawings and parts bulletins (scan page files 122-139)

B - List of Scanned Memos, Specifications and Studies Files

1-Dam-Found-EXC-May-19-1950

2-Letter to Consultants-may-26-1950

3-Memo- Investigation Study-June-16-1950

4-Design Comments-Response-July-21-1950

5-Geologist Inspection July-5-1950

6-Foundation Grouting-July-12-1950

7-Abutment Topo-July-32-1950

8-Dam Site Geology-August-12-1950

9-Grouting Memo-September-22-1950

10-Design Criteria-Specs-Lab-Proc-October-1950

11-Power Tunnel Seams January-11-1951

12-Tunnel Seepage-January-30-1951

13-Foundation Treatment-July-31-1951

14-Grouting Gunnite-September-8-1951

15-Progress-September-20-1952

16-Consultant Visit & Comments September-28-1952

17-Foundation Seams-October-9-1951

18-Inspection Trip-October-29-1951

19-Impervious Material Compaction-October-17-1951

20-Downstream Borrow-April-17-1952

21-Fill Compaction-April-28-1952

22-Right Abutment Fault-April-28-1952

C – Intake Crane & Stoplog Problem

A series of memos, problem timelines and other documents related to the Intake Crane startup and stoplog lifting problems. It covers the period June 22, 1953 through January 1, 1954. Additional Information can be found in the Construction Narrative for the same period, where significant design and construction problems and issues are noted in bold type.

CD 5

Piezometer Readings from March 26, 1953 through November 18, 1960

IRRIGATION TUNNEL DRAWINGS - CIVIL (10, 11, 21 & 31-F-Series)				
no.	Draw No.	Title	Sub Tittle	Comment
1		10, 11, 21, 31-F-Series - Civil Drawing List		gray=scanned
2	10-F-5	Topography Of Dam Site		boring locations
3	10-F-5 R2	Topography Of Dam Site		
4	10-F-6	Foundation Exploration	Logs Of Drill House	
5	10-F-8	General Section		
6	10-F-8 R2	General Section		done as Select Site Dwg Series
7	11-F-1 R2	DAM	Plan & Sections	done as Select Site Dwg Series
8	11-F-2 R1	DAM	Excavation & Treatment Plan	
9	11-F-3	Piezometer Installation - Sheet 1		done in May 2005
10	11-F-4	Piezometer Installation - Sheet 2		done as Select Site Dwg Series
11	11-F-4A	Piezometer Pressure Curves		
12	21-F-1 R2	Spillway Excavation	Plan , Profile & Sections	
13	21-F-1 R3	Spillway Excavation	Plan , Profile & Sections	
14	21-F-1A	Proposed Spillway Site		
15	31-F-1 R2	Future Installation for Power	Plan, Profile & Section	
16	31-F-1 R1	Intake Tunnel	Plan, Profile & Typical Sections	ARGHANDAB PROJECT
17	C-1	Spillway Channel Sections		
18		Downstream Bridge Site Topography		??
		Valve House Excavation Sections		
19	FSK-28	Valve House Excavation Sections	Sheet 1 of 4	
20	FSK-28	Valve House Excavation Sections	Sheet 2 of 4	
21	FSK-28	Valve House Excavation Sections	Sheet 3 of 4	
22	FSK-28	Valve House Excavation Sections	Sheet 3 of 4	
		Miscellaneous Drawings		
23	46981	1 Leffel Horizontal Turbine Unit	***** Arghandab Project *****	
24				

IRRIGATION TUNNEL DRAWINGS - STRUCTURAL (13-F-Series)

file no	Draw No	Title	Sub Tittle	Comment
1		13-F-Series - Structural Drawing List		
2	13-F-1 R9	Diversion Tunnels	Plan & Profiles	
3	13-F-2	Upstream Portal	General Arrangement	
4	13-F-3	Upstream Portal Structure	Concrete Outline - Sheet 1	
5	13-F-3 R5	Upstream Portal Structure	Concrete Outline - Sheet 1	
6	13-F-4 R3	Upstream Portal Structure	Concrete Outline - Sheet 2	
7	13-F-5	Upstream Portal Structure	Rock Anchors	
8	13-F-7	Upstream Portal Structure	Reinforcement - Sheet 1	
9	13-F-8 R1	Upstream Portal Structure	Reinforcement - Sheet 2	
10	13-F-25 R3	Emergency Generator House		
11	13-F-26 R1	Res W. S. Recorder House		
12	13-F-26 R3	Res W. S. Recorder House		
13	13-F-27 R1	Intake Tower	Concrete Outline - Sheet 1	
14	13-F-27 R2	Intake Tower	Concrete Outline - Sheet 1	
15	13-F-28	Intake Tower	Concrete Outline - Sheet 2	
16	13-F-28 R1	Intake Tower	Concrete Outline - Sheet 2	MKA
17	13-F-29 R1	Intake Tower	Reinforcement - Sheet 1	
18	13-F-30	Intake Tower	Reinforcement - Sheet 2	
19	13-F-31	Upstream Portal Structure	Reinforcement - Sheet 3	
20	13-F-32 R1	Upstream Portal Structure	Reinforcement - Sheet 4	see also 27-89 & 92
21	13-F-33 R1	Upstream Portal Structure	Reinforcement - Sheet 5	MKA R2 as redlined
22	13-F-34	Intake Tower	Reinforcement - Sheet 3	
23	13-F-34 R1	Intake Tower	Reinforcement - Sheet 3	MKA
24	13-F-36	Intake Tower	Reinforcement - Sheet 4	
25	13-F-40	Steel Conduit	Concrete Encasement	
26	13-F-41 R1	Valve House	General Layout	
27	13-F-42	Valve House	Concrete Outline - Sheet 1	
28	13-F-42 R1	Valve House	Concrete Outline - Sheet 1	
29	13-F-42 R2	Valve House	Concrete Outline - Sheet 1	
30	13-F-43	Valve House	Concrete Outline - Sheet 2	
31	13-F-43 R1	Valve House	Concrete Outline - Sheet 2	
32	13-F-44 R2	Valve House	Concrete Outline Sheet - 3	
33	13-F-45 R1	Valve House	Concrete Outline Sheet - 4	
34	13-F-46	Valve House	Reinforcement - Sheet 1	
35	13-F-47	Valve House	Reinforcement - Sheet 2	
36	13-F-48	Valve House	Reinforcement - Sheet 3	
37	13-F-49	Valve House	Reinforcement - Sheet 4	
38	13-F-50	Valve House	Reinforcement - Sheet 5	
39	13-F-51	Valve House	Reinforcement - Sheet 6	
40	13-F-52 R1	Valve House	Architectural Details	
41	13-F-53	Upstream Portal	Excavation	
42	13-F-54	Upstream Portal	Excavation	
43	13-F-55	Upstream Portal	Outline & Reinforcement - Sheet 1	
44	13-F-56 R3	Upstream Portal	Outline & Reinforcement - Sheet 2	
45	13-F-57 R2	Power Tunnel	Plug	
46	13-F-58 R3	Irrigation Tunnel	Plug	
47	13-F-61 R1	Rotolvalve Chamber	Concrete Outline	
48	13-F-61 R2	Rotolvalve Chamber	Concrete Outline	
49	13-F-61 R3	Rotolvalve Chamber	Concrete Outline	Supercedes 13-F-35
50	13-F-62	Rotolvalve Chamber	Reinforcement - Sheet 1	Supercedes 13-F-37 & 38
51	13-F-63	Rotolvalve Chamber	Reinforcement - Sheet 2	Supercedes 13-F-37 & 38
52	13-F-64	Rotolvalve Chamber	Reinforcement - Sheet 3	Supercedes 13-F-37
53	13-F-66	Valve House	Reinforcement - Sheet 8	
54	13-F-66 R1	Valve House	Reinforcement - Sheet 8	MKA R1
55	13-F-67	Valve House	Reinforcement - Sheet 9	
56	13-F-68	Pipe Trenches & Equipment	Foundations	
57	13-F-70 R0	Rotovalve Chamber	Rotovalve Drains	
58	????	Unknown, but Superstructure	Reinf.	

CD 8 & 9

IRRIGATION TUNNEL - EQUIPMENT (15-F-Series)						
file no.	Drawing No.	Title	Sub - Title	No of Copies	To Kabul	Comment
1	Equipment Drawing List				1	
2	15-F-1 R1	Stop Log Guides	Details	1	1	
3	15-F-2 R3	Stop Log Guides	Assembly & Anchor Bolts	2	1	
4	15-F-3 R3	Stoplog Steel Frame	Assembly & Details	1	1	
5	15-F-4	Stop Log	Outline And Reinforcement	2	1	
6	15-F-5 R1	Gate & Stop Log Lifting Device	Assembly & Details	1	1	
7	27-110	Gate & Stop Log Lifting Device	Alteration of Guide Beams	1	1	Also add to 27 Series
8	15-F-6	Irrigation Tunnel	Trashrack	2	1	
9	15-F-7	Irrigation Tunnel	Trashrack Guides	2	1	
10	15-F-8	Crane	Clearance Diagram	1	1	
11	15-F-9 R2	Intake Tower	MISC Metalwork - Sheet 1	1	1	
12	15-F-10 R1	Intake Tower	MISC Metalwork - Sheet 2	2	1	
13	15-F-11 R1	Wheel Gate	Assembly	2	1	
14	15-F-12 R1	Wheel Gate	Leaf	2	1	
15	15-F-13 R1	Wheel Gate	Seals	2	1	
16	15-F-14	Wheel Gate	Wheels	2	1	
17	15-F-15 R2	Wheel Gate Guides	Assembly & Anchor Bolts	2	1	
18	15-F-16	Wheel Gate Guides	Details	2	1	
19	15-F-17 R2	Intake Tower Access Bridge	Assembly & Truss	1	1	see also 27-89 & 92
20	15-F-18	Intake Tower	MISC Metalwork - Sheet 3	2	1	
21	15-F-52	Roto Valve Chamber	Hoist & Rail	4	1	
22	15-F-53 R1	Steel Conduit	Assembly & MISC Details	3	1	
23	505-27-570	Special Conduit Nipples		1	1	A3 size
24	505-27-936	Conduit-Nipples		1	1	A4 size
25	15-F-54 R1	Steel Conduit	Details Of Sections	3	1	
26	15F-55 R2	Testing Temporary Installation	Details	2	1	
27	15-F-56 R5	Valve House And Tunnel	Miscellaneous Metalwork	1	1	
28	15-F-57 R1	Valve House And Tunnel	Ladders and Railings	1 1/2	1	
29	15-F-59 R0	Ventilating System	Plans and Sections	2	1	
30	15-F-60 R1	Ventilating System	Details	1	1	
31	15-F-61 R1	Valve House	Plumbing & Drain Lines Details	2	1	
32	15-F-64 R1	Miscellaneous Metalwork		1	1	
33	15-F-65 R1	Intake Tower Access Bridge	Bent and Girder	1	1	
34	15-F-66 R1	Rotovalve Control piping	Plans and Sections	2	1	
35	15-F-67	Rotovalve Control piping	Details	2	1	
36	KAJ-V-1	Ventilating System	Key Plan & Typical Details		1	
37	KAJ-V-2	Ventilating System	Ductwork Details		1	
38	KAJ-V-3	Ventilating System	Misc. Details		1	
39	5846-IB-2	P. S. Draft Tube		1	1	blue
40	5846-IB-2	P. S. Draft Tube		1	1	normal

CD 10

IRRIGATION TUNNEL - ELECTRICAL (17-F-Series)				
no.	Draw No	Title	Sub - Title	comment
1		17-F-Series - Electrical Drawing List		
2	17-F-1 R1	Valve Chamber Tunnel & Valve House	Grounding Plan	
3	17-F-2	Valve Chamber & Tunnel	Power & lighting	
4	17-F-2 R1	Valve Chamber & Tunnel	Power & lighting	
5	17-F-3	ValveHouse	Power & lighting Plans	
6	17-F-4 R1	Power & Lighting	Sections & Details	
7	17-F-5 R2	Valve House Swichboard	Elementary Wiring	
8	17-F-6 R2	Aerial Distribution Line	Plan & Details	
9	17-F-7 R1	Emergency Generator House	Power & Lighting	
10	17-F-7 R1	Emergency Generator House	Power & Lighting	
11	17-F-8	Electrical	Single Line Diagram	
		SQUARE D COMPANY - ELECTRICAL		
12	D-1855-SF1	Valve House Switch Board	3 & 4 Wire 400 volt 50 cycle	
13	D-1855-SF2	Valve House Switch Board	Wiring Diagram - Panels1 & 2	
14	D-1855 SF-2A	Valve House Switch Board	Wiring Diagram - Panels 3, 4 & 5	job# 6898
15	D-1855-SF3	Valve House Switch Board	Sch. & Catalog No. of Equip. Mfg. & Supl. By Sq D	
16	C-2059-SF1	Valve House Switch Board	Nameplate Details	

Hitachi Gate Series		
file no.	Drawing No.	Title
1	Hitachi Series Drawing List	
2	174164 H-6	Hoist Rope End Assem. & Lifting Bolts
3	174167 H-9	Hoist Gears
4	174168 H-10	Hoist Shafts
5	174169 H-11 R1	Hoist Change-Over Mechanism
6	174170 H-12	Hoist Handcrank Device
7	174171 H-13	Slack Rope Detector

CD 11

	No. of copies						Kajakai Dam - Irrigation Tunnel 84" HOLLOW JET VALVE			
	negative (white text)		small print		large print					
File no.	site	kabul	site	kabul	site	kabul	Drawing No.	Title	Sub Title	Comment
1	Drawing List									
2	0	0	0	0	0	1	SV-1J171	General Arrangement	84" Hollow Jet Valve	
3	0	1	0	0	0	0	SV-1J171	General Arrangement	84" Hollow Jet Valve	
4	0	0	0	0	1	1	SV-1J170	Valve Assembly	84" Hollow Jet Valve	
5		1	0	0	0	0	SV-1J170	Valve Assembly	84" Hollow Jet Valve	
6	0	0	0	0	1	1	SV-1J167	Body Inlet Section	84" Hollow Jet Valve	
7	0	0	0	0	1	1	SV-1J168	Pumping System	84" Hollow Jet Valve	
8	0	0	2	1	0	0	SV-5A143	Hand Pump Assembly	84" Hollow Jet Valve	
9	0	0	1	1	0	0	SV-5A-59	Hand Pump Pedestal	84" Hollow Jet Valve	
10	0	0	1	1	0	0	SV-5A-58	Operator Assembly	84" Hollow Jet Valve	
11	0	0	0	1	0	0	35-F-142	Strainer Support	84" Hollow Jet Valve	
	0	0	0	0	0	0	SV-5C-138			
12	0	0	1	1	0	0	?missing?	Assembly ?????	Strainer ????, title block torn, may be for Jet or rotovalve	Winslow Engineering, Oakland
1. Folder Name (green); 2. File numbers starting with drawing list = file 1 written as 1 Drawing List, then; 3. each drawing is successive drawing file number (blue), drawing number (yellow) written as 2 SV-1J171. include title (rose) of drawing as file name after file no., abbreviate or use single best word to describe drawing if limited no. of characters for file name, therefore a complete file name would be "2 SV-1J171 General Arrangement" or "2 SV-1J171 Gen. Arr." , if abbreviated										

No. of copies						Irrigation Tunnel - 84" Dia. - 115 psi Rotovalve					
neg	black	med. black	small black	large blue	small blue	Draw No	Master No.	Other No.	Title	Sub Title	Comment
			1						Rotovalve Drawing List		
		1				6084-A-2	1	102116	Bill of Material - Body	84" Dia - Rotovalve	
		1				6084-B-2	2	102117	Bill of Material Plug	84" Dia - Rotovalve	
		1				6084-C-2	3	102118	Bill of Materials Lower Head	84" Dia - Rotovalve	
		1				6084-D-2	4	102119	Bill of Materials Upper Head	84" Dia - Rotovalve	
1						6084-E-1	none	?	Sectional Assembly ? (Parallel to Waterw??)	84" Dia - Rotovalve	
				1		6084-E-1	none	?	Sectional Assembly ? (Parallel to Waterw??)	84" Dia - Rotovalve	
	1					6084-E-1	none	?	Sectional Assembly ? (Parallel to Waterw??)	84" Dia - Rotovalve	
1						6084-F-1	none	none	? Rotovalve Section?	84" Dia - Rotovalve	
	1					6084-F-1	none	none	? Rotovalve Section?	84" Dia - Rotovalve	
1						6084-G-1	none	none	Sectional Plan	84" Dia - Rotovalve	
	1					6084-G-1	none	none	Sectional Plan	84" Dia - Rotovalve	
	1					6084-H-1	3	101084	Lower Head Detail	84" Dia - Rotovalve	
		1				6084-I-2	3	102120	Lower Trunnion Bearing	84" Dia - Rotovalve	
		1				6084-J-2	none	102121	Plug Centerline Head Bushing	84" Dia - Rotovalve	
				1		6084-K-1	none	101085	Plug Detail No. 1 Half Section	84" Dia - Rotovalve	
	1					6084-K-1	none	101085	Plug Detail No. 1 Half Section	84" Dia - Rotovalve	
				1		6084-L-1	none	1010866	Plug Detail? No. 2	84" Dia - Rotovalve	
	1					6084-L-1	none	1010866	Plug Detail? No. 2	84" Dia - Rotovalve	
		1				6084-M-2	none	102122	Plug Trunnion	84" Dia - Rotovalve	
	1					6084-N-1	4	101087	Upper Head Detail Half Section	84" Dia - Rotovalve	
		1				6084-O-2	4	102123	Upper Head Detail No 2	84" Dia - Rotovalve	
		1				6084-P-2	4	102124	Upper Trunnion Bearing	84" Dia - Rotovalve	
	1					6084-Q-1	5	10108?	Mechanism Support	84" Dia - Rotovalve	
					1	6084-R-2	5	102125	Bill of Materials - Mechanism Support	84" Dia - Rotovalve	bad print
			1			6084-S-3	5	102380	Bushings - Mechanism Support	84" Dia - Rotovalve	
	1					6084-U-1	1	101090	Lower Body Half ?????	84" Dia - Rotovalve	
				1		6084-V-1	1	?????	Upper Body Half Box Quarter??	84" Dia - Rotovalve	
	1					6084-V-1	1	?????	Upper Body Half Box Quarter??	84" Dia - Rotovalve	
	1					6084-W-1	none	101092	Body Assembly	84" Dia - Rotovalve	
					1	6084-X-2	14	102126	Washers & Bushing for Lift Lever & Lift Nut	84" Dia - Rotovalve	
					1	6084-Y-3	26	102391	Bushings - Rotator & Lifter	84" Dia - Rotovalve	
1						6084-AA-1	none	none	Control Piping	84" Dia - Rotovalve	
				1		6084-AA-1	none	none	Control Piping	84" Dia - Rotovalve	

