GOBI REGIONAL
ECONOMIC GROWTH INITIATIVE

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Water-Consultant Report

(2000)

Jim and Carrillo

Funded by the
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INITIAL ENVIRONMENTAL EXAMINATION AMENDMENT

Activity Location	Mongolia
Activity Title	Gobi Regional Economic Growth Initiative SO2, Economic Growth
Funding	US$1.0 million (approximate)
IEE Prepared by	Jim Talbot, Consultant/Team Leader
Recommended Threshold Decision	Negative Determination
Date	November 3, 2000

1. BACKGROUND

Mongolia Gobi Regional Economic Growth Initiative SO2, Economic Growth US$1.0 million (approximate) Jim Talbot, Consultant/ Team Leader Negative Determination November 3, 2000. An Initial Environmental Examination (IEE) was prepared by Jeffrey Goodson, ANE Bureau Environmental Officer, and approved by the Mission Director, Edward Birgells, in May 1999, for five results packages under the Gobi Regional Economic Growth Initiative implemented by Mercy Corps International (MCI), hereafter referred to as the Gobi Initiative (GI). Under the Strategic Objective 2 (S02), Economic Growth, Activity Area 3 (AA3), Rural Credit, a Negative Determination was approved with the provision that "no funds under the terms of this agreement (contract) shall be used to support the development of new water sources, such as new wells or new river diversions, without the prior written authorization of MCI." The intent with this provision was that no additional Rag 216 work would be required until USAID initiated new activities.

Since the approval of the IEE, a ca. $1 million water well rehabilitation activity has been identified to be carried out by MCI pursuant to provisions of the Mercy Corps Cooperative Agreement. Subject to the recommendations of the original IEE, this new activity must have an IEE Amendment (IEEA) for water well rehabilitate? to ensure that this activity is environmentally sound and helps to improve livestock and pasture land management in Mongolia.

This IEEA was prepared during the period October 13 through November 3, 2000 under a task order through Contract No. LAG-I-00-98-00018-00 to ARD, Inc. with the Activity Title of "Water Well Rehabilitation Initiative." The consultant held scooping sessions with USAID/Mongolia and MCI, and consulted with Government of Mongolia, local aimag and soum officials, and herder-stakeholders throughout the IEEA so that a comprehensive review of available data and information, and identification of pertinent issues was completed. A list of contacts consulted is presented in Annex 1. The terms of reference for the consultancy, resumes of the prepares and technical report supporting the conclusions and' recommendations of the IEEA are provided in the remaining annexes.

2. DISCUSSION

Pasture degradation poses a serious threat to livestock production in Mongolia, which is a mainstay of the rural economy. Pasture land degradation is increasing in Mongolia for three main reasons: (I) an increase in the population of livestock over time; (2) the development of the relatively lucrative cashmere market which is causing a shift from sheep towards goats which degrade pasture more rapidly; and (3) the decline in the marketing system for livestock leading herders to concentrate around aimag centers to be nearer to markets, functioning wells, and veterinarian services.

USAID can address pasture degradation by assisting communities to improve the health and quality of their livestock herds, improve farm-marketing systems, and rehabilitate wells in under-utilized pasture areas.

Proposed Activities

Under the GI Work Plan (dated 9/29/00) the activity for the water well rehabilitation program was briefly described and is included herein for the "agriculture development impact cluster." The major objective of the cluster is to increase the market value of selected agricultural products using sustainable practices.

Two of the four Priority Activities under this cluster include the water well rehabilitation program:

Activity 1: To expand herder management program and intensify activities (husbandry practices, fiber classing, breed improvement, winter preparation, business skills, product marketing, range and water resources management) in four Gobi aimags (provinces), Dundgobi, Omnugobi, Uvurbangai, and Gobi Altai. One key expected result that impacts the well rehabilitation efforts would be herders demonstrating willingness to work in groups, whether formal or informal.

Activity 4: To demonstrate improved livestock, water and range management approaches in three soums (Khuld, Tsogt-ovoo, and Kharkorin) affected by the 1999/2000 Dzud (natural climatic disaster affecting herd mortality by preventing herds from grazing). A key result of this activity will be development of resource and management plans by local stakeholders in the target soums.

For the well rehabilitation program the following activities in the GI program aimags are envisioned:

- Obtain herder recommendations for candidate wells for rehabilitation
- Conduct a pasture evaluation at the soum level
- Select existing but non-functional water wells for rehabilitation,
- Transfer technology to match well type with available pumps and other devices to provide water,
- Provide well rehabilitation standards to be followed by Mongolian well drilling companies,
- Develop water well sampling and water quality testing guidelines,
- Apply the previous activities into an integrated approach that lessens overgrazing by more broadly distributing grazing pressure spatially.

These activities will require the use (or deployment) of:

- Well water sampling and water testing equipment and methods,
- Drilling equipment to rehabilitate existing wells,
- Soil use and land management in the vicinity of rehabilitated wells,
- Technical assistance to herders and other stakeholders,
- Minor construction activities around each well,
- Training to herders (or herder associations) in well operation and maintenance.

No new infiestructure development (such as new water wells, rural roads, and water diversion structures) will be funded under the GI Activity. Minor facility construction will take place during the well rehabilitation to[1] construct well pads, buildings for protection of pumps, and water storage tanks. These are not expected to have significant effects on the local environment.

Implementation Plan

Careful consideration has been given to how to implement this activity so that with limited resources the GI can work in the right locations with the right stakeholders. The COM, the UKDP-funded WASH-21 project, the GTZ, other donors, private, is undertaking concurrent well rehabilitation programs citizens and civil society groups. Some lessons learned are available from these sources and are described in the attached Technical Report (Annex 2). For example, the WASH-21 Project started drilling and rehabilitating wells without prior consultation with local communities with the result that approximately one-third of the new wells are already out of service. The Japanese International Cooperation Agency (JICA) funded studies in Dundgobi, Omnogobi and Dornogobi aimags to identify the types of wells, and interrelation of use of water wells and rangeland grazing by livestock resulting in impacts on range production. The COM has recently made a request to the Japanese government for a large new well construction program in agriculture and pasture lands.

The GI will begin work in aimags and soums where they have established networks and relationships with herders. This work can be expanded based on lessons learned and availability of funds. In order to effectively make use of the resources available under this activity, a rapid and efficient phased approach is planned:

Phase 1 will consist of starting well rehabilitation in soums that are more progressive and with which the GI has a working relationship; herder preferences will be taken into account in developing an initial list of candidate wells; conducting a rapid rural appraisal of herder movements in the soums, identifying on maps which range areas are used on a seasonal basis, and which are not and why; concurrently, locations of existing functional and non-functional wells will be identified and plotted. Many of this data on existing wells exists in various databases either with consulting companies or with the Institute of Geo-ecology in the Mongolian Academy of Sciences. The outcome of Phase I will be a series of mapped locations where wells are needed, rangelands are suitable or not for livestock grazing, and herder movements are anticipated.

Phase 2 will involve the technical evaluation of candidate wells for rehabilitation. Determining if they can be physically rehabilitated will assess Wells. Many of the boreholes have been filled up or destroyed in one way or another since 1990. Wells that pass this initial screen will be tested for drinking water and livestock water quality. If quality passes certain criteria, the well will be added to the final candidate list. Concurrently, a socio-economic profile will be prepared by GI on herders willingness to participate in the well rehabilitation and maintenance program. This last factor is the "deal breaker" in that candidate wells will be prioritized according to the ability of the GI activity to ensure sustainability of the wells by obtaining herder/associations of herder buy-in for the O&M.

Phase 3 will involve the implementation of the activity by selecting wells for rehabilitation from the list of prioritized wells, tendering contracts with Mongolian drillers to conduct the rehabilitation, procurement of pumps and other equipment, training of herders in well management techniques, running awareness programs *in* the soums, and monitoring and supervision of the process listing lessons learned and results achieved.

Key Issues

The "Water Problem. Experts on many fronts concur that herders in the Gobi region are caught in a vicious of fewer rangeland-grazing areas near livestock watering points. This has caused increased pressure orrajfecific rangeland adjacent to functioning wells. During the last decade the problem of available water has been aggravated by the change from socialism to a market economy, privatization of herds, and decline by over *50%* (estimates vary by aimag) in the number of functioning water wells, especially those installed in deep aquifers and using pumps and generators

to pull the water out for watering. Fewer wells means more herding families settling down in one location near a few wells, aggravating overgrazing and accelerating the process of desertification.

Simultaneously, socio-economic factors are influencing this already difficult situation. Herders are moving closer to soum centers (administrative units immediately below the aimag) to avail themselves of medical and social services, education for their children, and the presence of good quality and reliable water. Many of these herders moved into the soums after the 1999/2000 Dzud with thehxremaining animals. Privatization has meant that the COM no longer takes care of the herders as they had under socialism by providing guidance on range rotation, whiter fodder for their **livestock, and other services.**

Herders are now on their own, and many need technical assistance and training to function properly in the market economy that is evolving. GOM policy and program dialogue involving a national water policy is focusing on ownership, proprietorship, use, and maintenance of wells; all of which is unresolved. Compounding this is the fact that four line ministries are responsible for one aspect or another of water. There is no central coordination, and programs are fragmented at best. The critical issue in well water use under the current market economy is that, with few exceptions, nobody has taken "ownership" of wells to ensure their long-term operation and maintenance (O&M). Prior to 1990 under the socialist government, well O&M was financed by the state; one person or group was assigned and funded to maintain each well.

Based on this review, it is recommended that a community-based well rehabilitation activity would reduce pressure on overgrazed lands by mobilizing herders to better use scarce water resources and assume more responsibility for well O&M. Existing programs with herders in livestock and range management under implementation with GI demonstrate that community-based approaches will work with water wells.

Water Quality and Aquifer Impacts. The potential for well interference and aquifer depletion was reviewed. During the sitting and installation of the engineering wells, Russian and Mongolian geologists and drillers employed exploratory boreholes and resistively studies to delineate aquifers, which promised good water production. Most wells are sufficiently far apart (> 5 km) and are completed within different geologic formations such that the likelihood of interference or depletion would not be a concern. At such time that GOM or donor programs initiate more intensive new well construction, this issue may need to be revisited. Under the proposed activity involving rehabilitation of existing wells, however, no impacts involving aquifer draw down or depletion would be expected.

Trace metal concentrations such as arsenic were considered as possible criteria for well selection. Concurrently, no quantitative information exists on the levels of these elements in groundwater in the Gobi region. After discussion with the Institute of Public Health, it was agreed that samples from candidate wells joule be sent to their lab in Ulaanbaatar for testing of trace elements. For example, any wells with levels of arsenic above Mongolian ware quality standards would be excluded from further consideration.

Fluoride is found in groundwater in several areas of the Gobi. Recent investigations by the Institute of Public Health have shown which soums have elevated levels at or above the standard. In these soums, fluoride levels will be tested in candidate wells and any wells with expedience of the standard of 0,7 - 1.5 mg/1 will be excluded from further consideration.

The most frequently observed concern over water quality in the Gobi related to hardness and salinity. For these two parameters, acceptability rather public health concerns prevail, and people tolerate hardness and salinity levels at or above the standards. For many herders, wells with salty or hard water are the only source fencing water for their families or for their livestock. For people and

livestock, a range of criteria is developed in the technical report that is protective of humans and livestock stocks and will be evaluated during the well selection phase. Waier testing, therefore, is recommended to screen wells.

Parks and Protected Areas (PPA). A number of PPA's are situated in the aimags where the well rehabilitation activities will be undertaken. Consultations with park management authorities and the GTZ, which is implementing a park and buffer zone management program in the Gobi Gurvan Shaikhan Park, indicate their preference to encourage well rehabilitation activities in the buffer zones of the park. Many of these buffer zones have good rangeland and more non-functional than functional wells. According to park management plans, it is believed that rehabilitating these wells will foster herder seasonal movements to more suitable rangeland, deflect pressure off park resources for part of the year, and allow much of the overgrazed areas to recover over time (S. Schmidt, GTZ; and B. Ravjir, GOM/South Gobi Special Protected Areas Administration, personal communications). This situation applies as well to most of the other PPA's in the aimags where GI activities are proposed. It is recommended, therefore, that well locations in buffer zones receive high priority in the selection process.

Rangeland Overgrazing. Land degradation in Mongolia is a much publicized phenomena, and significant research exists on the reasons why and solutions for improvements. The environmental problem manifests itself in many forms, including desertification, loss of topsoil and other erosion; decrease hi fertility of range and croplands. Natural causes such as low rainfall, high winds, extreme temperatures, thin topsoil, steep slopes and fires, are as much to blame as large numbers of livestock, herders with more horses, cattle, and goats than sheep or camels, inappropriate mining and industrial practices, multi-tracking (off-road driving), and fires. The Gobi region consists of four natural areas: mountain forest steppe, steppe, desert steppe, and desert. All of these have low annual rainfall, high winds, large temperature ranges between summer and winter, and support various types of vegetation communities. Within all of the land use/cover classes in the Gobi region, rangeland (it is referred to as pasture in most of the literature) accounts for the single largest use class, approximately 70-75% of the total land area. Information from the Ministry of Nature and Environment (MNE) published in 1998 indicates that in the four aimags where the GI is presently working, most of the rangeland is degraded to some extent due to the causes listed previously, and for over 80 % the level of degradation is medium to high.

The number of livestock in Mongolia has increased from approximately 25 million head at the end of the socialist era in 1990 to over 30 million presently. Several estimates exist on the number of livestock, which may be environmentally supportable. The concept of carrying capacity is complex, and takes into account fluctuations, trends and patterns in climate, distribution and abundance of livestock, herd composition, level of range management, animal rearing practices, and availability of water. In the Gobi region, the provision of watering points, both for people and livestock, is a major factor limiting the availability and management of adequate grazing land for the highly seasonal use of rangeland and pastures by herders. With the decrease in the number of functioning wells, livestock is concentrated in fewer range areas, resulting hi severe overgrazing around water wells that remain operational. GOM officials, soum governors, pasture experts, and herders unanimously agree that the short-term solution is to adequately repair the damaged or abandoned water wells in high priority areas, and then set up appropriate management and support systems to keep them functional. Sustainability, however, is an issue where there are different viewpoints on how to address ownership, management, and cost recovery methods. A policy dialogue is ongoing in the GOM about registration of water well ownership and use, with the view toward a critical review of the water rights legislation.

Based on this review, rehabilitation of water wells can reduce pressure on overgrazed rangeland resources in certain locations, as long as the wells are properly sited, constructed and maintained. Sustainability can be addressed by mobilizing associations of herders to assume routine O&M.

3. AUTHORY

As the Mission officer approving the initial design documentation for the above described program, the Mission Director is authorized by -22 CFR 216.3 (a) (2) (1) to make the initial environmental Threshold Decision. Under the above article, the initial Threshold Decision is required to be submitted for review and concurrence by the Bureau Environmental Officer. These clearances are shown below.

4. RECOMMENDATIONS

The considerations described above lead to the following recommendations for Environmental Threshold Decision for S02 Economic Growth, Activities 1 and 4 involving well rehabilitation:

Negative Threshold Determination: The GI Agriculture Development cluster will undertake sustainable practices to encourage more effective use of land and water resources through the implementation of a comprehensive program to rehabilitate selected water wells that are presently not functioning in rangeland areas that are underutilized. No new wells will be constructed. Herders and herder associations will be provided access to and use of information and improved technologies for water well O&M. Wells will be selected based on criteria established in the accompanying Technical Report section, Well Selection Criteria. These criteria will take into account herder movements, state of range quality, locations in buffer zones of parks and protected areas, and herder preferences for wells and their willingness to assume O&M responsibilities. Local drilling companies according to criteria established in the accompanying Technical Report section, Well Rehabilitation Standards, will rehabilitate Wells. Well water will be screened and tested for certain water quality parameters that conform to Mongolian Drinking Water Standards, 900-92, and described in the accompanying Technical Report section, Water Quality Testing Methods and Water Quality Standards.

Based on these environmental protection criteria built into the activity, a **Negative Determination** is recommended.

In addition, the Mission will ensure that all GI environmental documentation is translated into Mongolian, that necessary information is provided to all counterpart agencies, that recommended environmental activities associated with this GI are included in contractual documents to well drillers, and that any local environmental protection measures are incorporated, as appropriate.

All aspects of GI Well Rehabilitation Initiative dealing with training, research*, and technical assistance, are covered by "Categorical Exclusions" described in section 22 CFR 216.2 (C (2)(1) Environmental monitoring and review:

(*) Research activities, which may have an effect on the physical and natural environment, but will not have a significant effect as a result of limited scope, carefully controlled nature and effective monitoring.

5. ACTION REQUESTED

That the USAID/Mongolia Mission Director makes the recommended Threshold Decisions above. Once signed, this document will be forwarded to the ANE Bureau Environmental Officer for review and approval.
Approved:

Edward, Birgells
Mission Director
USAID/MaSfcglia

"Date: 11/3/00

Clearances:

ANE Bureau Environmental Officer, John O. Wilson: (In draft) Date: 11/6/00

ANNEX 1: LIST OF CONTACTS

USAlD/Mongolia - Edward Birgells, Mission Director

USAID/ANE - John O. Wilson, Bureau Environmental Officer; Jeffrey Goodson, Bureau Environmental Officer

Mercy Corps International - organization that will implement the well rehabilitation initiative
Stephen Vance, Chief of Party
David Dyer, Program Director for Agricultural Development
Jennifer Butz, Program Director for Local Governance
Ms. Altantsetseg Bazaragchaa, Program Officer for Agriculture
Mr. Baasankhuu Narrijildorj, Dundgovi Program Representative
Mr. Gerel, Agriculture Program Officer
Ms. Tsendsuren Darribarentsen, Umnugovi Program Representative
Mr. Khurelbaatar, Umnugovi Agriculture Program Officer

Government of Mongolia ("governmental or quasi-governmental agencies lumped^

Mongolian Technical University -
Dr. Batsukh N., Head of the Hydro geological and Oil Engineering Department (most knowledgeable about hydrogeology of Mongolia)

Institute of Genecology, Mongolian Academy of Sciences Dr. Janchivdorj L., Director of Mongolian National Water Association (source of information on water database in country)

Center for Nomadic Pastorals Studies, Institute of Geography, Mongolian Academy of Sciences - Dr. Bazargur D. (considered the most knowledgeable expert on Mongolian pastorals) Dr. Shirev-Adiya S. (research scientist on pastorals)

Ministry of feature and Environment Mr. Ravjir B., Director, South Gobi Special Protected Areas Administration (based in Dalanzadgad) Mr. Basandorj, Leader of National Water Committee and Member of Parliament (Ulaanbaatur)

Ministry of Food and Agriculture -
Mr. Batmunkh, Director, Program for Water and Well Rehabilitation for Pasture/Livestock

International Donors

WASH-21 Project, National Water, Sanitation and Hygiene Program - UNDP funded.
Ms. Uncheck D., Administrative Assistant (source of project documents)

Dr. Ondomsfeimeg, Director (was out of country during the IEEA)
Ms. Gerelmaa Omnogobi aimag Project Director

GTZ, Nature Conservation and Buffer Zone Project –
Dr. Sabine Schmidt, Advisor in Protected Area Management

Japanese International Cooperation Agency –
Mr. Eizaburo Furutani, Sanitary Engineering Expert

Consulting Firm; Active in Water and Range Management Problem-Solving

Center for Policy Research, Ulaanbaatar - water policy and pasture management issues Dr. Enkh-Amgalan A., Director

Geo Master Limited - Ulaanbaatar consulting firm responsible for preparing JICA-sponsored reports on well rehabilitation and pasture conditions in two aimags, Dundgobi and Dornogobi
Mr. Munkhtogtokh T., Director
Mr. Ganbaatar C., Chief Engineer

Us-Oyu Company Limited, Ulaanbaatar - consulting firm responsible for preparing JICA-sponsored report on well rehabilitation and pasture conditions in the Omnogobi aimag; this firm also operates well drill rigs, and supplies pumps and other equipment for well rehabilitation
Mr. Ganbold, Director

MonConsult Limited - Ulaanbaatar consulting firm working on water policy for the WASH-21 Project Mr. Bayambadorj, Director

Water Quality Testing Laboratories

Ministry of Health –
Mr. Dundii, Deputy Director, Public Health Institute
Mr. Sanjaa, Head, Environmental Health
Dr. Batdelger, Research Chemist

Hygiene Institute, Umnugovi aimag center- lab accredited by Mongolian National Center for. - Standards and Metrology
Mr. Byambaa S., Director

Metrology Center Laboratory, Dundgobi aimag center - lab accredited by Mongolian National Center for Standards and Metrology
Dr. Udelmaa, Director

Well Drilling tlompanies

Zarubejvodstroi (ZVS) - Russian drilling company based hi Ulaanbaatur
Mr. Michkhalyov Feodorovich, General Director

Undraga-Om (located in Dalanzadgad, Umnugovi) - presently installing and rehabilitating wells in the aimag for the WASH-21 project
Mr. Jargal

Dundgobi Bold - holding company for the aimag center that installs and repairs wells
Mr. UM&aljir, Water Engineer, Aimag Administration, Water Resources Policy Division

Local Herders'-'

Mr. Dembereldorj, Luus Soum, Dundgobi aimag

Mrs. Baasan, Luus Soum, Dundgobi aimag

Mr. Demberel, Khuld Soum, Dundgobi aimag

Herder Meeting held in MCI Offices, Omnogobi on 10/24/00 - 12 representative birders from several soums attended; issues related to wells and range management were discussed; consensus was that associations of herders would be best structural mechanism to ensure wells rehabilitated would be maintained over time.

Soum Governors (these are the elected representatives of the citizens of next level of government below the aimag or province')

Mr. Sumyasuren, Ulziid Soum, Dundgobi aimag

Mr. Baraaduuz, Bulgan Soum, Omnogobi

Aimag Center Staff Responsible for Water Wells and Water Supply

Mr. Batbileg, Water Policy, Agriculture Department, Omnogobi aimag

Mr. Ulziibaljir, Water Policy Research Division, Dundgobi aimag

ANNEX 2: CONSULTANT TECHNICAL REPORT

Task Order Report Submitted to the U.S. Agency for International Development

USAID/Mongolia

Rehabilitation Potential for Gobi Wells

SAID/Mongolia

ARD Water IQC Team
Final Technical Report

Submitted by:
ARD, Inc.
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3 November 2000

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REHABILITATION POTENTIAL FOR GOBI WELLS

1.0 INTRODUCTION

ARD, Inc. was tasked under contract LAG-I-00-98-00018-00 to conduct a reconnaissance level investigation of the potential for rehabilitating existing wells in the Gobi Region of Mongolia. The objective of the investigation was to determine what well conditions existed that would enable successful rehabilitation without causing additional harm to the grazing environment.

The scope of the investigation included meetings with personnel of the Gobi Regional Economic Growth Initiative (GREGI) in Ulaan Bator and in two Aimags, Dundgobi and Omnugovi. In addition, previous investigations were reviewed interviews were conducted with a variety of personnel from herders to government agency personnel, and field visits to various well installations within the two Aimags were conducted.

2.0 PREVIOUS INVESTIGATIONS

A number of studies have been conducted in recent years to evaluate the environmental conditions of the Gobi region of Mongolia. Each of these reports address grazing capacity, number of animals and a host of pertinent information related to water and carrying capacity of the rangeland. Only a summary of these reports is provided herein, however, it is imperative that the findings and recommendations in these reports be given serious consideration before any well rehabilitation efforts are implemented.

2.1 JICA Reports

Three studies were conducted under the sponsorship of the Japan International Cooperation Agency (JICA). These studies were conducted by two firms, GEOMASTERS CO., LTD, and Us Oyu Co., Ltd, and addressed the distribution of livestock supply wells and pastureland capacity in Omnogobi, Domogobi (and the new small aimag, Gobisymber), and Dundgobi. All three reports resulting from these studies address the four types of wells that exist, the general water quality, the number of wells of each type that exist, the reasons why a large percentage are non operational, and the reasons many cannot be rehabilitated. *(It should be noted that rehabilitation in these reports implies installing or re-installing a pump in the wells. There is no discussion of teriafor selection of wells, or standards for the process.)* The data included will be of the time an implementation program is initiated.

The reports describe four types of wells, three of which are considered "engineered" wells and hand dug wells or people's wells. The three engineered wells are designated as Type-A, those that are 200 meters or more in depth and have steel casing with a section of perforated pipe (filter pipe); Type-B

wells that are up to 30 meters in depth, have steel filter pipe, and are powered by rotary pumps (referred to locally as "Kasha"); and Type-C wells that are 7-17 meters in depth, have concrete "fence" for wall construction (basically concrete manhole sections 1 meter in diameter). Type-D wells are the hand dug wells, referred to locally as "people's wells.

All three reports strongly recommend the rehabilitation of the Type A wells citing the low capacity of the others as one reason not to consider installing a pump in them. Reasons for failure were given as: no government resolution as to ownership, no funds for maintenance, shortage of fuel and spare parts, and not economical to operate. The reasons for not considering wells for rehabilitation include, wells that have been filled-in or are known to have poor quality.

2.2 WASH-21 Reports

Four reports prepared under the UNDP WASH-21 project was reviewed; 1.) *Support to Policy Formulation in Rural Water Supply and Sanitation Sector, 2.) Rotation of the Pastureland and the Water Sources (Dundgobi aimag, Khuld soum), 3.) Water, Sanitation, and Hygiene Education Program. (Non/97/209) and 4.) Draft Discussion Paper on Drinking Water Supply, Hygiene and Sanitation. Policy for Peril-Urban areas, June 1999* The policy report contains information that may prove helpful in arriving at solutions to the future operation and maintenance of wells. Recommendations in this report are broader in scope than what may be needed for the well rehabilitation program, but many of the approaches may prove beneficial.

The second report is area specific, but contains information pertaining to family size and herd size that can be used for initial evaluation of pasture and water needs in other aimags. Indeed the estimate of water need for a family of five and a herd of 200 animals is used in the consideration of wells to be rehabilitated. The number given, 2258.7 liters per day (L/day) was rounded up to 2500 and applied without consideration for seasonal variation needs. In the WASH report a family of 200 animals is considered poor and unable to pay for well improvements. This may cause a problem when a rehabilitation program is proposed for implementation.

Report three covered a large range of issues as regards water supply and wells with a short section on well construction/rehabilitation and technology adaptation. Twenty-five wells in twelve soums were drilled and/or rehabilitated in three Aimags. By the end of 1999, 13 wells had been renewed and 80 new wells installed. There was no discussion as to what the rehabilitation efforts entailed.

