

Technical Assistance on the Development of a Regulatory Framework for Environmental Remediation Projects in Chile

FINAL REPORT

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- A. MANUAL TÉCNICO PARA LA INVESTIGACIÓN AMBIENTAL DE SITIO (Task 1 Manual in Spanish)
- B. REMEDIAL INVESTIGATION TECHNICAL MANUAL (Task 1 Manual in English)
- C. MANUAL TÉCNICO PARA EL ANÁLISIS DE FACTIBILIDAD (Task 2 Manual in Spanish)
- D. FEASIBILITY STUDY TECHNICAL MANUAL (Task 2 Manual in English)
- E. MANUAL DE PROCEDIMIENTOS ADMINISTRATIVOS Y MECANISMOS FINANCIEROS PARA LA REMEDIACION AMBIENTAL EN CHILE (Task 3 Manual in Spanish)
- F. MANUAL OF ADMINISTRATIVE PROCEDURES AND FINANCIAL MECHANISMS FOR ENVIRONMENTAL REMEDIATION IN CHILE (Task 3 Manual in English)
- G. Environmental Remediation Workshop CD (Task 4)

EXECUTIVE SUMMARY

To be added after comments from CONAMA

INTRODUCTION

Chile's economy is characterized by the extraction of natural resources, including minerals, metals, and lumber, as well as processing and primary manufacturing. The exploitation of Chile's natural resources, including old grown forests and mineral resources, together with a manufacturing industry associated to those industries has resulted in degradation of the environment. Also, ongoing urbanization has resulted in increased concerns associated with the generation and concentration of various wastes (CONAMA, 2005). CONAMA specifically lists the following activities as a potential concern to pollute soil and groundwater:

- Mining,
- Industrial activities,
- Forestry (wood treatment),
- Petroleum refining, together with transport, storage and distribution of petroleum liquid fuels,
- Uncontrolled disposal of residues,
- Transportation of hazardous substances,
- Agricultural activities.

The current size of the contaminated sites problem in Chile, although unknown, is anticipated to be significant. In fact, population in the vicinity of certain contaminated sites has already reported health effects that can be associated with those sites.

As part of one of the eight cooperative projects targeted by Chile and the United States in Annex 19.3 of the Free Trade Agreement, the U.S. Trade and Development Agency (USTDA) has provided a grant to Chile's Comisión Nacional del Medio Ambiente (CONAMA) for "Technical Assistance on the Development of a Regulatory Framework for Environmental Remediation Projects in Chile." This assistance is aimed at institutional strengthening of CONAMA's capability to develop and implement an environmental regulatory framework for environmental remediation. This Technical Assistance has five separate tasks:

1. Remedial investigation guidelines and protocols,
2. Feasibility study guidelines and protocols,
3. Environmental administrative procedures and financial mechanisms,
4. Environmental remediation workshop,
5. Final report (this report).

Tasks 1 through 3 required the preparation of comprehensive reports in English and Spanish. A summary of the substance and content of these reports is provided below, followed by an account of the activities associated with Task 4. All reports were thoroughly reviewed and approved by CONAMA. All deliverables are provided with this Task 5 report. Because the Task 3 report addresses administrative and financial topics that are specific for the Chilean situation, it was prepared by Chilean contractors in Spanish and then translated in English.

TASK 1. REMEDIAL INVESTIGATION GUIDELINES AND PROTOCOLS

As part of the Technical Assistance Program ARCADIS prepared a comprehensive manual entitled “Remedial Investigation Technical Manual,” for CONAMA. In Spanish this manual is entitled, “Manual Técnico para la Investigación Ambiental de Sitio.” The Manual primarily addresses environmental site and risk assessments during investigations in support of the National Environmental Policy for Contaminated Sites (Política Nacional para la Gestión de Sitios Contaminados). This manual provides guidance on planning, developing and conducting data collection operations in support of determining the nature and extent of contamination at a site. It also provides guidance on quantifying risks to human health and the environment posed by contaminants at the site and can be used to support risk management decision-making and for identifying preliminary response actions for a site. Throughout the manual practical experience from ARCADIS and other sources is included in the form of “tips.” The manual is intended to be used together with the Feasibility Study Technical Manual (Task 2), which provides guidance on developing and evaluating remedial options.

