Engineering and Design Quality Control Plan

Data Gap Analysis and Report, Numerical Groundwater Model, and Feasibility Study
Former Guterl Specialty Steel Corporation
Lockport, New York

Contract Number W912QR-08-D-0013
Delivery Order DN02

Prepared for:

U.S. Army Corps of Engineers
Buffalo District

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Shaw Project Number 140416

22 October 2010
Revision 1

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Abbreviations and Acronyms

AEC	Atomic Energy Commission
ARARS	applicable or relevant and appropriate requirements
ASQ	American Society for Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIH	Certified Industrial Hygienist
COPCs	Constituents of potential concern
CQA	Certified Quality Auditor
CPG	Certified Professional Geologist
CQE	Certified Quality Engineer
DOE	U.S. Department of Energy
FUSRAP	Formerly Utilized Sites Remedial Action Program
IDIQ	Indefinite Delivery Indefinite Quantity
ITR	Independent Technical Review
MCACES	Micro-Computer Aided Cost Estimating System
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
PA/SI	Preliminary Assessment/ Site Inspection
PE	Professional Engineer
PG	Professional Geologist
PM	Project Manager
PMP	Project Management Professional
QC	quality control
QCP	Quality Control Plan
RI	remedial investigation
RNA	remediation by natural attenuation
SESOIL	Seasonal Soil compartment model
Shaw	Shaw Environmental & Infrastructure, Inc.
SOW	Scope of Work
USACE	U.S. Army Corps of Engineers

1.0 Introduction

This Engineering and Design Quality Control Plan (QCP) has been prepared in support of the *Data Gap Analysis and Report, Numerical Groundwater Model, and Feasibility Study for the Former Guterl Specialty Steel Corporation,* to be performed by Shaw Environmental & Infrastructure, Inc. (Shaw) for the U.S. Army Corps of Engineers (USACE) Buffalo District under Delivery Order DN02 of Contract W912QR-08-D-0013. This QCP was generated in accordance with ER 1110-1-12, *Engineering and Design Quality Management* and CEORD 1110-1-9, *Quality Control*, and in accordance with Task 1 and Appendix B of the Scope of Work (SOW) dated March 2010. This QCP describes Shaw's quality control (QC) approach for performing and fulfilling the tasks specified in the SOW.

1.1 Background

The Guterl Specialty Steel Corporation (Guterl Steel) site, formerly known as the Simonds Saw and Steel Company, is located in Lockport, New York, approximately 20 miles north of Buffalo, New York. The approximately 70-acre site is bordered by Ohio Street to the east, residential and commercial properties to the north, Route 93 to the west, and the New York State Barge Canal to the south. The property is grouped into three areas, the 52-acre Allegheny Ludlum Corporation property, which includes four buildings that were constructed after the termination of Atomic Energy Commission (AEC) activities; the 9-acre landfill area, located in the northwest corner of the site; and the 9-acre excised property, which includes nine buildings that existed during the AEC activities, located in the southeast corner of the site. The site was used to perform rolling mill operations on uranium metal, and to a much smaller extent, thorium metal, during the period from 1948 to 1956.

The USACE Buffalo District completed a Preliminary Assessment/Site Inspection (PA/SI) report in May 2001 (USACE 2001a). In the PA/SI report, USACE Buffalo District recommended that the Guterl Steel site be included into the Formerly Utilized Sites Remedial Action Program (FUSRAP) based on evidence of residual contamination. In 2007, the USACE conducted field activities throughout the Guterl Steel site property, as well as some adjacent properties, in support of preparation of a remedial investigation (RI) report. These activities included the sampling and subsequent analysis of soil, sediment, surface water, ground water, and building material samples. Constituents of potential concern (COPCs) include U-238, U-235, U-234, Th-232, Th-230, Th-228, Ra-228, and Ra-226.

The strategy for the Guterl Steel site is to address all AEC related COPCs at the site (and adjacent properties, if necessary) as specified in the Baseline Risk Assessment. The strategy will follow the process defined in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The criteria in CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) will be used for site evaluation and remedy.

Based upon conclusions drawn from the RI report regarding the nature and extent of radiological contamination and risk to human health and the environment at the site, remedial alternatives will be developed and evaluated against the nine CERCLA criteria, namely overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; short-term effectiveness; reduction in toxicity, mobility, and volume through treatment; implementability; cost; State acceptance; and community acceptance. This analysis will serve as the basis for the choice of remedial action outlined in the Proposed Plan and documented in the Record of Decision.

1.2 Project Objective

The near term objective for the Guterl Steel project is the continuation of the CERCLA documentation, specifically preparation of the Feasibility Study. This will lead to preparation of the Proposed Plan and the Record of Decision, which are not part of the SOW for this Delivery Order. The long term objective is implementation of a remedy that is protective of human health and the environment and is compliant with the requirements of CERCLA.

The tasks associated with this project are listed below:

- Task 1 Engineering and Design Quality Control Plan
- Task 2 Technical Project Planning
- Task 3 Data Gap Analysis and Report
- Task 4 Numerical Groundwater Model
- Task 5 Feasibility Study
- Task 6 Community Relations Support
- Task 7 Technical Support Services

2.0 Management Philosophy

This QCP identifies a process of planned and systematic actions to be employed by the Shaw Project Team to create and deliver quality products and services that meet USACE objectives; requirements; and applicable laws, codes, policies, and standards. The Shaw Team management and staff assigned to this project are committed to meeting the objectives and requirements of this project, and uphold the Shaw Corporate Policy for Quality:

"To consistently provide services and products that satisfy the requirements and meet or exceed the expectations of our clients worldwide. Our goal is to be the industry benchmark for excellence."

The Shaw Team staff will use this QCP to plan for and perform QC-related tasks associated with this project. This QCP is applicable to all Shaw Team personnel, including Shaw subcontractors, performing activities under this project.

3.0 Management Approach

Quality management activities for tasks associated with this project will be performed in accordance with this QCP. Shaw Corporate policy and procedure requirements that are applicable to this project have been incorporated by reference into the applicable sections and are provided for reference in Table 1. Conformance with these requirements will generate deliverables aligned with client quality needs and project requirements. QC activities will focus on documentation management and control, communications, design coordination procedures, checking, and managerial continuity and flexibility.

Table 1, Applicable Shaw Corporate Procedures

EI-G004	Records Generation, Management, and Control
EI-GS063	Standards for Conducting Groundwater Flow and Solute Transport Modeling
EI-GS064	Standards for Conducting Geochemical Modeling
EI-Q007	Nonconformance Reporting
EI-Q011	Verification of Figures, Drawings, Tables, and Logs
EI-Q012	Verification of Calculations, Spreadsheets, and Databases
T-DP-001	Technical Studies and Reports

Copies of these procedures are included in Appendix A.

3.1 Documentation Management and Control

Records are considered one of the principal forms of objective evidence of a rigorous QC Program. Records may be in any of several media formats such as hard-copy or electronic and may be generated by Shaw E & I personnel, clients, or subcontractors. Such records are maintained as prescribed by Shaw Corporate SOP EI-G004, Records Generation, Management, and Control. The Shaw Project Records Clerk is responsible for maintaining control and retention for project-related records. Record control includes receipt from external and internal sources, transmittal, transfer to storage, and indication of record status.

Whenever possible, electronic records will be maintained on a secure network server, such as the Shaw network server, that is backed up on a routine basis. Electronic records that are not maintained on a secure network server will be periodically backed up to a secure second source storage media, transferred to an archive media (e.g., compact discs, optical discs, magnetic tape, or equivalent), or printed. In addition, a Shaw Intranet based Microsoft SharePoint website has

been established for projects under this contract that provides secure and convenient access to project files for the project team.

Retention includes receipt at storage areas, indexing and filing, storage and maintenance, and retrieval. These documents and electronic files are generated, organized, managed, and retained so that they are secure and retrievable for future reference. Shaw will maintain the project repositories at 5050 Section Ave, Cincinnati, Ohio for all project records, including correspondence. Records will be controlled and retained, as appropriate, in the office central files. The Project Records Clerk will assign control numbers to all outgoing documents and is responsible for properly filing the controlled records (except for those related to accounting, purchasing, and drafting, which are retained in the respective department files). Shaw will also provide the USACE Buffalo District with a copy of all telephone memos, written correspondence, and meeting minutes regarding information related to the project within ten (10) days of the event. Copies of all records will be retained by Shaw for a minimum of seven (7) years after the end of the contract period. In addition, project records deemed to be of importance by the USACE will be turned over to the USACE at the time of project close-out.

A submittal register (ENG 4288, provided in Appendix B) will be maintained and updated for this project by the Shaw QC Manager. The Submittal Register will be used to log and monitor required submittal activities. Submittals returned unapproved or with comments requiring revisions will be so noted on the submittal register and re-entered as a revision. Independent Technical Review (ITR) of documents prior to submittal to USACE is discussed in Section 3.4.1.

3.2 Communications

3.2.1 Weekly Conference Calls

The Shaw Project Manager will conduct weekly conference calls with USACE project personnel to discuss project progress. This call will also be attended by the Shaw Program Manager and technical team members, as appropriate. Meeting minutes will be prepared by Shaw and distributed for review.

3.2.2 Monthly Progress Reports

Shaw will submit monthly written progress reports to the USACE Project Manager for every month. The monthly reports will include an accurate and current account of all work completed and in progress. This report will include information on tasks that have been completed since the last report, tasks in progress, and tasks still to be executed. Any safety infractions, accidents,

violations of regulations, delays, problems, or expected cost overruns will be identified including recommendations/solutions. Work that is outside of the SOW but that is critical to project completion will be explained. The report will also include an updated schedule and records of correspondence/confirmation notices. Shaw will make a record of each telephone conversation, written correspondence, and confirmation notice regarding information related to the performance of tasks under this SOW.

The monthly report will also include a copy of the monthly payment request for services performed, and an accrual through the end of the month. The payment request will be accompanied by supporting documentation for each task worked on during the billing period. The accrual information will be presented in accordance with the sample format in the SOW.

This task also includes Shaw's monthly project management activities, including Program Manager and Contract Manager review of the progress of the schedule and evaluating earned value metrics. The earned value metrics are compiled by Project Cost/Schedule Control and validated by the Project Manager.

3.3 Design Coordination Procedures

The Shaw Project Manager and other technical staff will perform an initial site visit to determine existing conditions. The Shaw Project Manager or designee will document the results of the site visit, including logged photographs or videos, completed inspection checklists, and documentation acquired on-site so the information will be available to the technical staff.

The Shaw Project Manager will coordinate with the client to obtain any available data and information (e.g., as-built plans, survey information, or previous studies, etc.) relevant to the project and the Shaw Project Manager will work with the client to collect data or information available from other agencies. The Shaw Project Manager or designee will catalog and file all collected information for use by the technical staff.

3.4 Checking/ Independent Technical Review

Technical plans and reports that are deliverables for the USACE will be prepared, reviewed, and approved in accordance with Shaw Corporate SOP T-DP-001(b), *Technical Studies and Reports.* The Shaw QA program provides controls for the formal verification (checking) of documents, such as calculations and reports, and the presentation of information in the form of drawings, logs, and tables (Shaw QA Procedure EI-Q011, *Verification of Figures, Drawings, Tables, and Logs*). The Shaw QA Program also provides methods for verifying technical work products

(spreadsheets and databases) to ensure that information is correctly and accurately presented (Shaw QA Procedure EI-Q012, *Verification of Calculations, Spreadsheets, and Databases*). Required internal approvals are also cited for quality-related documents; however, during the course of a project or proposal, verification of technical decisions and concepts (such as interpretation of data and evaluation of results) is required in order that the project or proposal can proceed on a sound conceptual basis. The review concept, or approach, may be needed for the following:

- During the project planning stage, have appropriate steps been implemented to satisfy the goals and objectives of the project?
- Are data of sufficient quality and properly interpreted so that conclusions can be justified and demonstrated?
- Are design parameters reasonable for the computations performed? What is the effect of variations of the assumptions upon the results?
- Do the results presented by Shaw in the form of a report, or other document, adequately represent the work performed and the conclusions reached? Do the results fulfill the objectives of the project?

The ITR process is used to verify these steps. Documents to be written during a project and indicated in the proposal will be subjected to peer review. The Shaw Project Manager will complete a matrix of these documents and use it to obtain the required reviews.

A technical reviewer is selected based upon the following criteria:

- The reviewer must be independent of the project. The reviewer must be sufficiently informed regarding the project, but should not be making decisions that determine or affect the course of the project. The peer review process is an “outside” review of the project.
- The reviewer must be a person knowledgeable in the specific area of work, preferably a senior technical associate. Technical reviewers will be part of the Shaw organization.

At the conclusion of a technical peer review, the reviewer(s) will prepare written review comments, sign-off on the Discipline Sign-Off Review and Document Review forms (Appendix C) and forward it to the Shaw Project Manager; a copy of these review documents will also be placed in the project files. Technical review comments will be responded to in writing by the preparer of the document, incorporated into the document as appropriate, and submitted with the

document to the USACE.

External peer review will be performed on all draft project deliverables prior to issuance as final documents. It is anticipated that the external peer review will be performed, at a minimum, by the USACE. A formal response to peer review comments will be issued to all reviewing parties, documenting revisions made where appropriate to the draft deliverables. All responses to the peer review comments will be coordinated with the USACE for their concurrence prior to incorporation. Final deliverables will be submitted after incorporating any pertinent comments that arise from peer review of the draft documents.

3.5 Managerial Continuity and Flexibility

A key to the success of a project is ensuring that plans are in place should key personnel be unavailable for completing the planned work on schedule. Accordingly, Shaw has developed the following plan for providing backup resources for the key positions identified in the following table.

Table 2, Shaw Team Key Position Backup Resources

Position	Current	Backup
Project Manager	Karl Van Keuren, PG, PMP	Bill Scoville, PE, PMP
QC Manager	Steven Jones, ASQ CQA/CQE	John Patin
Data Gaps Technical Lead	Tom Battaglia	Jonathan Myers, PhD
Modeling Technical Lead	Vikas Tandon, PhD, PG	Gary Gaillot, PG
Feasibility Study Technical Lead	Sue Tituskin, CPG	Chris Norman, PE

A key strength of Shaw is the technical resource base within the company that can be used to recruit qualified personnel for projects.

Excellent technical performance is accomplished through initial and ongoing training. Shaw's policy in relation to QC is to provide adequate initial and ongoing training so project personnel are qualified to properly perform assigned tasks. Project Management identifies project-specific training and awareness needs for project employees to accommodate client-specific or regulatory requirements, to 1) enhance project team staff contribution to the success of the QC system and 2) ensure that project team staff possess the required skills to perform their tasks.

4.0 Management Structure

Shaw Project Management are dedicated and committed to reaching the quality objectives and goals set forth in this QCP and to provide quality services to our customers. The Shaw Program and Project Managers are responsible for ensuring that personnel in their organization understand the QCP. By design, Shaw's organizational structure fully supports the Program and Project Managers, who have complete responsibility for the quality of services that Shaw provides to the client. They are also responsible for ensuring that aspects relevant to their organization's functions are set up and maintained.

The Shaw QC Manager provides oversight of QCP and procedure implementation, performs QC review of documents, maintains and updates the submittal register, and reviews, logs, and tracks nonconformance reports.

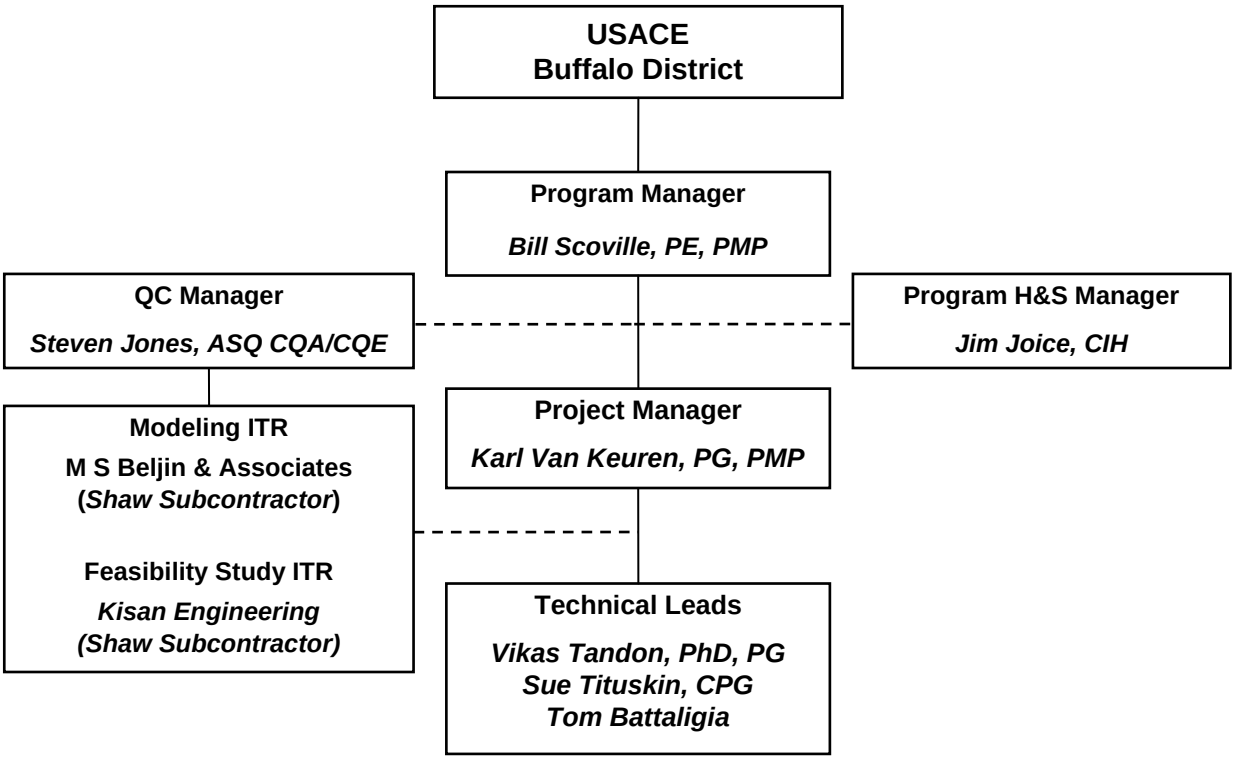
The Shaw Technical Leads, in cooperation with the Shaw Project Manager, will implement the QCP and procedures. They also ensure that project reports, models, as well as specifications and design calculations, are complete, accurate and are consistent with the SOW and other agreed upon client directions.

The Shaw Team members that have been assigned to this project are shown in Table 2. The resumes of the primary Shaw Team authors for various deliverables are provided in Appendix D. Figure 1 portrays the operational working relationships between Shaw Team personnel and USACE. The lines between boxes indicate accountability, authority, and communication. Technical direction flows down from management to operations. Reporting flows up to management to provide management with feedback and response.

