Using Irrigated Agriculture for the Control of Sandstorms & Desertification in Areas Surrounding Beijing, China

valmont
WATER MANAGEMENT GROUP

CCICCD
State Forestry Administration
Peoples' Republic of China

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Phone: 703-875-4357 • **Fax:** 703-875-4009 • **Web site:** www.tda.gov • **email:** info@tda.gov

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DEMONSTRATION PROJECT FOR THE CONTROL OF SANDSTORMS AND DESERTIFICATION IN AREAS SURROUNDING BEIJING USING IRRIGATED AGRICULTURE

28 February 2003

INCEPTION REPORT

The purpose of this project is to demonstrate a method for controlling sandstorms and desertification through the use of more intensively managed agriculture. This demonstration is focused on relieving the grazing pressure on the native grasslands by providing an alternative irrigated forage resource. This project is founded on a partnership between the State Forestry Administration of the People's Republic of China, Valmont Industries, and The United States Trade Development Agency.

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Client Approval

We have thoroughly reviewed the report titled "Inception Report - Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing Using Irrigated Agriculture" and feel that it fairly represents the observations and findings of this phase of the study, and that it is as described in the Contract for Desertification Prevention project in China, USTDA Grant No.: GH 2381659.

"The services for which disbursement is requested by the Contractor have been performed satisfactorily, in accordance with applicable Contract provisions and the terms and conditions of the TDA Grant Agreement."

Signature 刘拓 Date 18/7-2003

Mr. Liu Tuo
Director General
National Bureau to Combat Desertification

1.2 Conceptual Framework

The SFA/TDA/Valmont Demonstration Project involves the design, delivery, and installation of a Valley center pivot Irrigation System in the Zhenglan Banner of Xilingol League in Inner Mongolia. The site is located approximately 260 km due north of Beijing. The design activity will include describing the physical layout of the irrigation infrastructure and crops that will be planted initially on the land irrigated with the center pivot system. The types of crops planted will be determined in consultation with the Zhenglan Banner Administration and the State Forestry Administration in Beijing. We understand that most of the area beneath the center pivot will be used to grow forage crops, while a small portion of the area will be used to produce trees.

This project is being implemented within both local and national policy. The local policies include a strategy that was clearly stated by the leadership of the Zhenglan Banner. Their three-step strategy proposes to first stabilize the grasslands by making a shift toward more intensive agricultural production methods which rely less on the capabilities of the natural grasslands and more on modern agricultural methods.

The second step is to increase the level of industrialization. Local banner leadership anticipates that the agricultural changes in step one can contribute to increased industrialization through value added activities. For instance, milk production may result in a milk factory, cheese production, and a host of other processing opportunities.

The third point of this local policy for the future is a gradual shift of the rural population that is now dependent upon the grasslands to urban industrial occupations. It is the leadership's firm conviction that they can combine the agricultural, industrial and service industries to increase the quality of life for the residents of Zhenglan Banner. The contribution of high intensity agriculture involving irrigation is a key element in the implementation of this three-point strategy.

The SFA/TDA/Valmont Project is also being implemented within the context of a much larger project that is underway in many areas of Inner Mongolia and other areas of northern China. We understand that the goals of the larger project include reducing the rate at which grasslands and rangelands in northern China are being degraded by unsustainable levels of livestock grazing and inappropriate crop production activities. The goals also include the natural recovery of degraded lands to reduce the frequency and severity of sandstorms that move from rural areas of northern China to provinces and cities in other areas of the country. The methods used to achieve these goals include the resettlement of herder families in Ecological Migration Villages, in which livestock will be raised largely in confined areas, with greatly reduced use of open grazing land. At the same time that herder households are moved into these villages, the State Forestry Administration will continue planting grasses, shrubs, and trees on the degraded rangelands to enhance their recovery and to stabilize moving sand dunes.

The primary goal of the SFA/TDA/Valmont Demonstration Project is to enable intensive production of forage crops and nursery trees that will support implementation of higher productivity irrigated agricultural practices and at the same time support the Ecological Restoration Program in Zhenglan Banner. Hence, the success or failure of the TDA/Valmont

Project will be evaluated by our ability to produce forage crops and nursery trees on irrigated land in Zhenglan Banner. Success will be determined, in part, by the soil and water resources available at the project site, the crops chosen for production, and the agronomic skills applied throughout the growing season.

2.0 WATER RESOURCES

Based on a preliminary review of the area, groundwater will provide the main source of fresh water for the proposed pivot. The nearby rivers and streams are intermittent, making them unreliable, or at such distances as to make their use unattractive from an economic standpoint (i.e., additional pumping and piping costs). Based on local reports, groundwater is readily available and has been utilized for similar purposes in other parts of Zhenglan Banner.

Given the low rainfall conditions, limited recharge potential and an ever-increasing demand placed on this resource by a growing population, groundwater within the Zhenglan Banner is assumed to be limited, requiring that great care be taken to avoid misuse and over-allocation. With these considerations in mind, the feasibility study and the SFA/TDA/Valmont Demonstration project should be designed to address the following water resource concerns:

- A groundwater withdrawal rate that is large enough to supply sufficient water through the pivot to meet crop demand, but small enough to avoid exceeding the aquifer's long-term sustainable yield;
- Appropriate engineering of the wells and delivery system to minimize costs;
- Likely hydraulic impacts of the irrigation system production wells on the surrounding environment and on nearby existing water users; and
- The repeatability of the pilot study model elsewhere in the Zhenglan Banner basin. In other words, it will be necessary to determine how many systems the basin can support and how densely those systems can be concentrated while maintaining long-term viability and sustainability.

In order to address the concerns listed above, the feasibility study and the SFA/TDA/Valmont Demonstration Project should be designed to generate the following information:

Recharge Potential:
Aquifer recharge potential should be estimated as part of the feasibility study to help address the long-term sustainability issues associated with this project. Since a detailed investigation and field study of groundwater recharge within the Zhenglan Banner basin is beyond the scope of this assessment, recharge potential will be estimated based on climatic data, topographic maps, geologic information, and any other published literature that can be obtained readily. The recharge potential estimate developed in this manner will be used on an interim basis to support design and planning of the project, until an improved estimate can be made based on monitoring of relevant environmental parameters beginning during the period of operation of the pilot study.

The elements of the monitoring program necessary to allow production of an improved estimate of recharge potential thus must be specified as part of this information-gathering activity.

Groundwater Quality:
Since water quality plays an important role in crop selection and water usage (e.g., increased salt concentrations require additional water applications to leach applied salts out of the crop rooting zone), the groundwater quality should be assessed. For the feasibility study, known groundwater characteristics of local wells in the same area at similar depths can be used. After the Demonstration Project has been established, groundwater from the site wells will be tested for a range of parameters to confirm its suitability for irrigation use. Water quality parameters of particular interest include: Total Dissolved Solids (TDS), Chloride (Cl), Sodium (Na), Sulfate (SO_4), Calcium (Ca), Magnesium (Mg), and Nitrate Nitrogen (NO3-N). In addition to laboratory analysis of water samples for these parameters, a program of periodic routine analysis of parameters that can be measured in the field should be undertaken (e.g., specific conductance, hardness, and pH), to check for variation of these indicator parameters over time.

Withdrawal Impacts:
The relationship between pumping rates and aquifer impacts will be an important consideration in assessing the strategic success of the Demonstration Project as well as determining the long-term sustainability and repeatability described above. For this project, the feasibility study will assess potential groundwater withdrawal impacts, in conjunction with estimated recharge potential, to estimate the impacts that different withdrawal rates (matching the water requirements of different crops to be assessed as part of this study) can be expected to have on the environment surrounding the pilot study area as well as on the Zhenglan Banner basin itself. This will be accomplished based on reviews of geologic information and any other relevant literature or information that can be obtained easily. The pilot study itself will include testing and monitoring techniques to confirm or refine the estimates developed under the feasibility study.

Well Design:
The design of the well or wells to be drilled at the pilot study site will be reviewed to determine the most suitable installation parameters that will facilitate economical pumping and delivery. This assessment will be compared to the actual drilling, pumping, and piping systems that are available at the project site so as to maximize the use of appropriate technology within the area. The final design will optimize use of local resources. Design recommendations will be provided as part of the feasibility study, taking into account the range of hydrogeologic environments likely to be encountered in the Zhenglan Banner basin. An evaluation will be made of the performance of the wells installed to support the pilot study.

To summarize, appropriate utilization of local groundwater resources will play an important role in the economic development of the Zhenglan Banner basin. The additional knowledge gained from this pilot study will help the relevant governing agencies better address the development issues of water allocation, long-term development/sustainability, water rights, and economic value.

3.0 IRRIGATED FORAGE PRODUCTION

3.1 Irrigation Engineering Design

The purpose of the center pivot system is to provide timely and efficient use of irrigation water to meet the water demand of growing crops. Under this scenario, the pivot system is critical to help (1) maximize irrigation efficiencies, (2) increase crop variety and production rates, and (3) reduce risk of crop failure. For this project to be successful, it is important for the center pivot system to be designed consistent with the environmental and operational constraints associated with the site. With these considerations in mind, the feasibility study and Demonstration Project should be designed to address the following water engineering concerns:

1) Well locations and pumping distances that maintain appropriate pressures for proper pivot operation;

2) The reliability and quality of electricity;

3) Availability and quality of in-country parts, piping, wiring, and pump systems; and

4) The availability of local service providers/operators who can acquire the basic knowledge needed to maintain and operate the center pivot system.

To address the concerns listed above, the pivot system should, at a minimum, be designed with attention paid to the following:

1) **Pumping Requirements** – Based on the results of the groundwater resource assessment (Section 2.0), pumping systems will need to be designed to withdraw water at the appropriate rate to meet the proposed crop's peak water demand. At this time, it is assumed that 3 to 5 wells will be placed in the area to provide water to the pivot. Critical decisions that will be assessed during the detailed design stage will include: (1) pump type and size (e.g., turbines), (2) the need for booster pumps at the collection manifold, (3) pipeline size, (4) construction requirements (e.g., pump housing, piping depths, etc.), and (5) the need for pressure regulators.

2) **Electrical Service Characteristics** – The type and location of electrical service will need to be characterized to determine the type of equipment that will be best suited to operate under various site conditions. It has been assumed that 3-phase electrical service can be supplied to the site and that uninterrupted service is available. However, these assumptions will need to be confirmed during the feasibility study and appropriate alternatives, such as diesel generators, be assessed for improved operations. In addition, it will also be necessary to determine how the electrical lines will be placed and what type of safety equipment will be needed so as to reduce the risk of electrocution and/or disruption (e.g., damage from farm implements, circuit breakers, etc.)

3) **Auxiliary Equipment** – Aside from the center pivot, which is imported, the remaining auxiliary equipment (e.g., pumps, piping, electrical components, etc.) to be used by the project will need to be assessed for functionality. This materials selection process will be based on the following criteria: (1) availability, (2) reparability, (3) maintenance requirements, and (4) replacement parts availability.

4) **Technical Expertise** – The irrigation system will require trained operators and service professionals who can acquire the basic knowledge needed to maintain and operate the center pivot system. While the pivot itself can be easily maintained and serviced by in-country service representatives, auxiliary equipment service and operations will be dependent upon local professionals. This aspect of the project will try to match the appropriateness of the mechanical components to the local operators/service providers who will be responsible for day-to-day operations and maintenance.

To summarize, the irrigation system must be designed to maximize local resources and technical expertise, while minimizing the need for outside support. The technology must be considered appropriate for the conditions in which it will be used and promote self-sufficiency on the local level. Local input and support during the engineering process is therefore critical to meeting these design objectives.

3.2 Irrigated Forage Production

High quality forage must be readily available to maximize livestock production at the proposed ecological migration villages within the Zhenglan Banner. To reduce the dependence on imported feed and to increase the economic viability of the displaced herdsmen, improved forage production must be accomplished on the local level. Thus, forage production is a critical element in assessing the long-term economic success of the migration villages established for livestock production.

The primary challenge to production of high-quality forage in the Zhenglan Banner is the climate. Assuming that the low precipitation can be mitigated with a center pivot, productivity will still be impaired by lower-than-optimum temperatures and a short growing season. Also of concern are soil quality and fertility conditions. Even with additional management and nutrient inputs, poor soil conditions could decrease yields and increase forage production costs. Thus, the feasibility study and Demonstration Project should be designed to address the following forage production concerns:

- The identification of forage species and cultivars that are suitable for the climate and soil conditions;

- The suitability and availability of water resources for meeting crop water demands;

- Forage production quantity and quality, by forage type, as they relate to livestock production; and

- The planting, harvest, and storage requirements associated with different types of irrigated forages (e.g., silage production, hay storage, etc.).

To address the above concerns, the feasibility study and the SFA/TDA/Valmont Demonstration Project should be designed to assess forage viability, water requirements, forage yield, quality, and persistence, and management suitability.

Forage Viability:
The feasibility study will review the types of forages that should be considered for production at the Demonstration Project site. The first task is the identification of forage species and cultivars that are suitable for the climate and soil conditions grown under center pivot irrigation. This will require assembling and analyzing local data for climate, soils, and species characteristics. Key species characteristics include winter survival (for perennial species), ease of establishment, yield and quality potential, tolerance of sub-optimal management, and resistance to prevailing or anticipated pests.

Currently, forage is being produced on other pivots in the region, primarily corn for silage and saline-resistant grasses for hay. In addition, forage trials have been/are being conducted in adjacent banners, including alfalfa cultivar evaluations. Thus, there is some local information on what species and cultivars survive in conditions similar to the proposed project area and how much they are capable of producing.

Based on our understanding of this project and the availability of suitable reference materials, the initial work should be focused on four crop types: (1) corn (*Zea mays* L.) for silage, (2) alfalfa (*Medicago sativa* L.) for hay, (3) a perennial grass such as a winter-hardy brome species (*Bromus inermis* Leyss. or other) for hay, silage, and/or grazing, and (4) certain small grains such as cereal rye (*Secale cereale* L.) and/or barley (*Hordeum* spp.) for silage and/or grain.

Water Requirements:
Different forages have different irrigation requirements related to total evapotranspiration, peak demand, timing, and frequency. Since water quality and availability play an extremely important role in forage production, water requirements will need to be assessed for each potentially viable forage. The water supply (Refer to Section 2.0) will need to be checked against potential crop water demands to determine if deficit irrigation situations could occur and, if so, how crop stress can be minimized. Since water quality plays an important role in irrigation approach and crop productivity, a water quality assessment will also need to be conducted as part of the feasibility study. Groundwater can be tested from local wells established in the same area at similar depths. After the Demonstration Project has been established, the groundwater from the site wells will be tested for confirmation purposes. The water quality parameters of most concern are listed in Section 2.0. All water quality testing will be conducted in conjunction with the groundwater assessment activities described in that section.

Forage Yield, Quality, and Persistence:
To determine the maximum number of animal units that can be supported by the pivot system, the production quantity and quality of the selected forage species will need to be assessed. The key evaluation factors include yield potential, forage quality (and associated livestock nutritional

value), and water use efficiency. Crops that provide the greatest return on investment will be identified for potential use. During the actual Demonstration Project, the performance of the selected crops will be assessed according to the above-listed criteria. Due to the short duration of the project, long-term persistence of any selected perennial species will be estimated with stand counts following the first winter.

Management Suitability:
The appropriateness of the selected forage production strategy will be compared to local resource availability and skill level to assess the risk associated with the existing management capability. In other words, can local operators effectively plant, grow, harvest, process (e.g., make silage), and store the forage product without significant economic inputs or training? The SFA/TDA/Valmont Demonstration Project will list forage management improvements needed to reduce production risks.

For this portion of the project to be successful and provide pertinent results, it will be important for the project team to have access to both local and regional forage information. Scientific organizations (e.g., CAAS Institute of Animal Science in Beijing, the Grassland Research Institute in Hohhot, the Inner Mongolian Institute of Meteorology, and others) have regionally specific forage and livestock system expertise, and individuals from these groups should be consulted in developing the feasibility report and implementation plan. Ideally, trial sites in the region should be identified by detailed latitude, longitude, and elevation information, mapped using GIS software, and climate and soil characteristics compared to the project site. If none of the existing sites provides a reasonable match, a testing site should be established in the banner. Professor Lu has expressed interest in such a trial. LI Xianglin (CAAS IAS), WEI Yurong (IMMI), and GRI officials should be informed of this activity and asked to participate. In addition, ecologically oriented reference books, such as *Forage Resources of China,* are available for orientation to the historical and current conditions of the region. This and other resources should be consulted for assistance in determining recommendations.

Additional data that will be crucial to the success of this project include the following:

1) Digital Terrain Model - A detailed DTM is needed for the project site watershed (100 to 500 meter resolution).

2) Climate - Daily climate data is needed for calculation of growing degree-days. In addition, extreme cold data are needed for the local area and the probability of extreme events to determine winter death risk. Solar radiation, wind speed, and maximum temperature data are needed to calculate evapotranspiration for irrigation scheduling.

3) Soil - For the project site, detailed soil data are needed (1:50,000 - 1:100,000 scale) for soil type, drainage, pH, salinity, and alkalinity. Soil test data of the pivot site will also be needed for CEC, total N, nitrate N, P, K, S, B, Ca, Mg, Na, Cu, and Mo.

4.0 GRAZING AND LIVESTOCK PRODUCTION

Zhenglan Banner has already instituted a no-graze policy for the impacted grassland. As such, the effected herdsmen in the region will be required to move their families and livestock from the grassland commons and transition to a more sedentary agricultural lifestyle and/or find other means for self-support. Those electing to remain in agriculture will therefore need an alternative to pastoral grazing to maintain their livelihood. Under a program being implemented by the Zhenglan Banner government, displaced herdsmen will have an opportunity to relocate into Ecological Migration Villages designed to promote agricultural-related industries such as concentrated livestock production. At this time, the local government has decided to move the program forward by establishing a dairy industry. This approach would provide benefits not only to the migration villages in the form of milk production but also in the larger towns where additional employment opportunities could be created in association with milk processing (e.g., fresh milk, powdered milk, yogurt, cheese, butter, etc.).

The overriding livestock and grassland issue is the source of nutrients to support livestock production in a manner that can be adapted by the ecological migration villages. Forage for the livestock must come from (1) intensive agriculture production at the local level (i.e., irrigated cropland), (2) the natural grasslands (i.e., managed grazing and/or hay production), and/or (3) outside sources (e.g., the import and purchase of feeds produced outside of the local area). With these considerations in mind, the feasibility study and Demonstration Project should be designed to address the following livestock production concerns:

- The number of animal units, by type and class, that could be supported using irrigated forages produced within the Ecological Migration Villages;

- The amount of supplemental feed that would be required, from a nutritional standpoint to support a given number of animal units, by type and class.

- The suitability of water resources for meeting livestock watering needs; and

- The amount of supplemental feed that can be gained from the limited grazing and/or haying of the natural grasslands.

To address these concerns, the feasibility study and SFA/TDA/Valmont Demonstration Project should be designed to assess the following items:

Livestock Density:
The feasibility study will provide recommended numbers of animal units (e.g., dairy cattle, beef cattle, and sheep) that can be supported, on a land area basis, by the amount of forage estimated to be produced using a center pivot irrigation system. Given the time constraints of the actual Demonstration Project, long-term forage utilization by livestock is considered beyond the scope of this assessment.

Livestock Nutrient Requirements:
To help ensure that the nutritional requirements of the selected livestock can and will be met, the feasibility study will compare the expected nutritional value of various feed crops such as annual forages (e.g., corn silage), perennial forages (e.g., alfalfa, seeded grasses, etc.) and corn grain. This assessment will be based on published values. The objective is to minimize reliance on imported forages and supplemental nutrients. Long-term nutrient utilization by livestock and/or a review of silage production/storage techniques that maximize nutrient retention will be included where feasible. Detailed, long-term evaluation is considered beyond the scope of this assessment.

Water Quality:
Since water quality plays an important role in livestock production, water quality will need to be assessed. An adequate, high quality water source is essential, preferably one that is low in nitrates and dissolved minerals. For the feasibility study, groundwater can be tested from local wells established in the same area at similar depths. After the Demonstration Project has been established, the groundwater from the site wells will be tested for confirmation purposes. The water quality parameters of most concern are listed in Section 2.0. All water quality testing will be conducted in conjunction with the groundwater assessment activities described in Section 2.0.

Grassland Utilization:
The feasibility study will investigate the potential for gaining additional forage from the surrounding grasslands through controlled grazing and/or haying. The carefully controlled utilization of this existing resource, in a highly controlled environment, could increase the livestock carrying capacity of the Ecological Migration Villages while reducing reliance on imported feedstock. As documented by various research projects, controlled grazing and/or hay cutting might be preferred to no grazing, but only if proper defoliation management is practiced. Although the determination of grassland improvements using controlled grazing is beyond the scope of this assessment, the negative impact of uncontrolled hay cutting is similar to uncontrolled grazing. As such, the feasibility study will be limited to an assessment of the additional forage that could be realized using appropriate grazing and haying techniques. During the Demonstration Project, a section of grassland should be identified and studied to confirm the production potential estimates developed in the feasibility study.

The number of livestock that can be supported by the irrigated agriculture with supplemental forage from the surrounding grassland is one of the key elements in determining the economic potential of migration villages established in the Zhenglan Banner basin. While the information gained from this assessment will undoubtedly improve the chances for long-term success, there are many other aspects associated with confined livestock production that will need to be addressed by the local government and operators. They include: (1) the feeding and care of highly productive beef and/or dairy cattle, (2) operational labor requirements and training, (3) access to veterinary services and implementation of disease prevention practices, (4) sustainability of infrastructure, roads and electricity, (5) on-site milk handling facilities and availability of regional dairy processing services, (6) the management of non-reproductive cows and dairy calves, (7) the design and construction of animal holding facilities and appropriate shelters, (8) acquisition and use of appropriate low-impact machinery for maximizing hay production, and (9) grassland management in regards to controlled grazing and hay production.

5.0 SOCIO-ECONOMIC CONDITIONS

5.1 The Impact of Social Change

The success of Ecological Migration Villages established around the SFA/TDA/Valmont Demonstration Project in Zhenglan Banner will be affected by social issues resulting from voluntary/involuntary resettlement of uprooted populations. An experimental village already in existence indicates a high level of attrition (70%) for resettled families. Investigation of factors contributing to attrition will provide the basis for assessing the social feasibility of this model of confined animal production for Inner Mongolia. The investigation team will collect information on three central topics: 1) the origins, recent history and characteristics of resettled families, 2) the network structure and social geometry of the resettled community, 3) the allocation of time and labor, material conditions (especially related to poverty), remuneration, public services, and finances as they effect household viability.

Family Origins:
The Feasibility Study may evaluate such things as the places of origin for resettled families, their previous occupations, life styles, incomes, expenses, patterns of communication, social relationships (including kinship), material possessions (especially livestock, which are markers of accumulated wealth and status), and housing. The study may also consider the compensation provided to families for both tangible and intangible losses suffered in the resettlement. The subjective viewpoints, cultural values, and reactions of local officials and the resettled families themselves will be treated as equally or more important than objective measures of losses and gains. The Feasibility Study must take into consideration the depth of cultural/historical roots and transparency or informed consent in the resettlement process, along with the level of family participation and trust in institutional processes.

Social Geometry:
Migration, carries high potential for disorientation in people's sense of place and time, and disarticulation of social relationships. Migrating people often find themselves returning to ponder the basic questions of life, such as: "Where are we?" and "Who are we?" They are likely to suffer from feelings of deprivation, melancholy, grief, and depression. There is a tendency for them to move back to, or at least frequently visit, the place where they feel a strong cultural and ancestral attachment. Considering analog spatial and social environments will minimize disorientation, disarticulation and the sense of loss. Thus, the social feasibility analysis may consider the issue of analog features in the physical and social environment of the resettled community, including kinship ties, broader social networks, leadership and decision-making, cooperation, communication, and ritual and ceremonial life which shape the sense of individual and group identity.

Household Viability:
The feasibility study will also consider the material conditions of social life. How will people spend their time on a daily basis? Will the labor requirements and leisure be reasonable and balanced in terms of time commitment and the capabilities, skills and interests of the resettled

people? Specifically, how will they manage the transition from herding to dairy farming and horticulture? Will household members have convenient and inexpensive access to markets, energy supply, health care, education, communication, and transportation? Will income they receive from selling milk and nursery products exceed household expenses? Will the material benefits such as housing and the opportunity for households to gain wealth in the Ecological Migration Village compare favorably to their place of origin? What are the ownership, leasing or use rights of households regarding productive resources, i.e. cows, nursery stock, buildings, irrigation equipment, land, and water for both livestock and human consumption? What is their individual/collective sense of investment and responsibility regarding the successful operation and outcome of the project?

Feasibility Report:
The feasibility report will provide suggested measures for enhancing the success of the Ecological Migration Villages. These recommendations will take into consideration the three topics above and suggest ways of resolving any observed social issues with the objective of promoting successful migration and restoration of the grasslands of Inner Mongolia.

5.2 Economic Implications

The first component of an economic evaluation will include the definition of financial and economic analysis, within the context of efforts to reduce rangeland degradation and improve rural livelihoods in northern China. A limited financial analysis of the project would include evaluation of the costs of installing, operating, and maintaining the center pivot system and the values of crops produced each year. It is important to determine if such an evaluation would depict a positive net return to the center pivot system, as it is likely to be used in Zhenglan Banner during the course of this project.

The financial returns on forage crop production will be determined by the value of livestock products generated by households in the ecological village associated with the center pivot system. We understand that the members of those households will have little experience with dairy management and, hence, the initial returns to their efforts likely will be smaller than required to support a positive financial analysis. In addition, it is not yet clear that the market price of dairy products will be sufficient to justify production using the center pivot system. The nursery trees raised beneath the center pivot will have an economic value in their use to reverse desertification and stabilize moving sand dunes, but the financial returns to households involved in producing the trees is not yet clear. Hence, it is possible that the financial returns to production with the center pivot system in Zhenglan Banner will not be positive. However, the project still may generate positive economic values, as viewed from the broader perspective of reducing land degradation and improving rural livelihoods in China.

A complete economic analysis of the project would involve a much larger set of information, including the goals and results achieved in the larger, national Ecological Restoration Program. The government of China has embarked upon an aggressive program to reduce the degradation of its grasslands and rangelands, to restore areas that have already been degraded, and to improve rural livelihoods. That effort will require substantial investments by the government and by several international agencies working with the government. In a sense, both the government of

China and the international agencies have already determined that the economic value of reducing degradation and restoring degraded areas is greater than the cost of achieving those goals.

The Ecological Restoration Program is one of the efforts being implemented to achieve the larger set of national goals regarding grasslands, rangelands, and rural livelihoods. Hence, the true value of the SFA/TDA/Valmont Demonstration Project will be determined, in part, by the success of the larger, national program, particularly as that program is implemented within Zhenglan Banner. The economic value of producing forage crops and nursery trees in support of restoration efforts and to generate alternative rural livelihoods likely will exceed the financial value of the crops and trees. Hence, a positive economic value may be observed even if the financial net return is not positive.

It will not be possible, within the scope of the SFA/TDA/Valmont Demonstration Project, to estimate the larger set of economic values associated with national program goals. However, as noted above, several international agencies have already evaluated the costs and benefits of large-scale projects that address land degradation and poverty in northern China (e.g., ADB, 2002; World Bank, 1999). Economic analysis within the context of the SFA/TDA/Valmont Project likely should be focused on enhancing two probabilities:

- The probability that the center pivot system is operated appropriately, and
- The probability that goals of the larger Ecological Restoration Program (within Zhenglan Banner) are achieved.

Both probabilities can be enhanced by ensuring that households involved with the SFA/TDA/Valmont Demonstration Project have incentive to maximize the values generated through use of the mechanical irrigation system and to maintain the system over time. That incentive can be provided if prevailing policies and institutions reward household efforts to maximize production values from the irrigated land, and to thereby protect the grasslands and rangelands that are outside the area irrigated with the center pivot.

5.2.1 Economic Analysis in the Feasibility Report

The economic analysis we conduct for the Feasibility Report will include four components:

1) We will examine the costs and returns associated with installation, operation, and maintenance of the center pivot system in Zhenglan Banner,

2) We will examine the costs and returns associated with the crop and livestock production that occurs on land irrigated with the center pivot system,

3) We will examine the impact of the Demonstration Project on household incomes and livelihoods in the village associated with the Demonstration Project, and

4) We will examine how improvements in policies and institutions regarding crop production, livestock management, and rangeland access might enhance the net benefits generated by the center pivot system.

Component 1: Center Pivot Costs and Returns

We will collect information describing both the fixed and variable costs of installing, operating, and maintaining the center pivot system at the Demonstration Site. Fixed costs will include the initial costs of equipment and components, the costs of drilling and installing irrigation wells, and any site preparation costs associated with installing the center pivot system. Variable costs will include the energy required to obtain groundwater and to operate the center pivot system.

The variable costs of operating and maintaining the center pivot system include the costs of labor and energy costs of pumping water, operating the center pivot, performing maintenance tasks, and making repairs throughout the year. We will need assistance from local officials to ensure that these data are collected as they are generated, given that we will have limited time in the region to collect detailed data, following the irrigation season.

Component 2: Crop and Livestock Costs and Returns

To the extent possible, we will collect information describing the fixed and variable costs of producing crops and livestock under the center pivot system. Fixed costs include the costs of equipment, buildings, and land preparation. Variable costs of forage production include the costs of seeds, fertilizer, chemicals, cultivation, irrigation, and harvest. The variable costs of livestock production include the costs of feed and other inputs that vary with the level of production. We will need substantial assistance from local officials in obtaining this information during and after the irrigation season.

To the extent possible, we will estimate the returns to crop and livestock production using price and yield information we are able to obtain from households and local officials. This task will may be somewhat challenging, given that we are not yet aware of how production will be organized at the Demonstration Site. In particular, we are not yet aware of how the local government will allocate grazing area beneath the center pivot, or how forage production will be allocated among households in the village. In addition, we are not yet aware of how the dairy cows will be allocated or managed, or how the dairy products will be marketed. The quality of our economic analysis will depend substantially on the assistance we receive from local officials and households in providing detailed data describing costs and returns.

We understand that a portion of the area beneath the center pivot will be used to produce trees for planting in the local area to reduce the spread of desertification. We will examine and compile any information regarding the costs of production that are provided to us by local officials. Pertinent costs include the costs of land preparation, seedlings, fertilizer, chemicals, labor, cultivation, and harvest. The value of the trees likely will not be determined in market transactions. Hence, we likely will not have access to meaningful price information for the trees. However, we will compile and report any yield information we receive from local officials.

Component 3: Impacts on Household Incomes and Livelihoods

To the extent possible, we will collect information from households describing the impacts of the Demonstration Project on their incomes and livelihoods. It is possible that the project will enhance household incomes by providing irrigated forage that will support the management of dairy cows for milk production. However, we are not yet aware of how the forage or the cows will be distributed among households, and we are not yet knowledgeable regarding the ability of household members to perform the necessary management tasks. It is possible that the short-term impacts on household incomes may be quite small.

The normal procedure for estimating impacts on household incomes and livelihoods is to perform a before-and-after analysis that describes how incomes and livelihoods have changed with implementation of a specific project. In this case, however, we understand that the households that will benefit from the SFA/TDA/Valmont Demonstration Project have not yet moved into their new Ecological Migration Village. Hence, it is not possible to conduct a valid before-and-after analysis. We will visit with selected households in the region during our visit to the project area in March of 2003. However, it is not yet clear if the information provided by those households will apply directly to the households involved in the Demonstration Project.

Component 4: The Role of Policies and Institutions

As noted earlier in this Inception Report, policies and institutions play a very important role in determining how households conduct their production and marketing activities in rural areas. The current condition of rangeland and grassland areas in Inner Mongolia has resulted, in large part, from policies and institutional arrangements that have not motivated individuals to protect those areas. The goal of removing large numbers of sheep and goats from the open access rangelands of Inner Mongolia is appropriate, in order to restore those lands and reduce the severity of sandstorms generated in the region. We appreciate the goal of providing households with an alternative source of income by constructing new villages and encouraging them to produce irrigated crops that can be fed to livestock raised in confined environments. However, that goal alone, may not be sufficient to achieve the desired reduction in grazing of open access areas, or to provide sufficient, alternative income to all residents of the region.

To the extent possible, we will work with information provided by local officials to assist them in determining the changes in policies and institutions that may be helpful in achieving their ultimate goals of reducing the spread of desertification and improving livelihoods in rural areas.

5.2.2 Expectations Regarding the Economic Analysis

We anticipate great challenges in collecting the detailed information required to conduct high-quality analysis of the costs and returns to irrigated crop and livestock production, and to evaluate carefully the impact of the SFA/TDA/Valmont Demonstration Project on household incomes and livelihoods. The SFA/TDA/Valmont Demonstration Project is being implemented in fairly rapid fashion, in a region where historical information regarding economic variables is largely unavailable. The households that are likely to be impacted by the SFA/TDA/Valmont Demonstration Project are not yet in place, and the plans for allocating inputs and outputs

associated with the project have not yet been described to us. We have very limited time and resources for collecting original data during the growing season. Hence, we will be relying primarily on data provided by households and local officials, at the end of the growing season. Data constraints likely will have a large impact on the quality of our economic analysis.

It is likely that a detailed economic analysis of the SFA/TDA/Valmont Demonstration Project will show that the costs of producing crops, trees, and livestock products exceed the returns, if all pertinent costs are compared with the market value of the products. However, there is a non-market, public goods value in demonstrating the potential to reduce the spread of desertification and improve rural livelihoods by implementing this Demonstration Project. Hence, in one sense, it is not necessary that this Demonstration Project generate a positive economic impact based only on the costs and returns from irrigated production crops and livestock products. However, it is important to estimate the costs and benefits accurately, even if the net effect is negative, so that the Government of China and the Banner Administration can compare that result with the expected net benefits of other methods that might be implemented to achieve the same goals.

6.0 SITE SELECTION

The site of the demonstration has already been established as being in Zhenglan Banner in the Autonomous Region of Inner Mongolia. The proposed site is less than two kilometers north of Zhenglan (Xulun Hoh Dund Hot). The selected site is adjacent to the site of a planned Ecological Relocation Village. The exact location of the irrigation works, the well locations, the power service and other ancillary needs will be determined during the feasibility study. A secondary site is available in the event that the primary site is determined to be unacceptable in the course of the feasibility study.

7.0 WORK PLAN

7.1 Schedule

The revised schedule is as shown in Appendix I. This schedule has been modified significantly from that which was provided in the original proposal. These changes were necessitated by the need to establish the selected forage crop on the demonstration site during the 2003 crop year.

7.2 Objectives and Critical Success Factors

The objective of this project is to demonstrate how irrigated agriculture can be used to support forage crop production and livestock management in Zhenglan Banner. The larger goal of the Banner Administration is to reduce the number of animals grazing on open access rangelands and grasslands by constructing Ecological Migration Villages and providing residents with an alternative livelihood. That project involves many aspects that are beyond the scope of this Demonstration Project. As described throughout this Inception Report, we will work with local officials to help them gain information and insight regarding their larger project objectives. However, it is helpful to note that the primary focus of this Demonstration Project is limited to

installing and demonstrating the potential effectiveness of a center pivot irrigation system in the Zhenglan Banner.

To achieve that goal, the primary focus of the Feasibility Study and subsequent Demonstration Project will be the following:

- We will describe and evaluate optimal irrigated and rain fed forage production and management systems.
- We will evaluate the adequacy of infrastructure and natural resource inputs at the Demonstration Site, with special emphasis on the availability and suitability of groundwater.
- We will evaluate the costs and returns associated with installing, operating, and maintaining the center pivot system.
- We will evaluate the costs and returns associated with the crop and livestock production activities supported by the center pivot system.
- We will evaluate the impacts on household incomes and livelihoods.
- We will examine how improvements in policies and institutions regarding crop production, livestock management, and rangeland access might enhance the net benefits generated with the center pivot system.

8.0 RESPONSIBILITIES OF EACH PARTICIPANT

8.1 Valmont

Valmont Industries proposes activities consistent with the Terms of Reference as outlined in Annex I of the contract agreement. In brief this includes this Inception Report, the screening of intensification methods, and the production of a Feasibility Report. Following the Feasibility Report, an Implementation Plan will be provided for the installation and demonstration of the selected method for intensification of agricultural activities through the use of irrigated agriculture. These activities will be as described in the original Terms of Reference, with the exception of the timeline, which has been modified to reflect the expedited schedule shown in Appendix I. The demonstration phase of the project specifies that Valmont will provide the labor and technology for the operation of the Valley center pivot equipment through the first crop year.

8.2 State Forestry Administration

The National Bureau to Combat Desertification, State Forestry Administration of the People's Republic of China proposes activities consistent with the Terms of Reference (Annex I) of the Contract for Desertification Prevention Project in China. In summary these responsibilities

provide for access to national experts, relevant information, and government officials as necessary to facilitate the completion of the scope as described in the TOR. The contract also provides for facilitation and timely granting of visas, licenses, permits customs clearance and other privileges as listed. The cost detail attached to the agreement also specifies that in-country travel will be provided by the SFA.

8.3 Local Authorities

The role of the local authorities in the success of this demonstration project cannot be over emphasized. The local-level implementation of national policy in China is very different from that in the United States. Much greater authority and latitude are given to the Provincial (League) and County (Banner) officials in the implementation of national policy. Consequently it is critical that the local officials provide full support to the demonstration project. Local officials must provide the same level of support to this effort as the contract prescribes for the SFA at the national level.

Present plans provide for the construction of the demonstration irrigation facility at the site of a new Ecological Migration Village. The timely completion of this village and the staffing, planting, and harvesting of the necessary forage crops by the local officials is critical to the assessment of the demonstration phase of this project. Valmont will be responsible for the operation of the irrigation equipment including irrigation scheduling through the first crop year. All other production activities such as planting, tillage, weed control, fertilization and harvesting activities will be the responsibility of and under the control of the local authorities in Zhenglan Banner.

8.4 USTDA

The obligations of The United States Trade and Development Agency are as defined in the signed contracts between the USTDA and Valmont Industries and the National Bureau to Combat Desertification, State Forestry Administration of the People's Republic of China.

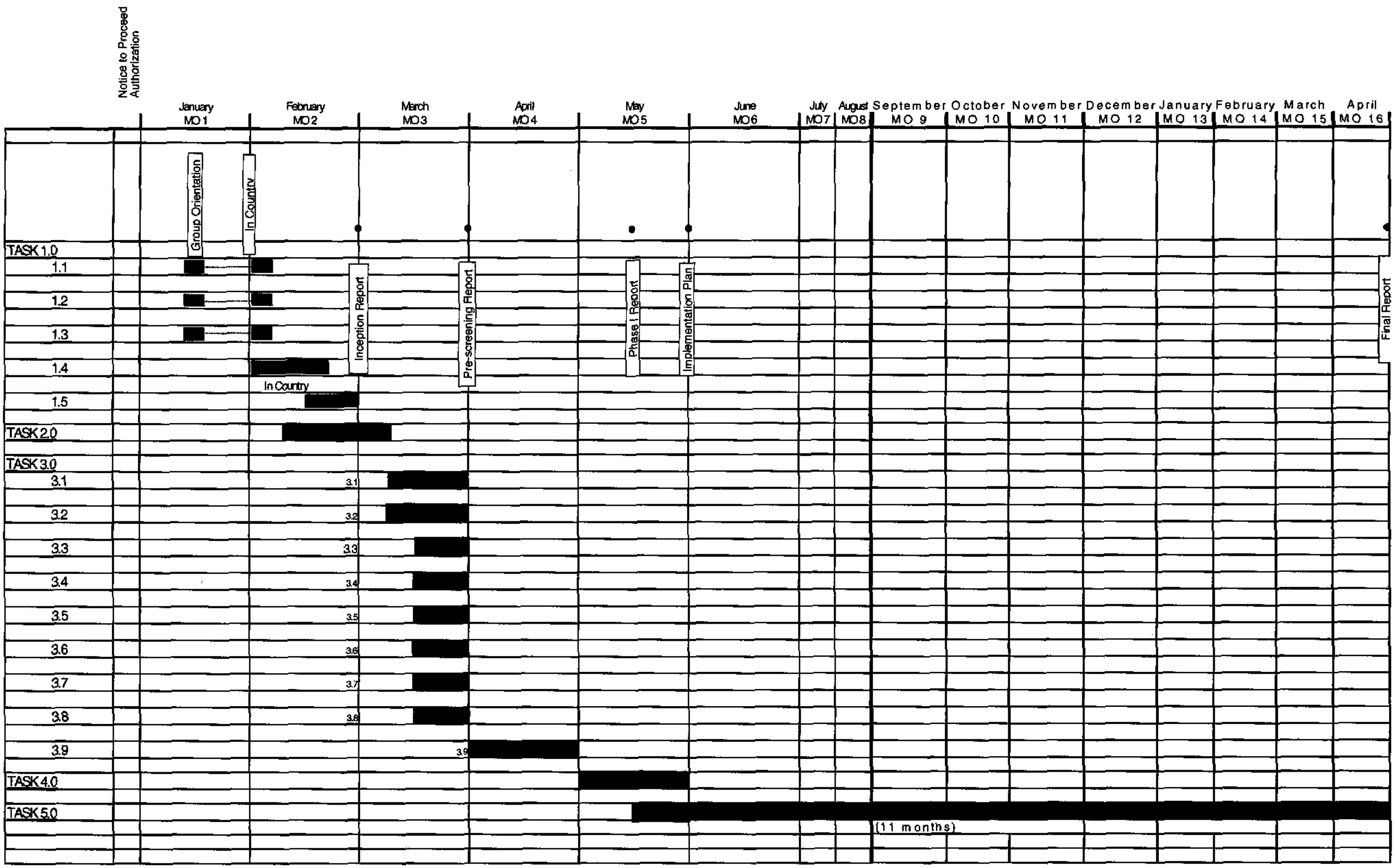
9.0 FEASIBILITY REPORT OUTLINE

The Feasibility Report outline is attached as Appendix II. The Feasibility Report will be delivered by Valmont as a draft for review to the National Bureau to Combat Desertification, State Forestry Administration, at least 10 days prior to the publication of the final document. The draft and subsequent comments will be delivered to the address of record as defined in the Contract for Desertification Prevention Project in China.

Appendix I

CONTRACT FOR CONTROL OF DESERTIFICATION AND DUST STORMS IN CHINA

TIMELINE BY TASK



Appendix II

Feasibility Report

Executive Summary

1.0 Introduction
- 1.1 Purpose Statement
- 1.2 Basis of Data
  - 1.2.1 Interviews
  - 1.2.2 Site Visits
  - 1.2.3 Literature

2.0 Grazing and Livestock Production
- 2.1 Livestock Densities
  - 2.1.1 Rain Fed Agriculture
  - 2.1.2 Irrigated Agriculture
- 2.2 Impact of Water Quality on Livestock Production
- 2.3 Grasslands Utilization Opportunities
  - 2.3.1 Grazing
  - 2.3.2 Dry Forage (Hay) Production
- 2.4 Recommendations for Optimum Grazing and Livestock Production

3.0 Irrigated Forage Production
- 3.1 Forage Viability
- 3.2 Water Requirements
- 3.3 Forage Yield, Quality and Persistence
- 3.4 Management Suitability
- 3.5 Recommendations for Optimum Irrigated Forage Production

4.0 Water Quality and Quantity Impacts
- 4.1 Recharge Potential
- 4.2 Groundwater Quality
- 4.3 Withdrawal Impacts
- 4.4 Well Design
- 4.5 Recommendations for Assuring Water Quality and Quantity

5.0 Engineering Feasibility of Irrigated Forage Production
- 5.1 Engineering and Design
- 5.2 Constructability
- 5.3 Operability
- 5.4 Maintenance Requirements
- 5.5 Long Term Adaptability
- 5.6 Regional Agro-Economic Applicability
- 5.7 Recommendations for Optimal Engineering Suitability

6.0 Project Socioeconomic Impacts
- 6.1 Economic Impacts (Cost Analysis of Project)
  - 6.1.1 Historic Agricultural Economics
  - 6.1.2 Implications of Current Agricultural Economics
  - 6.1.3 Economic Changes Based on Irrigated Agriculture
  - 6.1.4 Implementation Financing
  - 6.1.5 Recommendations for Supportive Policies and Institutions
- 6.2 Sociological Impact
  - 6.2.1 Background and History of Migrating Families
  - 6.2.2 Impacts of Group Identity (Social Geometry)
  - 6.2.3 Household Social Viability
  - 6.2.4 Recommended Options for Management of Irrigated Production

7.0 Environmental and Ecological Feasibility
- 7.1 Impacts on Human Health
- 7.2 Positive Impacts to Ecosystems
- 7.3 Negative Ecosystem Impacts to be Mitigated
- 7.4 Endangered Species Impacts
- 7.5 Required Mitigation to Protect Human Health and the Environment

8.0 Project Feasibility Summary
- 8.1 Engineering Feasibility
- 8.2 Economic Feasibility
- 8.3 Ecological Feasibility
  - 8.3.1 Water Supply
  - 8.3.2 Terrestrial Ecosystem Impacts
- 8.4 Sociological Feasibility

References
Tables
Figures
Appendices

March 18, 2003

Mr. Mark J. Dunn
Country Manager, Asia
U.S. Trade & Development Agency
1000 Wilson Blvd. Suite 1600
Arlington, VA. 22209-3901

SUBJECT: China Desertification Project
Appropriation No.: 112/31001
Activity No.: 02-30018B
Grant No.: GH2381659
Reservation No.: 2381659

Dear Mr. Dunn:

We have completed our review of the attached Inception Report and find its contents and scope in compliance with the requirements of the USTDA Desertification Prevention Project, Appropriation No.112/31001, Activity No. 02-30018B, Grant No. GH2381659, and Reservation No.2381659 dated February 25, 2003.

Our acceptance of this document is indicated by our signature below. Thank you very much for your continued support in our effort to control sandstorms and desertification in China.

Sincerely,

Mr. Liu Tuo, Sr. Engineer
Director General
National Bureau to Combat Desertification, State Forestry Administration, PRC

Enc: Inception Report
PN: 2223044
Doc: 2223044 SFA Letter Task Approval

INCEPTION STUDY WORKSHOPS

A pair of informal workshops were held in an effort to facilitate a clear understanding of the project on the part of the Valmont project team, the State Forestry Administration, and the Local Zhenglan Qi Banner public officials and Forestry Administration staff. These workshops occurred during the project team's first visit to the site, which occurred between January 8th and 19th of 2003. These workshops were generally described in the Terms of Reference (Annex I). The content and scope of the workshops were modified as necessary to facilitate further understanding and refinement of the project by the Valmont Project Team. Each Workshop is described below. Comments are summarized for brevity. Attendees are listed individually by workshop.

PROJECT SITE WORKSHOP

Zhenglan Qi Municipal offices, 10:00 AM January 14th, 2003

The informal agenda involved introductions of the project team and key municipal officials. Following introductions, the Valmont Project Team provided a summary of their goals and what they had learned from the site visit to date. They also reviewed the principles behind dramatic increases in forage production with irrigation and modern production methods. The local Forestry Officials then provided a summary of their efforts to control desertification through the development of Ecological Migration Villages, and discussed the timeline for the development of the Village that would provide a setting for the proposed demonstration.

Summary of Key Findings:

1) Ecological Migration Villages were the primary means they intended to use for the control of desertification.
2) Ecological Migration Villages were focused on the production of dairy products.
3) Australian dairy stock had already been purchased and was expected to arrive shortly.
4) All options that were to be considered by the team needed to be focused on providing forage for the anticipated livestock during the 2003 growing season.
5) Forage production and preservation principles did not seem to be well understood by those who were managing the project.
6) Discussions indicated that the desired forage production levels were at or near the maximum that could be produced in the proposed demonstration. The relationship between nutrient needs, forage production levels, and livestock numbers was not well understood by the Ecological Migration Village Designers.

ATTENDEES AT ZHENGLAN QI WORKSHOP

Fred E. Bickford, MS, CPG
26 Winter Street
Ashland, NH 03217
(603) 968-3733
fbickford@teamhydrosource.com

Dr. David Hannaway
Department of Crop and Soil Science
Oregon State University
Corvallis, OR 97331-3002
(541) 737-5863
david.hannaway@oregonstate.edu

David Odell
Cascade Earth Sciences
2417 Bank Drive, Suite 101
Boise, ID 83705
(208) 388-1030
davido@cascade-earth.com

Terry Rahe, CPSS
Cascade Earth Sciences
3511 Pacific Blvd. SW
Albany, OR 97321
(541) 812-6612
terryr@cascade-earth.com

Dr. Larry Rittenhouse
817 Scenic Drive
Fort Collins, CO 80526
(970) 226-0218
lrittenhouse@msn.com

Greg Thurman, PE
Cascade Earth Sciences
107 Island Avenue
La Grande, OR 97850
(541) 963-7758
gregt@cascade-earth.com

Dr. Dennis Wichelns
Department of Agricultural Economics
California State University at Fresno
5245 N. Backer Ave., M/S PB101
Fresno, CA 93740-8001
(559) 278-4629
dwichelns@csufresno.edu

Dr. John Young
1141 N.W. Charlemagne Place
Corvallis, OR 97330
(541) 737-4515
jyoung@oregonstate.edu

Mr. Si
Banner Party Leader
Forestry Administration
Zhenglan Qi
Inner Mongolia Autonomous Region
People's Republic of China
86-479-4226777

Mr. Shi
Assistant Banner Leader
Forestry Administration
Zhenglan Qi
Inner Mongolia Autonomous Region
People's Republic of China
86-479-4226777

Mr. Ai Bao-sheng
Director of Zhan Lanqi Forestry
Forestry Administration
Zhenglan Qi
Inner Mongolia Autonomous Region
People's Republic of China
86-479-4226777

Mr. Ma
Assistant Director
Forestry Administration
Zhenglan Qi
Inner Mongolia Autonomous Region
People's Republic of China
86-479-4226777

Mr. Shu
Assistant Director
Forestry Administration
Zhenglan Qi
Inner Mongolia Autonomous Region
People's Republic of China
86-479-4226777

Lu Xinshi
Professor, Forage and Range Science
Natural Resources and Environment College
Beijing Forestry University
Box 116
35, Qinhua East Street
Beijing, China 100083
010-62337834

Han Ling (Interpreter)
Department of Environmental Science
Beijing University

STATE FORESTRY ADMINISTRATION WORKSHOP
SFA Conference Room 2, 18 Hepingli Dongjie, Beijing, PRC

The informal agenda followed the lead of Mr. Luo Tuo, Director General. He initiated the meeting by explaining the relationship of the State Forestry Administration, the China National Committee for the Implementation of UN Convention to Combat Desertification (CCICCD), and the National Bureau to Combat Desertification. The Valmont Project Team then reviewed the information gathered during our site visit. Considerable discussion followed regarding the best methods to be used in the conduct of the demonstration project.

Summary of Key Points:

1) The Zhenglan Qi Banner Officials were to be the final authority in the design and implementation of the demonstration project from the Chinese side.
2) Dr. Lu, special consultant to the NBCD from China Forestry University, presented strong arguments that field trials needed to be conducted prior to selection of a forage crop for the demonstration.
3) Several of the NBCD staff concurred that the nomadic herdsmen knew little about irrigated forage production and forage preservation because of their historic reliance on open grazing.
4) The NBCD staff committed fully to support the project implementation and again reiterated the need for rapid implementation of the demonstration.
5) The Valmont Project Team pledged to move forward with the demonstration project as soon as possible.

ATTENDEES AT BEIJING WORKSHOP

Fred E. Bickford, MS, CPG
26 Winter Street
Ashland, NH 03217
(603) 968-3733
fbickford@teamhydrosource.com

Dr. David Hannaway
Department of Crop and Soil Science
Oregon State University
Corvallis, OR 97331-3002
(541) 737-5863
david.hannaway@oregonstate.edu

David Odell
Cascade Earth Sciences
2417 Bank Drive, Suite 101
Boise, ID 83705
(208) 388-1030
davido@cascade-earth.com

Terry Rahe, CPSS
Cascade Earth Sciences
3511 Pacific Blvd. SW
Albany, OR 97321
(541) 812-6612
terryr@cascade-earth.com

Dr. Larry Rittenhouse
817 Scenic Drive
Fort Collins, CO 80526
(970) 226-0218
lrittenhouse@msn.com

Greg Thurman, PE
Cascade Earth Sciences
107 Island Avenue
La Grande, OR 97850
(541) 963-7758
gregt@cascade-earth.com

Dr. Dennis Wichelns
Department of Agricultural Economics
California State University at Fresno
5245 N. Backer Ave., M/S PB101
Fresno, CA 93740-8001
(559) 278-4629
dwichelns@csufresno.edu

Dr. John Young
1141 N.W. Charlemagne Place
Corvallis, OR 97330
(541) 737-4515
jyoung@oregonstate.edu

Liu Tuo
Director General
National Bureau to Combat Desertification
State Forestry Administration
No. 18 Hepingli Dongjie Street
Beijing 100714
People's Republic of China
86-10-84238827

Wu Zhongze
Secretariat of CCICCD
State Forestry Administration
No. 18 Hepingli Dongjie Street
Beijing 100714
People's Republic of China
86-10-84238831

Luo Bin
Deputy Director General
State Forestry Administration
No. 18 Hepingli Dongjie Street
Beijing 100714
People's Republic of China
86-10-84238830

Jia Xiaoxia
Division Director
State Forestry Administration
No. 18 Hepingli Dongjie Street
Beijing 100714
People's Republic of China
86-10-84238831

Professor Zhang Ke Bin
Beijing Forestry University
College of Soil & Water Conservation
Box 116
35, Qinhua East Street
Beijing, China 100083
010-62337834

Xiaolei Wan
TDA Project Coordinator
U.S. & Foreign Commercial Service
U.S. Embassy Beijing
31st Floor, N. Tower, Beijing Kerry Center
Beijing, China 100020

Han Ling (Interpreter)
Department of Environmental Science
Beijing University

Lu Xinshi
Professor, Forage and Range Science
Natural Resources and Environment College
Beijing Forestry University
Box 116
35, Qinhua East Street
Beijing, China 100083
010-62337834

valmont WATER MANAGEMENT GROUP

FEASIBILITY REPORT
Demonstration Project For The Control of Sandstorms and Desertification In Areas Surrounding Beijing Using Irrigated Agriculture

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Principal Authors:

Mr. Terry Rahe – Valmont Water Management Group
Mr. Fred Bickford - Hydrosource
Dr. David Hannaway – Oregon State University
Dr. Lu Xinshi – PRC State Forestry Administration
Dr. Larry Rittenhouse – Colorado State University
Mr. Greg Thurman – Valmont Water Management Group
Dr. Dennis Wichelns – California State University Fresno
Mr. Wu Zhongze – PRC State Forestry Administration
Dr. John Young – Oregon State University

Prepared For:

USTDA
1000 Wilson Boulevard
Suite 1600
Arlington, VA 22209-3901

Prepared By:

Valmont Water Management Group
7150 Supra Drive
Albany, OR 97321
(541) 926-7737

PN: 2223044/July 2003

Client Approval

We have thoroughly reviewed the report titled "Feasibility Report – Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing Using Irrigated Agriculture" and feel that it fairly represents the observations and findings of this phase of the study, and that it is as described in the Contract for Desertification Prevention project in China, USTDA Grant No.: GH 2381659.

"The services for which disbursement is requested by the Contractor have been performed satisfactorily, in accordance with applicable Contract provisions and the terms and conditions of the TDA Grant Agreement."

Signature ____________________ Date 8-22-2003

Mr. Liu Tuo
Director General
National Bureau to Combat Desertification

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1
1.0 PROJECT DESCRIPTION 2
1.1 Introduction 2
1.2 Background 2
1.3 Purpose and Scope 3
1.4 Assessment Approach 4
2.0 ENGINEERING DESIGN 4
2.1 Short-Term Requirements 4
2.2 Assessment Summary 5
2.3 Long-Term Issues 5
3.0 WATER RESOURCES 6
3.1 Short-Term Requirements 6
3.2 Assessment Summary 6
3.2.1 Groundwater Yield 6
3.2.2 Groundwater Quality 7
3.2.3 Surrounding User Impacts 7
3.3 Long-Term Issues 8
3.3.1 Adequacy of Recharge 8
3.3.2 Well Construction Limitations 10
3.3.3 Resource Competition 10
3.3.4 Water Quality Impacts 11
4.0 SOIL RESOURCES 12
4.1 Short-Term Requirements 12
4.2 Assessment Summary 12
4.3 Long-Term Issues 12
4.3.1 Wind Erosion 12
4.3.2 Soil Fertility 13
4.3.3 Soil Salinity and Structure 13
5.0 IRRIGATION AND CROP PRODUCTION 13
5.1 Short-Term Requirements 13
5.2 Assessment Summary 14
5.2.1 Production Demand 14
5.2.2 Silage Production 16
5.2.3 Crop Survivability 16
5.2.4 Crop Water Demand 17
5.3 Long-Term Issues 19
5.3.1 Seed Availability 19
5.3.2 Forage Production Training 19
5.3.3 Augmenting Forage Production From Grasslands 20
6.0 LIVESTOCK MANAGEMENT 20
6.1 Short-Term Requirements 20
6.2 Assessment Summary 21
6.3 Long-Term Issues 21
7.0 SOCIAL STRUCTURE 22
7.1 Short-Term Requirements 22

TABLE OF CONTENTS (continued)

7.2 Assessment Summary 22
7.2.1 Social Cohesion 22
7.2.2 Consultation and Participation 23
7.2.3 Compensation and Livelihoods 23
7.2.4 Infrastructure and Social Services 24
7.3 Long-Term Issues 25
7.3.1 Equity and Conflict Resolution 25
7.3.2 Employment and Gender Roles 25
7.3.3 Cultural Preservation and Ethnic Identity 26
7.3.4 Wealth Distribution and Community Viability 26
8.0 ECONOMICS AND POLICY 27
8.1 Short-Term Requirements 27
8.2 Assessment Summary 27
8.2.1 Fixed Costs 27
8.2.2 Variable Costs 27
8.3 Long-Term Issues 28
8.3.1 Financial vs. Economic Feasibility 28
8.3.2 Financial Feasibility 28
8.3.3 Economic Feasibility 29
8.3.4 Economic Analysis 29
8.3.5 Economic Policy Recommendations 31
8.3.6 Summary of Economics 32
9.0 ENVIRONMENTAL AND ECOLOGICAL CONCERNS 32
9.1 Impacts on Human Health 32
9.1.1 Air 32
9.1.2 Water 33
9.1.3 Land 34
9.2 Impacts to Ecological Systems 35
9.2.1 Plant Communities 35
9.2.2 Animal Communities 35
10.0 CONCLUSIONS AND RECOMMENDATIONS 36
REFERENCES 38

TABLE OF CONTENTS (continued)

APPENDICES

Appendix A. Grazing Intensification Methods Pre-Screening
Appendix B. Project Design Plans

General Drawings:

G-1 Site Map and Index of Drawings
G-2 Site Location Plan – Zhenglan Banner Map
G-3 Site Location Plan – Topographic Area Map
G-4 Site Location Plan – Grassland Condition Area Map
G-5 Site Location Plan – Soil Survey Area Map
G-6 Standard Civil Symbols and Thrust Blocks
G-7 Standard Mechanical Symbols

Center Pivot Drawings:

C-1 Center Pivot Site Layout
C-2 Process Flow Diagram
C-3 Pivot Point Layout
C-4 Pipeline Routing Plan
C-5 Water Delivery System Mechanical
C-6 Site Improvement Details
C-7 Site Electrical Layout
C-8 Center Pivot Layout Alternative

EXECUTIVE SUMMARY

Valmont Industries, in cooperation with the People's Republic of China State Forestry Administration (SFA) and the United States Trade Development Agency (USTDA), has completed a feasibility assessment of the Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing Using Irrigated Agriculture. Issues regarding the selection of alternatives have been incorporated into the text of this report, and are detailed in the Grazing Intensification Methods Pre-Screening document attached as Appendix A. This Feasibility Study represents the findings and conclusions regarding the feasibility of implementing an intensely managed, irrigated agriculture site for the production of forage crops to be used by families relocated to an Ecological Migration Village located in Zhenglan Banner, Inner Mongolia, China.

The project itself involves the installation and operation of a 75-hectare (ha) center pivot at a project site located near the capital of the Zhenglan Banner. This pivot will be used for the production of forage in support of an Ecological Migration Village to be constructed near the site and settled with herding families relocated from highly degraded grassland. With support from the Banner Administration, the herding families will transition from open-range grazing into fixed-location dairy operations and associated industries as their primary means of livelihood. The goal of this program is to reduce or eliminate grazing pressures to the degree that would allow the rehabilitation of the degraded grasslands. In addition, this program would help alleviate the poverty experienced by the herding families attempting to live in these areas.

The results of this study are based upon the research conducted by the associates of the project team, specializing in the areas of engineering, groundwater, forage production, livestock management, sociology and economics. Based on the results of this assessment, this Demonstration Project appears feasible in all of these areas and is expected to provide an overall benefit to a number of environmental and ecological issues faced by the region. The project will, however, very likely suffer from reduced forage availability associated with first-year production, due, in part, to the lack of appropriate silage production technology. These logistical risks can be mitigated by the stockpiling of sufficient feedstock for the 2003 winter season. Given the high level of support offered by the private and government partners in this project, the limitations associated with the project are judged to be of little consequence to the short-term viability of this strategy. Considering the positive impacts that this project is expected to have on the area, the Demonstration Project should proceed as planned.

While no significant detriments associated with the short-term implementation of the Demonstration Project were discovered, this assessment has identified a number of issues that need to be addressed to help ensure the long-term sustainability and replicability of the program. The majority of these issues are associated with training and education, technology access, long-term water resource sustainability, and economic and social policy. Given the national importance of finding a solution for the control of desertification and dust storms and the local importance of a successful Ecological Migration Village Program, these potential obstacles can be overcome with cooperation, diligent study and the implementation of appropriate policy.

1.0 PROJECT DESCRIPTION

1.1 Introduction

Valmont Industries, in cooperation with the People's Republic of China State Forestry Administration (SFA) and the United States Trade Development Agency (USTDA), has completed a feasibility assessment of the Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing Using Irrigated Agriculture. Issues regarding the selection of alternatives have been incorporated into the text of this report. This document represents the findings and conclusions regarding the feasibility of implementing an intensely managed, irrigated agriculture site for the production of forage crops to be used by families relocated to an Ecological Migration Village in Zhenglan Banner, Inner Mongolia, China. Specifically, this report constitutes the detailed technical analysis of the proposed project implementation and the technical, environmental, social and economic feasibility of the overall project, as described in the Terms of Reference agreement dated July 5, 2002.

1.2 Background

Inner Mongolia, a large, autonomous region located in northern People's Republic of China (PRC), is composed of vast, open grasslands historically used for livestock production in a common access range society. The region has undergone a number of social, economic, and ecological changes in recent times that have resulted in significant losses of rangeland productivity and vegetative cover. These environmental changes have left the grasslands highly susceptible to wind erosion and increasingly frequent and intense sandstorms that have resulted in excessive biomass reduction and desertification. Given the PRC's concern over the alarming rate at which the rangeland has been degraded and its impact on environmental, social and economic issues, the PRC central government has undertaken to combat sandstorms and desertification using a number of techniques and approaches.

One strategy the PRC hopes will have a dramatic effect in sandstorm and desertification reduction is the overall reduction in grassland grazing pressure. Under this approach, the grazing animal population is being reduced to allow the grassland vegetation it uses to recover and propagate under various rehabilitation programs (e.g., reforestation, rangeland seeding, the creation of grassland management areas, allowing for natural recovery, etc.). For this strategy to be successful, however, the PRC must find suitable incentives for the herding families to leave the grasslands and reduce/eliminate their dependence on grazing as their primary livelihood.

In 2002, Valmont Industries, the People's Republic of China State Forestry Administration (SFA), and the United States Trade Development Agency (USTDA) formed a partnership to assess the feasibility of controlling sandstorms and desertification through the use of intensively managed agriculture. The primary focus of this project centers on the reduction/elimination of natural grassland grazing pressure by providing an alternative income-generating livelihood for local herding families. These herding families will be relocated to Ecological Migration Villages that rely on center pivot irrigation technology to produce forage in support of alternate livestock production operations.

1.3 Purpose and Scope

The goal of this report is to examine the feasibility of controlling sandstorms and desertification in Zhenglan Banner by reducing pressure on native grasslands and by providing an alternative livelihood for herding families who presently raise large numbers of sheep, goats, and cattle in the region. Specifically, this project was designed to examine the feasibility of using a center pivot irrigation system to grow forage crops in support of dairy cow operations at a new Ecological Migration Village located near the capital of Zhenglan Banner in the Xilingol League of Inner Mongolia. An evaluation of alternatives is contained in Appendix A, titled "Grazing Intensification Methods Pre-Screening." Herding families moving to the new village are expected to sell the majority of their sheep, goats, and beef cows and use the income as capital in the new dairy operations to be operated at the village level. Their new livelihood will be from milk production for sale in local markets or to a local milk processing facility. The center pivot irrigation system will be used for intense forage production in support of the dairy operations and will reduce or eliminate the reliance on the native grassland.

The program of establishing Ecological Migration Villages to manage grasslands and to provide alternative residences and livelihoods for herding families involves many issues regarding agronomy, animal husbandry, engineering, soil and water resources, human capital, economics, social structure, and government policies. This feasibility report examines both the short-term feasibility (2003 crop year) and the longer-term feasibility of this management strategy. While the primary focus of this project is on the role of the center pivot irrigation system in producing forage crops, it is necessary to examine other components of the program, including management of the irrigation system, forage crop production, and crop allocation. It is important to note that the ultimate goal of reducing pressure on native grasslands is contingent upon the dairy cow operation providing sufficient motivation for herding families to permanently refrain from grazing animals on the grasslands.

This feasibility study evaluates the technical, economic, and social conditions that must be present or produced during project implementation to ensure that herding families are sufficiently motivated to abandon traditional open-range grazing and remain off the grassland. During the study, operational issues such as water resources, the appropriateness of the technology, market dynamics, and village social structures were reviewed and assessed. Other very important issues, such as the economic viability or sustainability of the Ecological Migration Program and a detailed economic analysis of using center pivot irrigation systems to produce forage crops, were beyond the scope of this assessment. Recommendations, however, have been provided regarding how these topics or concerns might be addressed in further work.

This report was prepared based on the results of two trips to Beijing and Inner Mongolia for the purpose of collecting project information and discussing project design issues with representatives of the SFA and officials in Zhenglan Banner. During that time, project team members were able to visit with members of households in a nearby Ecological Migration Village and with herding families who will be moving to a new demonstration Village in the near future. Considerable insight was obtained from academic and agency literature reviews and during many discussions with officials and technicians in the Banner Administration and SFA regarding efforts to reduce pressure on the native grasslands in northern China.

1.4 Assessment Approach

The feasibility of implementing the proposed project was evaluated for eight critical components, including:

- Engineering Design
- Water Resources
- Soil Resources
- Irrigation and Crop Production
- Livestock Management
- Social Structure
- Economics and Policy
- Environmental and Ecological Concerns

Each topic was reviewed from a short-term perspective to determine if the minimum conditions are currently in place to facilitate the use of a center pivot irrigation system to produce irrigated forage crops in support of dairy cow production. Where appropriate, the long-term feasibility of these components in relation to the overall Ecological Migration Village Program was evaluated to identify potential concerns that could affect the sustainability and replicability of this project.

2.0 ENGINEERING DESIGN

2.1 Short-Term Requirements

The purpose of the center pivot system is to provide timely and efficient use of irrigation water to meet the water demand of growing crops. Under this scenario, the pivot system is critical to help:

- Maximize irrigation efficiencies
- Increase forage crop production
- Reduce risk of crop failure

To ensure the success of the project, it is important that the center pivot system be designed to address the site's environmental and operational constraints associated with the site, including soil and water resource conditions, topographic layout, and crop water demand requirements. In addition to the actual pivot design and performance requirements, the engineering design was also assessed for the following:

- Well locations and pumping distances that maintain appropriate pressures for proper pivot operation
- The reliability and quality of electricity
- Availability and quality of in-country parts, piping, wiring, and pump systems
- The availability of local service providers/operators who possess or can acquire the basic knowledge needed to maintain and operate the center pivot system

2.2 Assessment Summary

The center pivot system for this project has been designed by engineers at Valmont, in cooperation with technicians at Valmont-China, officials in the SFA, and officials in Zhenglan Banner. Based on review of the design plans and system components (Appendix B), the irrigation system should meet the forage production water demand needs of the project. The specific concerns identified by the Inception Report (Valmont Water Management Group, 2003) were addressed as follows:

- The irrigation well design and pumps were specified and selected by Banner Administration officials based on past well-construction experience in the immediate area. These items will be installed by the Banner Administration, in cooperation with technicians at Valmont-China. Connecting pipes and manifolds have been appropriately designed for moving water from the irrigation wells to the center pivot system.
- Electrical power has been confirmed and is suitable for pivot operations with the use of a transformer. The electrical supply and transformer will be installed by the Banner Administration.
- In-country piping, wiring, and pump systems are readily available in Inner Mongolia for use on this project. Although the pivot and some of the major assembly components will be imported from the United States by Valmont, replacement and spare pivot parts can be easily obtained from Valmont-China.
- Valmont Industries will hire and train an irrigation technician to operate the irrigation system for the 2003 crop season.

