OFFICE OF THE SPECIAL INSPECTOR GENERAL FOR IRAQ RECONSTRUCTION

RELIEF AND RECONSTRUCTION FUNDED WORK AT MOSUL DAM MOSUL, IRAQ

SIGIR PA-07-105
OCTOBER 29, 2007

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SPECIAL INSPECTOR GENERAL FOR IRAQ RECONSTRUCTION

October 29, 2007

MEMORANDUM FOR COMMANDING GENERAL, MULTI-NATIONAL FORCES-IRAQ,
COMMANDER, JOINT CONTRACTING COMMAND-IRAQ/AFGHANISTAN
COMMANDER, GULF REGION DIVISION, U.S. ARMY CORPS OF ENGINEERS
DIRECTOR, IRAQ TRANSITION ASSISTANCE OFFICE

SUBJECT: Report on Relief and Reconstruction Funded Work at Mosul Dam, Iraq (Report Number SIGIR PA-07-105)

We are providing this project assessment report for your information and use. We assessed the in-process relief and reconstruction funded work at the Mosul Dam, Iraq to determine its status. This assessment was made to provide you and other interested parties with real-time information on relief and reconstruction projects underway and in order to enable appropriate action to be taken if warranted.

We received comments on a draft of this report from the Deputy Chief of Mission for the United States Embassy-Iraq, advising that the Iraq Transition Assistance Office concurred with the report's general findings and recommendation. Specific comments were also provided to correct perceived errors and to suggest clarifications. The Gulf Region Division of the United States Army Corps of Engineers provided formal and informal comments concurring with the recommendation and providing clarifying information. We reviewed the information, documentation, and clarifying comments provided both by the Iraq Transition Assistance Office and Gulf Region Division and revised the final report as appropriate.

We want to express our thanks to United States Army Corps of Engineers, Gulf Region North personnel for their assistance in coordinating the site visit. In addition, the Iraq Transition Assistance Office and Gulf region Division representatives provided SIGIR inspectors ready access to key personnel and information in a timely manner. If you have any questions, please contact Mr. Brian Flynn at brian.flynn@sigir.mil or at 914-360-0607. For public or congressional queries concerning this report, please contact SIGIR Congressional and Public Affairs at publicaffairs@sigir.mil or at (703) 428-1100.

Stuart W. Bowen, Jr.
Inspector General

Special Inspector General for Iraq Reconstruction

SIGIR PA-07-105 **October 29, 2007**

Relief and Reconstruction Funded Work at Mosul Dam Mosul, Iraq

Synopsis

Introduction. This project assessment was initiated as part of our continuing assessments of selected sector reconstruction activities for water. The overall objectives were to determine whether selected sector reconstruction contractors were complying with the terms of their contracts or task orders and to evaluate the effectiveness of the monitoring and controls exercised by administrative quality assurance and contract officers. We conducted this limited scope assessment in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team included an engineer/inspector and two auditors/inspectors.

The Mosul Dam was constructed on a foundation of soluble soils that are continuously dissolving, resulting in the formation of underground cavities and voids that place the dam at some continuing risk and thus requires a continuous grouting program to mitigate. The objective of the original task order and associated contracts was to conduct studies specifically related to the Mosul Dam's problems, identify the most critical problems and develop solutions, and to implement those solutions. The project was funded through the Iraq Relief and Reconstruction Fund and administered by the United States Army Corps of Engineers, Gulf Region Division.

Contract W914NS-04-D-0007, an indefinite delivery/indefinite quantity, cost-plus-award-fee contract to restore, rebuild, and develop national water resources in Iraq was awarded to Washington International/Black and Veatch.

The United States government funded short-term solutions to the Mosul Dam problem, while the Iraqi Ministry of Water Resources was responsible for implementing a long-term solution. The short-term solutions required the ministry to be given the most critically needed replacement and spare parts for this grouting system, assistance with its massive grouting[1] program, and enhanced grouting[2] to augment their grouting efforts. Twenty-one contracts[3], worth approximately $27 million, were to help with short-term solutions at the dam.

Project Assessment Objectives. The objective of this project assessment was to provide real-time relief and reconstruction project information to interested parties to enable appropriate action, when warranted. Specifically, we determined whether:

1. Construction or rehabilitation was in compliance with the standards of the design
2. An adequate quality management program was utilized

[1] Massive grouting is the placement of a substantial volume of sandy mix grout to overcome washout conditions with the intent to stop or reduce the active flow of water.
[2] Enhanced grouting includes the use of high performance grout mixes as well as procedures for new grouting techniques.
[3] Two contracts were subsequently terminated for cause/cancelled.

3. Sustainability was addressed in the contract or task order for the project
4. The project results were consistent with its original objectives

Conclusions. The assessment came to a number of conclusions:

1. Although most of the contracts awarded were of the simple procurement type, several required design drawings and specifications. For example, design drawings and specifications were necessary for the construction of the stationary silos, the procurement and installation of five grout-mixing plants, and the comprehensive and relational diagram or schematic drawings of the complete assembly and implementation of the Intelligrout system[4] and enhanced grouting equipment for use inside and outside the Mosul Dam gallery. Gulf Region Division provided the design drawings for the stationary silos and mixing plants; however, no comprehensive and relational diagram or schematic drawings existed for the Intelligrout system and enhanced grouting equipment.

   After a thorough review of all available design drawings, we found the drawings to be deficient, leading to a number of safety concerns. For example, the stationary silos design drawings lacked significant details, such as bracing support for the entire height of the silos and how the Ministry of Water Resources personnel will deposit cement into the silos. For the 100 cubic meters per hour grout-mixing plant and the four 30 cubic meters per hour grout-mixing plants, the design drawings clearly indicated the contractor was offering *concrete*-mixing plants, not the required *grout*-mixing plants.

   We identified an instance where construction did not appear to be adequate. The inspection team observed that some foundation bolts cast within concrete columns had insufficient thread to properly fasten the nuts. Specifically, we determined that 43 of the 144 (30%) foundation bolts were inadequately installed. Further, the installation of the foundation bolts also contradicted the contractor's own design construction techniques, which required bolt threads to extend higher than the nut. Complete design drawings are needed to determine if the remaining foundation bolts are adequately secured within the foundation or pose a serious threat of failure. Because each stationary silo will hold approximately 1,500 tons of cement, we believe that the inadequate installation of the foundation bolts leaves this structure in a potentially dangerous condition.

   Iraq Transition Assistance Office representatives have significant concerns with the quality of the contractor's work; therefore, the contractor was terminated for default, and a new contract will be issued to construct new stationary silos at a different location on the Mosul Dam property. Consequently, a critical project awarded 19 months ago must be re-awarded, thereby significantly delaying its completion date, and the $635,138 already paid to the contractor resulted in a potentially unsafe silo framework.

   The mixing plants contract required construction and installation of five mixing-plants. We observed the single 100 cubic meters per hour "modified" grout-mixing plant; however, it was not operational due to control room issues. For the 30 cubic

[4] Intelligrout is a fully integrated, permeation grouting system providing real-time data collection, real-time data analysis, and real-time display of all results in multiple media formats. Intelligrout consists of Integrated Analytical System units, which provide a computer-based monitoring system for the grouting and geologic parameters relevant to the grouting. Intelligrout relies upon Integrated Analytical System operators to monitor pressures and volumes of grout being injected and to determine the pressures, volumes, and mix to fit the conditions.

meters per hour mixing plants, we found various pieces of two unassembled mixing plants on site. The construction for the two unassembled mixing plants was not in compliance with the contract requirement that the contractor deliver and install functioning mixing plants. According to the Material Inspection and Receiving Report (6 September 2006), the contractor delivered two 30 cubic meters per hour mixing plants "with all the accessories including valves, piping, screw conveyors, control room, control panel" and "50% Spare Parts according to the contract." However, the lack of any construction made it impossible for us to determine if the contractor delivered all the material necessary to construct the two mixing plants. In addition, none of the spare parts allegedly delivered could be located. Finally, even though the contractor did not install either mixing plant and may not have provided all the required components and spare parts, Gulf Region Division paid the contractor in full ($604,000).

2. The quality management program did not adequately ensure the correct delivery and construction of materials and equipment at the Mosul Dam. The Special Inspector General for Iraq Reconstruction judged the contractors' quality control programs to be deficient because many invoices did not provide the materials and equipment claimed on the invoices. For example, one contractor's invoice claimed the delivery of four contract-specified submersible pumps with 54 cubic meters per hour capacity with 20-meter lift capability, but the pumps actually delivered were 36 cubic meters per hour capacity with 17.5-meter lift capability.

   In addition, there was no evidence that a contractor quality control program was implemented for the construction of the stationary silo. Further, there was no indication that the contractor employed anyone to determine the quality of the stationary silos' construction. We observed inadequately installed foundation bolts; however, nothing in the project file documents identified this as a potential problem.

   The United States government quality assurance program was not adequate. Even though Gulf Region Division viewed the 21 contracts as procurement contracts only, a quality assurance program was necessary to verify that the contractors delivered the materials and equipment required by the contracts. Gulf Region Division transferred the responsibility to accept contractor deliveries of materials and equipment to Ministry of Water Resources personnel. This required the ministry to create a receiving committee to verify the delivery of materials and equipment from multiple contractors. However, according to the Mosul Dam manager, the Project and Contracting Office instructed him to sign for anything received from contractors.

   Gulf Region Division provided the dam manager with limited contract specifications for 13 of the 21 contracts prior to contractor deliveries of materials and equipment. For the contracts for which the ministry personnel did not have specifications, the receiving committee was forced to compare the actual delivered items against the contractors' invoice lists. In several cases, the ministry's receiving committee quickly documented and notified Gulf Region Division that the contractor had not provided the correct materials and/or equipment. For example, when the contractor failed to provide the contract-specified submersible pumps, the ministry identified this error and reported it to Gulf Region Division two days after delivery; nevertheless, the contractor was paid in full for delivering equipment that did not meet contract specifications.

   According to Gulf Region Division representatives, the 21 contracts were procurements for equipment, materials, and services—rather than construction contracts—even though the assembly of the stationary silos and mixing plants obviously required significant construction efforts. Gulf Region Division was not aware of the inadequately installed foundation bolts, which leaves this structure in a

potentially dangerous condition. In addition, there is no indication that anyone at Gulf Region Division was tracking the project's completion progress as distinct from invoices paid. This was important because the project was significantly behind schedule. Consequently, the contractor was paid approximately 81% of the contract's value for the inadequately constructed partial structure when the Show Cause Order was issued.

Further, because no government representative was on site to verify contractor deliveries, we cannot determine if the deliveries were actually made. For example, one contractor submitted invoices for 1,017 steel pieces for the stationary silos; however, during the site visit, as many as 900 steel pieces were either unaccounted for or missing.

3. Many of the contracts addressed sustainability in the form of spare parts for pieces of the procured equipment. For instance, the mixing-plants contract required the contractor to provide 50% spare parts by delivering additional items for the single 100 cubic meters per hour grout-mixing plant and the four 30 cubic meters per hour grout-mixing plants. The spare parts were included to provide the ministry with additional equipment to keep the mixing plants operational if a specific item wore out. Even though the Material Inspection and Receiving Report indicated that the contractor delivered the spare parts, we could not locate any during the site visit. Although sustainability was addressed in many individual contracts, because of the numerous discrepancies between invoices from different contractors compared to what was actually received and because there was no government representative on site to verify each contractor's deliveries, there is no assurance that the spare parts actually arrived.

4. The execution of the 21 contracts, valued at $27 million, was not consistent with the original project objectives to provide the Mosul Dam and Ministry of Water Resources personnel with critically needed spare and replacement parts and the ability to conduct massive grouting or to fully implement enhanced grouting.

   The procurement and delivery of spare and replacement parts for the ministry was partially consistent with the original objectives. Multiple contracts, valued at approximately $5.6 million, were awarded for materials and equipment to avoid any interruption of current grouting operations. Because of limited time at the site, we could not inspect every delivery to determine if it met contract requirements. Therefore, we relied on reviews of the contract files and interviews of ministry personnel to determine if the required equipment and materials had been delivered.

   Multiple contracts were awarded to provide for materials and equipment; nevertheless, in several instances, what was delivered did not meet contract specifications. In addition, because no United States government representative was on site to verify the delivery of the materials and equipment, we could not be assured that all of the required equipment was delivered to the Mosul Dam. We identified several instances in which the delivered materials and equipment did not meet the contract specifications, but after discussions with Ministry of Water Resources personnel, it appears that most of the contractor-delivered materials and equipment were usable by the ministry to continue current grouting operations.

   Approximately $19.4 million in multiple contracts were awarded for the massive and enhanced grouting programs. We observed an inadequately constructed partial stationary silo structure, which provides no usable benefit to the Ministry of Water Resources. In addition, because of the inability of the United States government's Evaluation Committee to notice the "CONCRETE BATCHING PLANT" cover pages on the contractor's submittals for the 100 cubic meters per hour and 30 cubic meters

per hour grout-mixing plants, the contractor believed that he was to deliver concrete-mixing plants. This led to an increase in contract cost and time delays.

A contract modification of $920,000 was issued to "modify" the concrete-mixing plants into the required grout-mixing plants. To date, $324,000 has been paid to the contractor for attempts to modify the concrete-mixing plants into grout-mixing plants even though the 100 cubic meters per hour grout-mixing plant is still inoperable, and the contract for the four 30 cubic meters per hour grout-mixing plants has been terminated. As a result, the three mixing plants currently have no value to the ministry. Because the contract required the delivery of the five grout-mixing plants by July 2006, the massive grouting and enhance grouting programs are now more than one year behind schedule.

The Advanced Grouting System, a significant portion of the enhanced grouting program, is also non-operational. The system comprises the Intelligrout system and enhanced grouting equipment, valued at approximately $16.4 million. The three Integrated Analytical System units continue to experience a variety of significant problems, delaying their use, and the enhanced grouting equipment remains unused because of a lack of comprehensive and relational diagram or schematic drawings to identify how the components are completely assembled and operate.

Consequently, at the time of our site visit, approximately $19.4 million worth of equipment and materials delivered to the Mosul Dam for the implementation of the massive and enhanced grouting operations currently do not provide benefit to the Ministry of Water Resources.

Post Delivery Support Plan. According to Iraq Transition Assistance Office, the Ministry of Water Resources has used materials and equipment procured by the Government of Iraq, the United States government, and other international donors to improve its current traditional grouting operation; however, full implementation of the enhanced grouting operation is necessary to augment ministry efforts to improve dam grouting. Iraq Transition Assistance Office[5] representatives are finalizing a detailed plan, the Post Delivery Support Plan, to provide the dam and the ministry with the required equipment and materials to improve current grouting operations and fully implement the enhanced grouting operation. For example, this plan calls for making the Integrated Analytical System units fully operational and procuring additional 30 cubic meters per hour grout-mixing plants. Iraq Transition Assistance Office representatives express confidence that the plan will adequately resolve the outstanding issues and problems and facilitate the ultimate implementation of the enhanced grouting.

Recommendations. The Special Inspector General for Iraq Reconstruction shares the concerns expressed by the United States Army Corps of Engineers, the Commander of the Multi-National Force-Iraq, and the United States Ambassador regarding problems at the dam. In view of the issues raised by this assessment and the resultant lack of significant progress in improving basic grouting capability, as well as the fact that equipment for enhanced grouting and the Integrated Analytical System were delivered

[5] The Iraq Transition Assistance Office is the successor organization to the Iraq Reconstruction Management Office. The purpose of the Iraq Transition Assistance Office is to perform the specific project of supporting executive departments and agencies in concluding remaining large infrastructure projects expeditiously in Iraq, to facilitate Iraq's transition to self-sufficiency, and to maintain an effective diplomatic presence in Iraq. For this report, we dealt with the Water Sector representatives of the Iraq Transition Assistance Office.

but are not operational, we recommend that the Iraq Transition Assistance Office Director expedite implementation of the Post Delivery Support Plan.

Management Comments. We received comments on a draft report from the Deputy Chief of Mission for the United States Embassy-Iraq, advising that the Iraq Transition Assistance Office concurred with the report's general findings and recommendation. Specific comments were also provided to correct perceived errors and to suggest clarifications.

Subsequent to the issuance of the draft report, Gulf Region Division provided additional information and documentation. Gulf Region Division also requested and was granted an extension of time for formal comments on the draft report. Gulf Region Division's formal comments concurred with the recommendation and provided clarifying information for the final report.

Two days after the receipt of Gulf Region Division's formal comments, United States Army Corps of Engineers and Gulf Region Division representatives contacted us, indicating that they were concerned with the accuracy of the final report and that they wished to provide additional information. The Special Inspector General for Iraq Reconstruction subsequently contacted the Gulf Region Division commander and further revised the report to address his concerns.

Evaluation of Management Comments. The Special Inspector General for Iraq Reconstruction appreciates the concurrence by Iraq Transition Assistance Office and Gulf Region Division with the recommendation to expedite implementation of the Post Delivery Support Plan.

We reviewed the information, documentation, and clarifying comments provided both formally and informally by the Iraq Transition Assistance Office, Gulf Region Division, and United States Army Corps of Engineers and revised the final report as appropriate. Comments received are provided verbatim in Appendices E and F of this report.

Indications of Potential Fraud. During this inspection, we found indications of potential fraud and referred these matters to the Special Inspector General for Iraq Reconstruction Assistant Inspector General for Investigations, for such actions as deemed appropriate.

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Introduction

Background

Mosul Dam, the largest dam in Iraq, is located on the Tigris River, approximately 50 kilometers (km) northwest from the town of Mosul, Iraq, and 100 km southwest of the Turkish city of Cizre (Figure 1 and Site Photo 1). The Tigris flood plain in the dam area has been in much the same location for more than 10,000 years. Over time, the river channel has migrated from east to west within the flood plain, as evidenced by the location of abandoned river terrace deposits that remain on the east side of the river (Figures 2 and 3).

Figure 1. Location of the Mosul Dam (Photo courtesy of the USACE)

Site Photo 1. Mosul Dam (Photo courtesy of the USACE)

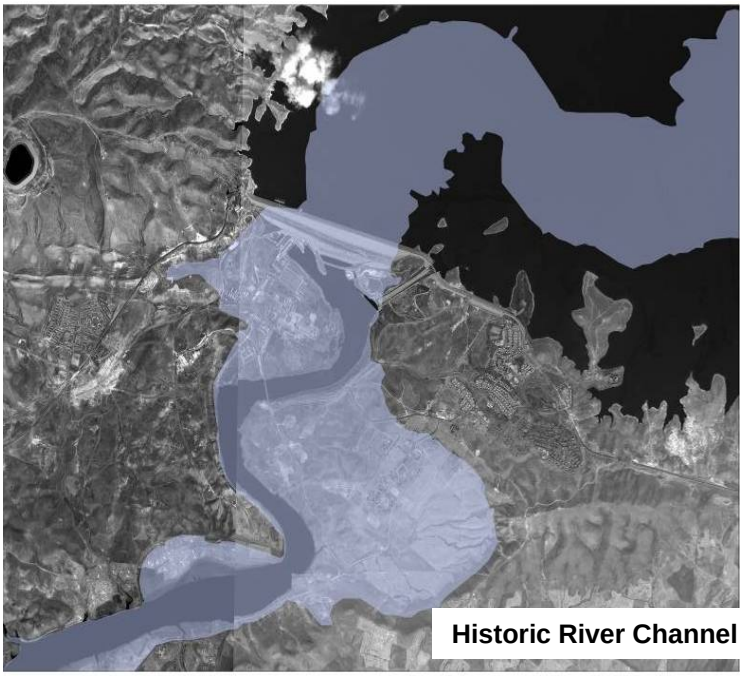


Figure 2. Original river flow (Courtesy of the USACE)

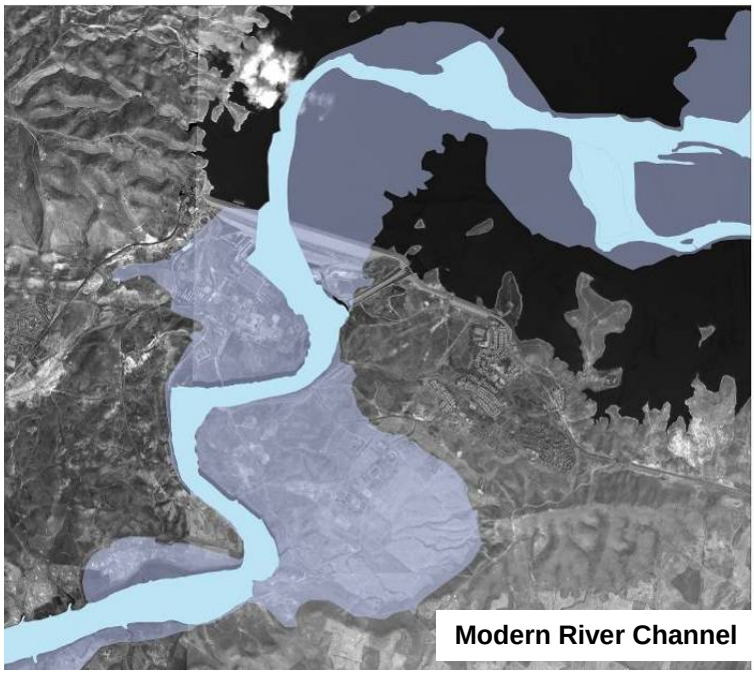


Figure 3. Current river flow (Courtesy of the USACE)

The main dam features a 3.4 kilometers (km)-long earth-fill dam, power house, bottom outlet, concrete-lined gated spillway, and fuse-plug secondary spillway. The embankment is 113 meters (m) high and composed of zoned earth-fill construction. It contains graded filters in the upstream and downstream shells, with an inclined-chimney drain and a blanket drain. The total volume of material in the embankment is reported to be approximately 37.7 million cubic meters (m^3). The embankment of the main dam has a crest elevation of 343m and a crest width of 10m.

The minimum operating-pool elevation is 300 m, with a maximum (at spillway invert) of 330m. Active storage is over 8.1 billion m^3, and total storage at maximum operating-pour level is 11.1 billion m^3. The spillway maximum discharge is 12,400 cubic meters per second (m^3/second) at maximum pool. The fuse plug spillway on the left abutment is 400m long and has a capacity of 4,000-m^3/second. The overflow of the fuse plug is 2 m below dam crest level.

The Tigris River originates in Turkey, in the highlands of eastern Anatolia, at elevations ranging up to 3,000 m above sea level. The Tigris collects 43% of its flow in Turkey and 57% from tributaries within Iraq. It has a total length of 1,900 km, of which 20% lies in Turkey, 78% in Iraq, and 2% in Syria. The Tigris cuts deep courses through the relatively soft bedrock in the plateaus of northern Iraq, and its route remains relatively stable. Considerable variation in stream flow occurs on an annual basis. A large portion of the river flow is generated by the Anatolian Highland, where most of the precipitation occurs during the winter as snow. Spring snowmelt releases vast quantities of water, creating periodic flooding downstream. The river has two distinct surge periods: a minor rise from November to the end of March, due mainly to rainfall in the highlands; and the main rise in March through June, due mainly to snowmelt. During the latter phase, the Tigris may carry ten times the flow volume typically experienced in the late summer. Reservoir filling generally begins in March with the high seasonal flow event.

The power generation facilities, located on and in the right abutment of the main dam, provide hydroelectric power for the 1.7 million residents of Mosul. The powerhouse is located at the downstream toe of the main dam, on the right side of the river. The powerhouse includes four Francis turbine/generator units, each rated at 187.5 megawatts (MW), for a total rated capacity of 750 MW. According to Gulf Region Division (GRD) representatives, 750 MW will supply enough power for approximately 675,000 homes in Iraq. Water is supplied to the powerhouse through an intake structure and four separate tunnels. The intake structure is located at the upstream toe of the dam and includes four 7.0 x 10.5 m hydraulically operated wheel gates. The lowest lake level that will allow continuous generation of power is 306 m.

Mosul Dam was designed as a multi-purpose dam, including water supply, irrigation, flood control, and power generation (Figure 4 and Site Photos 2, 3, and 4).