Table 3, Shaw Team Project Members and Roles

Name/Affiliation	Project Role	Phone Number, email
Bill Scoville, PE, PMP Shaw	Program Manager	513-782-4964, William.Scoville@shawgrp.com
Karl Van Keuren, PG, PMP Shaw	Project Manager	513-782-4745, Karl.VanKeuren@shawgrp.com
Steven Jones, ASQ CQA/CQE Shaw	QC Manager	513-782-4655, Steve.S.Jones@shawgrp.com
Jim Joice, CIH Shaw	Program Health & Safety Manager	419-424-4960, James.Joice@shawgrp.com
Dave Sablosky Shaw	Contract Manager	513-782-4832, Dave.Sablosky@shawgrp.com
Drew Kendall Shaw	Project Procurement Manager	513-782-4969, Drew.Kendall@shawgrp.com
Sherry Marshall Shaw	Project Cost Schedule/Control	513-782-4861, Sherry.Marshall@shawgrp.com
Tom Battaglia Shaw	Data Gaps Technical Lead	716-913-6318, thomas.battaglia@shawgrp.com
Vikas Tandon, PhD, PG Shaw	Modeling Technical Lead	412-877-7738, Vikas.Tandon@shawgrp.com
Sue Tituskin, CPG Shaw	Feasibility Study Technical Lead	412-858-3336, Sue.Tituskin@shawgrp.com
Vernon Singh, PE Kisan Engineering (Shaw Subcontractor)	Feasibility Study Independent Technical Reviewer	877-687-0490, vern_singh@kisancompany.com
Milovan Beljin, PhD M S Beljin & Associates (Shaw Subcontractor)	Modeling Independent Technical Reviewer	513-729-1602, mbeljin@cinci.rr.com

Figure 1. Shaw Organization Chart Showing Reporting and Communication Relationships of the Quality Management Organization



---------- Dashed lines represent direct communication relationships.

———————— Solid lines represent direct reporting relationships.

5.0 Design Tools

Modeling activities will be performed in accordance with Shaw Corporate SOPs EI-GS063, *Standards for Conducting Groundwater Flow and Solute Transport Modeling* and EI-GS064, *Standards for Conducting Geochemical Modeling*. In addition to the technical competence of the Shaw Team staff and reviewers, appropriate design tools will be used to ensure quality in the final deliverable. The types of design tools that may be used during the Numerical Groundwater modeling task are described below.

RESRAD is a computer model designed to estimate radiation doses and risks from RESidual RADioactive materials. RESRAD 6 represents the sixth major version of the RESRAD code since it was first issued in 1989. Since this time, RESRAD has been used widely by the U.S. Department of Energy (DOE), its operations and area offices, and its contractors for deriving limits for radionuclides in soil. RESRAD BUILD is a model for analyzing the radiological doses resulting from the remediation and occupancy of buildings contaminated with radioactive material. The model considers external exposure, inhalation of dust and radon, and ingestion of soil/dust. Up to 10 sources and 10 receptors can be modeled. The source geometry can be point, line, plane, or volume. Buildings can be any structure composed of up to three compartments. Radioactive contamination can be on surface or in the building material. Exposure scenarios considered include building occupancy (residential use and office worker) and building remediation (decontamination worker and building renovation worker).

SESOIL (Seasonal Soil compartment model) is a one-dimensional vertical transport screening-level model for the unsaturated (vadose) zone that simulates remediation by natural attenuation (RNA) based on diffusion, adsorption, volatilization, biodegradation, cation exchange and hydrolysis. It contains three submodels that simultaneously simulate contaminant transport, soil water movement and soil erosion. SESOIL has the ability to simulate seasonal climatic variations and varying soil properties with depth. Contaminant transport can be simulated without biological decay, or with biodegradation simulated as a first-order decay process. SESOIL can be used to simulate the fate of residual contaminant levels in soil to establish site-specific cleanup objectives. It can also simulate time-dependent releases from underground storage tanks, landfills and agricultural practices.

MINTEQA2 is an equilibrium speciation model that can be used to calculate the equilibrium composition of dilute aqueous solutions in the laboratory or in natural aqueous systems. The model is useful for calculating the equilibrium mass distribution among dissolved species,

adsorbed species, and multiple solid phases under a variety of conditions including a gas phase with constant partial pressures. A comprehensive database is included that is adequate for solving a broad range of problems without need for additional user-supplied equilibrium constants.

MODFLOW is a three-dimensional finite-difference groundwater model. It can simulate steady state and transient flow conditions in irregularly shaped aquifers. Individual aquifer layers can be confined, unconfined, or a combination of confined and unconfined. Influence from external stresses, such as flow to wells, areal recharge, evapotranspiration, flow to drains, and flow through river beds, can be simulated. Hydraulic conductivities or transmissivities for any layer may differ spatially and be anisotropic.

MODPATH is a particle tracking post-processing package that was developed to compute three-dimensional flow-paths using output from steady-state or transient groundwater flow simulations by MODFLOW. MODPATH uses a semi-analytic particle tracking scheme that allows an analytical expression of the particle's flow to be obtained within each finite-difference grid cell. Particle paths are computed in MODPATH by tracking particles from one cell to the next until the particle reaches a boundary, an internal sink/source, or satisfies some other termination criterion. Data input for MODPATH is a combination of data files and interactive keyboard input.

MT3D is a comprehensive three-dimensional numerical model for simulating solute transport in complex hydrogeologic settings. MT3D has a modular design that permits simulation of transport processes independently or jointly. MT3D is capable of modeling advection in complex steady-state and transient flow fields, anisotropic dispersion, first-order decay and production reactions, and linear and nonlinear sorption. MT3D99 can also handle bioplume-type reactions, monad reactions, and daughter products, which enables MT3D99 to do multi-species reactions and simulate or assess natural attenuation within a contaminant plume. MT3D99 is linked with MODFLOW, and is designed specifically to handle advectively-dominated transport problems without the need to construct refined models specifically for solute transport.

MCACES (Micro-Computer Aided Cost Estimating System) is a detail cost estimating program that is one of several modules of an integrated suite of cost engineering tools. It interfaces with other PC based support modules and databases and provides an integrated cost estimating system (software and databases) that meets USACE requirements for preparing cost estimates.

6.0 Scheduling

The project schedule and milestones are presented in Appendix E.

7.0 Cost Control

This section is not applicable to this project since the Delivery Order is fixed price. As noted in Section 3.2.2, the monthly progress report will include a copy of the monthly payment request for services performed, and an accrual through the end of the month, along with the supporting documentation for each task worked on during the billing period.

8.0 Construction Cost Estimate Control

There will be no construction involved in this project; therefore this section is not applicable.

9.0 Communications

Shaw communications with the USACE, in the form of weekly conference calls and monthly progress reports, are discussed in Section 3.2.

Shaw's technical staff and Project Manager will meet periodically with the Contracting Officer's Representative to discuss progress as well as concerns and problems. In the event of an unavoidable interruption in the QC Program, Shaw will notify the client immediately, both verbally and in writing. They will be informed of the nature of the interruption, its estimated duration and the procedures being used during the interruption period.

Changes or variances to approved plans and/or procedures will be initiated as necessary. Project staff identifying a need for a change or variance will communicate that need to the Shaw Project Manager. All variances will be approved by the Shaw QC Manager and the Shaw Project Manager prior to implementation of the change and will be formally recorded. Variances that will affect the project scope, cost, or schedule will be submitted to the USACE for approval prior to implementation.

Nonconforming equipment, items, activities, conditions, and unusual incidents that could affect compliance with project requirements will be identified, controlled, and reported in a timely manner in accordance with Shaw QA Procedure EI-Q007, *Nonconformance Reporting*. A nonconformance is defined as any item, service, or activity which deviates from drawings, specifications, or other project requirements and cannot be corrected readily within the scope of such requirements or otherwise requires a disposition. The originator (any Shaw employee) of a nonconformance report will describe the finding on the Nonconformance Report provided for this purpose and will notify the Shaw Project Manager and QC Manager. Each nonconformance will be reviewed and a disposition will be issued for the item, service, or activity. The disposition of a nonconformance will be documented and approved by the Shaw organization responsible for issuing the nonconformance. The QC Manager will concur with the disposition of the nonconformance prior to closure of the Nonconformance Report.

In addition, the Shaw Project Manager will notify the USACE Technical Coordinator immediately of significant nonconformances that could impact the project schedule or SOW and will indicate the corrective action taken or planned.

APPENDIX A

SHAW CORPORATE SOPs

STANDARD OPERATING PROCEDURE

Subject: Verification of Calculations, Spreadsheets, and Databases

1. PURPOSE

To provide acceptable methods for verifying technical work products and ensure that information is correctly and accurately presented.

2. SCOPE

This procedure is applicable to Shaw E & I functional groups and projects that perform calculations and use software applications, such as spreadsheets and databases, for developing technical work products.

This procedure is not intended to replace, but is intended to supplement, performance and verification requirements for engineering services, to include design, performed by Shaw E & I. The verification of engineering services work products shall be performed in accordance with referenced procedures.

3. REFERENCES

- Shaw E & I Quality Management System Plan
- Shaw Procedure No. EN001, *General Requirements for Engineering and Design*
- Shaw Procedure No. EN002, *CAD Standards*
- Shaw Procedure No. EN003, *Engineering and Design Calculations*
- Shaw Procedure No. EN004, *Engineering and Design Drawings*
- Shaw Procedure No. EI-Q011, *Verification of Figures, Drawings, Tables, and Logs*

4. DEFINITIONS

- **Checkprinting**—A documented quality control process that may be used for the verification of technical work processes. Checkprinting is a systematic and iterative process in which confirmation or concurrence is indicated by highlighted markings, and errors or disagreements are indicated in red prior to being corrected.
- **Technical Work Product**—Technical work products applicable to this procedure include calculations, spreadsheets, and databases. These activities include results involving technical decisions and/or evaluations and information of a scientific or engineering nature which is distilled into these products.
- **Transcription**—The one-to-one transfer of data and information from a reliable source.
- **Verification**—A systematic review to confirm or substantiate accuracy performed by a competent individual with sufficient knowledge or skill.

5. RESPONSIBILITIES

5.1 Responsible Manager

The manager responsible for the activity or task shall ensure that verification is performed for work products defined in this procedure and that verification activities are performed by qualified individuals.

5.2 Project or Task Personnel

Project or task personnel are responsible for performing verification activities in accordance with this procedure. Project personnel are responsible for notifying the Responsible Manager if they cannot perform verification activities due to conflict of interest, insufficient knowledge of the subject matter, or other reasons.

5.3 Preparer

The Preparer shall develop or revise technical work products and shall be qualified by knowledge and/or experience in the subject matter of the product.

5.4 Reviewer

The assigned Reviewer shall have knowledge of the technical area being reviewed. The Reviewer shall examine the work products, then sign (or initial) and date those work products found to be satisfactory.

6. PROCEDURE

6.1 General Verification Requirements

Work products such as calculations, spreadsheets, and databases shall be verified to ensure that errors are identified and corrected. The extent of verification effort shall depend upon the following:

- The complexity of the task
- The effects of the information being reviewed on the quality of the work product
- The potential for error

Other factors that may influence this graded approach include client expectations, regulatory concerns, and the level of scrutiny expected for the product.

Verification shall be performed by personnel with sufficient knowledge of the subject matter. Verification shall be performed before results are presented and should be performed as early in the process as practical.

6.2 Software Applications – Spreadsheets and Databases

Software applications such as spreadsheets and databases and their uses will be verified, to ensure that information is entered correctly and that the application is performing as intended. Uses subject to verification may include:

- Data Manipulations
- Spreadsheet Calculations

- Relational Database Links and Queries
- Database Codes

This verification should be accomplished following the checkprinting process, as described in Appendix 1 of Procedure No. EI-Q011, *Verification of Figures, Drawings, Tables, and Logs*, or an equivalent method documented in an approved plan or procedure.

More than one level of verification may be needed to include the following:

1. A transcriptional check of data entered into the spreadsheet or database shall be performed. This includes data which is entered manually or electronically such as by "cut-and-paste" methods.

2. A verification of a software application will be performed to ensure that the spreadsheet or database is performing as expected. This check shall verify that the mathematics, codes, formulas, queries, and relational links used are correct and functioning as intended. This verification may be accomplished by a variety of methods to include the following:

   – Comparison of inputs/outputs to a known data set
   – Review of results from a dummy set of data
   – Comparison of results to hand calculations
   – Check of formulas or codes embedded in a spreadsheet
   – Comparison of actual outputs to known outputs

3. Processes used to electronically manage blocks of data which do not change code, formula, mathematical, or query operations shall be verified. Examples of these processes include the following:

   – Importing or exporting data from one software program to another
   – Cutting/pasting blocks of data
   – Rearranging columns or rows of data

   Verification will focus upon the data management activities to ensure that data has not been changed or compromised and that the location of the data is as intended. Verification will ensure that information is not unexpectedly truncated, wrapped, or otherwise changed. The identification of potential problems in the process should be performed so that check points can be established. Depending upon the application, verification of a representative sample of the data may be performed.

6.3 Calculations

The development, verification, and documentation of manual and computer-assisted calculations shall be performed to verify technical, mathematical, and engineering analysis.

Calculations performed for engineering work shall also meet the requirements of Procedure No. EN003, *Engineering and Design Calculations*.

6.3.1 Calculation Preparation and Content

Calculations shall be documented to provide a logical presentation of the basis, development, and results. Calculations shall be prepared and organized such than an individual competent in the subject matter can understand the content and logic. The preparer of a calculation shall be qualified by knowledge and/or experience in the subject matter.

The contents of a calculation shall include the following, as applicable:

1. Purpose. State the purpose of the calculation.
2. Methods. Describe the methodology used.
3. Assumptions. List assumptions and any justification.
4. Conclusions. Summarize the results and/or conclusions, particularly where the results become input to subsequent computations.
5. References. List references to include, as appropriate, theoretical and input data sources and/or computer use applications.
6. Attachments. Reference attachments in the body of the calculation and include the information as documentation.

6.3.2 Review and Verification

Calculations shall be reviewed and verified by personnel knowledgeable or experienced in the subject matter. The verifier shall review a copy of the calculation for conceptual, theoretical, and numerical accuracy and verify that the approach and conclusions are technically sound and defensible. The verification shall consider the following:

- Correct objectives, intent, and development
- Presentation of sufficient information
- Defensible methodologies and assumptions
- Sound conclusions

The reviewer shall mark agreement with a highlighter (preferably yellow) and disagreement with a different conspicuous color (preferably red).

6.3.3 Comment Resolution and Approval

If comments are acceptable to the preparer, then the original calculation will be revised. If the comments are not acceptable and agreement cannot be reached between the preparer and reviewer, then the Project Manager or a senior member of the technical staff who is experienced in the technical issues involved shall review and mediate resolution. Once resolution is achieved, then both the preparer and reviewer shall document their approval of the calculation.

6.4 Records

The original, signed verification records shall be retained in the central filing system. This includes updates or revisions to these records.

7. ATTACHMENTS

None.

8. FORMS

None.

STANDARD OPERATING PROCEDURE

Subject: Verification of Figures, Drawings, Tables, and Logs

1. PURPOSE

To provide acceptable methods for the verification of technical work products to include figures, drawings, tables, and logs for Shaw Environmental & Infrastructure (Shaw E & I) to ensure that information is correct and accurately presented.

2. SCOPE

This procedure is applicable to Shaw E & I functional groups and projects that produce technical information to include figures, drawings, tables, and logs.

This procedure is not intended to replace, but rather supplement, performance and verification requirements for engineering services, to include design. The verification of engineering services work product are performed in accordance with referenced procedures.

3. REFERENCES

- Shaw E & I Quality Management System Plan
- Shaw Procedure No. EN001, *General Requirements for Engineering and Design*
- Shaw Procedure No. EN002, *CAD Standards*
- Shaw Procedure No. EN003, *Engineering and Design Calculations*
- Shaw Procedure No. EN004, *Engineering and Design Drawings*
- Shaw Procedure No. EI-Q012, *Verification of Calculations, Spreadsheets, and Databases*

4. DEFINITIONS

- **Checkprinting**—A documented quality control process used for the verification of technical work processes. Checkprinting is a systematic and iterative process in which confirmation or concurrence is indicated by highlighted markings, and errors or disagreements are indicated in red prior to being corrected.
- **Technical Work Product**—For the purposes of this procedure, includes figures, tables, and logs. These may include results involving technical decisions and/or evaluations and information of a scientific or engineering nature which is distilled into figures, tables, or logs.
- **Transcription**—The one-to-one transfer of data and information from a reliable source.
- **Verification**—A systematic review to confirm or substantiate accuracy performed by a competent individual.

5. RESPONSIBILITIES

5.1 Responsible Manager

The manager responsible for the activity or task shall ensure that verification is performed for applicable technical work product activities. The Responsible Manager shall ensure that verification activities are performed by qualified individuals.

5.2 Project or Task Personnel

Project or task personnel are responsible for verification activities in accordance with this procedure. Project personnel are responsible for notifying the Responsible Manager if they cannot perform verification activities due to conflict of interest, insufficient knowledge of the subject matter, or other reasons.

5.3 Preparer

The Preparer shall develop or revise technical work products and shall be qualified by knowledge and/or experience in the subject matter of the product.

5.4 Reviewer

The assigned Reviewer shall have knowledge of the technical area being reviewed. The Reviewer shall examine the work products in accordance with the requirements of this procedure, then sign (or initial) and date those work products found to be satisfactory.

6. PROCEDURE

Technical work products such as figures, drawings, tables, and logs shall be verified to ensure that errors are identified and corrected. The checkprinting process shall be used for verification of these activities in accordance with Attachment 1 unless an equivalent method is documented in an approved plan or procedure.

Technical work products that include calculations or mathematical equations or codes shall be verified in accordance with Procedure No. EI-Q012, *Verification of Calculations, Spreadsheets, and Databases*.

6.1 General Verification Requirements

The extent of the verification effort principally depends upon the following:

- The complexity of the task
- The effects of the information being reviewed on the quality of the work product
- The potential for error

Other factors that may influence this graded approach include client expectations, regulatory concerns, the likelihood that the information will be used in future work products, and the level of scrutiny expected for the product.

Verification of the technical aspects of the work product will be performed by personnel with sufficient knowledge of the subject matter. Verification activities shall be performed before results are presented and should be performed as early in the process as practical. Unverified data shall be clearly marked as being preliminary. Preliminary data shall not be used in final work products or future work products.

6.2 Verifying Tables and Logs

A transcriptional check of data entered into the table or log shall be performed to ensure the information has been recorded accurately. The correctness of titles, headings, end notes, references, and headers/footers shall also be considered.

Tables and logs should be compiled from data from such sources as publications, reports, and verified calculations and analyses. Data that is entered into tables and logs shall be checked to ensure the information has been recorded or transcribed accurately. Whenever possible, the original source of information should be used. Verification shall be performed for manual or electronic (i.e., cut-and-paste) data entry methods.

A transcriptional verification may be performed by personnel familiar with the compiling process, but not necessarily familiar with the underlying subject matter. The reviewer should use a transparent shaded marker, such as yellow, to indicate agreement, and a red pen to indicate corrections, as described in the checkprinting process outlined in Attachment 1.

Tables and Logs that include calculations or mathematical equations or codes shall be verified in accordance with Procedure EI-Q012, *Verification of Calculations, Spreadsheets, and Databases*.

6.3 Verifying Figures and Drawings

Figures and drawings shall be verified to ensure the accuracy and completeness of the information included. Items to be verified include dimensions, scale, legend, notes, coordinates, layouts, title blocks, and symbology. Figures and drawings shall be checked against the original source of information, which should be referenced or attached. Sources may include publications, reports, graphs, completed logs of information, or verified calculations.

Technical Figures and Drawings shall be developed within the framework of Procedure No. EN002, *CAD Standards*.

The development and verification of engineering figures and drawings shall be performed in accordance with Procedure No. EN004, *Engineering and Design Drawings*.

6.4 Records

Verification documentation shall be retained in the project files. The original, signed verification records shall be retained in the central filing system. Updates or revisions to these records shall also be included.

7. ATTACHMENTS

- Attachment 1, Checkprinting Process

8. FORMS

None.

Attachment 1
Checkprinting Process

The checkprinting process (or approved equivalent) shall be used for verification activities to include the development of drawings and figures and for data transcription, calculation, and manipulation activities. The checkprinting process is performed as follows:

1. The preparer shall provide the reviewer with a clean copy of the information and shall ensure the original source information is available to the reviewer.

2. The reviewer shall compare the information being checked to the original source of information. The reviewer will highlight in yellow (or other transparent marker) all items that have been verified as correct.