In summary, the engineering design satisfies the requirements for short-term feasibility of the Demonstration Project.

2.3 Long-Term Issues

The long-term sustainability and replicability of this project will depend upon several key issues:

Scheduling
The center pivot provides considerable water conservation opportunities for arid regions when operated correctly. The implementation of appropriate irrigation scheduling will maximize the effectiveness of the pivot.

Maintenance
The life of the center pivot can be extended indefinitely if properly maintained. This includes appropriate shutdown and storage for the non-growing season to protect against freezing conditions and the lubrication of all moving parts at recommended intervals.

Operations
The pivot has been designed to operate within various pressures and speeds suitable to the site at which it is being installed. Operation of the pivot outside of these tolerance values -- or operated in ways not specified -- would reduce the life of the pivot.

Training

Local personnel trained in the operation and maintenance of center pivot technology should be a high priority of Banner Administration to reduce the likelihood of improper irrigation scheduling and equipment fatigue. The pivot should be maintained and operated by a local operator who has been trained by Valmont-China in center pivot systems.

3.0 WATER RESOURCES

3.1 Short-Term Requirements

There must be adequate water to support operation of the center pivot system and to meet crop water requirements in a timely fashion. For this project, groundwater was chosen as the most viable water source for supplying the center pivot irrigation system. Both short- and long-term impacts to groundwater must be considered if the transition to irrigated forage production is to be sustainable. To this end, three issues were identified as potentially having a significant impact on the Demonstration Project:

- Groundwater yield rates must meet or exceed crop water demand;
- Water quality must be suitable for irrigation; and
- Negative effects on current groundwater users should be kept to a minimum.

3.2 Assessment Summary

3.2.1 Groundwater Yield

The results of this assessment indicate that it is feasible to drill wells that can produce enough water to meet the needs of the Demonstration Project. Operation of the center pivot irrigation system is expected to require water at an average rate of 190 m^3/hr during the growing season. Water is to be supplied by a series of four to five wells distributed around the center pivot (Sheet C-1, Appendix B). This implies that the average yield of each well would be approximately 40 to 50 m^3/hr.

The quantity of groundwater in storage and that would be available to the irrigation wells appears sufficient. For the limited duration of the Demonstration Project, long-term aquifer recharge rates are not considered to be a limiting factor.

The valley of the Shandian River is underlain by a thick layer of unconsolidated sand and gravel deposits. The depth to the water table is relatively shallow, and the saturated thickness of the unconsolidated sediments in nearby locations is approximately 50 m. This indicates that a large volume of groundwater is held in storage in the sediments and that water will be available to wells. Assuming that the porosity of the sediments is at least 10%, which is a reasonable assumption for sediments like those underlying the valley, pumping the irrigation wells at an average rate of 190 m^3/hr for a four-month growing season would remove a volume of water equivalent to the amount in storage beneath only 10.9 hectares of the river valley. It is therefore

safe to assume that there is ample groundwater in storage to support operation of the irrigation system during the Demonstration Project (Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing Using Irrigated Agriculture, Inception Report).

The ability to construct wells capable of yielding water at the required rates in aquifers consisting of unconsolidated sediments is a function of variables such as sediment grain size and shape, the degree of sediment sorting, and aquifer thickness. Together, these variables determine an aquifer's transmissivity, which is a measure of its ability to transmit water to a well. Although information gathered from lithology logs of nearby high-yielding wells indicates that much of the aquifer thickness consists of relatively fine-grained sediments, the aquifer's great thickness compensates for the average fine grain size. The best evidence indicating that it will be feasible to drill wells with adequate yield is the existence of high-yield wells in the same sedimentary environment in other parts of the valley. These wells have yields comparable to those needed for the center pivot system with only moderate amounts of water-level drawdown at the wellhead. Based on the hydrogeologic information reviewed, groundwater yields from the proposed supply well network are expected to be reasonably attainable and adequate for this project.

3.2.2 Groundwater Quality

Wells drilled to support the Demonstration Project should be capable of supplying water of acceptable quality for the project duration. Water produced by nearby wells in the Pleistocene-age sediments of the Shandian River Valley is of good quality for irrigation, and a production well at the Zhenglan Qi electric power plant produces water with Total Dissolved Solids (TDS) concentration of less than 500 mg/l. This is consistent with the hydrologic setting, as groundwater flowing through the unconsolidated sediments of the valley has probably had a relatively short contact time, resulting in low concentrations of dissolved solids. Also, the Pleistocene sediments are likely to contain little easily soluble material that could contribute to poor water quality. Finally, operation of the center pivot system is unlikely to initiate any physical processes that would promote significant degradation of groundwater quality in the immediate vicinity of the proposed water well network.

3.2.3 Surrounding User Impacts

Pumping of the irrigation system supply wells at the proposed rates for the duration of the Demonstration Project would not be expected to have an unacceptable impact on existing water users. Sustained pumping of the irrigation wells serving the center pivot system will cause a cone of depression in the water table that will be centered on the well cluster. This lowering of the water level will be significant in the region very close to the wells themselves, but will diminish rapidly with radial distance from the well cluster.

The precise relationship of pumping water levels to distance from the irrigation wells will depend on a number of site-specific factors that cannot be determined with accuracy before the wells are drilled. However, using generalizations on lithology and aquifer properties derived from study of well logs and pumping tests of existing wells, limited predictions can be made about water level impacts. To this end, a computerized, numerical groundwater flow model was employed to predict the shape of the water table that would be produced by pumping a group of

irrigation wells at a rate of 190 m^3/hr for 180 days, a length of time greater than a single growing season. To be conservative, it was assumed that no recharge from precipitation or from flow in the river would be available during that time. The results of this analysis showed that water levels could be about 10 cm lower than usual at a distance of two km from the pumping wells. Water users who rely on shallow dug wells in the alluvial sediments along the Shandian River would not be expected to experience noticeable water level impacts in their wells unless they were closer than 2 km to the irrigation wells. In addition, no meaningful impact would be expected on deeper wells.

In summary, the water resources at the site appear sufficient to ensure short-term feasibility of the Demonstration Project.

3.3 Long-Term Issues

Long-term impacts to groundwater resources involve consideration of:

- The adequacy of aquifer recharge
- The limitations of well construction
- The competition for resources
- Any possible degradation of water quality

3.3.1 Adequacy of Recharge

As already indicated, the groundwater held in storage within the unconsolidated sediments along the Shandian River valley should be adequate to support irrigation pumping at the site of the Demonstration Project for a single growing season. However, much greater groundwater demand will be associated with long-term, full-scale implementation of the anti-desertification project. Determining the sustainability of longer-term irrigation pumping at numerous sites distributed throughout the region requires consideration of recharge to the aquifer.

The ultimate source of all groundwater pumped from aquifers is precipitation, either rainwater or water derived from the melting of snow. The amount of water available to a well can be considered to be a function of the average precipitation rate in the drainage basin up gradient from the well, the amount of precipitation that is not lost to evapotranspiration, and the size of the drainage basin. For this region, average annual precipitation is estimated to range from 19.8 cm to 47.2 cm. (BGMIM, 1992).

The fraction of precipitation recharge that infiltrates the soil and eventually reaches the water table depends on many factors. To make a direct prediction of basin-wide precipitation capture rates is beyond the scope of this Demonstration Project. However, research on soil infiltration rates has been conducted in areas with climatic conditions similar to the Demonstration Project area. Investigations conducted by the U.S. Geological Survey at one semi-arid test site in the western United States indicated that recharge amounted to between 2% and 5% of precipitation at that site -- an area which experienced somewhat lower average precipitation rates than the region that is the subject of this study. A second source of recharge rate estimates was a hydrologic investigation conducted for the Zhenglan Qi power plant (BGMIM, 1992). For the

region surrounding that site, it was estimated that between 5% and 12% of precipitation was available as recharge, depending on whether the precipitation fell on the floodplain, on the lowlands beyond the floodplain, or on the hills underlain by bedrock.

Assuming that the percentage of precipitation that is captured as recharge is near the midpoint of the range (7% of precipitation), and that annual precipitation is 33.5 cm (the midpoint of the range 19.8 cm to 47.2 cm), the annual amount of available recharge to the basin upgradient from the Demonstration Project site would be 75 billion cubic meters. This would be equivalent to an annualized flow rate of 8400 m^3/hr. If these same assumptions are valid, then operation of a center pivot that used water at a rate of 190 m^3/hr during a four-month growing season would consume the annual recharge from an area measuring roughly 2,360 hectares.

If the center pivot irrigation wells at the Demonstration Project site were pumped at 190 m^3/hr for a four-month growing season, the system's average annual demand would be at a rate of 63 m^3/hr. This rate is much smaller than the estimated available recharge of 8400 m^3/hr derived using the median values for annual precipitation and percentage of captured precipitation. However, a determination that recharge is adequate to support long-term operation of the full-scale project depends on the number of center pivot systems ultimately installed, their average water demand, and their distribution throughout the region. For example, if a total of 40 center pivot systems were installed, each with average annual demand of 63 m^3/hr, total project demand would be at an annualized flow rate of about 2,500 m^3/hr. From the standpoint of recharge rates to the drainage basin overall, it is conceivable but not certain that this level of demand could be supported. However, operation of a center pivot might not be sustainable in some portions of the drainage basin because of site-specific recharge and hydrologic limitations.

Based on available data, it is not possible to make a dependable determination of the adequacy of recharge to support long-term operation of the full-scale project. Therefore, a long-term environmental monitoring program should be established to assess the impact of the project on aquifers and to collect the information necessary to better determine available recharge in the region. The monitoring program should include frequent, routine measurements on a set schedule for:

- Precipitation
- Flow volumes in streams and rivers
- Water levels in existing wells and a network of monitoring wells installed for this purpose

The program should also routinely collect water samples from wells and surface water bodies with measurement of a limited number of water quality indicator parameters to allow recognition and monitoring of any long-term water quality trends that may be influenced by project implementation. The data generated by the monitoring program should be used both to check for impacts to aquifers caused by the anti-desertification project's operation and to produce improved estimates of basin-wide aquifer recharge rates. The monitoring program should be established early so that baseline data can be collected, allowing comparison of aquifer conditions before and after project implementation. It should be kept in mind that such a monitoring program would have benefits well beyond those relating to the anti-desertification project.

3.3.2 Well Construction Limitations

It should be possible, at reasonable expense, to construct wells capable of producing the volume of water necessary to supply the center pivot irrigation systems proposed for this project. It is assumed that each center pivot system would be supplied by an average of five wells distributed at intervals around the pivot. At some locations, depending on site-specific hydrogeologic conditions, as few as one or two wells might be sufficient to supply the required water; however, development of an adequate water supply may not be possible at every future site proposed for an irrigation system. It must be anticipated that irrigation systems will be situated in locations representing a range of hydrogeologic environments. The difficulty in developing high-yield wells may vary tremendously from one hydrogeologic setting to another. For example, water supplies can be developed relatively easily in settings where substantial thicknesses of water-saturated, well-sorted, unconsolidated sediments exist, in good hydraulic communication with a source of recharge -- such as occurs in the Pleistocene-age sediments underlying the Shandian River valley. However, in areas where igneous and metamorphic bedrock is overlain by only a thin layer of unconsolidated sediment, wells will have to target fractured-bedrock aquifers. These aquifers consist of networks of discrete fractures in rock that may otherwise be impermeable or have low intrinsic storage capacity. Locating high-yielding fracture zones in such rocks is quite possible, but may require the drilling of several test wells before a suitable aquifer is found. Furthermore, wells in these aquifers should be subjected to pumping tests that are long enough to ensure that initial high yields will be sustainable under conditions of long-term production pumping. Where difficult hydrogeologic conditions are anticipated, it would be advisable to conduct a test-well drilling program to confirm that an adequate water supply can be developed before choosing the final site for the irrigation system. This should avoid wasted expenditures of time, effort, and money.

3.3.3 Resource Competition

Impacts on competing water users can be divided into two categories:

- Impacts on users who are close enough to a specific set of irrigation supply wells to be directly affected by the temporary cone of depression that surrounds those wells when they are being pumped; and
- Impacts on users throughout a drainage basin who might be vulnerable to long-term, basin-wide declining water levels caused by the aggregate increase in demand from all the center pivot systems installed in the basin in connection with this project.

Temporary, pumping-induced, seasonal impacts on existing water users who are within a few kilometers of each set of irrigation wells will depend on site-specific factors. In general, impacts will be most noticeable at wells that are closest to the irrigation wells, and in shallow, dug wells as opposed to deep, bedrock wells. In fractured-bedrock aquifers, water level impacts may be highly directional, and therefore unpredictable, because of extreme aquifer anisotropy. In such situations, undesirable impacts can at least be identified by conducting constant-rate pumping tests of the irrigation wells, while monitoring water levels in nearby wells that are considered vulnerable.

The potential for the operation of multiple irrigation systems in a drainage basin to cause declining aquifer water levels throughout the basin depends on the overall water balance in the basin. If existing basin-wide demand exceeds the average annual supply of water from precipitation, then it must be assumed that any additional consumptive use of water within the basin will have a negative impact on marginal water users, especially those who are downgradient from areas where new points of withdrawal are concentrated. The term "marginal water users" indicates those users who already face a chronic water deficit. If a particular watershed is already in a net water-deficit condition, then it will be the responsibility of the relevant government agencies to determine whether the benefits produced by the anti-desertification project are greater than the cost of providing compensation to negatively impacted water users elsewhere in the drainage basin.

Insufficient data are available to allow prediction of the likelihood of basin-wide negative impacts, or to quantify such impacts in response to full-scale implementation of this project. As a key component, the project should include an integrated, long-term monitoring program on a basin-wide or regional scale, as described above. The data generated by such a monitoring program would be used to produce a drainage basin or regional hydrologic model. The model would characterize and quantify inputs to and outputs from the drainage basin. It would then be used as a tool for monitoring and managing the impacts of the project on users throughout the drainage basin. The model would also be useful in regional planning and assessing the impact of additional water demands associated with future development.

In summary, individual center pivot irrigation installations can be expected to have limited and manageable seasonal impacts on neighboring water users, and should be feasible in many settings. It is possible that the increase in aggregate demand associated with the addition of multiple irrigation systems will cause long-term water level declines in drainage basins that are already in, or are approaching, a condition of water deficit. The costs associated with such impacts must be weighed by responsible government entities against the potential benefits of the anti-desertification program. The process of evaluating this cost/benefit tradeoff will be easier if a program of long-term aquifer monitoring has been instituted that allows better understanding of the hydrology and hydrogeology of involved watersheds.

3.3.4 Water Quality Impacts

Long-term operation of center pivot irrigation systems is not expected to cause unacceptable water quality impacts. Operation of the irrigation systems should not trigger physical processes that would cause water quality degradation. It is conceivable, however, that the changes of land use associated with establishment of the Ecological Migration Villages could have water quality impacts. The aquifer monitoring program recommended above should include routine monitoring of water samples for selected parameters (including field-measurable parameters like specific conductance, TDS, pH, and hardness) to measure water quality and to aid in remediation should degradation occur.

4.0 SOIL RESOURCES

4.1 Short-Term Requirements

Although many soil problems can be corrected using various mitigation techniques, these approaches can prove to be cost prohibitive. As a result, for the Demonstration Project to be successful, soil conditions – including texture and nutrient availability -- must be suitable to generate the anticipated yields and support crop growth and development.

4.2 Assessment Summary

For this project, the primary soils information was obtained from a soil map provided by the local Banner Administration (Sheet G-5, Appendix B). This map shows that the soils in the area of the Demonstration Project are composed of a deep *loess* (wind deposited) with a dark brown surface color suggesting high organic matter content (i.e., Brown Calcium Soil, dark brown, gray *loess*). Surface topography indicates moderate slopes of 2% to 5%. Some associated soils found in the broader area are reported to have *caliche* layers (cementing due to leached mineral deposits) at depth. Soils at this site appear suitable for tillage and will have moderate infiltration rates making them adaptable to irrigation. Reported soil pH and nutrient status appear favorable for irrigated forage production. If initial nutrient levels are inadequate, supplemental fertilizer or manure can be added to enhance nutrient availability. In summary, soils at this site appear to be well suited to irrigated agricultural production.

4.3 Long-Term Issues

The long-term impacts to soil resources can be focused on three overriding issues:

- The prevention of wind erosion;
- Soil fertility management; and
- Soil salinity and soil structure management

4.3.1 Wind Erosion

Management strategies to prevent wind erosion of tilled soil must be developed. To this end, the design of the pivot site includes a windbreak to help control soil particle movement at the site. However, this alone will not be effective on such a large tract. The period of time that is of the greatest concern will be the fall, after the crop is removed, and the spring, prior to crop planting -- with the spring season being of greatest risk. The options for minimizing wind erosion include the use of annual and perennial forage crops and annual grain crops. If annual forage crops such as corn are to be grown, then a locally adapted, fall-planted, cover crop should be included in the management plan. Production of perennial forage crops described in Section 5.0 would eliminate the need for a cover crop but would require management steps that assured a plant residual adequate to prevent wind erosion. The production of annual crops such as grain would require that a minimum of 10 cm to 32 cm of residual stubble remain to protect the soil surface over the winter.

4.3.2 Soil Fertility

Crop management strategies that maintain optimum soil nutrition and pH levels must be developed. Initially, the natural soil nutrient levels will be relatively high. These nutrients are the result of organic matter that has accumulated over thousands of years of grassland development. Once annual cultivation begins, however, the organic matter will quickly degrade and the natural fertility of the soil will drop significantly. Because, consistent production levels and forage quality are dependent upon the maintenance of optimum soil fertility, a program of soil testing and supplemental fertilization will be required to achieve consistency.

Additionally, to assist long-term soil fertility, measures should be undertaken to ensure that organic matter is maintained in the rooting zone. This organic matter can come from crop residues or from the addition of animal waste. Although livestock manure has been traditionally used as a heating source, the alternative heat sources available to the Ecological Migration Villages should allow the manure to be available as a fertilizer and soil conditioner. To ensure full use of this organic material, a plan should be developed by the Ecological Migration Village for returning livestock manure to the crop fields.

4.3.3 Soil Salinity and Structure

Management strategies that preserve the hydraulic capabilities of the soil system must be followed. Although soil salinity problems are typically associated with irrigated agriculture, the potential risk from salinity is considered low for this project. The irrigation water appears to have very low Total Dissolved Solids (TDS) levels and the soils are described as calcium-rich, which will further discourage the development of salinity problems associated with sodium imbalances. Another potential source of reduced hydraulic conductivity is connected to the cultivation of wet soil. With the addition of irrigation equipment, it is possible to have wet soil at any time of the year, and as such, soils must be allowed to dry out prior to tillage or harvesting operations. If the soils are tilled when wet, they will have the potential of forming a hard layer at the bottom of the tilled depth. This feature is described as a "plow pan" and can interfere with root growth and water infiltration. Harvesting on wet ground can lead to high compaction of the surface soil.

In summary, the concerns associated with erosion, fertility, salinity, and texture appear to be easily mitigated using simple and effective management techniques. The long-term risk of adverse impact to area soils under this agricultural production model appears minimal.

5.0 IRRIGATION AND CROP PRODUCTION

5.1 Short-Term Requirements

The crops to be produced beneath the pivot will provide forage for dairy cows as well as nursery stock for re-forestation efforts. The Banner Administration intends to plant corn and nursery stock beneath the pivot for the 2003 crop year (Sheet C-1, Appendix B). While the nursery stock will have limited water requirements, the irrigation system must be operated to maximize the quantity and quality of the forages being grown. The harvested crop will be transferred to the

Ecological Migration Village and converted to silage under the oversight of the Banner Administration. Valmont-China will operate the center pivot system and make irrigation decisions throughout the first production season. For the Demonstration Project to be successful (from an irrigation and crop production standpoint) the following issues and concerns must be addressed and, if necessary, mitigated:

- Adequate crop production to support livestock consumption demand
- Proper ensiling to preserve harvested forage crop
- Species selection for optimum crop survivability
- Irrigation delivery to meet crop water demand

5.2 Assessment Summary

5.2.1 Production Demand

The short-term plan for producing corn and nursery stock beneath the center pivot system is adequate to ensure that forage will be produced for the dairy cows in the Ecological Migration Village. However, it is necessary to develop accurate estimates of the amount of forage that will be produced and the number of dairy cows and other animals that can be raised successfully with that amount of forage. Given climate constraints, it is estimated that 30 metric tons of as-fed (i.e., 35% dry matter) silage can be produced per hectare under optimal conditions. This equates to approximately 10,500 kg of dry matter/ha. Assuming that 80% of the pivot is planted to silage with the remaining 20% dedicated to nursery stock, the total production is estimated at 1,680,000 kg of dry matter. Reducing this production rate by 20%, due to harvest, storage, and feeding losses, leaves 1,344,000 kg available for dairy cow consumption. If the cattle average 500 kg and eat dry matter each day equivalent to 3% of their body weight (15 kg), the estimated forage yield would be enough for 89,600 "cow days." If cows are fed the entire year (365 days) from this forage, 245 cows could be supported. However, a 20% safety margin should be included with this estimate to account for potential production problems. It is therefore assumed that the proposed irrigation and crop production activities should be adequate to support approximately 200 dairy cows in the Ecological Migration Village. Other combinations of forage yield, milk production and the number of dairy cattle that can be supported by the 75 ha pivot is displayed in Table 1.

Table 1. Approximate Relationship Between Forage Yield, Milk Production, and Number of Dairy Cattle Under a 75 ha Pivot

Assumed yield ton/mu wet	Yield ton/ha wet	Yield ton/ha assume 35% dry matter dry	Yield per pivot assume 75ha*.80 ton dry	Assume 20% safety margin ton dry	Dry matter consumption per cow, kg/day dry matter basis	days in year	Total producing cows
		15 kg of milk per day					
2	30	11	630	504	18	365	77
4	60	21	1260	1008	18	365	153
6	90	32	1890	1512	18	365	230
8	120	42	2520	2016	18	365	307
		20 kg milk per day					
2	30	11	630	504	21	365	66
4	60	21	1260	1008	21	365	132
6	90	32	1890	1512	21	365	197
8	120	42	2520	2016	21	365	263
		25 kg milk per day					
2	30	11	630	504	24	365	58
4	60	21	1260	1008	24	365	115
6	90	32	1890	1512	24	365	173
8	120	42	2520	2016	24	365	230
		35 kg milk per day					
2	30	11	630	504	27	365	51
4	60	21	1260	1008	27	365	102
6	90	32	1890	1512	27	365	153
8	120	42	2520	2016	27	365	205

Please note that this estimate assumes that weather conditions are favorable and there are no substantial losses from pests, diseases, or crop loss due to grazing of animals beneath the pivot system. Since all of these issues carry an inherent risk upon the total production, it is recommended that the Ecological Migration Village or the Banner Administration have an alternative source of forage available in the event that crop yields are not sufficient to satisfy dairy cow forage requirements. In this case, about 1,095,000 kg or approximately 1,000 metric tons dry matter or approximately 1,100 metric tons of 90% dry matter hay would be required to support 200 cows.

It is important to note that the estimates described are for forage only. A variety of concentrate feeds (i.e., grains, high protein meals, minerals, etc.) will be necessary for high-producing dairy cows (see Section 6.3). The Banner Administration will need to consult with dairy cow specialists to determine the total nutrient requirements of the proposed dairy operations.

5.2.2 Silage Production

To minimize forage losses due to spoilage, maximize nutrient content, and successfully store the harvested material through the fall and winter months, ensiling must be done properly. Concerns have been expressed that proper ensiling methods are not yet practiced in the region. Hence, it will be necessary to obtain training in those methods and dedicate someone to supervise silage production during the upcoming production season. Substantial forage loss would likely occur if this training were not provided, and would result in decreased food source availability for the dairy cattle. It is highly recommended that the Banner Administration immediately address the silage production issue with agricultural specialists.

Technical assistance can be provided to produce high quality green-chop, silage, and hay. If technical knowledge near the Project site is not currently adequate to produce high quality corn silage, then training sessions should be arranged in the Zhenglan Banner, Beijing, or at a location in the United States. Possibilities for contact and training include; Steve Fransen at Washington State University, Joe Lauer and Dan Undersander at the University of Wisconsin, and Neal Martin, Larry Satter, or Richard Muck at the Dairy Forage Research Center. If machinery or storage facilities are not adequate, arrangements must be made for these items immediately, since silage making is a time-sensitive operation, and all items must be in place and in proper working order by mid-summer to ensure successful silage making in the autumn.

5.2.3 Crop Survivability

Forage type and species selection is critical for identifying those plants that will survive and produce acceptable yields and quality under the estimated growing conditions. Local residents and provincial and national forage scientists have experience with forage species that are suitable for the Demonstration area. Alfalfa and various grasses have been grown for hay in the region, and a silage corn crop was produced under a nearby center pivot in 2002. Cultivars should be selected that are suited to the short growing season and able to provide high quality forage. Based on area climate data (Table 2), only cultivars with an early maturing growth cycle (i.e., short season crop) and with minimum Growing Degree Day (GDD) requirements of less than 1500, calculated using a 5°C base temperature, should be considered.

Table 2. Climate Information for the Zhenglan Qi Demonstration Area

Jan. mean temp.	Jan. mean min. temp.	July mean temp.	July mean max. temp.	Mean annual precipitation	Corn Heat Units	GDD (>5°C)
-18.2°C	-23 to -26°C	18.5°C	22 to 24°C	300-400 mm	1600	1450

Other annual crops suitable for silage include small grain cereals such as oats, barley, or triticale. These can be grown alone or in a mixture with legumes or annual ryegrass. The yield and quality of these types of crops grown in other areas with a climate similar to the Demonstration Project site have been excellent (Table 3). Perennial forage species having suitable winter hardiness include fall dormant types of alfalfa (*Medicago sativa*) and forage grasses like meadow bromegrass (*Bromus biebersteinii*), smooth bromegrass (*Bromus inermis*) and timothy (*Phleum*

pretense). Additional examples of potentially suitable species from Manitoba, Canada are listed in: http://www.gov.mb.ca/agriculture/crops/forages/bjb00s14.html.

Table 3. Comparison of Yield and Quality of Corn and Small Grain Cereals Grown at the Lacombe and Brooks Farms Near Alberta, Canada in 1999[1]

Crop, variety	Heat units required[2]	Seeding rates (per ha)	Yield[3] (kg/ha)		Acid Detergent Fiber (%)	
			Lacombe	Brooks	Lacombe	Brooks
Corn, Pioneer hybrid 39N03	2,000	74,100 seeds	6720	11,872	26	27
Semi-dwarf barley, CDC Earle	unknown	40 kg	7840	16,576	29	-
Forage oats, LAO-458-00	unknown	32 kg	13,440	16,576	43	-
Triticale, Pronghorn	unknown	49 kg	11,648	17,248	33	-

Notes:
[1] Refer to http://www.gov.mb.ca/agriculture/crops/forages/bjb00s22.html for additional information on forage species and cultivars from Manitoba, Canada, areas with climate similar to the demonstration site.
[2] Heat unit calculations described in http://www.gov.on.ca/OMAFRA/english/crops/facts/93-119.htm#appendix.
[3] Data from research conducted by Myron Bjorge, Lacombe Research Station, Alberta Province, Canada.

Crop yields of these hardy northern species are greatly affected by fertilization. For example, fertilized meadow bromegrass pastures typically produce twice as much forage dry matter as unfertilized grass-based pastures, averaging 4.9 tons versus 2.6 tons of forage dry matter per hectare, while alfalfa seeded with meadow bromegrass could average 4.1 tons of dry matter per hectare. Thus, reasonable estimates for well-managed perennial species for the demonstration area are 4-5 tons of dry matter per hectare.
See http://www.gov.mb.ca/agriculture/crops/forages/bjb00s22.html.

5.2.4 Crop Water Demand

Proper irrigation scheduling is a critical aspect for maximizing forage production in semi-arid regions. Forages can be ranked with respect to water use efficiency (i.e., forage produced per unit water used). An example summary of various crop water requirements is provided in Table 4.

Table 4. Climatic and Irrigation Requirements for Various Crops in the Doulun, China Area[1]

Month	Eto	Rainfall	Eff Rainfall	Potential Crop Water Needs[2,3]					
				Alfalfa	Barley	Maize	Pasture	Small Grains	Winter Wheat
	mm/ day	mm/ month		mm/month					
Jan	0.47	3.0	3.0	13.5			28.6		7.4
Feb	0.76	3.0	3.0	22.9			51.2		41.8
Mar	1.81	9.0	8.9	27.5			78.0		97.4
Apr	3.74	17.0	16.5	26.4			90.8		133.5
May	4.93	35.0	33.0	31.7	4.9		62.8	4.4	101.9
Jun	4.88	77.0	67.5	29.9	52.5	0.0	28.4	46.8	0.0
Jul	4.55	137.0	107.0	17.2	44.9	2.2	17.2	38.5	0.0
Aug	3.74	116.0	94.5	30.2	0.0	44.9	30.2	19.4	0.0
Sep	2.8	54.0	49.3	36.7		45.3	36.7	0.0	0.0
Oct	2.28	22.0	21.2	31.7		9.3	31.6		8.5
Nov	0.83	6.0	5.9	12.5			15.2		4.8
Dec	0.63	3.0	3.0	0.9			1.9		4.3
Total	--	482.0	412.8	281	102	102	473	109	399

Notes:
1 All data obtained from the CropWat4 computer program published by the UNFAO, http://www.fao.org/ag/AGL/AGLW/climwat.stm
2 Irrigation requirement is calculated ET minus the effective rainfall
3 Assumes Barley and Small Grains were planted on May 15, Maize was planted on June 1, Winter Wheat was planted September 15, and Alfalfa and Pasture to be established crops.

As an alternative for estimating water requirements, mean monthly values of precipitation and maximum temperature are available for Inner Mongolia in the Forage Information System at http://forages.orst.edu/projects/map/enmain.cfm?pageid=6).

5.3 Long-Term Issues

5.3.1 Seed Availability

A strategy must be developed to provide for continued supply of suitable forage seed, either from the PRC or from a United States source. Regardless of source, two issues must be addressed:

- Identifying suitable forage species and cultivars; and
- Supplying the seed of the recommended plants.

Identifying Suitable Forages
Initial recommendations will be made based on previous research and demonstration trials and expert knowledge of local, regional, national, and international forage scientists. This will provide a good starting point, but should be further refined by establishing an ongoing applied research program to evaluate the most current germplasm of high priority species.

This research program need not be complicated or extensive; it could be as simple as including several 20 meter-square blocks of test forage into the farmed area under the pivot. Or it could be province-wide or a more extensive regional approach involving capacity- building activities in advanced mapping technologies and field-based validation to allow extrapolation of concepts learned in the project to all of Northern and Western China. In either case, the trials need to be ongoing, including results from several successive years, to provide the most reliable data. This program should be coordinated with national and regional research and university programs such as Forage and Range Science at Beijing Forestry University, the CAAS-Institute of Animal Sciences in Beijing, the CAAS-Grassland Research Institute, Inner Mongolia Agricultural University, and Inner Mongolian Meteorology Institute in Hohehot, Inner Mongolia.

Securing High Quality Seed
High quality seed is essential to the ongoing success of forage-livestock production systems. Programs should be established to identify sources of high quality seed for the species and cultivars required in this region. This will include ensuring sufficient quantity and quality of seed, acceptable delivery schedules, and suitable storage facilities to maintain seed quality. To facilitate international cooperation, standardized methodologies must be adopted for seed sampling and testing.

5.3.2 Forage Production Training

A plan for a training and education program for forage-related topics should be developed and implemented. Topics should include species and cultivar selection, establishment methods and seeding rates, fertilization, irrigation scheduling, defoliation strategies, and conservation methods for silage and hay. Local, regional, national, and international workshops, conferences, visiting scholar, and degree programs should be utilized and coordinated with existing international, national, and provincial organizations (e.g., International Grasslands Congress, International Rangeland Congress, Chinese Grassland Society, etc.). Additional resources can be obtained from cooperative programs with universities, agencies, organizations, and companies (e.g., Oregon State University, United States Department of Agriculture, Oregon Seed Council,

Valmont Industries, individual seed companies, etc.). Short-term, medium-term, and long-term programs should be established to ensure rapid implementation and successive improvements.

5.3.3 Augmenting Forage Production From Grasslands

In the short-term, it does not appear feasible to rely on supplemental forage harvested from native, rain-fed grasslands. First, the change from range grazing to the Ecological Migration Village will occur gradually over the 2003 crop year. Second, the families that migrate to the village will be from the most disturbed and most overgrazed areas with the lowest potential for production. As a result, these lands may require years to reach a productive state.

In the future, households may be allowed to cut hay from the native grassland to augment forage produced by the center pivot system. The amount of supplemental forage provided by this activity would depend on the current condition of the land, the amount of nutrients available, the prevention of grazing on the land, annual rainfall, and the harvesting and transportation methods used. If soil and moisture conditions are adequate, overgrazing is prevented, and the hay cutting is properly done, households might harvest from 0.4 to 0.75 tons of hay per hectare. Not all land will be suitable for haying, however. It is probable that less than 50 percent of the land will be suited to continuous hay production. As such, a household of four individuals might have the ability to harvest hay on 680 mu of land (45 ha), which would result in an additional 18 to 34 tons of hay from its allocated grassland area.

When considering the long-term feasibility of harvesting supplemental forage from the open grasslands, the following issues need to be carefully evaluated:

- Restoration of vegetation cover and litter using natural processes. Grasses, trees, and shrubs create uneven surface texture and structural diversity that mitigate the impact of strong winds. Mowing extensive areas reduces structural diversity.
- Preparing a harvest plan that sustains vigor and productivity of important plants by controlling frequency and intensity of cutting. Hay should not be harvested in the same area year after year.

6.0 LIVESTOCK MANAGEMENT

6.1 Short-Term Requirements

The Banner has already implemented a plan to create a dairy industry in the area. Some of the Ecological Migration Villages already established have dairy cows as their primary source of income and livelihood. The Banner can draw experience from this implementation to control livestock management risks to the Demonstration Project. The dairy cattle for the proposed Ecological Migration Village will arrive this summer, prior to the resettlement of the herding families. For the livestock management aspect of the Demonstration Project to be successful, the proper feeding and housing of the animals will be critical.

6.2 Assessment Summary

Feed availability could be of primary importance during the first year of the Demonstration Project. No forage will be available from the current year's planned crop until late summer. It will be imperative to have adequately stockpiled feed and proper animal housing prepared for the winter season. Because of relocation stress on the cattle, the Banner Administration should anticipate reduced productivity and increased incidence of disease during the first year. The animals will need time to adjust to new surroundings, food sources, and environment, and the degree of breed-back and freshening will likely fall below expectations through the second year of operation.

6.3 Long-Term Issues

The long-term success of dairy operations depends on a number of issues already discussed regarding forage production, silage quality, and feed availability. Adequate, high quality forage will be the single most important factor limiting dairy production. The Banner Administration must maintain realistic expectations of the number of cows a circle of irrigated crops will support (see Section 5.2.1, Production Demand). Forage choice will depend on yield potential, available equipment and managerial skill. Mertens (1995) showed that differences in forage type and quality can be compensated for by changes in the forage to concentrate (F:C) ratio in the ration. Optimum production of 4% fat-corrected milk was achieved from a variety of forages by balancing rations to obtain an NDF intake of 1.1 to 1.2% of body weight per day (NDF is ash-free residue remaining following 1 hour digest in neutral solution of sodium lauryl sulfate, using sodium sulfite and heat-stable amylase).

The Banner Administration must maintain realistic expectations of the number of cows a circle of irrigated crops will support. Current plans call for production of corn silage; alfalfa, however, is a better dairy cow ration in the long-term, providing more Neutral Detergent Fiber (NDF) and having a higher energy content. Given the anticipated growing conditions, high-yielding, short-season corn varieties and cold-tolerant alfalfa cultivars will be required. High performance dairy cattle cannot be maintained on forage crops alone. They will need a variety of other nutrient sources including grains, high protein meals, and minerals.

Although beyond the scope of this project, other criteria critical for the long-term viability of a dairy operation include labor force stability and training, access to veterinary medicine and consultation, and development of markets and infrastructure. Gender issues and division of labor, both in the village and in processing, must be managed. Both men and women will be assuming non-traditional roles and the division of labor must be perceived as fair by both genders. Although many dairy jobs require minimal technical skills, managing a high-producing dairy herd requires great skill and technical support. Long-term success will depend on the commitment of the Banner Administration to training a technical support group in the areas of production management, animal health and husbandry, and veterinary care. The Banner Administration and project support staff must be committed to the development and maintenance of adequate infrastructure. Clean, modern processing facilities are required, and the importance of dependable village-to-market roads and transportation should not be overlooked. Ultimately, the dairy operations must be profitable and competitive. There must be an outlet for the product,

costs must be controlled, and value-added products offer the most potential to diversify and remain competitive.

7.0 SOCIAL STRUCTURE

7.1 Short-Term Requirements

Community structures and social relationships will form an integral aspect of the Demonstration Project. The breakdown of the basic social needs of the individual family unit or community can often lead to the failure of an otherwise successfully managed project. Four social structure criteria were deemed as critical in determining the short-term feasibility of the success of the Demonstration Project:

- Social cohesion
- Consultation and participation
- Compensation and livelihoods
- Infrastructure and social services

7.2 Assessment Summary

7.2.1 Social Cohesion

Community structures and social relationships will be substantially replicated and preserved in the residence pattern and informal mechanisms of exchange in the Ecological Migration Village. Herding families who will move to the new village have extensive ties with neighbors and kin that involve cooperation in caring for each other's animals, including both mature animals on the open range and young or sick animals in a domestic environment. Herding families also share vehicles for transportation to town and provide other mutual assistance as necessary. In the new village, the housing will be constructed in blocks of four units that will share a greenhouse shelter for the families' dairy cows. This allows for common feeding of the animals with forage and hay obtained from the center pivot system or cut from the grasslands in the future. Residents will be close to neighbors and kin with whom they will continue to cooperate.

People belonging to the same administrative unit will all be resettled at the same time (i.e., in the fall of 2003) and relocated to the same village. However, the new village will contain people from three different administrative units or "*ga ca.*" The viability of the new village as a community will depend on maintaining the physical, social, and political distinctiveness of these units, as people from different units will not be personally acquainted or have an established pattern of cooperation. The ethnic mix will be approximately 70% Han and 30% Mongolian. The two ethnic groups now appear to live together compatibly on the grasslands, adapting to each other linguistically and culturally. They can reasonably be expected to do the same after resettlement. Although the population of the new village will be larger (230 households vs. 115 households) and its structure more complex than that of a previous resettled village in the northern part of the Banner, it will be supported by its proximity to the Banner capital.

Resettlement in the new Ecological Migration Village appears socially feasible, as it provides the framework for maintaining social cohesion with the likelihood of a minimum of cultural disruption.

7.2.2 Consultation and Participation

Early consultation and participation of stakeholders in decisions that will affect their lives enhances the social feasibility of resettlement. To this end, families to be resettled in the proposed Ecological Migration Village have been informed well ahead of time and allowed to discuss the options presented to them, with the result that 85% (based on a survey by a Chinese sociologist) expressed their willingness to move. Consultations between Banner officials and herding families began more than one year before the planned move. Initially, many families were undecided about the advantages of resettlement, but after exchanging information and opinions among themselves, they developed a favorable impression. Six months before the scheduled move, the people interviewed by the project team reported that 90% of the households were now willing participants and that the remainder who preferred not to move would reluctantly follow their neighbors and kin to the Ecological Migration Village rather than stay behind on the grasslands by themselves. Many feel that they can no longer make a living in a severely degraded environment where they must purchase and transport expensive forage from town to feed their livestock.

Resettlement families have already contributed their suggestions about housing design and will have a choice of those with whom they will share a housing block and cooperate economically. A contract for forage production and pivot operation will be negotiated between the Banner Bureau of Hydraulic Affairs, the households that will act as the forage producers, and those who will enter into the dairy operation. All parties will have rights and responsibilities under this contract. Most resettled families will participate in managing dairy cows, while a small minority may pursue sideline occupations providing services or performing menial labor for the village.

7.2.3 Compensation and Livelihoods

The resettled villagers will receive compensation for lost assets, including new housing and a stake in continuing compatible livelihoods with the opportunity for building human capital and increasing household incomes. The government will use anti-desertification funds to finance the new houses, livestock shelters, and corrals, with the existing houses on the grasslands being demolished. The construction of the new houses will be superior to that of the old houses -- brick and mortar vs. sand and clay. Families will be able to return to their previous grazing lands in the fall to harvest from fenced areas where they have grown hay for supplemental forage. Their periodic return will allow them to maintain ties to ancestral lands (i.e., families opposed to resettlement cite their ties to their ancestors as their primary concern). Interviews with several families who have already been resettled in the northern part of the Banner and those who are scheduled to move into the demonstration village close to the Banner capital, support a reasonable expectation that incomes from dairy farming will be higher than current incomes from herding.

Families will sell their existing livestock and use the revenues to purchase dairy cows. Wealthy families may consign surplus animals to relatives for safe keeping on the grasslands. Poor families with too few animals to sell will have access to loans to purchase dairy cows. All families will have the option of raising a few sheep around the house to supply the customary mutton diet.

The domestic division of labor will remain similar and compatible with the pattern in the past. Women already accustomed to caring for animals in and around a domestic compound and dealing with home finances will be managing the dairy cows, breeding calves for the market, and selling milk at a village outlet station. According to the Banner Administration, visiting experts will teach workshops periodically to provide and upgrade the special skills necessary for operating a dairy business. Men, who in the past spent their days herding animals away from home, may still find employment away from home in a Banner milk factory planned for the future, construction, tree planting, repair shops, restaurants in town, etc. Although the job prospects for the men are less clear than those for the women, the incomes provided by the men are not likely to be essential for improving overall household income. The daily schedule for both men and women in the resettled community will be much less demanding than living on the grasslands.

Given the equitable compensation and the prospects for improved and compatible livelihoods provided by the proposed Ecological Migration Village, the social feasibility of resettlement appears enhanced.

7.2.4 Infrastructure and Social Services

In comparison to the isolation of remote grasslands, the location of the proposed Ecological Migration Village is less than five kilometers from the Banner capital and will offer immediate access to electric power, running water, supplies, health care, schools, communication, transportation, and cultural enrichment. Currently, herding families scheduled for resettlement have poor transportation access to urban areas. In the winter months, they are locked in by snow and extremely cold weather on denuded pasture lands where there are no roads to accommodate vehicles. The journey to town in the winter by a one-cylinder tractor with a cart to haul supplies -- the typical mode of transport -- takes more than one day of crossing streams, fence lines and severely rutted ravines. This same trip takes more than three hours by motorcycle. The logistics are especially difficult to overcome in the event of a health emergency. In the warmer months, the trip takes one hour by motorcycle and two by tractor. The rural herding families experience frequent sandstorms as the weather warms up. Power for telephone and lights comes sporadically from small propeller-driven windmills hooked up to automobile batteries in their homes. They burn animal dung for heating fuel, potentially increasing their exposure to indoor air pollution.

School children live apart from their parents for most of the year in rented or purchased dwellings in town. Younger children sometimes receive care from live-in baby sitters. Thus, families are fragmented and must pay extra money to support the children's education. The move to the Ecological Migration Village will alleviate many of these inconveniences and allow people to participate more often in civic affairs and cultural events.

The improved infrastructure and better access to social services provide a strong incentive to move and contribute significantly to the social feasibility of the resettlement project.

In summary, the available information clearly suggests that the resettlement of herding families in a Demonstration Ecological Migration Village near the Zhenglan Banner Capital is socially feasible in the short term. In this context, social factors are unlikely to interfere with the overall policy goals of regenerating vegetation on the grasslands and alleviating poverty for the resettled population.

7.3 Long-Term Issues

7.3.1 Equity and Conflict Resolution

Herding families previously adapted to living far apart on the open range and now residing in close proximity must maintain a sense of equity about the distribution of resources and market opportunities over time. They must also have access to mechanisms for expressing grievances and resolving conflicts. The proposed Village contract system proposed by the Banner Administration will serve as a basis for settling disputes through the local magistrate system. The potential for conflict may increase with time as people from different administrative units or *ga cas* adjust to living with each other. All families must have equal access to markets and services to support them in their dairy business. According to Chinese custom, informal third party mediation should be available to listen to grievances and facilitate reconciliation. Not all households or villages will be equally capable or successful in their endeavors, but their level of general satisfaction and commitment will depend on their sense of being treated fairly in relation to their peers.

7.3.2 Employment and Gender Roles

While women devote their efforts to managing dairy cows and selling milk, their husbands, who previously engaged in herding activities, will need expanded employment opportunities. Some work, such as construction and tree planting, will be seasonal and impermanent. Other types of work, such as employment in milk processing, restaurants or repair shops, may last longer, but will offer only a limited number of opportunities. The danger is that men may find themselves to be marginalized members of their households and communities without clearly defined and useful roles. According to the Banner Administration, 83 Ecological Migration Villages will be established in Zhenglan Banner alone. If resettlement is carried out on such a massive scale, unemployment could become a major issue for both men and women. The question remains as to what degree of market access the expanding dairy industry in northern China can provide to the growing number of milk producers in Banner. It may be necessary to diversify the economic base of the Ecological Migration Village program to accommodate the need for additional employment and to preserve the delicate balance of traditional gender roles. Villages established in remote areas without easy access to employment opportunities in nearby towns are not likely to succeed.

7.3.3 Cultural Preservation and Ethnic Identity

The resettled villagers, especially the ethnic Mongolians, would greatly benefit from visibly preserving their cultural identity, their history tied to the grasslands, and maintaining the use of their language both in schools and in daily life. It was observed that Han Chinese families living in a predominantly Mongolian area of the Banner have learned to speak Mongolian and that Mongolian families living in a predominantly Han Chinese area of the Banner have learned to speak Han Chinese. Although this adaptability is admirable and encouraging, pride in, and preservation of, language and ethnic identity is an important motivating factor in economic and social life. Active preservation of the Mongolian language will contribute to the viability of Ecological Migration Villages, especially in communities where the majority of the population is Han.

The Zhenglan Banner is the location of Yuanshangdu, an archaeological site of worldwide historical significance -- the northern (summer) capital of Genghis Khan's Mongolian Empire during the Thirteenth Century. The site is large with outer and inner walls, remnants of structures, caves, and a stone statue. It receives visitors, especially in the summer months, but remains undeveloped and unprotected from wind and water erosion. It has great potential for attracting both national and international tourists if it can be at least partly restored and its cultural importance seriously interpreted for the public. It could provide revenue for the Banner and employment for men resettled in Ecological Migration Villages. At the same time, it would be a source of pride and a marker of ethnic history for the Mongolian people. Volunteer tourism also exists in the area, as 700 Japanese visitors come every year to offer their labor for planting trees. A thorough site survey, including underground penetrating radar and a broader social, economic and environmental impact assessment would assist in evaluating the prospects for expanding tourism and employment to the area.

7.3.4 Wealth Distribution and Community Viability

The viability of the Ecological Migration Villages will be strengthened if less wealthy households keep their debt related to capitalization and production credit within manageable limits, and if the wealthier households refrain from using their surplus to put livestock back on degraded grasslands. At the end of the nineteenth century, Mongolian herders became increasingly debt-ridden, and many were forced to sell their land and move off the grasslands. This circumstance should not be repeated. Prices for forage and milk should be monitored to accommodate the ability to repay debt. The presence of relatives still living on the grasslands make it theoretically possible for households with sufficient resources to continue to graze animals. Incentives must be maintained to keep men gainfully and meaningfully employed in and around their new villages.

To summarize, the prospects for long-term social feasibility in the establishment of multiple Ecological Migration Villages, though promising, are not as clear cut as those for the shorter-term and depend on addressing a broader set of policy issues on a regional scale.

8.0 ECONOMICS AND POLICY

8.1 Short-Term Requirements

A basic understanding of the Ecological Migration Village program is that the forage crops produced with the irrigation system will be made available to the residents to feed the forage to dairy cows; they will, in turn, sell their milk output to a processing facility operated by the Banner Administration. The Banner will provide assistance to the households regarding veterinary care and other aspects of animal husbandry. In assessing the short-term economic feasibility of the Demonstration Project, the primary issues of concern center on the management of fixed and variable costs to the households resettled in the Ecological Migration Village.

8.2 Assessment Summary

8.2.1 Fixed Costs

Fixed costs include the costs of obtaining and installing the center pivot, the irrigation wells and pumps, electrical connections, and other durable features of the irrigation system. The Valmont Irrigation Company is donating the center pivot to the Zhenglan Banner Administration. The Banner has agreed to install the wells, pumps, cables, and electrical devices that will provide groundwater for irrigation. The costs of installing that equipment are fixed costs that can be recovered over time and need not be recovered during the period of the Demonstration Project.

8.2.2 Variable Costs

Variable costs include the costs of labor, water, seeds, fertilizer, and other inputs required to operate the irrigation system and produce forage crops. The Valmont Irrigation Company will be operating the center pivot during the period of the Demonstration Project. Hence, the cost of labor for operating the center pivot will not need to be recovered during the initial year of operation. Other variable costs can be recovered by charging a price for the forage crops that exceeds the variable costs of production. If such a price is viewed as too high for the new residents of the Ecological Migration Village, the Banner Administration can subsidize the purchase of forage during the Demonstration Project.

The net returns for households in the Ecological Migration Village will be determined by the per-unit costs of inputs, the volume of milk and other products generated, and the prices they receive for their output. The Banner Administration has an influence on all of these per-unit costs and prices, and given its role in providing inputs (including technical assistance, housing, barns and municipal infrastructure) and purchasing milk and other products from the households, the Banner Administration can ensure that households earn a positive net return during the Demonstration Project.

To summarize, economic feasibility will not be an issue of concern during the period of the Demonstration Project. The fixed and variable costs will be shared by the Zhenglan Banner Administration and the Valmont Irrigation Company during that period, as described in the

Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing Using Irrigated Agriculture, Inception Report (CES, 2003).

8.3 Long-Term Issues

8.3.1 Financial vs. Economic Feasibility

Both financial and economic feasibility require consideration when evaluating the long-term prospect of using center pivot systems to produce forage crops in Zhenglan Banner and other locations within Inner Mongolia. Financial feasibility involves the costs and returns from a productive activity, as viewed from the perspective of an individual, a firm, or a local government agency. For example, it is appropriate to consider whether or not dairy production activities will be financially viable long-term for residents of the Ecological Migration Villages. Financial viability requires that the revenues earned by households exceed their costs, when all fixed and variable costs paid by households are considered. An irrigation company or a consortium of households operating a center pivot system would view the financial feasibility in a similar fashion. The Banner Administration also might be concerned about financial viability of its Ecological Migration Village Program. The Banner receives financial support from the central government of China and revenue from the sale of dairy products and fees collected from entities operating irrigation systems for the Ecological Migration Villages. From the Banner Administration's perspective, financial feasibility will be achieved if the total revenue it receives from all sources (including its support from the central government) is greater than program expenditures.

Economic feasibility differs from *financial* feasibility by the scope of costs and returns considered in the analysis. *Financial* feasibility involves only the costs and returns pertaining to individuals, firms, or local governments. *Economic* feasibility is a broader concept that requires analysis of all pertinent costs and benefits, including opportunity costs, scarcity values, and non-market benefits. In most agricultural settings and in most areas of the world, households and firms do not pay the full costs of their production activities, and they do not receive prices that reflect the true market value of their output. Hence, in most cases, the numerical results of financial analysis will be different from the numerical results of an economic analysis, even if a project is feasible from both perspectives.

8.3.2 Financial Feasibility

Using center pivots to produce forage crops in Zhenglan Banner will be financially feasible for residents of Ecological Migration Villages if they receive prices that exceed their costs of production. This condition pertains both to households raising dairy cows for milk production and to households operating the center pivot irrigation systems under contract to the Banner Administration. The expectations are that the Banner will work to make the project financially viable, given its interest in establishing and maintaining successful Ecological Migration Villages, controlling dust storms and reducing desertification, and improving the livelihoods of residents moving into the Villages.

The Ecological Migration Program will be financially feasible for the Banner Administration over time if the sum of its annual support from the Central government and annual revenue from product sales are sufficient to provide the financial and technical support needed to maintain the program. The financial feasibility for households and irrigation groups is directly linked to the financial feasibility of the Banner Administration. Although all groups should raise revenue that exceeds their annual expenditures, support from the Banner Administration is an important component of household production activities. Household production will be financially feasible only if the Banner Administration is able to maintain a financially viable support program.

8.3.3 Economic Feasibility

The use of center pivot irrigation systems to support agricultural production in the Ecological Migration Villages will be economically feasible over time if the values generated with center pivots exceed the costs of providing, operating, and maintaining the systems. Pertinent values include the revenues received for the crops, livestock, and nursery products made possible with irrigation, and any non-market values associated with the improvement of rural livelihoods and reduction of grazing pressure on open grasslands. Pertinent expenditures include the fixed costs of the irrigation system, wells, pumps, and other equipment, and the variable costs of operating and maintaining the system. The fixed and variable costs of crop and livestock production also are pertinent in determining the net values of output generated with irrigation. Other costs that should be included when analyzing economic feasibility include the scarcity value of regional groundwater, if the supply is limited.

The long-term outlook regarding economic feasibility is less clear than the outlook regarding financial feasibility. Economic feasibility requires that the value of products is greater than the sum of all costs, including expenditures made by the Banner Administration and the opportunity costs of scarce resources. Key issues include whether there will be sufficient demand at attractive prices for the milk and other dairy products generated in the Ecological Migration Villages, and whether the value of products sold will exceed the true costs of forage and other inputs. If this is not the case, then the Banner Administration may need to provide a perpetual subsidy to households engaged in dairy production.

At first glance, perpetual subsidies might seem an unlikely solution, but such subsidies for agricultural production are found in many countries, including the United States, Canada, and many European nations. In some cases, the subsidies to dairy producers in the Banner might be justified on the basis of non-market benefits, such as the social value of maintaining viable communities in rural areas with few alternative production activities. In northern China, the government might justify perpetual subsidies as expenditures required to reduce desertification and improve rural livelihoods in areas where extensive degradation of natural grasslands has greatly reduced the productive potential of land, water, and human resources.

8.3.4 Economic Analysis

Economic analysis of an irrigation project normally includes estimation of the fixed and variable costs of installing and operating the project, and the expected net returns from crop and livestock production. The fixed costs are amortized over time using an appropriate interest rate to

determine the average annual fixed cost of the project. A successful project will generate sufficient net revenue to recover the average annual fixed cost and the variable costs of operating and maintaining the system. The net revenue also must be sufficient to compensate for depreciation of the asset, so that it can be replaced at the end of its useful life. The input and output prices used in the analysis are those reflected in market transactions.

A standard, detailed economic analysis of this Demonstration Project is neither possible nor essential, largely for two reasons:

- Most of the tangible inputs and outputs will not be purchased or sold in true market transactions; and
- The primary benefits of the project will involve intangible improvements in human welfare.
- As described above, the central government and Banner Administration have adopted the goals of reducing dust storms, controlling desertification, and improving the livelihoods of herder families in Inner Mongolia. The Ecological Migration Village Program is an essential component of efforts to achieve those goals, and irrigation is required to support agricultural production in the new villages.

Placing a dollar value on the benefits of reducing dust storms, controlling desertification, and improving livelihoods would require analytical effort beyond the scope of this Demonstration Project. However, it is safe to assume that the central government and Banner Administration have decided to provide the financial support necessary to ensure success of the Ecological Migration Village Program. The Banner Administration will ensure that residents of the villages receive fodder for their livestock. The Banner also will purchase dairy products from the households at prices that enable the households to obtain the inputs needed for production in subsequent years. Some of those inputs, such as technical assistance and veterinary services, will be provided by the Banner Administration at subsidized prices.

The inability to conduct a standard economic analysis of the Demonstration Project should not detract from the value of considering economic concepts and goals as the project is implemented. Both the central government and Banner Administration may wish to minimize the costs of providing irrigation services and achieving their objectives regarding dust storms and poverty alleviation. Those costs can be minimized by ensuring that all participants appreciate the value of scarce resources and that production decisions are responsive to demands for goods and services. The Banner Administration will be very involved in determining input and output prices during the early stages of the Ecological Migration Village Program. Over time, as residents of the villages gain experience with irrigation, dairy production, and the marketing of dairy products, it should be possible to reduce government involvement, so that prices will provide a more accurate reflection of supply and demand conditions. That development will enhance the long-term sustainability of irrigated dairy production in the region.

8.3.5 Economic Policy Recommendations

To facilitate the long-term success and sustainability of the Ecological Migration Village program, the Banner Administration should consider the following policy recommendations:

- The Banner Administration should implement a program of water pricing for the irrigation water provided to households in the Ecological Migration Villages. This water pricing should be based upon the availability of water as determined by the groundwater quantity study as described in Section 3.3.1. It is safe to assume that groundwater in the region is limited. Hence, the price of irrigation water should include a scarcity component, in addition to the per-unit cost of operating and maintaining the irrigation system. The appropriate magnitude of the water price can be adjusted, over time, as more information is gained regarding the availability of groundwater in the region. However, a small price should be implemented at the outset of the project, so that residents appreciate the scarcity concept from the beginning of the Ecological Migration Village Program. Water fees should encourage maintenance of an optimum irrigation schedule and should not simply focus on minimizing water use since this could lead to reduced crop production.
- Compensation to offset water charges can be provided in a manner that does not reduce the incentive effect of implementing a water price. For example, households could be given a fixed payment each year to assist them in paying for all of their productive inputs. The payment will not diminish the incentive to use irrigation water wisely if it rewards the users for maintaining the optimum irrigation schedule.
- The Banner Administration will need to be very active in ensuring that key inputs are available to the households, particularly in the near term. The households will have little experience in obtaining the inputs needed for dairy production, and they will rely upon the Banner Administration to assist them. Initially, some inputs will be provided at subsidized prices. Over time, it should be possible to reduce the subsidy component, so that household production decisions reflect the true costs of inputs.
- The Banner Administration will need to assist households in obtaining financial credit to support their crop and livestock production activities. It may be necessary for the Banner Administration to provide this service for a considerable length of time, unless a commercial bank for agricultural credit is established in the region.
- The Banner Administration should enable residents of the Ecological Migration Villages to operate and maintain the center pivot irrigation systems.
- The Banner Administration should also consider supporting the development of joint stock cooperatives in which the households collaborate in the production and marketing of their dairy products.
- The Banner Administration should support the development of true markets for all inputs and outputs in the region, while allowing households to respond to market prices when choosing inputs and outputs. The Banner Administration can be helpful in supporting the construction of roads and other facilities needed to bring crops and livestock to market, and to make inputs, such as fertilizer, chemicals, and veterinary care, available to farmers. The Banner Administration also can be helpful in establishing rules for enforcing contracts and in minimizing transaction and information costs for farmers wishing to engage in new production activities.

- The Banner Administration should support market development of other enterprises that will provide employment opportunities for Village residents, such as dairy product manufacturing, crop and livestock marketing, and other service industries.
- The Banner Administration will need to establish a quality control program for dairy products and to assist Village residents in achieving the goals of that program. The Banner will also need to link milk quality to the price that is paid to encourage production improvements over time.

8.3.6 Summary of Economics

Center pivot systems will enable the Zhenglan Banner Administration to establish Ecological Migration Villages in which residents raise dairy cows and produce milk for sale in local markets. Economic feasibility will not be an issue during the Demonstration Project, given that both the fixed and variable costs are being shared by the Valmont Irrigation Company and the Banner Administration. Long-term feasibility should be addressed from both financial and economic perspectives. The project will be financially viable for households if their returns exceed their costs of production. Economic feasibility requires that all costs are recovered, including any fixed and variable costs paid by the Banner Administration and the opportunity costs of scarce resources. Policies that encourage households to acknowledge the full costs of inputs, while providing them with access to training and affordable credit, will enhance the likelihood that using center pivots to reduce desertification and support agricultural production in northern China will be financially and economically feasible.

9.0 ENVIRONMENTAL AND ECOLOGICAL CONCERNS

9.1 Impacts on Human Health

9.1.1 Air

The air quality in Inner Mongolia varies drastically with season. The most significant generation of airborne dust has traditionally occurred in the months of March, April and May. In the past five years, these dust storms have begun to occur in winter months when there is not significant snow cover. The deserts of northern and western China are the second largest source of atmospheric dust in the world; only the Sahara Desert generates more dust annually than this region of China. Within China, the highest generation rates are observed in the Takelamagan Desert in the far western part of China. The second highest rates of dust generation are observed in the general area of this Demonstration Project, along the edges of the Gobi Desert. Dust generation rates (0.03mm particle size) are reported to be approximately 6.0×10^{-5} ton/ha year. Recent dust storms over the past few years have impacted Beijing, Korea, Japan and the air quality as far away as the eastern United States. Some of the worst air quality is experienced near the source of the dust's origin (Jie Xuan and Guoliang Lhi, 2002).

Air quality will be improved locally by this project. The degree to which the Demonstration Project will reduce dust generation, in the short term, will be undetectable. Even though

hundreds of hectares will be released from grazing pressure during this demonstration, there will not be an observable effect even on local air quality for at least two reasons:

- The dust generated from the Demonstration Area represents only a small part of the total dust generated in northern China. The total estimated dust released from all of north and west China is 25 million tons (Jie Xuan and Guoliang Lhi, 2002). A 1,000 ha demonstration area releases only an estimated 0.76 ton.
- The grasslands to be supplanted by the center pivot will probably not have recovered from the damage inflicted through climate change and overgrazing during the limited duration of the Demonstration Project.

If strategies to re-vegetate the vast expanses of the grasslands were to be realized on a large scale, there would clearly be a significant improvement in both local and regional air quality. Another way to look at the data provided above is that for every 1,000 ha project of this type, 0.76 tons of dust is removed from the atmosphere. Inner Mongolia reportedly has 7.22 million hectares of cultivated land and 86.66 million hectares of grassland (China Internet Information Center, 2003). If the combined 94 million hectares were allowed to recover, the projected reduction in dust would exceed 760,000 tons annually. Widespread wind erosion control measures clearly have the potential to significantly improve both local and regional air quality.

9.1.2 Water

The subject of groundwater impacts has been discussed in significant detail in Section 3.0. In the short term, it is determined to be extremely unlikely that there will be an adverse impact to groundwater or surface waters in this area. The long-term impact of this strategy on surface water and groundwater requires evaluation as described in that section.

Significant impacts to groundwater quality from over application of both human and livestock waste and commercial fertilizers must be managed to protect the long-term health of local groundwater. Livestock waste must be considered as a source of nutrients under the 75 ha irrigated area. The combined available nutrients from all manure applications and any added commercial fertilizer must not exceed the nutrient uptake from the crops grown each year. Because the nitrogen in the livestock waste is primarily in the organic form, the nitrogen is released over several years. The annual nitrogen release rate for the livestock waste can be assumed to be 30% of the total nitrogen each year. Commercial fertilizers are usually fully available in the first year so all of the contained nitrogen should be counted in the first year. Phosphorous and potassium must be maintained at levels, which meet but do not exceed crop requirements. These guidelines should be used only until site-specific information can be established. Total nutrient applications, especially nitrogen, cannot exceed crop uptake without the potential for long-term adverse impact to the local groundwater.

Groundwater quality can also be protected by careful control of irrigation activities. If soils are saturated due to over-irrigation, then the available nutrients that are intended for use in plant growth can be washed or leached beyond the reach of the crop roots and into the underlying groundwater. Following the recommended irrigation schedule will assure the availability of

nutrients to the crop and the protection of groundwater resources. Training for proper irrigation scheduling is provided as part of the Demonstration Project.

The long-term implementation of this strategy must include a thorough assessment of the impacts on groundwater quantity. The policy recommendation outlined in Section 8.3.5 should be followed to assess the impact to the region and to downgradient users. It is essential to demonstrate that total groundwater demand, including demand associated with the fully implemented project to combat desertification, does not exceed available aquifer recharge. Over-appropriation of the groundwater may result in the loss of surface water resources, the requirement to deepen wells, and can potentially make enterprises that are dependent upon groundwater infeasible.

This demonstration utilizes one of the most water-efficient technologies available for forage production. As a result, this Demonstration Project minimizes the potential for both the long-term and short-term impact to water resources in the grasslands. The use of water-efficient equipment makes it easier to ensure that irrigation demand does not exceed the sustainable supply of groundwater resources.

9.1.3 Land

Significant adverse impact to the land through overgrazing of the grasslands is widely documented. Overgrazing removes the grass cover and exposes the soil to the effects of the wind. Shortly after overgrazing, the surface layer of the soil is still protected by a thick, dense mat of decaying grass roots and a zone of high organic-matter content, created by the decay of plant residue over thousands of years. Water erosion, livestock paths, roads or vehicle tracks can quickly cause a breach in this protective layer. It is at this point that significant soil movement takes place, and the fine textured soil below is exposed to wind erosion. This begins the formation of unstable areas of soil that are unable to support grass because of their constant motion. It is reported that nearly 60% of the region is desertified or potentially desertified with 670,000 additional hectares moving into the classification each year (China Internet Information Center, 2003).

The scope of this Demonstration Project is focused on lessening grazing pressure and, in turn, reducing current degradation of the grassland resources. This project removes grazing pressure from the grasslands and will allow the areas that are still stable to recover in a few, short years. The areas that regenerate vegetative cover quickly will not only prevent further development of unstable landforms but will also serve as a source of native seed. Active government projects are also underway to stabilize areas that have been most disturbed.

These changes should have a positive impact on the land in both the long- and short- term. The reduction in grazing pressure proposed in this Demonstration Project should have a positive impact on both stable and unstable landforms. The active efforts included in ongoing government-sponsored stabilization programs will greatly facilitate the recovery.

9.2 Impacts to Ecological Systems

9.2.1 Plant Communities

The existing overgrazing of the grasslands has had a devastating impact on the diversity and viability of plant species in degraded areas. Some of the overgrazed areas were observed to have sheep digging out the root crown of the plants for forage. In areas that have become unstable, the entire plant community has been destroyed. This destruction is limited in scale with adjacent undisturbed areas providing seed for recovery. Inner Mongolia is reported to have 2,351 species of plants including trees, shrubs, and herbs. No current inventory of plant species was available for the area surrounding Zhenglan Qi.

Because of the localized nature (75 ha) of this demonstration, there is little potential for significant impacts to the native plant community to occur. In addition, there were no significantly threatened species of plants reported in this area. Replication of this program on a wider scale should consider possible impact to rare or precious plants that may have a very limited range.

The changes to the larger area associated with this proposed program can be expected to have a positive short- and long-term impact on the recovery of the historical diversity in the grasslands. If this approach is successful, approximately 10 ha to 100 ha of native grassland will be allowed to recover for every hectare that is placed under modern farm management as part of the Ecological Migration Village program. The program being demonstrated as part of this project has the potential to significantly benefit the native plant communities in Zhenglan Qi.

9.2.2 Animal Communities

Inner Mongolia is host to 117-plus species of wild animals and 362 species of birds. Forty-nine species are under state or regional protection with ten considered precious and rare. A current inventory for the area of Zhenglan Qi was not available. For further information, refer to China Internet Information Center, 2003 and China Endangered Species Information System (CESIS). It should be noted, however, that neither protected, precious, nor rare species were observed or reported in the area of the proposed Ecological Migration Village.

The location of this Demonstration Project adjacent to a developed urban area minimizes the potential for additional short-term adverse impacts to rare or precious species. The area of the Demonstration Project site has been heavily grazed and has undergone intensive rodent control efforts. In its present state, the area proposed for irrigated agricultural development in support of the Ecological Migration Village does not appear to have unique value to wildlife. The short-term impacts of reduced grazing on the open grasslands will be to facilitate additional cover and forage to support wildlife. Reduction in rodent control efforts will help the recovery of carnivorous mammals and birds of prey. The long-term result of this reduction in grazing pressure will be a slow, but steady return of the natural wildlife to the grasslands.

The long-term impacts on the balance of rare and precious wildlife will depend on a host of factors. These include development pressures only partially related to the Ecological Migration

Villages. In general, the lessening of competition from livestock and the reduced pressure from human encroachment on their territories would be expected to significantly benefit both the number and the diversity of wildlife in areas following this management practice.

10.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this assessment, this Demonstration Project appears feasible from a number of standpoints including engineering, water, soil, irrigation and crop production, livestock management, social structure, and financial and economic viability. In addition, the Demonstration Project is expected to be beneficial to a number of environmental and ecological issues in the region. Although the project will likely suffer from reduced forage availability associated with first-year productions and the lack of appropriate silage production technology, these are logistical risks that can be easily mitigated by the stockpiling of sufficient feedstock for the 2003 winter season. On the whole, the minor limitations associated with the project are judged to be of little consequence to the short-term viability of this strategy given the high level of support offered by the private and government partners in this project. Given the overwhelming short-term positive impacts that this project is expected to have on the area, the Demonstration Project is considered to be feasible.