The forth paper discusses some of the legal issues associated with water use. Of particular note is the fact that water resources are the property of the state, (Civil Code, 1994). Aimag and soum governors are entitled to issue programs and directives with respect to water resources management. There was some discussion on water pumps, but it related primarily to what pumps had been used, many not necessarily the best in retrospect. Reference was made to the water quality standards established as National Standard 900-92. Basic parameters able to be tested by local hygienic laboratories include: taste, odor, color, hardness, calcium, magnesium, nitrate, chlorine and fluoride. A list of water resources related laws, regulations, and resolutions was also provided and is included as Appendix A.

2.3 DAI Report

The DAI report (1998), *Environmental Profile of Mongolia, Draft,* provides a comprehensive baseline of environmental conditions in the country. Unfortunately, there is not a great deal of information pertaining to groundwater. Other than providing a basic understanding of environmental conditions in the country, this report will not be pertinent to the information needed for consideration of well rehabilitation efforts.

3.0 INTERVIEWS

Interviews were held with as many stakeholders as possible to develop a comprehensive perspective on the nature of water well rehabilitation and water quality challenges in Mongolia. Meeting and field notes from these interviews are appended to this report (Appendix B). A summary of the information obtained in these interviews and meetings is provided below. All of these findings were analyzed and included, where appropriate, in the technical approach described in later sections of the report»

3.1 Gobi Initiative Staff

Consensus among Ulaanbaatar and aimag offices was that water well rehabilitation would deflect pressure off overgrazed lands, if wells were sited appropriately and if well herder- "associations" (for lack of a better term) that would assume responsibility for well O&M. There may need to be different types of associations established, depending on the type of well rehabilitated. The Aimag Program Representatives felt that herder families, once a network of functioning wells, should involve the soum administrations, perhaps in assigning “ownership” of the wells to specific groups, or in assuring pasture rotation and regenerating pastures were developed. General agreement was that with limited resources and a huge problem with numerous non-functional wells, it was fundamental to select the right locations with the right people for the work to be completed.

3.2 Government of Mongolia, Ulaanbaatar

Extensive meetings were held with COM officials from various ministries and quasi-governmental organizations, such as the state universities and the Academy of Sciences, which are at least partially funded by the government. There is four line ministries responsible for water issues: Ministry of Nature and Environment (MNE), Ministry of Food and Agriculture (MFA), Ministry of Health (MH), and Ministry of Industrial Development (MID). As far as water supply in soum centers, no ministries or agencies have direct responsibility for support. The MID undertakes and implements programs mainly in the rehabilitation of water wells for pastures, as well as initiatives to deliver water to the population as part of their commitment to urban services; MNE takes the leading role in protecting and assessing water resources; MFA implements the Government program on exploration of water resources to be used for economic activities; MH controls the process to ensure that water quality meets sanitary standards. There is unanimous agreement that there is an urgent need to clarify roles and responsibilities of the various actors in the water supply and sanitation sub-sector. A National Water Committee has been created to promote better coordination. The team met with the chairman of this committee.

Most officials were supportive of the idea of well rehabilitation in the aimags where there was need for water and an opportunity to improve overall pasture management. Some recommended that herder preferences for specific wells be considered in the selection criteria. One problem cited was that herders are moving less than in previous generations, and that more were concentrating in and around soum centers for winter pasture. This was aggravating social conditions and causing overgrazing or depletion of rangeland near the soum. Another problem was that technical options for pumps were limited, and information on this topic needed to be researched and coordinated better.

Data and information exists on water wells primarily in the Institute of Genecology, which is a unit of the Mongolian Academy of Sciences; and also in the Central Geologic Fund, MID. This data represents the fruits of the Russian and Mongolian governments during the period 1950-mid 1980's to install engineered wells (Types A, B, C) throughout the country to supply herders with adequate water. Water well maps can be produced from their database if the well number or name is known

with the following accompanying data: depth, production in liters per second, chemical analysis at the time of construction, and if the well was rehabilitated. The consulting firms (Us Oyo Co., Ltd. and Geometers Ltd), which implemented the JICA-funded studies mentioned earlier, also maintain much of this data. The Ministry of Nature and Environment maintains a database on pasture and range management parameters, and has determined the level of pasture deterioration for each aimag.

Well rehabilitation should be guided by scientific principles to some degree, particularly as it relates to which areas have good pasture that can support grazing if wells were fixed in that specific area. Livestock and herder movements plotted for candidate soums at a scale of 1:100,000 could be superimposed with well locations. Rapid rural appraisal techniques to match range quality, non-functional wells, and herder requests could be accomplished in a week to 10 days for each soum, according to the Mongolian Academy of Sciences. This organization would be a candidate to support the GI under a modest tract.

3.3 Aimag and Soum Personnel

The centers of two aimags and soums within those aimags were visited during the course of this investigation. These included the Dundgobi and the Omnogobi aimags. Administrators within these jurisdictions as well as herders were interviewed and well sites visited.

3.3.1 Dundgobi - Aimag Center, Mandalgobi

The aimag center's water quality lab just received new HACK portable water testing kits under WASH-21. The lab has the capabilities to conduct chemical and bacteriological analysis in conformance with requirements for water testing to meet Mongolian Drinking Water Quality Standards. The lab director agreed to analyze samples for GI on a fee for service basis. An agreement should be worked out, however, with the lab to determine water sampling requirements, lab costs, and type of analysis reports that will be prepared for the well rehabilitation program.

The aimags water engineer reviewed the status of well supply in the aimag, provided a tour of the drilling company owned and operated by the aimag, and indicated that data on specific wells was available in their files. They are also rehabilitating water wells in pastures, selecting wells that are easy to fix (in part because their drilling equipment is incapable of installing a new well), and ones that the aimag center will have control over. He indicated that at the moment, water quality in these pasture wells was not a factor in their selection as candidates for rehabilitation.

Khuld Soum. The team met with the Deputy Governor of the soum to discuss, wells and water quality issues. He mentioned that pastures are not being used because of lack of nearby water wells. Water quality is a problem for human consumption in the soum, but not for livestock.

Ulziit Soum. The team met with the newly elected soum governor, who mentioned their priority need was rehabilitation of the deep, engineering wells. Participation of the soum government in well selection was encouraged to mediate any problems with herders. Out of the 52 engineering wells constructed during the socialist era, only 11 are functional today. Kasha wells are used regardless of whether or not they still function with the rotating pumping mechanism. People have bought portable pumps, or use hand pumps or buckets to get their water. He thought that the formation of herder associations to provide O&M was a good idea, but it may need some nudging from the soum government, which he offered to do.

3.2.2 Omnogobi -Aimag Center, Dalanzadgad

The water quality lab is accredited to perform analysis-supporting evaluation of the national water quality standards. They recently received portable HACH test kits for chemical and bacteriological samples, but have not yet done any testing using these field kits. The director offered to provide lab analysis of GI water samples collected as part of the Jill rehabilitation activity on a fee for service basis. The same recommendation applies to this lab as to the lab in Mandalgovi - get an agreement in writing spelling out sampling procedures, prices, and reports.

The team met with the water policy specialist for the aimag administration who has responsibility for supervision of water well construction and rehabilitation. He has critical of the local drilling company, which he said lacked good equipment and trained staff. On the subject of criteria to be used in well selection, he was firm in the belief that only wells that are requested by the local authorities should be fixed. He thought that some form of privatization of the wells would ensure their O&M over time. His focus would be on the deep wells and use of submersible pumps.

Bulgan Soum. The team met with the soum governor, both at the GI Office in Dalanzadgad and hi the soum. He concurs with our findings that pasture age being overgrazed because wells in good, unused pastures are not operational. This soum is progressive with use of springs for vegetable production, and would welcome solar or wind technology for any pumps supplied during the well rehabilitation activity. He concurs that associations of herders are the only way to ensure proper O&M of any wells that are fixed.

3.4 Herders.

The consultant team interviewed two men and one-woman herder individually, and conducted a herder meeting in Dalanzadgad where over a dozen men and women herders participated. We believe that we have adequately factored the views of women into our observations and generalizations about herder interest and information on pastyre'well rehab illation.

If you ask a herder where he would like you to fix a well, the answer almost always points to those wells near his range of operation. In general, herders believe that many pastures of good quality are being unused because there is no functional water supply well in that vicinity. Fixing these broken wells would appear to deflect pressure off overused lands by opening up new pastures and watering holes. Most mentioned that the deep, engineering wells should be fixed first.

During individual herder interviews, competition among herders for good pasture and water supply was a major concern. Many complained about new herders getting into the business, and increasing the pressure on natural resources. Some felt that these new herders didn't know what they were doing, and were aggravating the situation for everyone. All were cautious about agreeing that herder associations could manage the wells that were eventually fixed. Most were optimistic that, depending on the quality and quantity of the water supply and what their obligation in this potentially new arrangement would be, it might work. Having a group committed to common interests will be key to making this work. Because wells are already shared among several households, the foundation for this approach is already laid.

Generally, -they felt that water quality was acceptable, but salty and hard in some places.

Most wanted to know if the GI would make available cheap and reliable pumps, some portable, so that they could use the shallow and medium depth wells.

During the group herder meeting held in Dalanzadgad, most of the participants were optimistic that once wells were functioning in areas where water was needed and there were good pastures, they

could work out a system of maintaining the wells. Some were cautious about the requirements and costs associated with O&M for any deep wells rehabilitated. Because we were unable to specify types of pumps, fuel costs, and level of technical know-how needed, they agreed that maintenance factors should be explained to the associations that would be formed, prior them to making any commitments.

3.5 Donor Community

Donors such as UNDP through WASH-21 and the GTZ are actively initiating new water well construction and/or rehabilitation in the aimags. WASH-21 appeared to be having some successes and some problems in its water well program. Soum officials mentioned some wells where equipment was not functioning after installation, wells were not producing what was expected, and water quality was poor for human consumption. We suspect that some of the problems resulted from poor well construction and installation practices, or lack of groundwater protection from human or animal contamination, but have no way of confirming that. Examination of equipment operated by drillers indicated old, run-down equipment was being deployed.

The GTZ is attempting to deflect pressure off rangeland in the Gobi Gurvan Saikhan National Park by tempting herders to use buffer zone lands where wells could be fixed. Park and GTZ expressed hope that the GI would collaborate with them so that as many wells as possible could be rehabilitated, particularly in the eastern end of the park. The situation with use of parklands and buffer zones apply to many of the parks and reserves in the Gobi aimags. Use of buffer zones as potential candidate sites in the selection of wells for rehabilitation should be given high consideration.

4.0 FIELD OBSERVATIONS

During the course of this investigation, the team traveled south from Ulaan Bator to two aimags, Dundgovi and Omnugovi. Observations were made of the hydrogeology, wells and pasture conditions while enrooted, and again during visits to soums and meetings with herders. Conditions of wells and pastures observed during these travels and meetings were critical to our subsequent formulation of a rehabilitation program.

4.1 Hydrogeology

Prior leaving Ulaan Bataar hydro geologic maps was purchased at the state store. These maps provide a great deal of information regarding hydro geologic conditions in the Aimags. This includes information on wells, such as depth and quality, but without a geologic log of a well it is not possible to determine the aquifer in which it was completed. Suffice to say that aquifer materials include alluvial sand and gravel, sandstones, siltstones, conglomerates, igneous and volcanic materials. Wells within a kilometer of one another may be completed in an entirely different formation. These maps in conjunction with specific well data available at the Genecology Institute should be utilized during any rehabilitation efforts.

4.2 Well Conditions

Almost without exception, all Type-A, deep wells that were operated by Russian made diesel pumps were in various stages of ruin. Buildings that enclosed the well and pump in most instances no longer existed; pumps were absent or only remnants remained; and in a few instances the wells were filled-in with rock and soil. Fortunately, a metal or rock cover was protecting a number of the wells.

Likewise, most Type B and C wells were in ruin. Many of the B wells that had rotary pump equipment were filled in and of no further use. Others, including many C wells, were being utilized in a manner similar to hand dug wells, namely by extracting water using a rubber bucket or a small portable centrifugal pump.

4.2 Pasture Conditions

Because of the time of year of our investigation, we were not able to view the rangeland during the optimum growth period. Nonetheless, it seemed fairly obvious, even tiff the untrained eye, that large tracts several hundreds of square kilometers contained minimal to no vegetation. Even taking the time of year into consideration, it was obvious that no grazing would be possible in these areas. In some locations, conditions had deteriorated to the point where desert pavement was in progress. (This is a condition where the surface of the ground is becoming totally covered with a layer of rock. All soil and vegetation have been removed).

There is, little doubt that weather has played a significant role in the conditions observed, however, the presence of animal droppings in many of these areas suggests that overgrazing contributed. This fact was universally downplayed or outwardly denied by herders and others with whom we met in the soums. Because deterioration occurs over time, it may seem to all but the most senior herders that conditions are normal.

5.0 CRITERIA FOR WELL SELECTION

After extensive interviews with herders, soum governors, GI personnel, and others with first hand knowledge of conditions in the Gobi, criteria for selection of wells to be considered for rehabilitation were developed. These criteria are not to be cast in stone, cut utilized to initiate a program that will mitigate the problem of overgrazing while ending herders to survive. As the program progresses and lessons are learned, changes maj^be needed to continually improve the selection process.

Current criterion address; distressed soums, pasture conditions herders' desires, physical/chemical status of wells, and acceptance of operation and maintenance responsibility by end users. These are addressed in subsequent sections. Consideration was given to include the potential for well interference and aquifer depletion, however, upon further reflection it was apparent that these concerns could not be quantitatively addressed at this time. Most wells are sufficiently far enough apart and completed within different formations such that the likelihood of food interference or depletion is not of immediate concern. These issues should be raised when a sufficient number of wells have been rehabilitated and an opportunity exists to collect meaningful data from these wells.

Trace metal concentrations such as arsenic were also considered as possible criteria for selection of wells to be rehabilitated. Currently, no quality quantitative data exists. Water quality will be based on the likelihood for the presence of trace metals will be based on pH, temperature, and conductivity (total dissolved solids). A great deal of this data currently exists on hydro geologic maps and in the JICA reports for the various soums.

5.1 Distressed Soums

The GI personnel that have been working in the various aimags are best equipped to identify those areas that have suffered the most from the recent zud, and are experiencing the most difficulty in terms of water and pasture availability. In addition, the chances for success are going to be in those areas where progress has been made in the recognition of measures required to change the status quo. The first well selection criteria will therefore be prioritizing according to soum need,

5.2 Pasture Conditions

Because the major objective of the well rehabilitation program is to mitigate overgrazing conditions, rangeland or pasture conditions must be taken into account. Pastures within a soum: will need to be evaluated with respect to existing condition and potential for sustainability. A rapid study of herder movement within the soum should be conducted to assist in the selection of pastures that could be utilized, but are not being utilized due to lack of water. Upon selection of candidate pastures, two to three candidate wells should be identified within those pastures.

5.3 Buffer Zones Around National Parks

A number of PPA's are situated in the aimags where the well rehabilitation activities will be undertaken. Consultations with park management authorities and the GTZ,which is implementing a park and buffer zone management program in the Gobi Gurvan Shaikhan National Park, indicate their preference to encourage well rehabilitation activities in the buffer zones of the park. Many of these buffer zones have good rangeland and more non-functional than functional wells. According to park management plans, it is believed that rehabilitating these wells will foster herder seasonal movements to more suitable rangeland, deflect pressure off park resources for part of the year, and allow much of the overgrazed areas to recover over time (S. Schmidt, GTZ; and B. Ravjir, GOM/South Gobi Special Protected Areas Administration, personal communications). This situation applies as well to most of the other PPA's in the aimags where GI activities are proposed. It is recommended, therefore, that well locations in buffer zones receive high priority in the selection process.

5.4 Herder Recommendations

In order for any program to be successful, it is imperative that the end user be a part of the overall program. With respect to candidate wells, the herders are the most knowledgeable with respect to the current condition and water quality of those wells. The herders should therefore be consulted with respect to the candidate pastures and the wells within those pastures. Once agreement has been reached with regard to pastures and wells, a technical team consisting of a hydro geologist and a well driller should become involved.

5.5 Physical/Chemical Status of Well

Somewhat contrary to recommendations in the JICA reports, it seems prudent to consider all wells, not just Type-A wells, for rehabilitation. Because so many of the "engineered" wells were destroyed, there may not be sufficient wells of this type to consider for rehabilitation. By evaluating all wells, sufficient water may be attainable. At talkies Stage, it is assumed that there is acceptance by the herders and the soum administration to take responsibility for the operation and maintenance of any wells to be rehabilitated. "The sequence of procedures to assess the physical status of a well is as follows:

1. Use a mirror to check the borehole for any visible obstructions.
2. Using a weighted measuring tapes, fishing line or similar, measure the total depth of the well and compare to the depth when first drilled. (This information is obtainable from a number sources including hydrogeology maps, the drilling companies or from the Geo-Ecology Institute).
3. Using an electric water level measuring tape, or a fiberglass measuring tape with a water-soluble marking pen, measure the static water level in the well. (Note: a weighted lamp cord and an ammeter can also be used to check water level). Based on the total depth and the depth to water, calculate the volume of water in the well using the formula, volume = $3.14 * r^2 *$ height of water column.

4. Install a submersible or centrifugal test pump in the well and pump for a minimum of four hours or until the well is dry. These should be test pumps provided by and installed by the driller. On deep wells, where a submersible would be installed, measure the recovery of the water level in the well immediately after the pump is stopped. For shallow wells of large diameter, record the time it takes for the well to return to static level after the pump is shut down.
5. The rate of discharge should be measured in all instances using a bucket of known volume and a stopwatch. If the well is able to produce a minimum of 0.25 L/s, after the volume of water in the well has been removed, consider the well for rehabilitation.
6. During the pumping phase, collect a sample of the water and check for total dissolved solids, pH, and temperature. This sample should be sent to the aimag center lab for analysis of basic chemical and microbiological constituents. If the results are within water quality standards, the well is suitable for rehabilitation. (Note: For the shallower wells, the conditions around the well should be evaluated for potential bacterial or nitrate contamination. Herders should also be consulted re their knowledge of any health-related problems associated with the well).

5.6 Acceptance of Operation and Maintenance

The final decision whether a well should be rehabilitated will depend upon the acceptance of an organized entity to commit to supporting physically and monetarily the operation and maintenance of a well. It will serve no purpose to rehabilitate a well and then have it fall into disrepair and non-use within a short period of time.

6.0 STANDARDS FOR REHABILITATION

Alter a candidate well has been selected for rehabilitation; procedures to accomplish two objectives should be followed. The two objectives are getting the well back into production, and to the extent possible, improving the production. Based on available data or recently acquired data, a decision will need to be made regarding an attempt to redevelop the well. If the total depth of the well is considerably Jess than when first constructed, or if the well discharged sand when test pumped, redevelopment should be considered. This work may be limited by the experience and equipment limitations of the driller contracted to do the work. Each type of well will entail somewhat different approach. Table 6-1 provides a brief description of each of these well types.

Table 6-1 Description of Wells Tipes

Type	Construction	Depths, m	Pump Type
A	Steel pipe with section opposite aquifer	90-260	Diesel submersible
B	Steel pipe with filters section opposite meter concrete housing	7-30	Manual/ animal rotary
C	Concrete sections with lower section permeable	7-30	Portable centrifugal of rubber bucket
D	Native rock, hand dug	2-14	Manually with rubber bucket (some with “frog” pump)

6.1 Type-A Wells

For Type A wells, those that are greater than 30 meters deep and are equipped with steel pipe and filter pipe, the rehabilitation procedures would be as follows:

- Bail the well until total depth is restored or until no additional materials are being removed.
- Develop the well using a surge block, an air jet, or a combination. These procedures will depend upon driller experience, and available equipment. Development and bailing procedures should be continued until the well is no longer producing sediment or least a minimal amount.
- Set new pump and install related equipment.

6.2 Type B Wells

Type B wells are those constructed with steel pipe and filter pipe to depths of 7 to 35 meters. These wells were installed as shown in Figure 6-1. Because the well bore is located 4+A meters below the top of the meter diameter concrete sections, rehabilitation may not be possible. Unfortunately, many of these wells have been filled in with stone and debris, and the well bore is no longer accessible.

Where the well bore is accessible, the test pump would have been installed during the selection process, and the following procedures can then be followed to rehabilitate the well:

1. Clear all debris from around the wellhead and within the inside of the concrete housing.
2. Measure the depth of the well below land surface and compare with the « original construction data if available. If not available, a determination of the most likely depth should be made. For example, if depths being measured are 10 meters or less, it is an indication that infilling has occurred, and bailing in conjunction with other development techniques will be necessary.
3. Upon completion of any necessary cleaning and development, a section of steel pipe should be welded to the exposed wellhead to bring the ultimate wellhead just below the surface of the concrete.
4. Install pump or piping to enable pumping.

6.3 Type C Wells

Pending upon location and need, there can be two phases to the rehabilitation of these Phase 1 would consist of the following:

1. Pumping the water down to expose the bottom of the well, and manually or with a cable rig and bailer cleaning out any accumulated sediment. (A pump may need to be run continuously during this operation if cleaning is to be done manually.)
2. Evenly backfill the well with 15 to 20 centimeters of rounded stone of uniform size.
3. Allow the well to recover and install appropriate pump for the capacity of the well.

At this point PVC schedule 40 casing with a bottom cap and a meter of slots could be set and anchored to one side of the concrete wall, Figure 6-2. This would enable a submersible pump to be installed or a suction hose from a centrifugal pump if the static water level was 7 meters or less. Alternatively, if centrifugal pumps were more likely to be used, a section of galvanized pipe could be set inside the PVC with an elbow at the surface. This would allow for a better seal at the top of the well and herders would not have to haul around long sections of suction hose.
A Phase 2 procedure for these wells would be the same as Phase one, but instead of installing slotted PVC with an end cap, steel casing with a drive shoe and a meter section of torch slots or machined slots would be driven an additional 3 meters below the existing bottom of the well, Figure 6-2. This procedure would require a cable tool-drilling rig for installation of the steel pipe. Again the well would be suitable for a submersible or a centrifugal pump.

The advantage of both of these procedures is that it would allow the economically disadvantaged herder to continue to withdraw water with a rubber bucket. Installation of a "frog" pump off to one side might be a third alternative if the static water level were less than 7 meters.

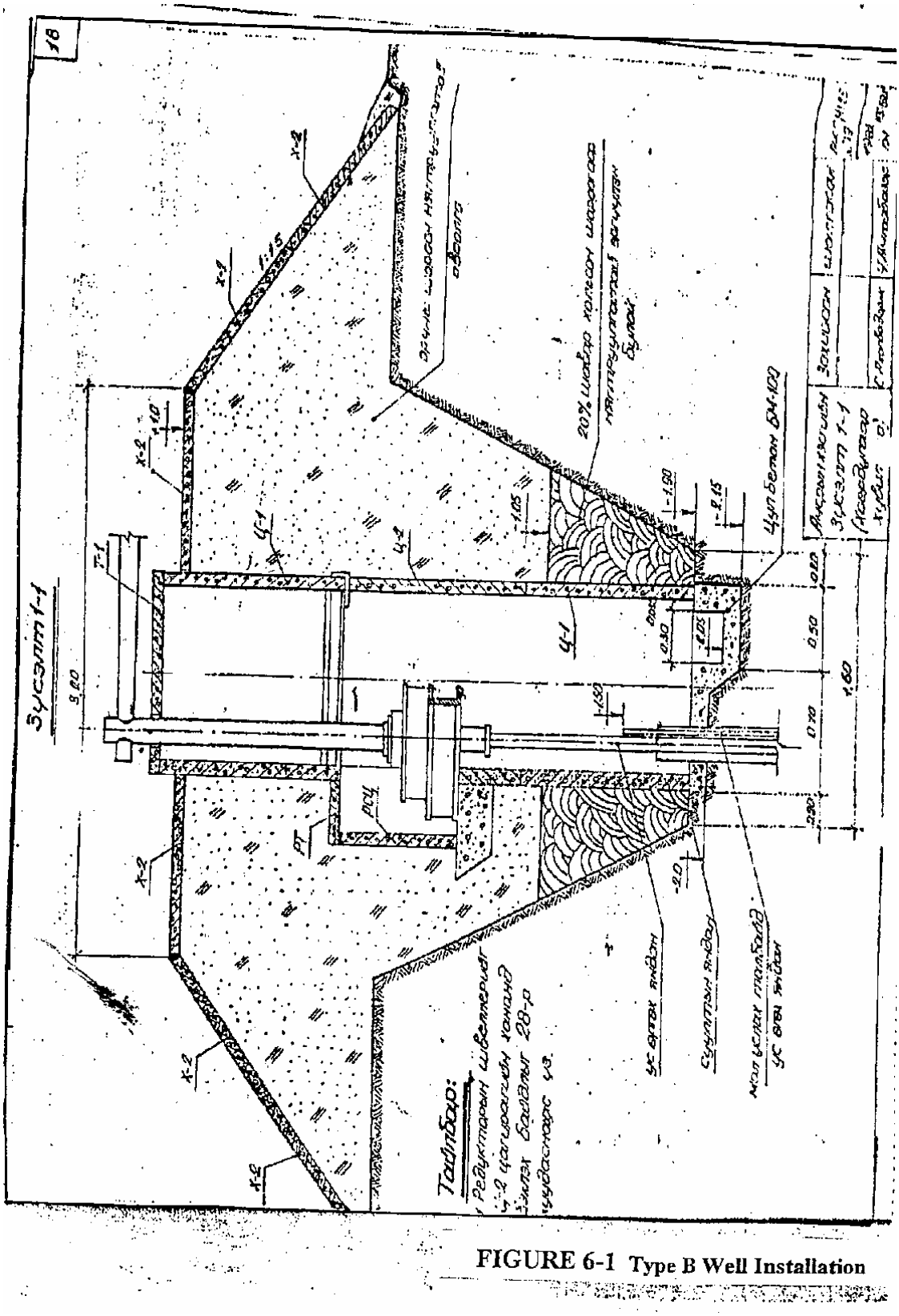

FIGURE 6-1 Type B Well Installation

6.4 People's or Hand Dug Wells

These wells, also designated Type-D wells, are typically 10 to 12 meters deep and constructed with stonewalls from local materials. Since the demise of the diesel wells, there has been a tremendous increase in the number of these wells throughout the Gobi. Typically, these wells are not a reliable source of water, and people and livestock easily contaminate them. Although earlier investigators have not recommended rehabilitation of these wells, it may prove useful to reconsider. Some of the hand dug wells viewed during the course of this investigation suggests that some are reportedly hundreds of years old, have never dried up, and have produced sufficient water for several families.

There is not a great deal that can be done to redevelop hand dug wells short of cleaning the bottom and installing some rounded stone to prevent upwelling of fines during water extraction. Procedures similar to those suggested for Type C wells could be applied to D wells. A section of PVC pipe with a bottom cap could be anchored to one side label those with portable centrifugal pumps easier access, Figure 6-3. In all Food, -frog pumps or portable hand pumps would work well in these wells and could be installed to one side. As suggested for Type-C wells, a steel casing with slotted section could be driven below the existing bottom. Most hand-dug wells only went one or two meters below water level; therefore, the potential exists for increased production below this depth.