3. If an error is discovered or a change desired, the reviewer will correct it in writing and/or markup in a different conspicuous color (preferably red) and will not highlight the content in question. The reviewer will write the correct information to the side or near the change so it can be clearly understood.

4. The reviewer shall initial or sign the first page of the checkprint (CP #1) and include the date. Checkprints shall be sequentially numbered beginning with the number 1. The project number and preparer's name should be included. A checkprint stamp may be used.

5. If no corrections or changes are required, then the checkprint process is complete. Otherwise, continue to step 6.

6. If corrections or changes are required to the checkprint (as indicated in writing/markups), then the preparer shall revise the information in accordance with the indicated change. The revised information shall then be re-printed or re-produced.

7. One of two processes shall be used to complete subsequent reviews:

   – The reviewer can review only the corrections from the previous version of the checkprint and highlight only the corrected changes to signify concurrence.

   – Alternatively, 100% checking may also be completed.

8. Once complete, the reviewer shall initial or sign the first page and include the date. The next sequential checkprint number shall also be included (e.g. CP #2). A checkprint stamp may be used. Reviewers shall maintain the sequence of checkprints as one unit.

9. If further corrections or changes are required, then they shall be noted in writing/markups on the latest checkprint and the product again revised by repeating Steps 6 through 8. This iterative process shall be implemented until corrections are completed and only yellow highlights (indicating acceptance) are found on the latest version of the checkprint.

STANDARD OPERATING PROCEDURE

Subject: Nonconformance Reporting

1. PURPOSE

To establish the system for initiating, processing, and controlling nonconforming items, services, or activities to include disposition and corrective actions.

2. SCOPE

This procedure applies when nonconforming items, services, or activities are identified during the course of performing project work activities. Nonconformances may be identified during the execution, monitoring and control, or closure phases of a project or activity. The responsibilities and requirements provided in this SOP are applicable for project or programmatic activities.

3. REFERENCES

- Shaw E & I Quality Management System Plan

4. DEFINITIONS

- **Disposition**—An evaluation or arrangement provided to determine the fate or condition of use of an item, service, or activity.
- **Nonconformance**—Non-fulfillment of a requirement. In addition, any item, service, or activity which deviates from drawings, specifications, or other project requirements and cannot be corrected readily within the scope of such requirements or otherwise requires a disposition. A nonconformance is not a deficiency whereby correction is part of the normal course of work outlined in project requirements (e.g., failing density tests that provide an indication of "in-process" work in a given point in time).
- **Corrective Action**—Action(s) taken to correct a nonconforming condition and prevent future recurrence.

5. RESPONSIBILITIES

5.1 Responsible Manager

The Responsible Manager of the product or service shall ensure that corrective action is implemented and that a cause analysis for nonconformances is performed. In addition, the Responsible Manager(s) shall ensure the disposition of nonconforming items to include the segregation of nonconforming products, when practical, to prevent unauthorized use or delivery.

5.2 Project Quality Representative

The Project Quality Representative is responsible for maintaining a status of nonconformance reports at project or program locations. This includes reviewing nonconformances, logging and tracking nonconformance reports (NCRs), and verifying the satisfactory completion and closure of corrective actions. These activities may be performed by oversight or project personnel independent of the activity.

5.3 All Personnel

Any individual assigned to a project who discovers a nonconforming product or service is responsible for initiating a nonconformance report describing the condition.

6. PROCEDURE

6.1 General

Identified nonconformances shall be handled in a controlled system as to ensure that the deviating condition is corrected as documented in the flowchart in Attachment 1.

In situations where the Quality Representative, Responsible Manager, or other staff determines that continued work would cause damage, jeopardize the safety of personnel, preclude subsequent inspections, or make corrective actions ineffective, work shall be stopped.

6.2 Identification and Reporting of Nonconformances

The identifying individual shall complete the description sections of the NCR form. The condition description will be clearly written after consultation with the responsible supervisor to ensure that the discrepancy is correctly described. Appropriate project criteria to include specifications, requirements, or codes violated must also be referenced to provide sufficient information to facilitate a proper and complete disposition. Sketches, photographs, reports, or other records may be included to supplement the NCR.

When this section of the NCR is completed, the report is sent to the Project Quality Representative for review. The Quality Representative shall review the NCR to ensure that it is complete and the reported condition(s) meets the criteria for a nonconformance. NCRs that are not complete or do not meet the criteria shall be reviewed with the originator to coordinate resolution. The NCR will be voided and filed if it is determined the criteria is not met. If the NCR is determined to be valid, the Quality Representative will assign a unique number or identifier and forward the NCR to the Responsible Manager for determining and documenting the appropriate corrective actions. A copy of the NCR shall be forwarded to the Director of Quality.

The Project Quality Representative shall maintain a status log of open and closed nonconformances. The log will also serve as the basis for numbering each discrepancy and tracking it through closure.

6.3 Disposition

The Responsible Manager shall evaluate the nonconforming characteristics of the item or service and determine the disposition. Disposition may include reject, use as is, and/or repair. The determination shall be documented on the NCR and a justification provided when the disposition is determined to be “repair” or “use as is.” The Quality Representative shall concur with the disposition.

Whenever practical, nonconforming items should be segregated from conforming items to prevent their inadvertent installation or use. When practical, identification tags or markings should be used to aid in this segregation.

When required by the contract or determined appropriate, the client shall be notified of the nonconformance by the Responsible Manager. The client must be promptly notified of technical errors in work previously completed and submitted to them.

6.4 Corrective Action

The Responsible Manager shall evaluate the nonconforming characteristics and determine the corrective actions for nonconforming items or services. The required section of the NCR shall be completed by the Responsible Manager who shall document the following:

- Corrective actions to be taken. Actions taken shall be appropriate for the nonconformance and shall be sufficient to preclude recurrence.
- Causes of the nonconformance and any preventive actions.
- Personnel responsible for implementing corrective actions.
- Date when necessary actions are to be completed.

The NCR shall be forwarded to the Quality Representative for review. If corrective actions are determined appropriate, then personnel responsible for implementation shall perform the corrective action in accordance with the scheduled due date. Extensions of time may be granted by the Project Quality Representative for extenuating circumstances.

After the completion of corrective actions, the Responsible Manager shall document the resolution on the NCR form, sign the form, and forward it to the Quality Representative. Any objective evidence of the corrective actions shall be included.

6.5 Verification and Closeout

Satisfactory resolution of nonconformances must be verified by the Quality Representative. The Quality Representative shall do the following to achieve resolution:

- Initiate an inspection and/or a review of objective evidence to verify satisfactory completion of the corrective action
- Sign off the NCR, if the work is satisfactory, and remove identification tags or markings as applicable

NCRs are not to be closed until the required corrective and preventative measures have been completed to the satisfaction of the Quality Representative, or long-term corrective measures have been established and implemented. Nonconformances will be monitored until the action is verified as complete and closed as documented on the NCR.

6.6 Records

The original, signed NCR form and associated documentation shall be retained in the project records.

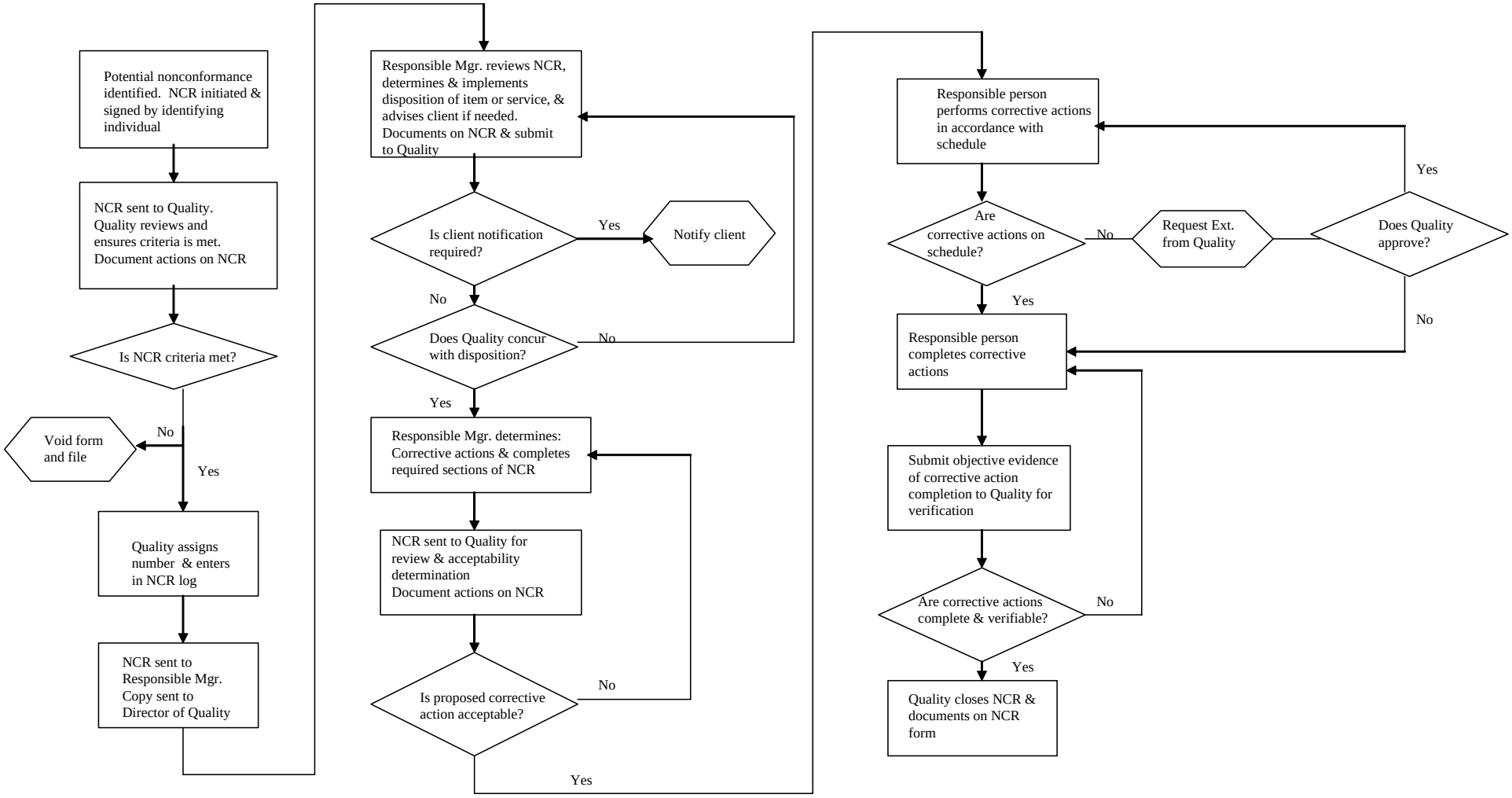
7. ATTACHMENTS

- Attachment 1, Nonconformance Process Flowchart

8. FORMS

- Nonconformance Report

Attachment 1
Nonconformance Process Flowchart



Nonconformance Report

1) NCR Number:	2) Project Name and Number:	3) Date:	Page 1 of

4) Nonconformance Description And Violation Type: (Specification __ Drawing __ Code __)

Identified by: _____ Date_____

Reviewed By: _____ Date_____

(Project Quality Representative)

5) Disposition of Nonconforming Condition (explain action to be taken to include 1) Reject 2) Use-As-Is, 3) Repair/Correct – any Use-As-Is or Repair/Correct determinations must be justified)

Evaluated by: _____ Date_____

Responsible Manager

6) Corrective Action(s) to be taken (include date when action(s) will be complete):

Corrective Action to be Performed by: _____Due Date_____

Responsible Manager: _____Date_____

Client Notification Required: _____ Yes _____No Date Notified: _____

7. Corrective Action Completion
Comments:

Responsible Manager: _____ Date:::

7) Corrective Action(s) Completion Verification and Date:
Comments:

Reviewed and Closed By: _____ Date_____

(Project Quality Representative)

STANDARD OPERATING PROCEDURE

Subject: Standards for Conducting Geochemical Modeling

1. PURPOSE

This procedure provides the standard practice for performing geochemical modeling. The procedure includes the minimum required steps and quality checks that employees and subcontractors are to follow when performing the subject task.

This procedure also contains guidance for recommended or suggested practice that is based upon collective professional experience. Recommended practice goes beyond the minimum requirements of the procedure, and should be implemented when appropriate.

2. SCOPE

Geosciences Standard Operating Procedure (SOP) EI-GS064 describes standards for geochemical modeling and how such modeling will be conducted and documented for projects executed by Shaw Environmental & Infrastructure, Inc., (Shaw E & I). For the purposes of this SOP, geochemical models are mathematical (computer) models used to simulate chemical reactions in soils and/or groundwater.

The SOP addresses technical requirements and required documentation. Responsibilities of individuals performing the work are also detailed. Additional project-specific requirements for geochemical modeling may be developed, as necessary, to supplement this procedure and to address project-specific conditions and/or objectives.

3. REFERENCES (STANDARD INDUSTRY PRACTICES)

Geochemical computer modeling should follow accepted industry practices for model construction, evaluation, verification, uncertainty analysis, and reporting. Unfortunately, few published standard practices exist. Some general guidance can be found in Jenne; Melchior and Bassett; Plummer (1984); and Parkhurst and Plummer; and in geochemical modeling conference proceedings such as those from Lawrence Livermore National Laboratory and the U.S. Nuclear Regulatory Commission (see full references below). User manuals for some of the popular codes such as PHREEQC (Parkhurst and Appelo, 1999), WATEQ4F (Ball and Nordstrom, 1991), MINTEQA2 (Allison et al., 1991), NETPATH (Plummer et al., 1994), and EQ3/6 (Wolery, 1992; Wolery and Daveler, 1992) also contain useful information. The following references may aid in planning and conducting geochemical modeling:

- Allison, J.D., D.S. Brown, and K.J. Novo-Gradac, 1991, *MINTEQA2/PRODEFA2, A Geochemical Assessment Model for Environmental Systems: Version 3.0 User's Manual*, EPA/600/3-91/021.
- Ball, J.W., and D.K. Nordstrom, 1991, *User's Manual for WATEQ4F, with Revised Thermodynamic Data Base and Test Cases for Calculating Speciation of Major, Trace, And Redox Elements in Natural Waters*, U.S. Geological Survey Open-File Report 91-183, 189 p. (Revised and reprinted August 1992).
- Jenne E.A., 1979, Chemical Modeling in Aqueous Sysems, ACS Symposium Series, vol. 93.
- Lawrence Livermore National Laboratory, 1986, *Proceedings of the Workshop on Geochemical Modeling*, CONF-8609134, Lawrence Livermore National Laboratory, Livermore, CA.

- Melchior, D.C., and R.L. Bassett, eds., 1990, "Chemical Modeling in Aqueous Systems II," American Chemical Society Symposium Series 416, p. 398-413," Washington D.C.
- Parkhurst, D.L., and L.N. Plummer, 1993, "Geochemical Models," in Alley, W.M., ed., Regional Ground-water Quality: New York, Van Nostrand Reinhold, chap. 9, p. 199-225.
- Parkhurst, D.L. and C.A.J. Appelo, 1999, "Users Guide to PHREEQC (Version 2) – A Computer Program for Speciation, Batch Reaction, One-Dimensional Advective Transport, and Inverse Geochemical Calculations," U. S. Geological Survey Water Resources Investigations Report 99-4259.
- Plummer, L.N., B.F. Jones, and A. H. Truesdell, 1976, WATEQF – A FORTRAN IV Version of WATEQ, A Computer Program for Calculating Chemical Equilibria in Natural Waters, USGS Water Resources Investigation 76-13.
- Plummer, L.N., 1984, "Geochemical modeling: A Comparison of Forward and Inverse Methods," in Hitchon, B., and Wallick, E.I., eds., Proceedings First Canadian/American Conference on Hydrogeology--Practical Applications of Ground Water Geochemistry, Banff, Alberta, Canada: Worthington, Ohio, National Water Well Association, p. 149-177.
- Plummer, L.N., E.C. Prestemon, and D.L. Parkhurst, 1994, "An Interactive Code (NETPATH) for Modeling NET Geochemical Reactions Along a Flow PATH--Version 2.0," U.S. Geological Survey Water-Resources Investigations Report 94-4169, 130 p.
- U.S. Nuclear Regulatory Commission, 1984, "Proceedings of the Conference on the Application of Geochemical Models to High-Level Nuclear Waste Repository Assessment," Edited by G.K. Jacobs and S.K. Whatley, Sponsored by U.S. Nuclear Regulatory Commission, NUREG/CP-0062, and Oak Ridge National Laboratory, ORNL/TM-9585.
- Wolery, T.J., 1992, EQ3NR, "A Computer Program for Geochemical Aqueous Speciation-Solubility Calculations: Theoretical Manual, Users Guide, and Related Documentation (Version 7.0)," Lawrence Livermore National Laboratory, UCRL-MA-110662 PT III.
- Wolery, T.J. and S.A. Daveler, 1992, "EQ6, A Computer Program for Reaction Path Modeling of Aqueous Geochemical Systems: Theoretical Manual, Users Guide, and Related Documentation (Version 7.0)," Lawrence Livermore National Laboratory, UCRL-MA-110662 PT IV.

4. DEFINITIONS

The following definitions are applicable to the use of geochemical models and this SOP:

- **Conceptual Model**—An interpretation or working description of the characteristics and dynamics of the chemical system.
- **Geochemical Model**—An application of a mathematical model to simulate chemical reactions in soil and/or groundwater.
- **Mathematical Model**—A set of mathematical equations expressing the coupled chemical reactions and other constraints (charge balance, mass balance, phase rule, etc.), including simplifying assumptions. The representation of a chemical system by mathematical expressions from which the behavior of the system can be simulated.
- **Model**—An assembly of concepts and site-specific data in the form of mathematical equations that portray understanding of a particular hydrogeologic system.
- **Model Code (Computer Program)**—The implementation of the mathematical model in the form of a computer program.

- **Sensitivity (Model Application)**—The degree to which the model result is affected by changes in a selected model input parameter.
- **Simulation**—One complete execution of a geochemical modeling computer program.
- **Verification**—Using field observations or laboratory experiments to determine the accuracy of a model result.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Geosciences Discipline Lead is responsible for the development, maintenance, and revision of this procedure. Any questions, comments, or suggestions regarding this technical SOP should be directed to the Geosciences Discipline Lead. The Geosciences Discipline Lead's location and associated contact information can be found on the Shaw Group intranet site, ShawNet.

5.2 Project Responsibility

Employees conducting geochemical modeling are responsible for meeting the requirements of this procedure. Employees conducting technical review of company geochemical modeling efforts are also responsible for following appropriate portions of this SOP. Project participants are responsible for recording information in sufficient detail to provide objective documentation (input files, checkprints, assumptions, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURES (TECHNICAL REQUIREMENTS AND STANDARDS)

Geochemical models are usually constructed to simulate the chemical interactions that occur between groundwater (including dissolved solutes and suspended particulates) and aquifer solids at a site. Many applications of geochemical modeling exist, such as the following:

- Speciation modeling to support selection of adsorption coefficients
- Sorption modeling to predict the retardation of dissolved contaminants
- Solubility modeling to determine the degree of groundwater saturation with respect to certain minerals
- Flow path modeling to provide independent assessments of flow directions, delineate areas of recharge, and define the extent of groundwater mixing
- Simulation of pump-and-treat or waste treatment systems in order to screen options, predict effectiveness, or optimize the process
- Simulation of in situ treatment processes in order to predict effectiveness or optimize the process

Modeling procedures vary based on the wide range of potential applications of geochemical modeling techniques. Modeling should not be done just for the sake of modeling; rather, modeling should be performed for a specific purpose such as to answer a question, test a hypothesis, provide independent evidence, select a treatment method, optimize a treatment process, etc. The objective of any modeling activity needs to be clearly defined and kept in mind throughout the process, so that the objective is realized.