While no significant detriments associated with the short-term implementation of the Demonstration Project were discovered, this assessment has identified a number of issues that need to be addressed to help ensure the long-term sustainability and replicability of the program. The work performed to date has revealed substantial evidence indicating that the conversion of the herding families' livelihood from grazed animal production to a more sedentary agricultural setting is a viable long-term strategy for the control of desertification and sandstorms. However, the following issues, which are beyond the scope of this assessment and not all-inclusive, will need to be researched and mitigated before a conclusive determination can be made regarding the degree of long-term success to be expected using a center pivot in support of the Ecological Migration Village program:

- The access to technical training to maximize irrigation efficiency, equipment maintenance, forage production, silage production, and dairy management
- Researching and managing water resources to ensure sustainability and appropriate allocation planning
- Maintenance of soil fertility and conditioning
- Ensuring seed stock availability, research, and production training
- Matching realistic forage production to dairy stocking rates
- Incorporating appropriate silage making techniques into current farming practices
- Providing access to animal health and management resources and training
- Minimizing negative social impacts due to equity, gender, employment opportunities, cultural differences, and community wealth distribution
- Implementing policies that encourage households to acknowledge the full costs of inputs, while providing them with access to training and affordable credit
- Successful programs to prevent unauthorized grazing activities and to promote the rehabilitation of the natural grasslands

Given the national importance of finding sustainable solutions to the control of desertification and dust storms, and the local importance of a successful Ecological Migration Village Program, these challenges appear to be solvable through careful study, innovative programs, and the implementation of sound governmental policy.

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Appendix A

Grazing Intensification Methods Pre-Screening

Task 2.0
Grant Number : GH2381659

Four alternative methods for controlling desertification were evaluated in a simplified matrix evaluation system. Information for the evaluation was collected during two trips to the project site in Zhenglan Qi, and through interviews with both Banner, League, and State Forestry Administration officials. It was concluded that the use of local irrigated forage production combined with confined livestock (dairy) production was the option with the greatest opportunity for significant contribution to the control of desertification and dust storms.

valmont
WATER MANAGEMENT GROUP

CCICCD
State Forestry Administration
Peoples' Republic of China

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Client Approval

We have thoroughly reviewed the report titled "Grazing Intensification Methods Pre-Screening" and feel that it fairly represents the observations and findings of this phase of the study, and that it is as described in the Contract for Desertification Prevention project in China, USTDA Grant No.: GH 2381659.

"The services for which disbursement is requested by the Contractor have been performed satisfactorily, in accordance with applicable Contract provisions and the terms and conditions of the TDA Grant Agreement."

Signature_____________________ Date 8.22-2003

Mr. Liu Tuo
Director General
National Bureau to Combat Desertification

APPENDIX A

GRAZING INTENSIFICATION METHODS PRE-SCREENING

1.0 BACKGROUND

The background of this project is discussed in greater detail in the Inception Study. In summary, this project is intended to demonstrate that modern mechanical move irrigation equipment can be effectively utilized in an ongoing program to limit desertification and to control the development of sandstorms. A wide range of options exists for accomplishing this goal. Ongoing programs at the selected demonstration site in Zhenglan Qi heavily impacted this process. State Forestry Authority and Local Banner officials have been working on the problem of desertification for over two decades and have considerable experience with the local conditions. This screening process relied heavily upon their oral input and existing strategies to optimize the contribution of center pivot irrigation.

2.0 STATED OBJECTIVES OF THE DESERTIFICATION AND SANDSTORM CONTROL PROGRAM IN ZHENGLAN QI

The process of controlling sandstorms and desertification is complex. Simply understanding that there are too many animals grazing on the grasslands is only the beginning. Programs must consider the impact on both national and local goals for economic and social change. In addition, the welfare of those herders living on the grasslands must be also considered. Interviews with both national and local officials demonstrated that a set of objectives had been developed for the region. These objectives can be divided into four key categories relating to desertification and sandstorm control. These objectives were:

- Recovery of the grasslands
- Improvement of farm incomes
- Modernization of agricultural production
- Increased potential for new farm related industries

2.1 Recovery of the Grasslands

Oral records extending many generations tell of the vast grasslands typified by the stories of the Khan Dynasty. This oral history is depicted visually by the art of the region. Paintings and folk music alike tell of the vast rain-fed plains occupied only by nomadic herdsman and their livestock. Misguided land management policies, climate change, and increasing populations have changed many areas into vast, barren, wind-swept plains with unstable landforms that are highly susceptible to wind erosion. While the impact of the dust storm may be felt far away from Inner Mongolia in places like Beijing and Tokyo, the worst impact is in the grasslands themselves. In these once pristine grasslands areas, the blowing sand now swallows buildings, chokes the herdsmen, and deprives their livestock of forage. Recovery of the grasslands with its thick vegetative cover and protective root mat is considered to be one of the most important issues in the minds of Banner, League, Regional, and National leaders. The ability of the selected strategy to support the recovery of the grasslands was considered by all parties to be of the greatest importance in selecting a management alternative for the demonstration project.

2.2 Improved Farm Incomes

Interviews conducted with herding families as part of this study indicated that the present economic conditions of many families in the Zhenglan Qi area are declining measurably with each passing year. This loss is being driven, of course, by the decline in the grassland productivity upon which the herding families depend. They are forced to sell more of their stock each year to cover the decline in income and herd subsistence, and now many of the families are importing virtually all of the forage for their animals. Work outside the farm is nearly impossible because of the isolation. The only employment opportunities are with nearby farms or those within the Ga cha that are struggling with the same environmental and economic challenges. The selected strategy for using mechanical move irrigation equipment to reduce the effects of desertification must provide opportunities for improved farm income.

2.3 Modernization of Agricultural Production

With each passing year it is harder and harder for traditional agricultural practices to remain economically viable. The movement of China into the World Trade Organization within recent years is but one example of this change. Eventually, every agricultural system finds itself selling against another similar production center located someplace else in the world. The system with the lowest true production cost frequently wins unless the responsible government entity steps in with subsidies or market adjustment.

All levels of government agreed that the introduction of modern farming practices with the potential for bringing production cost in line with world market prices was an important requirement for the strategy selected for this project.

2.4 Potential For New Farm Related Industries

All parties viewed a strategy for control of desertification and dust storms that created non-farm jobs in a positive way. This opportunity was viewed as having two benefits. First, it would allow the farm families a way to supplement their farm incomes. Secondly, it would provide community diversification and would allow some individuals to move out of farming and herding vocations into a new class of industrial workers. At the Banner level, this benefit was very strongly supported and considered to be an integral part of any proposed solution.

These four criteria were used to rank the various management alternatives for using mechanical irrigation to facilitate the control of desertification and sandstorms.

3.0 MANAGEMENT ALTERNATIVES FOR CONTROLLING SANDSTORMS AND DESERTIFICATION WITH MECHANIZED IRRIGATION

Four basic alternatives exist for using mechanical move irrigation to assist in the control of desertification and sandstorms. In order to be considered, each of these alternatives needed to be able to address the objectives identified by the local, regional, and national government leaders. Forage could be grown locally, or it could be produced in a centralized regional facility and distributed through a transportation system to the users. There are even those who proposed to produce forage in the water-rich south and transport it to the dry northwestern part of China. Another alternative was for the livestock to be fed on the open grasslands and allowed to continue grazing, or they could be fed in confined animal settings such as barns.

3.1 Option 1: Locally Produced Forage With Confined Feeding

This option would utilize a decentralized series of mechanical move irrigation systems that would be sized to produce forage sufficient for the number of animals at a given location. This option assumes a village-like setting near the forage production facility. This option also assumes that animals would be housed in barns or shelters and not allowed to graze on the grasslands at any time of the year. This option does not preclude seasonal harvesting of natural forage (hay) as long as prescribed harvesting practices were followed.

3.2 Option 2: Locally Produced Forage With Open Grazing

This option uses the same irrigation assumptions as Option 1, but assumes that the livestock would be allowed to return to the grasslands to graze for some or all of the year. Hay production would also be a possibility, but would be much less likely since the lands would be grazed. This option could have the livestock production centralized in one location or decentralized on widely scattered farms, as is the case at present. Either the forage or the livestock would need to be transported a significant distance for this option to be successfully implemented.

3.3 Option 3: Imported Forage With Confined Feeding

Forage would be produced at centralized production facilities under this option. These large regional or even national forage production facilities would then transport their production to the point of need. Animals would be confined to barns and feeding areas. They would not be allowed to graze on the open grasslands at any time of the year. The opportunity for hay production with the previously defined limitations would also be possible under this scenario.

3.4 Option 4: Imported Forage With Open Grazing

This scenario combines the centralized production of forage described in Option 3 with the continuation of open grazing practices as defined in Option 2. This option is actually very similar to the strategy presently being used by herders in the most heavily overgrazed areas.

4.0 GRAZING INTENSIFICATION METHODS PRE-SCREENING

To rank the various options, each of the management alternatives was evaluated using the four objectives described by the local, regional, and national leadership. The options were evaluated as being highly in support of the objective (3), moderately supportive (2), or as having a low support value (1). The options were evaluated against each other rather than against an absolute standard. This evaluation resulted in the creation of Table 1.

Table 1. Grazing Intensification Methods – Pre-Screening

GRAZING INTENSIFICATION METHODS - PRE-SCREENING

	Rank	Recovery of Grasslands	Improved Farm Incomes	Modernization of Agricultural Production	Potential for New Farm Related Industries	Total
Locally Produced Forage for Confined Feeding	1	High (3)	High (3)	High (3)	High (3)	12
Locally Produced Forage with Open Grazing	2	Medium (2)	High (3)	Medium (2)	Medium (2)	9
Imported Forage for Confined Feeding	3	High (3)	Medium (2)	High (3)	High (3)	11
Imported Forage with Open Grazing	4	Medium (2)	Medium (2)	Low (1)	Low (1)	6

5.0 DISCUSSION

5.1 Locally Produced Forage for Confined Feeding

This option was scored high in all criteria. The use of confined feeding reduces the pressure on the grasslands to the maximum extent possible and thereby facilitates the natural recovery of the grasslands. Seasonal harvesting of forage for hay is believed to be more easily controlled and prescribed than open grazing. Farm incomes are expected to recover for two reasons. The first is that there will be a reliable source of forage from the mechanical move irrigation equipment. The second reason for this high ranking is that the confined feeding approach allows the agricultural activities to be closer to an urban area where secondary (non-farm) income from a nearby village is more likely. This option would also provide a year round labor force for industrial and commercial production.

This option also offers the opportunity to modernize agricultural production by including mechanical irrigation and the construction of production buildings. The potential for new farm related industries is high because businesses will be created to meet the needs of forage production, commodity processing, and infrastructure construction. For example, the Banner officials pointed out that a dairy production alternative in this setting would include processing facilities and the associated labor requirement.

5.2 Locally Produced Forage With Open Grazing

The score for the recovery of the grasslands was lower than the previous option because this plan proposes to continue with managed grazing of the open grasslands. Even with strict controls on open grazing, the difficulties associated with their enforcement would create a decreased likelihood for natural recovery of the grasslands. Farm incomes would be expected to increase not only because of the forage production but also because of the utilization of open grazing to supplement forage production. However, a decentralized grazing strategy would not fit well with a centrally located village, since either the livestock would need to be transported to open grazing, or the products would need to be collected from a great distance. This has the potential to decrease net farm income because of transportation cost and the chance of product or livestock transport loss.

Modernization of agriculture production scored lower than Option 1 by virtue of the lack of advantage offered by confined feeding. Local and regional leaders view confined management of livestock as a step toward more efficient production. The potential for new farm related industries was also scored lower. The lower score for this option was based on the fact that the continued grazing of the livestock would require the attention of the male member of the household (according to gender tradition) and would not provide for the availability of a year round labor force to support industrial or commercial production.

5.3 Imported Forage for Confined Feeding

In Option 1 the forage was produced at the site of its use. With this option, the forage would be produced someplace else and transported to the location of use. As in Option 1, livestock production activities would take place in confined conditions and open grazing would not be allowed. This option would offer an excellent opportunity for the recovery of the grasslands because the impacts would be limited to a seasonal cutting of forage that could be strictly managed. The potential for improved farm income was ranked as medium even though this option assumes the importation of abundant forage and the advantages of confined feeding. The basis of this moderate rating was the belief that the importing of forage would be significantly more expensive than local production, due primarily to transportation cost. The degree to which farm incomes would be impacted is difficult to determine because of the heavily managed farm prices. Nonetheless, it seemed intuitive that the net income from livestock production would be diminished.

The potential for modernization would be equal to Option 1 because both confined feeding and modern irrigation methods would be added to the agricultural production program. The potential for new farm related industries was also rated high, based upon the belief that the use of confined feeding would free the herders for industrial work and the importing of forage would create agricultural jobs that were only slightly less numerous than those created by local forage production.

5.4 Imported Forage with Open Grazing

The potential for the recovery of the grasslands was rated as medium because grazing would continue. This would lessen the potential for the natural grasslands recovery. Incomes of farmers buying imported forage would not be expected to improve as much as those with local forage production due to the additional transportation cost. Interestingly enough, if the importation of forage were to occur, the added cost for delivery of the forage to the remote rural locations that are presently used would add only a slight cost over transportation to a central feeding facility. Nonetheless, a net decrease in farm income seems unavoidable under this option. Furthermore, the requirement to continue herding would reduce the opportunities for off-farm income.

Modernization of agricultural production was rated as low. This scenario is essentially the same management strategy that is presently being practiced by those who have completely exhausted the production capacity of the grasslands. This option represents a "no change from the present" management strategy. Much the same can be said about this option's potential for creating new farm-related industries. The family members would remain occupied in the herding activities, thereby reducing their availability for new industrial or commercial jobs. It is possible that the financial disadvantages of this option could drive the family to split and seek income from both livestock production and industrial income sources. In the winter this would divide families for long periods of time due to the bitter cold and windy conditions that are common in this region.

6.0 CONCLUSIONS

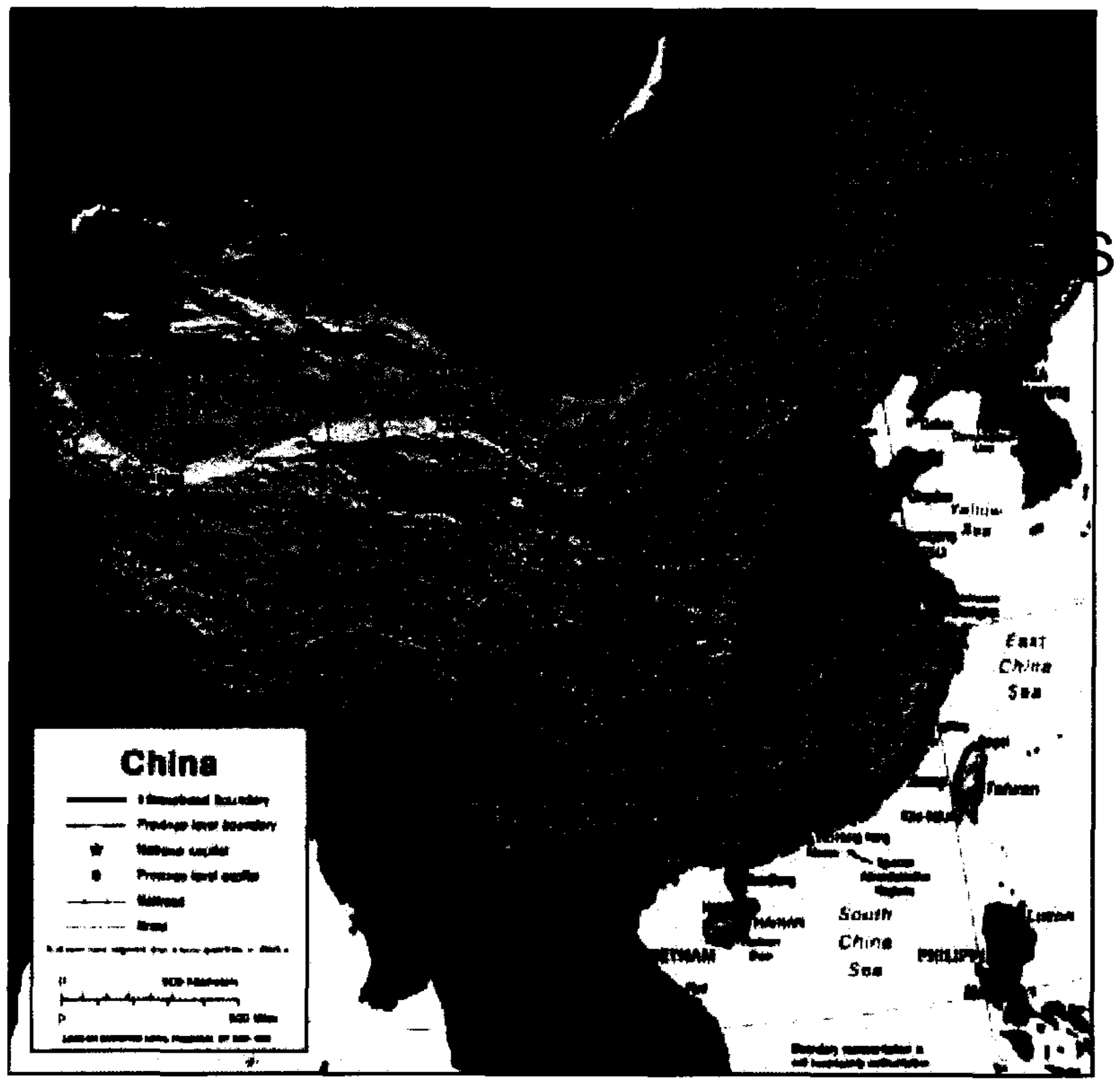
The option with the highest matrix score includes the local production of forage for use in confined feeding of livestock. The local leadership had agreed that this strategy did not lend itself well to the production of goats and sheep. They concluded that the production of dairy products under the conditions outlined in Option 1 was the strategy with the greatest likelihood for success. There are concurrent projects underway for the importation of dairy cattle from Australia. A milk processing facility is in the planning stages for when the threshold volume of milk can be reliably produced. Reliable high quality forage is a critical ingredient in the development of the proposed dairy industry.

Based upon the selection of Option 1, the feasibility study will evaluate a demonstration project that will be designed to provide forage for approximately 140 to 200 head of dairy cows belonging to 70 to 100 families. These families will be located in one of the Ecological Relocation Villages that are presently being constructed by Zhenglan Qi officials.

DESERTIFICATION CONTROL PILOT STUDY

PROJECT DESIGN PLANS

STATE ADMINISTRATION OF FORESTRY, VALMONT INDUSTRIES, U.S. TRADE DEVELOPMENT AGENCY
ZHENGLAN BANNER, INNER MONGOLIA, CHINA



SITE

INDEX OF DRAWINGS

SHEET	
	GENERAL DRAWINGS
G-1	SITE MAP & INDEX OF DRAWINGS
G-2	SITE LOCATION PLAN - ZHENGLAN BANNER MAP
G-3	SITE LOCATION PLAN - TOPOGRAPHIC AREA MAP
G-4	SITE LOCATION PLAN - GRASSLAND CONDITION AREA MAP
G-5	SITE LOCATION PLAN - SOIL SURVEY AREA MAP
G-6	STANDARD CIVIL SYMBOLS & THRUST BLOCKS
G-7	STANDARD MECHANICAL SYMBOLS
	CENTER PIVOT DRAWINGS
C-1	CENTER PIVOT SITE LAYOUT
C-2	PROCESS FLOW DIAGRAM
C-3	PIVOT POINT LAYOUT
C-4	PIPELINE ROUTING PLAN
C-5	WATER DELIVERY SYSTEM MECHANICAL
C-6	SITE IMPROVEMENT DETAILS
C-7	SITE ELECTRICAL LAYOUT
C-8	CENTER PIVOT LAYOUT ALTERNATIVE

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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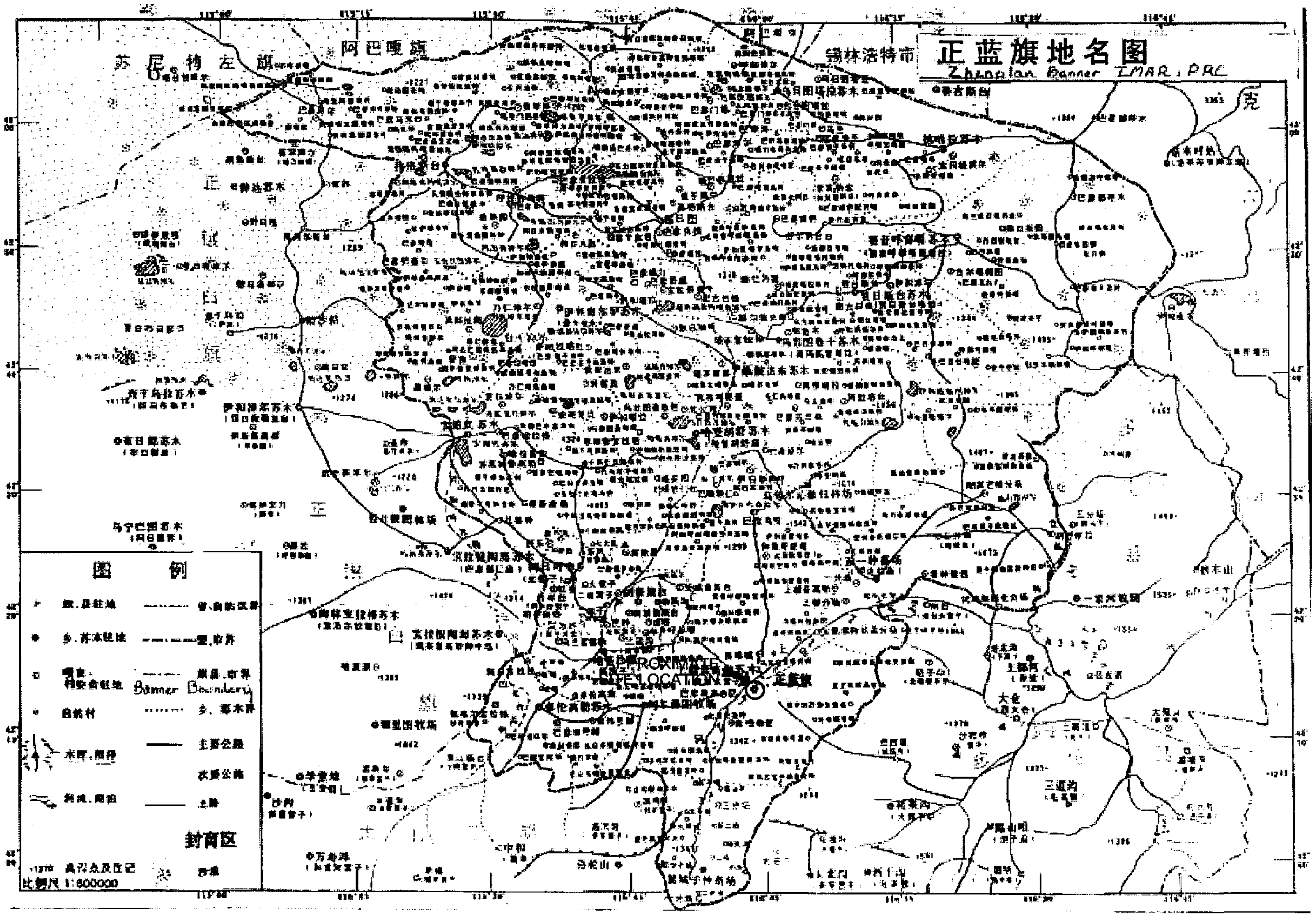
SITE MAP & INDEX OF DRAWINGS

PROJECT DESIGN PLANS

SHEET
G-1



ZHENGLAN BANNER

NOT TO SCALE

BANNER BOUNDARY

2223044G-2R.dwg DEO 5/19/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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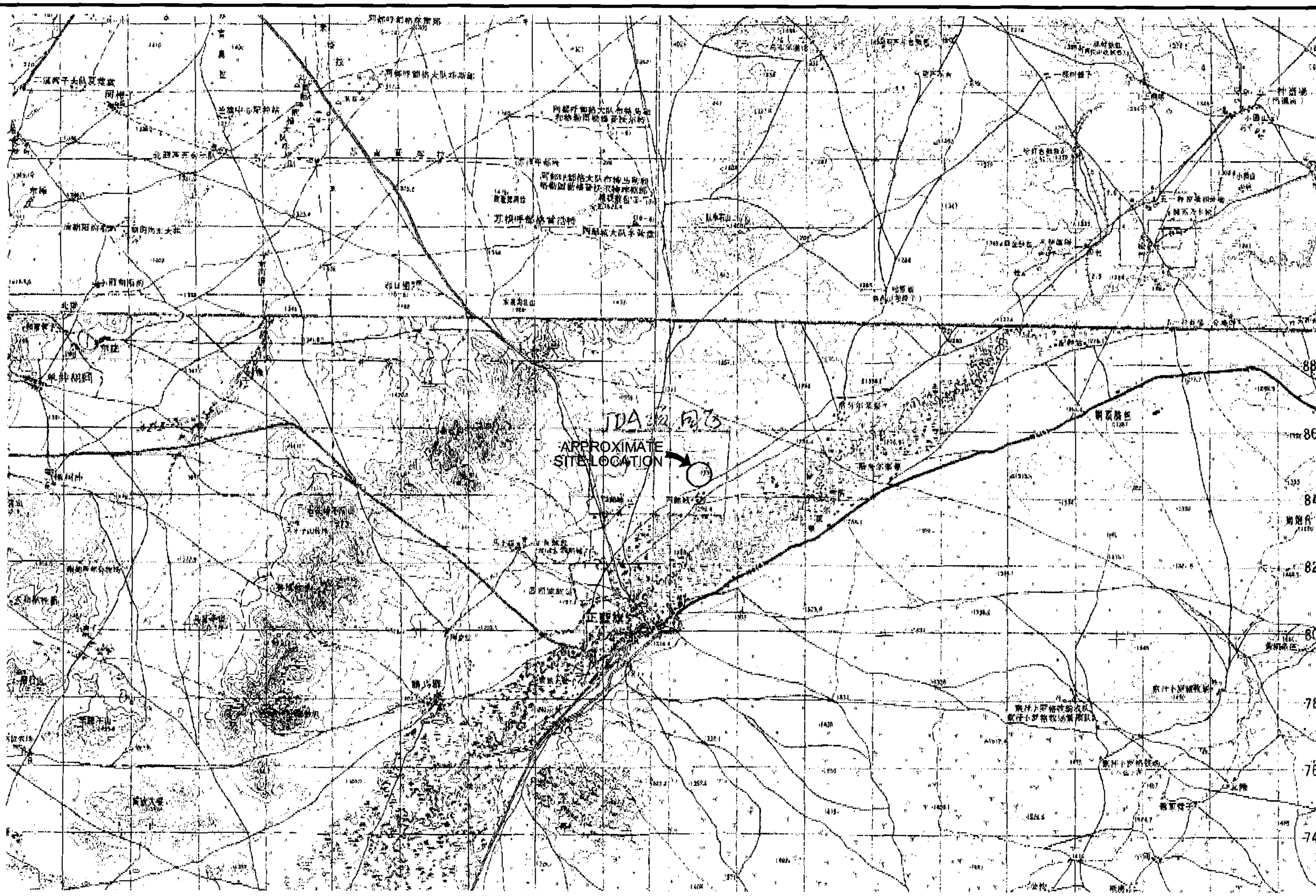
SITE LOCATION PLAN
ZHENGLAN BANNER MAP

PROJECT DESIGN PLANS

SHEET G-2



TOPOGRAPHIC MAP SHOWING SITE LOCATION

SCALE: 1cm = 600M

0 1200 FEET

SCALE

2223044G3&4R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	–	–	MO/DAY/YR
2	–	–	MO/DAY/YR
3	–	–	MO/DAY/YR
4	–	–	MO/DAY/YR
5	–	–	MO/DAY/YR

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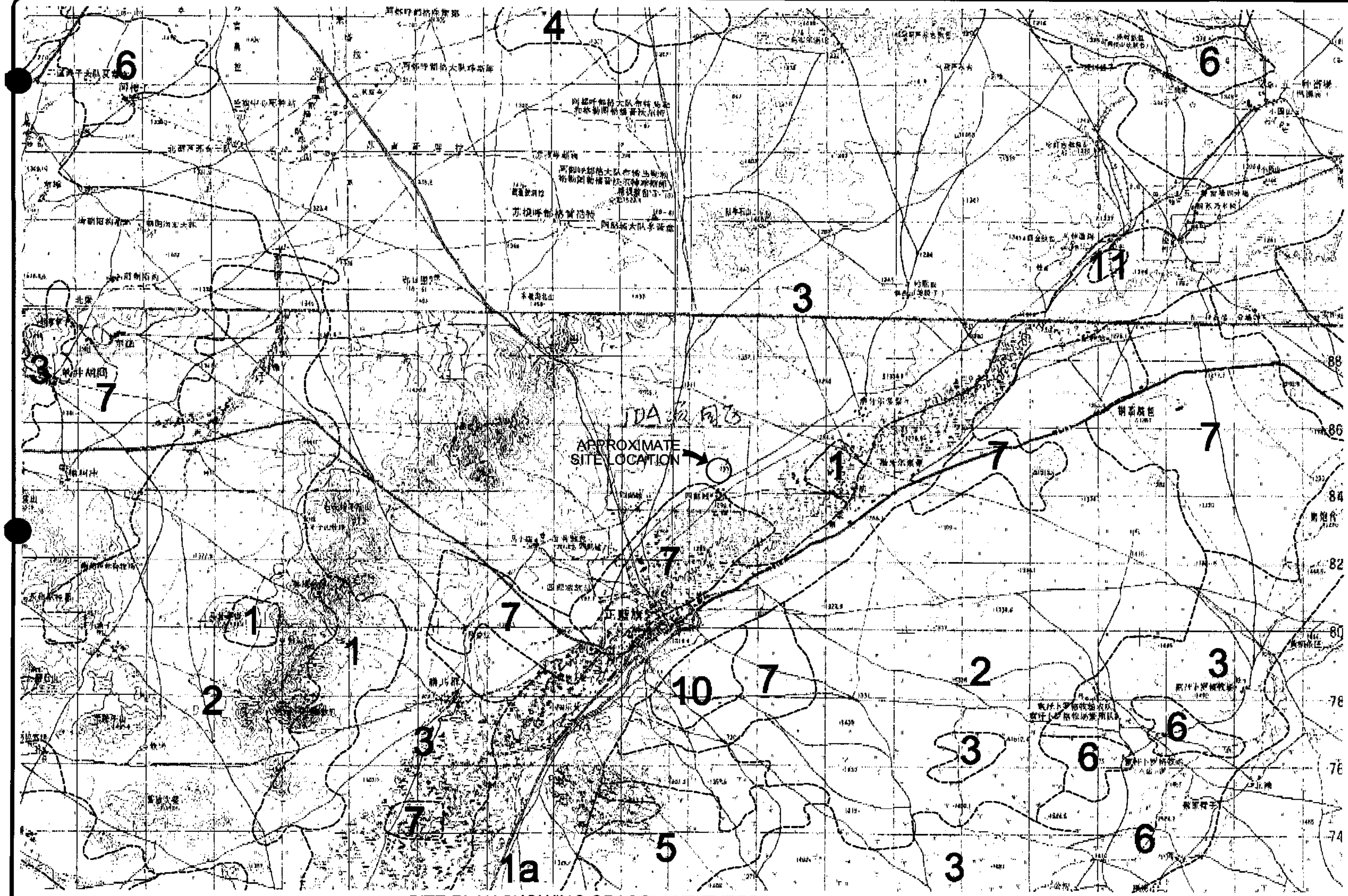
SITE LOCATION PLAN
TOPOGRAPHIC AREA MAP

PROJECT DESIGN PLANS

SHEET
G-3



SITE PLAN SHOWING GRASSLAND TYPES

SCALE: 1cm = 600M

0 1200 FEET

SCALE

GRASSLAND TYPES LEGEND

1	NON-DEGRADED GRASSLAND	6	SHIFT SAND LAND
1a	NON-DEGRADED MUD GRASSLAND	7	CROP LAND
2	MIDDLE-DEGRADED GRASSLAND	8	WOOD LAND
2a	MIDDLE-DEGRADED MUD GRASSLAND	9	OPEN LAND, ABANDONED
3	HEAVILY-DEGRADED GRASSLAND	9a	SALINITY ABANDONED
3a	HEAVILY-DEGRADED MUD GRASSLAND	10	TOWNSHIP
4	FIXED SAND LAND	11	WATER BODY
5	HALF-SHIFT SAND LAND		= GRASSLAND TYPE BOUNDARY

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	–	–	MO/DAY/YR
2	–	–	MO/DAY/YR
3	–	–	MO/DAY/YR
4	–	–	MO/DAY/YR
5	–	–	MO/DAY/YR

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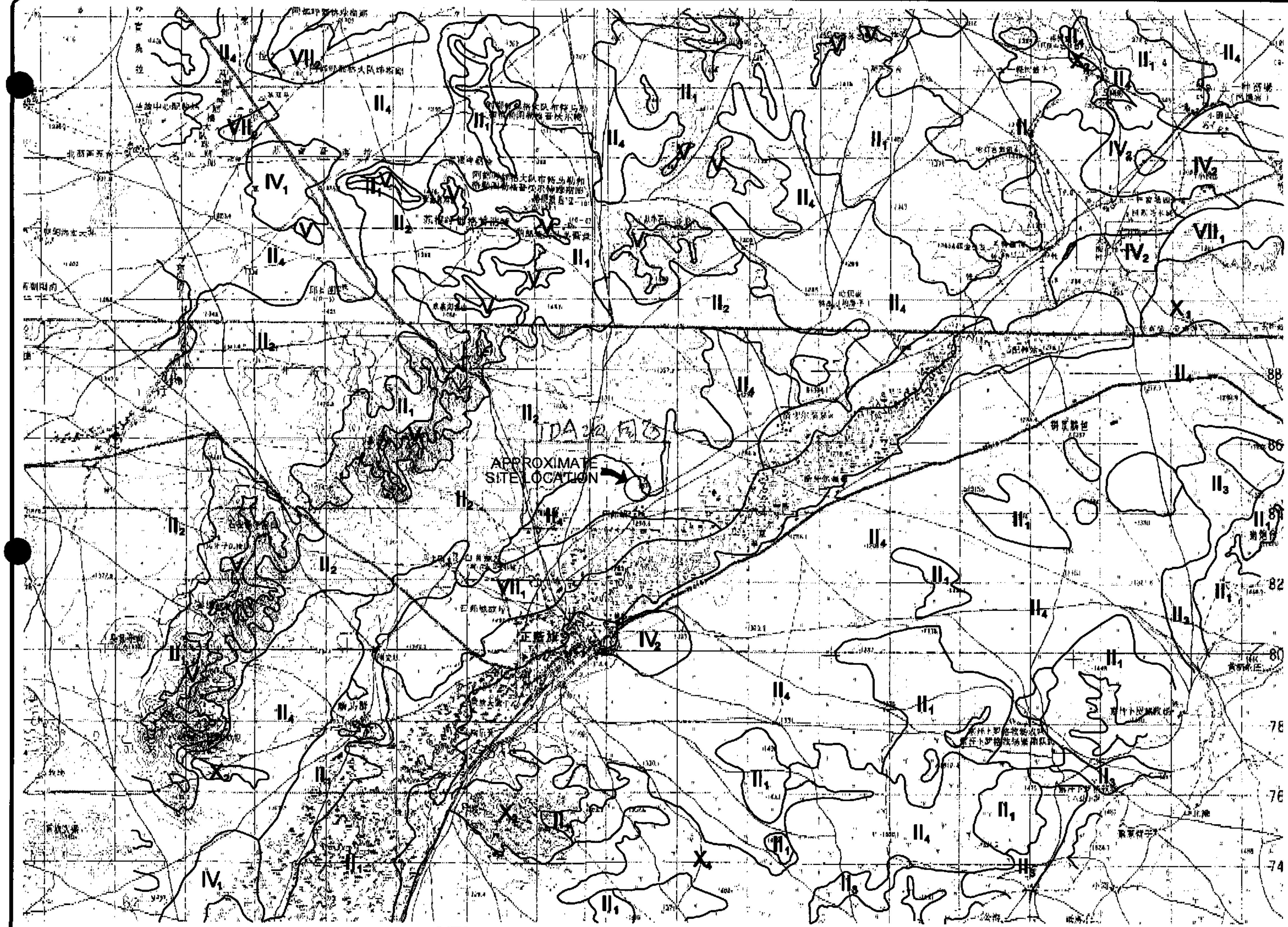
SITE LOCATION PLAN
GRASSLAND CONDITION AREA MAP

PROJECT DESIGN PLANS

SHEET
G-4



SITE LOCATION PLAN SOIL SURVEY AREA MAP

SCALE: 1cm = 600M

0 1200 FEET
SCALE

SOIL LEGEND

SYMBOL	SOIL TYPE	SUB TYPE	GROUP	POSITION
II2	BROWN CALCIUM	DARK BROWN CALCIUM	DARK BROWN LOESS	TOE SLOPE
	NOTES: "A" HORIZON DEEP, CLOSE TO BLACK CALCIUM SOIL, CLICHÉ LAYER AT DEPTH			
II1	BROWN CALCIUM	DARK BROWN CALCIUM	GRAY LOESS	LOW HILL
	NOTES: "A" HORIZON 35-55 CM, VEGETATION, STEPPE			
II4	BROWN CALCIUM	DARK BROWN	BROWN CLAY	INTER HILL PLAIN OF MT.
	NOTES: "A" HORIZON 30-40 CM, SANDY, KESHI STEPPE.			
VII1	MUD SOIL	DARK MUD	SANDY GRAY MUD SOIL	LOW LAND BANK OF RIVER
	NOTES: "A" HORIZON 30-40 CM, GRAY BROWN COLOR, WET AREAS ALONG RIVERS			

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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SITE LOCATION PLAN
SOIL SURVEY AREA MAP

PROJECT DESIGN PLANS

SHEET G-5

GENERAL

- EXISTING EQUIPMENT OR MATERIALS TO BE REMOVED
- TO BE BUILT FOR FUTURE REMOVAL
- NEW FACILITIES (SOLID)
- EXISTING
- NEW BACKGROUND
- PROPERTY LINE, PHANTOM LINE OR MATCH LINE
- CENTERLINE
- HIDDEN LINE OR FUTURE IMPROVEMENTS
- WATER SURFACE

@	AT
& OR ⨍	AND
ø	ROUND OR DIAMETER
∠	ANGLE
℄	CENTER LINE
⅊	PLATE OR PROPERTY LINE
2	NOTE DESIGNATION
W/	WITH
W/O	WITHOUT

CIVIL

- NATURAL GROUND OR GRADE
- GRANULAR MATERIAL SUCH AS CRUSHED ROCK OR GRAVEL
- HDPE IN PLAN
- EXISTING PAVEMENT IN PLAN
- PAVEMENT IN PLAN
- GRAVEL IN PLAN
- CONCRETE IN PLAN
- FENCE
- RAILROAD
- 110 EXISTING GRADE CONTOURS
- EXISTING CONTOURS DEMO
- 110 FINISH GRADE CONTOURS
- +120.0 EXISTING SPOT ELEVATION
- +110.50 FINISH GRADE SPOT ELEVATION
- 112.50 / 112.00 TOP OF CURB ELEVATION / GUTTER OR GROUND ELEVATION
- SWALE OR DEPRESSION
- EDGE OF WATER; FLOWLINE WITH DIRECTIONAL ARROW
- 3:1 SLOPE (3 HOR. TO 1 VERT.)
- CUT OR FILL SLOPE; ARROWS POINT DOWN SLOPE
- B9 SOIL BORING AND DESIGNATION
- HYDRANT
- BURIED VALVE
- MH MANHOLE
- CB CATCH BASIN OR INLET
- UTILITY POLE
- SURVEY MONUMENT
- SURVEY CONTROL POINT
- TREES, SHRUBS OR HEDGE
- TREES, SHRUBS OR HEDGE DEMO
- N E COMMONWEALTH PLANE COORDINATE
- W WATER WELL

ARCHITECTURAL / STRUCTURAL

- CONCRETE
- REINFORCEMENT IN SECTION
- PRECAST CONCRETE
- MORTAR, GROUT, PLASTER OR SAND
- CONCRETE BLOCK
- BRICK OR CAST IRON
- STEEL OR STAINLESS STEEL
- ALUMINUM
- WOOD
- RIGID INSULATION
- BATT INSULATION
- NEOPRENE, RUBBER OR PLASTIC
- OPENING OR DEPRESSION IN SLAB OR WALL
- GRATING SPAN
- CHECKER PLATE
- OPENING WITH GRATING COVER
- OPENING WITH CHECKER PLATE COVER
- FRP GRATING WITH COVER PLATE
- JOINT FILLER
- WATER STOP
- HANDRAIL

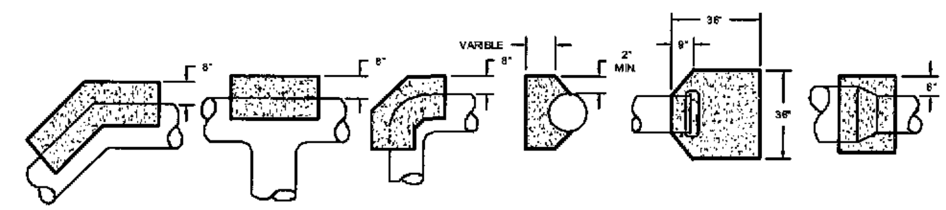
SITE SYMBOLS AND LEGEND

S	SEPTIC
	WELL
	WELL & SEPTIC
	CISTERN
	SLOPES >12%
	SOIL MOISTURE SENSOR
	MONITOR WELL (UP)
	MONITOR WELL (DOWN)
	0.25 MILE BOUNDARY
SH	SINKHOLE
LS	LIMESTONE OUTCROP PROPOSED CENTER
	PROP LOW PRESSURE LINEAR SYSTEM
B	IRRIGATION FIELD

CIVIL SYMBOLS and LEGEND

	CRUSHED ROAD BASE
	CONCRETE
	EARTH NATIVE MATERIAL & FILL
	POWER POLE
	EXISTING GRAVEL ACCESS ROAD
CONC 'V' DITCH	CONCRETE TRAPEZOIDAL CANAL
	EXISTING FENCE
12+00 13+00 14+00	NEW TRANSMISSION MAIN
	EXISTING PIPELINE
SD SD	EXISTING STORM DRAIN
R	LENGTH OF PIVOT HARDWARE
	PRESSURE GAUGE
	AIR/VACUUM RELEASE VALVE
EXISTING DRAIN	EXISTING IRRIGATION DRAIN
	CONTROL POINT
480V >	ELECTRIC POWER SUPPLY
M	MOTOR
D	ELECTRICAL SIGNAL (DISCRETE)
A	ELECTRICAL SIGNAL (ANALOG)
8"Ø IRR	NEW IRRIGATION PIPING
05	IRRIGATION PIPING COORDINATES
$	SWITCH - SPST EQUAL TO P&S 20AC1-I.
	RECEPTACLE-DUPLEX, GFI EQUAL TO P&S 2091-SI
	THERMOSTAT
	SPECIAL PURPOSE CONNECTION WORK AS NOTED
	ELECTRIC MOTOR CONNECTION
	SURFACE MOUNTED FLUORESCENT LIGHT FIXTURE
	WALL MOUNTED FIXTURE
MPC-2,4,6	CIRCUIT DESIGNATION, PANELBOARD BN1L, CIRCUITS 2, 4, 6.
1/E5.2	INDICATES DETAIL 1 ON SHEET E5.2
1	SHEET WORK NOTE.
	HOME RUN TO PANELS. NUMBER OF ARROWS INDICATES NUMBER OF CIRCUITS
	CONDUIT CONCEALED IN CEILING, WALL, OR BELOW FLOOR
	CIRCUIT. NUMBER OF HASH MARKS INDICATES NUMBER OF CONDUCTORS IN CABLE/RACEWAY. FROM LEFT TO RIGHT, HASHMARKS INDICATE GROUND, HOT, NEUTRAL & SWITCHLEG.

THRUST BLOCKS



THRUST BLOCK SIZE

PIPE DIAMETER INCHES	90° OR TEE AREA FT²	90° OR TEE VOLUME CY	45° AREA FT²	45° VOLUME CY	22.5°/REDUCERS AREA FT²	22.5°/REDUCERS VOLUME CY	END AREA FT²	END VOLUME CY
6	4	0.2	2	0.1	1	0.1	3	0.1
8	7	0.3	4	0.1	2	0.1	5	0.2
10	12	0.4	6	0.2	3	0.1	8	0.3
12	17	0.6	9	0.3	5	0.2	12	0.4
15	26	1.0	14	0.5	7	0.3	18	0.7
18	39	1.4	21	0.8	11	0.4	—	—
21	54	2.0	29	1.1	15	0.5	—	—
24	68	2.5	37	1.4	18	0.7	—	—

NOTE: ON 11.25° FITTINGS, USE SIMILAR THRUST BLOCK SIZES AS 22.5 DEGREE FITTINGS.

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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JOB No. 222304

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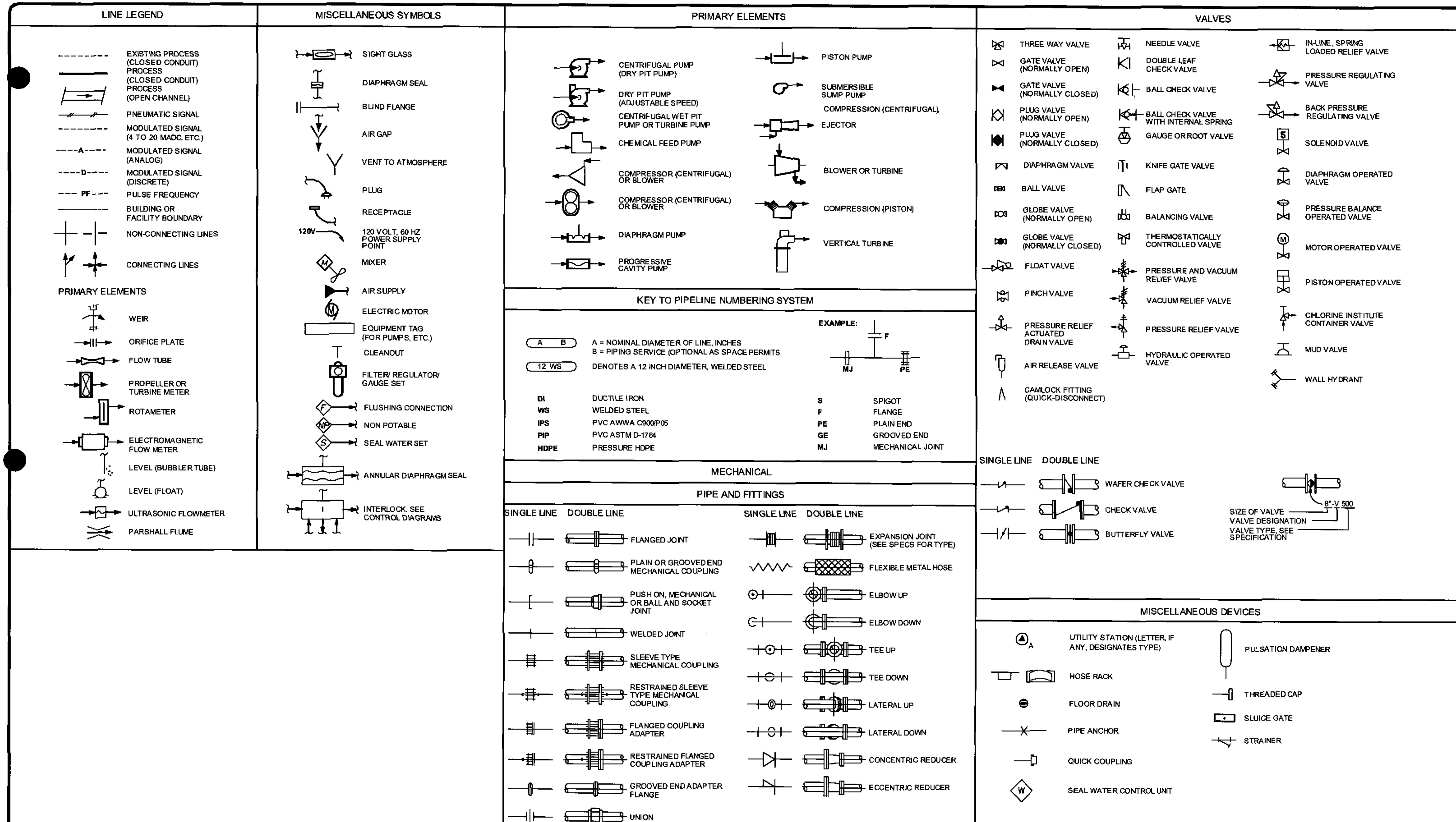
STANDARD CIVIL SYMBOLS & THRUST BLOCKS

PROJECT DESIGN PLANS

SHEET G-6



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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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STANDARD MECHANICAL SYMBOLS

PROJECT DESIGN PLANS

SHEET
G-7

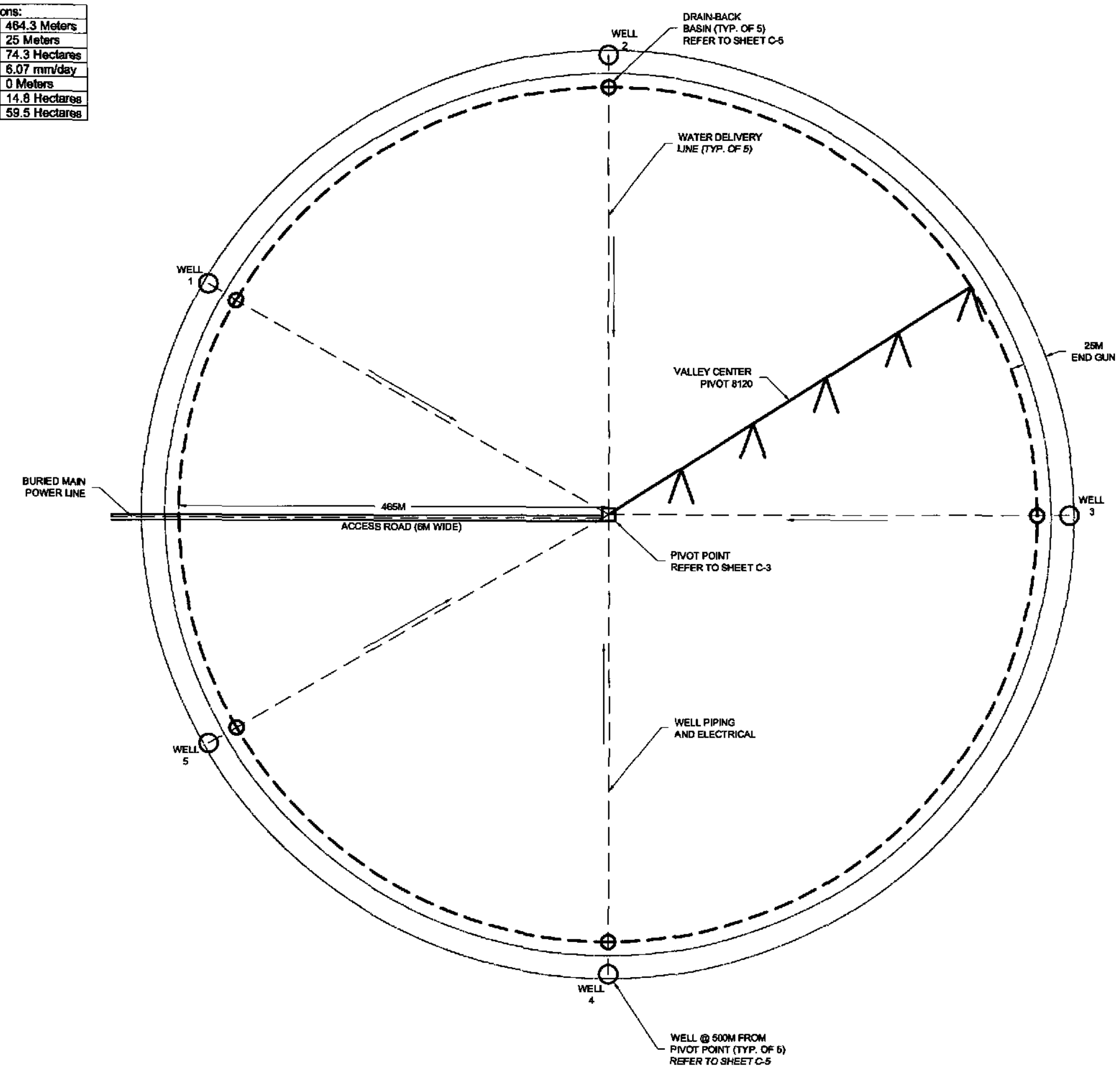
Field Specifications:	
Pivot Length	464.3 Meters
End Gun Coverage	25 Meters
Total Irrigated Area	74.3 Hectares
Design Application Rate	6.07 mm/day
Field Elevation Change	0 Meters
Irrigated Forage Area	14.8 Hectares
Irrigated Nursery Area	59.5 Hectares

CENTER PIVOT FIELD LAYOUT

SCALE: 1cm = 60M

0 120M SCALE

Notes:
1. Tree nursery to be established and managed by PRC State Forestry Administration.
2. Agricultural ground for forage production to be established and managed by Zhenglan Banner.
3. Perimeter windbreak to be established and managed by Zhenglan Banner.



CENTER PIVOT MECHANICAL LAYOUT

SCALE: 1cm = 60M

0 120M SCALE

Notes:
1. Specific pivot point location to be selected by Zhenglan Banner in approximate vicinity of site location shown on Sheet G-3.
2. All site improvements are the responsibility of Zhenglan Banner (wells, pumps, piping, access road, etc.).
3. Pivot installation, set-up, and initial operation are the responsibility of Valmont Industries.

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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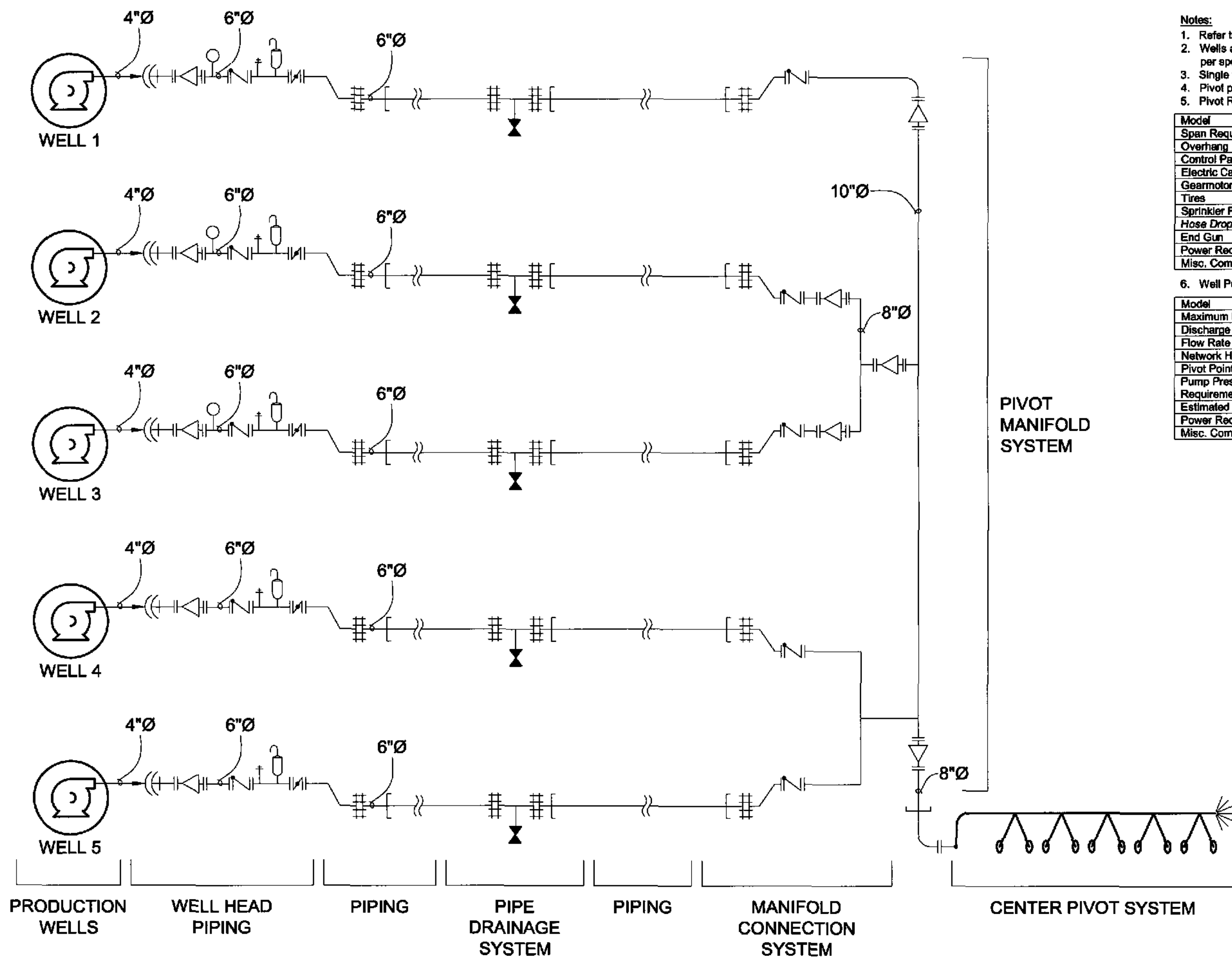
CENTER PIVOT
SITE PLAN

PROJECT DESIGN PLANS

SHEET
C-1



Notes:

1. Refer to Sheets G-6 and G-7 for nomenclature.
2. Wells and pumps to be installed by Zhenglan Banner per specifications referenced on Sheet C-5.
3. Single well operation of 50 M3/hr @ 59 psi.
4. Pivot point operation of 190 M3/hr @ 25.4 psi.
5. Pivot Requirements:

Model	Valley Model 8120 Center Pivot
Span Requirements	8 – Model 8120 6-5/8" spans @ 54.86 M
Overhang	1 – Model 8120 6-5/8" @ 25.08 M
Control Panel	Valley C:A:M:S Select
Electric Cable	10 GA per span (2.5 mm)
Gearmotor	Valley High Speed 1.2 HP Helicoidial
Tires	Valley 14.9" x 24" on 12" rim
Sprinkler Package	Valley Len Double/Triple PAD @ 6 psi w/Reg
Hose Drop	*5.5' Poly Slip w/ 6" galv. u-pipe*
End Gun	Komet SR101 w/ 2HP Booster
Power Requirement	380 V, 3-phase, 50 hz
Misc. Components/Hookups	Valley Specified for specific model

6. Well Pump Requirements

Model	TBD by Zhenglan Banner
Maximum Diameter	< 250 mm
Discharge Size	4"
Flow Rate Range	40 to 50 M^3/hr
Network Headloss	25 M (238 kPa or 34.5 psi)
Pivot Point Pressure	175 kPa or 25.3 psi
Pump Pressure Requirements	413 kPa or 59.8 psi
Estimated Power Needs	9.2 kW (12.3 Hp)
Power Requirement	380 V, 3-phase, 50 hz
Misc. Components/Hookups	Manufacturer specified

PROCESS FLOW DIAGRAM

NOT TO SCALE

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	–	–	MO/DAY/YR
2	–	–	MO/DAY/YR
3	–	–	MO/DAY/YR
4	–	–	MO/DAY/YR
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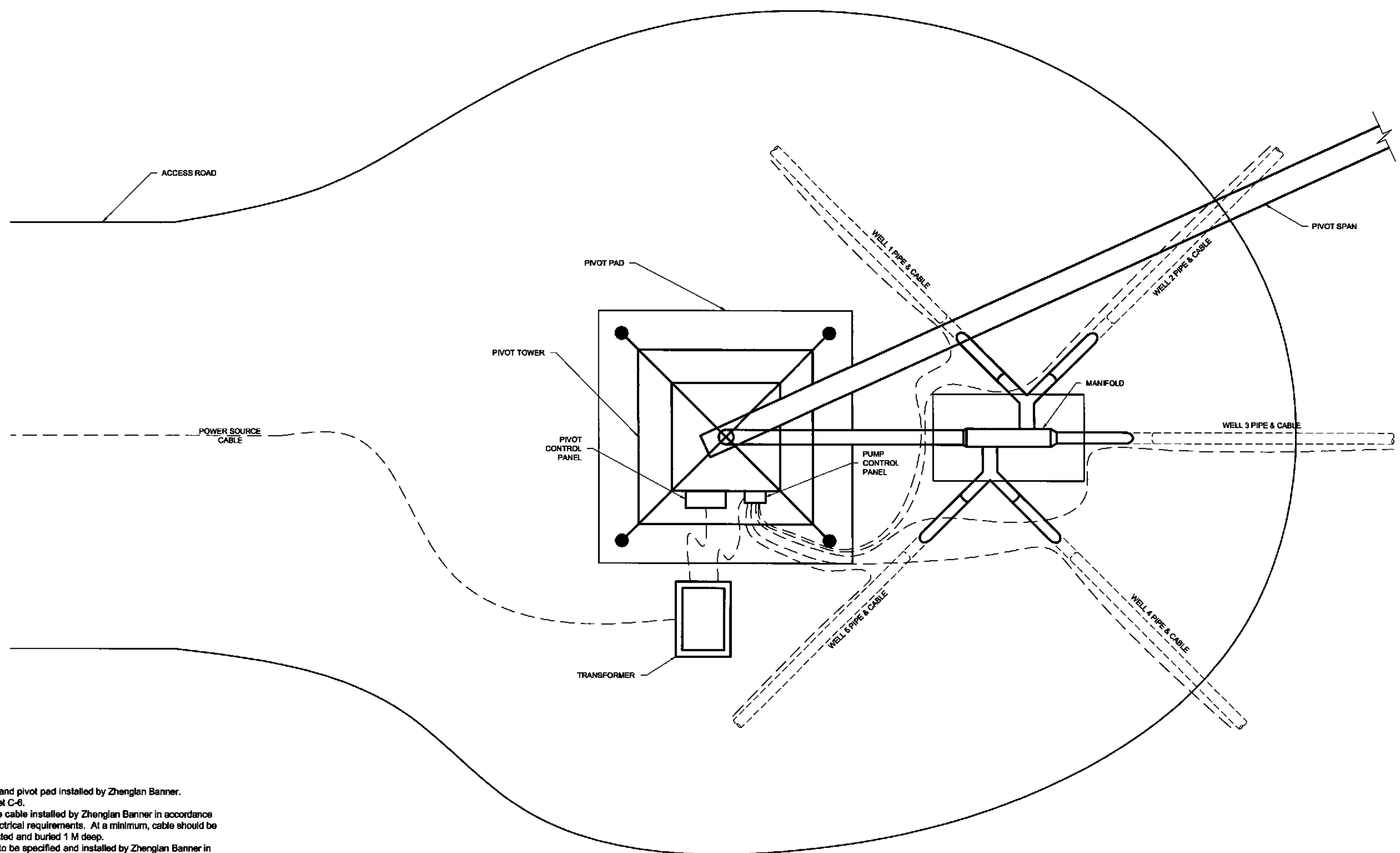
PROCESS FLOW DIAGRAM

PROJECT DESIGN PLANS

SHEET
C-2



Notes:

1. Access road and pivot pad installed by Zhenglan Banner. Refer to Sheet C-6.
2. Power source cable installed by Zhenglan Banner in accordance with local electrical requirements. At a minimum, cable should be double insulated and buried 1 M deep.
3. Transformer to be specified and installed by Zhenglan Banner in accordance with local electrical requirements. Refer to Sheet C-7 for power conversion requirements.
4. Pumps control panel to be specified by well pump manufacturer and installed by Zhanglan Banner per manufacturer guidelines and instructions.
5. Pivot tower, spans, and control panel to be installed by Valmont Industries per manufacturer guidelines and specifications.

CENTER PIVOT FIELD LAYOUT

SCALE: 1cm = 0.6M

0 0.6M

SCALE

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
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3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
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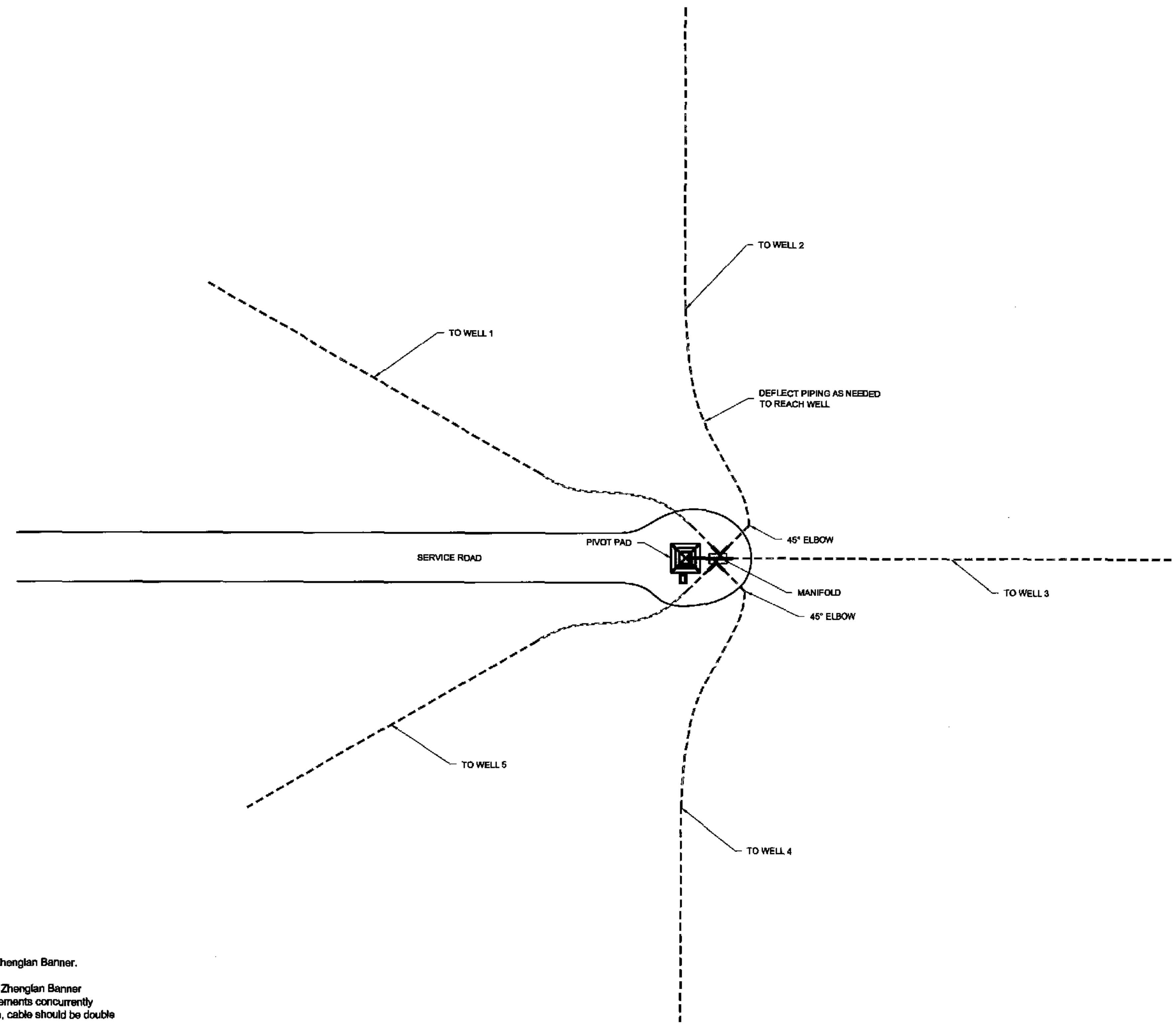
PIVOT POINT LAYOUT

PROJECT DESIGN PLANS

SHEET
C-3



Notes:
1. Access road and pivot pad installed by Zhenglan Banner. Refer to Sheet C-6.
2. Power cables to well pumps installed by Zhenglan Banner in accordance with local electrical requirements concurrently with pipeline construction. At a minimum, cable should be double insulated and buried adjacent to pipe.
3. Pipeline deflection shall not exceed tolerances set forth by pipe manufacturer.
4. Refer to Sheet C-6 for trenching and backfill requirements.
5. Refer to Sheet G-6 for thrust block requirements.