No. of copies						Irrigation Tunnel - 84" Dia. - 115 psi Rotovalve					
neg	large black	med. black	small black	large blue	small blue	Draw No	Master No.	Other No.	Title	Sub Title	Comment
	1					6084-AA-1	none	none	Control Piping	84" Dia - Rotovalve	
					1	6084-AB-2	400	none	Control Valve Brackets	84" Dia - Rotovalve	
		1				6084-AB-2	400	none	Control Valve Brackets	84" Dia - Rotovalve	
		1				6084-AC-2	6	102127	Lift Nut	84" Dia - Rotovalve	
			1			6084-AD-3	500	none	Mounting Details - Motor Pump Unit	84" Dia - Rotovalve	
		1				6084-AE-2	7	102128	Lift Lever	84" Dia - Rotovalve	
			1			6084-AF-3	8	102383	Lift Bushing	84" Dia - Rotovalve	
		1				6084-AG-2	9	102129	Rotator	84" Dia - Rotovalve	
			1			6084-AH-3	10	102384	Pivoting Bolt - Rotator & Lift Lever	84" Dia - Rotovalve	
			1			6084-AI-3	11	102385	Shaft Sleeve	84" Dia - Rotovalve	
					1	6084-AJ-2	12	102130	Shaft	84" Dia - Rotovalve	
		1				6084-AJ-2	12	102130	Shaft	84" Dia - Rotovalve	
				1		6084-AN-1	20	1010??	20" Cylinder Rotator Cylinder	84" Dia - Rotovalve	this one good
				1		6084-AN-1	20	1010??	20" Cylinder Rotator Cylinder	84" Dia - Rotovalve	
		1				6084-AO-2	21	102131	20" Dia Piston for Rotator Cylinder	84" Dia - Rotovalve	
			1			6084-AP-3	22	102386	Piston Rod - 20" Dia. Cylinder	84" Dia - Rotovalve	
		1				6084-AQ-2	24	102132	20" Dia Cylinder Head (rod end) Rotator Cyl	84" Dia - Rotovalve	
		1				6084-AR-2	23	102133	20" Dia Cylinder Head (blind end) Rotator Cyl	84" Dia - Rotovalve	
	1					6084-AS-1	30	101094	12" Diameter Cylinder Lifter	84" Dia - Rotovalve	
		1				6084-AT-2	31	102134	12" Dia Piston Lifter	84" Dia - Rotovalve	
			1			6084-AU-3	32-	102387	Piston Rod - 12" Dia. Cylinder	84" Dia - Rotovalve	
		1				6084-AV-2	34	102135	12" Dia Cylinder Head (rod end) Lifter	84" Dia - Rotovalve	
		1				6084-AW-2	33	102136	12" Dia Cylinder Head (blind end) Lifter	84" Dia - Rotovalve	
			1			6084-AX-3	none	none	Detail of Seat Pads for Body	84" Dia - Rotovalve	
1						6084-BA-1	40	none	Lubrication Plug Trunion	84" Dia - Rotovalve	
				1		6084-BA-1	40	none	Lubrication Plug Trunion	84" Dia - Rotovalve	
	1					6084-BA-1	40	none	Lubrication Plug Trunion	84" Dia - Rotovalve	
1						6084-BD-1	none	none	Oil Sump Tank	84" Dia - Rotovalve	
	1					6084-BD-1	none	none	Oil Sump Tank	84" Dia - Rotovalve	
			1			6084-BE-3	500	none	List of Materials - Control Piping	84" Dia - Rotovalve	
			1			6084-BF-3	500	none	List of Materials - Oil Sump Tank	84" Dia - Rotovalve	
1						6084-BG-1	none	none	Control Panel	84" Dia - Rotovalve	

CD 16

No. of copies				75 TON INTAKE TOWER CRANE				
file no.	large	med.	small	Drawing No.	File	Tittle	Sub Tittle	Comment
1				75 Ton Crane Drawing List				
2				Operation, Maintenance & Installation			Berger Intake Crane	6 text pages, cover missing
3		1	0	9698	D20	General Arrangement & Clearance Diagram	75 Ton Crane	Alt. 1
4	0	1	0	9768	D8	Runway Conductor Anchor Bolt Plan		
5	0	1	0	9772	D6	Trolley Wheel Ass'y		
6	0	1	0	9773	D10	75 Ton Load Block		
7	1	0	0	9774	G20	Trolley Hoist Arrangement		
8	0	1	0	9785	D8	Crane Control Schematic Diag.		
9	1	0	0	9787	G22	Crane Bridge Detail		
10	1	0	0	9794	G22	Crane Catwalk Detail		
11	1	0	0	9799	G23	Bridge Drive - Mach. Ass'y		
12	1	0	0	9801	F22	Crane Bridge - Wheel Truck Ass'y		
13	0	1	0	9836	D8	Trolley Drift Lock Assembly & Location		
14	0	1	0	10141	D10	15 Ton Hook Assay		
15	0	1	0	10164	D8	Electrical Conduit		
16		0	1	10198	B36	Load Brake Ass'y		
					1	to Kabul		

Kajakai Gates Project - April, 1977			
Contract Documents 912 - 2 Volume IV - Bid Drawings		**General Construction**	
File No.	**Drawing No.**	**Title**	**Availability**
i		Title/Cover Sheet	Yes
ii		**Summary of Volumes**	Yes
This "Table of Contents" is contained in file "ii". Text/volumes could not be found in Harza archives. Only the drawings herein were found and scanned and are available from and archived at the Energy Information Center in Kabul.		**Volume I - Bid and Contract Dorms**	
		Part 1 Instructions to Bidders	No
		Part 2 Bid Form	No
		Part 3 Contract Form	No
		Part 4 Performance Bond Form	No
		Volume II - General and Special Conditions	
		Part 6 General Conditions	No
		Part 6 Special Conditions	No
		Volume III - Technical Specifications	
		Part 7 Technical Specifications	No
		Volume IV - Bid Drawings	
		Part 8 Bid Drawings	Yes
iii		List of Drawings	Yes
C1	912 C 1	Project Location Map	Yes
C2	912 C 2	General Project Plan	Yes
C3	912 C 3	General Project Sections	Yes
C4	912 C 4	Construction Schedule	Yes
C12	912 C 12	Geologic Map	Yes
C13	912 C 13	Summary Borehole Logs	Yes
C14	912 C 14	Borrow Areas	Yes
C18	912 C 18	Standard Details	Yes
C21-1	912 C 21-1	Service Spillway Excavation - Sheet 1	Yes
C21-2	912 C 21-2	Service Spillway Excavation - Sheet 2	Yes
C22-1	912 C 22-1	Service Spillway Foundation Treatment Sheet 1	Yes
C22-2	912 C 22-2	Service Spillway Foundation Treatment Sheet 2	Yes
C26-1	912 C 26-1	Service Spillway Plan - Sheet 1	Yes
C26-2	912 C 26-2	Service Spillway Plan - Sheet 2	Yes
C27-1	912 C 27-1	Service Spillway Longitudinal Sections Sheet 1	Yes
C27-2	912 C 27-2	Service Spillway Longitudinal Sections Sheet 2	Yes
C28	912 C 28	Service Spillway Transverse Section	Yes
C29-1	912 C 29-1	Service Spillway Miscellaneous Details Sheet 1	Yes
C29-2	912 C 29-2	Service Spillway Miscellaneous Details Sheet 2	Yes
C30	912 C 30	Service Spillway Reinforcement Details	Yes
C31	912 C 31	Service Spillway Bridge	Yes
C33	912 C 33	Service Spillway Tailwater Control Weir	Yes
C35	912 C 35	Service Spillway Access Road	Yes
C41	912 C 41	Emergency Spillway Excavation	Yes
C43	912 C 43	Emergency Spillway Grouting	Yes
C45	912 C 45	Fuse Plug	Yes
C51	912 C 51	Crest Of Dam	Yes
C54	912 C 54	Tunnel Plug Grouting	Yes
E71	912 E 71	Electrical Diagrams And Symbols	Yes
E72-1	912 E 72-1	Electrical Service Spillway Sheet 1	Yes
E72-2	912 E 72-2	Electrical Service Spillway Sheet 2	Yes
E74	912 E 74	Electrical Cable & Conduit Schedule	Yes
E76	912 E 76	Power Supply	Yes
S61	912 S 61	Spillway Gate	Yes

<u>**CD 18**</u>

Foundation Treatment - Faults, Seams, Grouting & Special Treatment				
No.	**Drawing No.**	**Title**	**Sub - Title**	**Comments**
1	**Foundation Treatment - List**			
		Irrigation Tunnel		
2	**Table IT1**	**Drilling & Grouting Summary**		**Incomplete, 27-96, 3of3**
3	**IT-A**	**Concrete Plug Grouting**		
4	**IT-B**	**Drilling & Grouting Sections & Summary Tables**		
		Power Tunnel		
5	**PT-A**	**Plan & Section**	**Tunnel & Portal Grouting**	
6	**PT-B**	**Intake Portal - Excavation**		
7	**PT-C**	**Diversion Portal - Excavation & Grouting**		**Original FSK-29**
		Dam		
8	**D-A**	**Right & Left Abutment Foundation Study**	**Left Abutment Gunite Outline**	
9	**D-B**	**Mid-Channel Fault Foundation Study**	**Excavation & Grouting**	
10	**D-C**	**Left Abutment Joints & Seams**		**Original FSK-30**
11	**D-D**	**Dam Foundation & Abutment Treatment**	**Summary Drawing-Plan & Profile**	**Original FSK-31**
12	**D-E**	**Dam Foundation & Abutment Treatment**	**Summary Drawing-Plan & Profile**	**Sketch for SK-31, larger scale**
13	**D-F**	**Mid-Channel Fault - Shaft Collar**		
14	**D-G**	**Mid_Channel Shaft - Grouting**		**very small size**
15	**D-H**	**Miscellaneous Treatment Profiles**		
16	**D-I**	**Piezometer Pressure Curvess**		**for piez data ploting**
Drawing Number Designation: IT = Irigation Tunnel, PT = Power Tunnel, D = Dam				

Test Data				
No	**Item No**	**Title**	**Sub - Title**	**Comments**
1		**Test Data List**		
2	Table 1	Gradation	Borrow Areas 1 & 3	
3	Table 2	Gradation and Percolation	Borrow Areas 1 & 3	
4	Table 3	Test Summary	Borrow Area 1	
5	Plot 1	Percolation Rate (ft/yr) vs. Gradation Factor (& Unit Weight)		
6	Table 4	Triaxial Testing	Borrow Areas 1 & 3	

<u>**CD 19**</u>

1. **Daily Gage Discharge Data 1948-53**
2. **Jan 1951 Piez Manual, Memos & Data**
3. **Instructions for Operation and Maintenance (of) Kajakai Dam, Arghandab Dam and Diversion Dam Headworks for Boghra Canal Intake", November, 1955, IEC Inc**. (file name instruction-operation manual Nov 1955
4. **Irr. Valve Operation & Maintenance – Logbook**
5. **Site Area Topography Drawings**
6. **Test Data – Arghandab Dam Project**

Note: These CDs are available from the **Afghanistan Energy Information Center** in Kabul:

Annex to
House #15, Street #1
Ansari Square, Shahr-e-Naw

Web site:
Afghanistanenergyinformationcenter.org

Contact:
Ahmad Omar Ahmadi – Senior Information Officer - aomar@aeai.net

Document Search and Scanning Attachment 3
KAJIKAI DAM CONSTRUCTION NARRATIVE
(All CD references are for Scanned Documents Attachments CDs)

March 1950
Drilling, blasting and exc. on access roads and tunnel portals
Control survey monuments set, levels run
Strikes/dips of dam alignment, spillway and tunnel bedrock performed
Considerable rain, river flow from 4,600 cfs 3/1 to 12,400 cfs 4/1

April 1950
Cont. exc., more survey
River flow from 12,400 cfs to 25,000 cfs on 4/30

May 1950
Tunnel portals excavated, 20 m deep pilot driven at top of power tunnel – indicates good rock stands well
Tunnel alignments set and new dam axis set
Peak river discharge 38,500 cfs on 5/1, back to 18,000 cfs on 5/31
May 19 – One page foundation excavation spec issued (see Memos, Spcs, Consultants CD 4, B, item1)
May 26 – Three page letter to Consultants giving updated information for review. Added an eighth radial gate and decided on unlined tunnel.

June 1950
Some haul roads complete, power tunnel driven 30m, Irr tunnel 7m, left dam abut drilling and scaling
Prelim dam section received, 2.25:1 u/s and 2:1 d/s w/ 20m imp zone;
Tunnel portal stations established as Power = 0+765 & Irrigation = 0+840
No rain, river falls from 18,000 cfs to 6,000 cfs at month end

July 1950
Haul roads cont, 11m of tunnel, jumbos erected, left abut drill/scale cont, 2.25:1 u/s slope set
Flow down to 2,500 cfs at end? of month. **July 5 –** Dr. F. A. Nickel, Consulting Geologist Report, for Kajakai, Arghandab, Seraj and Palsu Dams **(see scan CD 4, B, item 5).**
July 12 – Grouting instructions for **Arghandab** Dam **(see scan CD 4, B, item 6).**
July 21 – Denver response to field design comments of June 30 **(see scan CD 4, B item 4).**
July 31 – Two page letter regarding abutment topo and excavation of overhangs **(see scan CD 4, B, item 7).**

August 1950
w/e 8/10 – 26.5m of PT and 3m of IT excavated
w/e 8/17 – PT to 0+660.7 (28.8m) and IT to 0+786.4 (25.8m)
w/e 8/24 – PT to 0+635.0 (25.7m) and IT to 0+758.5 (27.9m). Angled clay seam in power tunnel w/ thickness there & surface < 30'
w/e 8/31 – PT to 0+613.3 (22.7m) and IT to 0+732.0 (26.5m). Clay seams/pockets of decomposed materials hampered operations in power tunnel w/ short rounds, much scaling, slabby rock
monthly – IT at 105.7m all good rock; Power tunnel at 153.8m, from 0+650 to 0+610 saw 3 clay seams, one perpendicular one at 30^o and one dipping at 45^o to centerline, interval was blocky w/ clay seams & pockets of decomposed materials, looked like timber and gunite necessary but rock good again; u/s portals fixed w/ tunnels 50m apart and power portal well away from dam toe and bad seam; low river flow

September 1950
w/e 9/7 – 10' thick fractured material in IT at angle but vertical w/ 25.2m excavated; PT rock improved w/ 23.3m excavated
w/e 9/14 – 26.8m in PT and 26.2m in IT. Powder at 2.6 lb/cy.
w/e 9/21 – both tunnels w/ small mud seams making rock slabby & req scaling; same 10' clay seam/bad rock encountered at power tunnel was encountered at IT at sta. 0+712, dips at 80^o with bearing of N48^o W and 10' wide, 3.1 lbs/cy
w/e 9/28 – PT at 0+504 (29m) and IT at 0+623 (27m). Both good rock
monthly – PT at 0+500, IT at 0+619, left abut 55% complete, river flow down to 2,000 cfs

<u>October 1950</u>
w/e 10/12 – power tunnel clay seam at 0+450 running parallel & 4' left of centerline & takes sharp left at 0+450 resulting in slabby ground and much scaling left side
w/e 10/19 – numerous diagonal small seams in power tunnel w/ considerable scaling & little overbreak, large clay pocket right side, 1 round lost to scaling: PT at 0+419, IT at 0+533.3
w/e 10/26 – clay seams running diagonal in Power tunnel and perpendicular to each other, considerable scaling and some overbreak, large clay slab from clay pocket right side damaged one jumbo deck
monthly – left abut scaling at 72% complete, power tunnel at 0+370, Irrigation tunnel at 0+489, 3 lbs/cy powder

<u>November 1950</u>
w/e 11/2 – PT at 0+359.7 and IT at 0+479.2. Few seams crossing power tunnel diagonally, some parallel to tunnel on right side, some overbreak, considerable scaling
w/e 11/9 – PT at 0+332.4 and IT at 0+449.4, good rock in both, very few seams
w/e 11/16 – PT/IT, 32.7m/29.8m, 0+299.7/0+419.6, clay seams and pockets in power tunnel w/considerable scaling, clay seams in irr tunnel diagonal across & at right angles to each other
w/e 11/23 – PT/IT, 26.3m/21.8m, 0+273.4/0+397.8, few seems in PT, still diagonal seams IT w/ considerable scaling, rock good in both, 1 day off
w/e 11/30 – left abut excavation muck used in dam rock section below portals. Trouble finding sand (30 miles on access road). Diamond drill arrived and started dam borings for pressure tests w/ rock at 12' depth. PT/IT, 34.2m/32.8m, 0+239.2/0+365, few seams in both & diagonal, since last rain seepage coming through clay seams
monthly – PT/IT, 130.8m/124m, 0+239.2/0+365, some clay seams but generally good rock, 3 lbs/cy powder, first rain on 27th and seeping through clay seams, u/s portals almost complete, spillway location fixed