6-5 Infrastructure

Any wells being considered for rehabilitation should take into account the upgrading of the infrastructure immediately around the well. This is especially important to reduce the potential for contamination from watering animals. Applicable to all well types is the moving of the watering troughs sufficiently far from the wellhead to prevent the infiltration of bacteria and nitrates. Type B, C, and D wells are especially vulnerable to this type of contamination. A distance of 15 to 20 meters would be the minimum. Fencing around the well using this distance, as a radius would be very beneficial. (Naturally with bucket extraction this is not very feasible.)
Reconstructing the wellhead at B, C and D wells is also important. If wood covers are to be used, a plastic liner should be incorporated to prevent mud and contaminants from the herder's boots from entering the well. Where wells are located on sloping ground, a shallow drainage ditch should be dug in an arc up gradient of the well to prevent runoff from rain or snow melt to enter the well.

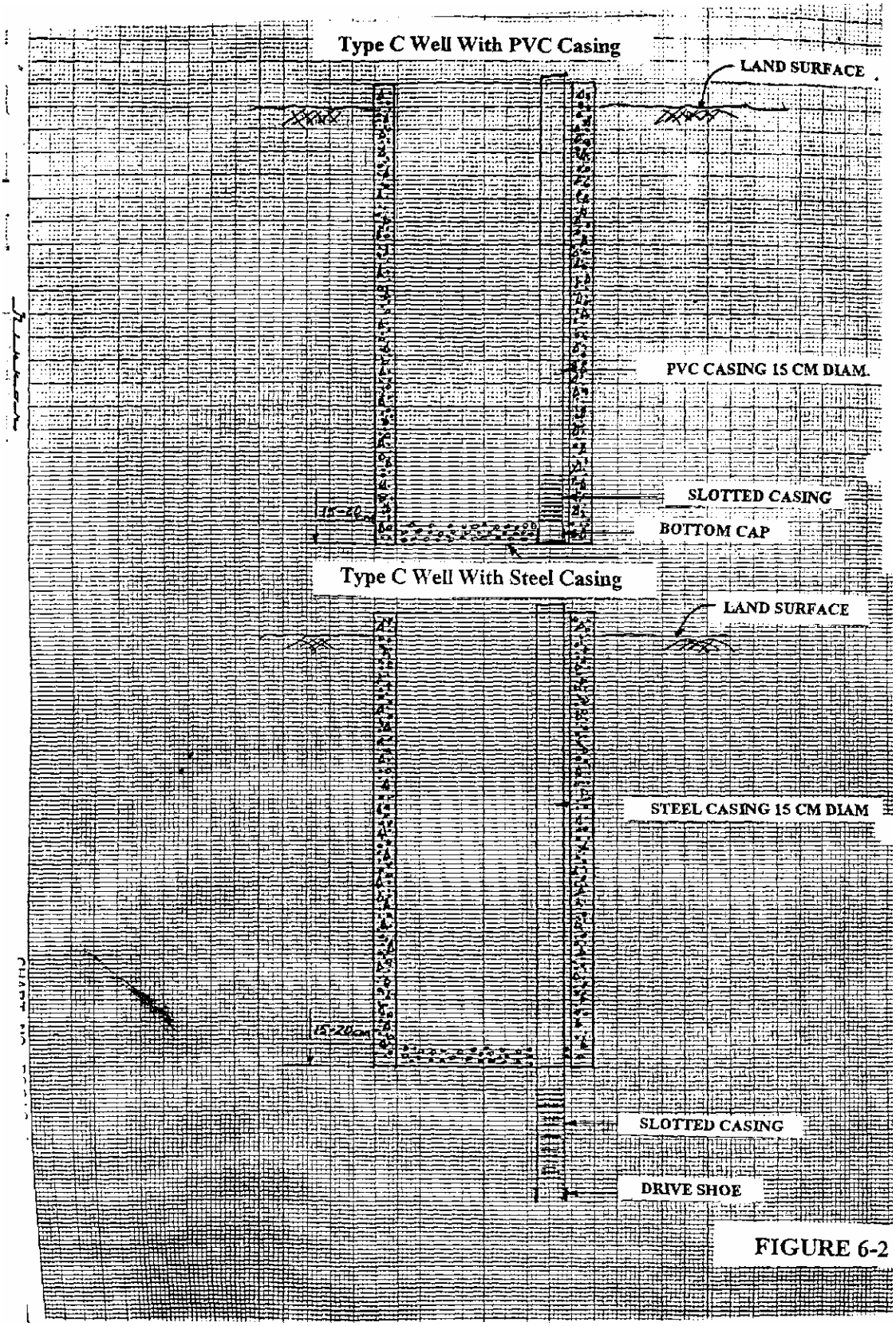
Type C Well With PVC Casing
LAND SURFACE
PVC CASING 15 CM DIAM.
SLOTTED CASING
BOTTOM CAP
Type C Well With Steel Casing
LAND SURFACE
STEEL CASING 15 CM DIAM
SLOTTED CASING
DRIVE SHOE

FIGURE 6-2

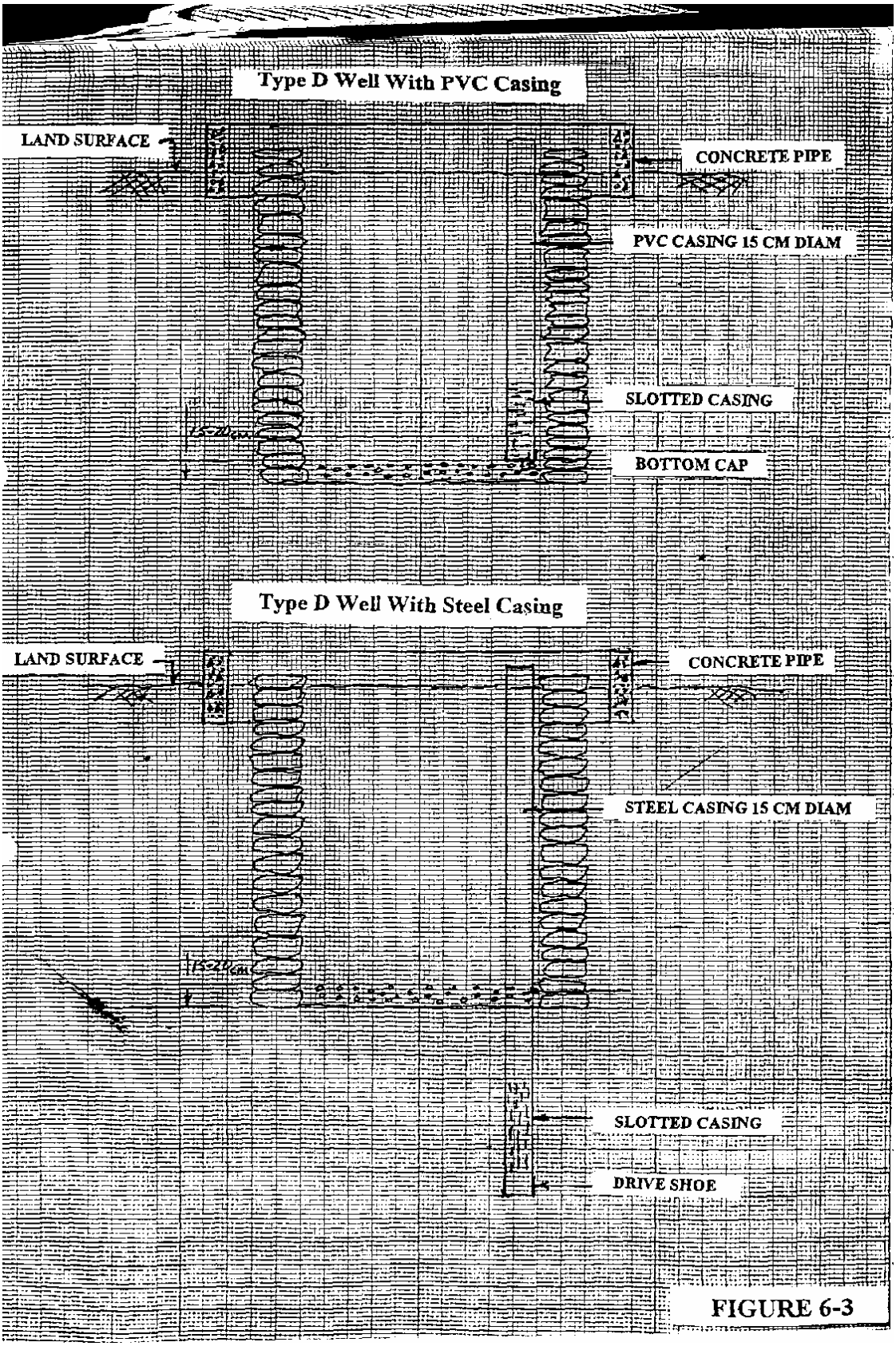
Type D Well With PVC Casing
LAND SURFACE
CONCRETE PIPE
PVC CASING 15 CM DIAM
SLOTTED CASING
BOTTOM CAP
Type D Well With Steel Casing
LAND SURFACE
CONCRETE PIPE
STEEL CASING 15 CM DIAM
SLOTTED CASING
DRIVE SHOE

FIGURE 6-3

7.0 STANDARDS FOR WATER QUALITY TESTING

7.1 Mongolian Standards

The Mongolian Drinking Water Quality Standards were published in 1992, as Standard 900-92. A summary for microbiological, poisonous chemicals, and other chemical and aesthetic elements are excerpted from 900-92 and shown below (translation from Mongolian to English). Bear in mind that no standards exist for livestock water. Some consideration is given, however, to their needs in the development of these standards for water quality testing.

STANDARDS ON DRINKING WATER.
DRINKING WATER, HYGIENIC REQUIREMENTS AND
CONTROL ON THE WATER QUALITY.

The quantity of micro-bodies contained in drinking water should not exceed the following standards:

	Name of micro- bodies	Allowed quantity
1	Total number of bacteria in 1 cm^3	100
2.	Number of micro-bodies causing stomach Diseases contained in 1 dm^3	3

The quantity of poisonous chemical elements contained in the drinking water should not exceed the following parameters (mg/dm^3 = mg/1):

	Chemical elements	Unit	Allowed Max. quantity
1	Molybdenum, Mo	Mg/dm3	0.25
2	Beryllium, Be	Mg/dm3	0.0002
3	Cadmium, Cd	Mg/dm3	0.01
4	Silver, Ag	Mg/dm3	0.05
5	Nitrate, NO^3	Mg/dm3	10.0
6	Policylamates	Mg/dm3	2.0
7	Selenium, Se	Mg/dm3	0.001
8	Strontium, Sr	Mg/dm3	2.0
9	Lead, Se	Mg/dm3	0.03
10	Chromium, Cr	Mg/dm3	0.05
11	Aluminum, Al	Mg/dm3	0.5
12	Arcenic, As	Mg/dm3	0.05
13	Cynanide, Cn	Mg/dm3	0.01
14	Flouride, Fl^-	Mg/dm3	0.7-1.5

The following parameters should not exceeded:

	Name	Measurement unit	Allowed maximum Quantity
1	Taste		2
2	Suspension	Mg/dm3	1.5
3	Color		20
4	Odor		2

Chemical elements, which are contained in the water and influence its quality, should exceed the following parameters:

	Names of chemical elements	Measurement unit	Allowed maximum Quality
1	Copper, Cu^{2+}	Mg/dm3	1.0
2	Calcium, Ca^{2+}	Mg/dm3	100.0
3	Magnesium, Mg^{2+}	Mg/dm3	30.0
4	^Manganese, Mn^{+2}	Mg/dm3	0.1
5	Soleplate, $S0_4^{+}$	Mg/dm3	500.0
6	Iron, Fe $^{+2, +3}$	Mg/dm3	0.3
7	Phenol group	Mg/dm3	0.002
8	Phosphate, PO_4^{3-}	Mg/dm3	3.5
9	Total size of hardness	Mg/dm3	7.0
10	Chloride, Cl^{-1}	Mg/dm3	350.0
11	Dry residue (total suspended solids, dried, weighed)	Mg/dm3	1000.0
12	Zinc, Zn^{2+}	Mg/dm3	5.0

When the water source is selected in the countryside, in case the quantity of elements shown in the above table should not exceed the allowed maximum quantity or exceed by the following characteristics, the Hygiene and Infection Research Supervision Authorities shall take the decision on the use of water:

- Dry residue: not more than 1500 mg/dm3;
- Total size of hardness; not more than 10.0 mg/dm3
- Total quantity of Fe: 0.7 mg/dm3
- Mn (Manganese): not more than 0.5 mg/dm3

Note for dry residue that this is a measure of total suspended solids, which includes salts and hardness factors, but can also include participate matter that gets into the well water. For people's wells, dust and wind-borne materials could factor into any values obtained.

7.2 Other Criteria*

Table 7-1 is primarily intended as a rough guideline for human drinking water where people and livestock are using the same water supply. While most animals can tolerate fairly high levels of total salts, the amount of magnesium in the water supply can be critical. Safe upper limits for stock range from 250-400 mg/1. Higher levels can be tolerated when pastures are green and succulent. Safe upper limits of total salt content in mg/1 of water for livestock are as follows: horses 6400; cattle 10,000; sheep 12800, measured as TDS,

Table 7-1. Suitability for Permanent Water Supply for People

WQ Factor	Mongolian WQ	WHO DWQ Standard[2]	Good	Fair	Moderate	Poor
Color	20TCU	15TCU	Colorless	Colorless	Tinted	Color easily distinguishe
Turbidity	1 .5 mg/l	5NTU	Clear	Clear	Somewhat opaque	Opaque
Odor	2	None, should be acceptable	Odorless	Hardly Perceptib	Slight	Slight to noticeable
Taste at 20^0	2	Acceptable	None	Perceptib le	Pronounce d	Unpleasant
TDS (mg/1)	-	1000	0-500	500-1000	1000-2000	2000-4000
Conductiv ity	-	-	0-800	800-1600	1600-3200	3200-6400
Sodium (mg/l)	-	200	0-115	115-230	230-460	460-920
Magnesiu m (mug's)	30	-	0-30	30-60	60-120	60-120
Hardness (Mg/1)	7	-	<100 (Corrosive	<200	> 200 (scale)	> 200 (scale)
Nitrate (mg/1)	10	50 (acute)	-	-	-	> 10
Chloride (mg/1)	350	250	0-180	180-360	360-710	710-1420
Soleplate (mg/1)	500	250	0-150	150-290	290-580	580-1150
Fluoride (Mg/1)	0.7-1.5	1.5	00-0.3	0.31-0,7	0.71-1.5	>1.5

Notes:

1. When the water source is from the countryside, and the quantity of elements shown in the standards exceed the allowed maximum quantity or exceed the following characteristics, the decision on the use of the water shall be made by the Hygiene and Infection Research Supervision authorities: dry residue not > 1500m/l; total hardness not > 10 mg/1; total quantity of Iron 0.7 mg/1; and Manganese not > 0.5 mg/1.
2. WHO lists chemicals of health significance to people in drinking water as the following for inorganic constituents: antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, cyanide, fluoride, lead, manganese, mercury, molybdenum, nickel, nitrate, nitrite, selenium, and uranium; and for bacteriological quality: E. coil and total oviform bacteria must not be detected in samples. There are a number of other water constituents, some of which are listed in the above table, which are of no direct consequence to human health at concentrations at which they normally occur in water, but which nevertheless may be objectionable to consumers for various reasons. In rural areas, many people have come to accept less stringent quality standards than people in urban areas. TCU = True Color Unit; NTU =Nephelometric Turbidity Unit

7.3 Issues in Gobi Water Quality

Throughout our field research the two most frequently heard concerns over water quality were over hardness and salinity. Nitrates and fecal oviform have been mentioned by soum officials and health experts consulted, but little information was available on levels of these constituents in Gobi water. It is recommended that GI consult with local aimag labs and with the WASH-21 Project to obtain records and compare results from waters in wells to be rehabilitated. Comparison of results with the published standards is recommended as well, however, there are no Mongolian standards for nitrates and TDS. In such cases, comparison with WHO Standards is recommended.

Hardness in water is caused by dissolved calcium and, to a lesser extent, magnesium. It is usually expressed as the equivalent quantity of calcium carbonate. Depending on the pH and alkalinity, hardness above 200 mg/1 can result in scale deposition, especially in X piping. Soft waters with a hardness of less than 100 mg/1 have a low buffering capacity be more corrosive to pipes and pumps. Although a number of ecological and epidemiological studies have shown a statistically significant inverse relationship between hardness of drinking water and cardiovascular disease, the available data are inadequate to permit a conclusion that the association is causal. There is some indication that very soft waters may have an adverse effect on mineral balance in the body, but detailed studies are not available for evaluation. No health-based guideline is proposed for hardness. Public acceptability for hardness varies from one community to another. The taste threshold for the calcium ion is in the range of 100-300 mg/1, and that for magnesium is probably less than for calcium. In some communities, water hardness in excess of 500 mg/1 is tolerated.

Total Dissolved Solids (TDS) comprise inorganic salts (calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and small amounts of inorganic matter that are dissolved in water. TDS in the Gobi originates from natural sources, and varies in different geological regions owing to differences in the solubility's of minerals. No health-based guideline exists or is proposed for TDS. The palatability of water with a TDS level of less than 600 mg/1 is generally considered good. Drinking water becomes increasingly unpalatable at TDS levels greater than 1200 mg/1. On the other hand, water with extremely low concentrations of TDS may be unacceptable because of its flat, insipid taste. Water with concentrations below 1000 mg/1 is usually acceptable to people, but can vary over all communities.

For livestock, quality of water affects the quantity of water they consume. Some general observations can be made relative to saline livestock waters:

- At high salt concentrations that are somewhat less than toxic, increasing salinity may actually cause an increased water consumption even if there is an initial refusal to drink the water;

- At very high salt concentrations, animals may refuse to drink for many days followed by a period where they drink a large amount at one time and become suddenly sick and die;
- Younger animals are more prone to harm than older animals;
- Any factor causing an increase in water consumption such as lactation, high air temperatures or exertion increases the danger of harm from saline waters;
- When animals suffer from the effects of saline waters are watered from a source. Of low concentration, they make rapid and complete recoveries.

In general any water with greater than 15,000 mg/1 TDS is unsuitable for all livestock; concentrations from 10,000- 15,000 maybe suitable for mature sheep; 6,000- 10,000 may be suitable for mature sheep and cattle; 4,500 - 6,000 may be unsuitable for lambs and calves, suitable for mature stock, and usable but not the best for lactating animals; 3,500 - 4,000 is usable, but not best quality for lambs and calves or for lactating stock; and less than 3,500 suitable for all livestock.

Nitrate and nitrite are naturally occurring ions that are part of the nitrogen cycle. Nitrate concentration in groundwater and surface water is usually low, but can reach high levels is a result of agricultural runoff or contamination with human or animal wastes. The consultant team was not able to verify that there were any problems with nitrate poisoning. The toxicity of nitrate to humans is mainly attributable to its reduction to nitrite The major biological effect of nitrite in humans is its involvement in the oxidation of normal hemoglobin (Hob) to met hemoglobin (math), which is unable to transport oxygen to the tissues. The reduced oxygen transport becomes clinically manifest when math concentrations reach 10% or more in normal Hob concentrations. This condition, called methemoglobinemia, causes cyanosis, and at higher concentrations asphyxia. The Hob of young infants is more susceptible to math formation than that of older children and adults. In sum, presence of nitrates in drinking water (and when infants are bottle fed with water and powdered milk or formula) and gastrointestinal infections increases the risk of higher yield of nitrite and thus a higher math formation. For methemoglobinemia in infants, the existing guideline value for nitrate ion of 50 mg/] was confirmed. However, Mongolian standards indicate a level not to exceed 10 mg/1 in drinking water. Therefore, that value must be used in well screening.

For livestock, nitrate concentrations less than 100 mg/1 should not cause harm; for concentrations of 100-300 mg/1 there is concern that animals given waters containing levels of nitrates approaching this upper limit of 300 mg/1 and over can cause poisoning in sheep and cattle, and is not recommended.

Fluoride has been studied in the Gobi, and some areas have elevated levels in drinking water. After discussing this issue with the Institute of Public Health in Ulaanbaatar, it is recommended that water in those soums where levels are commonly found at or above the standard of 0.7 - 1.5 mg/1 be tested Any wells that have a concentration greater than 1.5 should not be used for drinking water, but may be used for livestock watering.

Arsenic is widely distributed throughout the earth's crust and is used commercially in alloying agents. It is introduced into water through the dissolution of minerals^ from industrial effluents, and from atmospheric deposition. In groundwater, it forms from the weathering of rocks. Arsenic has been reported in the geological formations in Mongolia and in some well water samples. It could not be verified from the Institute of Public Health when and where testing was done. Officials did verify that there were no known or reported symptoms or disorders of elevated arsenic in drinking water. WHO reports that there is no consensus on the definition of arsenic poisoning; and, high concentrations of arsenic in a community well do not necessarily correlate with high levels of arsenic symptoms within a community. Health effects of consuming contaminated drinking water are delayed. After consultation with the Institute of Public Health, it is recommended that waters be tested for arsenic by sending a sample of the candidate well water to their Ulaanbaatar lab for analysis. Field screening could be done by putting a sample of well water into contact with pure silver, which turns black with dissolved arsenic.

7.4 Field Sampling

This section is intended as a primer for the GI staff in the collection of well water samples for screening during the well selection process. The three basic objectives for sampling are to determine (1) the presence or absence of contamination or values over pie water quality standard or guideline, (2) the extent and/or magnitude of co^amination, and (3) the possible contaminant pathways which may exist at a site. The midst-to is sampled will be primarily groundwater, but occasional surface water samples may be taken for comparison purposes, or if a surface water source is suspected of contaminating a groundwater source.

Each of the labs performing the chemical and bacteriological analyses may have their own protocols for water sample collection, so it is a good idea to check with the lab before deciding on size and

type of sample containers and how much water should be collected to run the full suite of analyses. A specific list can be helpful here.

Some other factors to consider are: (1) sample handling and delivery to the lab; (2) turnaround time for the analyses affected by how many samples you collect in one day, when they will be delivered to the lab, and how long they can be held prior to analysis; (3) lab contact, who is the person to whom questions should be directed.

Some training is required to perform sample collection in a manner that protects the sampler and enables a "clean" sample to be collected from each well. It is recommended that GI provide a short course for aimag staff on how to conduct water well sampling.

A simple equipment list for water well sampling could include: appropriate sample containers; coolers and ice for sample holding until dropped off at the lab; meters, measuring tape, and probes for field measurements; tools to assist in well access (screw drivers, hammers, chisel, pipe wrenches); tape measure for measuring diameter of well casing and elevation of casing above ground level; water level indicator for measuring static water level and total depth of the well; gallon bottle of distilled water for washing off probes and field sampling equipment; pocket calculator; log book and indelible ink; well evacuation equipment to pump out stagnant water prior to collecting the sample (small bailer, portable pump); decontamination equipment for washing equipment in between wells; buckets or graduated pails; camera/film to document well locations or procedures.

Well evacuation may be necessary to obtain a representative sample. Static water level should be measured to the nearest centimeter, if possible, below the measuring point elevation. The top of the casing or top of the pad should be used as the standardized point. Qalculatethe total depth of the well from the measuring point. Calculate the number of meters of static water (total depth of the well minus the static water level). Calculate the well volume in liters, using 3.14*radius of well squared in meters*number of meters of static water.

Sample collection involves purging the well at least once using a bailer, allowing the well to recover so that there is enough water in it to collect all the necessary sample volume. The bailer used for collecting the sample should first be rinsed with bottled water (preferably distilled water), lowered into the well, retrieved, and emptied once to ensure that the bailer has been rinsed of any reinstate. When collecting the sample for filling the sample bottles, the bailer should be lowered gently into the water column, jerked gently to ensure the ball valve or bailer mechanism is closed, and retrieved at a steady rate to the surface. When transferring the water from the bailer to the sample containers, care must be taken to-avoid agitation as much as possible. The geochemistry of groundwater is such that exposure to atmospheric conditions can result in loss of sample integrity. Therefore, it is necessary that upon collection, the samples are prepared, preserved, and/or stored in such a manner to prevent any changes in sample chemistry.

Samples should be stabilized as much as possible immediately following collection by placing them in coolers with ice (if available). Plastic or glass containers are usually suitable for most samples. What works best is if 1.0 or 1.5 liter water bottles are bought at a local market and kept unopened until sample collection. When sampling is to be done, each bottle can be emptied and immediately filled with the well water. One of the purchased water bottles should be submitted unopened to the lab and analyzed at the same time as the well water samples to check for possible contaminants in the purchased spring water or to verify any unusual constituents. On the other hand, the lab may be able to supply the GI team with appropriate containers at cost. AH sample bottles should be labeled with an indelible marker (a "Sharpie" is the best), indicating date, location, testing required (simply indicate either chemical or conforms), and if the sample was preserved in any special way (by adding nitric acid, or sulfuric acid). Once the sample is collected it should be placed immediately in the cooler.

The following table lists preservative, volume and holding time requirements for well water samples to be submitted to the lab for analysis. Holding times indicate the maximum amount of time that a sample can be held before running the analysis. In some cases, preservation of the sample may be necessary to increase the holding times. For some types of analyses it is just not possible to meet the holding times; e.g., conifers typically must be analyzed within 6 hours of sample collection. It is recommended that the GI field team check with the local laboratory on suggested ways to retard biological action so that samples can be representative, in the final analysis.

ANALYTE	PRESERVATIVE	VOLUME (ml)	TREATMENT	HOLDING TIME
Conforms		250	Cool	6 hours
Chloride	none	100	Cool	28 days
Fluoride,	none	300	Cool	28 days
Hardness	nitric acid	100	Cool	6 months
Metals	nitric acid,	100-200 each	Cool	6 months
pH	none	250 or w/ probe in	Cool	Immediately
TDS	none	250	Cool	7 days
Sulfate	none	200	Cool	28 days
Turbidity	none	100	Cool	48 hours

Infield Measurements are useful to collect at the time of water sample collection. Usably pH, temperature, and conductivity are measured with a hand-held portable meter. If shallow wells are sampled, it may be possible to stick the probe directly into the well. Be sure to wash off the probe with distilled water between sampling events.

The GI team should keep a log book recording as much information as possible at the time of the sampling event: site name, GPS reading, date, time, weather conditions, personnel on site, sample information (note anything unusual, water color or odor, etc.), and any metered field data collected such as pH, temperature, conductivity, and where the samples are going.