PIPELINE ROUTING PLAN - OPTION 1

SCALE: 1cm = 6M

0 6M
SCALE

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
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3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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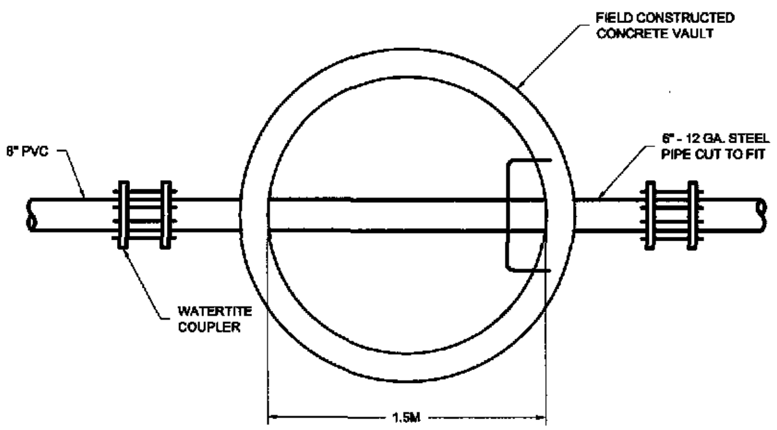
PIPELINE ROUTING PLAN

PROJECT DESIGN PLANS

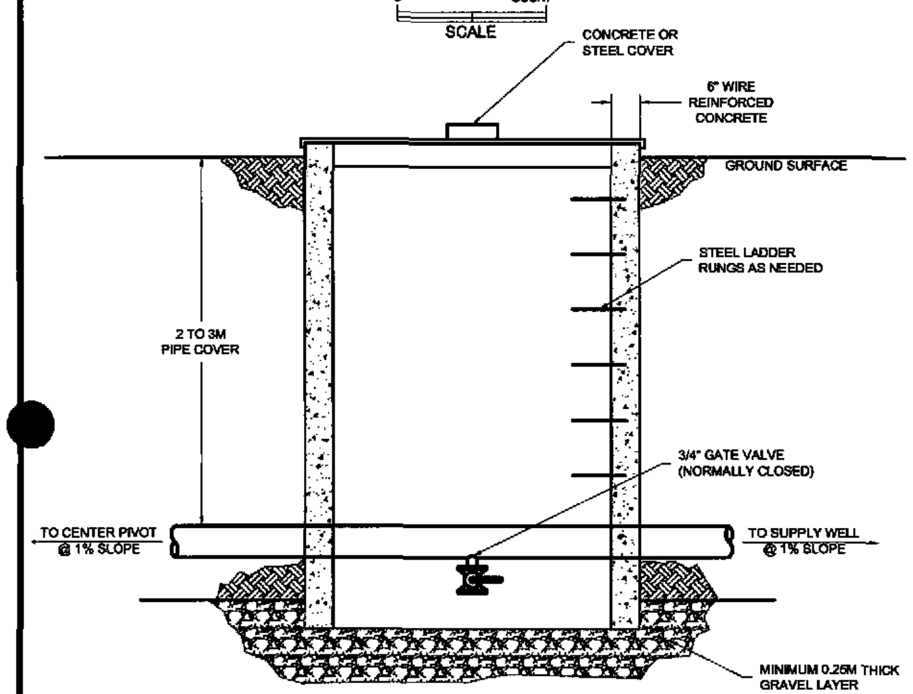
SHEET
C-4



DRAIN-BACK BASIN DETAIL - PLAN VIEW

SCALE: 1cm = 40cm

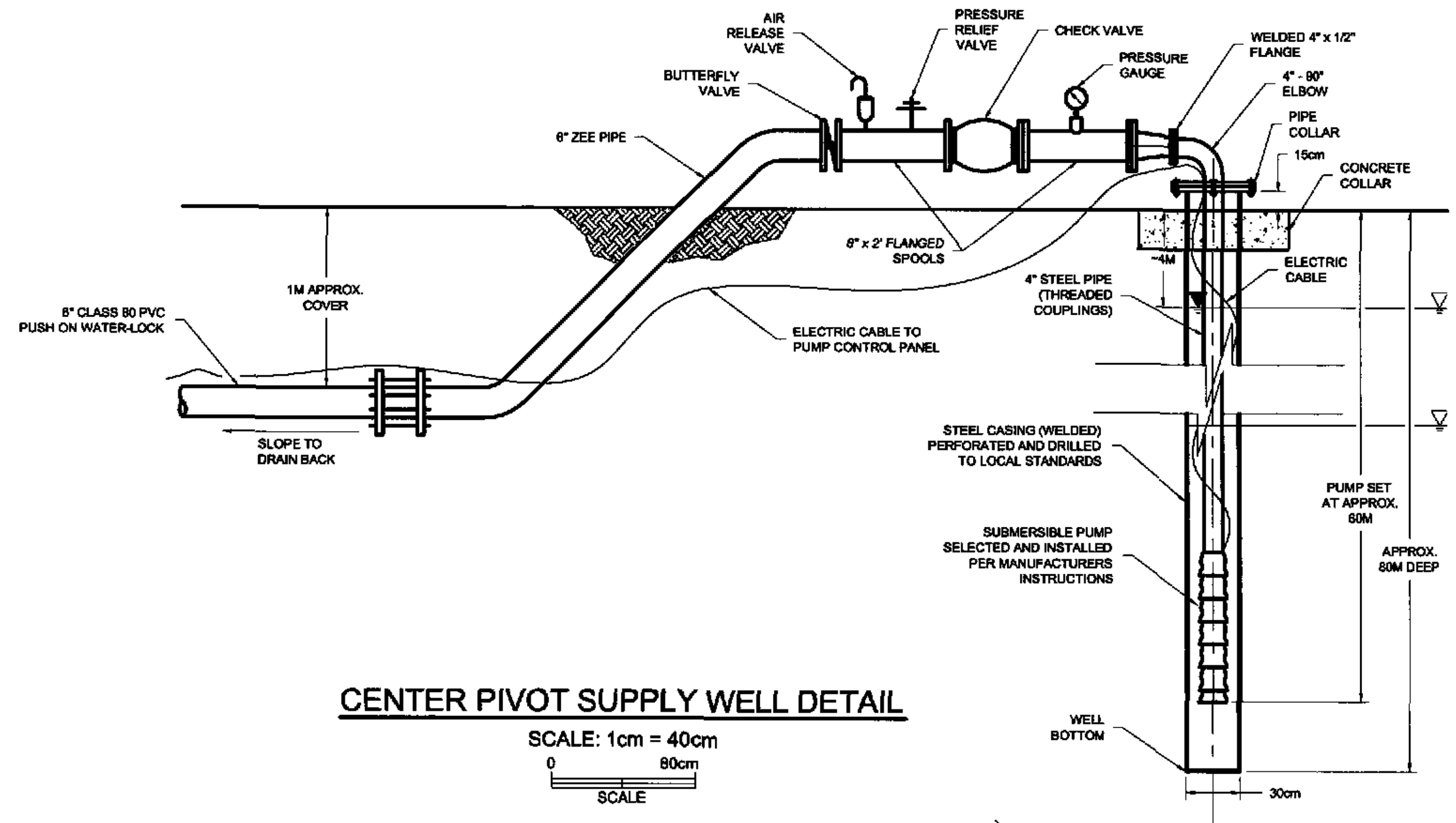
0 80cm SCALE



DRAIN-BACK BASIN DETAIL - SECTION VIEW

SCALE: 1cm = 40cm

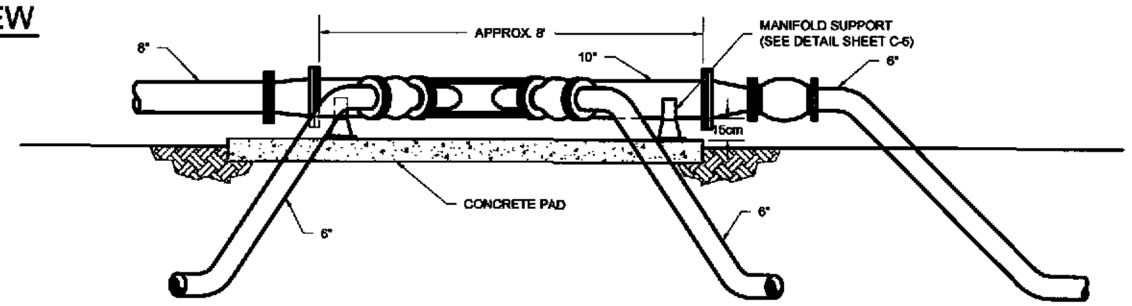
0 80cm SCALE



CENTER PIVOT SUPPLY WELL DETAIL

SCALE: 1cm = 40cm

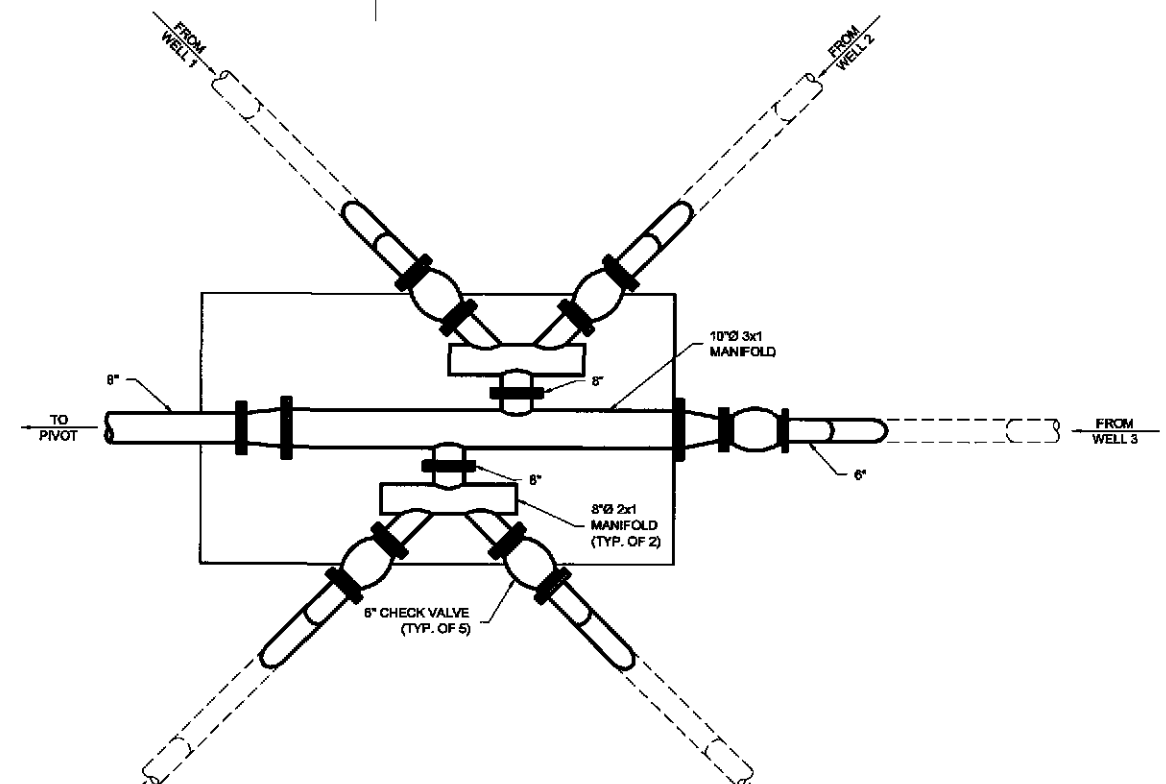
0 80cm SCALE



PIVOT MANIFOLD DETAIL - SECTION VIEW

SCALE: 1cm = 0.50M

0 1M SCALE



PIVOT MANIFOLD DETAIL - PLAN VIEW

SCALE: 1cm = 0.50M

0 1M SCALE

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
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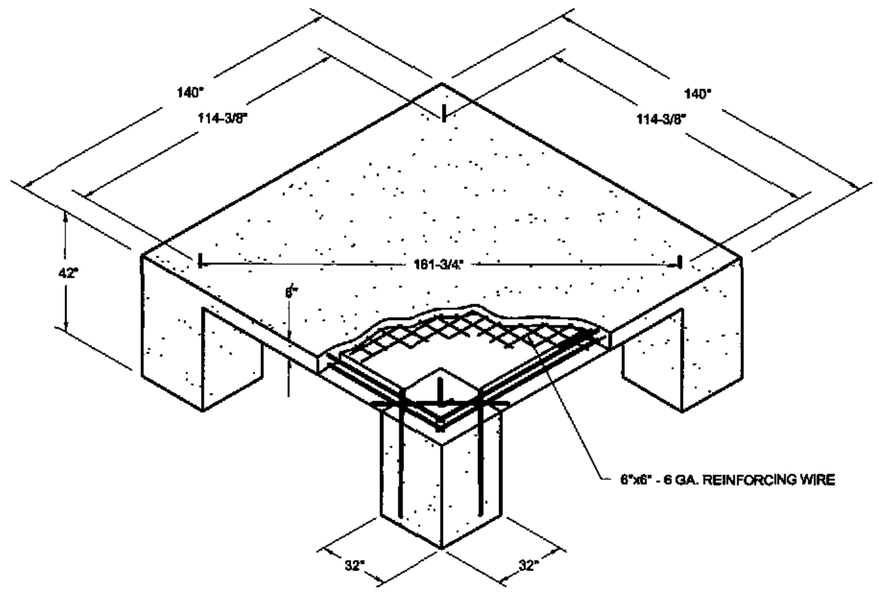
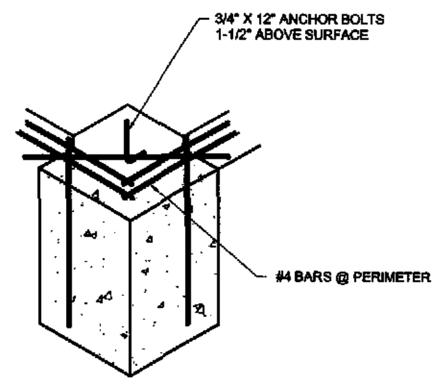
WATER DELIVERY SYSTEM
MECHANICAL

PROJECT DESIGN PLANS

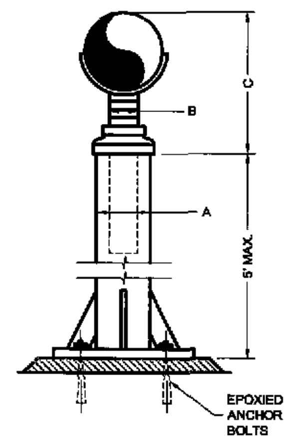
SHEET
C-5



DETAIL CENTER PIVOT PAD
NTS

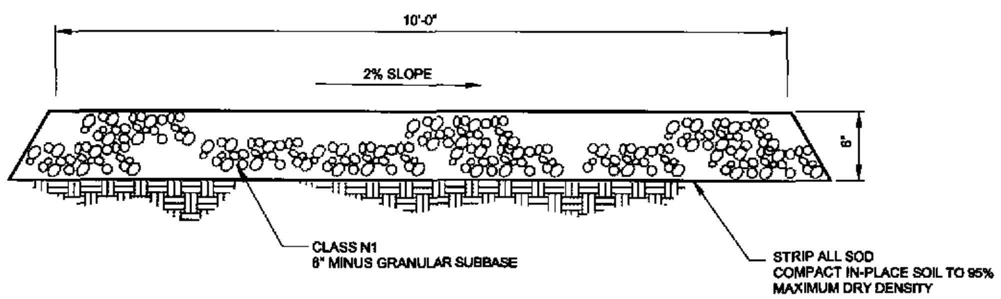


DETAIL C.P. PAD REINFORCEMENT
NTS

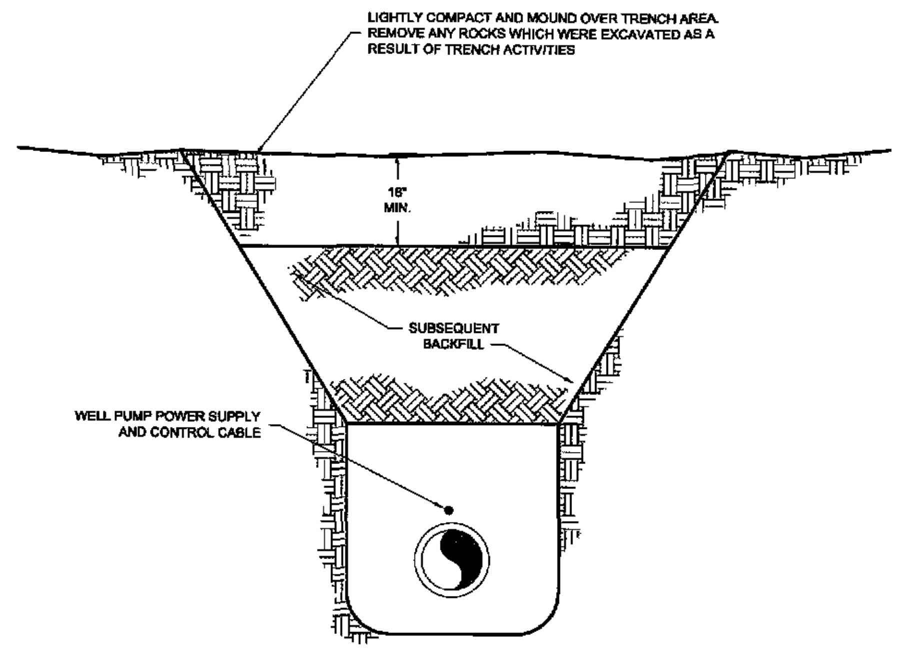


ADJUSTABLE PIPE SUPPORT APPROXIMATE DIMENSIONS IN INCHES			
PIPE SIZE	A	B	C (MAX.)
2-1/2	2-1/2	1-1/2	
3	2-1/2	1-1/2	8-1/4
3-1/2	2-1/2	1-1/2	8-1/2
4	3	x 2-1/2	10-1/4
6	3	x 2-1/2	11-5/8
8	3	x 2-1/2	13-5/8
10	4	x 2-1/2	14-5/8
12	4	x 2-1/2	15-5/8
14	6	3	18-7/8
16	6	3	19-7/8
18	8	3-1/2	21-1/4
20	8	3-1/2	23-1/4

SINGLE PIPE SUPPORT
SCALE: NTS



TYPICAL GRAVEL ACCESS ROAD
NTS



TRENCH RESTORATION AGRICULTURAL AREA
SCALE: NTS

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

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3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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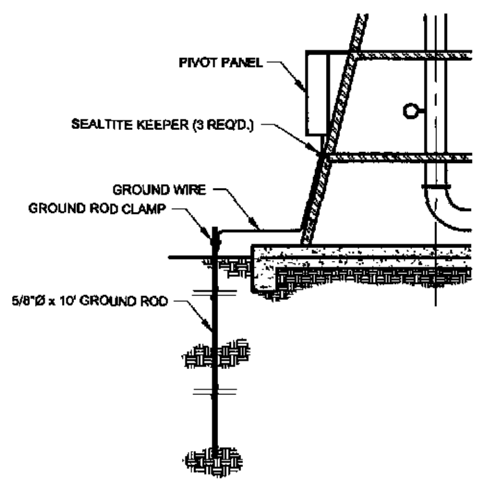
SITE IMPROVEMENT DETAILS

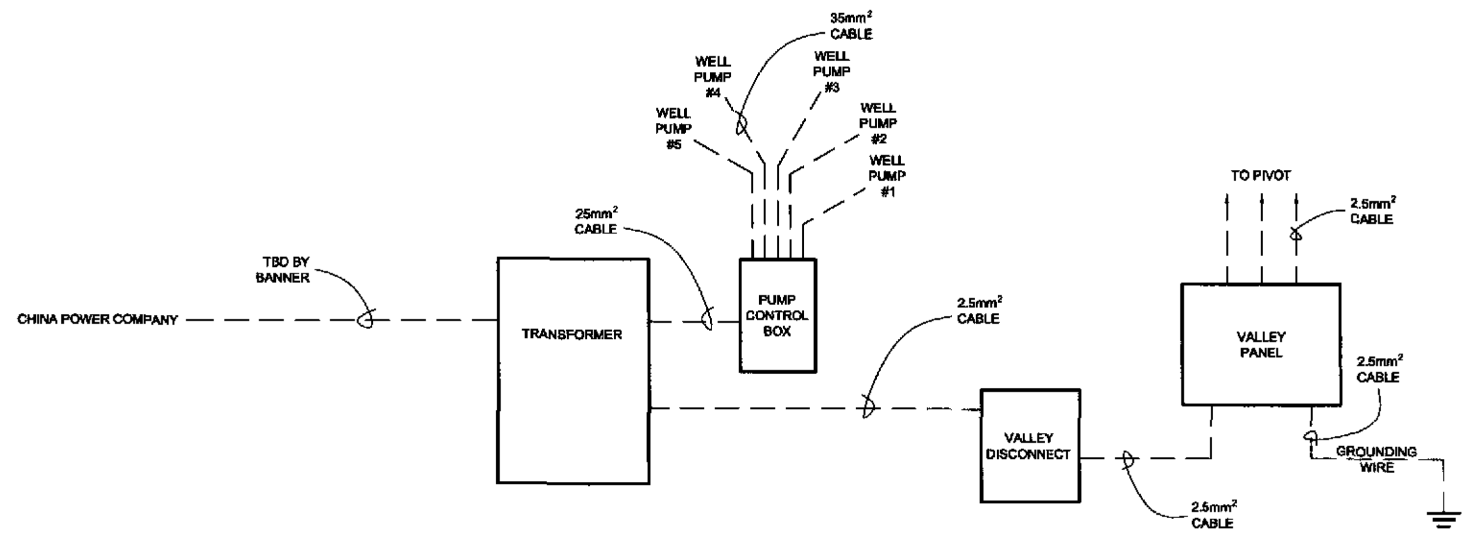
PROJECT DESIGN PLANS

SHEET
C-6



GROUNDING WIRE DETAIL

SCALE: NTS



SITE ELECTRICAL LAYOUT

SCALE: NTS

Notes:

1. Power source cable installed by Zhenglan Banner in accordance with local electrical requirements. At a minimum, cable should be double insulated and buried 1 M deep.
2. Power cables to well pumps installed by Zhenglan Banner in accordance with local electrical requirements concurrently with pipeline construction. At a minimum, cable should be double insulated and buried adjacent to pipe.
3. Transformer to be specified and installed by Zhenglan Banner in accordance with local electrical requirements.
4. Pumps control panel to be specified by well pump manufacturer and installed by Zhenglan Banner per manufacturer guidelines and instructions.
5. Power to pivot and pivot control panel to be installed by Valmont Industries per manufacturer guidelines and specifications.
6. Pump power supply and grounding wires to be installed per manufacturer guidelines and instructions.
7. Power Requirements:

Description	Voltage	Phase	Freq.	Current	Load
Main Power Line	130,000	3-Phase	50-Hz	TBD	TBD
To Pump Control Box	380	3-Phase	50-Hz	65.4 A	46 kW
To Pumps (5)	380	3-Phase	50-Hz	21.8 A	9.2 kW
To Disconnect	380	3-Phase	50-Hz	16.01 A	10.8 kW
To Pivot Panel	380	3-Phase	50-Hz	16.01 A	10.8 kW

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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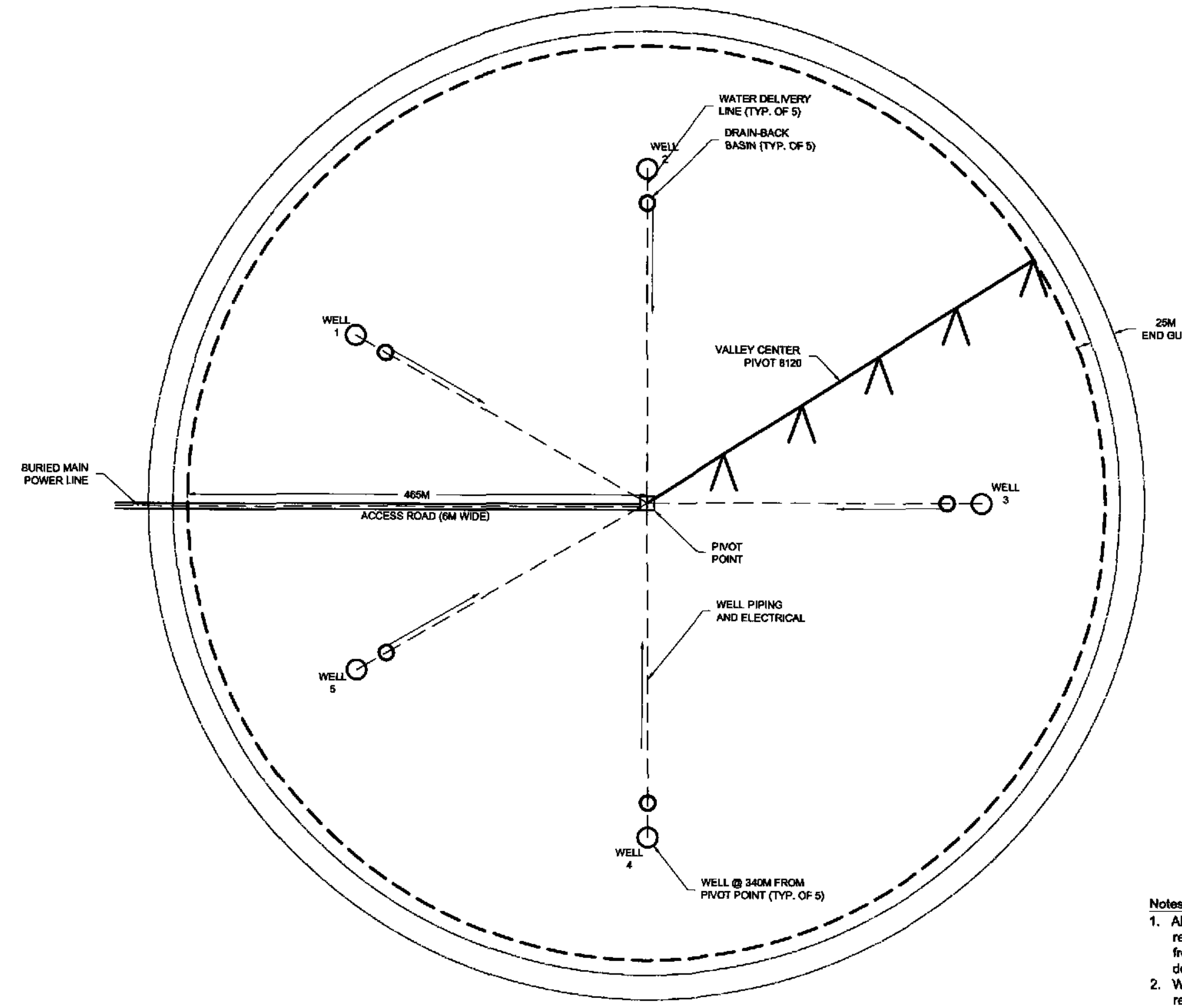
SITE ELECTRICAL LAYOUT

PROJECT DESIGN PLANS

SHEET
C-7



Notes:

1. Alternative mechanical layout if Banner selects to reduce construction requirements, however, this alternative increases risk of well damage from agricultural equipment and groundwater contamination. Does not decrease energy requirements.
2. Wells and pumps to be installed by Zhenglan Banner per specifications referenced on Sheet C-5.
3. Single well operation of 50 M^3/hr @ 58.5 psi.
4. Pivot point operation of 190 M^3/hr @ 25.4 psi.
5. Pivot requirements same as provided on Sheet C-2.
6. Well pump requirements same as provided on Sheet C-2.
7. Power requirements same as provided on Sheet C-7.
8. Cable size from pump control box to pumps may be reduced from 35 mm^2 to 16 mm^2.

CENTER PIVOT LAYOUT ALTERNATIVE

SCALE: 1cm = 60M

0 120M

SCALE

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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CENTER PIVOT
LAYOUT ALTERNATIVE

PROJECT DESIGN PLANS

SHEET
C-8

Project Implementation Plan

Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing using Irrigated Agriculture

valmont
WATER MANAGEMENT GROUP

CCICCD
State Forestry Administration
Peoples' Republic of China

This report was funded by the U.S. Trade and Development Agency (USTDA), a foreign assistance agency of the U.S. Government. The opinions, findings, conclusions, or recommendations expressed in this document are those of the author(s) and do not necessarily represent the official position or policies of USTDA.

Mailing and Delivery Address: 1000 Wilson Boulevard, Suite 1600, Arlington, VA 22209-3901
Phone: 703-875-4357 • **Fax:** 703-875-4009 • **Web site:** www.tda.gov • **email:** info@tda.gov

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 PROJECT IMPLEMENTATION METHODS 2

3.0 PROJECT IMPLEMENTATION AND DEMONSTRATION SYSTEM CONSTRUCTION 2
- 3.1 Project Construction 2
- 3.2 Demonstration Program Monitoring Activities 3
  - 3.2.1 Ecological Impacts 3
    - 3.2.1.1 Groundwater Monitoring Plan 3
    - 3.2.1.2 Irrigated Forage Production 4
      - 3.2.1.2.1 Immediate Monitoring Needs 4
      - 3.2.1.2.2 Harvest Time Monitoring Needs 5
      - 3.2.1.2.3 Immediate Project Management Decision Making Needs/ Recommendations 6
    - 3.2.1.3 Grasslands Recovery 6
    - 3.2.1.4 Output from Ecological Monitoring Activities 7
  - 3.2.2 Socioeconomic Impacts 8
    - 3.2.2.1 Agricultural Economics 8
    - 3.2.2.2 Evaluation of Sociological Change 9
    - 3.2.2.3 Output From Socioeconomic Monitoring 12

APPENDICES

Appendix A. Plans for Project Implementation

Appendix B. Data Sheets for Project Implementation

PROJECT IMPLEMENTATION PLAN

1.0 INTRODUCTION

On November 11, 2002 the National Bureau to Combat Desertification within the State Forestry Administration of PRC (NBCD/SFA) and Valmont Industries, a United States Corporation (Valmont) entered into a contract with the United States Trade and Development Agency (USTDA). The objective of this contract was to examine the feasibility of, and to subsequently demonstrate that, water efficient Valley brand irrigation equipment could effectively assist in the control of dust storms, desertification, and recovery of the grasslands.

The purpose of this document is to outline the actual implementation steps involved in the performance of the demonstration project envisioned in the original contract under Grant Number GH 2381659, and the subsequent feasibility report titled "Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing Using Irrigated Agriculture," published in May 2003.

Site-specific plans for the construction of the Valley center pivot demonstration system are included in Appendix A of this project implementation plan. These plans are the same plan sheets that were included in the feasibility study identified in the previous paragraph. The only differences are those that became necessary during construction of the system in June 2003. Consequently, this set of plans constitutes the "as-built" plans and specifications for the project implementation plan and the subsequent report.

The feasibility report identified several areas that could significantly affect the short and long term viability of this control strategy. These areas include the following:

<u>Ecological Impacts</u>
- Impacts to Groundwater
- Irrigated Forage Quantity and Quality
- Natural Grassland Recovery Potential

<u>Socioeconomic Impacts</u>
- Changes in Agricultural Economics
- Sociological Impacts to Herders

The purpose of this document is to identify the methods that will be used to ensure the proper operation of the water saving irrigation demonstration system and subsequently measure the impact of this operation on both the ecological environment and the socioeconomic impacts to the residents of the associated "Ecological Migration Village." These agriculturalists depend on the irrigated forage to support their livestock production system.

2.0 PROJECT IMPLEMENTATION METHODS

Construction of Ecological Migration Village Forage Production System

The forage production system at Zhenglanqi was constructed during the months of June and July 2003. Although the system was fully functional, the presence of abundant rainfall and the late construction due to SARS and tariff delays resulted in only limited use of the irrigation equipment in 2003. Valmont submitted a request for a delay in schedule to the USTDA. It was proposed that the actual demonstration phase of the project implementation plan would be delayed until Spring 2004 to provide a full season of irrigated forage production.

In order to demonstrate the effectiveness of the irrigation equipment in producing forage to replace open grazing of the grasslands, it is necessary that we establish specific monitoring protocols for each of the key areas listed in the feasibility study (see introduction above).

In particular, we need to conduct pre- and post-season analyses of both the ecological impacts and the socioeconomic impacts. To do this, we must measure pre-and post-season parameters. Key ecological parameters include groundwater levels and measurement of grasslands recovery. Key socioeconomic parameters include household performance measurements and economic information, including the costs and returns of producing forage crops and livestock products.

The project implementation plan includes one on-site employee working full time from May through August to collect data. We expect this individual will live and work full time at the demonstration site, and will provide measurements in weekly reports of critical demonstration parameters such as rainfall, irrigation hours, and groundwater levels in the wells. Other measurements will be made at other intervals depending upon the sensitivity of the parameter. Forage production will be measured only once at the end of the growing season. Formats for each implementation plan parameter are specific to each area of investigation and are detailed in the sections below.

Technical support will be provided by trained and experienced Chinese staff on a regular basis. Mr. Song Tao, Technical Service Supervisor for China, will be available for issues relating to pivot operation and forage production. Ms. Hao Gui-Yu, Chief Representative, Water Management Research and Consulting, will be available for support relating to groundwater and ecological issues and will have subconsultants available for socioeconomic issues that may develop during the course of the implementation demonstration project.

3.0 PROJECT IMPLEMENTATION AND DEMONSTRATION SYSTEM CONSTRUCTION

3.1 Project Construction

The original project plan proposed that the technology demonstration would occur during the 2003 growing season that extended from May through October. The SARS outbreak prevented the initial startup of the program through the months of May and June, causing us to optimally reschedule the demonstration activities to the 2004 growing season. However, the irrigation equipment had been committed to shipment earlier in 2003, so that timely completion of the construction activity was necessary to assure the security of the demonstration materials and equipment. Plans for the demonstration system are found in Appendix A.

3.2 Demonstration Program Monitoring Activities

This section describes the pre-growing season and post-growing season measurements we will make as part of the implementation phase of the project. Inventory forms and supplemental documentation are included in Appendix B.

3.2.1 Ecological Impacts

The effectiveness of using Valley brand irrigation equipment will be assessed from the perspective of its impact on the ecology of the site. These parameters were discussed earlier and include, groundwater monitoring, forage production levels, and grasslands recovery rates.

3.2.1.1 Groundwater Monitoring Plan

The parameters to be monitored routinely during the monitoring program are:

- Aquifer water levels as measured in all five of the production wells (weekly)
- Aquifer water levels as measured in one well near the migration village (weekly)
- Pivot flow volume records (weekly)
- Selected water quality parameters that can be measured conveniently and at minimal cost in the field (specific conductance, pH, and nitrate), with measurements to be made on water samples from one production well (weekly), and also from the river (once every two weeks)
- River water levels (once every two weeks)
- Precipitation (weekly).

The monitoring will have the following purposes:

- Measure the near-term impact of irrigation pumping on aquifer water levels.
- Identify changes in aquifer water quality related to pumping and irrigation.
- Allow us to distinguish between water level changes caused by irrigation pumping and those caused by normal variations (seasonal and drought-cycle) in precipitation.
- Generate data that could be used later, when combined with longer-term monitoring data, to develop a watershed-scale groundwater flow model to predict the number of irrigation systems that can be supported in a given watershed.

The following tasks were accomplished during the May 2004 site visit:

- Inspect production wells, choose wells to monitor, confirm that a water level probe can be used to measure levels in each well
- Identify neighboring well feasible to monitor

- Choose a practical river water level monitoring site and identify a monitoring point
- Set up a rain gauge at the project site
- Agree on frequency of monitoring for each parameter
- Train the people who will be on the site making measurements, including procedures for collecting the data, entering data on forms, and storing completed forms in a safe location
- Conduct a one-hour pumping test on one of the production wells, measuring water levels in the pumped well and in the idle wells, to allow calculation of basic aquifer properties
- Make observations on site-specific hydrogeology.

Data collection forms are contained in Appendix B-1.

3.2.1.2 Irrigated Forage Production

The primary goals of this segment of the demonstration project are: 1) To document the quantity and quality of forage produced by the demonstration project, and 2) To examine alternative production scenarios that might offer larger quantities or improved quality of forage.

In the current crop year, we will document production capability of the Valley demonstration unit from the standpoints of both quantity and quality. We will document forage quality visually and by obtaining silage samples approximately three weeks after ensiling (to be sure product is stable). We will also develop ration formulation plans, including the purchase of supplemental forages, concentrates, minerals, and pharmaceuticals. In addition, we will discuss future growing season options that may include such things as small grain cereal crops and perennial grasses and legumes.

3.2.1.2.1 Immediate Monitoring Needs

1. ***Soil Analysis.*** To ensure that high quantities of silage are produced, soil samples will be taken of the production area, standard analyses conducted, and fertilizer and liming recommendations made based on test results.

   - *Soil sampling procedure.* Standard soil sampling procedures will be used, sampling 15-20 areas of the production field to a depth of 15 cm (6 inches) with a soil probe or clean shovel or trowel, mixing all subsamples thoroughly and placing 1 kg (~2.2 lbs) in a bag labeled to indicate sampling date, location, analyses requested, and sampler name and contact information.
   - *Soil analyses to be conducted.* Soil tests to be conducted include pH, cation exchange capacity (CEC), total nitrogen and nitrate nitrogen, phosphorus (P), potassium (K), calcium (Ca), and sulfur (S). Since no analytical capabilities exist in the demonstration area, samples will be transported to Beijing for analysis.
   - *Fertilizer and liming recommendations.* Recommendations for fertilization will be provided based on corn silage fertilizer trials conduced in similar environmental conditions. Personnel from the Inner Mongolia Agricultural University, China Agricultural University, and the Chinese Academy of Agricultural Sciences Institute of

Animal Sciences will be consulted and recommendations provided to local banner officials.

2. ***Forage Analysis***. Current feeding rations will be characterized by sampling and testing hay, silage, and concentrate supplements. Separate samples will be obtained from five different farmers to obtain a representative sample of the variation of forage quality.

    - *Silage sampling procedure*. Silage samples will be taken from the center of remaining piles or pits. Four to six grab samples of silage will be placed in plastic bags and frozen or refrigerated until analysis.
    - *Hay sampling procedure*. Hay sampling of loose hay will be the same (4-6 grab samples); however, hay samples may be placed in paper bags and transported to the analytical lab.
    - *Forage analyses to be conducted*. Forage analysis should follow international standards including dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), calcium, and phosphorus. For silage samples, volatile fatty acids (VFAs) should also be determined. However, less than optimal sampling and transportation options may make VFA analysis of little value, since these are subject to loss unless immediately analyzed or frozen to prevent loss. Ideally, analytical capability should be developed in the local banner. Until that develops, samples will need to be processed in Beijing.

3. ***Concentrate Supplement Analysis***. Current ration formulation is based on recommendations by the local dairy company. However, the only portion of the ration recommended is the concentrate. Forage is fed ad libitum. Analysis is needed to verify the protein, energy, and mineral composition of the supplement and to recommend quantities of each component of the diet.

    - *Supplement analyses to be conducted.* A sample of the commercial supplement will be obtained and analyzed for dry matter, crude protein, energy (Mcal/kg), Ca, and P. In addition, the analysis tag provided on the bag will be compared with the actual analysis and used to estimate the vitamin content of the supplement.

3.2.1.2.2 Harvest Time Monitoring Needs

When the forage is ready for ensiling, yield assessment will be performed by harvesting a known area, weighing the fresh forage, subsampling, and determining forage dry matter and quality analysis.

1. ***Forage Yield***. Four samples will be taken to assess yield from 100 square meter quadrates. Fresh forage will be cut from the quadrate, weighed for fresh weight, chopped, subsampled, dried, and weighed for dry weight. Yield will be expressed on a dry matter basis.

2. ***Forage Quality Analysis***. Sampling and analysis for current year forage will be similar to springtime analyses. Five samples will be obtained from fresh forage and from ensiled forage.

- *Fresh forage sampling procedure.* Fresh forage will be chopped and sampled at various times in the chopping process. One kg (2.2 lb) samples will be obtained and placed in plastic bags, frozen or refrigerated and transported immediately to forage testing facilities.
- *Silage sampling procedure.* Silage samples will be taken from the center of silos 3 weeks after ensiling. Four to six grab samples will be obtained for a total sample weight of 1 kg (2.2 lb). Silage will be placed in plastic bags and frozen or refrigerated until analysis.
- *Forage analyses to be conducted.* Forage analysis will include dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), calcium, and phosphorus. For silage samples, volatile fatty acids (VFAs) will be determined.

3.2.1.2.3 Immediate Project Management Decision Making Needs/ Recommendations

1. ***Centralize silage-making operations in each village***. Forage production, silage making, and ration formulation issues appear to be a major limiting factor to the potential success of the demonstration. Producing forage is not enough. High quality silage must be made and fed to cows as part of a complete ration, meeting the production and long-term health requirements of the dairy cows. At present, 50-70% of the forage produced is wasted due to poor ensiling techniques. Thus, changes are needed to ensure high quality silage production.

Our recommendation is to establish one silage making operation per village, rather than each household being responsible for silage making. This would greatly increase the potential for high quality silage to be made. Rationale for this recommendation is that a centralized silage making facility would allow for more uniform chopping, packing, and sealing of the silo. In addition, only one or a few individuals would need to be trained in proper techniques.

B. ***Obtain additional funding through an add-on USTDA project to address the silage making need.*** This "Achilles heel" of the project (inability to make high quality silage) requires additional funding to solve and immediate action. Equipment, facilities, and on-site training are needed immediately. Decisions about where, how, and who must be made with in the very short-term future, since all operations need to be ready to function properly within 3 months time (forage will be harvested in mid- to late-August for ensiling).

The team leader will work with the forage advisory team to pursue discussions with US silage making companies and with USTDA to determine if additional funding can be obtained for this need. Local Banner officials will be consulted to determine if they would be willing to consider centralized ensiling operations. In addition, video/CD/DVD education resources on silage making will be pursued to assist with training needs.

3.2.1.3 Grasslands Recovery

This demonstration must do more than show it is possible to produce forage without impacting groundwater levels. We also must show that the removal or reduction of grazing pressure on the grasslands will result in reduced potential for dust generation and desertification. One of two configurations of exclosures will be relied upon to demonstrate this. An exclosure is a fenced area designed to keep grazing livestock out of the area, allowing grasses to recover. One potential configuration includes three separate exclosures of 100m on a side. The other alternative is the construction of a single exclosure 100m by 400m in size. This demonstration will be limited because more than one year is required to produce some native grass stands to demonstrate significant recovery. Given that limitation, this capability of the grasslands will be demonstrated using two critical objectives:

Critical Objective #1. Establish *indicators* of changes in erosion due to removal of grazing, assuming ecosystem health is directly associated with system stability.

Critical Objective #2. Measure changes in critical system attributes such as soil cover and vegetation structure, assuming that vegetation cover and structure are effective means of stabilizing eroding soils.

Method for Critical Objective #1:

> Complete a check sheet of indicators of ecosystem health (see Appendix B2A for check sheet).

Method for Critical Objective #2:

> Assess potential vegetation and litter response to livestock exclusion (see Appendix B2B for sample data sheet).

Documentation would include one or more of the following:

- Oblique photos
- Estimate organic ground cover (i.e., live vegetation, dead vegetation and litter). Take at least 2, 10-step transects at each site. Estimate percent ground cover in $1m^2$ quadrant.

Standard and guide to stabilize soil erosion will be established in concert with local experience. Examples follow:

- Minimum acceptable ecosystem-health classification must be classification II with evidence supporting the transition toward classification I, a stable plant community with adequate ground cover.
- Minimum acceptable ground cover is 30% with less than 15% active erosion.

3.2.1.4 Output from Ecological Monitoring Activities

This monitoring data will allow for an evaluation of the impact of small areas of irrigated forage on the total sand storm danger of the region. Questions to be answered include:

- What is the demonstrated level of forage production at this site?
- How fast can the damaged rangelands recover with this action strategy?

- What will be the estimated ecological impacts to groundwater from these activities? The final report will include suggestions for improving management of forage production, grasslands management and water resources.

3.2.2 Socioeconomic Impacts

3.2.2.1 Agricultural Economics

The economic impacts of the center pivot irrigation system will be evaluated at two levels: 1) The system-wide level where we will determine the total value of all of crops produced under irrigation, and 2) The household level where we will determine the total household income from all sources of income, not just the irrigated forage.

The goal of this effort is to describe the net value of crops produced using the center pivot irrigation system during the 2004 growing season. We need to collect information describing the areas planted in each crop, the inputs used to produce each crop, the amount of each crop produced, and the value of production. We will calculate the total value of production by multiplying the amount of each crop produced by the price received for each crop. We will calculate the total cost of production by multiplying the amount of each input used by each input price. We will calculate the net value of crop production by subtracting the total cost from the total value. This effort will enable us to describe the net values generated by using the center pivot irrigation system to produce crops in Zhenglanqi.

We understand that a department or production team organized by the Banner Administration will manage crop production using the center pivot irrigation system. Someone from that team should be assigned the task of recording the types and amounts of all inputs used in production (labor, seed, fertilizer, water, electricity, tractor time, etc.) and the types and amounts of all output produced (corn grain, corn forage, and other crops). We might call that person the Farm Accountant of production costs and revenues. The Farm Accountant should record also the prices paid per unit of all inputs and the prices received for all outputs. The cost information will include the wage rates for labor (RMB per hour or day), the cost of fertilizer (RMB per kg), the cost to pump water (RMB per day or per irrigation event, and the cost of tractor time (RMB per hour or day). Crop price information will include the prices received for corn grain (if any grain is harvested separately from the corn forage, in RMB per kg), corn forage (RMB per kg), and the prices of any other crops produced using the center pivot irrigation system. The goal is to construct an accounting budget of all the inputs and outputs, so that the Farm Accountant can calculate the total costs, total revenue, and net revenue from production.

An outline for collecting the cost and revenue information is provided on page 1 of Appendix B-3. The Farm Accountant can use this outline as a guide for collecting the needed information. The Farm Accountant might decide to include additional information and he should feel free to add that information in any way that is sensible. For example, the Farm Accountant might describe the proportions of crop production that are sold to households at different prices, if crops are sold at more than one price during the season or at harvest time.

Careful and complete work by the Farm Accountant will provide the Banner Administration with an accurate assessment of the economics of production using the center pivot irrigation system.

This will enable the Banner to adjust its choice of crops and the use of inputs in subsequent years to maximize the net values generated with the irrigation system.

The goal of this effort is to describe the net income earned by households in the ecological village during the 2004 growing season. We need to collect information describing the areas planted in each crop, the areas harvested or grazed by livestock, the number of animals raised and sold in 2004, the revenue from livestock sales, the amounts of wool and milk produced, and the prices received for those products. We will calculate total income of households by summing the values of crop and livestock products sold in 2004. In addition, we will ask households to describe their total expenditures for crop and livestock production. We will calculate the net income of households by subtracting their total expenditures from total income. This effort will enable us to describe the net incomes earned by households when they move to an ecological village and begin producing crop and livestock products.

We understand that households are not involved directly in the production of crops using the center pivot irrigation system. Rather, a unit of the Banner Administration produces the crops and sells its output to households at fixed prices. We understand also that households pay for feed concentrate and other inputs used in dairy production. They also have expenses for cutting and transporting hay from areas where they once lived. Some households might have expenses also for producing livestock products from sheep and goats. We understand that households sell the milk they produce to a dairy company that collects the milk and processes it for sale in local and distant markets. Households receive payment for milk sales once every month. Our goal in this effort is to obtain a full accounting of the costs paid by households and the revenues received for their output.

It might be helpful to assign the task of Household Accountant to someone in each household. The Household Accountant would record the types and amounts of inputs used, and the types and amounts of output produced. Inputs will include the forage, feed concentrate, and other inputs purchased for dairy production. Inputs should include also the time, labor, and energy required to harvest hay from distant areas. There might also be inputs for creating silage from forage. Outputs will include the sale of milk, wool, animals, and any other products sold by households during the year.

The Household Accountant should keep monthly records of expenditures for inputs and revenues from the sale of milk and other livestock products. This will simplify the task of calculating annual costs and revenues. An outline for collecting and recording the household information is provided on page 2 of Appendix B-3.

3.2.2.2 Evaluation of Sociological Change

Baseline monitoring of the resettlement community Silangcheng began on May 17 and 18, 2004, when the project team visited the pivot irrigation plot and recently constructed village. The social impact team took digital photos and interviewed five households; three in Silangcheng where residents had been living for less than one year, and two in nearby areas where resettlement had been in progress for three years. The three households in Silangcheng will begin to use forage from the pivot irrigation plot during the monitoring period — May to November.

These households included two Han families (one with four cows and the other with two cows) who had experienced a decline in income, and one relatively wealthy Mongolian family with ten cows and additional personal savings. The two households outside of Silangcheng provide a base of comparison and an opportunity to identify issues that may arise in Silangcheng during the monitoring period.

The social impact team will visit Silangcheng again in November to conduct further observations and interviews. We will conduct follow-up interviews in the same three households visited on May 18 — Zhang Wanli, Meng Ke, and Hao Shiyou. In addition we will interview nine other families, bringing the total to 12. We will conduct four interviews on three consecutive days. (Note: If resources allow, we could increase the number of interview to 16 or 20 over one or two more days.) The format will be semi-structured interviews that will last from one to one-and-one-half hours each. The families will be selected by a combination of opportunity sampling; e.g., going door to door in different sections of the village to find willing participants, and snowball sampling; e.g., asking those we interview to introduce us to other families in their networks of friends and relatives. The community consists of about 50 households and 200 people divided evenly between Han and Mongolian ethnicity. All are from the same *ga tsa* administrative unit. We will attempt to divide the sample evenly between Han and Mongolian households and include a range of age and wealth in the sample.

The village is designed to accommodate 200 milk cows, the maximum that can be fed with forage from the pivot irrigation plot. As of May 19, 2004, not all the cows had been delivered from Australia, and most of the cows that had been delivered were still too young to be producing milk. The stress of the transition between livestock herding on the grasslands and sedentary dairy operation has been exacerbated by a one-year delay in setting up the pivot irrigation system due to the SARS epidemic during the spring and summer of 2003. Previous sources of income had been given up without immediate replacement from selling milk. Monitoring will focus on how well lost income is likely to be replaced and how well the project is able to avoid or alleviate impoverishment.

Other issues that emerged from interviews on May 17 and 18 include the following:

- Lack of space surrounding people's houses and no garden area with fewer vegetables in diet
- Narrow space and lack of functional separation and sanitation in the animal shelter
- Meeting the needs for training and veterinarian assistance
- High price and difficulty in obtaining and processing forage (feeling that the cost of pivot forage should be lower than the going market price of 100 Y per ton
- High cost in time or money for cutting and transporting hay from the grasslands
- Delays in providing running water, television and telephone service
- Ability and willingness to pay for the high cost of modern life (e.g., electricity, running water, television, and telephones)
- Increased expenses for food
- Tension and resentment in the village between the "haves" and "have nots'
- Easier but more time-consuming work load
- Lack of available capital forcing families to borrow from each other

- Dealing with a sense of loss of personal autonomy and control over one's life
- More difficult adjustment for older people.

Issues that will be watched but are not critical at the moment include the following:

- Preserving the relationships between friends and family in housing arrangements
- Sharing animal shelters (by two households)
- The structural features of houses
- Gender conflict in changing the division of labor in the family
- The existence of a stable market for milk
- Transportation to schools, medical facilities, markets and cultural events, despite muddy and rutted roads
- Availability of wage labor jobs (especially for men and younger adults) outside the village.

During the household interviews in November we will collect information about household composition, age, gender, level of education, occupation/training and sources and amount of income for each member, and the primary language used in the home. In addition, we will ask for:

- Annual income in the year or months before and after resettlement
- Number and types of animals in the year before resettlement
- How many animals were sold and the income from the sale
- Amount of money spent and/or borrowed for resettlement
- Number and kind of animals or other assets carried over or acquired in the resettlement
- Choice of housing and other matters associated with the process of resettlement, kinds and amounts of household, and work-related expenses
- Amount and price of forage purchased
- Kinds of training related activities and amount of time spent in these activities
- Wage labor jobs working on the new railroad, power plant, nursery seedlings, restaurants, grocery shops, etc.
- Social services accessed
- Visits to relatives, old neighbors and grasslands (to check on animals, cut hay, etc.
- Participation in cultural activities.

The interview also will include narratives about problems, issues and subjective impressions/feelings that arise, any changes in language use and social interaction patterns, and how problems/conflicts are resolved or not resolved in the adjustment to resettlement. To a large extent the topics of importance to villagers will guide the interviews and contribute to the process of discovering new or unanticipated information. The line of questioning will be similar but not uniform from one interview to the next. We will go through all records and notes from interviews and prepare a summary of information. Analysis of the summary and emergent themes will provide the basis for the assessment of the ongoing social impacts of resettlement, and suggested mitigation and lessons learned from the initial stages of project implementation.

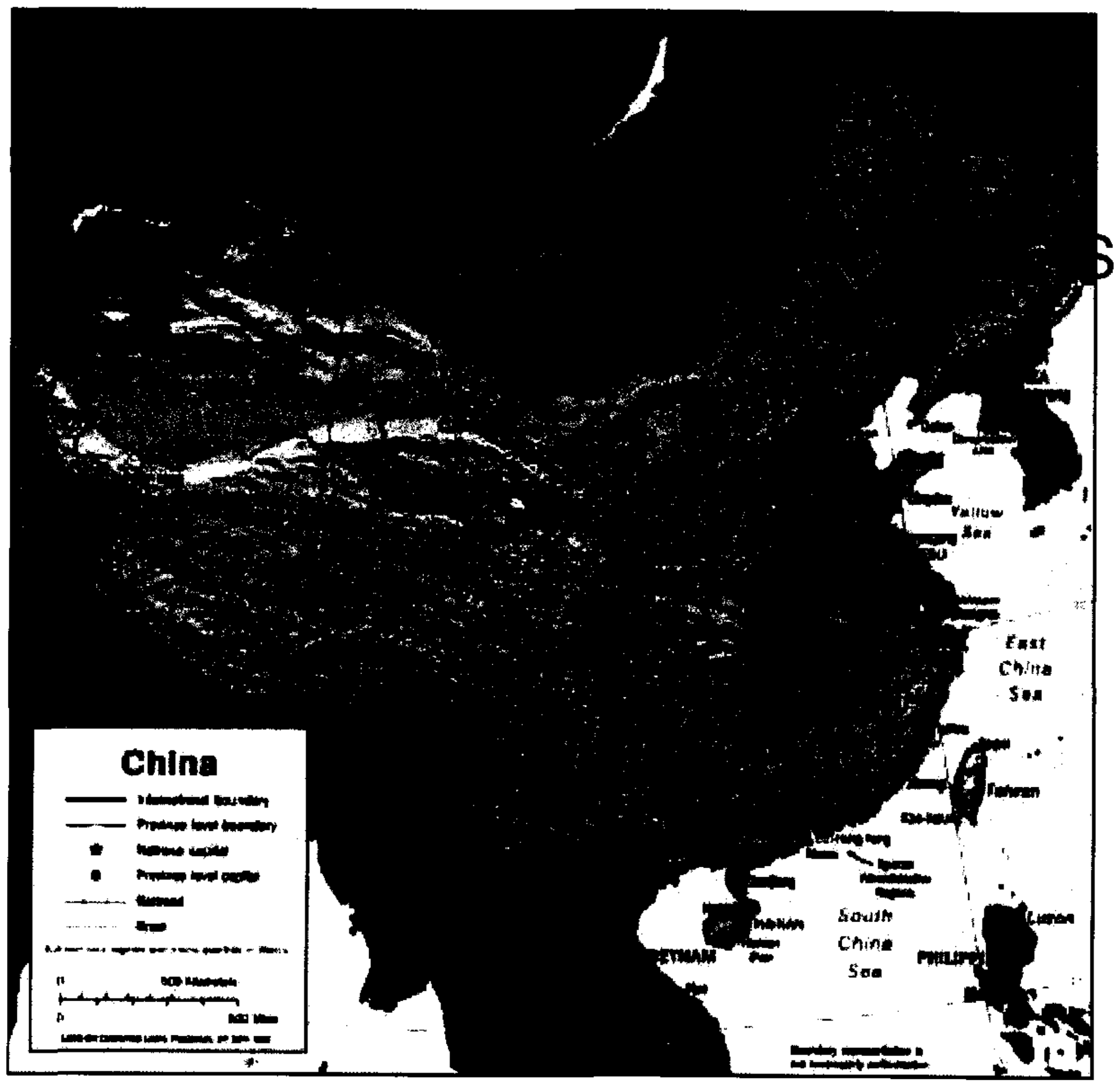
3.2.2.3 Output From Socioeconomic Monitoring

The socioeconomic monitoring conducted in this phase of the project will enable us to describe changes in both the economic status and social fabric of the Ecological Relocation Village.

DESERTIFICATION CONTROL PILOT STUDY

PROJECT DESIGN PLANS

STATE ADMINISTRATION OF FORESTRY, VALMONT INDUSTRIES, U.S. TRADE DEVELOPMENT AGENCY
ZHENGLAN BANNER, INNER MONGOLIA, CHINA



SITE

INDEX OF DRAWINGS

SHEET	GENERAL DRAWINGS
G-1	SITE MAP & INDEX OF DRAWINGS
G-2	SITE LOCATION PLAN - ZHENGLAN BANNER MAP
G-3	SITE LOCATION PLAN - TOPOGRAPHIC AREA MAP
G-4	SITE LOCATION PLAN - GRASSLAND CONDITION AREA MAP
G-5	SITE LOCATION PLAN - SOIL SURVEY AREA MAP
G-6	STANDARD CIVIL SYMBOLS & THRUST BLOCKS
G-7	STANDARD MECHANICAL SYMBOLS
	CENTER PIVOT DRAWINGS
C-1	CENTER PIVOT SITE LAYOUT
C-2	PROCESS FLOW DIAGRAM
C-3	PIVOT POINT LAYOUT
C-4	PIPELINE ROUTING PLAN
C-5	WATER DELIVERY SYSTEM MECHANICAL
C-6	SITE IMPROVEMENT DETAILS
C-7	SITE ELECTRICAL LAYOUT
C-8	CENTER PIVOT LAYOUT ALTERNATIVE

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

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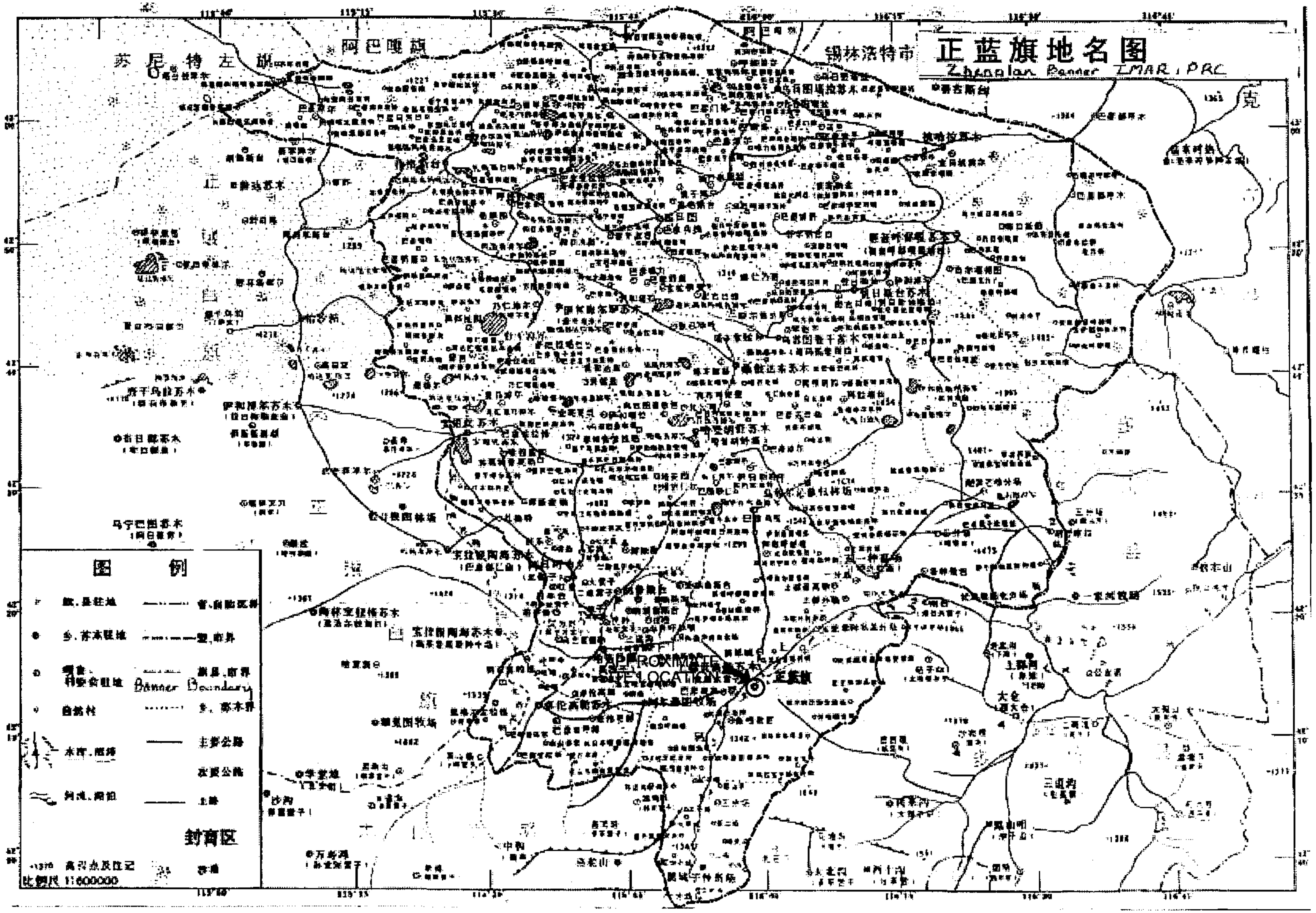
DRG. BY DEO
CHK. BY CES
DATE CREATED 2/27/03
JOB No. 2223044

valmont WATER MANAGEMENT GROUP

SITE MAP & INDEX OF DRAWINGS

PROJECT DESIGN PLANS

SHEET G-1



ZHENGLAN BANNER

NOT TO SCALE

BANNER BOUNDARY

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
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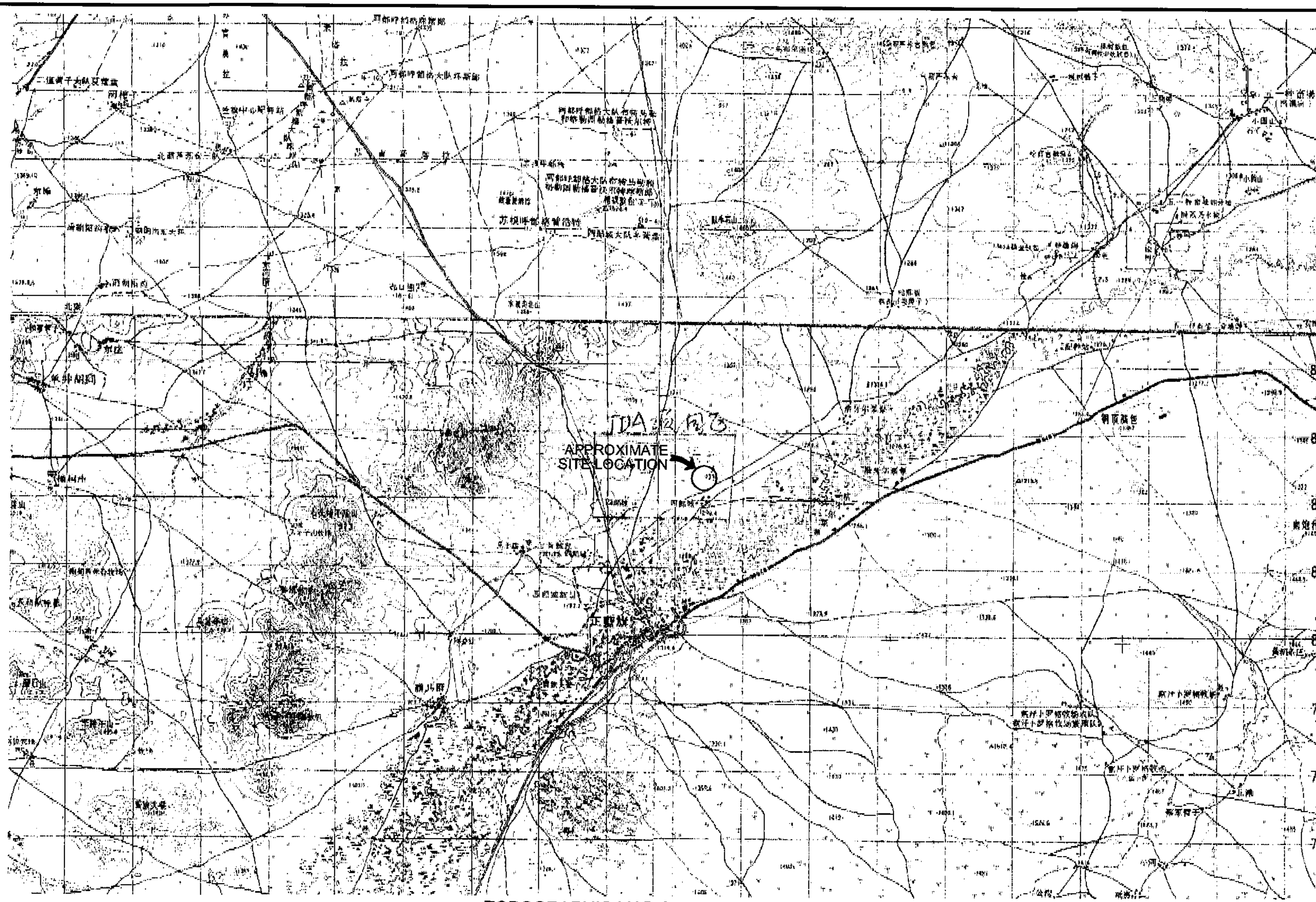
SITE LOCATION PLAN
ZHENGLAN BANNER MAP

PROJECT DESIGN PLANS

SHEET
G-2



TOPOGRAPHIC MAP SHOWING SITE LOCATION

SCALE: 1cm = 600M

0 1200 FEET

SCALE

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
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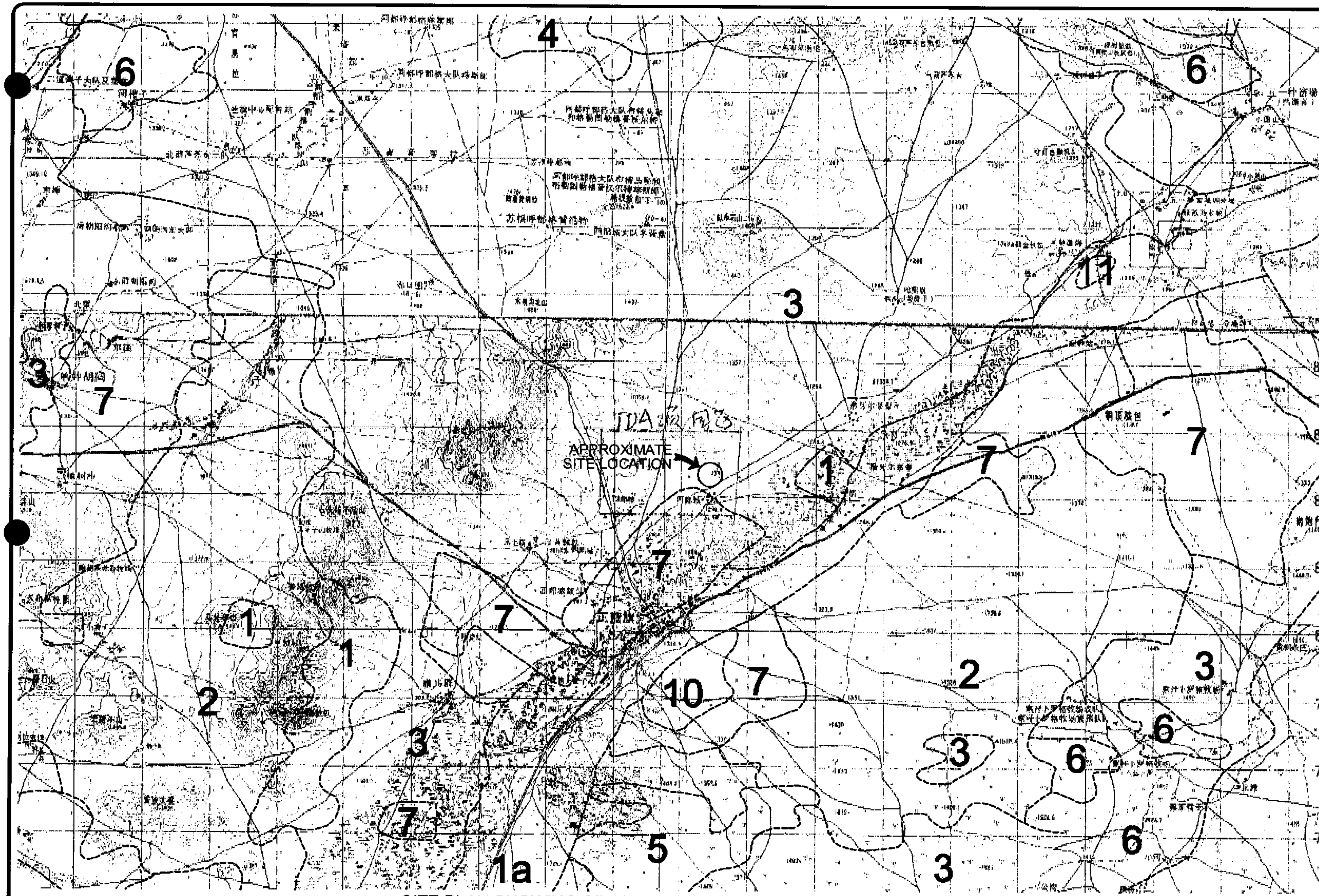
SITE LOCATION PLAN
TOPOGRAPHIC AREA MAP

PROJECT DESIGN PLANS

SHEET
G-3



SITE PLAN SHOWING GRASSLAND TYPES

SCALE: 1cm = 600M

0 1200 FEET

SCALE

GRASSLAND TYPES LEGEND

1	NON-DEGRADED GRASSLAND	6	SHIFT SAND LAND
1a	NON-DEGRADED MUD GRASSLAND	7	CROP LAND
2	MIDDLE-DEGRADED GRASSLAND	8	WOOD LAND
2a	MIDDLE-DEGRADED MUD GRASSLAND	9	OPEN LAND, ABANDONED
3	HEAVILY-DEGRADED GRASSLAND	9a	SALINITY ABANDONED
3a	HEAVILY-DEGRADED MUD GRASSLAND	10	TOWNSHIP
4	FIXED SAND LAND	11	WATER BODY
5	HALF-SHIFT SAND LAND		= GRASSLAND TYPE BOUNDARY