<u>December 1950</u>
<u>w/e 12/7 –</u> PT/IT, 32m/31.4m, rock good in both, still few diagonal seams, drill finished 1st boring on left bank & pressure tests were satisfactory
<u>w/e 12/14 -</u> lower bridge location borings showed about 30' of overburden, boring on right abutment reached solid limestone at 15' depth. PT holed through to 0+191 on 12/11, reference line for portal structure established at 0+190. IT encountered seams diagonal & some parallel to centerline, rock harder, very little scaling
<u>w/e 12/21 –</u> 2 high cars being built in preparation for scaling and guniting tunnel seams, coldest day recorded at 15 degrees, dam test holes completed, rig down, lower bridge shows sufficient overburden for driven pile foundations and **complete logs and <u>penetration tests</u> to be sent after last hole finished**, **surface locations of left abut seams surveyed to tie into tunnel seams (see Drwg. 27-95 R_2),** IT = 37.7m excavation and to Sta 0+267.1. Encountering clay pockets and seams, rock good. <u>Mentioned spillway channel sections as opposed to spillway itself: Therefore scanned drawing C-1 could be used to determine erosion issues, if section locations can be determined and compared to present day sections</u>
<u>w/e 12/28 –</u> lower bridge borings finished and results sent, IT = 36.9m (0+230.2) & numerous small seams & clay pockets, considerable scaling
<u>monthly –</u> abutment excavation muck used in portals cofferdam, trace of rain on 29th, spillway topo complete, 7 borings at lower bridge, average advance/day at PT w/ jumbo = 14.4'. In IT numerous diagonal clay seams through six-9' rounds then resumed 13' rounds, rock is good, still 3 lbs/cy powder, IT at 0+214.8 and 150.2m this month

<u>January 1951</u>
w/e 1/4 – drill rig taken off 30' hole w/ one pressure test done w/ no take, IT 33.6 m (to 0+196.6) of 9' rounds due to small and one large clay seam area w/ considerable scaling, at 0+196.6
w/e 1/11 – aggregate plant producing sand and gravel at Kandahar road site
January 11 - Table of Power & Irrigation Tunnel seam locations and thickness Memo **(see scan CD 4, B, item 11),** which are shown on Dwg. 27-95 R_2)**.**
w/e 1/18 – fuel and cement shortages, IT holed through on 17th
w/e 1/25 – started scaling/cleaning of seams at large fault at 0+623 PT for gunite on 25th, continued fuel shortage reduced shifts
January 30 – Outlet portal seam seepage due to rainfall letter **(see scan CD 4, B item 12).**
monthly – drill rig came back and doing pressure tests at dam left abutment and tunnel seams, includes powder summaries

February 1951
w/e 2/8 – portal drill/blast almost finished, large seam cleaning at 0+623 done, pressure test of dam fault to 180 psi/no loss/30 min, start freezing temperatures, only day shifts
w/e 2/15 – at 0+623 2 borings intercepting large seam at 30' & 38' in, at 170 psi & 2 min water returned 2 places in steady stream including at fault and 10' ahead. Other hole 170 psi for 30 min & no loss; 2 borings at 0+476 on right side one parallel to bottom other at 45^0 angle w/ horizontal 1st 170 psi/30 min/no loss other 170 psi/15 min/no loss then 5 gpm for 20 min w/ no tunnel return, fuel & cement back on track end of week
w/e 2/23 – high car for gunnite moved to PT, borings at 0+395 not pressure tested due to pump trouble, Kandahar sand good after crusher run

March 1951
w/e 3/2 – fault/seam cleaning stopped pending decision on extent of gunnite coverage, 4 PT borings done w/ 3 at 160 psi/30 min/no take & 1 at 160 psi/4 gpm take for 30 min w/ no tunnel return, concrete trial mixes performed
w/e 3/9 – gunite machine made ready, 4 seams drilled in IT and 160 psi/no loss, test pits done in u/s borrow area, trial mix cylinders showed high 7 & 14 day breaks, river rising
w/e 3/16 – PT invert clean & exc high invert at u/s portal, IT flooded from d/s portal so no work, 2 IT borings showed no takes at 160 psi/20 min, river still rising
w/e 3/23 – river down a bit, d/s IT portal diked off and dewatering, no borings
w/e 3/30 – IT invert mucking 43% complete, PT large seam across invert at 0+628 was cleaned & and average 18" concrete placed, gunite training in progress, right abutment impervious zone vertical ledges being blasted out (to slope I assume), underground powder house being excavated near spillway, PT outlet portal bridge in progress, test pits in u/s Borrow area 3 completed now moving to d/s borrow area 1 across river from camp (adjacent to Kajiki bridge), tunnel seam borings cont., river flow steady

April 1951
w/e 4/6 – both tunnel invert removal complete, gunite placement started in PT at 0+628, rt abut rock scaling placed in d/s rock zone, left abut scaling placed in u/s portal cofferdams, preparing for u/s PT portal structure concrete, lab testing cont, river flow steady at 15,000 cfs, planning for spillway exc to be level for use in dam construction
w/e 4/12 – placed 39.2 cm of gunite, drill/grout in PT & IT from 4/1 = 546 lf, about 4,500 cm of rock placed in d/s of dam, d/s borrow area 1 investigation delayed by farmer protests, river rising, u/s bridge soon to be overtopped and provisions being made for equip and labor transfer by cable
w/e 4/19 – tunnel gunite 24.4 cm this week, tunnel drill/grout = 353 lf this week, river rose 4/12 and holding steady at 28,000 cfs on 4/18, u/s bridge again accessible when river dropped to 25,000 cfs
w/e 4/26 – PT gunite 42.4 cm, Tunnels drill/grout 102 lf, u/s bridge crossing intermittent

May 1951
w/e 5/3 – short on engineering personnel, diamond drill idle no foreman, river high of 35,500 cfs on 5/2 and receded to 32,900 on 5/3
w/e 5/10 – u/s portal cofferdams complete, cont. diamond drill foreman delay for pressure test and grout tunnels, river high of 49,000 cfs on 5/7 receded to 38,300 on 5/10
w/e 5/17 – **need invert area solution for IT??,** 48 cm gunite, **gunite mix = 6 sacks cement to 1 cm concrete or 1 part cement to 4 parts sand,** Engineering short handed, river down to 30,000cfs
w/e 5/24 – pumping tunnel cofferdams, jumbos removed, dam grouting by diamond drill to start soon, drill and pressure tests in tunnel roofs resumed, total PT gunite is 195.5 cm and all clay seams considered complete, u/s access bridge crossing deck el of 966 m considered too low for 8,000 cfs diversion qty due to backwater effects and request redesign, river soon down to < 25,000 cfs to allow u/s bridge crossing,
w/e 5/31 – tunnel pumping cont, 37,700 cm of rockfill in dam to date, tunnel roof drilling cont, dam grout curtain started, no tunnel gunite, powder house complete, river still over bridge and has been since 4/14 except for 2 days 5/31, expected crossing 6/4

June 1951
w/e 6/8 – Pt u/s structure to el 973.23 m, tunnel roof drill and pressure test cont, drill and pressure test of left abut toe indicate tight w/ 1 gpm at 160 psi, u/s access bridge to be concrete decked, river at 14,000cfs and falling similar to last year

w/e 6/15 – u/s IT invert poured, u/s PT roof forming prepared for structure completion, preparing large rock for 1st stage river closure and diversion to tunnels, estimate 200,000 cm of spillway excess rock exc, drill/grout tunnels 1378.5' to date, dam grout 425.5' to date, river at 10,500 cfs at end
w/e 6/22 – steel imbeds at IT u/s portal, cont 1st stage diversion prep, river at 8,080 at end, dam grout 683 lf to date
w/e 6/30 – irrigating of borrow areas for last several weeks continues, river flow 6,200 cfs, grout reports verified against drawings tables & discrepancies noted, **mentions core trench grouting adjacent to left abutment as stations +103.6 to +119.4 which is impossible as these stations are at top of abutment between the tunnels???**

<u>July 1951</u>
<u>w/e 7/6 –</u> work slowed due to holidays, river at 6,200 cfs, impervious dam fill placed on completed grout curtain at left abutment toe to later build access road for dam construction, invert of u/s IT concrete lined section was placed
<u>w/e 7/13 –</u> work continued on both portal INLET CHANNEL bridges u/s and d/s (unfortunately, no drawings have been found to show the inlet channel excavation limits, EXCEPT FOR SKETCHES ON CERTAIN EXTRA COPIES OF BORROW AREA 3 BORINGS), upstream river bridge work continues; **left dam abut grout hole #46 at 10 m up from toe lost water circ at 18.5 m & drilled to 20 m, 4 hr pressure test had leakage u/s & d/s for 50-100' and in line at PT leakage = to 1" pipe flowed into it on river side;** river flow 5,360 cfs, gunite prepped to shoot left abut dam seams prior to grouting
<u>w/e 7/20 –</u> No attached drawing showing left abutment drill/grout progress, **hole 46 at 66' took 122 sacks cement** w/ numerous leaks in addition to those gunited and finally sealed and pressure increased to 150 psi w/ no grout leakage in PT, **additional seams cleaned** in prep of additional tunnel gunite plan and larger seam crossing inverts will be concreted and doweled, **plan to survey and tie dam left abut seams w/ tunnel seams (see dwg 27-95 R_2)**, **PT grout ring planned in line w/ dam curtain** and in 2 stages to allow high 2nd stage pressures and may be similar to high pressure ring of IT d/s of u/s portal structure, river at 4,160 cfs on 7/17, coming diesel shortage resulting in shift cancellations
<u>w/e 7/27 –</u> after study of both tunnels vert and horiz joints/seams many additional joints and some seams marked for cleaning and gunite, crews trnsf to PT cleaning, now plan to divert Aug 1 through PT while treating seams/joints in IT and completing u/s portal concrete, need gunite machine back from Arghandab to accomplish, boring crew in IT to pressure test near u/s portal, right abutment & toe cleaning planned w/ gunite sealing of surface seams in advance of drill/grout to stay ahead of coming diversion and dam fill, 90 sacks cement and 13 cm gunite to seal dam found jts and seams, river at 3,500 cfs, diesel back on 24th.
July 31 - Foundation treatment recommendations for abutments, river channel and tunnels **(see scan CD 4, B, item 13).**

<u>August 1951</u>
<u>w/e 8/3</u> – work concentrated on u/s portal bridges as 1st stage diversion started on 8/1, drill/grout of dam stopped for now, **diamond drill in IT busy with 137' exploration hole at 0+159 right side angled up at 25^0 and 60^0 to right w/ computed end el of 983 m and horiz distance of 124.5' about E4842 & N4732 w/ clay jt at 109' and several jts/seams at other depths, all day water test at 30-40 psi took 30 gpm later reducing to 18 gpm at 60 psi & small leaks in IT sidewall & in PT just below portal conc structure leakage occurred many places in roof and side walls following horiz seams however also several vertical jts that had previously been identified for gunite treatment**, grout spec received, stoplogs placed on IT and clay dike against them to keep dry, PT inlet/outlet channels opened and diversion started from both sides of river, river at 3,190 cfs at diversion start 8/1 & 2,800 cfs at end on 8/5, short on local drivers since layoff
<u>w/e 8/10</u> – **U/S cofferdam consists of u/s dam toe 2.5:1 rockfill slope w/ gravel/sand placed over rockill slope and subsequent clay blanket for water tightness, below the dam found and at the d/s toe of the 2:1 rockfill slope another cofferdam being placed across river channel & dam dewatering will start once sealing of both cofferdams is complete, all pumps reconditioned w/ limited available parts and adequate capacity unknown until start of pumping,** drill/grout on hold, crews cleaning seams/jts on left abut and IT, Gunite to start ASAP in IT from 0+700 & progressing u/s as fast as cleaning done, 2nd gunite machine still at Arghandab & could use 3rd setup, Extensive discussion of dam and tunnel seam and fault mapping, investigations and treatment as it may impact location of IT plug and schedule of dam raise prior to next flood season
<u>w/e 8/17</u> – **u/s cofferdam left abut contact is leaky and grouting w/ cement/clay/sawdust/straw is in progress, a secondary cofferdam was placed across**

the channel about 40 m d/s & at extreme u/s toe of the gravel zone w/ material suitable for permanent construction provided that foundation is stable and free from silt and clay and its u/s face blanketed w/ clay, 3rd cofferdam is located below the dam area & when completed will hold back water from entering the foundation work area, shortage of diamond drilling superintendent & drillers

w/e 8/24 – left abutment side of both u/s cofferdams still leaking severely, 6" churn drill added on 1st cofferdam in a curtain in addition to diamond drill holes to plug leaks, a trial pumping indicated the 1st cofferdam curtain was working, 5 pumps set at d/s cofferdam in preparation of final closure, the 2nd cofferdam will be extended thru the abutment haul road rock fill, pumping to start when grouting complete or extended cofferdam stops flow, 75 cm of tights in IT roof from 0+132.4 to 0+146.0 removed, discussion of downstream bridge **(current bridge to town on right bank)** design and construction

w/e 8/31 – drill/grout along 1st cofferdam from left abut towards right cont on 2 shifts since 8/14 w/ 2279 sacks cement to date, left abutment of 2nd cofferdam was extended through haul road to a tighter contact, all pumps set in lower cofferdam but only lowered level by 2 feet & now appears great deal of leakage is through is through clean gravels in cofferdam foundations, 4,300 cm in 1st and 4,700 cm in 2nd cofferdam, IT drill/grout is deferred due to cofferdam grouting

Two page Memo discussing "vacuum" triaxial tests and results of two Arghandab and one Kajakai samples is being added to the testing drawing tables.

September 1951

w/e 9/7 – 1st **cofferdam churn drill holes cont at 5' centers & grouting co**nt w/ some success in certain holes w/ cement/sand mixture placed by an air injector pot using 550 sacks this period and 2,829 total**, 2nd cofferdam CREST EL = 966.0**, was blanketed **w/ clay on u/s slope w/o reducing flow &** now dragline digging an **(?u/s record says d/s)** toe trench to rock for cutoff of foundation gravel leakage, IT drill/grout hole #15 from tower bench 0+142 el 994 230 down from horizontal along tunnel line to depth of 138' through 3-4 joints about 30' from tunnel roof near 0+167 w/ 5 gpm at 150 psi & leaked in tunnel roof in vicinity of 0+167, hole #16 at 0+157 left wall 136' deep 10 gpm at 120 psi,

Sept. 8 – Confirmation of Treatment Program **(see scan CD 4, B, item 14).**

w/e 9/14 – trench excavated below 2nd cofferdam as deep as dragline bucket would go & backfill started on 9/9 with borrow material and after 1 day's placement it was evident that cutoff was effective and by 9/11 water down across entire core trench and sump dug near d/s cofferdam

Sept. 20 – Work Plan for dewatering dam and core trench and piezometer cabinet and trench layout **(see scan CD 4, B ,item 15).**

w/e 9/21 – churn holes stopped & completed ones grouted, waste materials used to widen u/s cofferdam, water cutoff effective such that 2 pumps each at u/s & d/s handle all flow including abutment sluicing/cleaning water, 2 shovels removing silt/clay from dam cutoff trench found including unacceptable material already placed in d/s rock zone, IT seams/jts to now be excavated followed by gunite from u/s to d/s w/ max crew and equip, at **dam right abut el 980 and just below dam axis a shaft being sunk in fault which passes through the dam axis at station +400 w/ total depth of about 70'and a vertical concrete cutoff will be placed against the lower shaft wall & remaining shaft filled w/ select fill and capped w/concrete**, drill/grout delayed due to loss of lines in fire, d/s bridge has 5 pile bents driven and working on river bottom

w/e 9/28 – added 1 dam dewatering pump due to extensive abutment sluicing, most of dam foundation exc going back into rock section, cleaning /gunite of IT done all week, 16 of 18 pile bents driven in d/s bridge, 1st right abutment fault shaft exc to 70' depth

Sept. 28 – Consultant visit and comments **(see scan CD 4, B, item 16).**

monthly – river at 2,300 cfs through PT, waste material further extends 1st cofferdam u/s **which may enhance stability if extension limits can be found**, spillway excavation and wasting of bad rock is way behind schedule, **2nd cofferdam pervious sands/gravels will be reworked to required placement requirements**, dam foundation core trench cleaning for drill/grout, **IT joint/seam series near sta +220 requires much cleaning and gunnite**, right abutment shaft almost completed to 70' where the fault crosses the spillway road, a 6' wide vertical clay joint was found at sta +339 crossing at axis at 90^0 with its beginning at intersection of main fault which runs down the right abutment and toe of slope and 27m d/s from axis sta +345, urgent need for Engineering inspection help

October 1951

w/e 10/5 – discontinuing weekly reports due to lack of manpower, 12 grout holes drilled in dam curtain for 676' from both abutments towards river, dam grouting with more take towards river than left abut side w/ all seams sealing nicely w/ 297 sacks cement in 10 holes, IT 3 drill/grout holes for 180', a pump placed in lower core trench for dewatering, core trench complete to lower river channel where fault found which will delay completion of dam core trench, excavation of dam d/s toe trench to rock completed, dam d/s toe trench rockfill partially done & to be completed w/ larger rock from spillway exc, IT seam cleaning to 0+260 and gunite to 0+230, 1st abutment fault shaft finished and 2nd one down 20' w/ other locations not yet decided, d/s bridge caps bracing and stringers started w/ decking to be done at night shift, piezometer tip #4 installed

<u>w/e 10/12 –</u> initial field densities at 94% (below requirements) because moisture too low and inadequate compactive effort, later densitiesimproved to minimum 96% requirements with moisture at 1% below optimum, pumps installed between 1st and 2nd cofferdams to dewater (and excavating waste to prepare for transition zone fill), all dam core trench bedrock exposed except vicinity of 2 faults that run at right angles to axis w/ drilling and shooting boulders in faults and laborers w/ picks/shovels exc pots and seams, seams along right abutment cleaned and gunited and dam bedrock cleaned, spillway rock placed/sluiced into d/s section and some gravel from borrow and from core trench placed in gravel zone and impervious placed in left end of core trench, IT seam cleaning continued w/ no gunite done, 2nd abutment fault shaft continued slowly due to boulders encountered, 8 spans of d/s bridge completed, <u>hard copy of piez/ fill tests attached</u>