7.5 Test Analyses

Certain chemical and microbiological analyses should be determined in well water samples from candidate wells, based on anticipated use, prior to final selection of wells to be rehabilitated. Consideration should be given to those wells where people and livestock use the same wells and to those wells where only livestock will be watered.

7.5.1 Where People and Livestock Use the Same Well

It is recommended that waters be tested for all of the constituents on the Mongolian Drinking Water Quality Standards for chemical and microbiological parameters, or at a minimum Hardness, Magnesium, Chloride, Sulfate and fecal and total conifers. In addition, water should be tested for nitrates, fluoride, TDS, Manganese, and Iron. Field measurements of well water during the screening should include pH, temperature, and conductivity using portable field probes.

7.5.2 Water for Livestock Only

It is recommended that water for livestock be tested for TDS, hardness, and nitrates, as well as fecal and total conifers. Field measurements of well water during the screening should include pH, temperature, and conductivity using portable field meters.

7.6 Use of Mongolian Laboratories

There are two options for the GI to obtain analyses of water well samples collected during the screening phase: perform the analysis themselves using portable test kits; or send the samples to the local aimag labs and/or to the Institute of Public Health Lab (IPHL) *in* Ulaanbaatar. Given the need to analyze some water samples for arsenic, the only lab with a Flame AA apparatus is the IPHL. Therefore, all water samples for arsenic assessment should be sent to IPHL. The consultant team visited each aimag lab and determined that the Mongolian Bureau of Standards and Metrology to analyze the basic drinking water parameters certified them. The cost per analysis would vary from 2500 - 5000 MNT, depending on whether it was for chemical or microbiological samples. If GI staff were to conduct analyses, it is recommended that they purchase the hatch portable field testing kits, similar to those purchased by the WASH-21 Project These kits can be purchased from Raychem Son, Malaysia, for a cost of $2600 (oviform taffy) and $3450 for DREL/2010 (chemical analysis) which includes a spectrophotometer and field meters for pH, conductivity and temperature. Training would be required to operate this equipment. Given the focus of the GI, using the local labs is the recommended cost-effective method of getting these analyses done during the well screening phase.

8.0 WELL DRILLERS

Three well drillers were interviewed during the course of this investigation. These included a Russian, state -owned enterprise, Zarubejvodstroi in Mongolia, a driller's helper in Mandalgovi, and a driller in Dalanzadgad, Mr. Jargal of Undraga-Om. All three have antiquated Russian rigs in various states of disrepair. The drilling company in UB has personnel with extensive experience throughout Mongolia, and could most likely carry out redevelopment and rehabilitation work assigned.
The driller in Mandalgovi was not present when we visited his yard, but an employee showed us around. His equipment was marginally operative from all appearances. He may be capable of installing a pump, but may not be able to do much in the way of well development (a process which entails the removal of accumulated silts and sands from the screened zone).

Mr. Jargal of Undraga-Om Ltd. seemed quite knowledgeable about wells and conditions in the Omnugovi. He had rotary and cable drilling rigs, that although quite old seemed to be in operable condition. Mr. Jargal showed us a Chinese submersible pump that he has installed and a bladder suction pump, locally known as a "frog" pump that he manufactures and sells. Installed cost of this pump is about 60,000 MNT.

It would appear that with a prepared scope of work and some supervision, the work necessary to rehabilitate wells could be accomplished using Mongolian drillers. The condition of their equipment could create some logistical problems, but short of contracting with an expatriate company that was willing to bring in updated equipment and personnel, there are not many options.

9.0 GENERAL RECOMMENDATIONS

In the course of our interviews and field observations, several things are worth additional comment. These include springs, wellhead protection, pumps, and water associations. Some of these topics have been discussed or alluded to in previous sections, but are presented here in greater detail.

9.1 Springs

Although a great number of springs were not visited during the course of our field visits, of those that were observed several things are readily apparent. One, there is no up-grasping protective zone

above the spring, nor any protection at the discharge points. These conditions are conducive to bacterial, viral, and nitrate contamination. At a minimum a 20-meter protective zone should be installed around the spring to keep animals from contaminating the source. A ditch above the spring would prevent spring runoff from carrying contaminants into the spring discharge, Figure 9-1.

Two, minimal to no effort has been made to improve the spring source. Many of these spring sites are releasing more water than is currently being captured. Although what is missed does result in some peripheral irrigation and some recharge to ground water, it is not an efficient use of a natural resource. Depending on the topographic and geologic characteristics at the source, one of two improvements could be made, as shown in Figure 9-1.

Three, the spring's can be an indicator of areas where further shallow wells could be installed. By knowing the elevation of the springs and the formation from which they are discharging, locations for potential shallow wells can be sited. A topographic map with the springs accurately located could be used for this purpose in conjunction with a field investigation.

9.2 Wellhead Protection

Regardless of the type of well or water source being utilized, it is imperative that consideration and actions be taken to protect the quality of that source. Beginning with the land area around the source and ending with the wellhead itself, protection must be provided. There are many ways to address this issue. Consideration should be. Given to eliminating or at least minimizing animal and man-made activities in the recharge areas of water sources. This will require some training, and some effort on the part of all. Stakeholders. At the wellhead, covers and seals should be installed, and animals being watered and kept at a minimum of 20 meters. This will be quite difficult, but not impossible where rubber buckets are still being used.

9.3 Pumps

Almost without exception, everyone interviewed has suggested submersible pumps for the deep wells and portable pumps for the shallow wells. Information with respect to a wells capacity will need to be obtained before specific recommendations can be made. It is, however, important with regard to pumps that consideration is given to all types of submersible and portable pumps. Consideration should also include interviews with herders, availability, quality, and cost

There are a variety of hand pumps available, many of which are portable and may appeal to herders having to use shallow wells. Likewise, there are a variety of submersible pumps, some known simply as suction pumps, that are portable and useful in wells up to 8 meters deep. In addition to the portability of the pumps, there are generators that are le and yet have the capacity to run a submersible pump. Unfortunately, specific recommendations cannot be given at this time. The locally manufactured "frog pump" sells for 60,000 MNT; submersible electric pumps range from USD $ 150-300, and portable centrifugal pumps can range from USD S 150-500.

In addition to the broad range of products above, there are solar pumps that do not require batteries. These are admittedly more expensive upfront (USD $ 15,000 and higher - see Appendix C), but require little or no maintenance. These pumps are typically installed in Conjunction with water storage tanks to insure water availability on cloudy days. Fortunately, many of the former diesel-operated wells have concrete storage tanks of approximately 1000 liter capacity still standing. Additional water storage would be required, but this would be a nominal cost if modern "plastic" tanks were utilized.

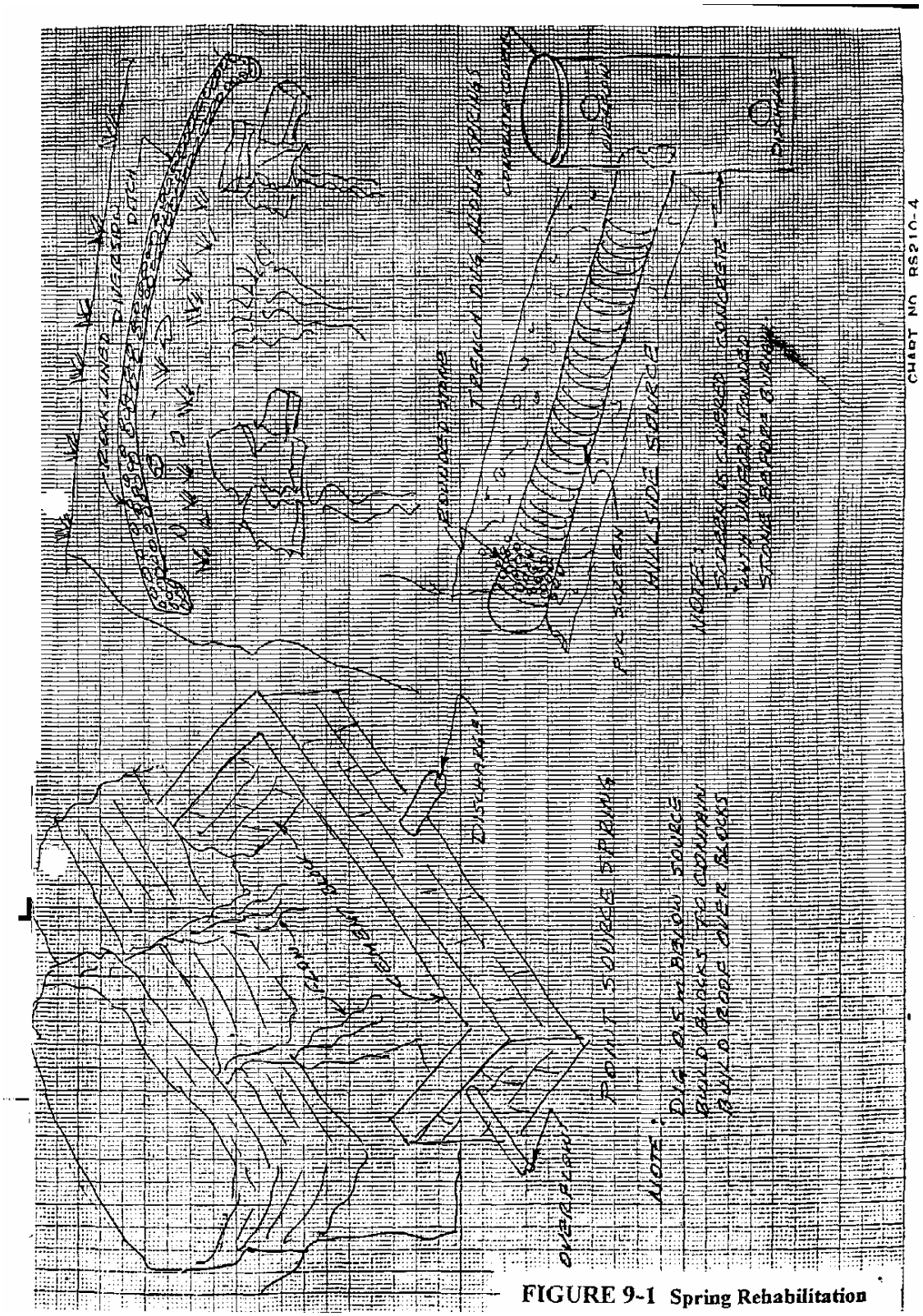

FIGURE 9-1 Spring Rehabilitation

9.4 Water Associations

Because the GI is concentrating on bringing unity and cooperation among the herders, soums and Aimags, our team did not concentrate on this endeavor. Our observation certainly concurs that for the well rehabilitation to be successful and sustaining, some type of non-governmental association amongst end-users must be created. We felt strongly enough about this issue to make it a criteria prior to considering a well as a candidate well for rehabilitation. Continued efforts in this direction are encouraged.

9.5 Implementation Plan

Careful consideration has been given to how to implement this activity so that with limited resources the GI can work in the right locations with the right stakeholders. The GOM, the UNDP-funded WASH-21 project, the GTZ, other donors, private citizens and civil society groups are undertaking concurrent well rehabilitation programs. Some lessons learned are available from these sources and are described in the attached Technical Report (Annex 2). For example, the WASH-21 Project started drilling and rehabilitating wells without prior consultation with local communities with the result that approximately one-third of the new wells are already out of service. The Japanese International Cooperation Agency (J1CA) funded studies in Dundgobi, Omnogobi and Dornogobi aimags to identify the types of wells, and interrelation of use of water wells and rangeland grazing by livestock resulting in impacts on range production. The GOM has recently made a request to the Japanese government for a large new well construction program in agriculture and pasture lands.

The GI will begin work in aimags and soums where they have established networks and relationships with herders. This work can be expanded based on lessons learned and availability of funds. In order to effectively make use of the resources available under this activity, a rapid and efficient phased approach is planned:

Phase 1 will consist of starting well rehabilitation in soums that are more progressive and with which the GI has a working relationship; herder preferences will be taken into account in developing an initial list of candidate wells; conducting a rapid rural appraisal of herder movements in the soums, identifying on maps which range areas are used on a seasonal basis, and which are not and why; concurrently, locations of existing functional and hon.-functional wells will be identified and plotted. Much of this data on existing wells is stored in various databases, either with consulting companies or with the Institute of Geo-ecology in the Mongolian Academy of Sciences. The outcome of Phase I will be a series of mapped locations where wells are needed, rangelands are suitable or not for livestock grazing, and herder movements are anticipated.

Phase 2 will involve the technical evaluation of candidate wells for rehabilitation. Determining if they can be physically rehabilitated will assess Wells. Many of the boreholes have been filled up or destroyed in one way or another since 1990. Wells that pass this initial screen will be tested for drinking water and livestock water quality. If quality passes certain criteria, the well will be added to the final candidate list. Concurrently, a socio-economic profile will be prepared by GI on herder's willingness to participate in the well rehabilitation and maintenance program. This last factor is the "deal breaker" in that candidate wells will be prioritized according to the ability of the^ GI activity to ensure sustainability of the wells by obtaining herder/associations of herder buy-in for the O&M.

Phase 3 will involve the implementation of the activity by selecting wells for rehabilitation from the list of prioritized wells, tendering contracts with local drillers to conduct the rehabilitation, procurement of pumps and other equipment, training of herders in well management techniques, naming awareness programs in the soums, and monitoring and supervision of the process listing lessons learned and results achieved.
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APPENDIX A

List **of Water Resources Related Laws, Regulations, and Resolutions**

Laws	
Law on Water	April 13, 1995
Law on Water and Mineral Water Use Fees	May 22, 1995
Law on Environmental Protection	March 30, 1995
Law on Government	May 18,1993
Law on Administrative and Territorial Units And Their Management	August 21, 1992
Government Resolutions	
Determination of Fees for the Use of Water	August 25, 1995
On Water Assessment and Registration	March 6, 1996
Some Measures for Improving Water Supply in the Gobi Region	October 7 1998
Approval of National Program on Water	March 10, 1999
Ministerial Regulations	
Regulation for the protection of water resources for household purposes	April, 1992, MNE
Determination of boundaries of small rivers and water protection areas	April, 1992, MNE
Approval of the contract form for the use of water and watersheds	November 18, 1995, MNE
Temporary norms of indicative water use of water for production of unit output	November 18, 1995, MNE
Procedure on maintenance and use of pipes of non-clean water	Dec 28, 1995, MNE/MHSW
Procedure on registration of water pollution decrease and its restoration	July 16, 1996, MNE 1995,MNE
Regime of protected and sanitary areas of water points for household purpose	1995, /MHSW/MID
Other	
Quality Standards for Drinking Water, 900-92	1992

APPENDIX B

MEETING AND FIELD NOTES

These notes are recorded directly from Dictaphone and field note pads and are unedited.

October 13, 2000

USAID, Ed Birgells

There is a USAID "resource center" and a UNDP library for additional materials.
In preparing our report, Ed would prefer not to have to react to a document, rather we just tell him what they need to do to comply with AID Rag 16, as well as tell him if Gobi Initiative can do the activities contemplated. ARD should brief everyone on what will be agreed to do. Ed doesn't want USAID to get involved in activities that will be embarrassing to USAID.
The money for this activity is coming from the Embassy magnetized fund (416B food aid).
ARD should set up the hoops for environmental compliance for the well rehab work. It should be a

"program" and "process" not specific to any given well, rather types of situations.
Land use protection should be recommended to the extent it is a water issue, up brief, a set of criteria and the conditions that must be met to do the well rehabilitation.
Will be working initially in 4 aimags, with the option of going into 2 remaining aimags in out years (Dornogobi, and Bayankhongor).
Note if there are any gender issues on watering, and any division of labor.

October 14-15, 2000

Review Documents. October 16, 2000

GI: David Dyer, Ms. Alta
Center for Policy Research work was done before David arrived; need to look at water material in that report and decide what you want to do with it. GTZ have an environmental focus to their projects, dealing with wildlife and desertification; ask about any wildlife-well rehab concerns they may have, esp. in their l Park project in South Gobi.
Look to make a short presentation on findings in the Oct 31-Nov 1 timeframe.
Wells - missing link is ownership and maintenance; user fees OK
Supplemental feeding of livestock - herders are weather driven; cut weeds but can't carry fodder with them if they have to move quickly; used to a paternalistic system; if it were bought, where would they store it? Herders are less nomadic than under previous regimes, especially since privatization; forage production was in the north (of UB) and brought down south under the needle (collectivism) system; now suggesting Supplemental feeding for "elite" animals, near well points with rested forage would be ideal' build incentives on water use and well maintenance.

WASH-21, Ms. XJndrakh, Admin Assistant
This turned into a useful meeting, since initially I thought since we couldn't see the director, Ms. Odonchimeg, that is might not be. Instead, Ms. Undertake gave me a lot of useful information.
WASH-21 has 4 branch offices, with coordination at the Sown level; now have 53 volunteers; LOP is 4/97 thru 12/01; key involved GOM units - MID, MAI, MNE, MHSW, with MID dealing with towns and settlements, but MAI with well construction. Received $ from Dutch Trust Fund to do well rehabilitation in 32 soums in response to the Dzud, specifically in Tub, Omnogobi, Gobi-Altai, Dundgobi, and Dornogobi. 200 priority wells provided by the aimags, but with resources limited were able to select 74 in 32 soums; refer to Disaster Management Report from UNDP (get off website, www.owc.org.mn/zud/); in MAI Mr. Brahma is the contact; Raps sent out to soums by WASH-21, and local drillers were asked to respond (Jim obtained copies of the bidders list and a one-page SOW for the drilling work); most of the drillers visited the wells before submitting their cost estimates; contracts are between the drillers and WASH-21; some deep wells with electric pumps; some mid-level wells (10-50m); costs were' budgeted at TG 48MM (23 wells), with TG 2-3 MM per deep well.
Annual Report for 1999 obtained, having some information on the well rehab activity. Water Chemistry - HACK Kits were purchased in Malaysia for the bract and physical-chemical water analysis; one for each of 7 MHSW units located in the aimags, and one for MHSW, Hygiene and Epidemiologist Department; visit their offices in each aimag to get performance information. Jim obtained specs from ARD Home Office and price list, as well as WASH-21 order information (obtained from Malaysia at much lower price than from US). Contacts were provided to our translator to see in both Omnogobi and Dundgobi.
WQStandards - Get copy of National Water Quality Standards, 900-92, from Mongolian National Center for Standardization and Metrology, where they have a catalogue and sell copies of the standards; make sure we get standards for physical and chemical as well as bacteriological for drinking water, not surface waters.
Spring protection activities - sanitation zones have been set up around each well, forced on

communities by the standards; and every well is supposed to have this zone. (We need to check and observe how this is working in the field). Again, these wells are for people, not livestock. Umps - primary India Mark III and some electric pumps for the deep wells; have had

Note: we need to find out what selection criteria they used.

SWECO

Dropped by their office, which is adjacent to WASH office (I suppose they are the contractors implementing the project, didn't ask). Local Mongol gave me some names of drillers and other contacts who may be of help; Mr. Tsehenhamba, Chief Specialist, GIAUD? Geological Investigation Office, MID?, head is Mr. Basandorj, Cell # 9611-3902, and Tel. # 632-895; and David Levi, Enterprise Reconstruction Project, Cell # 9911-7969, and Tel. # 976-1-310537.

Ministry Nature and Environment (MNE\ Mr. Basandorj, Leader of National Water Committee

This guy is also a MOP, and responsible for water development. Gave us 20 minutes of his time, and let us know that only because it was water did he do that.

There are 5 ministries involved with water and this resource needs coordination. Wells deal with three areas: supply at the aimag level; soum level; and pastures.

General questions about coordination must be settled first, and then go to specifics was his caution to us concerning well rehabilitation! There are 60,000 wells and 200,000 herders, who water their animals once a day (as a norm).

Must rehab wells or solve the problem in another way. Policy needs to be worked out before one goes ahead with rehabilitation. (I wonder if he knows what is going on in spite Otego?)

Interface needed between the NWC and Gobi Initiative, about (1) which pumps to use, with GI making recommendations to the NWC, and (2) herders and communities need to be involved. If there is cooperation on these two issues you will be successful Plan: get several families involved; get them to provide the $ to maintain wells, with some $ from the GOM; work together.

Coordination between/among projects: herders should take the initiative; sub-committees at the aimag level responsible for water; use Dundgobi as an example to follow (what?) getting the information from JICA; coordination to know which project and where, but in general, all water work needs to be coordinated.

Pump questions - make some exhibitions about what's feasible; function of depth used; cooperate on which kinds, and provide specifications and costs for people to do on their own.' Herders should also decide which pumps, $ they can spend, and better to get their input. Each well must have an "owner."

Family-level issues - when traveling to the soums, individual families need water filters or ways to purify their drinking water.

Note: Jim asked the translator to provide a write-up of his notes too, since there were some items that needed more elaboration that were lost in the translation.

GTZ, Ms. Sabina Schmidt

Two projects, (1) park and protected areas management, and (2) combating desertification, dealing with technical, as well as pasture management, governance, and legislation.

Gurvan Saikhan National Park, Omnogobi - will be affected by well rehab Wells in these regions - 80-90% of the wells are non-functional so there is plenty of room for donors to work toward common objectives. WQ is bad (didn't explain); need to establish user groups; no coordination of pasture movements right now, like under collectivism; herders need to agree on winter pasture and need to set aside these areas and manage; # of animals are increasing; herd structure has changed from single or two animals systems **to** mixed herds, with goats the most popular and profitable

animal; short distribution; less frequent herd movements; winter shelters too close to one another and to population centers.

Key issues - without guarantee of pasture use coordination, negative impacts on the environment will be expected; coordination with GTZ in the park area (join efforts); more wells will attract more people, and put more pressure on pasture; how can we prevent new people from coming into areas where wells are rehabbed; some wildlife conflicts with ibex (mountain goat) and wild sheep, which are mostly in the mountains, and not so much on the steppes, where there wouldn't be many conflicts expected.

Policy changes - pasture use coordinated; land tenure issues (land reform needed); MNE has a new Department of Strategic Planning and Management that could get involved; taxation and user **fees** should be reviewed; urban areas are problematic.
Other contacts - Don Edina, livestock and range management; Maria Fernandez Jimenez. During our visit to Omnogobi, we should visit with the park administrator who can show us the critical areas (Jim needs to schedule this), Mr. Pandas (Pads?), Mrs. Dogma; and see GTZ stiffer, Dr. Rents in Maytag, who is a water expert.

October 17, 2000

UNDP, Mr. Batkhuyag (deals with water issues) - did not show.

Public Health Institute/MHSW, Mr. Dundii, and Deputy Director
We had tried to get a meeting with Dr. Tarantula, the director, but she was out of the country until next week. Her deputy, who gave us a quick synopsis "of how the institute was organized and what it does, handled our visit. There was little substantive discussion of water issues. In general, there are 4 centers within the institute; Environmental Impacts, Infectious Diseases, Food Research, and Biotechnology. Most of the funding comes from the GOM, but they participate in some donor-financed projects (e.g., JICA) to supplement their program budget. Much of the research is on environmental media (air, soil, water) and the impacts on people's health. I still need to confirm that they participate in WASH-21. There is an analytical lab there, and we will try to visit it to find out more about what they do during our last week in UB. Mr. Dundii was trying to arrange for their water expert (name?) to see us on 10/18/00.

Mongolia Technical University, Dr. Batsukh (water **expert), Hydro geological the and Oil Engineering Department**
He knows Jennifer Butz; studied in Russia as a hydro geologist; now a professor; has done research on lands in the Silence (north); has worked with WASH-21.
What's the best way to approach well rehabilitation? During the last 10 years wells with pumps have been destroyed; now people get water by hand; this issue is being discussed by the GOM,
Why were the wells ruined? (1) Shortage of diesel fuel for the motors driving pumps, and metal removed from pumps for sale as scrap, (2) all wells that were diesel or rotated by animals had replacement parts problems, and now can't such parts, (3) nobody was there to look after the wells, whereas in the past the GOM used to handle this, (4) livestock privatized and now there were wells without owners. Land and water were not privatized, but if wells were privatized there would be conflicts. The constitution of Mongolia says that the GOM will take measures to protect the livestock of Mongolia. Well rehab fits this obligation.
Deep wells - source of energy should be cheap; DTW > 50 m = deep; salty in some places, but OK.
Back to the Question - what approach to well rehab to take? (1) Get proposals from herders (herders like to settle along roads to take advantage of infrastructure, (2) vegetation quality, (3) water quality. Herders don't move as much, and now look for winter pasture. Now people almost stay in one place, if weather permits (pasture OK and rains OK); usually people move with livestock 15-20 km; due to shortages of wells, they stay close to the main road. Under socialism, herders were

located far from each other and there were plenty of wells; they were supplied with goods from Vans/shops, which delivered to the germ. Pumps were all ruined and these ruined wells may be difficult to reconstruct according to Carrillo. Listen to herders, but meet the professionals and local administrators to get their input.

Issue - do we want to make this a local government activity? Open it up to rajah ' community to have them decide how to do the well rehab, take ownership, make decisions about which wells from a short list based on tech input from GI?

Question- any well construction records? Where? Map of locations at the Geo-ecology institute, under Dr. Blander, who knows more about pastures and wells than anyone.
Current Db on WQ? No, only records from when wells built.
Is data on WQ? Only post-construction analysis; WAHS-21 only for wells in settlements, and they may sample with greater frequency than annual if there is a perceived problem. Soum centers — not sure.
Labs are operating within MNE and the Geo-ecology Institute.