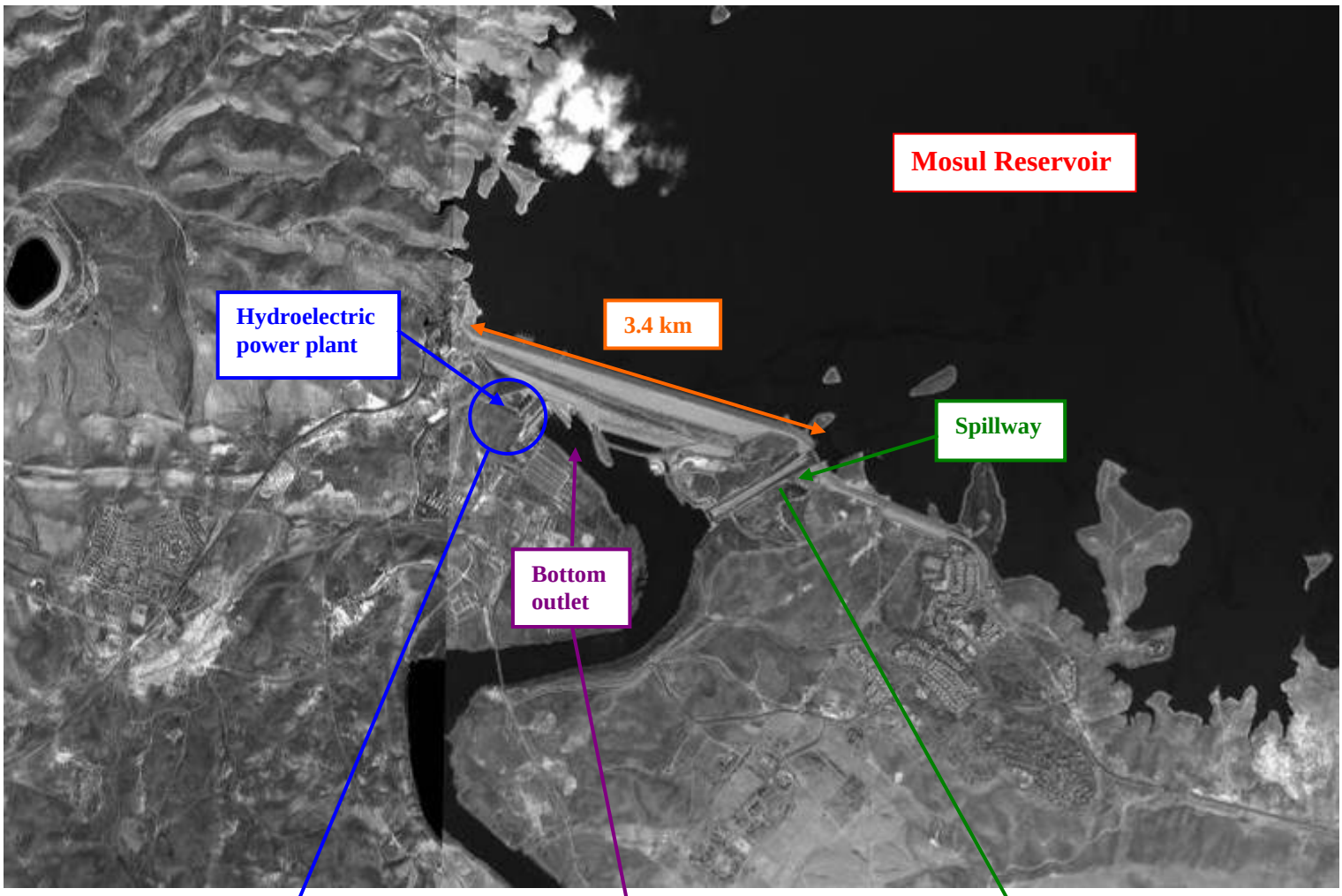


Figure 4. Aerial view of the Mosul Dam (Courtesy of the USACE)

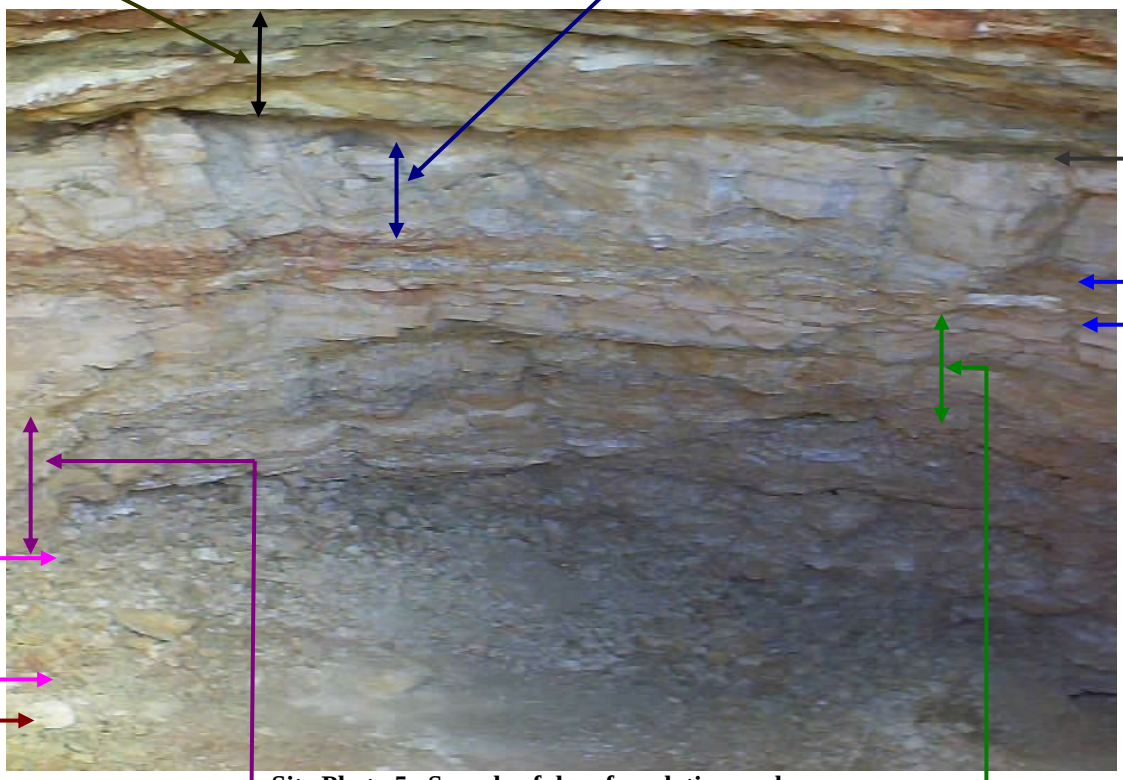
Site Photo 2. Close up of hydroelectric power plant (Photo courtesy of the USACE)

Site Photo 3. Close up of bottom outlet (Photo courtesy of the USACE)

Site Photo 4. Close up of spillway (Photo courtesy of the USACE)

Geology

The foundation geology of the dam comprises a layered sequence of rocks, including marls, chalky limestone, gypsum, anhydrite, clays, and severely fractured limestone (Site Photo 5). Most of the rock layers near and under the Mosul Dam are subject to dissolution and the development of karst features. Karst topography is characterized by landforms that result from subsurface dissolution of water-soluble geologic materials and appears at the Earth's surface as sinkholes. They form after rock dissolution creates subsurface cavities that cause the loss of support of the overlying material and result in a collapse feature recognizable at the surface. The portion of the sinkhole visible at the surface represents only a small percentage of the total dissolution of rock that formed the feature.



Site Photo 5. Sample of dam foundation geology (Photo courtesy of the USACE)

Construction

Construction of the Mosul Dam started in 1980 and was completed in June 1984. The first reservoir filling took place in the spring of 1985. The embankment was designed by the Swiss Consultants Group and constructed by the German Italian Mosul Dam Joint Venture (GIMOD), a consortium of experienced international contractors. In an effort to save construction time, the dam was built without completing the grouting needed to control seepage through the foundation. As an alternative, the designer elected to build a grouting gallery during construction to continue the grouting operation after the dam was constructed and in operation. Design and construction was reviewed by a Board of Experts commissioned and paid for by the Ministry of Irrigation[6] that met 30 times from 1979 through 1989.

Problems with the Mosul Dam

According to the Washington Group International/Black and Veatch (WI/BV) study, the "…decision to locate such a major and important dam on the foundation rock mass which exists at the Mosul Dam site was fundamentally flawed." The presence of difficult foundation conditions was recognized during design. Geologic exploration had accurately identified the foundation as being composed of a series of strata with a gentle eastward dip composed of soft weathered marls, brecciated and clay-like marls, fresh-to-weathered limestone, and beds and pods of anhydrite/gypsum often interbedded with sandy, silty layers. The presence of layers of gypsum, anhydrite, and karstic limestone throughout the foundation provides materials susceptible to solution and erosion over the short and long terms.

According to the United States Army Corp of Engineers (USACE), the Mosul Dam was "constructed on a very poor foundation that should have had an inverted dam foundation" (Figure 5).

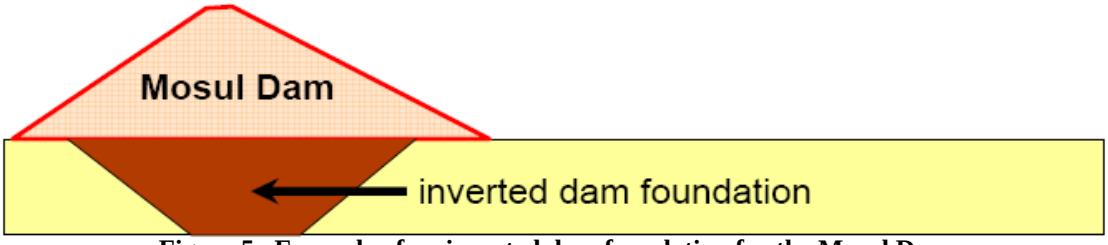


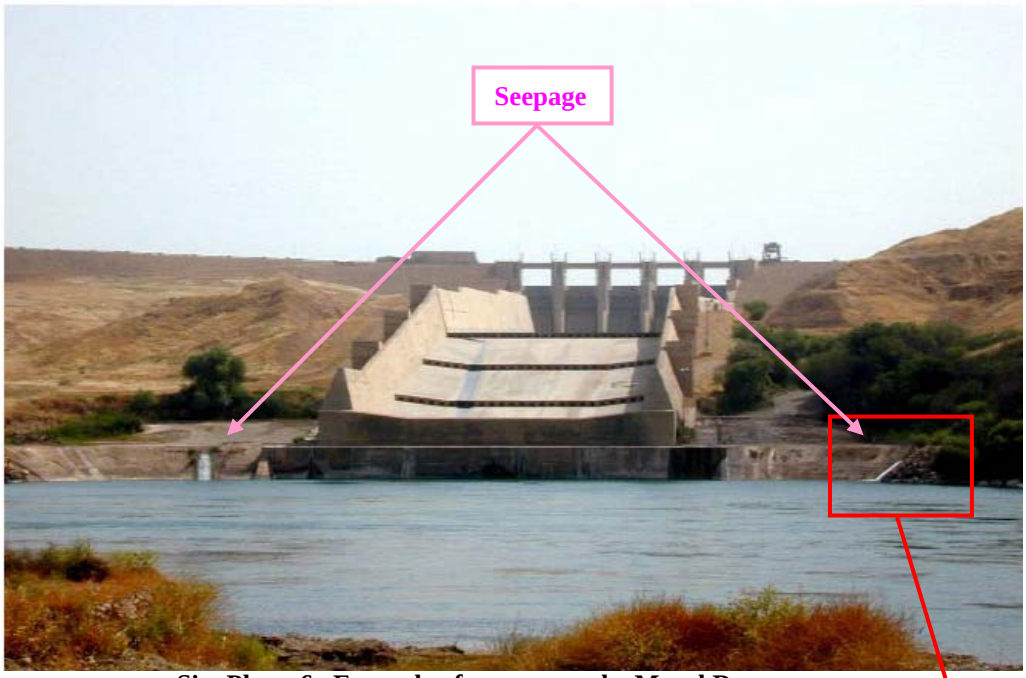
Figure 5. Example of an inverted dam foundation for the Mosul Dam (Figure courtesy of USACE)

Seepage

With the first filling of the reservoir, in March 1985, seepage appeared immediately. By 1986, seepage near the spillway had exceeded 800 liters per second (l/s). It abated when grouting was initiated. Seepage is monitored at three locations towards the spillway and the left abutment. Seepage flows are collected and measured at three plate weirs. Water comes from three locations: the access gallery and the right and left sides of the spillway. The water from the left side is the largest flow and appears to emanate from the limestone rocks of the abutment, with a typical flow reported as 170 l/s. The flow from the right side is thought to be water passing under the spillway. All the flows are described as relatively constant, having started since impounding, and always clean and clear.

[6] The Ministry of Irrigation was the predecessor organization of the Ministry of Water Resources.

For examples of current seepages, see Site Photos 6 and 7.



Site Photo 6. Example of seepage at the Mosul Dam
(Photo courtesy of USACE)

Site Photo 7. Close-up view of seepage at the Mosul Dam
(Photo courtesy of USACE)

Sinkholes

Seven sinkholes developed following initial impoundment of the reservoir. Sinkholes are an indicator of possible subsurface failure of the dam's foundation. Most sinkholes observed were downstream of the dam--with three in a linear arrangement in the work area on the right bank, approximately 500m downstream from the dam (Site Photo 8).

The sinkholes seem to have materialized because of fluctuations in the water level within the regulating reservoir. The maximum settlement measured approximately 3.6 m and generally is between 2 m and 3 m. One of the sinkholes was beneath a concrete paved area, and the sunken concrete may have bridged over settled ground at a lower level (Site Photo 9).

The latest sinkhole, which appeared in early 2005, was very close to the dam, and raised concerns that cavities underneath the structure could cause dam failure. The close proximity of the sinkhole to the dam indicated migration of the cavities. The earlier six sinkholes were further away from the dam, closer to the river. According to a USACE analysis, "…due to the recent sinkhole near the dam, the potential for dam failure has been raised."

A new sinkhole was discovered and reported by the dam manager in December 2006. This one is relatively small and is located in a depression on the west (right) bank, some 200 m west of the dam. According to dam personnel, the larger depression was used as a holding pond created during construction. A larger sinkhole appeared, and was filled after the initial flooding of the area behind the dam. The new sinkhole is part of the original one, which indicates active dissolution occurring below the surface. The dam manager noted that the grouting operation has focused more on the east (left) bank and the gallery.

Site Photo 8. Example of a sinkhole (Photo courtesy of the USACE)

Site Photo 9. Sinkhole beneath a concrete-paved area (Photo courtesy of the USACE)

Erosion

The spillway has a "ski jump" at its downstream end, the flows from which have eroded the opposite (right) riverbank. This occurred because the bank lay unprotected; it is made up of alluvial deposits of unconsolidated silts and gravels about 4m thick on top of the cemented conglomerate.

A further problem with erosion appears at the discharge point from the bottom outlet. During operation of the outlet, there has been erosion of the stilling basin plunge pool. Erosion has removed part of the rollcrete base to the plunge pool and eroded or undermined both banks.

Echo-sounding surveys of the plunge pool have shown that the erosion is not symmetrical and is concentrated on the left side, with a maximum erosion depth of 6 m. The concern is that continued erosion might impinge upon the toe of the embankment. However, the Mosul Dam engineers designed and implemented a remedial measure for the erosion of the plunge pool of the bottom outlet. The remedial measure was reviewed and approved by an international panel of experts (IPE)[7], and the bottom outlet was used to empty the reservoir during the wet season of 2007 to maintain the water level restriction of 319 m. The bottom outlet is now operational.

According to a USACE study, "…damage caused by internal seepage…can ultimately cause total failure of an embankment dam. Voids (generated by internal erosion) will eventually manifest themselves as a hole on the upstream face of the dam."

Post-Construction Temporary Fixes

The Mosul Dam was constructed on a foundation of soluble soils that are continuously dissolving. This results in the formation of underground cavities and voids that endanger the dam. Because these conditions have existed since the dam was constructed, the Iraqi Ministry of Water and Resources (MWR) has pursued both short-and long-term risk-reduction measures over the past 25 years. To fill the voids and cavities in the foundation strata, a continuous grouting program—implemented 24 hours a day, six days per week—has, since the 1980s, constituted the primary and ongoing measure for mitigating risk (Figure 6).

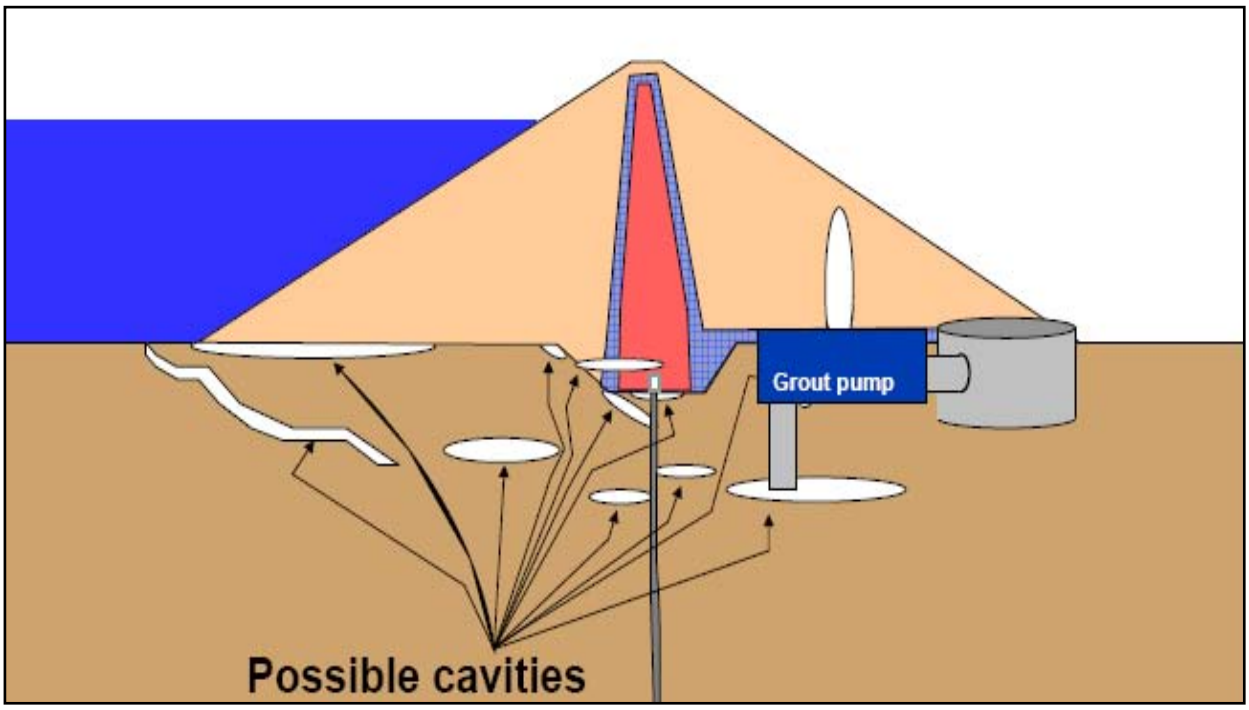


Figure 6. Illustrative example of the Mosul Dam's grouting program aimed at filling voids and cavities from the gallery (Figure courtesy of USACE)

[7] The international panel of experts (IPE) is a panel commissioned and paid for by the MWR. It was formed in early 2006 and has been advising the MWR on matters related to the Mosul Dam since. The IPE includes dam experts from the United States, the United Kingdom, and Italy.

Figures 7[8] and 8[9] provide monthly drilling and grouting production from 1986 to 2007. Figure 7 indicates that the average drilling production over the years is generally less than one half of that attained in 1987. Figure 8 appears to show a general trend of decreasing grout injection over the years. While Figure 8 seems to indicate that grouting may have some success in sealing karst channels and reducing erosion or solution, it is also worth noting the significant amount of grout and massive grout still required to fill large voids.

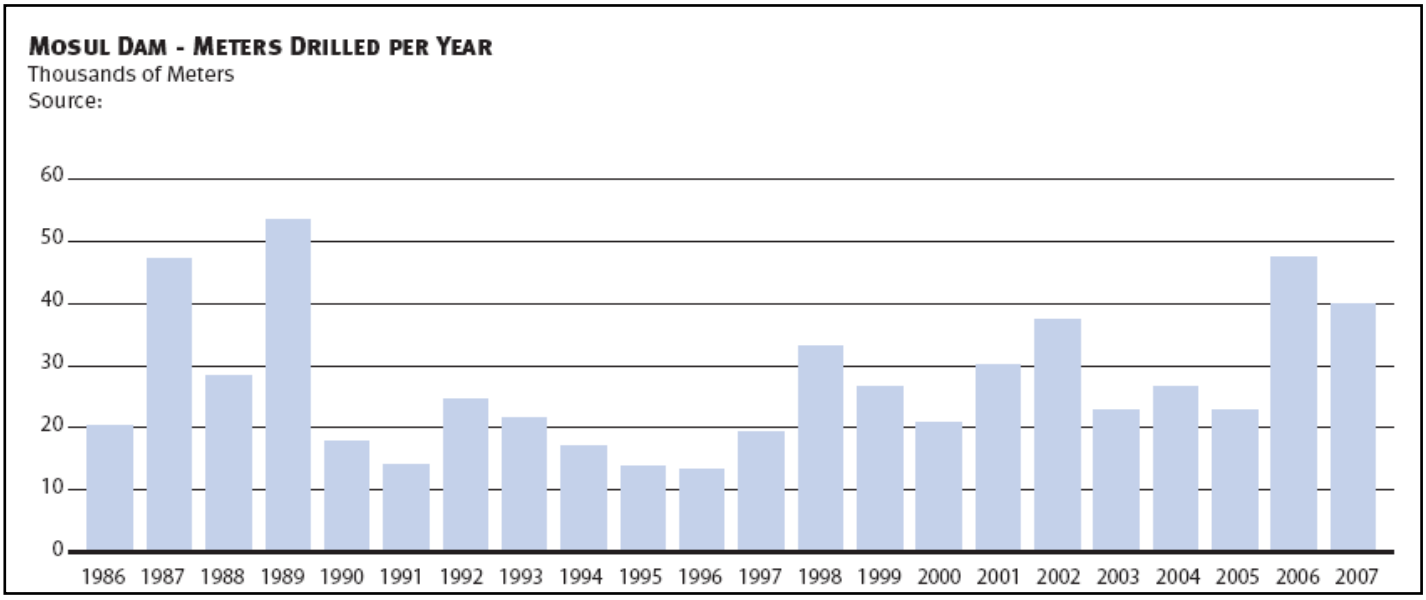


Figure 7. Meters drilled per year at the Mosul Dam from 1986-2007 (Data provided by dam management)

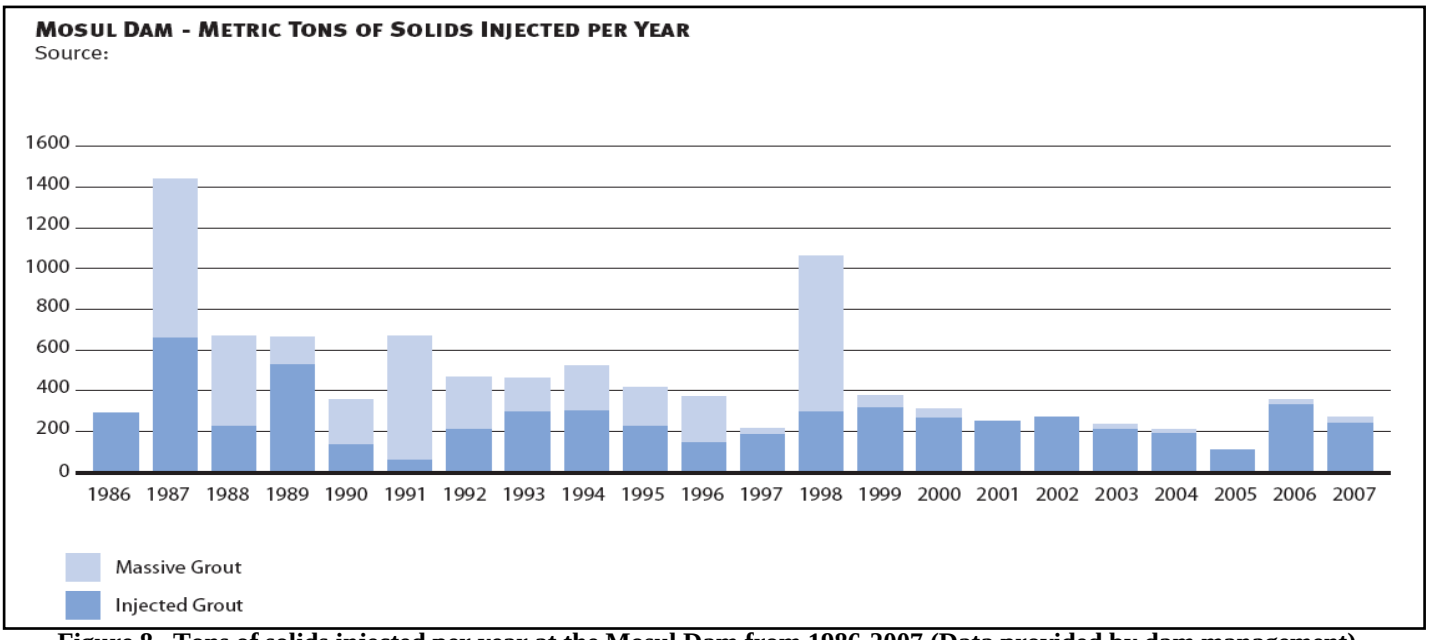


Figure 8. Tons of solids injected per year at the Mosul Dam from 1986-2007 (Data provided by dam management)

The Mosul Dam has two main grout-mixing plants, one on each side of the dam. The plant situated toward the west side of the dam includes three mixing units, two of which

[8] For the raw number data behind Figure 8, please see Appendix B.
[9] For the raw number data behind Figure 9, please see Appendix C.

are 20 cubic meters per hour (m^3/hour) and one is 7-m^3/hour (Site Photo 10 and Figure 9). All three grout-mixing units are automated and controlled from a single control room. The second grout-mixing plant includes only two units with a capacity of 20-m^3/hour each. All grout-mixing plants were constructed during the mid-1980s.

Site Photo 10. Existing 20-m^3/hour grout-mixing plant (Photo courtesy of the Iraq Transition Assistance Office (ITAO)

Figure 9. Location of the existing grout-mixing plants (Figure courtesy of ITAO)

Project and Contracting Office/USACE Actions

The Project and Contracting Office (PCO) performed studies in 2004 and 2005 to characterize critical problems and identify long-term solutions. The PCO developed the following two-phase action plan:

- Phase I – The development of studies specifically related to the Mosul Dam problems and the identification of the most critical problems and their solutions
- Phase II – The implementation of solutions.

Phase I

Under contract W914NS-04-D-0007, WI/BV was issued Task Order (TO) 0008 on 13 August 2004 in response to concerns about the conditions, long-term stability, and safety of the Mosul Dam. The main concerns were the impact of solution erosion, plunge pool erosion, and the development of sinkholes. In order to address these issues, a Panel of Experts[10] (POE) was retained by WI/BV to review the concerns and provide recommendations. The POE was tasked with the following:

- Evaluate the existing conditions of Mosul Dam;
- Define the problems and identify conditions needing correction;
- Define potential alternate solutions; and
- Recommend one (or more) solutions that will resolve the conditions.

[10] The Panel of Experts consisted of world experts in the fields that would be of most concern to the Mosul Dam issue, such as grouting, soil and rock mechanics, foundations, engineering geology, and embankment foundations.

The most critical issue identified in the original studies was that the "…foundation solutioning issue is the prime concern at Mosul Dam and the risks are high." The POE concluded that the "…safety of the Mosul Dam cannot be assured due to unpredictable and unique foundation conditions."

Phase II

In August 2005, the Iraq Reconstruction Management Office[11] (IRMO) requested $20 million for the purchase of specialized grouting equipment and seismic monitors to sustain Mosul Dam stabilization efforts to reduce the risk of dam failure and maintain sufficient water to generate 320 MW electricity and irrigation for farmers.