Oct. 9 – treatment of faults and seams in dam foundation **(see scan CD 4, B, item 17).**

<u>w/e 10/19</u> – plane table survey of seams/jts/faults is finished, rock between the 2 dam foundation faults is cap rock with an unsound horizontal material at depths of from 7'-12' and this cap and unsound material is being removed, **,** dewatering between 1st/2nd cofferdams will require additional 1st cofferdam grouting, limited right abut seam cleaning/gunite, some IT seam cleaning done w/ no gunite, d/e access bridge nearing completion, abut fault shaft #2 cont slow due to water ingress from diamond drills and clay sloughing, <u>mentioned lab report is missing</u>

<u>w/e 10/26</u> – pumping between 1st/2nd cofferdams was stopped to allow rock placement on d/s slope of 1st cofferdam while churn drill continued to drill grout holes on right end of 1st cofferdam to seal leakage, dam foundation exc virtually complete w/ 4,020 cm loose this week and placed in dam embankment, shaft necessary in left fault and was started on right boulders & gravel still being removed w/ indication that rock to be encountered soon, grout curtain has reached fault area from both sides and grout holes going down in the rock between faults, gravel & transition from borrow was placed on the 2nd cofferdam & the upstream transition section, core trench seam cleaning and gunite was completed to the edge of the right fault in core trench leaving only area between faults to finish the bottom, no gunite placed on abutments, IT seams cleaning to 0+400 w/ no gunite placed, d/s bridge completed except for hand railing and road bumpers and right bank approach fill, abutment fault seam 2nd shaft to be extended to 70' per San Francisco and at 60' and 3rd shaft in left fault at core trench bottom was started, Lab Report scan (pages 4e and 4f) contains good description of main dam fault extension and gouge material description and also contains test results for Arghandab Dam

Oct. 20 – Impervious fill compaction **(see scan CD 4, B, item 19).**

Oct. 29 – Inspection and status of fault excavation and treatment at dam foundation **(see scan CD 4, B, item 18).**

<u>month</u> – fault gouge material testing done, river jumped from 2,350 to 2,800 on 10/27, (PECULIARLY) the 1st cofferdam d/s side was extended into the rockfill zone by first removing undesirable material with dragline underwater along d/s toe of 1st cofferdam to form trench and tunnel muck was dumped into it in hopes of reducing seepage sufficiently to completely dewater this area of rockfill zone between cofferdams 1 and 2 for later placement of select rockfill from spillway excavation, drill/grout takes was checked against drawing table and discrepancies noted

<u>November 1951</u>

<u>w/e 11/2</u> – clay joint located along toe of right abutment and parallel to river u/s of curtain line and station 0+335 was excavated to 4' depth and backfilled w/ concrete w/ 3 density test taken of natural material below concrete and the results indicate it is well compacted 100% & 115% of optimum (Lab Report scan pages 1f & 1g) for two separate material color/type and meets sound foundation requirements, the 70' shaft concrete also on grout curtain 0+335 was placed and metal water stop joint made to the trench slab concrete section placed a few days earlier, the clay joint ends at a point of intersection w/ the main right abutment fault 29 meters d/s from the dam axis station 0+345, IT grout ring at 0+486 has 7 holes completed for 480 lf w/ 4 holes refusing grout at 150 psi, grouting of 4 holes at 0+185.5 and 192.5 also refused grout at 150 psi, dam curtain drilling of 588 lf and 10 holes grouted w/ 447 sacks take, abutment shaft #2 at 0+335 and 14 m u/s completed to 70' depth and took 87 cm of concrete and clay joint trench u/s of curtain took 42 cm concrete, river increased from 2,700 cfs on 10/18 to 4,000 cfs on 10/30 w/ no damage but much pumping of 1st cofferdam leakage, flow now bit more than 2,700 cfs w/ u/s bridge under few inches of water

w/e 11/9 – decision to irrigate borrow areas (very good one) well ahead of usage to achieve optimum moisture, dam foundation excavation essentially complete except for some minor hand work, river leveled to 3,025 cfs from 4,000 cfs flash w/ u/s bridge deck under few inches of water, IT seam cleaning and gunite up to dam axis intersection, 31 shaft on spillway road was filled w/ concrete and #3 shaft in left core bottom fault was down to 15', Lab Report (scan page 2g) indicates joint backfill material with Optimum of 113 lbs/cf and 15% moisture to have densities of 102% to 96.5% with average of 98% of Optimum

w/e 11/16 – some additional check holes to be done in IT to verify gunited intervals, churn drill grouting of u/s cofferdam right end continues but still unable to lower pool completely, 2-3 days of IT seams and gunite remaining, work resumed on #3 fault shaft in abutment, Lab Report (scan page 3g) indicates impervious contact material placed at 98% to 102% of Optimum

w/e 11/23 – it has been decided that the entire left abutment impervious core contact area will be gunited, tunnel muck rockfill placement was stopped after 1,850 cm due to unsatisfactory sluicing and until nozzles provide adequate quantity of water, dam foundation exc concluded w/ 500 cm removal mostly by hand and remaining is cleaqnup and fault exc, some final gunite performed and right side of core trench is ready for impervious material placement following final ok, one 2,700 cm of d/s rockfill was rejected and removed with part placed in other parts and some wasted, hand tamping done along contact on right abutment and some impervious placed there but core trench needs to be brought up to level of rest of fill before more can be placed there, gravel placement in u/s section halted until test pits can be excavated to verify satisfactory placement, with new abutment fault excav size and depth drilling and mucking was again started at top and excavated d/s of shaft while concrete was placed in right fault, Lab Report indicates impervious core contact material densities ranging from 98% to 103% for hand compaction and typically 99% for traffic compaction

Test pits being excavated in cofferdam to determine the condition of the remnant foundation material and the "relative density" of the cofferdam soils. Test pits were located in relation to the dam axis as as follows:

Station	**Offset (m)**
0+262	**51 rt**
0+312	**56 rt**
0+278	**107 rt**
0+305	**111 rt**
0+309	**79 rt**

Also contains Arghandab Dam shear test results several of which fail the 17^0 requirement (see scan pages 4h & 4i).

w/e 11/30 – foundation prep included hand cleaning left abutment and gunite in core trench area around the shaft locations, right fault is compacted backfill to bedrock level on each side, new sluicing nozzles performing satisfactorily, abutment left fault between the two shafts was excavated and backfilled w/ concrete and main shaft widened at collar in accordance with new plan and masonry collar started, drilling in enlarged shaft was resumed and area d/s from 2nd shaft was cleaned out to the transition zone ready for concrete; **Two shear strength test results for Arghandab Dam on scan page 5d**

month - mentioned lab tests not found, 7 pumps to dewater between 1st & 2nd cofferdams, 1 pump u/s of impervious fill at river channel, 1 pump at d/s cofferdam, dam foundation curtain grouting completed to el 970, IT fault seam excavation is 682 cm to date

December 1951

w/e 12/7 – hand cleaning of both abutments w/ gunite on left and finished gunite around shaft collar, large rock into d/s toe trench and d/s slope, left abutment fault masonry collar around the main shaft in the left fault was completed to allowable height and the 15' shaft d/s from main shaft was excavated to depth and backfilled w/ concrete, excavation continued in main shaft

w/e 12/14 – excavated 300 cm in 5 x 6 x 10 m shaft located 14 m u/s of dam axis station 0+261.5 requiring drilling and blasting & excavation by hand and clam shell, total abutment seam excavation to date = 1,255 cm, gunite of seams continues both abutments, **Lab Report piezometer #1 - #6 tip locations were compared to summary sheet and discrepancies noted.**

w/e 12/21 – still trying to seal 1st cofferdam leakage with little additional success, continue abutment seam cleaning and gunite, abutment fault excavation continued w/ bad ground requiring timber support, sheet pile ring around shaft collar was started
w/e 12/28 – cont 1st cofferdam sealing w/ little improvement, abutment fault shaft excavation reached el 941.5
monthly - 1st cofferdam sealing by jetting sand and clay at 10 to 25' depth with considerable success and believed that removal of waste material will be successful with dragline to bottom of riverbed, flash flows of 10,000 to 15,000 cfs anticipated in February and necessary to prepare IT for additional diversion flow and should be achieved by 2/1, a fabricated steel arch form is successfully accelerating IT concrete arch placement, bottom of the main collared shaft at the required 100' depth is 925.5, **34 impervious fill density tests taken with most taken in the contact zone (< 1/4" size) due to coarseness of the "random" zone and unreliability of the reference test, Summary results for the < ¼" material follows (see scan page 6e):**

Value	**Lowest**	**25%**	**median**	**75%**	**Highest**
% Optimum Dry Density	**88(1)**	**95**	**97**	**100**	**102**
Dry Dens. Soil and rock	**102**	**107**	**110**	**112**	**115**
Optimum Dens, lbs/cf Standard Comp.	**109**	**112**	**113**	**114**	**121**
Placement Moisture from Optimum	**0**	**-1.5**	**-2.5**	**-3.5**	**-5.0**
% passing ¼" sieve	**97**	**98**	**100**	**100**	**100**

(1) Where densities were < 93% OD (3 cases), additional compaction and check densities were taken. When < 95% (7) cases) additional rolling or tamping was specified.

January 1952
w/e 1/4 – no lab test results found, mid-river channel fault shaft excavated to 53' w/ 47' to go & estimating 2/1 completion & 2/10 concrete, it is estimated that spring runoff of about 10,000 cfs will flood u/s bridge deck of el 968.3 and therefore the shovels must be removed from u/s borrow by then or be stranded by rising backwater & also want to remove and salvage timber decking, downstream borrow is bone dry and requires flooding irrigation for moisture conditioning prior to placement, **still jetting to seal 1st cofferdam**, last of tunnel muck stockpile used in dam w/ remainder wasted as too dirty, large rock from spillway excavation going to blanket d/s face and into toe section, slow progress in main shaft exc.
w/e 1/11 – main shaft to 60', staff gages installed at u/s and d/s portals, **1st cofferdam jetting w/sand/water continues w/ little sealing effect**, about 2% of spillway excavation is unacceptable rockfill and wasted, d/s rock bench placement at el 990 m and haul road reconfiguration will eliminate d/s face road and need to cross d/s portal channel bridges for dam access, abutment fault decision to reduce shaft size and concrete the sides to current depth prior to excavating deeper, alternate dam haul road construction from above ongoing.
w/e 1/18 – **1st cofferdam jetting continued w/ improvement in lowering d/s pool level**, main fault shaft concreting from narrowed depth at el 938.5 to top el 959.0 complete & excavation to continue after form stripping, grout pipes were installed at various shaft depths of rock/concrete contact, the main clay gougehas pinched down to about 7.5' thick and test holes had been drilled in the questionable quality (left) wall and verified sound rock, continued shaft excavation will proceed in a 10.5' wide by 12.6' length for a depth of 40', IT interior concrete complete w/ exterior concrete to el 975.5 construction joint and el 976.1 at trashrack, **density test were performed and summarized for impervious (hand tamped at shaft and right abutment) and "coarse" impervious (rolled fill) in the following table:**

Value	**Lowest**	**25%**	**median**	**75%**	**Highest**
	Hand Tamped at shaft & abutment				
% Optimum Dry Density	**91**	**98**	**100**	**102**	**104**
Dry Dens. Soil and rock	**114**	**117**	**124**	**126**	**132**
Optimum Dens, lbs/cf Standard Comp.	**111**	**115**	**117**	**118**	**122**
Placement Moisture from Optimum	**-5**	**-2**	**-1**	**0**	**0**

% passing ¼" sieve 87 94 96 98
100

Lowest 25% Rolled fill median 75% Highest

Value

% Optimum Dry Density 96 100
105
Dry Dens. Soil and rock 140(1) 144(1)
150(1)
Optimum Dens, lbs/cf Standard Comp. 120 120
126
Placement Moisture from Optimum -3 0 0
% passing ¼" sieve 80 82
84

(1) These values seam excessively high and possibly erroneous (2005 comment)

A summary of large scale percolation test data for foundation, transition and pervious material which includes in-place density, mechanical analysis and perc values will be compiled into a data base (includes borrow samples as well)

w/e 1/25 – revised topo profile made at intake tower bridge alignment, point of intersection of IT centerline w/ extended dam axis is N4832.42 E4585.45 at IT station 0+492.73, spillway excavation to uniform el 1060 m level, remaining rockfill for d/s to reach el. 990 is 81,500 (loose measure) and for u/s to reach el 972 (tunnel roof el) is 40,000 cm and 200,000 cm to reach el 990, Balance of dam fill to el 990 and to complete are as follows:

Balance (cm) to Construct Dam		
Fill Type	**El 990 level**	**Completion (el 1050 crest)**
Rock & Earth	960,500	2,758,000
Rock	281,500	998,000
Earth	679,000	1,760,000

While pumps operating between 1st & 2nd cofferdams the dragline is removing clay from 2nd cofferdam face and as soon as bottom of pool is dredged out it will be backfilled with rock, dike in front of IT is being removed, stripping forms from main fault shaft concrete, stripping of IT portal forms, isolation ward established for typhoid patients

monthly – on night of 1/28 river diversion through IT began resulting in noticeable backwater drop which eased the dewatering between cofferdams 1 and 2, dragline removed 13,000 cm of unsuitable material (1/20-31) between cofferdams (from 90 m u/s of axis to about 195 m u/s of axis) and replaced with select clean sand/gravel from new u/s borrow placed on contact excavated to original riverbed gravels (scan page 6d sketch tends to verify this**), Lab Report reference made to abutment contact ("random") material placed at an average dry density of 151 lbs/cf (6 tests) ranging from 91% (one case) to 105% of the optimum (sounds high, but confirms the high values of data for 1/15/52)**

February 1952

w/e 2/1 – main fault shaft excavation resumed to 79' depth, haul road to left rock bench at el 990 now in use.

w/e 2/8 – all dewatering pumps removed until about July when IT will again be cofferdamed and concrete resume and equipment installation start, dam abutment grouting resumed w/ 7 holes and 150 lm drilled and 10 holes grouted w/ 1-49 sacks/hole take between 0+393 and 0+436, **grouting of main shaft concrete/rock contact was performed after concrete set/shrinkage and these takes were verified against sidewall drawing data and grouting also occurred at concrete base for which this data was added to the drawing**

w/e 2/15 – estimating about 60,000 cm/week placement thru May 1 when high water expected versus optimistic 75,000/week, large rock shortage for d/s zone placement so most spillway rock going to u/s zone, 3 right abutment dam grout holes drilled for 57.3 lm (70 sacks) and same 3 holes took 5.5 cm grout w/ max 26 sacks at 0+384 hole, river rose then settled at 14,000 cfs w/ bridge decks and some borrow under backwater, impervious filled placed in core trench after shaft area cleanup, d/s large rock placement from 980 to 970 berm holding up 980-990 rock bench closure, d/s bridge now complete, **Lab Report indicates that typically field densities will be taken 3 times/day with 2 tests/time = 6 tests per day and 42/week of which 3-4 taken in gravel (free draining), 1-2 in transition and the balance in impervious abutment (tamped) contact and rolled section. A total of 16 tests (taken between 2/1 & 2/14, all impervious) were taken within a total of 7 days with 1-4**

tests/day, likely that fill placement did not occur everyday and reports indicate impervious and gravel was placed during this period, the data applies rock correction and 3 of 5 abutment samples indicated inadequate compaction (for material with 2-15% > ¼") and 6 of 11 rolled samples indicating inadequate density (92.3% to 97.8% compaction versus 98% required) for material containing 5.3 to 52% > ¼" (< 40% required), % > ¼" was the only gradation parameter indicated, no comments regarding reworking of fill. A total of 15 more tests (taken between 2/6 and 2/14, on 4 separate days) of which 6 were transition (4 failed) and 10 were gravel (8 failed). There were no indications of reworked material within the available documents. Data will be compiled to summarize engineering properties of dam material zones.
w/e 2/22 – three 66' 1st stage grout holes drilled and grouted w/ max 21 sack take in 0+055, river down from 14,000 cfs on 2/15 to 5,000 cfs 0n 2/22 w/ bridges undamaged w/ 3'-4' of overflow,
monthly – concerns regarding required placement qtys/schedule, u/s portal bridges being removed, renewed abutment contact excavation , **significant tabular summary of dam drill/grout data was compared to data on drawings and discrepancies noted**

March 1952
w/e 3/7 – dam grout hole #45 at 0+197.5 drilled to 40.2 m depth w/ 1st stage (66') 18 sack take and bottom stage 2 sacks, u/s portal bridges removed, more right abutment exc of steep section w/ very little remaining to finish
w/e 3/14 – Scheme "D modified" to el 983 m requires 210,000 cm more fill, expect to achieve this or better by May 1, 3 holes drilled and grouted on right abutment to 28', 66' and 66' w/ grout takes between 17 and 10 sacks/hole, river to 15,100 cfs and el 969.63, 41, 750 cm earth/rock placed.
w/e 3/21 – 52,800 cm earth/rock placed, hydrograph records for past 4 years indicate earliest peak flow of 50,000 cfs on April 27, 1949 while the diversion tunnel discharge graph on Dwg. 10-F-4 indicates a lake level of 981.0 with both tunnels discharging total of 50,000 cfs, river flow decreased from 15,100 cfs on 3/14 to about 11,000 cfs on 3/21,
w/e 3/28 – after heavy rain on 3/25 the river rose to 29,000 cfs, w/ minor damage to d/s portal bridges, reservoir level reached 972.65, 54,600 cm of earth and rock placed this week
monthly – mentioned test data not found attached to this report, average impervious fill level is 978.0 m, **average abutment gunite thickness placed is 3 ¼" w/ right abutment thickness greater than this due to roughness of surface**