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

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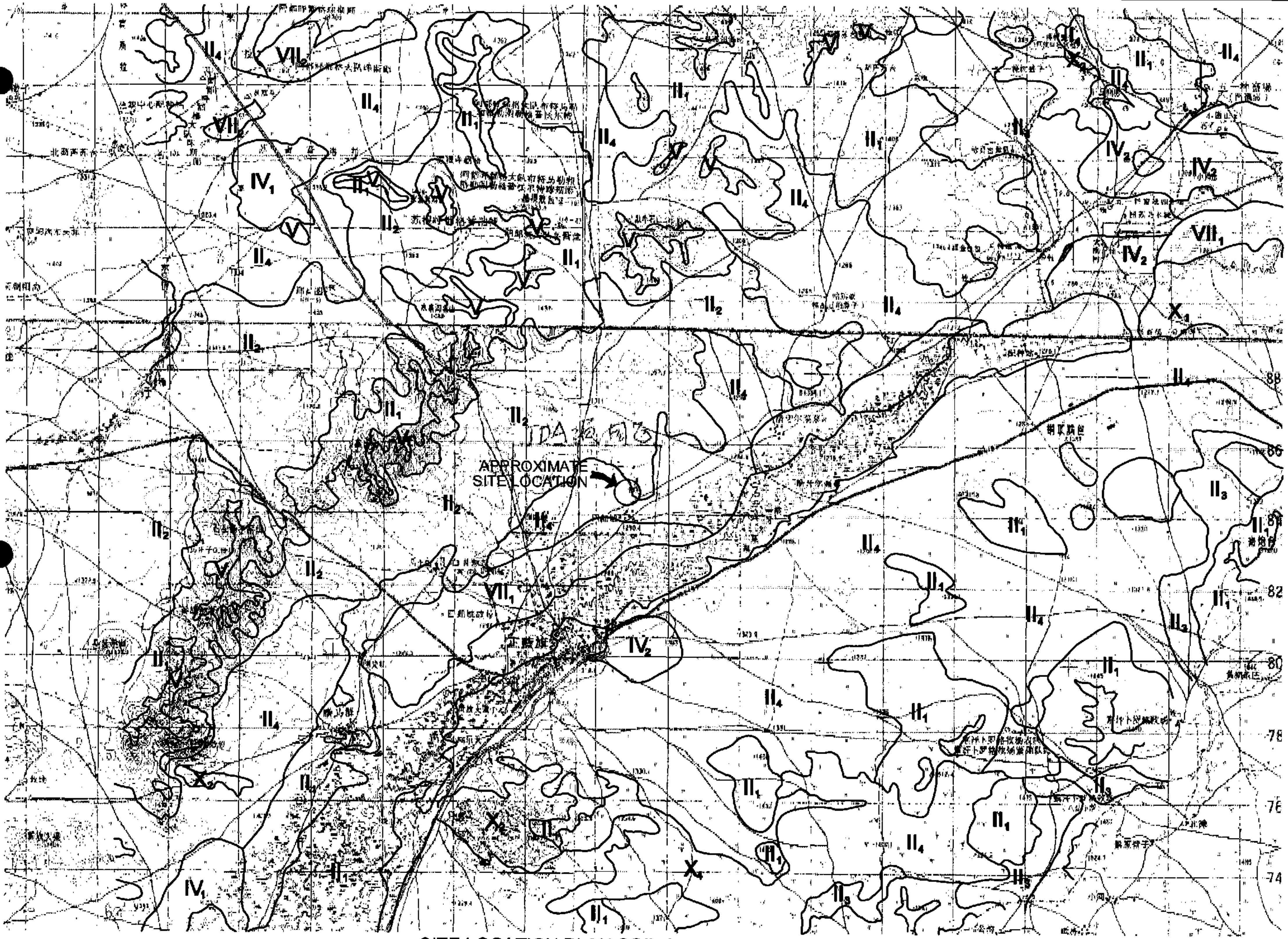
SITE LOCATION PLAN
GRASSLAND CONDITION AREA MAP

PROJECT DESIGN PLANS

SHEET
G-4



SITE LOCATION PLAN SOIL SURVEY AREA MAP

SCALE: 1cm = 600M

0 1200 FEET

SCALE

SOIL LEGEND

SYMBOL	SOIL TYPE	SUB TYPE	GROUP	POSITION
II2	BROWN CALCIUM	DARK BROWN CALCIUM	DARK BROWN LOESS	TOE SLOPE
	NOTES: "A" HORIZON DEEP, CLOSE TO BLACK CALCIUM SOIL, CLICHÉ LAYER AT DEPTH			
II1	BROWN CALCIUM	DARK BROWN CALCIUM	GRAY LOESS	LOW HILL
	NOTES: "A" HORIZON 35-55 CM, VEGETATION, STEPPE			
II4	BROWN CALCIUM	DARK BROWN	BROWN CLAY	INTER HILL PLAIN OF MT.
	NOTES: "A" HORIZON 30-40 CM, SANDY, KESHI STEPPE.			
VII1	MUD SOIL	DARK MUD	SANDY GRAY MUD SOIL	LOW LAND BANK OF RIVER
	NOTES: "A" HORIZON 30-40 CM, GRAY BROWN COLOR, WET AREAS ALONG RIVERS			

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IRRIGATION PILOT STUDY
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SITE LOCATION PLAN
SOIL SURVEY AREA MAP

PROJECT DESIGN PLANS

SHEET G-5

GENERAL

EXISTING EQUIPMENT OR MATERIALS TO BE REMOVED
TO BE BUILT FOR FUTURE REMOVAL
NEW FACILITIES (SOLID)
EXISTING
NEW BACKGROUND
PROPERTY LINE, PHANTOM LINE OR MATCH LINE
CENTERLINE
HIDDEN LINE OR FUTURE IMPROVEMENTS
WATER SURFACE

@ AT
& OR AND
ø ROUND OR DIAMETER
∠ ANGLE
℄ CENTER LINE
℘ PLATE OR PROPERTY LINE
(2) NOTE DESIGNATION
W/ WITH
W/O WITHOUT

CIVIL

NATURAL GROUND OR GRADE
GRANULAR MATERIAL SUCH AS CRUSHED ROCK OR GRAVEL
HDPE IN PLAN
EXISTING PAVEMENT IN PLAN
PAVEMENT IN PLAN
GRAVEL IN PLAN
CONCRETE IN PLAN
FENCE
RAILROAD
110 EXISTING GRADE CONTOURS
EXISTING CONTOURS DEMO
110 FINISH GRADE CONTOURS
+120.0 EXISTING SPOT ELEVATION
+110.50 FINISH GRADE SPOT ELEVATION
112.50 / 112.00 TOP OF CURB ELEVATION / GUTTER OR GROUND ELEVATION
SWALE OR DEPRESSION

EDGE OF WATER; FLOWLINE WITH DIRECTIONAL ARROW
3:1 SLOPE (3 HOR. TO 1 VERT.)
CUT OR FILL SLOPE; ARROWS POINT DOWN SLOPE
B9 SOIL BORING AND DESIGNATION
HYDRANT
BURIED VALVE
MH MANHOLE
CB CATCH BASIN OR INLET
UTILITY POLE
SURVEY MONUMENT
SURVEY CONTROL POINT
TREES, SHRUBS OR HEDGE
TREES, SHRUBS OR HEDGE DEMO
N E COMMONWEALTH PLANE COORDINATE
W WATER WELL

ARCHITECTURAL / STRUCTURAL

CONCRETE
REINFORCEMENT IN SECTION
PRECAST CONCRETE
MORTAR, GROUT, PLASTER OR SAND
CONCRETE BLOCK
BRICK OR CAST IRON
STEEL OR STAINLESS STEEL
ALUMINUM
WOOD
RIGID INSULATION
BATT INSULATION

NEOPRENE, RUBBER OR PLASTIC
OPENING OR DEPRESSION IN SLAB OR WALL
GRATING SPAN
CHECKER PLATE
OPENING WITH GRATING COVER
OPENING WITH CHECKER PLATE COVER
FRP GRATING WITH COVER PLATE
JOINT FILLER
WATER STOP
HANDRAIL

SITE SYMBOLS AND LEGEND

S SEPTIC
WELL
WELL & SEPTIC
CISTERN
SLOPES >12%
SOIL MOISTURE SENSOR
MONITOR WELL (UP)

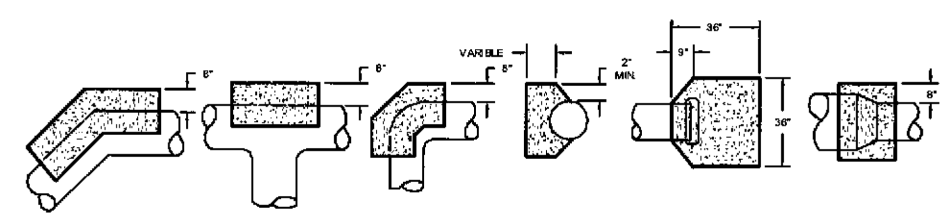
MONITOR WELL (DOWN)
0.25 MILE BOUNDARY
SH SINKHOLE
LS LIMESTONE OUTCROP PROPOSED CENTER
PROP LOW PRESSURE LINEAR SYSTEM
B IRRIGATION FIELD

CIVIL SYMBOLS and LEGEND

CRUSHED ROAD BASE
CONCRETE
EARTH NATIVE MATERIAL & FILL
POWER POLE
EXISTING GRAVEL ACCESS ROAD
CONC 'V' DITCH CONCRETE TRAPEZOIDAL CANAL
EXISTING FENCE
12+00 13+00 14+00 NEW TRANSMISSION MAIN
EXISTING PIPELINE
SD SD EXISTING STORMDRAIN
R LENGTH OF PIVOT HARDWARE
PRESSURE GAUGE
AIR/VACUUM RELEASE VALVE
EXISTING DRAIN EXISTING IRRIGATION DRAIN
CONTROL POINT
480V > ELECTRIC POWER SUPPLY
M MOTOR

D ELECTRICAL SIGNAL (DISCRETE)
A ELECTRICAL SIGNAL (ANALOG)
8"Ø IRR NEW IRRIGATION PIPING
D5 IRRIGATION PIPING COORDINATES
SWITCH - SPST EQUAL TO P&S 20AC1-I.
RECEPTACLE-DUPLEX, GFI EQUAL TO P&S 2091-SI
THERMOSTAT
SPECIAL PURPOSE CONNECTION WORK AS NOTED
ELECTRIC MOTOR CONNECTION
SURFACE MOUNTED FLUORESCENT LIGHT FIXTURE
WALL MOUNTED FIXTURE
MPC-2,4,6 CIRCUIT DESIGNATION, PANELBOARD BN1L, CIRCUITS 2, 4, 6.
1/E5.2 INDICATES DETAIL 1 ON SHEET E5.2
1 SHEET WORK NOTE.
HOME RUN TO PANELS. NUMBER OF ARROWS INDICATES NUMBER OF CIRCUITS
CONDUIT CONCEALED IN CEILING, WALL, OR BELOW FLOOR
CIRCUIT. NUMBER OF HASH MARKS INDICATES NUMBER OF CONDUCTORS IN CABLE/RACEWAY. FROM LEFT TO RIGHT, HASHMARKS INDICATE GROUND, HOT, NEUTRAL & SWITCHLEG.

THRUST BLOCKS



THRUST BLOCK SIZE								
PIPE DIAMETER INCHES	90° OR TEE AREA FT²	90° OR TEE VOLUME CY	45° AREA FT²	45° VOLUME CY	22.5°/REDUCERS AREA FT²	22.5°/REDUCERS VOLUME CY	END AREA FT²	END VOLUME CY
6	4	0.2	2	0.1	1	0.1	3	0.1
8	7	0.3	4	0.1	2	0.1	5	0.2
10	12	0.4	6	0.2	3	0.1	8	0.3
12	17	0.6	9	0.3	5	0.2	12	0.4
15	26	1.0	14	0.5	7	0.3	16	0.7
18	39	1.4	21	0.8	11	0.4	—	—
21	54	2.0	29	1.1	15	0.5	—	—
24	68	2.5	37	1.4	18	0.7	—	—

NOTE: ON 11.25° FITTINGS, USE SIMILAR THRUST BLOCK SIZES AS 22.5 DEGREE FITTINGS.

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IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

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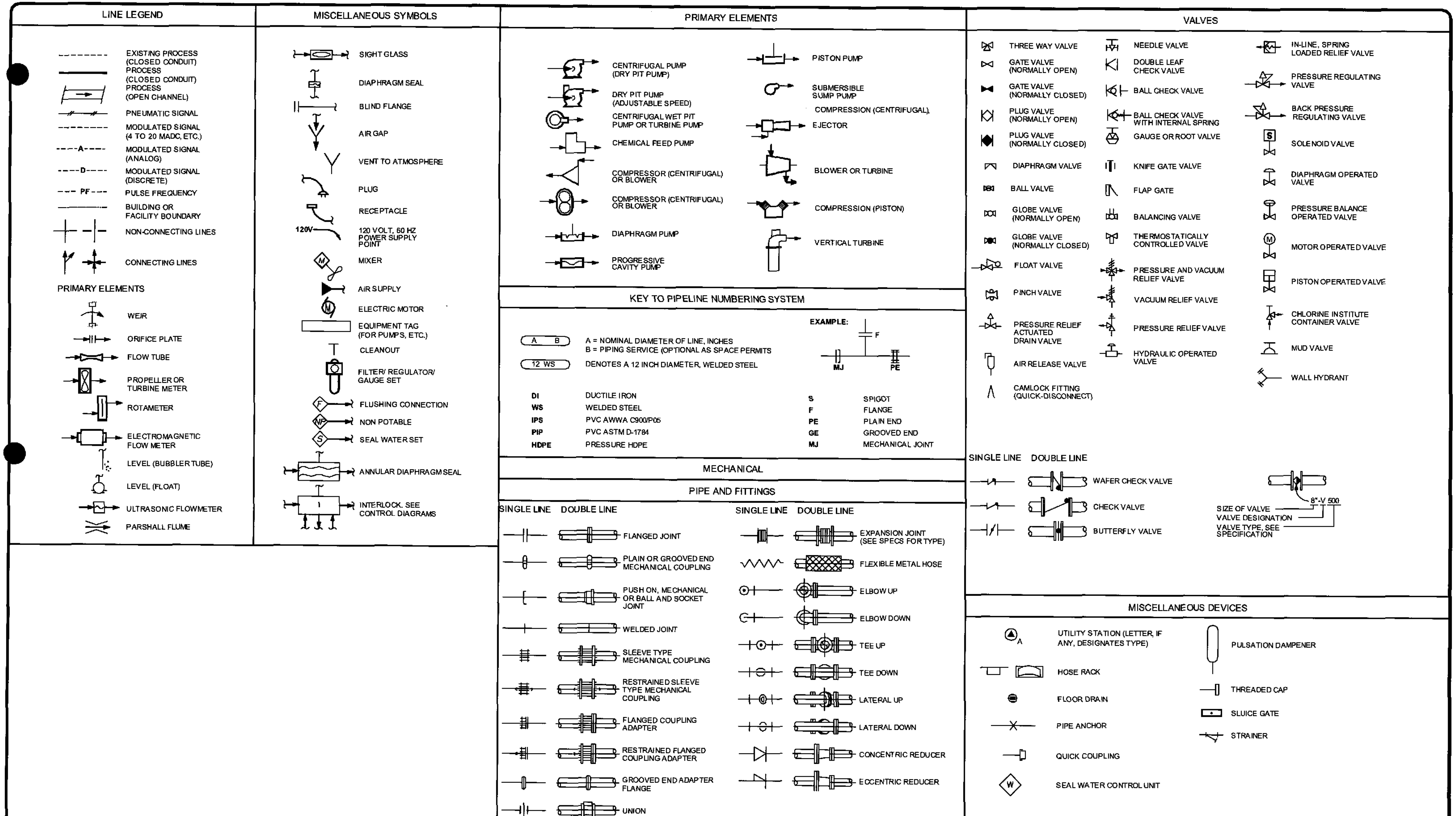
JOB No. 2223044

valmont
WATER MANAGEMENT GROUP

STANDARD CIVIL SYMBOLS & THRUST BLOCKS

PROJECT DESIGN PLANS

SHEET
G-6



2223044G7R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

DES. BY GLT
DRG. BY DEO
CHK. BY CES
DATE CREATED 2/7/03
JOB No. 2223044

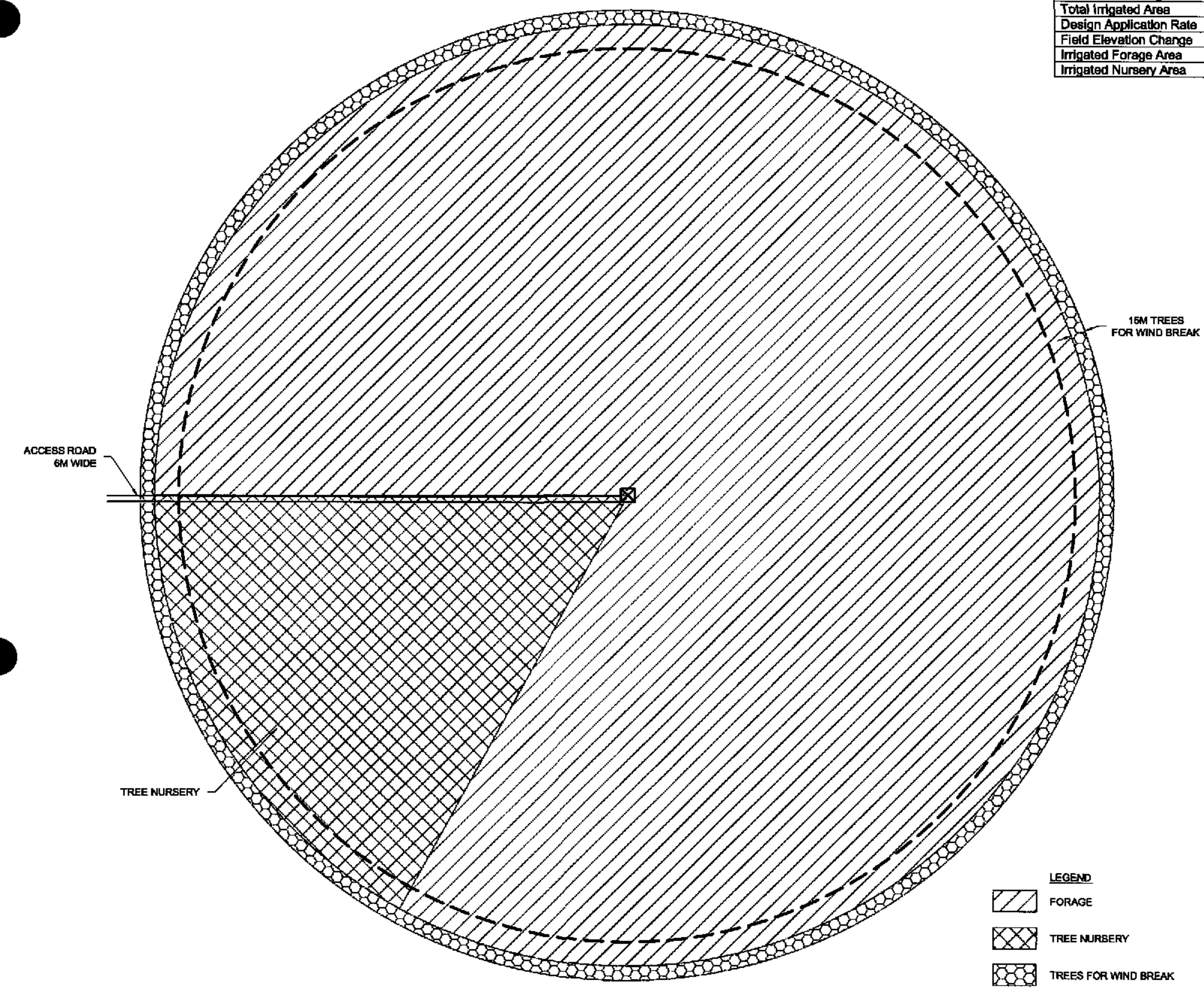
valmont
WATER MANAGEMENT GROUP

STANDARD MECHANICAL SYMBOLS

PROJECT DESIGN PLANS

SHEET
G-7

Field Specifications:	
Pivot Length	464.3 Meters
End Gun Coverage	25 Meters
Total Irrigated Area	74.3 Hectares
Design Application Rate	6.07 mm/day
Field Elevation Change	0 Meters
Irrigated Forage Area	14.8 Hectares
Irrigated Nursery Area	59.5 Hectares



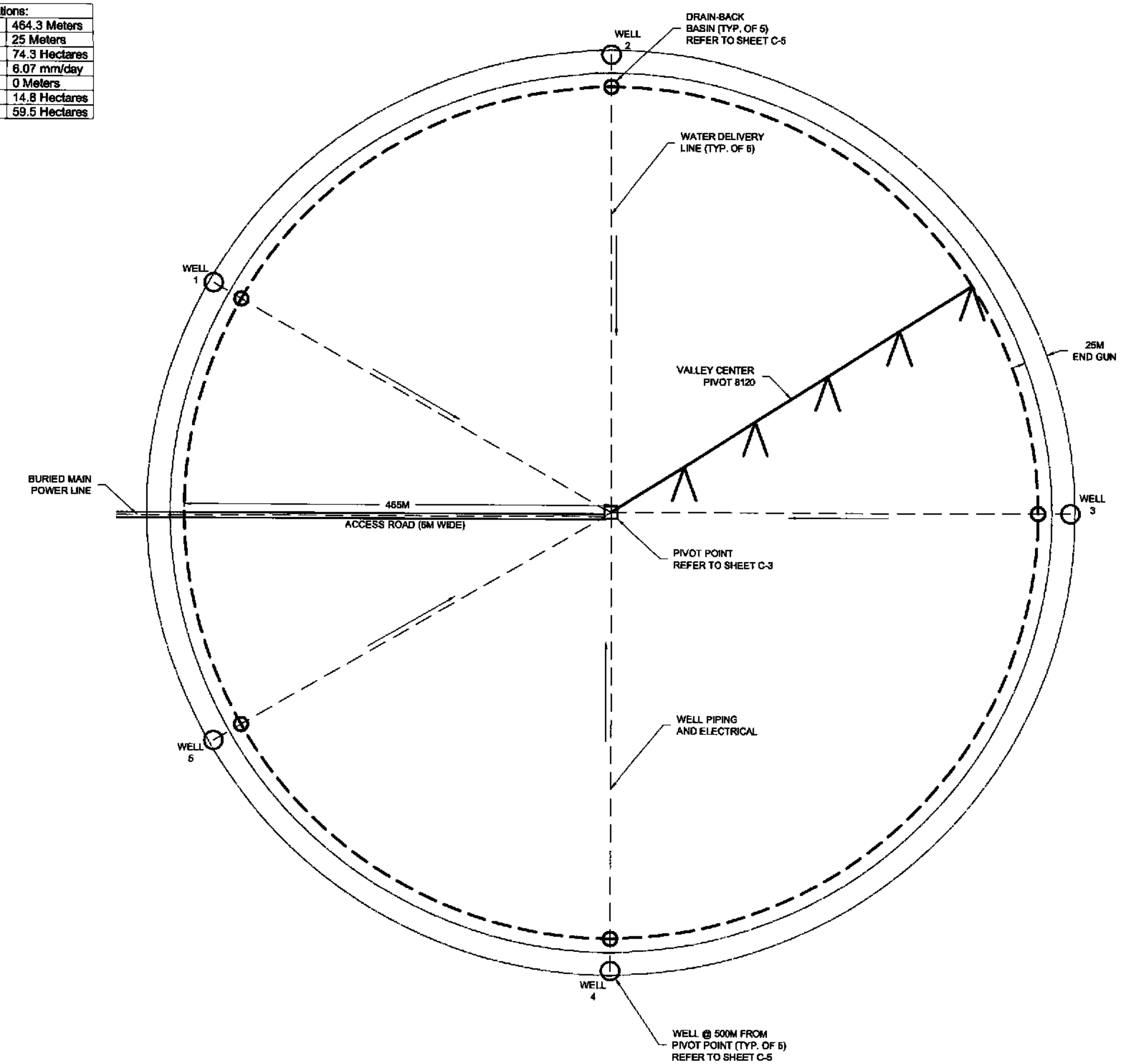
Notes:
1. Tree nursery to be established and managed by PRC State Forestry Administration.
2. Agricultural ground for forage production to be established and managed by Zhenglan Banner.
3. Perimeter windbreak to be established and managed by Zhenglan Banner.

CENTER PIVOT FIELD LAYOUT

SCALE: 1cm = 60M

0 120M

SCALE



Notes:
1. Specific pivot point location to be selected by Zhenglan Banner in approximate vicinity of site location shown on Sheet G-3.
2. All site improvements are the responsibility of Zhenglan Banner (wells, pumps, piping, access road, etc.).
3. Pivot installation, set-up, and initial operation are the responsibility of Valmont Industries.

CENTER PIVOT MECHANICAL LAYOUT

SCALE: 1cm = 60M

0 120M

SCALE

2223044C1R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

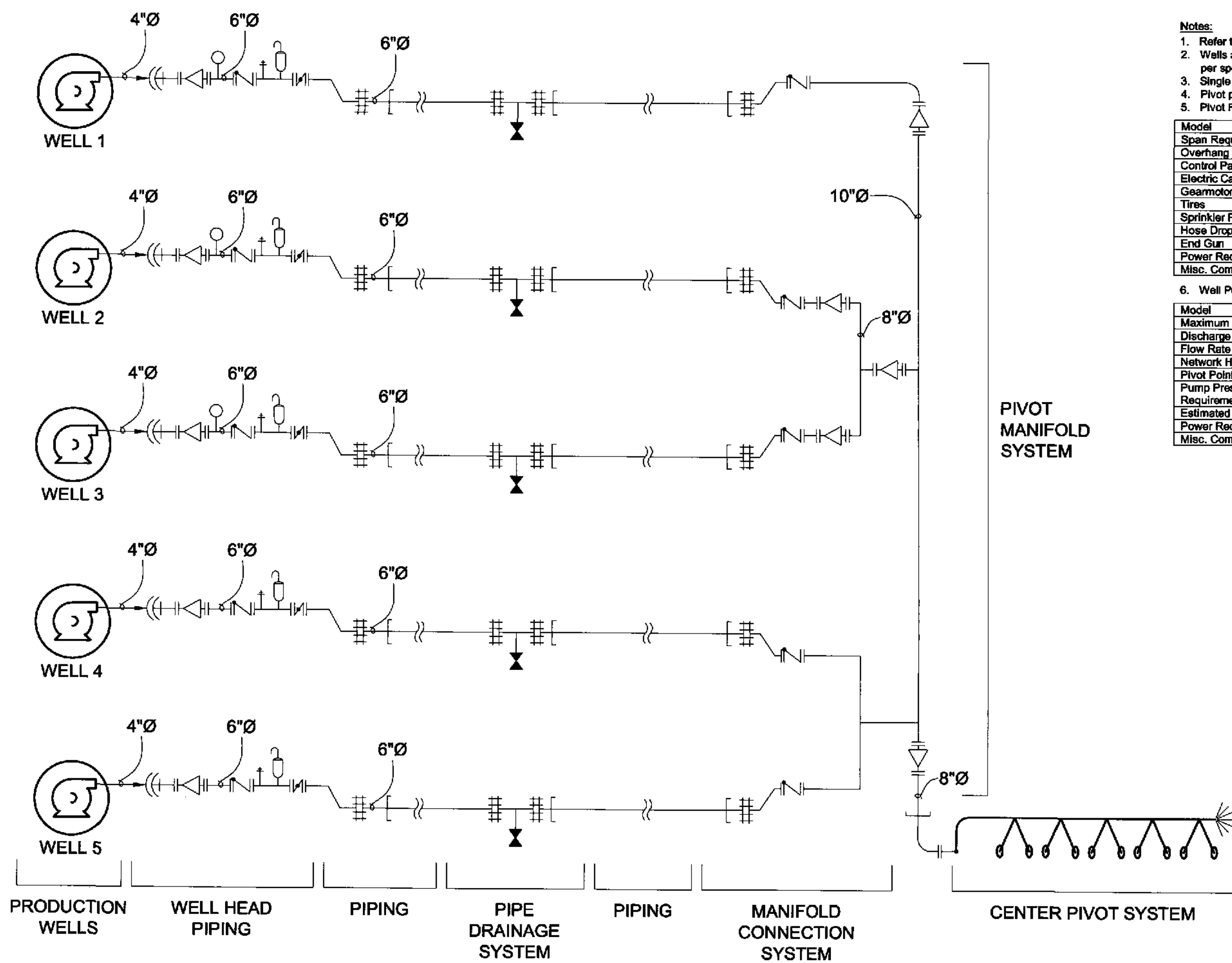
DES. BY GLT
DRG. BY DEO
CHK. BY CES
DATE CREATED 5/19/03
JOB No. 2223044

valmont
WATER MANAGEMENT GROUP

CENTER PIVOT
SITE PLAN

PROJECT DESIGN PLANS

SHEET
C-1



Notes:

1. Refer to Sheets G-6 and G-7 for nomenclature.
2. Wells and pumps to be installed by Zhenglan Banner per specifications referenced on Sheet C-5.
3. Single well operation of 50 M3/hr @ 59 psi.
4. Pivot point operation of 190 M3/hr @ 25.4 psi.
5. Pivot Requirements:

Model	Valley Model 8120 Center Pivot
Span Requirements	6 ~ Model 8120 6-5/8" spans @ 54.86 M
Overhang	1 – Model 8120 6-5/8" @ 25.08 M
Control Panel	Valley C:A:M:S Select
Electric Cable	10 GA per span (2.5 mm)
Gearmotor	Valley High Speed 1.2 HP Helicoidial
Tires	Valley 14.9" x 24" on 12" rim
Sprinkler Package	Valley Len Double/Triple PAD @ 6 psi w/Reg
Hose Drop	5.5' Poly Slip w/ 6" galv. u-pipe
End Gun	Komet SR101 w/ 2HP Booster
Power Requirement	380 V, 3-phase, 50 hz
Misc. Components/Hookups	Valley Specified for specific model

6. Well Pump Requirements

Model	TBD by Zhenglan Banner
Maximum Diameter	< 250 mm
Discharge Size	4"
Flow Rate Range	40 to 50 M^3/hr
Network Headloss	25 M (238 kPa or 34.5 psi)
Pivot Point Pressure	175 kPa or 25.3 psi
Pump Pressure Requirements	413 kPa or 59.8 psi
Estimated Power Needs	9.2 kW (12.3 Hp)
Power Requirement	380 V, 3-phase, 50 hz
Misc. Components/Hookups	Manufacturer specified

PROCESS FLOW DIAGRAM

NOT TO SCALE

2223044C2R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	–	–	MO/DAY/YR
2	–	–	MO/DAY/YR
3	–	–	MO/DAY/YR
4	–	–	MO/DAY/YR
5	–	–	MO/DAY/YR

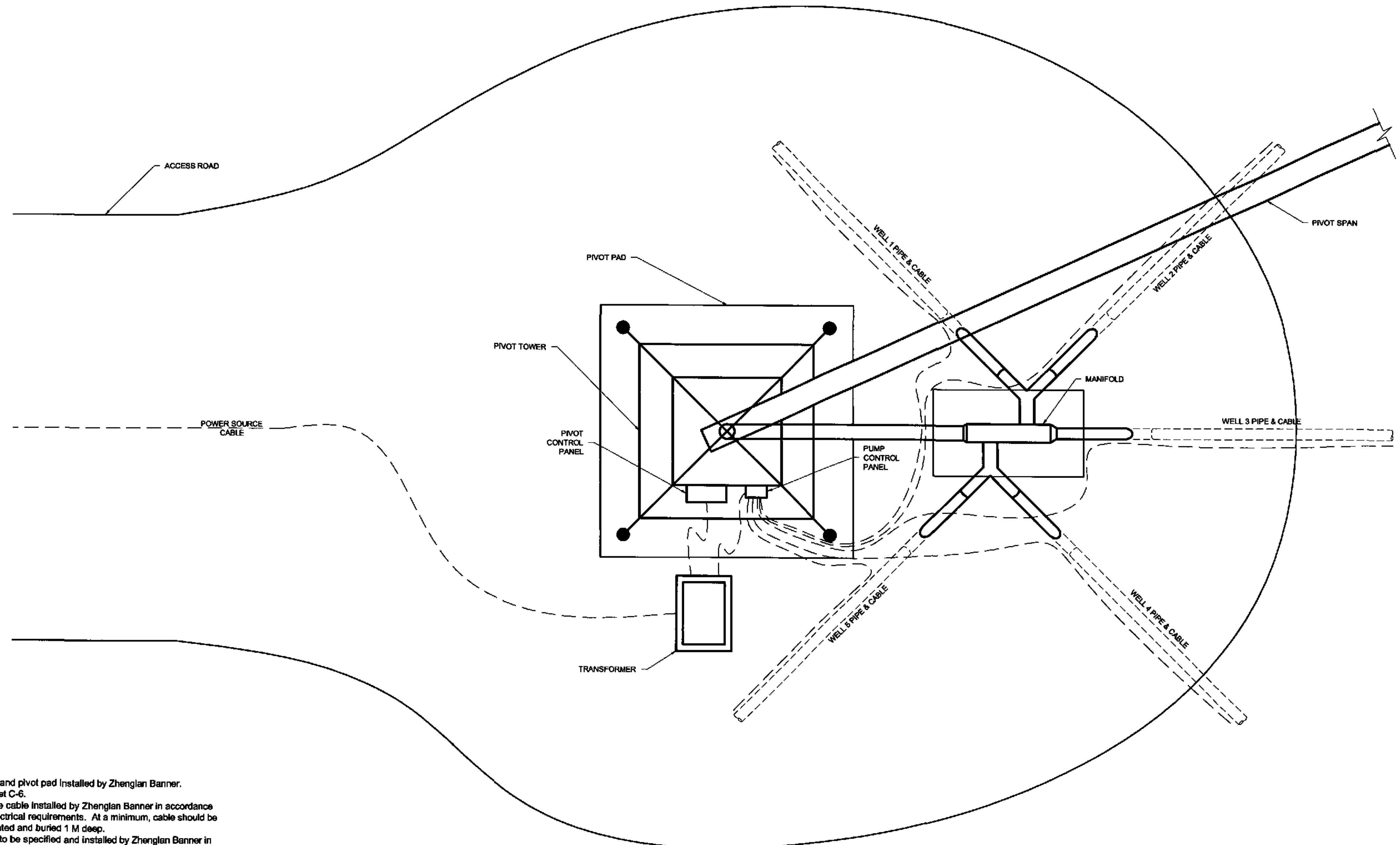
DES. BY GLT
DRG. BY DEO
CHK. BY CES
DATE CREATED 5/19/03
JOB No. 2223044

valmont
WATER MANAGEMENT GROUP

PROCESS FLOW DIAGRAM

PROJECT DESIGN PLANS

SHEET
C-2



Notes:
1. Access road and pivot pad installed by Zhenglan Banner. Refer to Sheet C-6.
2. Power source cable installed by Zhenglan Banner in accordance with local electrical requirements. At a minimum, cable should be double insulated and buried 1 M deep.
3. Transformer to be specified and installed by Zhenglan Banner in accordance with local electrical requirements. Refer to Sheet C-7 for power conversion requirements.
4. Pumps control panel to be specified by well pump manufacturer and installed by Zhanglan Banner per manufacturer guidelines and instructions.
5. Pivot tower, spans, and control panel to be installed by Valmont Industries per manufacturer guidelines and specifications.

CENTER PIVOT FIELD LAYOUT

SCALE: 1cm = 0.6M

0 0.6M
SCALE

2223044C3R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	–	–	MO/DAY/YR
2	–	–	MO/DAY/YR
3	–	–	MO/DAY/YR
4	–	–	MO/DAY/YR
5	–	–	MO/DAY/YR

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CHK. BY CES
DATE CREATED 5/20/03
JOB No. 2223044

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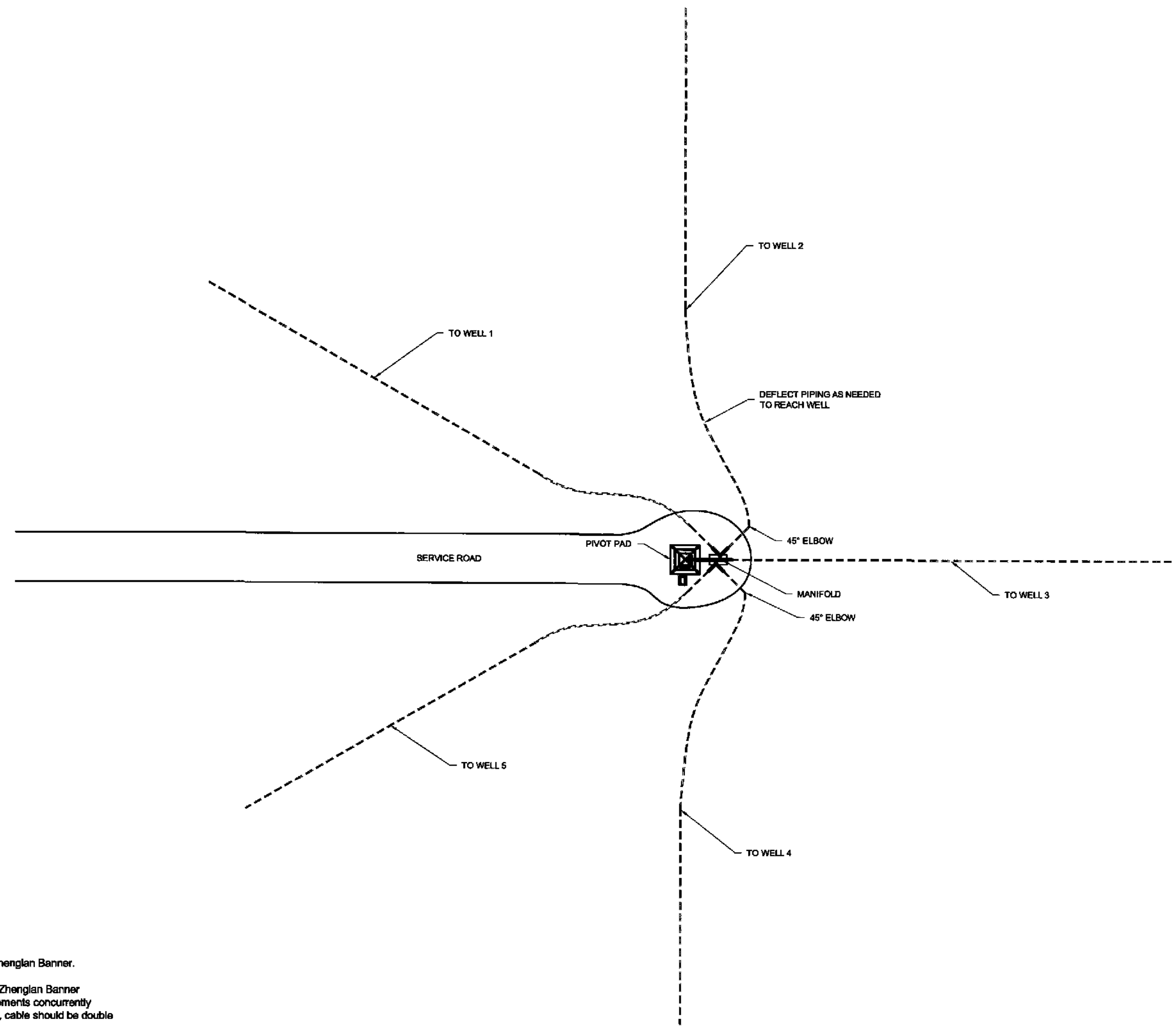
WATER MANAGEMENT GROUP

PIVOT POINT LAYOUT

PROJECT DESIGN PLANS

SHEET
C-3



Notes:
1. Access road and pivot pad installed by Zhenglan Banner. Refer to Sheet C-6.
2. Power cables to well pumps installed by Zhenglan Banner in accordance with local electrical requirements concurrently with pipeline construction. At a minimum, cable should be double insulated and buried adjacent to pipe.
3. Pipeline deflection shall not exceed tolerances set forth by pipe manufacturer.
4. Refer to Sheet C-6 for trenching and backfill requirements.
5. Refer to Sheet G-6 for thrust block requirements.

PIPELINE ROUTING PLAN - OPTION 1

SCALE: 1cm = 6M

0 6M
SCALE

2223044C4R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	–	–	MO/DAY/YR
2	–	–	MO/DAY/YR
3	–	–	MO/DAY/YR
4	–	–	MO/DAY/YR
5	–	–	MO/DAY/YR

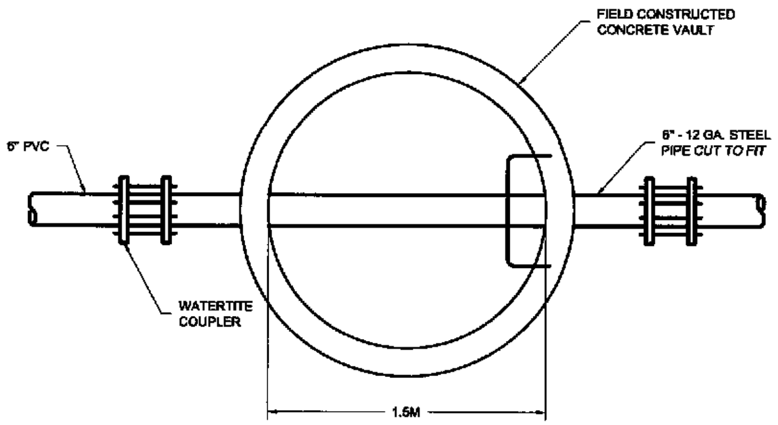
DES. BY GLT
DRG. BY DEO
CHK. BY CES
DATE CREATED 5/29/03
JOB No. 2223044

valmont
WATER MANAGEMENT GROUP

PIPELINE ROUTING PLAN

PROJECT DESIGN PLANS

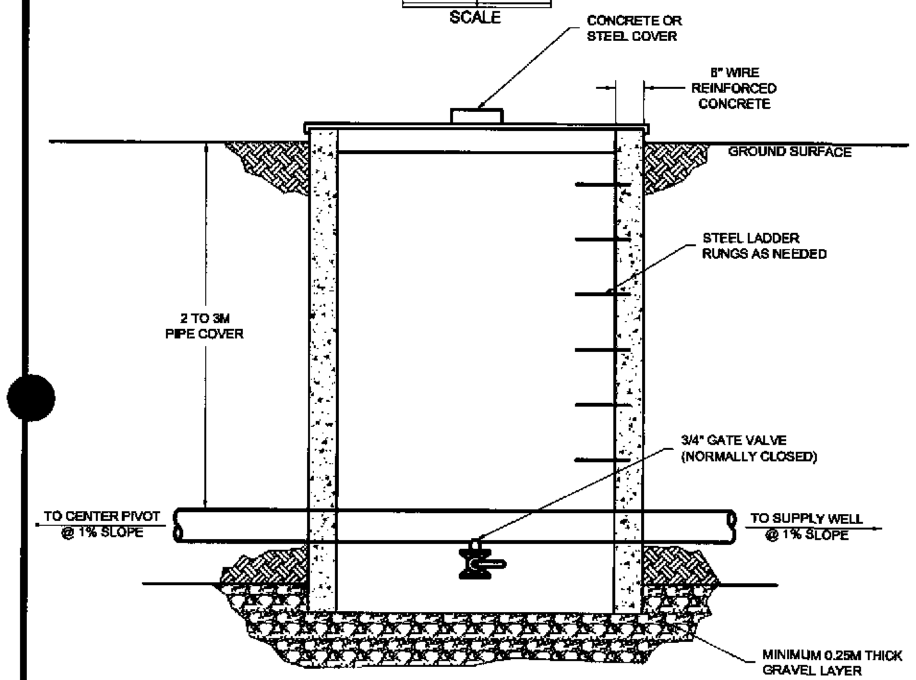
SHEET
C-4



DRAIN-BACK BASIN DETAIL - PLAN VIEW

SCALE: 1cm = 40cm

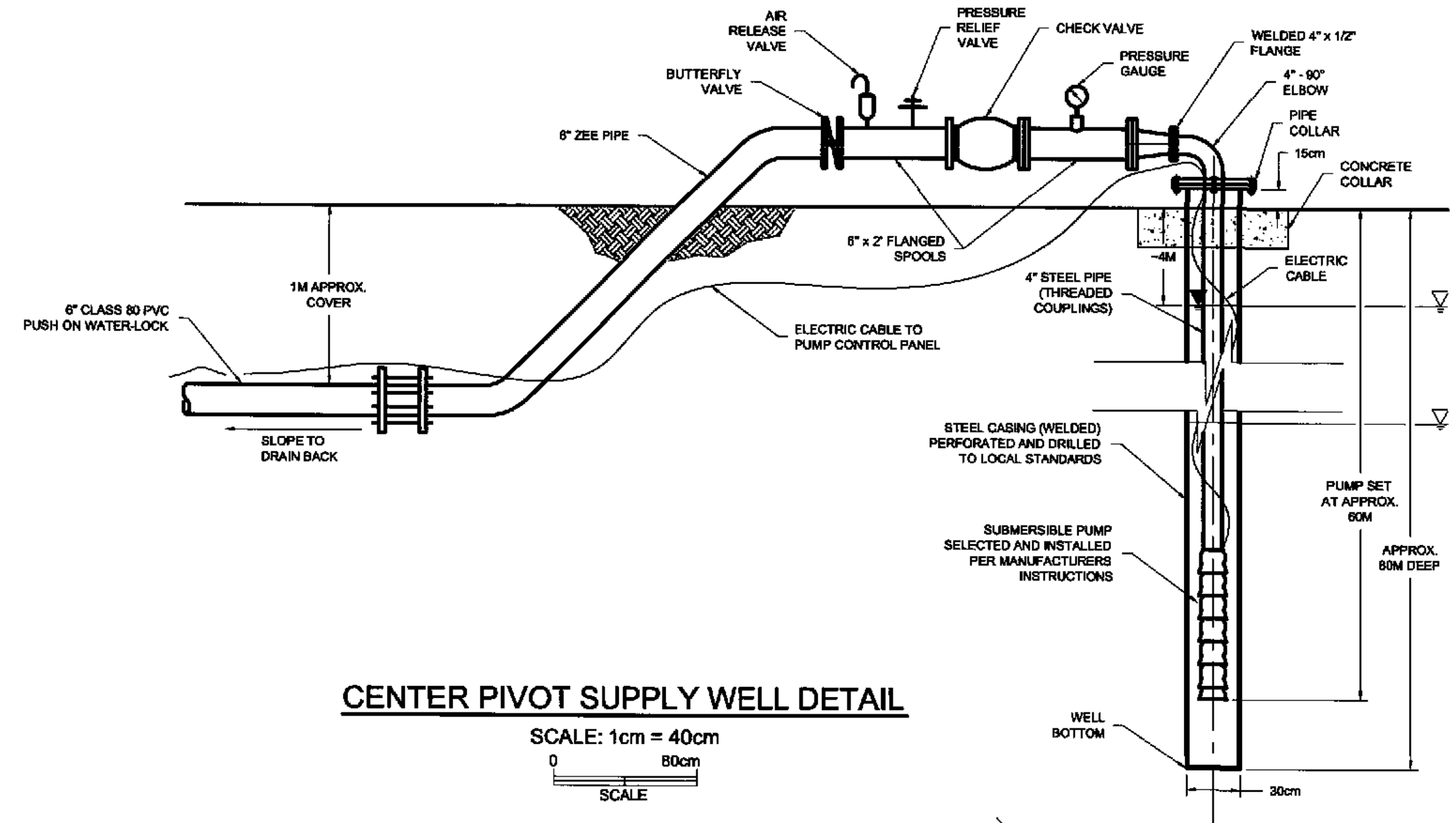
0 80cm SCALE



DRAIN-BACK BASIN DETAIL - SECTION VIEW

SCALE: 1cm = 40cm

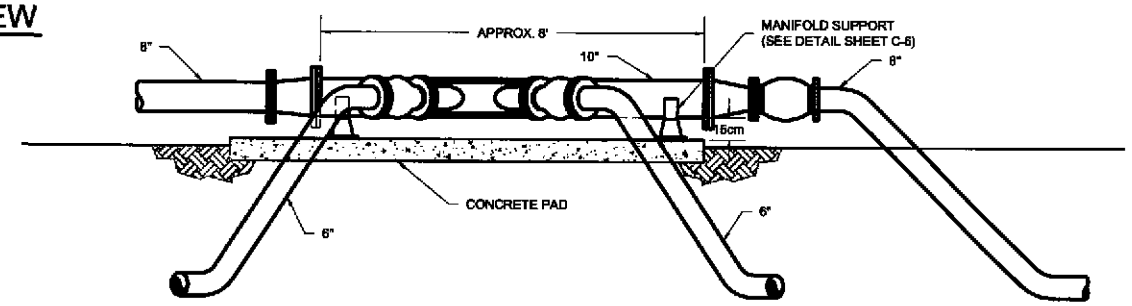
0 80cm SCALE



CENTER PIVOT SUPPLY WELL DETAIL

SCALE: 1cm = 40cm

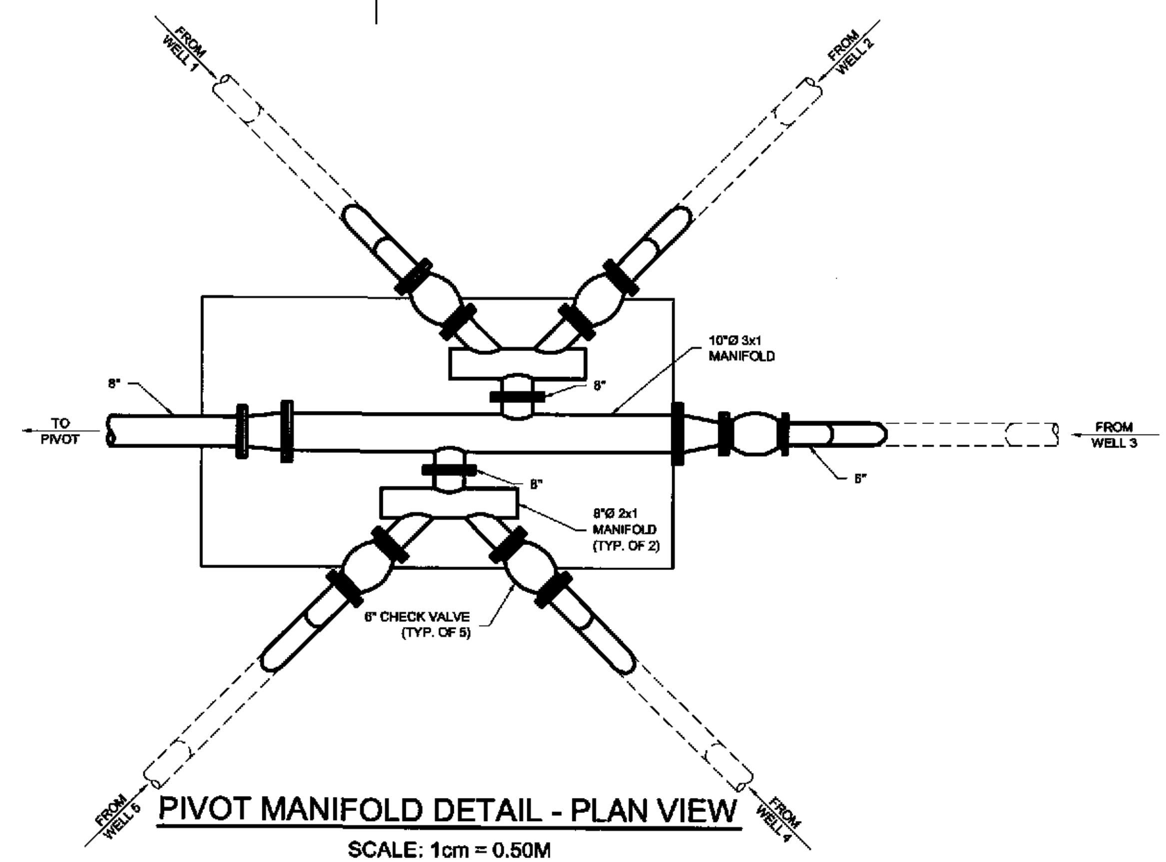
0 80cm SCALE



PIVOT MANIFOLD DETAIL - SECTION VIEW

SCALE: 1cm = 0.50M

0 1M SCALE



PIVOT MANIFOLD DETAIL - PLAN VIEW

SCALE: 1cm = 0.50M

0 1M SCALE

2223044C5R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	–	–	MO/DAY/YR
2	–	–	MO/DAY/YR
3	–	–	MO/DAY/YR
4	–	–	MO/DAY/YR
5	–	–	MO/DAY/YR

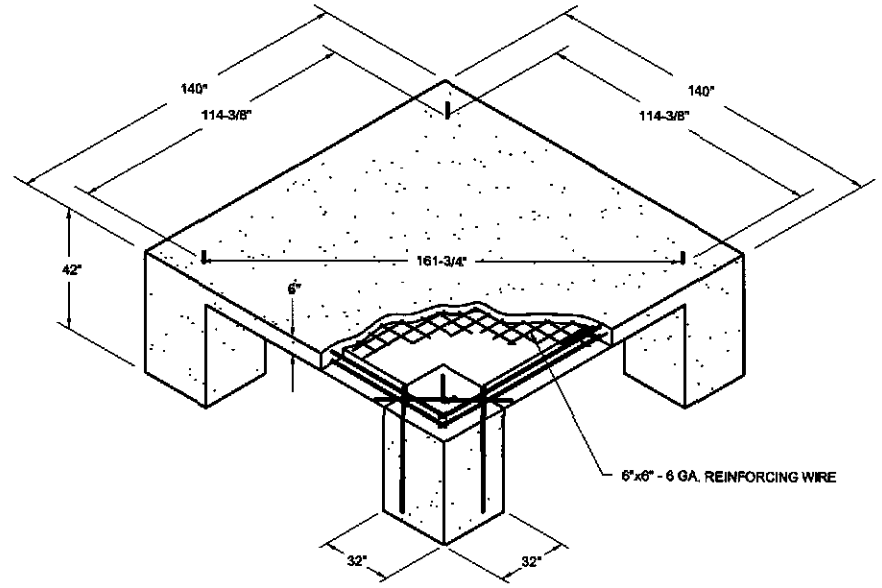
DES. BY GLT
DRG. BY DEO
CHK. BY CES
DATE CREATED 5/20/03
JOB No. 2223044

valmont
WATER MANAGEMENT GROUP

WATER DELIVERY SYSTEM
MECHANICAL

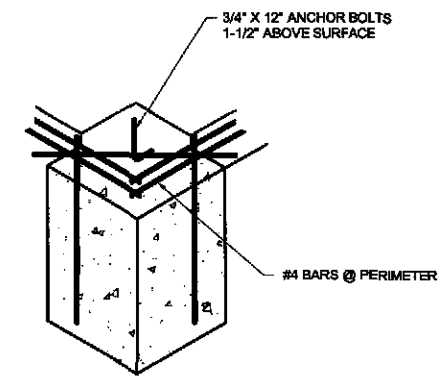
PROJECT DESIGN PLANS

SHEET
C-5



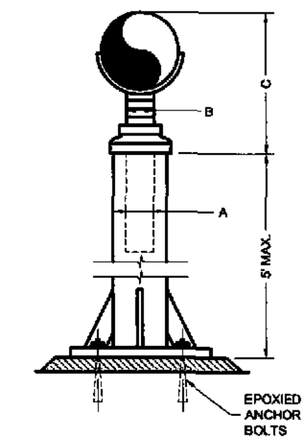
DETAIL CENTER PIVOT PAD

NTS



DETAIL C.P. PAD REINFORCEMENT

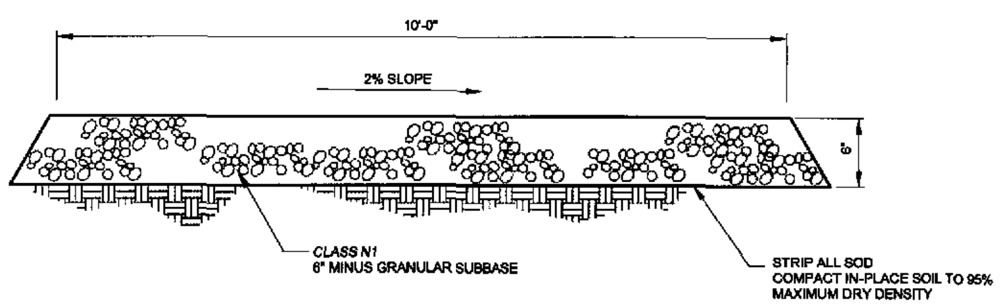
NTS



ADJUSTABLE PIPE SUPPORT APPROXIMATE DIMENSIONS IN INCHES			
PIPE SIZE	A	B	C (MAX.)
2-1/2	2-1/2	1-1/2	
3	2-1/2	1-1/2	8-1/4
3-1/2	2-1/2	1-1/2	8-1/2
4	3	x 2-1/2	10-1/4
6	3	x 2-1/2	11-5/8
8	3	x 2-1/2	13-5/8
10	4	x 2-1/2	14-5/8
12	4	x 2-1/2	15-5/8
14	6	3	18-7/8
16	6	3	19-7/8
18	8	3-1/2	21-1/4
20	8	3-1/2	23-1/4

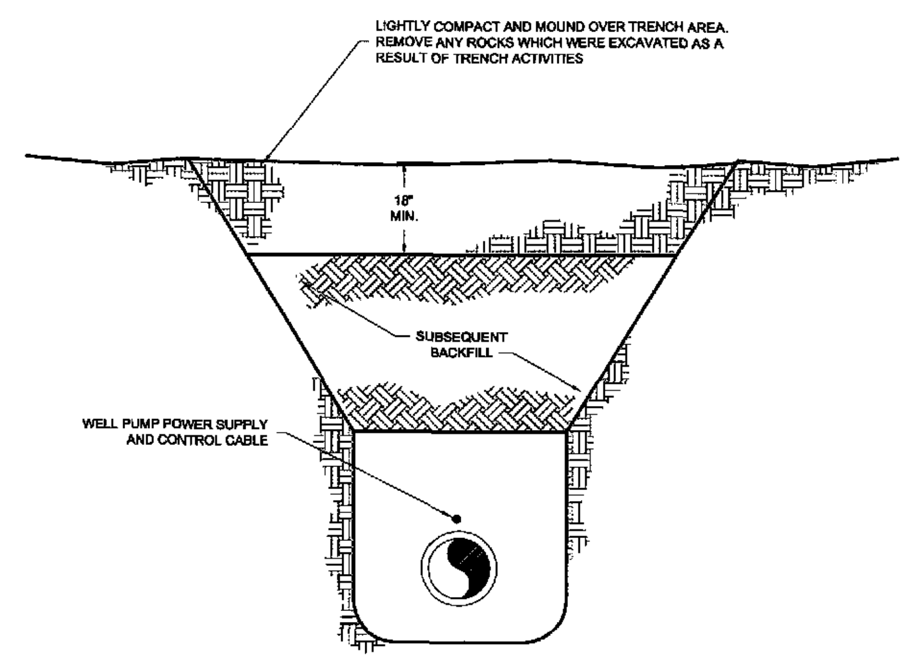
SINGLE PIPE SUPPORT

SCALE: NTS



TYPICAL GRAVEL ACCESS ROAD

NTS



TRENCH RESTORATION AGRICULTURAL AREA

SCALE: NTS

2223044C6R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

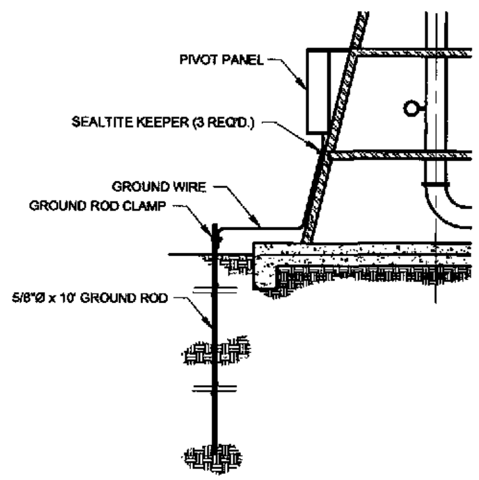
DES. BY GLT
DRG. BY DEO
CHK. BY CES
DATE CREATED 2/27/03
JOB No. 2223044

valmont
WATER MANAGEMENT GROUP

SITE IMPROVEMENT DETAILS

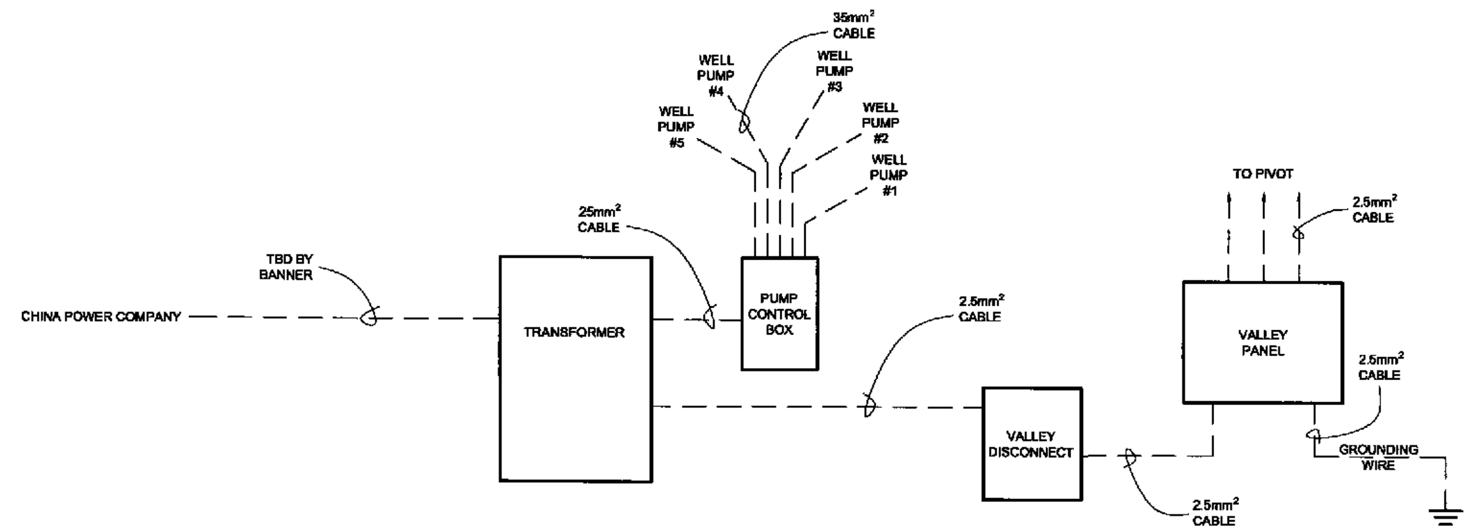
PROJECT DESIGN PLANS

SHEET
C-6



GROUNDING WIRE DETAIL

SCALE: NTS



SITE ELECTRICAL LAYOUT

SCALE: NTS

Notes:

1. Power source cable installed by Zhenglan Banner in accordance with local electrical requirements. At a minimum, cable should be double insulated and buried 1 M deep.
2. Power cables to well pumps installed by Zhenglan Banner in accordance with local electrical requirements concurrently with pipeline construction. At a minimum, cable should be double insulated and buried adjacent to pipe.
3. Transformer to be specified and installed by Zhenglan Banner in accordance with local electrical requirements.
4. Pumps control panel to be specified by well pump manufacturer and installed by Zhanglan Banner per manufacturer guidelines and instructions.
5. Power to pivot and pivot control panel to be installed by Valmont Industries per manufacturer guidelines and specifications.
6. Pump power supply and grounding wires to be installed per manufacturer guidelines and instructions.
7. Power Requirements:

Description	Voltage	Phase	Freq.	Current	Load
Main Power Line	130,000	3-Phase	50-Hz	TBD	TBD
To Pump Control Box	380	3-Phase	50-Hz	65.4 A	46 kW
To Pumps (5)	380	3-Phase	50-Hz	21.8 A	9.2 kW
To Disconnect	380	3-Phase	50-Hz	16.01 A	10.8 kW
To Pivot Panel	380	3-Phase	50-Hz	16.01 A	10.8 kW

2223044C7R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

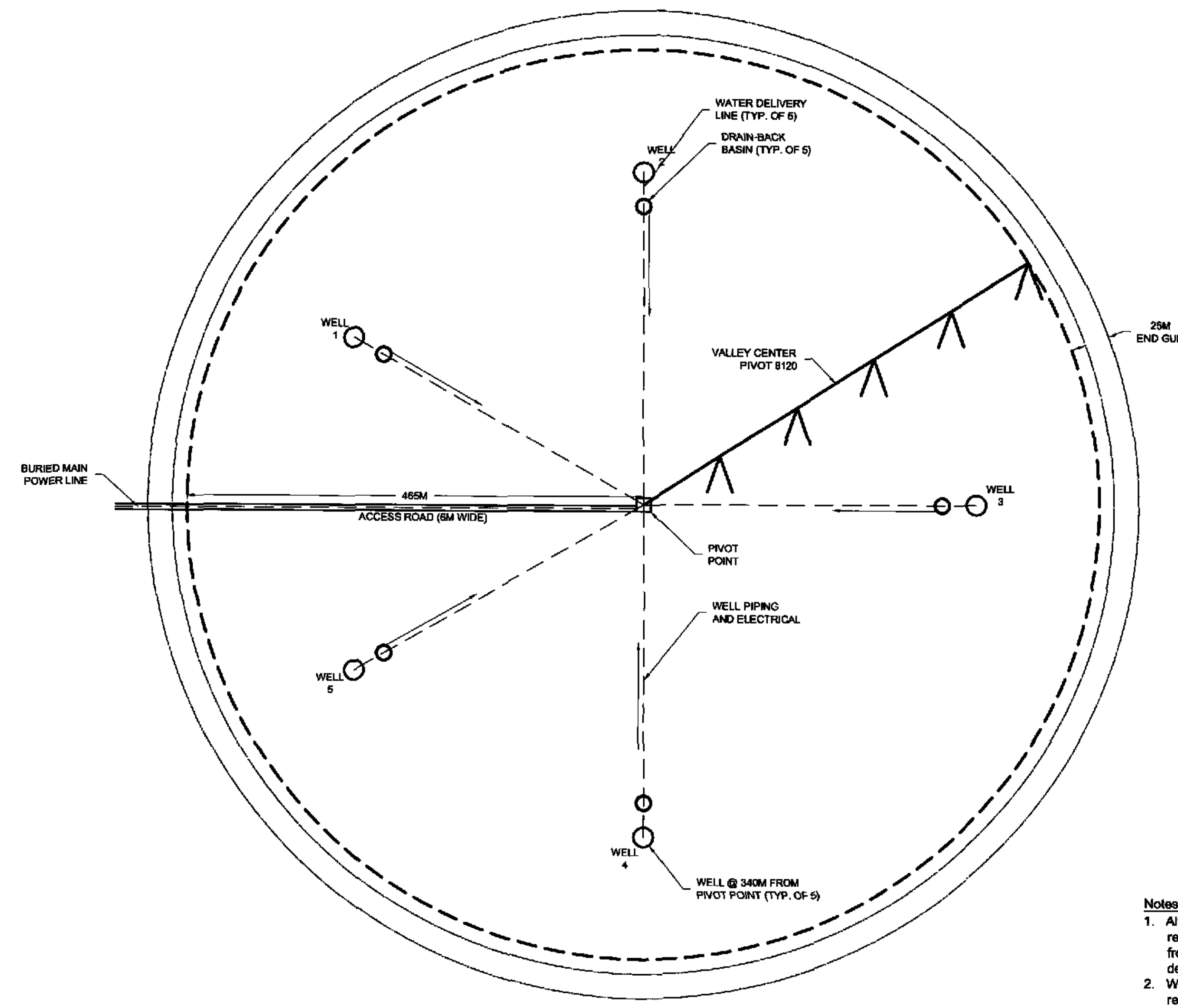
DES. BY GLT
DRG. BY DEO
CHK. BY CES
DATE CREATED 5/21/03
JOB No. 2223044

valmont WATER MANAGEMENT GROUP

SITE ELECTRICAL LAYOUT

PROJECT DESIGN PLANS

SHEET C-7



Notes:

1. Alternative mechanical layout if Banner selects to reduce construction requirements, however, this alternative increases risk of well damage from agricultural equipment and groundwater contamination. Does not decrease energy requirements.
2. Wells and pumps to be installed by Zhenglan Banner per specifications referenced on Sheet C-5.
3. Single well operation of 50 M^3/hr @ 58.5 psi.
4. Pivot point operation of 190 M^3/hr @ 25.4 psi.
5. Pivot requirements same as provided on Sheet C-2.
6. Well pump requirements same as provided on Sheet C-2.
7. Power requirements same as provided on Sheet C-7.
8. Cable size from pump control box to pumps may be reduced from 35 mm^2 to 16 mm^2.