Institute of Genecology, Dr. Janchivdorj (water wells and hydrogeology) The institute is a unit of the Mongolian Academy of Sciences. There are 3 Divisions, Water Resource and Use, Forests, and Land. His institute in part of the Water division and is the only professional research agency involved with water resources. Maps - computer generated from their Db, showing all water wells in the country, v, organized by soum; data amalgam includes: well location by number, depth, diction in liters per second, chemical analysis of water at time of construction and if was rehabilitated; so for some wells there are two analyses.
Privatization - led to most wells falling into disrepair since no one took ownership of them. Types of wells — 3 basic
(1) Deep drilled, > 30 m, with diesel pumps and steel casing; 7000 were installed, many in pasture areas; no information in their office on broken wells.
(2) Mining wells, < 30 m, concrete walls and casing, 1 m diameter; 20,000 installed; pumping mechanism had metal parts which were stolen and sold for scrap by the general populace; mainly used for livestock watering; if < 6 m DTW people could get water by hand methods; easily can be fixed; many were located in areas with "bad" water, i.e., salty and hard (e.g., TDS UB 0.3 g/1, Gobi 1.5 g/1, GOM Standard 1.0 g/1.
(3) People's wells, hand-made wells; diameter 0.6 - 1.0 m; DTW 8 m; 15,000 total in Mongolia; many in poor quality, but not chemical, high in nitrates contaminated by animals; within the standards but higher than you would like; no frames or pads; can't make analysis.
Sanitary protection zones - mostly will work in urban areas.
Map wells in pastures - shows efficiency in spring and winter.
Pay attention to engineering side, meeting the requirements of hygiene.
Deep wells need proper equipment; construction where necessary; depends on quality and quantity of pasture/range.
Good vegetation - animals come to eat and drink water; where the grass is best.
Winter shelters built where can protect animals from wind, and have water.
Discussion about how the situation (degradation of pasture) worsened over the last decade; what is the ideal radius? # Of herders doesn't increase so rapidly; if good quality forage; varies depending on range quality; in Gobi 8 km/d movement avgas; if good range, move less, if poor move more; distance between wells depends on grass, which zones have better grass (or potential) should be a consideration.
Who can help the Gobi Initiative decide? Herders must! Depends also on (1) cupidity in given year or precipitation, (2) grass productivity, and (3) what the herders say is avg. Must ask herders which is the best location for a well; institutions have information concerning vegetation productivity of various areas; on that basis, the institutions used to determine radius between wells. If left to

individual herders, may decide on personal profit motives; **vegetative productivity+herder+well water quality is a good way to focus on the best locations
Wellhead protection — each should have protective cover against vandalism; build huts for some; choose one owner or herdsman and it will be protected.
Can GI come to the Institute to look for data? Yes, it's possible; to get information, go to each aimag and record (1) name of each well, (2) # of the well; must pay the institute to provide the data, but the amount $ depends on volume of the data and the "degree of cooperation" between institutions, i.e., if GI pays the institute to design the well pad and/or housing, the institute will lower the cost of providing the data on wells and water quality that is in their database.

October 18, 2000

JICA, Mr. Furutani
This was unproductive since he was not responsible for any activities in the water well area, but he did pass on the names of the someone else at JICA who could help us: Mr.Amagay.
Center for Policy Research, Mr. Enkh-Amgalan, and Director {did study for Gobi Initiative)
CPR is an NGO, think tank, founded in 1998, which assists the public to make
Knowledgeable decisions about choices they have; consulting work (like for the report and strategic plan they did for GI); and contract with national scientists on pressing issues, producing reports through mass media and publications.
Holistic approach to well rehab - agrees with our thinking on this matter; water is an integral part of the herder's life; must have all components for pastureland management; no tag land and water.
UNDP - recent review mission highlighted problems they are having with well O&M, since they are installing supply wells where there had been no ownership from the local population; on livestock wells, these were ruined after the fall of socialism because no ownership established; livestock under state protection; must solve the ownership issue first to make any efforts successful.
Make clear - strengthen informal communities around one water source; how? NGO participatory approach; began by asking local groups whether or not they liked formal organizations and which type to protect their interests; offered (1) company, (2) cooperative, and (3) NGO; they choose the simplest = NGO since not required to pay taxes, no financial statements at end of year, etc.
Under socialism, set up cooperative to exploit herders.
NGO = 5-10 herder families with a common water source; ensures mechanism to make sure O&M happens.
Equipment - herders don't like machines requiring more petrol; alternatives OK, but smaller the better.
Large volume production wells are not recommended - why? - Lead to overgrazing areas since each well can handle 1-0-20 households; but if larger wells, new families will come into the area, resulting in over use of the pasture. Question? — If we did put in large production wells, could mechanisms be set up to manage this? NO, Cap = 100 kg/yr, or less than 1 Sheep Unit per ha; 1 ha produces 280 kg dry mass; 1 SU requires 560 kg dry mass per year; in highly productive areas, 2 ha per SU, but in Gobi may be double or triple (range 2-10 ha/SU). Whatever GI does, it shouldn't destroy the existing distribution of livestock and their families; small capacity wells, more of these types, scattered around is the best solution.
How does family establish tenure? Under normal weather conditions this is self-policing; through informal arrangements; use natural boundaries, such as hills and valleys; winter shelter is a limiting factor, need radius of at least 5 km to sustain herds.
Herd size has changed - < 1990 avgas herder had 500 sheep per family; but this has collapsed to < 200 per family now; # goats has increased 2 X from 5 MM to 11 MM nationally; no incentive to improve cashmere since market controlled by Chinese and is a price issue.
Herders as consumers of water - primary nationally; provide 35% GDP, but contribute 2% of the national budget, because don't pay taxes.
GOM Involvement - Must attack this problem at the grass roots; make herders understand what's in

it for them, let them take ownership.
Contacts -MAI, Mr. Byrne, Head Livestock Division; MNE protection of water, Dep. Min. Bloat. Working group on Land Reform set up includes water; elected not to go privatization, will expand land use contracts, (need to find out what this means?)

Mr. Michkhalyov Feodorovich, Zarubejvodstroi (driller)
General Director of ZVS, a Russian, state-owned drilling company; pamphlet' given to Carrillo; operating cable and mud rotary rigs (3 of each); primarily hard rock; company has done 20>000 wells in Mongolia; does work Mongolian companies can't do, e.g. 300 m, large diameter (273 mm, 10 dime).
Which types of wells are there in Mongolia? (1) People's wells, 10m deep, ID stone or wood, DTW 2.5 m; water taken by hand; (2) small pipe wells, 15 m deep, diameter 100-120 m, screened holes 15-20 mm wide, hand pumps or wheel turning rope; (3) engineering wells, deep, mechanical or electrical pumps; suction pumps; well construction diagrams and other information on these wells is located an institute in St. Petersburg, Russia.
Participated in seminars on well rehabilitation, a matter of funding; meeting in Dalanzadgad rehabilitation last year; talked to Jennifer about doing it. ZVS Overview of how he would do the work on well rehab - Don't see Gobi as separate parts of land; see it as a territory with pastures, some of which are used, some not, some overgrazed, some not because there is no water; there is overgrazing where there is water; so take it as one territory, not aimags, and can see which parts give move economical water production for the national economy; go to these parts put wells, then go to other parts. ZVS proposed to do this work, (1) list all wells existing, data collected before, aimags are spread out, existing pastures with water, put all of this on maps; (2) aerial photos, interpret, do maps based on aerial and hydrogeology, decide best areas*to frill; (3) divide territory into existing water resources, on basis of information, work out what types of wells are to be drilled; he made the order to his institution in Russia to standardize well pads, and must have same types of pumps on all wells; partially completed tasks 1, 2, 3 when the first Russian wells were installed, but equipment was poorer and technology has changed; probably 60% of those wells were sited properly; Mongolian hydrogeology is difficult to find the right place 1 Plan -"set up intermediary companies to organize the herds help thorn get money to finance the wells.

Water Institute, Mr. Blander - did not show

Dr. Bazargur and Dr. Shirev-Adiya, rangeland/hubs Mongolian Academy of Sciences, Institute of George Pastorals Studies (at Gobi office)
Livestock movements — how herd moves from one place to summer they're at 3000 m, then move lower; per annum ire t, they mostly move to lower camps; why? Herder rot!« animals; remain in lower elevations; herds privatized forced to change locations. Steppe - North to south maven wells are gone.
Approach to selecting/sitting wells - using map at 1:100,000 scale, plot all movements of herders (research is done on some of this) to see where the population is situating; what you'll find is that one area will be thickly populated, and areas north and south or east and west, depending on topography, will be empty; must ask a critical question why they Are not moving; if the herder answers because of water, then OK, we can proceed with this.
Herder movement - make the movements proper, as they used to move, according to well locations; used to move along 4 points; (1) determine the right location of wells; locate wells when traditional movements restored; to create proper pasture management program; study whether traditionally the herders used to move, then why they stopped & role of the well in the traditional movement; (2) now stay in winter places because these are preferred; did research on 3 soums on pasture management; found out there were changes in the movements; confident it's possible, now selects places by desertification; there's a right way to do it; # herders around well, what happened to the land no research based on technical figures.
Bazargur proposed to help GI, and would send people to make our project successful. How long

would it take to do this research? - # Soums
How many heads over accepted # on 1 hack of land? # Heads per hectare depend on a # factors; e.g., did research in 1 - 2 soums, where the herders move, worked out guidelines for herdsman; to make move, need to force them to move through some directives or incentives; Bazargur believes that each sandbag administrative unit must make them move; should be determined what stage of degradation; average pasture revival is 5 - 10 years. Herds used to move 4 X per year, now they're moving 2 X per year.
What about degradation of pasture? - There's no place where pasture degradatiorf is so bad it won't come back; easier to move and build new well than to re-seed. No pasture management exists; now herdsmen decide for him when to move; no science applied. If build well — he thinks people will move to new places, could be a problem, if build one well; must create associations; group of households, #'s vary, but live along range of mountain, in one valley, along a river; traditionally lived together; 4-5 households, with several factors influencing their creation (1) relatedness, (2) economics, (3) territory or which' valley; ownership of wells must be based on such communities.
Process - get agreement on est. community association; study; site wells. It will take 5-7 days to study one soum; working out periodic movements, places, # households moving; where, # livestock and on that basis; find out e.g., # extra animals; # wells to be rehabilitated will vary; set priorities for the # and as result pasture management will change in such a way.
Which questions should we ask herders? Herders will not tell you proper place to site a well; ask indirect questions such as "what difficulties they are facing, and in past how did they overcome these difficulties, where did they move? Once the research is done, land degradation impossible to live and had to move to another place - ask about this. Historically - < 1950 movements from steppe to Gobi, from mountain A to B took place, some moving N-S, others S-N; used to meet 5 X per year, which was a socio-economic activity to exchange animals, meet new people, intermarry, trade; > 1950 areas where hawsers used to live in mixed groups declined and territory was limited; gradually each family stays in one place; don't mix with each other, causing inbreeding problems; changing herders to a settled way of live (may be their preference now).
This series of interviews ended the initial work in UB prior to going to the field.

October 19, 2000

Mandalgovi, Water Quality Lab (Metrology Center Laboratory), Dr. Udelmaa, Tel. 22-26 at office

Participated in spring 2000 seminar on water; built up lab through WASH project; perform 18-20 kinds of analyses; Back-T, 2-3 types; just recently received HACK portable equipment; not sure how to use it, especially batteries and charging the systems for the field; have reagents for 100 sample analysis sets; performed Back-T analysis once a month from the aimag/soums; analyzed several wells for chemical parameters once every 3 months.
Possible for public to bring samples into lab for analysis; fee for service? Yes. Will analyze herdsmen samples gratis; if organizations bring in samples they must pay; if in constant use, free of charge; if rehab wells, yes must pay; TG 2559 for chem. analysis under old system (not the new portable lab); Back-T would be more than TG 3000. Problems with WQ in aimag; carbonate balance lost from 1:3 to 1:1; water salty as well in the aimag center; some soums are good, but WQ varies over all scrums; most are just within the standards; Back-T, salmonella, typhus in one well Springs have more contamination; 5 out of 13.
Aimag center supplied from water source via pipeline underground and reserv6irs. Soums have some contamination; all use own means to get water, e.g. buckets.

Aimag Administration; Water Policy, Mr. Ulziibaljir, Water Engineer

He was able to discuss the availability of data and information on wells and WQ; and accompanied us into the field on the following day.
<1990 - specific organization was responsible for water sources and supplies; # of wells in aimag*

1990-97 - no measures taken in this field. Organizations connected to water supply stopped their activities; wells under agricultural companies and when these companies were stopped working no owner to look after the wells = pasture wells. > 1997 - economy improved, some rehab of wells, e.g. in 1998, 55 wells rehabbed, in 1999 and 2000 $ by MAI, so in 2000, 15 wells rehabbed; $ from Japanese Peace Winds, and private fund for Kasha Zen (wrestler); in 98 and 99, WASH 21 installed 22 new wells in 10 soum centers; now contract with WASH-21 to rehab 10 pasture wells; implementing organization is a company established on the basis of the old water organization = drilling company; work not started yet, but we can see the equipment. Focus - (1) rehab wells that don't require much effort, (2) which after rehab gobs will wave. Responsibility for maintenance; at the moment don't care about water quality, only not destroy the well.
When to the rehab, what is done? Pull old pump, develop well; wells with clean borehole OK, but sometimes must clean hole; no pumps in them; sitting? In appropriate place, (1) no other wells around, (2) urgent necessity to have well operating; only wells which worked with diesel pumps; why? Because belonged to state and after rehab, these can be someone's responsibility; representative of the gob's, not paid. What about other types of wells? Rotary (Kasha) and people's wells are not property of the gob's, and after rehab, nobody can be in charge of these wells.
Can GI proceed without COM involved? We need to answer this.
Mr. Ulziid knows more about diesel pump wells; will show us well they are going to rehab. Have a company here in the aimag to drill wells and rehab wells; the Director is out of town. Wall want wells near the germ and show DW surveys.
What should GI focus its effort on? The aimag selected wells after speaking with herdsmen, and identified the wells around 30 m and 195 mm diameter; drilling company is holding company for the aimag; have contract with development projects and with the aimags and soums.

October 20, 2000

Luus Soum Visit - herders, see 3 diff types; GI staff (Mr. Gerel, Agra Program Officer; Mr. Baasankhuu, Dundgovi Program Rep)

Gobi, GW draws down. (1) Impacts on the aquifer? Not unless wells closely spaced would there be impact expected; (2) GW in Gobi tends to be hard and highly mineralized; many wells are salty with high TDS levels; (3) 4 aimags have least water per area, in ascending order Umnugovi, Dornogobi, Dundgobi, and Skater, all of which are in the SE part of the country; (4) given the high evapotranspiration, it is unlikely that much of the Water withdrawal is replenished; it is estimated that only 3% of annual precipitation infiltrates back into the soil to replenish GW.

People's wells - hand bucket on pole; 3-4 m DTW; problem when lots of animals since hard work to draw water; want portable pump; easy to put hand pump on with pad; need shed if hand pump like India Mark 3.

Diesel Veil No. 1 - data available from Mr. Alsip; trough and pump over borehole, moot too expensive; vegetation condition OK; holding tank; building around unit; N 45, 55, 403 and El 06, 00, 102.

Herder Interview, Mr. Dembereldorj, Luus Soum area

What difficulties do you face and how do you overcome these? All diesel pump wells destroyed, all huts re-used by people; rotary wells have nobody to look after them; no spare parts.
Luus Soum - water points OK, lots of people's wells located 5 km from each other, no more than 10 km apart.
Condition of pasture? 5 km distance, # households have big influence on overgrazing; if reliable water at new pastures, then people will move there; wells with diesel have OK pastures, but diesel

and rotary not reliable; recommend not rehab diesel and rotary = his opinion!
What should GI rehab then? Diesel pumps are costly; need people to look after; smaller pumps such as Honda, portable, when herdsmen come and switch on, took pump back with him.
Do these pumps work in the deep, engineering wells? Small pumps in Southern regions of the aimag, e.g. Khuld Soum, use portable pumps in wells with 10-12 met; need long hose, rubber is better because plastic breaks down easier.
What if? Pastures well, no one there; rehab them and people will come to live; pumps will break down again, nobody to care for them.
What pumps? 5-6 GPM sound good. if breakage is low, possible; troughs are 7 m X 25 cm X 25 cm.
Would people still move around if rehab wells or not change back to old ways? If
Untouched pasture, without wells, people will move there; when med administrative people, may say diesel or rotary were good because they don't know our real travels or herder experiences.
Portable pumps? Good enough, if can be carried by hand on a motorbike.
Solar panels? Capacity low or what?
>1990 - people moved here from cities to pursue animal husbandry; built shelters
Anywhere they liked; good pastures ruined; shelters were built on good pastures.
1990 - herdsmen were distributed lands, and given certain land for winter camps and knew where to move according to the seasons, and now move wherever they want. (1) herdsmen who lived here for years can agree, (2) newcomers, no use to talk to them and can move to whosever's pastures they want, (3) vegetation not thick; spots are vulnerable and easy to destroy.
How long does it take to regenerate pasture after grazing? 60 days; can be shifting, but let some land rest; provided enough rains; frequency of movement connected with rains and condition of the vegetation. In some years, only move 2X, other years more frequently.

Question - any suggestions on how to improve this situation? Can move to pastures; leave land for revival; when there people from other areas can come to place herder A left, no renewal of used pasture; if one herder moves, another comes to take his pace. (1) Admin measures not solved it; if number of wells on uninhabited areas, people may move" there; but not many kids of school age; soums have not uninhabited areas there; Domogobi and Omnugobi may have some areas like this. Problems with moving 300 km, (1) left children here at soum center to live in dormitories, (2) no medical services out there; and (3) couldn't do am trading, no earnings.

WQ? Not so salty in the steppe zone; but to south in Gobi desert, deeper wells and salty water.
South Khuld Soum - desert; distance between wells 30-40 km; no suitable DW; Luus Soum is good; some Sculpture smell in water, e.g. Ulziit Soum, people's well, in Buoyant Bag, name of well is Klahanie Us.

There are some wells in this region that have been used for 100 years or more never cleaned.
Any joinable stomach disorders? Yes, gas and diarrhea in some places. Related to totality of \voter?
In low places when soil soft (mud) shale's, high places are good.
Uranium mines in Ulziit Soum.

Man and Mg possible mineral deposits; animals don't like. Dishware with black stripes in pans; where? In rotary wells; not user if still has water.

Action: In screening process, GI needs to test the water before deciding on a well! Can find wells with bad and good water within 5 km of each other.
W-E Well Water Sample - N 45, 36, E 105, 33. Sample taken from each adjacent well; but the west well smelled bad. Sample left at GI office to drop off at lab.

Recap of 10/20/00 field Day:
(1) LC send email to get solar pump information from World Water Corporation; S solution.

(2) Water analysis, 3 samples collected for chemical and Back-T analysis.
(3) Mr. Dembereldorj, herder interview - older herders can reach agreement on well maintenance; portable pumps, others if technology simple, cheap, fix-able; doesn't like diesel wells or rotary wells.
(4) Saw operating diesel well
(5) Non-FUNCTIONAL 3 type hi various locations.

October 21, 2000

Question for today - private herders are required to obtain a grazing permit from aimag governor?

Summarize Impacts - for IEE

Basins Photo, N 45, 14, 516 and E 108, 04, 248; elevation 1450 m. Acidic, igneous and metamorphic with crystals; very decertified; rocky pavement.

Old Engineering Well - N 45, 08, 847 and E 106, 01, 711; elevation 3874 ft (corrected in meters). Using engineering well with portable pump; photos; 3-4 families now using; if rehab this, 10-20 more will move in; problems is not enough water; pasture is OK. Hose being used not flexible; made up portable pump.

Action: Feasible? Support private enterprise by coop or NGO making or assembling pumps to sell to other herders.

Zairt Well, 100 year old people's well, N 45, 01, 302 and E 105, 55, 631 at 3968 ft; 5 m DTW; 7 m total depth. Camels around; and horses.

Pumps - Homelike, TG 260,000, AP-125, 1860 GPH, 7040 LPH; Chinese portable pump.

Mr.Ulziisaikhan, Winter Camp, N44, 56, 003 and E 105, 55, 125 at 3899 ft; 10 km to well.
Well with submersible pump; hookup generator here and pump out water; salty only for watering animals; called Stanch; had diesel, but gone; put submersible in well, but not right, not sure if water output is small or well pump is problem.

<u>Herder Interview, Mrs., Baasan (had primarily camels)</u>
What difficulties faced? How overcome them? Conditions of pasture?
2 hand wells go there for DW. Travel 25 Km; 8 km to spring, but little water there. What difficulties with water? (1) Not enough, recharge not good; has 150-160 camels, which drink 80 liters per day in summer; must water every 1-3 days when cool weather.

One well nearby, only enough for watering 300 sheep; engineering well 4 km away, but motor destroyed; to south no wells; spends all day watering animals. WQ -s ally.
How can you solve your water problems? (1) Some years ago, when coop existed, angry well used to produce enough water; (2) if works, water salty, but OK; (3) pumps adequate? Works, but capacity not enough, but shortage of fuel causes problems (issue - her budget is inadequate to cover fuel, esp. in January when they must use buckets to water the animals); bought Japanese/Yamaha for 80,000 TG, but now costs TG 200,000;

Pasture is poor now; much of herd lost lass Dzud, but now betters.
Why is pasture so poor? Now only weather; lack of rainfall and not connected with overgrazing; in spring and winter lost many animals; no problems now. Before this spring, was problem with Dzud, people lost most of their animals, some left w/o single head! If big numbers of animals, soil will degrade; sheep and goats; # families? 11 live; several in one place. Used to move to Luus soum, still

moving 300 km with horses; 200 km to GGS National Park last year because it had good vegetation. If more wells, would move with more frequency? Yes, if add wells, more welcome; people still want to live close to the soum center for school, medical services. What other types of pumps are used? Frog pumps (bladder pumps); appear to be brought from somewhere else, not hand-made here. Would she show us her hand-pump? Not near her germ; buys gas from soum center; Finances before Dzud were OK, 300 goats, but lost all but 10.

Well near her Ger-N 44, 31, 195 and E 105,48,061 at 3710 ft, 5 met, ID 15 cm (6 “)

Painted Desert, N 44, 34, 616 and E 105, 43, 006, at 4467 ft.

Ger hotel in Khuld Soum

Recap 10/21/00

1. Rocs - advance team with A-frame and test pump in all candidate engineering wells to run crude pump test to see if worth putting submersible pump down the hole; take sample of water to analyze; consult with herders on WQ and quantity issues.
2. Possible to find Map showing military installations; were good producers and OK to rehab those?
3. Herder moved to NP for better pasture; obviously knew about those conditions.

Interview with Head of Khuld Soum Governor's Office, Mr-Chimednegzen

Wells, 2 WASH-21, but one had fecal contamination and were closed; 1 had India Mark 3 pump; 2 people's wells, when first dug WQ OK, now hard water. After installed this one well, couldn't use it because of Back-T contamination; other well had India 3, but broken and WASH promised to fix it in July 2000, but didn't.

Soum has 150 families or 600 people; 110 families moved in from the Dzud. Some talk about living here, others want to move out after 4-5 years.

3 wells - (1) 9-10 m, used to be rotary; (2) 98 m, with broken India 3 has best water; (3) 50-60 m, was muddy when recharged, yellowish.

Pumps? Any type will do.

General observations of wells in soum/WQ?

(1) All suitable for livestock, most not suitable for people; (2) shallow (mostly hi North) vs. deep (mostly in E, W, S), 10 m DTW hand pumps are OK.

Pastures not used because of lack of water -if 2-3 m to water, people can dig new wells to take advantage of these better pastures; were "old" people who knew where there was good GW, but these people are dead, and nobody to tell the people where the good water is to be found.

Base Map, 1:100,000 scale, 1999, prepared by Langrage for the aimag and taken from the topes; land use classification; other well map at 1:200,000, prepared by Land Policy Institute in 1991, is land use only.

Dzud Types: (1) white, snow, (2) back, poor vegetation or lack of rainfall resulting in poor pasture quality that year, and (3) B&W, where both phenomena occur in same season or year.

October 22, 2000

Kaska.Well, N 45, 18, 095 and E 106,16, 610, at 1400 mask, salty, DTW 1.5 m; rubber trough used from truck tire; took off housing from well to use it once pump broke.

Ulziid soum, Mr. Sumyasuren

General observations of WQ in soum; nature parks status/use? : Arrest soum, with 20% of area of aimag; located in Gobi zone of aimag; water supply not good; used to be 52 engineering wells, but only 11 are FUNCTIONAL; distance W to E is 260 km, and N to S is 160 km; were 106 Kasha

wells, but only 8 FUNCTIONAL as Kasha, almost all of these wells are used anyway in one form or another; most 8-11 m deep; some 10 families with pumps, mostly portable Chinese pumps which easily break down; able to pump water from shallow depths. Russian pumps from the Engineering pumped from 25-40 m.

Why were the Angry Wells important? No pasture and needed deep wells.
How decide which wells to rehab? (1) Deep, even Honda and Yamaha can't get water from> 10m, impossible to had dig these wells Recent Dzud, had 20,000 camels, now with 11,500.
How did you rehab the Angry Wells? (1) Based on information where families with largest # livestock and when destination, distance to wells, and (2) livestock camels and horses. Will soum governor want to be involved in selection process? Admin should participate in selection of wells; every herdsman would want to have a well near his shelter otherwise; people moving away and to soum center; more to north, more wells. South have deeper wells, need water because most angry wells shot.

Overgrazing - good pasture, if water enough, no problem with vegetation on pastures.
Operating wells - worn out equipment; just herder initiative that remaining pumps still operating.
Deep wells with better WQ; hand-dug are salty.
Any other area of soum with critical water shortage or need? 3 places
Nature Reserve, Magnus - hand wells there, angry non-functional; sexual arid gazelle; can be used but is there anyone there to watch for overgrazing? No limit on pastures grazing. only not cut the sexual is only restriction.
250 households; + 100 in soum center. Is enough pasture for 250? Yes, sufficient, but not enough water. (1) Sufficient pasture doesn't mean sufficient pasture with water; (2) would overall quality and quantity improve, yes, why? People would move there and animals now will use pasture not used. Will they move there voluntarily? Yes, but great difference between old and new. Old - selection, what time of year to move to good pasture; new - education of herdsman, going in two ways: (1) family let experienced herders teach people, share experiences; (2) by TV, radio, brochures, seminars organized by GI which runs training programs.

Would need to form an association or cooperative if wells rehabilitated? Willingness to participate; Gobi people usually very cooperative with each other; if wells, they sire among several households, choose 1 person to operate well and others will help with fuel, guard the well, and protect it. Yes, herdsman (when necessary), collect money from each other; soum with big cooperative; help with wells, did lot of work until recently; had 25 Angry wells functional, but only 10 working now. Pumps, shot, no parts; submersible pumps better, asked if prefers any equipment? Solar and wind pumps, especially portable needed.

Are wells where the pumps broken, have boreholes OK? (1) Can install solar pump with reedit card box; get so many liters with each card; only maintenance is to keep panels clean; pumps in well must stay sealed; market economy by paying for water. Difficulty would be one herder with more camels than goats, would pay more. Herders will not want complicated system.
If rehab, will be useful to develop criteria. His personal view - where big animals; water pasture with good vegetation where larger #'s can graze.

ASH - one rehab well *in* soum center; hole dug by soum; driller came and installed 1.5 m diameter; 2 m deep. WQ? Good, WASH analysis and aimag lab data did not disagree; former governor has the data; sufficient quality and quantity, with 5-6 wells in soum center; located in streambed, so enough water.

Alta's Questions too - not recorded here since not relevant to well component.

Permit for herders - what's the process? Use of shelter and wood that goes into the shelter' right to use shelters that were originally built at the expense of the GOM; herders use them, if move to one place or another; permit? Pay $? Right given to certain person; pasture is different, property of state; question of herders to coordinate this arrangement among themselves should one or the other want to use it, if the existing herder is moving elsewhere for the winter. Called, "certification for right of use of shelter", provided by the soum administration, registered with soum center, existing shelters distributed at time of privatization; can trade around; no spare shelters on which exist; this soum special, can work out Herder A, new Herder B comes, negotiate for new sitting of shelter. His opinion on well rehabs - angry wells with group of herders; study why some are still working. Study Angry wells and why work; recommend go there; those not working, is the hole still open.