The POE recommended short term and permanent solutions for the Mosul Dam. The short term recommendation was to "…continue with the grouting program and enhance it with new technology…," while the permanent solution was the "construction of Badush[12] Dam as backstop."

Implementation of Solutions

The POE, in coordination with the dam manager, decided upon the following approach:

1. Provide enough equipment and materials to avoid interrupting the current "traditional" grouting operation;
2. Perform laboratory and field testing of high performance grouting; and
3. Implement the fully enhanced grouting operation.

In order to accomplish this, the Phase II implementation of solutions consisted of providing the MWR with: spare parts for existing Wirth grout equipment, Piezometers, enhanced grout system and training in the operation of the new grouting system, and a foundation model.

According to USACE documentation, the MWR developed a long list of needed replacement and spare parts for the Mosul Dam. The MWR later decided to purchase many of the items on its own, such as new Wirth drill rigs and spare parts for old Wirth rigs. This left the PCO with a list of the most critical items required for the dam.

Enhanced grouting included the use of high performance grouts as well as new means and methods for minimizing residual permeability of the rock mass. The goal was to reduce residual permeability by 50% to 80% of that achieved using traditional mixes and methods.

Ultimately, 21 separate contracts were awarded to implement the solutions identified by the POE. One contract was for an Advanced Grouting System (AGS), which consisted of a totally integrated system for data collection, monitoring and display, record keeping, and analysis of the grouting operation and various specialized enhanced grouting equipment.

In March-April 2006, the Iraqi government convened an IPE which recommended the MWR lower the water level in the dam by 11m to 319m. However, the storage in the Mosul Dam Reservoir is of considerable value to Iraq. Limiting the water level reduces the water available for irrigation during the dry season. In addition, lowering the water

[11] In 2007, the IRMO became the Iraq Transition Assistance Office.
[11] Badush Dam is alternately spelled Bedoush in some sources.

level has a negative effect upon the dam's ability to produce hydroelectric power for the residents of Mosul.

Ministry of Water Resources Actions

In addition to the assistance received by the U.S. government, the MWR committed its own funding to the purchase of additional drilling rigs for inside and outside the gallery. The Mosul Dam manager said the MWR desperately needed the five grout-mixing plants (one 100-m^3/hour and four 30-m^3/hour production rate) to support the increased demand for grout[13] production and consumption of large quantities of cement[14]. To make cement available on demand and in large volume, stationary storage silos were the logical choice. The MWR's plan for the four 30-m^3/hour grout-mixing plants was to strategically locate one outside each side of the gallery and also have one each on the left and right banks (Figure 10).

With the 100-m^3/hour mixing plant, dam personnel would have the ability to perform massive grouting from the top of the dam. According to the ITAO representatives, the top of the dam currently has three locations where grout can be placed directly into the dam in order to fill large cavities.

The additional cement storage stationary silos were critical for allowing Mosul Dam personnel the flexibility to have large quantities of cement on hand in case an immediate need arose.

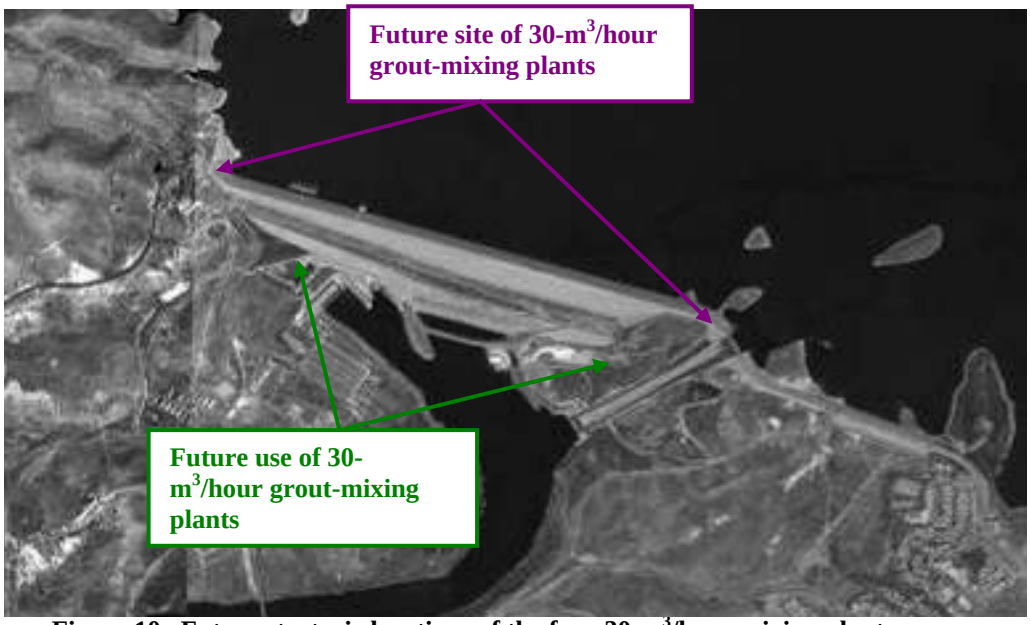


Figure 10. Future strategic locations of the four 30-m^3/hour mixing plants (Figure courtesy of ITAO)

[13] Grout is a construction material used to embed reinforcement bars in masonry walls, connect sections of pre-cast concrete, fill small voids, fissures, cracks, fractures, cavities, and seal joints (such as those between tiles). Grout is generally composed of a mixture of water, cement, sand, and (sometimes) additives to produce and modify engineering properties to meet special requirements.

[14] Concrete ("cement" is the commonly used non-technical term) is a construction admixture that consists of cement (commonly Portland cement), coarse aggregate (generally gravel), sand, and water. Concrete solidifies and hardens after mixing and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like hard material. It is used to make a variety of pavement and structural elements.

The USACE concluded in September 2006 that "in terms of internal erosion potential of the foundation, Mosul Dam is the most dangerous dam in the world… If a small problem [at] Mosul Dam occurs, failure is likely."

In December 2006, the USACE's "Hypothetical Dam Failure Scenarios" concluded that the current probability of dam failure is considered to be exceptionally high. As a result, the U.S. Ambassador to Iraq and the Commanding General of the Multi-National Force-Iraq, in May 2007, co-authored a letter to the Iraqi Prime Minister[15], which stated that the Mosul Dam presented unacceptable risks and did not meet international standards for risk and reliability, and as such, the safety of the dam cannot be assured. Therefore, in the event of a failure of the Mosul Dam, the worst case scenario would be a significant loss of life and property.

The USACE determined that in the event of a dam failure, the result would include flood waters reaching the city of Mosul in approximately 3 to 4 hours with a maximum depth greater than 20 m.

Objective of the Project Assessment

The objective of this project assessment was to provide real-time relief and reconstruction project information to interested parties to enable appropriate action, when warranted. Specifically, we determined whether:

1. Construction or rehabilitation was in compliance with the standards of the design.
2. An adequate quality management program was utilized.
3. Sustainability was addressed in the contract or task order for the project.
4. The project results were consistent with its original objectives.

Pre-Site Assessment Background

Contract, Costs and Payments

Contract W914NS-04-D-0007, an indefinite delivery/indefinite quantity, cost-plus-award-fee contract to restore, rebuild, and develop national water resources in Iraq was awarded to WI/BV, Boise, Idaho, on 11 March 2004.

TO 0008, which contained nine modifications, required the initial study of the Mosul Dam. The objective of the study was to identify the most critical problems and their solutions. In an effort to implement the identified solutions, 21 individual contracts were awarded[16]. For a detailed list of the contracts, see Appendix E.

Project Objective, Pre-Construction Description

The objective of the TO and associated contracts was to conduct studies specifically related to the Mosul Dam problems, identify the most critical problems and their solutions, and implement those solutions.

[15] For the letter in its entirety, see Appendix D.
[16] Two contracts were subsequently terminated/cancelled for cause.

The studies concluded that the safety of the Mosul Dam could not be assured due to foundation conditions and identified short-term, long-term, and permanent solutions. The U.S. government would assist the MWR with some of the short-term solutions; while the Government of Iraq would be responsible for the long-term and permanent ones.

The short-term solutions consisted of:

1. Providing enough equipment and materials to avoid interrupting the current "traditional" grouting operation;
2. Performing laboratory and field testing of high performance grouting; and
3. Fully implementing enhanced grouting operations.

Statement of Work

In an effort to assist the MWR with short-term solutions for the Mosul Dam, the course of action decided upon was for the PCO to provide the following:

- Five mixing plants (one 100-m^3/hour and four 30-m^3/hour grout-mixing plants) to allow for accelerated grouting;
- Stationary silos for additional cement storage capacity;
- The most critically needed replacement and spare parts; and
- An enhanced grout system and training in the operation of the new grouting system.

Mixing Plants

All existing mixing plants were constructed during the mid-1980s and were in need of repair and/or replacement after approximately 20 years of continuous use. Four 30-m^3/hour grout-mixing plants were proposed to produce high performance grouts necessary to fully implement the enhanced grouting program for the dam. According to the POE, this program is essential to reduce the probability of dam failure.

An additional 100-m^3/hour mixing plant was proposed to provide dam operators the ability to produce massive grouting output.

The contract's Section B – Supplies or Services and Prices/Costs identified the specifications for the five grout-mixing plants. The specifications for the four 30-m^3/hour and one 100-m^3/hour grout-mixing plants were:

- Total capacity 30-m^3/hour, wet system, with all the accessories, including valves, piping, screw conveyors, control room, control panel, 50% spare parts, made in Turkey, European standards.

- Grout weight cement sandy batching/ plant for massive grouting output 100-m^3/hour, cement handling-silo and screw feed, bentonite handling-silo and screw feed, sand handling-silo and screw feed, complete unit with all accessories, made in Turkey, European standards, and 20% spare parts.

Stationary Silos

A POE recommendation to assist with the massive grouting program called for, dam personnel should be provided with additional cement storage capabilities. Currently,

the dam has a limited storage capacity. In order to provide dam personnel with additional cement storage capabilities, a contract was issued to build four stationary silos, each with a capacity of 1,500 tons. The contractor was to provide all accessories, measuring level of quantity, and a control room for each silo.

The contract required all welding to comply with approved welding procedures; quality control procedures to be enforced during manufacturing, assembly, erection, and commissioning; foundation drawings showing the size of the foundation pad, thickness, and type of reinforcement required; and the size of foundation bolts.

Enhanced Grouting System

The enhanced grouting system was procured through several contracts for materials and equipment such as the following:

- laboratory equipment
- superplastizicer
- anti-wash agent
- Welam Gum/fly ash
- grouting material

These additives were to be added to the four new 30-m^3/hour grout-mixing plants in order to produce an enhanced grouting material.

Computer Aided Grouting System

Contract W91GY1-06-C-1000 provided for the "Advanced Grouting System for Mosul Dam, Iraq." This system consisted of two basic components, an Integrated Analytical System (IAS) for automated, computer aided grouting monitoring and analysis; and modified grout batching and delivery equipment for balance stable grout handling, mixing, and injection with associated fittings, pumps, hoses, packers, air compressors, and quality control testing equipment.

The IAS and its associated hardware were to come with one-year parts replacement and one-year help desk service agreements. The parts replacement will be for one-for-one replacement of any system component that fails due to normal wear and tear or latent defect. The vendor will also provide a one-year web site hosting for posting of drawings and data generated during operation of the IAS.

The contract called for the expedition of design, fabrication, and preparation of submittals. In order to accomplish this, a "…team approach can be considered by the Vendor, so the Government and the Contractor can jointly work to ultimately define the details of those specifications included in this solicitation." According to the contract, the:

> *"…joint team (Vendor-Client team) would then work through all major configurations issues, project constraints, service conditions, practical issues of the operating environment and special requirements. The joint team will be able to resolve all major questions, issues, and most of the details of each item included in this solicitation; so that, project delivery targets can be achieved and the system is designed to cope effectively with the foundation conditions in Mosul Dam."*

The vendor was also required to submit (in both electronic format and hard copy and in Arabic as well as in English) five copies of each submittal.

Project Design

Role of CH2MHill/Parsons (Sector Project and Contracting Office Contractor)

The Sector Project and Contracting Office Contractor (SPCOC) for this project was CH2MHill/Parsons. CH2MHill has a background in program management of water treatment, irrigation, water supply, and sewage projects; while Parsons' expertise is in construction. The role of the SPCOC was to bring a full range of program management services to assist the U.S. government in the following: engineering analysis and technical consulting; requirements management; quality assurance; contract administration; and acquisition, procurement, and logistics support.

In the role of engineering analysis and technical consulting, CH2MHill/Parsons was responsible for determining the requirements, creating the request for proposal, reviewing all bids and submissions, and evaluating the adequacy of the winning bidder's subsequent submittals.

Determining the requirements

Mixing Plants

In order to assist with massive and enhanced grouting, the decision was made to procure one 100-m^3/hour and four 30-m^3/hour grout-mixing plants, respectively. According to a USACE representative formerly involved with this project, this 100-m^3/hour grout-mixing plant would be considered the "Mother of All Grout Plants" since it "would be one of the largest capacity grout plants on the planet." Referring to the data in Figure 8 (Appendix C), the largest amount of massive grouting used during an entire year occurred in 1987 at 7,784 tons. A 100-m^3/hour grout-mixing plant would be able to produce the 7,784 tons in approximately 45 hours. Thus the need for such a large plant does appear to be questionable. Further, the need for procurement of an additional four 30-m^3/hour grout-mixing plants is questionable. Referring to the data in Appendix C, the largest amount of injected grout during an entire year occurred in 1987 at 6,646 tons. A single 30-m^3/hour grout-mixing plant would be able to produce 6,646 tons of grout in approximately 120 hours.

The contract file lacked any documentation to support the need for five grout-mixing plants, specifically the need for the "Mother of All Grout Plants" (100-m^3/hour). Further, it is evident that five grout-mixing plants were not needed at the Mosul Dam. The SPCOC, as the U.S. government's technical expert, was responsible for analyzing the available data and determining the required number and size of grout-mixing plants needed at the Mosul Dam.

Finally, the USACE representative also stated all five grout-mixing plants would be "construction" projects, which in his opinion violated the "intent of the equipment-only procurement." The CH2MHill/Parsons group, with its background in water project management and construction, should have identified this project as a construction project, which would have required construction oversight via quality control and quality assurance programs.

Stationary Silos

In order to assist with the massive grouting program, the U.S. government contracted to build four stationary silos, each with a capacity of 1,500 tons, to provide the Mosul Dam with additional cement storage capabilities. According to a USACE representative, in January 2005, he visited the Mosul Dam and "saw the scale of the existing silos and immediately recognized this would be 'construction.'" He took photos of the existing 5-story tall silos and sent them to CH2MHill/Parsons and "informed them these silos would be considered construction and not simple procurement." Even though the SPCOC was informed that this project should be contracted as a construction project, 14 months later, in March 2006, the stationary silos contract was issued as a simple procurement contract. Consequently, comprehensive quality control and quality assurance programs were not required.

The Advanced Grouting System

The U.S. government's specifications for the AGS equipment does not show the gallery's layout, profile, cross-sections, limited height and width nor do the specifications show that some of the equipment will be used inside the gallery. According to Mosul Dam personnel, some of the equipment procured will not fit into the gallery. We do not understand how an experienced program management and construction joint venture could omit such critical information.

The AGS contract consisted of the procurement of Intelligrout (through the IAS units and associated equipment) and specialized equipment to perform enhanced grouting, such as the High Mobility Grout and Low Mobility Grout (LMG) mixing plants. The IAS units and other state of the art equipment procured under this contract require a high level of expertise and experience to operate. However, the vendor was unwilling to come to the site to set up the equipment and provide training. The vendor was not required to provide on-site commissioning, training, or technical support. While a seven week training class was held for 10 MWR personnel to provide hands-on experience, there are other issues that required a vendor to be on site, including the deployment of the sensors, operation of the software, and the installation of the communications system. The SPCOC needed to consider that this sophisticated equipment was being provided to a third world country, which has been isolated from the world for approximately 20 years, and was to be operated in a war zone.

In addition, the AGS contract provided for Web Site Hosting by the vendor as a method for posting drawings and information generated during operation of the IAS. According to the contract, the "Web uplink service from the site shall be provided by others." In this case, the "others" refers to the MWR; however, according to MWR and ITAO representatives, high speed internet is not available in the Mosul area because there are no internet service providers in the Mosul area capable of providing high speed internet service. The SPCOC did not verify the availability of high speed internet service in the Mosul area. The contract file lacked any documentation of discussions with the MWR to see if high speed internet was available in the Mosul area or if the MWR had the resources and desired to pay for this service.

Preparing contract specifications

Grout-Mixing Plants

For the five grout-mixing plants, the contract required four "Total Capacity 30-m^3/hour, wet system" mixing plants and one "Grout weight Cement sandy batching

plant for massive grouting Output 100-m^3/h" mixing plant. For all five grout-mixing plants, the contract stated that "complete specifications are attached." For the 30-m^3/hour grout-mixing plants, the specifications consisted of a simple three page schematic drawing, which lacked significant details, such as the control room, pump sizes and their capacity, and a mechanism to fill the silos. The contract specifications did clearly indicate the 30-m^3/hour mixing plants were to be grout-mixing plants (Figure 11).

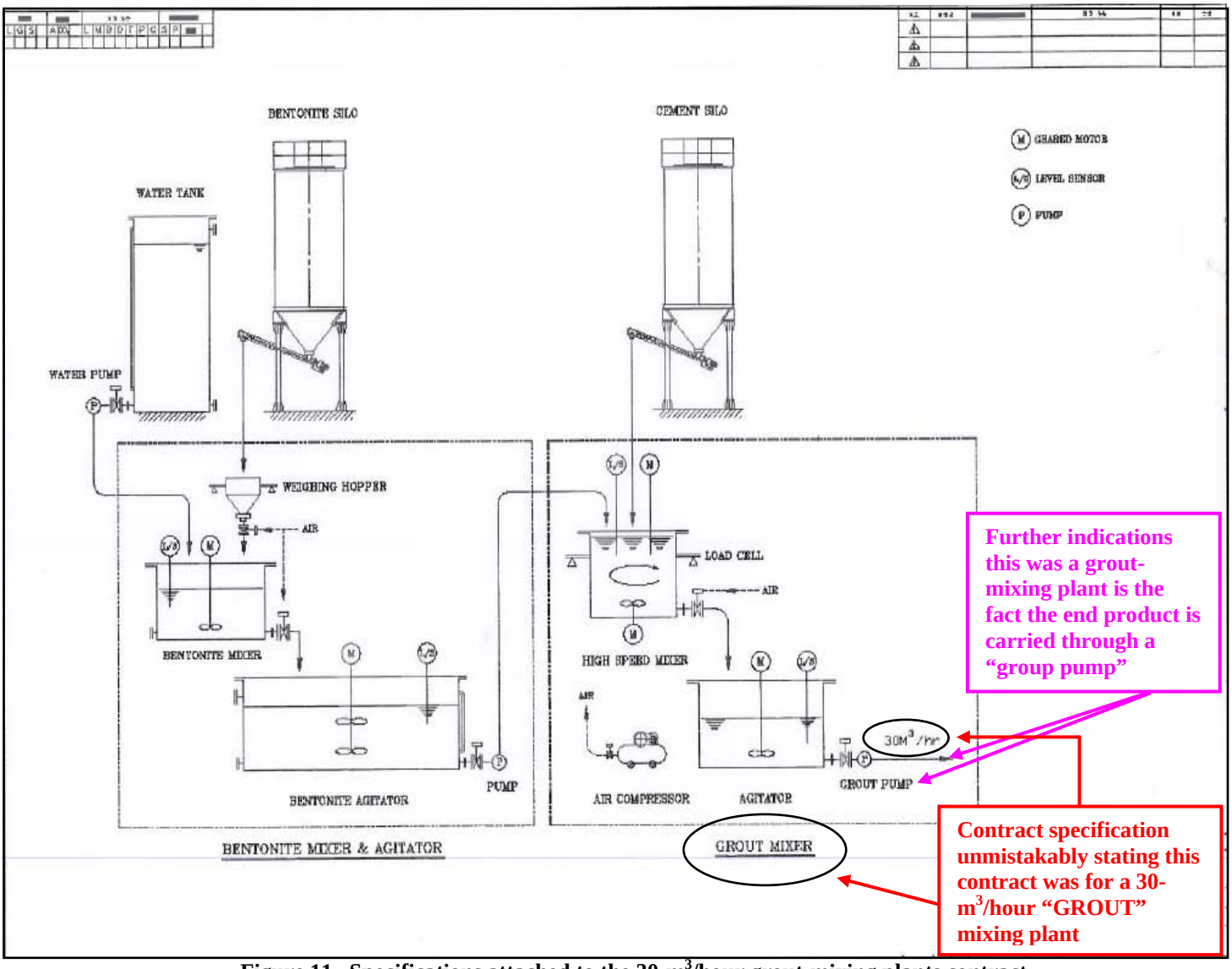


Figure 11. Specifications attached to the 30-m^3/hour grout-mixing plants contract

The design specifications for the 100-m^3/hour grout-mixing plant were the following:

> *"Grout weight Cement sandy batching plant for massive grouting Output 100m3/h, cement handling-silo and screw fee, bentonite handling-silo and screw feed, sand handling-silo and screw feed, Complete unit with all accessories + 20% spare parts."*

Reviewing design drawings and submittals

Grout-Mixing Plants

GRD provided the contractor's design submittals for the two sizes of grout-mixing plants (i.e., 30-m^3/hour and 100-m^3/hour), which we reviewed. For the 30-m^3/hour grout-mixing plants, our review of the design drawings concluded that the contractor was clearly offering concrete-mixing plants, not grout-mixing plants (Figures 12 and 13). Grout mixing plants require a bentonite silo and water and hydration tanks, associated weighing and measuring devices, additional pumps and motors, which were not included in the design drawings.

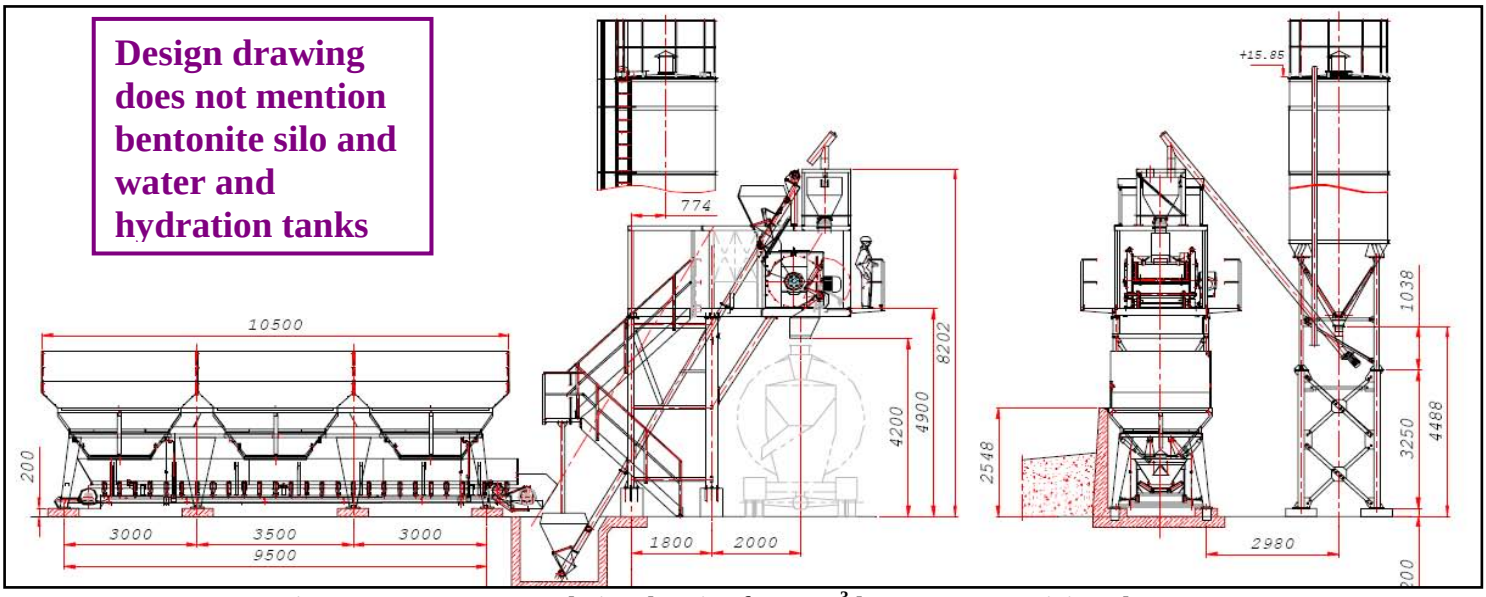


Figure 12. Contractor's design drawing for 30-m^3/hour concrete-mixing plant

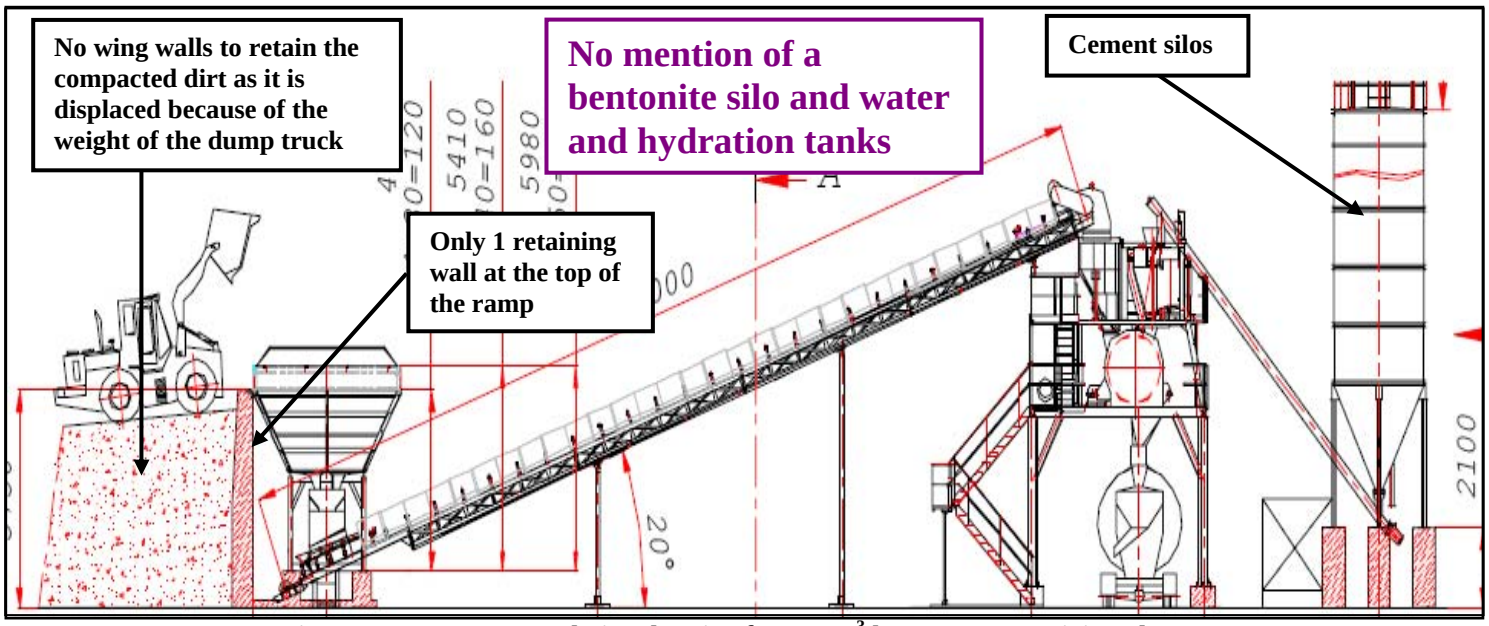


Figure 13. Contractor's design drawing for 100-m^3/hour concrete-mixing plant

In July 2006, the CH2MHill/Parsons Acting Implementation Manager issued a memorandum to the Joint Contracting Command – Iraq/Afghanistan (JCC-I/A) Contracting Officer stating the following:

> *"[The vendor] submitted his offer on 12 February 2006 for 4 new Mixing Plants and spares…the Vendor offered in his bid a Concrete Mixing Plant…When the Evaluation Committee (EC) proceeded to review the offers, they did not notice that the Vendor was in fact offering a Concrete Mixing Plant as opposed to the Grout Mixing Plant requested in the solicitation."*

As part of the Evaluation Committee (EC), the SPCOC, with responsibility for meticulously analyzing and evaluating the contractor's submittals, failed to "notice" the offer was for a concrete-mixing plant instead of a grout-mixing plant. We question the thoroughness of the EC's review, considering the cover page of the contractor's design submittal stated in large print "CONCRETE BATCHING PLANT" (Figure 14).

