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El Salvador Surface Water Diversion, Storage, and Use Project

Final Report

APRIL 2005

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It was prepared by Chemonics International Inc.

COVER PHOTO: The photo shows the liner installation hands-on training conducted by Firestone (the liner's manufacturer) in Ahuachapan. The training session was attended by construction company personnel, the SWDSU team, and some of the beneficiaries.

Photo: Jorge Sosa

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El Salvador Surface Water Diversion, Storage, and Use Project

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El Salvador Surface Water Diversion, Storage, and Use Project Final Report
Contract No. PCE-I-25-99-00003-00 Task Order 25

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The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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RICARDO MUÑOZ

Beneficiaries were trained in the installation, operation, maintenance, and repair of the pipe irrigation network. All beneficiaries should be able to solve most operation and maintenance problems.

EXECUTIVE SUMMARY

In the absence of water storage and irrigation systems, the majority of poor farmers in El Salvador are left with few, if any, income generating activities during the six-month dry season. The Surface Water Diversion, Storage, and Use (SWDSU) project was designed to address this situation, providing small farmers with the water resources needed to raise incomes and combat poverty through the design of integrated water systems. During the eight-month project period, the SWDSU team built 13 water systems benefiting 40 people, surpassing original targets.

SWDSU interventions can be grouped into three areas: Design and construction of water systems, use of stored water by project beneficiaries, and building local capacity to operate and maintain reservoirs. During the design and construction phase, the SWDSU team selected and developed the reservoir sites based on topographic studies, irrigation requirements for crop production, and environmental impact assessments. The SWDSU team also worked with project beneficiaries to select appropriate crops and income generating activities linked to the water systems. According to cost-

benefit analyses, these new crops will yield higher returns than those currently under cultivation. The team also trained farmers in the maintenance of the systems and production of the new crops. Participation of beneficiaries in water system construction and hands-on training at demonstration sites developed by the project were backed by training manuals and field guides to promote sustainability and replicability.

In implementing this project, the SWDSU team confronted several challenges. First and foremost, SWDSU had to update or create new materials on water resource management, irrigation, and crop production in El Salvador because little information about the topics existed prior to project implementation. Second, because of the short timeframe of the project, which limited the follow-up that could be provided, it was critical to develop effective practical training tools. The use of demonstration sites to provide project beneficiaries with hands-on training in operating the reservoirs and cultivating new crops was found to be a successful solution. Finally, there were quality control problems with one construction company. These problems were resolved through close supervision and discussions with the company's management. Despite these challenges, SWDSU successfully met its objectives. Below is a summary of the project's results:

- Constructed 13 water systems to irrigate crops and raise tilapia during the dry season.
- Created water storage capacity of 11,432 m3, surpassing the original target of 10,000 m2, thereby providing Salvadoran farmers with more stored water for the dry months than originally planned.
- Trained 40 people to use the reservoirs and irrigation systems in order to cultivate crops during the dry season. This was more than anticipated.
- Prepared 20 documents to train farmers and field technicians in system management and production techniques.
- Established 4 demonstration sites to provide hands-on training for beneficiaries

USAID should build on the advances achieved under SWDSU. Project beneficiaries could use additional training and hands-on support as they proceed to use water systems for crop cultivation and/or to raise tilapia. It is also important that future training include a component on educating a new generation of water resources and irrigation engineers in El Salvador so that this work can be sustained for the long term.

FINANCIAL FEASIBILITY OF SWDSU INTERVENTION

The financial feasibility study for the project was based on the construction design and budget, and not on the final cost of the project due to time constraints encountered during construction of the reservoirs. Nevertheless, the difference is minor and the analysis is valid. The feasibility study assumed that a 1,000 m3 storage reservoir could irrigate 2,000 m2 of land and that the cost of the initial investment is $17,000. The study assessed the benefits from the standpoint of production during the dry season and also during the periods of drought during the rainy season known as "caniculas." The analysis also assumed that all crops are cultivated on irrigated land and that tilapia are raised in the reservoirs. It is expected, however, that over time, project beneficiaries will cultivate a combination of cash crops that offers a higher rate of profitability. This enhances the financial feasibility potential of the reservoirs and the overall benefit for each dollar invested.

The internal rate of return (IRR), assuming no benefits from mitigating the canicula effect during the rainy season, is 12%. If alleviation of the dry spells during the rainy season is assumed to reduce crop loss by 25%, the IRR is 17.5%. If the more optimistic crop loss reduction rate of 50% is assumed for alleviation of the dry periods during the rainy season, the IRR is 22.5%. These figures are all in real terms, and the nominal rates are higher. With respect to irrigation projects, these three values for the IRR are all acceptable and the intervention is considered to be cost effective.

The chart below presents the feasibility analysis for a range of discount rates for the more conservative scenario derived from estimating a 25% reduction in crop loss due to alleviation of the canicula effect, and the more optimistic scenario derived from estimating a 50% reduction in crop loss due to alleviation of the canicula effect.

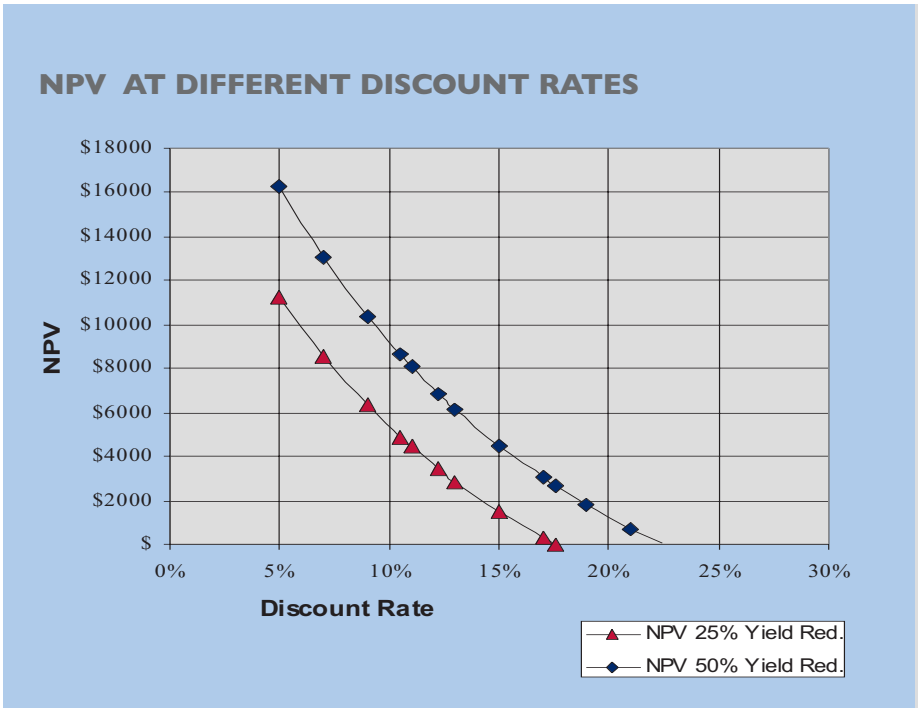

FIGURE NO. 1

NET PRESENT VALUE AT DIFFERENT DISCOUNT RATES

The analysis shows that the reservoirs and the proposed cultivation of crops and tilapia is economically feasible with rates of return on investment between 12% and 22.5% in real terms. Due to these rates of return, the reservoirs and irrigation systems should generate interest within the farming community without any need for additional subsidies.

However, given the socioeconomic position of the target beneficiaries, the limiting factor for implementation of similar projects will likely be the lack of capital for the initial investment. Farmers who are interested in similar projects in the future will need support to identify and leverage financing.

RICARDO MUÑOZ

Mr. Chepe Vargas, a beneficiary of one of the Pilot Schemes (previously built by USAID) in the area of Usulutan, explains the benefits of his irrigation system to the beneficiaries of SWDSU during the training phase of the project.

THE SWSDU APPROACH

In El Salvador, many farmers live at or below the poverty line. Living on the edge of poverty makes subsistence farmers vulnerable to climatic changes, especially drought and the six-month dry season. For the most part, subsistence farmers are only economically active during the rainy season, when they can cultivate the land and grow crops. The rest of the year they are either inactive or seeking employment. By constructing reservoirs for water storage, project beneficiaries can now grow crops during the dry season when prices are higher.

In addition to the six-month dry seasons, periodic drought conditions have had drastic effects on farmers living at or below the poverty line. An example occurred in 1992, when normal rainfall did not begin until four months into the rainy season. These dry periods can be particularly destructive, as they tend to ruin crops and leave the farmer with few possibilities of producing another crop.

Through the construction of surface water diversion and reservoir storage systems, the SWDSU project aimed to help lift Salvadoran farmers out of poverty and into increased agricultural production.

AREAS OF INTERVENTION

During project implementation, SWDSU designed and built reservoirs and irrigation systems; through training activities, created local capacity to use the stored water; and instructed project beneficiaries in the operation of the water systems.

1. Design and Construction of Water Systems

Reservoirs

SWDSU received 15 pre-selected sites chosen on the basis of previous USAID interventions. Following visits to the sites, 12 were chosen for construction activities. The process began with a topographic survey to determine construction feasibility. Following the topographic survey, the project designed the systems and assessed the amount of water needed to cultivate crops. This information was used to determine the size of the reservoirs, plan the irrigation area, and estimate the potential costs and benefits of the intervention. These efforts culminated in a design manual identifying the criteria used and the assumptions made to determine the size of the reservoirs and the irrigation area. The manual will be an important tool for the design and sizing of future projects. To complete the overall design of the project, SWDSU incorporated environmental impact assessments and risk mitigation plans that had been completed on an earlier project.

The original goal of the SWDSU project was to complete construction of 12 reservoirs. As the project wound down, it was determined that the project had significant cost savings. The savings were ultimately used to build an additional water system.

Table 1 shows the location of each site, names of the beneficiaries, volume of stored water, and area to be irrigated.

TABLE 1
Project Beneficiaries and Areas to be Irrigated

DEPARTMENT	OWNER NAME	RESERVOIR VOLUME M3	IRRIGATED AREA M2
Ahuachapán	M. Jiménez	652	1300
	H. García	630	1300
	S. Amaya	929	1900
Usulután	D. Escobar	830	1700
	O. Quintanilla	811	1700
	S. de Jesús	985	2000
	L.D. López	643	1300
	La Bomba	2177	4400
	A. Parada	822	1700
	J.L. Campos	1050	2100
	M.T. Pineda	723	1500
Morazán	T. Hernández	615	1300
	N. Berríos	565	1200
Total		11432	23400

Drip Irrigation Systems

The drip irrigation systems were designed by the SWDSU team and the equipment was purchased from a local company, which assembled and installed the systems. The equipment was the same as that used in the pilot project, as project beneficiaries expressed a high level of satisfaction with that equipment.

The total cost of each of the systems is presented in Table 2 and the financial report by line item is contained in Table 3.

TABLE 2
Cost of Systems

SYSTEM	LINER	RESERVOIR	GALLERY	PIPELINE	FENCE	IRRIGATION	TOTAL
R1	$2,671	$6,943	$1,236	$357	$1,838	$480	$13,524
R2	$2,581	$6,232	$840	$488	$1,068	$621	$11,830
R3	$3,805	$8,156	$1,175	$510	$1,306	$631	$15,584
R4	$3,400	$5,255	$1,192	$675	$3,170	$624	$14,317
R5	$3,322	$4,940	$1,437	$675	$3,274	$368	$14,017
R6	$4,035	$6,616	$1,323	$822	$3,348	$749	$16,891
R7	$2,634	$6,038	$1,323	$1,332	$3,016	$562	$14,905
R8	$8,918	$8,040	$2,696	$557	$4,336	$1,149	$25,696
R9	$3,367	$5,637	$2,632	$1,374	$3,862	$641	$17,513
R10	$4,301	$6,871	$1,439	$1,147	$3,468	$756	$17,982
R11	$2,519	$12,605	$1,006	$716	$1,655	$756	$19,257
R12	$2,314	$12,346	$1,006	$246	$998	$425	$17,335
R13	$2,962	$8,072	$1,185	$600	$1,680	$575	$15,074
Total	$46,828	$97,751	$18,490	$9,498	$33,019	$8,337	$213,925

TABLE 3
Financial Report by Line Item

LINE ITEM	CONTRACT BUDGET	CUMULATIVE EXPENDITURES THROUGH APRIL 11, 2005 (ESTIMATED)	REMAINING BUDGET
Workdays Ordered	$251,942	$250,961	$981
Other Direct Costs	$366,349	$317,799	$48,550
G&A	$14,654	$12,712	$1,942
Total	$632,945	$581,472	$51,473

RICARDO MUÑOZ

Beneficiaries learned the cropping practices of irrigated agriculture, during which new crops were introduced to them. Special emphasis was made on the identification of potential pests and diseases they will face when they put their systems into operation.

2. Use of Stored Water by Project Beneficiaries: Introduction of New Income Generating Activities

The SWDSU team worked with project beneficiaries to determine the crops and other income generation activities for which the stored water could be used. An additional goal was to make these activities easily replicable for other poor farmers in El Salvador.

The criteria used for selecting the crops considered the agricultural parameters of the land in addition to the financial costs and benefits of crop production. In the original design, the project intended to provide technical assistance and fish to beneficiaries, and convert some reservoirs into fisheries to be harvested during the rainy and dry seasons. However, this component was implemented in only two reservoirs, due to the absence of captured water as a consequence of completing construction well into the dry season.

Figure No. 2 shows the volume of selected vegetables imported into El Salvador during the dry season.

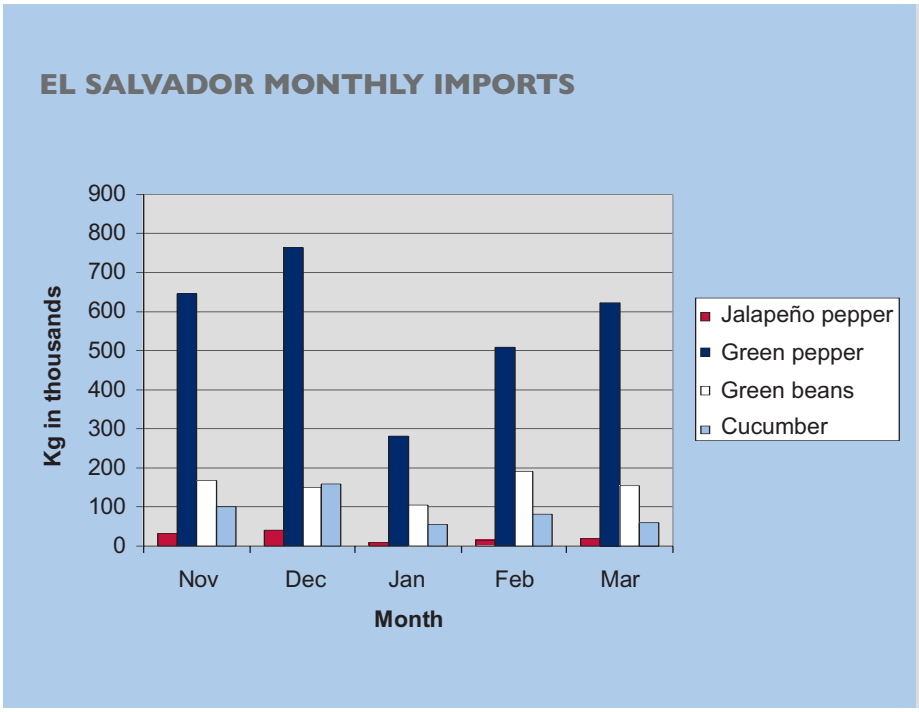

FIGURE NO. 2

AVERAGE MONTHLY IMPORTS OF VEGETABLES IN EL SALVADOR DURING THE DRY SEASON

It was a challenge to introduce new crops to farmers who had no experience with vegetables or irrigation systems for production. New problems arise with respect to pests and diseases, and the lack of experience using irrigation for production meant that farmers did not know the amount of moisture needed for each new crop. To address these issues, the project set up four demonstration sites across El Salvador. These sites provided beneficiaries the opportunity for hands-on training in the use of the reservoirs and irrigation systems.

To ensure the economic viability of the crops to be produced using water from the reservoirs, SWDSU conducted two studies of the crops' market potential. Five manuals and four technical field guides were prepared to assist beneficiaries with converting stored water into sustainable revenue. A list of these training documents is presented in Table 4.

TABLE 4
Production Manuals and Field Guides

NO.	DOCUMENT NAME
Technical Manuals	
1	MT-1 Growing Green Pepper Manual (Capsicum Annun)
2	MT-2 Cultivating Tilapia Fish Manual
3	MT-4 Vegetables Marketing Manual
4	MT-5 Growing Cucumbers Manual
5	MT-6 Growing Tomatoes Manual
Field Manuals	
1	GT-1 Cultivating Tilapia Fish in Reservoirs Field Guide
2	GT-4 Plant Nutrition and Pathology Field Guide
3	GT-11 Growing Cucumbers Field Guide
4	GT-12 Seasonal Market Prices for Vegetables Field Guide

TABLE 5
Manuals and Field Guides Produced for Beneficiary Use

NO	DOCUMENT NAME
Technical Manuals	
1	MT-3 Soil and Water Conservation in Hilly Area Manual
Field Guides	
2	GT-2 Soil and Water Conservation in Hilly Areas Field Guide
3	GT-3 The Use of Level "A" Field Guide
5	GT-5 Building Hillside Ditches Field Guide
6	GT-6 Building Individual Terraces Field Manual
7	GT-7 Operation and Maintenance of Artisan Drip Irrigation Systems Field Guide
8	GT-8 Drip Irrigation Systems Operation and Maintenance Plan
9	GT-9 Infiltration Galleries and Reservoirs Maintenance Plan
13	GT-13 Installation, Maintenance and Repair of Drip Irrigation Systems Field Guide
14	GT-14 Cleaning and Washing Drip Irrigation Tapes Field Guide

RICARDO MUÑOZ

Beneficiaries visited the Pilot Schemes (previously built by USAID) in the area of Usulutan, where they had the opportunity to see how their systems will look. They learned the benefits of having water stored in a reservoir during the "caniculas" (dry spells during the rainy season) and the dry season.

3. Building Local Capacity to Operate and Maintain Reservoirs

Through hands-on training, beneficiaries learned about the physical components of each system and how those components can be maintained and protected. Hands-on training was also provided in soil conservation practices to prevent erosion in hilly areas. One training session culminated with beneficiary farmers building hillside ditches to divert water to collection filters to prevent soil erosion. Where needed, project beneficiaries also built rock barriers to protect the infiltration galleries, the reservoirs, and their land. Along with the SWDSU team, beneficiaries marked the places where special grass with long roots will be planted to create natural protective barriers when the rainy season starts.

During construction of the reservoirs, SWDSU ensured that project beneficiaries were hired by local construction companies to perform the labor. Beneficiaries hence became familiar with the structure of the water systems, the strengths of the system design, and the areas where maintenance is regularly required to prevent malfunction.

Project beneficiaries also received hands-on training in all aspects of the installation, maintenance, and repair of the piping network for the irrigation systems. The project also completed two field guides and provided copies to all the beneficiaries so they can make repairs to the irrigation systems without outside assistance.

It was carefully explained to the beneficiaries that the irrigation systems will last a long time if properly maintained.

The training documents and field guides prepared to ensure sustainability of the systems are presented in Table 5.

PROJECT CHALLENGES, BEST PRACTICES, AND LESSONS LEARNED

1. Training Manuals

During the initial phase of project activities, SWDSU developed a work plan to address the requirements contained in the scope of work. First, a review of existing literature was conducted on irrigation and water resource projects in El Salvador. This proved to be challenging, as the documents were more than 20 years old and no longer relevant. Furthermore, universities in El Salvador have abandoned the specialization altogether. In addition, while the work currently being done contains empirical analysis, there are no numbers to support the empirical studies. Because the current work in El Salvador in water resources management and irrigation is not documented, it is likely that the same work is being repeated on similar projects without follow-up studies or analyses. Because of this, the SWDSU team created its own materials for the design of infiltration galleries, reservoirs, and irrigation systems. SWDSU also analyzed crop consumption to determine the economic feasibility of each prospective crop. During the project's eight months of implementation, 25 papers were produced and/or adapted from other water projects currently being implemented in El Salvador.

The lack of literature about irrigation and water resources projects in El Salvador presents a challenge for future projects in the same technical area. With this in mind, SWDSU consolidated and centralized work done in water resources management and irrigation in El Salvador and adapted these materials to the needs of project beneficiaries. Hard copies of all project-produced documents were printed and electronic files in PDF format were stored on CD-ROM. Through this medium, SWDSU was able to share knowledge with partner institutions, technical experts, and beneficiaries at minimal cost.

2. Construction Activities

All construction activities proposed by local subcontractors were assessed and approved by the SWDSU construction supervisors. The activities were presented in a chronogram, and the SWDSU team developed a checklist for weekly progress to ensure effective management and accurate reporting to USAID.

The construction supervisors visited each site three or four times per week to ensure that the technical specifications and chronograms were being followed. Despite the presence of the construction supervisors, there were quality control problems with one of the local firms, indicating the critical importance of constant supervision. The problems were primarily the result of poor management by the firm's executives. The quality control problems created delays, because in several cases, the construction supervisors had to reject work done by the subcontractor. In some cases, the crests of the reservoirs were not properly leveled. This created problems with the tops of the embankments and jeopardized the entire structure. In another instance, poor supervision of the construction of the infiltration galleries led to contamination of the filter media with the surrounding soil. Ultimately, these problems were resolved.

During construction, there were two cases in which many boulders were found. Although the boulders did not create contractual problems because the subcontractors had visited the sites during the bidding phase, the boulders did cause delays as it takes much longer to excavate rocky soil than plain dirt.

In one case, the reservoir site had to be relocated due to problems with the required difference in elevation between the reservoir's bottom and the field to be irrigated.

In two of the construction sites, project beneficiaries had problems with their neighbors due to the location of the infiltration gallery and the running of the conveyance pipelines across their property. The infiltration gallery sites were relocated.

Some changes to design were made during construction. This included the addition of gates at the fences; extension of the main irrigation line up to the field; addition of plugs at the reservoirs to protect them from losing water; and a few other minor changes and additions. All construction activities were completed within the contractual timeframe for project activities.

3. Demonstration Sites

It would have been ideal if the project had been able to identify potential construction sites rather than work from a list of pre-selected sites. This would have given SWDSU more control over the topographic surveys

and the opportunity to create a preliminary design for each potential site. Tailored feasibility studies for each site would have helped determine where a smaller amount of money and effort could have the biggest overall impact. In addition, for future projects of this sort, it is advisable to verify and re-verify that project beneficiaries are committed to project objectives and hold legal title to their land.

It would also be advantageous for projects to do additional follow-up after the construction of the water systems. The project team of agronomists could concentrate on hands-on training to ensure that beneficiaries have the right skills and knowledge to operate and maintain the water systems, and properly introduce them to the cultivation of new crops using irrigation techniques. Ideally, this would happen over the course of one year. First, beneficiaries would be provided guidance in diverting water to the infiltration galleries and on protecting the infiltration galleries from water erosion during the rainy season. Next, during the dry season, beneficiaries would be accompanied by a team of agronomists during the planting and cultivation of the new crops. Beneficiaries would receive direct assistance in using the stored water from the rainy season for the purpose of irrigating their land in order to produce during the dry season.

However, in lieu of such activities, because SWDSU was operating under time constraints, the project successfully used demonstration sites to provide hands-on training for beneficiaries.

4. Importation of Specialized Parts

SWDSU found a limited market in El Salvador for specialized goods such as the material for the lining of the reservoirs and the equipment for the irrigation systems. The project had been aware that the lining material was not locally available, but when it started the importation process, it was unclear how much time it would take to shepherd the material out of customs in El Salvador. Learning from the lining material experience, a local market survey was conducted before a request for quotations was released for procurement of the drip irrigation system. The market survey, however, proved to be inaccurate, as the information received from local dealers was proven wrong when the received bids included limitations on the availability of some of the equipment in country. For future projects similar to SWDSU in El Salvador, it is recommended that a thorough market survey be conducted and that a contingency plan be prepared for procurement and importation of materials or parts that may be difficult to find locally.

SWDSU VOICES

Mr. Chepe Vargas, a beneficiary from Usulután said, *"I was planning to leave the country because I couldn't make enough money to support my family. With the reservoir and the irrigation system, I will be very busy and will be able to make enough money to send my children to school. Who wants to leave the country when you can make enough money to feed your kids at home?"*

When Mrs. Margarita Jimenez from Ahuachapán saw her system built and ready to collect water, she commented, *"When the agronomists talked me into participating in the project I was hesitant, but as I saw the system being built, I could see the benefits that having reliable water could bring for the lives of my family members. My kids will now be able to have more choices of what they eat and a more varied diet. "*

Mr. Santiago Amaya, a beneficiary from Ahuachapán, participated actively in the construction of his system. After the reservoir liner had been installed, but before the system had been completed, he said, *"I can't wait to have the reservoir full of water. Can we rent a pump and pump water from a nearby river to fill it up and start planting some vegetables?"*

Mr. José Neftalí Berríos, a beneficiary from Corinto, Morazán (an area containing large quantities of rock and very little arable land), said, *"I never thought that this rock field, totally useless for agriculture, could be useful to store water and benefit my property. I can farm in the dry season now on the good soil I have."*

SUSTAINABILITY

The sustainability of the systems rests primarily on the hands-on training that was provided through the demonstration sites and the manuals that the project produced. In addition, agreements were made with several local NGOs to provide follow-up activities in support of SWDSU objectives.

Each beneficiary has signed a commitment letter to properly operate and maintain the systems, and record information about the planting and harvesting dates of crops, in addition to the costs and benefits of the new crops.

Both construction companies have contractually agreed to one-year warranties on the physical soundness of the reservoirs and water system. The irrigation system also includes warranties for the individual components and a one year warranty on the installation of the work. Additionally, we suggested that CARE/El Salvador provide follow-up support to project beneficiaries.

RICARDO MUÑOZ

Mr. Luis Mario Aguirre, a SWDSU agronomist, explains the proper operation and maintenance of the systems, and the importance of keeping a record of the crop planting and harvesting dates, pests and diseases, and the costs and benefits.

RECOMMENDATIONS FOR FUTURE WORK AND INVESTMENT

Although SWDSU project beneficiaries have received ample hands-on training in the operation of the water and irrigation systems, more follow-up work would further promote project objectives. More technical assistance would be useful as beneficiaries start to use the water systems to plant and irrigate new crops during the dry season. SWDSU recommends that follow-up project activities be conducted for at least one full year to provide appropriate guidance in using the water systems.

El Salvador currently suffers a dearth of water resources and irrigation engineers. Without these individuals, it is difficult to provide effective support for the technicians and farmers in the field who are experimenting with new irrigation techniques. To advance the objectives of SWDSU, it is recommended that more support and training be provided to educate a new generation of water resources and irrigation engineers. Specifically, this involves the development of additional hands-on training programs, field guides and manuals on irrigation, design of infiltration galleries and reservoirs, and training programs for conducting financial feasibility analyses.

The financial feasibility study conducted by SWDSU illustrates how the water and irrigation systems constructed by the project are a viable instrument in the fight against poverty. It is recommended that investments in building the capacity of Salvadorans in the use of their water resources continue and be encouraged.

ANNEX A
Publications List

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1	WP-1 Reservoirs' Water Budget
2	WP-2 Pilot Reservoirs – Lessons Learned
3	WP-3 Challenges of Marketing Vegetables in El Salvador
4	WP-4 Financial Feasibility
5	WP-5 Design Manual
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9	GT-9 Infiltration Galleries and Reservoirs Maintenance Plan
10	GT-10 SWDSU Technical and Financial Parameters
11	GT-11 Growing Cucumbers Field Guide
12	GT-12 Vegetables Seasonal Market Prices Field Guide
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Annex W -1

Working Paper No.1
Reservoirs' Water Budget

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Water Budget For The Four Different Scenarios Three And Six Months, Crops For Ahuachapan

WORKING PAPER No.01

El Salvador Surface Water Diversion, Storage and Use

RESERVOIRS' WATER BUDGET

1. INTRODUCTION

The purpose of the El Salvador Surface Water Diversion, Storage and Use project is the promotion and adoption of better surface water resources management. Accordingly the construction of 12 reservoirs to catch and store irrigation water in the Departments of Ahuachapan, Usulutan and Morazan has been planned. The spatial distribution of the annual "canícula" (1) phenomena is presented on Annex A.

The present document estimates the crop water requirements and simulates the reservoirs operation in order to maximize the potential area to be cultivated during the dry season. Four different water catchment alternatives are analyzed under two different cropping scenarios. The first one assumes that all the water stored during the rainy season – May to October – is used to irrigate the crops during the next three months – November to January - and the second scenario assumes that the water stored is used in the next six months – from November to April.

2. CLIMATIC DATA AND FACTORS[1]

Mean Monthly Precipitation

The monthly precipitation for the schemes near Usulután were taken from Estación Climatológica de Usulután (2) and the monthly data for the schemes near Ahuachapán from Estación Climatológica de San Pedro Puxtla (2). These data are presented in Tables 1 and 2 respectively. The mean annual isohyets for El Salvador are presented on Annex A.

Evapotranspiration

The mean monthly evapotranspiration values were taken for the schemes near Usulután from Estación Climatológica

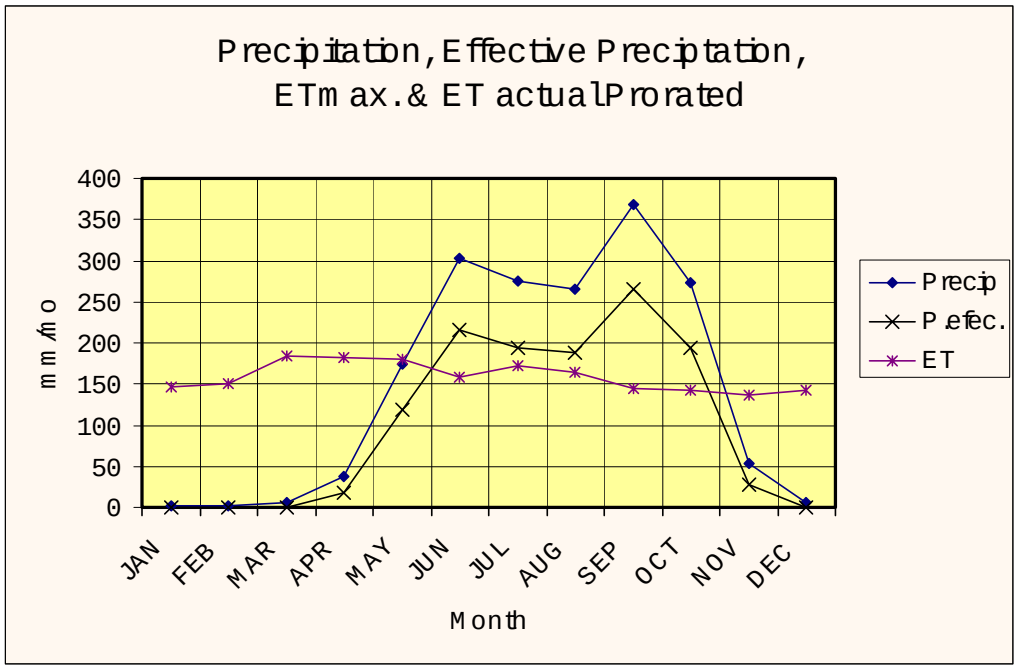
[1] The climatic data was kindly provided by the Ministerio de Agricultura Librarian, Ms. Carmencita Landaverda.

de Santa Cruz Porrillo (2). The evapotranspiration data for the schemes near Ahuachapán were taken from Estación Climatológica de Ahuachapán (2). These data are presented in Tables 1 and 2 respectively. The Evapotranspiration for Usulután is presented in Figure 1

Evaporation

The monthly pan evaporation for Usulután was taken from the. *"Informe de Factibilidad – Proyecto de Olomega en el Río Grande de San Miguel" (3).* This data is provided in Table 1. Not having data available for Ahuachapán, a monthly factor based on evapotranspiration data for Usulután and Ahuachapán was estimated. The values for the pan evaporation for Ahuachapán were estimated with these factors. These data are presented in Tables 1 and 2 respectively.