April 1952
w/e 4/4 – river decreased from 29,000 cfs on 3/28 to 18,250 cfs on 4/3, balance of right abutment steep rock face was excavated to a uniform slope, 67,000 cm of earth and rock placed this week
w/e 4/11 – river increased from18,250 0n 4/3 to 22,900 on 4/10, 68,500 cm of earth and rock placed
April 17 – Pervious material sub zoning proposal due to inadequate permeability results **(see scan CD 4, B item 20).**
w/e 4/18 – due to gravel borrow pit percolation test results the gravel zone will be sub-zoned with more pervious gravels in the outside halves and less pervious gravel within the inside halves, left abutment grouting takes ranged between 26 and 1 sacks w/ concreted shaft hole took 3 sacks, river flow increased from 22,900 cfs 0n 4/10 to 28,600 cfs on 4/18, average height of earth fill is about 984.5, the piezometer cabinet was put in place
w/e 4/25 – one dam grout hole took 9 sacks, river flow decreased from 28,600 cfs on 4/18 to 22,000 cfs on 4/25, right abutment scaling is complete, the average earth fill el is 986.5
April 28 – Compaction Modifications to avoid inadequate densities (see scan CD 4, B, item 21). Memo implies that all densities are inadequate and the cause attributed to non-systematic use of rollers. Roller direction taken over by engineering, resulting in improvements but still failing densities. Further improvements made by systematic rolling and resulting in 4 passes of single roller for the outer gravel and 6, 8 and 10 passes of tandem roller for the inner gravel, transition and impervious zones respectively. Also implication that better moisture control is needed. There is no comment regarding whether the densities became satisfactory in all zones.
April 28 – Right abutment fault treatment status and plan **(see scan CD 4, B, item 22). Planning to excavate a 3' x 4' x 30' or more deep shaft at right abutment seam intersection with axis at station +405 and the seam between this shaft and the previous d/s shaft will be excavated to a depth of 2' and concrete placed to key into the cleaned sound rock on either side**
monthly - the test data was not found, total earth and rock this month was 319,600

<u>May 1952</u>
<u>w/e 5/2</u> – river decreased from 22,480 a & el 971.47 on 4/26 to 19,650 & 970.76 on 5/1, piezometer tubing raised and backfilled once per week, <u>gravel compaction memo where request to use modified proctor size mold as density reference (at within 5% of same % compaction as for standard mold) was recommended to not be implemented, they have been unable to achieve required density with standard mold and (?smaller max size?) I suspect</u>
<u>w/e 5/9</u> – single dam grouted hole took 35 sacks, river level rose sharply to 23,885 0n 5/3 from 19,655 on 5/1 then receded steadily to 17,900 on 5/7, 5- 30' section of 84" conduit welded
<u>w/e 5/16</u> – the proposed right abutment (fault) shaft was marked and scheduled to go to 91' depth, river continued to decrease from 17,900 cfs on 5/7 to 12,000 cfs on 5/18, apparent early runoff looks favorable that flow may decrease to 5,000 cfs by 6/10 allowing use of u/s bridges earlier than anticipated & on about 6/25 flow may decrease to 3,000 cfs & the entire river can again be diverted through the PT advancing last years single tunnel diversion of 8/2 by 38 days, 6-30' sections of conduit welded, fault shaft at axis station 0+405 started, 87,600 cm of earth and rock placed
<u>w/e 5/23</u> – Earth section el now 988.3 m. It is noted that maintaining the earth sections about 10 m above the rockfill section allows for maximum fill placement rates and this method has been in effect for about 6 weeks. fault shaft depth to now be 30' deep, 3 dam grout holes take between 50 and 2 sacks, serious concrete sand shortage requiring investigations, local sands are usually too fine, river slowly decreasing from 12,000 to 11,050 cfs on 5/24, significant silt was deposited in lake u/s of tunnel portals, planning to initially divert through IT to rehab any damaged PT concrete at stoplog location, concrete in intake tower started. Discussion regarding the imbalance (deficiency) of available rockfill versus earthfill such that either earth fill needs to be slowed for ideal 10m bench differential for idea rockfill placement or earth fill will be completed far a head of rockfill and result in overall schedule loss due to difficult and perhaps less well placed rockfill
<u>w/e 5/30</u> – river down to 9,350 cfs on 5/31, runoff following1949 graph indicating 3,000 cfs on 7/10, still plan to first divert through IT, shortage of compressors delaying rock exc, 66,900 cm earth and rock placed
<u>monthly</u> – no test data found, 306,300 cm earth & rock placed, average rockfill el is 989.0 earthfill el 997.5 a difference of 8.5 m, need to keep the earth fill 10 m ahead of rock to enable access for 10 m bench rockfill placement, need to double rock excavation to accomplish this and need more drills at spillway, river at 9,350 cfs on 5/31 compared to 25,000 cfs same date last year

<u>June 1952</u>
<u>w/e 6/6</u> – PT hole #1 2 stages to 100' depth from above tunnel and angled into area of water leakage into tunnel from hole #14 and took 130 sacks sealing at 180 psi, river decreased to 7,425 cfs on 6/7, 71,500 cm earth placed w/ only 9,200 cm rock & **short 32,000 cm rock for balanced operation**, right abutment fault shaft is now at 14' depth
<u>w/e 6/13</u> – average earth el = 1002.6 & average rock el = 990.8, river level down from 7,425 cfs to 5,650 cfs on 6/14, 61,900 cm earth & 18,400 cm rock **w/ 50,600 cm rock shortage for balanced placement**, using a tower elevator lift and auto bucket to place concrete on tower and working well, right abutment fault shaft down to 18'
<u>w/e 6/20</u> – average el of earth is 1003.5 and rock is 992.0, grout holes 15 & 16 located along abutment slope in the u/s gravel contact zone at a point which would intersect the 2 joints which appear to continue on into the PT opening below the proposed concrete plug location and took 50 & 70 sacks respectively, river decreased from 5,650 cfs on 6/14 to 4,540 cfs on 6/21, expect flows < 3,000 cfs = reservoir el 966.8 to be diverted through one tunnel by July 1 while bridge deck at 966.9, there is 8' of mud and silt deposited on road to be cleaned up, 21,000 cm rock and 57,000 cm earth was placed this week
<u>w/e 6/27</u> – river decreased from 4,540 to 3,880 cm on 6/28, 25,600 cm rock and 36,200 cm earth were placed this week
<u>monthly</u> – earth fill at 1005.5 while rockfill at 993.7, river at 3,555 cfs on 6/300 as compared to 7,000 cfs on same day last year, pressure grouting around the portal intake structures was performed in the fractured rock for water-tightness which had not been anticipated in design, 3 significant joints have been cleaned located and gunited on the left abutment u/s of the dam and are shown on dwg no 27-85 R1, the right abutment fault shaft excavation has been completed to 28' of the required 30' and is the last of 4 seepage cutoff shafts. Two page memo discussing the gravel reference density testing standards of the March 1952 revision to the gravel zone from original "dumped in windows or piles and compacted by machinery or sluiced and preferably sluiced" to placed in 4" and 8" loose lifts at abutment and main dam

respectively and compacted by heavy power tampers and at least 3 passes of minimum 2 tons /linear foot rollers and achieve 95% of maximum laboratory test density defined as 112,500 foot-lbs/cf. Original criteria of 41,413 ft/yr permeability and friction angle of 340 remained although the permeability could not be achieved with available material and coarse and fine gravel sub-zones were initiated 4/15/05 through 7/1/52

July 1952

w/e 7/4 – river decreased from 3,880 cfs to 3,024 cfs on 7/5, 23,450 cm of rock & 47,640 cm of earth were placed this week

w/e 7/11 – river decreased from 3,024 cm to 2,755 0n 7/12, on 7/6 the cofferdam in front of the PT stop log structure was closed and river diverted through the IT, 2 concrete stop logs were placed in the PT slots 7/8-9, removal of the PT cofferdam & construction of a similar cofferdam was performed at the IT on 7/11, 34,900 cm of rock & 67,200 cm of earth placed this week, gravel zone has been subdivided into coarser outer and finer inner subzones starting at elevation1005 u/s & 1008 d/s as compared to minimum reservoir operating level of el 1008, **included 7 pages of information which tabulated and summarized percolation, shear and reference density tests from start of fill placement through June 30, 1952, it includes reference density, but not the in place density if taken**, following drawings were completed or revised:

- Valve House Exc Plan FSK-27
- PT Portal Structures – Drill & Grout
- Treatment of Found – Joints & Seams FSK-30
- Found & Abut Treatment FSK-31

w/e 7/18 – 21,300 cm rock & 40,400 cm of earthfill were placed this week to el 1009.8 earthfill, river decreased to 2,600 cfs on 7/18 w/ sudden rise on 7/18 to 2,970, cofferdam closure of IT on 7/13 and start preparation of timber stop log closure to better seal and completely dewater in few days, gunite of abutment slopes has been ongoing throughout and continues, drilling & grouting also been going on throughout & continues, piezometer installations are complete, placed 15 cm concrete in rather large cavern 2 m u/s of dam axis left abut at 0+1008 and grout pipes installed for later contact grouting of shrinkage voids, 21,300 cm rock & 40,400 cm earth placed this week.

w/e 7/25 -

monthly – 225,760 cm of fill placed, average max elevation of dam was 1011.0, downstream rock to el. 1,000 and upstream to el. 995, river flow was 1,980 cfs on 7/31 versus 3,190 cfs last year, the valve house excavation was started (see FSK-27 for outline), drilling for the IT plug and rotovalve section was started, 851 ms of gunite was installed in both abutments between el 1008 & 1016, 6.9 cm of grout placed in dam foundation and 3.0 cm in PT portal, intake tower to el. 1008.35 & 256 cm total concrete, completed 30 foot shaft on right abutment station +405 & backfilled w/ 38.8 cm of concrete, excavated cavern on left abutment at station +186 & el. 1009 w/ 15 cm of concrete and later pressure grouted, **no soil data found** SEE SCAN PAGE 6Z2 – CONSTRUCTION PROJECT MAP

August 1952

w/e 8/1 – river flow decreased from 2,303 cfs on 7/26 to 1,851 csf on 8/2, drilling rotovalve chamber enlargement, 6-84" pipe sections welded to form angle section, problems with rockfill sluicing water pressure.

w/e 8/8 – Reference made to Kajakai Dam Foundation Treatment Memo of July 31, 1951 by J. B. Hays which defines treatment requirements for clay filled seams between the tunnels and dam abutment contact u/s of the core section to include 1. tunnel jts to be cleaned out and gunited and the abutment jts sealed (unspecified, but final solution appears to have been to gunite the entire tunnel abutment side). The memo and a site response regarding one method of sealing seams by shot drilling across them. These documents are available on valve house document scans CD 4 – in the file named "memos, specs, consultants". A field map of surface joints was prepared and forwarded to the main office and requesting advise on how to achieve Hays' requirements. The earth zone is to el. 1014 m. Valve house excavation is behind schedule. River flow at 1,809 cfs all week. Valve chamber and plug roof & sidewall drill and blast is completed. Low pressure grouting behind u/s IT portal concrete is being performed. Sluice pump problem for rockfill was resolved. SEE SCAN PAGES 2h and 2i of w/e 8/8 for field memo regarding altering the rock section by incorporating coarse gravel/coble material with fine sand and silt into rockfill (attached). This is due to reduced availability of "clean" rockfill from spillway excavation (due to fault area and weathered surface rock) and from previous tunnel muck.

w/e 8/15 – Valve House excavation was staked out. The masonry retaining wall for haul road above valve house portal is within exc and will have to be removed. Earth section to el 1015.7

m. River flow decreased to 1,688 cfs by 8/16 (was 2,500 cfs last year). Drill/blast of IT plug and rotovalve chamber invert is completed. Intake tower concrete to el. 1017 m. Manhole openings being welded onto the irrigation pipes. Also field change regarding substituting 3 pipe sections marked MK-CL for those marked MK-GC & GD (not yet available). I believe these would be the pipe sections to be embedded in the plug concrete to avoid schedule delay. Manholes to be shifted on pipes, but same station shown on drawings. Invert jts in IT being cleaned out and filled w/ concrete at +210 to +220.
w/e 8/22 – Earth section to el 1017.8. Pressure grouting behind IT portal concrete continues. River flow steady at 1,610 cfs. Tights being excavated in plug/chamber area of IT. Forms and steel for 2nd stage u/s portal (previously delayed to avoid damage from d/s portal blasting) was completed. Revised change request for substitute of delayed conduit sections = the various lengths to be made up of cutting lower ends of pipes marked MK-G, MK-GGR & MK-GGL. Cleaning IT jts between +210 & +250 continues.
w/e 8/29 – 1-2 pages missing. 2nd stage IT u/s portal to el. 971.64. Final placement to be next week. 1st IT plug concrete placed in invert. Cutting for and welding of 6 manholes as shown on drawings was completed. Pipe substitution cutting to start next week. IT seam cleaning and concrete delayed due to no air.
monthly – earth section to el. 1018 m w/ 293,400 cm placed of which 115,450 is rock. 1,300 cm of rock excavated from completed IT plug and chamber. 82 cm of dam abutment gunite placed. Predicting about 31,000 cm of rockfill deficiency from spillway. Intake tower concrete to el. 1025 m. IT tunnel faults & seams completed from +190 to +250. Completed 8-high pressure plug grout holes. Water curing of concrete mentioned.

September 1952
w/e 9/5 – IT drill/grout is behind. Several visitors from headquarters (US) toured the site. IT invert gravel placed for equipment access is to be removed prior to tunnel use to avoid possible conduit and valve damage. River flow 1,690 cfs on 9/6. Drill/blast completed for valve house excavation. No gunite of dam abutments. Final IT portal concrete placed. Conduit concrete encasement started between +744.5 and +823.0.
w/e 9/12 – Earth section to el 1024 m. Rotovalve chamber drill and grout between +722 and +742 being done per drawings. River flow increase to 1,788 cfs on 9/13. Some additional drill/blast for rotovalve foundations. Intake tower forms to el 1033.4 & requested substitute 1" steel for 1 ¼" steel until larger steel arrives. IT portal form removal & concrete curing. 2nd plug concrete placed in d/s ½ . 1st concrete placement for rotovalve made to 18" below conduit at 4 places. Concrete encasement of conduits started last week was completed to el. 961.7 m.
w/e 9/19 – Two high pressure grout rings in plug and one in rotochamber were completed with all holes tight. Intake tower lift six (to el 1032 m) used 1" rebar in lieu of 1.25". Preparing to install misc. metal for gate, stoplog and trashrack. River flow to 1,800 cfs on 9/19. 35,730 cm of dam fill placed.
w/e 9/26 – A brief written report is mentioned concerning the treatment of jts in the two tunnels and discussion of remaining treatment work – **THIS REPORT WAS NOT FOUND HEREIN NOR LOCATED ELSEWHERE**. Drill/test/grout of plug & rotovalve area completed. River flow 1,900 cfs on 9/26. 56,950 cm of dam fill placed. Indicates 5-24' holes were drilled/grouted under abutment gunite. All conduit saddles from chamber to portal were placed. Nine sections of conduit were placed and welded completing the plug section. Excavation & drypack cement backfill continues in tunnel seams (dry pack has been used for several weeks, in lieu? of gunite).
monthly – Concrete break and compaction data indicated, **but not found**. Drill/test/grout drawing indicated but not found, HOWEVER THERE EXISTS SIGNIFICANT NUMBER OF FINAL AS-BUILT DRAWINGS FOR DAM GROUTING AND SHAFTS AND APPARENTLY MANY SIMILAR DRAWINGS FOR TUNNELS AND THEREFORE SUCH INTERIM DRAWINGS WILL NOT BE BROUGHT UP HEREIN IN THE FUTURE. 243,649 cm of dam fill was placed & earth section was to el 1027 m. SEE SCAN PAGES 6c, 6d & 6y for tunnel grouting itemized high pressure and treatment holes. A significant aerial survey was performed of the Arghandab and Helmand Valleys. See scan file 6x for details.

October 1952
w/e 10/17 – Consulting Engineer Savage (see Sept 1951 Field Report from CD 4) visited site with other dignitaries. River flow 2,208 cfs on 10/15. Four stoplogs were poured. Valve House excavation found sound rock at 1-2 m below required excavation elevation. The IT discharge stilling basin slab was placed with about 335 cm of overbreak concrete & 196 cm of planned concrete between stations 836 & 856 & to minimum rock elevations.

w/e 10/23 – Rebar placed for the stilling basin walls. River flow of 2,351 cfs on 10/24. 58,480 cm of dam fill placed. Concreting of valve house started. Six PT stoplogs were poured. Intake tower lift #8 was formed.
w/e 10/31 – River flow of 2,449 cfs. U/s bridge deck is 1' under water. 64,525 cm of dam fill placed. Valve house concrete from station 836 to 841.5 & el 962 to 18" below top of conduit. Jet valve saddles formed and poured. Continued welding flanges in the rotovalve chamber. Still erecting trashrack guides. Total of 16 PT stoplogs completed for placement.
monthly - Concrete break and compaction data indicated, **but not found**. Tower access bridge and PT inlet structure were laid out. 203,310 cm of dam fill was placed w/ top of earth section at el 1035 m. Irrigation special treatment drill/grout holes SEE SCAN PAGE 6c. Intake tower concrete to el 1041.7.