Figure 14. Cover page of the contractor's design submittal for the 30-m^3/hour concrete-mixing plant

In our opinion, the 100-m^3/hour mixing plant design submittal also clearly indicated the contractor was offering a concrete-mixing plant, not a grout-mixing plant (Figure 15). The design submittal lacked a bentonite silo, water and hydration tanks, associated weighing and measuring devices, and additional pumps and motors, which are essential for a grout-mixing plant (Figure 13).

Figure 15. Cover page of the contractor's design submittal for the 100-m^3/hour concrete-mixing plant

The July 2006 CH2MHill/Parsons' memorandum did not mention the 100-m^3/hour grout-mixing plant. The contract file lacked any documentation regarding how the concrete-mixing plant was reviewed and approved instead of the required grout-mixing plant. It appears that for the 100-m^3/hour grout-mixing plant design submittal, the EC also did not "notice" the contractor's submittal offer was for a concrete-mixing plant, not a grout-mixing plant. In addition, the EC did not recognize the contractor's design submittal lacked side retaining walls (i.e. wing

walls) for the loading ramp (Figure 13). The wing walls are crucial for the use of the loading ramp because without them, when the full dump truck drives up the ramp, the compacted dirt will disperse under the truck's weight resulting in the truck not being able to reach the hoppers to unload the materials.

As a result, on 25 March 2006, the contractor entered into a contract with the U.S. government for what he thought was to provide five concrete-mixing plants in the amount of $2,461,400. According to CH2MHill/Parsons, this issue was not discovered until the "Ministry [MWR] realized the order was proceeding with a Concrete Mixing Plant instead of a Grout Mixing Plant."

The U.S. government acknowledged its responsibility for the error and negotiated with the contractor to modify the concrete-mixing plants into grout-mixing plants. Contract Modification #2, in the amount of $920,000, was awarded on 3 August 2006, to modify the five concrete-mixing plants into grout-mixing plants.

Stationary Silos

For the stationary silos contract, GRD provided the contractor's design submittals, such as the foundation and super structure drawings; however, the contract file lacked geotechnical exploration information for the foundation. Without this information, we cannot evaluate the adequacy of the structural details shown on the plan.

The "Plans and Viev [sic]" design submittal provided multiple views of the finished stationary silo (Figures 16 and 17). According to the design drawings, each silo was to be approximately 120 feet high (from the base to the top). After thoroughly reviewing all available design drawings, we found the designs lacked significant details, such as lateral bracing support for the entire height of the silos (Figure 19), notes for the thread size, length, washer size, base plate requirement, and torque (for the foundations bolts – Figures 18-21), how the MWR personnel will deposit cement into the silo, and safety concerns. The lateral bracing supports for the entire height of each silo are important in order to keep each silo in its intended vertical position while allowing the load to transfer to the matt foundation during the cement filling process. The proportion of the silos is very large, since the height to diameter ratio is almost 6 (Figure 17), which could result in the silos overturning. According to an internal GRD document, the "standard practice is to resist overturning by a ratio of 1.5." A consulting engineer for GRD stated the silos looked like an "inverted pendulum." Further, detailed information for the foundation bolts is critical, since the foundation bolts will be required to counter all gravitational forces that would cause the silo to tip over, under most conditions. Further, since the opening to fill each silo is located at the top (120 feet high), for safety reasons, we are concerned that the contractor's designs did not include a safety ladder to climb or a safety bar and railing at the top (Figure 17). Additionally, no secure walkway with safety railings is shown to connect all silos at the top.

Finally, the awarded contract required the stationary silos to have a "control room." The design drawings did not mention the use of a control room.

Since the stationary silos, in total, will hold up to 6,000 tons of cement, the issues we identified need to be thoroughly examined and reviewed in order to determine the adequacy of the contractor's proposed structure submittal.

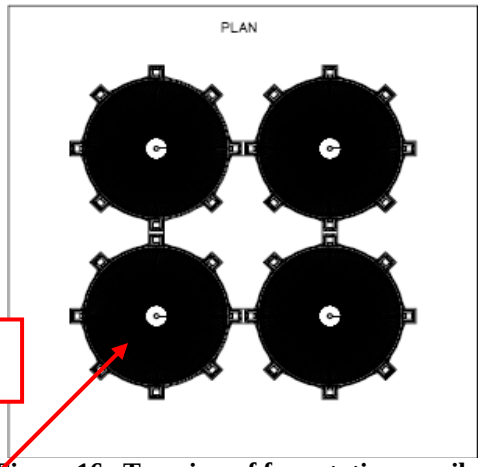


Figure 16. Top view of four stationary silos

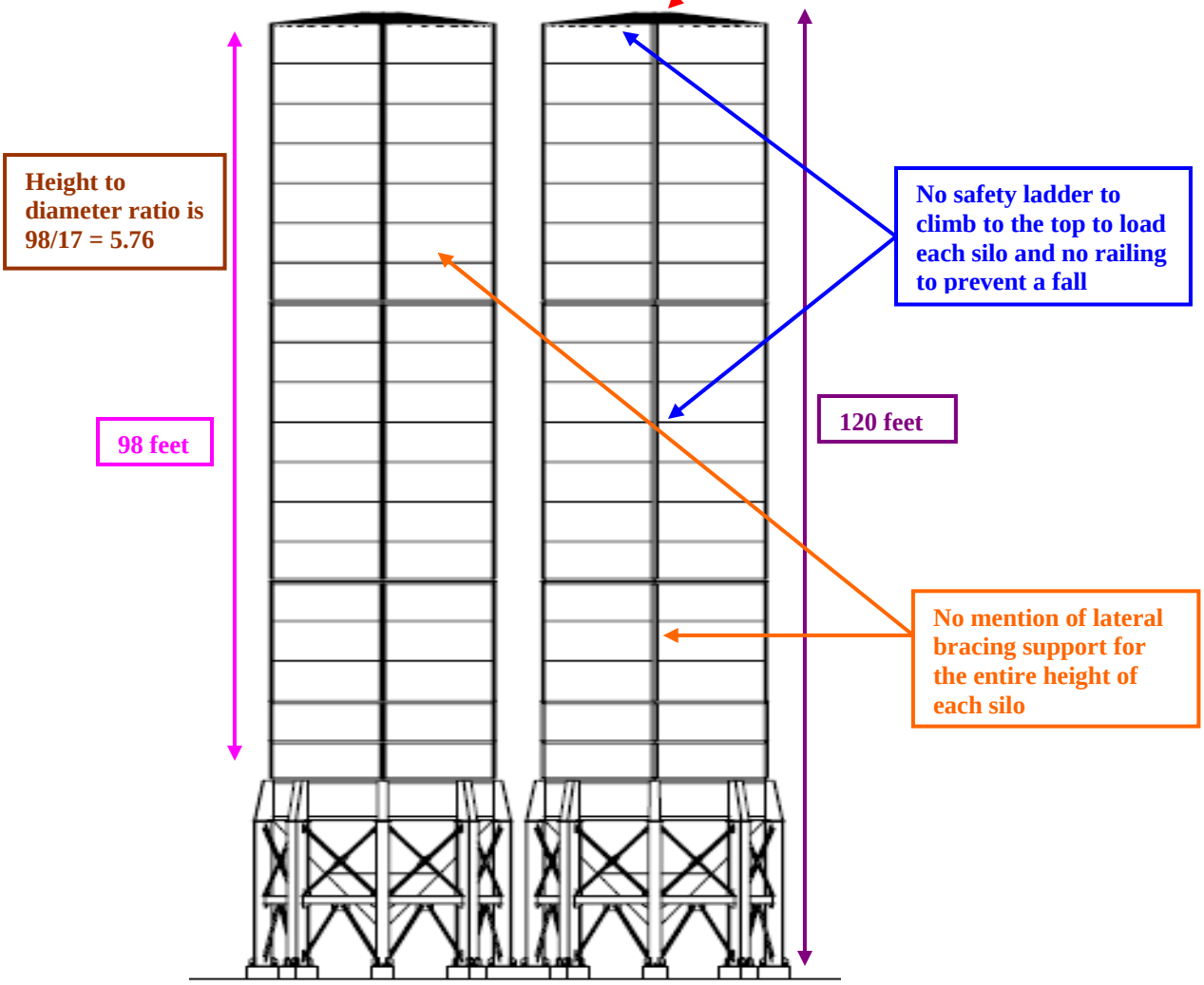


Figure 17. View of two stationary silos

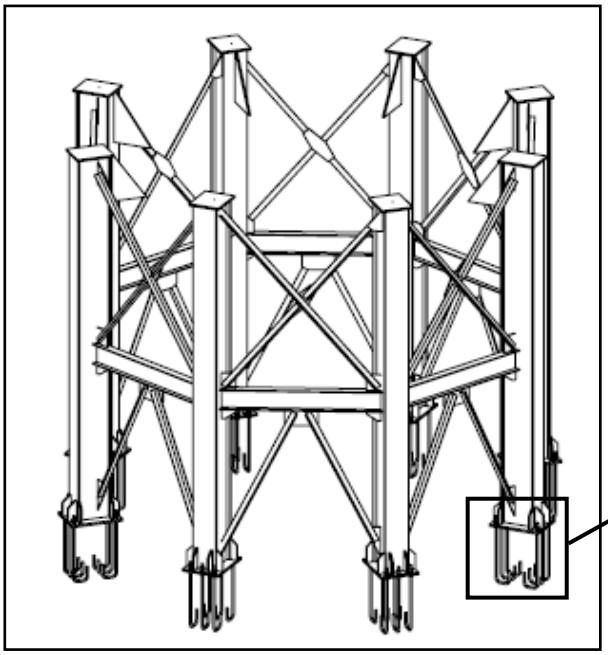


Figure 18. View of column group for the stationary silos

Design does not mention diameter size, thread size and length and strength grade for steel

Figure 19. Foundation bolt

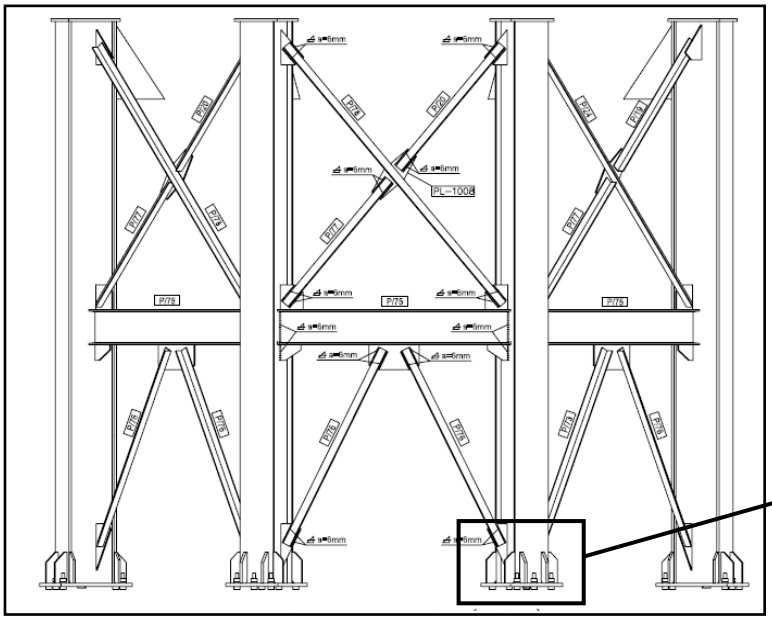


Figure 20. Column group view for the stationary silos

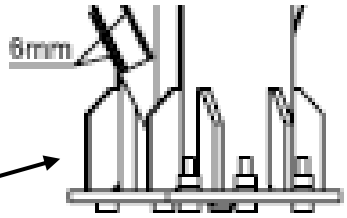


Figure 21. Close-up view of Figure 20

Further, the SPCOC should have identified from a review of the contractor's design drawings that this structure would be extremely labor intensive to construct. According to the design drawings, the contractor's construction will require the bending and subsequent welding of straight 20 millimeter (mm), more than 3/4 inch thick, steel plates to form the cylindrical holding tanks (Figures 22, 23, and 24). This process will require experienced welders and detailed efforts by the construction crew. Consequently, the SPCOC, after reviewing the contractor's design drawings, should have identified this as a construction project and required the contractor to provide a detailed cost and delivery schedule to determine the breakdown of costs

(materials versus labor) and the timeframe for completing the project (not just delivering the materials on site). In addition, detailed quality control and quality assurance programs are essential for a project of this complexity.

Figure 22. Delivered piece of straight steel

Figure 23. Condition of steel piece after being bent into desired shape

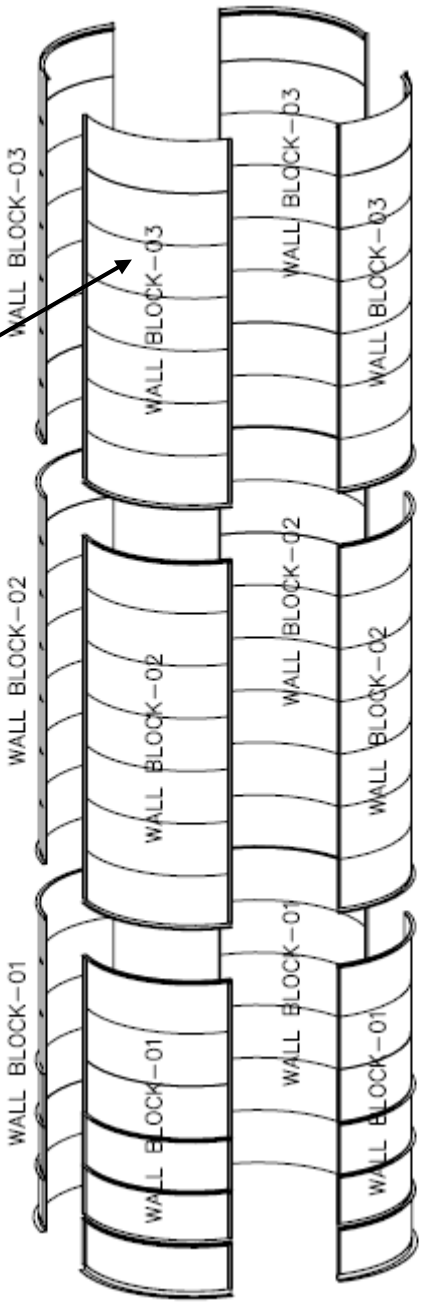


Figure 24. Bent steel pieces used to create cylindrical holding tanks

Finally, an Independent Government Estimate (IGE) for a single 1,500 ton silo was determined to be $1 million. However, the U.S. government awarded the contract to a contractor who bid only $195,000 for each silo. Such a disparity between the IGE and the contractor's bid should have raised significant issues about the ability of the contractor to perform this contract. The project file did not document any effort by

the U.S. government to determine how the contractor was going to perform this contract for approximately 20% of the IGE. It was the responsibility of the SPCOC to thoroughly research and evaluate the contractor's ability to provide the materials and construct each stationary silo for the awarded amount.

Advanced Grouting System

The AGS contract required that the contractor provide "…shop drawings, descriptions, specifications, O&M Manuals, or other as appropriate for each of the major items to be furnished. Identified major items are the IAS, flow meters, pressure transducers, IAS housing unit/trailer, radio and telephone systems, the grouting mixing and pumping plant, water flush pumps, grout reel machine, hoses, grout transfer tubes and compressors."

No comprehensive and rational diagram or schematic drawings were provided for the specialized equipment procured under this contract. A USACE grouting expert formerly associated with the project stated that "no schematics are required" because the "equipment as delivered, which the Iraqis trained on for 7 weeks in the U.S. in Spring/2007, is equivalent to a Lego kit." However, this comment contradicts a CH2MHill/Parsons' review of the contractor's Commissioning and Acceptance Plan for the AGS, which stated the following:

> *"Contractor should consider whether the Commissioning and Acceptance Plan would benefit from a graphic schematic (understandable by laymen) or schematics that show the various major components of the Advanced Grouting System. Such schematics could include the feature locations where the components will operate (surface, control trailer, grouting gallery, etc), to make clear the communications, piping, power and other links between the components."*

The project file lacked any documentation to determine why this recommendation was not incorporated into the contractor's final Commissioning and Acceptance Plan. However, in our opinion, a comprehensive and relational diagram or schematic drawings are necessary not only for the MWR personnel but also for the sake of the U.S. government. Presently, no current GRD, ITAO, or SPCOC representative, including the current U.S. government's grouting expert, could articulate a clear understanding of how the equipment is to be assembled and used inside/outside the gallery.

Conclusion

The role of CH2MHill/Parsons was to provide expertise in water program management and construction. Specifically, determine project requirements, develop specifications, and review and evaluate the contractors' design submittals for completeness and accuracy. In general terms, the SPCOC was responsible for oversight of the objectives of the contracts awarded for the Mosul Dam.

After a thorough review of the 21 contracts awarded, it appears that the execution of the projects did not have a comprehensive vision of how everything would work together. Instead, a fragmented approach was used. For example, a low mobility grout (LMG) mixing plant was procured under the AGS contract; however, a separate contract (with a different contractor) procured the 100-m^3/hour grout-mixing plant. With the purchase and installation of the 100-m^3/hour grout-mixing plant for massive grouting, the LMG mixing plant procured under the AGS contract

was not needed and redundant. In addition, the 100-m^3/hour grout-mixing plant for the massive grouting is fully automated; while the LMG mixing plant is manual.

Further, it is apparent that the highly specialized equipment procured under the AGS contract required Subject Matter Expertise to assemble and operate. While a seven week training class was conducted for 10 MWR personnel, the SPCOC did not take into consideration that the current MWR personnel are familiar only with 20-30 year old technology; therefore, their ability to absorb new technology may be severely limited.

Site Assessment

On 12 and 18 September 2007, the inspection team of the Special Inspector General for Iraq Reconstruction (SIGIR) performed on-site assessments of the Mosul Dam. We were accompanied by representatives from ITAO and GRD. We spoke directly with the dam manager and deputy manager regarding the status of the contracts. During both site visits, we observed MWR personnel working continuously on the grouting of the Mosul Dam.

Due to security concerns, we performed an expedited assessment. The time allotted for each site visit was approximately three hours; therefore, a complete review of all project work completed was not possible.

Mixing Plants

100-m^3/hour Grout Mixing Plant

Contract W91GY1-06-M-0019 provided for a single 100-m^3/hour grout-mixing plant. The contract's scope of work stated the "Contractor is responsible for performing or having performed all inspections and tests necessary to substantiate that the supplies or services furnished under this contract conform to contract requirements, including any applicable technical requirements for specified manufacturers' parts."

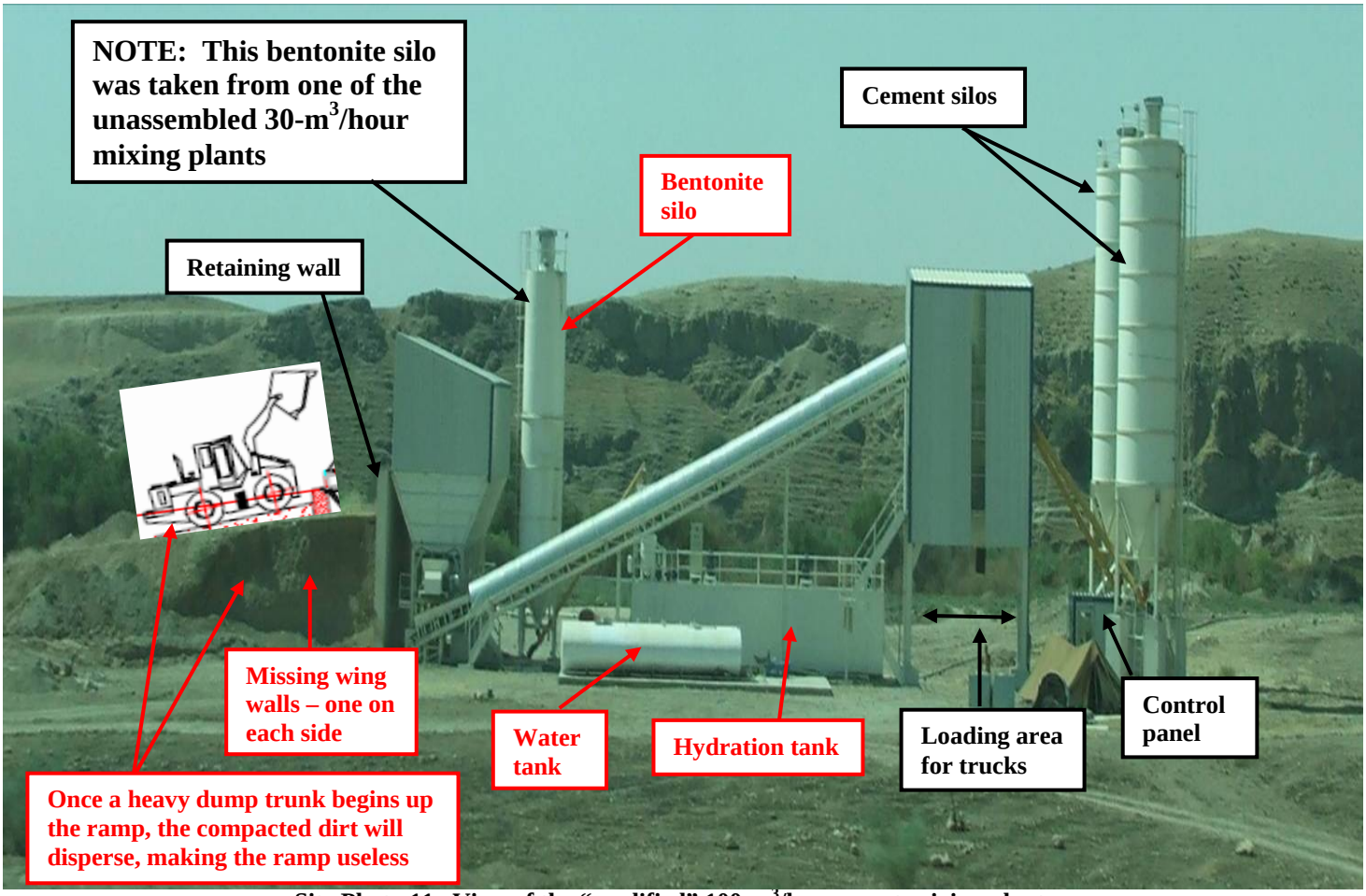
On 26 August 2006, the contractor delivered a 100-m^3/hour mixing plant; however, according to GRD documentation, what was delivered was a "concrete mixing plant, as opposed to the grout mixing plant in the solicitation." Dam personnel identified this error two days later and notified GRD that the delivered item was a "batching plant for concrete not for massive grouting." Dam personnel assisted in finding a way to convert the concrete-mixing plant into a grout-mixing plant, which included adding a bentonite silo, water and hydration tanks, and associated pumps and gages to the original structure (Site Photo 11 and Figure 25). However, as mentioned in the Project Design section, because the EC did not notice that the contractor's design submittal was for concrete-mixing plants, the U.S. government was responsible for the cost to modify the concrete-mixing plants into grout-mixing plants. For the 100-m^3/hour mixing plant, this modification resulted in an additional cost of $280,000 to the U.S. government.

On 18 September 2007, we observed the non functional 100-m^3/hour mixing plant (Site Photo 11). According to dam personnel, in an effort to modify the 100-m^3/hour mixing plant, the contractor used a new silo from one of the 30-m^3/hour mixing plants for the bentonite silo (Site Photo 11). Part of the contract modification required the contractor to "install and erection of the equipment and parts of the grouting plants including its silos bunkers and all accessories." Considering the contractor was paid in full for the 100-m^3/hour mixing plant modification and he used a piece of equipment from the

unassembled 30-m^3/hour mixing plant, it appears the contractor was paid twice for the silo.