Figure1. Usulután Precipitation, Effective Precipitation and Potential Evapotranspiration



Effective Precipitation

The effective precipitation is the amount of water that is beneficial to the plants. In the present document, based on experience in different parts of the world, it was calculated assuming that the precipitation during any given month must be above 15 mm to be beneficial to the plants. Of the rain

depth in excess of 15 mm, only three fourths of it is considered to be the effective precipitation. These data are presented in Tables 1 and 2 for Usulután and Ahuachapán respectively. The estimated effective precipitation for Usulután is presented in Figure 1.

Table 1. Usulután Climatic Data

No.	Month	Precipitation		Pan	ETP	
		Mean	Effective	Evaporation	Hargreaves	
		mm	mm	mm	mm	mm/day
1	Jan	2	0	154	146	4.7
2	Feb	1	0	145	150	5.4
3	Mar	6	0	199	184	5.9
4	Apr	38	17	159	183	6.1
5	May	174	119	154	180	5.8
6	Jun	302	215	139	158	5.3
7	Jul	275	195	146	172	5.5
8	Aug	266	188	143	164	5.3
9	Sep	368	265	130	145	4.8
10	Oct	273	194	132	143	4.6
11	Nov	53	29	126	137	4.6
12	Dec	5	0	132	143	4.6
Annual		1763	1222	1759	1905	

Table 2. Ahuachapán Climatic Data

No.	Month	Precipitation		Pan	ETP	
		Mean	Effective	Evaporation	Hargreaves	
		mm	mm	mm	mm	mm/day
1	Jan	3	0	169	133	4.3
2	Feb	6	0	164	133	4.8
3	Mar	26	8	223	164	5.3
4	Apr	70	41	170	171	5.7
5	May	322	230	170	163	5.3
6	Jun	489	356	154	143	4.8
7	Jul	268	190	149	169	5.5
8	Aug	365	263	157	149	4.8
9	Sep	516	376	143	132	4.4

10	Oct	392	283	143	132	4.3
11	Nov	123	81	135	128	4.3
12	Dec	2	0	147	128	4.1
Annual		2582	1827	1924	1745	

3. THE RESERVOIR WATER BUDGET MODEL

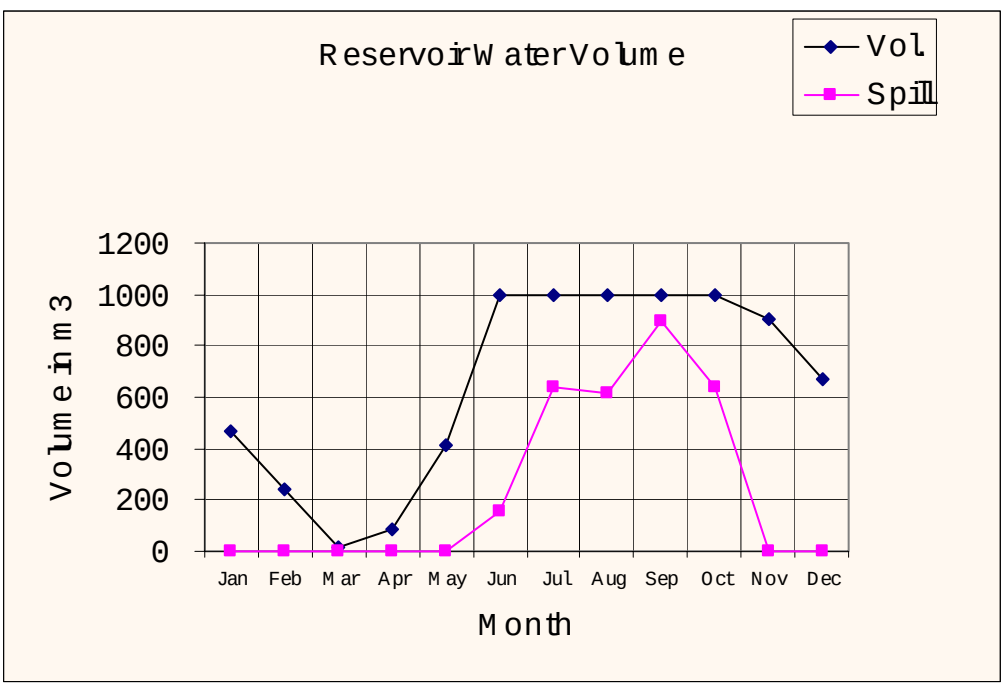
The reservoir Water Budget during the year can be represented with the following equation

$$V_i = V_{i-1} + V_c - I_L - E_L - I_d \qquad (2)$$

Where: V_i = the stored volume at the end of the present month in m^3
V_{i-1} = the stored volume at the end of the previous month in m^3
V_c = the volume of the captured water (galleries, reservoir surface area, roof runoff) during the month in m^3
I_L = infiltration losses during the month in m^3
E_L = evaporation losses during the month in m^3
I_d = irrigation demand during the month in m^3

The estimated water volume balance for a reservoir with an infiltration gallery irrigating a field during six months in Usulután is presented in Figure 2.

Figure 2. Usulután Reservoir Water Budget. Water stored in the reservoir and spilled out.



Volume of the captured water, Vc

- Galleries.- The volume of water that can be intercepted by the galleries can not be easily quantified. Moore (4) reports that the monthly runoff in El Salvador is about 20 percent of the rainfall mean monthly precipitation. In this document, it was estimated to be equal to the 10 percent of the monthly runoff on 10 hectares catchment area.

- Roofs Runoff.- The volume of water that can be captured from the roofs of the beneficiaries, can be calculated by means of the Rational Equation, where the discharge coefficient can be as high as 0.95. The roof catchment area in this report was estimated to be 150 m2. The Rational Equation can be expressed as follows:

$$V_r = C\ P\ A_r/1000 \qquad (3)$$

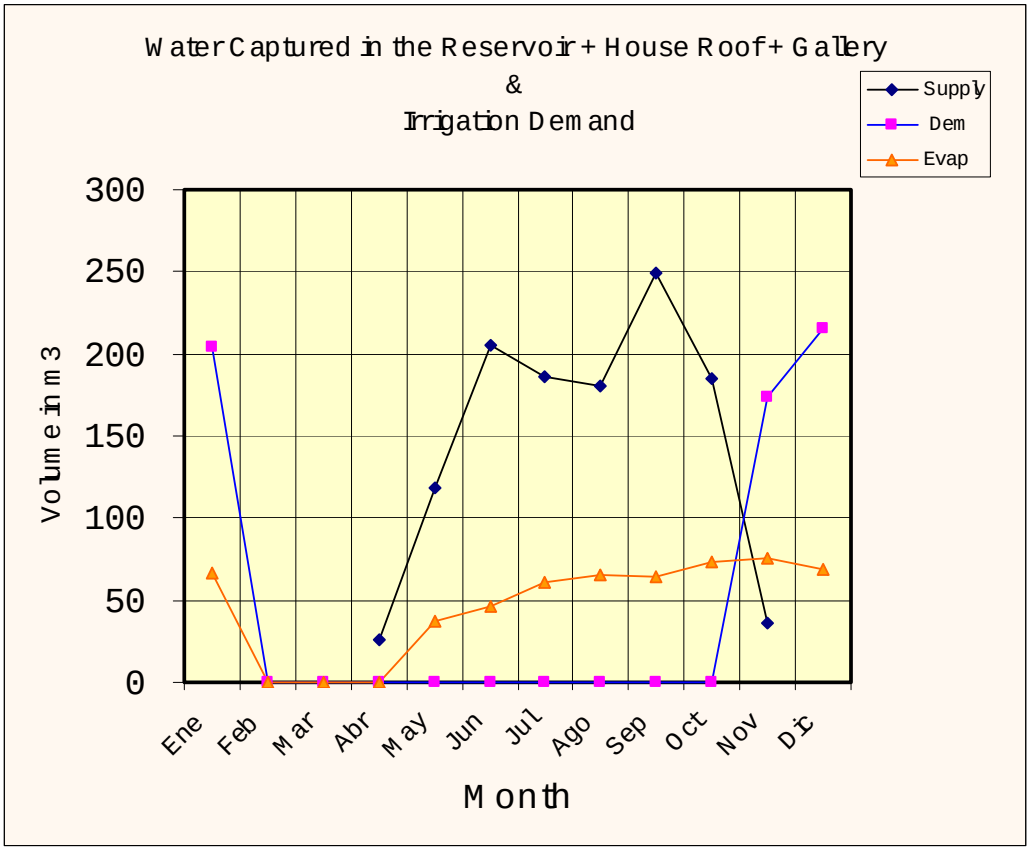
Where: V_r = is the volume of water captured from the roof during the month in m3
C = is the discharge coefficient (0.95)
P = is the monthly precipitation in mm
A_r = is the roof area in m2 (150 m2)

- Reservoirs.- The reservoirs can catch significant volumes of rainfall on their surface. For the case being analyzed, the surface area of a 1000 m3 storage reservoir is 678 m2.

Evaporation losses, E_L

The water losses due to evaporation can be very significant. In the particular case of a reservoir with 700 m2 exposed, about 700 m3 of water could be expected to evaporate during the year, depending on the operation of the reservoir. Originally it was planned to consider two alternatives for the water budget computations of the present document. The first one being the surface exposed and the second one being the surface protected with a shade net (saran), which blocks the sun rays about 80%. Unfortunately, there is no data available regarding the evaporation losses of this type of protection and the idea had to be abandoned. The loss for a three months crop scheme in Usulután is presented in Figure 3.

Figure3. Usulután Water Inflow, Irrigation Demand & Evaporation Loss for a three months crop.



Irrigation demand, Id

The monthly irrigation demand is calculated with a separate crop demand water budget model, described below. The demand for a three months crop scheme in Usulután is presented in Figure 3.

4. THE CROPS WATER BUDGET MODEL

Evapotranspiration, ET

The crop water demand can be calculated by means of the following equation:

$$ET = Kc\,ETP \qquad (4)$$

Where: ET = crop Evapotranspiration in mm
Kc = crop coefficient
ETP = potential Evapotranspiration in mm

Crops & Crop Coefficients, Kc

The crops recommended by the beneficiaries and selected by the SWDSU Team are presented in Table 3. The crop coefficients (5) and growing period from planting to harvest for these selected crops are also presented in the same table, as follows:

Table 3. Crops Coefficients

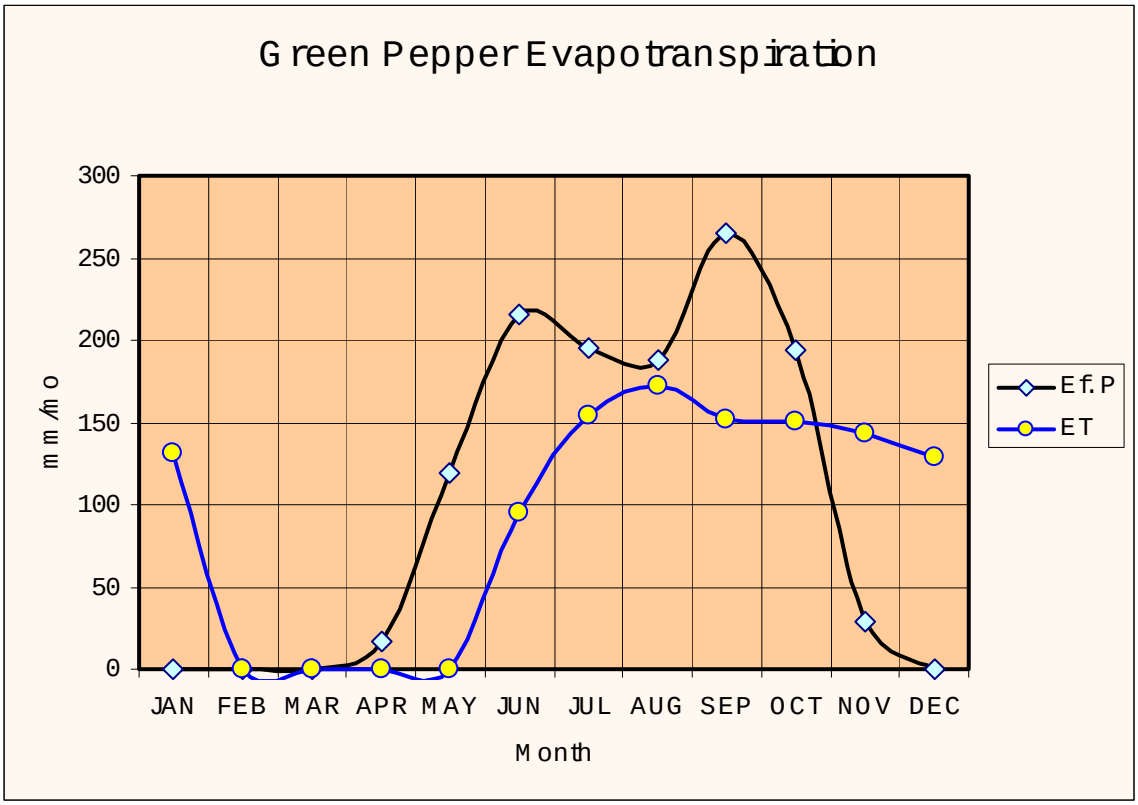
Crop	Growing Season days	Crop Coefficient for every month, Kc							
		M - 1	M – 2	M – 3	M – 4	M – 5	M – 6	M – 7	M - 8
Green pepper	240	0.60	0.90	1.05	1.05	1.05	1.05	0.90	0.90
Jalapeño	210	0.60	0.80	1.05	1.05	1.05	0.90	0.90	
Tomatoes	180	0.60	0.95	1.15	1.15	0.90	0.80		
Zucchini	90	0.60	1.00	0.90					
Squash	90	0.60	1.00	0.90					
Cucumber	90	0.60	1.00	0.90					

The crop water demand estimated for these crop coefficients are presented in Figure 4 for Green Pepper planted in June and harvested in January.

Irrigation Efficiency

The irrigation efficiency for trickle irrigation systems is high and in this particular document, as the fields are small, it is assumed to be of the order of 80%. The conveyance and distribution efficiency should be 100%, as all the water is piped and as mentioned before the systems are very small and any leaks should be easily identified and promptly fixed.

Figure 4. Usulután. Green Pepper Water Demand and Effective Precipitation for planting in June and harvesting in January (three months irrigation).



5. SCHEME ALTERNATIVES

The Alternatives

Several Alternatives can be simulated to estimate the area that can benefit from the "Reservoirs Project". To simplify the analysis in order to be able to compare the different alternatives, only four Alternatives are analyzed. For each alternative we assume the water will be used to irrigate crops for three and six months. In any case, this will allow the beneficiaries of the Project to plan the operation of their reservoir according to their own judgment.

Please observe that for the three month Alternatives the chilies and tomatoes had to be planted during the preceding rainy season to be harvested during the dry season. Zucchini, cucumbers and squashs can be planted and harvested within three months.

The Alternatives are presented in Table 4.

Table 4. Scheme Alternatives

Alternative	Description
1	Lined reservoir water fed only by its own precipitation catchment. R
2	Lined reservoir water fed by its own precipitation catchment plus a gallery. R + G
3	Lined reservoir water fed by its own precipitation catchment plus a gallery plus the water collected on a 150 m2 house roof. R + G + T
4	Lined reservoir water fed by its own precipitation catchment plus the water collected on a 160 m2 house roof. R + T

6. THE SIMULATION AND THE RESULTS

The Crops

For the present simulations process, the areas assigned to each of the crops, but the cucumbers is the same; about 14% of the total area. The spreadsheet template to calculate the crop's water budget assigns the percentage mentioned above to estimate the water requirements of each particular crop, according to its own crop coefficients. The simulation details are presented in Annexes B & C.

The Reservoir

The reservoir for this particular exercise has the following physical characteristics:

- Volume = 1,000 m3
- Top length = 30 m
- Top width = 22 m
- Depth = 2.1 m
- Side slope = 2:1

Areas that can be Irrigated

USULUTAN SCHEMES

The areas that can be benefited by a 1000 m3 reservoir on each of the alternatives described above are presented in Table 5. The detailed computations for each of the four alternatives for 3 and 6 months crops are presented in Annex B.

Table 5. Areas that can be irrigated under different Alternatives in USULUTAN

Areas that can be irrigated in m2				
Scenarios	**Alternative No. 1 R**	**Alternative No. 2 R + G**	**Alternative No. 3 R + G + T**	**Alternative No. 4 R + T**
Nov. to Jan. 3 months	1260	1900	1920	1670
Nov. to Apr. 6 months	530	840	840	740

AHUACHAPAN SCHEMES

The areas that can be benefited by a 1000 m3 reservoir on each of the alternatives described above are presented in Table 6. The detailed computations for each of the four alternatives for 3 and 6 months crops are presented in Annex C.

Table 6. Areas that can be irrigated under different Alternatives in AHUACHAPAN

Areas that can be irrigated in m2				
Scenarios	**Alternative No. 1 R**	**Alternative No. 2 R + G**	**Alternative No. 3 R + G + T**	**Alternative No. 4 R + T**
Nov. to Jan. 3 months	1900	2400	2490	1950
Nov. to Apr. 6 months	820	1020	1020	850

7. CONCLUSSIONS AND RECOMENDATIONS

The areas that can be benefited by the reservoirs are significant if we consider that the beneficiaries are small farmers, who have nothing to do during the dry season. The area benefited will require the owner to work full time in their orchard, which is a benefit by itself, as the person becomes selfemployed.

The reservoirs systems will provide a reliable source of usable water during the dry season, opening a more lucrative market to their products

The analysis shows that the three months crop can irrigate more than twice the area than the six months crop, which should be obvious, as the number of months of irrigation applications is also twice as long. However, the difference is

the volume of water loss through evaporation, which is of the order of 20% of the total volume stored. Nevertheless, the final decision whether to irrigate during three or six months, should be economical and not merely based on the water budget.

The analysis shows that the potential area to be benefited between Alternatives 2 & 3 i.e. between having a Reservoir plus a gallery with and without a roof runoff is negligible. The reason being that the limiting factor is the size of the reservoir, as significant volume of water is spilled out of the reservoir. Both catchment systems have their own advantages. The gallery can catch a significant volume of water even during the transition months of May and November, when there is little precipitation. The water captured during November has significant impact, increasing the total area to be benefited. The roof runoff has the main advantage that it requires less operation and maintenance.

An economic analysis is recommended, as the operations and management costs must be included in the analysis before final conclusions are drawn.

BIBLIOGRAPHY

(1) Plan Nacional de Ordenamiento y Desarrollo Territorial

(2) Ministerio de Agricultura y Ganadería "Almanaque Salvadoreño 1993"

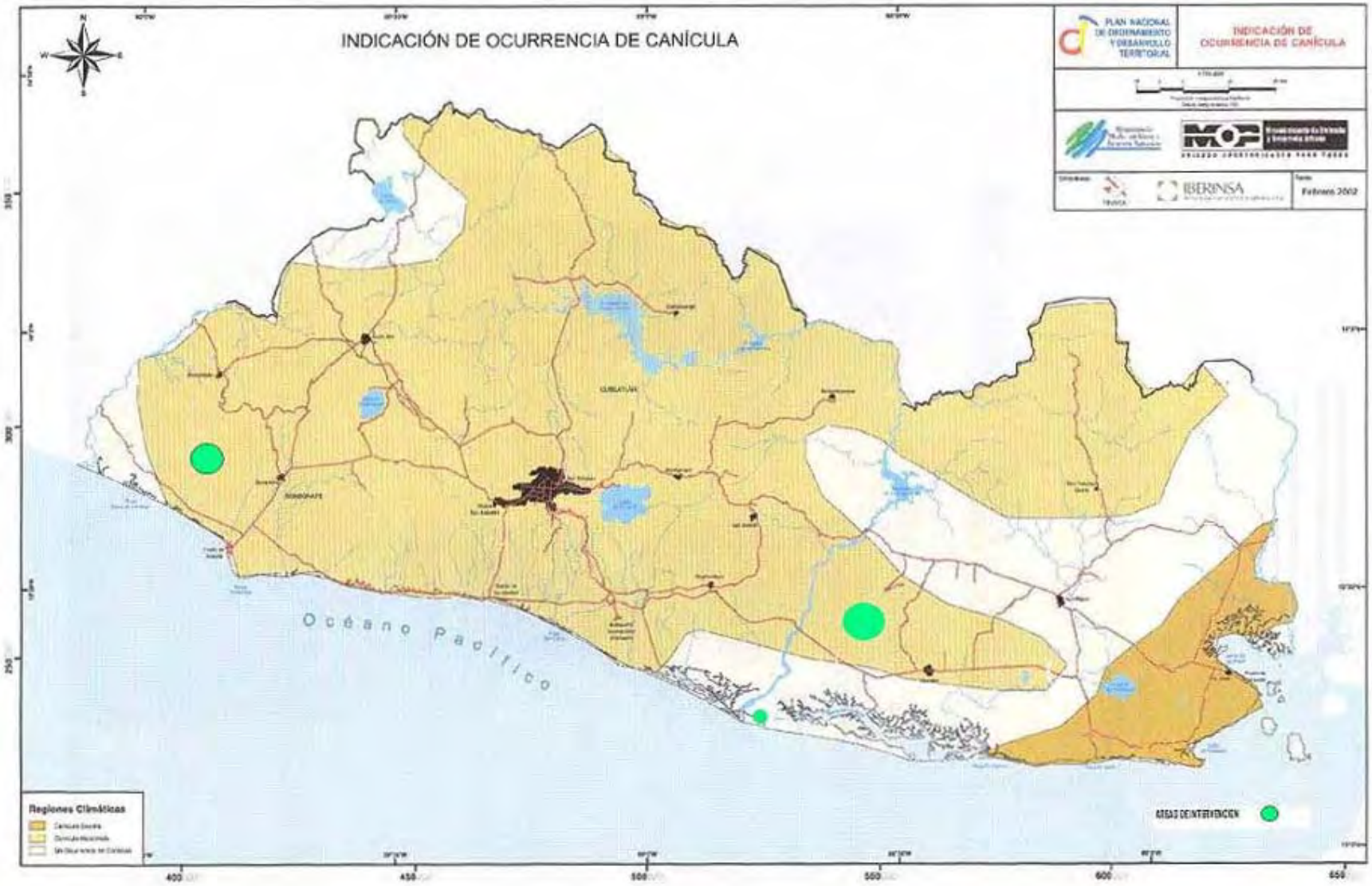
(3) *Harza & Garcia-Prieto 1961 "Informe de Factibilidad – Proyecto de Olomega en el Río Grande de San Miguel" (3). Vol II Apendices.*

(4) Moore John. "Embassy Science Fellow Report. January 2003.

(5) FAO Publication No.56

APPENDIX A

- CANICULA SPATIAL DISTRIBUTION
- El SALVADOR ISOHYETS


INDICACIÓN DE OCURRENCIA DE CANÍCULA
PLAN NACIONAL DE ORDENAMIENTO Y DESARROLLO TERRITORIAL
INDICACIÓN DE OCURRENCIA DE CANÍCULA
IBERINSA
Febrero 2002
Océano Pacífico
Regiones Climáticas
AREAS DE INTERVENCION

PLUVIOMETRÍA. ISOYETAS MEDIAS ANUALES
PLUVIOMETRIA
ISOYETAS MEDIAS ANUALES
Océano Pacífico
Pluviometría

APPENDIX B

WATER BUDGET FOR THE FOUR DIFFERENT SCENARIOS THREE AND SIX MONTHS, CROPS FOR USULUTAN

USULUTAN RESERVOIRS OPERATION SIMULATION

SCENARIO Reservoir + Gallery + Roof

3 months

Initial Water Volume in April	0	m3
Annual Evaporation	1759	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	376.76	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Water Level in April	0.00	m Depth
Irrigated Area	1920.00	m2

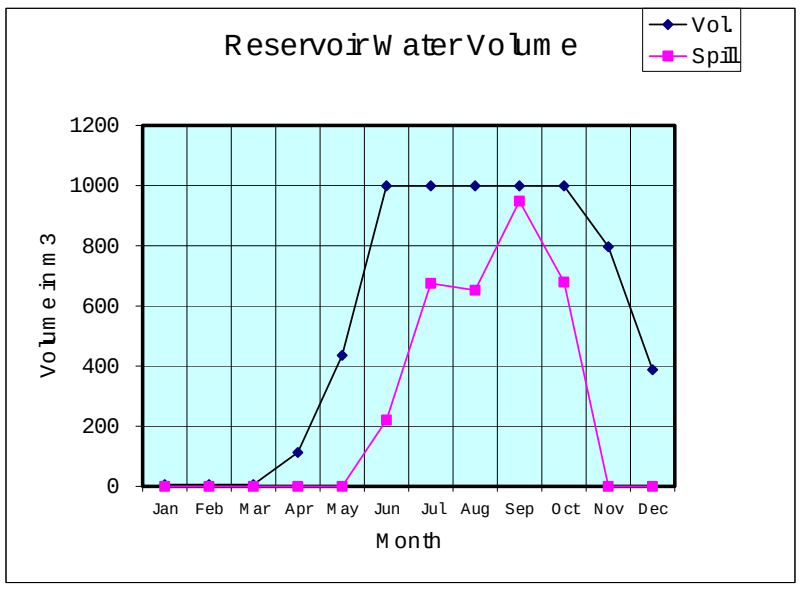
Rainfall Catchment Area		
Reservoir	678	m2
Roof	150	m2
Gallery Watershed	10	ha

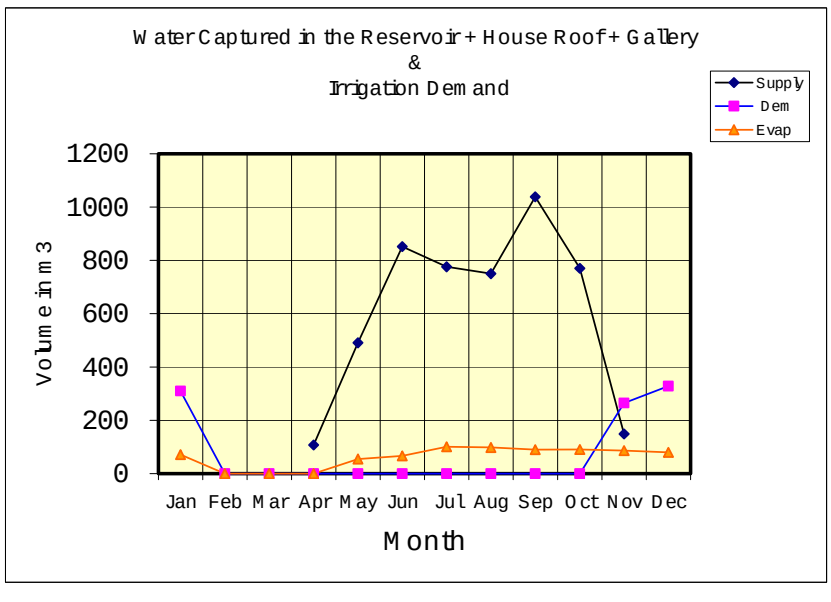
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	RED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Wate (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	VolReservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	2					8.75	154.0	467.4	72	0	34.32	310	6	0.04	0
2	Feb	28	1					8.24	145.0	0.0	0	0	0.00	0	6	0.04	0
3	Mar	31	6					11.31	199.0	0.0	0	0	0.00	0	6	0.04	0
4	Apr	30	38	26	5	76	107	9.04	159.0	0.0	0	0	0.00	0	113	0.33	0
5	May	31	174	118	25	348	491	8.75	154.0	359.7	55	0	0.00	0	435	1.08	0
6	Jun	30	302	205	43	604	852	7.90	139.0	482.4	67	0	0.00	0	999	1.98	221
7	Jul	31	275	186	39	550	776	8.30	146.0	689.1	101	0	0.00	0	999	1.98	675
8	Aug	31	266	180	38	532	750	8.13	143.0	689.1	99	0	0.00	0	999	1.98	652
9	Sep	30	368	250	52	736	1038	7.39	130.0	689.1	90	0	0.00	0	999	1.98	948
10	Oct	31	273	185	39	546	770	7.50	132.0	689.1	91	0	0.00	0	999	1.98	679
11	Nov	30	53	36	8	106	149	7.16	126.0	689.1	87	0	29.35	265	796	1.72	0
12	Dec	31	5					7.50	132.0	606.0	80	0	36.33	328	388	0.98	0
		365	1763	1186	249	3498	4933	100.00	1759.0		741	0.00	100.00	904			3175

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
VolReservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olmeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

Santa Cruz Porrillo

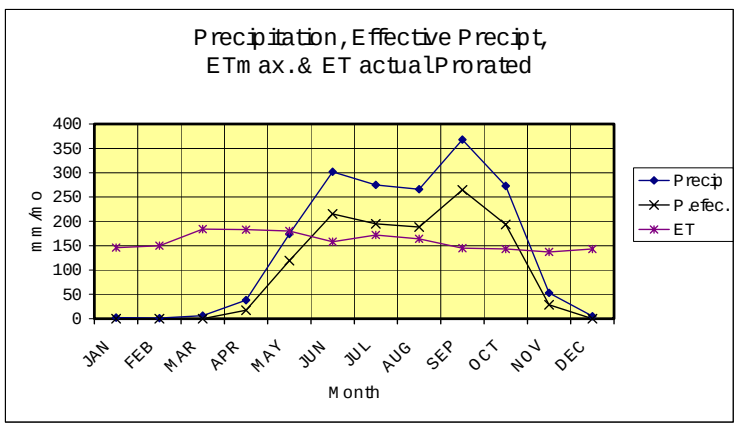
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

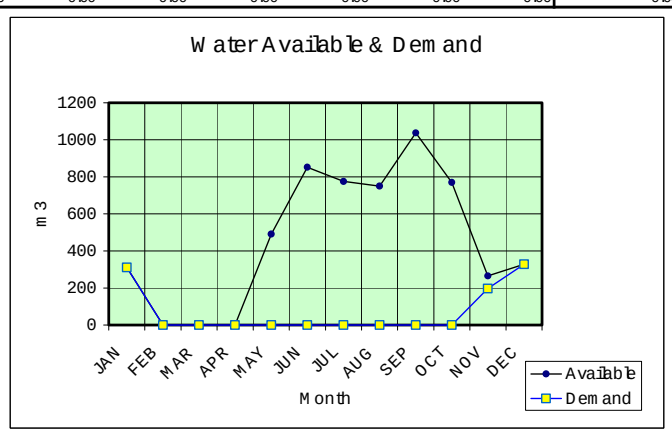
USULUTAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 1920

		Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL
1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000
	AREA UNDER OPTIMUM IRRIG, ha	0.027	0.027	0.027	0.027	0.027	0.055	0.000	0.000	0.000	0.000	0.1920
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	

2a	Perim.Max.Ha	10.00
2b	Factor Area	0.2743
2c	Cap.Canal lps	40.00

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.71	5.36	5.94	6.10	5.81	5.27	5.55	5.29	4.83	4.61	4.57	4.61		
3b	ET (mm/month)	146.00	150.00	184.00	183.00	180.00	158.00	172.00	164.00	145.00	143.00	137.00	143.00	1905.00	
4a	Prec. (mm.)	2.00	1.00	6.00	38.00	174.00	302.00	275.00	266.00	368.00	273.00	53.00	5.00	1763.00	
4b	Prec.Efec. (mm.)	0.00	0.00	0.00	17.25	119.25	215.25	195.00	188.25	264.75	193.50	28.50	0.00	1221.75	
5a	Kc (Crop No.1) Green Peppers	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	ETactual	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	Irr.Req. (mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	128.70	375.45	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.027
	Net Req. (m3)	36.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.64	35.30	103	
6a	Kc (Crop No.2) Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	ETactual	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	Irr.Req. (mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	128.70	375.45	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.027
	Net Req. (m3)	36.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.64	35.30	103	
7a	Kc (Crop No.3) Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax	116.80	0.00	0.00	0.00	0.00	0.00	0.00	98.40	137.75	164.45	157.55	128.70		
	ETactual	116.80	0.00	0.00	0.00	0.00	0.00	0.00	98.40	137.75	164.45	157.55	128.70	803.65	
	Irr.Req. (mm.)	116.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	129.05	128.70	374.55	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03		0.027
	Net Req. (m3)	32.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.40	35.30	103	
8a	Kc (Crop No.4) Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req. (mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03		0.027
	Net Req. (m3)	36.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.73	39.22	90	
9a	Kc (Crop No.5) Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req. (mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03		0.027
	Net Req. (m3)	36.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.73	39.22	90.00	
10a	Kc (Crop No.6) Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req. (mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05		0.055
	Net Req. (m3)	72.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.46	78.45	180	
	Area Total (ha.)	0.19	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.08	0.19	0.19	0.19	Correcto
	Net Req. (m3)	248	0	0	0	0	0	0	0	0	0	158	263	669	Sum
	Net Irrig. Req. (mm)	129.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.08	136.87	348.26	Sum
	Consumo Ponderado (mm)	129.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	110.58	136.87	376.76	
	Factor Demanda Riegos %	34.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.35	36.33	100.00	
A	Net Irrig. Req. (l/s)	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.10	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.51	0.109	Avg
WATER DEMAND															
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	161.643	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	102.598	171.089	435.330	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.12	0.026	Avg
	Gross Irrig. Req. (m3)	310	0	0	0	0	0	0	0	0	0	197	329	836	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.604	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.396	0.639	0.137	Avg
WATER AVAILABLE															
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	310	0	0	0	491	852	776	750	1,038	770	265	328	5,581	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	310	0	0	0	491	852	776	750	1,038	770	265	328	5,581	Sum
E"	TOTAL (l/s)	0.12	0.00	0.00	0.00	0.18	0.33	0.29	0.28	0.40	0.29	0.10	0.12	0.176	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.12	0.00	0.00	0.00	0.18	0.33	0.29	0.28	0.40	0.29	0.10	0.12	0.176	Avg
	Actual Water Available (m3)	310	0	0	0	491	852	776	750	1,038	770	265	328	5,581	Sum
BALANCE															
C/D	Irrigation Area (ha)	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.19		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.18	0.33	0.29	0.28	0.40	0.29	0.03	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	0	491	852	776	750	1038	770	68	0	4,745	Sum
G=E/D	Max.Irrig. Area (ha)	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.19		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

USULUTAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir + Gallery

3 months

Initial Water Volume in April	0	m3
Annual Evaporation	1759	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	376.76	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	1900.00	m2

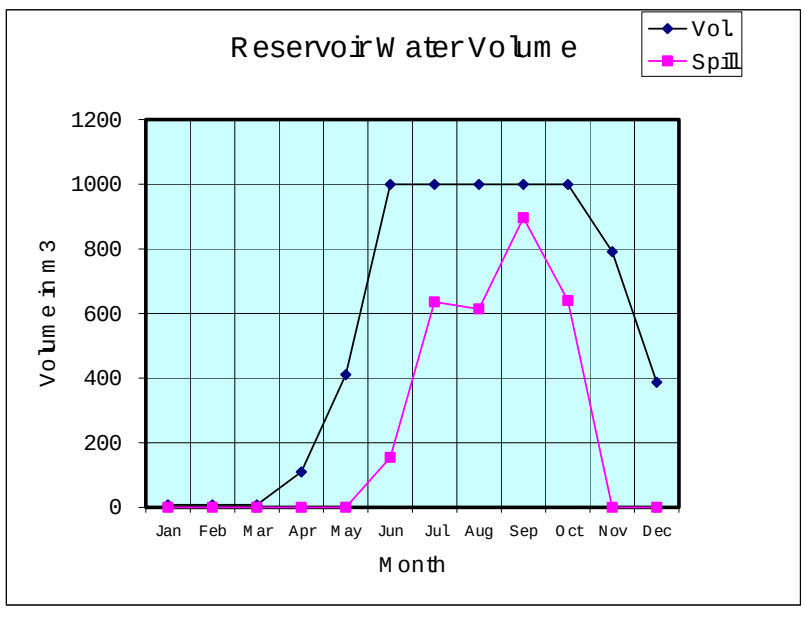
Rainfall Catchment Area		
Reservoir	678	m2
Roof	0	m2
Gallery Watershed	10	ha

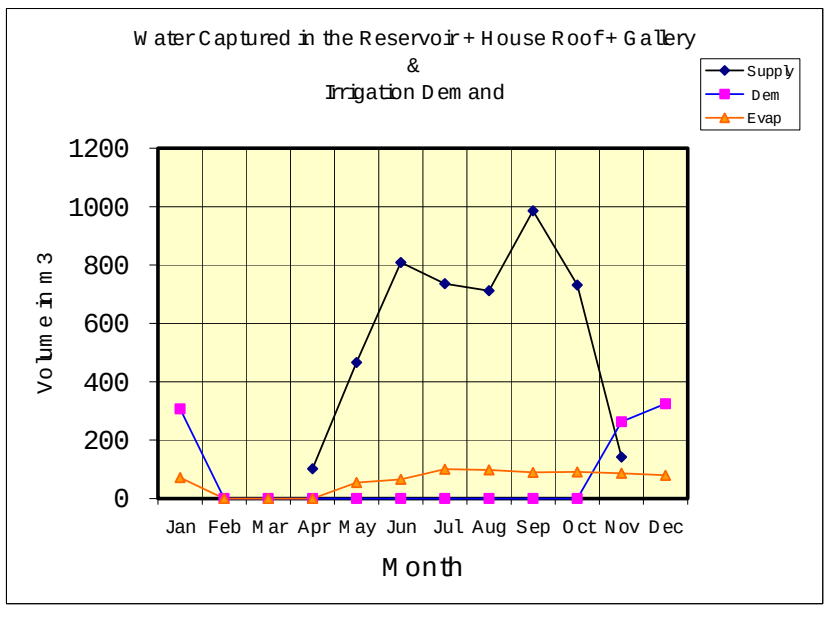
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Wate (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol.Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	2					8.75	154.0	467.0	72	0	34.32	307	8	0.05	0
2	Feb	28	1					8.24	145.0	0.0	0	0	0.00	0	8	0.05	0
3	Mar	31	6					11.31	199.0	0.0	0	0	0.00	0	8	0.05	0
4	Apr	30	38	26	0	76	102	9.04	159.0	0.0	0	0	0.00	0	110	0.32	0
5	May	31	174	118	0	348	466	8.75	154.0	357.4	55	0	0.00	0	411	1.03	0
6	Jun	30	302	205	0	604	809	7.90	139.0	474.7	66	0	0.00	0	999	1.98	155
7	Jul	31	275	186	0	550	736	8.30	146.0	689.1	101	0	0.00	0	999	1.98	636
8	Aug	31	266	180	0	532	712	8.13	143.0	689.1	99	0	0.00	0	999	1.98	614
9	Sep	30	368	250	0	736	986	7.39	130.0	689.1	90	0	0.00	0	999	1.98	896
10	Oct	31	273	185	0	546	731	7.50	132.0	689.1	91	0	0.00	0	999	1.98	640
11	Nov	30	53	36	0	106	142	7.16	126.0	689.1	87	0	29.35	263	792	1.71	0
12	Dec	31	5					7.50	132.0	604.2	80	0	36.33	325	387	0.98	0
		365	1763	1186	0	3498	4684	100.00	1759.0		739	0.00	100.00	895			2940

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol.Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

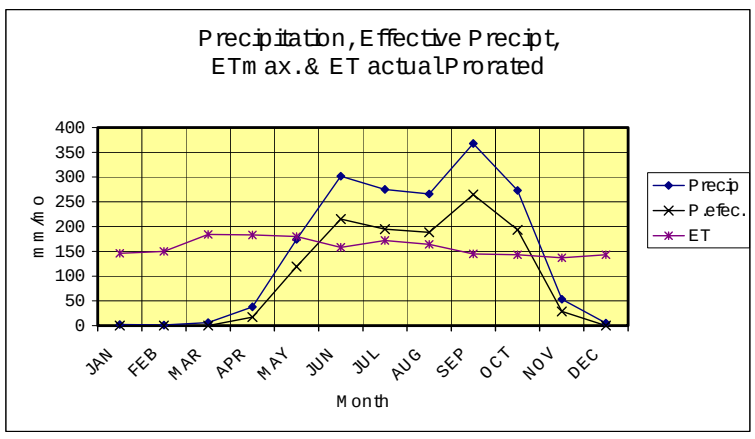
Santa Cruz Porrillo

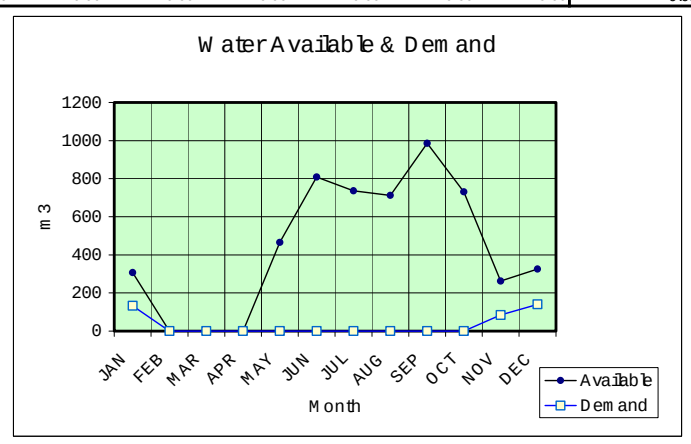
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

USULUTAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 820

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	2a	Perim.Max.Ha 10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	2b	Factor Area 0.1171
	AREA UNDER OPTIMUM IRRIG, ha	0.012	0.012	0.012	0.012	0.012	0.023	0.000	0.000	0.000	0.000	0.0820	2c	Cap.Canal lps 40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.71	5.36	5.94	6.10	5.81	5.27	5.55	5.29	4.83	4.61	4.57	4.61		
3b	ET (mm/month)	146.00	150.00	184.00	183.00	180.00	158.00	172.00	164.00	145.00	143.00	137.00	143.00	1905.00	
4a	Prec. (mm.)	2.00	1.00	6.00	38.00	174.00	302.00	275.00	266.00	368.00	273.00	53.00	5.00	1763.00	
4b	Prec. Efec. (mm.)	0.00	0.00	0.00	17.25	119.25	215.25	195.00	188.25	264.75	193.50	28.50	0.00	1221.75	
5a	Kc (Crop No.1) Green Peppers	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	ETactual	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	128.70	375.45	
	Area (ha)	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	15.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.51	15.07	44	
6a	Kc (Crop No.2) Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	ETactual	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	128.70	375.45	
	Area (ha)	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	15.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.51	15.07	44	
7a	Kc (Crop No.3) Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax	116.80	0.00	0.00	0.00	0.00	0.00	0.00	98.40	137.75	164.45	157.55	128.70		
	ETactual	116.80	0.00	0.00	0.00	0.00	0.00	0.00	98.40	137.75	164.45	157.55	128.70	803.65	
	Irr.Req.(mm.)	116.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	129.05	128.70	374.55	
	Area (ha)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	13.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.11	15.07	44	
8a	Kc (Crop No.4) Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01		0.012
	Net Req. (m3)	15.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.29	16.75	38	
9a	Kc (Crop No.5) Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01		0.012
	Net Req. (m3)	15.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.29	16.75	38.42	
10a	Kc (Crop No.6) Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02		0.023
	Net Req. (m3)	30.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.58	33.49	77	
	Area Total (ha.)	0.08	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.04	0.08	0.08	0.08	Correcto
	Net Req. (m3)	106	0	0	0	0	0	0	0	0	0	67	112	285	Sum
	Net Irrig. Req. (mm)	129.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.08	136.87	348.26	Sum
	Consumo Ponderado (mm)	129.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	110.58	136.87	376.76	
	Factor Demanda Riegos %	34.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.35	36.33	100.00	
A	Net Irrig. Req. (l/s)	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.01	Avg
B	Net Irrig. Req. (l/s/ha)	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.51	0.109	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	161.643	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	102.598	171.089	435.330	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.011	Avg
	Gross Irrig. Req. (m3)	132	0	0	0	0	0	0	0	0	0	84	140	357	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.604	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.396	0.639	0.137	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	307	0	0	0	466	809	736	712	986	731	263	325	5,335	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	307	0	0	0	466	809	736	712	986	731	263	325	5,335	Sum
E"	TOTAL (l/s)	0.11	0.00	0.00	0.00	0.17	0.31	0.27	0.27	0.38	0.27	0.10	0.12	0.168	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.11	0.00	0.00	0.00	0.17	0.31	0.27	0.27	0.38	0.27	0.10	0.12	0.168	Avg
	Actual Water Available (m3)	307	0	0	0	466	809	736	712	986	731	263	325	5,335	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08		
F=E-C	Exceeding/Deficit Water (l/s)	0.07	0.00	0.00	0.00	0.17	0.31	0.27	0.27	0.38	0.27	0.07	0.07		
	Exceeding/Deficit Water (m3)	175	0	0	0	466	809	736	712	986	731	179	185	4,978	Sum
G=E/D	Max.Irrig. Area (ha)	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.19		
H=F/D	Additional Area (has.)	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.11		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

USULUTAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir + Roof

3 months

Initial Water Volume in April	0	m3
Annual Evaporation	1759	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	376.76	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	1670.00	m2

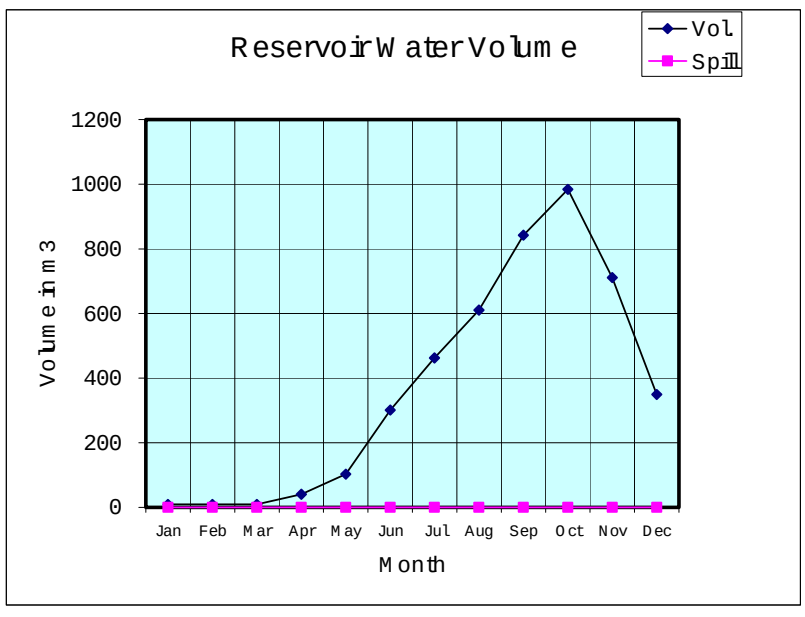
Rainfall Catchment Area		
Reservoir	678	m2
Roof	150	m2
Gallery Watershed	0	ha

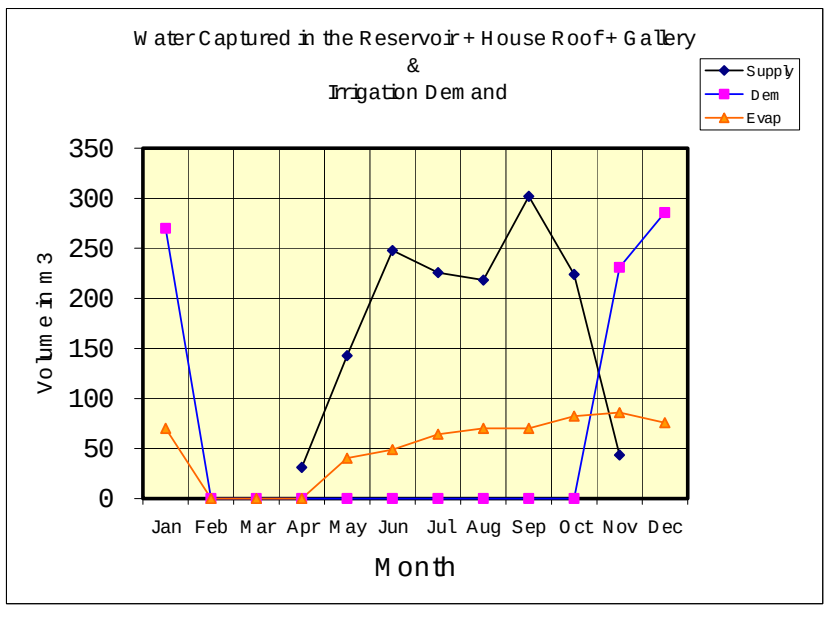
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip.	CAPTURED VOLUME (m3)				Fac.Ea	Ea	Surface Wate	Ev	Inf.	Fac.Ir.	Ir.	Vol Reservoir		Spill
			mm	Reser.	Roof	Gallery	TOTAL	(%)	(mm)	(m2)	(m3)	(m3)	(%)	(m3)	(m3)	Prof. (m)	(m3)
1	Jan	31	2					8.75	154.0	455.1	70	0	34.32	270	9	0.05	0
2	Feb	28	1					8.24	145.0	0.0	0	0	0.00	0	9	0.05	0
3	Mar	31	6					11.31	199.0	0.0	0	0	0.00	0	9	0.05	0
4	Apr	30	38	26	5	0	31	9.04	159.0	0.0	0	0	0.00	0	40	0.14	0
5	May	31	174	118	25	0	143	8.75	154.0	262.4	40	0	0.00	0	102	0.30	0
6	Jun	30	302	205	43	0	248	7.90	139.0	352.1	49	0	0.00	0	301	0.79	0
7	Jul	31	275	186	39	0	226	8.30	146.0	439.5	64	0	0.00	0	463	1.14	0
8	Aug	31	266	180	38	0	218	8.13	143.0	491.1	70	0	0.00	0	611	1.42	0
9	Sep	30	368	250	52	0	302	7.39	130.0	539.6	70	0	0.00	0	842	1.78	0
10	Oct	31	273	185	39	0	224	7.50	132.0	623.8	82	0	0.00	0	984	1.96	0
11	Nov	30	53	36	8	0	43	7.16	126.0	682.5	86	0	29.35	231	711	1.59	0
12	Dec	31	5					7.50	132.0	574.4	76	0	36.33	286	349	0.90	0
		365	1763	1186	249	0	1435	100.00	1759.0		608	0.00	100.00	786			0

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

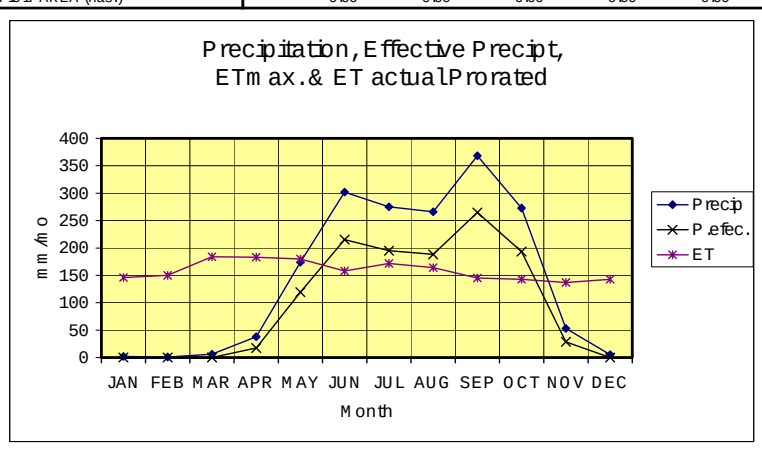
Santa Cruz Porrillo

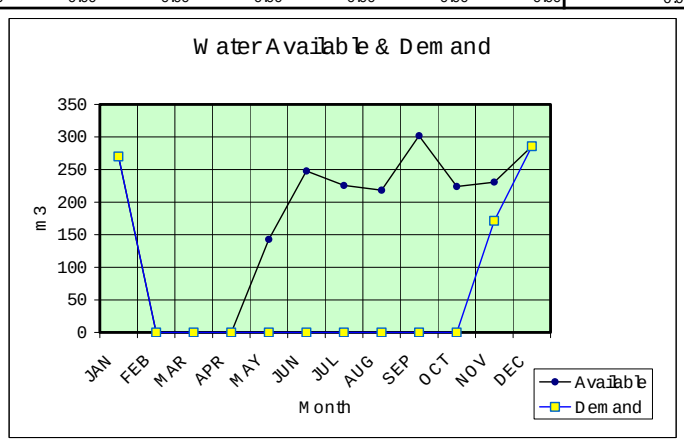
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

USULUTAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 1670

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	2a	Perim.Max.Ha	10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	2b	Factor Area	0.2385
	AREA UNDER OPTIMUM IRRIG, ha	0.024	0.024	0.024	0.024	0.024	0.048	0.000	0.000	0.000	0.000	0.1670	2c	Cap.Canal lps	40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.71	5.36	5.94	6.10	5.81	5.27	5.55	5.29	4.83	4.61	4.57	4.61		
3b	ET (mm/month)	146.00	150.00	184.00	183.00	180.00	158.00	172.00	164.00	145.00	143.00	137.00	143.00	1905.00	
4a	Prec. (mm.)	2.00	1.00	6.00	38.00	174.00	302.00	275.00	266.00	368.00	273.00	53.00	5.00	1763.00	
4b	Prec. Efec. (mm.)	0.00	0.00	0.00	17.25	119.25	215.25	195.00	188.25	264.75	193.50	28.50	0.00	1221.75	
5a	Kc (Crop No.1) Green Peppers	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	ETactual	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	128.70	375.45	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.024
	Net Req. (m3)	31.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.51	30.69	90	
6a	Kc (Crop No.2) Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	ETactual	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	128.70	375.45	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.024
	Net Req. (m3)	31.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.51	30.69	90	
7a	Kc (Crop No.3) Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax	116.80	0.00	0.00	0.00	0.00	0.00	0.00	98.40	137.75	164.45	157.55	128.70		
	ETactual	116.80	0.00	0.00	0.00	0.00	0.00	0.00	98.40	137.75	164.45	157.55	128.70	803.65	
	Irr.Req.(mm.)	116.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	129.05	128.70	374.55	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02		0.024
	Net Req. (m3)	27.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.78	30.69	89	
8a	Kc (Crop No.4) Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02		0.024
	Net Req. (m3)	31.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.81	34.11	78	
9a	Kc (Crop No.5) Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02		0.024
	Net Req. (m3)	31.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.81	34.11	78.25	
10a	Kc (Crop No.6) Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05		0.048
	Net Req. (m3)	62.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.61	68.21	157	
	Area Total (ha.)	0.17	0.00	0.00	0.00	0.00	0.05	0.05	0.07	0.07	0.07	0.17	0.17	0.17	Correcto
	Net Req. (m3)	216	0	0	0	0	0	0	0	0	0	137	229	581	Sum
	Net Irrig. Req. (mm)	129.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.08	136.87	348.26	Sum
	Consumo Ponderado (mm)	129.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	110.58	136.87	376.76	
	Factor Demanda Riegos %	34.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.35	36.33	100.00	
A	Net Irrig. Req. (l/s)	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.51	0.109	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	161.643	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	102.598	171.089	435.330	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.11	0.023	Avg
	Gross Irrig. Req. (m3)	270	0	0	0	0	0	0	0	0	0	171	286	727	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.604	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.396	0.639	0.137	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	270	0	0	0	143	248	226	218	302	224	231	286	2,147	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	270	0	0	0	143	248	226	218	302	224	231	286	2,147	Sum
E"	TOTAL (l/s)	0.10	0.00	0.00	0.00	0.05	0.10	0.08	0.08	0.12	0.08	0.09	0.11	0.068	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.10	0.00	0.00	0.00	0.05	0.10	0.08	0.08	0.12	0.08	0.09	0.11	0.068	Avg
	Actual Water Available (m3)	270	0	0	0	143	248	226	218	302	224	231	286	2,147	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.17		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.05	0.10	0.08	0.08	0.12	0.08	0.02	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	0	143	248	226	218	302	224	60	0	1,420	Sum
G=E/D	Max.Irrig.Area (ha)	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.17		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

USULUTAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir

3 months

Initial Water Volume in April	0	m3
Annual Evaporation	1759	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	376.76	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	1260.00	m2

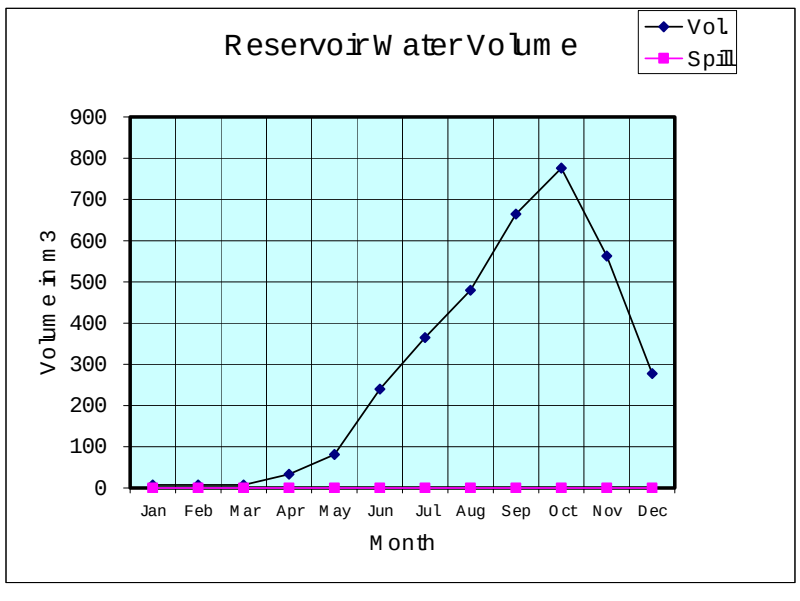
Rainfall Catchment Area		
Reservoir	678	m2
Roof	0	m2
Gallery Watershed	0	ha

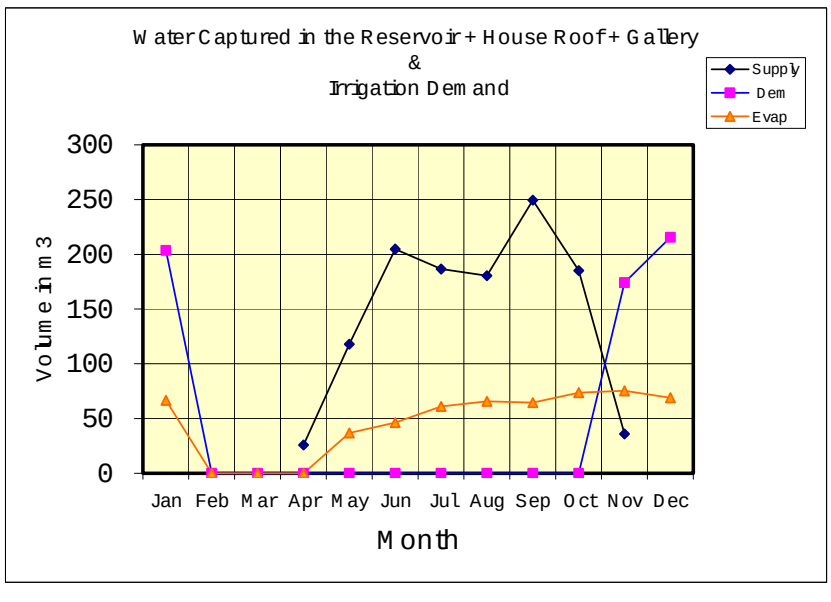
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Water (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	2					8.75	154.0	431.7	66	0	34.32	204	8	0.05	0
2	Feb	28	1					8.24	145.0	0.0	0	0	0.00	0	8	0.05	0
3	Mar	31	6					11.31	199.0	0.0	0	0	0.00	0	8	0.05	0
4	Apr	30	38	26	0	0	26	9.04	159.0	0.0	0	0	0.00	0	33	0.12	0
5	May	31	174	118	0	0	118	8.75	154.0	238.3	37	0	0.00	0	81	0.25	0
6	Jun	30	302	205	0	0	205	7.90	139.0	333.1	46	0	0.00	0	240	0.65	0
7	Jul	31	275	186	0	0	186	8.30	146.0	418.5	61	0	0.00	0	365	0.93	0
8	Aug	31	266	180	0	0	180	8.13	143.0	460.1	66	0	0.00	0	480	1.17	0
9	Sep	30	368	250	0	0	250	7.39	130.0	496.5	65	0	0.00	0	665	1.51	0
10	Oct	31	273	185	0	0	185	7.50	132.0	558.1	74	0	0.00	0	776	1.69	0
11	Nov	30	53	36	0	0	36	7.16	126.0	598.3	75	0	29.35	174	562	1.33	0
12	Dec	31	5					7.50	132.0	523.4	69	0	36.33	216	278	0.74	0
		365	1763	1186	0	0	1186	100.00	1759.0		559	0.00	100.00	593			0

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olmeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

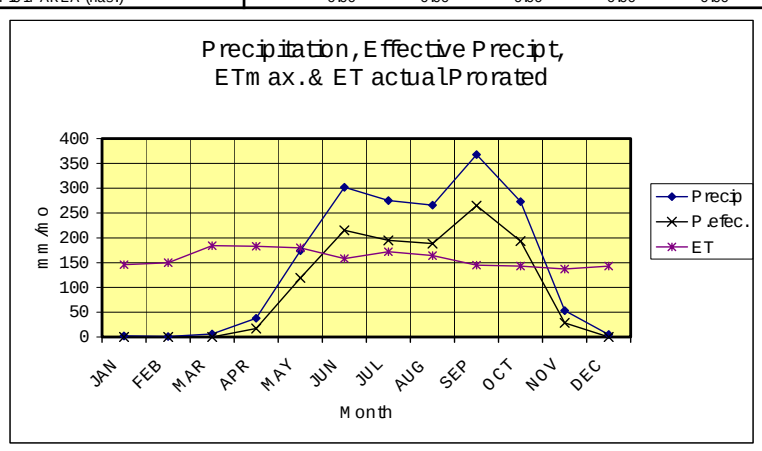
Santa Cruz Porrillo

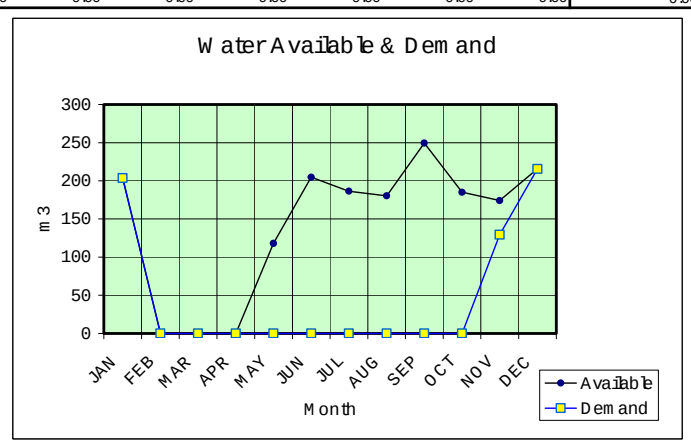
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

USULUTAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 1260

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	2a	Perim.Max.Ha 10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	2b	Factor Area 0.1800
	AREA UNDER OPTIMUM IRRIG, ha	0.018	0.018	0.018	0.018	0.018	0.036	0.000	0.000	0.000	0.000	0.1260	2c	Cap.Canal lps 40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.71	5.36	5.94	6.10	5.81	5.27	5.55	5.29	4.83	4.61	4.57	4.61		
3b	ET (mm/month)	146.00	150.00	184.00	183.00	180.00	158.00	172.00	164.00	145.00	143.00	137.00	143.00	1905.00	
4a	Prec. (mm.)	2.00	1.00	6.00	38.00	174.00	302.00	275.00	266.00	368.00	273.00	53.00	5.00	1763.00	
4b	Prec. Efec. (mm.)	0.00	0.00	0.00	17.25	119.25	215.25	195.00	188.25	264.75	193.50	28.50	0.00	1221.75	
5a	Kc (Crop No.1) Green Peppers	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	ETactual	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	128.70	375.45	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.018
	Net Req. (m3)	23.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.76	23.17	68	
6a	Kc (Crop No.2) Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	ETactual	131.40	0.00	0.00	0.00	0.00	94.80	154.80	172.20	152.25	150.15	143.85	128.70	1128.15	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	128.70	375.45	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.018
	Net Req. (m3)	23.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.76	23.17	68	
7a	Kc (Crop No.3) Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax	116.80	0.00	0.00	0.00	0.00	0.00	0.00	98.40	137.75	164.45	157.55	128.70		
	ETactual	116.80	0.00	0.00	0.00	0.00	0.00	0.00	98.40	137.75	164.45	157.55	128.70	803.65	
	Irr.Req.(mm.)	116.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	129.05	128.70	374.55	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02		0.018
	Net Req. (m3)	21.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.23	23.17	67	
8a	Kc (Crop No.4) Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02		0.018
	Net Req. (m3)	23.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.67	25.74	59	
9a	Kc (Crop No.5) Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02		0.018
	Net Req. (m3)	23.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.67	25.74	59.06	
10a	Kc (Crop No.6) Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00		
	ETactual	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.20	143.00	356.60	
	Irr.Req.(mm.)	131.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.70	143.00	328.10	
	Area (ha)	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04		0.036
	Net Req. (m3)	47.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.33	51.48	118	
	Area Total (ha.)	0.13	0.00	0.00	0.00	0.00	0.04	0.04	0.05	0.05	0.05	0.13	0.13	0.13	Correcto
	Net Req. (m3)	163	0	0	0	0	0	0	0	0	0	103	172	439	Sum
	Net Irrig. Req. (mm)	129.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.08	136.87	348.26	Sum
	Consumo Ponderado (mm)	129.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	110.58	136.87	376.76	
	Factor Demanda Riegos %	34.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.35	36.33	100.00	
A	Net Irrig. Req. (l/s)	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.01	Avg
B	Net Irrig. Req. (l/s/ha)	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.51	0.109	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	161.643	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	102.598	171.089	435.330	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.08	0.017	Avg
	Gross Irrig. Req. (m3)	204	0	0	0	0	0	0	0	0	0	129	216	549	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.604	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.396	0.639	0.137	Avg
	WATER AVAILABLE														
16a	Name… (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	204	0	0	0	118	205	186	180	250	185	174	216	1,718	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	204	0	0	0	118	205	186	180	250	185	174	216	1,718	Sum
E"	TOTAL (l/s)	0.08	0.00	0.00	0.00	0.04	0.08	0.07	0.07	0.10	0.07	0.07	0.08	0.054	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.08	0.00	0.00	0.00	0.04	0.08	0.07	0.07	0.10	0.07	0.07	0.08	0.054	Avg
	Actual Water Available (m3)	204	0	0	0	118	205	186	180	250	185	174	216	1,718	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.04	0.08	0.07	0.07	0.10	0.07	0.02	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	0	118	205	186	180	250	185	45	0	1,169	Sum
G=E/D	Max Irrig. Area (ha)	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.13		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