Modeling results may be used for decision-making, design efforts, and other evaluations such as risk analysis. Consequently, it is important that the modeling effort be technically defensible and conducted following consistent requirements, standards, and/or procedures. The requirements,

standards, and/or procedures for conducting geochemical modeling are provided in the subsequent text.

6.1 Methodology

The model development process consists of many individual steps, which include the following:

- Definition of the problem
- Development of the conceptual model
- Selection of model code
- Parameterization of model input
- Model application
- Model sensitivity analysis
- Model validation (if data set is available)

These steps are common to all models regardless of their size or scope, and all require documentation of their approaches and conclusions to complete the modeling process. The documentation process is described in the following sections.

6.2 Initial Model Documentation and Development of Conceptual Model

Modeling is conducted to address a site-specific issue or problem. All models have application limitations, and the degree of model representativeness to site conditions will depend on the planned model use. Consequently, the site-specific problem for which the modeling will be conducted must be defined, and the conceptual model and description of the scope and limitations of the modeling program must also be compiled and documented.

These steps are usually addressed in the project-specific work plans or proposal. If so, copies of these documents must be included in the modeling records. If they are not, documentation must be created that clearly defines the modeling objectives and concepts. Any changes to the modeling program's scope and/or conceptual model must be documented and approved by an appropriate level of management (Project Manager or designee), with a reference to the original documentation.

The model's scope should include the following:

- A basic description of the problem
- Site background information
- A description of the regulatory framework
- A definition of the chemical system to be modeled
- A description of model sensitivity analysis and/or validation to be conducted
- Discussion of special factors that may influence or limit the accuracy of the modeling results

The conceptual model description will include the following:

- A description of the system to be modeled
- A definition of parameters needed for model input
- A description of any and all assumptions used in the development of the conceptual model

The conceptual model, initial model input parameters, and model results shall be reviewed and approved by the Project Geochemist. The Project Geochemist is the professional responsible for providing technical oversight of geochemical characterization of the site and for verifying that model output is consistent with site conditions.

6.3 Model Code Selection

Code selection is an important step in modeling. It consists of matching the specific modeling needs of the project to the key characteristics or capabilities of existing computer codes.

The selected code should be able to simulate the required processes (precipitation, dissolution, kinetics, sorption, redox effects, redox disequilibrium, fixed fugacity, solid solution phases, mixing of different water compositions, temperature ramping, etc.) and should contain an adequate thermodynamic database to include the elements, aqueous species, and solid phases that are necessary to simulate the system of interest. Individuals evaluating model code should verify that the model is capable of producing accurate results at the temperatures and ionic strengths of interest. In addition, the model code selection shall be documented and maintained as project records. Those individuals needing assistance in model code selection and documentation may consult internal Shaw technical listings for experts in geochemical modeling.

6.4 Model Parameter Input

Model input parameters should be derived from site-specific studies and investigations covering site geology, hydrogeology, and geochemistry. If site-specific parameter data are not available, data from local and regional geologic studies that are suitable for the application may be used as model input parameters. If neither site-specific nor local or regional data are available, then non-site-specific literature values may be used. Literature sources and their values must be documented and included in the modeling documentation files.

6.5 Other Modeling Documentation

Model application or simulation runs, sensitivity analysis, and validation runs are conducted as the modeling effort progresses. The basic purpose of the run must be documented as related to the scope of the modeling program, along with documentation of their implementation and results. Sensitivity analyses should consider key parameters that were not well defined during the input parameterization step, and should reference the parameterization documentation. Model validation runs should describe the new data sets to be used. In all cases, both paper and electronic copies should be made for each modeling run. These copies and accompanying run descriptions should be included in the modeling documentation files.

6.6 Potential Modeling Errors

The following is a list of potential modeling errors. The most appropriate method for eliminating modeling errors is to apply good scientific judgment and to effectively question the model results.

Model Conceptualization Errors:

- Lack of understanding of site-specific geochemical processes
- Inappropriate code selection
- Lack of adequate characterization of groundwater chemistry and/or flow-path mineralogy
- Oversimplification of the problem, including the complexity of chemical interactions and the groundwater flow system
- Failure to consider redox disequilibrium or redox gradients

Data Input Errors:

- Inconsistent parameter units (especially conversion to master basis species)
- Overestimation of aqueous concentrations by using analyses of unfiltered samples
- Poor charge balance in aqueous concentration data set
- Incomplete analyses of water samples
- Data entry errors

Simulation Results Errors:

- Equilibration with inappropriate minerals
- Assuming that kinetically hindered reactions will proceed quickly
- Omitting results inconsistent with conceptual model
- Blind acceptance of model output
- Insufficient modeling documentation

If model results do not make physical sense or are not consistent with observed site conditions, the model should be checked for potential errors or other causal factors. The model should then be revised appropriately before formally presenting the results and generating conclusions. The model results, sensitivity analysis, and validation should also be checked by the Project Geochemist to ensure that the output(s) are consistent with observed site conditions.

6.7 Technical Review

All models and modeling results should undergo technical review. The technical reviewer should preferably be a senior geochemist or a senior geologist with suitable geochemistry experience. At a minimum, the technical reviewer should be a person capable of conducting the modeling and also understanding and comparing observed field data to the conceptual and numerical models. The technical reviewer should not have developed or conducted the particular modeling to be reviewed. For state-of-the-art or highly sensitive models, the technical reviewer should be carefully selected and may be a qualified person outside the project team. Individuals needing assistance in finding qualified technical reviewers may consult internal Shaw technical listings for experts in geochemical modeling, or may possibly use an expert outside of Shaw, if necessary.

The technical review, at a minimum, should consider and evaluate the following items:

- Definition of the problem—The basic description of the problem is provided as well as the basic scope of the modeling to be conducted.
- Site conceptual model—The chemical system to be modeled is appropriately defined and is supported by site data; parameters needed for model input are appropriately identified; the conceptual model is approved by the Project Geochemist.
- Applicability of selected code—The code selected for use is optimum for the specific problem.
- Model input parameters—Input parameters are clearly specified and their values are appropriately documented; parameters are technically supportable and internally consistent.
- Model sensitivity analysis—The conducted sensitivity analysis and the results and conclusions generated are technically supportable.

- Model documentation—All documentation has been completed in accordance with this SOP and any other applicable procedures.
- Model results—In general, all modeling results are supported by the field data, and all errors are identified as to root cause and corrected if possible.
- Modeling assumptions—Any and all assumptions used for the modeling are appropriately documented and justified.

Any issues raised during the technical review should be resolved between the reviewer and the staff conducting the modeling before external (i.e., outside of Shaw E & I) submission of the model and modeling results. The technical review comments and issues, and corresponding resolution, should be documented and filed with the project records. If a modeling report is prepared, documentation of the report review should also be included with the project records. Such records should be maintained until project closeout.

7. ATTACHMENTS

None.

8. FORMS

None.

STANDARD OPERATING PROCEDURE

Subject: Standards for Conducting Groundwater Flow and Solute Transport Modeling

1. PURPOSE

This procedure provides the standard practice for generating groundwater flow and solute transport models and includes the minimum required steps and quality checks that employees and subcontractors are to follow when performing the subject task.

This procedure may also contain guidance for recommended or suggested practice that is based upon collective professional experience. Recommended practice goes beyond the minimum requirements of the procedure, and should be implemented when appropriate.

2. SCOPE

Geosciences Standard Operating Procedure (SOP) EI-GS063 describes standards for groundwater flow and solute transport modeling and how such modeling will be conducted and documented for projects executed by Shaw Environmental & Infrastructure, Inc. (Shaw E & I). The SOP addresses technical requirements and required documentation. Responsibilities of individuals performing the work are also detailed.

3. REFERENCES (STANDARD INDUSTRY PRACTICES)

Computer modeling shall follow accepted industry practices for model construction, calibration, evaluation, verification, uncertainty analysis, and reporting. These are as defined by the latest version of various ASTM Standards:

ASTM D 5447	Standard Guide for Application of a Ground-Water Flow Model to a Site-Specific Problem
ASTM D 5610	Standard Guide for Defining Initial Conditions in Ground-Water Flow Modeling
ASTM D 5609	Standard Guide for Defining Boundary Conditions in Ground-Water Flow Modeling
ASTM D 5611	Standard Guide for Conducting a Sensitivity Analysis for a Ground-Water Flow Model Application
ASTM D 5490	Standard Guide for Comparing Ground-Water Flow Model Simulations to Site-Specific Information
ASTM E 978	Standard Practice for Evaluating Mathematical Models for the Environmental Fate of Chemicals
ASTM D 5981	Standard Guide for Calibrating a Ground-Water Flow Model Application
ASTM D 5880	Standard Guide for Subsurface Flow and Transport Modeling
ASTM D 5718	Standard Guide for Documenting a Ground-Water Flow Model Application
ASTM D 6170	Standard Guide for Selecting a Ground-Water Modeling Code
ASTM D 6025	Standard Guide for Developing and Evaluating Ground-Water Modeling Codes
ASTM D 6033	Standard Guide for Describing the Functionality of a Ground-Water Modeling Code

ASTM E 1689	Standard Guide for Developing Conceptual Site Models for Contaminated Sites
ASTM D 6171	Standard Guide for Documenting a Ground-Water Modeling Code

Additional reference materials that are useful for conducting modeling include the following:

- Anderson, M.P. and W.W. Woessner, 1992, *Applied Groundwater Modeling, Simulation of Flow and Advective Transport*.
- Committee on Fracture Characterization and Fluid Flow, U.S. National Committee for Rock Mechanics, 1996, *Rock Fractures and Fluid Flow, Contemporary Understanding and Applications, National Academy Press*, Specifically Chapter 6, "Field-Scale Flow and Transport Models."
- McDonald, M.G., and A.W. Harbaugh, 1988, "A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model," *Techniques of Water-Resources Investigations of the United State Geological Survey*, Book 6, Chapter A1, 576 pp.
- U.S. Environmental Protection Agency (EPA), *Quality Assurance and Quality Control in the Development and Application of a Groundwater Model*, EPA/600/R-93/011.
- U.S. Environmental Protection Agency, 1993, *A Manual of Instructional Problems for the U.S.G.S. MODFLOW Model*, EPA/600/R93/010, EPA.
- Zheng, C., and G.D. Bennett, 1995, *Applied Contaminant Transport Modeling*, Van Nostrand Reinhold, New York, NY, 440 pp.

4. DEFINITIONS

The following definitions are applicable to the generation of groundwater flow and solute transport models and are used in this SOP.

- **Calibration**—The process of refining the model representation of the hydrogeologic framework, hydraulic properties, boundary conditions, and solute transport (if sufficient data are available) to achieve a desired degree of correspondence between the model simulations and actual observations or measurements of the groundwater flow and transport systems.
- **Conceptual Model**—An interpretation or working description of the characteristics and dynamics of the physical system.
- **Groundwater Flow Model**—An application of a mathematical model to represent a groundwater flow system.
- **Mathematical Model**—Mathematical equations expressing the physical system (site conceptual model) including simplifying assumptions. The representation of a physical system by mathematical expressions from which the behavior of the system can be deduced with known performance.
- **Model**—An assembly of concepts and site-specific data in the form of mathematical equations that portray understanding of a particular hydrogeologic system.
- **Model Code (Computer Program)**—The assembly of numerical techniques, bookkeeping, and control language that represents the model from acceptance of input data and instructions to delivery of output.
- **Sensitivity (Model Application)**—The degree to which the model result is affected by changes in a selected model input parameter representing hydrogeologic framework, hydraulic properties, and boundary conditions.

- **Simulation**—In groundwater flow modeling, one complete execution of a groundwater modeling computer program, including input and output.
- **Verification**—Using the set of parameter values and boundary conditions from a calibrated model to acceptably approximate a second set of field data measured under similar hydrologic conditions.

5. RESPONSIBILITIES

5.1 Procedure Responsibility

The Geosciences Discipline Lead is responsible for the development, maintenance, and revision of this procedure. Any questions, comments, or suggestions regarding this technical SOP should be directed to the Geosciences Discipline Lead. The Geosciences Discipline Lead's location and associated contact information can be found on the Shaw Group intranet site, ShawNet.

5.2 Project Responsibility

Employees conducting groundwater flow or solute transport modeling, or any portion thereof, are responsible for meeting the requirements of this procedure. Employees conducting technical review of company groundwater flow or solute transport modeling efforts are also responsible for following appropriate portions of this SOP. Project participants are responsible for documenting information in sufficient detail to provide objective documentation (checkprints, calculations, reports, etc.) that the requirements of this SOP have been met. Such documentation shall be retained as project records.

6. PROCEDURES (TECHNICAL REQUIREMENTS AND STANDARDS)

Groundwater flow and solute transport models are constructed to represent the physical and geochemical system of a site. The degree of representativeness of the modeling results depends on the complexity of the site setting, the amount of available site data, the complexity of the model, and the effort necessary to adjust the model to site conditions. Modeling results are used for decision-making, design efforts, and other evaluations (such as risk analysis). Consequently, it is important that the modeling effort be technically defensible and conducted following consistent requirements, standards, and/or procedures. The requirements, standards, and/or procedures for conducting groundwater flow and solute transport modeling are provided in the subsequent text.

6.1 Methodology

The model development process consists of many individual steps, which include the following:

- Definition of the problem
- Development of a conceptual model
- Selection of the model code
- Verification of the model code
- Parameterization of the model input
- Model construction
- Model calibration
- Model sensitivity analysis

- Model application
- Model validation (if data set is available)

These steps are common to all models regardless of their size or scope, and all require documentation of their approaches and conclusions to complete the modeling process. The documentation process is described in the following sections.

6.2 Initial Model Documentation

Modeling is conducted to address a site-specific issue or problem. All models have application limitations, and the degree of model representativeness to site conditions will depend on the planned model use. Consequently, the site-specific problem for which the modeling will be constructed must be defined, and the conceptual model and description of the scope of the modeling program must also be compiled and documented.

These steps are usually addressed in a project work plan or proposal. If so, a copy of this document must be included in the modeling records. If they are not, documentation must be created which clearly defines the modeling objectives and concepts. Any changes to the modeling program's scope and/or conceptual model must be documented and approved by an appropriate level of management (Project Manager or designee), with a reference to the original documentation.

The model's scope will include the following:

- A basic description of the problem
- Site background information
- Regulatory framework
- Definition of the size of the area to be modeled
- Calibration criteria
- Model sensitivity analysis and/or validation
- Special factors that may influence the modeling program

The conceptual model description will include the following:

- A definition of the system to be modeled
- Definition of parameters needed for model input
- Description of the conceptual flow system
- Definition of the conceptual solute transport system (if applicable)
- Any and all assumptions used in the development of the conceptual model

The conceptual model, initial model input parameters, and model results shall be reviewed and approved by the Project Hydrogeologist. The Project Hydrogeologist is the individual responsible for providing technical oversight of the site conceptualization, determining site aquifer parameters and other hydrologic parameters (i.e., model input parameters), and verifying that the model output is consistent with site conditions.

6.3 Model Code Selection

Code selection is an important step in modeling. It essentially consists of matching the modeling needs of the project and known hydrogeologic site conditions to the key characteristics or capabilities of existing computer codes. The selected code should possess essential characteristics or capabilities to effectively address the problem to be answered while representing known site conditions. In addition, the model code selection shall be documented and maintained as project records.

Selection of the model code, and documentation of model code selection, shall follow guidelines contained in the industry standards listed in Section 3. Those individuals needing assistance in model code selection and documentation may consult internal Shaw technical listings for experts in groundwater flow and solute transport modeling.

6.4 Model Parameter Input

Model input parameters should be derived from site-specific studies and investigations covering site geology, hydrogeology, and geochemistry. If site-specific parameter data are not available, data from local and regional geologic studies that are suitable for the application may be used as model input parameters. If neither site-specific nor local or regional data are available, non-site-specific literature values may be used. Initial input values for parameters should closely approximate literature values and should not be changed until model calibration is begun. Literature sources and their values must be documented and included in the modeling documentation files.

6.5 Model Calibration

Model calibration is the mid-step between model selection and development and model application. Documentation of the calibration process is important. The documentation provides an unbroken record of the input parameters used in the calibration of the model, beginning with the initial input parameters and ending with the parameters used for the final calibrated model. For manual calibration, each model calibration run should be limited by changing only one parameter at a time; if multiple parameters are changed, their effects may mask each other, and the results may be unclear. Each parameter changed during calibration should be changed only within the range of possibilities defined during conceptual model development and model input parameterization. The first calibration run of any modeling program should be a baseline run using all initial input parameters. Sufficient documentation of calibration runs will be made and will include the following:

- Modeler's name and date
- Calibration run number
- Input filename(s)
- Output filename(s)
- Program name and version
- Purpose of the calibration run
- Parameter(s) changed during the run and their values
- Results of the calibration run
- Plans for the next calibration run based on the present results, if necessary

For model calibration using codes such as PEST, UCODE, MODFLOWP, MODAC, or similar software, documentation shall be sufficient to describe the process and results.

Documentation for calibration runs shall be filed in the project modeling records. Such documentation shall include both a hardcopy and an electronic copy of the model input and output files for the final calibration run, and other runs, if necessary.

6.6 Other Modeling Documentation

Model application or simulation runs, sensitivity analysis, and validation runs are conducted as the modeling effort progresses. These runs require identical documentation as used in calibration runs and also require documentation of their basic purpose as related to the scope of the modeling program. Sensitivity analyses should consider key parameters that were not well defined during the input parameterization step and should reference the parameterization documentation. Model validation runs should describe the new data sets to be used and should reference the original model calibration. In all cases, both paper and electronic copies will be made for each modeling run. These copies and accompanying run descriptions will be included in the modeling documentation files. An expanded report outline is shown in Attachment 1 (Section 7) as an example means of providing appropriate information and documentation.

6.7 Potential Modeling Errors

The following is a list of potential modeling errors. The most appropriate method for eliminating modeling errors is to apply good hydrogeologic judgment and to effectively question the model simulations.

Model Conceptualization Errors:

- Lack of understanding of site hydrogeological processes
- Inappropriate model code selection
- Selection of inappropriate boundary conditions
- Excessive discretization
- Lack of far-field data
- Oversimplification of the problem, including complexity of the groundwater flow system and equivalent porous media assumptions for fractured rock
- Placing model boundaries too close to the area of interest, especially pumping centers

Data Input Errors:

- Inconsistent parameter units
- Incorrect sign (+/-) for pumping or recharge
- Inappropriate use of model code modules (e.g., MODFLOW, DRAIN, or RIVER, and ET)
- Extraction well not specified correctly
- Aquifer stresses not specified correctly over entire transient simulation period
- Use of interpolated or extrapolated data
- Forcing questionable data to fit
- Misinterpreting mass balance data

Simulation Results Errors:

- Deviations from standard industry practices without proper justification and documentation
- Improper or insufficient model calibration
- Omitting results inconsistent with conceptual model
- Blind acceptance of model output
- Insufficient modeling documentation

If model results do not make physical sense or are not consistent with observed site conditions, the model should be checked for potential errors or other causal factors. The model should then be revised appropriately before formally presenting the results and generating conclusions.

6.8 Review & Approval

All models and modeling results shall undergo technical review. The technical reviewer should be a person capable of conducting the modeling and also understanding and comparing observed field data to the conceptual and numerical models. The technical reviewer should not have developed or conducted the particular modeling to be reviewed. For state-of-the-art or highly sensitive models, the technical reviewer should be carefully selected and may be a qualified person outside the project team. Individuals needing assistance in finding qualified technical reviewers may consult internal Shaw technical listings for experts in groundwater flow and solute transport modeling. Experts outside of Shaw may be used, if necessary, for highly sensitive projects after internal Shaw reviews have been performed.