According to Mosul Dam personnel, the contractor appeared to successfully modify the 100-m^3/hour concrete-mixing plant into a grout-mixing plant. However, dam personnel characterized this plant as unusable because of continuing issues within the control room since this was originally a concrete-mixing plant. Dam personnel are optimistic that these issues will be resolved shortly. However, the 100-m^3/hour mixing plant, which was delivered in August 2006, was not available to provide the massive grouting required for the Mosul Dam at the time of our site visit. As a result of the EC's failure to "notice" the contractor offered the wrong type of mixing plant, the massive grouting program is over one year behind schedule.

In addition, the contractor did not provide wings for the retaining walls of the 100-m^3/hour modified mixing plant (Site Photo 11). Without wing walls, the ramp, where heavy dump trucks back up to drop materials into the hoppers, cannot be used. Currently, dam personnel are in the process of trying to correct this omission with their own funding.



Site Photo 11. View of the "modified" 100-m^3/hour grout-mixing plant

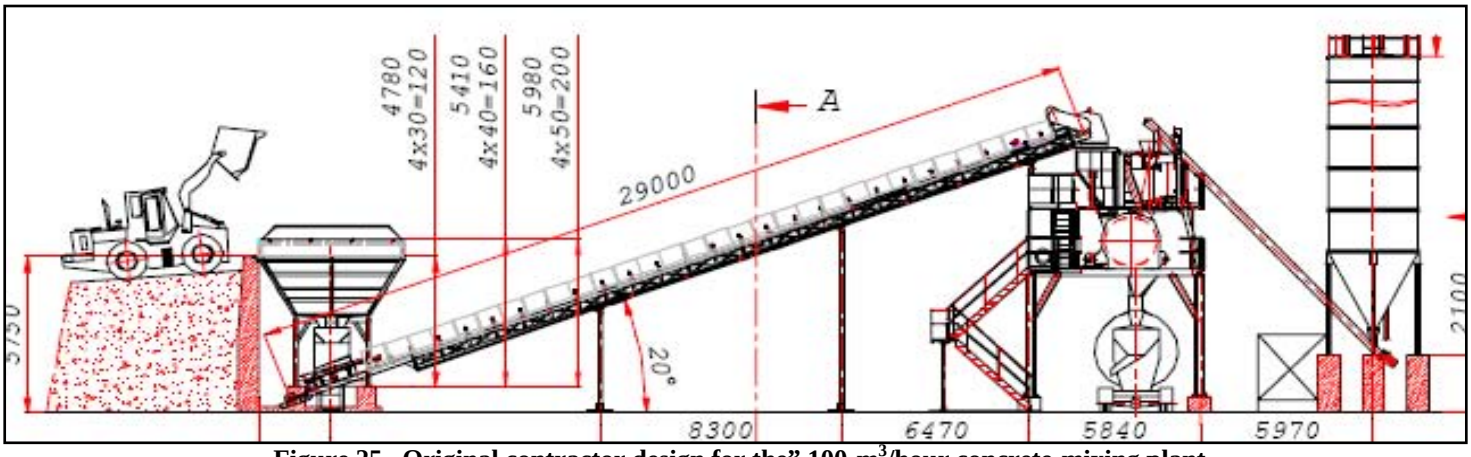


Figure 25. Original contractor design for the" 100-m^3/hour concrete-mixing plant

30-m^3/hour Grout Mixing Plants

Contract W91GY1-06-M-0019 required the delivery and assembly of four 30-m^3/hour grout-mixing plants. The contract's scope of work stated: "Contractor is responsible for performing or having performed all inspections and tests necessary to substantiate that

the supplies or services furnished under this contract conform to contract requirements, including any applicable technical requirements for specified manufacturers' parts."

On 6 September 2006, the contractor delivered two unassembled 30-m^3/hour concrete-mixing plants. However, according to CH2MHill/Parsons, the contractor delivered concrete-mixing plants "…as opposed to the grout mixing plant as requested in the solicitation." As mentioned in the Project Design section of this report, the contract specifications required the delivery of a 30-m^3/hour grout-mixing plant (Figure 26), which clearly confirms that the contractor delivered the wrong equipment. When the delivery arrived, dam personnel identified the error and notified GRD representatives.

Since it was the U. S. government that did not identify the contractor's incorrect submittal for concrete-mixing plants, on 3 August 2006, Contract Modification #2, in the amount of $920,000, was issued to modify the five concrete-mixing plants into grout-mixing plants. The cost of modifying the four 30-m^3/hour concrete-mixing plants into grout-mixing plants was $515,000 ($128,750 each).

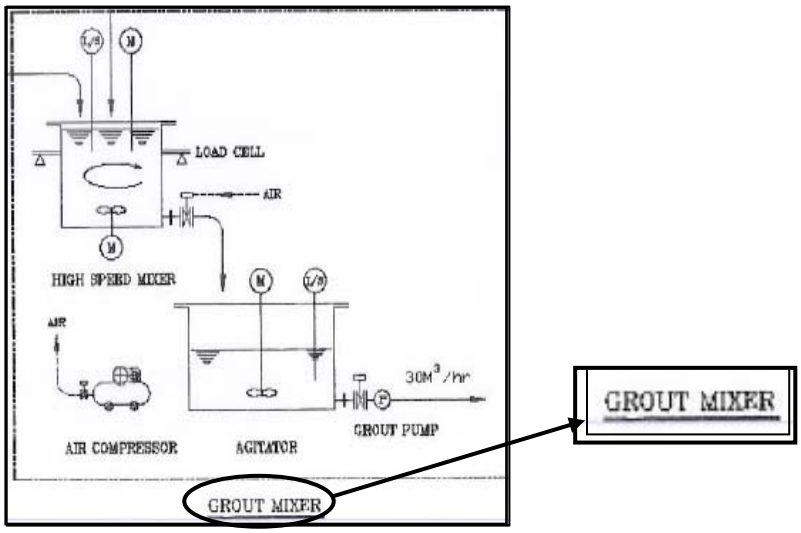


Figure 26. Partial view of contract specification for a 30 m^3/hour grout-mixing plant

On 7 July 2007, the JCC-I/A partially terminated the contractor for cause, because the contractor was unable to successfully modify the two delivered 30-m^3/hour concrete-mixing plants into grout-mixing plants. At the time of the termination, the contractor had not only been unsuccessful in modifying the mixing plants, the two delivered concrete-mixing plants were still unassembled. However, the contractor had already been paid the entire amount for the two mixing plants ($560,000), which included assembly. In addition, the contractor was paid $44,000 for providing design drawings attempting to modify the concrete-mixing plants into grout-mixing plants.

On 12 September 2007, we observed the pieces of an unassembled 30-m^3/hour concrete-mixing plant (Site Photos 12-16). After reviewing the contractor's design submittals for the 30-m^3/hour concrete-mixing plant (Figure 27), we attempted to determine if all the mixing plant pieces were delivered. The available pieces did not appear to be adequate to fully construct either a grout or concrete-mixing plant. It appeared that several items were missing, such as screw conveyor, pipes, and air compressor. Considering the contractor used one of the four silos dedicated for the 30-m^3/hour mixing plants, it will not be possible to construct both mixing plants.

Without a detailed parts list, assembly instructions, or until the concrete-mixing plants are put together, it will be impossible to determine if the contractor delivered all the material necessary to construct two concrete-mixing plants. However, according to the Material Inspection and Receiving Report, dated 6 September 2006, the contractor delivered two 30-m^3/hour mixing plants "with all the accessories including valves, piping, screw conveyors, control room, control panel" and "50% Spare Parts according to the contract." We could not locate any of the spare parts required by the contract and claimed by the contractor as delivered.

According to GRD documentation, the U.S. government paid the contractor $604,000 for the delivery and installation of the two mixing plants and the unsuccessful design drawings to convert the concrete-mixing plants into grout-mixing plants. However, the contractor did not install either mixing plant and may not have provided all the required components and spare parts. Yet, the contractor was paid in full.

The four 30-m^3/hour mixing plants are required to produce the high performance grout necessary to fully implement the proposed enhanced grouting program for the Mosul Dam. The contract required the delivery of the mixing plants by 25 July 2006. However, as a result of the EC's failure to "notice" the contractor provided the wrong type of mixing plant, the enhanced grouting program is over one year behind schedule.

Site Photos 12 and 13. Hydraulic control mechanism and aggregate handling components with for the delivered 30-m^3/hour concrete-mixing plant.

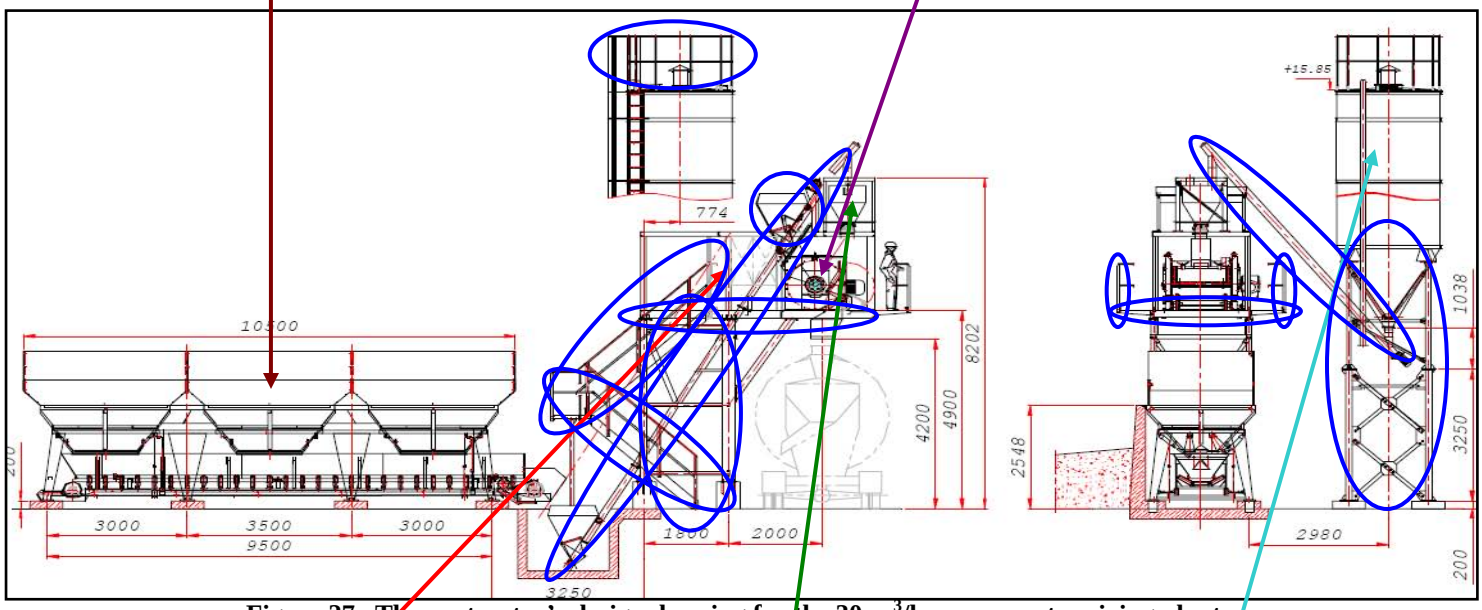


Figure 27. The contractor's design drawing for the 30-m^3/hour concrete-mixing plant (Colored arrows identify pieces found at the site and what relationship they are to the design) (Areas circled in blue are equipment required by the design that could not be accounted for/located during site visit)

Site Photo 14. Concrete batch-mixing plant control room

Site Photo 15. Three silos (two needed for each mixing plant)

Site Photo 16. Miscellaneous 30 m^3/hour concrete-mixing plant parts

Submersible Pumps

The contract for the grout-mixing plants also required the contractor to provide four $54m^3$/hour with 20m lift capability submersible pumps to assist with the four 30-m^3/hour mixing plants. The contractor's delivery order, dated 10 December 2006, stated that four $54m^3$/hour with 20m lift capability submersible pumps were delivered to the Mosul Dam on 28 November 2006; however, on 3 December 2006, MWR personnel discovered that the required equipment was not delivered. Instead of providing the contract-specified equipment, the contractor delivered four $36m^3$/hour with 17.5m lift capability submersible pumps. Even though MWR personnel notified GRD of this error, the contractor was paid in full ($40,000) for delivering equipment that did not meet contract specifications.

Stationary Silos

According to the Mosul Dam manager, the stationary silos were to provide additional storage capacity for cement. The manager stated this additional storage capacity is critical for two reasons – the security situation around the dam (which could cause delays in cement being delivered to the site) and the potential need for a large amount of cement at a moment's notice.

We inspected the site of the cluster of the four stationary silos. At the time of our inspection, the contractor had not completed the silos (Site Photo 17). On 17 August 2007, the JCC-I/A issued a Show Cause Order (SCO) to the contractor, which stated it "failed to perform…within the time required" of the contract. At the time of the SCO, the contractor was considerably behind schedule. The original contract, dated 15 March 2006, required delivery within 60 to 75 days; however, four subsequent modifications extended the contractor's period of performance to 30 August 2007. In order to facilitate the installation of the stationary silos, the MWR paid for its own contractor to construct the reinforced concrete matt foundation (Site Photo 17).

Foundation bolts are essential for the stability of the structure. The contractor erected steel columns, bracings, and beams by welding structural steel elements together. We observed foundation bolts cast within concrete columns so deficient that there was insufficient thread available to properly fasten the nuts on. (Site Photos 18 and 19). A foundation bolt is essential to secure the steel columns. Inadequately installed foundation bolts increase the probability of the structure's failure. We identified 43 of 144 (30%) foundation bolts inadequately installed. The installation of the foundation bolts also contradicts the contractor's own design construction techniques, which required bolt threads to extend higher than the nut (Figure 28 and Site Photo 20). In some instances, the contractor extended the foundation bolt well beyond the nut and continued to use poor installation practices, such as the use of too many washers (Site Photo 21). Considering that the stationary silos are to hold approximately 6,000 tons of cement, along with the weight of the steel superstructure with columns, we believe that inadequate installation of the foundation bolts leaves this structure in a potentially dangerous condition.

Site Photo 17. View of the partially constructed stationary silos

Site Photos 18 and 19. Close-up view of foundation bolts for the stationary silos

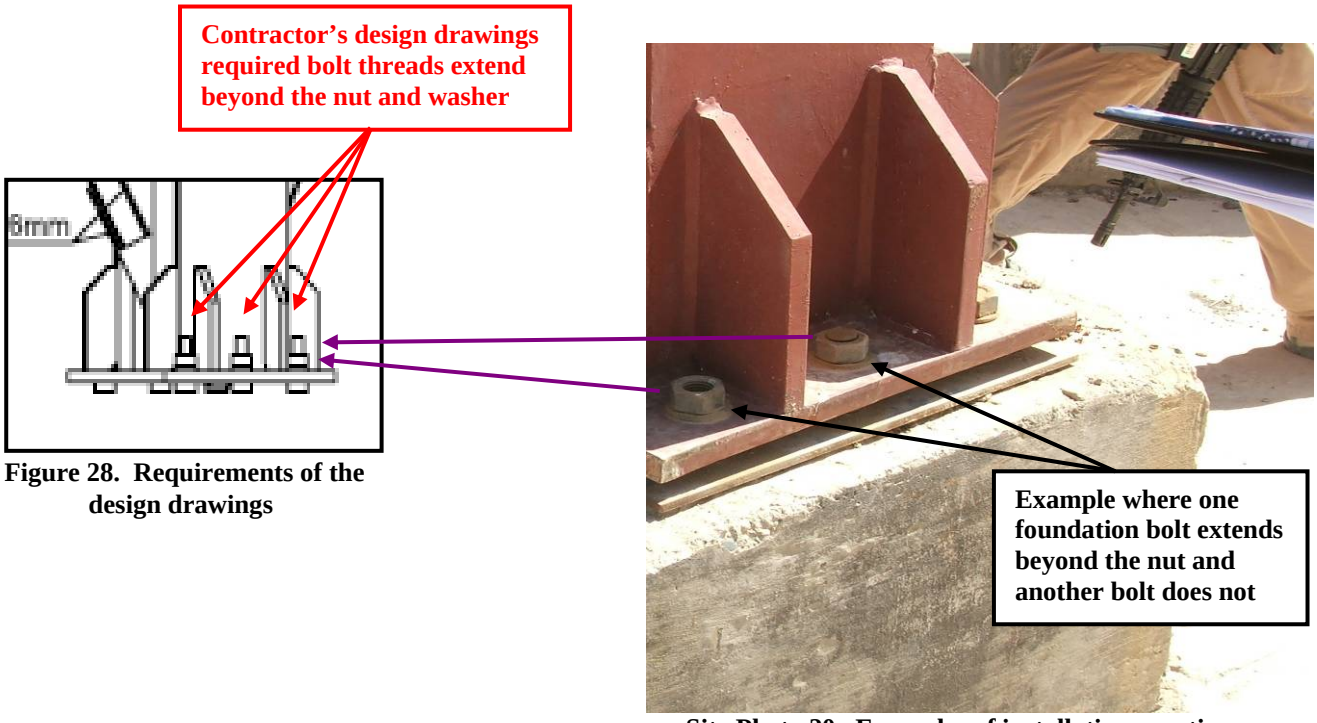


Figure 28. Requirements of the design drawings

Site Photo 20. Examples of installation practices

Site Photo 21. Poor installation technique (the use of 7 washers)

We also identified additional parts, located near the site of the stationary silos, but seemingly not enough to complete the project. For example, we located only three stationary silo funnels, four are required (Site Photo 22), and a few additional support beams (Site Photo 23). Dam personnel stated that, to the best of their knowledge, these were all the parts left by the contractor when the SCO was issued.

When comparing the partially constructed frame and additional parts left on site with the contractor's final conceptual drawing, it appears significant pieces of material and construction effort are needed to complete these structures (Site Photos 22-24 and Figure 29). According to GRD documentation, at the time of the SCO, the contractor had been paid $635,138 of the $780,000 contract value. GRD documentation also showed a

potentially unsafe shell. In addition, we have concerns about the number of steel pieces delivered (according to the contractor's invoices) versus the number of steel pieces required to construct the stationary silo (as designed). Based upon a review of the design drawings, possibly as many that this project was tracked solely by costs associated with the delivery of materials instead of by the actual construction of the stationary silos. For example, a GRD spreadsheet indicated that the "Percentage Complete" for this project was 81%, which is based on the percentage of funds expended (Table 1), not based upon the amount of work accomplished. In addition, after a thorough review of the contractor's invoices, we could not determine what specifically the contractor had delivered. For instance, the contractor presented seven invoices for payment. The description for six invoices was simply "Cement Silos Steel Parts" and included the number of pieces delivered. According to the invoices, 1,107 pieces of steel parts were delivered for this project. However, based upon our review of the design drawings, the amount of steel parts delivered is significantly more than what is needed to construct the stationary silos. Further, there appears to be a significant number of steel pieces either unaccounted for or missing.

Considering the amount of materials and manpower necessary to complete this project, in our estimation this project is closer to 20% compete rather than 81% complete. In addition, the approximate 81% of the contract cost expended has compensated the contractor for an inadequately constructed superstructure shell with a considerable amount of material not delivered to the site.

According to ITAO representatives, the contractor is being terminated for default. ITAO representatives have significant concerns with the quality of the contractor's work. Therefore, a new contract will be issued to construct new stationary silos at a different location on the Mosul Dam property. Consequently, a critical project awarded 19 months ago will have to be re-awarded, thereby significantly delaying its completion date, and the $635,138 already paid to the contractor resulted in as several hundred steel pieces appear to be unnecessary to construct the stationary silos. Further, because of the lack of an on-site U.S. government representative to verify contractor deliveries, as many as 900 steel pieces were unaccounted for, and we cannot determine if all the deliveries were actually made.

In conclusion, $635,138 has been spent on partially completed stationary silos, which provide no useful benefit to the MWR.

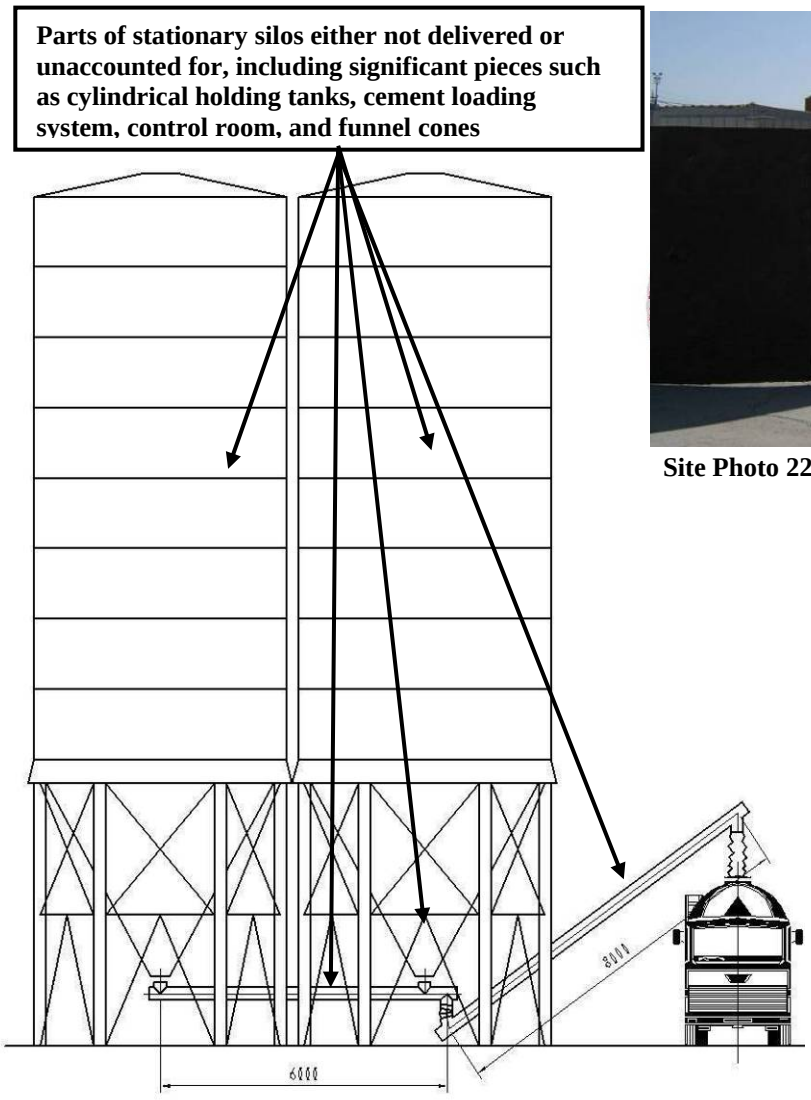


Figure 29. Design drawing of a completed stationary silo

Site Photo 22. Three partially welded funnels for the stationary silos

Site Photo 23. Miscellaneous pieces of metal for the stationary silos

Site Photo 24. Additional pieces of metal

W91GY1-06-M-0018

INVOICE #	Date	Item Description	Quantity	Unit	Amount	Total	Percentage	$ 780,000.00
18836	1-Jul-06	Anchors, Plates, Bolts & Bolt Accessories			$ 42,864.00	$ 42,864.00	95%	$ 737,136.00
18842	15-Sep-06	Cement Silo Steel Parts	184	pieces	$ 84,000.00	$ 84,000.00	84%	$ 653,136.00
18844	29-Sep-06	Cement Silo Steel Parts	123	pieces	$ 48,774.00	$ 48,774.00	77%	$ 604,362.00
18845	27-Sep-06	Cement Silo Steel Parts	139	pieces	$ 75,000.00	$ 75,000.00	68%	$ 529,362.00
18846	27-Sep-06	Cement Silo Steel Parts	208	pieces	$ 93,000.00	$ 93,000.00	56%	$ 436,362.00
18847	27-Sep-06	Cement Silo Steel Parts	158	pieces	$ 85,000.00	$ 85,000.00	45%	$ 351,362.00
18850	13-Feb-07	Cement Silo Steel Parts	155	pieces	$ 68,000.00	$ 68,000.00	36%	$ 283,362.00
18852	28-Feb-07	Cement Silo Steel Parts	25	pieces	$ 63,000.00	$ 63,000.00	28%	$ 220,362.00
18855	5-Sep-07	Cement Silo Steel Parts	25	pieces	$ 75,500.00	$ 75,500.00	19%	$ 144,862.00
			1017			$ -		
						$ -	Contract Total	
		Percentage Complete:			81%	$ 635,138.00	$ 780,000.00	
							$ 635,138.00	
							$ 144,862.00	

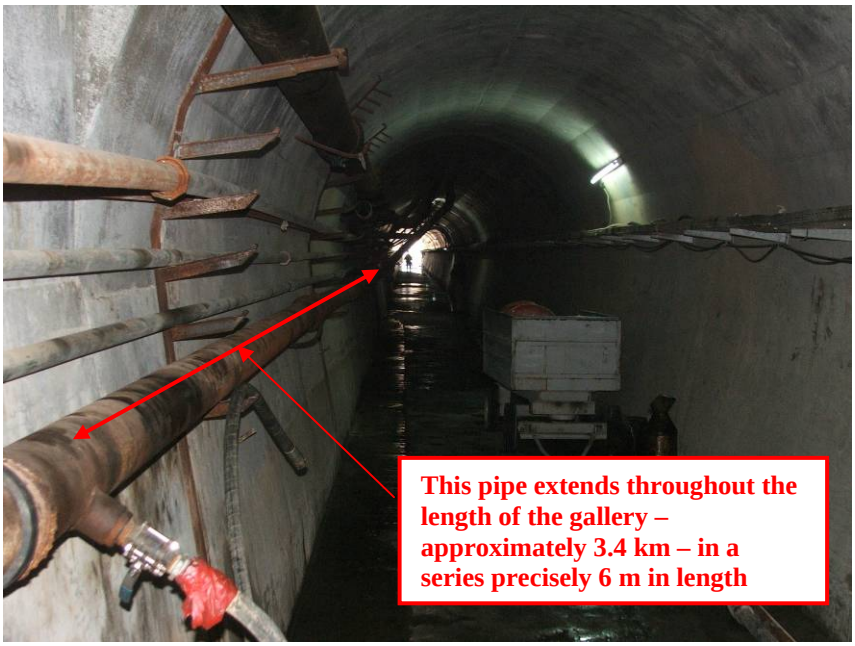
Table 1. GRD tracking percentage complete based upon invoices received

Replacement and Spare Parts

6 m Pipes

Contract W91GY1-06-M-0012 required the contractor to supply "Pipes, Valves, and Miscellaneous Steel pipe, length 6 m with canner (ring) fixed rubber washer and clamp with bolts." The pipes are used to carry water from the outside to the gallery (Site Photo 25). Their procurement was necessary to replace the existing pipes within the dam gallery, which are old and in desperate need of replacement. Since the gallery runs approximately 3.4 km under the dam, the pipes needed to be sized precisely for length, as each pipe length will be used to replace an exact length of faulty pipe within the gallery. However, according to Mosul Dam personnel, the pipes delivered by the contractor are not of the specified length (i.e. 6m) (Site Photo 26); the pipes vary from approximately 5.90m to 5.95m each. ITAO representatives confirmed that the pipes are of different lengths, with larger manufacturing tolerance.