USULUTAN RESERVOIRS OPERATION SIMULATION

SCENARIO Reservoir + Gallery + Roof

6 months

Initial Water Volume in April	0	m3
Annual Evaporation	1759	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	704.57	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	840.00	m2

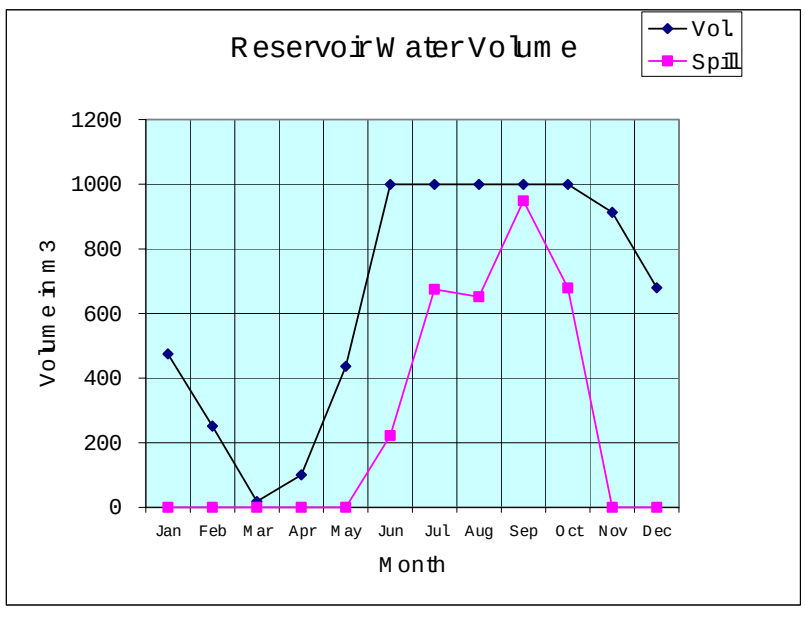
Rainfall Catchment Area		
Reservoir	678	m2
Roof	150	m2
Gallery Watershed	10	ha

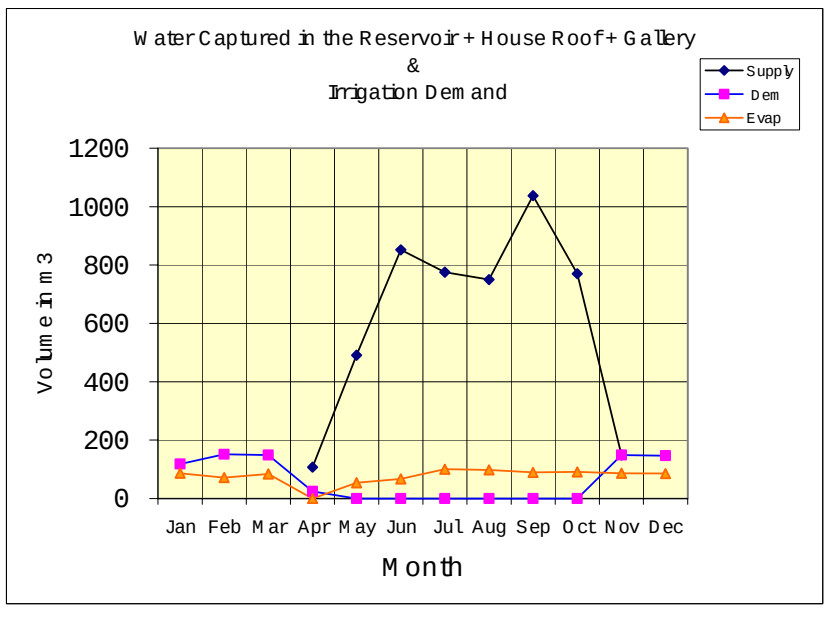
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip.	CAPTURED VOLUME (m3)				Fac.Ea	Ea	Surface Wate	Ev	Inf.	Fac.Ir.	Ir.	Vol Reservoir		Spill
			mm	Reser.	Roof	Gallery	TOTAL	(%)	(mm)	(m2)	(m3)	(m3)	(%)	(m3)	(m3)	Prof. (m)	(m3)
1	Jan	31	2					8.75	154.0	563.4	87	0	15.99	118	475	1.16	0
2	Feb	28	1					8.24	145.0	495.0	72	0	20.53	152	251	0.68	0
3	Mar	31	6					11.31	199.0	422.5	84	0	20.15	149	18	0.08	0
4	Apr	30	38	26	5	76	107	9.04	159.0	0.0	0	0	3.34	25	101	0.30	0
5	May	31	174	118	25	348	491	8.75	154.0	350.6	54	0	0.00	0	437	1.09	0
6	Jun	30	302	205	43	604	852	7.90	139.0	482.9	67	0	0.00	0	999	1.98	222
7	Jul	31	275	186	39	550	776	8.30	146.0	689.1	101	0	0.00	0	999	1.98	675
8	Aug	31	266	180	38	532	750	8.13	143.0	689.1	99	0	0.00	0	999	1.98	652
9	Sep	30	368	250	52	736	1038	7.39	130.0	689.1	90	0	0.00	0	999	1.98	948
10	Oct	31	273	185	39	546	770	7.50	132.0	689.1	91	0	0.00	0	999	1.98	679
11	Nov	30	53	36	8	106	149	7.16	126.0	689.1	87	0	20.14	149	913	1.88	0
12	Dec	31	5					7.50	132.0	652.2	86	0	19.86	147	680	1.54	0
		365	1763	1186	249	3498	4933	100.00	1759.0		916	0.00	100.00	740			3176

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from : Almanaque de El Salvador 1993. Page No. 53

Santa Cruz Porrillo

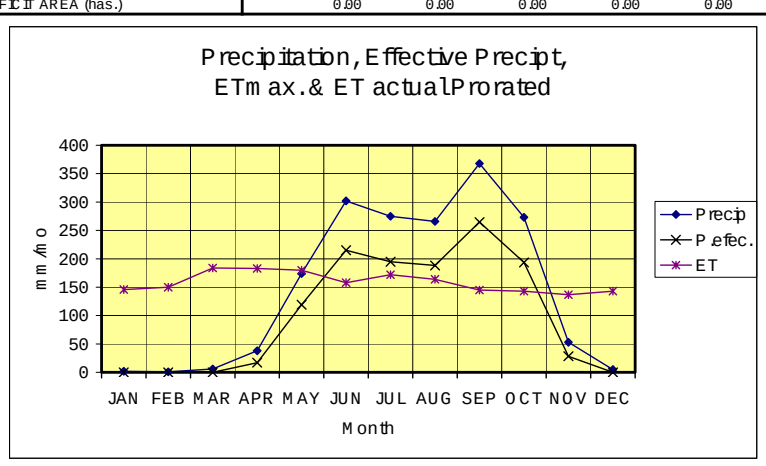
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

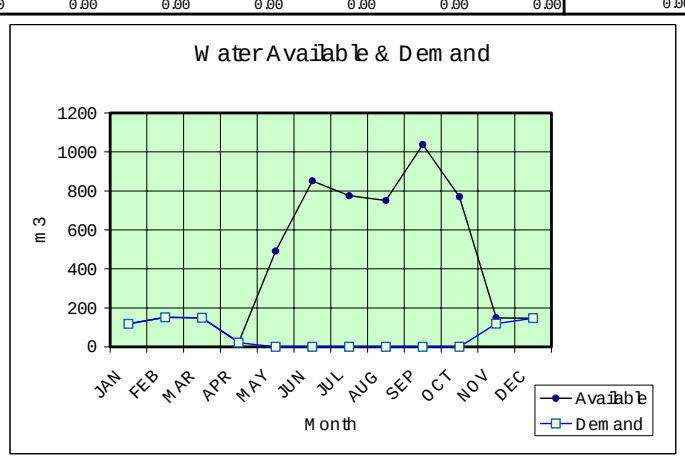
USULUTAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 840

													TOTAL
1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers						
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000		0.7000
	AREA UNDER OPTIMUM IRRIG, ha	0.012	0.012	0.012	0.012	0.012	0.024	0.000	0.000	0.000	0.000		0.0840
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

2a	Perim.Max.Ha	10.00
2b	Factor Area	0.1200
2c	Cap.Canal lps	40.00

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.71	5.36	5.94	6.10	5.81	5.27	5.55	5.29	4.83	4.61	4.57	4.61		
3b	ET (mm/month)	146.00	150.00	184.00	183.00	180.00	158.00	172.00	164.00	145.00	143.00	137.00	143.00	1905.00	
4a	Prec. (mm.)	2.00	1.00	6.00	38.00	174.00	302.00	275.00	266.00	368.00	273.00	53.00	5.00	1763.00	
4b	Prec.Efec. (mm.)	0.00	0.00	0.00	17.25	119.25	215.25	195.00	188.25	264.75	193.50	28.50	0.00	1221.75	
5a	Kc (Crop No.1) Green Peppers	1.05	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	153.30	157.50	165.60	164.70	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	1150.80	
	ETactual	153.30	157.50	165.60	164.70	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	1150.80	
	Irr.Req.(mm.)	153.30	157.50	165.60	147.45	0.00	0.00	0.00	0.00	0.00	0.00	115.35	150.15	889.35	
	Area (ha)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	18.40	18.90	19.87	17.69	0.00	0.00	0.00	0.00	0.00	0.00	13.84	18.02	107	
6a	Kc (Crop No.2) Jalapeño	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	963.60	
	ETactual	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	963.60	
	Irr.Req.(mm.)	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	150.15	719.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	18.40	16.20	19.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.84	18.02	86	
7a	Kc (Crop No.3) Tomatoes	0.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15		
	ETmax	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	87.00	135.85	157.55	164.45		
	ETactual	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	87.00	135.85	157.55	164.45	796.25	
	Irr.Req.(mm.)	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	129.05	164.45	544.90	
	Area (ha)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	15.77	14.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.49	19.73	65	
8a	Kc (Crop No.4) Zucchini	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.012
	Net Req. (m3)	10.51	18.00	19.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.02	15.44	77	
9a	Kc (Crop No.5) Squash	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.012
	Net Req. (m3)	10.51	18.00	19.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.02	15.44	76.85	
10a	Kc (Crop No.6) Cucumbers	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02		0.024
	Net Req. (m3)	21.02	36.00	39.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.04	30.89	154	
	Area Total (ha.)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.04	0.08	0.08	0.08	0.08	Correcto
	Net Req. (m3)	95	122	119	18	0	0	0	0	0	0	95	118	566	Sum
	Net Irrig. Req. (mm)	112.63	144.64	165.60	147.45	0.00	0.00	0.00	0.00	0.00	0.00	113.39	139.94	823.65	Sum
	Consumo Ponderado (mm)	112.63	144.64	141.94	23.53	0.00	0.00	0.00	0.00	0.00	0.00	141.89	139.94	704.57	
	Factor Demanda Riegos %	15.99	20.53	20.15	3.34	0.00	0.00	0.00	0.00	0.00	0.00	20.14	19.86	100.00	
A	Net Irrig. Req. (l/s)	0.04	0.05	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.42	0.60	0.62	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.52	0.264	Avg
	WATER DEMAND														
15a	Eff.Diversion	1.00													
15b	Eff.Conveyance Main Canal	1.00													
15c	Eff.Distribution	1.00	EFFICIENCY												
15d	Eff.Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	140.786	180.804	207.000	184.313	0.000	0.000	0.000	0.000	0.000	0.000	141.741	174.920	1029.563	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.04	0.06	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.023	Avg
	Gross Irrig. Req. (m3)	118	152	149	22	0	0	0	0	0	0	119	147	707	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.526	0.747	0.773	0.711	0.000	0.000	0.000	0.000	0.000	0.000	0.547	0.653	0.330	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	118	152	149	25	491	852	776	750	1,038	770	149	147	5,416	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	118	152	149	25	491	852	776	750	1,038	770	149	147	5,416	Sum
E"	TOTAL (l/s)	0.04	0.06	0.06	0.01	0.18	0.33	0.29	0.28	0.40	0.29	0.06	0.05	0.171	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.04	0.06	0.06	0.01	0.18	0.33	0.29	0.28	0.40	0.29	0.06	0.05	0.171	Avg
	Actual Water Available (m3)	118	152	149	25	491	852	776	750	1,038	770	149	147	5,416	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.18	0.33	0.29	0.28	0.40	0.29	0.01	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	3	491	852	776	750	1038	770	30	0	4,709	Sum
G=E/D	Max.Irrig. Area (ha)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.08		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

USULUTAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir + Gallery

6 months

Initial Water Volume in April	0	m3
Annual Evaporation	1759	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	704.57	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Profundidad
Irrigated Area	840.00	m2

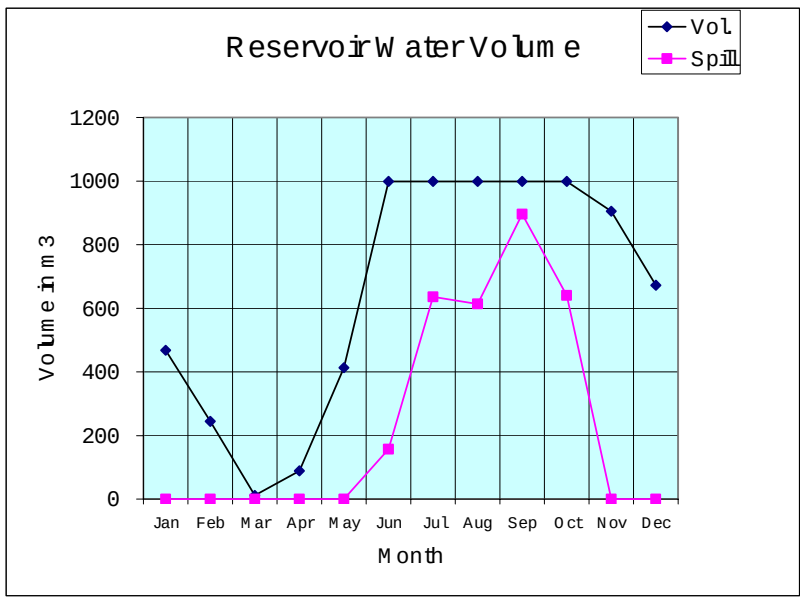
Rainfall Catchment Area		
Reservoir	678	m2
Roof	0	m2
Gallery Watershed	10	ha

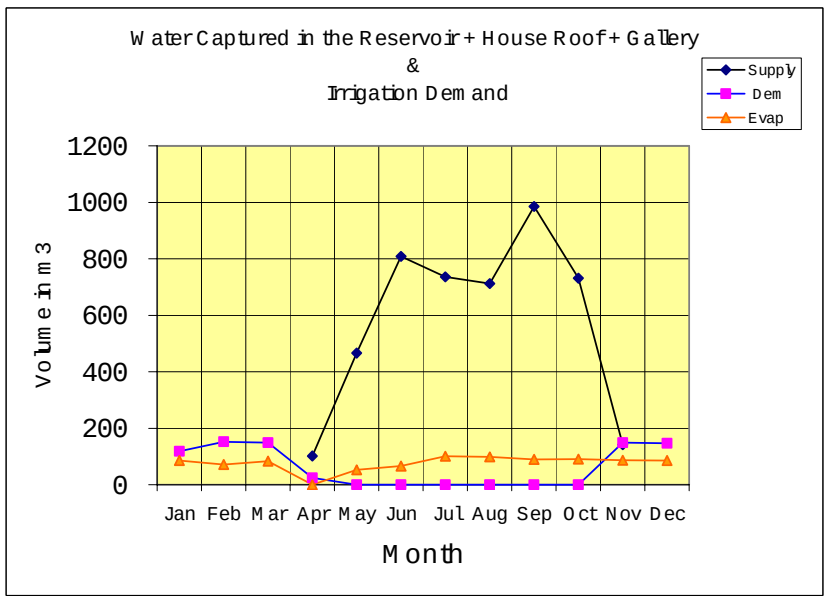
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Wate (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	2					8.75	154.0	560.9	86	0	15.99	118	468	1.15	0
2	Feb	28	1					8.24	145.0	492.8	71	0	20.53	152	245	0.66	0
3	Mar	31	6					11.31	199.0	420.3	84	0	20.15	149	12	0.06	0
4	Apr	30	38	26	0	76	102	9.04	159.0	0.0	0	0	3.34	25	89	0.27	0
5	May	31	174	118	0	348	466	8.75	154.0	340.9	52	0	0.00	0	413	1.04	0
6	Jun	30	302	205	0	604	809	7.90	139.0	475.5	66	0	0.00	0	999	1.98	157
7	Jul	31	275	186	0	550	736	8.30	146.0	689.1	101	0	0.00	0	999	1.98	636
8	Aug	31	266	180	0	532	712	8.13	143.0	689.1	99	0	0.00	0	999	1.98	614
9	Sep	30	368	250	0	736	986	7.39	130.0	689.1	90	0	0.00	0	999	1.98	896
10	Oct	31	273	185	0	546	731	7.50	132.0	689.1	91	0	0.00	0	999	1.98	640
11	Nov	30	53	36	0	106	142	7.16	126.0	689.1	87	0	20.14	149	905	1.87	0
12	Dec	31	5					7.50	132.0	649.0	86	0	19.86	147	673	1.53	0
		365	1763	1186	0	3498	4684	100.00	1759.0		912	0.00	100.00	740			2943

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from : Almanaque de El Salvador 1993. Page No.53

Santa Cruz Porrillo

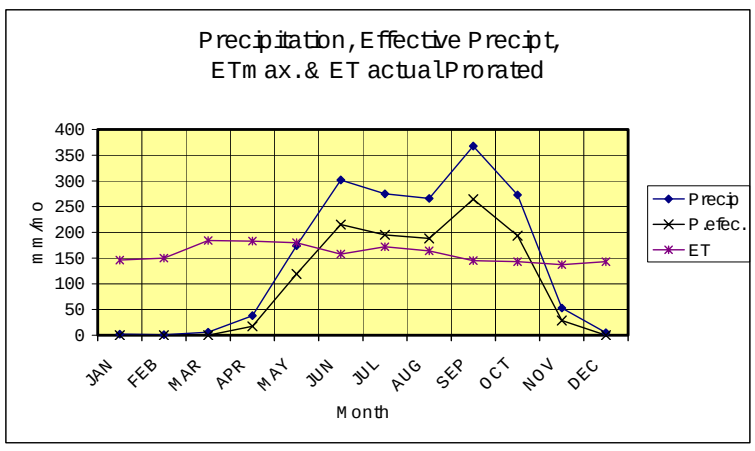
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

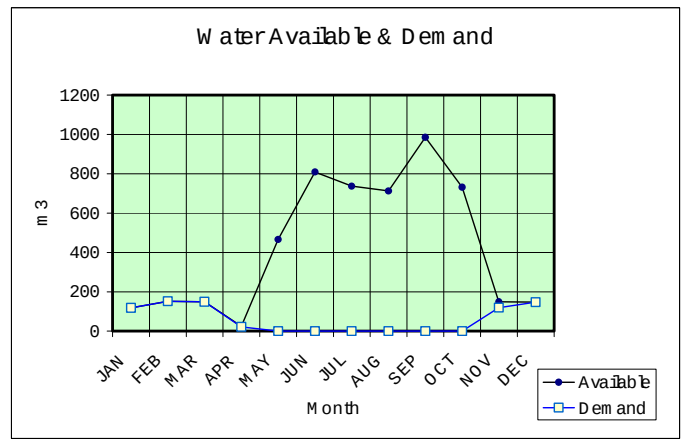
USULUTAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 840

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL		
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000		
	AREA UNDER OPTIMUM IRRIG, ha	0.012	0.012	0.012	0.012	0.012	0.024	0.000	0.000	0.000	0.000	0.0840		
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			

2a	Perim.Max.Ha	10.00
2b	Factor Area	0.1200
2c	Cap.Canal lps	40.00

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.71	5.36	5.94	6.10	5.81	5.27	5.55	5.29	4.83	4.61	4.57	4.61		
3b	ET (mm/month)	146.00	150.00	184.00	183.00	180.00	158.00	172.00	164.00	145.00	143.00	137.00	143.00	1905.00	
4a	Prec. (mm.)	2.00	1.00	6.00	38.00	174.00	302.00	275.00	266.00	368.00	273.00	53.00	5.00	1763.00	
4b	Prec. Efec. (mm.)	0.00	0.00	0.00	17.25	119.25	215.25	195.00	188.25	264.75	193.50	28.50	0.00	1221.75	
5a	Kc (Crop No.1) Green Peppers	1.05	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	153.30	157.50	165.60	164.70	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	1150.80	
	ETactual	153.30	157.50	165.60	164.70	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	1150.80	
	Irr.Req.(mm.)	153.30	157.50	165.60	147.45	0.00	0.00	0.00	0.00	0.00	0.00	115.35	150.15	889.35	
	Area (ha)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	18.40	18.90	19.87	17.69	0.00	0.00	0.00	0.00	0.00	0.00	13.84	18.02	107	
6a	Kc (Crop No.2) Jalapeño	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	963.60	
	ETactual	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	963.60	
	Irr.Req.(mm.)	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	150.15	719.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	18.40	16.20	19.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.84	18.02	86	
7a	Kc (Crop No.3) Tomatoes	0.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15		
	ETmax	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	87.00	135.85	157.55	164.45		
	ETactual	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	87.00	135.85	157.55	164.45	796.25	
	Irr.Req.(mm.)	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	129.05	164.45	544.90	
	Area (ha)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	15.77	14.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.49	19.73	65	
8a	Kc (Crop No.4) Zucchini	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.012
	Net Req. (m3)	10.51	18.00	19.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.02	15.44	77	
9a	Kc (Crop No.5) Squash	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.012
	Net Req. (m3)	10.51	18.00	19.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.02	15.44	76.85	
10a	Kc (Crop No.6) Cucumbers	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02		0.024
	Net Req. (m3)	21.02	36.00	39.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.04	30.89	154	
	Area Total (ha.)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.04	0.08	0.08	0.08	0.08	Correcto
	Net Req. (m3)	95	122	119	18	0	0	0	0	0	0	95	118	566	Sum
	Net Irrig. Req. (mm)	112.63	144.64	165.60	147.45	0.00	0.00	0.00	0.00	0.00	0.00	113.39	139.94	823.65	Sum
	Consumo Ponderado (mm)	112.63	144.64	141.94	23.53	0.00	0.00	0.00	0.00	0.00	0.00	141.89	139.94	704.57	
	Factor Demanda Riegos %	15.99	20.53	20.15	3.34	0.00	0.00	0.00	0.00	0.00	0.00	20.14	19.86	100.00	
A	Net Irrig. Req. (l/s)	0.04	0.05	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.42	0.60	0.62	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.52	0.264	Avg
	WATER DEMAND														
15a	Effc. Diversion	1.00													
15b	Effc. Conveyance Main Canal	1.00													
15c	Effc. Distribution	1.00	EFFICIENCY												
15d	Effc. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	140.786	180.804	207.000	184.313	0.000	0.000	0.000	0.000	0.000	0.000	141.741	174.920	1029.563	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.04	0.06	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.023	Avg
	Gross Irrig. Req. (m3)	118	152	149	22	0	0	0	0	0	0	119	147	707	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.526	0.747	0.773	0.711	0.000	0.000	0.000	0.000	0.000	0.000	0.547	0.653	0.330	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	118	152	149	25	466	809	736	712	986	731	149	147	5,180	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	118	152	149	25	466	809	736	712	986	731	149	147	5,180	Sum
E"	TOTAL (l/s)	0.04	0.06	0.06	0.01	0.17	0.31	0.27	0.27	0.38	0.27	0.06	0.05	0.164	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.04	0.06	0.06	0.01	0.17	0.31	0.27	0.27	0.38	0.27	0.06	0.05	0.164	Avg
	Actual Water Available (m3)	118	152	149	25	466	809	736	712	986	731	149	147	5,180	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.17	0.31	0.27	0.27	0.38	0.27	0.01	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	3	466	809	736	712	986	731	30	0	4,473	Sum
G=E/D	Max. Irrig. Area (ha)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.08		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

USULUTAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir + Roof

6 months

Initial Water Volume in April	0	m3
Annual Evaporation	1759	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	704.57	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient		
Gallery Runoff Coefficient	0.95	
Coef. Escorrentia Galería	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	740.00	m2

Rainfall Catchment Area		
Reservoir	678	m2
Roof	150	m2
Gallery Watershed	0	ha

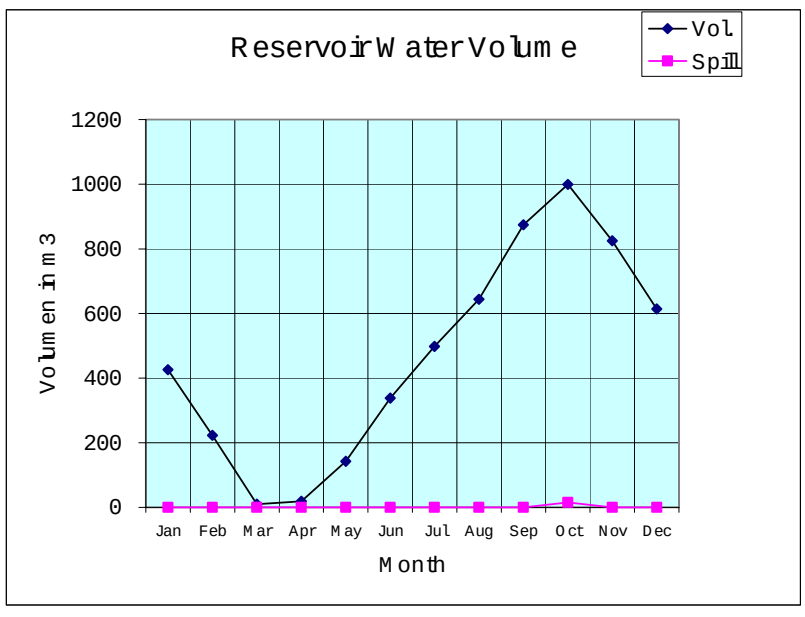
`

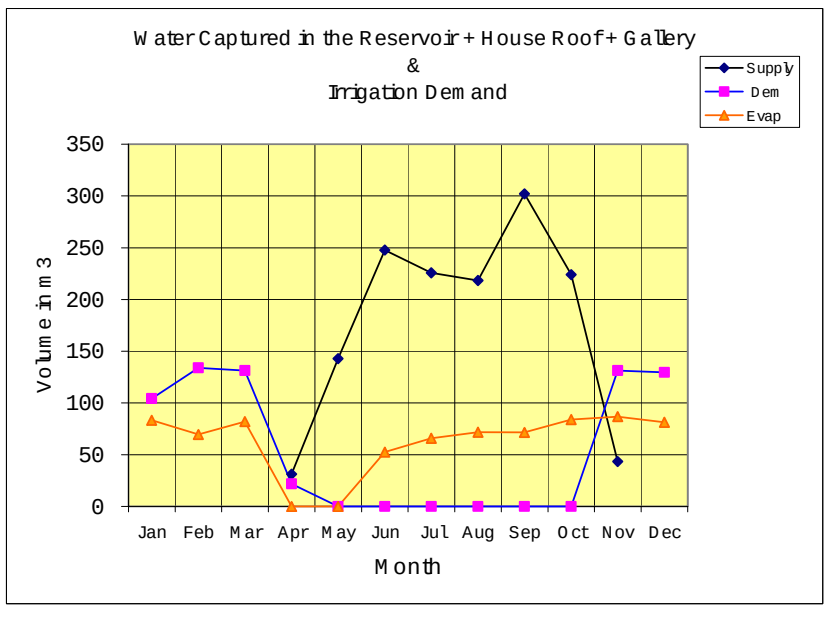
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Wate (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	2					8.75	154.0	540.6	83	0	15.99	104	426	1.06	0
2	Feb	28	1					8.24	145.0	479.5	70	0	20.53	134	223	0.61	0
3	Mar	31	6					11.31	199.0	412.4	82	0	20.15	131	10	0.05	0
4	Apr	30	38	26	5	0	31	9.04	159.0	0.0	0	0	3.34	22	19	0.08	0
5	May	31	174	118	25	0	143	8.75	154.0	0.0	0	0	0.00	0	143	0.41	0
6	Jun	30	302	205	43	0	248	7.90	139.0	377.6	52	0	0.00	0	338	0.88	0
7	Jul	31	275	186	39	0	226	8.30	146.0	451.5	66	0	0.00	0	498	1.21	0
8	Aug	31	266	180	38	0	218	8.13	143.0	502.4	72	0	0.00	0	644	1.48	0
9	Sep	30	368	250	52	0	302	7.39	130.0	551.0	72	0	0.00	0	875	1.83	0
10	Oct	31	273	185	39	0	224	7.50	132.0	636.5	84	0	0.00	0	999	1.98	15
11	Nov	30	53	36	8	0	43	7.16	126.0	689.1	87	0	20.14	131	825	1.76	0
12	Dec	31	5					7.50	132.0	616.8	81	0	19.86	129	614	1.42	0
		365	1763	1186	249	0	1435	100.00	1759.0		749	0.00	100.00	652			15

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

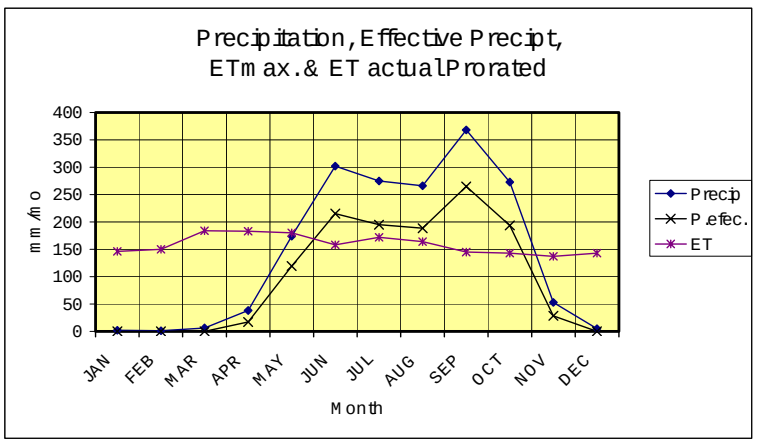
Santa Cruz Porrillo

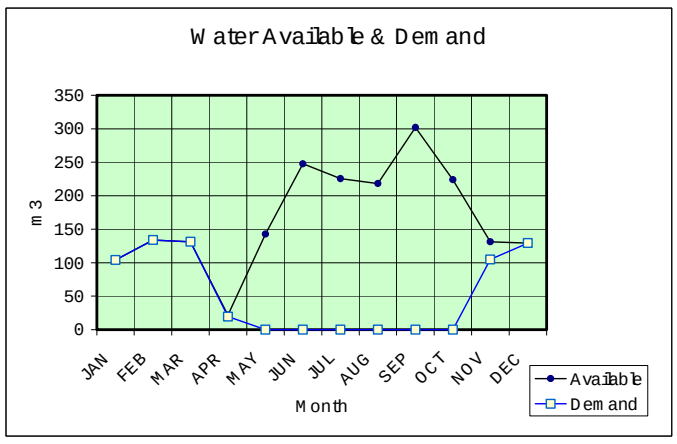
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

USULUTAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 740

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	2a	Perim.Max.Ha	10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	2b	Factor Area	0.1057
	AREA UNDER OPTIMUM IRRIG, ha	0.011	0.011	0.011	0.011	0.011	0.021	0.000	0.000	0.000	0.000	0.0740	2c	Cap.Canal lps	40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.71	5.36	5.94	6.10	5.81	5.27	5.55	5.29	4.83	4.61	4.57	4.61		
3b	ET (mm/month)	146.00	150.00	184.00	183.00	180.00	158.00	172.00	164.00	145.00	143.00	137.00	143.00	1905.00	
4a	Prec. (mm.)	2.00	1.00	6.00	38.00	174.00	302.00	275.00	266.00	368.00	273.00	53.00	5.00	1763.00	
4b	Prec.Efec. (mm.)	0.00	0.00	0.00	17.25	119.25	215.25	195.00	188.25	264.75	193.50	28.50	0.00	1221.75	
5a	Kc (Crop No.1) Green Peppers	1.05	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	153.30	157.50	165.60	164.70	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	1150.80	
	ETactual	153.30	157.50	165.60	164.70	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	1150.80	
	Irr.Req. (mm.)	153.30	157.50	165.60	147.45	0.00	0.00	0.00	0.00	0.00	0.00	115.35	150.15	889.35	
	Area (ha)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.011
	Net Req. (m3)	16.20	16.65	17.50	15.59	0.00	0.00	0.00	0.00	0.00	0.00	12.19	15.87	94	
6a	Kc (Crop No.2) Jalapeño	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	963.60	
	ETactual	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	963.60	
	Irr.Req. (mm.)	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	150.15	719.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.011
	Net Req. (m3)	16.20	14.27	17.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.19	15.87	76	
7a	Kc (Crop No.3) Tomatoes	0.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15		
	ETmax	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	87.00	135.85	157.55	164.45		
	ETactual	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	87.00	135.85	157.55	164.45	796.25	
	Irr.Req. (mm.)	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	129.05	164.45	544.90	
	Area (ha)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.011
	Net Req. (m3)	13.89	12.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.64	17.38	58	
8a	Kc (Crop No.4) Zucchini	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req. (mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.011
	Net Req. (m3)	9.26	15.86	17.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.47	13.60	68	
9a	Kc (Crop No.5) Squash	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req. (mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.011
	Net Req. (m3)	9.26	15.86	17.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.47	13.60	67.69	
10a	Kc (Crop No.6) Cucumbers	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req. (mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02		0.021
	Net Req. (m3)	18.52	31.71	35.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.94	27.21	135	
	Area Total (ha.)	0.07	0.07	0.06	0.01	0.00	0.00	0.00	0.00	0.03	0.07	0.07	0.07	0.07	Correcto
	Net Req. (m3)	83	107	105	16	0	0	0	0	0	0	84	104	498	Sum
	Net Irrig. Req. (mm)	112.63	144.64	165.60	147.45	0.00	0.00	0.00	0.00	0.00	0.00	113.39	139.94	823.65	Sum
	Consumo Ponderado (mm)	112.63	144.64	141.94	23.53	0.00	0.00	0.00	0.00	0.00	0.00	141.89	139.94	704.57	
	Factor Demanda Riegos %	15.99	20.53	20.15	3.34	0.00	0.00	0.00	0.00	0.00	0.00	20.14	19.86	100.00	
A	Net Irrig. Req. (l/s)	0.03	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.42	0.60	0.62	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.52	0.264	Avg
	WATER DEMAND														
15a	Eff.Diversion	1.00													
15b	Eff.Conveyance Main Canal	1.00													
15c	Eff.Distribution	1.00	EFFICIENCY												
15d	Eff.Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	140.786	180.804	207.000	184.313	0.000	0.000	0.000	0.000	0.000	0.000	141.741	174.920	1029.563	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.04	0.06	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.020	Avg
	Gross Irrig. Req. (m3)	104	134	131	19	0	0	0	0	0	0	105	129	623	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.526	0.747	0.773	0.711	0.000	0.000	0.000	0.000	0.000	0.000	0.547	0.653	0.330	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	104	134	131	22	143	248	226	218	302	224	131	129	2,012	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	104	134	131	22	143	248	226	218	302	224	131	129	2,012	Sum
E"	TOTAL (l/s)	0.04	0.06	0.05	0.01	0.05	0.10	0.08	0.08	0.12	0.08	0.05	0.05	0.064	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.04	0.06	0.05	0.01	0.05	0.10	0.08	0.08	0.12	0.08	0.05	0.05	0.064	Avg
	Actual Water Available (m3)	104	134	131	22	143	248	226	218	302	224	131	129	2,012	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.07	0.07	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.05	0.10	0.08	0.08	0.12	0.08	0.01	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	2	143	248	226	218	302	224	26	0	1,389	Sum
G=E/D	Max.Irrig.Area (ha)	0.07	0.07	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.07		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

USULUTAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir

6 months

Initial Water Volume in April	0	m3
Annual Evaporation	1759	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	704.57	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	530.00	m2

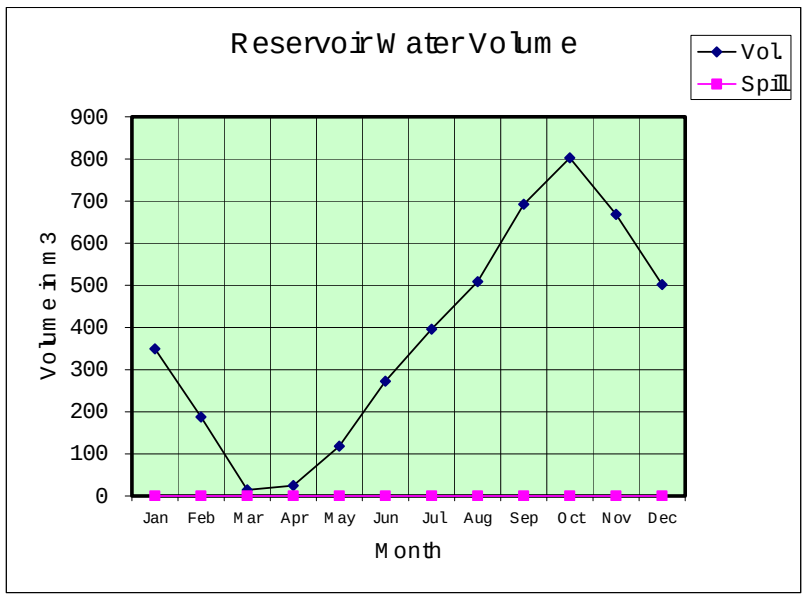
Rainfall Catchment Area		
Reservoir	678	m2
Roof	0	m2
Gallery Watershed	0	ha

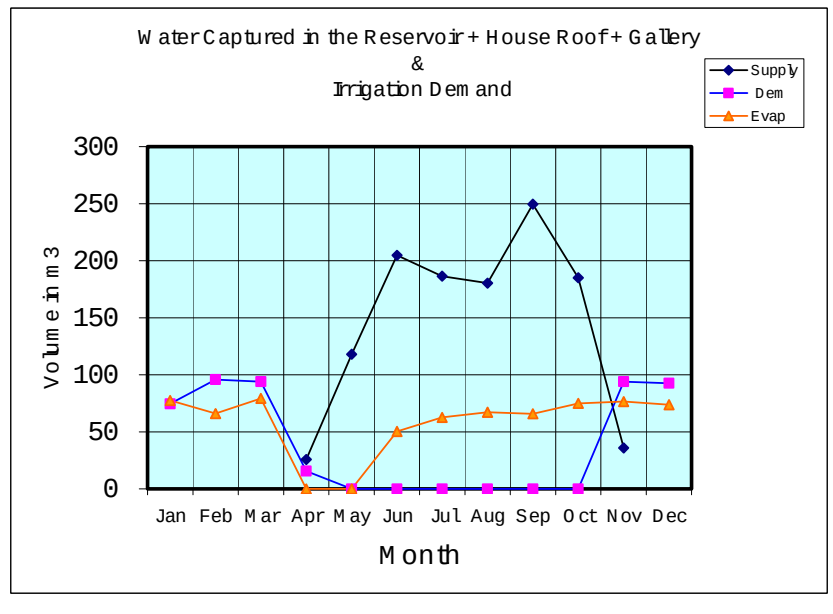
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Water (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	2					8.75	154.0	503.6	78	0	15.99	75	349	0.90	0
2	Feb	28	1					8.24	145.0	455.1	66	0	20.53	96	188	0.52	0
3	Mar	31	6					11.31	199.0	398.5	79	0	20.15	94	14	0.07	0
4	Apr	30	38	26	0	0	26	9.04	159.0	0.0	0	0	3.34	16	24	0.09	0
5	May	31	174	118	0	0	118	8.75	154.0	0.0	0	0	0.00	0	118	0.34	0
6	Jun	30	302	205	0	0	205	7.90	139.0	363.1	50	0	0.00	0	272	0.73	0
7	Jul	31	275	186	0	0	186	8.30	146.0	429.8	63	0	0.00	0	396	1.00	0
8	Aug	31	266	180	0	0	180	8.13	143.0	469.9	67	0	0.00	0	509	1.23	0
9	Sep	30	368	250	0	0	250	7.39	130.0	506.0	66	0	0.00	0	693	1.56	0
10	Oct	31	273	185	0	0	185	7.50	132.0	568.0	75	0	0.00	0	803	1.73	0
11	Nov	30	53	36	0	0	36	7.16	126.0	608.5	77	0	20.14	94	668	1.52	0
12	Dec	31	5					7.50	132.0	559.3	74	0	19.86	93	502	1.22	0
		365	1763	1186	0	0	1186	100.00	1759.0		695	0.00	100.00	467			0

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

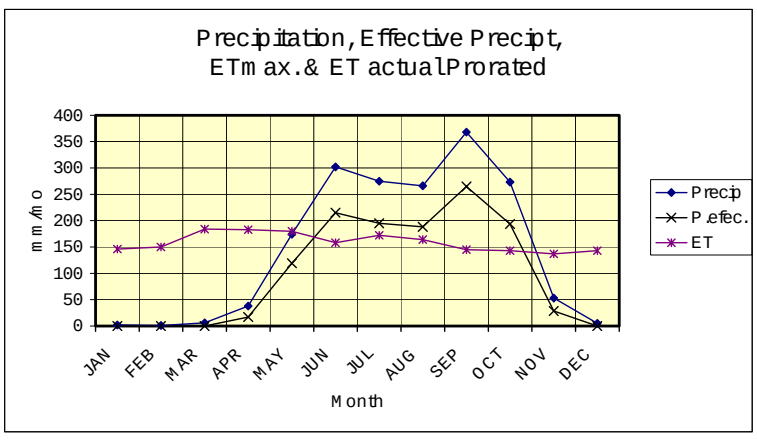
Santa Cruz Porrillo

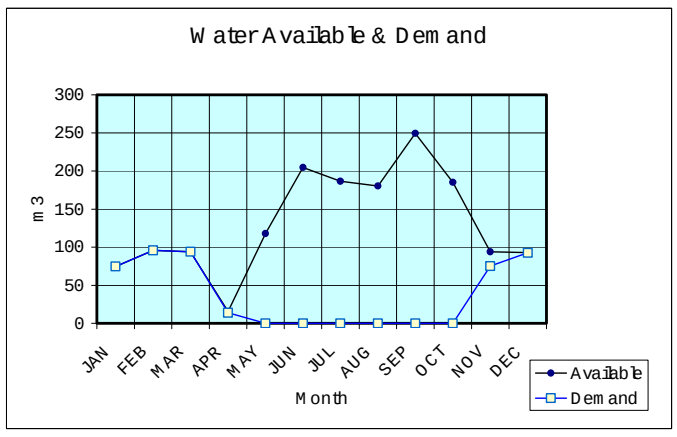
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

USULUTAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 530

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	2a	Perim.Max.Ha 10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	2b	Factor Area 0.0757
	AREA UNDER OPTIMUM IRRIG, ha	0.008	0.008	0.008	0.008	0.008	0.015	0.000	0.000	0.000	0.000	0.0530	2c	Cap.Canal lps 40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.71	5.36	5.94	6.10	5.81	5.27	5.55	5.29	4.83	4.61	4.57	4.61		
3b	ET (mm/month)	146.00	150.00	184.00	183.00	180.00	158.00	172.00	164.00	145.00	143.00	137.00	143.00	1905.00	
4a	Prec. (mm.)	2.00	1.00	6.00	38.00	174.00	302.00	275.00	266.00	368.00	273.00	53.00	5.00	1763.00	
4b	Prec. Efec. (mm.)	0.00	0.00	0.00	17.25	119.25	215.25	195.00	188.25	264.75	193.50	28.50	0.00	1221.75	
5a	Kc (Crop No.1) Green Peppers	1.05	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	153.30	157.50	165.60	164.70	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	1150.80	
	ETactual	153.30	157.50	165.60	164.70	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	1150.80	
	Irr.Req.(mm.)	153.30	157.50	165.60	147.45	0.00	0.00	0.00	0.00	0.00	0.00	115.35	150.15	889.35	
	Area (ha)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.008
	Net Req. (m3)	11.60	11.92	12.54	11.16	0.00	0.00	0.00	0.00	0.00	0.00	8.73	11.37	67	
6a	Kc (Crop No.2) Jalapeño	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	963.60	
	ETactual	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	87.00	128.70	143.85	150.15	963.60	
	Irr.Req.(mm.)	153.30	135.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.35	150.15	719.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.008
	Net Req. (m3)	11.60	10.22	12.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.73	11.37	54	
7a	Kc (Crop No.3) Tomatoes	0.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15		
	ETmax	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	87.00	135.85	157.55	164.45		
	ETactual	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	87.00	135.85	157.55	164.45	796.25	
	Irr.Req.(mm.)	131.40	120.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	129.05	164.45	544.90	
	Area (ha)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.008
	Net Req. (m3)	9.95	9.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.77	12.45	41	
8a	Kc (Crop No.4) Zucchini	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.008
	Net Req. (m3)	6.63	11.36	12.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.21	9.74	48	
9a	Kc (Crop No.5) Squash	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.008
	Net Req. (m3)	6.63	11.36	12.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.21	9.74	48.48	
10a	Kc (Crop No.6) Cucumbers	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70		
	ETactual	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	85.80	137.00	128.70	754.70	
	Irr.Req.(mm.)	87.60	150.00	165.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	108.50	128.70	640.40	
	Area (ha)	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02		0.015
	Net Req. (m3)	13.26	22.71	25.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.43	19.49	97	
	Area Total (ha.)	0.05	0.05	0.05	0.01	0.00	0.00	0.00	0.00	0.02	0.05	0.05	0.05	0.05	Correcto
	Net Req. (m3)	60	77	75	11	0	0	0	0	0	0	60	74	357	Sum
	Net Irrig. Req. (mm)	112.63	144.64	165.60	147.45	0.00	0.00	0.00	0.00	0.00	0.00	113.39	139.94	823.65	Sum
	Consumo Ponderado (mm)	112.63	144.64	141.94	23.53	0.00	0.00	0.00	0.00	0.00	0.00	141.89	139.94	704.57	
	Factor Demanda Riegos %	15.99	20.53	20.15	3.34	0.00	0.00	0.00	0.00	0.00	0.00	20.14	19.86	100.00	
A	Net Irrig. Req. (l/s)	0.02	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.01	Avg
B	Net Irrig. Req. (l/s/ha)	0.42	0.60	0.62	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.52	0.264	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	140.786	180.804	207.000	184.313	0.000	0.000	0.000	0.000	0.000	0.000	141.741	174.920	1029.563	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.03	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.014	Avg
	Gross Irrig. Req. (m3)	75	96	94	14	0	0	0	0	0	0	75	93	446	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.526	0.747	0.773	0.711	0.000	0.000	0.000	0.000	0.000	0.000	0.547	0.653	0.330	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	75	96	94	16	118	205	186	180	250	185	94	93	1,591	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	75	96	94	16	118	205	186	180	250	185	94	93	1,591	Sum
E"	TOTAL (l/s)	0.03	0.04	0.04	0.01	0.04	0.08	0.07	0.07	0.10	0.07	0.04	0.03	0.050	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.03	0.04	0.04	0.01	0.04	0.08	0.07	0.07	0.10	0.07	0.04	0.03	0.050	Avg
	Actual Water Available (m3)	75	96	94	16	118	205	186	180	250	185	94	93	1,591	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.05	0.05	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.04	0.08	0.07	0.07	0.10	0.07	0.01	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	2	118	205	186	180	250	185	19	0	1,145	Sum
G=E/D	Max.Irrig. Area (ha)	0.05	0.05	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.05		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

APPENDIX C

WATER BUDGET FOR THE FOUR DIFFERENT SCENARIOS THREE AND SIX MONTHS, CROPS FOR AHUACHAPAN

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO	Reservoir + Gallery + Roof

3 months

Initial Water Volume in April	0	m3
Annual Evaporation	1924	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	343.63	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	2490.00	m2

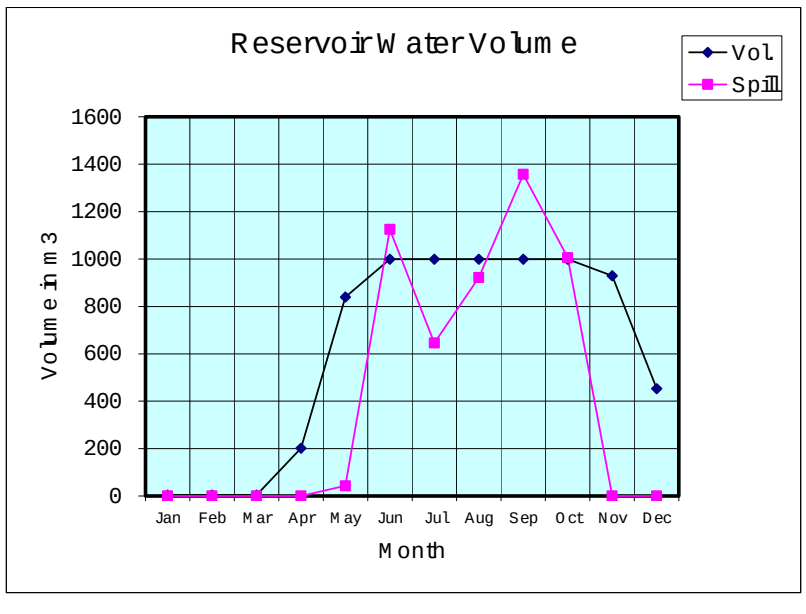
Rainfall Catchment Area		
Reservoir	678	m2
Roof	150	m2
Gallery Watershed	10	ha

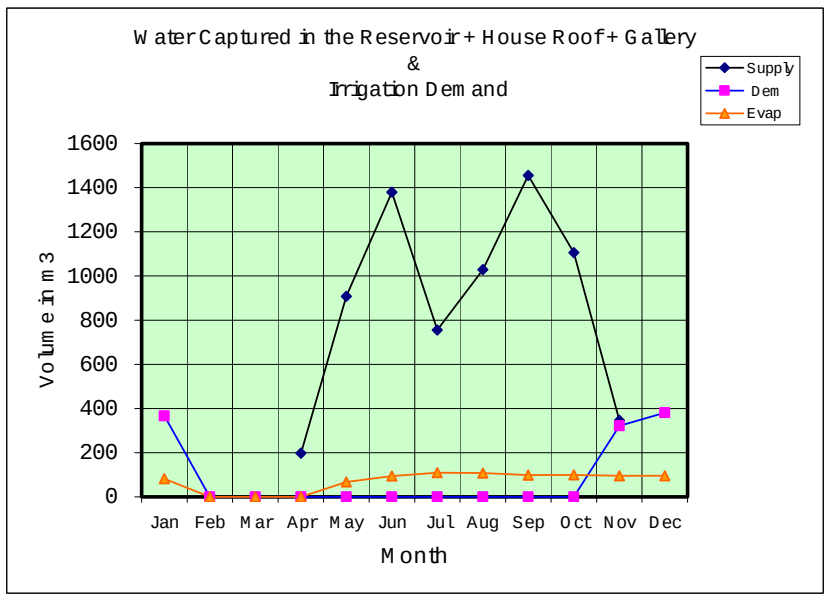
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip.	CAPTURED VOLUME (m3)				Fac.Ea	Ea	Surface Wate	Ev	Inf.	Fac.Ir.	Ir.	Vol Reservoir		Spill
			mm	Reser.	Roof	Gallery	TOTAL	(%)	(mm)	(m2)	(m3)	(m3)	(%)	(m3)	(m3)	Prof. (m)	(m3)
1	Jan	31	3					8.75	168.4	488.1	82	0	34.28	367	4	0.04	0
2	Feb	28	6					8.24	158.6	0.0	0	0	0.00	0	4	0.04	0
3	Mar	31	26					11.31	217.7	0.0	0	0	0.00	0	4	0.04	0
4	Apr	30	70	47	10	140	197	9.04	173.9	0.0	0	0	0.00	0	202	0.56	0
5	May	31	322	218	46	644	908	8.75	168.4	404.2	68	0	0.00	0	840	1.78	43
6	Jun	30	489	332	70	978	1379	7.90	152.0	622.9	95	0	0.00	0	999	1.98	1125
7	Jul	31	268	182	38	536	756	8.30	159.7	689.1	110	0	0.00	0	999	1.98	646
8	Aug	31	365	247	52	730	1029	8.13	156.4	689.1	108	0	0.00	0	999	1.98	922
9	Sep	30	516	350	74	1032	1455	7.39	142.2	689.1	98	0	0.00	0	999	1.98	1357
10	Oct	31	392	266	56	784	1106	7.50	144.4	689.1	99	0	0.00	0	999	1.98	1006
11	Nov	30	123	83	18	246	347	7.16	137.8	689.1	95	0	30.07	322	930	1.90	0
12	Dec	31	2					7.50	144.4	659.1	95	0	35.65	381	453	1.12	0
		365	2582	1726	363	5090	7178	100.00	1924.0		850	0.00	100.00	1070			5099

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir

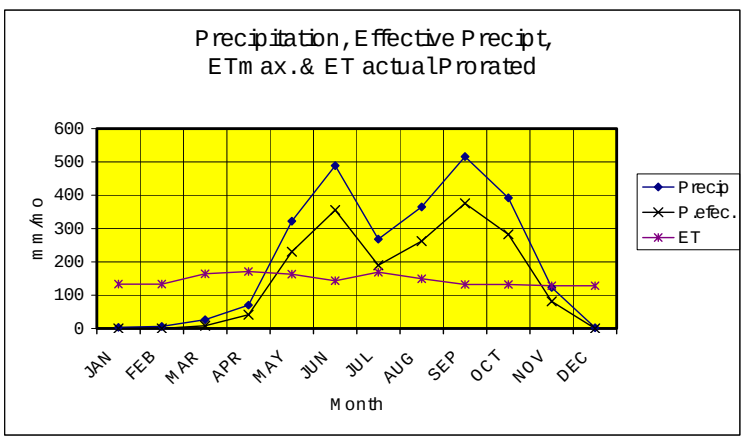


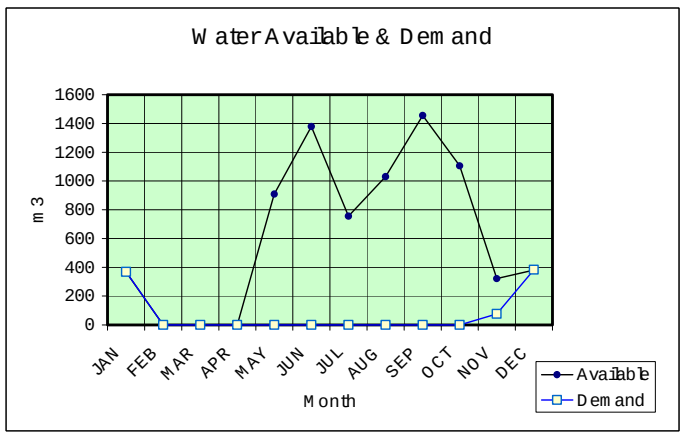


References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000		2b	Factor Area 0.3571
	AREA UNDER OPTIMUM IRRIG, ha	0.036	0.036	0.036	0.036	0.036	0.071	0.000	0.000	0.000	0.000	0.2500		2c	Cap.Canal lps 40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				

			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
			31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)		4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)		133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)		3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec.Efec. (mm.)		0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1)	Green Pepper	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax		119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual		119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr.Req. (mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)		0.04	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04	0.04	0.04		0.036
	Net Req. (m3)		42.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.07	41.14	103	
6a	Kc (Crop No.2)	Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax		119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual		119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr.Req. (mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)		0.04	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04	0.04	0.04		0.036
	Net Req. (m3)		42.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.07	41.14	103	
7a	Kc (Crop No.3)	Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax		106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20		
	ETactual		106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20	735.40	
	Irr.Req. (mm.)		106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	115.20	287.80	
	Area (ha)		0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04		0.036
	Net Req. (m3)		38.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.64	41.14	103	
8a	Kc (Crop No.4)	Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req. (mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)		0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04		0.036
	Net Req. (m3)		42.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.71	88	
9a	Kc (Crop No.5)	Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req. (mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)		0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04		0.036
	Net Req. (m3)		42.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.71	88.45	
10a	Kc (Crop No.6)	Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req. (mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)		0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07		0.071
	Net Req. (m3)		85.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	91.42	177	
	Area Total (ha.)		0.25	0.00	0.00	0.00	0.00	0.07	0.07	0.11	0.11	0.11	0.25	0.25	0.25	Correcto
	Net Req. (m3)		294	0	0	0	0	0	0	0	0	0	62	306	662	Sum
	Net Irrig. Req. (mm)		117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.71	122.51	265.03	Sum
	Consumo Ponderado (mm)		117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.31	122.51	343.63	
	Factor Demanda Riegos %		34.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.07	35.65	100.00	
A	Net Irrig. Req. (l/s)		0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.02	Avg
B	Net Irrig. Req. (l/s/ha)		0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.46	0.083	Avg
	WATER DEMAND															
15a	Efic. Diversion		1.00													
15b	Efic. Conveyance Main Canal		1.00													
15c	Efic. Distribution		1.00	EFFICIENCY												
15d	Efic. Aplication		0.80	0.80												
	Gross Irrig. Req. (mm)		147.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	30.893	153.143	331.286	Sum
C=A*Ef	Gross Irrig. Req. (l/s)		0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.14	0.026	Avg
	Gross Irrig. Req. (m3)		368	0	0	0	0	0	0	0	0	0	77	383	828	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)		0.550	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.572	0.103	Avg
	WATER AVAILABLE															
16a	Name...	(m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs	(m3)	367	0	0	0	908	1,379	756	1,029	1,455	1,106	322	381	7,703	Sum
16c	River	(m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater	(m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)		367	0	0	0	908	1,379	756	1,029	1,455	1,106	322	381	7,703	Sum
E"	TOTAL (l/s)		0.14	0.00	0.00	0.00	0.34	0.53	0.28	0.38	0.56	0.41	0.12	0.14	0.243	Avg
17a	Third Parties Water Rights (l/s)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)		0.14	0.00	0.00	0.00	0.34	0.53	0.28	0.38	0.56	0.41	0.12	0.14	0.243	Avg
	Actual Water Available (m3)		367	0	0	0	908	1,379	756	1,029	1,455	1,106	322	381	7,703	Sum
	BALANCE															
C/D	Irrigation Area (ha)		0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25		
F=E-C	Exceeding/Deficit Water (l/s)		0.00	0.00	0.00	0.00	0.34	0.53	0.28	0.38	0.56	0.41	0.09	0.00		
	Exceeding/Deficit Water (m3)		-1	0	0	0	908	1379	756	1029	1455	1106	244	-1	6,875	Sum
G=E/D	Max.Irrig. Area (ha)		0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.25		
H=F/D	Additional Area (has.)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00		
I	DEFICIT AREA (has.)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque ElSalvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO Reservoir + Gallery

3 months

Initial Water Volume in April	0	m3
Annual Evaporation	1924	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	343.63	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	2400.00	m2

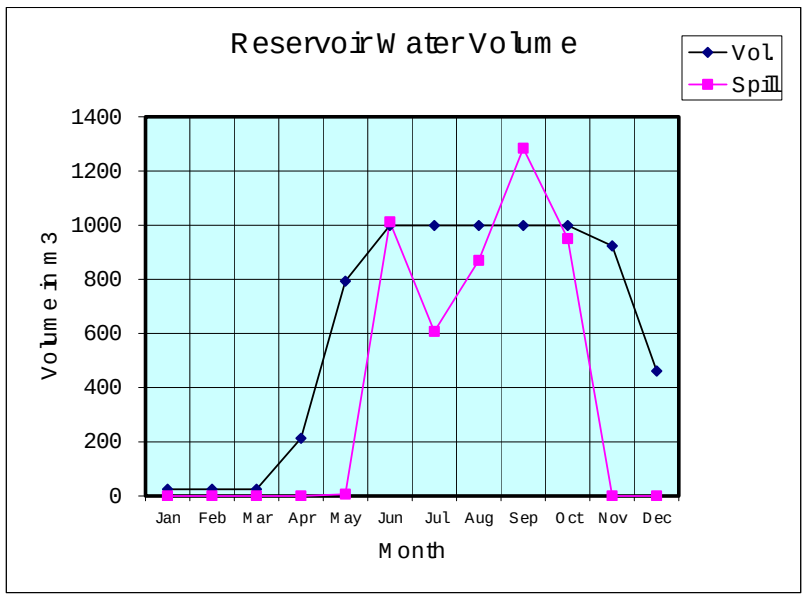
Rainfall Catchment Area		
Reservoir	678	m2
Roof	0	m2
Gallery Watershed	10	ha

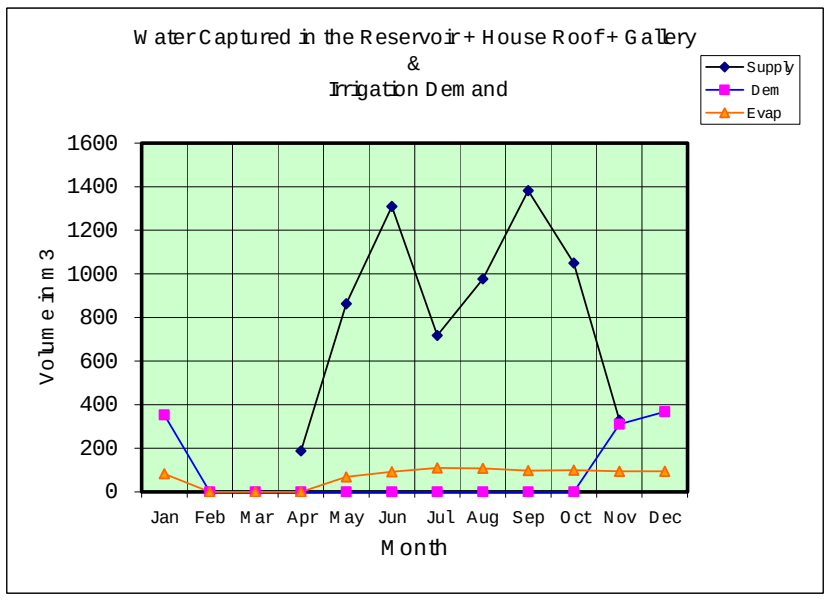
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip.	CAPTURED VOLUME (m3)				Fac.Ea	Ea	Surface Wate	Ev	Inf.	Fac.Ir.	Ir.	Vol Reservoir		Spill
			mm	Reser.	Roof	Gallery	TOTAL	(%)	(mm)	(m2)	(m3)	(m3)	(%)	(m3)	(m3)	Prof. (m)	(m3)
1	Jan	31	3					8.75	168.4	490.7	83	0	34.28	353	25	0.10	0
2	Feb	28	6					8.24	158.6	0.0	0	0	0.00	0	25	0.10	0
3	Mar	31	26					11.31	217.7	0.0	0	0	0.00	0	25	0.10	0
4	Apr	30	70	47	0	140	187	9.04	173.9	0.0	0	0	0.00	0	213	0.58	0
5	May	31	322	218	0	644	862	8.75	168.4	408.5	69	0	0.00	0	794	1.71	7
6	Jun	30	489	332	0	978	1310	7.90	152.0	604.9	92	0	0.00	0	999	1.98	1012
7	Jul	31	268	182	0	536	718	8.30	159.7	689.1	110	0	0.00	0	999	1.98	608
8	Aug	31	365	247	0	730	977	8.13	156.4	689.1	108	0	0.00	0	999	1.98	870
9	Sep	30	516	350	0	1032	1382	7.39	142.2	689.1	98	0	0.00	0	999	1.98	1284
10	Oct	31	392	266	0	784	1050	7.50	144.4	689.1	99	0	0.00	0	999	1.98	950
11	Nov	30	123	83	0	246	329	7.16	137.8	689.1	95	0	30.07	310	924	1.89	0
12	Dec	31	2					7.50	144.4	656.7	95	0	35.65	368	461	1.14	0
		365	2582	1726	0	5090	6816	100.00	1924.0		849	0.00	100.00	1031			4730