Sources of Chilean guidance and information that were reviewed included CONAMA and the Ministry of Health (MINSAL). Available U.S. information on planning and conducting environmental assessments that was reviewed included:

- Guidance for conducting RI/FS under the Comprehensive Environmental Responsibility, Compensation and Liability Act (CERCLA)
- Applicable or Relevant and Appropriate Requirements (ARARs) guidance (CERCLA Compliance with Other Laws Manual)
- Superfund Program Representative Sampling Guidance
- Risk Assessment Guidance for Superfund
- Superfund Exposure Assessment Manual
- Resource Conservation and Recovery Act (RCRA) Facility Investigation Guidance
- RCRA Groundwater Monitoring: Draft Technical Guidance
- National Contingency Plan (NCP) Soil Screening Guidance
- US EPA publication SW-846, entitled Test Methods for Evaluating Solid Waste, Physical/Chemical Methods
- US EPA Contract Laboratory Program (CLP) Guidance for Field Samplers
- Guidelines for preparing Quality Assurance Project Plans (QAPPs)
- Guidelines for preparing Data Quality Objectives (DQOs)
- Guidelines for preparing and conducting Data Quality Assessments
- ASTM standards for Phase I and II Environmental Site Assessments (ESAs)
- ASTM standard for Risk-Based Corrective Action (RBCA).

Content of the Remedial Investigation Technical Manual

The manual and appendices are approximately 300 pages and include the sections listed below.

1. Introduction

This section outlines the remedial investigation/feasibility study process, Chilean perspective, and organization of the manual. It also describes the intended audience.

2. Preliminary Assessment

This section describes the four steps that typically make up the preliminary assessment (determining the nature and extent of the contamination):

- 1) Review existing information about the site,
- 2) Conduct a site and surrounding areas reconnaissance,
- 3) Conduct interviews, both with current owners and occupants of the site, and local government officials,
- 4) Prepare report.

3. Conceptual Site Model

During the preliminary assessment, available information on potential hazardous waste sources, migration pathways and human and environmental receptors, together with the results of a site reconnaissance are integrated to develop a conceptual understanding of the site with relation to potential risks to human health and the environment. This conceptual understanding is the Conceptual site (exposure) model (CSM).

4. Site investigation: sampling and analysis plan development

If a further investigation is needed at a site, a Site Investigation (SI) is conducted. The purpose of the SI is to determine the nature and extent of contamination at a site, to provide information to quantify risks posed to human health and the environment, and support the selection and implementation of appropriate remedies.

5. Site physical characteristics

Assessments of the geology, hydrogeology, geomorphology, geography and meteorology of the site are covered in this section. Especially the characterization of groundwater flows is important for remediation projects.

6. Field investigation

This chapter has three sections: sample collection equipment, sample collection procedures, and sample handling. The first two sections are generally divided up per medium: groundwater, surface water, sediments, soil, and air. The third section includes general sample handling and documentation guidance, which is not medium-specific. Site investigation methods and sampling technology that are discussed include: geophysical techniques, hand augering, trenching, soil vapor

surveys, direct sampling methods, drilling, surface water sampling, sediment sampling, groundwater sampling, and air monitoring.

7. Sample analysis

This section includes information on analytical method selection, field analytical technologies, and laboratory analytical techniques, as well as on laboratory quality assurance and quality control (QA/QC).

8. Data validation

Data validation is an important process whenever site decisions are being made based on analytical data. During the site investigation process, no or very few new measurements are taken and evaluating existing site data (historical data from previous investigations) is important to ensure that environmental programs and decisions are defensible. Evaluating existing site data involves a sequence of three activities, namely Data Verification, Data Validation and Data Quality Assessment (DQA).

9. Analysis of investigation data

The final objective of the Site Investigation is to evaluate hydrogeological data, determine the nature and extent of impacts in environmental media, and perform fate and transport modeling such that informed decisions can be made as to the level of risk or hazard presented by exposure to constituents detected at the site, together with the development of remedial alternatives.

10. Risk assessment

The baseline risk assessment establishes whether a potential threat to human health and/or the environment is present in connection with exposure to constituents detected at a site. The risk assessment also defines a range or magnitude of the risk by combining the results of an exposure assessment with chemical-specific toxicity information. This section includes the baseline human health risk assessment and the ecological risk assessment. Each section includes subsections on hazard identification, exposure assessment (pathways), toxicity assessment, risk characterization, exposure assessment and uncertainties.