<u>November 1952</u>
w/e 11/7 – 43,500 cm of dam fill placed w/ earth section to el 1040.6. Two conduits are laid out and ready to be welded to jet valve flange. All IT drill/grout complete except one hole. River flow 2,449 cfs. Intake tower concrete to el 1048.5 m. Continue placing trashrack. Total of 22 PT stoplogs completed. 1st part of jet valve arrived 11/6.
w/e 11/14 – Earth section to el 1044.7. **1st of three jet valves arrived and being assembled for pressure test.** Two sections of conduit have been placed between chamber and valve house for the pressure tests. Sand and gravel has been removed from the IT u/s invert. River flow at 2,900 cfs on 11/14. 51,700 cm of fill placed in dam. Plug and chamber concrete placement continues. Some intake tower guides placed. Seam treatment at dam toe near tower. Total of 28 PT stoplogs completed. PT intake slot being drilled.
w/e 11/21 – Earth section completed except for 2,000 cm of gravel for 1.5 m camber above el 1050.0. 1st jet valve/conduit section were water tested with no leakage**. 2nd jet valve being assembled for same.** Plug concrete completed to el 967.7 with 1.5 m to go to top out to tunnel roof. Preparations for pouring concrete for stoplog gate. Two additional grout holes completed near PT inlet and el 1000 m. Seven additional grout curtain holes added at left abutment by Bleifus (IEC Chief Eng.). River flow at 3,100 cfs. Intake tower concrete to el 1050 m. IT stilling basin left wall placed. Intake tower guides completed. Total of 34 PT stoplogs completed. Dam toe seams cleaned near intake tower.
w/e 11/28 – River flow 3,100 cfs. 19,710 cm of rockfill placed. Hackley? gun? Was placed and final plug concrete placement was begun. IT stilling basin right wall was placed. **2nd jet valve was assembled and pressure tested with conduit segment.** Stop log frame concrete was placed. Stoplog guides installation continued. Total of 38 PT stoplogs completed. Cleaning and guniting of weathered seams above dam toe continued. Exc & dry pack cement backfill continued in tunnel fault seams.
monthly – Lab testing was discontinued near end of month and no data available at this time. Tower bridge pier footings laid out. Tunnel drilling for grouting represents about 55.6% of all drilling for grouting. The completed plug concrete was a total of 2,810.2 cm. SEE SCAN PAGES 1a, 1b & 2a for pressure grouting volumes

<u>December 1952</u>
w/e 12/05 – Drill/blast for intake tower access road is complete. Cleaning and guniting of weathered seams above dam toe continued. River flow 3,100 cfs on 12/05. Increased waste from spillway excavation. Intake tower concrete to el. 1056.8. 3rd jet valve saddles completed. Stoplog guide installation continues.
w/e 12/12 – Rock quarry location for dam rockfill shortage has been located at N5100 E5000 at about 160 m from dam right abutment. **The original plan to substitute/incorporate cobble/gravel/sand/silt into rockfill zone was tried for a few loads and <u>abandoned</u>.** Intake tower concrete was completed (top el 1058 m). River flow was 3,100 cfs. Stoplog guides installation continued. 3rd conduit and jet valve were assembled and pressure tested. Cleaning and guniting of weathered seams above dam toe continued.
w/e 12/19 – First concrete valve block placed. River flow was 2,600 cfs on 12/19. Curing and stripping of completed tower concrete. Stoplog guides installation continues. Tower crane rails being installed.
w/e 12/26 – U/s portal closure by stoplogs is tentatively scheduled for Jan 10-15. Concern about blasting of PT plug keyway so close to stoplogs (500'). Minimum charge to be used. Conduit encasement continued at valve house/chamber. Concrete valve block section completed. Gunite was installed on either side of IT plug concrete as seal for later pressure grouting of plug. All permanent gate operating equipment has been hoisted to top of intake tower for assembly/installation. River flow is 2,600 cfs. 14,720 cm of rockfill placed in dam. Intake tower guides installation continues. Electrical conduits placed in valve house. Tower

crane rail installation complete. Cleaning and guniting of weathered seams above dam toe continued.
monthly – 68,100 cm of rockfill was placed in dam. Drill/blast continued for PT inlet structure to 5,000 cm. This work needs to be expedited in order to allow time to clean seams, gunite and pressure grout all joints before reservoir level rise.

January 1953
w/e 01/02 – River flow 2,255 cfs on 01/03. Intake tower concrete curing and stripping continues. Conduit encasement was completed except for the rotovalve section. Intake tower electrical conduits and crane are being installed. Cleaning and guniting of weathered seams above dam toe continued. Tower footbridge pier concrete was started. PT inlet structure excavation continued.
w/e 01/09 – 84,000 cm of rock excavation remains in spillway. Valve house road crossing walls and beams being formed and steel placed. **Intake tower crane electrical hookup being made.** Tower footbridge steel bent being erected. River flow 2,710 cfs on 01/10. 18,820 cm of rockfill placed in dam. Intake tower curing and stripping of concrete and installation of stoplog guides continues. Tower crane hand rails installed and crane being painted. Conduit installation in valve house block was completed. Cleaning and guniting of weathered seams above dam toe continued. PT inlet structure excavation continued.
w/e 01/16 – Preparations are being made for diversion of river from PT to IT completed control works (JET VALVES). Drill grout crew still unavailable and could impact diversion schedule. Work continues on crane electrical hookup and tower guides for stoplogs. Tower bridge steel bent now assembled for erection. Painting of conduits in concrete plug was started, but there will only be enough primer to complete ½ of the conduitbelow the rotovalve chamber. Jet valves to be painted once adjacent concrete forms are removed.
w/e 01/23 – IT timber stoplogs removed and started to remove the cofferdam.1st tower bridge span is being erected and stoplog guides installation continues. Painting was continued inside the 84" conduits with "somewhat better results". Began exploiting the rockfill borrow pit. River flow was 2,850 cfs on 01/22. Spillway excavation wasting about 18% of rock, indicating that care was taken to place good quality rock in dam. Valve house concrete placement continued. Continued installation of tower stoplog guides. Conduit painting continued with **primer and hot enamel bitumastic. Crane assembly completed and successful trial lifting the concrete stoplogs and wheel gate.** Cleaning and guniting of weathered seams above dam toe continued. PT inlet structure excavation continued. 2,430 cm of rock taken from the borrow quarry. A January 20, 1953 memo regarding **installation** was issued by Engineering/Materials Testing personnel and refers to the final piezometer tip as built location. Both of these documents have been scanned and are available.
w/e 01/30 – River flow 2,200 cfs on 01/29. Diversion occurred by removal of both cofferdams at IT. PT d/s cofferdam was installed. 15,410 cm of rockfill placed in dam. Valve house roadway slab placed. Cleaning and guniting of weathered seams above dam toe continued. PT inlet structure excavation continued. **"Although the IT stoplogs and wheel gates were hoisted to the trashrack roof el to divert the river, it will be necessary to iron cut some *bugs* of the crane before it is working efficiently."** PT concrete stoplogs placed for closure and sealing being performed. Footbridge center bent was raised and placed in position, while progress made on bridge and truss span fabrication.
NOTE – Regarding crane/hoist issue, refer to Valve House scanned documents, CD4 and file titled, "Intake Crane & Stoplog Lifting Problems". A table of the file contents follows:

Scan File - Intake Crane and Stoplog Lifting Problems – 1953/1954 (Valve House Scans, CD 4 of 4)			
Item	**pages**	**Date**	**Description**
1	2	June 22	Letter from M-K to Berger (crane fabricator) regarding shaft bearing and mounting replacement parts
2	1	July 8	Hoist parts shipping order
3	3	Oct 8	Hoist problem report from Afghanistan/Kajakai
4	1	Oct 28	Letter regarding precautions for current hoist operation
5	1	Oct 31	Telegram summary of Oct 28 letter
6	1	Nov 4	Letter of Berger/IEC meeting & action plan to resolve hoist problem
7	2	Nov 14	Field Report on hoist load brake problem of Nov 11, 1953
8	2	Dec 3	Berger letter responding to M-K report of hoist problems (action plan)
9	1	Dec 7	Cover letter for Dec 3 Berger letter
10	1	Dec 14	Kandahar request for field to check hoist load brake oil circulation

			system
11	2	Dec 20	Field report on hoist load brake oil pump and circulatory system
12	2	Dec 24	Hoist load brake problem discussion
13	2	Dec 26	Hoist load brake performance discussion
14	1	Dec 31	Cover letter to (above) Dec 24 & 26 letters
15	2	Jan 1	Lifting device coming out of guides problem and modifications to resolve

monthly – Most tunnel items completed except for PT plug excavation. **PT stoplogs have been placed and diversion through IT works is operational with all three jet valves discharging 2,200 cfs on 01/31** and with reservoir level at 971.65 m. Inflow during the diversion is estimated to be 3,200 cfs. Spillway channel excavation nearly complete except for final floor grade and the road ramp out of the spillway floor. Concrete aggregate borrow area is located at N5350 & E 2200. Due to sand deficiency and excess of 8,900 cm of gravel will be produced and stockpiled. 67,910 cm of dam fill placed. Seven additional dam curtain holes started with two completed & total of 452.3 of 717 m drilled and 1,033 sacks of cement injected. This is a large take and additional curtain holes are anticipated to achieve closure at left abutment and with the two tunnels.

February 1953

w/e 02/06 – Girder span of footbridge was placed. 4,000 cm of gravel, sand and clay was placed against the PT concrete stoplogs reducing seepage to a negligible quantity, which will be further reduced by interior caulking of stoplogs. River flow of 2,400 cfs with reservoir at el 975.09. Reservoir rose average of 1.9 feet per day since 01/31.

w/e 02/13 – PT was surveyed to lay out the concrete plug location with its u/s face at station +342.0. Reservoir level is expected to reach el 995 = base of future PT intake structure by March 10, 1953. Therefore this excavation needs to be expedited in order to achieve completion of drilling and grouting of the intake area seams and cutoff line with the plug. Drill/grout continues along extension of dam axis over the tunnels with evidence of drill water appearing in tunnel roof and sidewalls. **Concrete stoplog gate was blocked up on deck of trashrack structure and wheel gate was rested on deck.** Footbridge truss was erected and will be prepped and painted in place as this could not be done prior to erection due to delivery delay. Three jet valves were closed on 02/11 and trash removed from trashrack bars. Outlet channel was dewatered and a 1m deep by 7m long hole was found at the end of the concrete lined section. Smaller rocks were removed from area and 1 cy boulders placed in entire area of unlined channel. Completion expected by 16th at which time valves to be opened and discharge of 4,000 cfs and reservoir level of 986 expected. Temp gravel roadway with drain pipe was completed in PT. River flow 2,900 cfs with reservoir at el 978.0 when valves were shut off for trash removal. 10,210 cm of rockfill placed in dam. Work continued on valve house conduits and fittings. Cleaning and guniting of weathered seams above dam toe continued. PT inlet structure excavation continued.

w/e 02/20 – plug area excavation started. Drill/grout of curtain extension over tunnels continued. Footbridge misc metal installation continued. **Jet valves 2 & 3 opened about half and valve 1 fully for discharge of 2,700 cm with reservoir at 988.6. Some mechanical difficulties while re-opening the jet valves. It is expected that the mechanical failure will be corrected in next few days and all valves opened to 100%.** Installation of permanent jet valve oil control system is in progress. Electrical switchboard for oil pump motors will be installed after room dry out to avoid damage. With reservoir 84' above PT stoplog invert, log and rock formation leakage is handled with 8" Jaeger pump at half capacity. 13,410 cm of rockfill placed in dam. Cleaning and guniting of weathered seams above dam toe continued. PT inlet structure excavation continued. Footbridge handrails and security gates completed.

w/e 02/27 – Jet valves were closed for about 24 hrs to make some necessary mechanical adjustments **(no other comments & no Engineering report for this week).** Reservoir is currently at el 990.5 with 3 jet valves discharging 4,500 cfs. 9,980 cm of rockfill and 7,150 cm of gravel were placed in the dam. Power and light conduits and fittings installation continues in the valve house, emergency generator & from generator to the Stevens water level recorder. The Stevens water level mechanical gage was installed. Bridge sand blasting continues as prep for painting. Cleaning and guniting of weathered seams above dam toe continued. PT inlet structure excavation continued. The Kajakai baseball team beat the team from Kandahar.

monthly – An access road was completed in PT from the d/s portal to the plug location where one sidewall blast was made. Falsework was started for rotovalve chamber concrete, where access is limited due to valve house concrete placements and some additional rock excavation is necessary to provide minimum concrete thickness. **"Following some**

mechanical difficulty and with corrections made, all 3 jet valves were opened to full capacity on 02/25 and on 03/01 the combined discharge was 4,610 cfs with reservoir level at 990.22 m." The turbine to be installed in valve house is waiting (was due 02/15) for the Morgan Smith Co. Technician for erection. The spillway access ramp rock is now accessible for transport to dam fill and will possibly eliminate further need for the rock borrow quarry. Valve house concrete is complete to the bridge deck level (el. 973.1m). Installation of the permanent operating control system for the 3 hollow jet valves is in progress.

March 1953

w/e 03/06 – reservoir rose from 989.8 to 993.0 this period with inflow estimate of 25,000 cfs near end when valves were discharging 4,900 cfs. **Morgan Smith Co. technician arrived 03/04 to install valve house turbine generator.** Bridge sandblasting/painting continued. Transition section excavation of the PT intake slot was completed but could not be mucked due to high reservoir. The rock face above valve house has been scaled, cleaned up and stabilized and work on valve chamber and valve house superstructure re-started. PT plug excavation is 90% complete. Wiring in valve house and emergency generator house continues. Cleaning and guniting of weathered seams above dam toe continued. Bridge sandblast/paint continues. Backfilling of the dam d/s cofferdam sump continued.

w/e 03/13 – Reservoir rose from 993 to 1001m with inflow reaching an estimated 32,000 cfs on 03/08 and valve discharge of 5,800 cfs. Dam rockfill topped off at el 1050.0 and half of the gravel camber material has also been placed. Spillway weir section continues to be cleaned up. Turbine generator was installed and second stage concrete placed. **Electrical hookup being made for later testing, which can only achieve half of turbine rating due to the current reservoir level.** PT plug excavation is complete. To handle water through plug, 3-10" pipes will be embedded in lower concrete lift and more pipes will be installed higher if necessary. Most seepage enters through seams d/s of intake structure or at points of contact between rock & concrete at end of lined section. Caulking of stoplogs has been abandoned. Drilling/grouting complete except for work inside tunnels. Bridge sandblasting completed. Kajakai was defeated 11 to 6 by the Chah-I-Anjir baseball team.

w/e 03/20 – Reservoir rose to el 1004.4 and had discharge of 6,000 cfs. The dam camber fill was completed. Spillway weir section highs were shot and overbreaks were filled with concrete. Drill/grout for plug cutoff ring was started and invert concrete placed. **Turbine generator and valve house electrical connections continued.** The first rotovalve chamber roof concrete was placed. Cleaning and guniting of weathered seams above dam toe was completed.

w/e 03/27 – No report found.

monthly – PT plug excavation completed with little overbreak. The 12 grout ring holes completed with one hole taking 34 sacks while the others had no take at 200 psi. Two collar lifts and 2 mass lifts placed in plug with seepage constant and passed through 4-10" embedded pipes. Seepage appeared at roof of IT and plug which was partially sealed with 2 grout holes. Should additional leaks occur, they will be sealed with a semi-circular cutoff ring in the roof. Jet valve operating machinery was connected and wired. **Turbine generator was installed and tested by Morgan Smith Co. and the valve house switch board installed.** All work on dam embankment was finished on 03/28. "Work was started on aligning the load break shaft on the intake tower crane."

April 1953

w/e 03/03 & 10 – No report found

w/e 03/17 – reservoir rose to el 1022 with valve discharge of 7,200 cfs. IT leakage at plug roof was sealed off. Valve discharge spray is eroding the valve house access road and road width being maintained by excavating the slope side. **"Adjustments in the electrical circuits and the oil pumping system for the hollow jet valves were completed; limit and thrust switches were set and the operation of each valve tested."** PT plug concrete was finished to el 971 (3' above reference line). "The remaining concrete will be placed by Hackley gun. Gunite instead of concrete was used to place the top of the collar and the contact between the rock and concrete on the upstream face of the collar was gunited after the forms had been stripped." In spillway, a 12 foot shaft was started at station 200 to intercept the clay seam running through the weir section. General spillway excavation was completed. **"After minor repairs at the intake tower crane had been completed both the wheel gate and the stoplogs were raised to el 1050 from the deck at el 983 where they had been resting on timbers. The timbers over the stoplog opening have not been recovered, and are probably wedged in between the guide columns. Another try to raise them by means of the cable originally attached will be made next week."**

w/e 03/25 - No report found.

w/e 03/30 – Reservoir level to el 1026m. Excavation of spillway shaft in clay seam is complete and has been filled with concrete. Power tunnel drilling and grouting continued. Rotovalve chamber wall forms and steel ready for concrete placement. Power line poles to Intake tower being placed.
monthly – Reservoir rose from 1013 to el 1026m and valve discharge from 6,700 to 7,400 cfs. PT plug concrete complete and final grouting to be done after concrete cooling. Seepage from u/s of plug remained constant. Six more holes drilled and grouted in IT plug roof with remnant seepage negligible. Form and steel placement continues for Chamber roof concrete. Valve house fixtures complete and wall/floor painting continues. Final adjustments and settings to jet valves oil pumping machinery and electrical counterparts made. All valves can now be operated electrically. **The turbine/generator is being used to power both tunnel lights.** Spillway excavation and 12 foot shaft at station 200 and 28m left of center line (including concrete backfill) were completed. Footbridge painting completed. Drill/grout program to seal PT local leaks was started with 240m complete of 1900m planned. Jet valve discharge is causing erosion of Valve House access road, which will worsen once spillway discharges. Road will have to be relocated into solid rock.

May 1953
w/e 05/07 – Reservoir rose to el 1028.3m with valve discharge of 7450 cfs. 300m of central chamber arch concrete was placed between el 963 and 969m. Remaining concrete will be placed with a Hackly gun. Drilling of holes at the PT plug continues with water draining from several holes. Grouting to be done after concrete cools. Valve house painting is complete. Temporary repairs made to access road with no more erosion taking place. Wiring and conduit installation continued on footbridge and emergency generator house. Power pole installation continued.
w/e 05/14 – Reservoir surface el rose to 1029.5 with valve discharge at 7,550 cfs. Forming of rotovalve chamber arch continues. One coat of paint completed on valve control equipment. **Machinist came from Kandahar to inspect overheating main thrust bearing on turbine generator. Minor adjustments made and SAE 20 motor oil was substituted for the lighter oil and bearing is now running 30 to 40 Farenheit degrees cooler and remains at constant and safe running temperature.** Drilling continued in PT with hole seepage rates remaining constant. Grouting to be started by May 19 when concrete cooling is complete. Excavation started on new layout of valve house access road.
w/e 05/21 – Reservoir rose to el 1030.14 at a discharge of 7,600 cfs. Appears that reservoir level will not reach spillway crest this season. Wiring of emergency generator was completed. Transmission line pole installation was completed.
w/e 05/28 – No report found.
monthly – The reservoir rose to el 1030.88 and a valve discharge of 7,560 cfs. The PT drill and grout completed 1,020m of holes with 840m to go in current plan. Drilling rate is decreased due to use of coring bits. A gunite seal was placed on the concrete/rock contact of the plug and final grouting completed. The 4-10” drain pipes were closed and grouted. There are a few minor seeps around the plug which will be intersected and grouted with a few shallow holes. 377 cm of concrete was placed between station 720 and 725 in the IT rotovalve chamber. **Minor adjustments were made on the main turbine bearings.** The transmission line poles, crossarms, insulators and guys were completed. The **aluminum wire**, which has arrived, will be strung next month. Work on relocation of the valve house access road has progressed nicely. As no spillage is anticipated this year, there is no way to know if the road fill portion will be affected until next year. An attempt is being made to place large rock fill as riprap within the zone directly across from the spillway channel discharge.