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

San Pedro Puxtla

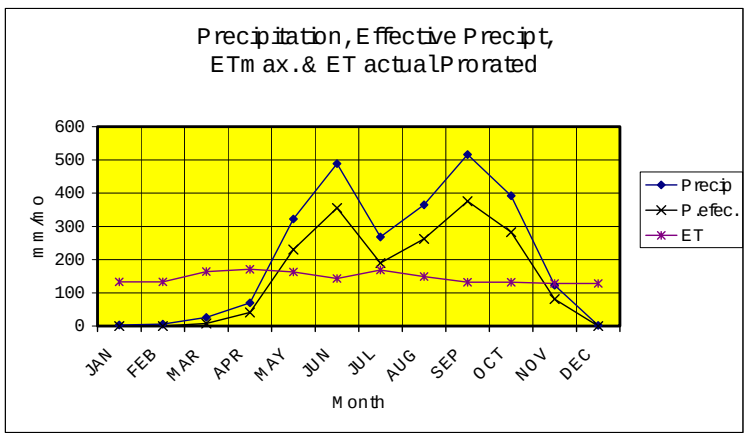
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

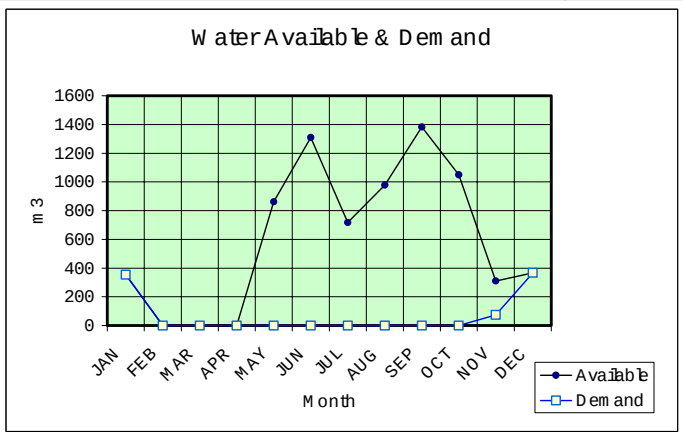
AHUACHAPAN, EL SALVADOR | PROJECT: RESERVORIOS | AREA (m2) 2400

1a	CROP	Green Pepper	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL		
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000		
	AREA UNDER OPTIMUM IRRIG, ha	0.034	0.034	0.034	0.034	0.034	0.069	0.000	0.000	0.000	0.000	0.2400		
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			

2a	Perim. Max. Ha	10.00
2b	Factor Area	0.3428
2c	Cap. Canal lps	40.00

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)	133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)	3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec. Efec. (mm.)	0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1) Green Pepper	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr.Req. (mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.034
	Net Req. (m3)	41.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.31	39.49	99	
6a	Kc (Crop No.2) Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr.Req. (mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.034
	Net Req. (m3)	41.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.31	39.49	99	
7a	Kc (Crop No.3) Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax	106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20		
	ETactual	106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20	735.40	
	Irr.Req. (mm.)	106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	115.20	287.80	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03		0.034
	Net Req. (m3)	36.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.69	39.49	99	
8a	Kc (Crop No.4) Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req. (mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03		0.034
	Net Req. (m3)	41.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.88	85	
9a	Kc (Crop No.5) Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req. (mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03		0.034
	Net Req. (m3)	41.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.88	84.91	
10a	Kc (Crop No.6) Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req. (mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07		0.069
	Net Req. (m3)	82.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	87.76	170	
	Area Total (ha.)	0.24	0.00	0.00	0.00	0.00	0.07	0.07	0.10	0.10	0.10	0.24	0.24	0.24	Correcto
	Net Req. (m3)	283	0	0	0	0	0	0	0	0	0	59	294	636	Sum
	Net Irrig. Req. (mm)	117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.71	122.51	265.03	Sum
	Consumo Ponderado (mm)	117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.31	122.51	343.63	
	Factor Demanda Riegos %	34.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.07	35.65	100.00	
A	Net Irrig. Req. (l/s)	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.46	0.083	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	147.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	30.893	153.143	331.286	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.14	0.025	Avg
	Gross Irrig. Req. (m3)	353	0	0	0	0	0	0	0	0	0	74	367	795	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.550	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.572	0.103	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	353	0	0	0	862	1,310	718	977	1,382	1,050	310	368	7,330	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	353	0	0	0	862	1,310	718	977	1,382	1,050	310	368	7,330	Sum
E"	TOTAL (l/s)	0.13	0.00	0.00	0.00	0.32	0.51	0.27	0.36	0.53	0.39	0.12	0.14	0.231	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.13	0.00	0.00	0.00	0.32	0.51	0.27	0.36	0.53	0.39	0.12	0.14	0.231	Avg
	Actual Water Available (m3)	353	0	0	0	862	1,310	718	977	1,382	1,050	310	368	7,330	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.24		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.32	0.51	0.27	0.36	0.53	0.39	0.09	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	0	862	1310	718	977	1382	1050	236	0	6,535	Sum
G=E/D	Max. Irrig. Area (ha)	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.24		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir + Roof

3 months

Initial Water Volume in April	0	m3
Annual Evaporation	1924	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	343.63	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	1950.00	m2

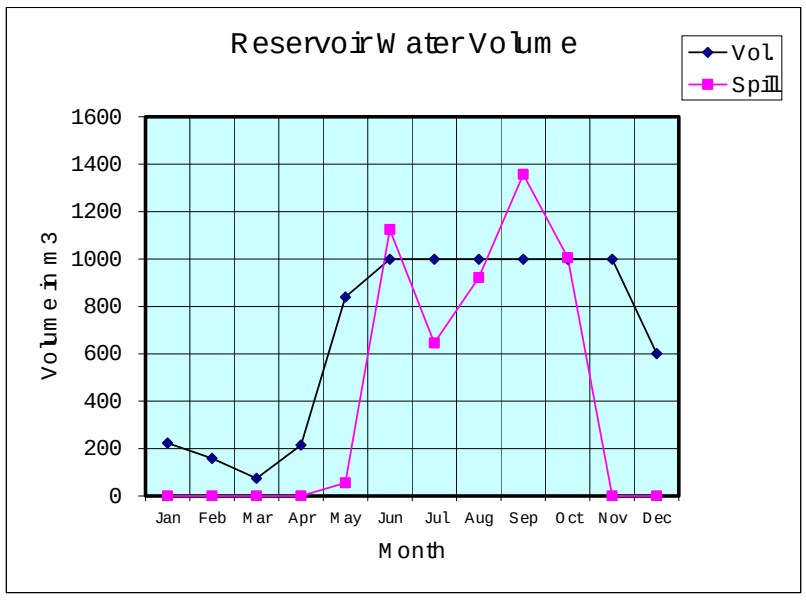
Rainfall Catchment Area		
Reservoir	678	m2
Roof	150	m2
Gallery Watershed	10	ha

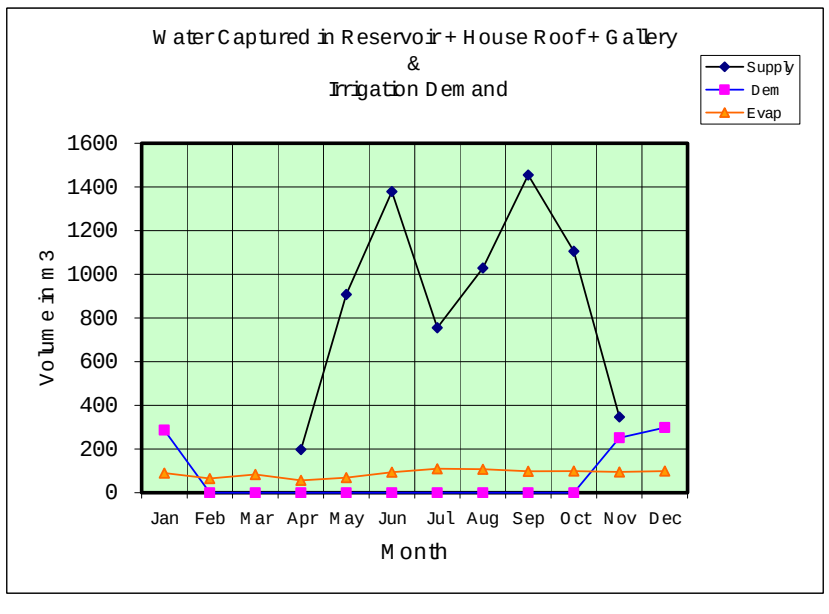
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Water (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	3					8.75	168.4	536.3	90	0	34.28	287	224	0.61	0
2	Feb	28	6					8.24	158.6	412.6	65	0	0.00	0	158	0.45	0
3	Mar	31	26					11.31	217.7	385.4	84	0	0.00	0	74	0.23	0
4	Apr	30	70	47	10	140	197	9.04	173.9	325.2	57	0	0.00	0	215	0.59	0
5	May	31	322	218	46	644	908	8.75	168.4	409.4	69	0	0.00	0	839	1.78	55
6	Jun	30	489	332	70	978	1379	7.90	152.0	622.5	95	0	0.00	0	999	1.98	1125
7	Jul	31	268	182	38	536	756	8.30	159.7	689.1	110	0	0.00	0	999	1.98	646
8	Aug	31	365	247	52	730	1029	8.13	156.4	689.1	108	0	0.00	0	999	1.98	922
9	Sep	30	516	350	74	1032	1455	7.39	142.2	689.1	98	0	0.00	0	999	1.98	1357
10	Oct	31	392	266	56	784	1106	7.50	144.4	689.1	99	0	0.00	0	999	1.98	1006
11	Nov	30	123	83	18	246	347	7.16	137.8	689.1	95	0	30.07	252	999	1.98	0
12	Dec	31	2					7.50	144.4	689.1	99	0	35.65	299	601	1.40	0
		365	2582	1726	363	5090	7178	100.00	1924.0		1070	0.00	100.00	838			5111

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

San Pedro Puxtla

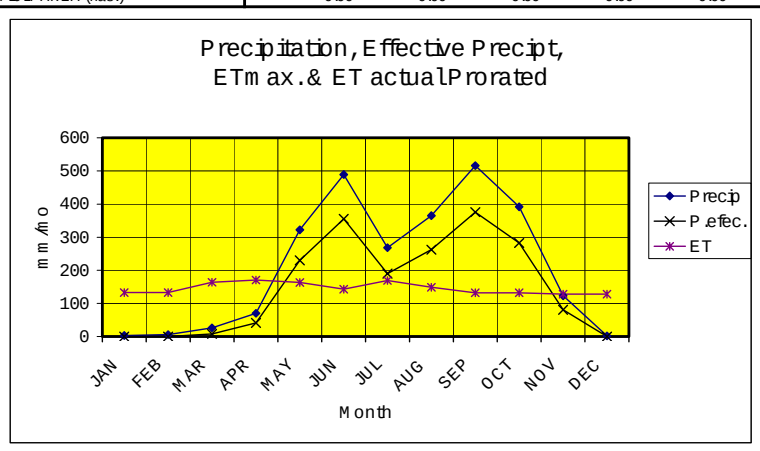
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

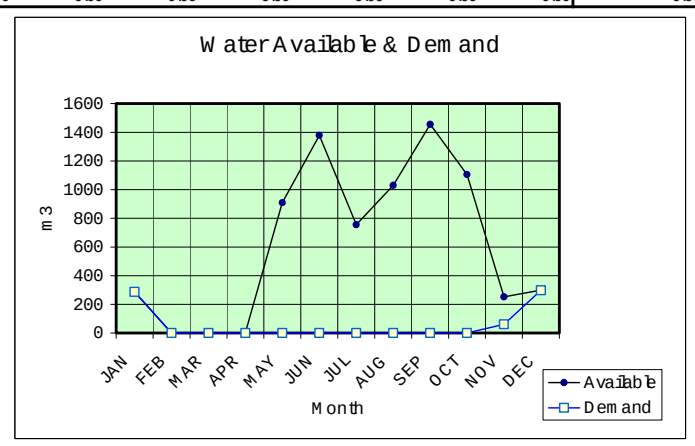
AHUACHAPAN, EL SALVADOR | PROJECT: RESERVORIOS | AREA (m2) 1950

1a	CROP	Green Pepper	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	
	AREA UNDER OPTIMUM IRRIG, ha	0.028	0.028	0.028	0.028	0.028	0.056	0.000	0.000	0.000	0.000	0.1950	
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

2a	Perim. Max. Ha	10.00
2b	Factor Area	0.2785
2c	Cap. Canal lps	40.00

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)	133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)	3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec. Efec. (mm.)	0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1) Green Pepper	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.028
	Net Req. (m3)	33.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.87	32.08	80	
6a	Kc (Crop No.2) Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.028
	Net Req. (m3)	33.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.87	32.08	80	
7a	Kc (Crop No.3) Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax	106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20		
	ETactual	106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20	735.40	
	Irr.Req.(mm.)	106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	115.20	287.80	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03		0.028
	Net Req. (m3)	29.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.44	32.08	80	
8a	Kc (Crop No.4) Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03		0.028
	Net Req. (m3)	33.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.65	69	
9a	Kc (Crop No.5) Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03		0.028
	Net Req. (m3)	33.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.65	68.98	
10a	Kc (Crop No.6) Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06		0.056
	Net Req. (m3)	66.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.30	138	
	Area Total (ha.)	0.19	0.00	0.00	0.00	0.00	0.06	0.06	0.08	0.08	0.08	0.19	0.19	0.19	Correcto
	Net Req. (m3)	230	0	0	0	0	0	0	0	0	0	48	239	517	Sum
	Net Irrig. Req. (mm)	117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.71	122.51	265.03	Sum
	Consumo Ponderado (mm)	117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.31	122.51	343.63	
	Factor Demanda Riegos %	34.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.07	35.65	100.00	
A	Net Irrig. Req. (l/s)	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.46	0.083	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	147.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	30.893	153.143	331.286	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.020	Avg
	Gross Irrig. Req. (m3)	287	0	0	0	0	0	0	0	0	0	60	299	646	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.550	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.572	0.103	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	287	0	0	0	908	1,379	756	1,029	1,455	1,106	252	299	7,471	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	287	0	0	0	908	1,379	756	1,029	1,455	1,106	252	299	7,471	Sum
E"	TOTAL (l/s)	0.11	0.00	0.00	0.00	0.34	0.53	0.28	0.38	0.56	0.41	0.10	0.11	0.236	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.11	0.00	0.00	0.00	0.34	0.53	0.28	0.38	0.56	0.41	0.10	0.11	0.236	Avg
	Actual Water Available (m3)	287	0	0	0	908	1,379	756	1,029	1,455	1,106	252	299	7,471	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.19		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.34	0.53	0.28	0.38	0.56	0.41	0.07	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	0	908	1379	756	1029	1455	1106	192	0	6,826	Sum
G=E/D	Max. Irrig. Area (ha)	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.20		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir

3 months

Initial Water Volume in April	0	m3
Annual Evaporation	1924	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	343.63	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	1900.00	m2

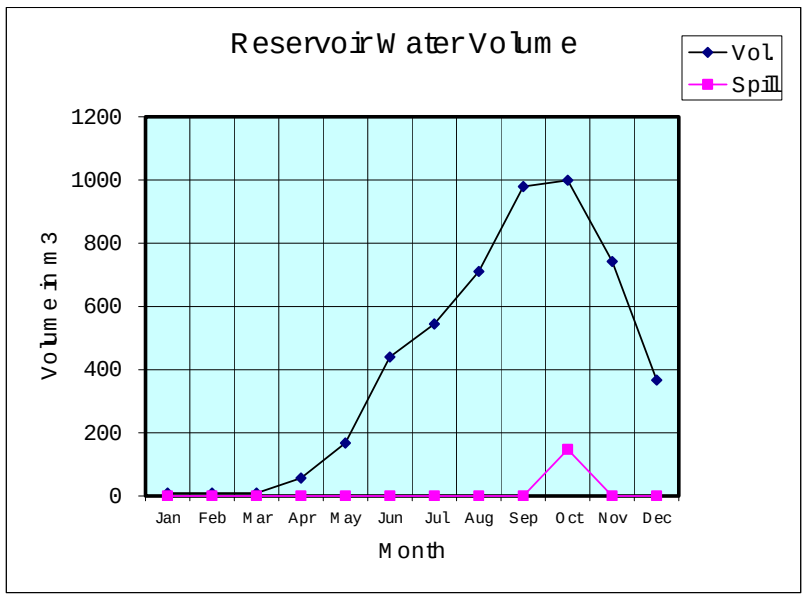
Rainfall Catchment Area		
Reservoir	678	m2
Roof	0	m2
Gallery Watershed	0	ha

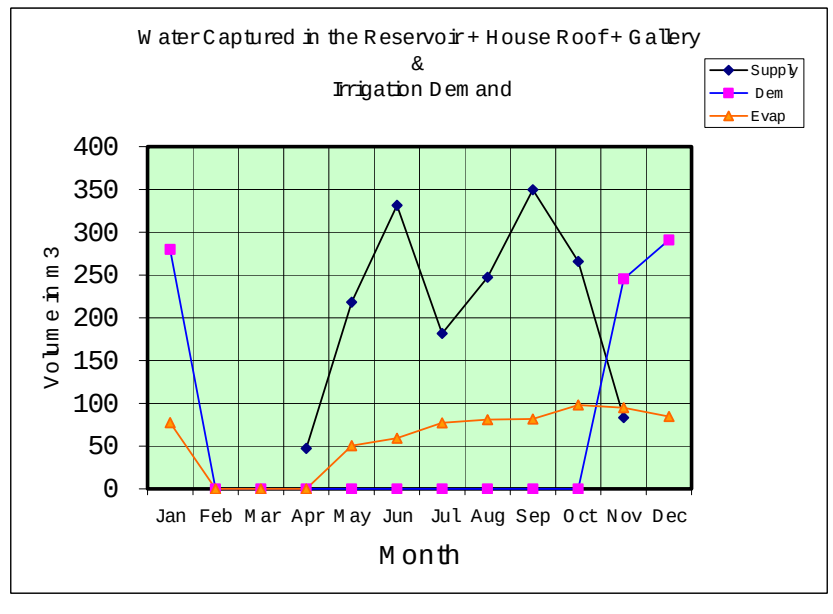
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Wate (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	3					8.75	168.4	460.6	78	0	34.28	280	9	0.05	0
2	Feb	28	6					8.24	158.6	0.0	0	0	0.00	0	9	0.05	0
3	Mar	31	26					11.31	217.7	0.0	0	0	0.00	0	9	0.05	0
4	Apr	30	70	47	0	0	47	9.04	173.9	0.0	0	0	0.00	0	57	0.18	0
5	May	31	322	218	0	0	218	8.75	168.4	299.8	51	0	0.00	0	168	0.47	0
6	Jun	30	489	332	0	0	332	7.90	152.0	389.9	59	0	0.00	0	440	1.09	0
7	Jul	31	268	182	0	0	182	8.30	159.7	483.9	77	0	0.00	0	545	1.30	0
8	Aug	31	365	247	0	0	247	8.13	156.4	517.5	81	0	0.00	0	711	1.59	0
9	Sep	30	516	350	0	0	350	7.39	142.2	574.5	82	0	0.00	0	979	1.96	0
10	Oct	31	392	266	0	0	266	7.50	144.4	680.3	98	0	0.00	0	999	1.98	148
11	Nov	30	123	83	0	0	83	7.16	137.8	689.1	95	0	30.07	245	742	1.64	0
12	Dec	31	2					7.50	144.4	585.8	85	0	35.65	291	367	0.94	0
		365	2582	1726	0	0	1726	100.00	1924.0		705	0.00	100.00	816			148

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

San Pedro Puxtla

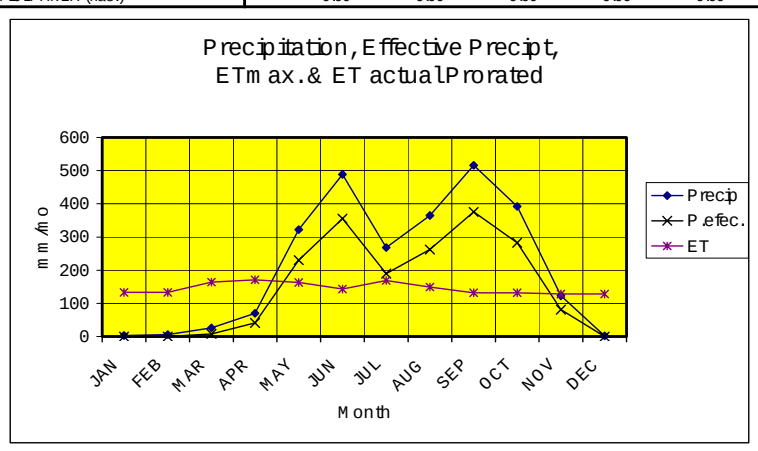
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

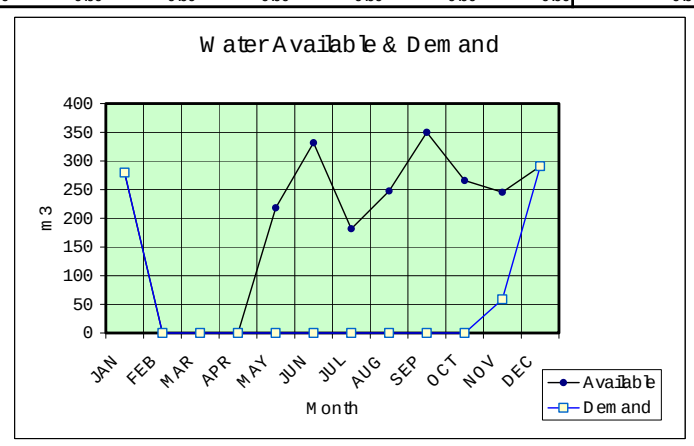
AHUACHAPAN, EL SALVADOR | PROJECT: RESERVORIOS | AREA (m2) 1900

1a	CROP	Green Pepper	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	
	AREA UNDER OPTIMUM IRRIG, ha	0.027	0.027	0.027	0.027	0.027	0.054	0.000	0.000	0.000	0.000	0.1900	
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

2a	Perim.Max.Ha	10.00
2b	Factor Area	0.2714
2c	Cap.Canal lps	40.00

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)	133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)	3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec. Efec. (mm.)	0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1) Green Pepper	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.027
	Net Req. (m3)	32.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.49	31.27	78	
6a	Kc (Crop No.2) Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual	119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.027
	Net Req. (m3)	32.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.49	31.27	78	
7a	Kc (Crop No.3) Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax	106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20		
	ETactual	106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20	735.40	
	Irr.Req.(mm.)	106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	115.20	287.80	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03		0.027
	Net Req. (m3)	28.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.97	31.27	78	
8a	Kc (Crop No.4) Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03		0.027
	Net Req. (m3)	32.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.74	67	
9a	Kc (Crop No.5) Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03		0.027
	Net Req. (m3)	32.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.74	67.23	
10a	Kc (Crop No.6) Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr.Req.(mm.)	119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05		0.054
	Net Req. (m3)	64.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.48	134	
	Area Total (ha.)	0.19	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.08	0.19	0.19	0.19	Correcto
	Net Req. (m3)	224	0	0	0	0	0	0	0	0	0	47	233	504	Sum
	Net Irrig. Req. (mm)	117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.71	122.51	265.03	Sum
	Consumo Ponderado (mm)	117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.31	122.51	343.63	
	Factor Demanda Riegos %	34.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.07	35.65	100.00	
A	Net Irrig. Req. (l/s)	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.46	0.083	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	147.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	30.893	153.143	331.286	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.020	Avg
	Gross Irrig. Req. (m3)	280	0	0	0	0	0	0	0	0	0	59	291	629	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.550	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.572	0.103	Avg
	WATER AVAILABLE														
16a	Name… (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	280	0	0	0	218	332	182	247	350	266	245	291	2,411	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	280	0	0	0	218	332	182	247	350	266	245	291	2,411	Sum
E"	TOTAL (l/s)	0.10	0.00	0.00	0.00	0.08	0.13	0.07	0.09	0.13	0.10	0.09	0.11	0.076	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.10	0.00	0.00	0.00	0.08	0.13	0.07	0.09	0.13	0.10	0.09	0.11	0.076	Avg
	Actual Water Available (m3)	280	0	0	0	218	332	182	247	350	266	245	291	2,411	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.19		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.08	0.13	0.07	0.09	0.13	0.10	0.07	0.00		
	Exceeding/Deficit Water (m3)	0	0	0	0	218	332	182	247	350	266	187	0	1,781	Sum
G=E/D	Max.Irrig. Area (ha)	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.19		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO	Reservoir + Gallery + Roof

6 months

Initial Water Volume in April	0	m3
Annual Evaporation	1920	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	637.18	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	1020.00	m2

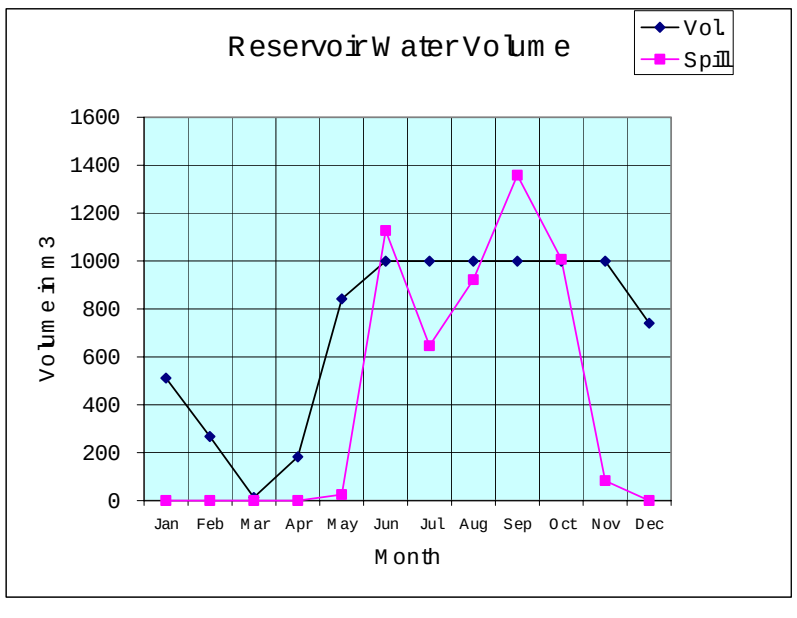
Rainfall Catchment Area		
Reservoir	678	m2
Roof	150	m2
Gallery Watershed	10	ha

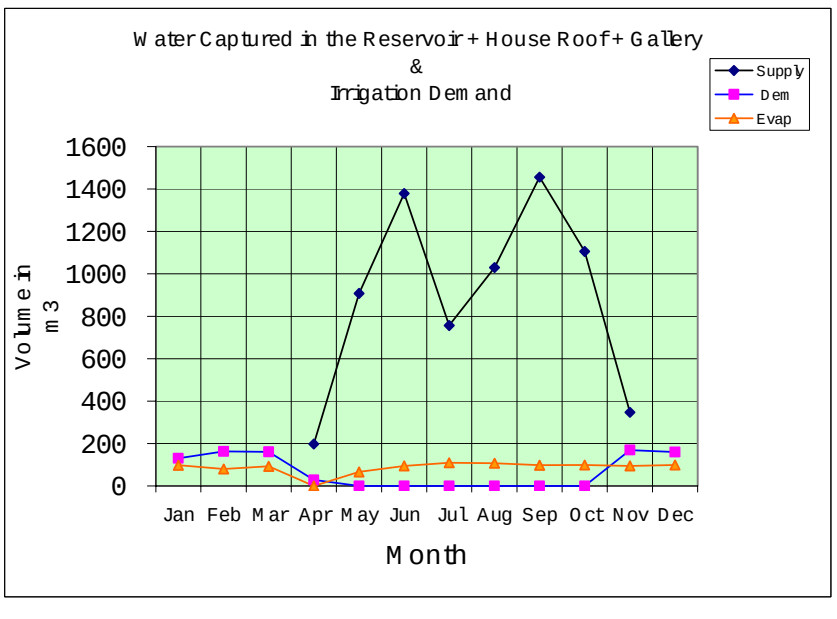
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Water (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	3					8.75	168.1	585.1	98	0	16.10	131	511	1.23	0
2	Feb	28	6					8.24	158.3	506.6	80	0	20.13	164	267	0.71	0
3	Mar	31	26					11.31	217.2	428.1	93	0	19.86	161	13	0.06	0
4	Apr	30	70	47	10	140	197	9.04	173.6	0.0	0	0	3.45	28	182	0.51	0
5	May	31	322	218	46	644	908	8.75	168.1	396.3	67	0	0.00	0	842	1.78	25
6	Jun	30	489	332	70	978	1379	7.90	151.7	623.4	95	0	0.00	0	999	1.98	1127
7	Jul	31	268	182	38	536	756	8.30	159.4	689.1	110	0	0.00	0	999	1.98	646
8	Aug	31	365	247	52	730	1029	8.13	156.1	689.1	108	0	0.00	0	999	1.98	922
9	Sep	30	516	350	74	1032	1455	7.39	141.9	689.1	98	0	0.00	0	999	1.98	1358
10	Oct	31	392	266	56	784	1106	7.50	144.1	689.1	99	0	0.00	0	999	1.98	1006
11	Nov	30	123	83	18	246	347	7.16	137.5	689.1	95	0	20.81	169	999	1.98	83
12	Dec	31	2					7.50	144.1	689.1	99	0	19.66	160	740	1.63	0
		365	2582	1726	363	5090	7178	100.00	1920.0		1041	0.00	100.00	812			5167

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olmeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

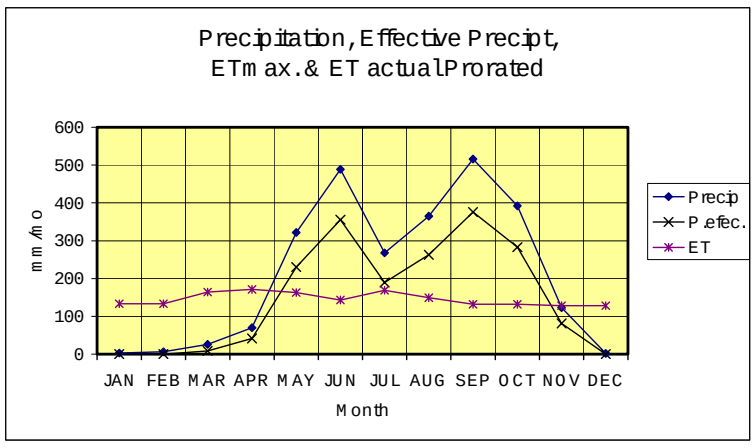
San Pedro Puxta

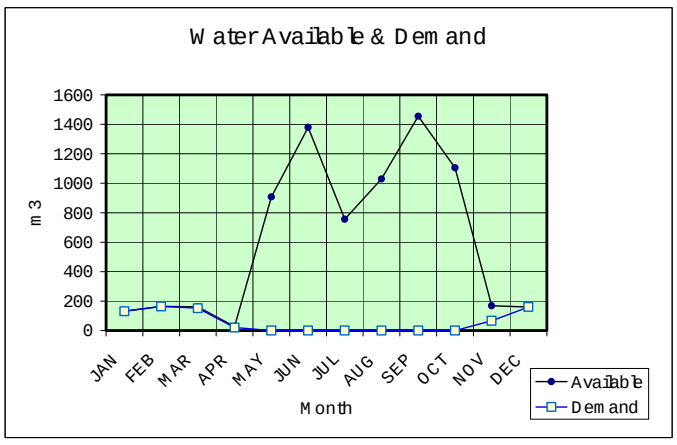
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