11. Preliminary remedial action objectives

In this section preliminary remedial action objectives and goals and response actions are described.

12. Remedial investigation report

An example table of contents for the report is provided here.

Appendices

Eight appendices provide practical check lists that can be copied for use in the field, as well as background information on decision rules, sampling design and sample size equations, sampling locations, monitoring well construction,

statistical tests, contaminant fate and transport processes and supplemental equations for exposure pathway calculations.

Note: Identification of applicable or relevant and appropriate requirements (ARARs), identification of remedial technology, screening of remediation alternatives, and treatability studies are included in the task 2 report.

TASK 2. FEASIBILITY STUDY GUIDELINES AND PROTOCOLS

The Feasibility Study Technical Manual primarily addresses selection of remediation approaches following site characterization investigations in support of the Chilean National Environmental Policy for Contaminated Sites (Política Nacional para la Gestión de Sitios Contaminados). It is intended to be used together with the Remedial Investigation Technical Manual, which provides guidance on data collection operations in the site investigation stage that precedes the feasibility study. An overview of the Remedial Investigation and Feasibility Study process is provided in the Task 1 Manual. In a general sense, the Remedial Investigation precedes the feasibility study, but in reality, the two processes are somewhat iterative and overlapping.

The feasibility study process consists generally of the development, screening and detailed analysis of alternatives for remediation. The complexity of the process is site-dependent, but the following steps are generally included:

- Development of general response actions for each medium of interest (based on the conceptual site model and remedial action objectives established during the RI and refined as necessary in the Feasibility Study);
- Identification and first screening of potential remedial technologies applicable to each medium;
- Evaluation of technology process options;
- Organization of the identified technologies into alternatives, representing a range of options;
- Screening of remediation alternatives for each medium;
- Individual and comparative analysis of remediation alternatives for each medium, and selection of preferred alternatives.

Sources of Chilean guidance and information that were reviewed included CONAMA and the Ministry of Health (MINSAL). In addition, U.S. EPA information on evaluating and selecting remediation alternatives that was reviewed included guidance on:

- Conducting remedial investigations and feasibility studies under CERCLA,
- Institutional controls,
- Presumptive remedies,
- Cost Estimates

Content of the Feasibility Study Technical Manual

The Feasibility Study Technical Manual includes the sections described below.

1. Introduction

This section includes the intended audience and a summary of the Chilean context.

2. Overview of the feasibility study development process

This section pertains to establishing the basis for developing a remediation strategy and the feasibility study evaluation, including identifying applicable or relevant appropriate requirements (ARARs), as well as assessing the need for treatability and/or pilot testing. Also included is the development of General Response Actions including the No Action response.

3. Presumptive remedies

Presumptive remedies (preferred alternatives) are preferred technologies for common categories of sites, based on historical patterns of remedy selection and the scientific and engineering evaluation of performance data on technology implementation. The objective of the presumptive remedies approach is to use past experience to streamline site investigations and speed up selection of cleanup actions. Presumptive remedies are provided for wood treater sites, soils contaminated with volatile organic carbons, contaminated groundwater, municipal landfills, and metals-in-soil sites.

4. Development of remedial alternatives

This section includes a general discussion on assembly of possible alternative technologies and selection (screening) for principal threats and low-level threats for each medium. A significant part of this section is taken up by tables for groundwater, soil and air which provide examples of remedial action objectives, general response actions, technology types, and example process options for the development and screening of technologies.

5. Detailed analysis of alternative technologies

In this step of the Feasibility study process, the remedial alternatives remaining after the alternatives screening are defined more specifically and subjected to a detailed evaluation against nine criteria. This step is intended to provide regulators with sufficient information to select a final remedy or remedies for the site. Specifically, this section includes information on: overall protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, reduction in toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, cost, support agency (regulatory) and public acceptance, as well as comparative analysis of alternatives.

6. Feasibility study report

This section includes a suggested table of contents for a feasibility study report.

Appendices

Five appendices include information on:

- common remediation technologies,
- remediation technologies for the mining industry,
- remediation technologies for sawmills and wood treater sites,
- a glossary of technical idioms and their translations,
- a list of acronyms with translations.