June 1953
w/e 06/05 – Valve house access road about 90% complete. IT air ducts being installed. Reservoir level rose to el 1031.4.
w/e 06/12 – Installed rotovalve chamber anchor bolts for hoist monorail system. Continued work on anchors for air duct hangers. Completed valve house access road. Reservoir level rose to el 1031.47 on 06/08, before slowly receding.
w/e 06/19 – Air duct installation 85% complete. Reservoir level dropped to el. 1031.09m.
w/e 06/26 – Core drilling and grouting continued in PT. Began forming superstructure over valve house. Kandahar ordered jet valves closed from fully open with discharge of 7,600 cfs, to about 300 cfs. All walls and arch section completed in chamber. Remainder IT concrete consists of paving over the encased conduits and placing second phase encasement concrete after rotovalves have been installed. Completed installation of air ducts between chamber and valve house. **Using valve house turbine generator for all camp power and lighting requirements.**

monthly – Reservoir level at el 1029.7 with fully open (as usual) jet valves discharging 7,500 cfs. 780 m of PT drill and grout completed. Will be necessary to drill a few additional holes in areas that still show leakage, especially around the fault zone where there appears to be an increase in the size and number of leaks. An attempt will also be made to seal a few small leaks around the plug by drilling 5 shallow holes that will intersect the rock-concrete contact seam. 283.4 cm of concrete was placed by Hackley gun in the chamber arch, completing that work.

July 1953

w/e 07/03 – No report found.
w/e 07/10 – Original PT drill/grout program completed except for some remaining leaks. Drilling of rotovalve chamber liner concrete started for low pressure contact grouting. The aluminum cable was strung between the valve house and intake tower. Valve house superstructure work continued. Reservoir level dropped to el 1028.73. Turbine generator does not supply enough power to satisfactorily operate shop motors, water supply pump and other needs during daylight hours.
w/e 07/17 – Continued drill/grout and guniting seams in PT. Drilling for chamber low pressure grouting is completed. Reservoir level dropped to 1027.39 and valve discharge of 7,450 cfs.
w/e 07/24 – Reservoir level dropped to el 1025.88 with valve discharge of 7,400 cfs. 114 cm of 2nd stage conduit encasement concrete was placed between stations 744.5 and 836.0 (about 40% of total). Valve house superstructure work continued. PT drill/grout of plug and fault continued with only modest success at fault, which will need additional holes.
w/e 07/31 – Continued drill/grout of PT fault, reducing seepage significantly. Engineering will determine if more holes are necessary. Valve House superstructure walls placed to el. 976.82. Resumed work on spillway weir. Reservoir surface receded to el 1024.31. Conduit (2nd stage encasement) paving between chamber and valve house was completed.
monthly – Five holes were drilled and grouted into the plug concrete-rock contact seam and grouted resulting in negligible leakage. Original PT drill/grout included 93 holes 20m deep. To seal the remaining fault and other joints, another 48 holes averaging 11m deep were drilled and grouted. This resulted in a total of 2,388m of holes. All the major leaks have been sealed, however, a few new leaks have recently appeared both u/s and d/s of the fault zone. <u>The transmission line from valve house to emergency generator was completed and power from turbine generator can now be used at the intake tower.</u> The spillway concrete weir was started between station 0+200 and 0+220.

August 1953

w/e 08/06 – Reservoir level receded to el 1022.62 and discharge of 7,200 cfs. Low pressure grouting of chamber arch was started and an attempt is being made to seal a new vertical seam leak at station 0+761. Valve house superstructure concrete is now complete except for stripping and curing. PT floor seams are now being excavated and cleaned in preparation for dry packing. A few more holes may be required in PT. Work continued at spillway weir.
w/e 08/13 – Reservoir level receded to el 1020.84 with valve discharge of 7,100 cfs. 16.4 cm of grout (184 sacks) were injected into the completed chamber arch contact. The arch vent holes were all drilled to 2 m depth. 3-10m holes were drilled/grouted into the station 761 vertical seam. The leaks were sealed, but later leakage resumed at a higher point. Additional holes will be drilled in this zone. Four holes totaling 60m were drilled and grouted into some new vertical seam seeps. About 50% of spillway weir concrete has been completed. Continued cleaning out and sealing seams in PT invert.
w/e 08/20 – Reservoir receded to el 1019.02 with a discharge of 7,000 cfs. The spillway concrete weir was completed, with about 15-20% of volume consisting of hand placing clean hard cobbles in concrete. Three additional holes (total of 50m) were drilled to seal the station 761 seam, which continues to leak. Additional holes will be drilled. Five more holes (75m total) drilled/grouted in PT areas of new leakage. Dry packing of PT invert seams was completed.
w/e 08/27 – Reservoir level receded to el 1017.18 with discharge of 6,900 cfs. <u>IT monorail system installation began.</u> D/s PT bridge removed and tunnel allowed to flood. Valve house windows and doors completed. Completed anchors and hangers for lighting in IT. Began installing 2" drain pipes for chamber weep holes.
monthly – Chamber lining concrete was contact grouted and drains drilled and drain pipe system installed. Monorail system was 50% completed. Permanent lighting was completed in valve house and IT.

September 1953

<u>w/e 09/04 –</u> Completed IT gutters. Completed IT air ducts. Wiring of IT, chamber and valve house. Reservoir surface receded to el 1015.3.
<u>w/e 09/10 –</u> Reservoir surface receded to el 1013.17 and discharge of 6,500 cfs. River color changed to a murky green. **Monorail system 90% complete, but with some alignment problems, requiring resetting of some of the beams.** The permanent light and power systems for both tunnels and valve house are complete and being used. **The hollow jet valves were given a periodic test and all parts of the control system functioned properly.** Emergency generator was installed.
<u>w/e 09/17 –</u> Reservoir receded to el 1011.8 and with one jet valve shut off, the two open valves discharged 4,300 cfs. Three 10m holes were drilled and grouted through the station 761 seam leakage and leakage was stopped. **"The new shaft and outboard bearing was installed in the intake tower crane primary gear reduction box and the crane is ready for further testing". Correction of the monorail switch misalignment will consist of loosening the two outside curved beams and resetting them in correct alignment (waiting for welder). Granite monument to be installed on rock cliffs near left abutment.** Drilling and grouting complete in both tunnels.
<u>w/e 09/24 –</u> Reservoir level receded to el 1010.82 with a discharge of 4,000 cfs through two open valves. Chamber concrete now complete except for around rotovalves (which are not yet installed). **Further tower crane tests resulted in following:**

- **Center bushing on the brake assembly output shaft is tight**
- **Brake assembly was dismantled and the bushing was re-machined with greater tolerance**
- **Oil lines were re-installed to insure proper lubrication to the two bushings on the output shaft**
- **Brake assembly was then assembled and tested**
- **Under full load, ampere readings are still excessive**
- **and the brake assembly became very hot while lowering the stop log an estimated 35 feet**

<u>monthly –</u> On 09/14 number 1 and 3 jet valves were fully closed (valve 2 had already been in closed position) for a period of 63 hours, during which time the reservoir rose 0.35m. Valves 1 and 3 were then reopened. **On September 28 the wheel gate was lowered and the tunnel was dewatered ((in 36 hours) in preparation for rotovalve installation. Dewatering was accelerated by removing conduit #1 manhole and using high head pump to remove water. Upon completion, the Dresser coupling was removed and an inspection made of tunnel in a rubber boat. The tunnel was found to be in very good condition. Only 4 minor leaks were visible, the largest of which was about 20m d/s from the end of the concrete lined section in the tunnel crown. "The gates were both tight except for small leaks at the bottom corners of the wheel gate." All tunnel concrete appeared to be in good condition. The conduit enamel was found peeled off in some sections especially along the inverts.**

<u>October 1953</u>
<u>w/e 10/02 –</u> Completed installation of fans and ventilating system in valve house and IT. **"Attached bulkhead to middle conduit above rotovalve location and reopened valves of the two outside conduits. The flow now from these two conduits is about 4,000 cfs with the two valves fully open. We removed section of temporary 84" conduit where # 1 <u>(Engineering report calls it # 2)</u> rotovalve is to be installed, and began removing temporary concrete saddle supports that were under same."**
<u>w/e 10/09 –</u> Continued preparation for rotovalve installation including excavating anchorage bolt trenches, sandblasting middle conduit for paint and hauling in valve parts. Reservoir receded to el 1009.65 and two valve discharge is 3,900 cfs.
<u>w/e 10/16 –</u> Reservoir receded to el 1008.8 and two valve discharge is 3,800 cfs. Anchor bolts for valve # 2 were concreted in place. All remaining valve parts arrived and most transported into valve chamber. The two valve base sections have been bolted together and are ready to be placed into position. **Valve erector from Morgan Smith Co. arrived on 10/14.** Sandblasting continues on conduit # 2.
<u>w/e 10/23 –</u> Reservoir receded to el 1008.0 and two valve discharge is 3,700 cfs. Valve assembly continued with bolting of lower and upper valve sections completed. Assembly and installation of plug section will begin next week. **Considerable difficulty, due to lack of proper wrenches. Several wrenches were fabricated in shop and an order for more was made.** Sandblasting completed and cleanup started. Installation of electric control and power wires was completed to valve chamber.
<u>w/e 10/30 –</u> Reservoir receded to el 1007.21. **(Note: Construction refers to #1 valve assembly, while Engineering refers to #2 assembly, although it is clearly the middle**

one) "Valve is installed and assembled including the plug and plug shaft. Upon installing the plug and seated under its own weight, in closed position, feeler gages indicated a 0.006 gap between body and plug seals. This gap appears on both u/s and d/s seals at top center flow line. This gap diminishes to 0.00 at flanged section of lower and upper body section. The erector seems to think that this gap will close when the upper head is bolted into place, and the plug is seated by the operating mechanism." The operating mechanism has been transported to chamber for assembly. The #2 flange was out of alignment with the centerline of the valve, so welder was called from Kandahar on 10/26 and has completed the necessary cutting and welding for alignment. Welder is now making the flange and Dresser coupling section for the u/s for the valve and #2 conduit. "Electrical wiring to the control panel and to the #1 motor driven pump assembly is complete." Conduit #2 cleanup is complete and priming was started on 10/30 **with Kooper's Bitumastic No. 70-B** and **hot enamel** will be applied as soon as primer is dry.
monthly – Valve assembly 85% complete. The temporary 12" conduit through the chamber was removed and will be replaced as soon as permanent section is made up. Dresser coupling is made up and ready for installation.

November 1953
w/e 11/06 – Reservoir receded to el 1006.42 and two valve discharge is 3,800 cfs. Rotovalve assembly is complete. Oil pump piping and temporary control lines were installed and **the valve tested several times. All parts of the valve and control system appeared to function properly.** Parts for next valve began arriving and were transported into chamber area. The next valve assembly will begin once the conduit painting is complete, is coupled to valve and the monorail system modifications have been completed. Anchor bolt trench excavation for the two remaining valves has been completed.
w/e 11/13 – On 11/10 the jet valves were closed and the tunnel again dewatered for installation of valve on conduit #3. Modifications to the monorail switch section were completed and system is operating satisfactorily. **"The modifications were made by spreading the two outside beams and then cutting them off about 1 ¼". An angle tie brace was welded across the top of the three beams and anchored to the concrete arch on both sides of the chamber. A new difficulty has arisen. The 16 ton Yale hoist will not readily travel around any of the monorail curves. It was first thought that the minor changes made to the monorail had caused this condition but the hoist will not travel even on those curves that were not slightly altered or in the switch section. In order to install rotovalves 1 and 3 it will be necessary to round off some of the sharp corners of the hoist where it hits the web and if this doesn't help the condition, a tugger hoist will be rigged to pull the hoist around the bends."** Enameling of conduit #2 was omitted due to application difficulties and time restraints. Inspection of conduit #3 indicated that practically all of the enamel had been scoured off. Therefore necessary to sandblast and repaint all conduits, which will be done after completion of all valve installations.
w/e 11/20 – Jet valves #1 and #2 were opened after a four day shutdown in order to bulkhead valve #3. Tunnel filling done without difficulty. The wheel gate was raised and dogged off and the stoplog was brought up to the water surface. The two hoist drum cables were then tied off as a safety measure. **The monorail web sharp corners were slightly trimmed off, so as not to affect the hoist strength. The hoist and monorail system now appears to work in satisfactory manner.**
From Engineering - **"The tunnel was filled on Nov 14 with rotovalve #2 in the closed position and jet valve #2 in the open position. An attempt was made to open the rotovalve with the empty conduit, however when the valve was in an estimated 35 % open, vibrations and hammer in the exposed conduit section immediately d/s of the rotovalve became so severe that the valve was closed as soon as possible. The #2 jet valve was then closed and the rotovalve cracked open until the u/s and d/s pressures had equalized after which it was fully opened and seated. The hollow jet valve was then fully opened. It is felt that opening or closing the #2 rotovalve under pressure is dangerous, at least until the conduit is embedded in concrete."**
From Construction – **"With tunnel dewatered, bulkhead on #3 conduit was fastened an place in preparation for installation of this rotovalve. #2 rotovalve was tied into u/s #2 conduit by means of a single flanged section of 84" conduit and Dresser coupling. This change over was completed at 2:00 AM Nov 14. With manholes fastened down, jet valve #1 was closed and jet valve #2 left open. The latching device was lowered to wheel gate and gate raised 9 inches at 6:00 AM Nov 14. Tunnel full at 9:30 AM. Wheel gate was hoisted and dogged off at el 1050. Stoplog was hoisted to el 10006.55 with the mechanism clear of the water but leaving the stoplog submerged. This was done to avoid stressing the hoisting mechanism with added weight of the stoplog out of the**

water. Two safety cables attached to the tower and hoist frame were clamped to the two hoisting cables. The hoist operated normally while lifting the submerged stoplog and showed no sign of heating. At 1:30 PM Nov 14, jet valve #1 was fully opened allowing normal flow. With approximately 47 psi against u/s end of rotovalve, the water leakage was nil around the plug on the d/s end. With jet valve #2 open, proceeded to open rotovalve plug. At about 35% open, the turbulence of the water around the plug set up a severe vibration of the valve and conduit on the d/s end. The valve was immediately closed as it was apparent that severe damage might be done. Jet valve #2 was then closed and rotovalve slowly opened until conduit was filled and then fully opened. Jet valve then opened allowing normal flow of water, at 3:00 PM Nov 14. With water flowing thru conduits #1 and 2 at about 3,800 cfs, the reservoir receded to el 1006.43."
Second valve was assembled including the base and bottom half of the body, but broken wrenches prevented assembly of the top half.
w/e 11/27 – Work continued on rotovalve #3. The shaft, top head and operating mechanism remain to be installed. Valve checked for grade and aligned with conduit flow line. U/s and d/s flanges were bolted to valve ready for welding to conduits. The Dresser coupling segment of conduit was shortened and placed, ready for welding. All of the 3rd valve parts have arrived and most have been transported to chamber for unpacking and cleaning. The sandblast crew has been removing remnant enamel patches from conduit #3 with steel slice bars. Machine shop busy making slugging wrenches. Reservoir receded to el 1005.65 at a discharge of the two valves of 3,750 cfs.
monthly – Rotovalve #2 complete and #3 complete except for operating mechanism and controls. "**It was noted that the rubber seal groove on the vertical face of the bottom head (of valve #1 was omitted in fabrication. This groove will be made in the field but with considerable difficulty. It is expected that some installation time will be lost because of it." "An inspection of jet valve #3 showed that considerable damage has been done to the knife edges of the splitters. One edge has been flattened to a depth of about 1". These edges Are being built up with stainless steel and ground down to the original contour. The seal replacements for the hollow jet valves arrived and will be installed when time permits."**