CENTER PIVOT LAYOUT ALTERNATIVE

SCALE: 1cm = 60M

0 120M
SCALE

2223044C8R.dwg DEO 6/3/03

IRRIGATION PILOT STUDY
ZHENGLAN BANNER, INNER MONGOLIA

REV #	DESCRIPTION	BY	DATE
1	-	-	MO/DAY/YR
2	-	-	MO/DAY/YR
3	-	-	MO/DAY/YR
4	-	-	MO/DAY/YR
5	-	-	MO/DAY/YR

DES. BY GLT
DRG. BY DEO
CHK. BY CEB
DATE CREATED 5/22/03
JOB No. 2223044

valmont
WATER MANAGEMENT GROUP

CENTER PIVOT
LAYOUT ALTERNATIVE

PROJECT DESIGN PLANS

SHEET
C-8

valmont IRRIGATION

Part of phase II
See Valmont/CES
cost

INVOICE

Valmont International Corp

2105 Mannix Drive,
San Antonio, Texas 78217

(210) 829-7971 Tel
(210) 824-3233 Fax

SOLD TO	SHIP TO:		
National Bureau to Combat Desertification (NBCD)	National Bureau to Combat Desertification (NBCD)	***INVOICE NUMBER***	**CHG069-03**
State Forestry Administration	Xingang (Tianjin) China	***DATE***	15-Mar-03
18 Hepingli Dongjie Street	P.R. China	***REFERENCE***	TDA PROJECT
Beijing 100714	**NOTIFY**	***VESSEL***	XIBO HE V-52W
P.R. China	WU ZHONGZE	***USA PORT:***	HOUSTON, TX
	TEL: +86+10-8423-8831	***FOREIGN PORT***	XINGANG (TIANJIN) CHINA
	FAX: +86-10-8423-8848	***CONTAINERS***	216180-0 Seal: 0000236
			422261-6 Seal: 0000237
			738906-8 Seal: 0000238

Item	Description	Quantity	Unit Price	Total Price
	COVERING VALLEY AGRICULTURAL IRRIGATION EQUIPMENT			
1	Mechanical Irrigation Equipment Valley brand Center Pivot Total Length 464m with 8 Spans 54.86m x 6-5/8" with the Following Equipment Pump to pivot hardware with valves 6" PVC pipe and accessories Sprinkler package complete Generator set and installation package Control panel and ancillary equipment and cable	1	109,500.0	$109,500.00

TOTAL EX WORKS	**$109,500.00**
SHIPPING AND TRANSPORT	**$22,000.00**
TOTAL CIF	**$131,500.00**

Packing List

Valmont International Corp

2105 Mannix Drive,
San Antonio, Texas 78217

(210) 829-7971 Tel
(210) 824-3233 Fax

SOLD TO
National Bureau to Combat Desertification (NBCD)
State Forestry Administration
18 Hepingli Dongjie Street
Beijing 100714
P.R. China

SHIP TO:
National Bureau to Combat Desertification (NBCD)
Xingang (Tianjin) China
P.R. China

NOTIFY
WU ZHONGZE
TEL: +86+10-8423-8831
FAX: +86-10-8423-8848

DATE:	15-Mar-03
REFERENCE	CHG069-03
VESSEL	XIBO HE V-52W
USA PORT:	HOUSTON, TX
FOREIGN PORT	XINGANG (TIANJIN) CHINA

CONTAINER INFORMATION

NUMBER	216180-0	422261-6	738906-8
SEAL	0000236	0000237	0000238
NET LBS	16,966.1	12,645.9	29,715.8
PIECES	216	263	152

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
1	1701103	ASSM NEW 14.9 X 24 FRONTHI FLOAT TIRE	8	208.0	1,664.0	422261-6
2	1701104	ASSM NEW 14.9 X 24 REARIGHT I FLOAT TIRE	8	208.0	1,664.0	422261-6
3	9360683	TOWER TRUSS ROD PURPLE 0.750" X 266.84"	32	35.0	1,120.0	738906-8
4	9360682	INTER TRUSS ROD GOLD 0.750" X 224.28"	112	29.0	3,248.0	738906-9
5	KA09288	KTA TR ANGLE - 180 INTLSPAN	8	736.0	5,888.0	738906-9
6	1780995	ASSM 6.625" BASEBEAMNON-TOW	8	199.0	1,592.0	738906-9
7	9360827	DRIVE UNIT LEG R.H. STDPROFILE PLAIN	16	60.6	969.6	738906-9
8	9360828	DRIVE UNIT LEG L.H. STDPROFILE NOTCH	16	60.6	969.6	738906-9
9	9360722	TOWER SUPPORT RED	16	37.0	592.0	738906-9
10	1700622	CLAMP 4IN WIDE GALV 65/8 DIA	8	3.5	28.0	738906-9
11	9360724	ASSM 6.625" TOWERSUPPORT BRACKET	8	6.6	52.8	738906-9
12	9360733	TIE BRACE INTERNATIONALSPAN	8	7.0	56.0	738906-9
13	1780327	BRACE UPPER 8" STD SPAN	16	4.0	64.0	738906-9
14	9360835	DRIVE UNIT INTERMEDIATEBRACE	16	3.0	48.0	738906-9
15	9360834	DRIVE UNIT LOWER BRACE	16	2.2	35.2	738906-9
16	1780326	TUBE DRIVE UNIT DIAG 8"STD SPAN	16	6.4	102.2	738906-9
17	1780400	PLATE D.U.REINFORCING	8	7.6	60.6	422261-6
18	1702215	DRIVE SHAFT FLEX JOINT	16	13.0	208.6	738906-9
19	992715	DRIVE SHAFT SHIELD, STANDARD	16	0.8	12.8	738906-9
20	1701966	ASSM GEARBOX COMPLETENONTOW FRONT WITH STUDS	8	127.0	1,016.0	738906-9
21	1701965	ASSM GEARBOX COMPLETENONTOW REAR WITH STUDS	8	127.0	1,016.0	738906-9
22	9361464	ASSM 6.625" X 4-9.41 PVTPIPE W/8-5/8" FLANGE	1	64.0	64.0	738906-9
23	9360687	ASSM 6.625" X 38 INTER PIPE- 75.5 SPACING	32	305.0	9,760.0	738906-9
24	9360685	ASSM 6.625" X 19 INTER PIPE- 75.5 SPACING	8	155.0	1,240.0	738906-9

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
25	9360677	ASSM 6.625" FIXED STUB PIPE	7	87.0	609.0	738906-9
26	9360675	ASSM 6.625" SWIVEL STUB PIPE	7	79.0	553.0	738906-9
27	9360676	ASSM 6.625" LAST STUB PIPE	1	85.0	85.0	738906-9
28	9360646	ASSM OH PIPE 6.625" X 27.00 W/DRAN 30 SP	1	220.0	220.0	738906-9
29	9360642	ASSM OVERIGHT ANG PIPE 6.625X 27.00 30 SP	1	205.0	205.0	738906-9
30	1781323	ASSM OVERIGHT ANG PIPE 4.00X 27-0.00 30 SPACING	1	149.0	149.0	738906-9
31	1700982	OVERIGHT ANG SUPPORT ANGLE	2	92.3	184.6	738906-9
32	9360229	SIGN SUPPORT, UPPER LONGOVERIGHT ANG	1	19.0	19.0	738906-9
33	1701021	NAME PLATE SUPPORT	1	7.6	7.6	738906-9
34	9361392	ASSM 8 5/8" PIVOT SWIVEL	1	205.0	205.0	422261-6
35	9361365	ASSM 8 5/8" RISER PIPESTD PROFILE	1	95.0	95.0	738906-9
36	9361566	ASSM ELBOW 8" ANSIFLANGE STD PROFILE GALV	1	22.0	22.0	738906-9
37	9361586	RISER PIPE SUPPORT ANGLE STD PROFILE	2	14.0	28.0	738906-9
38	1701659	GUSSET SMALL FLAT TRUSS	1	4.5	4.5	738906-9
39	9361374	ASSM TIE ROD RISER8 5/8" STD., THREADED	2	5.6	11.2	738906-9
40	9361382	HD PIVOT LEG 8 5/8" STD PROFILE	4	56.0	224.0	738906-9
41	9361383	BOTTOM BRACE 8 5/8" PIVOT	4	26.0	104.0	738906-9
42	9361385	MIDDLE BRACE 8 5/8" PIVOT	4	22.0	88.0	738906-9
43	9361386	TOP BRACE 8 5/8" PIVOT	4	15.0	60.0	738906-9
44	9360103	8-5/8" PIVOTFLEX	2	28.0	56.0	738906-9
45	9361394	ASSM 8 5/8" PIVOT SWIVELBEARING TUBE	1	218.0	218.0	422261-6
46	246117	MS U PIPE DROP 3/4"NPT 6.00" GALV.	232	1.5	348.0	422261-6
47	994385	2 LB. HOSE DROP WEIGHT -POLYETHYLENE	232	2.0	464.0	422261-6
48	271077	HOSE FITTING 3/4" NPT X 3/4" " HOSE BARB PVC	464	0.1	60.3	422261-6
49	270002	1/4 UNION TEE SERVICE ONLY	19	0.0	0.4	422261-6
50	211014	NIPPLE MS 3/4" X 2 GVSCH 40	17	0.3	5.1	422261-6
51	232483	VALVE CP 3/4 AQUAMATICNORMALLY OPEN WITH DRAIN	17	3.1	53.4	422261-6
52	2SA005	TUBING 1/2" X 2'	17	0.2	3.4	422261-6
53	KA00023	KIT EGSO 2 IN. VALVEKIT	1	6.1	6.1	422261-6
54	272033	HOSE 3/4" FLEX X 250FT. ROLL	9	35.0	315.0	422261-6
55	271080	HOSE CLAMP 1 1/16" HOSE CLAMP-CRIMP	232	0.1	18.6	422261-6
56	271084	HOSE CLAMP 1 1/4" S.S. HOSEDROP CLAMP	232	0.1	23.2	422261-6
57	211009	NIPPLE MS 1" X 12 GVSCH 40	1	1.5	1.5	422261-6
58	211047	NIPPLE MS 2" X 4-1/2" GALVSCH 40	1	2.2	2.2	422261-6
59	211053	NIPPLE MS 3/4" X 4 GVSCH 40	1	0.5	0.5	422261-6
60	227210	PRESSURE REG 10 PSI3/4 FEM X 3/4" FEM PSR	232	0.4	95.1	422261-6
61	232442	GAE MS 0-60 PSI PRESSUREGAUGE	1	0.6	0.6	422261-6
62	241005	ELBOW 3/4" X 90° GALV	1	0.2	0.2	422261-6

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
63	241012	STREET ELBOW 3/4" X 90° GALV	1	0.3	0.3	422261-6
64	244038	FIT PB 1" X 3/4" GALV REDUCER	1	0.5	0.5	422261-6
65	496190	NOZZLE SPRAY NZ #19 ORF.297	1	0.2	0.2	422261-6
66	503100	NOZZLE BASE VALLEY ADAPTER 3/4 MNPT	232	0.3	58.0	422261-6
67	503103	NOZZLE CAGE VALLEY SPRAYBODY	232	0.3	60.3	422261-6
68	503108	NOZZLE # 8/128 VALLEY ORIFICE	16	0.1	2.2	422261-6
69	503109	NOZZLE # 9/128 VALLEY ORIFICE	4	0.1	0.6	422261-6
70	503110	NOZZLE # 10/128 VALLEY ORIFICE	5	0.1	0.7	422261-6
71	503111	NOZZLE # 11/128 VALLEY ORIFICE	3	0.1	0.4	422261-6
72	503112	NOZZLE # 12/128 VALLEY ORIFICE	5	0.1	0.7	422261-6
73	503113	NOZZLE # 13/128 VALLEY ORIFICE	9	0.1	1.3	422261-6
74	503114	NOZZLE # 14/128 VALLEY ORIFICE	5	0.1	0.7	422261-6
75	503115	NOZZLE # 15/128 VALLEY ORIFICE	8	0.1	1.1	422261-6
76	503116	NOZZLE # 16/128 VALLEY ORIFICE	5	0.1	0.7	422261-6
77	503117	NOZZLE # 17/128 VALLEY ORIFICE	8	0.1	1.1	422261-6
78	503118	NOZZLE # 18/128 VALLEY ORIFICE	10	0.1	1.4	422261-6
79	503119	NOZZLE # 19/128 VALLEY ORIFICE	7	0.1	1.0	422261-6
80	503120	NOZZLE # 20/128 VALLEY ORIFICE	10	0.1	1.4	422261-6
81	503121	NOZZLE # 21/128 VALLEY ORIFICE	11	0.1	1.5	422261-6
82	503122	NOZZLE # 22/128 VALLEY ORIFICE	8	0.1	1.1	422261-6
83	503123	NOZZLE # 23/128 VALLEY ORIFICE	12	0.1	1.7	422261-6
84	503124	NOZZLE # 24/128 VALLEY ORIFICE	10	0.1	1.4	422261-6
85	503125	NOZZLE # 25/128 VALLEY ORIFICE	12	0.1	1.7	422261-6
86	503126	NOZZLE # 26/128 VALLEY ORIFICE	12	0.1	1.7	422261-6
87	503127	NOZZLE # 27/128 VALLEY ORIFICE	10	0.1	1.4	422261-6
88	503128	NOZZLE # 28/128 VALLEY ORIFICE	16	0.1	2.2	422261-6
89	503129	NOZZLE # 29/128 VALLEY ORIFICE	9	0.1	1.3	422261-6
90	503130	NOZZLE # 30/128 VALLEY ORIFICE	14	0.1	2.0	422261-6
91	503131	NOZZLE # 31/128 VALLEY ORIFICE	11	0.1	1.5	422261-6
92	503133	NOZZLE # 33/128 VALLEY ORIFICE	1	0.1	0.1	422261-6
93	503134	NOZZLE # 34/128 VALLEY ORIFICE	2	0.1	0.3	422261-6
94	503136	NOZZLE # 36/128 VALLEY ORIFICE	1	0.1	0.1	422261-6
95	503138	NOZZLE # 38/128 VALLEY ORIFICE	1	0.1	0.1	422261-6
96	503140	NOZZLE # 40/128 VALLEY ORIFICE	6	0.1	0.8	422261-6
97	503141	NOZZLE # 41/128 VALLEY ORIFICE	1	0.1	0.1	422261-6
98	601572	PAD SENN LDN PAD BLACK	110	0.2	17.6	422261-6
99	601576	PAD SENN LDN PAD 15-19.5 BL/BK	30	0.2	4.8	422261-6
100	601577	PAD SENN LDN PAD 20-24 B/B/B	7	0.2	1.1	422261-6

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
101	601593	PAD SENN LDN PAD BLACK 24	85	0.2	13.6	422261-6
102	500691	NOZZLE KOMET ENDGUNTAPERED .71"/18MM	1	0.8	0.8	422261-6
103	9360034	INNER CABLE 54'& 82' OVERIGHT ANG	2	5.1	10.2	422261-6
104	1780203	1/4" 0/H CABLE'D'	2	8.0	16.0	422261-6
105	1780205	ASSM 1/4 O.H. CABLE 'F'	2	11.3	22.6	422261-6
106	1780228	SUPPORT CABLE#10 STD. SPAN	2	3.7	7.3	422261-6
107	9360714	ASSM BACK CABLE 142'	2	17.0	34.0	422261-6
108	9360136	OVERIGHT ANG ENDPLATE FORENDGUN & BSTR PUMP	1	14.0	14.0	422261-6
109	1702117	ASSM PIPE LINE DRAIN	1	2.5	2.5	422261-6
110	KA01179	KTA SIGN INSTALL HRDWE SMALL OVERIGHT ANG TRUSS	1	0.5	0.5	422261-6
111	994656	SN 7TH GENERATION VALLEY SIGN	1	4.1	4.1	422261-6
112	KA09044	KTA HD 64' & 82' OVERIGHT ANG HARDWARE	1	13.7	13.7	422261-6
113	1900024	BR OVERIGHT ANG DOWN CABLESUPPORT BRACKET	6	2.5	15.0	422261-6
114	1700976	0/H SPREADERCABLE #36 263 3/4"	1	2.1	2.1	422261-6
115	1700975	BR 0/H TRUSS SUPPORTBRKT	2	5.2	10.3	422261-6
116	03E1554	MR ORANGE 34 RPM USMOTOR/GEARBOX ASSM	3	58.0	174.0	422261-6
117	03E1558	MR (GREEN) 68 RPM USMOTOR/GEARBOX ASSM	5	61.0	305.0	422261-6
118	1702614	U-JOINT SHIELD - LONG	32	0.5	16.0	422261-6
119	271013	HOSE CLAMP 1-1/16" TO 2.00"	32	0.1	1.9	422261-6
120	KA01075	KTA HD FLEX JOINT 7/8 SQX 1IN DIAMETER NONTOW	32	2.2	71.4	422261-6
121	1812442	ASSM INTER TOWER BOX 6000	6	13.3	79.5	422261-6
122	1812441	ASSM. TIME DELAY WATERING BOX-MOD.ALIGN	1	14.6	14.6	422261-6
123	KA09001	KTA HD TOWER BOX MOUNTING-FIRST/ADD SPAN	7	1.3	9.3	422261-6
124	KA09008	KTA HD TOWER BOX MTGHARDWARE LAST SPAN	1	3.0	3.0	422261-6
125	1701295	ASSM CONTROL BAR	7	4.0	28.0	738906-9
126	9360069	OUTER SOCKET	128	2.7	349.4	422261-6
127	9360070	INNER SOCKET	128	1.4	179.2	422261-6
128	KA09003	KTA TRUSS ROD SOCKET HARDWARE W/O SPACER	8	0.5	3.8	422261-6
129	KA01244	KTA ELEC GROUNDING HARDWARE	7	0.7	4.6	422261-6
130	1800318	6-5/8" IN X 16 INFLEX HOSE JOINT	7	4.5	31.5	422261-6
131	991087	FLEX JNT CLAMP6-5/8" ADJUSTABLE	14	0.5	6.3	422261-6
132	991107	GASKET GASKET 6.625" PIPE	48	0.4	17.3	422261-6
133	232001	DRAIN SEAL	12	0.0	0.2	422261-6
134	232004	VALVE MS LOWER DRAIN BODY	12	0.2	2.3	422261-6
135	246170	UPPER DRAIN BODY -PLASTIC	12	0.1	1.2	422261-6
136	271021	CLAMP-HYD TUBE-24IN F/6" PIPE 43	152	0.1	13.7	422261-6
137	271040	HOSE CABLE CLAMP	256	0.1	20.5	422261-6
138	1750318	HYD HOSE CLAMP	256	0.0	7.7	422261-6

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
139	314466	STRAIN RELIEF HUB(1.00 HUB)	16	0.2	3.4	422261-6
140	314467	STRAIN RELIEF HUB1IN F/#8GA WIRE	2	0.2	0.4	422261-6
141	1704017	ASSM PIVOT FOOT EAR	4	4.0	16.0	738906-8
142	996370	8 5/8" FLAT GASKET	2	1.0	2.0	422261-6
143	315165	30 AMP 11 COND COLLECTOR RING	1	14.9	14.9	422261-6
144	1702191	BOLT - PIVOT ANCHOR	4	3.2	12.9	422261-6
145	1780265	8" HOSE	1	3.5	3.5	422261-6
146	991147	FLEX JOINT CLAMP8" SYSTEM	2	0.5	1.0	422261-6
147	1781386	HAND RAILASSEMBLY	2	4.4	8.8	738906-8
148	314910	GROUND ROD 5/8 X 10 FT	1	8.5	8.5	738906-8
149	KA00032	KIT GROUND RODHARDWARE	1	1.5	1.5	422261-6
150	KA09004	KTA HRDWRE 6-5/8" - 8 5/8- 10 PIVOT FLEX	1	1.0	1.0	422261-6
151	KA09509	KTA 8-5/8" PIVOT HARDWARE STD PROFILE	1	15.0	15.0	422261-6
152	1780272	BRACKET PIVOT BOX VERTICAL	2	4.9	9.8	422261-6
153	1780273	MOUNTING BRACKET TOP	4	0.7	2.7	422261-6
154	1781544	UNIVERSALRUNNING LIGHT BRACKET	1	7.9	7.9	422261-6
155	KA09086	KIT RUNNING LIGHTHARDWARE	1	8.1	8.1	422261-6
156	315130	LIGHTNING ARRESTER - 3 POLE	1	1.4	1.4	422261-6
157	1811653	FIELD INSTALL LIGHTNING ARRESTOR	1	0.0	0.0	422261-6
158	KA01153	KIT PIVOT FOOT HARDWARE KIT	1	1.3	1.3	422261-6
159	9361379	COLLECTOR RING SUPPORTJ-PIPE 8 5/8" PIVOT	1	19.0	19.0	422261-6
160	9361575	ASSM 8 5/8" PIVOT SLEEVE	1	9.0	9.0	422261-6
161	KA00416	KIT INDUCED VOLTAGEDISSIPATION	1	1.1	1.1	422261-6
162	9310012	IRR BLUE CONTROL PANELENCLOSURE	1	80.0	80.0	422261-6
163	931K000	KTA ASSEMBLY CONTROL BOX KIT	1	1.5	1.5	422261-6
164	931K004	KTA PIVOT SELECT MODULEAND RELAY BOARD	1	1.9	1.9	422261-6
165	03E1711	SELECT MODULE ASSEMBLY (INTERNATIONAL)	1	7.0	7.0	422261-6
166	931K655	KTA FIELD INSTALL KIT,RESOLVER STANDARD PIVOT	1	1.9	1.9	422261-6
167	931K013	KTA PSI TRANSDUCERASSEMBLY KIT	1	0.8	0.8	422261-6
168	931K077	KTA SEL CONTROL BOX DECAL KIT (SPANISH)	1	1.0	1.0	422261-6
169	931K521	KTA 6A THRU 20A FS, 20ADECALS SPANISH	1	0.3	0.3	422261-6
170	931K076	KTA SEL CONTROL BOX MANUAL KIT (SPANISH)	1	0.0	0.0	422261-6
171	9310074	ASSM 30 AMP BACKPANEL	1	29.1	29.1	422261-6
172	1813096	CABLE ORG 16 COND 10 GA(20'0)3E1533	1	9.2	9.2	422261-6
173	931K355	KTA 20 AMP FUSES	2	1.0	2.0	422261-6
174	931K667	KTA ASSM AUX CONTROL W/1.6-2.5 AMP OVERLOAD	1	1.9	1.9	422261-6
175	994639	DECAL "CE" EUROPEANCOMMUNITIES	1	0.0	0.0	422261-6
176	931K528	KTA END GUN ON/OFF ASSEMBLY KIT	1	1.0	1.0	422261-6

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
177	1812008	CB 4 COND. 14 GA. (20'-6") 314571	8	2.8	22.3	422261-6
178	9310841	CABLE 11 COND. 12 GA.(186'-9") 03E1717 (BTO)	8	60.0	480.0	422261-6
179	992806	PUMP BERKELEY 2HPW/BALDOR MOTOR	1	78.0	78.0	422261-6
180	992752	HOSE POLY PIPE 2.50"IDX 42'6" LONG	2	26.2	52.4	738906-8
181	232480	VALVE MS 495 DIAPHRAMANGLE VALVE	1	15.2	15.2	422261-6
182	1811602	ASSM BOOSTER PUMP BOXSTANDARD MACHINE	1	18.0	18.0	422261-6
183	KA09072	KIT HARDWARE FOR B.P.PLUMB. MODEL 8000	1	20.6	20.6	422261-6
184	1702676	ASSM HOSE SPLICE 2 1/2"	1	2.5	2.5	422261-6
185	271059	HOSE CLAMP 2-3/4" MUFFLER CLAMP PLATED	2	0.6	1.1	422261-6
186	500680	SPRINKLER KOMET ENDGUN TWIN101 PLUS	1	35.0	35.0	422261-6
187	271051	CLAMP-HYD TUBE-42IN F/10" PIPE	25	0.1	3.5	422261-6
188	131018	NUT HEX 3/8-16UNC-2BPLT	32	0.0	0.6	422261-6
189	133005	NUT LOCK 1/2-13UNC-2BPLT GRADE B	1534	0.0	61.4	422261-6
190	133010	NUT LOCK 5/8-11UNC-2BPLT GRADE B	128	0.1	10.2	422261-6
191	133011	NUT LOCK 3/4-10UNC-2BPLT GRADE B	82	0.1	10.7	422261-6
192	141007	WASHER LOCK 3/8" PLT.094" X .375 X .683	32	0.0	0.3	422261-6
193	142025	WASHER FLAT 1/2 PLT SAE	244	0.0	4.9	422261-6
194	134055	NUT MS 3/8-16UNC-2B PLT.195 X .875 OD FLANGE	64	0.0	1.3	422261-6
195	161026	SCREW CAP 1/2" X 1 1/213UNC-2A PLT GRADE 5	24	0.1	2.6	422261-6
196	161024	SCREW CAP 1/2" X 213UNC-2A PLT GRADE 5	482	0.1	62.7	422261-6
197	161023	SCREW CAP 1/2" X 2 1/213UNC-2A PLT GRADE 5	32	0.2	5.1	422261-6
198	161027	SCREW CAP 1/2" X 1 1/413UNC-2A PLT GRADE 5	1012	0.1	91.1	422261-6
199	161082	SCREW CAP 3/8" X 1 1/216UNC-2A PLT GRADE 5	32	0.1	1.9	422261-6
200	161088	SCREW CAP 5/8 X 1 3/411UNC-2A PLT GRADE 5	64	0.2	12.8	422261-6
201	161139	SCREW CAP 3/4" X 1 3/410UNC-2A PLT GRADE 5	66	0.3	20.5	422261-6
202	161159	SCREW CAP 3/4" X 2 1/210UNC-2A PLT	16	0.4	6.4	422261-6
203	175005	U-BOLT 3/8" X 416UNC-2B PLT	16	0.3	4.0	422261-6
204	176035	U-BOLT 3/8" X 15/1616UNC-2B PLT 1-3/4" LONG	16	0.1	1.6	422261-6
205	161379	SCREW CAP 5/8 X 1 1/411UNC-2A PLT GRADE 5	64	0.2	10.9	422261-6
206	9360068	TRUSS ANGLETRAPAZOID PLATE	48	3.0	144.0	422261-6
207	2105400	FLANGE 4" X 1/2" " MACHINED STEEL	5	6.0	30.0	216180-0
208	2120004	4" FLANGE GASKET & FASTENER (5/8" X 2-1/2") KIT	5	2.7	13.5	216180-0
209	3DA0406	DISCHARGE ADAPTER 4" X 6" FLANGED GALV	5	18.0	90.0	216180-0
210	2120006	6" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	5	6.5	32.5	216180-0
211	2SA0206	PIPE SPOOL FLANGED 6" X 2'	5	30.0	150.0	216180-0
212	2120006	6" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	5	6.5	32.5	216180-0
213	1SA1151	CHECK VALVE, 6" FLANGED GALV	5	35.0	175.0	216180-0
214	2120006	6" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	5	6.5	32.5	216180-0

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
215	2SA0206	PIPE SPOOL FLANGED 6" X 2'	5	30.0	150.0	216180-0
216	2SA4002	NIPPLE 2" WELDED ONTO FITTING - GALV.	10	2.7	27.0	216180-0
217	20-662-368002	PRESSURE RELIEF 2"	5	7.5	37.5	216180-0
218	20-AV-200	AIR RELIEF VALVE 2"	5	1.5	7.5	216180-0
219	994156	6" BUTTERFLY VLVLEVER OPERATED	5	23.0	115.0	216180-0
220	2125006	6" BUTTERFLY HARDWARE (3/4" X 4-1/2") KIT	5	8.1	40.6	216180-0
221	2108066	ZEE PIPE 6" FLANGE X 6" WT COUPLER	5	58.5	292.5	216180-0
222	PIP06080M	PIPE PVC 6" X 18.5 PIP CLASS 80 PSI (M)	205	29.0	5,939.1	216180-0
222A	PIP06080M	PIPE PVC 6" PIP CLASS 80 PSI (M)	120	29.0	3,476.5	422261-6
223	7055006	ELBOW - PVC PIPE 6" X 45° WT STEEL	5	21.0	105.0	216180-0
224	2108066	ZEE PIPE 6" FLANGE X 6" WT COUPLER	5	58.5	292.5	216180-0
225	2120006	6" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	5	6.5	32.5	216180-0
226	2145006	ELBOW 6" X 45° FLANGED GALV	5	27.0	135.0	422261-6
227	1SA1151	CHECK VALVE, 6" FLANGED GALV	5	35.0	175.0	216180-0
228	2120006	6" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	5	6.5	32.5	216180-0
229	2SA4001	NIPPLE 1" WELDED ONTO FITTING - GALV.	5	1.1	5.3	216180-0
230	244025	FIT PB 3/4" X 1/4 GALV REDUCER	5	0.3	1.5	216180-0
231	211031	NIPPLE MS 1/4" X 3 GVSCH 40	5	0.1	0.5	216180-0
232	245008	CAP 1/4" GALV	5	0.1	0.4	216180-0
233	232442	GAE MS 0-60 PSI PRESSUREGAUGE	5	0.6	3.0	216180-0
234	MAN2618	MANIFOLD 2 INLETS 6" FLG X 1 OUTLET 8" RINGLOCK	2	105.0	210.0	422261-6
235	MAN0010	10" MANIFOLD SUPPORT	4	15.0	60.0	422261-6
236	2120008	8" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	2	6.5	13.0	216180-0
237	1SA0608	MANIFOLD 10" x 3m A - 1" X 8"; B - 3" X 6"	1	264.6	264.6	422261-6
238	MAN0010	10" MANIFOLD SUPPORT	2	15.0	30.0	422261-6
239	2120008	8" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	1	6.5	6.5	216180-0
240	2SA1008	PIPE SPOOL FLANGED 8" X 10'	1	125.0	125.0	216180-0
241	2120008	8" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	1	6.5	6.5	216180-0
242	1SA0547	TELESCOPE PIPE 8" X 8' - 15' RL GALV	1	165.0	165.0	422261-6
243	2105800B	BLIND FLANGE 8" X 1/2" " MACHINED STEEL	1	18.6	18.6	422261-6
244	2120008	8" FLANGE GASKET & FASTENER (3/4" X 2-1/2") KIT	1	6.5	6.5	216180-0
245	VAL-001	CHEMIGATION SYSTEM I70/HVI PUMP & SPARGER	1	3.0	3.0	216180-0
246	1SA3516	STORAGE TANK - POLY 1550 Gal (5860l), Dia. 87" x 65"	1	325.0	325.0	216180-0
247	0026W76	PLUG, WOODHEAD ELECTRIC	2	2.0	4.0	216180-0
248	0027W76	FEMALE CONNECTOR W/LID WOODHEAD 27W76 20A/3/480V	2	2.1	4.2	216180-0
249	54-SOW124M	CABLE SOW UL OUTDOOR COPPER AWG #12/4 (METER)	20	1.5	30.0	216180-0
250	03E1558	MR (GREEN) 68 RPM USMOTOR/GEARBOX ASSM	3	61.0	183.0	216180-0
251	03E1554	MR ORANGE 34 RPM USMOTOR/GEARBOX ASSM	3	58.0	174.0	216180-0

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
252	KA01075	KTA HD FLEX JOINT 7/8 SQX 1IN DIAMETER NONTOW	20	2.2	44.6	216180-0
253	1701965	ASSM GEARBOX COMPLETENONTOW REAR WITH STUDS	2	127.0	254.0	216180-0
254	1701966	ASSM GEARBOX COMPLETENONTOW FRONT WITH STUDS	2	127.0	254.0	216180-0
255	03E1678	FUSE 5 AMP 600VCLASS CC	10	0.0	0.2	216180-0
256	03E1590	CIRCUT PROTECTORRESET SWITCH	1	0.0	0.0	216180-0
257	03E1848	4 POLE,40 AMP,120V COIL CONTACTOR	4	1.6	6.4	216180-0
258	03E1540	TRANSFORMER,UNIVERSAL PIVOT BOX	1	14.3	14.3	216180-0
259	03E2248	SELECT MODULEASSEMBLY (BULK)	1	0.2	0.2	216180-0
260	03E2211	SELECT/PRO RELAYBOARD PLUS I/O	1	0.0	0.0	216180-0
261	03E1669	2 AMP MS	5	0.0	0.1	216180-0
262	931K013	KTA PSI TRANSDUCERASSEMBLY KIT	1	0.8	0.8	216180-0
263	931K655	KTA FIELD INSTALL KIT,RESOLVER STANDARD PIVOT	1	1.9	1.9	216180-0
264	315663	SUPPRESSOR 200VDC	4	0.1	0.2	216180-0
265	315746	POWER DISCONNECTCA11	1	0.4	0.4	216180-0
266	03E1597	DISCONNECT SWITCH(3 STACK)	1	0.4	0.4	216180-0
267	314708	TIME DELAY SWITCH(60 SEC.) BULK	1	0.0	0.0	216180-0
268	03E1861	CONTACTOR 30 AMP 120V COIL 4 POLE	1	1.4	1.4	216180-0
269	314858	1-1/2 AMPSTEERING & BURIED WIRE	10	0.0	0.1	216180-0
270	03E0307	MICRO MI N TRAVEL BZ-3RW899555110-PC2-S	6	0.1	0.6	216180-0
271	314167	MAIN PANEL 20 AMP600V	30	0.2	4.8	216180-0
272	314820	BULB RUNNING LITE69 WATT TRAFFIC	5	0.1	0.4	216180-0
273	232452	VALVE SOLENOID W/COIL 120VOLT 60 CYCLE NO.	1	0.9	0.9	216180-0
274	254004	SEL VP 2"OD X 1.31ID	2	0.1	0.2	216180-0
275	221001	GASKET 8 PIERCETYPE #3219-2	1	0.5	0.5	216180-0
276	KA00413	KIT FIELD REPAIRSTEER SWITCH RAINGER	1	0.2	0.2	216180-0
277	099P178	25A CONTACTOR 120V 3 POLE W/PREM COIL	6	1.1	6.7	216180-0
278	315165	30 AMP 11 COND COLLECTOR RING	1	14.9	14.9	216180-0
279	931K040	KTA LOW VOLTAGE RELAY MONITOR KIT	1	1.5	1.5	216180-0
280	9360716	ASSM BACK CABLE 180'	2	22.3	44.5	216180-0
281	503100	NOZZLE BASE VALLEY ADAPTER 3/4 MNPT	10	0.3	2.5	216180-0
282	503130	NOZZLE # 30/128 VALLEY ORIFICE	10	0.1	1.4	216180-0
283	601576	PAD SENN LDN PAD 15-19.5 BL/BK	5	0.2	0.8	216180-0
284	601577	PAD SENN LDN PAD 20-24 B/B/B	5	0.2	0.8	216180-0
285	503110	NOZZLE # 10/128 VALLEY ORIFICE	2	0.1	0.3	216180-0
286	503114	NOZZLE # 14/128 VALLEY ORIFICE	2	0.1	0.3	216180-0
287	503116	NOZZLE # 16/128 VALLEY ORIFICE	2	0.1	0.3	216180-0
288	503120	NOZZLE # 20/128 VALLEY ORIFICE	4	0.1	0.6	216180-0
289	503124	NOZZLE # 24/128 VALLEY ORIFICE	4	0.1	0.6	216180-0

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
290	503128	NOZZLE # 28/128 VALLEY ORIFICE	4	0.1	0.6	216180-0
291	503130	NOZZLE # 30/128 VALLEY ORIFICE	4	0.1	0.6	216180-0
292	503134	NOZZLE # 34/128 VALLEY ORIFICE	4	0.1	0.6	216180-0
293	503138	NOZZLE # 38/128 VALLEY ORIFICE	4	0.1	0.6	216180-0
294	503142	NOZZLE # 42/128 VALLEY ORIFICE	4	0.1	0.6	216180-0
295	503146	NOZZLE # 46/128 VALLEY ORIFICE	4	0.1	0.6	216180-0
296	503150	NOZZLE # 50/128 VALLEY ORIFICE	2	0.1	0.3	216180-0
297	500689	NOZZLE KOMET ENDGUNTAPERED .55"/14MM	1	0.8	0.8	216180-0
298	227206	PRESSURE REG 6 PSI3/4 FEM X 3/4" FEM PSR	10	0.4	4.1	216180-0
299	246117	MS U PIPE DROP 3/4"NPT 6.00" GALV.	10	1.5	15.0	216180-0
300	272033	HOSE 3/4" FLEX X 250FT. ROLL	1	35.0	35.0	216180-0
301	271084	HOSE CLAMP 1 1/4" S.S. HOSEDROP CLAMP	20	0.1	2.0	216180-0
302	271080	HOSE CLAMP 1 1/16" HOSE CLAMP-CRIMP	20	0.1	1.6	216180-0
303	271077	HOSE FITTING 3/4" NPT X 3/4" " HOSE BARB PVC	40	0.1	5.2	216180-0
304	7040006	REPAIR COUPLER WT STEEL 6" - PIP	5	22.0	110.0	216180-0
305	1SA4000	IMPACT WRENCH 1/2" HEAVY DUTY	1	10.0	10.0	216180-0
306	1SA4001	IMPACT SOCKET SET (11) 1/2"	1	5.0	5.0	216180-0
307	1SA4002	IMPACT SOCKET 3/4" X 1/2" " STD	1	0.1	0.1	216180-0
308	1SA4003	IMPACT SOCKET 3/4" X 1/2" " DEEP	1	0.1	0.1	216180-0
309	1SA4004	IMPACT SOCKET 7/8" X 1/2" " DEEP	1	0.1	0.1	216180-0
310	1SA4005	IMPACT SOCKET 15/16" X 1/2" " DEEP	1	0.1	0.1	216180-0
311	1SA4006	IMPACT SOCKET 1-1/8" X 1/2" " DEEP	1	0.1	0.1	216180-0
312	1SA4007	IMPACT SOCKET 9/16" X 1/2" " DEEP	1	0.1	0.1	216180-0
313	1SA4008	IMPACT SOCKET 1/2" X 1/2" " DEEP	1	0.1	0.1	216180-0
314	1SA4009	DRIVE SOCKET SET 1/2"	1	4.0	4.0	216180-0
315	1SA4010	NUT DRIVE SET (7 PIECES)	1	1.0	1.0	216180-0
316	1SA4011	DRIVE RATCHET 1/2"	1	1.0	1.0	216180-0
317	1SA4013	WIRE STRIPPER	1	1.0	1.0	216180-0
318	1SA4014	PRY/ALIGNING BAR 18"	1	1.4	1.4	216180-0
319	1SA4015	UTILITY KNIFE	1	0.3	0.3	216180-0
320	1SA4018	CHANNEL LOCKS SET (2)	1	3.0	3.0	216180-0
321	1SA4020	HAMMER - BALL PEIN 1.5LBS	1	2.2	2.2	216180-0
322	1SA4021	WRENCH SET (16 PIECES)	1	6.0	6.0	216180-0
323	1SA4022	TOOL BOX CONTICO 37" X 21" X 20"H	1	17.0	17.0	216180-0
324	1SA4023	HAMMER - SLEDGE 4LBS SHORT HANDLE	1	5.0	5.0	216180-0
325	1SA4024	GENERATOR 440W 8HP 110/220 (GASOLINE)	1	125.0	125.0	216180-0
326	1SA4025	SCREWDRIVER SET STANLEY (8 PCS)	1	1.0	1.0	216180-0
327	1SA4026	DRILL ELECTRIC 1/2" 800 RPM	1	3.0	3.0	216180-0

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
328	1SA4027	DRILL BIT SET	1	2.0	2.0	216180-0
329	1SA4028	CRESCENT WRENCH SET (2 PCS)	1	4.0	4.0	216180-0
330	1SA4029	BLADES - UTILITY KNIFE	1	0.1	0.1	216180-0
331	1SA4030	SLING HEAVY DUTY	1	2.0	2.0	216180-0
332	314119	STRAIN RELIEF HUB(0.50 HUB)	4	0.1	0.3	216180-0
333	1SA4032	HACKSAW	1	2.0	2.0	216180-0
334	1SA4033	HACKSAW BLADES (10 PIECES)	1	1.0	1.0	216180-0
335	1SA4035	ALLEN WRENCH SET	1	1.0	1.0	216180-0
336	1SA4037	CABLE CUTTER	1	1.0	1.0	216180-0
337	1SA4039	LUBRICANT WD-40	1	1.5	1.5	216180-0
338	7600008	CONTROL VALVE ON/OFF 8" SOLENOIDE	1	49.0	49.0	216180-0
339	1SA4043	GLOVES - LEATHER FACED	1	0.1	0.1	216180-0
340	1SA4044	GLOVES - CLOTH	1	0.2	0.2	216180-0
341	1SA4091	GRINDER 4-1/2"	1	4.0	4.0	216180-0
342	1SA4047	GRINDING DISKS 4.5"	1	0.5	0.5	216180-0
343	1SA4048	DIAGONAL CUTTERS	1	0.4	0.4	216180-0
344	1SA4049	GAS CAN 2.5GPM	1	2.5	2.5	216180-0
345	1SA4117	PIPE WRENCH 10" RIDGIT TO 1-1/2" CAST IRON	1	1.7	1.7	216180-0
346	1SA4017	PIPE WRENCH 18"	1	6.0	6.0	216180-0
347	1SA4054	DIGITAL MULTIMETER FLUKE 12	1	4.0	4.0	216180-0
348	1SA4058	HOLSTER ONLY	1	0.5	0.5	216180-0
349	1SA4078	KNOCKOUT PUNCH	1	2.0	2.0	216180-0
350	1SA4087	TAPE MEASURE - 1" X 30'	1	0.8	0.8	216180-0
351	178008	MS OETIKER CRIMPTOOL	1	0.8	0.8	216180-0
352	MAN0006	6" MANIFOLD SUPPORT	4	9.0	36.0	216180-0
353	0027W76	FEMALE CONNECTOR W/LID 20A/3/480V	6	2.1	12.6	216180-0
354	0026W76	PLUG, WOODHEAD ELECTRIC	4	2.0	8.0	216180-0
355	APPCG137125	CONNECTOR 1-1/2" APPLETON	2	0.6	1.2	216180-0
356	APPCG125125	CONNECTOR 1-1/4" APPCG87100	8	0.5	4.0	216180-0
357	003LK36	SPLIT BOLT CONNECTORS 1/0 TO #8	4	0.3	1.2	216180-0
358	NERL500	NUT 1-1/2"	10	0.1	1.0	216180-0
359	005W180	COLD GALVANIZING SPRAY	10	2.0	20.0	216180-0
360	002A227	TAPE #88, 3M RUBBER	6	0.2	1.2	216180-0
361	3M-KOTE	SCOTCH KOTE	6	8.0	48.0	216180-0
362	004UH07	SILICONE SEALANT 10 OZ TUBE	6	1.0	6.0	216180-0
363	004YT75	TAPE #23, ELECTRICAL INSULATION	6	0.2	1.2	216180-0
364	TEFLON	TEFLON TAPE	6	0.1	0.6	216180-0
365	54-305602	CABLE COPPER THHN IN CONDUIT AWG # 2/3 W/G (FT)	2000	0.8	1,500.0	216180-0

valmont IRRIGATION

Packing List

Item	Part Number	Description	Quantity	Unit Lbs	Total Lbs	Container
366	54-305602	CABLE COPPER THHN IN CONDUIT AWG # 2/3 W/G (FT)	2000	0.8	1,500.0	216180-0
367	54-305702	CABLE COPPER THHN IN CONDUIT AWG # 0/3 W/G (FT)	1700	1.1	1,870.0	216180-0
368	54-CBL-14-2	CABLE 14/2 (FT)	13400	0.1	1,809.0	216180-0
369	7040006	REPAIR COUPLER WT STEEL 6" - PIP	6	22.0	132.0	216180-0
370	2SA4075	NIPPLE 3/4" WELDED ONTO FITTING - GALV.	5	0.9	4.5	216180-0
371	5140750	3/4" BRASS GATE VALVE IPS THREADS	5	0.8	3.9	216180-0
372	B6.6250	GASKET WATERTIGHT 6.625" IPS	17	1.0	17.0	216180-0
373	9360688	STEEL TUBE-6.625IN X 20FT-0.00IN 12GA.	1	180.0	180.0	216180-0
374	2106006	GASKET RED RUBBER FULL FACE 5" X 1/8"	5	0.3	1.4	216180-0
375	2106008	GASKET RED RUBBER FULL FACE 6" X 1/8"	1	0.5	0.5	216180-0
376	LUBE	PIPE LUBRICANT 1 GALLON	4	10.0	40.0	422261-6

Appendix B-1 Groundwater Monitoring Forms

ZHENGLAN BANNER IRRIGATION PILOT STUDY - GROUNDWATER MONITORING PROGRAM

Well Monitoring Form

Well Name:
Measuring Point:

Page # ______

	1	2	3	4	5	6	7	8	9	10	11
						Water Chemistry					
	Date (DD-MM-YY)	Time (24-hour)	Water Depth (meters)	Pump On? (on/off)	Flow Meter Reading (cubic meters)	Spec. Cond. (µhmos)	pH -	Temp. (8C)	Hard-ness (mg/l)	Nitrate (mg/l)	Notes (Include initials of person making measurements)
1											
2											
3											
4											
5											
6											
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8											
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10											
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26											
27											
28											
29											
30											

River Monitoring Form

River Monitoring Point Name:	Page # ______

	1	2	3	4	5	6	7	8	9
				Water Chemistry					
	Date (DD-MM-YY)	Time (24-hour)	River Depth (meters)	Spec. Cond. (µhmos)	pH -	Temp. (8C)	Hard-ness (mg/l)	Nitrate (mg/l)	Notes (Include initials of person making measurements)
1									
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27									
28									
29									
30									

MONITORING PROGRAM

Precipitation Monitoring Form

Page # ______

	1	2	3	4
	Date (DD-MM-YY)	Time (24-hour)	Precip. (mm)	Notes (Include initials of person making measurements)
1				
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APPENDIX B-2 Determination of Grassland Health

Indicators of change in erosion as a response to removal of grazing. Assumes ecosystem health is directly associated with system stability.[1]

Class	I	II	III
Phase or Indicator	**Healthy**	**System on Threshold of Permanent Transition to Different Ecological State**	**Unhealthy; System at Risk of Permanent Change to Less Productive Site**
Plant cover and litter	Plant and litter distribution unfragmented	Fragmented distribution developing, with some evidence of enlarging barren areas	Fragmented distribution developed, with large barren areas between fragments
Soil stability	Little or no evidence of soil movement	Some evidence of soil wind erosion, for example, plant pedestaling	Active soil cutting and soil is moving off site
Rooting	Rooting throughout the available soil profile with a good mix of grasses and perennial forbs; roots of forbs deeper than grasses	Rooting is shallow, few perennial forbs; and, perennial forbs not rooted deeper than grasses	Few rooted plants; rooting in only a portion of the available profile
Energy flow	Photosynthetic activity occurs throughout the period suitable for plant growth	Photosynthetic activity more restricted to one season than another	Photosynthetic activity restricted to only one season
Nutrient cycling	Site occupied by long-lived, perennial, N- and water-efficient grasses	Evidence long-lived plants are dying or absent with mostly short-lived, perennial grasses; not N- or water-efficient	Site has no grasses or only ephemeral, annual grasses or forbs during a single part of the growing season.
Life history of plants	Site occupied by bunchgrasses and long-lived, perennial forbs	Site occupied by rhizomatous or stoloniferous grasses, and short-lived, unpalatable perennial forbs	No plants or annuals; maybe a few remnant rhizomatous or stoloniferous plants present
If trees part of natural stand	Savannah stand with evidence of diverse age structure	Denser stand or lack of diverse age structure	Very dense stand or no trees present

[1] Modified from National Research Council. 1994. Rangeland Health – new methods to classify, inventory, and monitor rangelands. National Academy of Sciences, Washington, DC.

<u>Appendix B2A</u> Rangeland Ecosystem Health

Location ___________________________________

Name of Recorder _________________________ Date ___________________

	Healthy	At Risk	Unhealthy	Notes
Plant cover and litter				
Soil stability				
Rooting				
Energy flow				
Nutrient cycling				
Life history of plants				
If trees part of natural stand				

NOTE: It is unreasonable to expect that all indicators will simultaneously fall into one of the above categories. It is more likely that the preponderance of evidence will place that system in one of the categories.

Appendix B2B **Determination of Ground Cover**

Ground Cover Estimates - Project for the control of sandstorms and desertification …
Using irrigation agriculture

Date: ____________________

Recorder(s) ______________________________________

Grazing (circle one) Open Excluded

Notes ____

Transect	**Quadrant**	**Percent Cover**
Beginning UTM(s)		
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
Ending UTM(s)		
	Average	
Beginning UTM(s)		
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
Ending UTM(s)		
	Average	

Appendix B-3 **Monitoring Plan for Economics, Page 1 of 2**

Outline for the Farm Accountant

Economic Data for All Crops Produced Using the Irrigation System

A. Crop Areas Under the Pivot

Crop	Size of Area Planted	Size of Area Harvested or Grazed by Animals
1. ______	______ mu	______ mu
2. ______	______ mu	______ mu
3. ______	______ mu	______ mu
4. ______	______ mu	______ mu
5. ______	______ mu	______ mu

B. Inputs Used for Each Crop Under the Pivot

Crop	Seeds	Fertilizer	Pesticides	Other Inputs
1. ______	______ kg	______ kg	______ kg	______
2. ______	______ kg	______ kg	______ kg	______
3. ______	______ kg	______ kg	______ kg	______
4. ______	______ kg	______ kg	______ kg	______
5. ______	______ kg	______ kg	______ kg	______

C. Crop Production and Value

Crop	Total Production	Price Received	Total Value
1. ______	______ kg	______ RMB/kg	______ RMB
2. ______	______ kg	______ RMB/kg	______ RMB
3. ______	______ kg	______ RMB/kg	______ RMB
4. ______	______ kg	______ RMB/kg	______ RMB
5. ______	______ kg	______ RMB/kg	______ RMB

Outline for The Household Accountant

Economic Data for Household Production, Costs, and Revenue

Please prepare one copy of this page for each selected household.
(Household selection as described in the sociology section, page 9.0)

A. Household Costs of Production

Inputs	Amount Purchased	Price Paid Per Unit	Total Expenditure
1. Forage	________ kg	________ RMB/kg	________ RMB
2. Concentrate	________ kg	________ RMB/kg	________ RMB
3. Others	________ kg	________ RMB/kg	________ RMB

B. Household Revenue from Milk and Wool

Item	Amount Sold	Average Price Received	Revenue From Sales
1. Milk sales	________ kg	________ RMB /kg	________ RMB
2. Wool sales	________ kg	________ RMB /kg	________ RMB
3. Other products	________ kg	________ RMB /kg	________ RMB

C. Household Revenue from Livestock Sales

Animals	Number of Animals Owned	Animals Sold This Year	Revenue from Animal Sales
1. Sheep	________	________	________ RMB
2. Goats	________	________	________ RMB
3. Dairy Cows	________	________	________ RMB
4. ________	________	________	________ RMB

D. Household Monthly Income from Milk Sales

Month: ____________

The amount of milk sold this month: ________ kg of milk

Average price received this month: ________ RMB per kg of milk
Income from milk sales this month: ________ RMB this month

Monthly Data Collection Sheet

The goal of this sheet is to provide a template for collecting information from the Farm Accountant once per month, per week, or any other suitable time period.

Period Covered by this Sheet: From: ________________ **To:** ________________

Data Recorded by: ______________________________

Inputs Using During the Period (Labor, Water, Seeds, Fertilizer, Chemicals, etc.)

Input	Amount	Price per Unit	Total Expenditure

Observations and Comments Regarding the Crops

____

____

____

____

____

____

____

Appendix B-4A

Household Initial Interview

Household Members

Name Relationship to Head Age Gender Education/Training Occupation

(Head)

1.
2.
3.
4.
5.
6.

Ethnicity ______________ Language Spoken in Home ______________________________

Annual income (Yuan) the year before resettlement __________________________________

Number and kinds of animals owned before resettlement ______________________________

____

Amount of money (Yuan) received for the sale of livestock before resettlement ____________

Amount of money (Yuan) spent after resettlement for livestock ________________________

housing ______________________________ other ________________________________

Amount of money (Yuan) borrowed for resettlement ___________________ and terms of

payment ____________________

Number and kinds of animals currently owned and where kept _________________________

Other assets and equipment owned ____

How housing arrangement was made ____

Satisfaction with housing ____

____

Describe process of resettlement ____

____

Describe continuing interaction with relatives, previous neighbors, old friends _______________

____

Amenities: electricity _____________ running water _____________ other ________________

Appendix B-4B

Household Monthly Interview

Sources and amount of income during the month for each member. Average hours worked per day.

(Head) 1. ____________________ 1. ____________________

(Spouse) 2. ____________________ 2. ____________________

(Other) 3. ____________________ 3. ____________________

Total income ____________________

Amount and type of work-related expenses for supplies, food, etc. ____________________

____

Expenses related to household consumption: food ______________clothes ____________

heating/cooking fuel ______________ transportation ______________other ____________

Training/other educational activities attended ____________________________

Types of social services accessed and how often: medical ______________________

schools ____________________ other ____________________________

Visits and activities with relatives, old friends ____________________________

____

Visits back to grasslands and purpose ____________________________

____

Narrative of impression; feelings, issues, that need attention, uncertainties, conflicts that should be addressed, changes in social patterns in resettlement.

Appendix B-4C

Community Profile

Population of *ga ca* #1 _____ #2 _____ #3 _____ Total

Number of Households *g aca* #1 _____ #2 _____ #3 _____ Total
Hans _____ Mongolian _____

Number of Households in dairy _____ pivot _____ other _____

Other occupations, sources of income ____

____

Gender tasks in dairy men ____

women ____

Average household income _______________ range of household income ____________

Number of households borrowing money _________ Average indebtedness ____________

Arrangements for sharing shelters, livestock ________________________________

Community leadership structure and responsibilities ___________________________

____

____

Arrangement for operating the pivot, producing forage _________________________

____

Market arrangement for selling milk ____

____

Relations, interaction with nearby town ____________________________________

____

Availability and type of: electric power ____________________________________

running water ____________________________________ communication ______________________________

transportation ______________________________

supplies ______________________________

health care ______________________________

schools ______________________________

cultural activities ______________________________

Describe process of resettlement ______________________________

____

____

valmont
WATER MANAGEMENT GROUP

FINAL REPORT (REVISED JANUARY 2006)
Using Irrigated Agriculture for the Control of Sandstorms and Desertification in Areas Surrounding Beijing, China

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Principal Authors:

Mr. Terry Rahe – Valmont Water Management Group
Mr. Fred Bickford – HydroSource Associates
Dr. David Hannaway – Oregon State University
Dr. Lu Xinshi – Beijing Forestry University
Dr. Larry Rittenhouse – Colorado State University
Mr. Greg Thurman – Valmont Water Management Group
Dr. Dennis Wichelns – California State University Fresno
Mr. Wu Zhongze – PRC, National Bureau to Combat Desertification
Dr. John Young – Oregon State University
Dr. Zheng Ke Bin – Beijing Forestry University

Prepared For:

USTDA
1000 Wilson Boulevard
Suite 1600
Arlington, VA 22209-3901

Prepared By:

Valmont Water Management Group
7150 Supra Drive
Albany, OR 97321
(541) 926-7737

PN: 2223044/January 2006

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"The services for which disbursement is requested by the Contractor have been performed satisfactorily, in accordance with applicable Contract provisions and the terms and conditions of the TDA Grant Agreement. The Final Report submitted by the contractor has been reviewed and approved by the client."

Signature ____________ Date 1.16-2006.

Mr. Liu Tuo
Director General
National Bureau to Combat Desertification

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1
1.0 PROJECT DESCRIPTION 2
1.1 Introduction 2
1.2 Monitoring Activities During the Demonstration Period 3
1.2.1 Groundwater Supply Monitoring Activities 3
1.2.2 Irrigated Forage Quantity and Quality Monitoring Activities 5
1.2.3 Monitoring Natural Grasslands Recovery Potential 7
1.2.4 Monitoring of Forage Production Costs 8
1.2.5 Economic Data for Household Production, Costs, and Revenue 9
1.2.6 Monitoring of Sociological Impacts to Herders 10
2.0 RESULTS OBSERVED DURING THE DEMONSTRATION PERIOD 11
2.1 Results of Groundwater Supply Monitoring 11
2.2 Results of Irrigated Forage Quantity and Quality Monitoring 13
2.3 Results of Natural Grasslands Recovery Monitoring 13
2.4 Resulting Changes in Agricultural Economics 15
2.4.1 Budget Scenarios 15
2.4.2 Economic Implications of Budgets 16
2.5 Resulting Sociological Impacts to Herders 17
2.5.1 Milk Production 17
2.5.2 Household Economics 17
2.5.3 Forage Production 19
3.0 CONCLUSIONS BASED UPON THE RESULTS OF THE DEMONSTRATION 20
3.1 Conclusions Regarding Groundwater Supply 20
3.2 Conclusions Regarding Irrigated Forage Quantity and Quality 21
3.3 Conclusions Regarding Natural Grasslands Recovery Potential 21
3.4 Conclusions Regarding Changes in Agricultural Economics 21
3.5 Conclusions Regarding Sociological Impacts to Herders 22
4.0 SUGGESTIONS FOR IMPROVING FORAGE PRODUCTION SYSTEMS 23
4.1 Groundwater Supply 23
4.2 Irrigated Forage Quantity and Quality 23
4.3 Natural Grasslands Recovery Potential 24
4.4 Changes in Agricultural Economics 25
4.5 Sociological Impacts to Herders 25
5.0 CONCLUSIONS 26

TABLE OF CONTENTS (Continued)

TABLES

Table 1.	Soil Sample Analysis Information
Table 2.	Corn Silage Yield Estimates Based on Plot Sampling
Table 3.	Corn Forage Sample Quality Analyses Expressed on a Dry Matter Basis
Table 4.	Data Sheet Rangeland Ecosystem Health
Table 5.	Expenditure Data Collected from 16 Households in Silangcheng Village
Table 6.	Household Budgets When Interest Rate is Three Percent
Table 7.	Household Budgets When Interest Rate is Zero Percent and Repayment in Three Years
Table 8.	Household Budgets When Interest Rate is Zero Percent and Repayment in Six Years
Table 9.	Household Budgets When Interest Rate is Zero Percent and Repayment in Six Years and Milk Yield is 40 kg Per Day Per Cow

FIGURES

Figure 1.	Project Location
Figure 2.	Local Map Showing Center Pivot
Figure 3.	Summer 2004 Water Levels, Zhenglan Qi Ecological Migration Village Center Pivot Wells
Figure 4.	Summer 2004 Water Quality, Zhenglan Qi Ecological Migration Village Center Pivot Wells

APPENDICES

Appendix A.	Methods Used in Combating Desertification in Zhenglan Qi
Appendix B.	Groundwater Data
Appendix C.	Forage Data
Appendix D.	Grasslands Recovery Data
Appendix E.	Socioeconomic Inventory

EXECUTIVE SUMMARY

Sandstorms and desertification have become significant problems in areas along the southern margins of the Gobi Desert. Several areas within China have experienced increases in the number of dust storm events and the growth of the desert during the past twenty years. One strategy being used in the battle against these two problems is the reduction of grazing pressure by encouraging herders to remove their livestock from the open grasslands. Herders are resettled in ecological migration villages where they support themselves using confined animal feeding approaches to livestock agriculture (e.g., dairy production, beef cattle, etc.). This project was designed to demonstrate that modern Valley brand high efficiency irrigation equipment can significantly increase forage production to support confined animal agricultural practices associated with the ecological migration village.

During the 2004 growing season (May to August), forage was produced using Valley brand irrigation equipment at an 80 hectare demonstration site. Monitoring included assessments of groundwater impacts, forage production (quantity and quality), grassland recovery rates, changes in agricultural economics, and sociological impacts.

Data collected in this demonstration period indicate that using local groundwater for irrigation did not have a measurable adverse impact on groundwater levels. Even though the year was considered to have average rainfall, the volume of forage produced using the Valley brand irrigation equipment was 40% greater than that in un-irrigated areas. Significant opportunities for improving the forage production and storage are offered. Qualitative and quantitative measurements of areas that had been protected from grazing indicated that significant recovery of the grasslands is possible within three years.

Economic measurements taken in the newly established ecological migration village indicated that the residents are experiencing significant economic hardship during the time of transition from herding to dairy production. Several economic scenarios are provided to both explain the difficulties that herders are encountering and to assist the local government officials in evaluating possible solutions. The process of changing from a lifestyle of herding sheep and goats on the open grasslands to raising dairy cows in an ecological migration village offers both advantages and disadvantages. The disadvantages are made more challenging by the transitional economic problems that are being experienced.

In summary, the investigation described in this document demonstrated clearly that the use of modern mechanical irrigation equipment can reliably produce large quantities of high quality forage for use by herders as they relocate into ecological migration villages. The observations also indicate that the reduction in open grazing that is made possible by this replacement forage supply can significantly reduce wind erosion and dust generation in as little as three years. The effective use of this technology will depend upon the development of complementary skills that can effectively preserve this forage for use during the winter season and the development of a suitable market for the resulting products of the Ecological Migration Village.

1.0 PROJECT DESCRIPTION

1.1 Introduction

On November 11, 2002 the National Bureau to Combat Desertification within the State Forestry Administration of the Peoples Republic of China (NBCD/SFA) and Valmont Industries, a United States Corporation (Valmont), entered into a contract with the United States Trade and Development Agency (USTDA). The objective of this contract was to examine the feasibility of forage production in rural regions of Inner Mongolia using water efficient Valley brand irrigation equipment to help alleviate grazing pressures on the surrounding native grasslands. This reduction in grazing pressure would allow for the grassland recovery, which should result in the reduction of dust storms and desertification currently being experienced in this region. The demonstration site was located in the Xilinghol League of the Inner Mongolia Autonomous Region of China (Figure 1). Local government officials of the Zhenglan Qi Banner provided support for this project as part of their effort to establish a new ecological migration village known as Silangcheng (Figure 2). A description of antidesertification strategies in this area is included as Appendix A.

This document represents the final project report based on data collected during the demonstration phase of the project that extended throughout the 2004 growing season as described by the original contract under Grant Number GH 2381659, the Inception Study, the subsequent feasibility report titled "Demonstration Project for the Control of Sandstorms and Desertification in Areas Surrounding Beijing Using Irrigated Agriculture," published in May 2003, and the project implementation plan that was published in May 2004.

The inception report, the feasibility report, and the project implementation plan identified several areas that could significantly affect the short and long term viability of forage production as part of a sandstorm and desertification control strategy. These areas include the following:

Ecological Impacts
- Impacts to Groundwater
- Forage Quantity and Quality
- Natural Grassland Recovery Potential

Socioeconomic Impacts
- Changes in Agricultural Economics
- Sociological Impacts to Herders

This report describes the monitoring activities that were employed to demonstrate the effectiveness of producing forage to replace open grazing of the grasslands and includes the following: (1) a summary and description of the data collected during the demonstration period, (2) an evaluation of project results regarding ecological and socioeconomic impact, and (3) suggestions for further improving the performance of this sandstorm and desertification control strategy. Our suggestions and recommendations are important because the basis of this strategy assumes that the herder households will depend exclusively on irrigated forage to support their milk and livestock production system.

It is important to note that the scope of the demonstration project was modified in the course of completing the Inception Study. The purpose of performing an inception study is to be certain that the original vision of the demonstration project matches with the conditions that are found at the selected demonstration site. Two major changes occurred in the study as a result of the Inception Study. The first major change was the use of a publicly managed farming organization to conduct all of the farming activities. This limited the ability of the project to evaluate costs for forage production by individual members of the ecological migration village. As a result the cost to the ecological migration village members was a set price established by the government. Secondly, the fact that the single government farm operator was involved in production of both nursery stock for desertification control and in the production of forage for the ecological migration village made it difficult to accurately determine the cost per unit area for crop production, net income per farm and net income for day of labor and water cost as a percent of income. In summary, the specific conditions at the demonstration site made some of the proposed areas of investigation irrelevant and they were removed from the scope as noted in the Inception Study.

This demonstration project, as modified in the inception study, was not designed to collect data to economically justify the investment in irrigation equipment based exclusively upon forage production for the ecological migration village. The primary purpose of this work was to demonstrate the role of this equipment in the control of dust that is generated by the processes of desertification. The economics of reduced dust and decreased desertification are difficult to quantify economically. Consequently, the quantification of economic improvements in forage production as they relate to equipment investments is beyond the scope of this demonstration project.

1.2 Monitoring Activities During the Demonstration Period

1.2.1 Groundwater Supply Monitoring Activities

The goal of the water resources monitoring program was to demonstrate that the aquifer beneath the Shandian River Valley is capable of supporting sustained irrigation pumping at rates high enough to allow forage crops and tree seedlings to be grown beneath a center pivot irrigation system. To achieve this goal, we examined several short-term and long-term issues:

Short-Term Issues:

- Is groundwater yield sufficient to satisfy crop water requirements?
- Is groundwater quality sufficient to support crop production?
- Will groundwater pumping for irrigation cause impacts on other groundwater users?

Long-Term Issues:

- What is the volume of annual groundwater recharge?
- Are there limitations in constructing wells in the area?
- Will an increase in groundwater pumping degrade water quality?

We conducted the monitoring program for just one growing season. Hence, it is not possible to provide clear answers to all of these questions. However, the program we conducted is a good example of the kind of monitoring approach that should be adopted over a larger area and for a longer period of time to allow assessment of impacts associated with a larger irrigation project involving many center pivot irrigation systems.

The monitoring activities outlined in the project implementation plan include the following parameters:

- Aquifer water levels as measured in all five of the production wells (weekly)
- Aquifer water levels as measured in one well near the migration village (weekly)
- Pivot flow volume records (weekly)
- Selected water quality parameters that could be measured conveniently and at minimal cost in the field (specific conductance, pH, and nitrate), with measurements made on water samples from one production well (weekly), and also from the river (once every two weeks)
- River water levels (once every two weeks)
- Precipitation (weekly).

The monitoring was designed to accomplish the following:

- Measure the near-term impact of irrigation pumping on aquifer water levels.
- Identify changes in aquifer water quality related to pumping and irrigation.
- Allow us to distinguish between water level changes caused by irrigation pumping and those caused by normal variations (seasonal and drought-cycle) in precipitation.
- Generate data that could be used later, when combined with longer-term monitoring data, to develop a watershed-scale groundwater flow model to predict the number of irrigation systems that can be supported in a given watershed.

We conducted the following tasks during the May 2004 site visit, prior to the start of the monitoring program:

- We inspected production wells, chose wells to monitor, and confirmed that a water level probe could be used to measure levels in each well.
- We identified a neighboring well that was feasible for monitoring.
- We chose a practical river water level monitoring site and identified a monitoring point.
- We installed a rain gauge at the project site.
- We established the frequency of monitoring for each parameter.
- We trained the people who would be making measurements, including procedures for collecting the data, entering data on forms, and storing completed forms in a safe location.
- We conducted a one-hour pumping test on one of the production wells, measuring water levels in the pumped well and in the idle wells, to allow calculation of basic aquifer properties.

- We made observations on site-specific hydrogeology.

During the course of the demonstration, the following changes were made in the data collection program. Only three of the five wells could be operated due to well construction problems and difficulties with the pumps themselves. Other monitoring activities were conducted essentially as proposed. Monitoring data were provided periodically in electronic form from the site. This provided an opportunity for progressive monitoring of the data collection activities.

The monitoring program was conducted during a 14-week period, from May 18, 2004 to August 23, 2004. During that time, the water level depth in each of the five irrigation wells that provide water to the center pivot irrigation system was measured approximately once per week. These wells were named PW-1 through PW-5. The water level was also measured in another well, MW-1, that is several kilometers from the center pivot, beside the road between the pivot and the ecological migration village. The elevation difference between the road surface and the water surface in the Shandian River was also measured at a bridge near Zhenglan Qi where the main road crosses the river. Rainfall was measured at a rain gauge that was installed at the tractor parking area near the center pivot.

Water quality measurements were made once per week on samples of water from one of the irrigation wells, PW-2, the well closest to the pivot point. Water quality testing was also done on samples collected from the Shandian River at the same place where the river water level was measured. The water samples were tested for specific conductance (which indicates the concentration of total dissolved solids in the water), pH, temperature, and nitrate. Mr. Fang Ming, a recent graduate in environmental sciences and economics from Peking University, conducted all sampling.

1.2.2 Irrigated Forage Quantity and Quality Monitoring Activities

The primary goals of this portion of the demonstration project were 1) to document the quantity and quality of forage produced using the Valley brand center pivot irrigation system, and 2) to examine alternative production scenarios that might offer larger quantities or improved quality of forage.

We documented the site-specific production capability of the Valley demonstration unit from the standpoints of both quantity and quality of the forage produced. The details regarding the demonstration unit are fully described in the project implementation plan. Forage quality was determined visually and by obtaining forage samples for laboratory analysis. The assessment included both on-site and laboratory measurements. In addition, we evaluated future growing season options that could include such things as small grain cereal crops and perennial grasses and legumes.

Some of the activities described in the monitoring plan were not implemented during the demonstration project due to challenges that arose regarding forage production and data collection. Despite those challenges, we can recommend improvements in production methods that will enhance the amount and quality of forage and silage produced.

Pre-Season Monitoring:

- ***Soil analysis.*** We analyzed soil samples obtained in the production area and we made recommendations regarding fertilizer and lime to enhance silage production.
- ***Forage analysis.*** We had planned to examine current feeding rations by sampling and testing hay, silage, and concentrate supplements. We planned to collect separate samples from the feed supply of five different farmers.
- ***Concentrate supplement analysis.*** Current feeding rations are based on recommendations by the local dairy company. However, the only portion of the ration recommended is the concentrate. Forage is fed at the discretion of the individual farmer. Further analysis is needed to verify the protein, energy, and mineral composition of the supplement, and to recommend quantities of each component of the diet.