TASK 3 ENVIRONMENTAL REMEDIATION FINANCES

The objective of this task was to identify and document viable funding mechanisms and regulatory protocols for the implementation and management of environmental remediation projects in Chile. ARCADIS provided technical assistance to CONAMA in suggesting changes to existing Chilean legislation to incorporate remediation requirements at contaminated sites. Several possible associated financing mechanisms are discussed and an overview of existing international financing mechanisms is also included. The Manual has five chapters and five appendices which are discussed below.

Chapter 1 includes a brief introduction to the problem of contaminated sites in Chile.

Chapter 2 includes a description of the current regulatory framework associated with contaminated sites which consists of the general environmental law under which CONAMA was formed and the Draft National Policy for the Management of Contaminated Sites from 2005. Also the chapter provides a detailed description of existing potential management tools including: administrative mechanisms, mandates by the Courts of Justice, as well as direct intervention of public services, for example in the case of an environmental emergency.

Chapter 3 describes existing potential financial mechanisms associated with the management of contaminated sites. It includes a description of potential Chilean funds, as well as text on the limitations in the Chilean Law regarding mechanisms for evaluation of impact.

Chapter 4 presents an analysis of foreign experience, regarding normative and financial instruments. Examples of regulatory frameworks from other countries include: the U.S. CERCLA and RCRA programs, as well as examples from Canada, the United Kingdom and the Netherlands. Furthermore this section includes a listing of potential international financial instruments for the remediation and management of contaminated sites.

Chapter 5 presents targeted comprehensive proposals for the development of a legislative framework and administrative procedures, as well as financial instruments for implementation of RI/Feasibility Study and remedial actions. Suggestions for fiscal mechanisms and payment and recovery methods include: insurances, tax incentives, credits or lines of financing, guarantees, voluntary instruments and self-regulation.

Appendix A provides a tabular overview of public governmental organizations in Chile that can be associated with the subject matter.

Appendix B includes legal text discussing sanctions associated with management of contaminated sites.

Appendix C describes several outstanding cases in Chile of sites that have been identified as contaminated.

Appendix D discusses market limitations for the redevelopment of contaminated sites.

Appendix E provides background on the Chilean Clean Production Agreement, which is commits industrial sectors to the voluntary implementation of improved health and environmental management plans.

TASK 4 ENVIRONMENTAL REMEDIATION WORKSHOPS

This task served to disseminate the remediation guidelines prepared in Tasks 1 through 3. In cooperation with CONAMA one two-day workshop was organized in Santiago, instead of three one-day workshops in different locations. The workshop took place on November 29 – 30 and was attended by thirty Chilean officials from central and local governments not including ARCADIS and subcontractor personnel.

A manual in binder format approved by CONAMA was distributed to all attendees. In addition to logistical information, the manual includes summary descriptions of the Task 1 and Task 2 manuals, as well as a comprehensive draft of the Task 3 manual. Furthermore, six case studies were included based on ARCADIS and other experience. CONAMA had indicated it is particularly interested in case studies concerning remediation of mining and wood treatment sites. Accordingly two case studies focused on contamination from mining and two others on wood treatment. One case study described a brown field development project and another case study provided a clear example of a feasibility study. Together with the paper manual each participant in the workshop received a CD with files of the Task 1, Task 2, and Task 4 manuals. As noted above, the Task 3 text was included in the Task 4 manual. The CD is provided as an attachment to this report.

Detailed presentations of the environmental remediation process were made, based on the content of the environmental remediation manuals. Table 1 includes a schedule of the presentations as well as speaker assignments. Remediation experts from the United States included Jim Bedessem and Angela Frizzell, as well as Dr. Ruddle Clarkson on risk assessment. Financial experts included Dr. Raul O’Ryan and Dr. Michael Cruz, from the University of Chile. Legal information from the Task 3 manual was covered by Mr. Gonzalo Cubillos, a partner in a large law firm specialized in environmental law. The workshop schedule allowed for ample discussion time and the audience had the opportunity to ask multiple questions.

Several planning meetings were held between ARCADIS staff and CONAMA before the workshop and a wrap-up meeting was held after the workshop.



Figures 1 and 2. Impressions from the workshop.