December 1953
w/e 12/04 – No report found.
w/e 12/11 – The current reservoir el is 1005.3 with a two valve discharge of 3,700 cfs. On 12/03 at 2:00 PM #1 and 2 jet valves were closed in order to dewater the PT to put rotovalve #3 into service and to bulkhead the b#1 conduit for the last rotovalve installation. On 12/06 at 11:30 AM #2 jet valve was reopened and at 2:00 PM #3 jet valve was opened and the second rotovalve put into service. Installation of rotovalve #1 was then started. **"The (missing) rubber seal groove on the vertical face of the bottom head was chipped in without loss of installation time. By the end of the week the base and lower half of the body were in place. Approximately two days of installation time were lost due to the lack of wrenches." "A small leak in the vertical joint of the top head developed in the #3 rotovalve as soon as it was put into service. This leak was sealed by drilling into the joint down as far as the rubber seal and injecting #50 bitumastic tar with a grease gun. Otherwise the valve appeared to operate properly." "No attempt was made to open or close #3 rotovalve with the hollow jet valve in the open position. From experience on #2 rotovalve it was felt that it would be better to wait until the valves and adjoining conduits are embedded in concrete before service operating tests are made."** The built up roofing on the valve house superstructure and the emergency generator house was completed. All window glass in the valve house was completed. Sandblasting of conduit #1 was started in preparation for enamel paint.
w/e 12/18 – Reservoir receded to el 1004.5 with two valve discharge at 3,600 cfs. #1 valve installation continued with top head assembled and ready to install. Welders have completed cutting and welding the conduit u/s of the valve. Sanblasting of conduit #1 is complete and sand is being cleaned up. The shop is making up a machine to spray on the enamel and it will be tested next week. Carpenters continue forming for the coupling pit and blockouts around the conduits. Steelmen started to install the reinforcement steel around the coupling pit and conduits. Painters worked on the intake hoist and bridge cleaning and repainting those parts that have become grease soaked or scared.
NOTE – A memorandum regarding the **questionable piezometer readings** was issued by Kandahar to Kajakai Field Office on December 21, 1953. The memo indicated pressure reading and flushing tests that were performed in field and in accordance with "Section M of

the Instruction Manual prepared by IEC." This Instruction Manual (dated January 1951) was found and has been scanned and is available, as is the above memo.
w/e 12/25 - No report found.
monthly – "No. 3 hollow jet valve was reopened on 12/28 at 11:00 PM" (*This implies that the tunnel was again dewatered to remove the bulkhead u/s of the #1 rotovalve installation and only #1 valve was placed back into service*). Installation of rotovalves #1 and 3 was completed and both were test operated dry and appeared to function properly. **"No tests on any of the valves have been done made with their respective hollow jet valve in the open position. Tests and necessary adjustments will be made as soon as the encasement concrete around the valves has been placed. No. 1 rotovalve leaks about 1 gallon per minute from inside the horizontal seam next to the plug. There are no significant leaks around the valve seats."** Structural valve block concrete placement was completed. Sandblasting of conduits #1 and 2 continued. Testing of shop fabricated enamel sprayer was performed and it is hoped that a few more modifications will result in satisfactory performance. **"On 12/28, while lowering the lifting device and block to raise the stoplog, the lifting device came out of its guides. It was freed again from the el 983 deck slot on 12/30. It was decided that some of the clearance between the lifting device rollers and the guides should be taken out before attempting to lower the assembly into the water again. In the meantime all the water being discharged through hollow jet valve #3 is passing through the wheel gate opening."**

January 1954
w/e 01/08 – Reservoir rose 2.2m to el 1008.35 with a single (#3) valve discharge of 1,900 cfs. 80 cm of porous concrete was placed around the rotovalves. Continued removing blast sand from #2 conduit and two tests were made in #1 conduit with the shop fabricated enamel painting machine. They showed that a very heavy coat was applied to the invert. The crown enamel met spec (thickness), but the field is at a loss in finding a way to modify the machine so that an even coat is applied all around. Further painting has been stopped until Kandahar performs an inspection of this work. A loud noise sounding like an explosion was heard on Jan 7 at 8:15 PM. A check of all dam features immediately following the noise showed everything to be in order. A slight tremor coinciding with the noise was also felt. ***(will check for known earthquake at this time and general location)***
w/e 01/15 – Reservoir rose 0.6m to el 1008.95with single valve discharge of 1,900 cfs. With the top slab placed around the rotovalves, concrete is now complete except for a small amount required to bring the drain gutters up to grade. **"The first tests on the three rotovalves under full wet conditions were made on 01/13. The tests proved the valves to be satisfactory except for the fact that the lifting and seating piston had a tendency to move in the seating direction during the first part of the rotating travel from full open to close. It was decided that this defect could be eliminated by adding additional check valves to the oil discharge lines of the controls."** It was decided to omit conduit enameling until further inspection and consideration of the ultimate value of the enamel is made. Modifications to the stoplog lifting devise were completed. **"The guide rollers were moved out 3/16" on each end, which eliminated 3/8" of the ¾" total clearance. The lifting device and block were lowered into the guide and the stoplog waqs raised to water surface elevation without difficulty. The two hoist drum cables were then tied off as a safety measure. No further work will be done at the tower until the new lowering brake assembly arrives."**
w/e 01/22 – Reservoir surface receded to el 1008.75. "On January 18, after testing the rotovalves, jet valves #2 and 3 were left in the full open position and current discharge is 3,800 cfs. Permanent control piping installation for the rotovalves was completed. **"The cleaning oil was drained from the system and replaced with new oil (Shell Tellus – 29). During the installation of the permanent control piping, additional check valves were added to the rotovalve control discharge lines. These check valves prevent the lifting and seating piston from tending to seat itself during the first part of the rotating travel from the full open to close. On Jan 18, the three rotovalves were tested under wet conditions with the hollow jet valves in the full open position. Each valve was opened and closed three times, and were found to operate satisfactorily. The S. Morgan Smith Co. erector left Kajakai on Jan 19."** It was decided to postpone enamel painting of the conduits indefinitely.
monthly – Reservoir el rose from el 1006.15 to 1009.0 and then receded to current el 1007.3. Average discharge from Jan 1 to 18 was about 1,800 cfs (only one valve open) and from Jan 18 to 28 was 3,800 cfs (two valves open). On Jan 28, the third valve was opened and current discharge is 5,700 cfs. The reservoir is now receding at the rate of about 0.25m/day. Valves were tested under the current 45m head and found to work satisfactorily. **"There is some**

question as to whether or not the present oil pumps have sufficient capacity to operate the valves under full head. The three rubber replacement seals for the hollow jet valves were installed." The outside of the jet valves were cleaned and painted with #50 coal tar enamel.

<u>February 1954</u>
<u>w/e 02/05 –</u> No report found.
<u>w/e 02/12 –</u> Reservoir receded to el 1006.35 at a discharge of 5,700 cfs through all three valves. The rotovalve chamber drain gutters were brought up to grade and concrete placement in the tunnel is now complete. Exposed sections of conduit were cleaned and painted with #50 coal tar enamel.
<u>w/e 02/19 –</u> Reservoir surface rose to el 1007.11 at a discharge of 5,800 cfs. Cleaning and painting of exposed sections of conduit in the Dresser coupling pits with #50 coal tar enamel was completed. Painting of rotovalves and the oil control system was started. **"On Feb 13, all six valves were test operated through a full cycle of closing and opening. All the valves functioned properly, On Feb 17, the emergency generator was started and operated for a period of one hour. A station log will be kept in the valve house giving information as to when the valves were operated, etc.**
NOTE – <u>A log book was found and scanned. However it begins on Nov 1955 and ends on Dec 1963. See valve house scans CD 4 of 4</u>
This log will also give pertinent information about the station and emergency generators. Dr. Savage (consulting engineer) made an inspection trip on Feb 18 of all Kajakai features."
<u>w/e 02/26 –</u> Reservoir surface rose to el 1007.24 at a discharge of 5,800 cfs. Painting of equipment continues.
<u>monthly –</u> Reservoir dropped to el 1007.24 at a discharge of 6,000 cfs. Painting of first coat of grey enamel to the rotovalves and control piping was completed. The station turbine has been working continuously and very well as the source of power for the tunnel and camp.
Another memo regarding the Piezometers and dated February 27, 1954, was issued from Kandahar to the field. It refers to the Dec 21, 1953 memo as well as to the 1951 Piezometer Instruction Manual and instructs the field to flush all piezometer tips with de-aired water and to make a correction to part "B" of the 12/21 memo in accordance with part "M" of the 1951 manual. This memo has also been scanned and is available.

<u>March 1954</u>
<u>w/e 03/05 –</u> Reservoir level rose to el 1007 25 at a discharge of 6,000 cfs. Equipment painting continued. **Reference point set on dam. This point was set in a reinforced concrete column poured in a 1.5m deep hole dug at station 0+290 and approximately 10m u/s from the dam axis. A sketch giving tie in points and elevations will be prepared for future reference. An inspection of the power tunnel showed that no new visible leaks of any consequence have formed since the tail water was allowed to flood the tunnel.**
<u>w/e 03/12 –</u> Reservoir level rose to el 1007.3 at a discharge of 6,000 cfs. Equipment painting continued. **Two days were spent working on piezometer installation. More work will be done on some tips as readings are still erratic. A sketch giving the tie in points and elevations of the reference point was prepared and sent to Kandahar. A piezometer data sheet of readings (before and after water flushing) dated March 6, was found and scanned. Review of data indicated some improvements to the readings, BUT the readings are still questionable and suspected of being affected by air in the water and tubing.**
<u>w/e 03/19 –</u> Reservoir rose to el 1008.3 at a discharge of 6,200 cfs. Equipment painting continued, as well as concrete finishing. **"All jet and rotovalves were operated during the week and functioned properly in every respect. The emergency generator was also started without difficulty. More work was done to the piezometer installation, but tips #12, 13 and 15 are still erratic. It appears as though tip #16 is either broken or plugged. A close check will be kept on the tips for next week and if it is felt that further pumping will help get better readings on the above tips, this will be done." A March 22, 1954 memo was issued by Kandahar to the field regarding the piezometer flushing and questionable readings, which have improved but do not appear to yet be air free. I (R. Joyet, 2005) concur with this implication and feel that air free water was never aggressively prepared or utilized. A piezometer data sheet of readings (before and after water flushing) dated March 15, was found and scanned. Review of data indicated some improvements to the readings, BUT the readings are still questionable and suspected of being affected by air in the water and tubing.**

<u>w/e 03/26 –</u> Reservoir rose to el 1014.75 at a discharge of 6,600 cfs. Painting of second equipment coat and concrete finishing is now complete**. "On March 20, the stoplog was raised about 8m in order that the cable and block would not become submerged due to the rising reservoir. No difficulties were encountered with either the hoist or emergency generator."**
<u>monthly –</u> "The control tower stoplog was raised twice during the month in order that the cable and block would not become submerged due to the rising reservoir. The two drum lines were tied off after each raise as a precautionary measure. No difficulties were encountered with either tower crane or the emergency generator. The hollow jet valves and the rotovalves were operated once during the month. All elements functioned properly. Some work was done to the piezometer installation during the month. An attempt was made to obtain more consistent readings by pumping all the lines and removing any air that may have entered them during the past year. In some cases this pumping helped, however some of the tips still have erratic readings.

<u>April 1954</u>
<u>w/e 04/10 –</u> Reservoir rose to el 1027.8 at a discharge of 7,400 cfs. Valve house Miscellaneous metal painting continued. **"On April 3, the stoplog, which has been hanging from the crane was raised to the tower deck level and dogged off. No difficulties were encountered with the crane during this operation."**

<u>w/e 04/17 –</u> Reservoir rose to el 1032.12 at a discharge of 7,600 cfs. All valve house painting was completed. **"Six staff gauges were installed at the spillway. These gauges are made of repainted stadia boards. Work started on setting two more deflection reference points on the crown and axis of the dam"**

Document Search and Scanning Attachment 4
Construction Narrative Milestone Events

March 1950
Beginning of construction with blasting of portals and building access roads.

May 1950
May 19 – One page foundation excavation spec issued **(see scan CD 4 of 4).**
May 26 – Three page letter to Consultants giving updated information for review. Added an eighth radial gate and decided on unlined tunnel **(see scan CD 4 of 4).**

June 1950
Tunnel portal stations established as Power = 0+765 & Irrigation = 0+840.
Start left abutment drilling and scalling.
June 16 – One page memo regarding dam material properties which were studied in 1949 and had no triaxial or permeability tests performed. Now requesting permeability tests on the free draining and other materials **(see scan CD 4 of 4).**

July 1950
July 5 – Dr. F. A. Nickel, Consulting Geologist **(Preliminary)** Report, for Kajakai, Arghandab, Seraj and Palsu Dams **(see scan CD 4 of 4).**
July 12 – Grouting instructions for **Arghandab** Dam, presumably would also apply to Kajakai **(see scan CD 4 of 4).**
July 21 – Denver response to field design comments of June 30 **(see scan CD 4 of 4).**
July 31 – Two page letter regarding abutment topo and excavation of overhangs **(see scan CD 4 of 4).**

August 1950
August 12 - Dr. F. A. Nickel, Consulting Geologist **(Final)** Report, for Kajakai, Arghandab, Seraj and Palsu Dams **(see scan CD 4 of 4).**

September 1950
September 22 - Grouting instructions for **Kajakai** Dam, same as for Arghandab **(see scan CD 4 of 4).**

October 1950
Design Criteria, Specifications & Laboratory Procedures – Embankment, Rockfill & Foundations **(see scan CD 4 of 4).**

December 1950
w/e 12/7 - Test holes started on core trench grout curtain. **w/e 12/21** d/s bridge boring logs (including penetration tests) to be sent **(logs not found, but this would be pertinent to liquefaction potential of dam foundation sands and gravels left in place)**

January 1951
Jan. 11 – Table of Power & Irrigation Tunnel seam locations and thickness **(see scan CD 4 of 4) and Dwg 27-95 R_2.**
Jan. 30 – Outlet portal seam seepage due to rainfall **(see scan CD 4 of 4).**

February 1951
Began Tunnel test and grout holes to treat seams. Noted that precipitation resulted in tunnel seam seepage.

May 1951
w/e 5/31 – Dam grout curtain starte.d

July 1951
w/e 7/27 – following joint/seam study additional joints and seams selected for treatment
July 31 – Foundation treatment recommendations for abutments, river channel and tunnels **(see scan CD 4 of 4).**

August 1951
w/e 8/17 – Beginning of extensive dam diversion cofferdam grouting to seal extensive subgrade soil (same as dam foundation soils) leakage.

<u>September 1951</u>
Sept 8 - Confirmation of Treatment Program **(see scan CD 4 of 4).**
Sept. 20 – Work Plan for dewatering dam and core trench and piezometer cabinet and trench layout **(see scan CD 4 of 4).**
Sept. 28 – Consultant visit and comments **(see scan CD 4 of 4).**

<u>October 1951</u>
Oct. 9 – treatment of faults and seams in dam foundation **(see scan CD 4 of 4).**
Oct. 19 – unable to dewater between two u/s cofferdams, more grouting necessary on right end of main dam
Oct. 20 – Impervious fill compaction **(see scan CD 4 of 4).**
Oct. 29 – Inspection and status of fault excavation and treatment at dam foundation **(see scan CD 4 of 4).**

<u>November 1951</u>
Nov. 9 – decision to irrigate borrow area for moisture conditioning, dam foundation excavation is essentially complete
Nov. 23 – decided that entire left abutment impervious core contact will be gunited

<u>December 1951</u>
Cofferdam sealing at 10' to 25' depth with jetting of sand and clay and dragline excavation to bottom of riverbed should be successful

<u>January 1952</u>
on night of 1/28 river diversion through IT began resulting in noticeable backwater drop which eased the dewatering between cofferdams 1 and 2, dragline removed 13,000 cm of unsuitable material (1/20-31) between cofferdams (from 90 m u/s of axis to about 195 m u/s of axis) and replaced with select clean sand/gravel from new u/s borrow placed on contact excavated to original riverbed gravels (scan page 6d sketch tends to verify this**)**

<u>April 1952</u>
April 17 – Pervious material sub zoning proposal due to inadequate permeability results **(see scan CD 4 of 4).**
April 28 – Compaction Modifications to restore adequate densities **(see scan CD 4 of 4).**
April 28 – Right abutment fault treatment status and plan **(see scan CD 4 of 4).**

<u>May 1952</u>
w/e 5/2 - Discussion of different reference density mold sizes and criteria (standard versus modified) due to problems of achieving gravel density requirements and necessary verification versus standards. There seems to be problem achieving densities
w/e 5/23 – problem with insufficient quantity of acceptable rockfill production at spillway which will result in unbalanced placement (earthfill will surge ahead of rockfill, resulting in loss of the ideal 10m bench differential for placement

Document Search and Scanning Attachment 5
Construction Narrative Pertinent Issues

Inlet Channel sections at tunnel portals, if important, may be illustrated by sketches on certain copies of Borrow Area #3 drawings, which were situated directly u/s of portals and had to be cut/excavated and bridged for access during construction

Dam Foundation Material (Liquefaction)
Cofferdam leakages and sealing problems as an indicator of free draining and dense dam foundation soils. Start with w/e 8/17/51 Report.
W/e 9/7/51 - churn drill holes to 5' centers and not always successful, including u/s slope clay blanket, so digging cutoff trench at u/s toe through clean sand and gravels. 2,829 sacks of cement injected to date. Cutoff was effective and water down in entire area by 9/11.
w/e 11/23/51 - **Test pits being excavated in cofferdam to determine the condition of the remnant foundation material and the "relative density" of the cofferdam soils. Test pits were located in relation to the dam axis as as follows:**

Station	**Offset (m)**
0+262	**51 rt**
0+312	**56 rt**
0+278	**107 rt**
0+305	**111 rt**
0+309	**79 rt**

Unfortunately, there were no results in the Construction Reports.

1/15/52 – Lab Report contains data for 3 dam foundation material samples in place density, mechanical analysis and percolation tests

Dam Fill Material

Impervious fill from Borrow Area #3
1. Impervious material (27,000 cm) for contact with abutment and between the impervious and transition zones – Silty soil with no size larger than ¼" (from w/e 11/9/51 scan page 4h)
2. Remainder of impervious material (130,000 cm) – the coarsest material by spec will be maximum of 3", 60% passing the ¼" screen, 30% passing the #200 and 15 % passing 1 hour (from w/e 11/23/51 scan page 4i).

Transition material
1/15/52 – Lab Report contains data for 3 borrow and 2 dam samples of transition material mechanical analysis, density and percolation tests

Pervious material
1/15/52 – Lab Report contains data for 4 borrow and 3 dam samples of transition material, mechanical analysis, density and percolation tests

General Attachments

1. **Kajakai Project Photos (Table of Contents only, Photos are on General Attachments CD 1 & 2)**

Attachment 1

Kajakai Project Photos

Table of Contents

Note: These Photos are available on two CDs, at the **Afghanistan Energy Information Center** in Kabul:

Annex to
House #15, Street #1
Ansari Square, Shahr-e-Naw

Web site:
Afghanistanenergyinformationcenter.org

Contact:
Ahmad Omar Ahmadi – AEIC Senior Information Officer - aomar@aeai.net