The technical review, at a minimum, should consider and evaluate the following items:

- Definition of the problem—The basic description of the problem is provided as well as the basic scope of the modeling to be conducted.
- Site conceptual model—The hydrogeologic system to be modeled as well as the conceptual flow and solute transport system (if applicable) are appropriately defined and are supported by site data; parameters needed for model input are appropriately identified; the conceptual model is approved by the Project Hydrogeologist.
- Applicability of selected code—The code selected for use is optimum for the described conceptual model and supported by observed site conditions.
- Model input parameters—Input parameters are clearly specified and their values are appropriately documented; parameters are technically supportable.
- Model calibration—The calibration is complete or sufficient, and the results and conclusions generated are compatible with standard industry practice; change in calibration is conducted and documented.
- Model sensitivity analysis—The conducted sensitivity analysis and results and conclusions generated are compatible with standard industry practice and are technically supportable.
- Model validation and agreement with field data—Model validation is conducted appropriately, reflects standard industry practice, and is technically supported by the field data.
- Model documentation—All documentation has been completed according to this SOP and any other applicable procedures.

- Model results—In general, all modeling results are supported by the field data and all errors are identified as to root cause and corrected.
- Modeling assumptions—Any and all assumptions used for the modeling are appropriately documented and justified.

Any issues raised during the technical review shall be resolved between the reviewer and staff conducting the modeling before external (i.e., outside of Shaw) submission of the model and modeling results. The technical review comments and issues, and corresponding resolution, shall be documented and filed with the project records. If a modeling report is prepared (such as in Attachment 1), documentation of the report review may also be included with the project records.

7. ATTACHMENTS

- Attachment 1, Suggested Modeling Report Sections

8. FORMS

None.

Attachment 1
Suggested Modeling Report Sections
(As Applicable)

7.8 Water Budget
7.9 Areas of Uncertainty
7.10 Comparison of Initial Model to Final Calibrated Version
8.0 Flow Model Simulation Results and Discussion
9.0 Flow Model Sensitivity Analyses
9.1 Approach and Procedures
9.2 Variations in River Stage and Bed Conductance
9.3 Variations in Precipitation Recharge Rate
9.4 Variations in Horizontal and Vertical Hydraulic Conductivity Values
9.5 Variations in Boundary Conditions
10.0 Model Validation
11.0 Particle Tracking
12.0 Water Budget Analysis
12.1 Flux Through Model Boundaries
12.2 Groundwater Discharge to the Streams
13.0 Solute Transport Modeling
13.1 Objectives
13.2 Scope of Work
13.3 General Approach and Modeling Assumptions
13.4 Sources of Contaminants Entering the Model Domain
13.4.1 Loading Rates From Leachate Sources
13.4.2 Loading Rates from Potential DNAPL Sources
13.5 Physical Attenuation Processes
13.5.1 Hydrodynamic Dispersion
13.5.2 Adsorption and Desorption Processes
13.6 Biodegradation Processes
13.7 Simulation Solute Transport
13.7.1 Initial Distribution
13.7.2 Predicted Changes in Concentrations Over X Years
13.7.3 Mass Budgets
14.0 Sensitivity of the Solute Transport Models
14.1 Adsorption and Desorption
14.2 Biodegradation
14.3 Dispersion
15.0 Quality Control and Peer Review
15.1 Quality Assurance/Quality Control
15.2 Internal Peer Review
15.3 External Peer Review
15.4 Numerical Dispersion Analysis
15.5 Permanent Loading Source Areas
16.0 Conclusions
16.1 Groundwater Flow Model
16.2 Transport Modeling
17.0 References

Note: All main topics covered in the modeling work plan (if prepared) need to be addressed as topics in the report.

STANDARD OPERATING PROCEDURE

Subject: Records Generation, Management, and Control

1. PURPOSE

This procedure specifies an organized records management system that provides for the adequate generation and proper handling of records to ensure their completeness, protection, and ability to be retrieved. The methods for managing and controlling records are defined to address collection, indexing, storage, access, maintenance, and disposition to ensure that records are adequately generated, managed, and controlled to furnish evidentiary documentation of the conduct and quality of work.

2. SCOPE

This procedure applies to the management and control of records, which begins with the initiation of activities and projects and continues through planning, execution, monitoring & control, and closure. Records may be in any of several media formats such as hard-copy or electronic and may be generated by Shaw E & I personnel, clients, or subcontractors.

3. REFERENCES

- Shaw E & I Quality Management System Plan
- Shaw Procedure No. FE000, *Records Management and Records Retention*

4. DEFINITIONS

- **Record**—A document stating results achieved or providing evidence of activities performed. Records, regardless of their physical form, are created as a result of documenting an activity or project. Records may include, but are not limited to, correspondence, reports, forms, data, or photos. Records may be generated as the documentation of planning, execution, monitoring, confirming, or supporting projects, or of performing closure activities.
- **Records Management**—Administrative activities associated with record creation, use, archival, maintenance, retrieval, and disposition.
- **Active Project Record**—A record generally associated with an active project, which has not been submitted for archival storage.

5. RESPONSIBILITIES

5.1 Shaw E & I Director of Quality

The Director of Quality is responsible for developing and maintaining a procedure for Shaw E & I record generation, management, and control consistent with The Shaw Group and other applicable requirements.

5.2 Responsible Manager

The Responsible Manager shall establish, manage, and control project or activity records in accordance with the requirements of this procedure. Responsible Managers shall ensure sufficient staff and resources are provided to adequately manage and control records from project or activity initiation through closure.

6. PROCEDURE

6.1 Records Generation and Preparation

Sufficient records shall be generated during work activities to provide complete and adequate documentation of the conduct and quality of the work. Records shall be complete and shall adequately document the activity to allow future reconstruction of the recorded event.

Records can be initiated or signed by Shaw E & I personnel, the client, subcontractors, or others providing input to the project or activity.

6.1.1 Record Completion

Entries on records shall be concise, legible, and made in dark, indelible ink, printer toner, or similar permanent print. The use of pencils is prohibited for entries on official records.

All records shall be completed in such a manner as to accurately and thoroughly document the activity. Information recorded on forms shall be completed such that all requested fields within the form are addressed. If a required field is not relevant, the responsible individual shall line through the field, identify the entry as N/A, or make an equivalent notation.

6.1.2 Correction of Records

Corrections to records shall consist of striking a single line through the incorrect information, entering the correct information (adjacently), and initialing and dating the change with the date of the correction. Corrections to records shall be made so as not to obliterate the original entry. The use of erasers and correction fluid is prohibited, as are electronic changes that obscure or remove the original entry, or otherwise render it illegible.

As necessary, notes or a cross reference to more detailed information to offer clarification for the change may be made (e.g., nature of the change, justification for the change). Consideration should be given to how the change(s) could affect results and decisions. If relevant, a responsible authority shall be notified.

6.1.3 Traceability of Records

All records shall be traceable to their origin. Individual records should include the following information:

- Brief descriptive title
- Date
- Inclusive pagination (Page x of y)
- Originator
- Project Name
- Project or Work Breakdown Structure number

Computer-generated labels, stamps, or handwritten notes are acceptable means to ensure the requisite information is included on individual records.

6.2 Record Management and Control

Records shall be managed and controlled to ensure adequate collection, indexing, storage, access, maintenance, and disposition is achieved. Key elements of control to be applied during the active record life cycle are identified below.

6.2.1 Identification of Records

The identification of project records may result from the review of contract documents, including codes, standards and specifications, contract deliverables, program plans, procedures, and other administrative documents that demonstrate contract compliance and effective implementation of the quality management system. Project records may be produced in various types of media including paper, photographic media, electronic data and imaging, magnetic media (tapes, disk packs, compact disks, or optical disks), microforms, etc.

6.2.2 Status

To prevent the inadvertent use of obsolete or superseded records or the improper use of unverified or unapproved information, the following process shall be used:

- Records shall be considered final, unless otherwise noted. In general, unverified work should be labeled “preliminary,” and work that has undergone applicable QC requirements, but has not been approved as final, should be noted as “draft.”
- Outdated or superseded records shall be marked to reflect their status to preclude inadvertent use (e.g., void, cancelled, information only).
- Shaw E & I personnel are responsible for proper labeling of obsolete, superseded, or unverified/unapproved records to preclude inadvertent use and for reporting such records that are not labeled to a Responsible Manager (e.g., Project Manager, line manager).
- The Responsible Manager shall notify affected personnel of any change in record status.

6.2.3 Records Validation

If required by regulatory/contractual requirements, specific records shall be formally validated. When this is necessary, the records shall be authenticated by the following:

- Initialing, or signing, and dating a record as part of the normal compliance with other Shaw E & I requirements
- Signing and dating, or stamping, a record prior to its external transmittal and/or inclusion in a project file

A list of initials and signatures of personnel authorized to validate records should be developed and maintained for the subject project.

6.2.4 Collection

Records shall be collected in a controlled central filing system. Records shall be acquired and collected from project activities as they are produced and shall be submitted to the central filing system on a periodic basis.

Depending upon the project size, duration, and degree of on-site involvement, the Responsible Manager may delegate certain records-management responsibilities to other suitably trained on-site personnel. These individuals must have a good understanding of what records are required to be maintained and must be delegated the necessary authority to acquire needed records.

6.2.4.1 Central Files

Each office or project shall maintain the following files, as are applicable to the scope of activities in that location. Files may be maintained in the same or in different physical locations, depending on use of the record and space constraints of the location. The locations and personnel responsible for each must be documented.

- **Project Central File**—Interim repository for project-specific records, except for some electronic storage, confidential records, and records specified in other locations. References to other file locations should be noted within the project files.
- **Business Development File**—Records associated with individual proposals and marketing efforts.
- **General Computer File**—Records associated with design, development, verification/ validation/use testing, licensing, and configuration management of computer software for multi-projects, Business Line or Division, and corporate uses.
- **Graphics/Drafting**—Electronic storage of drawings and graphics (e.g., CAD drawings) and hard copy storage of hand-drawn originals and oversized drawings.
- **Administrative Function Files**—Records associated with activities in the areas of purchasing, billing, and contracts and subcontracts administration.
- **Non-project Central File**—Records associated with non-project operations (e.g., facilities, general equipment, etc.).

6.2.4.2 Satellite Working Files

Files may be maintained at a satellite location for long-term activities/projects or if frequent access is required. Records in satellite working files shall be submitted to a central filing system when the activity is complete or when frequent access is no longer required. Control of the files will be the responsibility of the functional area or project and will comply with applicable records management requirements.

6.2.5 Filing and Indexing

Records shall be filed and indexed in an organized fashion that assists in the retrieval of records and that is easy for users to understand.

Records shall be indexed to reflect the location of the records for retrieval. The indexing format shall be adequate for the size and complexity of the project or task and the amount of records generated. The indexing structure shall be consistent with the example provided in Attachment 1 for a small- or medium-sized project. File index categories as shown in Attachment 1 are required where that record type is produced by the project.

File folders shall be labeled to identify the record and any established filing category or series. Labels shall be generated and affixed to electronic media such as tapes, discs, etc.

Where a database is used in place of paper records, the location, folder, and file names must be identified within the record index. For records filed and retained in electronic document management systems, protection shall be provided via software controls such as write access authorization and remote backup provisions. Backup provisions are recommended for physical electronic media such as floppy disk, optical disks, CD ROM, DVD ROM, or computer tape files.

6.2.6 Records Security and Access Control

The central filing system shall be secure and shall have controlled access. Access to records and files shall be controlled to ensure the safekeeping of records and to minimize the potential for records loss.

Satellite working files, to include work location files, shall also be locked and shall not be accessible to outside contractors or workers. Locked rooms or file cabinets may be used to satisfy this requirement.

When records are removed for review and use, sign-out cards or sheets should be used to identify who has possession of the record(s) and the date the record(s) was/were removed from the file. Records removed from files shall be returned in a timely manner.

6.2.7 Storage

Records shall be maintained in good order during the life of a project or activity and submitted to archival storage when they are considered inactive. The central filing system shall be maintained in a facility that provides a suitable environment for minimal deterioration, damage, or loss. Records shall be stored to provide protection from excess moisture and temperature extremes. Consideration for records storage shall be given to minimize the following potential damages:

- Fire
- Water and chemicals
- Sunlight
- Temperature and humidity extremes
- Natural disasters
- Rodent or pest infestation

Record storage areas shall be free of unnecessary combustibles, maintained by good housekeeping standards, and appropriately supplied with fire extinguishers in close proximity.

Records shall be archived in accordance with The Shaw Group corporate procedure No. FE000, *Records Management and Records Retention*. Records shall be submitted via formal transmittal by the local facility Records Coordinator to the designated archival storage facility. This should generally occur after the closure of an activity or project to include a phase of the project.

To document custody transfer and improve retrievability of records sent to the archival storage facility, copies of Records Transfer Sheets, Box Inventory Worksheets, and shipment pickup receipts should be retained and filed at the local facility. Records retrieval from and return to the archival storage facility must be coordinated through the local facility Records Coordinator in accordance with procedure No. FE000, *Records Management and Records Retention*.

6.2.8 Records Retention

Records shall be retained for specified periods as detailed in the most current approved Shaw Records Retention Schedule, found as an attachment to The Shaw Group corporate procedure No. FE000, *Records Management and Records Retention.* Record retention shall comply with client contractual and applicable regulatory retention requirements.

6.3 Record Review

Project records shall be properly reviewed in accordance with requirements specified within contract documents, policies, plans, procedures, and the Quality Management System. Prior to

demobilizing or completing a project, the Responsible Manager will ensure that active project records are reviewed, inventoried, and prepared for safe shipment.

These reviews shall be performed by qualified personnel who possess the knowledge and technical expertise to confirm that records satisfactorily meet the required review criteria.

As a minimum, records shall be reviewed for the following:

- Completeness
- Accuracy
- Legibility
- Reproducibility (including electronic or software imaging capabilities)
- Condition of form
- Authentication, as required
- Identification of item or activity traceability

6.4 Record Turnover and Internal Processing

Project records subject to client turnover and/or internal processing shall be submitted using formal transmittal forms or letters. Receipt acknowledgements should be obtained when records are transmitted external to the company. On various projects, submittal transmittal forms may serve as an appropriate means to demonstrate that records have been submitted or turned over to the customer for receipt, customer review, and acceptance. Where such forms are not addressed in established plans and procedures, the Records Submittal Form (EI-G004.01.r0) is provided for use.

For internal processing of project records for archival storage, refer to the forms required within Procedure No. FE000, *Records Management and Records Retention*.

Note: Records shall ***Not* be released to anyone outside of the company other than the client (e.g., regulators) without the written authorization of the client. If records are requested by way of subpoena or other legal document, the date and means by which the document was delivered and the person who received it must be documented and the request immediately forwarded to Shaw E & I Legal Counsel.**

7. ATTACHMENTS

- Attachment 1, Sample Index for Project Records

8. FORMS

- Records Submittal Form
- Project Record Transmittal Form

Attachment 1
Sample Index for Project Records with Required Index Categories

1. CONTRACT

- Contract/Purchase Order
- Contract Change Documentation
- Proposals
- Confidentiality Agreements
- Letters of Intent
- Memos of Understanding
- Teaming Agreement
- As-Sold Estimate

2. CONTRACT SUBMITTALS [Record Copies]

- Work Plans
- Technical Reports
- Drawings
- Specifications

3. PROJECT MANAGEMENT

- Job Initiation Records
- Project Planning Records
  - Project Management Plan
  - Integration, scope, time, cost, quality, human resource, communication, and risk planning records and documents
- Project Execution Records
  - Kick-Off Meeting Records
  - Project Activity Report/Documents
  - Project Summary/Status Reports
- Project Monitoring & Control Records
  - Integration, scope, time, cost, quality, human resource, communication, and risk monitoring & control records and documents
- Project Closure Records
-

4. TECHNICAL

- Work Performance Documentation
- Surveys, Inspections, and Assessments
- Analytical Data
- Computer Program or Mathematical Models

- Calculations and Verification
- Figures, Tables, Drawings, Logs and Verification
- Photographs
- Technical Analysis, Evaluation, and Reports and Verification
- Specifications and Verification
- Design Documentation and Verification
- Operation and Maintenance Manuals

5. PROCUREMENT AND SUBCONTRACTS

- Procurement Plan
- Procurement Requisitions
- Purchase Orders
- Invoices
- Subcontractor Services Scopes of Work
- Vendor/Subcontractor Documentation including Installation and O&M Manuals

6. QUALITY

- Quality Project Plans
- Project Procedures
- Quality Activity Reports
- Assessment Reports
- Training Records
- Non-conformance Reports and Corrective Actions

7. HEALTH & SAFETY

- Health & Safety Project Plan
- Tailgate Safety Logs
- Health and Safety Activity Reports and Documentation
- Training Records
- Accident Reports

8. EXTERNALLY SUPPLIED INFORMATION

- Client-supplied information
- Historical Reports, drawing, photos
- Outside information

Records Submittal Form

Example

QA Review _____

Project Number: _____

Project Name: _____

Originated By: _____

Date of Document: _____

Suggested File Category: _____

Project QA Record: Yes? _____ No? _____

Title of File: _____

_____

_____

Project Record Transmittal Form

To:	Date:	Transmittal No:
	Attention:	
	Project No :	
From:	Project Name & Location	

Project Records as identified below are submitted for the following action(s):

- ☐ Internal Quality Review
- ☐ Customer:
  - ☐ Receipt and Acknowledgement
  - ☐ Review and Acceptance
- ☐ Central File Storage
- ☐ Preparation for Archival Storage Processing

Document / File No.	Date / Revision	Document / Record Title or Description

Instructions: _____

_____

_____

Originator: _____ Date: _____

Receipt Acknowledgement:

Please acknowledge receipt of this transmittal and accompanying records by signature and date below. Please make a copy of this transmittal for your records, and return a signed and dated copy to the originator identified above.

Received by: _____ *Date:* _____

STANDARD OPERATING PROCEDURE

Subject: TECHNICAL STUDIES AND REPORTS

1. PURPOSE

This procedure establishes the requirements for the preparation, review, and approval of technical studies and reports. These requirements also apply to project documents that describe approaches for implementing technical work, such as project work plans. Such reports, studies, and plans are hereafter referred to as "documents." The objective of this procedure is to ensure that documents produced by Shaw E & I are accurate and defendable, and fulfill client and regulatory requirements. In addition, this procedure establishes requirements for content and format that enhance the consistency of documents produced throughout the company and promote a unified corporate identity.

2. SCOPE

This procedure applies to plans, studies, and reports of an engineering/technical nature that are issued to clients as Shaw E & I deliverables. This procedure does not apply to reports that are generated for project management purposes, such as status/progress reports and cost/scheduling reports, or other documents that are not of an engineering/technical nature.

3. REFERENCES

- Shaw E & I, *Style Guide for Proposals and Technical Document Preparation*, current version.
- Shaw E & I SOP T-DP-002(c), *Formatting Documents.*

4. DEFINITIONS

- **Preliminary Document (Working Draft)**—For the purposes of this SOP, a preliminary or "working draft" document is one that has not yet undergone Shaw's required internal reviews, as outlined by this procedure. Such a document may be distributed for information or collaboration purposes only. Shaw E & I reserves the right to change any or all of the contents of such documents.
- **Draft Document**—For the purposes of this SOP, a draft document is considered to be one that has been reviewed by Shaw E & I, and is issued for the purpose of client, agency, or other external review (outside of Shaw E & I).
- **Draft Final Document**—For the purposes of this SOP, a draft final document is considered to be one that has been issued by Shaw E & I after addressing client or agency comments. A Response to Comments table may be prepared and submitted in conjunction with a draft final document to identify and explain any changes that have been made. Two example Response to Comments tables are provided in Attachment 1.
- **Final Document**—For the purposes of this SOP, a final document is considered to be one issued subsequent to internal reviews directly following project work, such as a report, or following required client and/or regulatory approval. Documents issued as final are completely checked and reviewed by all involved parties prior to issuance and address all required external review comments (e.g., client, regulatory agency, etc.).