Mosul Dam personnel stated that because the pipe sizes are not accurate, workers will have to cut and weld two pieces together (which is very difficult to do) or simply not use the pieces. Currently, the pipes sit unused located outside a warehouse.



Site Photo 25. View of interior gallery pipes used to carry water outside

Site Photo 26. Pipes delivered by the contractor

Enhanced Grouting System

The enhanced grouting program was recommended to mitigate the risk of failure of the Mosul Dam. The enhanced grouting system consisted of the procurement of equipment, materials/additives, and mixing plants. Excluding the mixing plants, six additional contracts were awarded to procure the equipment and materials, ranging in price from $2,200 to $40,375. Due to time limitations on site and the relatively small value of the contracts, we did not inspect these items.

Advanced Grouting System

The contract specifications required the AGS to have two basic components: an IAS for automated computer aided grouting monitoring and analysis; and modified grout batching and delivery equipment for balance stable grout handling, mixing, and injection with associated fittings, pumps, hoses, packers, air compressors, and quality control testing equipment.

Intelligrout

The Intelligrout system consists of the IAS units, which provide a computer-based monitoring system for the grouting and geologic parameters relevant to the grouting. Intelligrout relies on the IAS operators to monitor pressures and volumes of grout being injected and to determine adjustments to pressures, volumes, and mix to fit the conditions.

According to GRD documentation, the major benefits of Intelligrout are:

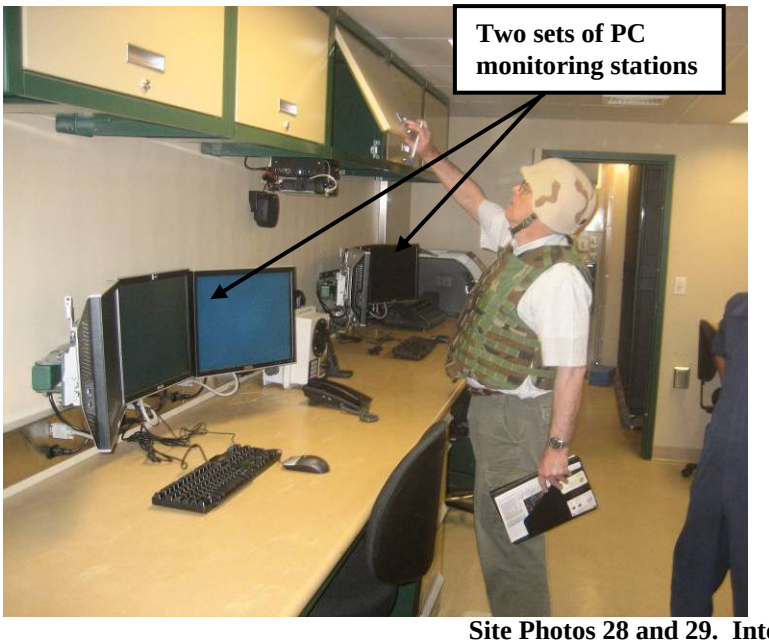
- fully integrated system
- minimal physical set-up
- menu drive
- real time
- query tools
- automatic closure graphs
- CADD (Computer-Aided Design and Drafting) visualization
- internet connection

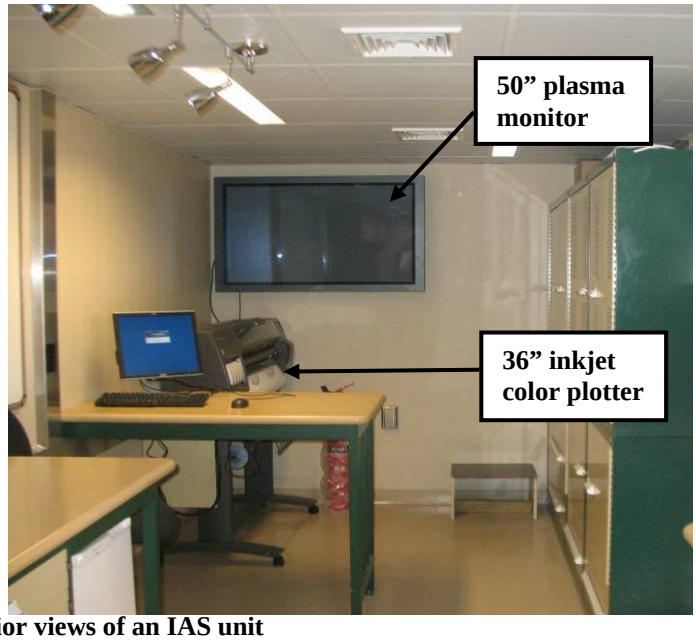
The contract provided for three Intelligrout IAS units; each unit consists of a fully self-contained, totally integrated system for data collection, monitoring, display, record-keeping, and analysis permitting the monitoring of up to eight simultaneous grout or pressure test operations. The system defines all measurements and calculations needed for pressure testing and grouting, all data output products needed for project record keeping, and all analyses needed for work management, specification compliance, verification, as well as for evaluation of grouting results. The contract called for the IAS to arrive "on site fully factory tested and commission ready for use requiring only power hook-up."

During our site visit, we observed one IAS located near the western side of the Mosul Dam gallery (Site Photos 27 and Figure 30). According to dam personnel, the IAS units arrived in May 2007. The IAS was contained in the required 10 foot by 40 foot trailer with climate control, central vacuum, and lighting protection systems. In addition, we identified the equipment called for in the contract, such as four PC monitoring stations, each with three 17-inch flat screen monitors, one 50-inch plasma monitor, and one 36-inch color inkjet plotter (Site Photos 28 and 29).

Site Photo 27. Exterior view of an IAS unit

Figure 30. Locations of the three IAS units





Site Photos 28 and 29. Interior views of an IAS unit

According to dam personnel, the three IAS units are currently not being used for several reasons. First, all three IAS units are experiencing air conditioning problems. Each IAS unit contains non standard, high powered computers to analyze and process collected data from multiple drilling assemblies. Each IAS unit creates and recommends location specific unique solutions by specifying grout materials and additives, needed volume, and monitors grout injection progress. This entire process from start to finish collects data and stores it into a database for further use to create graphic presentations, as well as, to maintain automated records of operation. This unique IAS computer system generates a sizeable heat load, and according to dam personnel, the air conditioning system within each IAS unit does not have the capacity to continuously keep the unit cool, which has led to failures. In addition, one IAS unit is experiencing CADD problems and the software will not boot up.

Further, the dam manager complained the software is far too advanced for their needs, especially considering the vendor/manufacturer would not provide on-site assistance. Specifically, the dam manager stated they are having difficulties simply booting up the software, which contradicts the contract's requirement that the IAS units arrive "requiring only power hook-up."

In addition, the dam manager is upset that the 12-month warranty will be exhausted by the time the IAS unit is finally up and running, as the warranty expires on 18 January 2008[17].

Website Hosting and Help Desk Service

The contract required the vendor to provide one year of secure website hosting as a method of posting drawings and information generated during operation of the IAS. According to the contract, the website hosting "will start within 15 days after the equipment is delivered to an identified and designated location within 30 miles of the Turkish-Iraqi border." Since the SPCOC failed to verify the availability of high speed internet service in the Mosul area, the website hosting requirement was added to the contract on the assumption high speed internet service was available. Since high speed internet service is not available in the Mosul area, not only is the website hosting by the vendor of no benefit to the MWR, but the U.S. government is incurring a monthly charge in the amount of $6,883.75 for this service.

In addition, the contract required the vendor to provide "one-year of help desk service for system instruction and troubleshooting." According to the June 2007 Material Inspection and Receiving Report, one month's "Help Desk Service" charge in the amount of $23,765 was billed to the U.S. government. The contractor billed the U.S. government even though none of the IAS units are operational and one specific IAS unit cannot even boot up the preloaded software.

Modified Grout Batching and Delivery Equipment (Enhanced Grouting Equipment)

The contract to satisfy enhanced grouting required providing modified grout batching and delivery equipment for balanced stable grout handling, mixing, and injection with associated fittings, pumps, hoses, packers, air compressors, and quality control testing equipment. Specifically, it required a high and semi-low mobility, high speed, high shear air-driven mixing and pumping plant with a minimum mixing drum capacity of 0.5 m and an agitator holding tank capacity of 1.5 m; LMG mixing and pumping plant (to be no wider than 1 m, mounted on heavy duty rollers with a pump capable of injection pressures to deliver LMG to 50 m in depth); automated air-powered grout reel machine mounted on heavy duty rollers; satellite/transfer grout tubs, 0.5 m capacity with air powered Moyno Type of equal progressive cavity; and air compressors, diesel compressors, and electric compressors.

During our site visit, we observed the modified grout batching and delivery equipment provided by the contractor. We found partially assembled equipment in multiple, transportable conex boxes (Site Photos 30-35).

[17] Even though the IAS units were not delivered to the Mosul Dam until late May 2007, according to the contract's warranty clause, the IAS units will be warranted for 12 months from the date of acceptance by the U.S. government. The U.S. government accepted the IAS units on 18 January 2007.

Site Photos 30, 31, and 32. Conex boxes with partially assembled enhanced grouting equipment

Site Photos 33, 34, and 35. Conex boxes with partially assembled enhanced grouting equipment

According to the Mosul Dam manager, GRD did not provide him with schematic drawings to assemble the equipment or even determine how the equipment will need to be placed inside the gallery. Considering the AGS contract did not require the vendor to provide on-site commissioning, training, or technical support, a schematic drawing was required.

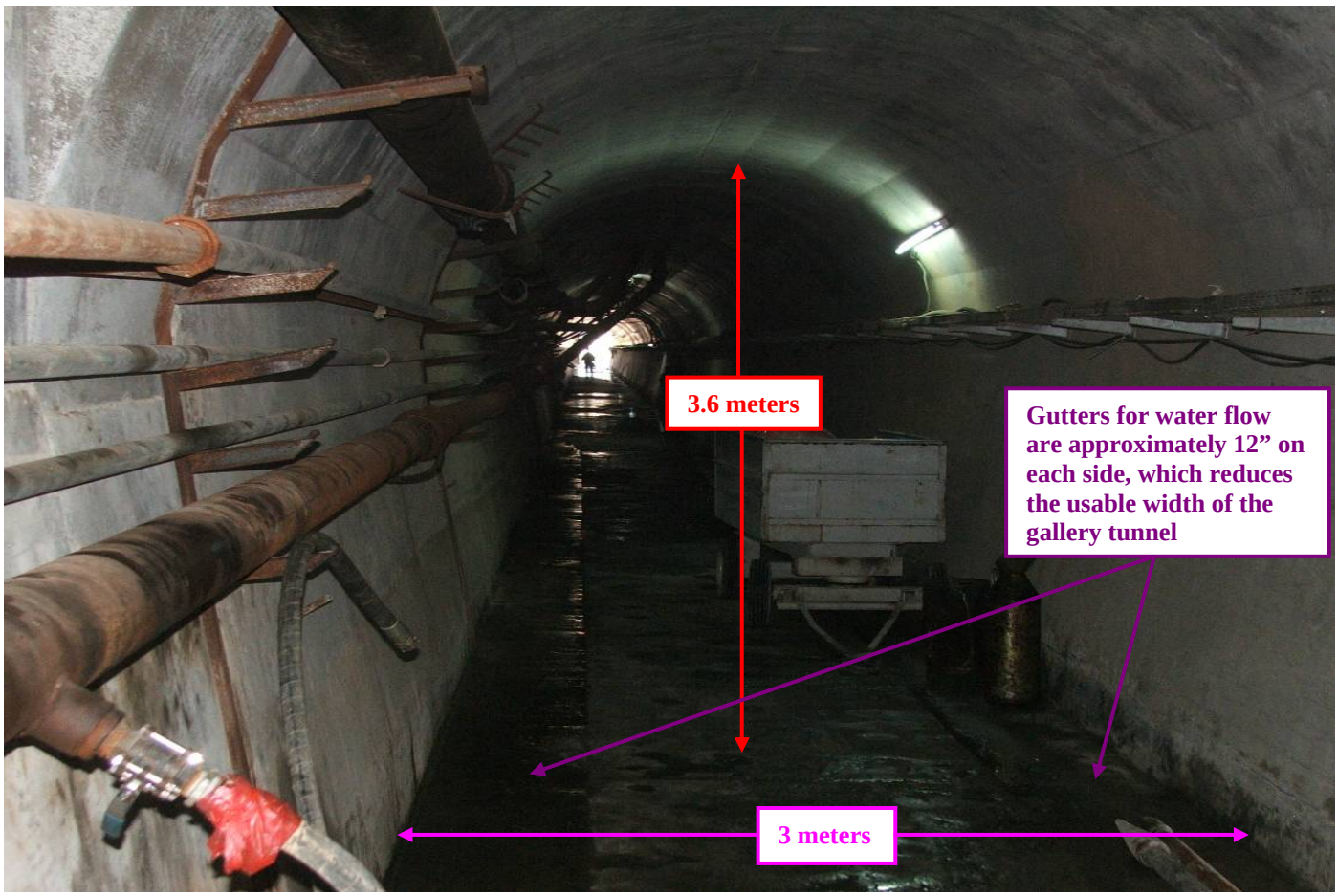
A USACE grouting expert formerly associated with the project stated the following:

> *"Grouting is highly specialized, using highly specialized equipment; only an expert with years of experience on a wide range of grouting projects involving different operational environments, equipment, and staging techniques can readily discern the nuts-and-bolts of the required equipment and equipment functions on a given project."*

We agree that grouting is very technical and requires years of expertise. Considering the MWR personnel responsible for this project are only familiar with 20-30 year old technology, it was unrealistic to think that a seven week training course would make the MWR personnel proficient with this equipment, especially with no schematic drawings or on-site training. Even the SPCOC, while reviewing the contractor's Commissioning and Acceptance Plan, cited the need for a graphic schematic by the contractor for the AGS to "include the feature locations where the components will operate (surface, control trailer, grouting gallery, etc), to make clear the communications, piping, power and other links between the components."

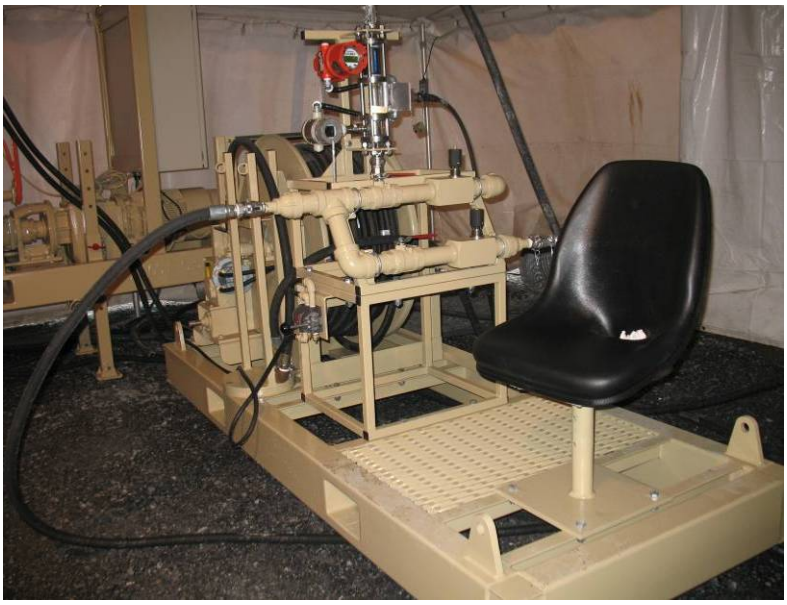
During our site visit, neither GRD nor ITAO representatives could provide even a simplistic explanation of how the procured equipment was to be completely assembled and used either inside or outside the gallery. Since our site visits, no current representative from GRD, ITAO, or the SPCOC can definitively explain the complete assembly and usage of the enhanced grouting equipment.

We later spoke with the dam manager, who stated that this equipment is not appropriate for the Mosul Dam. The gallery is very small and tight, with dimensions of 3 m wide by 3.6 m high (Site Photo 36) and there are sharp turns and steep inclines throughout the length of the 3.4 km gallery (Site Photo 37). In the manager's opinion, the equipment is too large and heavy to be used within the Mosul Dam gallery. Since the equipment was not completely assembled at the time of our site visit, the only visuals of the assembled equipment available are photographs taken during its commissioning in Harrisburg, PA (Site Photos 38-40). While Site Photo 40 shows the two pieces of equipment at 90 degrees, according to the USACE's grouting expert, the "two units would be in-line with each other." In the dam manager's opinion, which is based upon more than 20 years of experience at the Mosul Dam, the equipment procured was too wide and long to fit inside the gallery. Until the equipment is completely assembled, operational, and schematics provided for its use; it will not be known whether the equipment will fit in the gallery or not.

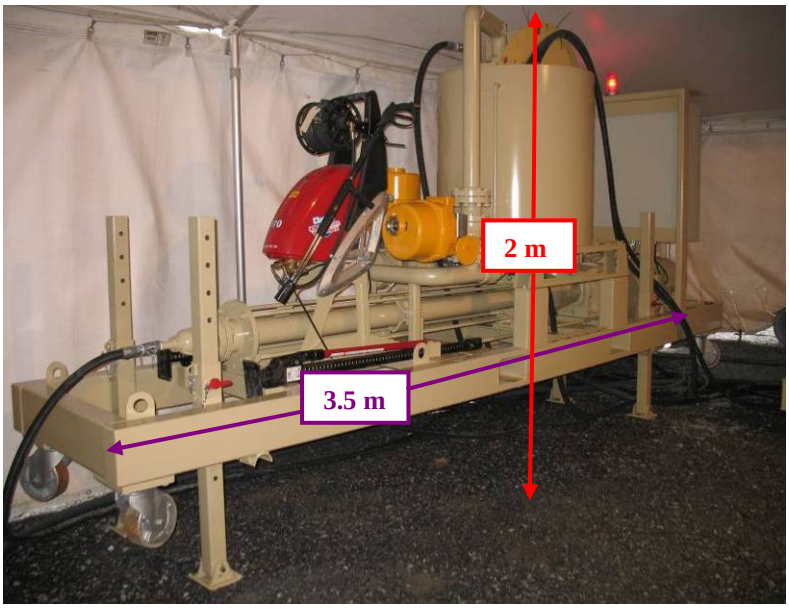


Site Photo 36. View of the dimensions within the Mosul Dam gallery tunnel

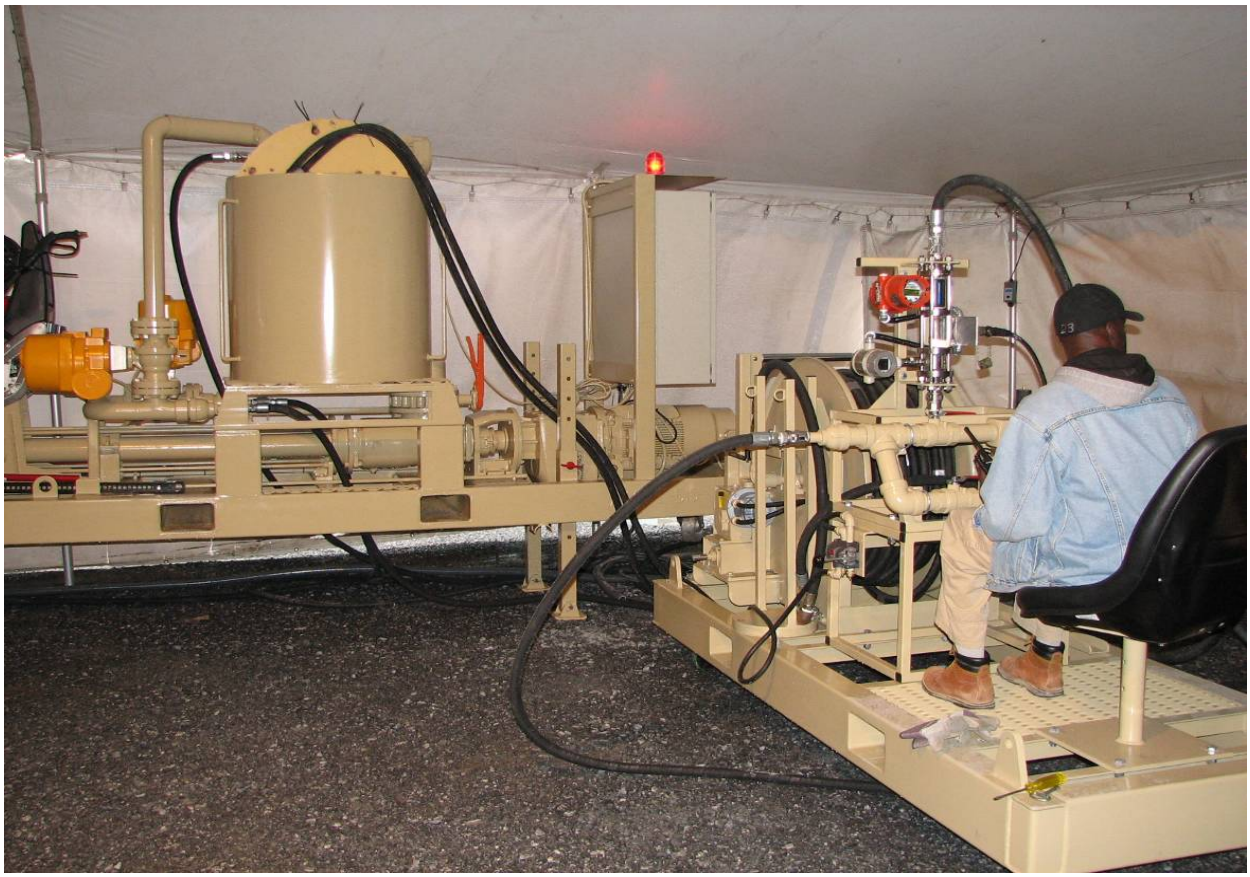
Site Photo 37. Partial view of the sharp right turn within the gallery tunnel



Site Photo 38. Final control point
(Photo courtesy of USACE)



Site Photo 39. Satellite mixing plant
(Photo courtesy of USACE)



Site Photo 40. Assembled and connected satellite mixing plant and final control point
(Photo courtesy of USACE)

Conclusion

To date, more than $16.2 million has been expended for the AGS contract. The purpose of the AGS was to provide the Mosul Dam personnel with advanced technologies and equipment to perform enhanced grouting. However, the Mosul Dam personnel cannot implement enhanced grouting because the three IAS units remain in a non-operational state and the enhanced grouting equipment remains unused because of a lack of a comprehensive and relational diagram or schematic drawings to identify how the components are completely assembled and operate.

Mosul Dam's Continuing Grouting Efforts

According to the dam manager, even though the majority of the specialized equipment procured by the U.S. government under the AGS contract is currently not available for use, the Mosul Dam personnel are still operating a continuous grouting program to fill the voids and cavities in the dam's foundation strata.

During our site visits, we observed dam personnel conducting drilling and grouting work outside and inside the gallery. We observed outdoor drilling (Site Photo 41), which must be done prior to grouting. Inside the gallery, we witnessed one hole being actively grouted. Specifically, we viewed an agitator actively mixing grout (Site Photo 42) and a grout pump actively placing the grout into a hole (Site Photos 43 and 44). In addition, ITAO representatives stated grouting activities were also ongoing during a previous site visit (Site Photo 45). Figures 8 and 9 also verify that the dam personnel are still operating a continuous grouting program.

Site Photo 41. Dam personnel conducting above ground drilling operations

Site Photo 42. Existing agitator within the gallery actively mixing grout

Site Photo 43. SIGIR inspector pointing out an active grout pump placing grout into a hole

Site Photo 44. A grout pump actively placing grout into a hole (Photo courtesy of ITAO)

Site Photo 45. A hole being actively grouted (Photo courtesy of ITAO)

Project Quality Management

Contractor's Quality Control Program

Department of the Army Engineering Regulation (ER) 1180-1-6, dated 30 September 1995, provides general policy and guidance for establishing quality management procedures in the execution of construction contracts. According to ER 1180-1-6, "…obtaining quality construction is a combined responsibility of the construction contractor and the government."

Of the 21 separate Mosul Dam contracts, two were construction related and the remaining 19 contracts were for the procurement of equipment and materials. Contracts W91GY1-06-M-0018 and W91GY1-06-M-0019, for the construction of stationary silos and grout-mixing plants, respectively, stated that the contractor was "responsible for performing or having performed all inspections and tests necessary to substantiate that the supplies or services furnished under this contract conform to contract requirements."

For the stationary silos contract, we reviewed the project file and found no evidence that the contractor performed any tests to substantiate that the partially erected silos conformed to the contract requirements. We noted earlier in this report that we consider approximately 30% of the foundation bolts to have been inadequately installed, which left this structure in a potentially dangerous condition.

For the grout-mixing plants contract, we found no evidence the contractor performed any tests to substantiate that the delivered mixing plants conformed to the contract requirements. Since none of the mixing plants are currently operational, the grout production rate cannot be verified. According to GRD documentation, the production rate "will be verified during commissioning of the plant."