Interview with Herder, Mr. Demberel

Owns 100 camels, 400 goats and sheep; uses Kasha well; tried to dig well; moved to 16 different places this year along; not much rain; vegetation is not well developed this year, causing these frequent movements; competition for pastures is intense.
Wells? Hand dug with frog pump is best; Snot good, better to use frog pump; Angry wells need an operator, must give $ for operating the well; submersible pumps equipped with solar or wind generator would be ideal.
Would Angry wells work now if herder associations were formed to manage them?
Cooperation would be Ok, but he can't say if it would work.
What selection criteria should be used? (1) Only good pastures, not water; (2) # animals and type, mixed herds; yes, large animals, camels vs. sheep choose different vegetation.
Have meeting with herders, good to get herders, but hard to get them together in one place at one time. Let the governor choose; he was chosen because they thought he would be able to improve the situation in town. What needs to be improved in soum? Social issues like education, medical services.
Likes the GI newspaper - good information; when will you start charging for it?
Bladder pump - well used for Buddhist monastery, shallow.
Posh Dunes - located at N 44, 41, 184 and E 107, 04, 273, at 3370 ft Operating Kasha well.

Recap 10/22/00

1. Interview with soum governor, Mr. Sumyasuren
2. Herder interview with Mr. Demberel
3. Visit to Oosh with FUNCTIONAL Kashka well being run by diesel generator and submersible pump; adjacent to tourist and spa center, which used sand dunes to cure liver ailments.
4. Wells showed variation, but mostly OK quant/quality
5. Pumps – shallow/frog; deep/submersible; some portable pumps for kashkas.

October 23, 2000

Travel from Mandalgovi to Dalanzadgad, 300 km, 6 hours; notes from this segment

Meeting with GI Coordinator, Mrs. Tsendsuren

Aimag has 45,000 people, 65% young, 15 soums, avgas population is 2000-2500 per soum; 12,000 households, of which 54% engaged in animal husbandry; 70% gross production in livestock; 1,800,000 head animals; registered # goats = 1 M, # camels 98,000; increasing due to privatization; 15 soums divided in 54 bags; representatives changing, new soum governor has decided water is primary issue to improve; 400 SW springs, lakes, to the east; one is bad; Administration concerned about water supply, but due to lack of $, can't be solved at proper level; latest studies indicate water sources can't meet hygiene requirements; 3 soums with WQ problems in DW, Tsogt-ovoo, Tsogt-

tsetsii, Manila; requirement to make fresh ASAP; filters installed in wells. WQ Problems (1) salty, (2) protection pads from contamination. Since 1999, WASH 21 began working (1) training for water utilization, (2) 7 soums rehab and repaired wells, (3) took measures to improve latrines and places that could contaminate water sources, (4) rehab people's wells on pastures by repairing pumps (5) research too; Question - what causing problems? Water sources in pastures; people say 5 - 6,000 in aimag of diesel and kasha types, but less than 50% working.

Every year GOM provides TG 25-30 M, to rehab 15-20 wells; only can spend TG 2M to rehab one well; focused on diesel/Angry wells.

Pastures - preservation in case something happens to existing pastures, but wash not functional. Each soum/bag with certain areas preserved as reserve pasture; herders say in case something happens, will move to preserved pastures so required soum authorities to make wells FUNCTIONAL; have studies on wells of preserved areas, based on information from soum authorities and research by economists from aimag center; submitted to GOM but replied only can rehab 3 out of 20 included in the research; herders interested in having people's wells, newly dug ones, only they can do it; nobody rewards them for digging these wells; one can dig it and 4-10 households use it, with no rewards; GOM only $ for 100 wells, protection is not provided; knows herds, Khan Bog soum - equipment for making people's wells; ask for S; driller there has equipment that reveals location of water underground; and can install wells.

Ownership of wells a problem - poor production of water; don't like others to use his wells; any type; difficulties, not privatized one person "unofficially" owns it for some reason, provides fuel, fixes it Will rehab wells aggravate this problem of overgrazing? Someone should look after the well; chosen by someone; not one person, because he becomes like the owner; possible to form associations; Where some wells rehab; no controls were in place; wells destroyed; proves that need an owner. Most important to choose the right driller, or rehab organization.
Herders interested in moving? (1) Drilling companies can make wells, but (2) genetic inSferoyement program, agreement made, what herders responsibilities will be - serve as model- for the well rehab program too.

Meeting with Mrs. Gerelmaa, Director, WASH-21 (on loan from Skater aimag, and only here for one month)
12 soums veered by WASH-21; reviewed goals; implementing organization for well installation and rehabilitation is well drilling company; tender from UB, with local firm selected; work in 4 soums rehabilitating pasture wells of the Angry type. What criteria used in selecting ENGR wells for rehab? (1) Requests from 4 soums asking for well rehab based on necessity; (2) analysis not done on pasture wells; (3) portable kits are being used by hygiene center lab; training done. Were changes in pasture quality considered? Decision to rehab based only on request of soum; studies made by local professionals on condition of the pastures (refer to Mr. Davamyam, Water Policy specialist).
Sufficient number of drillers to make competitive tender? Usually local firm wins. How will the rehab wells be maintained? (1) Company must present to WASH-21 officially the work that is done, and they will inspect it; (2) WASH-21 will introduce the wells to the herders, and (3) herders will be responsible for the maintenance, or so that is the plan.

Meeting with Mr. Byambaa, Water Quality Lab, Hygiene Institute

Established 1999 to improve separation of two labs that used to work in the aimag; made into one lab so that they complement one another; fee for service yes, possible; any private person or org can ask them to do analysis and will charge a small fee.
Any repetitive sampling programs? Soum water, 2X per year; analyzed here. » Any observations on

water quality? Generally, bad to the E, good in the mountains; 2 soums with poor WQ, Tsogt-ovoo and; hard, salty, Back-T; used to analyze *11* constituents, but with new lab can do 34 parameters.
People's wells near soum center, banned use of well because of bad water.
Any observations on various wells by type and WQ? Slight differences.
Any program existing planned to educate people about WQ? E.g., not bring animals near DW wells; not throw objects down the well. Now people pay attention to quality; want to know wheat is good and bad.
Can agreement be worked out between lab and GI to work together during the well rehab project to take samples and have them analyzed during the well screening? Yes.
The lab is accredited by the Mongolian National Center for Standards and Metrology.

Pinned Meeting with Consultants, Ms. Salmon, State Land Agency, MNE; Mr. Batmunkh, Agricultural Cooperative Association. UB; Ms. Baasandulan and Mr. Gambit, part-time employees from GI

Tsogt-ovoo up to relay station is not overgrazed, but is situation with poor rainfall and soils.
Mr. Batmunkh not keen on Angry wells since they are complicated, association will work, business entrepreneur approach, say, to make local pumps, assemble them here.

October 24, 2000

Meeting with Mr. Baraaduuz, Soum Governor of Bulgan Soum

Newly elected governor but was head of the agricultural department of the aimag administration before his new appointment; 98 km N Dalanzadgad; unusual climatic swings, e.g., summer 40C, winter -40C; didn't suffer from Dzud, drought; grass grows faster there, earlier in spring; greater degree of agricultural development in his soum; with over half population growing fresh vegetables for markets in Dalanzadgad and elsewhere; using water from the abundance of springs in his soum; livestock herd composition - first, goats; second, camels; third, yaks; 500 households, 2000 people in the soum; applies scientific research in his Soum to develop practical solutions to problems; 60 wells of all types, but many have fallen into disrepair or are destroyed; primarily the pumps went, were disassembled and taken away to sell as scrap. Many pastures are not being used now because of the lack of water; the wells are there, but e.g., 30% of pasture can't be used because there is no nearby water for the livestock.

Why is pasture over-utilized in his soum? The JICA report indicates his soum is at 120% of pasture capacity? Shortage of wells and because herders are forced in fewer areas, those pastures become overgrazed. Goats are hard on the vegetation because they eat the seeds of grass; believes the method of goat husbandry is wrong -herders just want cashmere; # goats increased, affecting composition of the herds; greater # goats affects fodder of other animals; solution = make people understand that they must leave something to the next generation; animal husbandry can be pursued in the right way using science; goats are vulnerable to the Dzud, can lose entire herd; he's been watching this situation for 40 years in this aimag; and' this was a real bad Dzud this time (99/00 winter); has seen all kinds of Dzud, (1) snow can be 30-40 cm deep in other aimags, which is usual; (2) snow is only 10 cm in Bulgan soum, but with the high winds, this small amount causes a Dzud, in some instances due to drifting of the snow, which can cover animals and gars. Last spring was not a severe Dzud, but herders lost animals anyway; 70% of the animals that died were goats, since they can only last 3 days in the severe cold. Goat hair depends on summer pasture quality. The average south Gobi (Omnogobi) herd composition is 57% sheep, 27% goats.
Which wells are non-functional? Primarily the ENGR wells, and other Kasha types (1 m concrete culverts or tubes).
What adaptations are made by herders to use Kasha's? Hand buckets; not many with centrifugal pumps; not sure where to get these kind of pumps. What are the preferred pumps? Solar, wind

powered generators seem Ok, esp. if portable.
Would herders pay to maintain any pumps installed by GI? Problem is heeders to provide some $ for maintenance, and people with goats have $, and own the wells; down in the Gobi, most people don't have a lot of S. much would they be willing to pay? No research has been done on this to his owl edge, but should be; so he can't really say; a household with 500 head of livestock use 1500 liters per day; 1 liter = 1 MNT here in the soum center; so one could calculate that if the herder was paying 1500 MNT per day to water his livestock, it would total min. 45,000 MNT monthly. It seems pump maintenance is cheaper that buying water.

What is the average monthly income of herders? Herders get $ when they sell products; receiving around MNT 2 Million in June and July when they sell their animals; then buy a motorbike or other essentials; then no money is left for the most part for the remainder of the year.

Are associations of herders possible to maintain the wells? That would be the only solution! One would have to unite the households; save $ for maintenance and other purposes as well; how much $ needed from herders depends on the number of herders using each well and the type of well being used; is it feasible to put this or that type of pump? Depends on various factors —e.g., in the mountains there are a greater # of herders around each well; down *in* the Gobi there are fewer # herders around each well; depends on the recharge of the well, if not much recharge, can't supply a lot of families; people are lining up all day to get water; having the herds waiting around watering hole causes overgrazing on the pasture; if people could work out a watering scheme and they were sure the wells would produce enough water, this could be managed.

Meeting with Mr. Batbileg, Water Policy Specialist for the Agriculture Department of Aimag Administration

Questions on recharge of wells, economical pumps, how to select wells, ways rehab wells
Drilling company in socialist times, used to be good, but now equipment is poor, and personnel not as well-trained; most wells ruined; not as many wells FUNCTIONAL now; different types of wells, almost all pastures were provided with wells and herders can dig shallow; not reliable, however. Check is borehole is OK, but just matter of pumps to be replaced.
Data available from driller? Year well constructed; total depth to bottom of well; production; depth pump set; static water level; dynamic level (pumping water level); level water found; type of pump; total cost well; geographic location.

WQ - possible to use for DW and animals; no information on WQ analysis, no need for it.
Selection Criteria? Request from local authorities primarily, know more about utilization; why? Usually done from state and aimags, distribute $ to soums, e.g. aimag give $ to driller under order to repair # wells; only if privatized will ownership be assured and wells made FUNCTIONAL.
What are his duties? Supervises drillers; drillers don't have enough professional staff; equipment is old, not meeting requirements of present; does some frilling, but not deep; surveys, where are places where wells can be dug; hydro geologist on staff.
Can they install submersible pumps? Yes
What pumps are available> mainly Chinese, electrical; can't use them. India 3 is made modified to pump more water. Enough wells to be rehab in aimag.

Meeting with Drilling Company, Undraga-Om, Mr. Jargal

Soum water with depth of > 100 m; established state-owned organization Suring socialist times; constructed 70% wells in aimag, which is why all of the data is kept with them.
Presently, do about 10 new wells per year; rehab about 50 wells, pasture wells is funded by the government; did 18 UNDP wells.
Pumps - submersible, Chinese, we have specifications on these; 8 cu m per hour, 1.1

Kew, 5.8 amps; with generator, uses 25 mm discharge pipe; cost is TG 200,000, and generator is TG 600,000; pump is guaranteed for 2 years, and they guarantee it for 6 months when installed; he knows different types of pumps, such as Chinese and Italian (cost a lot to run); good for 30-40 m down to 100 m; consume fuel 1.5 liters per hour; TG 40 x 5 - 6 hours per day running; 200 TG per day X 30 days = 6000 TG/month. 6 cu m per hour capacity.
Diameter 12.5 cm pump; teams for survey and repairs.
What type of well development? Cleaning work; dug out, pump out water - good.
Does he have capability? Sample water, recovery.
Augers - 30-50 cm; how sort casing; filter pipe; 2 rigs, only ENGR wells.
Kasha costly to rehab, because of concrete pad; other kinds less costly.
If were to rehab a Kasha, what would you do? (1) Pump it out, clean it, removing any layers of mud; (2) install pump, usual portable type, and (3) pad, less costly, reliable cover must be installed too.
Makes frog pumps - installed costs TG 60,000; 10m DTW; 1 push = 3 liters, better for goats, but better than the India 3; bladder lasts one year, but herders can replace; primary available parts a key factor in selection of pumps; Japanese centrifugal not available, use to have workshop. India 3 requires push 40X for 10 liters of water.
Question - data available? Yes.
Possible to repair? Can't tell which ones, some are difficult. After 1950's.
What factors do you take into account in rehabilitation of a well? (1) Borehole is protected, then usually OK; (2) if filled in, not possible to fix; (3) casing broken, can pull it out, requires much effort, can pull out casing from 100 m; (4) test recharge? Before other activates; take into account production; have data about well, pump out water with pump, w/in certain period compare with data they have; if not, clean out and decide.

Meeting with GI Herders

Key questions were posed to a group of two dozen herders present at the GI office for training; the following discussion was focused on these questions:

1. What factors should we take into account hi selection of wells for rehab?
2. What knowledge do you have of water quality and quantity and condition of pastures?
3. How best to ensure wells will be maintained over time?
4. Are herders aware of consequences of watering animals under DW wells?
5. Is it possible to set up a small area of protection around well so that animal's manure doesn't contaminate the well? How would we protect the well in the immediate area around the well?
6. What kind of pumps are preferred by herders for deep, Kasha and people's wells?
7. What wells do you prefer to use?
8. What factors are considered in your ability to use or maintain a well you need for watering your animals?
9. Would herders be interested in setting aside a portion of income for well maintenance?
10. Livelihood of herders depends on good water supply; does it require that al herders work Together to ensure water is available and is of good quality?

Factors in well selection? Pasture not used for various reasons, usually no wells, not FUNCTIONAL; location of water points, and see if possible; maintenance, make someone responsible, families will choose one person and will contribute to maintenance.
Expenses for repairs at front stage!
ENGR wells should be rehab, deep wells!
Kasha, portable pumps needed for these.
Maintenance factors? Depend on what kind of pumps used; fuel costs.
Middle-depth wells - only family can handle these costs, using portable pumps.
Deep wells - association of herders needed to handle, but must ask this question for each well under

consideration.
Availability of parts? Chinese and Japanese pumps are useful.
WQ - generally salty or hardness problems.
Questions for us? (1) bring small portable pumps from US, if make available so we can buy them? Price important; 10-15 m needed; better if we can assemble them here; portable is primary; (2) improve production of wells? Yes, some wells.

Meeting with Mr. Ravjir, Director, South Gobi Special Protected" Areas Administration, MNE

Protected areas are primarily in mountainous zones; lots of households inhabit these areas; Gobi precipitation low; mountains are better; many households there; problems with overgrazing; shortage of wells in this area.

Main duty - increase # FUNCTIONAL wells; determine locations and condition of ENGR wells and location of hand dug wells; by rehab wells to increase pasture lands.
When Visit households in mountain regions of the protected areas, receives many requests to rehab wells or dig new wells; main goal is to make households move out of the park area; not use NR lands for pasture, and use as least as possible pasture.
Does he know # of wells to be rehab in NA? They have data on ENGR wells,
FUNCTIONAL and non-FUNCTIONAL. East areas are difficult situations; too many families, large # of animals, shortage of wells.
How cope with long migrations of herders coming into park? To settle in protected area, must ask permission, coordinated by the gob's; this year they repaired one well; easy to do because hold was covered and protected (ENGR with diesel pump); drilling company financed by his project.
Can GTZ and GI cooperate on rehab? Yes,
GTZ Limited, 1 unit per well; Germans say expenses should not exceed TG 2 M per well rehab.
Situation different, (1) overgrazed areas, +/-; (2) GGS, more degraded areas; (3) other parts, Gavin Baja Dockhand Souza Gazer.
New gob's - attempts to make something real; rehab wells, make people move. Well drillers have the data on wells.
Plans - request for rehab certain wells, some already slated for rehab, and we don't need to worry about them; another reason for coordination; herders require places where can dig hand wells.

Visit to GGS Park - notes
Enclosures to demonstrate effects of grazing vs. resting pasture quite dramatic; 2-yr old grass *(Step* sp.) N 43, 34, 22 and E 104, 02, 104, 2140 mask.

October 25, 2000

Worked in GI Office only analyzing field notes. October 26, 2000

Meeting in Bulgan soum with Governor, Mr. Baraaduuz

Types of wells? (1) Diesel wells, were 21 hi 1990, now only 4 function, and these remaining have been kept running with parts from those that broke down; 6 out of the 21 are possible to rehabilitate now because the hole is protected; 11 out of 21 are not possible to fix. (2) Kasha wells were 46 in 1990, and 10 are operating now; tie rest can be rehabilitated, but 10 are not used at all; these are under his supervision; avgas depth is 8-16 m; few are > 20 m; DTW is 10m; few with < 2 m DTW; socialist period - used to dig wells, if water > 10 m. Production > 1.3 1/s; if > ENGR well construction, if < 10 m, well not dug. He knows more about kasha wells than ENGR wells; depth 16-17 meters. Problems (1) pump difficult to push when new and when old because of the rubber seal; (2) with drought, if well not used, metal parts corroded; seals freeze up; (3) if wells not given to someone to take care of, pumps got corroded.

Pumps? ^ 30 put into operation, possible, not sure which types herders could afford? Undraga-Om drilling company received pumps. What problems with portable pumps? Talked to herders about pumps; thinking of locked hut with portable pump, so all can use same pump; or each herder owns his own portable pump and brings to well when wants to water livestock.
How rehab? 2-3 m below last concrete culvert install casing with screen; screened interval is critical factor in production.

Will rehab wells in GGS National Park work? Yes, but rehab in buffer zones will be problem. Why? Not realistic; 60-70% of the goats are grazed in the protected area because in mountains are better pastures; if take goats down to the steppe, goats will decrease in size; winter shelters are in the mountains; grass quality to suit goats is better in the mountains; in principal, possible to rest the mountain pasture - solution = (1) reduce the # goats, (2) rotate them down to the Gobi, but quality will suffer.

Closeout Meeting with GI Staff, Ms. Tsendsuren and **Mr. Khurelbaatar**

Reviewed draft approach; received feedback; modified some aspects.
(1) Work more closely with soums where they have good cooperation.
(2) GI should establish close relationships with soums; in general, work with the whole aimag.
(3) Because $ limited, requirements unlimited - must determine the right place, and the right people to start this off with.
(4) Sometimes when different projects, study work is done and finally deal with certain # people
(5) In the countryside, soums, aimags, it's possible to work on technical questions of water quality in the Gobi
(6) Process seems OK, something can be achieved
What else? To whom should the wells be presented - soum administration? On whose land should it be the responsibility for maintenance - herders say on their land; soums should repair it? Herders are registered in a particular soum center, and could pay into a well maintenance fund. Coordination of relations between soum administration, who will receive the well, and the herders who will use the well? The wells will belong to all herders.

October 27, 2000

Returned to UB from Omnogobi

Meeting with Geometer Limited, Mr. Munkhtogtokh and Mr. Ganbaatar

This meeting was fruitful in that it identified additional data and information that they possess in a GIS that was used in their JICA-funded well rehabilitation and pasture quality report. We arranged to meet them at their offices on 10/30/00 to review this data. They also have a hydro geologist on staff that will talk with Carrillo. They can make available to GI at cost a CD with all of this data. Action - we need to arrange this and find out how much it will cost.

October 30, 2000

Meeting with US OYU Co. Ltd, Mr. C. Ganbold

This is a water exploration, drilling and construction company set up by the Japanese, but which is now wholly owned Mongolian company. Mr. Ganbold is a hydrogeology's with over 20 years experience-drilling wells in the Gobi region. Completed two JICA-funded studies in water well rehabilitation potential and pasture conditions in Dundgobi and Dornogobi (and the small aimag of Gobisymber). Which GOM agencies have the most complete database on wells and groundwater

quality? The old Water Institute (now Institute of Geo-ecology) and the Central Geologic Fund (?).
WQ in the Gobi is variable, but tends to be hard and salty. DW is OK. When he worked for the Russian expeditions installing wells in the Gobi in the early 1980's they used to analyze water, and attach the results to a report that went into the GOM files; he showed us an example, [note: later that day, he showed up at GI office to apologize for showing us the data he did, because he claimed it was confidential, and he wasn't authorized to give it to us]. The parameters measured, and for which they have data on each installed deep well, include: Cal", $S0_4$, NO_3, NO_2, CO_3, Na, Ca, Mg, NH_4, Fe (+2 and +3), and HCO_3.

Water quality labs? The best one is the central lab here in UB because they are more reliable.
Data on wells? How would you use WQ data? Wells have a #, according to date kept at the Water Institute and State Geologic Fund; look at that data and on the basis of the WQ, make an initial yes/no decision to rehab the well or not; then take your well sample to the lab and analyze it, and make the final decision. Would you expect any significant changes in WQ since these wells were installed out in the Gobi? In principal, no.

What was the deepest well you drilled out there? 1986, 260 m, using a rotary rig from Russia.
How much filter pipe was installed in these diesel (Type A) wells? Depended on thickness of water, how much water was in the wells, all data is written in reports and he indicated that he could give us this information [now it turns out that we have to ask someone hi the Ministry of Agriculture to write a letter to him, authorizing him to release any such data].
Annexes to the JICA reports include: George location, well depth, filter, static/dynamic water levels, make of pump installed, notes about what can be repaired there based on information from local people,

US OYO worked 45 days on the report, gathering information in the field, but not visiting all wells, collected as much as possible; obtained some information from local people.
How were the Kasha and Deep wells installed? Kasha - we drilled exploratory holes; additional drilling beside Kasha wells may tell you where will be the best depth to produce; ENGR wells we screened using resistively surveys. How would you rehab a Kasha well? (1) Pump out the water, clean sediments; (2) clean to the bottom of culvert, see what it is producing; (3) install pump; (4) do WQ (analysis.

After speaking with Ganbold, we have a much better idea what these Kasha wells were all about. He later faxed us drawings to use in our report. Fishing tool "yours" a Russian word. They fabricate these on site, if needed to fish out pumps or other objects in the well.
Watering Troughs - tanks which were 9-12 m; water pumps were designed to fill these up at a rate of 30-60 1/m; if the well pump produced < 30 1/m the animals will drink all the water before it fills. The aimags used to make the concrete troughs you see out there.
Pumps? They import pumps Andean get U.S., Italian, and Russian. They don't like the Chinese pumps because they are unreliable.
He promised to prepare the Data annexes from the JICA reports to send over to us by Tuesday. See my earlier note about his "re-nagging on this".

Meeting with Ministry of Food and Agriculture, Mr. Batmunkh, Water Engineer

What do they do? Deal with water supply for animal husbandry and irrigated lands; and do water exploration in the Gobi.
1998, Government Action Program on water well construction hi 8 aimags, 1.5 Billion MNT; did hydro geologic survey too.
1999, water well rehabilitation program - provided some perspective on the problem.
In socialist days, 45,000 wells now reduced to 35,000 with 10,000 completely destroyed. Of this 27,000 were in need of rehabilitation (21,000 other and 6,000 ENGR). So far, they had rehabbed

500 ENGR wells.
How did they conduct the Rehab? Request goes from Soum governor-aimag-central Gob's; Water resources are state property; then they make a decision on which wells to fund.
Criteria? The soum government knows which ones are more important; if overgrazed, they won't put a well there; presence/absence of winter shelters, if well needed there, that takes priority; herd composition, with herders with larger animals taking first preference since camels and cattle need more water than sheep or goats.
But, must balance this out. They rehab ENGR wells with some families, and shallower wells for others.
Herders want to get wells with shallower depth.
How to. Maintain wells after 5 years is a problem!
Program? 70% < 20 m to rehab; have 300 million MNT for year 2001; have 100 million MNT for investigations such as hydro geological exploration and geophysical works.
Drilling companies 40 companies; each aimag also has its own drilling company.
Which ones are good? Us Oyo Co. Ltd is more careful; have worked witched
Japanese since 1992. What do these drillers do? Change the old tube and screen, install pump.
Have determined a "state budget" for well rehab, for deep wells 2.5 - 3.5 million MNT, including equipment, labor, everything.
UNDP came up with $ 120,000 for some well rehab work.
Pumps - submersible; generator either gas or diesel. New technology from Japan; Russia is OK; and Chinese are cheap but poor quality.
How to decide on which wells to rehab? Water resources belong to the state; 3-5 families need 1 or 2 wells; can they contribute to the O&M; how can one organize and collect $ from these herders is a challenge.
Storage tanks? Well water < 5 m will freeze in winter; if > 5 m OK won't.
Forward thinking program? Get S for herders in rural areas; need 10,000 new wells, with 6,000 < 30 m, and 4,000 > 30 m. for the shallow wells, use hand pumps, simple tech.
Gobi Altai - geologically deep wells, > 100 m. Camels need deep wells because they drink more.
Here are his back of the envelope calculations for the future!!!
180,000 herder households managing 32 Million livestock - how solve water supply?
180,000 / 3 households sharing a well = 60,000 wells needed.
Presently there are 35,000 wells; so will need 25,000 wells, of which 15,000 should be shallow, and 10,000 deep wells. They have a proposal into Japan for $110 Million. The plan will be to have at least 10,000 new wells, or around 500 per aimag. E.g., Omnogobi, there are 800 wells to be rehabbed; some pasture areas are unused; some overgrazed; but new areas are far from infrastructure and settlements, so herders won't move there, but may move if better and more water is available. How can we foster cooperation and coordination on the well rehab efforts?