- **Author/Preparer**—An individual competent in the subject discipline who is assigned to develop part or all of a document or to prepare a revision to a document.
- **Reviewer**—An individual, other than the author, assigned to review a document.

5. RESPONSIBILITIES

5.1 Document Production Discipline Lead

The Document Production Discipline Lead is responsible for the development, maintenance, and revision of this procedure. Any questions, comments, or suggestions regarding this technical SOP should be directed to the Document Production Discipline Lead.

5.2 Project Personnel

Project personnel involved in preparing technical documents have the responsibilities outlined below.

5.2.1 Project Manager/Technical Lead

The Project Manager (PM) is the primary individual responsible for meeting the objectives of this SOP. The PM is responsible for the overall administration of this procedure, including assignment of authors and reviewers. The PM may delegate responsibilities to additional project personnel, including the technical lead, document author(s), peer reviewer(s), technical reviewer(s), etc.

The Project Manager or Technical Lead is responsible for resolving any issues that the reviewer(s) and document author(s) are not able to come to an agreement on.

5.2.2 Document Author (Preparer)

The document author is responsible for following this procedure to ensure consistency of the product and to provide a technically adequate document. Document authors have the primary responsibility for developing the content of the document body and appendices.

Document authors are also responsible for evaluating reviewers' suggestions and either indicating concurrence with the changes or modifying the changes in collaboration with the reviewer(s). Document authors are further responsible for addressing any questions or comments raised during the review and for providing additional information in the document text, as needed.

5.2.3 Reviewer

Reviewers are responsible for confirming that technical documents conform to the requirements of this procedure. The reviewer shall provide notification to the author of suggested revisions and shall follow up with the author and/or project team to obtain resolution for any outstanding issues.

6. PROCEDURE

All technical documents will be prepared following Shaw E & I requirements for organization, content, expression, and format, unless superseded by client requirements. Style preferences and format requirements are outlined in the Shaw E & I Style Guide and SOP T-DP-002(c).

6.1 Document Preparation

Preparation of each element of a typical document is presented in the following subsections. Document authors are typically responsible for generating the content identified in Section 6.1.1 and Sections 6.1.3 through 6.1.7 of this SOP. Document production personnel will typically generate the front material (Section 6.1.2) during the document formatting and editorial review processes.

6.1.1 Title Page

The title page identifies the document and should include the following information, at a minimum: document title, project name and location, *prepared by* information, *prepared for* information, and publishing date (approximate date the document will be distributed to recipients).

6.1.2 Front Material

The front material includes the Table of Contents, List of Figures, List of Tables, List of Appendices, and Acronyms and Abbreviations list. This material is typically generated by document production personnel. General requirements for each of these elements are identified below.

6.1.2.1 Table of Contents

The Table of Contents should identify the starting page numbers for the List of Figures, List of Tables, List of Appendices, and Acronyms and Abbreviations list, as well as for each section and subsection of the document body (up to 4 levels).

6.1.2.2 List of Figures

The List of Figures should identify the included figure numbers and their titles. If figures are presented in a section following the text, no page identification is required. If figures are embedded in the text, a page number or location should be identified for the figure (figure locations may be listed as *Follows Page X*).

6.1.2.3 List of Tables

The List of Tables should identify the included table numbers and their titles. If tables are presented in a section following the text, no page identification is required. If tables are embedded in the text, a page number or location should be identified for the table (table locations may be listed as *Follows Page X*).

6.1.2.4 List of Appendices

Appendices are identified by a letter designation and title. Appendices may each have their own table of contents, depending on their length and complexity.

6.1.2.5 Acronyms and Abbreviations

A list of acronyms and abbreviations should be included in all formal documents of sufficient length or complexity. The acronyms and abbreviations list should provide definitions for all acronyms and abbreviations used in the body of the document.

6.1.3 Executive Summary (Optional)

A brief synopsis should be prepared for technical studies and reports (not applicable for project plans) to summarize the work purpose, the results of activities, and the document's conclusions and recommendations.

6.1.4 Document Body

The document body should consist of an introduction, the main text, conclusions and recommendations (for studies and reports), and reference information. The main text must be formulated based on the project scope of work, contractual and regulatory requirements, and the intent of the document.

6.1.4.6 Introduction

The introduction should identify and describe the purpose for which the work is planned or was undertaken. It should briefly discuss activities pertinent to the subject. For a report, these may

include fieldwork; consultations with the client, regulatory agencies, and others; laboratory testing; collection of data from other sources; analysis and resulting conclusions; and the formulation of recommendations.

6.1.4.7 Main Text

The main text of the document should describe the work or subject in detail. Shaw E & I and subcontractor work relating to the document subject should be discussed. The findings of field explorations and testing, literature searches, external consultations, and observations should be included. The laboratory testing program should be described, and its results should be discussed. The analytical procedures proposed or employed and designs formulated should be indicated. The results of work performed should be discussed in detail and must be traceable to the project records.

6.1.4.8 Conclusions and Recommendations

The body of studies or reports should also include a section summarizing the purpose of the project and the tasks Shaw E & I has undertaken towards meeting that purpose. This section should emphasize the results of the work and any conclusions or recommendations reached.

6.1.4.9 References

The references section should be included as the final section of the document body. Reference sources cited in the text should be included whether they be external data, publications, or correspondence. Reference information should generally include the author's name, title of the publication, publisher, location of the publisher, and date. Reference information for correspondence should include the subject, date, names of the parties contacted, and type of correspondence.

Additional detail on reference material, including required information and formats, is provided in the Shaw E & I Style Guide.

6.1.5 Figures

Figures provide graphical presentations to present concepts and details to the reader. Each figure shall be identified by a figure number, a Shaw E & I drawing number (if appropriate), and a title. Figures are generally included as a separate section following the document body, but may be included within each section of text following the initial citation in the text.

6.1.6 Tables

Tables are used to present groups of information in an orderly manner. Tables are generally included as a separate section following the Figures section, but may be included within each section of text following the initial citation in the text.

6.1.7 Appendices

Appendices contain supplemental information pertinent to the subject of the document. Often the information contained in an appendix is technical in nature and is included to provide details of topics discussed in the text. Appendices should be identified sequentially by letter of the alphabet. Pages within an appendix should be presented in logical sequence, but need not be numbered unless a sequence cannot be reasonably maintained without page numbers.

6.2 Document Review (Technical/Peer Reviews)

Each document shall be reviewed by an individual other than the author for technical adequacy, completeness, and compliance with this procedure and applicable client requirements. The document should be reviewed by individuals qualified in each discipline represented in the text (e.g., a report presenting information and data in hydrogeology, geochemistry, and risk assessment may not be reviewed by a risk assessment expert alone).

Typically, documents will undergo an editorial review subsequent to peer/technical reviews [see SOP T-DP-002(e)]. In such cases, the technical/peer reviewers should focus primarily on the document's content and development and should avoid addressing editorial issues (grammar, word choice, capitalization, expression, etc.). Such issues should be addressed only after the overall content and organization have been finalized, to avoid making unnecessary changes and introducing possible rework.

The process for conducting internal peer/technical reviews is as follows:

1. Document author or project team submits the document manuscript for peer/technical reviews (document should be as complete as possible, including all available figures, tables, and appendices [draft or markup versions are acceptable]).

2. Document reviewers clearly mark suggested revisions, questions, and requests for additional information on the document manuscript or within the electronic files (use of Track Changes feature is recommended).

3. Document reviewers provide notification to the author of suggested revisions and follow up with the author and/or project team to obtain resolution for any outstanding issues.

4. Document authors evaluate the suggested revisions and either indicate concurrence with the changes or modify the changes in collaboration with the reviewer(s).

5. Document authors address any other questions or comments raised during the review and provide additional information in the document text, as needed.

A detailed description of the requirements for technical and peer review is provided in Attachment 2.

The internal reviews shall be documented on an appropriate form. Issue resolution shall be acknowledged by reviewers' signatures. The Manuscript Routing Sheet or Document Review Comment Record is an acceptable method of documenting reviews.

6.3 Document Approval

Each document shall be approved for issuance by the Project Manager or designee. The Project Manager may require use of a Document Issuance Checklist or similar form as a method of verifying that the document is ready for issuance.

6.4 Document Submittal

The Project Manager or designee will determine the required distribution (internal, client, and regulatory agency) for each document submittal, including the number of copies required by each recipient. Documents may be issued as *draft*, *draft final*, or *final* versions, as defined in Section 4 of this SOP. (Note that versions may be designated differently on the actual submittal, based on client-specific needs.)

Preliminary (working draft) documents may also be submitted, based on client request. However, such documents should not be used for evaluation or implementation purposes. Recipients should be apprised that preliminary submittals have not undergone Shaw's standard internal review processes and are to be used for information or collaboration purposes only. Preliminary documents that are submitted for external use must carry a watermark or other indication with the words *Preliminary Copy*, *Working Draft*, *Over-The-Shoulder Review*, or similar text prominently placed on each page.

Other than preliminary documents, all submitted documents should be complete, in proper format, and free of grammatical and typographical errors. Such documents will have undergone in-house technical review prior to being issued and should be considered final work products.

Final documents will be accompanied by a transmittal that identifies the contract number and contractual requirement that mandates the document, as applicable; indicates whether Shaw E & I considers the document to be a partial or full satisfaction of the requirement; and states the document title, number of copies transmitted, and Shaw E & I personnel to contact regarding questions concerning the document. The transmittal letter will be signed by the Project Manager or designee indicating approval for release. The document will be sent to the distribution identified by the Project Manager.

6.5 File Copies (Project Records)

Copies of documents submitted external to Shaw E & I must be maintained as a part of the project records. Review comments for document submittals shall also be maintained as project records. Such records should be maintained until project closeout.

- Preliminary and Draft Documents—A copy of any document formally transmitted externally will be maintained in the project files (not applicable to collaboration or "over-the-shoulder" copies that are shared through informal means [e.g. email]).
- External Review Comments—Documents that are issued to clients or agencies and returned with marked up comments/revisions should be maintained in the project files. Comments arriving in the form of regular correspondence should also be filed.
- Internal Review Comments—Internal review comments do not need to be maintained as project records; however, documentation of internal reviews should be maintained (such as completed Manuscript Routing Sheets or similar forms).
- Final Document—A complete copy with required signatures shall be maintained in the project file.

7. ATTACHMENTS

- Attachment 1, Example Response to Comments Tables
- Attachment 2, Review Requirements

8. FORMS

- Manuscript Routing Sheet
- Document Review Comment Record
- Document Issuance Checklist
- Boilerplate Response to Comments Table

Attachment 1
Example Response to Comments Tables

Response to Comments on the Preliminary Draft Project Plans, dated May 23, 2001
Fuel Line Abandonment/Removal - Alameda Point, Alameda, California

Comments by: Greg Lorton, P.E., June 12, 2001				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
Work Plan				
1	iii	Abbreviations	For what it's worth, SWDIV should be "Naval Facilities Engineering Command– Southwest Division."	The correction has been made.
2	2-1	2.1	The pipeline segments (A through E) are not indicated on Figure 2. In the third paragraph, the second sentence states that Figure 2 shows the storm sewers (with radium contamination). However, the Figure does not appear to show those storm drains.	The Figure 2 of the SAP is now used here and shows the storm sewer locations, and Segments A through E.
3	2-2	2.3	Add a sentence to the end of the first paragraph, "The Regional Water Quality Control Board has indicated that no additional closure requirements are necessary."	This sentence has been added.
4	4-2, 3	4.2	The Navy has adopted new cleanup criteria for sites contaminated with petroleum products. These new criteria (which are attached) supersede the 100 mg/kg value used in this section. In most cases, the relevant criteria are the residential remediation criteria (1,030 mg/kg gasoline; 1,380 mg/kg diesel or jet fuel; or 1,900 mg/kg motor oil).	A new bullet item entitled "Soil Overexcavation and Reuse Criteria" has been added to Section 4.2 defining the criteria for trench overexcavation and overburden reuse to be the residential Preliminary Remediation Criteria (PRC) of the Petroleum Strategy. A Table 2 has been added giving these criteria, and the use of the criteria is promulgated through the discussion of field procedure in the remainder of Section 4.2 and in the SAP. Chemical testing of soil screening and documentation samples is broadened to include BTEX and lead, but not MTBE due to the age and nature of potential pipeline losses.
5	4-3, 4	4.2	If radium 226 is a concern, should we be monitoring and/or analyzing for it?	A field prescreening program for Segment B of the pipeline removal alignments has been incorporated into the field work, and is described in a new Section 3.7. Use of the prescreening sample data to decide between pipeline removal or grouting in place is now described in the last paragraph of Section 4.2.
6		Table 1	Since Section 2.1 discusses radium contamination, radium should be added to Table 1. Chlorinated solvents should also be mentioned as an IR Site Chemical of	"Radium 226 (in drain lines)" has been added for IR Site 5 and 10 under the soil column of Table 1. DCE, TCE, VOC's and CHC (chlorinated hydrocarbons) are already listed as COCs in Table 1.

Comments by: Greg Lorton, P.E., June 12, 2001				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
			Concern.	
7		Figure 1	This figure seems to be unnecessary, since it doesn't provide any information that isn't already in Figure 2. The scales are inconsistent between Figure 1 and Figure 2. (For example, in Figure 1, the north side of Seaplane Lagoon is approximately 2,470 feet long, while in Figure 2, it is approximately 2,970 feet long.	Figure 1 contains a regional map showing the location of Alameda Point relative to the San Francisco Bay. The labeling of this figure has been augmented to enhance it usefulness in orienting the subsequent figures. The scale of Figure 1 has been corrected.
8		Figure 2	To be consistent with the text in Section 2.1, indicate the storm drains. To be consistent with the text in Section 2.1, indicate the different fuel segments (segments A through E). Also, the location of UST 7-1 (north of Building 7 in Parcel 82) should be indicated. *(The 11 x 17 Figure 2 included in the Sampling and Analysis Plan seems to be better suited than the D-size Figure 2 currently included in the Work Plan.)* Earlier information from Dan Baden indicated that the storm drain segment between parcels 30 and 49 (in the north-south section along Monarch Street) has already been removed. I'd recommend a brighter color and/or a heavier line weight to indicate the lines to be removed or abandoned. (And use a solid line, not a dashed line.)	The 11x17 Figure 2 of the SAP is now used as Figure 2 of the Work Plan Addendum. This figure distinguishes between those portions of the sewer lines leading to the "F" outfall which have been cleaned or replaced from those portions which have not been addressed. Several refinements to the figure have been made. First, the fuel lines to be removed are shown as a heavy red solid line. The storm sewer lines from Building 5 which have been cleaned or replaced are shown as heavy solid green lines. The storm drain segment between 5F and 5F-2, for which the soil above the pipe has been radiologically screened by New World Technologies, is shown as a heavy dashed line. The remainder of the storm sewers are shown as solid blue line. The former industrial sewer line exiting the north site of Building 52 (Site 10) is shown as a solid brown line. This industrial line, which had survey readings above 8000 nCi, has been removed but was not replaced.

Comments by: Greg Lorton, P.E.				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
Sampling and Analysis Plan				
1	1-2, 3	1.1	The Navy has adopted new cleanup criteria for sites contaminated with petroleum products. These new criteria (which are attached) supersede the 100 mg/kg value used in this section. In most cases, the relevant criteria are the residential PRCs (1,030 mg/kg gasoline; 1,380 mg/kg diesel or jet fuel; or 1,900 mg/kg motor oil).	See Comment No. 4 to the Work Plan Addendum. In the FSP, the updates of the sampling program to reflect the new Petroleum Strategy criteria are presented in the fourth paragraph of Section 1.1, the action level discussions of Section 1.2, the sampling and analysis objectives discussion of Section 1.3, the field sampling discussion of Section 3.3, and the analytical requirements of Section 4.0. A Table 1 giving the residential PRCs has been added to the FSP, and the other tables renumbered accordingly. Decision rules based on the new cleanup criteria are presented in the QAPP, Section 3.1.5.
2	1-3	1.2.1	Same comment.	See the response to SAP Comment No. 1.
3	1-4	1.2.2	Same comment.	See the response to SAP Comment No. 1.
4	3-2	3.2	Same comment.	See the response to SAP Comment No. 1.
5	3-1, 2	3.2	Are we going to be looking for any evidence of radiological contamination?	See Work Plan Addendum Comment No. 5. In the FSP, the field prescreening program is now described in the sixth paragraph of Section 1.1. A new Section 3.1 has been added describing the sampling process design of the prescreening program. The decontamination methods for the prescreening program are discussed under Section 3.4 (Waste Characterization). Radiological testing has been added to the analytical requirements of Section 4.0, and the prescreening program sampling procedures added to Section 5.1.
6	4-1	4.0	Same comment.	See the response to SAP Comment No. 5.
7		Figure 1	This figure seems to be unnecessary, since it doesn't provide any information that isn't already in Figure 2.	Figure 1 contains a regional map showing the location of Alameda Point relative to the San Francisco Bay. The labeling of this figure has been augmented to enhance it usefulness in

Comments by: Greg Lorton, P.E.				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
				orienting the subsequent figures. The scale of Figure 1 has been corrected.

Comments by: Greg Lorton, P.E.				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
Health and Safety Plan				
1	3-1	3.2	The potential to encounter radiological hazards is described in the Work Plan, but not mentioned in the Health and Safety Plan. It needs to be mentioned here. Chlorinated hydrocarbons are also mentioned in the Work Plan as chemicals of concern, but not mentioned in the Health and Safety Plan. They need to be mentioned here.	Radiological hazards have been included in Section 3.2, as well as Section 3.5, Radiological Prescreening Field Program. Chlorinated hydrocarbons have been included in Section 3.2.
2		Table 1	This table should include chlorinated solvents and radium.	Chlorinated solvents and radium have been added to Table 1.
3		Appendix C	Why is the use of diesel-fired equipment recommended as a control measure to avoid CO poisoning?	Statement has been changed to "CO monitoring will be conducted."
4		Appendix D	The last MSDS (for Naptha (sic), Aromatic) is included twice.	The second copy is removed.
5		Appendix E	The Muster Points indicated may not be easily accessible because of fences. For example, I believe that a fence separates pipeline segment F from the Muster Points shown on the runway area. Similarly, the Muster Point shown just north of Site 5 on the figure is in a normally locked building. Check all of the Muster Points for access from the work areas.	Muster point locations will be verified at the site by the SHSS prior to field operations. All site personnel will be made aware of the muster point locations prior to entry into the EZ.