AHUACHAPAN, EL SALVADOR	PROJECT: RESERVOIRS	AREA (m2) 1020

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	2a	Perim.Max.Ha	10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	2b	Factor Area	0.1457
	AREA UNDER OPTIMUM IRRIG, ha	0.015	0.015	0.015	0.015	0.015	0.029	0.000	0.000	0.000	0.000	0.1020	2c	Cap.Canal lps	40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)	133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)	3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec. Efec. (mm.)	0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1) Green Peppers	1.05	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	139.65	139.65	147.60	153.90	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	1047.60	
	ETactual	139.65	139.65	147.60	153.90	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	1047.60	
	Irr.Req.(mm.)	139.65	139.65	139.35	112.65	0.00	0.00	0.00	0.00	0.00	0.00	53.40	134.40	719.10	
	Area (ha)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.015
	Net Req. (m3)	20.35	20.35	20.30	16.41	0.00	0.00	0.00	0.00	0.00	0.00	7.78	19.58	105	
6a	Kc (Crop No.2) Jalapeño	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	139.65	119.70	147.60	0.00	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	873.75	
	ETactual	139.65	119.70	147.60	0.00	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	873.75	
	Irr.Req.(mm.)	139.65	119.70	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	134.40	586.50	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.015
	Net Req. (m3)	20.35	17.44	20.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.78	19.58	85	
7a	Kc (Crop No.3) Tomatoes	0.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15		
	ETmax	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	79.20	125.40	147.20	147.20		
	ETactual	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	79.20	125.40	147.20	147.20	725.10	
	Irr.Req.(mm.)	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	147.20	439.50	
	Area (ha)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.015
	Net Req. (m3)	17.44	15.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.65	21.45	64	
8a	Kc (Crop No.4) Zucchini	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req.(mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.015
	Net Req. (m3)	11.63	19.38	20.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.85	16.78	75	
9a	Kc (Crop No.5) Squash	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req.(mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.015
	Net Req. (m3)	11.63	19.38	20.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.85	16.78	74.94	
10a	Kc (Crop No.6) Cucumbers	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req.(mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03		0.029
	Net Req. (m3)	23.25	38.76	40.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.70	33.57	150	
	Area Total (ha.)	0.10	0.10	0.09	0.01	0.00	0.00	0.00	0.00	0.04	0.10	0.10	0.10	0.10	Correcto
	Net Req. (m3)	105	131	122	16	0	0	0	0	0	0	53	128	554	Sum
	Net Irrig. Req. (mm)	102.60	128.25	139.35	112.65	0.00	0.00	0.00	0.00	0.00	0.00	51.57	125.26	659.68	Sum
	Consumo Ponderado (mm)	102.60	128.25	126.51	21.99	0.00	0.00	0.00	0.00	0.00	0.00	132.57	125.26	637.18	
	Irrigation Demand Factor%	16.10	20.13	19.86	3.45	0.00	0.00	0.00	0.00	0.00	0.00	20.81	19.66	100.00	
A	Net Irrig. Req. (l/s)	0.04	0.05	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.38	0.53	0.52	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.47	0.211	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	128.250	160.313	174.188	140.813	0.000	0.000	0.000	0.000	0.000	0.000	64.464	156.571	824.598	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.05	0.07	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.022	Avg
	Gross Irrig. Req. (m3)	131	164	152	21	0	0	0	0	0	0	66	160	693	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.479	0.663	0.650	0.543	0.000	0.000	0.000	0.000	0.000	0.000	0.249	0.585	0.264	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	131	164	161	28	908	1,379	756	1,029	1,455	1,106	169	160	7,446	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	131	164	161	28	908	1,379	756	1,029	1,455	1,106	169	160	7,446	Sum
E"	TOTAL (l/s)	0.05	0.07	0.06	0.01	0.34	0.53	0.28	0.38	0.56	0.41	0.07	0.06	0.235	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.05	0.07	0.06	0.01	0.34	0.53	0.28	0.38	0.56	0.41	0.07	0.06	0.235	Avg
	Actual Water Available (m3)	131	164	161	28	908	1,379	756	1,029	1,455	1,106	169	160	7,446	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.10	0.10	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.34	0.53	0.28	0.38	0.56	0.41	0.04	0.00		
	Exceeding/Deficit Water (m3)	0	0	9	8	908	1379	756	1029	1455	1106	103	0	6,754	Sum
G=E/D	Max.Irrig. Area (ha)	0.10	0.10	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.10		
H=F/D	Additional Area (has.)	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir + Gallery

6 months

Initial Water Volume in April	0	m3
Annual Evaporation	1924	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	637.18	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	1020.00	m2

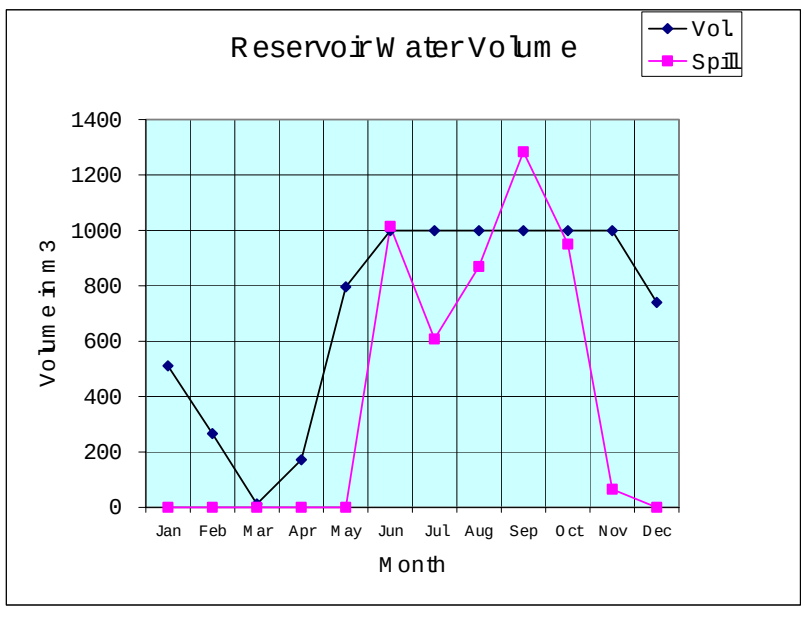
Rainfall Catchment Area		
Reservoir	678	m2
Roof	0	m2
Gallery Watershed	10	ha

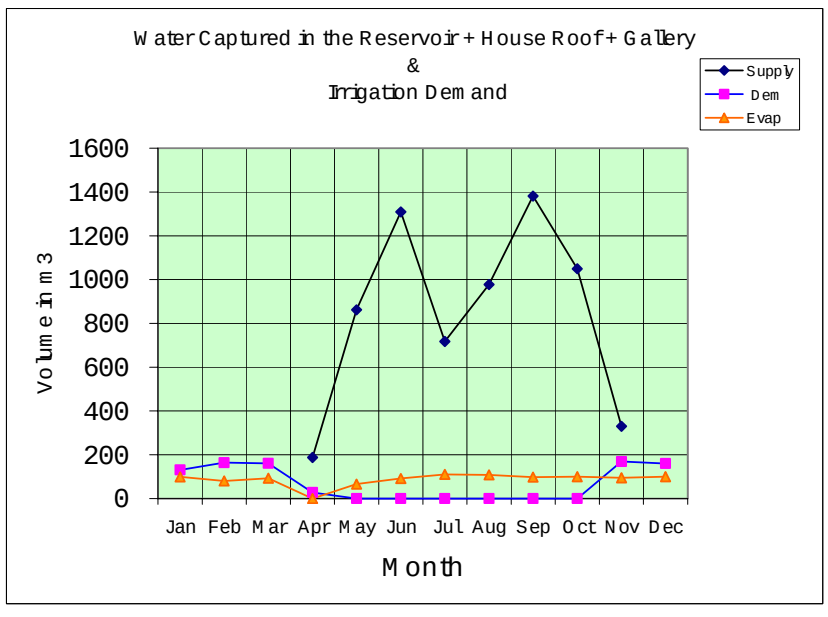
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Wate (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	3					8.75	168.4	585.0	99	0	16.10	131	511	1.23	0
2	Feb	28	6					8.24	158.6	506.5	80	0	20.13	164	267	0.71	0
3	Mar	31	26					11.31	217.7	428.0	93	0	19.86	161	12	0.06	0
4	Apr	30	70	47	0	140	187	9.04	173.9	0.0	0	0	3.45	28	172	0.48	0
5	May	31	322	218	0	644	862	8.75	168.4	391.7	66	0	0.00	0	796	1.72	0
6	Jun	30	489	332	0	978	1310	7.90	152.0	606.0	92	0	0.00	0	999	1.98	1015
7	Jul	31	268	182	0	536	718	8.30	159.7	689.1	110	0	0.00	0	999	1.98	608
8	Aug	31	365	247	0	730	977	8.13	156.4	689.1	108	0	0.00	0	999	1.98	870
9	Sep	30	516	350	0	1032	1382	7.39	142.2	689.1	98	0	0.00	0	999	1.98	1284
10	Oct	31	392	266	0	784	1050	7.50	144.4	689.1	99	0	0.00	0	999	1.98	950
11	Nov	30	123	83	0	246	329	7.16	137.8	689.1	95	0	20.81	169	999	1.98	65
12	Dec	31	2					7.50	144.4	689.1	99	0	19.66	160	740	1.63	0
		365	2582	1726	0	5090	6816	100.00	1924.0		1040	0.00	100.00	812			4791

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
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Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

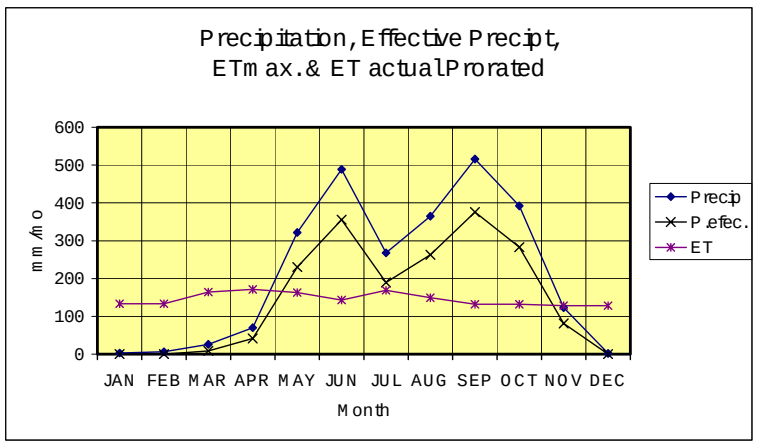
San Pedro Puxtla

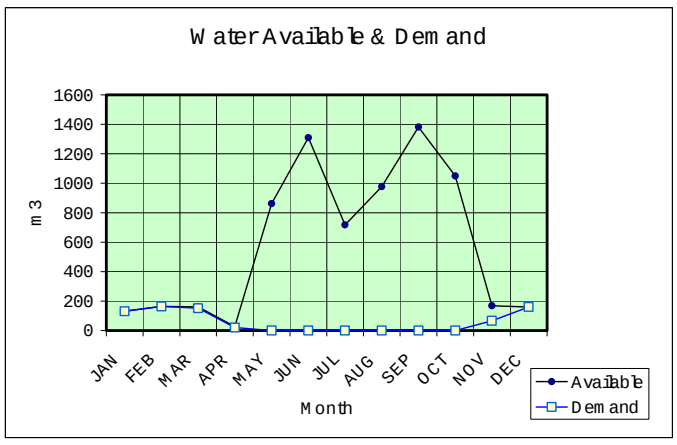
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

AHUACHAPAN, EL SALVADOR	PROJECT: RESERVORIOS	AREA (m2) 1020

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL		2a	Perim.Max.Ha 10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000		2b	Factor Area 0.1457
	AREA UNDER OPTIMUM IRRIG, ha	0.015	0.015	0.015	0.015	0.015	0.029	0.000	0.000	0.000	0.000	0.1020		2c	Cap.Canal lps 40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)	133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)	3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec.Efec. (mm.)	0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1) Green Peppers	1.05	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	139.65	139.65	147.60	153.90	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	1047.60	
	ETactual	139.65	139.65	147.60	153.90	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	1047.60	
	Irr.Req.(mm.)	139.65	139.65	139.35	112.65	0.00	0.00	0.00	0.00	0.00	0.00	53.40	134.40	719.10	
	Area (ha)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.015
	Net Req. (m3)	20.35	20.35	20.30	16.41	0.00	0.00	0.00	0.00	0.00	0.00	7.78	19.58	105	
6a	Kc (Crop No.2) Jalapeño	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	139.65	119.70	147.60	0.00	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	873.75	
	ETactual	139.65	119.70	147.60	0.00	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	873.75	
	Irr.Req.(mm.)	139.65	119.70	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	134.40	586.50	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.015
	Net Req. (m3)	20.35	17.44	20.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.78	19.58	85	
7a	Kc (Crop No.3) Tomatoes	0.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15		
	ETmax	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	79.20	125.40	147.20	147.20		
	ETactual	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	79.20	125.40	147.20	147.20	725.10	
	Irr.Req.(mm.)	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	147.20	439.50	
	Area (ha)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.015
	Net Req. (m3)	17.44	15.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.65	21.45	64	
8a	Kc (Crop No.4) Zucchini	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req.(mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.015
	Net Req. (m3)	11.63	19.38	20.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.85	16.78	75	
9a	Kc (Crop No.5) Squash	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req.(mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.015
	Net Req. (m3)	11.63	19.38	20.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.85	16.78	74.94	
10a	Kc (Crop No.6) Cucumbers	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req.(mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03		0.029
	Net Req. (m3)	23.25	38.76	40.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.70	33.57	150	
	Area Total (ha.)	0.10	0.10	0.09	0.01	0.00	0.00	0.00	0.00	0.04	0.10	0.10	0.10	0.10	Correcto
	Net Req. (m3)	105	131	122	16	0	0	0	0	0	0	53	128	554	Sum
	Net Irrig. Req. (mm)	102.60	128.25	139.35	112.65	0.00	0.00	0.00	0.00	0.00	0.00	51.57	125.26	659.68	Sum
	Consumo Ponderado (mm)	102.60	128.25	126.51	21.99	0.00	0.00	0.00	0.00	0.00	0.00	132.57	125.26	637.18	
	Factor Demanda Riegos %	16.10	20.13	19.86	3.45	0.00	0.00	0.00	0.00	0.00	0.00	20.81	19.66	100.00	
A	Net Irrig. Req. (l/s)	0.04	0.05	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.02	Avg
B	Net Irrig. Req. (l/s/ha)	0.38	0.53	0.52	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.47	0.211	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	128.250	160.313	174.188	140.813	0.000	0.000	0.000	0.000	0.000	0.000	64.464	156.571	824.598	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.05	0.07	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.022	Avg
	Gross Irrig. Req. (m3)	131	164	152	21	0	0	0	0	0	0	66	160	693	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.479	0.663	0.650	0.543	0.000	0.000	0.000	0.000	0.000	0.000	0.249	0.585	0.264	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	131	164	161	28	862	1,310	718	977	1,382	1,050	169	160	7,111	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	131	164	161	28	862	1,310	718	977	1,382	1,050	169	160	7,111	Sum
E"	TOTAL (l/s)	0.05	0.07	0.06	0.01	0.32	0.51	0.27	0.36	0.53	0.39	0.07	0.06	0.225	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.05	0.07	0.06	0.01	0.32	0.51	0.27	0.36	0.53	0.39	0.07	0.06	0.225	Avg
	Actual Water Available (m3)	131	164	161	28	862	1,310	718	977	1,382	1,050	169	160	7,111	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.10	0.10	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.32	0.51	0.27	0.36	0.53	0.39	0.04	0.00		
	Exceeding/Deficit Water (m3)	0	0	9	8	862	1310	718	977	1382	1050	103	0	6,419	Sum
G=E/D	Max.Irrig. Area (ha)	0.10	0.10	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.10		
H=F/D	Additional Area (has.)	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir + Roof

6 months

Initial Water Volume in April	0	m3
Annual Evaporation	1920	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	637.18	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	850.00	m2

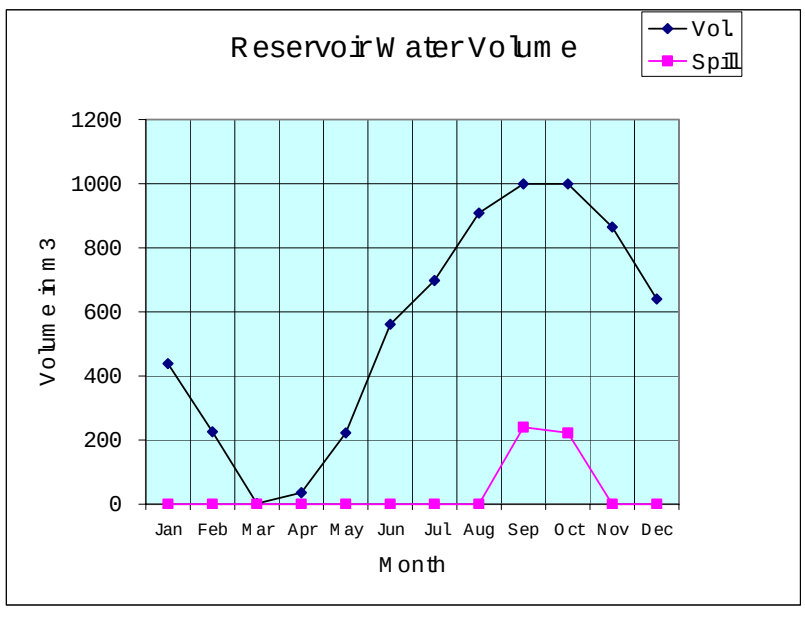
Rainfall Catchment Area		
Reservoir	678	m2
Roof	150	m2
Gallery Watershed	0	ha

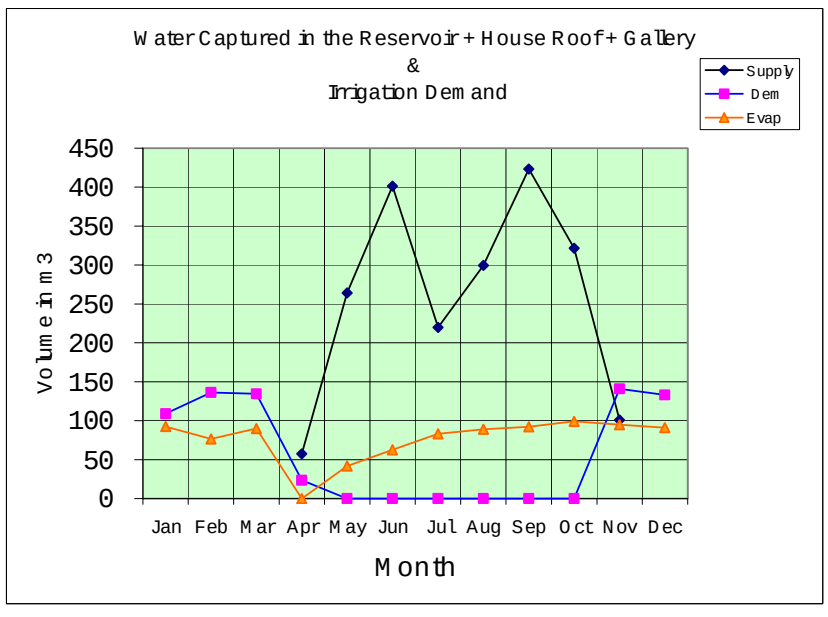
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Wate (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	3					8.75	168.1	549.7	92	0	16.10	109	439	1.09	0
2	Feb	28	6					8.24	158.3	483.5	77	0	20.13	136	226	0.62	0
3	Mar	31	26					11.31	217.2	413.5	90	0	19.86	134	2	0.03	0
4	Apr	30	70	47	10	0	57	9.04	173.6	0.0	0	0	3.45	23	36	0.13	0
5	May	31	322	218	46	0	264	8.75	168.1	247.8	42	0	0.00	0	223	0.61	0
6	Jun	30	489	332	70	0	401	7.90	151.7	412.2	63	0	0.00	0	561	1.33	0
7	Jul	31	268	182	38	0	220	8.30	159.4	523.0	83	0	0.00	0	698	1.57	0
8	Aug	31	365	247	52	0	299	8.13	156.1	569.8	89	0	0.00	0	908	1.87	0
9	Sep	30	516	350	74	0	423	7.39	141.9	650.3	92	0	0.00	0	999	1.98	240
10	Oct	31	392	266	56	0	322	7.50	144.1	689.1	99	0	0.00	0	999	1.98	222
11	Nov	30	123	83	18	0	101	7.16	137.5	689.1	95	0	20.81	141	864	1.81	0
12	Dec	31	2					7.50	144.1	632.5	91	0	19.66	133	640	1.47	0
		365	2582	1726	363	0	2088	100.00	1920.0		913	0.00	100.00	677			463

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

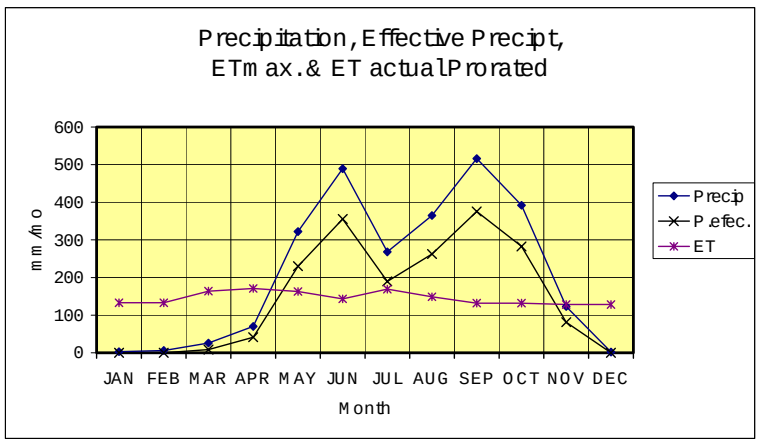
San Pedro Puxtla

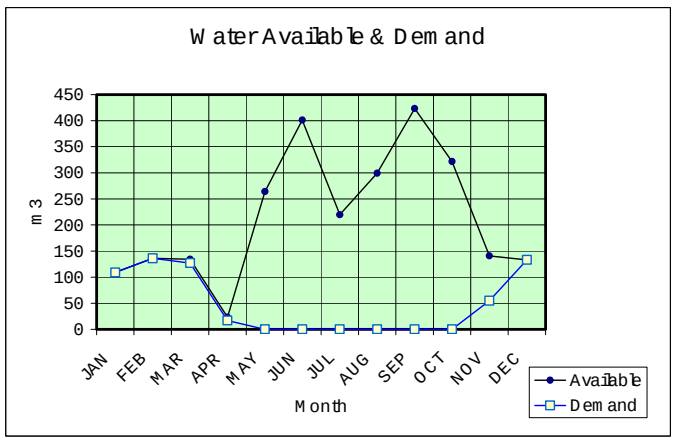
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

AHUACHAPAN, EL SALVADOR | PROJECT: RESERVORIOS | AREA (m2) 850

1a	CROP	Green Peppers	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	2a	Perim.Max.Ha 10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	2b	Factor Area 0.1214
	AREA UNDER OPTIMUM IRRIG, ha	0.012	0.012	0.012	0.012	0.012	0.024	0.000	0.000	0.000	0.000	0.0850	2c	Cap.Canal lps 40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)	133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)	3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec.Efec. (mm.)	0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1) Green Peppers	1.05	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	139.65	139.65	147.60	153.90	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	1047.60	
	ETactual	139.65	139.65	147.60	153.90	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	1047.60	
	Irr.Req. (mm.)	139.65	139.65	139.35	112.65	0.00	0.00	0.00	0.00	0.00	0.00	53.40	134.40	719.10	
	Area (ha)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	16.95	16.95	16.92	13.68	0.00	0.00	0.00	0.00	0.00	0.00	6.48	16.32	87	
6a	Kc (Crop No.2) Jalapeño	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	139.65	119.70	147.60	0.00	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	873.75	
	ETactual	139.65	119.70	147.60	0.00	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	873.75	
	Irr.Req. (mm.)	139.65	119.70	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	134.40	586.50	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	16.95	14.53	16.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.48	16.32	71	
7a	Kc (Crop No.3) Tomatoes	0.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15		
	ETmax	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	79.20	125.40	147.20	147.20		
	ETactual	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	79.20	125.40	147.20	147.20	725.10	
	Irr.Req. (mm.)	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	147.20	439.50	
	Area (ha)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	14.53	12.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.04	17.87	53	
8a	Kc (Crop No.4) Zucchini	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req. (mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.012
	Net Req. (m3)	9.69	16.15	16.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.71	13.99	62	
9a	Kc (Crop No.5) Squash	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req. (mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.012
	Net Req. (m3)	9.69	16.15	16.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.71	13.99	62.44	
10a	Kc (Crop No.6) Cucumbers	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req. (mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02		0.024
	Net Req. (m3)	19.38	32.29	33.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.41	27.97	125	
	Area Total (ha.)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.04	0.08	0.08	0.08	0.08	Correcto
	Net Req. (m3)	87	109	102	14	0	0	0	0	0	0	44	106	462	Sum
	Net Irrig. Req. (mm)	102.60	128.25	139.35	112.65	0.00	0.00	0.00	0.00	0.00	0.00	51.57	125.26	659.68	Sum
	Consumo Ponderado (mm)	102.60	128.25	126.51	21.99	0.00	0.00	0.00	0.00	0.00	0.00	132.57	125.26	637.18	
	Factor Demanda Riegos %	16.10	20.13	19.86	3.45	0.00	0.00	0.00	0.00	0.00	0.00	20.81	19.66	100.00	
A	Net Irrig. Req. (l/s)	0.03	0.05	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.01	Avg
B	Net Irrig. Req. (l/s/ha)	0.38	0.53	0.52	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.47	0.211	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	128.250	160.313	174.188	140.813	0.000	0.000	0.000	0.000	0.000	0.000	64.464	156.571	824.598	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.04	0.06	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.018	Avg
	Gross Irrig. Req. (m3)	109	136	127	17	0	0	0	0	0	0	55	133	577	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.479	0.663	0.650	0.543	0.000	0.000	0.000	0.000	0.000	0.000	0.249	0.585	0.264	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	109	136	134	23	264	401	220	299	423	322	141	133	2,607	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	109	136	134	23	264	401	220	299	423	322	141	133	2,607	Sum
E"	TOTAL (l/s)	0.04	0.06	0.05	0.01	0.10	0.15	0.08	0.11	0.16	0.12	0.05	0.05	0.083	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.04	0.06	0.05	0.01	0.10	0.15	0.08	0.11	0.16	0.12	0.05	0.05	0.083	Avg
	Actual Water Available (m3)	109	136	134	23	264	401	220	299	423	322	141	133	2,607	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.10	0.15	0.08	0.11	0.16	0.12	0.03	0.00		
	Exceeding/Deficit Water (m3)	0	0	8	6	264	401	220	299	423	322	86	0	2,030	Sum
G=E/D	Max Irrig. Area (ha)	0.09	0.09	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.09		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO: Reservoir

6 months

Initial Water Volume in April	0	m3
Annual Evaporation	1924	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	999	m3
Weighted Annual Irrigated Depth	637.18	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	820.00	m2

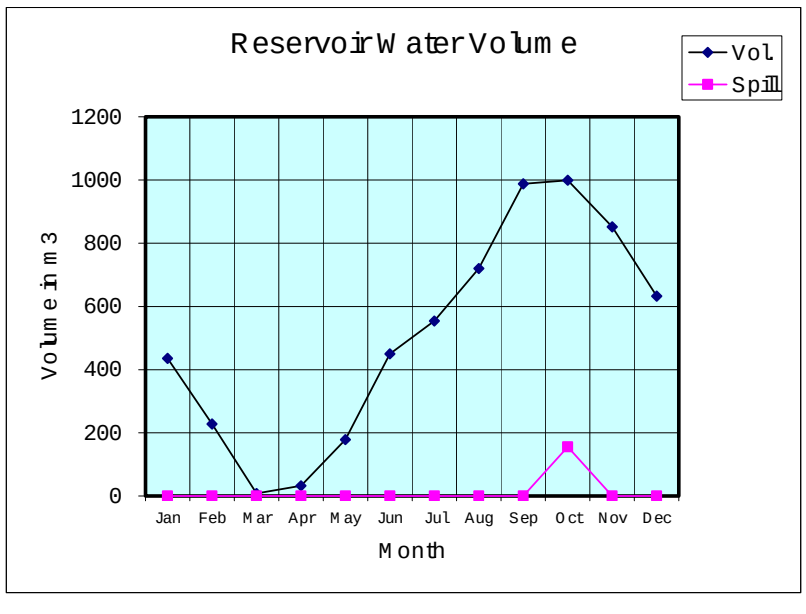
Rainfall Catchment Area		
Reservoir	678	m2
Roof	0	m2
Gallery Watershed	0	ha

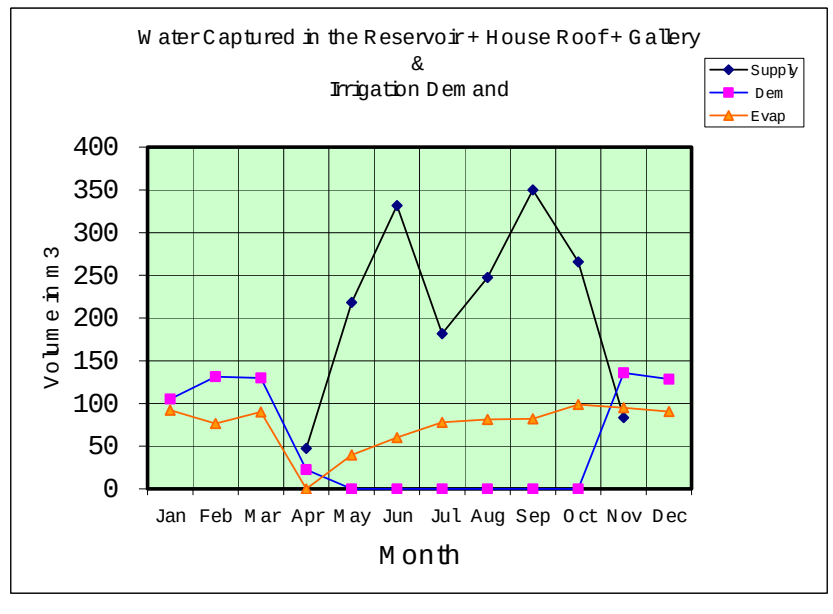
Reservoir Dimensions			
Top Length (m)	30	Bottom Length (m)	22
Top Width (m)	22.6	Bottom Width (m)	14.6
Depth (m)	2		
Side Slope H:1	2		
Bottom Area (m2)	321.2		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Wate (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	3					8.75	168.4	547.1	92	0	16.10	105	435	1.08	0
2	Feb	28	6					8.24	158.6	482.4	77	0	20.13	131	227	0.62	0
3	Mar	31	26					11.31	217.7	414.0	90	0	19.86	130	8	0.05	0
4	Apr	30	70	47	0	0	47	9.04	173.9	0.0	0	0	3.45	23	33	0.12	0
5	May	31	322	218	0	0	218	8.75	168.4	235.3	40	0	0.00	0	179	0.50	0
6	Jun	30	489	332	0	0	332	7.90	152.0	394.7	60	0	0.00	0	450	1.11	0
7	Jul	31	268	182	0	0	182	8.30	159.7	487.1	78	0	0.00	0	554	1.32	0
8	Aug	31	365	247	0	0	247	8.13	156.4	520.7	81	0	0.00	0	720	1.60	0
9	Sep	30	516	350	0	0	350	7.39	142.2	577.8	82	0	0.00	0	988	1.97	0
10	Oct	31	392	266	0	0	266	7.50	144.4	684.1	99	0	0.00	0	999	1.98	156
11	Nov	30	123	83	0	0	83	7.16	137.8	689.1	95	0	20.81	136	852	1.80	0
12	Dec	31	2					7.50	144.4	627.4	91	0	19.66	128	633	1.46	0
		365	2582	1726	0	0	1726	100.00	1924.0		884	0.00	100.00	653			156