For the 19 individual procurement contracts, each contractor was "responsible for performing or having performed all inspections and tests necessary to substantiate that the supplies or services furnished under this contract conform to contract requirements." However, from a review of the available contractor invoices and Material Inspection and Receiving Reports, in several cases, a contractor submitted invoices for equipment and materials that did not conform to contract requirements. For example, one contract required the delivery of 350 adjacent valves. Even though the MWR receiving committee told the GRD that the "valves aren't the right valves," the contractor was paid in full. Other examples include one contractor invoicing for the contract required 63 bags of 50kg fly ash (when only 62 bags were delivered) and another contractor invoicing for multiple pipes that were not the contract required length or width.

Even though each contract stated the "Contractor shall only tender for acceptance those items that conform to the requirements of this contract," the contractor invoiced and was paid for materials not conforming to the contract requirements. In addition, we identified questionable contractor invoices, in the amount of $635,138, for 1,017 pieces of steel parts for the stationary silos.

Government Quality Assurance Program

USACE ER 1110-1-12 and PCO Standard Operating Procedure (SOP) CN-100 specified requirements for a government quality assurance program. This crucial oversight technique needed to be present at the construction site.

According to GRD and ITAO representatives, the 21 awarded contracts were viewed as simple procurement and delivery contracts, not as construction projects in need of on-site quality assurance. ITAO representatives stated the GRD relied upon local national employees of CH2MHill/Parsons to periodically visit the Mosul Dam site to verify the contractors' deliveries of materials and equipment. After reviewing GRD documentation, it appeared the local nationals sporadically visited the Mosul Dam to verify concerns the GRD had with a contractor's performance. For example, the local national visited the Mosul Dam to verify if the contractor for the stationary silos was progressing. While no official report was made, the local national emailed a brief message regarding the status of the stationary silos and included several photographs.

However, the effectiveness of the local nationals only visiting the Mosul Dam occasionally is questionable. For example, in 24 March 2007, the local national emailed the GRD and provided an "updated list fo [sic] deliveries" for the Mosul Dam. The email attachments included a two page list by the MWR receiving committee, which identified multiple contracts that did not deliver the required items. Since the local national was not present for the deliveries all he could do was forward this list to the GRD, not validate the deliveries. In addition, even though the local national was told to verify the status of the stationary silos project, he did not identify or document the significant issue of the foundation bolts, which causes us to question his value as a quality assurance representative.

According to GRD representatives, the 21 "contracts were procurements for equipment, materials, and services rather than construction contracts," even though the USACE representative formerly associated with the project stated that he "immediately recognized" the stationary silos and grout-mixing plant projects required "construction" efforts.

The lack of a dedicated on-site U.S. government representative at the Mosul Dam site to verify contractor deliveries and construction work ultimately resulted in the payment for mixing plants in which no one knows if all the required pieces were delivered, what appeared to be an excessive number of steel parts for the stationary silos, the poor construction techniques employed at the stationary silos, and the cannibalization of parts from the 30-m^3/hour mixing plant for the 100-m^3/hour mixing plant, which resulted in the contractor being paid twice for a silo.

Relying Upon Mosul Dam Personnel to Verify Contractors' Deliveries

In February 2007, the JCC-I/A contracting officer issued a letter to a contractor stating the following:

> *"This letter confirms USG will provide periodic on-site representation at Mosul Dam, but is unable to place this representative at the location on a full time basis. An on-site representative will visit the dam on an irregular frequency of but not less than weekly."*

The letter carbon copied the Mosul Dam manager and GRD representatives. However, a GRD/PCO Water Sector "Mosul Dam Update, Revised 01 May 07" presentation stated that for one specific project, "MoWR staff to verify delivery of the Piezometers and Temperature Sensors."

According to the Mosul Dam manager, GRD has transferred the responsibility to "accept" contractor deliveries to the MWR personnel. The MWR created a "receiving committee" of MWR personnel to review the actual delivered items. However, the dam

manager explained the fundamental problem with this approach is that he was never provided with any of the contracts and/or contract specifications. The dam manager said, "How can we be expected to sign for materials when we do not know what we were supposed to receive?"

According to the dam manager, GRD/PCO told him to "…just sign for anything received from the contractor."

The GRD was able to document an email sent to the dam manager with limited contract specifications for 15 of the 21 contracts awarded. This email occurred on 18 April 2006; however, by this date, the materials and equipment for two contracts had already been delivered.

According to the dam manager, for the contracts in which the MWR personnel were not provided the contract specifications, the receiving committee would be forced to compare the actual delivered items against the contractors' invoice lists. In several cases, the receiving committee quickly documented and notified GRD that the contractor had not provided the correct materials and/or equipment. For example, the contract required two pieces of pipe with diameters of 195 millimeter (mm) and 220 mm, respectively; however, the contractor delivered four pieces of 193 mm pipe. The receiving committee documented this discrepancy, but the dam manager stated the contractor was still paid and the correct sized pipe was never delivered to the dam.

The dam manager expressed frustration over GRD not holding the contractors accountable for delivering either wrong or defective materials and equipment.

Future Plans for the Mosul Dam

ITAO and GRD representatives acknowledge problems with the previous procurement and delivery of equipment and materials to the Mosul Dam. Currently, ITAO representatives are finalizing a detailed plan, referred to as the "Post Delivery Support Plan," to provide the dam and MWR with the required equipment and materials to improve current grouting operations, implement field and lab testing programs while maintaining traditional grouting capacity, and fully implement the enhanced grouting operation. Some of the items included in this plan are the following:

- Fix the IAS units (Intelligrout) to make them fully operational;
- Procure additional 30-m^3/hour grout-mixing plants;
- Provide additional materials required for continuing grouting operations;
- Perform required laboratory testing to establish the design mixes with the desired rheological properties, using water and mix components;
- Conduct two separate field tests, one inside the gallery and one outside; and
- After completion of the field tests and identifying the desired design mixes, fully implement enhanced grouting.

ITAO representatives believe this plan will adequately resolve the outstanding issues and problems at the Mosul Dam and ultimately permit enhanced grouting.

In February 2007, representatives from ITAO, GRD, and MWR held their first meeting on Post Delivery Expert Support. The participants recognized the past problems with the acceptance of materials and equipment, such as the receiving committee being

responsible for accepting materials and equipment without having been provided the contract or contract specifications. The solution to this problem was to provide the receiving committee with the details of the contract, specifically, the amount and specifications of material and equipment that are to be delivered. In addition, GRD was tasked with determining the "mechanism and/or the recourse" for ensuring the delivery of the proper equipment and material as well as what to do if equipment or material are not delivered according to contract specifications.

Actions Taken Since Site Visits

Since our September 2007 site visits, GRD has attempted to resolve the outstanding issues with the IAS units. According to GRD representatives, the IAS HVAC system components arrived at the Mosul Dam and have been installed. In addition, three computers and miscellaneous parts were delivered. Two computers were rejected by the dam manager because they were damaged and the third computer experienced some technical problems.

According to GRD representatives, the 100-m^3/hour grout-mixing plant is currently being commissioned and they are optimistic it will be completed by the end of October 2007.

Conclusions

Based upon the results of our site visit, we reached the following conclusions relative to our assessment objectives. Appendix A provides details pertaining to Scope and Methodology.

1. Determine whether construction or rehabilitation is in compliance with the standards of the design.

   Although most of the contracts awarded were of the simple procurement type, several required design drawings and specifications. For example, design drawings and specifications were necessary for the construction of the stationary silos, the procurement and installation of five grout-mixing plants, and the comprehensive and relational diagram or schematic drawings of the complete assembly and implementation of the Intelligrout system and enhanced grouting equipment for use inside and outside the Mosul Dam gallery. GRD provided the design drawings for the stationary silos and mixing plants; however, no comprehensive and relational diagram or schematic drawings existed for the Intelligrout system and enhanced grouting equipment.

   After a thorough review of all available design drawings, we found the drawings to be deficient, leading to a number of safety concerns. For example, the stationary silos design drawings lacked significant details, such as bracing support for the entire height of the silos and how the MWR personnel will deposit cement into the silos. For the 100-m^3/hour grout-mixing plant and the four 30-m^3/hour grout-mixing plants, the design drawings clearly indicated the contractor was offering *concrete*-mixing plants, not the required *grout*-mixing plants.

   We identified an instance where construction did not appear to be adequate. The inspections team observed that some foundation bolts cast within concrete columns had insufficient thread to properly fasten the nuts. Specifically, we determined that 43 of the 144 (30%) foundation bolts were inadequately installed. Further, the installation

of the foundation bolts also contradicted the contractor's own design construction techniques, which required bolt threads to extend higher than the nut. Complete design drawings are needed to determine if the remaining foundation bolts are adequately secured within the foundation or pose a serious threat of failure. Because each stationary silo will hold approximately 1,500 tons of cement, we believe that the inadequate installation of the foundation bolts leaves this structure in a potentially dangerous condition.

ITAO representatives have significant concerns with the quality of the contractor's work; therefore, the contractor was terminated for default, and a new contract will be issued to construct new stationary silos at a different location on the Mosul Dam property. Consequently, a critical project awarded 19 months ago must be re-awarded, thereby significantly delaying its completion date, and the $635,138 already paid to the contractor resulted in a potentially unsafe silo framework.

The mixing plants contract required construction and installation of five mixing-plants. We observed the single 100-m^3/hour "modified" grout-mixing plant; however, it was not operational due to control room issues. For the 30-m^3/hour mixing plants, we found various pieces of two unassembled mixing plants on site. The construction for the two unassembled mixing plants was not in compliance with the contract requirement that the contractor deliver and install functioning mixing plants. According to the Material Inspection and Receiving Report (6 September 2006), the contractor delivered two 30-m^3/hour mixing plants "with all the accessories including valves, piping, screw conveyors, control room, control panel" and "50% Spare Parts according to the contract." However, the lack of any construction made it impossible for us to determine if the contractor delivered all the material necessary to construct the two mixing plants. In addition, none of the spare parts allegedly delivered could be located. Finally, even though the contractor did not install either mixing plant and may not have provided all the required components and spare parts, GRD paid the contractor in full ($604,000).

2. Determine whether an adequate quality management program is utilized.

The quality management program did not adequately ensure the correct delivery and construction of materials and equipment at the Mosul Dam. We judged the contractors' quality control programs to be deficient because many invoices did not provide the materials and equipment claimed on invoices. For example, one contractor's invoice claimed the delivery of four contract-specified submersible pumps with 54-m^3/hour capacity with 20-meter lift capability, but the pumps actually delivered were 36-m^3/hour capacity with 17.5-meter lift capability.

In addition, there was no evidence that a contractor quality control program was implemented for the construction of the stationary silo. Further, there was no indication that the contractor employed anyone to determine the quality of the stationary silos' construction. We observed inadequately installed foundation bolts; however, nothing in the project file documents identified this as a potential problem.

The U.S. government quality assurance program was not adequate. Even though GRD viewed the 21 contracts as procurement contracts only, a quality assurance program was necessary to verify that the contractors delivered the materials and equipment required by the contracts. GRD transferred the responsibility to accept contractor deliveries of materials and equipment to MWR personnel. This required the ministry to create a receiving committee to verify the delivery of materials and equipment from

multiple contractors. However, according to the Mosul Dam manager, the Project and Contracting Office instructed him to sign for anything received from contractors.

GRD provided the dam manager with limited contract specifications for 13 of the 21 contracts prior to contractor deliveries of materials and equipment. For the contracts for which the ministry personnel did not have specifications, the receiving committee was forced to compare the actual delivered items against the contractors' invoice lists. In several cases, the ministry's receiving committee quickly documented and notified GRD that the contractor had not provided the correct materials and/or equipment. For example, when the contractor failed to provide the contract-specified submersible pumps, the ministry identified this error and reported it to GRD two days after delivery; nevertheless, the contractor was paid in full for delivering equipment that did not meet contract specifications.

According to GRD representatives, the 21 contracts were procurements for equipment, materials, and services—rather than construction contracts—even though the assembly of the stationary silos and mixing plants obviously required significant construction efforts. GRD was not aware of the inadequately installed foundation bolts, which leaves this structure in a potentially dangerous condition. In addition, there is no indication that anyone at GRD was tracking the project's completion progress as distinct from invoices paid. This was important because the project was significantly behind schedule. Consequently, the contractor was paid approximately 81% of the contract's value for the inadequately constructed partial structure when the Show Cause Order was issued.

Further, because no government representative was on site to verify contractor deliveries, we cannot determine if the deliveries were actually made. For example, one contractor submitted invoices for 1,017 steel pieces for the stationary silos; however, during the site visit, as many as 900 steel pieces were either unaccounted for or missing.

3. Determine whether sustainability is addressed in the contract or task order for the project.

   Many of the contracts addressed sustainability in the form of spare parts for pieces of the procured equipment. For instance, the mixing-plants contract required the contractor to provide 50% spare parts by delivering additional items for the single 100-m^3/hour grout-mixing plant and the four 30-m^3/hour grout-mixing plants. The spare parts were included to provide the ministry with additional equipment to keep the mixing plants operational if a specific item wore out. Even though the Material Inspection and Receiving Report indicated that the contractor delivered the spare parts, we could not locate any during the site visit. Although sustainability was addressed in many individual contracts, because of the numerous discrepancies between invoices from different contractors compared to what was actually received and because there was no government representative on site to verify each contractor's deliveries, there is no assurance that the spare parts actually arrived.

4. Determine if project results will be consistent with original objectives.

   The execution of the 21 contracts, valued at $27 million, was not consistent with the original project objectives to provide the Mosul Dam and MWR personnel with critically needed spare and replacement parts and the ability to conduct massive grouting or to fully implement enhanced grouting.

The procurement and delivery of spare and replacement parts for the ministry was partially consistent with the original objectives. Multiple contracts, valued at approximately $5.6 million, were awarded for materials and equipment to avoid any interruption of current grouting operations. Because of limited time at the site, we could not inspect every delivery to determine if it met contract requirements. Therefore, we relied on reviews of the contract files and interviews of ministry personnel to determine if the required equipment and materials had been delivered. Multiple contracts were awarded to provide for materials and equipment; nevertheless, in several instances, what was delivered did not meet contract specifications. In addition, because no U.S. government representative was on site to verify the delivery of the materials and equipment, we could not be assured that all of the required equipment was delivered to the Mosul Dam. We identified several instances in which the delivered materials and equipment did not meet the contract specifications, but after discussions with MWR personnel, it appears that most of the contractor-delivered materials and equipment were usable by the ministry to continue current grouting operations.

Approximately $19.4 million in multiple contracts were awarded for the massive and enhanced grouting programs. We observed an inadequately constructed partial stationary silo structure, which provides no usable benefit to the MWR. In addition, because of the inability of the U.S. government's EC to notice the "CONCRETE BATCHING PLANT" cover pages on the contractor's submittals for the 100-m^3/hour and 30-m^3/hour grout-mixing plants, the contractor believed that he was to deliver concrete-mixing plants. This led to an increase in contract cost and time delays.

A contract modification of $920,000 was issued to "modify" the concrete-mixing plants into the required grout-mixing plants. To date, $324,000 has been paid to the contractor for attempts to modify the concrete-mixing plants into grout-mixing plants even though the 100-m^3/hour grout mixing plant is still inoperable, and the contract for the four 30-m^3/hour grout-mixing plants has been terminated. As a result, the three mixing plants currently have no value to the ministry. Because the contract required the delivery of the five grout-mixing plants by July 2006, the massive grouting and enhance grouting programs are now more than one year behind schedule.

The AGS, a significant portion of the enhanced grouting program, is also non-operational. The system comprises the Intelligrout system and enhanced grouting equipment, valued at approximately $16.4 million. The three IAS units continue to experience a variety of significant problems, delaying their use, and the enhanced grouting equipment remains unused because of a lack of comprehensive and relational diagram or schematic drawings to identify how the components are completely assembled and operate.

Consequently, at the time of our site visit, approximately $19.4 million worth of equipment and materials delivered to the Mosul Dam for the implementation of the massive and enhanced grouting operations currently do not provide benefit to the MWR.

Post Delivery Support Plan

According to ITAO, the MWR has used materials and equipment procured by the GOI, the U.S. government, and other international donors to improve its current traditional grouting operation; however, full implementation of the enhanced grouting operation is necessary to augment ministry efforts to improve dam grouting. ITAO representatives are finalizing a detailed plan, the Post Delivery Support Plan, to provide the dam and the

ministry with the required equipment and materials to improve current grouting operations and fully implement the enhanced grouting operation. For example, this plan calls for making the IAS units fully operational and procuring additional 30-m^3/hour grout-mixing plants. ITAO representatives express confidence that the plan will adequately resolve the outstanding issues and problems and facilitate the ultimate implementation of the enhanced grouting.

Recommendations

The Special Inspector General for Iraq Reconstruction shares the concerns expressed by USACE, the Commander of the Multi-National Force-Iraq, and the U.S. Ambassador regarding problems at the dam. In view of the issues raised by this assessment and the resultant lack of significant progress in improving basic grouting capability, as well as the fact that equipment for enhanced grouting and the Integrated Analytical System were delivered but are not operational, we recommend that the ITAO Director expedite implementation of the Post Delivery Support Plan.

Management Comments

The Special Inspector General for Iraq Reconstruction received comments on a draft report from the Deputy Chief of Mission for the U.S. Embassy-Iraq, advising that ITAO concurred with the report's general findings and recommendation. Specific comments were also provided to correct perceived errors and to suggest clarifications.

Subsequent to the issuance of the draft report, GRD provided additional information and documentation. GRD also requested and was granted an extension of time for formal comments on the draft report. GRD's formal comments concurred with the recommendation and provided clarifying information for the final report.

Two days after the receipt of GRD's formal comments, USACE and GRD representatives contacted us, indicating that they were concerned with the accuracy of the final report and that they wished to provide additional information. The SIGIR subsequently contacted the GRD commander and further revised the report to address his concerns.

Evaluation of Management Comments

The SIGIR appreciates the concurrence by ITAO and GRD with the recommendation to expedite implementation of the Post Delivery Support Plan.

We reviewed the information, documentation, and clarifying comments provided both formally and informally by ITAO, GRD, and USACE and revised the final report as appropriate. Comments received are provided verbatim in Appendices E and F. Comments received are provided verbatim in the final report.

Indications of Potential Fraud

During this inspection, we found indications of potential fraud and referred these matters to the SIGIR Assistant Inspector General for Investigations, for such actions as deemed appropriate.

Appendix A. Scope and Methodology

We performed this project assessment from August through September 2007 in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team included an engineer/inspector and two auditors/inspectors.

In performing this Project Assessment we:

- Reviewed contract documentation to include the following: Task Order 8, Task Order 8 Modifications, Contract documentation for all 21 contracts associated with the Mosul Dam project, including Statements of Work, Invoices, and Material Inspection and Receiving Reports;
- Reviewed studies, conclusions, and recommendations from Washington International/Black and Veatch and the United States Army Corps of Engineers' Engineer Research and Development Center;
- Reviewed the available design package (drawings and specifications);
- Interviewed the United States Army Corps of Engineers' Gulf Region Division personnel, Iraqi Transition Assistance Office personnel, and Mosul Dam personnel; and
- Conducted two on-site assessments and documented results at the Mosul Dam project.

Appendix B. Monthly Meter Drilling Production from 1986-2007

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUX	SEP	OCT	NOV	DEC	TOTAL
1986	3803	2616	2756	2164	1630	2098	1506	650	40	338	697	1950	**20248**
1987	1965	1275	2245	3230	3210	2580	3220	4775	3760	6640	6610	7600	**47110**
1988	7210	2318	924	2280	2303			557	2013	2208	2935	5386	**28134**
1989	6707	6209	7632	7367	5275	5507	2745	1605	340	2143	3475	4554	**53559**
1990	4828	4251			921	1101	423	421	453	1311	1442	2475	**17626**
1991	1350				1225	1272	2313	1283	1483	1642	1447	1956	**13971**
1992	1998	3114	1895	1495	727	121	628	2749	2421	4179	3219	1781	**24327**
1993	1047	2009	1194	2097	1163		1026	1948	1810	3522	2816	2864	**21496**
1994	2184	1907	2273	1835	1338	1336	1262	1079	952	1136	767	903	**16972**
1995	805	995	1256	1381	960	1205	1878	677	978	510	1213	1688	**13546**
1996	924	391	2064	1938	1684	1330	982	1091	517	465	709	946	**13041**
1997	1108	1667	1657	327	495	953	1142	2939	2540	2880	2089	1395	**19192**
1998	1231	810	1405	1309	3528	3536	2625	3992	4158	4970	3743	1942	**33249**
1999	2151	2212	1577	2332	2619	1740	2767	2008	1707	1761	3083	2649	**26606**
2000	1925	1037	454	1043	2162	1735	1630	1280	1907	2195	2752	2624	**20744**
2001	3252	2441	2048	2409	2191	2868	2503	2541	2227	2845	2625	2038	**29988**
2002	2714	1220	868	2902	4110	4152	4446	4149	2975	3765	3616	2300	**37217**
2003	4158	2349	2500	1464	1663	1643	889	843	774	1475	1571	3498	**22827**
2004	4067	930	1825	971	1128	1508	2794	3435	2483	2549	1627	3230	**26547**
2005	2178	1796	1757	1706	2398	2456	1732	1436	2294	2086	1595	1078	**22512**
2006	972	1687	2681	3972	5183	5180	4763	6187	4362	3898	5119	3404	**47408**
2007	3606	3988	4205	4240	5454	5666	5982	6747					**39888**

Monthly meter drilling production at the Mosul Dam from 1986-2007
(Courtesy of the Mosul Dam manager)

Appendix C. Tons of Solids Injected Monthly from 1986-2007

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUX	SEP	OCT	NOV	DEC	TOTAL	Massive Grouting	GRAND T
1986	85	121	584	606	440	558	296	34	12	105	149	21	3011		3011
1987	28	17	1007	220	671	196	379	688	477	1892	615	456	6646	7784	14430
1988	514	136	69	68	95			39	107	110	331	870	2339	4420	6759
1989	637	942	621	726	470	775	289	213	50	109	79	409	5320	1387	6707
1990	270	159	159		125	93	36	65	39	124	210	135	1415	2265	3680
1991	28				35	67.7	81	126	109	114	68	75	704	6052	6756
1992	73	251	177	290	224	19	10	196	205	145	194	406	2190	2546	4736
1993	153	109	157	132	160		184	552	564	555	244	220	3030	1651	4681
1994	230	205	259	252	334	199	335	153	217	313	383	221	3101	2186	5287
1995	301	159	302	199	138	118	163	239	156	322	98	138	2333	1950	4283
1996	346	121	69	193	106	36.5	63	92	121	72	52	253	1524	2225	3749
1997	52	107	95	126	139	169	179	242	202	72	163	388	1934	325	2259
1998	206	189	212	274	443	229	273	276	154	156	164	448	3024	7638	10662
1999	173	218	410	250	219	356	309	294	270	246	245	221	3211	596	3807
2000	231	281	220	302	64	221	440	281	236	201	137	118	2732	419	3151
2001	186	326	119	152	199	193	142	210	381	221	287	156	2572		2572
2002	181	284	532	271	198	165	209	201	181	137	256	197	2812		2812
2003	153	85	96	91	96	278	196	209	178	224	346	235	2187	293	2480
2004	278	230	186	112	145	145	230	202	114	124	77	150	1993	215	2208
2005	125	66.4	53.2	59.2	155	163	109	93.7	74.7	66.2	129	96	1191		1191
2006	57.9	78	178	582	328	236	581	358	204	204	226	345	3377	295	3672
2007	485	254	234	284	285	311	276	350					2478	279	2756

Tons of solids injected monthly at the Mosul Dam from 1986-2007
(Courtesy of the Mosul Dam manager)

Appendix D. Complete Text of Letter to Iraqi Prime Minister Regarding Mosul Dam Concerns

HEADQUARTERS
MULTI-NATIONAL FORCE – IRAQ
BAGHDAD, IRAQ
APO AE 09342-1400

3 May 2007

The Honorable Nouri al-Maliki
Prime Minster
Republic of Iraq

Mr. Prime Minister:

In December 2006, the US Army Corps of Engineers completed a review of existing information on the safety of Mosul Dam to identify the potential risks of a dam failure. Based on this review, the Army Corps of Engineers determined that the dam presented unacceptable risks and recommended that assets be removed from the Tigris River floodplain in the Mosul area. Recognizing, however, that Iraqi citizens and assets are equally at risk from a potential dam failure, the purpose of this letter is to inform you of the safety concerns we have identified for the dam and corresponding consequences if the dam fails.

Mosul Dam, the largest dam in Iraq, was constructed on a foundation of soluble soils that are continuously dissolving, resulting in the formation of cavities and voids underground that place the dam at risk for failure. These conditions have existed since the dam was constructed in the mid-1980s, and to mitigate the risk of the foundation dissolution, the Iraq Ministry of Water Resources has pursued both short-term and long-term risk reduction measures over the past 25 years. A continuous grouting program, which fills the voids and cavities in the foundation strata, has been the primary ongoing measure for mitigating risk since the 1980s.

Despite this continuous grouting operation at Mosul Dam, the Army Corps of Engineers does not believe that the dam meets international standards for risk and reliability, and as such, the safety of the dam cannot be assured. A catastrophic failure of Mosul Dam would result in flooding along the Tigris River all the way to Baghdad. However, the most severe impact of a dam failure would be to the City of Mosul, located 50 kilometers downstream of the dam with a population of 1.7 million. Assuming a worse case scenario, an instantaneous failure of Mosul Dam filled to its maximum operating level could result in a flood wave 20 meters deep at the City of Mosul, which would result in a significant loss of life and property.

Over the past three years, the US Government has worked closely with the Iraq Ministry of Water Resources to study the conditions of Mosul Dam and implement an enhanced grouting program for the dam. We will continue to offer support to the Ministry in its efforts to improve Mosul Dam operations, complete further engineering analyses, and develop permanent solutions to the challenges that exist at Mosul Dam. This work should be a national priority for the Government of Iraq. At present, we believe the following actions are essential to mitigating the risk at Mosul Dam:

1. The Ministry of Water Resources imposed a reservoir restriction of 319 meters above sea level at Mosul Dam in April 2006 in response to recommendations by its International Panel

Appendix D. Complete Text of Letter to Iraqi Prime Minister Regarding Mosul Dam Concerns

of Experts on Dams. We recommend maintaining this lower than normal reservoir elevation to reduce hydrostatic pressure on the dam and thus the potential for failure.