Response to Comments on the Draft Remedial Design and Implementation Plan dated February 2002
Pacific States Steel Corporation Plant Site, Union City, California

Comment No.	Page No.	Section, Figure, Table	Comments	Response
Comments by: Larry Cheeves/Mark Evanoff/John Rigter, City of Union City, February 28, 2002				
General Comments by Environmental Programs Division				
1			Does the RDIP provide a mechanism for ensuring that the existing clay layer below the Waste Containment Area (WCA) is capable of containing the waste? We were not able to find this in the document submitted. The RAP indicated specific criteria would have to be met prior to placing materials into cooling pond/clay pit area (page 41, Phase V). The boring data presented to date does not appear to provide this. Please provide details in the RDIP on how this will be handled.	The new Section 4.3.10 covers the verification of the thickness of the clay layer of the Newark Aquifer. The procedure will result in the establishment of a minimum of one foot of 1 X 10^{-6} cm/sec clay are required in the RAP.
2			Asbestos Containing Materials (ACM) were identified in the RAP, RDIP and the Caltrans - Route 84 investigation. We share this concern, and understood that a site survey for ACM would be included in the RDIP, and conducted prior to beginning construction/remedial activities at the site (from Agency/Gruen meeting of 8/28/01 question 10 and associated response). During our review of the document, we were unable to locate a site-wide ACM survey activity. Have all of the areas containing ACM been identified? And if not, can the survey be conducted as part of the area specific activities?	New sections have been inserted in the RDIP (Sections 3.5.6 and 3.5.7 to address the standards and sampling) and the Sampling and Analysis Plan (Section 2.6.3) to address the ACM survey activities.
3			As indicated in several places in the RDIP, the Regional Water Quality Control Board will approve discharges to the ACFCD channel. However, additional agency approvals may be required which could include State Department of Fish, U.S. Coast Guard, etc. IT needs to investigate this further.	A check with the Bay Area Regional Water Quality Control Board indicates it will not be necessary to contact the State Department of Fish and Game nor the U.S. Coast Guard concerning the NPDES permit.
4			Will the final RDIP document be "stamped" by a registered professional? It seems this would be a requirement. In the meantime (during the draft phase), should the personnel who will ultimately sign off on the document be identified in the beginning of each volume?	A registered Professional Engineer responsible for the design components of the document will be identified by name and registration number. The final documents will be stamped and signed.

Comments by: Larry Cheeves/Mark Evanoff/John Rigter, City of Union City, February 28, 2002				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
5			Along with the organizational chart (provided), would a statement of qualifications for those personnel responsible for the implementation of the RDIP be appropriate?	DTSC has indicated that personnel qualifications are not a requirement of the RDIP.
General Comments by Public Works Engineering Division				
6			Confirm that the Storm Water Pollution Prevention Plan (WEPPP) is current and should be included in the RDIP. Separate copies shall be submitted to the City including a copy of the NOI for issuance of the grading permit. Detailed grading plans shall be included in the submittal as well as copies of other required permits and access agreements.	The SWPPP will be updated to conform with the final approved design.
7			Slag and slag-impacted soil will be removed to a maximum depth of 10 feet beneath the proposed 11th Street alignment and grade. Verify that this is adequate for utilities and conforms to the proposed final grade for Route 84. Proposed 11th Street requires a 100 ROW.	IT will remove any and all visually impacted soils from beneath the proposed location of Route 84. This will be confirmed via our sampling and analysis plan. IT can make no guarantee beyond confirmation sampling that all Slag and slag-impacted soil has been removed form beneath Route 84 once further proposed excavations are conducted in these areas.
8			Since the proposed cap is designed solely as a barrier to infiltration and not designed as a foundation for future development, further discussion on design measures should be explored and identified to ensure that the Waste Containment Area (WCA) will support the Research and Development campus as indicated on the Randall Planning land use map (February 1, 2002), while preserving the integrity of the cap.	In the March 28, 2002, DTSC eMail response to the Gruens, item 3 states, "We understand and agree that the current cap design in not intended to fully accommodate the construction of building foundations. Further modifications of the cap will be required in connection with future development when it occurs."
9			Confirm that the remediation schedule conforms to, or will allow for concurrent construction of the proposed 11th Street extension.	The schedule has been modified to confirm the concurrent construction of 11th Street.
10			Include construction details for the Waste consolidation Area Surface Water Control System.	Additional Figures have been added to the Red-Line version of the RDIP.

Comments by: Larry Cheeves/Mark Evanoff/John Rigter, City of Union City, February 28, 2002				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
11			Verify/confirm that post construction grades for residential areas are above flood zone elevations.	Verification/confirmation that the residential grades are above the flood zone elevations is a requirement the residential developer must meet to secure the necessary building permits.
Specific Comments by Environmental Programs				
12	ES-1	3rd bullet	"flood control channel or the sanitary sewer." *Minor typo.*	The text in ES-1 has been modified.
13	ES-3	4th bullet	"If necessary, the dewatered sludge will be treated before use as backfill…" *What will determine if treatment of sludge is necessary?*	The Sampling and Analysis Plan includes the testing of the sludge to verify it meets the limits required for backfill.
14	ES-3	7th bullet	*The cap design summary discussed in this section is not consistent with the one discussed in Section 4-1.*	The text on ES-3 has been corrected to show a 3-foot layer of soil in the cap design.
15	ES-4	4th bullet	…"underlying soils will be remediated to appropriate standards." *Is this in reference to standards for materials placed under the capped area discussed in the RAP? Or elsewhere? This should be clarified.*	There is no plan to over excavate all the "underlying soils" in the WCA then recompacting it to "appropriate standards." The text has been corrected.
16	1-5	1.3.2	…"during IT's Geotechnical investigation of the former clay pit, bedrock was encountered in one trench at the site." *In discussions with several professionals (agency and non0-agency) it seems unlikely that bedrock would be found in this location.*	It is doubtful that bedrock was actually encountered during test pit investigations. The text of Section 1.3.2 has been modified to clarify this statement.
17	2-2	2.2.2	*Are the design/construction details for the lay down area provided somewhere else in the RDIP and/or Appendices? If not, please provide these details.*	Lay down areas are generally not complicated structures requiring a "design". The decontamination pads will be located at each site exit as shown on the modified Figures 2 and 3.
18	2-5	2.8	"Native soil will be segregated and stockpiled in an area designated for clear soil"… *What methods will be used to segregate the soil initially? Will there by any laboratory analytical testing to confirm thee materials are clean/non-contaminated?*	The soil will be visually segregated during excavation and stockpiled accordingly. Before the soil is used as backfill, testing, as described in the Sampling and Analysis Plan will be performed to verify it meets the standards for clean fill.

Comments by: Larry Cheeves/Mark Evanoff/John Rigter, City of Union City, February 28, 2002				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
19	3-1	3.1.1	"They are based upon analysis conducted by the U.S. Environmental Protection Agency (EPA) and/or the California Regional Water Quality Control Board (RWQCB), San Francisco Bay Region, that are documented in the following:" *Consider rewriting this sentence to read: "They are based upon cleanup standards developed by the U.S. Environmental Protection Agency"…*	The sentence in Section 3.1.1 has been modified as suggested.
20	3-2	3.1.1 Metal 1st bullet	*Why was the proposed background level for arsenic of 14 mg/kg from the Lawrence Berkeley Lab report used instead of the site-specific data, which indicated a mean value of 8.48 mg/kg?*	After discussions with DTSC, the background level for arsenic has been selected based on a more appropriate data base.
21	3-3	3.1.1 Petroleum Hydrocarbons	*Consider reversing the order of the 3rd and 4th sentences in this paragraph. This way, it should read more clearly.*	The order of the 3rd and 4th sentences has been reversed.
22	3-3	3.1.1 Polychlorinated Biphenyls	*Provide a heading for the Statistical Methods section.*	A new Section 2.1.3 Statistical Methods has been inserted in the text.
23	3-4	3.2.3 Description of Area	*Provide area description including summary of previous activities conducted in the area; a summary of previous investigations and analytical results; and the specific types of materials that are expected in the area (soil, debris, sludges, etc.).*	The text of Section 3.2.2 has been replaced with a area description of the Autoshredder Area.
24	3-6	3.2.6	… "cleanup of these constituents and identify the <u>bases</u> for their development." *A minor typo? Consider the word "basis"? This was observed in other parts of the document.*	The typo has been corrected in Sections 3.2.6, 3.7.6, 3.9.6, 3.11.6, 3.12.6.
25	3-7	3.2.8 2nd sentence	*We are not sure what this sentence meant to convey. Please clarify.*	The sentence has been replaced.

Comments by: Larry Cheeves/Mark Evanoff/John Rigter, City of Union City, February 28, 2002				
Comment No.	**Page No.**	**Section, Figure, Table**	**Comments**	**Response**
26	3-7	3.3.2 Description of Area	*Provide sump/foundation specific analytical results for the contaminated contents in each unit. Consider using a chart within the text to convey a summary of this data. This will help clarify, and simplify the sampling activities (confirmation, treatment, etc.) that will be conducted during the remediation phase of the area.*	Sump information from the RI and other sources have been inserted in Section 3.3 and referenced in Section 3.12.
27	3-8	3.3.3 Remedial Actions	*Consider moving 1st paragraph forward into section 3.3.2 (Area Description related).*	Section 3.3.2 had been moved to the appropriate area of the text.
28	3-9	3.3.3 Remedial Activities 1st bullet	*The depth of the excavation is not clearly indicated in Figure 9.*	The figure has been modified to indicate the estimated depth of excavation.
29	3-24	3.9.1 Location of PCB Transformer Area	*There are no points of reference to determine where the area is located in relation to other site features. Adjustment of the scale should help resolve this.*	The text has been modified to help locate the PCB area.
30	3-25	3.9.2 last sentence in paragraph	*"These soils are the focus of the remedial actions proposed in this <u>part of the</u> document." This addition will clarify the sentence.*	The suggested addition has been inserted in the last sentence of Section 3.9.2
31	3-32	3.12.3 Remedial Activities Sludge Characterization	*Will additional analysis (other than TPH) be needed to characterize these materials?*	The text has been modified to state that the six metals of concern at the site will also be tested.

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ATTACHMENT 2
REVIEW REQUIREMENTS

The following requirements apply to technical documents that are formally submitted to Shaw clients and/or regulators for their review, approval, and distribution. The purpose of technical and peer reviews is to maintain a high degree of technical quality in Shaw documents and to demonstrate that we are committed to and can implement projects predicated upon technical competence.

Technical or peer reviews will be performed by appropriate reviewers after completion of a preliminary, or working draft, document. Reviewers shall be qualified individuals who are independent of the original work but who have sufficient expertise to perform the work.

A technical review will include an in-depth analysis and evaluation of the document to ensure the following:

- Applicability
- Correctness
- Technical Adequacy
- Completeness
- Supportability of interpretation
- Compliance with technical requirements

A peer review will address all of the above, as well as the following:

- Adequacy of information and references presented to support use or evaluation of a state-of-the-art technology
- Adequacy of information and methodologies presented when pertinent technical criteria do not exist or are being developed

Technical and peer reviews will evaluate the following aspects of each document, as appropriate:

Technical Correctness

- ❑ Is the document technically defensible?
- ❑ Are the interpretations supported by the data and assumptions?
- ❑ Has adequate explanation been provided for selection of only a partial data set (in the event that not all data have been honored)?
- ❑ Is the information and reference documentation adequate?
- ❑ Is the document consistent throughout? Is it consistent with other documents in the submittal?

Objectives

- ❑ Have the goals and objectives of the document and of the project/study been adequately defined?
- ❑ Have the key technical issues affecting the goals been identified and described?

Assumptions

- ❑ Are assumptions pertinent, clearly stated, and justified?
- ❑ Does the justification reference appropriate supportive material or studies?

Methods

- ❑ Have appropriate techniques or methods been used or recommended for the work?
- ❑ If new or nonstandard methods are used or proposed, have they been clearly identified? Are they adequately described? Is information provided for appropriate reference sources?

The following items will be considered for each identified area in the document:

- **Executive Summary**—Does it state the purpose of the document? Is it clear, concise, and logical? Does it describe the scope of work and summarize the main results and conclusions? Does the information match that in the main text?

- **Introduction**—Does it clearly state the problem addressed by the document, the objectives and scope of work, and the pertinent background information? Does it identify any key technical issues pertaining to the main problem and objectives? Does it identify key regulatory drivers or issues?

- **Main Text**—Is it organized to present information, evaluation, and/or interpretation in a logical manner to support results and conclusions? Do the referenced figures, tables, and appendices support the text? Are all included figures, tables, and appendices cited in the text?

- **Conclusions and Recommendations**—Do the conclusions and/or recommendations meet the goals and objectives stated in the introduction? Are the conclusions technically defensible? Is sufficient technical information presented to support the conclusions/recommendations? Does the information included match with that presented in the main text?

- **References**—Are pertinent and up-to-date references incorporated and cited correctly in the document? Are all references cited in the text, tables, and figures listed in the References section?

- **Figures, Tables, and Calculations**—Is the information presented technically correct? Have figures, tables, and calculations been checked and approved, as appropriate? Is basic information presented clearly? Are figures and tables able to stand alone (are they understandable outside of the text)? Do figures and tables acknowledge sources for quoted information, base maps, etc. and provide reference information for cited documents?

- **Appendices**—Are appendices used appropriately to provide detail descriptions, methodologies, evaluations, and data that are not covered in the text? Does the information in the appendices support the propositions or conclusions in the text, as appropriate? Do appendices conform to the technical requirements stated above for the main document, as appropriate?

APPENDIX B

ENG FORM 4288 SUBMITTAL REGISTER

SUBMITTAL REGISTER
(ER 415-1-10)

CONTRACT NO.

TO NO.

TITLE AND LOCATION:

CONTRACTOR:

SPECIFICATION SECTION:

Scope of Work

				TYPE OF SUBMITTAL									CLASSIFICATION			CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		
TRANS-MITTAL NO. a.	ITEM NO. b.	SPECIFICATION PARAGRAPH NO. c.	DESCRIPTION OF ITEM SUBMITTED	DATA e.	DRAWINGS f.	INSTRUCTIONS g.	SCHEDULES h.	STATEMENTS i.	REPORTS j.	CERTIFICATES k.	SAMPLES l.	RECORDS m.	INFO ONLY n.	GOV. APPROVED o.	REVIEWER p.	SUBMIT q.	APPROVAL NEEDED BY r.	MATERIAL NEEDED BY s.	CODE t.	DATE u.	SUBMIT TO GOVERN-MENT v.	CODE w.	DATE x.	REMARKS y.

APPENDIX C

DISCIPLINE SIGN-OFF REVIEW

DOCUMENT REVIEW FORM

Shaw Environmental & Infrastructure, Inc.

DISCIPLINE SIGN-OFF REVIEW

Client Name: _____

Project Description: _____

Contract No. | | | | | | | - | | | - | | - | | | | | Delivery Order No. | | | | |

Project No. | | | | | | | Task/Phase Number: | | | | | | | | |

Document Type

Identify specific section or segment covered by this checkprint

- ☐ Technical / Cost Proposal _____
- ☐ RFP _____
- ☐ Contract / Subcontract _____
- ☐ SHP, SSAP, CDAP, or QAPP _____
- ☐ Report _____
- ☐ Risk Assessment / Evaluation _____
- ☐ Specifications & Plans _____
- ☐ Design Calculations _____
- ☐ Tables _____
- ☐ Drawings / Figures
- ☐ Other:

Document Origin

- ☐ Originator Developed
- ☐ Edited Standard
- ☐ Client Furnished

Document Status

- ☐ Preliminary
- ☐ Internal Draft
- ☐ Draft
- ☐ Draft Final
- ☐ Final
- ☐ Other:

Required Person	Signature	Date
Principle Author		
Technical Review		
Technical Review		
Project Review		

NOTICE: By signature above, parties certify that the subject document has been prepared by and/or reviewed by them (as appropriate), that all review comments have been resolved, and that the document is ready for submittal.

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Document Review Form

The attached document is submitted for your review. Please return this sheet along with the completed comment sheet to the author. Direct all questions to the author.

Document Information

Title:
Date:
Author:

Reviewer Information

Date Issued: _____ **Response Required By:** _____

This document is being reviewed by the following individuals:

Review Team	ITR Reviewer

Review

☐ Concur without comment **SIGNATURE:** _____ **DATE:** _____

☐ Concur with minor comments **SIGNATURE:** _____ **DATE:** _____

☐ Comments must be resolved **SIGNATURE:** _____ **DATE:** _____

Resolution

☐ Comments have been resolved and incorporated

Reviewer's Signature: _____ **DATE:** _____

Author's Signature: _____ **DATE:** _____

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Document Review Form

Title:

ITEM	Page No. Paragraph	Comment	Author's Response

APPENDIX D

RESUMES

Name (Employer):	Scoville, William H., PE, PMP, LEED Green Practitioner (Shaw)
Job Title:	DoD Program Manager
Project Role:	Program Manager
Education:	MS/ Geotechnical Engineering/1985; AB/Engineering/Earth Sciences/1983

QUALIFICATIONS

- 25 years experience in supporting and managing aggressive and innovative environmental restoration and compliance programs for Federal customers, including FUSRAP sites
- Managed more than 50 task orders under ID/IQ contracts with a total value of more than $100M

RELATED PROJECT EXPERIENCE

09/09 – 09/10, LINDE FUSRAP (Formerly Utilized Site Remedial Action Program) Site Remediation, Project Manager

As the Project Manager, Mr. Scoville is responsible for all project activities related to the remediation and close out of this site used during the 1940's by the Manhattan Engineer District to isolate uranium from the ore. The contaminants of concern are uranium-238, thorium-230, and radium-226.

Under Mr. Scoville's direction, the Linde technical team completed more than 20 Final Status Survey Unit reports, six monthly perimeter air sampling data reports, and two quarterly dosimetry reports. He directed the Project Construction Report documenting the remediation efforts, including: utility relocation, new utility construction, building demolition, radiological characterizations, excavation, transportation and disposal, water treatment, and site restoration.

03/08 – Current, USACE Louisville District Environmental Services, Various Sites, Program Manager

Mr. Scoville is Program Manager for 23 active task orders totaling more than $10M, including:

- Treatability study of in situ bioremediation of nitroaromatic-contaminated groundwater via the injection of an organic substrate. Two members of Mr. Scoville's technical team presented the results of the successful treatability study, (which demonstrated contaminant reduction and sequestration), at three national conferences and in the Federal Facilities Environmental Journal.
- Geochemistry review of groundwater to remove contaminants of concern (COCs) from a monitoring program. He oversaw the geochemical evaluation of metals in groundwater, which established a baseline of naturally occurring background concentrations of inorganics and determined if elevated concentrations of metals in groundwater are naturally occurring. The study also identified geologic, hydrogeologic, and geochemical processes that control the distributions of naturally occurring minerals and inorganic compounds in groundwater.

03/91 – 09/00, Wright-Patterson AFB CERCLA Treatability / Feasibility Studies, and Remedial Actions, Project Manager

Mr. Scoville managed design and implementation of treatability testing and remedial action activities for Landfills 8 and 10 at WPAFB, Ohio. He used results of the treatability tests, including biological treatment studies, to develop the Final Design for a pilot leachate treatment system. Subsequently, he managed the installation and testing of a 20-gpm fluidized bed reactor and a 1 gpm sequencing batch reactor pilot leachate treatment system. These systems were evaluated using procedures in a detailed testing plan. Results of the pilot testing indicated the leachate characteristics were at levels suitable for treatment at a POTW, eliminating the requirement for onsite treatment, and thus saving the client over $10M, and removing the need for long-term permits.

03/91 – Current, Wright-Patterson AFB Air, Water, and Stormwater Compliance and Natural Resources Support, Program Manager

Mr. Scoville is the Program Manager for more than 20 concurrent task orders on this $8.1M, 5-year ID/IQ contract supporting WPAFB's Installation Restoration Program compliance, NEPA, natural and cultural resources, and hazardous materials/waste programs. Projects managed by Mr. Scoville included CERCLA site investigations, an outdoor range facility; remediation designs and 25 NEPA/cultural resources projects. He also managed and coordinated WPAFB's Environmental, Safety, and Occupational Health Compliance Management Program audits in 2005, 2007, and 2008.

11/03 – 06/04, American Laundry Brownfields Remediation / LEED Project

Mr. Scoville was Project Manager for environmental remediation of former industrial property and compilation of documentation for project LEED certification. The 83-year old, building had sustained environmental damage and required soil remediation and asbestos removal. Mr. Scoville managed remediation efforts, which included tank removals, contaminated soil removal, lead-based paint abatement, and hazardous material (e.g., mercury switches and PCB ballast) removal. Mr. Scoville directed the collection and evaluation of groundwater and soil data to document no further action at the site. The project received LEED NC 2.1.Certification in July of 2007.