Harvest Time Monitoring:

When the forage was near harvest, yield assessment was made by harvesting a known area, weighing the fresh forage, sub-sampling, and determining forage dry matter and quality analysis.

- ***Forage yield.*** We had planned to collect four samples to assess yield from 100 m^2 plots. We planned to cut fresh forage from the plots, weigh the fresh forage, and obtain dry weight estimates of the forage yield.
- ***Forage quality analysis.*** Sampling and analysis for current year forage was to be similar to springtime analyses. Five samples were to be obtained from fresh forage and from ensiled forage.

The monitoring plan for the demonstration project included a list of issues that must be examined to ensure successful crop production:

- ***Matching Crop Production with Livestock Demand***
  Accurate estimates of the amount of forage that can be produced and the number of dairy cows and other animals that can be raised successfully with that amount (and quality) of forage[1,2] are needed to ensure success of the ecological migration village program.

---

[1] Given climate constraints, it was estimated that 30 tonnes of "as-fed" (i.e., 35% dry matter) silage could be produced per hectare under optimal conditions. (This equates to approximately 10.5 tonnes of dry matter/ha.) Since only 80% of the pivot was planted to silage (the remaining 20% was dedicated to nursery stock), the total production potential was estimated at 1,680 tonnes of dry matter. Reducing this optimal production estimate by 20%, due to harvest, storage, and feeding losses, gave an estimate of 1,344 tonnes available for dairy cow consumption. If the cattle averaged 500 kg and consumed dry matter each day equivalent to 3% of their body weight (15 kg), the estimated forage yield would support 89,600 "cow days." If cows are fed the entire year (365 days) from this forage, 245 cows could be fed. However, a 20% safety margin was recommended to account for potential production problems. Thus, 200 dairy cows were recommended as the maximum number for this village. Please refer to the monitoring plan for additional details.

[2] It was recommended that the ecological migration village or Banner Administration have an alternative source of forage available in the event that crop yields were not sufficient to satisfy dairy cow forage requirements. Approximately 1,000 tonnes of dry matter (1,100 tonnes of 90% dry matter hay) was estimated to be required to support 200 cows.

- ***Properly Ensiling the Forage Produced***
  The production of silage (ensiling) must be done properly to minimize forage losses due to spoilage, to maximize nutrient content, and to successfully store the harvested material through the fall and winter months. Concerns were expressed that proper ensiling methods are not yet practiced in the region. For this reason, a silage workshop was conducted and educational materials obtained and translated into Chinese. It was also recommended that the Banner dedicate an agricultural specialist to supervise silage production. Without such an effort, forage losses would be substantial. Recommendations were also made for obtaining the necessary machinery and storage facilities because silage making is a time-sensitive operation, and all items must be in place and in proper working order by mid-summer to ensure successful silage making in the autumn.
- ***Species Selection Recommendations***
  Forage type and species selection is critical for identifying those plants that will survive and produce acceptable yields and quality under the local growing conditions. It was recommended that cultivars be selected that are suited to the short growing season and able to provide high quality forage. Based on area climate data, only cultivars with an early maturing growth cycle (i.e., short season crop) and with minimum growing degree day (GDD) requirements of less than 1500, calculated using a 5°C base temperature, were recommended. Specific recommendations and web resources were provided in the monitoring plan.
- ***Crop Water Demand and Delivery***
  Proper irrigation scheduling is a critical aspect for maximizing forage production in semi-arid regions. Forages can be ranked with respect to water use efficiency (i.e., forage produced per unit water used). A summary of various crop water requirements was provided as a guide.

To summarize, several changes to the forage monitoring plan had to be made during the implementation phase of the project. First, no sampling or analysis of the 2003 crop year was conducted since pivot operations were delayed due to the SARS outbreak. Although there had been some production at the demonstration site in 2003, there was no remaining forage that was suitable for evaluation. Second, the 2004 growing season forage sampling procedures were modified. The forage sampling was restricted to 1m x 3m sampling areas rather than the 100 m^2 proposed in the monitoring plan. This became necessary for two reasons: 1) the absence of any weighing capability beyond that which could be hand held, and 2) the late growing season required that the determination occur several weeks before the crop harvest. We were able to evaluate a "no irrigation variable" using several areas planted outside the reach of the center pivot. Third, samples of ensiled material were not evaluated as proposed due, again, to the late harvest that extended beyond the end of the on-site staffing schedule. Finally, it was also not possible to secure samples of the supplemental ration as proposed. As a result a complete analysis of the ration for livestock was not possible.

1.2.3 Monitoring Natural Grasslands Recovery Potential

The grasslands recovery demonstration phase was designed to determine whether the reduction of grazing pressure on the grasslands would reduce the potential for dust generation and desertification. Exclosures were to be relied upon to control grazing and evaluate the potential for recovery. (An exclosure is a fenced area designed to keep grazing livestock out of the area, allowing the natural grasses to recover.) One potential configuration included three separate exclosures of $100m^2$. The other alternative proposed was the construction of a single exclosure of 100m x 400m. This demonstration, as proposed, would be limited because more than one year is required to allow native grass stands to demonstrate significant recovery. Given the time limitations, the capacity of grassland recovery was to be demonstrated using two critical objectives:

Critical Objective #1: Establish *indicators* of changes in erosion due to removal of grazing, assuming ecosystem health is directly associated with system stability.

Critical Objective #2: Measure changes in critical system attributes such as soil cover and vegetation structure, assuming that vegetation cover and structure are effective means of stabilizing eroding soils.

Documentation included one or more of the following:

- Oblique photos
- Estimates of organic ground cover (i.e., live vegetation, dead vegetation and litter). Take at least 2, 10-step transects at each site. Estimate percent ground cover in $1m^2$ quadrants.

Standardization and guidance in stabilization and soil erosion were established in concert with local experts:

- Minimum acceptable ecosystem health classification must be classification II with evidence supporting the transition toward classification I, a stable plant community with adequate ground cover.
- Minimum acceptable ground cover is 30% with less than 15% active erosion.

During the course of the demonstration, the following changes were made in the data collection program. The design of the exclosure areas was changed based upon our ability to access larger scale, longer term exclosures to evaluate indicators of recovery. This provided a better opportunity for observation than we could expect to achieve in a single year. Mr. Ai Bao-sheng, Director of Zhenglan Qi Forestry Department, provided access to two adjacent areas that had been managed as exclosures. These areas were approximately 25 kilometers northwest of Silangcheng, but still within Zhenglan Qi. Each of these areas was several hundred hectares in size. Grazing in one of the areas had been prohibited for three years. The other area was currently open to grazing. As a result, the evaluation methods proposed in the monitoring plan were applied to these two sites rather than single season exclosures.

1.2.4 Monitoring of Forage Production Costs

The goal of this effort was to describe the net value of crops produced using the center pivot irrigation system during the 2004 growing season. We needed to collect information describing the areas planted in each crop, the inputs used to produce each crop, the amount of each crop produced, and the value of production. We intended to calculate the total value of production by multiplying the amount of each crop produced by the price received for each crop. This effort was designed to enable us to describe the net values generated by using the center pivot irrigation system to produce crops for Silangcheng.

We understood that a department or production team organized by the Banner Administration was to manage crop production using the center pivot irrigation system. Someone from that team was to be assigned the task of recording the types and amounts of all inputs used in production (labor, seed, fertilizer, water, electricity, tractor time, etc.) and the types and amounts of all output produced (corn grain, corn forage, and other crops). The cost information was to include the wage rates for labor (RMB per hour or day), the cost of fertilizer (RMB per kg), the cost to pump water (RMB per day or per irrigation event, and the cost of tractor time (RMB per hour or day). Crop price information was to include the prices received for corn grain (if any grain is harvested separately from the corn forage, in RMB per kg), corn forage (RMB per kg), and the prices of any other crops produced using the center pivot irrigation system. The goal was to construct an accounting budget of all the inputs and outputs. Forms for recording this data through the production season were provided (Implementation Study, June 3, 2004).

During the course of the demonstration, the necessary farm accounting was not available. Consequently, the focus of this report was shifted to household finance as described in the following section. There are several reasons why this change in focus was made. In the course of the preliminary work that was conducted in May of 2004, it became evident that the economic conditions within the households were less than satisfactory in the view of the residents of the new ecological migration village. Secondly, a team from the local Forestry Bureau was conducting the farming at the irrigation site. The people at the site were not knowledgeable of the costs and were provided necessary supplies from a source that also managed nursery stock being raised at other sites for stabilization purposes. In addition, a significant portion of the supplies provided to the demonstration site were used to raise nursery stock as well as forage. Finally, market prices for the forage do not appear to be set exclusively by the forces of the open market conditions. The combination of incomplete data, the blending of forage expenses with non-forage production activities, and the complicated trail of cost information prevented us from obtaining accurate production cost data. It is also important to realize that this forage production site is not strictly a for-profit enterprise. The goal is to reduce the grazing pressure on the grasslands. This fact provided an additional variable whose quantification is beyond the scope of this demonstration.

1.2.5 Economic Data for Household Production, Costs, and Revenue

The goal of this effort was to describe the net income earned during the 2004 growing season by households in Silangcheng, the newly constructed ecological migration village. We collected information describing the areas planted in each crop, the areas harvested or grazed by livestock, the number of animals raised and sold in 2004, the revenue from livestock sales, the amounts of wool and milk produced, and the prices received for those products. We calculated total income of households by summing the values of crop and livestock products sold in 2004. In addition, we asked households to describe their total expenditures for crop and livestock production. We calculated the net income of households by subtracting their total expenditures from total income. This effort enabled us to describe the net incomes earned by households when they moved to an ecological migration village and began producing crop and livestock products.

We understood that households were not involved directly in the production of crops using the center pivot irrigation system. Rather, a unit of the Banner Administration produced the crops and sold its output to households at fixed prices. We understood also that households pay for feed concentrate and other inputs used in dairy production. They also have expenses for cutting and transporting hay from areas where they once lived. Some households might also have expenses for producing livestock products from sheep and goats. We understood that households sold the milk they produce to a dairy company that collected the milk and processed it for sale in local and distant markets. Households receive payment for milk sales once every month. Our goal in this effort was to obtain a full accounting of the costs paid by households and the revenues received for their output.

An outline for collecting the cost and revenue information is provided in Appendix E along with the actual data that was collected.

1.2.6 Monitoring of Sociological Impacts to Herders

Baseline monitoring of the ecological migration village in Silangcheng began on May 17 and 18, 2004, when the project team visited the pivot irrigation plot and the recently constructed village. The social impact team interviewed five households -- three in Silangcheng where residents had been living for less than one year, and two in nearby areas where resettlement had been in progress for three years. The three households in Silangcheng were to begin using forage from the pivot irrigation plot during the monitoring period from May to November. These households included two Han families (one with four cows and the other with two cows) who had experienced a decline in income and one relatively wealthy Mongolian family with ten cows and additional personal savings. The two households outside of Silangcheng provide a base for comparison and an opportunity to identify issues in Silangcheng during the monitoring period.

The social impact team was scheduled to visit Silangcheng again in November to conduct further observations and interviews. We proposed to conduct follow-up interviews in the same three households visited on May 18 -- Zhang Wanli, Meng Ke, and Hao Shiyou. In addition, we proposed to interview nine other families, bringing the total to 12. We planned to conduct four interviews on three consecutive days. The format was to be semi-structured interviews that would last from one to one-and-one-half hours each. The families were to be selected by a combination of opportunity sampling (e.g., going door to door in different sections of the village to find willing participants), and snowball sampling (e.g., asking those we interviewed to introduce us to other families in their networks of friends and relatives). The community consists of about 50 households and 200 people divided evenly between Han and Mongolian ethnicity. All are from the same *ga tsa* administrative unit. We intended to divide the sample evenly between Han and Mongolian households and include a range of age and wealth in the sample.

The village (Silangcheng) is designed to accommodate 200 milk cows, the maximum that can be fed with forage from the pivot irrigation plot. As of May 19, 2004, not all the cows had been delivered from Australia, and most of the cows that had been delivered were still too young to be producing milk. The stress of the transition between livestock herding on the grasslands and sedentary dairy operation had been made more severe by a one-year delay in setting up the pivot irrigation system due to the SARS epidemic during the spring and summer of 2003. Previous sources of income had been given up without immediate replacement from selling milk. Our monitoring program was designed to determine if the lost income could be replaced through milk production and if the project could contribute to reducing the poverty of the households.

The monitoring period of May to September 2004 serves as the reference point for this evaluation of socioeconomic impacts on 50 households in the ecological migration village of Silangcheng. The monitoring plan (described above) established before this period called for interviews with 15 of the 50 households during the forage harvest season. The monitoring indicators in this plan called for a comprehensive look at social and economic changes to households and community life. The principle investigator and field assistant could not return to the site to conduct these interviews because of a funding shortfall not projected in the original project budget. However, a research assistant already hired, Mr. Fang Ming, to collect technical data was able to collect additional information from the households regarding the economics of milk production. The economic information we describe in this report was derived from 15 interviews with village residents, focusing primarily on household economics and an additional interview with the milk station manager.

2.0 RESULTS OBSERVED DURING THE DEMONSTRATION PERIOD

2.1 Results of Groundwater Supply Monitoring

The aquifer consists of unconsolidated sediments deposited in a bedrock trough between the mountains on both sides of the Shandian River Valley. The sediments include fine-grained to medium-grained sand with layers of silt and clay, with at least some layers of coarse-grained sand and gravel. These sediments are at least 60 meters thick at the center pivot. The sediments were apparently deposited in rivers and lakes that occupied this valley during a time when rainfall amounts were much higher in the region. Sediments exposed in a gravel pit near Zhenglan Qi are coarse-grained, well-sorted, and show cross bedding, indicating that they were laid down in fast-moving water.

Limited aquifer testing was conducted on well PW-2 during the visit the Valmont team made to Zhenglan Qi on May 17 and May 18, 2004. Pumping of the well at an estimated rate of 50 m^3/hour for 74 minutes on May 18 produced drawdown of 5.17 meters, for a specific capacity[3] of 9.7 m^3/hour per meter of drawdown for that well. The testing suggested that aquifer transmissivity at this well is about 500 m^2/day. Pumping at PW-2 did not produce any detectable change in water level in any of the other irrigation wells. The average distance between PW-2 and the neighboring wells is about 200 m.

[3] Specific capacity is a measure of well productivity that is calculated based on pumping test data by dividing the rate at which the well is pumped by the amount of water level drawdown that is produced by pumping the well at that rate.

Table 1 is a summary of the results of the monitoring. Total rainfall near the center pivot during the 97-day monitoring period from May 18 to August 23, 2004 was more than 183 mm. The actual total amount of rainfall is not known, because at four times during the monitoring period, the amount of rain was greater than the maximum capacity of the rain gauge (25.4 mm), and the gauge overflowed before the measurement was recorded. Average rainfall for the summer growing season is approximately 251 mm (40 year average, 1960 to 2001). This suggests that the demonstration occurred during a period where precipitation levels were at or slightly below the historic average, but well within the normal rainfall range.

Average annual rainfall recorded at Zhenglan Qi is 383.4 mm. For perspective, the driest year on record was in 1965 with an annual precipitation recorded at 235.2 mm. The wettest year on record was 1959 with an annual precipitation of 559.9 mm. A total of 383 mm falling annually on a circle with a radius of 505 m (the irrigation coverage radius of the center pivot) is equivalent to an average flow rate throughout the year of about $35m^3$/hour.

There was less need for irrigation in 2004 than there would have been in a dry year. The irrigation system operated for a total of 155 hours during the summer of 2004. Since one cycle of the center pivot system takes about 24 hours to complete, 155 hours represents five complete irrigation cycles during the 14-week monitoring period. Because of well problems, only three of the wells were being used at the same time during operation of the pivot system. Assuming an average flow rate of 50 m^3/hour for each well, the combined flow rate when the system was operating was 150 m^3/hour. A total of about 23,250 m^3 of water was pumped during the irrigation season. The annualized pumping rate would be 2.7 m^3/hour, or only about 7.7% of the annual precipitation falling on the pivot irrigation coverage area based on the long-term average rainfall rate ($35m^3$/hour) that was measured during the monitoring period.

Pumping of the irrigation wells produced no detectable decline in the water table during the growing season (Figure 3). No impact could be detected in the pumping wells, or in monitoring well MW-1. Instead, aquifer water levels were slightly higher (by about 0.25 m) at the end of the monitoring period than they had been at the beginning. It is assumed that this is the result of ample rainfall during the period. The water level in the river rose by a similar amount during the monitoring period.

Most of the tested water quality parameters remained steady throughout the monitoring period for samples from both the well and the river (Figure 4). Specific conductance was slightly higher in well PW-2 than in the river, but the specific conductance results indicate the level of total dissolved solids in water from the aquifer is acceptable for irrigation. Levels of pH were slightly alkaline, with aquifer pH because the water-bearing zones in the well are relatively deep and the wells are a considerable distance from the river. River water temperature was consistently higher than water from the aquifer. Nitrate concentrations ranged between 3 and 5 mg/l in water from the aquifer. No change was seen in aquifer nitrate levels during of the monitoring program that would indicate that fertilization at the pivot site was causing nitrate increases in the aquifer, though any such changes would probably be detected only over a longer period of time. River nitrate levels were consistently low.

Recorded field data is included in Appendix B.

2.2 Results of Irrigated Forage Quantity and Quality Monitoring

Information was collected on soil characteristics and fertility, rationale of forage species and cultivar selected, seeding rate, fertilization, weed control, and irrigation. Discussions were held with officials and farm managers regarding available equipment and plans for ensiling.

Soil samples were taken and analyses conducted by the Green Environmental Center of China Agricultural University in Beijing. The results are provided in Table 1.

Analyses indicate adequate levels of fertility for potassium, calcium, and sulfur to support high levels of production for the corn that was planted for ensiling. Normal practice is to add nitrogen in split applications. This was done and growth seemed adequate in most sections of the field. Additional phosphorus should be applied for next year's crop as a plowed down nutrient prior to planting. Micronutrient status of the soil should be evaluated for boron and zinc, both in absolute amounts and as ratios with phosphorus. (See the following URL from the University of Wisconsin for additional information on suitable corn silage hybrid selection, fertilization, and ensiling: http://www.uwex.edu/ces/crops/uwforage/Silage.htm)

Forage samples were taken of the corn at the end of August 2004. Forage corn yield estimates for the sprinkler irrigated pivot and a non-irrigated production area are provided in Table 2.

These data are estimates because samples were taken from a small (3*1 m^2) plot and fresh weight scale measurements were thought to be only approximate as an accurate scale was not available. Dry matter estimates were used from samples submitted to the lab in Beijing. If dry matter was 25%, then yield estimates would be 10,692 and 7,642 kg/ha, respectively. These values are consistent with the projected yields described in footnote 1. Whatever the exact yields were for each of the fields, the irrigated fields yielded 40% more dry matter, even in what has been characterized as a relatively wet year. Thus, the objective of producing high amounts of forage through use of an efficient, center pivot sprinkler irrigation system was accomplished.

Corn forage sample quality analyses were conducted on sub-samples submitted to the China Agricultural University Feed Testing Center in Beijing. Data are reported in Table 3.

These data indicate a high variability of moisture content and dry matter expressed quality measures. However, this may indicate a need for quality control efforts at the laboratory to ensure that samples are consistently analyzed correctly. Analytical data is included in Appendix C.

2.3 Results of Natural Grasslands Recovery Monitoring

The monitoring activities originally proposed for monitoring rangeland health were centered on the development of exclosures to remove grazing pressures. These exclosures were the subject of considerable debate and skepticism. It is often observed that exclosures are seldom successful in completely excluding grazing. Discussions with the local Forestry staff revealed the existence of two protected areas located approximately 25 kilometers northwest of Zhenglan Qi that had been managed by them as exclosures in an effort to reduce desertification. These areas were several hundred hectares in size, and located adjacent to one another. The sites identified as UTM 404670 and UTM 404794 were presently open to grazing by nomadic herdsmen. The second site, UTM 404268 had been protected from grazing for the past three years. Four transects were performed on each site. The results are summarized in Table 4, with filed notes provided in Appendix D.

A three-person team under the guidance of Mr. Ai Bao-Sheng, director of Zhenglan Qi Forestry Department, inspected each of the areas. Vegetation counts were conducted at each quadrant (1.0 m^2) and recorded as the estimated percentage of vegetative cover with oblique photos taken for further evaluation.

Conditions documented in the area that was subject to open grazing ranged from drifting sand to lightly vegetated grassland interrupted periodically by sharply eroded land forms. Plant cover ranged between none and cover that was near the threshold for active cutting by wind erosion. Soil stability ranged from actively blowing sand to marginal soil cover in danger of complete destabilization. Plants in these areas were not healthy. Rooting ranged from none to small, less than 15 cm. The plant population was non-existent in the open blowing areas and where there were plants, there was little diversity in age or species. Nutrient cycling was characterized as open. Plants were either non-existent or very even in age. In summary, the conditions were either in complete collapse with open blowing sand or they were on the edge of becoming open blowing sand. The availability of natural rainfall and the velocity of the wind will determine the advance of desertification. If rainfall is abundant and the winds abate, then portions of this area could stabilize if further grazing is eliminated. However this general area is characterized by high winds (especially in the spring months) and very dry conditions. Natural recovery under continued grazing seems unlikely.

Conditions documented in the area that had been restricted from grazing were significantly different. Plant cover had exceeded 30% over most of the surface. Some sharp banks and wind cut features were observed, but they were not dominant. Root systems were more extensive, but not fully recovered. The plant diversity appeared to be increasing, but the nitrogen-inefficient plants density was still very low. The nutrient cycles appeared to be closing. This area had been subject to active attempts at re-vegetation with grasses and shrubs. These plants were all approximately the same age but there was still very little plant diversity.

The difference between these two areas suggests that within three years significant recovery of the grasslands is possible if two things happen. First, the grazing pressure must be reduced or eliminated during the period of recovery. Second, the recovery process can be enhanced by active attempts to establish a base population of locally adapted plants. Once the active erosion is halted, these sites will still require carefully managed grazing to prevent a return to conditions that are conducive to desertification and the generation of large quantities of dust. These observations are generally consistent with those of other investigators.

2.4 Resulting Changes in Agricultural Economics

The financial data collected from 16 households provide the opportunity to examine the household costs and returns from milk production. In particular, we can examine how those costs and returns vary with assumptions regarding key parameters, such as the interest rate and repayment period on loans to purchase dairy cows. We can examine also the impact of milk yield per cow on the revenue received from milk sales and determine if the net revenue is sufficient to pay for typical household expenditures. The database is limited in size (16 households) and the households were not selected at random. However, the data provide helpful insight regarding the household economics of producing milk in the newly formed ecological migration villages.

We have organized the expenditure data collected from the households into several categories of expenditures: 1) fixed costs of production, 2) variable costs of production, and 3) household expenses. Fixed costs include monthly payments pertaining to loans for purchasing dairy cows, while variable costs include expenditures for feed concentrate, grassland fees, and the cost of purchasing winter forage. Household expenses include the purchase of feed, clothing, and energy and payments for education and social services. The social services category includes expenditures for medical treatment, visits with friends, and visits to grassland areas.

The data used in this analysis are the mean values for each expenditure category, after eliminating the highest and lowest household observation in each category. For example, the mean value of 335 yuan per month for household expenditures on clothing, food, energy is obtained by eliminating the highest (1,050 yuan per month) and lowest (86 yuan per month) observations in that category and determining the mean value of remaining observations (Table 5).

Observations of zero are not included when calculating the mean values because our goal is to describe typical household expenditures. For example, it appears that the average expenditure for education is 360 yuan per month among households reporting such an expenditure. Households without school-age children will not have a monthly expenditure for education. Budget analysis for such households can be conducted by entering a zero in the line item for the education category. Similarly, it appears that the average expenditure on social services for households engaged in those activities is 399 yuan per month.

2.4.1 Budget Scenarios

We examined household budgets for several scenarios that involve different rates of interest and repayment periods on loans for purchasing dairy cows, and different milk yields per cow. In all scenarios we assume the purchase price of a cow is 17,200 yuan, the price of milk is 1.50 yuan per kilogram (kg), the feeding program includes 8 kg of concentrate per day per cow, the price of concentrate is 1.60 yuan per kg, the grassland fee is 28 yuan per day, winter forage is fed to cows during 4 months at the rate of 10 kg per day, and the price of winter forage is 0.10 yuan per kg. We examine budgets for households with one to four dairy cows. These scenarios are shown as Tables 6 to 9.

In the first scenario (Table 6), we assume each dairy cow produces 20 kg of milk per day during 10 months of the year. The milk is sold for 1.50 yuan per kg, such that annual revenue is 9,000 yuan. Dividing that sum by 12 months of the calendar year produces an equivalent average monthly revenue of 750 yuan per cow (Table 6). The 3% loan is repaid over three years with monthly payments of 507 yuan per cow.

The revenue from milk production is greater than the variable costs of production for households with one to four cows (Table 6). However, the revenue remaining after paying variable costs is not sufficient to pay the full amount of the monthly loan payment. A household with only one cow needs an additional 179 yuan per month to make the full payment, while a household with four cows needs an additional 715 yuan per month. The shortfall of revenue with respect to all costs and household expenditures ranges from 1,273 yuan per month for a household with one dairy cow to 1,809 yuan per month for a household with four cows.

In Scenario II (Table 7), we assume that the interest rate on loans to purchase dairy cows is zero. All other parameter values, including the repayment period of three years, are the same as in Scenario I. Reducing the interest rate from 3% to zero causes the monthly loan payment to decline from 507 yuan per cow to 478 yuan per cow. That reduction improves the household budget situation somewhat, but the revenue remaining after paying variable costs remains insufficient to pay the full amount of the monthly loan payment (Table 7). Revenue minus all costs and household expenditures also remains negative for households with one to four cows.

We extend the loan repayment period from three years to six years in Scenario III, while retaining the zero interest rate (Table 8). The monthly loan payment is reduced to 239 yuan per cow, which can be paid from the revenue remaining after paying the variable costs of production. However, monthly revenue from milk production remains insufficient to pay all of the household expenses. The monthly shortfall ranges from 738 yuan for a household with four dairy cows to 1,005 yuan for a household with only one cow.

We examine the potential impact of greater productivity in Scenario IV, in which we increase the milk yield to 40 kg per day per cow (Table 9). The equivalent average monthly revenue from milk sales increases to 1,500 yuan per cow. All other parameter values are the same as in Scenario III. The increase in milk yield generates revenue that is sufficient to pay all variable costs, fixed costs, and household expenses for households with two or more cows (Table 9). A household with only one cow faces a monthly shortfall of 256 yuan, even with the assumed improvement in productivity.

2.4.2 Economic Implications of Budgets

The estimated revenue from milk production is not sufficient to pay for both the variable and fixed costs of production when the milk yield per cow is 20 kg per day and the loan for purchasing dairy cows must be repaid in three years, even if the interest rate is zero. Extending the repayment period to six years (with a zero interest rate) reduces the monthly loan payment from 478 yuan to 239 yuan. This enables households to pay both the fixed and variable costs of production, with some revenue remaining to pay a portion of their monthly household expenses. If the milk yield is doubled to 40 kg per day, per cow, without increasing any fixed or variable costs of production, households with two or more cows earn enough revenue to pay all of their monthly expenses.

This analysis demonstrates the important role of the monthly loan payments in determining whether or not households will, in three years with an interest rate of 3%, generate a monthly loan payment equivalent to 68% of the average monthly revenue from milk sales (507 yuan divided by 750 yuan) when cows produce only 20 kg of milk per day (Table 6). The estimated variable costs of production (422 yuan per month) are equivalent to 56% of the average monthly revenue (Table 6). Hence, it is not possible to pay both the fixed and variable costs of production. Reducing the interest rate to zero generates a monthly loan payment of 478 yuan per month (64% of estimated revenue), which still exceeds repayment capability (Table 7).

2.5 Resulting Sociological Impacts to Herders

2.5.1 Milk Production

Milk was normally collected twice per day -- 6:00 to 8:00 in the morning and 6:00 to 9:00 in the evening. Sometimes milk could not be collected because it did not pass a quality test. The issue of quality was related to excess acidity perhaps caused by substandard storage facilities in the households, long periods of storage, and/or unhealthy or undernourished cows. The director of the milk station reported that farmers sometimes added alkaline water to the milk so that it would pass the quality test. At other times, milk was not collected either because the two storage tanks in the milk station had exceeded their capacity, or because the motors used to cool one or both of the tanks had broken down. The company processing the milk was not making a profit and halted construction of a larger milk station. The reasons for lack of profit might include low product quality in relation to purchase price, the high cost of transportation, interruptions in supply, or problems inside the dairy company. Village residents heard a rumor that the price they receive for milk sold to the station might be reduced by 33% to 1.0 yuan per kg.

2.5.2 Household Economics

Households in Silangcheng report that their revenues received for milk production are low compared to the cost of feeding the cows. They receive 1.50 yuan per kg of milk sold plus 50 g of concentrate to use in feeding the cows. The concentrate is priced at 1.60 yuan per kg. However, price does not seem to be a factor in the losses they report. The problem lies partly in the fact that the milk yield from carefully bred and expensive Australian cows does not measure up to expectations. The expected yield is 40 kg of milk per day, but the actual yield in Silangcheng averages only about 20 kg per day. We can infer from the reports of low yield and poor quality of the milk mentioned above that village residents, for lack of technical assistance and other important reasons, are not properly feeding and caring for the cows. This scenario is a classic problem in development projects introducing new breeds of livestock. The tendency is for farmers to feed and care for them the same way they have always done for traditional livestock. This tendency is especially likely to be observed as incomes fall below expectations and farmers feel the need to cut costs. In other words, if the milk yield is low and they receive less compensation for selling their milk, the farmers will be skeptical about the cost-effectiveness of using increasingly scarce resources to purchase additional nutrients and high-quality feed concentrates to improve the diet and yield of the cows.

The problem of low income also partly derives from the fact that the milk station does not always collect the milk on a daily basis due to reasons mentioned above. This kind of uncertainty can also cause farmers to be overly cautious about making necessary investments in their cows. Moreover, two cows died in a period of three days from pathogens that either proved untreatable or could not be diagnosed early enough to receive timely treatment. Such disease problems are often related to poor nutrition and lack of veterinary attention. The death of a cow can cause a household with only three or four cows to lose a substantial portion of its wealth (17,000 to 19,000 yuan for one Australian cow) and its monthly income.

Eleven of fifteen households had borrowed anywhere from 10,500 yuan to 69,000 yuan to purchase cows and establish themselves in the dairy business. We understand these loans must be paid back within three years. Payments are deducted from milk sales with the result that milk sales may not improve cash flow. For example, a household that receives 750 yuan from selling 500 kg of milk might have 400 yuan deducted for a monthly loan payment, and must pay 480 yuan for 300 kg of forage. This household will end up owing 130 yuan to the milk station and have little or no cash flow for three years unless it decides not to buy the forage or concentrate.

Comparison of monthly income and expenses for the two households with the highest income/cash flow shows that both are experiencing a net loss. Neither gained any income from wage labor from outside employment. Both were paying back debt, both had bred and sold at least two calves from the local breed of cattle, and both were paying rent for grassland to help feed their cattle and small stock of sheep and goats as well. One household reported gross income of 7,171 yuan and the other a total of 2,014 yuan. The wealthy household spent 4,608 yuan for feed/concentrate whereas the poor household spent only 240 yuan. Although the expenditures for food in the two households were about the same, discretionary expenditures for clothes, electricity, telephone, transportation, education, and medical services were vastly different -- 2,688 yuan to 15 yuan (in the latter case all for electricity). Their net incomes/cash flows during the monitoring period were minus 5,346 yuan and minus 561 yuan (third lowest among 15 households). Excluding discretionary expenditures, the gross incomes of two households (not the same ones) the year before the move to Silangcheng were 14,800 yuan and 7,000 yuan. They received net positive incomes of 5,000 and 3,000 yuan respectively.

The data from another 13 household interviews confirms the general perception among residents of Silangcheng that they now feel they are undergoing at least temporary hardship and that poor families are in a financial bind which causes a conservative approach to expenditures as described in the paragraph above. All but two had negative net monthly income/cash flow. The two households with positive net monthly incomes of 50 yuan and 667 yuan received 500 and 600 yuan respectively from outside labor performed by a husband or son. Seven households reported such outside income, but the work in all cases was sporadic and temporary (e.g., railroad construction, local housing additions, etc.). One of these households ran a small shop that brought in 1,030 yuan per month. Seven households reported no income at all and were living on savings. Four were waiting for cows to produce milk while three older residents (60, 58, and 54 years of age) had no cows/animals and no occupation/work with prospects to earn income in the future.

Poor families in Silangcheng are unable to pay their basic expenses, and they cannot afford the amenities of modern living that are now more available to them. They now have no gardens to provide free vegetables, no livestock to slaughter for meat, and no free grassland for grazing their cows. Thus, expenses for food are much higher than before. Without additional help they might not be able to succeed in the new dairy farming economy.

2.5.3 Forage Production

The center pivot irrigation system used to produce forage is a critical component of the household economic system. The Forestry Bureau currently operates the pivot, but we understand a household or private firm will operate it in the future. The Forestry Bureau reports that the price of corn forage in the local market is now 0.08 yuan/kg, well below the price of 0.18 yuan that is needed to achieve a profit. Part of the reason for the low price may be low demand due to farmers' low profits and/or the tendency for farmers to rent grasslands in the surrounding area to provide summer forage for their livestock. One family reported visiting their original home on the grasslands. It is also unclear how many families are also cutting and transporting hay from their previous location where they still have rights to land. Village residents reported that the government had not constructed any silage storage pits by the end of August 2004. Also they indicated that the government had not provided enough stalk cutters to process the corn forage.

There were other observations made in the course of the interviews throughout the monitoring period. These observations are recorded here to broaden the understanding of the existing sociological conditions and how they deviate from the stated objective of reducing overgrazing and controlling sandstorms and desertification:

- We observed that households keep pigs and chickens, and sheep, sometimes in larger numbers.
- We saw sheep and cattle being taken to graze on the open grasslands in the surrounding area (seven households in the sample of 15 reported renting surrounding grasslands paying 120 to 400 yuan per month).
- We saw piles of dried dung intended for use in heating and cooking, though in lesser quantity per household than existed in the original location. Residents will have to purchase much of their winter fuel.
- We found that several households dug their own backyard wells in the absence of a promised running water system. We observed them watering their livestock at these wells.
- We saw people building their own brick walls outside of shelters to provide confined open-air space for livestock.
- Four households built additional rooms onto their houses, paying the costs of up to RMB 7,500 themselves.
- We heard that community cohesiveness was beginning to be disrupted by disparities in wealth between households and that community members had begun borrowing money from

each other. In the sample of 15, four households had personal loans, up to 6,000 yuan in one case.

- The houses we saw in Silangcheng seemed to be superior in construction compared to those we saw on the grasslands. Some residents agreed while others disagreed that they now had better housing. Leaking roofs and small size seemed to be the main problems. They complained about having only two rooms. Houses on the grasslands were bigger and had more rooms, as many as eight rooms in one case.
- Residents paid 2,000 yuan for their houses. (We heard on our first visit that they would pay nothing for their houses.)
- A few objected to sharing shelters for cows with another household, indicating that space for animals in the shelters was cramped.
- Residents were promised five connections -- power, running water, cable for television, telephone, and a road. By August 2004 they had received only power, and the road was under construction.
- Several families were still renting housing for their school children in the banner town. This choice may have been made due to lack of housing space and inconvenient transportation along the rutted dirt road.

Field data sheets are included in Appendix E.

3.0 CONCLUSIONS BASED UPON THE RESULTS OF THE DEMONSTRATION

3.1 Conclusions Regarding Groundwater Supply

Irrigation pumping during the 2004 growing season produced no detectable changes in aquifer water levels, either in the irrigation wells or in the off-site monitoring well. Instead, aquifer water levels rose slightly during a period of slightly less than normal rainfall. The aquifer is extensive and highly productive, and it contains a large volume of water in storage. The amount of rain that fell in the summer of 2004 appeared to provide ample aquifer recharge. The available evidence indicates that the aquifer should be able to support substantially more irrigation pumping without negative impacts.

Water levels rose by similar amounts in the aquifer and the river during the monitoring period, and this indicates that the river is hydraulically connected to the aquifer. The similarity of specific conductance and pH values in samples from the aquifer and the river can also be interpreted as evidence for such a hydraulic connection. Nitrate levels in the aquifer were stable during the monitoring period, showing that application of fertilizer on the irrigated land had not produced a change in water chemistry as measured by this parameter.

The monitoring activities indicated that only 7% of the rainfall that fell on this 80 hectare area during the year of the demonstration was needed to provide the supplemental growing season irrigation. Secondly, when the entire water shed was reviewed, the supply of water was many times the quantity needed for irrigation with high efficiency units like the Valley center pivot used in this demonstration project. Finally, the fact that the water level actually increased during the monitoring period suggests that the withdrawal of groundwater during the demonstration period did not deplete the groundwater supply. These observations indicate that the ground water supply in this watershed is adequate for the development of additional irrigated forage production in support of reducing grazing and desertification control without adverse impact on groundwater supplies.

Both the scope and duration of this monitoring program were limited. However, the monitoring results suggest it is reasonable to consider substantially expanded irrigation as a means of reducing overgrazing in Zhenglan Banner and similar areas. If the government decides to adopt a policy of encouraging more irrigation, it would be wise to accompany that increase with an integrated, watershed-scale monitoring program to gain a better understanding of the ability of the aquifer to support sustained irrigation pumping.

3.2 Conclusions Regarding Irrigated Forage Quantity and Quality

This demonstration has shown that high quantities of forage can be grown using center pivot irrigation. Even during years that are considered to have average natural rainfall, production can be as much as 40% higher than similar production schemes without sprinkler irrigation. However, while the increase in production is significant, the reliability of the annual forage supply is more meaningful. The availability of irrigation helps eliminate the bad forage production years when it does not rain at all. This avoids one of the major risks to the success of the proposed milk production program. However, several fundamental issues need further study and improvement to obtain the maximum benefits from forage production. First, better species and cultivars are available that better match the environment. Second, forage production goals must be better planned to match forage quantity and quality with animal numbers and nutritional requirements. Finally, and probably most important at this time, the production of high quality silage from the harvested forage must be improved. The best forage production operations in the world will not be successful if 50% to 70% of the produced forage is lost during the silage production process.

3.3 Conclusions Regarding Natural Grasslands Recovery Potential

Field observation and data provide strong evidence that protection from grazing and cutting can lead to positive changes in ecosystem health, reduced erosion, and less blowing dust. The ecosystem health assessment shows that areas protected from grazing and cutting for as little as three years are healing and resulting in substantial soil stabilization. Systems need more time to colonize plants with varied age class and to close mineral cycles, but have already attained the 30% threshold needed to protect the soil surface. Conservation/planted trees have become established and provide protection by decreasing wind velocities near the soil surface.

3.4 Conclusions Regarding Changes in Agricultural Economics

Financial viability of the dairy enterprise from a household's perspective can be enhanced substantially by extending the loan repayment period to six years or longer and by enhancing productivity. Our analysis suggests that doubling milk production from 20 kg per day per cow to 40 kg per day will enable households to pay all costs and household expenses. However, we have not included any additional variable costs that might be required to achieve such an improvement in productivity. Higher expenditures for concentrate, winter forage, and veterinary care will reduce the estimated revenue remaining after variable costs are paid.

The household budgets provide helpful insight regarding the impacts of different parameters on the financial viability of milk production. Results will vary with the parameter values selected for analysis. Additional scenarios can be examined by replacing any of the parameter values appearing in Tables 6 through 9 with alternative values that pertain to a particular household, village, or policy program. Government officials involved in the development of future ecological migration villages are encouraged to evaluate these factors carefully as they work to establish farm financing, set prices for agricultural inputs such as forage, and evaluate the market prices for agricultural products.

3.5 Conclusions Regarding Sociological Impacts to Herders

The positive aspects of resettlement include proximity to extended family and kinsmen and, possibly, additional employment opportunities for men. We did not come across increased gender strife or internal family problems. Women continue to be the primary caretaker of animals around the house and yard. The issue of underemployment for men still is an issue as some are looking for work and cannot find it. During our visit in May we observed several men spending their morning playing mahjong. On one occasion in the middle of the day an angry, drunken man barged in to disrupt an interview.

These observations and points made earlier indicate that residents resettled in Silangcheng are using means with which they are familiar to adapt to a new and, as they experience it, relatively difficult situation. Previous practices have re-emerged in the new economy. These do not point directly to success or failure for dairy farming, but they do have adaptive value during a challenging transitional stage when livelihood is changing.

Social and economic impacts of resettlement primarily relate to the project goal of assessing the feasibility of providing an alternate livelihood for resettled herding people. The difficulties so far in Silangcheng derive from the need for more investment in and attention to technical and financial matters. Residents of Silangcheng are coping with relative hardship and, in some cases, absolute hardship by using savings, resourcefulness, and industriousness they have brought from the grasslands despite their lack of knowledge and financial capacity to fix technical and market problems. Carrying out the recommendations below can help them fully realize an alternate livelihood in dairy cow management. In terms of the goal of reducing pressure on native grasslands, resettlement in somewhat smaller measure has merely shifted the pressure from severely eroded land to other land where grass still grows in comparative abundance. As more herding families are resettled, this pressure on still fertile lands has the potential to increase, at least until these families receive adequate technical assistance and feel assured of their new livelihood does not require a backup system. In the broader scope of this project, developing employment opportunities for men outside dairy farming would be a constructive step forward. We caution against moving ahead with the grasslands resettlement program until the lessons learned from Silangcheng can be applied to increase the chances of success in meeting resettlement goals.

4.0 SUGGESTIONS FOR IMPROVING FORAGE PRODUCTION SYSTEMS

4.1 Groundwater Supply

Future projects, which rely on groundwater for supplying irrigated forage production, should include a groundwater-monitoring program. The basic parameters of a monitoring program should be similar to those outlined in this study, except that it should be on a larger scale. A complete assessment of the entire river basin was not possible given the scope of this demonstration. However, widespread implementation of groundwater withdrawals is a different matter. This approach to combating desertification is being proposed for Inner Mongolia, where irrigation during the growing season can significantly increase forage production.. The use of high efficiency irrigation technology to minimize groundwater withdrawal is essential if maximum production of irrigated forage is to be achieved.

4.2 Irrigated Forage Quantity and Quality

The following is a list of recommendations for the improvement of forage production:

- Matching crop production with livestock numbers and production targets. Specific calculations and recommendations made for matching livestock numbers to anticipated forage production must be completed during the planning process and adhered to during implementation. Use of these types of calculations in planning for the number of animals that will be included in the villages would significantly increase the probability of success. More attention, however, must be given to ration formulation, including quantity and quality, to ensure that farmers will be successful in producing salable products.
- Ensiling techniques. Much effort was expended in determining the current state of silage production technology, in planning and executing a silage training session, and in obtaining and translating instructional materials. This effort was not sufficient and, at present, the farming company and village appear to remain unprepared to make effective use of the forage that has been produced. Additional equipment, facilities and technical oversight are needed to reduce the waste and inefficiencies that appear to be occurring.
- Matching species and cultivars with environment and management. Recommendations were made for selecting forage species and cultivars as part of the feasibility study. However, the decision was already made to plant corn silage and to obtain the seed locally. The production quantity and quality would be greatly improved by selecting species and cultivars that better match the environmental and management constraints of the area. Seed selection should be completed before next year's planting using input from university sources and conferring with reputable seed companies.
- Matching irrigation with crop requirements. Using irrigation scheduling techniques and developing local expertise through training and use of scheduling models can improve irrigation scheduling based on crop use. An example product used in Minnesota and Wisconsin is described at the following URL:
  http://www.bae.umn.edu/extens/ennotes/enspr01/software.htm.
  North Dakota State University's "Corn Production Guide" also includes information on irrigation management and methods for estimating corn silage yield:

http://www.ext.nodak.edu/extpubs/plantsci/rowcrops/a1130-8.htm. Many other resources are available on the web and through connection with U.S. universities. The main goal of irrigation scheduling is to improve production (e.g., provide the water when the plant needs it) and to increase water efficiencies (i.e., minimize evaporation and leaching losses).

General Recommendations

- Scientific oversight and technical advisors. The multidisciplinary nature of this demonstration project underscores the need for an integrated technical advisory team within the Chinese ministries and agencies responsible for ecological villages and antidesertification projects. All groups must understand and be working toward a common goal. At present, portions of the project are given to various persons or agencies, some of which are not always aware of action by others. Training of local personnel and the installation of improved agricultural production practices would be greatly enhance through the use of joint planning, implementation meetings, and routine monitoring trips. This project was successful, but to expand this demonstration model to a regional basis will require a concerted effort from all parties involved.
- Interdisciplinary, interagency connections. Related to the above recommendation, greater attention must be given to involving all appropriate cooperators from the international, national, provincial, and local levels. Again, the successful expansion of this demonstration model to a regional basis will require a concerted effort from many different agencies and organizations (e.g., international development organization, the Ministry of Agriculture, the CAAS and CAS, and provincial universities, etc.).
- "Green" accounting. This demonstration project is conceptually based on the premise that high intensity forage production can be used in areas with sustainable water resources to reduce the environmental damage being caused by overstocking fragile rangelands. This is an environmental objective. This benefit should be assigned an economic value in the local production system to better assess the economic impacts using measurements to account for the "green" benefits.
- Laboratory certification. In the USA, there is a laboratory certification program. The URL describing the program is: http://www.foragetesting.org/. A similar program could be initiated in China. In addition, for silage samples, analysis capability could be developed for the volatile fatty acids present in silage (<http://www.dairylandlabs.com/vfa.html>). A combined energy measure is needed. Concentrate analysis data provide an energy measure in terms of MJ/kg. A similar measure is needed for forage analyses to assist in ration balancing. An example corn silage evaluation program with the associated quality measures appropriate for balancing dairy rations is found in the following URL describing work done at Mississippi State University: http://msucares.com/pubs/infobulletins/ib0360.pdf. Linkage with universities experienced in work of this type and with corn silage seed companies would be of benefit in quickly developing a cultivar evaluation program which includes yield and quality estimates.

4.3 Natural Grasslands Recovery Potential

Recovery of the natural grasslands in Inner Mongolia has been demonstrated and documented by several investigations. However, all of these investigative efforts have been relatively short in duration. The development of a regional monitoring program to track the recovery of the grasslands is essential. If we successfully stabilize one area at the same time that another sub-region is becoming less stable, the objectives of reducing the advance of desertification and controlling sandstorms will not be achieved. A regional reporting system that measures the success of various control strategies over time is essential to controlling desertification and the resulting sandstorms.

4.4 Changes in Agricultural Economics

One of the key ingredients in reducing the advance of desertification is assuring a reduction in grazing pressure. The successful implementation of the ecological migration village strategy is dependent upon the economic success of the relocated individuals. If the transition creates an unacceptable financial reality, the relocated herders will either return to the grasslands or they will become a burden on some other part of society. A careful evaluation of the economic scenarios included in this report will assist the implementing authorities in their future household level planning.

Viable economics at the household level are important not only to the household and the ecological migration villages, but also to regional authorities. If household finances are not adequate to support the purchase of forage at a price that is greater than the cost of production, an additional financial burden will be placed on Banner and regional budgets

4.5 Sociological Impacts to Herders

Social and economic impacts of resettlement primarily relate to the project goal of assessing the feasibility of providing an alternate livelihood for resettled herding people. The difficulties so far in Silangcheng derive from the need for more investment in and attention to technical and financial matters. The following key socioeconomic issues need to be carefully evaluated and resolved if the ecological migration village concept is to become an effective tool in the battle against overgrazing, and the resulting desertification and sandstorms.

Key Socioeconomic Recommendations to be Considered:

- Give more technical assistance and direct supervision to households in how to feed their cows.
- Give financial assistance/subsidies to poor households to feed their cows properly until such time as higher incomes allow them to do it themselves.
- Extend the payback period for loans to improve household cash flow.
- Improve facilities and equipment.
- Assist men, especially young men, in finding outside employment.
- Give more veterinary and technical assistance in how to care for the cows and training in how to recognize early symptoms of potentially fatal disease.
- Continue to allow village residents to keep smaller animals around their houses and yards as insurance against food shortage.
- Set aside space for a communal vegetable garden.
- Develop a new business plan for the milk processing company, taking advantage of knowledge gained from initial experience and proceeding to increase its storage capacity.

- Help the milk processing company to build on-site capabilities in maintaining and repairing its electrical equipment to eliminate interruptions in operation and milk collection.
- A careful evaluation of setting up a collective enterprise for milk production should be undertaken. This approach might work better than the current model of relying on individual farmers who lack capital and technical expertise.
- Gradually phase out grazing on surrounding grasslands, but not until technical and economic issues of milk and forage production have been solved.

5.0 CONCLUSIONS

One way to evaluate this work is to consider the condition of the grasslands with and without the project. This evaluation could be economic or it could be socioeconomic. A complete economic assessment is not realistic given the scope of the project as revised in the Inception Study. Further, the blending of forage production activities with forestry production makes the economic issues difficult to define. In addition, it is not easy to place an exact economic value on environmental improvements such as reduced dust and improved grassland health, nor is it easy to compare those costs to other options for achieving the same end result.

This Irrigated forage production demonstration project does offer some socioeconomic contrasts. Without this demonstration project it is probable that the well documented expansion of desertification would continue unchanged. The degradation would worsen because increasing population growth will result in greater numbers of grazing animals as additional generations of pastoralists follow the historic practices.

With the results of the irrigated forage demonstration project there are now new alternatives available for decreasing desertification and dust. This report helps governmental officials to better understand both strengths and weaknesses in this approach. Now that these issues are more clearly understood, managers can focus on the key issues. For example, it is now clear that adequate water is available for water efficient irrigation. It is also clear that the soils are well suited to this type of irrigation. Irrigated forage production rates are now documented under these conditions. With the completion of this demonstration project it is also evident that there are opportunities for improvement. Some of these improvements have already been implemented according to communications from the local government. However, solutions to the preservation of forage for use during the long winter, the stability of the milk market and other issues outlined in this document remain as challenges.

It is not realistic to believe that a change from open pastoral grazing to confined dairy production based on modern irrigated forage could occur without encountering obstacles and discovering opportunities for improved performance. With this demonstration project the Chinese professionals with the responsibility for controlling desertification have a clearer focus on which issues need their attention.

Modern, water saving Valley mechanical irrigation equipment is an important tool for use in the battle against desertification. Forage produced with this water saving technology has the potential to reduce degradation of the grasslands by shifting agricultural production from open grazing to more confined production associated with dairy and beef products. The reduction of grazing pressure results in significant recovery of the grasslands in as little as three years. The data developed as part of this project indicates that the use of this technology is sustainable and that the groundwater supply is capable of supporting this approach to controlling desertification. It is important to note that the greatest successes observed in this demonstration were in the areas that are the most difficult, if not impossible to change. The sustainability of the groundwater supply is an example of one of these successes.

Significant opportunity exists for increasing the effectiveness of this approach to controlling desertification. Fortunately, these things are within the control of the local banner and can be managed. Improvements in the preservation of forage will require renewed commitment and significant effort, but it can be accomplished in a relatively short time. The decision may even be made to change from the production of corn forage, which requires more complex silage preservation practices, to alfalfa production which is simpler to manage as a hay product. This may be particularly true if the storage is to be provided by the individual dairymen. Improvements in the market for milk and beef products can also be achieved with the encouragement and support of the local Banner officials.

These agricultural and social changes are not easy. They will require a sustained commitment on the part of local, regional, and national government officials. However, for those who have witnessed the incredible hardship experienced by herding families in severely overgrazed areas, there is no choice but to do something quickly to protect their livelihoods, the soil resource, and the Inner Mongolian grasslands.

Table 1. Soil Sample Analysis Information

Analysis	Sample 1	Sample 2	Notes
pH	7.23	7.06	Neutral
NH3-N	0.133 %	0.119 %	High nutrient level
Phosphorus (P)	2.38 mg/kg	4.12 mg/kg	Low
Potassium (K)	130 mg/kg	97.5 mg/kg	Medium
Calcium (Ca)	1470 mg/kg	2685 mg/kg	Abundant
Sulfur (S)	43.9 mg/kg	43.5 mg/kg	Abundant
Cation Exchange Capacity (CEC)	11.8 cmol/kg	9.93 cmol/kg	Medium

Table 2. Corn Silage Yield Estimates Based on Plot Sampling

Sample description	Sample Fresh Weight (kg)	% Dry Matter (estimated)	Yield estimate (kg/ha)
Pivot 1	12.00		
Pivot 2	14.50		
Pivot 3	12.00		
Average	12.83	30	12,830
Not Irrigated 1	8.50		
Not Irrigated 2	10.0		
Not Irrigated 3	9.00		
Average	9.17	30	9,170

Table 3. Corn Forage Sample Quality Analyses Expressed on a Dry Matter Basis

Sample Description	Moisture	Crude Protein (CP)	Neutral Detergent Fiber (NDF)	Acid Detergent Fiber (ADF)	Calcium (Ca)	Phosphorus (P)
Pivot 1	69.29	8.89	64.74	36.33	0.67	0.14
Pivot 2	77.17	12.37	59.73	32.70	0.65	0.23
Pivot 3	60.54	11.68	62.53	33.29	0.80	0.18
Non-irrigated 1	77.95	12.39	60.43	31.54	0.99	0.17
Non-irrigated 2	62.02	14.18	64.86	33.31	0.90	0.24
Non-irrigated 3	72.32	12.32	57.52	29.17	0.54	0.18

Table 4
Data Sheet Rangeland Ecosystem Health

Name of Recorder – Rittenhouse Date: May 18, 2004

	Open Grazing Location UTM 404670 - active erosion; blowing dust				Two Year Exclusion Location UTM 404794 -*adjacent to eroding area; system at risk*				Three Year Exclusion Location UTM 404268			
	Healthy	At Risk	Unhealthy	Notes	Healthy	At Risk	Unhealthy	Notes	Healthy	At Risk	Unhealthy	Notes
Plant cover and litter			X	Little to none		X		Cover is near threshold; any further reduction in cover or structure increases the chance of active cutting vis-à-vis wind erosion	X	X		Plant cover adequate to arrest erosion
Soil stability			X	Actively eroding; blowing dust		X		No active wind erosion, but soil cover is marginal and plants are not healthy		X		Stabilizing, but some sharp banks remain
Rooting			X	No remaining roots		X		Root systems are unhealthy. Bulk of roots less than 15 cm.	X	X		Roots systems expanding; healthy but not recovered
Energy flow			X	None		X		Little age or *structural* diversity		X		Needs more time to restore diversity
Nutrient cycling		X	X	Mineral cycles open		X		Mineral cycles are open	X	X		Density of Nitrogen-inefficient plants is low. Nutrient cycles seem to be closing.
Life history of plants			X	None		X		Even age		X		Plants either young or introduced. Time will be required to establish *life-history* diversity.
If trees part of natural stand	NA	NA	NA		NA	NA	NA		NA	NA	NA	Trees planted for erosion control

[a] It is unreasonable to expect that all indicators will *simultaneously fall into one* of the above categories. It is more likely that the preponderance of evidence will place that system.

Table 5. Expenditure data collected from 16 households in Silangcheng Village of Zhenglan Banner in Inner Mongolia, during the summer of 2004

House Number	Number of Individuals	Clothing, Food, and Energy	Education	Social Services
			(yuan per month)	
1	3	357	$\boxed{250}$	0
2	4			
3	5	$\boxed{86}$	380	40
4	3	325	0	1,000
5	2	200	0	100
6	3	500	0	100
7	4	200	0	0
8	2	285	0	0
9	5	200	0	400
10	3	173	300	300
11	4	320	400	1,055
12	3	100	0	$\boxed{10}$
13	2	$\boxed{1{,}050}$	0	0
14	4	955	$\boxed{730}$	200
15	3	215	0	0
16	3	530	358	$\boxed{2{,}000}$
Means	3.3	335	360	399

Notes: Means are calculated after eliminating the highest and lowest non-zero observations. Observations of zero are not included when calculating the means.
Household Number 2 did not provide expenditure information.

Scenario I

Table 6. Household budgets when the interest rate on loans to purchase dairy cows is three percent and the repayment period is three years

Item	Number of Cows per Household 1	2	3	4
	(yuan per month)			
Revenue from milk sales	750	1,500	2,250	3,000
Fixed costs of production				
Loan payment	507	1,013	1,520	2,027
Variable costs of production				
Feeding concentrate	384	768	1,152	1,536
Grassland fees	28	56	84	112
Winter forage	10	20	30	40
Household expenses				
Food, clothing, energy	335	335	335	335
Education	360	360	360	360
Social services	399	399	399	399
Revenue minus variable costs	328	656	984	1,312
Revenue minus variable and fixed costs	-179	-357	-536	-715
Revenue minus variable and fixed costs, and household expenses	-1,273	-1,451	-1,630	-1,809

Key Assumptions:

Yield of milk per cow	20	kg per day
Price of milk	1.50	yuan per kg
Days per month	30	days per month
Milking months per year	10	months per year
Purchase price of cow	17,200	yuan
Interest rate on loan	3	percent
Repayment period	3	years
Loan payment	507	yuan per month
Feeding concentrate	8	kg per day, per cow
Price of concentrate	1.60	yuan per kg
Grassland fee	28	yuan per day, per cow
Winter forage period	4	months per year
Winter forage feeding	10	kg per day, per cow
Price of winter forage	0.10	yuan per kg

Scenario II

Table 7. Household budgets when no interest is charged on loans to purchase dairy cows, and the repayment period is three years

Item	Number of Cows per Household 1	2	3	4
	(yuan per month)			
Revenue from milk sales	750	1,500	2,250	3,000
Fixed costs of production				
Loan payment	478	956	1,433	1,911
Variable costs of production				
Feeding concentrate	384	768	1,152	1,536
Grassland fees	28	56	84	112
Winter forage	10	20	30	40
Household expenses				
Food, clothing, energy	335	335	335	335
Education	360	360	360	360
Social services	399	399	399	399
Revenue minus variable costs	328	656	984	1,312
Revenue minus variable and fixed costs	-150	-300	-449	-599
Revenue minus variable and fixed costs, and household expenses	-1,244	-1,394	-1,543	-1,693

Key Assumptions:

Yield of milk per cow	20	kg per day
Price of milk	1.50	yuan per kg
Days per month	30	days per month
Milking months per year	10	months per year
Purchase price of cow	17,200	yuan
Interest rate on loan	**0**	**percent**
Repayment period	3	years
Loan payment	478	yuan per month
Feeding concentrate	8	kg per day, per cow
Price of concentrate	1.60	yuan per kg
Grassland fee	28	yuan per day, per cow
Winter forage period	4	months per year
Winter forage feeding	10	kg per day, per cow
Price of winter forage	0.10	yuan per kg

Scenario III

Table 8. Household budgets when no interest is charged on loans to purchase dairy cows and the repayment period is six years

Item	Number of Cows per Household 1	2	3	4
	(yuan per month)			
Revenue from milk sales	750	1,500	2,250	3,000
Fixed costs of production				
Loan payment	239	478	717	956
Variable costs of production				
Feeding concentrate	384	768	1,152	1,536
Grassland fees	28	56	84	112
Winter forage	10	20	30	40
Household expenses				
Food, clothing, energy	335	335	335	335
Education	360	360	360	360
Social services	399	399	399	399
Revenue minus variable costs	328	656	984	1,312
Revenue minus variable and fixed costs	89	178	267	356
Revenue minus variable and fixed costs, and household expenses	-1,005	-916	-827	-738

Key Assumptions:

Yield of milk per cow	20	kg per day
Price of milk	1.50	yuan per kg
Days per month	30	days per month
Milking months per year	10	months per year
Purchase price of cow	17,200	yuan
Interest rate on loan	0	percent
Repayment period	**6**	**years**
Loan payment	239	yuan per month
Feeding concentrate	8	kg per day, per cow
Price of concentrate	1.60	yuan per kg
Grassland fee	28	yuan per day, per cow
Winter forage period	4	months per year
Winter forage feeding	10	kg per day, per cow
Price of winter forage	0.10	yuan per kg

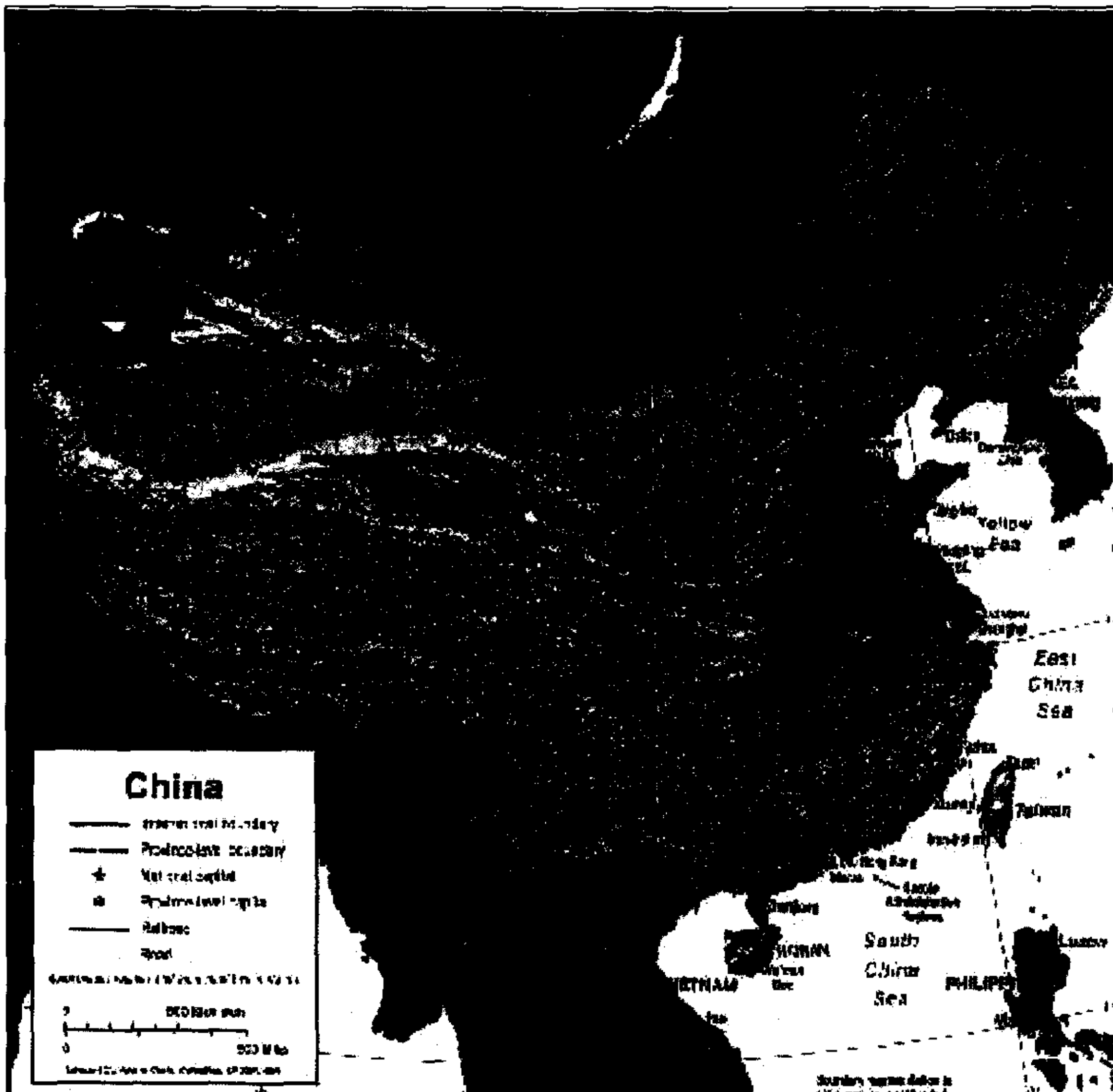
Scenario IV

Table 9. Household budgets when no interest is charged on loans to purchase dairy cows, the repayment period is six years, and the milk yield is 40 kg per day per cow

Item	Number of Cows per Household 1	2	3	4
	(yuan per month)			
Revenue from milk sales	1,500	3,000	4,500	6,000
Fixed costs of production				
Loan payment	239	478	717	956
Variable costs of production				
Feeding concentrate	384	768	1,152	1,536
Grassland fees	28	56	84	112
Winter forage	10	20	30	40
Household expenses				
Food, clothing, energy	335	335	335	335
Education	360	360	360	360
Social services	399	399	399	399
Revenue minus variable costs	1,078	2,156	3,234	4,312
Revenue minus variable and fixed costs	839	1,678	2,517	3,356
Revenue minus variable and fixed costs, and household expenses	-255	584	1,423	2,262

Key Assumptions:

Yield of milk per cow	**40**	**kg per day**
Price of milk	1.50	yuan per kg
Days per month	30	days per month
Milking months per year	10	months per year
Purchase price of cow	17,200	yuan
Interest rate on loan	0	percent
Repayment period	**6**	**years**
Loan payment	239	yuan per month
Feeding concentrate	8	kg per day, per cow
Price of concentrate	1.60	yuan per kg
Grassland fee	28	yuan per day, per cow
Winter forage period	4	months per year
Winter forage feeding	10	kg per day, per cow
Price of winter forage	0.10	yuan per kg

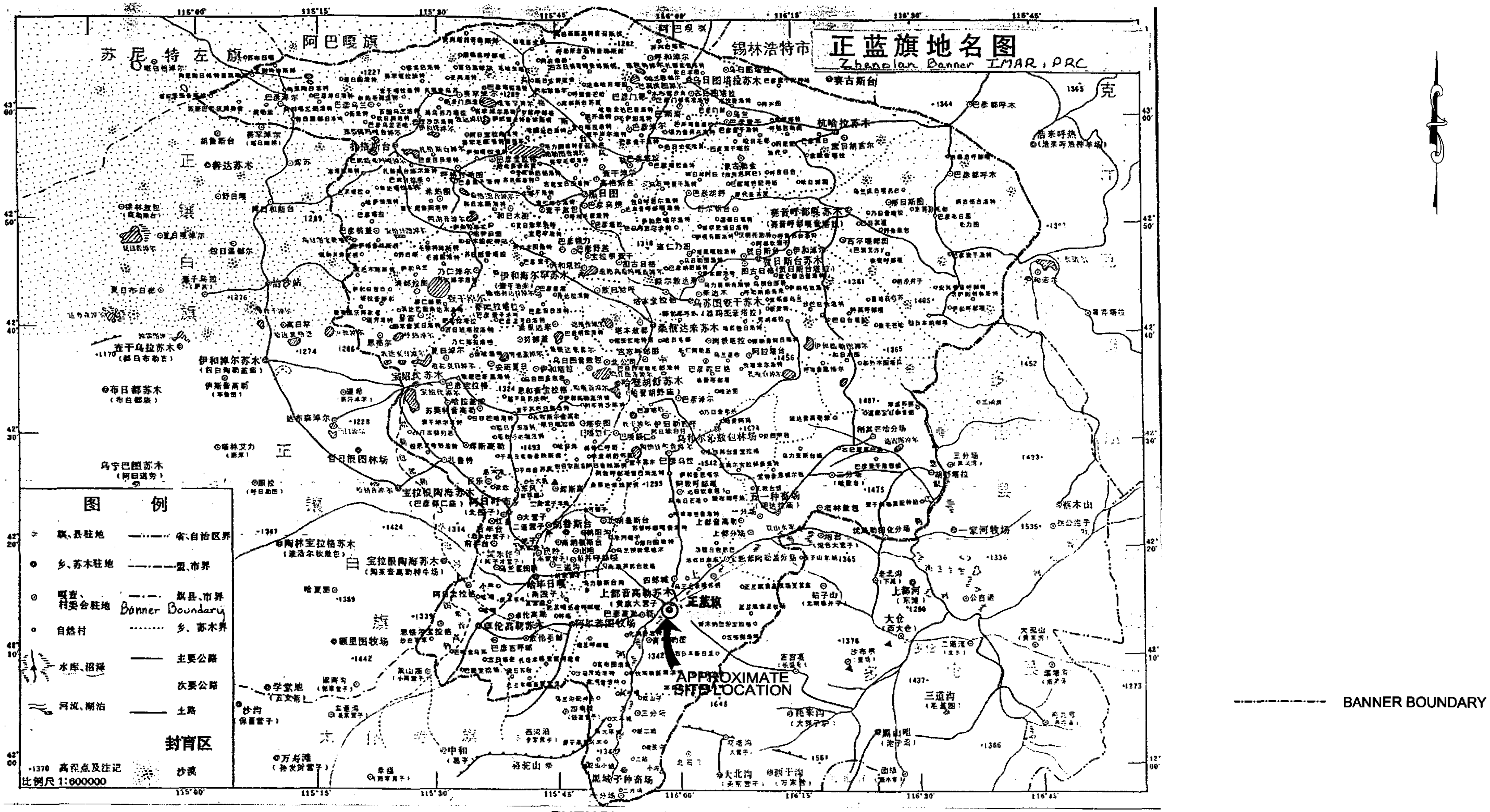


SITE

Figure 1. Project Location

PROJECT NUMBER: 2223044		IRRIGATION PILOT STUDY FINAL REPORT
DATE: 12/29/04		
DWG BY: JHW	DWG NO: G1	ZHENGLAN BANNER, INNER MONGOLIA
PROJECT MANAGER: GLT		
REVISED:		CES CASCADE EARTH SCIENCES A Valmont Industries Company

(SOURCE:)



ZHENGLAN BANNER

NOT TO SCALE

Figure 2. Local Map Showing Center Pivot

PROJECT NUMBER: 22230044	IRRIGATION PILOT STUDY FINAL REPORT
DATE: 12/29/04	
DWG BY: JHW / DWG NO: 22230044G2R	ZHENGLAN BANNER, INNER MONGOLIA
PROJECT MANAGER: GLT	
REVISED:	CES CASCADE EARTH SCIENCES A Valmont Industries Company

(SOURCE:)

Figure 3. Summer 2004 Water Levels, Zhenglan Qi Ecological Migration Village Center Pivot Wells

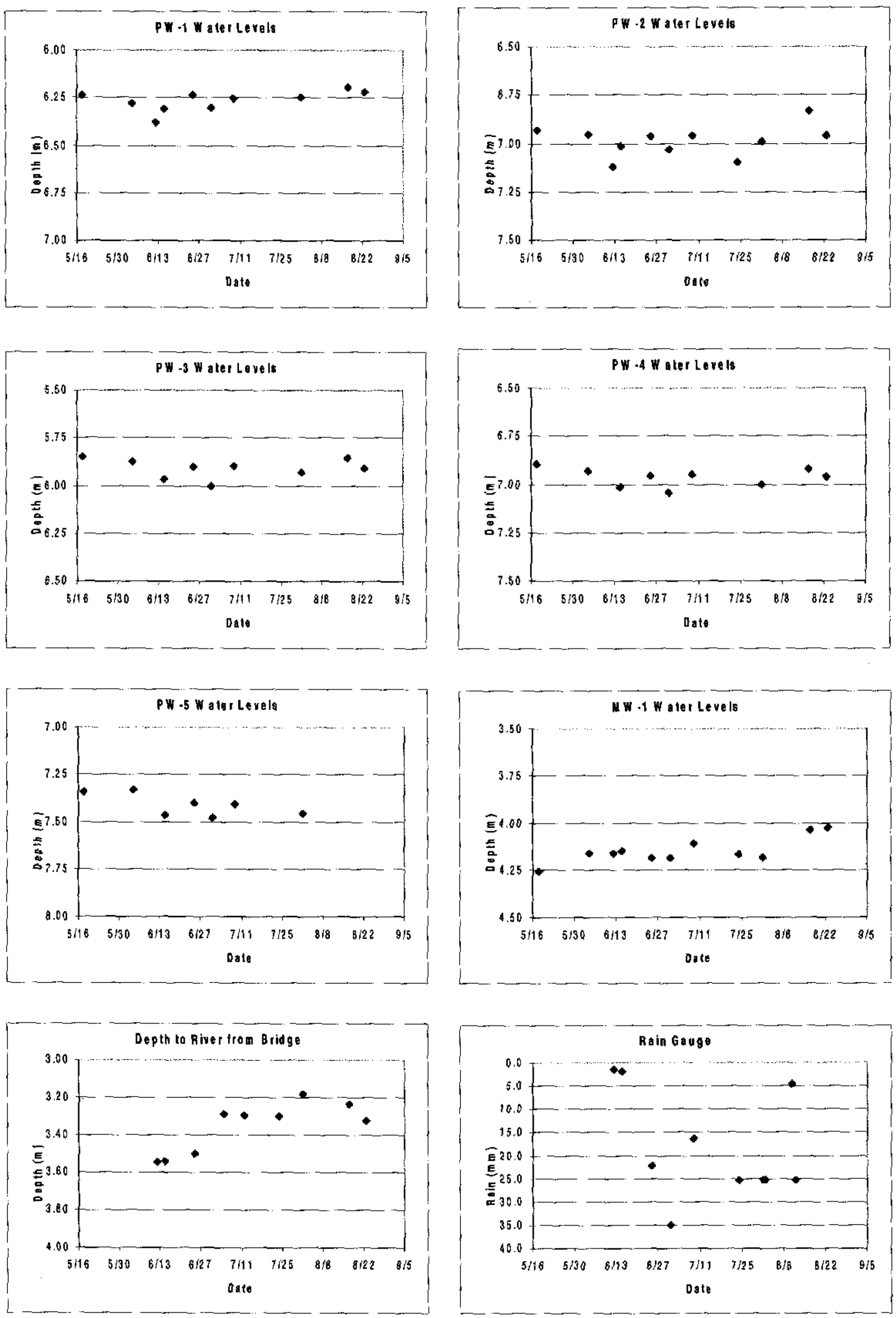
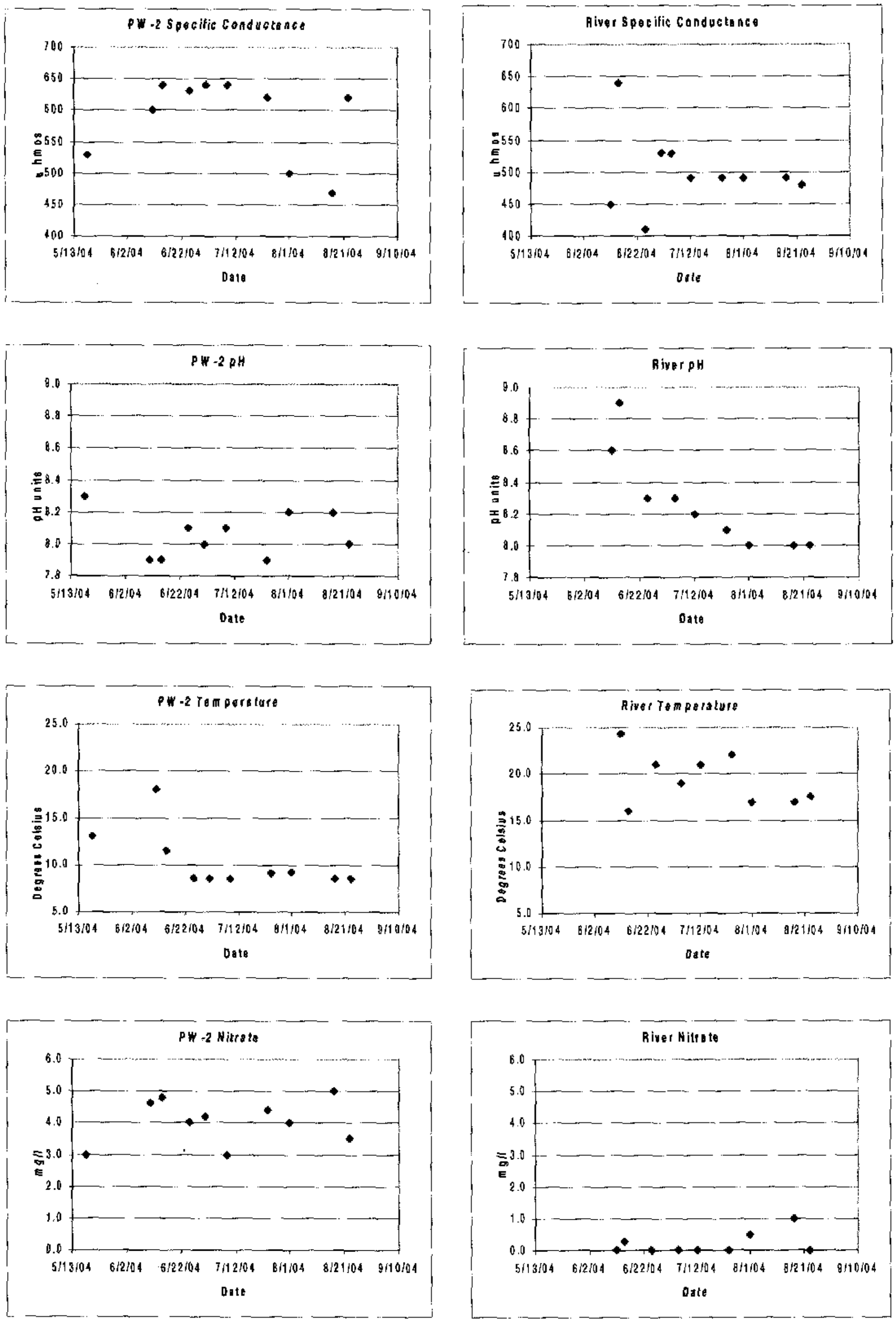


Figure 4. Summer 2004 Water Quality, Zhenglan Qi Ecological Migration Village Center Pivot Wells



Appendix A

Methods Used in Combating Desertification in Zhenglan Qi
Provided by Professor Zhang KeBin
College of Soil and Water Conservation
Beijing Forestry University

1.0 BRIEF INTRODUCTION AND THE MAIN CAUSE OF DESERTIFICATION IN ZHENGLAN QI

Zhenglan Banner, about 200 km north of Beijing, is located in the Xilingol League of Inner Mongolia. It is also located in the Otingtag Sandland, which is one of the sources of Asian dust storms in north China. The total land area is 9963 km^2 with a population of 79,000. Farmland per capita is 0.33 ha. Grassland per capita is 10.55 ha.