Table 1. Workshop Schedule and Presenters

DAY 1		
8:30 – 9:00	Official welcome	Hans Willumsen, Department Manager CONAMA
9:00 – 9:15	Introduction	Michiel Doorn, Project Manager
9:15 – 10:00	Preliminary Assessment	Jim Bedessem, Remediation Expert
10:00 – 10:45	Conceptual Site Model and Sampling Plan Development	Sat Sansar Singh, Geotécnica
10:45 – 11:15	Break	
11.15 – 12:00	Sample Collection/Field Investigation	Anna Llenas, Geotécnica
12:00 – 12:30	Integration of Information	Sat Sansar Singh, Geotécnica
12:30 – 13:00	Questions and Answers	Sat Sansar Singh, Geotécnica
13:00 – 14:30	Lunch	
14:30 – 16:00	Risk Assessment	Dr. Ruddle Clarkson, Risk Assessment Expert
16:00 – 16:30	Break	
16:30 – 17:30	Applications	All speakers
17:30 – 18:00	Questions and Answers	Sat Sansar Singh, Geotécnica
DAY 2		
9:00 – 9:15	Introduction	Michiel Doorn, Project Manager
9:15 – 10:15	Feasibility Study process	Angela Frizzell, PE, Feasibility Study Expert
10:15 – 10:45	Risk Assessment in the Feasibility Study Process	Dr. Ruddle Clarkson, Risk Assessment Expert
10:45 – 11:15	Break	
11:15 – 12:00	Remediation Technologies	Jim Bedessem, Remediation Expert
12:00 - 13:00	Applications	Jim Bedessem and Angela Frizzell
13:00 – 14:30	Lunch	
14:30 - 15:45	Regulatory Framework	Gonzalo Cubillos, Legal Expert
15:45 -16:30	Financial Mechanisms	Dr. Raul O’Ryan and Dr. Miguel Cruz, Financial Experts
16:30 – 17:00	Break	
17:00 - 17:30	Community Stakeholder Involvement	Michiel Doorn, Project Manager
17:30 – 18:00	Questions and Answers, wrap-up	Michiel Doorn, Project Manager
18:00 – 19:00	Closure and cocktail offered by CONAMA	

U.S. SOURCES OF SUPPLY OF REMEDIATION TECHNOLOGIES AND SERVICES

There are hundreds if not thousands of U.S. companies that provide services and/or equipment for the soil and groundwater remediation industry. Examples include drilling, sampling, monitoring and analytical services and equipment, ground movement equipment, groundwater pumping services, as well as environmental engineering and consulting services. Any of these companies may have a potential interest in entering the Chilean market. A company wanting to do so would have to establish itself in Chile, as they would in other countries, by developing representation, and possibly a distribution and service network. U.S. firms may also opt to acquire a Chilean firm to gain market share. Larger U.S. companies are likely to make such a decision based on perceived opportunities in the general environmental consulting market and not just the market associated with remediation.

Many remediation services can also be supplied by Chilean companies, e.g. soil excavation or water pumping systems. As the remediation industry in Chile matures, opportunities for U.S. companies may be found in more high-end services, e.g., environmental design and consulting, and specialized high-tech equipment.

Any list of U.S. sources is bound to be an incomplete subset, because the industry is so diverse and has so many potential players. The Environmental Yellow Pages (<http://www.enviroyellowpages.com>), offer search options to identify environmental companies in different categories and countries. Using this site, the following companies were identified as offering remediation related services, or at least having an interest in doing so.

U.S. Suppliers of Remediation Equipment and/or Services Listed as Active in Chile (from Environmental Yellow Pages):

ALMAC Environmental Services (Sampling and remediation services)
809 Balmoral Court
Friendswood, TX 77546
Office: 281-648-2088 Cell: 832-794-5922

Amprotec, Inc. (Supplier of plastic tanks)
PO Box 680383
Houston, TX 77268
Ph: 281-825-4055

Drewelow Remediation Equipment, Inc. (DRE) (Environmental Services)
1523 Sterling Court
Escondido, NV
Office: 702-255-5933 Cell: 702-526-3269

Enviro-Equipment, Inc. (Environmental Services)
11180 Downs Road
Pineville, NC, 704-588-7970

FPM Geophysical & UXO Services (Geophysical Imaging Services)
706 S. Illinois Ave., Suite D-104
Oak Ridge, TN 37830
Ph: 865-483-0199 Fax: 865-483-3981