(1) Need rehab work in the aimags; > $ for the 4 GI aimags than for some others; but need 200-500 for the other 3 aimags, and 800 for Omnogobi, or 1,500 total needed. (2) How to solve cost recovery is big concern, e.g. WASH-21 organized water groups OK, but problem was how to share the costs. Herders are not legal entities, so how to pay the state; cooperatives are legal entities, seems like the easy way to go. How to maintain wells in the future? Herders move roughly 3 xs per year from winter to spring to summer pastures, and then into whiter shelter again. It would seem that they need 3 wells; but in summer water is not problem in the mountains, but the Gobi is more difficult.

What about solar? OK, 260 sunny days on avgas; storage tanks and issue for non-sunny days; concrete tanks will freeze in D-J-F mostly, but perhaps not in March. Each place is different. Wind - no, won't work; either too much or too little; and air not dense enough.

October 31, 2000

Meeting with MonConsult, Mr. Bayambadorj

This company produced a report on water policy for the WASH-21 project. He formed the company in 1994, when he left government.
Presently preparing action plan for rural water supply; strategic approaches; proposing to streamline water supply; strengthen the National Water Committee; submit priority areas, such as pasture areas, but there is a key policy issue here: (1) ownership of wells and O&M - must develop regulations, (2) community-based O&M before investments are made, (3) cost sharing, (4) choices for herders, such as advanced technology, pumps, generators, tanks, reservoirs, and solar power. Let them choose what they can afford and what's best for them. Ownership of infrastructure is a big issue because the law states that water is free and available to everyone; if they charge a fee, but GOM needs to set guidelines for this, e.g. will local government impose a tax? Must take into account climatic conditions, e.g. some wells not needed because herders use surface water sources in summer; herders pay into common fund in each soum; herders form cooperatives to care for the wells in their areas.

Can gob's pass law that all wells registered in the soum; local soum governor must assure adequate water; now GOM must assign guidelines - water free, but some type of service charge is OK. Should LG impose a tax on water? Or well?
Annual soum budgets are 50 million MNT, but some herders make 200 million MNT; 80% of the local soum budget is subsidized by the central gobs. (Herd composition), enforce? Local soums all have representatives and constituencies are represented so these can be enforced. Soum > Representative Herders.

GOM's role should be provision of timely information to consumers; let herders decide what they need and want; but give them costs, types available, etc. Provide a service. Who are the most active donors in well rehabilitation? (1) Sweden funds for drilling; Geological Exploration Bureau is the gob's company set up to drill; (2) ADB is coming out with a project soon dealing with investments in pasture areas; (3) JICA not as active as they used to be; (4) GTZ deals more with cooperatives.
Problems with WASH-21? (1) Started drilling wells w/o any prior consultation with communities; 35% of wells by WASH are out of service already; action? Community needs identified, and go w/their recommendations. (2) Rely too much on the India M3 hand pump, which is not the best for these conditions; problem was WASH didn't look at other options such as other hand pumps, electric pumps in soums with electricity; shallow wells seem OK, so put other pumps there. (3) Didn't take into account the specific conditions of the soums, put wells where didn't need to put them.
Successes? 65% of wells are working; good wells were needed; and sanitary education program was great.
Dutch Trust Fund started to rehab pasture wells.
Donor review meeting on 10 NOV for UNDP and other donors on water issues.

Meeting with Institute of Public Health, Ministry of Health, Mr. N. Saijaa, Dr. S. Batdelger, and Dr. Coloma

What is happening with the WQ Standards? Under revision right now. Have you noted any symptoms of Arsenic or Mercury poisoning in the Gobi? We have no information on this problem.
What are the new proposed DW standards for water for Hg and as? Hg 0.001 mg/1 and as 0.01 mg/
Previously the as level was 0.05, but there was none for Hg.
What about nitrates and nitrites since the 900-92 standards did not exist? Nitrate must be < 10 mg/1; and nitrite must be 1.0 mg/1.

Any other problems? Fluoride in the steppe regions. Dr. Coloma gave me maps from her thesis showing soums in both Omnugobi and Dundgobi with problems. In Omnugobi the highest Fluoride levels were in Bulgan soum. Fl standard ranges from 0.7 - 1.5, OK, but many soums over this amount. We could screen from these maps too. Discussion of way to screen for need to run as and Hg analysis using well water from candidate wells for rehabilitation? They will work on this for us. We talked about using pH as a cutoff, if higher than some pH, not to worry about trying to run this analysis, if lower than certain pH recommend running As analysis.
Levels of hardness in aimags? Liberalization standards is 1000 mg/1; averages found are:
Domogobi 1479.3 mg/1
Omnugobi 1011 mg/1
Dundgobi 1170 mg/1
Hunger region 373 mg/
Values for Mg - standard are 30 mg/1, but aimags with 40-45; Ca standard is 52.9 but Gobi Italic is 101 mg/1. For 99 soums, the standard is exceeded.

NOTE'S OF CLARIFICATION

1. some shorthand abbreviations were used during note taking. E.g., S = dollars or money; ENGR wells = a type of well that usually was deep, and supplied with a diesel generator; TG - MNT = Mongolian Tigris; TDS = total dissolved solids; DTW = depth to water;
2. We had the use of in interpreter, Mr. Unutegsh, who was excellent. The Mongolians use the world “pasture” to refer to the areas where the livestock is grazed. In U.S. terminology, the world rangeland is preferred.

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UNDP, Sept 2000. Support to policy Formulation Rural Water Supply Sanitation Sector, Draft Final Report. Prepared by MonConsult LTD, UB, for WASH-21 Project.

Muller, Franz – Volker and Bat-Ochir Bold. 1996. On the necessity of new regulations for pastoral land use in Mongolia. Applied Geography and Development, 48:29-51.

Neupert, R.F.1996. Population and the pastoral economy in Mongolia. Asia – Pacific Population Journal 11(4):27-46.

Conner J.R. et al. Date? Grassland – based livestock production in temperate zones. FAO information files.

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- Sub report by Borchuluun, MAI on Current Situatio of Water supply Service mentions hydrogeology maps, water quality testing labs existing
- Narantuya’s report on water and hygiene.

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National center for standardization and Metrology. 1992. Drinking Water Hygiene Requirements and Quality Control. Standard 900-92. Ulaanbaatur, Mongolia.

Government of Mongolia (GOM). The Government Resolution No. 43 on approval of the National Water Program. 10 March 1999, Ulaanbaatur, Mongolia.

GOM. Mongolian State Government Resolution No. 185 on "some measures on improving livestock feed and water provisions for aimags of desert region." 1998.10.07. Ulaanbaatur, Mongolia.

Initial Environmental Examination. May 1999. IEE for various activities under the GOBI Regional Economic Growth Initiative, prepared for USAID/Mongolia by Mr. Jeff Goodson, US AID/ANE. - Note that the IEE recommended that no funds be provided to support the development of new water sources, such as new wells and new river diversions without prior written authorization of MCI. The purpose of the present TOY to write an IEE Amendment that will review the potential environmental effects of well rehabilitation, and to present it to the USAID mission and submit to USAID/W any recommended further actions.

USAID/Mongolia. October 1998. FY 1999-2003. Country Strategic Plan for Mongolia. - Discusses IR 2.4 Improve Management of Natural Resource Base for Long-term Sustainable Use; lays out USAID addressing pasture degradation by assisting communities to rehabilitate wells in under-utilized pasture areas, among other activities. This was subsequently the focus on Goodson's trip in spring 1999 to write the IEE.

Vance, S.D. memo to E. Birgells, 29 Sep 2000. Final revisions for Gobi Initiative Work Plan. - Included is Activity 4 for improved livestock, water and range management for three areas affected by the Dzud; these will be the focus of the present TDY on well rehabilitation; what would be nice is to link well rehab work with Activity 1, which will work with selected herders on, among other topics, range and water management. *

Bazargur, D. 1996. Geography of Pastoral Animal Husbandry. Mongolian Academy of Sciences, Institute of Geography, Ulaanbaatar, Mongolia. 57 pages.

Batsukh, N. et al. 2000. Present condition of rural water supply and future objectives. Pages 5-14 in, Hydro geological, engineering, geological and gynecological problems of Mongolia, No, 8, Mongolian Technical University, Ulaanbaatar.

Schmidt, S. 2000. Community Participation in Protected Area Management People, Pastures and Park Protection. Draft paper for publication. GTZ and Project Nature enervation and Buffer Zone Development, Mongolia.

APPENDIX C

SOLAR PUMP COST INFORMATION

This cost information was provided by World Water Corporation, which manufactures and distributes solar equipment to supply water resources development projects. Bear in mind that solar pumps have a higher capital cost outlay than conventional pumps and generators, but their overall O&M is significantly less over time.

Total Dynamic Head (m)	Wattage Required (watts)	Summer Yield (liters Per day)	Winter Yield (liters per day)	Required Yield of Well (1/s)	Price in US$
5	1350	150,000	62,000	9.1	13,250
20	1350	38,000	15,000	2.3	13,250
45	1350	17,000	7,000	1.0	13,250
60	1350	12,500	5,000	0.8	13,250
75	2700	20,000	8,000	1.2	24,300
90	2700	17,000	7,000	.1.0	24,300

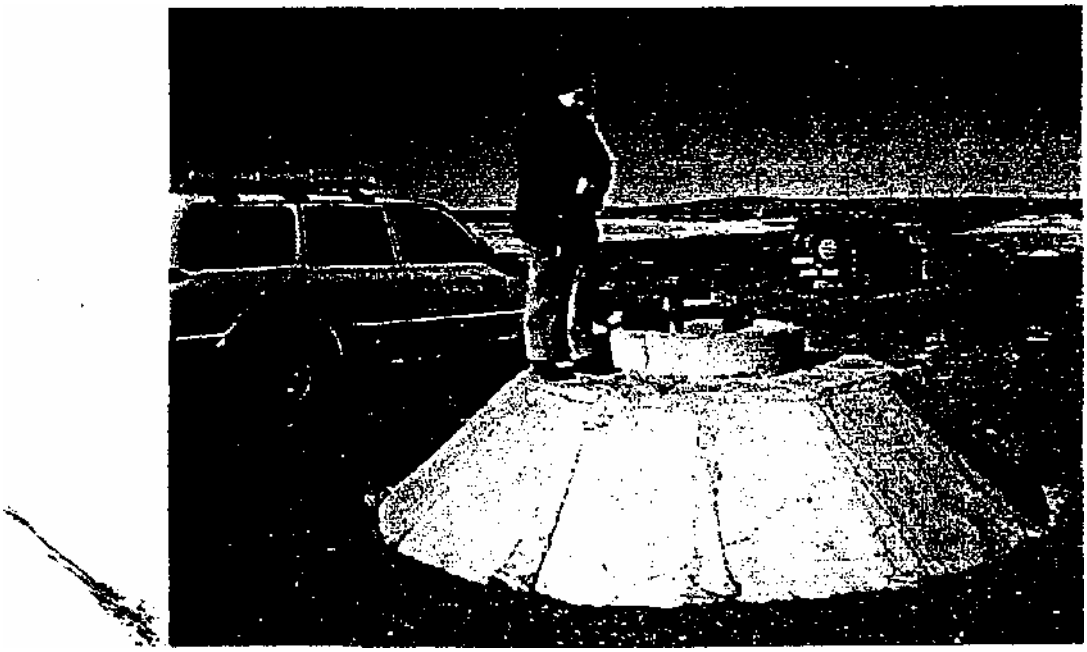
Assumptions:

1. Insulation data taken from NASA data for 43°N latitude, 105°E longitude.
2. Maximum summer temperature of 40° C; max. Winter temperature of 20° C.
3. Minimum system summer yield of 12,500 liters per day.
4. System voltage of 460 volt, 3-phase AC.
5. Adequate well already on site.
6. Prices do not include storage tanks, piping, or associated civil works.
7. Prices do not include freight, customs, or local taxes or fees.

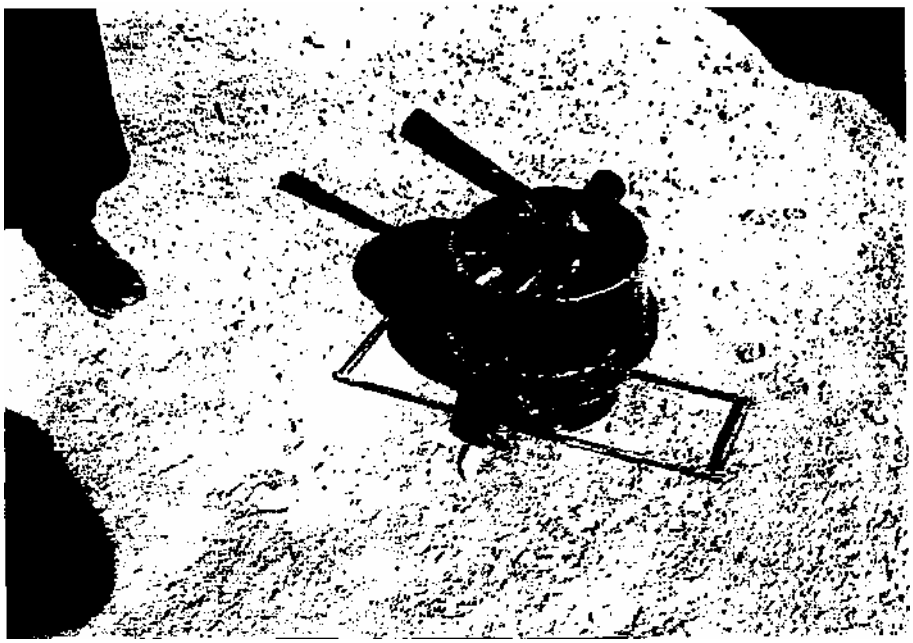
APPENDIX D

PHOTOS OF WELL TYPES

Remains of Type A Well



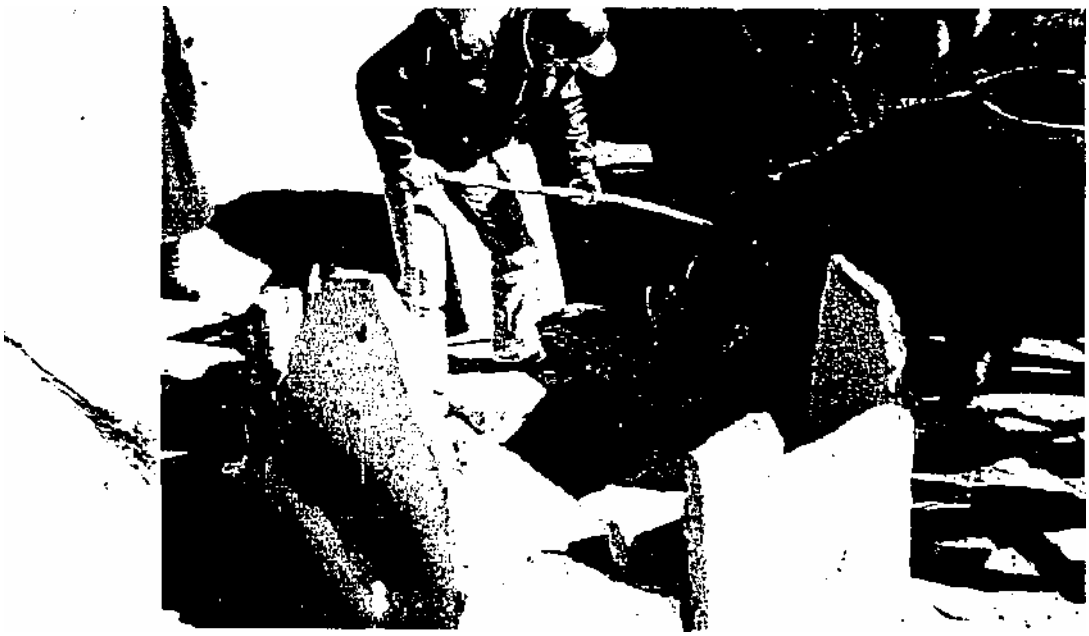
Type B Well "Kasha"



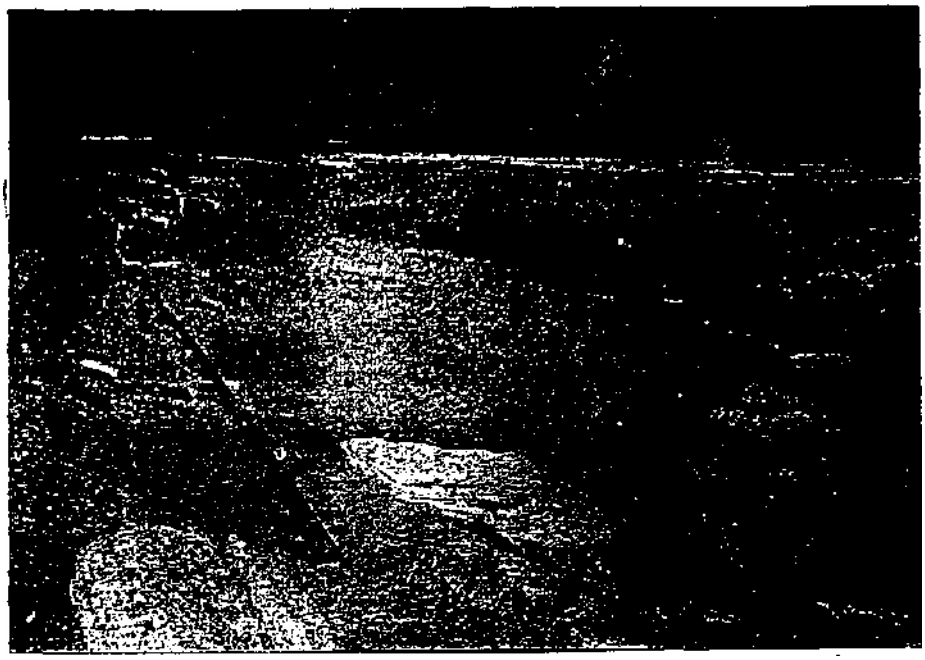
'Frog" Pump

'Frog" Pump Installed on Type D Well

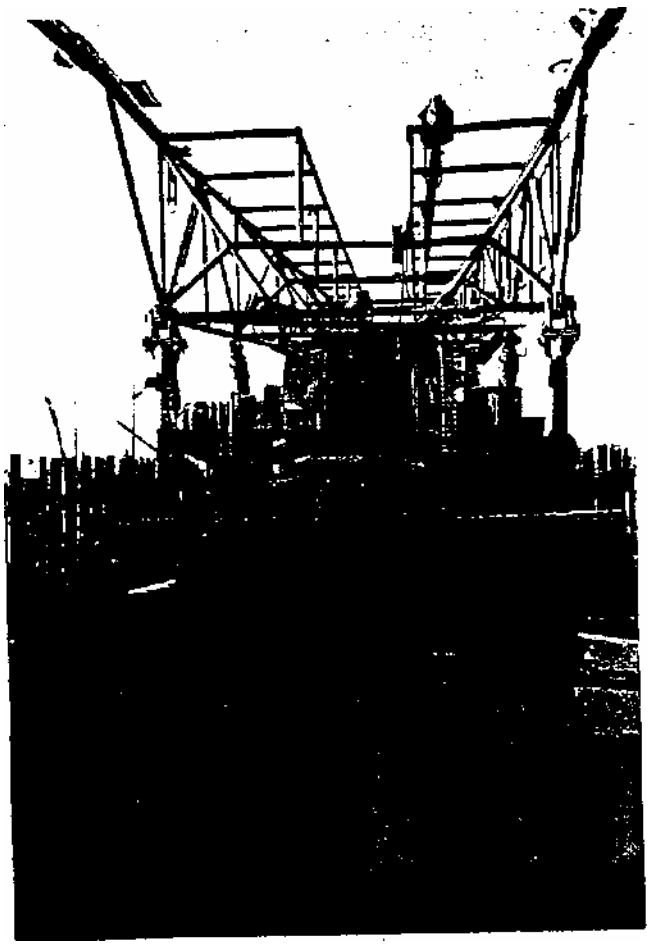
TypeCWeUhead



Type D Wellhead



Spring From Rock Outcrop, Bulgan Soum



Russian Rotary Drilling Rig

ANNEX 3: CONSULTANT TERMS OF REFERENCE

I. Background:

Land degradation poses a serious threat to livestock production in Mongolia, which is a mainstay of the rural economy. Pasture land degradation is increasing in Mongolia for three main reasons: (1) an increase in the population of livestock over time; (2) the development of the relatively lucrative cashmere market which is causing a shift from sheep towards goats which degrade pasture more rapidly; and (3) the decline in the marketing system for livestock leading herders to concentrate around aimag centers to be nearer to markets, functioning wells, and veterinarian services.
USAID can address pasture degradation by assisting communities to improve the health and quality of their livestock herds, improve farm-marketing systems, and rehabilitate wells in under-utilized pasture areas.

II. Objective:

The purpose of this activity is to prepare an IEE amendment for a water well rehabilitation activity to ensure that this activity is environmentally sound and helps to improve livestock and pasture land management in Mongolia.

HI." Scope of Work:
A small two-person team, consisting of a team leader/senior data acquisition specialist and a senior water quality management specialist, will travel to Mongolia to prepare an amendment to the Initial Environmental Examination (IEE) of the Mercy Corps Cooperative Agreement. The amendment will cover a ca. $1.0 million water well rehabilitation activity to be carried out by Mercy Corps pursuant to the provisions of their current cooperative agreement with USAID/Mongolia. In addition to this IEE amendment, the contractor will prepare: (1)" a list of criteria to guide Mercy Corps in the selection of wells to be rehabilitated; (2) written standards for the rehabilitation of wells; and (3) written standards for the testing of water quality at wells which may also provide water for human consumption.

Much of the preliminary work required to implement the well rehabilitation activity has already been carried out Specifically, the Japanese have carried out a survey of water wells in the target region(s), along with information on rehabilitation requirements. The team should review and summarize this background information in their final report,

Well Selection Criteria:
Suggested criteria for well selection under the well rehabilitation activity shall include:

- Rehabilitation Only. Work under the new activity will be restricted to rehabilitation of existing wells; no new well construction will be financed. Any drilling of new wells will require the written approval • of USAID/Mongolia, after consultation with the ANE Bureau Environmental Officer (BEO).»- Numbers and Spacing. The numbers and spatial distribution of wells to be rehabilitated should not exacerbate overall overgrazing. On the contrary, well rehabilitation should be designed in large part to overgrazing by more broadly distributing grazing pressure. The breakdown of many existing wells d to heavy concentration of livestock around the few operating wells that remain. At the same time thaftisSAID/MongoIia's overall livestock program works to reduce or control the growth of overall livestock (especially cashmere goat) numbers, the selection of wells for rehabilitation should lessen overgrazing by more broadly distributing grazing pressure spatially.
- Screening. The Aimags and Soums should originally propose Wells recommended for rehabilitation, after deliberation and consultation with local herders. Mercy Corps will then screen recommended wells pursuant to the criteria established for well selection. USAID/Mongolia may

periodically review both the well selection criteria and the specific wells targeted for rehabilitation.

- Aquifer Impacts. The spacing, density, and production of the wells rehabilitated under this activity shall be such as to ensure that significant and irreversible long-term draw down of the aquifers tapped by the wells shall not occur.

Well Rehabilitation Standards

Standards for well rehabilitation shall include, where practicable, well pad construction to reduce the potential for well contamination.

Water Quality Testing Standards

Standards and detailed implementation guidance for well water quality testing shall be developed during this assignment, including estimates of testing costs. Testing may or may not be required for each individual well rehabilitated, and periodic re-testing may or may not be required for each well originally tested. - Initial testing, when and where it occurs, should include an appropriate spectrum of water quality parameters including, but not restricted to, oviform and arsenic.

Well Driller Availability

The team shall confirm the availability of well drillers/well rehabilitation specialists in country during this TDY.

Consultations

While in-country, the team shall consult with as broad a range of stakeholders interested in rural well rehabilitation as practicable, including but not restricted to Government of Mongolia (GOM) interests at the national, Aimag, and Sown levels; USAID personnel; US contractors; other donors; and other interested specialists.

The Team

The team should consist of two full-time specialists. The Team Leader should be an environmental impact assessment specialist The water quality specialist should have experience with well water quality testing and monitoring, groundwater management, and well repair and rehabilitation.

IV. Deliverables

Deliverables for this Tidwell include: (1) an amended IEE; (2) a list of written criteria to guide Mercy Corps in the selection of wells to be rehabilitated; (3) written standards for the rehabilitation of wells; and (4) written standards for the testing of*#after quality at wells which may provide water for human consumption. These shall be provided in draft to U^AID/Mongolia for review and approval not later than three days prior to departure from country. The draft deliverables shall be finalized after receipt of comments from USAJD/Mongolia, and submitted to USAlD/Mongolia prior to departure from country.

V. Estimated Level of Effort

The estimated level of effort for this activity is 26 days (including travel time) for the team leader/senior data acquisition specialist (Talbot), 25 days (including travel time) for the senior water quality management specialist (well rehabilitation), and 5 days for cooperating country national support.

ANNEX 4: RESUMES OF IEEA PREPARERS

James J. Talbot, Team Leader and IEEA Prepare

Lawrence Carrillo, Hydro geologist and Water Quality Specialist

JAMES J. TALBOT

ARD, Inc.

POSITION: ENVIRONMENTAL ASSESSMENT SPECIALIST

KEY QUALIFICATIONS:

More than 24 years of professional and consulting experience in the field of environmental science and environmental assessment (EA), with private environmental and scientific organizations, with development banks and other donors, and with public, federal agencies. Specific skills and experience include: USAHVLAC/DR Regional Environmental Officer for the Caribbean (1982-1987), including preparation of IEE/EA/EIS according to USAID Rag 16 environmental procedures; preparation of EA and EIS for World Bank, Asia Environment Department (1990-1991); preparation of EA for public and private sector organizations; assessment of impacts of agricultural development projects; pesticide use, storage, and disposal management; pesticide training, and environmental impact assessment (EIA) training. Specific experience in Bolivia under World Bank support for preparation of water resources management project (1997). Fluency in Spanish,

EDUCATION:

Ph.D., Biology/Ecology, 1976, University of Southern California
B.S., Biology, 1970, Villanova University

Special Studies:

Development Alternatives, Inc., USAID Project Implementation Course, 1985.
U.S. Occupational Health and Safety Administration, Course in Hazardous Materials Handling and Management for OSHA 1910.120 (40-hour Certificate of Completion, 9/93; Annual 8 hour Refresher Course, 4/97).

Professional Registrations:

Certified Hazardous Materials Manager (1995), Senior Level, Institute of Hazardous Material management, Rockville, Maryland, U.SA.
Certified Senior Ecologist, Ecological Society of America (since 1982)
Certified Environmental Professional in Environmental Assessment, National Association of Environmental Professionals (since 1987)
Registered Environmental Assessor, #REA 03350, State of California (since 1991).