The rainfall in Zhenglan Qi is 383 mm annually. Studies show that in past half century, the population in the sand region has increased 20 times and the livestock population has increased 8.5 times. The pressures from rapid population growth, over-cultivation of the grassland, overgrazing, and deforestation due to the collection of fuel wood have led to serious desertification. It is estimated that the livestock population in Zhenglan Qi is about two times more than the grasslands can support. (Wang Xian, 2004). Shifting sand areas increased from 2% in 1950s to 33% in 1990s (over 50% in the eastern part of the Otingtag Sandland). Shifting sand is still moving forward at a speed of 1.8 km southeast annually (Jiang Gaoming, 2003). Over this period the grass yield decreased 50% - 70%, and the sheep and goat animal weight has decreased 20% - 30%. Some herders are facing the loss of their homes.

2.0 METHODS USED IN COMBATING DESERTIFICATION IN ZHENGLAN QI

2.1 Fencing, Rotation Grazing, Banning of Grazing & Control Animal Stock Numbers

Since the early 1980s, grassland contracting policies have been introduced in this region. Local herdsman began fencing their grassland using various methods. This is one of the successful methods used to protect grassland from overgrazing. Historically, there have been no boundaries for herdsmen in the grassland. Wire-fence for preventing the degraded rangeland from further degradation and over-grazing is one of the practical and cost effective methods for encouraging rotation grazing.

In light of the effectiveness of this method in the protection of the pastures, steppes, and rangeland from over-grazing, the wire-fencing system is widely adopted in densely populated steppe and transitional zones in Zhenglan Qi. The rotation-grazing system is carefully used in the steppe. Herdsmen protect the over-grazed steppe and rangeland through artificial approaches and optimum management. This approach includes:

- Classifying the pasture and the grazing land into different classes according to an inventory, and then choosing the animals that suit to the existing condition (sheep or goats). Finally, they determine the carrying capacity;
- Determining the grazing stage of the steppe, rangeland, and the fenced pastures according to their growth rate of grasses. They also consider rain, flooding, harvesting season, geographic location, and elevation;
- Improving the quality of grazing land through the establishment of fodder or forage farms and the introduction of species with high yield harvest.
- Inter-dune or low-lying areas are fenced as grazing lands and must be irrigated as winter grazing land. Grazing is completely forbidden in early spring.
- In order to increase rangeland or steppe productivity, optimum rotation grazing is used in Zhenglan Qi. Wire-fence, used to prevent the rangeland from further degradation and over-grazing, is one of the practical, low cost methods for rotation grazing.

Results show (Liu Yuehua, 1999) that after rotation grazing in the summer, the grass yield increased from 666.14kg/ha in the first year to 725.5 kg/ha 4 years later, and coverage increased from 13.7% to 25.8%.

2.2 Reversion of Farmland to Forest & Grassland (Artificial Grassland Establishment)

After strong sandstorms in the early spring of 2000, the central government of China has been carrying out a policy of "reversion of farmland to forest and grassland" in north China. This policy is used in Zhenglan Qi as one of the useful methods to combat desertification. Corn, peas, grasses, carrots, and *Astragalus spp* have been seeded in these farmland reversions. Some facilities like forage processors have been provided with loans by the government. Using these methods, the yields were increased 128.9%. Wool productivity increased 17.9%. Local herdsman saw their income increased by 1.5 times (Ji Muse et al, 2000).

2.3 Resettlement (Ecological Immigration) - Ecological Migration Program

Conditions in some remote areas of the desertification region are almost unsuitable for living. Resettlement (ecological immigration) methods have been used in these areas. The government provides land in better locations and also provides 5000 yuan RMB for each person to build a new house. These provisions were included in the program of desertification control in the vicinity of Beijing and Tianjin. Some loans are also provided for residents of the ecological immigration village to buy a milk cow or other domestic animals. The USTDA/Valmont/SFA Desertification Control Project has been carried in one of the Resettlement Village about 7 kilometers north Dundahot town of Zhenglan Qi. People in the ecological immigration village come from the desertification region 30-50 km from their original home. In order to help and encourage the new ecological village, an enterprise has been set up to operate a milk collection station in their village.

2.4 Air Seeding

Air seeding is one of the effective methods for stabilizing sand in China. After 40 years, successful experiences have been summarized not only in the fixation of semi-fixed dunes in rangeland areas but also in the stabilization of vast mobile dunes. The key techniques of air seeding include:

1. **Introduction and selection of pioneer species:** The species used for air-seeding must be native to insure proper germination, rapid growth, and resistance to wind erosion and sand accumulation, as well as producing adequate biomass. Species used for air seeding in Zhenglan Qi are: *Hedysarum mongolicum, H. scoparium, Artimisa arenaria, and Astragalus spp.*
2. **Seed treatment:** Species used for air-seeding are small in size, light in weight and, as a consequence, they are easily blown away by the wind. It is necessary to double the size and weight of the seeds through treatment. They are sometimes treated with isotopes and high molecular compounds in order to improve their germination capacity and prevent them from wind transport.
3. **Sowing season:** Choosing the right season for spreading of seeds is a key issue. This is important in assuring the survival, germination, and growth by avoiding excessive wind transport and, of course, weather conditions must be adequate for the flying aircraft. Climatic conditions are well suited to air seeding. In Zhenglan Qi, the seeding season is from late May to early June.
4. **Pest control:** After air-seeding, the protection of the seeded areas must be arranged to avoid damage from human beings and farm animals. Pesticide use is also necessary for the survival of the seeded rangeland and for controlling rodents.

2.5 Windmill, Solar Energy Use, and Greenhouses

Because of the shortage of electrical power and fuel wood, there has been an increase in the use of windmills, solar energy (in oven, lights, and water heating cells), and greenhouses. These technologies have been increasingly used in this region since the late 1980s. A windmill can provide power for local herdsmen to enjoy TV in the evening and for technical learning. Solar energy use can improve local living conditions by providing hot water for cooking and showering. Greenhouses can be used to produce vegetables in the early spring. Some greenhouses are also used as barns for sheep and goats in the winter. Solar heated barns are also used for milk cow breeding in Zhenglan Qi.

2.6 Water-Saving Irrigation Techniques

Water conserving irrigation was introduced into Zhenglan Qi in the early 1990s for irrigation of farmland and improving grassland, but it is on a small scale. The USTDA/Valmont/SFA Desertification Control Project in Zhenglan Qi is a good example which started in 2002. Valmont provided modern irrigation facilities to local resettlement (ecological migration village) and established a forage base for milk production.

2.7 Checkerboard, Sand Barriers for Shifting Sand Control

Checkerboard and sand barriers are very popular, and frequently used in Zhenglan Qi for shifting sand control, especially along the highway and railway around the villages. They are in dimensions of 2-3 X 2-3 m or 1.5-4.0 m based on the natural conditions. Many different materials can be used as raw material to build these checkerboard sand barriers. Tree branches and shrubs are popular materials used in Zhenglan Qi for this purpose.

2.8 Shelterbelt Establishment for Farmland Protection

Shelterbelts have a long history in Zhenglan Qi. People plant trees surrounding their farmland for protection. Species used for shelterbelts are *Poplar spp* and *Ulmu spp*. Some shrubs are also used.

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Appendix B

Summary 2004 Zhenglan Banner Center Pivot Water Monitoring

Date	Water Levels								Water Quality							
									Well PW-2				River			
	PW-1 (m)	PW-2 (m)	PW-3 (m)	PW-4 (m)	PW-5 (m)	MW-1 (m)	River (m)	Precip. (mm)	SC (µhmos)	pH	Temp (°C)	Nitrate (mg/l)	SC (µhmos)	pH	Temp (°C)	Nitrate (mg/l)
5/18/04	6.24	6.93	5.85	6.89	7.34	4.26			530	8.3	13.0	3.0				
6/4/04	6.28	6.96	5.87	6.93	7.33	4.16										
6/11/04		10.86							600	7.9	18.0	4.6				
6/12/04	6.38	7.12	10.08	10.88	9.42	4.16	3.55	1.5					450	8.6	24.3	0.0
6/15/04	6.31	7.02	5.97	7.02	7.47	4.15	3.54	1.9	640	7.9	11.5	4.8	640	8.9	16.0	0.3
6/25/04	6.24	6.96	5.90	6.96	7.40	4.18	3.50	22.4	630	8.1	8.5	4.0	410	8.3	21.0	0.0
7/1/04	6.30	7.03	6.00	7.05	7.48	4.19		35.1	640	8.0	8.5	4.2	530			
7/5/04							3.29						530	8.3	19.0	0.0
7/9/04	6.25	6.96	5.90	6.95	7.41	4.11		16.3	640	8.1	8.5	3.0				
7/12/04							3.29						490	8.2	21.0	0.0
7/24/04		7.10	15.61	14.34		4.17	3.30	>25.4	620	7.9	9.2	4.4	490	8.1	22.0	0.0
8/1/04	6.25	6.99	5.93	7.00	7.46	4.19	3.19	>25.4	500	8.2	9.3	4.0	490	8.0	17.0	0.5
8/2/04								>25.4								
8/11/04								4.6								
8/12/04								>25.4								
8/17/04	6.20	6.83	5.86	6.92		4.04	3.24		470	8.2	8.5	5.0	490	8.0	17.0	1.0
8/23/04	6.22	6.96	5.91	6.96		4.03	3.32		620	8.0	8.5	3.5	480	8.0	17.5	0.0

NOTES: PW-1, PW-2, PW-3, PW-4, and PW-5 are irrigation wells that pump water to the center pivot irrigation system. MW-1 is a well between the Ecological Migration Village and the center pivot irrigation site several kilometers from the irrigation site. Water levels in the wells were measured from the top of the casing. The depth to the surface of the water in the Shandian River was measured from the main bridge over the river near Zhenglan Qi. Rain amounts were measured using a rain gauge set up near the center pivot. Water samples were collected from Well PW-2 and the river for water quality testing. SC is the abbreviation for Specific Conductance, which is directly proportional to the concentration of total dissolved solids.

①

中国农业大学饲料分析测试中心

收费通知单

维蒙特公司：

Samples for one concentrate, 6 corn

我实验室于 2004.9.2 收到贵公司送检 1 个精料、6 个玉米样品，

具体检测费如下：

	检测指标	单价：元/个	数量	总计:元
moisture	水分	40.00	7	280.00
coarse protein	粗蛋白	70.00	7	490.00
energy	能量	80.00	1	80.00
Calcium	钙	70.00	7	490.00
Phosphorus	磷	70.00	7	490.00
Sault	盐分	80.00	1	80.00
neutral fibre	中性洗涤纤维	120.00	6	720.00
acid fibre	酸性洗涤纤维	120.00	6	720.00
coarse fibre	粗纤维	80.00	1	80.00
Total	合计			3430.00.00
10% Discount	九折优惠后			3087.00

如方便的话，请将款汇在：

单位名称：北京德宝群兴科贸有限公司

账号：11-052701040000135（0135）

开户行：农业银行圆明园西路分理处

并将汇款单传真给我实验室一份，以便我们核对。

联系人：卢学平

联系电话：010 62891272　传真：010-62891272

地址：北京海淀区圆明园西路 2 号

中国农业大学院内农业部饲料工业中心（实验室）

谢谢！

2004 年 9 月 16 日

Sep. 16, 2004

②

中国农业大学饲料分析测试中心测试报告

Sample Testing Results of CAU Feed Testing Center

报告编号(Report No.): C2K4-1412
送样单位(Sample from): 维蒙特公司 Valmonts
客户地址(Address): –
样品名称(Sample Name): 精料(Concentrate)
样品描述(Sample Description): 粉状 (powder)
送样日期(Sampling date): 2004.9.2
报告日期(Report date): 2004.9.13

结果报告(Results): 原样基础 (on as it basis)

list 序号	item 检测参数	unit 单位	result 检测结果	method 检测方法	note 备注
1	moisture 水分	%	11.38	GB6435-1986	
2	coarse protein 粗蛋白	%	12.84	GB/T6432-1992	
3	energy 能量	$MJ.Kg^{-1}$	16.09	ISO9831:1998	
4	Ca 钙	%	0.60	GB/T6436-2002	
5	P 磷	%	0.46	GB/T6437-2002	
6	coarse fibre 粗纤维	%	3.36	GB/T6434-1994	
7	salt 盐分	%	0.67	GB/T6439-1992	
8			以下空白		
9					
10					

编制人：卢学平　　审核人员：王燕华　　批准人：张丽英
Report editing: Lu Xueping　　Verification: Wang Yanhua　　Signature of CLA: 张丽英

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中国农业大学饲料分析测试中心测试报告

Sample Testing Results of CAU Feed Testing Center

报告编号(Report No.): C2K4-1413
送样单位(Sample from):
客户地址(Address): 维蒙特公司 Valmont
样品名称(Sample Name): 玉米饲料 pivot(1) forage (1)
样品描述(Sample Description): 鲜样 fresh
送样日期(Sampling date): 2004.9.2
报告日期(Report date): 2004.9.13

结果报告(Results): 干物质基础 dry material

list 序号	item 检测参数	unit 单位	result 检测结果	method 检测方法	note 备注
1	elementary 初水分	%	69.29	GB6435-1986	
2	combined water 结合水分	%	7.94	GB/T6436-2002	
3	coarse protein 粗蛋白	%	8.89	GB/T6432-1992	
4	Ca 钙	%	0.67	GB/T6436-2002	
5	P 磷	%	0.14	GB/T6437-2002	
6	medium fibre 中性洗涤纤维	%	64.74	MAFIC-LAB/METH023-2001	
7	acid fibre 酸性洗涤纤维	%	36.33	MAFIC-LAB/METH023-2001	
8			以下空白		
9					
10					

编制人：卢学平 审核人员：王燕华 批准人：张[illegible]
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(4)

No. 10398

中国农业大学饲料分析测试中心测试报告

Sample Testing Results of CAU Feed Testing Center

报告编号(Report No.): C2K4-1414
送样单位(Sample from): -
客户地址(Address): 维蒙特公司 Valmont
样品名称(Sample Name): 玉米饲料 pivot(2) forage (2)
样品描述(Sample Description): 鲜样
送样日期(Sampling date): 2004.9.2
报告日期(Report date): 2004.9.13

结果报告(Results): 干物质基础 dry material

list 序号	items 检测参数	unit 单位	results 检测结果	method 检测方法	notes 备注
1	elementary 初水分	%	77.17	GB6435-1986	
2	combined water 结合水分	%	11.72	GB/T6436-2002	
3	coarse protein 粗蛋白	%	12.37	GB/T6432-1992	
4	钙 Ca	%	0.65	GB/T6436-2002	
5	磷 P	%	0.23	GB/T6437-2002	
6	medium fibre 中性洗涤纤维	%	59.73	MAFIC-LAB/METH023-2001	
7	acid fibre 酸性洗涤纤维	%	32.70	MAFIC-LAB/METH023-2001	
8			以下空白		
9					
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中国农业大学饲料分析测试中心测试报告
Sample Testing Results of CAU Feed Testing Center

报告编号(Report No.): C2K4-1415
送样单位(Sample from): -
客户地址(Address) : 统蒙特公司
样品名称(Sample Name): 玉米饲料 pivot(3) forage (3)
样品描述(Sample Description): 鲜样
送样日期(Sampling date): 2004.9.2
报告日期(Report date): 2004.9.13

结果报告(Results): 干物质基础

序号	检测参数	单位	检测结果	检测方法	备注
1	初水分	%	60.54	GB6435-1986	
2	结合水分	%	9.04	GB/T6436-2002	
3	粗蛋白	%	11.68	GB/T6432-1992	
4	钙	%	0.80	GB/T6436-2002	
5	磷	%	0.18	GB/T6437-2002	
6	中性洗涤纤维	%	62.53	MAFIC-LAB/METH023-2001	
7	酸性洗涤纤维	%	33.29	MAFIC-LAB/METH023-2001	
8			以下空白		
9					
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中国农业大学饲料分析测试中心测试报告

Sample Testing Results of CAU Food Testing Center

报告编号(Report No.): C2K4-1416
送样单位(Sample from): [illegible]
客户地址(Address): [illegible]
样品描述(Sample Description): 鲜样
送样日期(Sampling date): 2004.9.2
报告日期(Report date): [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	%	[illegible]	[illegible]	
2	结合水分	%	9.29	GB/T6436-2002	
3	粗蛋白	%	12.39	GB/T6432-1992	
4	钙	%	0.99	GB/T6436-2002	
5	磷	%	0.17	GB/T6437-2002	
6	中性洗涤*纤维	%	60.43	MAFIC-LAB/METH023-2001	
7	酸性洗涤*纤维	%	31.54	MAFIC-LAB/METH023-2001	
8			以下空白		
9					
10					

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中国农业大学饲料分析测试中心测试报告

Sample Testing Results of CAU Feed Testing Center

报告编号(Report No.): C2K4-1417
送样单位(Sample from): -
客户地址(Address): 维紫特公司
样品名称(Sample Name): 玉米饲料 Not Irrigated(2) forge (not irrigated) (2)
样品描述(Sample Description): 鲜样
送样日期(Sampling date): 2004.9.2
报告日期(Report date): 2004.9.13

结果报告(Results): 干物质基础

序号	检测参数	单位	检测结果	检测方法	备注
1	初水分	%	52.02	GB6435-1986	
2	结合水分	%	9.36	GB/T6436-2002	
3	粗蛋白	%	14.18	GB/T6432-1992	
4	钙	%	0.90	GB/T6436-2002	
5	磷	%	0.24	GB/T6437-2002	
6	中性洗涤纤维	%	[illegible]	[illegible]	
7	酸性洗涤纤维	%	33.31	MAFIC-LAB/METH023-2001	
8			以下空白		
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8

中国农业大学饲料分析测试中心测试报告

Sample Testing Results of CAU Feed Testing Center

报告编号(Report No.): C2K4-1418
送样单位(Sample from): -
客户地址(Address) : 维蒙特公司
样品名称(Sample Name): 玉米饲料 Not Irrigated(3) forage (not irrigated, (5)
样品描述(Sample Description): 鲜样
送样日期(Sampling date): 2004.9.2
报告日期(Report date): 2004.9.13

结果报告(Results): 干物质基础

序号	检测参数	单位	检测结果	检测方法	备注
1	初水分	%	72.32	GB6435-1986	
2	结合水分	%	10.47	GB/T6436-2002	
3	粗蛋白	%	12.32	GB/T6432-1992	
4	钙	%	0.54	GB/T6432-2002	
5	磷	%	0.18	GB/T6437-2002	
6	中性洗涤纤维	%	57.52	MAFIC-LAB/METH023-2001	
7	酸性洗涤纤维	%	29.17	MAFIC-LAB/METH023-2001	
8			以下空白		
9					
10					

编制人: 卢学平　　审核人员: 王燕华　　批准人:
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(9)

中国-苏格兰国际高尔夫教育合作项目北京办事处
China-Scottish International Golf Education Program, Beijing Office

样品测试委托书 Testing agreement

Company Valmont Hao Guiyun 编号：

委托单位：郝桂云（内蒙古）

联系方式：电话：　传真：

委托日期：2004.9.6.　委托人：

样品数量：土壤样品2个。2 soil samples

测试项目 items	单价（元/个） price	请选择是或否 Yes or no
土壤有机质	80	
土壤全氮 NH_3-N	100	✓
土壤 pH 值 pH	30	✓
土壤电导率(EC) EC	30	
土壤速效氮 N	50	
土壤有效磷 P	80	✓
土壤速效钾 K	30	✓
土壤碳酸钙 $CaCO_3$	80	
土壤阳离子交换量(CEC)	150	✓
土壤有效钙 Ca	80	✓
土壤有效铁、锰、铜、锌	200	
土壤有效硫 S	100	✓

测试费用总计 Total price 570元×2=1140 元。 ¥1140, 20% discount, is

8折：共900元。 ¥900.

中国农业大学绿色环境中心

2004.9.

中国农业大学绿色环境中心　邮编:100094
Tel:010-62893729,13661230066 Fax:010-62829389　Email: gec102@cau.edu.cn

2004-9-24 17:21 NO.835 P.10

(10)

Testing Report

中国农业大学绿色环境中心样品测试报告

编号：20040906

Company
送样单位：郝桂玉（内蒙古）Valmont, Hao Guiyu

Date
送样日期：2004年9月6日 Sep. 6, 2004

Samples
样　品：土壤样品2个 2 for soil

测试项目及方法 item	土壤样品 1号 1#	土壤样品 2号 2#	备注 Notes	
土壤pH值 pH	7.23	7.06	土壤属中性。neutral	
土壤全氮含量 NH_3-N	0.133%	0.119%	土壤肥力水平属高等。high	nutrient level
土壤有效磷 P	2.38mg/kg	4.12mg/kg	土壤有效磷水平很低，需要及时补充磷肥。low	
土壤速效钾 K	130mg/kg	97.5mg/kg	土壤速效钾水平中等。medium	
土壤有效钙 Ca	1470mg/kg	2685mg/kg	说明土壤中钙充足。abundance	
土壤有效硫 S	43.9mg/kg	43.5mg/kg	说明土壤供硫充足。abundance	
土壤CEC含量 CEC	11.8cmol/kg	9.93cmol/kg	土壤阳离子交换能力属中等水平。	medium

Green Environmental Center of CAU
中国农业大学绿色环境中心
2004年9月12日
Sep, 12, 2004

Appendix D

GPS/UTM	Site	Grazed = 1 Protected = 2	Transect	quadrat	Percent ground cover			
404670	1	1	1	1	2		Note: This area is actively eroding; visible blowing dust	
4701964	1	1	1	2	4			
	1	1	1	3	2			
	1	1	1	4	0			
	1	1	1	5	1			
	1	1	1	6	1			
	1	1	1	7	2			
	1	1	1	8	2			
404742	1	1	1	9	2			
4701897	1	1	1	10	2			
404742	1	1	2	1	2			
4701897	1	1	2	2	2			
	1	1	2	3	1			
	1	1	2	4	1			
	1	1	2	5	2			
	1	1	2	6	0			
	1	1	2	7	0			
	1	1	2	8	0			
404690	1	1	2	9	1			
4701826	1	1	2	10	1	1.4		
404794	1	1	1	1	7		Note: This area is at risk, but not actively eroding	
4701971	1	1	1	2	10			
	1	1	1	3	12			
	1	1	1	4	15			
	1	1	1	5	10			
	1	1	1	6	25			
	1	1	1	7	30			
	1	1	1	8	25			
404763	1	1	1	9	25			
4702055	1	1	1	10	20			
404763	1	1	2	1	20			
4702055	1	1	2	2	35			
	1	1	2	3	30			
	1	1	2	4	45			
	1	1	2	5	35			
	1	1	2	6	65			
	1	1	2	7	60			
	1	1	2	8	75			
404681	1	1	2	9	70			
4700294	1	1	2	10	80	18.05		30.7

Appendix D

404504	2	2	1	1	25		Note: This area is recovering, but should not be grazed until most of indicators indicate a stable *condition*
4703042	2	2	1	2	45		
	2	2	1	3	15		
	2	2	1	4	40		
	2	2	1	5	3		
	2	2	1	6	40		
	2	2	1	7	95		
	2	2	1	8	30		
404445	2	2	1	9	40		
4702978	2	2	1	10	20		
404445	2	2	2	1	40		
4702978	2	2	2	2	90		
	2	2	2	3	35		
	2	2	2	4	95		
	2	2	2	5	65		
	2	2	2	6	50		
	2	2	2	7	10		
	2	2	2	8	40		
404420	2	2	2	9	1		
4703076	2	2	2	10	0		
404420	2	2	1	1	70		Note: This area is recovering, but should not be grazed until most indicators indicate a stable condition
4703076	2	2	1	2	30		
	2	2	1	3	80		
	2	2	1	4	70		
	2	2	1	5	85		
	2	2	1	6	30		
	2	2	1	7	90		
	2	2	1	8	85		
404268	2	2	1	9	25		
4703018	2	2	1	10	25		
404268	2	2	2	1	25		
4703018	2	2	2	2	80		
	2	2	2	3	65		
	2	2	2	4	70		
	2	2	2	5	55		
	2	2	2	6	85		
	2	2	2	7	30		
	2	2	2	8	65		
404222	2	2	2	9	50		
4703097	2	2	2	10	35	48.225	

Appendix E

Notes for Household Investigation

The sheets record some important information during the households' investigation; however, some information would be lost when I put them into the sheets. And since I have to put some information into figures to be convenient for calculation, I have to give you some notes.

1. The Loan, Payment of Interest And Sales Income of Milk

Loan is commonly associated with purchase of milk cows, and there is a contract between household and bank and another contract between household and Wan Da Shan (milk collector). I haven't got the details of the contract, but I will take a camera there next time to take photos of important details such as interest rate, term and returning way.

Interest----It's said by one of the household that the government will pay for the interest for the first two years. But I still heard that the entire loan has to be returned within 3 years. For confirmation of interest payment, I should get it from the contract by households and bank.

Sales of Milk----The current price of milk is 1.50 yuan/kg, and someone heard that the price will drop to 1.00 yuan/kg (hasn't been confirmed). As another part of sales price is the discount of refined forage from milk station. When one kg of milk is sold, household will get 0.1 kg of refined forage that is worth 0.16 yuan. So the real price of milk is 1.50+0.16=1.66 yuan/kg.

Deduction of Interest and Refined Forage----Wan Da Shan, milk collector, will deduct 400 yuan for interest of loan and value of refined forage each month. That is to say, when a household takes milk to the station, the station will not pay him money. As a result, the station will deduct 400 yuan in account each month, and then deduct the value of refined forage this household buys in this month. For example, if one household sells 500 kg milk a month which is worth 750 yuan (500*1.5=750), he will get 50 kg free refined forage (the discount). And in this month he buys 300 kg refined forage which is worth 480 yuan. And there is 400 yuan of interest left. He doesn't pay money for the station, nor is he paid by the station. As a result, he owes 130 yuan to the milk station (750-480-400= -130). For detailed information of this, I should investigate the milk station next time and take pictures of the contracts.

**400 yuan for interest is not included in my sheets, since I haven't confirmed this.

2. How Low Income Is

You can find that almost all the households investigated tell that income in milk village is much lower. How can this be explained?

First, main income comes from milk sales activity, which is transferred on account now. That is to say, they will not get "money" from such an activity. And this condition will last for at least 3 years.

Second, some young people in milk village go out for work, such as labor in construction and so on. This part of income is not stable (it's a temporary job and sometimes people cannot get money for their work).

3. How High Expense Is

This is comparative to the life before. As they told me, they had a garden for planting vegetables for diet. And as they fed cattle and sheep, they didn't need to pay for meat and beef. For another point, the grassland was free.

The current situation is that every thing needs to be paid by money, as they said. They need to pay for vegetables and meat, and they need to rent grassland for feeding cows.

4. Housing and Purchase

You can find that some households told me they pay 2,000 yuan for a house with two rooms, and others pay 1,000 yuan. In fact, this is the same to all households. They have paid 1,000 yuan for such a house and they were told to pay another 1,000 yuan later.

5. "Five Connections"

People in the village told me they had been promised "five connections" before resettlement, and they are: connection of power, water supply, cable for television, road and telephone. Many people complained about this since only one connection is completed so far. Road Connection will be completed later[4].

6. Price for Forage, Hay, Refined Forage, and Grassland

Refined Forage:	1.60 yuan/kg
Forage (grow in the field):	0.10 yuan/kg for self-delivery
	0.14 yuan/kg for cut and packed
Grassland:	5.00 yuan/mu
	28.00 yuan/month/cow

7. Common Complaints

Common complaints include:

1. Low income and high expense
2. Bad construction of houses, sheds and roads
3. High price for forage, refined forage and other feed stuff
4. Cow Death (2 died in 3 days, and they didn't know the cause and who will be responsible)

[4] Subsequent communications from Zhenglanqi Forestry Bureau officials dated December 21, 2005 indicate that, although later than planned, the "Five Connections" have now been completed

Appendix E

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You can find that some households told me they pay 2,000 yuan for a house with two rooms, and others pay 1,000 yuan. In fact, this is the same to all households. They have paid 1,000 yuan for such a house and they were told to pay another 1,000 yuan later.

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Forage (grow in the field):	0.10yuan/kg	for self-delivery
	0.14yuan/kg	for cut and packed
Grassland:	5.00yuan/mu	
	28.00yuan/month.cow	

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Common complaints include:

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2. Bad construction of houses, sheds and roads
3. High price for forage, refined forage and other feed stuff
4. Cow Death (2 died in 3 days, and they didn't know the cause and who will be responsible)

If you have any other questions or something else for me to investigate, please tell me.

Household Members

	Name	Relationship	Age	Gender	Education	Occupation
1	Qi Muge		40	F	Ele. Sch	Feed Cows
2	An Zhengying	Husband	39	M	Jun. Sch	Feed Cows
3	Bao Gede	Son	14	M	Jun. Sch	Student
4						
5						
6						

Basic Information

Ethnicity	Meng
Language Spoken at Home	Han
Annual Income Before Resettlement	Over 10 thousands for selling cattles and sheep. Over 800 yuan for a cattle, and over 100 yuan for a sheep averagely.
Housing Arrangement	Two rooms, two beds (with photos)
Assets and Equipment	One Truck (5 years)
Resettlement Description	They were not willing to resettle there, since they never fed milch cows before. The rooms are narrow and the equipment government promised before hasn't come true.
Personal Opinion	Complaints about the resettlement and the life there.
Others	

Comparison Sheet

	Before Settlement		Note for Before	After Settlement	Note for After
Livestock					
Kind	Local Cattle	Sheep		Milch Cow	
Number	>10	40~50		3	
Sales Income	>800/cattle	>100			
Purchase Expense				19,000+17,000+15,000	
New Birth				1	sold for 200yuan (male)
Equipment Spent(yuan)					
Housing				2,000	
Electricity					
Water					
Other					
Money Borrowed					
From Bank				29,000	
Interest Rate					
Terms of Payment					
From Person					
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows				
Milk Sales	37.35			
Cow Sales	200			
Other Animals				
Total Cows	237.35			
Other				
Labor	300			
Others				
Total Other	300			
Total Income	537.35			
Expense				
Feedingstuff				
For Milk	618			
For Common	90			
Qingchu				
Total Feedingstuff	708			
	assume 25 kg for common a day			
Debt				
Interest				
Capital				
Total Debt	0			
Household Consump.				
Food	350			
Clothes				
Fuel				
Transportation				
Electricity	7			
Other				
Total Consumption	357			
Education				
School	250			
Other				
Total Education	250			
Social Service				
Medical				
Visits for Friends				
Visits for Grass				
Other				
Total Service	0			
Total Expense	1315			
Net Income	-777.65			

Household Members

	Name	Relationship	Age	Gender	Education	Occupation
1	Meng Ke		58	M	Ele	At home
2	Qi Qige	Wife	52	F	Ele	At home
3	San Shun	Daughter	21	F	Sec	At home
4	Xia Shun	Daughter	21	F	Sec	At home
5						
6						

Basic Information

Ethnicity	Meng
Language Spoken at Home	Both Han and Mongolian
Annual Income Before Resettlement	Over 10 thousands of sales income, and above 1 thousand of net income.
Housing Arrangement	2 rooms, 1 bed, 1 stove, 5 cabinet, 1 sofa
Assets and Equipment	
Resettlement Description	They were not willing to resettle. They have sold many facilities with much less money than they bought.House is much worse than what they owned before.
Personal Opinion	
Others	

Comparison Sheet

	Before Settlement		Note for Before	After Settlement	Note for After
Livestock					
Kind	Local Cattle	Sheep		cattle	haven't bought
Number	20	60		10	
Sales Income	3000	4000+3000	sell 2 cattles, 15 sheep,3000yuan wool		
Purchase Expense					
New Birth					
Equipment Spent					
Housing				2000	
Electricity				400	
Water				300	
Other				2000 for shed	
Money Borrowed					
From Bank					
Interest Rate					
Terms of Payment					
From Person					
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows	None for this month			
Milk Sales				
Cow Sales				
Other Animals				
Total Cows				
Other				
Labor				
Others				
Total Other				
Total Income				
Expense				
Feedingstuff				
For Milk				
For Common				
Qingchu				
Total Feedingstuff				
Debt				
Interest				
Capital				
Total Debt				
Household Consump.				
Food				
Clothes				
Fuel				
Transportation				
Electricity				
Other				
Total Consumption				
Education				
School				
Other				
Total Education				
Social Service				
Medical				
Visits for Friends				
Visits for Grass				
Other				
Total Service				
Total Expense				
Net Income				

Household Members

	Name	Relationship	Age	Gender	Education	Occupation
1	Li Jinbao		45	M	Ele	sheepherder
2	Zhao Shangzhi	Wife	48	F	Ele	feed cows
3	Shan Rentuoya	Daughter	15	F	Sec	student
4	Shan Renshuhuo	Son	18	M	Ele	sheepherder
5	Shan Renbaogena	Son	25	M	None	horseherder
6						

Basic Information

Ethnicity: Meng

Language Spoken at Home: Both Mongolian and Han

Annual Income Before Resettlement: About 9 thousand. Sell for sheep, about 90 sheep are sold every year.

Housing Arrangement: 4 rooms. 2 for old couples and others for younger son.

Assets and Equipment: 1 bed, 1 cupboard, 2 boxes (in 2 rooms)

Resettlement Description: They resettled themselves, and they rented trucks to move 5 times, spending 1,000 yuan for resettlement

Personal Opinion: his house is not even smooth. When it rained, water will flow into his house

Others

Comparison Sheet

	Before Settlement		Note for Before	After Settlement	Note for After
Livestock					
Kind	Goat	Sheep	Cattle & Horse	Cow	
Number	100	20	6 & 2	3	2 big & 1 young
Sales Income					
Purchase Expense				15700*2	
New Birth				1	
Equipment Spent					
Housing				2,000	
Electricity					
Water				40	
Other					
Money Borrowed					
From Bank				31400	
Interest Rate					
Terms of Payment				3	
From Person				3000	
Interest Rate					
Terms of Payment				3	
Satisfaction Attitude					

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows				
Milk Sales	720			
Cow Sales				
Other Animals				
Total Cows	720			
Other				
Labor				
Others				
Total Other				
Total Income	720			
Expense				
Feedingstuff				
For Milk				
For Common				
Qingchu				
Total Feedingstuff	2550			
Debt				
Interest				
Capital				
Total Debt				
Household Consump.				
Food	60			
Clothes	20			
Fuel				
Transportation				
Electricity	3			
Other	2.5			
Total Consumption	85.5			
Education				
School	80	800 for a year		
Other	300	live in town		
Total Education	380			
Social Service				
Medical	40			
Visits for Friends				
Visits for Grass				
Other				
Total Service	40			
Total Expense	3055.5			
Net Income	-2335.5			
	figure for feeding may be mistaken			

Household Members

	Name	Relationship	Age	Gender	Education	Occupation
1	Xue Yuchun		50	M	None	None
2	Qi Qige	wife	52	F	None	None
3	Xue Yanbin	son	24	M	High	None
4						
5						
6						

Basic Information

Ethnicity: Meng / Han

Language Spoken at Home: Han

Annual Income Before Resettlement: [illegible]0 thousand yuan, including 7 thousand for wool, over 10 thousands for young sheep and over 10 thousands for cattles sold.

Housing Arrangement:

Assets and Equipment: 2 beds, 1 sofa, 4 boxes, 2 cabinets, 1 cupboard

Resettlement Description: They spent over 1000 yuan for the transportation during resettlement.

Personal Opinion: Life there is difficult, and house is much smaller than old one. They want to buy cows now, but cows are not available.

Others:

Comparison Sheet

	Before Settlement		*Note for Before*	*After Settlement*	*Note for After*
Livestock					
Kind	cattle	sheep		none	
Number	20	100			
Sales Income	70~80 thousands				
Purchase Expense					
New Birth					
Equipment Spent					
Housing				1000	
Electricity					
Water				400	
Other					
Money Borrowed					
From Bank					
Interest Rate					
Terms of Payment					
From Person					
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows				
Milk Sales				
Cow Sales				
Other Animals				
Total Cows	0			
Other				
Labor				
Others				
Total Other	0			
Total Income	0			
Expense				
Feedingstuff				
For Milk				
For Common				
Qingchu				
Total Feedingstuff	0			
Debt				
Interest				
Capital				
Total Debt	0			
Household Consump.				
Food	300			
Clothes	25			
Fuel				
Transportation				
Electricity				
Other				
Total Consumption	325			
Education				
School				
Other				
Total Education	0			
Social Service				
Medical	1000			
Visits for Friends				
Visits for Grass				
Other				
Total Service	1000			
Total Expense	1325			
Net Income	-1325			

Household Members 1st, Right 03.11 to be resttled

	Name	Relationship	Age	Gender	Education	Occupation
1	Zhang Wanlin		62	M	Ele	Feed Cow
2	Zhao Wenlong	Wife	57	F	None	Feed Cow
3						
4						
5						
6						

Basic Information

Ethnicity	Meng & Han
Language Spoken at Home	Mandarin
Annual Income Before Resettlement	40~50 thousands of sales income, and 10 thousands of net income.
Housing Arrangement	
Assets and Equipment	2 rooms + 1 room (built by himself), sofa, bed, television, cupboard
Resettlement Description	By themselves. They rented trucks for 2,000 yuan.
Personal Opinion	They spent less money before resettlement (they plant vegetables, and feed cattles and sheep). And the house with 8 rooms was much bigger than the new one.
Others	

Comparison Sheet

	Before Settlement		Note for Before	After Settlement	Note for After
Livestock					
Kind	cattle	sheep		cow	
Number	60	300		2	
Sales Income	1000/cattle	250/sheep			
Purchase Expense				17200*2	
New Birth				0	
Equipment Spent					
Housing				2000	
Electricity					
Water				1800	well
Other					
Money Borrowed					
From Bank				24000	
Interest Rate					
Terms of Payment					
From Person					
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows				
Milk Sales	0			
Cow Sales	0			
Other Animals	0			
Total Cows	0			
Other				
Labor				
Others				
Total Other	0			
Total Income	0			
Expense				
Feedingstuff				
For Milk	0			
For Common	684			
Qingchu				
Total Feedingstuff	684			
Debt				
Interest				
Capital				
Total Debt	0			
Household Consump.				
Food	200			
Clothes				
Fuel				
Transportation				
Electricity				
Other				
Total Consumption	200			
Education				
School				
Other				
Total Education	0			
Social Service				
Medical	100			
Visits for Friends				
Visits for Grass				
Other				
Total Service	100			
Total Expense	984			
Net Income	-984			

Household Members 1st, right 03.6 to resettle

	Name	Relationship	Age	Gender	Education	Occupation
1	Si Qing		44	F	None	Milking worker
2	Huo Jianyu	Husband	45	M	None	Labor
3	Su He	Son	20	M	Ele	Labor
4						
5						
6						

Basic Information

Ethnicity: Meng & Han

Language Spoken at Home: Mandarin

Annual Income Before Resettlement: 15 thousands of sales income for about 10 cattles each year.

Housing Arrangement:

Assets and Equipment: Grass Cutter(4,000yuan), bed, 2 cupboard, stove...

Resettlement Description:

Personal Opinion: Worse than the life before resettlement. There is little income here and the expend is more than before. The house is better, but the quality is still bad since water leaks when it rains.And the house is small.

Others: Most of the facilities was unuseful now.

Comparison Sheet

	Before Settlement		Note for Before	After Settlement	Note for After
Livestock					
Kind	cattle	goat		cow	
Number	20	60		1	
Sales Income	22500	6000	15 cattles+40 goats		
Purchase Expense				15200	
			other animals are now in		
New Birth			relative's home	0	
Equipment Spent					
Housing				2000	
Electricity					
Water				300	well
Other				4000	grass cutter
Money Borrowed					
From Bank				15000	
Interest Rate					
Terms of Payment					
From Person					
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows				
Milk Sales		0		
Cow Sales		0		
Other Animals		0		
Total Cows		0		
Other				
Labor		600		
Others		30		
Total Other		680		
Total Income		680		
Expense				
Feedingstuff				
For Milk		0		
For Common		30		
Qingchu				
Total Feedingstuff		30		
Debt				
Interest				
Capital				
Total Debt		0		
Household Consump.				
Food		500		
Clothes				
Fuel				
Transportation				
Electricity				
Other				
Total Consumption		500		
Education				
School				
Other				
Total Education		0		
Social Service				
Medical		100		
Visits for Friends				
Visits for Grass				
Other				
Total Service		100		
Total Expense		630		
Net Income		50		

Household Members 4th, left 03.11 for resettlement

	Name	Relationship	Age	Gender	Education	Occupation
1	Wang Wenyou		54	M	Sec	Feed Cow
2	Yang Caixia	Wife	52	F	Sec	Feed Cow
3						
4						
5						
6						

Basic Information

Ethnicity: Han

Language Spoken at Home: Mandarin

Annual Income Before Resettlement: Over 10 thousands yuan for sales of cattles and sheep.

Housing Arrangement: 2 rooms, 2 beds, some furniture

Assets and Equipment

Resettlement Description

Personal Opinion: He was not willing to resettle, since there is low income here and higher expense. Before resettle, he had a garden for vegetables and he could get the meat from his cattles and sheep. But now, everything will cost money.

Others

Comparison Sheet

	Before Settlement		*Note for Before*	*After Settlement*		*Note for After*
Livestock						
Kind	Cattle	Sheep		Cow	Cattle	
Number	20	50		1	2	
Sales Income	12000	12000	1200/cattle+300/sheep			
Purchase Expense			Others are rented out	17200		
New Birth				0		
Equipment Spent						
Housing				2000		
Electricity						
Water						
Other						
Money Borrowed						
From Bank				12200		
Interest Rate						
Terms of Payment				3		
From Person						
Interest Rate						
Terms of Payment						
Satisfaction Attitude	His health is not good, but he has not much money to hospitals. The life is hard here, he thinks.					

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows				
Milk Sales	0			
Cow Sales	0			
Other Animals	0			
Total Cows	0			
Other				
Labor	0			
Others				
Total Other	0			
Total Income	0			
Expense				
Feedingstuff				
For Milk				
For Common	444	rent for grassland		
Qingchu		and feedingstuff		
Total Feedingstuff	444	rent=28yuan*3/month		
Debt				
Interest				
Capital				
Total Debt				
Household Consump.				
Food	200			
Clothes	35			
Fuel				
Transportation				
Electricity				
Other	50			
Total Consumption	285			
Education				
School				
Other				
Total Education	0			
Social Service				
Medical				
Visits for Friends				
Visits for Grass				
Other	0			
Total Service	0			
Total Expense	729			
Net Income	-729			

Household Members 4th, Left 03.11 for resettlement

	Name	Relationship	Age	Gender	Education	Occupation
1	Zhang Yulong		48	F	Ele	Feed Cow
2	Yao Yurui	Husband	48	M	Ele	Labor
3	Yao Ligang	Son	16	M	Sec	at home
4	Yao Lihang	Daughter	17	F	Sec	at home
5						
6						

Basic Information

Ethnicity: Han

Language Spoken at Home: Mandarin

Annual Income Before Resettlement: 10~20 thousands for sales income. They had to spent 7 thousand for feedingstuff, and others for living expends.

Housing Arrangement

Assets and Equipment: 2 beds, 2 cupboard, washer machine

Resettlement Description: 3 times to move, and it cost 240yuan for each time

Personal Opinion: complaints about the life here with low income and high expends. The house is smaller than before.

Others

Comparison Sheet

	Before Settlement		Note for Before	After Settlement		Note for After
Livestock						
Kind	cattle	sheep		Cow	Cattle	Pig
Number	20	60		3	2	1 (120yuan)
Sales Income	32000	18000	1600/cattle + 300/sheep			
Purchase Expense				32400	5000	Cow:17200+15200
New Birth				1	1	Cattle:5000
Equipment Spent						
Housing				2000		
Electricity						
Water						
Other						
Money Borrowed						
From Bank				29200		
Interest Rate						
Terms of Payment						
From Person						
Interest Rate						
Terms of Payment						
Satisfaction Attitude						

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows				
Milk Sales	900			
Cow Sales	0			
Other Animals	0			
Total Cows	900			
Other				
Labor				
Others				
Total Other	0			
Total Income	900			
Expense				
Feedingstuff				
For Milk	504	10.5kg		
For Common	630	15kg *0 7yuan/kg for all		
Qingchu				
Total Feedingstuff	1134			
Debt				
Interest				
Capital				
Total Debt	0			
Household Consump.				
Food	200			
Clothes				
Fuel				
Transportation				
Electricity				
Other				
Total Consumption	200			
Education				
School				
Other				
Total Education	0			
Social Service				
Medical				
Visits for Friends				
Visits for Grass				
Other				
Total Service	0			
Total Expense	1334			
Net Income	-434			

Household Members 4th, Right 03.11 for resettlement

	Name	Relationship	Age	Gender	Education	Occupation
1	Bai Guicai		57	M	Ele	Feed Cow
2	Li Guizhi	Mother	84	F	None	at home
3	Bai Guojiang	Son	28	M	Ele	labor
4	Wang Bingyi	Wife's brother	43	M	None	disabled
5	Yan Hang	Child of sister	18	F	Sec	at home
6						

Basic Information

Ethnicity: Han

Language Spoken at Home: Mandarin

Annual Income Before Resettlement: Less than 10 thousands yuan for sales income.

Housing Arrangement: 2 houses with 4 rooms. 2 beds, 1 table, 1 cupboard

Assets and Equipment

Resettlement Description: He spent 1000 yuan for resettlement (moving). Water leaks when it rains, but the houses are better than before.

Personal Opinion: The income is low and expense is high. And now they can just use the money they have accumulated before.

Others

Comparison Sheet

	Before Settlement		Note for Before	After Settlement	Note for After
Livestock					
Kind	Cattle	Sheep		Cow	
Number	20	80		2	
Sales Income	11000	16000	1100/cattle+200/sheep		
Purchase Expense			10 cattles are left, which need 3000 yuan a year for rent of grassland	34400	
New Birth				0	
Equipment Spent					
Housing				4000	
Electricity					
Water					
Other					
Money Borrowed					
From Bank				24400	
Interest Rate				0	
Terms of Payment				3	
From Person				10000	for living
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	June,2004	July, 2004	August, 2004	September, 2004
Income				
Cows				
Milk Sales	0			
Cow Sales				
Other Animals				
Total Cows	0			
Other				
Labor				
Others				
Total Other	0			
Total Income	0			
Expense				
Feedingstuff				
		government gave		
		some free		
For Milk		feedingstuff		
		200yuan for rent of		
For Common	25	grassland a year		
Qingchu				
Total Feedingstuff	25			
Debt				
Interest				
Capital				
Total Debt				
Household Consump.				
Food	200			
Clothes				
Fuel				
Transportation				
Electricity				
Other				
Total Consumption	200			
Education				
School				
Other				
Total Education				
Social Service				
Medical	400			
Visits for Friends				
Visits for Grass				
Other				
Total Service	400			
Total Expense	625			
Net Income	-625			

Household Members 1st, left 03.11 for resettlement

	Name	Relationship	Age	Gender	Education	Occupation
1	Liu Xilin		62	M	Sec	at Home
2	Fan Shuzhi	wife	59	F	Ele	at Home
3	Liu Yanghong	Granddaughter	19	F	High	Student
4						
5						
6						

Basic Information

Ethnicity: Han

Language Spoken at Home: Mandarin

Annual Income Before Resettlement: About 6 thousand yuan for sales income, including about 2 cattles (1000/cattle), 10 sheep (200/sheep), 2000 yuan for wool

Housing Arrangement:

2 rooms, TV, VCD, 1 bed, 1 table, 1 cupboard

Assets and Equipment:

Resettlement Description: They spent 1500 yuan for resettlement, including rent for truck and labor.

Personal Opinion: The life here is leisure, an the house is good even though there are some cracks. Although there is not many expenses since they don't feed any cow, they have to bring up their granddaughter and there is not any way to get income. All the children have to lead their own hard life (some are in this village feeding cows).

Comparison Sheet

	Before Settlement		*Note for Before*	*After Settlement*	*Note for After*
Livestock					
Kind	Cattle	Sheep			
Number	10	50			
Sales Income	10000	10000	1000/cattle 200/sheep		
Purchase Expense					
New Birth					
Equipment Spent					
Housing				2000	
Electricity					
Water				300	
Other					
Money Borrowed					
From Bank				4500	
Interest Rate					
Terms of Payment					
From Person				6000	3 month in hospital
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	Before Harvest Monthly	Note	After Harvest Monthly	Note
Income				
Cows				
Milk Sales				
Cow Sales				
Other Animals				
Total Cows	0			
Other				
Labor				
Others				
Total Other	0			
Total Income	0			
Expense				
Feedingstuff				
For Milk				
For Common				
Qingchu				
Total Feedingstuff	0			
Debt				
Interest				
Capital				
Total Debt	0			
Household Consump.				
Food	150			
Clothes	20	200/year		
Fuel				
Transportation				
Electricity	3	20 for half year		
Other				
Total Consumption	173			
Education				
School	300	3000 for a year		
Other				
Total Education	300			
Social Service				
Medical	300			
Visits for Friends				
Visits for Grass				
Other				
Total Service	300			
Total Expense	773			
Net Income	-773			

Household Members 1st, Left 03.11 for resettlement

	Name	Relationship	Age	Gender	Education	Occupation
1	Lin Zhiqiang		37	M	Ele	Shop Owner/Cows
2	Lin Guiqiang	Wife	35	F	Sec	Feed Cows
3	Lin Aihua	Daughter	14	F	Sec	Student
4	Lin Aili	Daughter	8	F	Kindergarten	Student
5						
6						

Basic Information

Ethnicity: Han

Language Spoken at Home: Mandarin

Annual Income Before Resettlement: Over 10 thousand yuan of net income.

Housing Arrangement: 1 bed, 1 TV, 1 VCD, 1 table, 1 cupboard

Assets and Equipment: They built one house by 1500 yuan, since the house government built is too small for their family.

Resettlement Description

Personal Opinion

There are four big problems they meet.
1. The government didn't build forage basement for them
2. The station doesn't buy all the milk: sometimes the station doesn't collect milk for some reason, say, the barrel is full.
3. The cow shed isn't seperatedly for each family, so some households share one shed. There is not any accessorial equipment in the shed, such as water fence.
4. Grassland is not free beside the village, they need to pay rent. Grassland is free in pasturing area.

Comparison Sheet

	Before Settlement		*Note for Before*	*After Settlement*	*Note for After*
Livestock					
Kind	Cattle	Sheep		Cow	
Number	20	100		5	
Sales Income	24000	30000	1200/cattle 300/sheep		
Purchase Expense				86000	17200/cow
New Birth				2	
Equipment Spent					
Housing				1000	
Electricity					
Water				400	
Other					
Money Borrowed					
From Bank				69000	
Interest Rate					
Terms of Payment					
From Person					
Interest Rate					
Terms of Payment					
Satisfaction Attitude				Feeding Condition is bad, so dairy cows don't produce much milk	

	Before Harvest Monthly	Note	After Harvest Monthly	Note
Income				
Cows				
Milk Sales	44.82	10% cut since the milk can't be totally sold		
Cow Sales				
Other Animals				
Total Cows	44.82			
Other				
Labor				
Others	1030	Shop Sales income		
Total Other	1030			
Total Income	1074.82			
Expense				
Feedingstuff				
For Milk	960	2 milking cows		
For Common	984	hay:0.4yuan/kg		
Qingchu				
Total Feedingstuff	1944			
Debt				
Interest				
Capital				
Total Debt				
Household Consump.				
Food	150			
Clothes	20	200 for a year		
Fuel				
Transportation				
Electricity				
Other	150			
Total Consumption	320			
Education				
School	100	1000 for a year living in town during terms		
Other	300			
Total Education	400			
Social Service				
Medical	55			
Visits for Friends				
Visits for Grass				
Other	1000	Buy goods		
Total Service	1055			
Total Expense	3719			
Net Income	-2644.18			

Household Members 2nd, left 03.11 for resettlement

	Name	Relationship	Age	Gender	Education	Occupation
1	Shui Hua		32	F	Ele	Feed Cows
2	Chu Lu	Husband	30	M	Ele	Labor/cows
3	Tao Tao	Daughter	2	M		
4						
5						
6						

Basic Information

Ethnicity: Meng

Language Spoken at Home: Mongolian

Annual Income Before Resettlement: 3 thousand yuan of sales income, which was spent for living.

Housing Arrangement: 2 rooms, 2 beds, 2 cabinets, 1 refrigerator, 2 boxes

Assets and Equipment

Resettlement Description

Personal Opinion: The life is worse than before since the living cost is higher. But the house is better than the one they lived before resettlement.

Others

Comparison Sheet

	Before Settlement	*Note for Before*	*After Settlement*	*Note for After*
Livestock				
Kind	Cattle		Cow	
Number	20	belong to parents	1	
Sales Income				
Purchase Expense			15200	
New Birth			1	born on Apr. 28
Equipment Spent				
Housing			1000	
Electricity				
Water				
Other				
Money Borrowed				
From Bank			15200	
Interest Rate				
Terms of Payment				
From Person			2500	
Interest Rate				
Terms of Payment				
Satisfaction Attitude				

	Before Harvest Monthly	Note	After Harvest Monthly	Note
Income				
Cows				
Milk Sales	747	15kg/day		
Cow Sales				
Other Animals				
Total Cows	747			
Other				
Labor	500	husband		
Others				
Total Other	500			
Total Income	1247			
Expense				
Feedingstuff				
For Milk	400	250kg for a month		
For Common	60	rent for grassland		
Qingchu				
Total Feedingstuff	460			
Debt				
Interest				
Capital				
Total Debt				
Household Consump.				
Food	100			
Clothes				
Fuel				
Transportation				
Electricity				
Other				
Total Consumption	100			
Education				
School				
Other				
Total Education	0			
Social Service				
Medical				
Visits for Friends				
Visits for Grass	10	50yuan for once every half a year		
Other				
Total Service	10			
Total Expense	570			
Net Income	677			

Household Members 2nd, Left 04.3 for resettlement

	Name	Relationship	Age	Gender	Education	Occupation
1	Li Fengmei		22	F	Ele	Feed Cows
2	Huo Junbiao	Husband	25	M	Ele	Feed Cows
3						
4						
5						
6						

Basic Information

Ethnicity	Han
Language Spoken at Home	Mandarin
Annual Income Before Resettlement	Over 10 thousand yuan of net income.
Housing Arrangement	
Assets and Equipment	1 refrigerator, 1 truck, 2 motorcycles, 1 stove, 2 houses (one was built by themselves)
Resettlement Description	They spent 3000 yuan for rent of truck and labor.
Personal Opinion	The life in the cow village is worse than before, as follows: 1. Milk produced can't be collected totally. 2. House is too small 3. The price of milk is heard to drop to 1yuan/kg from 1.5yuan/kg 4. No income

Comparison Sheet

	Before Settlement		Note for Before	After Settlement	Note for After
Livestock					
Kind	Cattle	Sheep		Cow	
Number	20	100		3	
Sales Income	28000	30000	1400/cattle 300/sheep		17200*2
Purchase Expense				49600	15200*1
New Birth				1	born in March
Equipment Spent					
Housing				9500	7500 for self-builing house
Electricity					
Water				1500	Power-well
Other					
Money Borrowed					
From Bank				39200	
Interest Rate					
Terms of Payment					
From Person					
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	Before Harvest Monthly	Note	After Harvest Monthly	Note
Income				
Cows				
Milk Sales	747			
Cow Sales				
Other Animals				
Total Cows	747			
Other				
Labor				
Others				
Total Other	0			
Total Income	747			
Expense				
Feedingstuff				
For Milk	720			
For Common	510			
Qingchu				
Total Feedingstuff	1230			
Debt				
Interest				
Capital				
Total Debt				
Household Consump.				
Food	1000			
Clothes	50	500 for a year		
Fuel				
Transportation				
Electricity				
Other				
Total Consumption	1050			
Education				
School				
Other				
Total Education	0			
Social Service				
Medical				
Visits for Friends				
Visits for Grass				
Other				
Total Service	0			
Total Expense	2280			
Net Income	-1533			

Household Members 3rd, Right 03.11 for resettlement

	Name	Relationship	Age	Gender	Education	Occupation
1	Yang Tibin		37	M	Ele	Feed Cows
2	Qi Muge	Wife	40	F	Ele	Feed Cows
3	Yang Guiye	Daughter	17	F	Sec	Student
4	Yang Guifang	Daughter	12	F	Sec	Student
5						
6						

Basic Information

Ethnicity	Han / Meng
Language Spoken at Home	Mandarin
Annual Income Before Resettlement	About 15 thousand yuan of sales income, and 5 thousand yuan of net income.
Housing Arrangement	They built another house with 3 rooms by themselves.
Assets and Equipment	1 Truck, equipment for producing feeding wine.
Resettlement Description	
Personal Opinion	Little income with much more expenses
Others	1. Milk isn't collected totally 2. income is little 3. 400 yuan of interest to pay (deducted in the sales of milk), so they will not have income within 3 years. 4. The price of milk has to be stable at current one. 5. The equipment of housing is not like what was promised before resettlement. 6. Many staffs are at loss of worth.

Comparison Sheet

	Before Settlement		*Note for Before*	*After Settlement*	*Note for After*
Livestock					
Kind	Cattle	Sheep		Cow	
Number	30	100		6	1 is dead, cause hasn't been confirmed
Sales Income	30000	20000	1000/cattle 200/sheep		
Purchase Expense				105200	5*17200 1*19200
New Birth				0	
Equipment Spent					
Housing				22000	2000 for common house, 20000 for self-build one
Electricity					
Water					
Other					
Money Borrowed					
From Bank				73000	
Interest Rate					
Terms of Payment					
From Person					
Interest Rate					
Terms of Payment					
Satisfaction Attitude					

	Before Harvest Monthly	Note	After Harvest Monthly	Note
Income				
Cows				
Milk Sales				
Cow Sales				
Other Animals				
Total Cows	0			
Other				
Labor				
Others				
Total Other	0		432	
Total Income				
Expense			720	
Feedingstuff				
For Milk				
		250 for rent		
		432 for refined forage		
For Common	1402	720 for hay		
Qingchu				
Total Feedingstuff	1402			
Debt				
Interest				
Capital				
Total Debt				
Household Consump.				
Food	500			
Clothes				
Fuel	400	coal		
Transportation				
Electricity	55			
Other				
Total Consumption	955			
Education				
School	380	3400+400 for a year		
Other	350	200+150 for living		
Total Education	730			
Social Service				
Medical	200	for curing the dying cow		
Visits for Friends				
Visits for Grass				
Other				
Total Service	200			
Total Expense	3287			
Net Income	-3287			

CONTRACTOR LIST FOR CHINA DESERTIFICATION PROJECT

Fred E. Bickford, MS, CPG
26 Winter Street
Ashland, NH 03217
(603) 968-3733
fbickford@teamhydrosource.com

Dr. David Hannaway
Department of Crop and Soil Science
Oregon State University
Corvallis, OR 97331-3002
(541) 737-5863
david.hannaway@oregonstate.edu

David Odell
Cascade Earth Sciences
2417 Bank Drive, Suite 101
Boise, ID 83705
(208) 388-1030
davido@cascade-earth.com

Terry Rahe, CPSS
Cascade Earth Sciences
3511 Pacific Blvd. SW
Albany, OR 97321
(541) 812-6612
terryr@cascade-earth.com

Dr. Larry Rittenhouse
817 Scenic Drive
Fort Collins, CO 80526
(970) 226-0218
lrittenhouse@msn.com

Greg Thurman, PE
Cascade Earth Sciences
107 Island Avenue
La Grande, OR 97850
(541) 963-7758
gregt@cascade-earth.com

Dr. Dennis Wichelns
Department of Agricultural Economics
California State University at Fresno
5245 N. Backer Ave., M/S PB101
Fresno, CA 93740-8001
(559) 278-4629
dwichelns@csufresno.edu

Dr. John Young
1141 N.W. Charlemagne Place
Corvallis, OR 97330
(541) 737-4515
jyoung@oregonstate.edu

Carol Maresh
Cascade Earth Sciences
3511 Pacific Blvd. SW
Albany, OR 97321
(541) 812-6650
carolm@cascade-earth.com

VENDOR LIST FOR CHINA DESERTIFICATION PROJECT

Valmont Industries
7002 North 288th Street
Valley, NE 68064-0358
Phone: (800) 825-6668
Fax: (402) 359-6081
E-mail: irrigation@valmont.com