Schrader Environmental Services (Used and Rental Remediation Equipment)
212 S. Pine River, Ithaca, MI 48847
Ph: 989-875-6500 Fax: 989-875-8880

ARCADIS Geotécnica
Eliodoro Yañez 1893
Providencia, Santiago, Chile
Ph: (56-2) 381 6058 Fax: (56-2) 381 6074

**U.S. suppliers of remediation equipment and/or services listed as active in Mexico
(from Environmental Yellow Pages):**

ALMAC Environmental Services (Sampling and remediation services)
809 Balmoral Court
Friendswood, TX 77546
Office: 281-648-2088 Cell: 832-794-5922

Ace Tricone Rock Bits (Drilling bits)
22537 ST HWY. 34
Thompsonville, IL, 62890
Ph: 618-439-7275 Fax: 618-435-4347

Amprotec, Inc. (Supplier of plastic tanks)
PO Box 680383
Houston, TX, 77267
Ph: 281-825-4055

Blue Lightning Underground Enterprises - B.L.U.E. (Groundwater Remediation
Equipment, In Situ Oxidation Services, Ozone Systems, Vadose Remediation)
9 W. Front St.
Trenton, NJ, 08608
Ph: 609-352-0668

EnviroTech Services (Sales, rental and repair of Sampling Instruments and equipment
used in environmental, geotechnical and remediation projects)
1125-B Arnold Dr.

Martinez, CA, 94553
Ph: 925-370-1541 Fax: 925-370-8037

FPM Geophysical & UXO Services (Geophysical Imaging Services)
706 S. Illinois Ave., Suite D-104
Oak Ridge, TN 37830
Ph: 865-483-0199 Fax: 865-483-3981

Xitech Instruments (Pumps and oil-skimming equipment)
06 Camino De Los Desmontes
Placitas, New Mexico 87043
Phone: Toll Free 1-888-867-9483, fax: (505) 867-0212
Web: <http://www.xitechinc.com>

Other Selected U.S. Companies Involved with Remediation Site Characterization

Site Characterization is the first step of the remediation process. This information comes from the Buyers Guide of the Journal Ground Water Monitoring & Remediation, Summer 2006.

AMS Inc. (Direct-push technology)
105 Harrison St.
American Falls, ID 83211
Ph. 208-226-2421

Columbia Technologies LLC (Direct-push technology)
1448 South Rolling Rd.
Baltimore, MD 21227
Ph: 410 536-9911

Flexible Liner Underground Technology, Inc. (Chemical sensing tools)
6 Easy St.
Santa Fe, NM 87506
Ph: 505 455-1300

Geophysical Applications Inc. (Geophysical instruments, borehole logging equipment, seismic refraction and reflection)
215 Hopping Brook Rd.
Holliston, MA 01746
Ph: 508 429-2430

Geoprobe Systems (Geophysical instruments, borehole logging equipment, direct-push technology, well installation tools, grouting, cone penetrometers)
601 North Broadway Blvd.
Salina, KS 67401
Ph: 785-825-1842

Geotech Environmental Equipment, Inc. (Geophysical instruments, borehole logging equipment, analytical equipment)
2650 East 40th Ave.
Denver, CO 80205
Ph: 303-320-4764

Kerfoot Technologies Inc. (Direct-push technology, ground water sampling tools)
766 B Falmouth Rd.
Mashpee, MA 02649
Ph: 508-539-3566

Marks Products Inc. (Geophysical instruments, borehole logging equipment)
1243 Burnsville Rd.
Williamsville, VA 24487
Ph: 540-396-4740

Mount Sopris Instrument Co. Inc. (Geophysical instruments, borehole logging equipment)
17301 West Colfax Ave. #255
Golden, CO 80401
Ph: 303-279-2730

SIMCO Drilling Equipment, Inc. (Direct-push technology)
802 South Furnas Dr.
PO Box 448
Osceola, IA 50213
Ph: 641-342-2166

TestAmerica Analytical Testing Corp. (Analytical equipment and services)
17461 Derian Ave #100
Irvine, CA 92614
Ph: 949-261-1022

Zonge Engineering and Research Organization (Geophysical instruments, borehole logging equipment, electrical resistivity and electromagnetic conductivity)
3322 East Fort Lowell Rd.
Tucson, AZ 85716
Ph: 520 327-5501