Honors and Awards

Latin American Teaching Fellow, Fletcher School of Law and Diplomacy, Tufts University, 1976-1977, assigned to National University, Asuncion, Paraguay. Superior Unit Citation - U.S. Agency for International Development, 1985 (Haiti Mission)

GEOGRAPHIC EXPERIENCE:

Antigua & Barbuda, Argentina, Barbados, Belize, Bolivia, Brazil, Costa Rica, China, Dominican Republic, Dominica, Ecuador, England, Germany, Guatemala, Haiti, Honduras, Hungary, Ivory Coast, Jamaica, Mexico, Morocco, Paraguay, Peru, St. Lucia, St. Vincent.

LANGUAGES:

English (Native); French (good); Spanish (excellent); Creole (good); Portuguese (fair)

PROFESSIONAL EXPERIENCE:
April 1998-present, **Vice President for Program Operations**, ARD, Inc., Burlington, VT. As a member of the senior management team at ARD his responsibilities include formulating policies, strategies, and plans for the operation of projects and sectoral activities; providing advice on marketing strategies, technical operations policies, and technical staffing plans; supervising Assistant Project Managers and Interns; and providing expert technical consulting services (short- and medium-term assignments) on overseas projects within his area of expertise.

- Team Member, Coastal Water Quality Improvement Project, USAID/Jamaica. Review Annual Work Plans, Performance Monitoring Plans, and Procurement Plans; provide technical input to pollution prevention planning.

1987-1998, **Principal and Senior Program Director**, ERM Program Management Company, Philadelphia, Pennsylvania. Responsible for federal customers and international projects, including Ices for the Department of Defense, National Park Service, Fish and Wildlife Service, US Postal Service, and US Agency for International Development Technical work products included remedial investigations/feasibility studies; due diligence and environmental compliance audits; development of Environmental Management Systems (EMS); EIS/EA; pollution prevention plans; environmental site assessments for real property transfer; site investigations; field sampling; coordination with laboratories and subcontractors on specific field assignments such as well drilling and installation, soil borings, and sample collection. IQC Project Management responsibilities included management of budget, schedule, and technical staffing and QA/QC of work products for over $25 million in task orders. During 1990-1991, Dr. Talbotwassecunded to the World Bank, Asia Environment Department, to assist in developing SOPs and conducting project reviews to implement the Banks newly approved Operational Directive 4.0 and 4.01. Assignments included:

<u>Environmental Policy/Regulatory Frameworks</u>
Consultant, Government of Bolivia, Ministry of Environment and Sustainable Development, to prepare RFP for $3 million urban water resources project for the cities of La Paz, Cochabamba and Santa Cruz, financed by the Nordic Development Fund (July-August 1997); project included development and promotion of market-based incentives and policy instruments for urban and industrial pollution control.

Mission Consultant, MNIAG, World Bank, for water quality review and institutional analysis as part of Water Sector Assessment, Morocco (July 1993).

- Provided technical assistance to World Bank, ASTEN, in area of environmental assessment (e.g., developing environmental management and monitoring plan guidance), environmental input to project design (e.g., review of India Sonic Lands Reclamation Project; re-write of section of China BlVironinent Strategy Paper), and drafting of Torso for consultant missions (1991-1992).
- Prepared environmental assessment guidelines and mission-specific terms of reference (over 30 Torso prepared) for Asia Technical Department, Environment Division (ASTEN), World Bank, for energy, natural resources, industry and infrastructure development projects (January 1990 May 1991), implementing Operational Directive 4.00 on Environmental Assessment.
- Wrote environmental review guidance documents on cement manufacturing, pulp/paper processing, tourism, agro industry, and fisheries for World Bank Sourcebook on EIA (1990). The World Bank published this extensive three-volume manual in 1991.

Environmental Management Practices Techno logics

Project Manager, for 5800,000 task order on development of EMS for US Postal Service mail processing plans and vehicle mauwenance facilities for Allegheny Area, including over 65 facilities over 50,000 square feet; tasks included audits, conducting training programs, development of compliance manuals and Bumps, and installation of environmental filing systems at facilities (September 1996-April 1998).

Project Manager, preparation of environmental compliance audits, and pollution prevention plans for approximately 45 vehicle maintenance and mail processing facilities for U.S. Postal Service (September 1996-December 1997).

Assessor, Environmental Site Assessment (due diligence audits), Phase 1, under NEPA for 12 properties in Puerto Rico under consideration for acquisition or lease by the U.S. Postal Service (January 1997-Febraary 1998).

Project Manager, NEPA Environmental Assessment for Joint Readiness Training Center, Ft Polk, Louisiana, for U.S. Army Environmental Center, Aberdeen, Maryland (September 1995-March 1996).

Project Manager, NEPA Environmental Impact Assessment for proposed 780,000 so Processing & Distribution Center, U.S. Postal Service, Philadelphia, PA (August-December 1995).

- Managed EA for Hungary Power Project for Hungarian Electricity Board, which included upgrading three fossil-fueled steam turbine power plants to combined cycle gas turbine facilities and conducting the necessary environmental impact analysis according to World. Bank guidelines (1992); key component included conducting consultation sessions/public foray with affected groups to develop community-based environmental management plans.
- Sat on selection panel and conducted review of consulting firm proposals for sect oral environmental assessment on irrigation in Morocco, including development of scoring methodology, bid evaluation, and consultant selection, for World Bank, EM2AG (1991).
- Reviewed EIA for Hewing Highway Project for China Infrastructure/Transport Division, World Bank; recommended additional studies; wrote TOR for environmental management and monitoring plans for submission to the Pry's National Environmental Protection Agency and Provincial Environmental Protection Bureau (1991).
- Managed preparation of a hazardous waste management manual in Spanish for Mexican *maquttadora* industry for Allied Signal Corporation (1990).

Member of World Bank Pre-Appraisal Mission to People's Republic of China for Ugandan Agricultural Development Project, preparing terms of reference for EIA, which would be conducted by Hingham University, Ugandan Province (1990).

- Wrote Community Right-to-Know incident manual for major pharmaceutical firm's facility in Portsmouth, United Kingdom (1989).
- Environmental Assessment - Haiti Agro forestry Project. Prepared for USAID/Haiti to support Project Paper - National Agro forestry Program (1989).
- Conducted environmental audits of pesticide manufacturing, storage, and distributing facilities in Morocco for the IMF/World Bank, EMTEN/EMENA to ensure compliance with Bank and borrower environmental guidelines for pesticides (1988).

Instimn'onal Strengthening. Capacityjgm'lding. Training

Consultant, hitter-American Development Bank, to prepare training manual for operations staff on preparation of environmental documentation necessary to comply with Bank guidelines and policies

on environmental and social assfc&sment incorporating lessons learned with best management practices (January-April 1998).

Trainer, Hazard Communication Standard, OSHA 1910.1200, for 180 U.S. Postal Service employees at the Manhattan vice Maintenance Facility, New York (June 1996).

Trainer, Pollution Prevention Plan Preparation and Emergency Planning and Community Right to Know Reporting for New York Metro and Puerto Rico Vehicle Maintenance Facilities. U.S. Postal Service. Facilities Service Office. Hoboken, NJ (June 1996).

Trainer for Wyes College, UK, in environmental impact assessment of agricultural projects for UNDP/UNEP and EBRD staff; offered June 28-July 13, 1992 at University of Kent, U. K.

- Conducted training program in Spanish for large pharmaceutical firm on Emergency Planning and Community Right to Know Act (EPCRA), in Puerto Rico (1989).

1982-1987, Regional Environmental Management Specialist (REMS), U.S. Agency for International Development, posted in the Caribbean (Haiti), responsible for Belize, Dominican Republic, Guyana, Haiti, Jamaica, and all of the Eastern Caribbean countries (RDO Barbados). Specific responsibilities included advising LAC/C Missions on development and conduct of their environmental and natural resource management programs; assisting in conceptualization, design, and implementation of E/NR projects; preparing Initial Environmental Examinations (EE), environmental assessments (EA) pursuant to provisions of AID Rag 16 (22 CFR Part 216); assisting the LAC Chief Environmental Officer (Jim Hester) in development of Caribbean regional resource sector strategies and programs; developing working relationships with host country E/NR personnel; and providing Specialized technical services to other LAC USAJD Missions and USAJD/W. Selected assignments included:

- Haiti: Country Environmental Profile, USAID/Haiti (1987).
- IEE: Hillside Agriculture Project (AID 532-0101), prepared for USAID/Jamaica (May 1986).
- IEE: Agricultural Research Project (AID 532-0128), prepared for USAID/Jamaica (May 1986).
- IEE: Commercial Farming Systems (AID 517-0214), prepared for USAID/Dominican Republic (March 1986).
- Agro forestry Outreach Project (521-0122): End-of-Project Evaluation. USAID/Haiti, REMS prepared analysis of research activities conducted under the project (April 1986).
- IEE: Investment Export and Promotion (AID 521-0186), prepared for USAID/Haiti (February 1986).
- Guidelines for Environmental Analysis of AID-rounded Projects. Prepared for USAID Regional Development Office/Caribbean-Barbados under the HIAMP Project, ADO (January 1986).
- Assessment of Environment and Natural Resource Project Needs for St. Lucia. Report prepared at the request of the Government of St Lucia's Ministry of Finance and Planning and forwarded to GOSL (January 1986) (file copy with RDO/C Bridgetown).
- A Review of Project Design/Implementation Models for Soil and Water Conservation and Management in the Caribbean. Paper presented at International Seminar on Impact of Hillside Land Use on Downstream Agriculture. Sponsored by the Undersecretary for Natural Resources (SURENA), Dominican Republic (December 2-6, 1985).
- IEE: Targeted Watershed Management Project (AID 521-0191), prepared for USAID/Haiti (November 1985).
- Statement of Work: Land Use Management Plant for St Kitts Southeast Peninsula Road Project Cable "X Port-au-Prince 6981 (10/16/86) to Regional Development

Office/Bridgetown.

- Statement of Work: Natural Resources Management Project (AID 517-0126). Prepared for Incan Republic to be executed under contract 517-0126-C-006012-00 with RONCO, Washington, DC (October 1985).
- Review of Progress: Cumberland Watershed Management Project (AID 517-0091).
- Report prepared for USAJD Regional Development Office/Caribbean (October 1985).
- IEE: Incentives for Improving Basic Education (AID 521-0190), prepared for USAID/Haiti (September 1985).
- EA: Belize Agricultural Diversification Project (AID 505-008). Review and revise EA prepared by consultants for USAJD/Belize (July 1985).
- EA: Rodent Control Sub project of Basic Human Needs Trust Fund Project (AID 5380103). Review and correct draft EA for USAID Regional Development Office/Caribbean-Barbados (June 1985).
- Statement of Work: St. Kitts Southeast Peninsula Road Project Environmental Assessment, prepared for USAID Regional Development Office/Caribbean-Barbados (June 1985).
- Statement of Work: St. Lucia Geothermal Environmental Assessment, prepared for USAID Regional Development Office/Caribbean-Barbados (May 1985).
- IEE: St. Kitts Southeast Peninsula Access Road Project Environmental Assessment, prepared for USAID Regional Development Office/Caribbean-Barbados (May-June 1985).
- Mime Mine EA: Prepared for Overseas Private Investment Corporation (OPIC), and transmitted by Cable Port-au-Prince #1858 to Secretary of State, Washington, DC (April 1985).
- Watershed Project Implementation Plan: Cumberland Hydroelectric Project. Assisted Regional Forestry Advisor, Dr. Henry Technical in preparation of draft plan, for the USAID Regional Development Office/Caribbean (July 1984).
- Concept Paper: Coastal Fisheries Development Project, prepared for the Annual Budget Summary, USAED/Haiti (July 1984).
- EA: Dominican Rural Electrification Project (AID 538-0130), prepared for USAID Regional Development Office/Caribbean-Barbados (July 1984).
- Statement of Work: Haiti Country Environmental Profile, prepared for USAID/Haiti (May 1984). Statement of Work: Jamaica Country Environmental Profile, prepared for USAID/Jamaica (May 1984). EA: Agricultural Education Project (AID 532-0082), prepared for USAID/Jamaica (May 1984).
- EA: Cumberland Hydroelectric Project, St. Vincent (AID 538-0091), prepared for USAID Regional Development Office/Caribbean Barbados (February 1984).
- EA: Schistosomiasis Control Project for the Dominican Republic, prepared for USAID Dominican Republic (December 1983).
- Final Report of Tropical Research and Training Center (CATIE), Trial, Costa Rica. Institutional analysis prepared by Coopers & Libran Washington, DC and USAID Team of James Talbot, Emhart Uppercut, and Phil Warren for ROCAP, Guatemala (November 1983).
- Ecological Trends Analysis for the Lacily, Margot, and Trios Rivers Watersheds. Report prepared for the Social Institutional Profile of the Cays Plain Basin and used by the Clark University Team (October 1983).
- Summary Report: Environmental Analysis and Utilization of Primary Screening Criteria on Secondary Roac'Project (AID 521-0149), prepared for the Office of Engineering, USAID/Haiti (September 1983).
- IEE: Rural Access Roads and Bridges (AID 505-0007), prepared for USAID/Belize (August 1983).
- IEE: Community Water Systems Development (AID 521-0155) prepared for USAID/Haiti (June 1983).

- IEE: Interim Swine Population Project (521-0170) prepared for USAID/Haiti (June 1983).
- Statement of Work: Belize Country Environmental Profile.
- IEE: Commercial Bank Discount Fund (AID 505-0005) prepared for USAID/Belize (March 1983).
- Environmental Assessment (EA): St. Lucia Agricultural Structural Adjustment Project (AID 538-0091). Prepared for the USAID Regional Development Office/Caribbean (Bridgetown, Barbados) (February 1983).
- Initial Environmental Examination (IEE): On-Farm Water Management (AED 517-0159), prepared for USAID/Dominican Republic (December 1982).
- Resource Optimization and Peat Mining in Jamaican Wetlands prepared for USAID/Jamaica (December 1981).

1981-1982, **Staff Ecologist**, Science Applications International Corporation (SAIC), McLean, VA. Managed studies on estuary health and status under EPA contract Managed international programs on ecological assessment and preparation of Country Environmental Profiles (CEP) for Honduras, Bolivia, and Dominican Republic under a USAID IQC. Assisted EPA 404 Dredge and Fill Program through task order contract and wrote paper on wetland functions and values.

1978-1981, **Staff Officer**, National Academy of Sciences, Washington, DC. Served as Administrator for Committee on Research Priorities in Tropical Biology, NSF-faded project (also called the "Raven Committee"). Organized meetings and facilitated committee interactions with Federal agencies. Organized seminar on Alaska's natural resources and information transfer needs for Institute of Northern Forestry, Fairbanks, AK. Coordinated activities of Committee on Selected Biological Problems in the Humid Tropics, sponsored by NPS and USAID, and coordinated activities on Committee on Wild Horses and Burros, sponsored by BLM.

1977-1978, **Consulting Ecologist**, United Engineers and Constructors,
Philadelphia, PA. Managed baseline studies, analyzed and interpreted ecological data and prepared site selection reports for electric power-generating facilities and EIS/EA. Participated in multidisciplinary team of engineers, hydrologists, biologists and modelers to prepare modeling studies for striped bass population dynamics in Delmarva Peninsula, and prepared 316 (a) and (b) Waiver Applications.
1976-1977, visiting Professor of Environmental Sciences, Universidad National de Asuncion, and Paraguay, under a Latin American Teaching Fellowship from Fletcher School of Law and Diplomacy, Tufts University.

SELECTED PUBLICATIONS:

1995 Workbook and Generic Pollution Prevention Plan for Vehicle Maintenance Facilities. Used in conducting training program in same topical area. For U.S. Postal Service, Hoboken, NJ.

1994 Contingency Plan to provide safe drinking water for the City of Milan, TN. Paper published in the Proceedings of the Hazardous Materials Research Institute, Federal Environmental Restoration Conference HI, April 27-29, 1994.

1991 Environmental Assessment Sourcebook, Volume I, Policies, Procedures, and Cross Sect oral Issues. World Mabank Technical Paper 139, Environmental Department, Washington, DC (Contributing author: Chapter 8, "Agriculture and Rural Development; Chapter 9, Population, Health and Nutrition; Urban Development; Tnoljjjartation; Water Supply and Sewerage; and Chapter 10, Energy and Industry).

1991 Environmental Assessment Sourcebook, Volume II, Sect oral Guidelines. World Bank Technical Paper 140, Environmental Department, Washington, DC (Contributing author; Chapter 8, Agriculture and Rural Development; Chapter 9, Population, Health and Nutrition; Urban Development; Transportation; Water Supply and Sewerage.

LAWRENCE A. CERRILLO

ARD, Inc.

Water Quality and Well Rehabilitation Specialist

KEY QUALIFICATIONS:

Mr. Carrillo has national and international experience in ground-water supply that ranges from exploration through well design, installation, testing, and distribution. He has worked in a variety of geologic environments including unconsolidated glacial, alluvial, and Aeolian deposits, karts environments, and fractured igneous/metamorphic rocks. Mr. Carrillo has developed large capacity wells for municipal, industrial; mining and irrigation supply; designed, coordinated and conducted hundreds of aquifer pumping tests and evaluated pumping test data in a variety of hydro geologic terrain. In addition to exploration and production well design and construction, he has designed and installed infiltration galleries and horizontal wells to develop ground-water supplies, designed and conducted artificial recharge experiments and installed artificial recharge and deep injection well systems to prevent salt-water intrusion.

In groundwater exploration and development his expertise includes:

- Regional groundwater assessments.
- Exploration utilizing aerial photos and geologic mapping.
- Design and implementation of exploration drilling programs.
- Design and implementation of alternative ground-water extraction methods.
- Aquifer test design, execution and analysis.
- Design and implementation of well rehabilitation programs.
- Analysis of fractured rock aquifer systems.
- Design of artificial recharge systems.
- Downhtfle geophysics logging interpretation.
- Design, implementation, and interpretation of surface resistively surveys.
- Production well and pumping system design.
- Permitting and regulatory interface.
- Water resource management.

EDUCATION:

M.S., Hydro geology., 1967, Colorado State University

B.S., Gecko, 1964, Syracuse University

Other Training:

Principal Hydro geologist
Certified Professional Geologist - AIPG No. 2763
Professional Geologist - Wyoming No. 1397
International Association of Hydro geologist
Certificate-Environmental and Public Policy Dispute Resolution, CDR, 1998
Certificate-Water Resources Training, U, S. Geological Survey, WRD, 1967

PROFESSIONAL EXPERIENCE:

1997-present, **Principal Hydro geologist**, Vincent Hull Associates, Inc.

1995-present, **President**, Ingenuity Enterprises Int'l Inc.

1991-1995, **Associate/Project Field Manager**, Louis Berger and Associates.

1990-1991, **Independent Consultant.**

1989-1990, **Marketer, Geraghty & Miller,** Inc, European Operations.

1987-1989, **Manager, Hunter Environmental** Sciences, Colorado Office.

1986-1987, **Managing Hydro geologist**, Parsons Brinckerhoff/ Quad & Douglas.

1984-1986, **Project Manager**, Louis Berger International, Inc.

1982-1984, **Project Hydro geologist**, Engineering Science.

1980-1982, **Senior Hydro geologist,** Science Applications, Inc.

1979-1980, **Independent Consultant.**

1977-1979, **Manager**, Engineering Enterprises, Inc., Colorado.

1975-1977, **Hydro geologist**, Greiner Environmental.

1970-1975, **Coordinator**, Geraghty & Miller, Inc., Puerto Rico.

1967-1970, **Hydro geologist**, U. S. Geological Survey, WRD. Conducted groundwater and surface water studies and injection well studies utilizing tertiary treated sewage effluent to prevent salt-water intrusion.

Consultancies: '

United States

Mining companies in Wyoming, Idaho, and California. **Hydro geologist**, exploration and development of water supplies for mining operations. (1979-1980)

Residential/Municipal Properties, Colorado. **Hydro geologist,** exploration and development of water supplies for land developers and for individual homeowners. (1979-1980)

Puerto Rice. Coordinator Puerto Operations, supervision of construction, development, and testing of production weir, 300 to 1200 gallons per minute, for industrial and municipal clients throughout Puerto • Rico. These included Union Carbide, PPG Industries, Sun Oil, Palmas del Mar, and others. (1970-1975)

International Assignments:
Colombo, Sri Lanka. **Principal Hydro geologist** for the evaluation of the potential for developing ground-water supplies along the southeast coast. (8/2000)

Bahawalpur, Pakistan. **Principal Hydro geologist** for the evaluation of the potential for developing ground-water supplies in the Holliston Desert of Pakistan. (7/2000)

Cuba, Philippines. **Principal Hydro geologist** for the evaluation of the potential for developing ground water supplies in towns and villages throughout the island. (1999)

Ethiopia. **Project Hydro geologist** for the gathering of information for proposal preparation of a water supply project involving five widely scattered municipalities. (1997)

Argentina. **Hydro geologist** for supervision of 12 inch diameter dewatering wells at large copper/gold mining operation. (1997)

Israel. **Hydro geologist** for the gathering of information for a proposal to develop water supplies for the West Bank. (1996)

Pakistan. **Project Hydro geologist** for the gathering of information for proposal preparation of aground water investigation in Questa. (1991)

Somalia, East Africa. **Project Manager** for comprehensive ground water development program throughout central and southern Somalia. Hundreds of wells in a variety of geologic environments were located, drilled, developed, tested, and placed into production. The S13 million dollar project involved supervision and coordination of four drilling rigs, 2 pump rigs, numerous pickup trucks and other support vehicles, 15 expatriates, and 50 plus nationals. (1984-1986)

Jaffna Peninsula, Sri Lanka. **Project Hydro geologist** of a regional investigation to define saltwater intrusion areas and to develop water supplies for market towns. Designed, installed and tested horizontal well to skim$_{m}$er«neater in low-lying dune areas of the Peninsula. (1982-1984)

Yucatan, Mexico. Project **Hydro geologist** for the evaluation of groundwater contamination, and the development of an alternative ground water supply in a karts environment. (1970-1975)

Groundwater Contamination Investigations:

Satellite Station, Antigua. **Project Hydro geologist**, supervised site investigation of diesel pipeline break and abandoned landfill site on the primarily limestone island. (1994)

Fort kale, Kansas. Project Field **Manager**, served as project field manager for the site characterization of 100,000 acre military installation designated a superfund site. Supervised the sitting, design, and installation, development and sampling of monitoring wells to determine the extent of PCE, hydrocarbon, and other corilsimination associated with various operable units on the facility. (1991-1995)

Rocky Mountain Arsenal, Colorado. **Manager**, Colorado Branch Office, supervised the data compilation, interpretation, and preparation of a six-volume water-media report for the superfund site. (1987-1989)

Love Canal, New York. Senior **Hydro geologist** supervised the drilling and installation of 174 sampling/monitoring wells as part of total site investigation. Wells were completed in glacio-lacustrine deposits and in bedded limestones and dolomites. (1980-1982)

Chemical Plant, Delaware. **Hydro geologist**, supervised drilling, testing and sampling of wells to define extent of groundwater contamination resulting from plant operations. Surface waters in the area were also sampled. (1970-1975)

Fertilizer Plant, Kansas. **Hydro geologist**, conducted surface resistively survey to delineate horizontal and vertical extent of groundwater contamination from plant operations. (1970-1975)

Trina Mining and Milling, Wyoming. **Hydro geologist**, monitored excavation and construction of 60 feet deep, mile long interceptor trench for effluent from a tailings pond, and the installation of monitoring wells to determine the results of the trench. (1970-1975)

Sauerkraut Plant, New York. **Geologic Technician**, conducted surface resistively survey to define the source of groundwater contamination to a production well serving a nearby dairy. (1962)

Environmental Investigations:

Coal Mine, North Dakota. **Manager** of multi-discipline team of scientist and engineers in the conduct of an environmental impact statement for the major expansion of a coal mine operation. (1987-1989)

Coal Mines, Western U.S. **Co-manager** of investigative team for the evaluation of the effects of surface coal mining on groundwater quality. Mines in Colorado, Wyoming, Montana, and New Mexico were investigated. (1977-1979)

In-Situ Coal Gasification, Wyoming. **Hydro geologist** associated with investigation of the effects of in-site coal gasification on groundwater quality. (1977-1979)

Phosphate Mine, Idaho. **Hydro geologist** supervised hydrologic and hydro geologic investigation associated with preparation of environmental impact statement for the mine. Located and installed surface water gagging stations, conducted surface resistively investigations, located, designed, installed monitoring wells, and prepared report. (1975-1976)

Ground water Contamination, Northwestern U.S. **Principal field investigator** for six-state study of groundwater contamination problems in northwestern United States. (1970-1975)

Artificial Recharge:

Bay Park, Long Island. Hydro geologist on team investigating the use of tertiary treated sewage effluent to prevent salt-water intrusion on Long Island. (1967-1970)

Expert Testimony:

Mr. Cerril^jhas conducted basin-wide groundwater investigations to determine the availability of water supplies for eSpimercial and residential development. He has testified in water court in Colorado and at county planning and zoning hearings with respect to these investigations.

LANGUAGES:

Spanish (working level), German, Italian (basic)

SELECTED PUBLICATIONS:

Cerrillo, L. A., et al, 1989, Water Media Report, Rocky Mountain Arsenal, Colorado.
Cerrillo, L. A., et al, 1986, End of Project Report, Comprehensive Groundwater Development Project, Somali Democratic Republic. Louis Berger International, Inc., and Roscoe Moss Company for USAID.

Cerrillo, L. A., et al, 1981, Water in the West Colorado Section AIPG Publication.

Hounslow, A, Carrillo. L. A., and McLean, W. J., 1979, Use of Mineralogy in Predicting Possible Ground-Water Chemical Changes Resulting From In-Site Gasification of Coal—Preliminary Study. Prepared for Robert S. Kerr Environmental Research Laboratory, Project C80415.

Hounslow, A., Carrillo, L. A. and Fitzpatrick, J, 1978, Overburden Mineralogy as Related to Ground Water Chemical Changes *in* Strip Mining of Coal EPA-600/7-78-156.

Van deer Leaden, F., Carrillo, L. A., et al, 1974, Groundwater Contamination Problems in the Northwestern United States. Ecological Research Series, EPA-600/3-75-OI8.

Vecchioli, J., Carrillo, L. A., et al, 1974, Geohydrology of the Artificial Recharge Site at Bay Park, Long Island, New York. U. S. Geological Survey Professional Paper 75-C.

Cerrillo, Lawrence A., 1967, Hydrogeology of Beaver Creek Basin, Larimore County, Colorado. M.S. Thesis, Colorado State University, Fort Collins, Colorado.