Name (Employer):	VanKeuren, Karl, PG, PMP (Shaw)
Job Title:	Project Manager
Project Role:	Project Manager
Education:	MS/ Geology /1987; BS/ Geology /1983

QUALIFICATIONS

- Over 23 years of experience in environmental investigation and remediation.
- Managed Task Orders with annual revenues of over $1MM. involving investigation and remediation of soil and groundwater contamination, aquifer testing, computer modeling of groundwater flow and contaminant transport, and design and installation of groundwater remediation systems.
- Project experience includes remedial investigations, risk assessments, and feasibility studies under RCRA, CERCLA, and state regulations.

RELATED PROJECT EXPERIENCE

09/06-10/10, Mound OU-1 Remediation, Miamisburg, OH, Project Manager/Technical Lead

Mr. Van Keuren managed and provided technical support for the Shaw portion of a DOE remediation project in Miamisburg, Ohio. The project involved the excavation and disposal of over 500,000 cubic yards of low-level radioactive and mixed.

09/06-10/09, Navy OEL Assessment Project, Team Leader/Estimator

Inventoried potential Other Environmental Liabilities (OELs) that would need to be address in the case of base closure, including RCRA storage areas, process equipment, and CERLA sites not funded under Defense Environmental Restoration Program (DERP). Inspections included former and active explosives production, testing, and disposal areas. Cost estimates were prepared to decommission/remediate each OEL.

09/06-6/08, Environmental Service, Defense Fuel Support Point, Cincinnati, OH, Project Manager/Technical Lead

Conducted the selected remedial alternative, a monitored natural attenuation (MNA) evaluation for this Defense Energy Support Center (DESC) facility. Services for this facility have included SIs with soil and groundwater sampling, human health risk assessment, ecological assessment, and an EBS. Prepared a report that evaluated remedial alternatives and included costs estimates. Received an NFA closure for an Ohio Bureau of Underground Storage Tank Regulations (BUSTR) regulated UST. As a result of successful investigation and characterization, this site has received a Finding of Suitability for Early Transfer (FOST).

06/99-01/06, RI/FS Former Lordstown Ordnance Depot, Lordstown, OH, Project Manager/Technical Lead

Directed Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) SI/RI/FS activities that included auger and Geoprobe drilling, soil, groundwater, surface water, and sediment sampling, chemical analysis, aerial/land/geophysical surveys, human health risk assessment, in situ aquifer hydraulic tests, hydrogeology characterization, IDW management and disposal, and prepared all associated documents including WPs, QAPPs, and reports. Used an integrated combination of geophysics, CAD, and GPS to high-bias sample locations for complete characterization of disposal areas. This project included the collection and analysis of 527 soil samples, 52 groundwater samples, 15 surface water samples, and 13 sediment samples. Twenty-five monitoring wells were also installed. Based on visual observations, the disposal areas were confirmed; analytical data indicated that no

significant contamination was present, resulting in NFA for the sites.

09/99-06/06, SI Former Lockbourne Air Force Base, Columbus, OH, Project Manager/Technical Lead

Services at FLAFB included an SI for 21 Areas of Concern (AOCs) including soil and groundwater sampling using a Geoprobe and a cone penetrometer to delineate the nature and extent of contamination, monitoring well installation with sonic drilling, human health risk assessment, hydrogeology, and UST investigations with geophysics. This project included the collection and analysis of 124 soil samples and 43 groundwater samples. Successfully negotiated with Ohio EPA for NFAs at 22 AOCs. Received Ohio BUSTR NFA closures on all regulated USTs that were removed.

Name/ Employer:	Tituskin, Sue, CPG, LRS (Shaw)
Job Title:	Technical Leader
Project Role:	Feasibility Study Technical Lead
Education:	MS/ Geology/1983; BS/Geology/1979; BA/Anthropology/1976

QUALIFICATIONS

- 31 years of experience investigating contaminated sites and evaluating and implementing remedial actions
- Experienced in the integration of a variety of data including soil gas, geophysics, computer models and chemical data collection to develop site conceptual models for development of remedial measures

RELATED PROJECT EXPERIENCE

03/09-Present, Groundwater Feasibility Study, Former Raritan Arsenal, Technical Lead

Ms. Tituskin is the technical lead for preparation of a comprehensive groundwater feasibility study to evaluate and recommend remedial alternatives for nine sites at the Former Raritan Arsenal in Edison, NJ. She reviewed geochemical data for each site to document the occurrence of natural attenuation of chlorinated organic compounds at eight of the sites. She used the criteria from the States standards to document biodegradation of the primary Contaminants of Concern, chlorinated organic compounds, primarily TCE. She studied the results of field pilot tests to evaluate the effectiveness of in situ chemical oxidation and enhanced in-situ bioremediation at the remaining sites. She evaluated remedial alternatives including no action, in-situ treatment and monitored natural attenuation for each site. She evaluated each against the CERCLA criteria to support the selection of a final alternative. She determined that chemical oxidation was most successful in the area of highest contamination and enhanced bioremediation was successful and more cost effective in other portions of the plume.

05/99-Present, CERCLA Support, Vance AFB, Technical Lead

Ms Tituskin had technical responsibility for the preparation of feasibility studies, proposed plans, and records of decision (RODs) for multiple sites and areas of Vance AFB. A chlorinated solvent plume more than 3 miles long is present, with multiple sites contributing to the plume consisting primarily of TCE and its degradation products. A second benzene plume was also addressed. Ms Tituskin has used soil and groundwater data, soil gas data, and membrane interface probe date to develop a site conceptual model for each site study. She used a groundwater flow, fate and transport model to evaluate the performance of various technologies including in situ treatment, phytoremediation, groundwater intercept trenches, groundwater extraction using horizontal wells, and monitored natural attenuation. She used the results to select various technologies to address groundwater contamination including interceptor trenches, phytoremediation, and individual recovery wells. The study found that the selected technology combinations are reducing the concentrations in the contaminate plume at a faster rate than predicted thus reducing the overall time frame and cost. The extraction systems take advantage of available capacity in the onsite treatment plant which has also significantly reduced the treatment cost.

09/07-06/09, CERCLA Five Year Review, Multiple Sites, Vance Air Force Base, Technical Lead

Ms. Tituskin provided technical support and oversight for all efforts in the design of the sampling program, field implementation, and update of a groundwater model to support the performance evaluation of multiple groundwater remediation systems at Vance AFB. The remedial

actions implemented at these sites address a combined groundwater plume approximately one mile long. A groundwater monitoring program and update of the Modflow/GMS groundwater flow and transport model were also preformed. She reviewed the chemical and hydrogeologic data. She provided recommendations to improve the systems performance through better maintenance of the pumping system to maintain extraction rates and thus reduce time needed for operation. Ms. Tituskin made expert presentations of study updates and final results at a series of public meetings.

10/00-02/08, RCRA Facility Investigation (RFI), Former Quaker State Refinery, Project Manager/Technical Lead

Ms Tituskin served as the technical lead for the RCRA Facility Investigation at a former Quaker State Refinery. She was responsible for all technical aspects, as well as cost and schedule. Due to above and below ground infrastructure present at the operating facility, she used non-intrusive investigation techniques including soil gas studies and geophysical investigations. Ms. Tituskin used the data to design a focused subsurface investigation to characterized approximately 30 SWMUs and AOCs using two different drilling methods for well installation, and three types of Geoprobes, including a mobile folding unit placed in the sampling locations using a crane. A benzene plume covering more than 30 acres was found as well as several acres of free product. She implemented interim measures to address the free product and a contaminated soil pile. She was responsible for the removal and disposal of these materials. Both free product and soil were sent to recycling facilities for re-use.

Name (Employer):	Tandon, Vikas, PhD, PG (Shaw)
Job Title:	Manager/Senior Modeler
Project Role:	Modeling Technical Lead
Education:	PhD/Hydrogeology/2000; MS/Geology/1991; MTech/Applied Geology/1989; BS/Physics, Geology, Math/1986

QUALIFICATIONS

- 13 years experience developing, calibrating and optimizing models at different spatial and temporal scales.
- Manager and lead modeler for a number of projects involving soil, groundwater and surface water media.
- Experienced in use of models and methods for: capture zone estimation; groundwater dewatering, natural attenuation feasibility; evaluation of long-term sustainability of water supplies; optimization of groundwater remediation systems; vadose zone mounding and contaminant leaching analyses; effects of effluent discharges to river, lakes, and streams.

RELATED PROJECT EXPERIENCE

06/04 – 07/09, Groundwater Modeling to Support Remedial Design in Complex Geological Setting, Maywood FUSRAP Site, Maywood, NJ, Senior Modeler

Dr. Tandon managed and performed groundwater flow and solute transport modeling to project the future extent of contaminant plumes and to evaluate remedial approaches at the Maywood FUSRAP Site. He developed three-dimensional models for metals, radio-nuclides, and organic contaminants. He used the Groundwater Modeling System (GMS) platform and the MODFLOW, MT3D and MODPATH codes to surmount the complexity of evaluating the combined overburden/ fractured bedrock flow system. Dr. Tandon evaluated the feasibility and effectiveness of a number of groundwater remedial alternatives including no action, natural attenuation, groundwater extraction followed by ex-situ treatment, enhanced biodegradation and in-situ redox alteration for metals. Model results were used as a basis for the Feasibility Report.

06/04 – Present, Modeling of Groundwater Extraction during Soil Removal Action and Post Removal Evaluation of Natural Attenuation, Colonie FUSRAP Site, Colonie, NY, Task Manager, Technical Lead

Dr. Tandon managed and performed calculations and modeling to estimate the dewatering requirements for the excavation activities during the soil removal-based remediation. He designed a dewatering system consisting of extraction wells. Observations during the removal action indicate that the dewatering system was successful. Following the soil removal action, Dr. Tandon designed a plan for the Long Term Monitoring (LTM) of natural attenuation of the residual contamination in groundwater. Dr. Tandon recently completed an evaluation of the LTM first-year data. Results indicate that natural attenuation is successfully occurring according to expectations.

12/07 – 03/10, Nuclear Plant Construction Site Dewatering, Vogtle Electric Generation Plant, Southern Nuclear Company, GA, Lead Hydrogeologist / Modeler

Dr. Tandon served as the Lead Hydrogeologist and modeler for the successful dewatering design at a proposed nuclear power plant. He prepared design criteria specifications and performed modeling for the Power Block Excavation/Backfill Dewatering and for the dewatering of the River Water Intake structure area to allow excavation and backfilling to occur at depths below the groundwater table. This involved design of a dewatering system to support excavation up to 95 feet below grade, about 35 feet below water table. He provided the permitting team with estimates of impact of excavation dewatering on surrounding

community's water resources. A number of dewatering techniques were modeled such as vertical wells, horizontal trenches and drains, and slurry wall barriers to impede the flow of the water from the Savannah River to the excavation area.

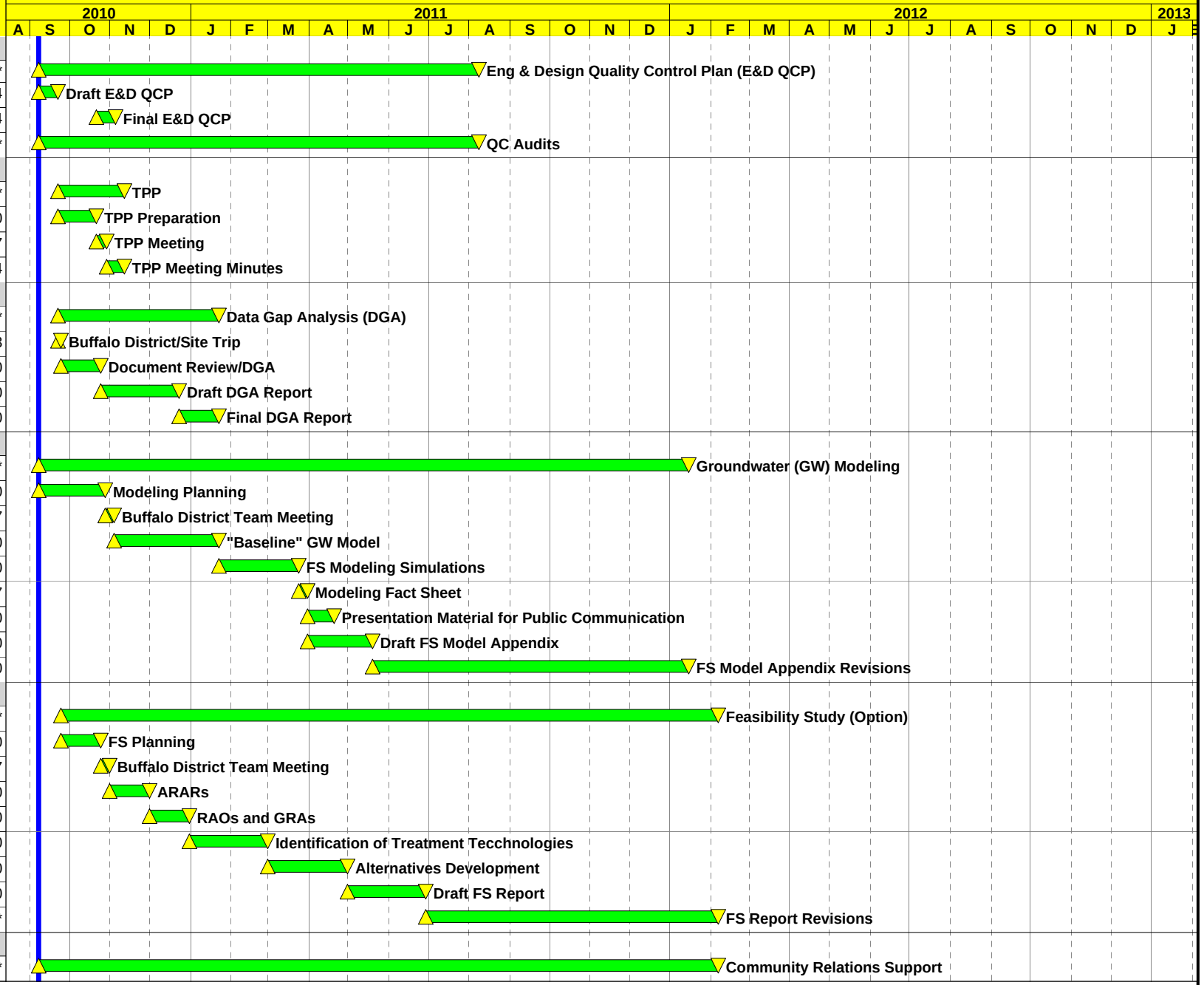
02/03 - 05/03,-Groundwater Pump and Treat System Optimization Modeling, Allied Chemical and Ironton Coke Superfund Site, Honeywell International, Ironton, OH, Modeler

Dr. Tandon combined hydrogeologic visualization, evaluation of contaminant distribution, and groundwater flow modeling to evaluate and optimize an existing groundwater containment and recovery system. He proposed an optimization approach in order to better align system performance with the long term remedial goals, and eliminate redundant extraction centers. To evaluate the completeness of groundwater plume capture, capture zones were calculated and groundwater flow paths / contaminant extraction trajectories were superimposed on the plume maps. Results of the model were used to make system adjustments and operational changes to optimize the remedial system. Net system capacity reduction was about 17%, resulting in savings of $450,000/ year.

APPENDIX E

PROJECT SCHEDULE

Activity ID	Early Start	Early Finish	Orig Dur
E&D QCP			
01000000	08SEP10	08AUG11	335*
01010000	08SEP10*	21SEP10	14
01020000	22OCT10	04NOV10	14
01030000	08SEP10	08AUG11	335*
TPP			
02000000	22SEP10	11NOV10	51*
02010000	22SEP10	21OCT10	30
02020000	22OCT10	28OCT10	7
02030000	29OCT10	11NOV10	14
DATA GAP ANALYSIS (DGA)			
03000000	22SEP10	22JAN11	123*
03010000	22SEP10	24SEP10	3
03020000	25SEP10	24OCT10	30
03030000	25OCT10	23DEC10	60
03030100	24DEC10	22JAN11	30
GROUNDWATER (GW) MODELING			
04000000	08SEP10	14JAN12	494*
04010000	08SEP10*	27OCT10	50
04020000	28OCT10	03NOV10	7
04030000	04NOV10	22JAN11	80
04040000	23JAN11	23MAR11	60
04050000	24MAR11	30MAR11	7
04060000	31MAR11	19APR11	20
04070000	31MAR11	19MAY11	50
04070100	20MAY11	14JAN12	240
FEASIBILITY STUDY (OPTION)			
05000000	25SEP10	06FEB12	500*
05010000	25SEP10	24OCT10	30
05020000	25OCT10	31OCT10	7
05030000	01NOV10	30NOV10	30
05040000	01DEC10	30DEC10	30
05050000	31DEC10	28FEB11	60
05060000	01MAR11	29APR11	60
05070000	30APR11	28JUN11	60
05070100	29JUN11	06FEB12	223*
COMMUNITY RELATIONS SUPPORT			
06000000	08SEP10	06FEB12	517*



Start Date 08SEP10
Finish Date 06FEB12
Data Date 08SEP10
Run Date 16SEP10 10:17

Early Bar
Progress Bar
Critical Activity

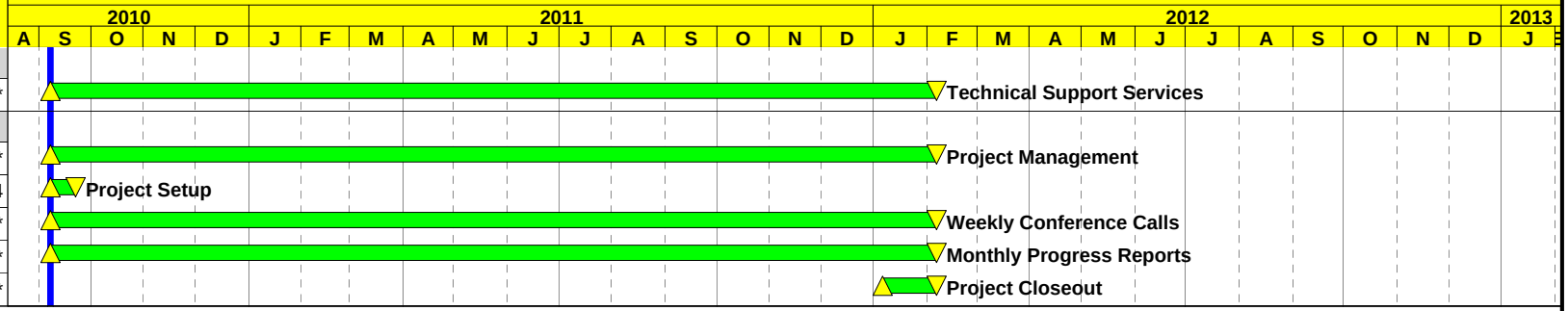
GUT3 Sheet 1 of 2

GUTERL FS

Classic Schedule Layout

Date	Revision	Checked	Approved

Activity ID	Early Start	Early Finish	Orig Dur
TECHNICAL SUPPORT SERVICES			
07000000	08SEP10	06FEB12	517*
PROJECT MANAGEMENT			
08000000	08SEP10	06FEB12	517*
08010000	08SEP10	21SEP10	14
08020000	08SEP10	06FEB12	517*
08030000	08SEP10	06FEB12	517*
08040000	06JAN12*	06FEB12	32*



Start Date 08SEP10
Finish Date 06FEB12
Data Date 08SEP10
Run Date 16SEP10 10:17

Early Bar
Progress Bar
Critical Activity

GUT3 Sheet 2 of 2

GUTERL FS

Classic Schedule Layout

Date	Revision	Checked	Approved