2. Continue the dam grouting program. Over the past two years, the Ministry of Water Resources, US Government, and UN Food and Agricultural Organization invested considerable resources in purchasing equipment and materials, as well as developing new grouting procedures to improve the effectiveness of the grouting operation at the dam. This work must remain a high national priority.

3. Continue detailed on-site engineering evaluations of the dam conditions and operational practices by a team of experts. The Ministry of Water Resources has been completing numerous geophysical studies of the dam foundation over the past year under the guidance of its International Panel of Experts to better assess the foundation conditions at the dam site in order to make recommendations on future operation of the dam.

4. Develop a dam break warning, evacuation, response, and recovery plan for downstream communities, and coordinate dam emergency action plans with dam personnel, including acquisition of equipment, and materials. The Ministry of Water Resources is reviewing its emergency plans for Mosul Dam and will be receiving training this year from the US Government on emergency planning for its critical infrastructure. The US Army Corps of Engineers also recently installed a basic warning and notification system to notify the US Government of any emergency situation at the dam.

5. Continue development of permanent solutions to the safety threat at Mosul Dam. The Ministry of Water Resources will complete an engineering review of the partially completed Badoosh Dam. If constructed, it would serve as a safety backstop in the event of failure of Mosul Dam. The Ministry is also considering other long-term measures to mitigate the risk of Mosul Dam.

We look forward to continuing to work with the Ministry of Water Resources on addressing the risks posed by Mosul Dam to ensure a bright future for the Nation of Iraq.

Sincerely,

Ryan C. Crocker
Ambassador
United States Embassy, Baghdad

David H. Petraeus
General, US Army
Commanding

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Appendix E. Contracts for the Mosul Dam

CONTRACT	TYPE OF EQUIPMENT	CONTRACT AMOUNT	AMOUNT PAID
W91GY1-06-C-0051	Pipes & accessories	$1,250,927.50	$1,250,927.50
W91GY1-06-C-1000	Intelligrout	$16,527,174.46	$16,213,743.06
W91GY1-06-M-0006	Laboratory equipment	$11,104.69	$11,104.69
W91GY1-06-M-0007	Laboratory equipment	$7,737.50	$7,737.50
W91GY1-06-M-0008	Superplastizier	$6,160.00	$6,160.00
W91GY1-06-M-0009	Antiwash agent	$0.00[18]	$0.00
W91GY1-06-M-0010	Welam gum/Fly ash	$40,375.00	$40,374.88
W91GY1-06-M-0011	Parts & valves	$22,990.00	$22,990.00
W91GY1-06-M-0012	Parts & valves	$167,111.42	$139,277.27
W91GY1-06-M-0013	Parts & valves	$7,000.00	$7,000.00
W91GY1-06-M-0014	Parts & valves	$0.00[19]	$0.00
W91GY1-06-M-0015	Piezeometer material	$3,590.75	$3,590.00
W91GY1-06-M-0016	Piezeometers	$35,117.00	$35,116.00
W91GY1-06-M-0017	Piezeometer material	$59,994.00	$58,811.10
W91GY1-06-M-0018	Silos for cement	$780,000.00	$635,138.00
W91GY1-06-M-0019	Mixing plants & spare parts	$3,381,400.00	$2,225,400.00
W91GY1-06-M-0020	Wirth drilling rigs spares	$3,355,000.00	$3,355,000.00
W91GY1-06-M-0025	Transport of Intelligrout equipment	$214,226.53	$214,226.53
W91GY1-06-M-0031	Grouting material	$36,365.00	$36,365.00
W91GY1-06-M-0032	Drilling rods	$714,500.00	$714,500.00
W91GY1-06-M-0035	Casing pipe	$494,100.00	$0.00
		$27,114,873.85	**$24,977,461.53**

[18] Contract was terminated for cause on 8 May 2007.
[19] Contract was terminated for cause on 15 August 2007.

Appendix F. Complete Text of Iraqi Transition Assistance Office Comments

Embassy of the United States of America
Baghdad, Iraq

October 21, 2007

INFORMATION MEMORANDUM

UNCLASSIFIED

TO: The Special Inspector General for Iraq Reconstruction

FROM: The Deputy Chief of Mission – Patricia A. Butenis

SUBJECT: Response to questions – Mosul Dam SIGIR PA-07-105

Please find attached the Embassy's comments to your request for comments to SIGIR PA-07-104, *Relief and Reconstruction Funded Work at Mosul Dam, Mosul, Iraq.*

Appendix F. Complete Text of Iraqi Transition Assistance Office Comments

Tab A

October 18, 2007

Response to SIGIR PA-07-105 Draft Report: Relief and Reconstruction Funded Work at Mosul Dam, Mosul, Iraq.

The Iraq Transition Assistance Office (ITAO) agrees with the general findings of the report that there have been several problems with the specifications, procurement, and delivery of equipment and material during the execution of the Mosul Dam project that resulted in delay in the implementation of the enhanced grouting phase of the project and limited the effectiveness of the support for the traditional grouting.

ITAO also concurs with the recommendation to implement the ITAO post delivery support plan. ITAO appreciates SIGIR PA-07-105 confidence in its plan to implement the enhanced grouting program and welcomes SIGIR's support as we move forward with implementation of the plan.

Specific comments provided below are to correct errors of fact or to suggest clarifications:

Please be advised that some of the information contained in the report is not releasable to the public because it either contains LIMDIS satellite imagery or sensitive information on critical infrastructure that might identify vulnerabilities for terrorists. Please see comments regarding Page 14 Paragraph 5, Page 15, and Page16 of the SIGIR Report. We recommend a short, joint, by page review of graphics to ensure no inappropriate information is released outside USG/GOI channels.

Technical Corrections

Throughout the document the authors refer to three different panels of experts; however the report confused the three in the following instances:

- **Page 6 Paragraph 1:** The design and construction review Board of Experts was a committee of international dam experts that was commissioned and paid for by the Ministry of Irrigation (the predecessor organization for the Ministry of Water Resources) and was responsible for reviewing the design, construction, and operation of Mosul Dam. The role of this board ended in 1989. The report correctly identifies the board but incorrectly uses the abbreviation POE to refer to it.

- **Page 6 Paragraph 2:** The POE referred to in Paragraph 2 is actually a WI/BV Panel of Experts (POE) convened in 2005, not the Board of Experts.

- **Page 14.** the International Panel of Experts (IPE) is a panel commissioned and paid for by the Ministry of Water Resources. IPE was formed in early 2006 and its first meeting occurred in March 2006 and it has been advising the Ministry on matters related to Mosul Dam since. The IPE includes Dam Experts from the United States, the United Kingdom and Italy. IPE (not the POE) was responsible

Appendix F. Complete Text of Iraqi Transition Assistance Office Comments

for setting the reservoir restriction at 319 m a.m.s.l. for two consecutive years and continues to work with the Ministry on review of field data, geophysical explorations, permanent solutions, and the design of Badoosh Dam. The report misses the important role this panel continues to play in providing advice to the Ministry on Mosul Dam.

Page i, Paragraph 4: Massive grouting is actually part of the "traditional grouting" program. Suggest changing the second sentence to read "*The short-term solutions required that the Ministry of Water Resources be provided the most critically needed replacement and spare parts, assistance with its traditional grouting program, and enhanced grouting to…*"

Page ii, Paragraph 2: This project included construction of four (4) 1500 tons silos giving rise to a total storage of 6000 tons. The paragraph needs to use plural *silos*.

Page iv, Paragraph 4. Suggest modifying the first sentence to read "*The Ministry of Water Resources, with assistance from procured material and equipment by the Government of Iraq, the US Government and other international donors, has improved its current traditional grouting operation*".

Page 6, Paragraph 1. Suggest rephrasing the last sentence to give proper credit to the government of Iraq as "*Design and construction was reviewed by a Board of Experts commissioned and paid for by the Ministry of Irrigation (the predecessor organization of the Ministry of Water Resources) that met 30 times from 1979 through 1989*".

Page 6, Paragraph 3. Grouting and grouting galleries have been used in dams built over difficult foundations in France, Morocco, Japan, Spain, and Argentina (see Weaver and Bruce, Dam Foundation Grouting, 2007). It is clear from the WI/BV POE that the designer underestimated the amount of blanket and curtain grouting necessary to stabilize the foundation. The reference to the inverted dam foundation is of limited value to the report. Suggest removing reference to the inverted dam foundation.

Page 8, Paragraph 1. Suggest revising the second sentence to read "*Sinkholes are an indicator of possible subsurface cavities.*" Sinkholes SD2, SD2S, SD3-2 and SD4 are believed to be all linked to a subsurface feature that extends to the west and does not pass under the dam; hence it can not be linked to the dam foundation.

Page 9, Figure 6. We are not aware of seepage points that pass through the main embankment. Field observations did not identify seepage points in the main body of the dam as shown in the figure. Please either remove the figure or provide reference to the source of the figure and the analysis used to identify these seepage points.

Page 9, Paragraph 3. The Mosul Dam engineers designed and implemented a remedial measure for the erosion of the plunge pool of the bottom outlet. The design and implementation of the remedial measure was reviewed and approved by the International Panel of Experts (IPE) which convened 14-15 May 2007. The bottom outlet was used successfully to empty the reservoir during the wet season of 2007 to maintain the water level restriction of 319 m a.m.s.l. The bottom outlet is operational and can be used anytime. The

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Appendix F. Complete Text of Iraqi Transition Assistance Office Comments

statement mentioned in the SIGIR report was true in 2005 but has since been cured. Suggest providing the above explanation to accompany the identification of the problem.

Page 9, Paragraph 4. Internal erosion and piping through the dam embankment is a concern for all embankment dams. However, the WI/BV POE Failure Mode Analysis lists the "Internal seepage/piping through the embankment" as "judged to be very unlikely" (See WI/BV Page 31 Table 3-7of the failure mode analysis report). Suggest removing this paragraph.

Page 10, Figure 7. Mosul dam engineers do not have means of "filling cavities" away from the grouting gallery. Figure 7 shows a grout pump filling a cavity downstream from the gallery; there is no means available to achieve this. Grouting can only occur from the grouting gallery. Suggest removing this figure.

Page 11, Table 1 and 2. The tables were prepared by Mosul Dam Manager not the USACE. Suggest citing the dam manager as the source of data.

Page 14, Paragraph 1. The International Panel of Expert (IPE) has been the panel that imposed the reservoir restriction. Please note that this IPE is commissioned and paid for by the Ministry of Water Resources. Their meetings are always attended by the Minister of Water Resources and they have been meeting to review information and advice the Ministry on the operation and remediation measures at Mosul Dam since March 2006.

Page 14, Paragraph 5. The quote "… ***Mosul Dam is the most dangerous dam in the world***…" is inflammatory and almost certainly disprovable. ITAO is not aware of the September 2006 report that declares Mosul to be the most dangerous dam in the world. Suggest removing this sentence. Also recommend providing the USACE September 2006 report to ITAO Office of Water for review and transmittal to the Ministry of Water Resources.

Page 15 and 16. The write up contains sensitive information and Figures 10 and 11 contain LIMDIS satellite imagery that may not be released to the public. Suggest removing these two pages.

Page 41, Site Photo 44. The quoted picture shows a considerable improvement in grouting along the saddle dam. In 2006 Mosul Dam project did not have casing/drill pipes and as a result, the dam manager made the decision to grout upstream of the saddle dam. This practice has the potential to cause the water to overtop the grout curtain. It was essential that the grout curtain be tied to the saddle dam core. The US Government initiated the procurement of the casing/drill pipes for the dam to allow drilling through the core. However, due to delays in delivery, and ordering pipe with the wrong dimensions, the casing pipes did not arrive on site at the date of the SIGIR site visit. The Ministry of Water Resources ordered and delivered casing/drilling pipes. As can be seen in Site Photo 44, the Mosul Dam staff are now drilling and grouting along the saddle dam crest, hence tying the grout curtain with the saddle dam core which is a considerable improvement.

Page 45, Paragraph 1. ITAO appreciates the authors' confidence in their ability to plan and execute the plan envisioned with input from all stakeholders.

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Appendix F. Complete Text of Iraqi Transition Assistance Office Comments

Page 48, Paragraph 5. ITAO supports the recommendation of the authors to expedite the implementation of the Post Delivery Support Plan.

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Appendix G. Complete Text of Gulf Region Division Comments

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
GULF REGION DIVISION
BAGHDAD, IRAQ
APO AE 09348

REPLY TO
ATTENTION OF

CEGRD-CG

21 October 2007

MEMORANDUM FOR Special Inspector General for Iraq Reconstruction, US Embassy Annex, M-202, Old Presidential Palace, APO AE 09316

SUBJECT: Draft SIGIR Assessment Report – Relief and Reconstruction Funded Work at Mosul Dam, Mosul, Iraq (SIGIR PA-07-105)

1. This memorandum provides the U.S. Army Corps of Engineers, Gulf Region Division (GRD) comments to the subject draft report.

2. We appreciate the opportunity to comment on the draft report and the extra time you gave us to prepare our comments (see enclosure 1). We have also enclosed responses (see enclosure 2) to follow-on questions you sent after submitting the draft report to GRD.

3. Based upon the sensitive nature of the project, GRD recommends that SIGIR carefully vet the supporting documentation that will be included in the report. Specifically, GRD recommends removing the flood maps on pages 14 through 16 of the draft report.

4. Due to the complexity of the project, GRD also requests that it have the opportunity to review an updated draft report before the final report is published. This will allow GRD to ensure that no inaccuracies remain in the report.

5. If you have any questions, please contact Mr. Milton Naumann at (540) 665-5021 or his email Milton.L.Naumann@tac01.usace.army.mil.

Encls
as

JEFFREY J. DORKO
Brigadier General, USA
Commanding

Appendix G. Complete Text of Gulf Region Division Comments

COMMAND REPLY

SIGIR Draft Assessment Report – Relief and Reconstruction Funded Work at Mosul Dam ,Mosul, Iraq (SIGIR PA-07-105)

The Gulf Region Division (GRD) provides the following comments to SIGIR report.

Recommendation and Command Comments

Recommendation. We recommend that the Director, Iraqi Transition Assistance Office expedite the implementation of the Post Delivery Support Plan.

GRD Comments. Concur.

Conclusions and Command Comments

1. SIGIR Conclusion. Page ii, Paragraph 1. The U.S. Army Corps of Engineers, Gulf Region Division could only provide a simple schematic drawing of the 30 cubic meters per hour (m3/hour) mixing plants, which lacked significant details.

GRD Comments: Detailed designs were provided to SIGIR for the 30 and 100 cubic meter per hour plants. Procurement contracts provided specific and detailed equipment designs.

SIGIR Conclusion (continued). Page ii, Paragraph 3. Without schematics and/or design drawings and specifications, we cannot conclusively determine if the enhanced grouting equipment, when assembled, will fit inside the Mosul Dam gallery. According to the Mosul Dam manager, who has more than 20 years experience at the Mosul Dam, the equipment procured is too wide and long to fit inside the gallery

GRD Comments. This conclusion presents an untested assumption with which GRD disagrees.

2. SIGIR Conclusion. Page ii, Paragraph 4. An adequate quality management program was not utilized for the delivery and construction of materials and equipment at the Mosul Dam.

GRD Comment. Mosul Dam is in a dangerous area. GRD officials relied upon reports and photographs from ministry personnel to verify receipt, quality, and quantity of delivered materials. Grout plants and silos will be re-awarded as construction projects to ensure that proper evaluation of equipment, construction quality control and detailed construction schedules are followed. GRD will assume control of construction and procurement activities to make sure the project activities are completed as required.

Enclosure 1

Appendix G. Complete Text of Gulf Region Division Comments

COMMAND REPLY

SIGIR Draft Assessment Report – Relief and Reconstruction Funded Work at Mosul Dam, Mosul, Iraq (SIGIR PA-07-105)

1. This document responds to additional questions SIGIR had regarding the Mosul Dam review. In order to validate comments obtained during email correspondence, SIGIR requested the following information and documentation:

a. SIGIR Question. The furnished copies of Senior GRD Representative inspection and receiving reports that were provided to Mosul Dam manager [SIGIR removed name].

GRD Comment. As provided in Attachment 3 of the JV Input folder, P:\DPM\Water\Mosul Dam, please find copies of the documentation provided to ITAO and Mosul Dam manager [SIGIR removed name].

b. SIGIR Question. The photos and any write-up by GRD Engineering Geologist [SIGIR removed name] from January 2005 when he first visited the Mosul Dam site and immediately recognized the silo project would be a construction project.

GRD Comment. Please find below an extract of GRD Engineering Geologist's [SIGIR removed name] April 2006 site visit report. The complete report can be found in Attachment 3 of the JV Input folder, P:\DPM\Water\Mosul Dam.

Memorandum for Project Record 11 April 2006

Subject: Site Visit Report, Mosul Dam Foundation Remediation.

1. On 11 April, myself with a PSD visited Mosul Dam to inspect the east abutment remedial grouting, general equipment inventory and conditions, the on-going sinkhole (SD-5) investigation, and work progress of the Silo Contractor. The site visit occurred on Monday's holiday at the Manager's request. For security reasons the Dam Manager was not visited on site. Due to the holiday not all drilling and grouting operations were active. The grout gallery was not visited. This report's contains only empirical observations and makes no recommendations until further study.

Enclosure 2

Appendix G. Complete Text of Gulf Region Division Comments

c. SIGIR Question. Why did GRD/CH2M HILL / Parsons still awarded this contract (stationary silo) as a procurement only contract when told over a year earlier (from GRD Engineering Geologist) that this would be a construction project?

GRD Comment. ITAO directed GRD to procure the stationary silos using funds allocated for non-construction projects, so that all material and equipment procured for Mosul Dam was classified as non-construction.

d. SIGIR Question. The complete trouble-shooting log and list of replacement parts sent by the Enhanced Grouting System vendor for the IAS.

GRD Comment. Please refer to Attachment 3 of the JV Input folder in P:\DPM\Water\Mosul Dam for the equipment list and Attachment 1 which provides the equipment list as approved by MWR and Mosul Dam manager [SIGIR removed name].

e. SIGIR Question. GRD Engineering Geologist stated the $100m^3$/hour grout mixing plant would be the "Mother of All Grout Plants" and that it would be the one of the "largest capacity grout plants on the planet." GRD Engineering Geologist casts doubt on the need for the Mosul Dam to have a mixing plant of this size. If this is true, then why did the GRD and SPCOC agree to contract for this? Isn't the role of the SPCOC to identify the needs and capabilities of the Mosul Dam in order to make the correct recommendations?

GRD Comment.
The original solicitation prepared by MWR (as forwarded to PCO and directed to proceed with procurement by ITAO) required a $150m^3$/hour grout mixing plant.

f.. SIGIR Question. Any emails and/or telephone conference memorandum regarding discussions with IRMO and the SPCOC that 3 IAS units were not needed.

GRD Comment. As provided in Attachment 3 of the JV Input folder in P:\DPM\Water\Mosul Dam, and in accordance with the 30 May 2006 letter to IRMO, MWR officially approved the procurement of 3 IAS systems. This approval was in direct response to IRMO as stated in the MWR letter.

g. Did the SPCOC fire Washington Group International/Black and Veatch? If so, what was the basis for the termination?

GRD Comment. No. PCO and IRMO jointly agreed to reduce overhead costs by no longer using DB contracts.

h. SIGIR Question. GRD Engineering Geologist [SIGIR removed name] stated that the CH2M HILL /Parsons JV was staffed primarily with Parsons personnel - is this true? If so, why were there more people from the construction side of the JV on the project than the CH2M HILL people who had extensive program management experience in water projects?

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Appendix G. Complete Text of Gulf Region Division Comments

GRD Comment. No, this is not true, but perhaps coincidental. Both partners of the JV (CH2M HILL and Parsons) have substantial construction and program management experience in water projects. Work under the JV team was performed without consideration of the particular company affiliation. Staff assignments within the overall program changed periodically as members completed their assignments (tour of duty) and were replaced by new staff. Team composition was determined by individual experience and qualifications, not by company. The JV representation between each company was roughly equal for the duration of the contract

i. SIGIR Question. The detailed training syllabus for the seven week training class in the US for the Iraqis.

GRD Comment. Please refer to the training syllabus in Attachment 3 of the JV Input folder in P:\DPM\Water\Mosul Dam.

j. SIGIR Question. GRD Engineering Geologist [SIGIR removed name] said that for each one of his site visits, an RMS report was completed and a trip report submitted to the JV - please provide us with these documents According to GRD Engineering Geologist's [SIGIR removed name] write-up, the above-mentioned items should be readily available.

GRD Comment. At this time, we have located the 10 Apr 2006 trip report from GRD Engineering Geologist [SIGIR removed name]. Please see Attachment 2 for this report.

2. The following paragraphs provide a response to general questions from SIGIR.

a. General SIGIR Question. During our exit conference, we explained that the objectives of the Mosul Dam project were to provide the Mosul Dam and the MWR with critically needed spare and replacement parts, the ability to conduct massive grouting, and fully implement enhanced grouting. We briefed that the procurement and delivery of spare and replacement parts was partially consistent with the first objective, but the results for the massive and enhanced grouting were not consistent with the objectives. Specifically, we stated that the IAS units were not operational for various reasons (air conditioning, software and CADD issues) and that it appeared the enhanced grouting equipment would not fit inside the gallery. No one at the exit conference contradicted what we briefed. However, GRD Engineering Geologist is now stating the cause of the IAS units not working is the Iraqi's fault for either using "dirty" power or that Mosul Dam manager has his own agenda for intentionally not using the IAS units. Further, GRD Engineering Geologist has implied that either Mosul Dam manager or other MWR personnel may have stolen the IAS generators and possibly sold them to insurgent groups.

GRD Comment. GRD participants were not aware of GRD Engineering Geologist's [SIGIR removed name] concerns at the time of the exit conference. JV was not in attendance.

b. General SIGIR Question. What is GRD's official stance on the status of the IAS units and the associated enhanced grouting system equipment? Is it not working or is it just not being used? The Mosul Dam manager told us during the site visit that the air

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conditioning was not working in all 3 IAS units and that there were also problems with software and CADD. Has this been resolved? GRD Engineering Geologist [SIGIR removed name] stated that the CADD problem has been resolved - this needs to be verified.

GRD Comment. The IAS and associated enhance grouting system equipment was fully operational when shipped. After the equipment arrived at Mosul Dam, a weekly conference with GF was conducted to discuss all installation issues. Please refer to Attachment 3 of the JV Input folder in P:\DPM\Water\Mosul Dam for the troubleshooting log. It is our opinion that with assistance through the help desk system, the enhanced grouting program could be implemented and operational in short order.

c. General SIGIR Question. Does GRD believe that a comprehensive and rational diagram or schematic drawings are not required? GRD Engineering Geologist stated that the equipment as delivered is "equivalent to a Lego kit." Is it that easy to put together?

GRD Comment. It is our opinion that sufficient guidance, publications, and training was provided to the Mosul Dam staff to install and operate the equipment provided. Training in the US was provided to dam staff, along with the appropriate guides and manuals to assist them on-site

d. General SIGIR Question. Does GRD believe that the enhanced grouting equipment, when assembled, will fit inside the gallery?

GRD Comment. Yes, only the mixing tub and the packing equipment with sensors were intended to fit in the gallery.

e. General SIGIR Question. According to GRD Engineering Geologist [SIGIR removed name] the MWR on-site did not use the generators provided with the IAS units to provide clean power and blew-out the dual redundant HVAC systems. Considering GRD Engineering Geologist had left country well before the IAS units arrived, I want to know if GRD shares this opinion. If so, what is the basis for this statement?

GRD Comment. GRD is unable to substantiate this claim by GRD Engineering Geologist [SIGIR removed name] with existing documentation.

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f. General SIGIR Question. GRD Engineering Geologist [SIGIR removed name]also makes reference to generators for the grout plants. We have reviewed all of the design drawings for the grout plants and didn't see any mention of generators.

GRD Comment. Please refer to the photographs provided above from the field showing the delivery of the generators in question.

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g. General SIGIR Question. Also, does GRD agree with GRD Engineering Geologist's [SIGIR removed name] comments that ITAO's Post Delivery Support Plan is "doomed?"

GRD Comment. No, it is our opinion that if MWR and the dam manager are dedicated to implementation and use the equipment, supplies, and training provided to date, the system will work effectively.

h. General SIGIR Question. Finally, GRD Engineering Geologist [SIGIR removed name] made comments that contradicted information/documentation from GRD within the Water Sector. Who should I note as the more credible source - GRD Engineering Geologist [SIGIR removed name], USACE Engineering Research and Development Center (ERDC; formerly Waterways Experiment Station WES), or the studies done by WI/BV?

GRD Comment. Neither. GRD will judge information provided by all sources on its own merit.

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Appendix H. Acronyms

AGS	Advanced Grouting System
EC	Evaluation Committee
ER	Engineering Regulation
CADD	Computer-Aided Design and Drafting
GIMOD	German Italian Mosul Dam
GRD	Gulf Region Division
IAS	Integrated Analytical System
IGE	Independent Government Estimate
IPE	International Panel of Experts
IRMO	Iraq Reconstruction Management Office
ITAO	Iraq Transition Assistance Office
JCC-I/A	Joint Contracting Command – Iraq/Afghanistan
km	Kilometer
LMG	Low mobility grout
l/s	Liters per second
m	Meter
m^3	Cubic meters
m^3/hour	Cubic meters per hour
m^3/second	Cubic meters per second
mm	Millimeter
MW	Megawatts
MWR	Ministry of Water Resources
PCO	Project and Contracting Office
POE	Panel of Experts
RFP	Request for Proposal
SCO	Show Cause Order
SIGIR	Special Inspector General for Iraq Reconstruction
SOP	Standard Operating Procedure
SPCOC	Sector Project Contracting Office Contractor
TO	Task Order
USACE	United States Army Corps of Engineers
WI/BV	Washington Group International/Black and Veatch

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Appendix J. Project Assessment Team Members

The Office of the Assistant Inspector General for Inspections, Office of the Special Inspector General for Iraq Reconstruction, prepared this report. The principal staff members who contributed to the report were:

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