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





References:
Free-water evaporation. Data taken from Harza: Factibilidad Olomeca 1967
Precipitation. Data taken from: Almanaque de El Salvador 1993. Page No. 53

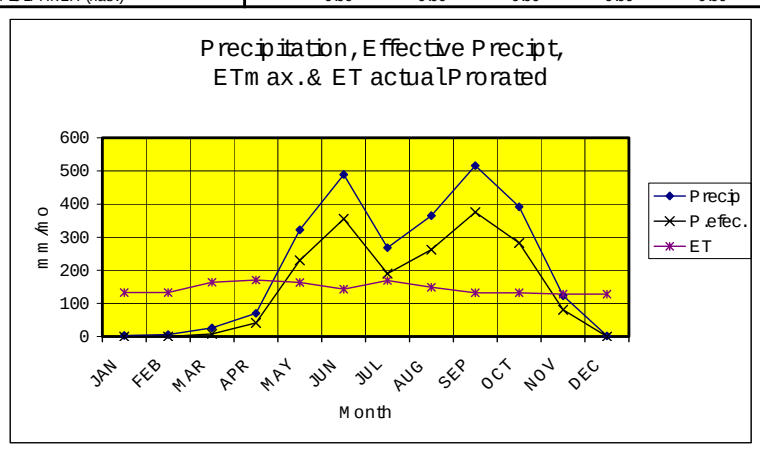
San Pedro Puxtla

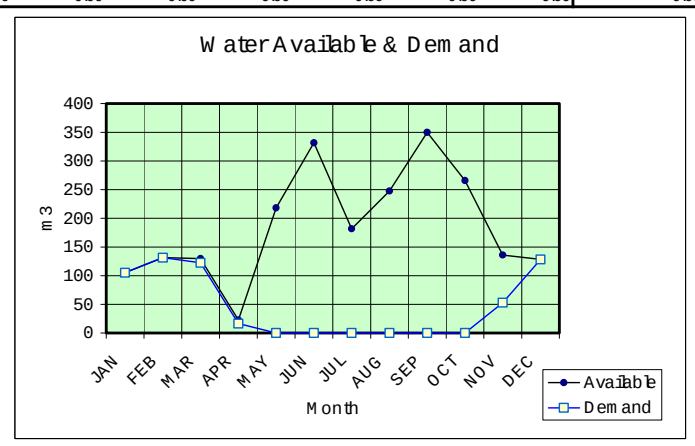
AG.HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

AHUACHAPAN, EL SALVADOR | PROJECT: RESERVORIOS | AREA (m2) 820

1a	CROP	Green Pepper	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	2a	Perim.Max.Ha 10.00
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	2b	Factor Area 0.1171
	AREA UNDER OPTIMUM IRRIG, ha	0.012	0.012	0.012	0.012	0.012	0.023	0.000	0.000	0.000	0.000	0.0820	2c	Cap.Canal lps 40.00
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			

	Reservorio	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
		31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)	4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)	133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)	3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec.Efec. (mm.)	0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1) Green Pepper	1.05	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	139.65	139.65	147.60	153.90	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	1047.60	
	ETactual	139.65	139.65	147.60	153.90	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	1047.60	
	Irr.Req. (mm.)	139.65	139.65	139.35	112.65	0.00	0.00	0.00	0.00	0.00	0.00	53.40	134.40	719.10	
	Area (ha)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	16.35	16.35	16.32	13.19	0.00	0.00	0.00	0.00	0.00	0.00	6.25	15.74	84	
6a	Kc (Crop No.2) Jalapeño	1.05	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05		
	ETmax	139.65	119.70	147.60	0.00	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	873.75	
	ETactual	139.65	119.70	147.60	0.00	0.00	0.00	0.00	0.00	79.20	118.80	134.40	134.40	873.75	
	Irr.Req. (mm.)	139.65	119.70	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	134.40	586.50	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	16.35	14.02	16.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.25	15.74	69	
7a	Kc (Crop No.3) Tomatoes	0.90	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15		
	ETmax	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	79.20	125.40	147.20	147.20		
	ETactual	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	79.20	125.40	147.20	147.20	725.10	
	Irr.Req. (mm.)	119.70	106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	147.20	439.50	
	Area (ha)	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01		0.012
	Net Req. (m3)	14.02	12.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.75	17.24	51	
8a	Kc (Crop No.4) Zucchini	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req. (mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.012
	Net Req. (m3)	9.34	15.57	16.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.50	13.49	60	
9a	Kc (Crop No.5) Squash	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req. (mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.012
	Net Req. (m3)	9.34	15.57	16.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.50	13.49	60.23	
10a	Kc (Crop No.6) Cucumbers	0.60	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00	0.90		
	ETmax	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20		
	ETactual	79.80	133.00	147.60	0.00	0.00	0.00	0.00	0.00	0.00	79.20	128.00	115.20	682.80	
	Irr.Req. (mm.)	79.80	133.00	139.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	115.20	514.35	
	Area (ha)	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02		0.023
	Net Req. (m3)	18.69	31.15	32.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.01	26.98	120	
	Area Total (ha.)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.04	0.08	0.08	0.08	0.08	Correcto
	Net Req. (m3)	84	105	98	13	0	0	0	0	0	0	42	103	445	Sum
	Net Irrig. Req. (mm)	102.60	128.25	139.35	112.65	0.00	0.00	0.00	0.00	0.00	0.00	51.57	125.26	659.68	Sum
	Consumo Ponderado (mm)	102.60	128.25	126.51	21.99	0.00	0.00	0.00	0.00	0.00	0.00	132.57	125.26	637.18	
	Factor Demanda Riegos %	16.10	20.13	19.86	3.45	0.00	0.00	0.00	0.00	0.00	0.00	20.81	19.66	100.00	
A	Net Irrig. Req. (l/s)	0.03	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.01	Avg
B	Net Irrig. Req. (l/s/ha)	0.38	0.53	0.52	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.47	0.211	Avg
	WATER DEMAND														
15a	Efic. Diversion	1.00													
15b	Efic. Conveyance Main Canal	1.00													
15c	Efic. Distribution	1.00	EFFICIENCY												
15d	Efic. Aplication	0.80	0.80												
	Gross Irrig. Req. (mm)	128.250	160.313	174.188	140.813	0.000	0.000	0.000	0.000	0.000	0.000	64.464	156.571	824.598	Sum
C=A*Ef	Gross Irrig. Req. (l/s)	0.04	0.05	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.018	Avg
	Gross Irrig. Req. (m3)	105	131	122	16	0	0	0	0	0	0	53	128	557	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)	0.479	0.663	0.650	0.543	0.000	0.000	0.000	0.000	0.000	0.000	0.249	0.585	0.264	Avg
	WATER AVAILABLE														
16a	Name... (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs (m3)	105	131	130	23	218	332	182	247	350	266	136	128	2,248	Sum
16c	River (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater (m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL (m3)	105	131	130	23	218	332	182	247	350	266	136	128	2,248	Sum
E"	TOTAL (l/s)	0.04	0.05	0.05	0.01	0.08	0.13	0.07	0.09	0.13	0.10	0.05	0.05	0.071	Avg
17a	Third Parties Water Rights (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)	0.04	0.05	0.05	0.01	0.08	0.13	0.07	0.09	0.13	0.10	0.05	0.05	0.071	Avg
	Actual Water Available (m3)	105	131	130	23	218	332	182	247	350	266	136	128	2,248	Sum
	BALANCE														
C/D	Irrigation Area (ha)	0.08	0.08	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08		
F=E-C	Exceeding/Deficit Water (l/s)	0.00	0.00	0.00	0.00	0.08	0.13	0.07	0.09	0.13	0.10	0.03	0.00		
	Exceeding/Deficit Water (m3)	0	0	7	6	218	332	182	247	350	266	83	0	1,691	Sum
G=E/D	Max.Irrig. Area (ha)	0.08	0.08	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.08		
H=F/D	Additional Area (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00		
I	DEFICIT AREA (has.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO DEFICIT





Referencias:
ET según Hargreaves. Tomado de Almanaque El Salvador 1993. Página 96
Kc según FAO 56 Table 11 & 12

Annex W-2

Working Paper No.2
Pilot Reservoirs – Lessons Learned

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WORKING PAPER No.02

El Salvador Surface Water Diversion, Storage and Use

Pilot Reservoirs' Lessons Learned

1. INTRODUCTION

The purpose of El Salvador Surface Water Diversion, Storage and Use project is the promotion and adoption of better surface water resources management. Accordingly, the constructions of 12 reservoirs to catch and store irrigation water in the Departaments of Ahuachapan, Usulutan and Morazan have been planned.

The present document describes the construction of the pilot systems and the modifications made since the completion of the schemes.

2. VICTOR FUNES SYSTEM

2.1 Location

The system is located in Canton El Cerrito, Municipio & Departamento Ahuachapan.

2.2 The infiltration gallery & conveyance pipeline

Infiltration galleries are also known as *"blind inlet or French drainage structures"*, when used for drainage schemes.

Description

The infiltration gallery was built on a gully, downstream from a dirt road crossing. The general slope of the gully is about 2% and, according to the villagers, the discharge is relatively low compared to the size of the gully, as soil and water conservation structures have been built in the upper micro-watershed.

The gallery is four meters wide by nine meters long, as shown on Annex A. Five 0.10 m hand perforated PVC pipes lay down parallel to the stream direction of flow (1). These pipes run parallel and are connected through a Tee union to a pipe collector which is itself

connected to the conveyance pipeline that runs perpendicular to the axis of the gully.

The pipes are placed on top of a gravel layer 0.30 m thick of a 1.3 to 2 cm size gravel filter. A geotextile blanket covers the pipe network, which is enclosed by another 0.30 m of gravel filter. Initially a sand filter was placed on top of the gravel, but was later removed and replaced by a gabion mattress.

One meter thick gabions were installed perpendicular to the axis of the stream channel. The upstream and upper faces of the gabions are embedded in 0.10 m concrete slab.

The conveyance waterway is a 0.10 m diameter galvanized pipe that runs on the edge of the gully about 300 m down to the reservoir. The pipe is exposed and anchored along most of its length. The pipeline contains a tee located near the end, which allows cleaning and draining the pipe.

Performance

The gallery, as reported by Mr. Victor Funes, performed well after construction, but stopped conveying water after some time. When the SWDSU Team visited the project, it was found out (after running infiltration tests) that the gallery was unable to transmit any water, as an impermeable layer (from about 0.30 to 0.45 m) composed of fine sand, silt and clay had settled down on top of the gallery. The gravel pack looked relatively clean, as well as the geotextile fabric. After removal of the impermeable layer, the gallery's performance was adequate. Photos taken during the visit are presented in Annex B.

The conveyance pipeline does not present any problem. Pictures of the pipeline are also presented in Annex B.

Actions Taken

USDA Consultant, Mr. John Moore removed the sand filter of the top of the gallery and replaced it with a 4 x 10 m gabion mattress with a 2% slope. The mattress was placed flush with the gabion upper side.

Lessons learned

1. The infiltration galleries should be placed in locations where limited amount of sediment is expected.

2. As the sediment deposits due to low velocities during the receding component of the hydrograph, in places where high water velocities (2) are expected (more than 1.8 m/s), a gabion mattress on top of the gallery with slope similar to the natural slope of the stream is recommended, to protect the filter from being washed away by the water,

3. In places where the water velocity is expected to be less than 1.8 m/s, no gabion mattress should be provided, as the filter will not be carried away.

4. The water velocity and sediment transport should be controlled/reduced upstream from the location of the gallery by means of dry stone walls across the gullies, live (plant) barriers and the combination of both.

5. The geotextile blanket should be removed, as it tends to clog permanently.

6. The conveyance pipeline should be provided with a flush valve immediately downstream from the gallery.

7. Training regarding maintenance of the gallery should be provided to beneficiaries.

2.3 The Reservoir

Description

The reservoir was dug out in a field with a very mild slope. The reservoir is mainly in cut, 12 x 18 x 2.4 meters with 2:1 side slopes. The inlet pipe discharges freely over the spillway level. The reservoir is also provided with a 0.15 m PVC spillway pipe and a tower outlet consisting on a 0.30 m perforated pipe supported by a concrete base and a 0.0375 m PVC irrigation pipe inside the pipe tower. The details are presented in Annex A

The lining material is a combination of soil and cement. Photos of the reservoir are presented in Annex B.

Performance

The soil-cement lining material did not perform as expected. It cracked and peeled off leaving the soil underneath exposed. When visited by the SWDSU Team the reservoir was empty, but in conversations held with Mr. Funes, it was learned that it did not hold the trapped water. The reasons may be several. Among the more likely ones are that the natural soil may not be suited for this type of lining method and/or that the contractor may not have had experience with this technique of lining.

Lessons learned

1. The use of soil cement lining material is discouraged.

2. A cut and fill ratio should be explored on each reservoir to reduce the construction costs, as the disposal of excess soil is expensive.

2.4 The Irrigation System

Description

Even though the main line and manifolds were in place, no laterals were installed. The irrigation system has not operated in this scheme, as there is no water stored in the reservoir. It was observed that some of cultivable land is above the maximum water level in the reservoir, and pumping will be required.

Lessons learned

1. Pumping should be discouraged, as it increases the production costs.

2. The reservoir should be built part on fill, as it provides more available head for irrigation.

3. JOSE VARGAS SYSTEM

3.1 Location

The system is located in Canton El Cerrito, Municipio & Departamento Usulután.

3.2 The infiltration gallery & conveyance pipeline

Description

The infiltration gallery was built on a dirt road roadside ditch. The general slope of the roadside ditch is about 10% and, according to the villagers, the discharge is relatively high, as it collects water from the road.

The gallery is two meters wide by eight meters long. Three 0.15mm hand perforated PVC pipes lay down parallel to the stream direction of flow. These pipes are connected to a pipe collector which is itself connected to the conveyance pipeline that runs perpendicular to the axis of the ditch.

The pipes are placed on top of a gravel layer 0.20 m thick of 1.3 to 2 cm size gravel filter. A geotextile blanket covers the pipe network, which is enclosed by 0.30 m of gravel filter. In the beginning a sand filter was placed on top of the gravel, but was later removed and replaced by a gabion mattress.

A 1.5m deep masonry wall was built perpendicular to the axis of the stream channel.

A medium size tree was left in the middle of the gallery. A picture is presented on Annex C.

The conveyance pipeline is a combination of 0.0625 m diameter galvanized and PVC pipes that runs on the edge of the gully about 300 m down to the reservoir. The pipe is mostly buried -except near the gallery- and anchored along most of its length. A flush valve and pipe have been provided just downstream from the masonry wall.

Performance

The gallery, as reported by Mr. Vargas, performed well after construction, but stopped conveying water after some time. When the SWDSU Team visited the project, it was found out (after running infiltration tests) that the gallery, was unable to transmit any water, as an impermeable layer (less than 0.10 m) composed of silt and clay had settled down on top of the gallery. Most of the sediment is believed to come from the dirt road.

The inlet to the water conveyance pipe was closed by Fundamuni (a local NGO that participated in the design and construction supervision of the pilot schemes). The gravel pack looked contaminated by silt and clay, as well as the geotextile fabric. After removal of the impermeable layer, the gallery's performance was adequate. Photos taken during the visit are presented in Annex C.

Some scouring downstream from the masonry wall could be observed. The reason seems to be that the wall was constructed mainly above the natural bed level of the ditch, providing a vertical water drop without an energy dissipating structure.

Actions Taken

USDA Consultant, Mr. John Moore removed the sand filter from the top of the gallery and replaced it with a 2 x 8 m gabion mattress with a 2% slope. The mattress was placed flush with the wall upper edge and added concrete to the wall to make the top section level. Mr. Moore also removed the trees as they interfere with the flow and their roots will tend to grow inside the gallery, plugging the filter. Moreover, he added boulders downstream of the wall to dissipate the energy, providing some protection against the scouring.

Lessons learned

1. The infiltration galleries should not be placed near roads.

2. As the sediment deposits due to low velocities during the receding component of the hydrograph, a gabion mattress on top of the gallery is recommended.

3. The water velocity and sediment transport should be controlled/reduced upstream from the location of the gallery by means of dry stone walls across the gullies, live (plant) barriers and the combination of both.

4. The geotextile blanket should be removed, as it tends to clog.

5. Trees should either be removed or avoided.

6. Training regarding maintenance of the gallery should be provided to beneficiaries.

3.3 The Reservoir

Description

The reservoir was dug out in a field with a minor slope. The reservoir is mainly in cut, 16 x 32 x 2.4 meters with 2:1 side slopes. It has two inlet pipes, which discharge freely over the spillway level. One of the conveyance pipes, transports water from the infiltration gallery and the other one transports water from Mr. Vargas' roof runoff. The reservoir is also provided with a 0.15 m PVC spillway pipe and an outlet pipe 0.15 m diameter hand perforated and supported on a concrete base.

The lining material is rubber membrane liner. Photos of the reservoir are presented in Annex C.

Performance

The rubber membrane liner performance is as expected. It holds the water and no leakage losses were observed, except at the pipe tower, where the binding between the rubber membrane and the concrete base was not done properly during construction. When first visited by the SWDSU Team the reservoir was empty, because Fundamuni had drained the reservoir in order to fix the leak. However, during the last visit early September, the reservoir water level was about one third of its capacity, being filled with the water trapped by its' own exposed surface and the roof runoff, as the gallery conveyance pipe had been closed.

Lessons learned

1. The use of rubber membrane lining material is recommended.

2. Based on Mr. Vargas roof runoff catchment's experience, it should be replicated -if considered appropriate-, based on a case by case analysis.

3. The water outlet system should be revised and improved to avoid leaks problems as in Mr. Vargas reservoir.

4. A removable filter fabric around the riser (outlet pipe) to reduce clogging of irrigation emitters should be considered during the design phase.

5. Install animal guards (strainers) over open pipes.

6. Install safety lines on pool in case a person falls in the pond.

7. Install a drawdown pipe in the bottom of the reservoir to allow dewatering and cleaning.

8. Training regarding the operation and maintenance of the reservoir should be provided to beneficiaries.

3.4 The Irrigation System

Description

Even though the main line and manifolds were in place, no laterals were installed, as Mr. Vargas removed and stored them to protect them from the sun. According to Mrs. Vargas the irrigation system operated quite well in this scheme.

The Vargas family is very pleased with the system as a whole.

Lessons learned

1. Filters should be provided as the water in the reservoirs will have some silt and organic material in suspension. The type of filters should be investigated.

2. The type of drip irrigation emitters should be investigated keeping in mind that the filters will not be able to stop all silt and organic material in suspension.

3. Irrigation training should be provided, as most of the beneficiaries are not familiar with irrigated agricultural practices.

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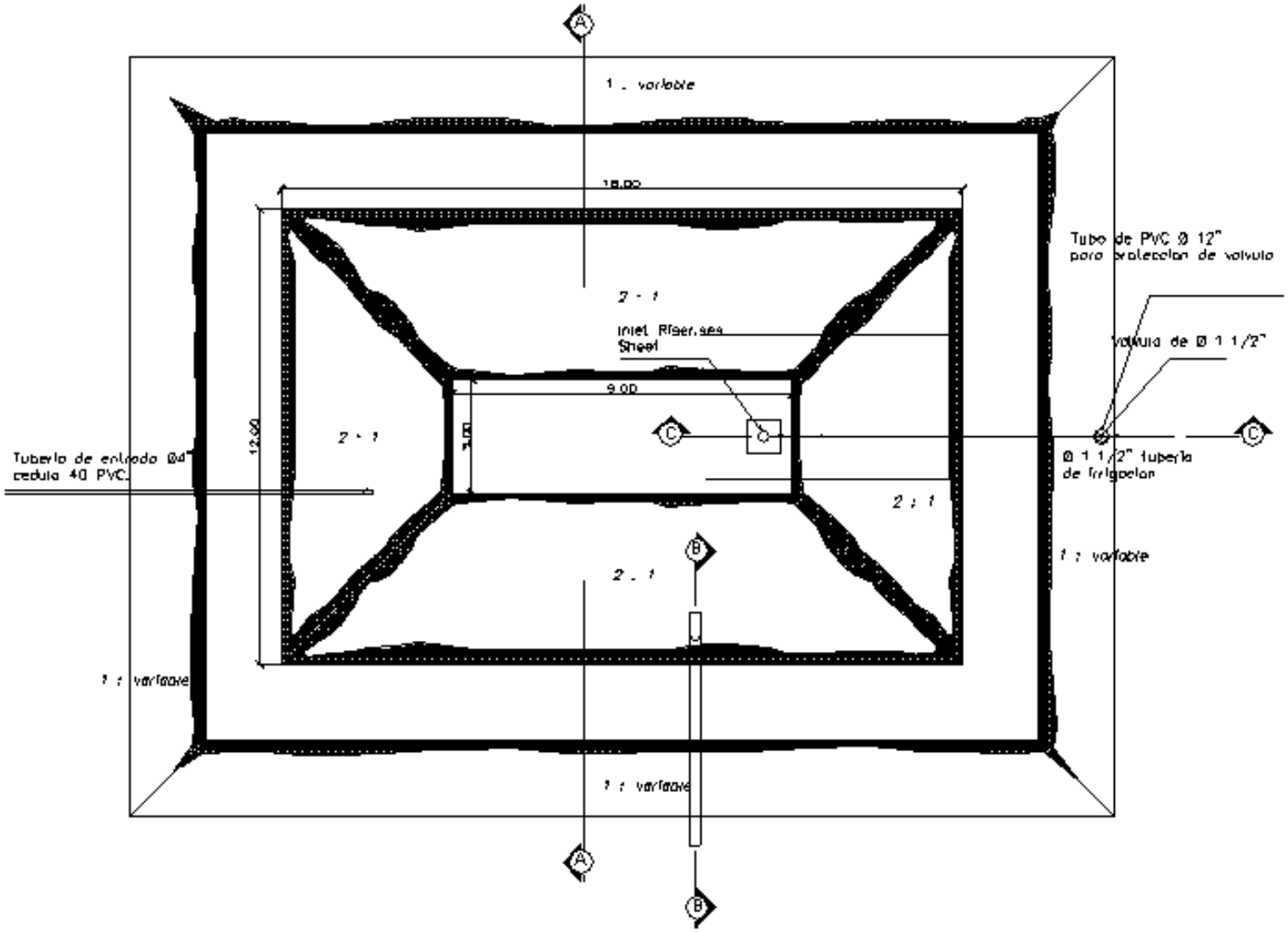
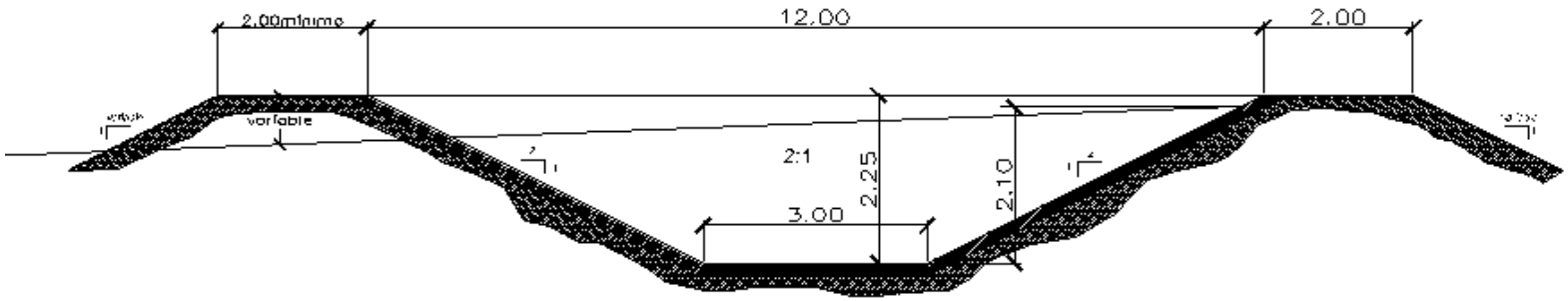
(2) Soil Conservation Service. Technical Publication No. 61

APPENDIX A

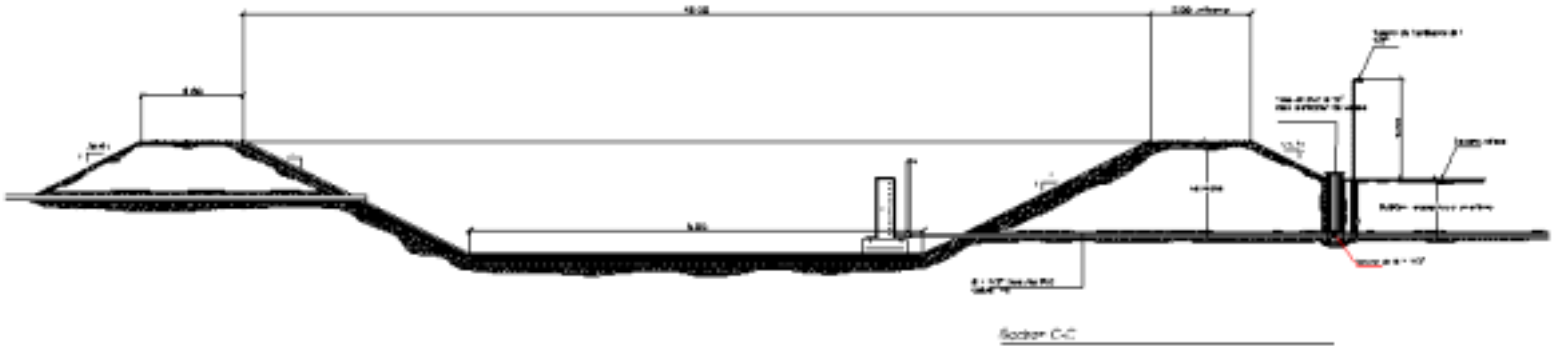
MR. VICTOR FUNES INFILTRATION GALLERY, RESERVOIR AND DRIP IRRIGATION SYSTEM AS-BUILT DRAWINGS


A
1 : variable
18.00
2 : 1
Inlet Riser see Sheet
9.00
12.00
3.00
2 : 1
C
Tubo de PVC Ø 12" para protección de válvula
Válvula de Ø 1 1/2"
Tubería de enlodo Ø4" cedula 40 PVC
Ø 1 1/2" tubería de Irrigación
2 : 1
B
2 : 1
1 : variable
1 : variable
1 : variable
A
B

RESERVORIO



Section A-A — *Seccion Transversal del Reservorio*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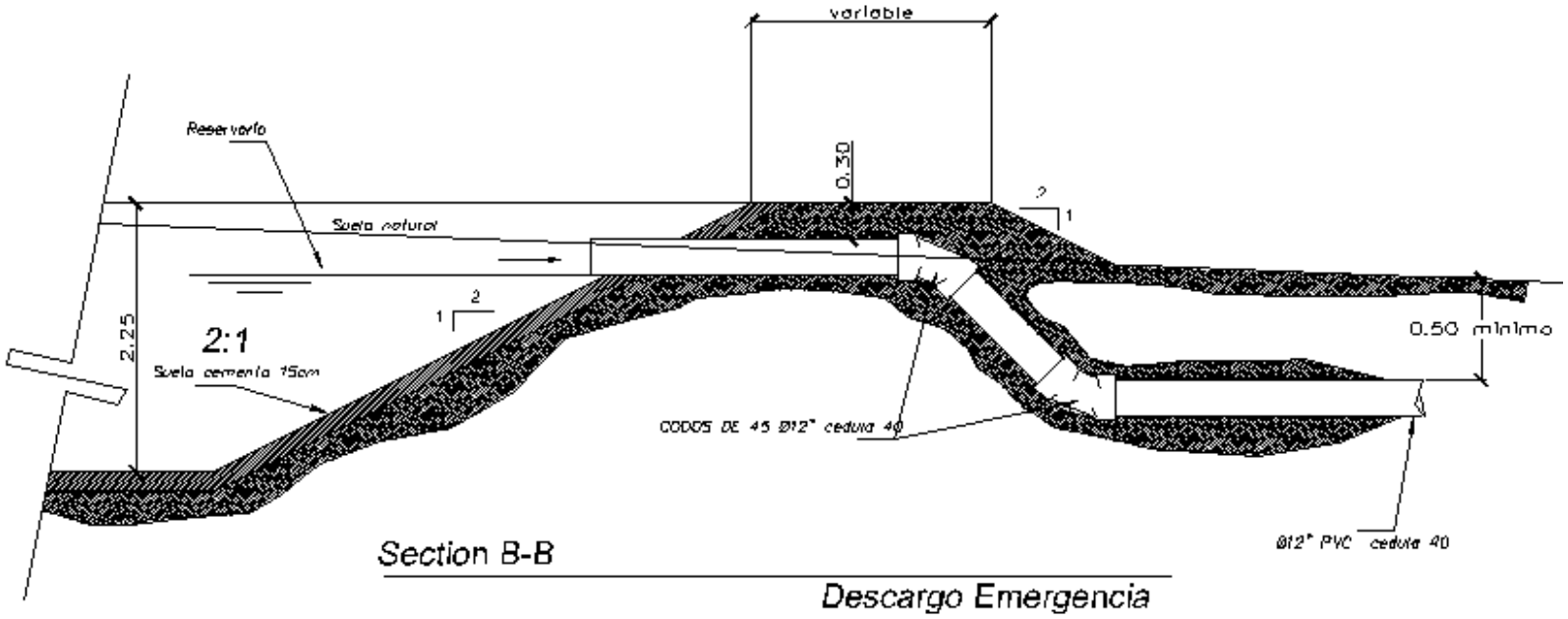
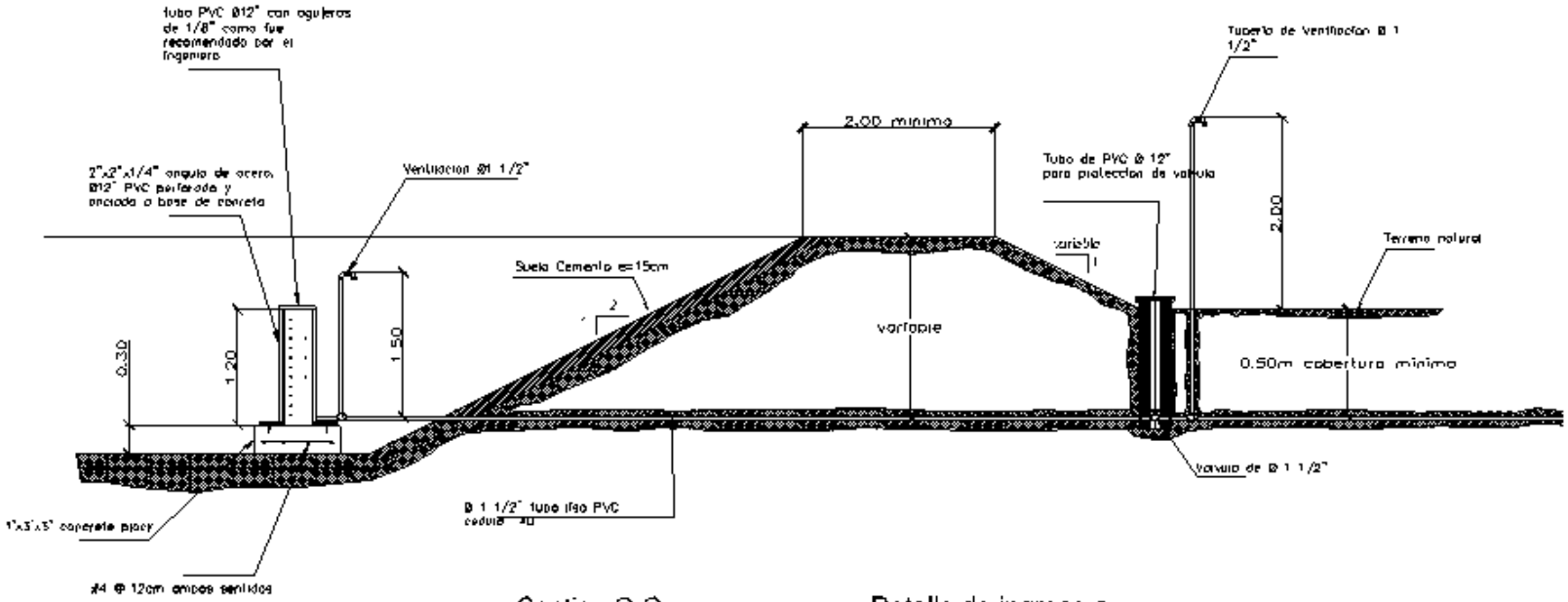


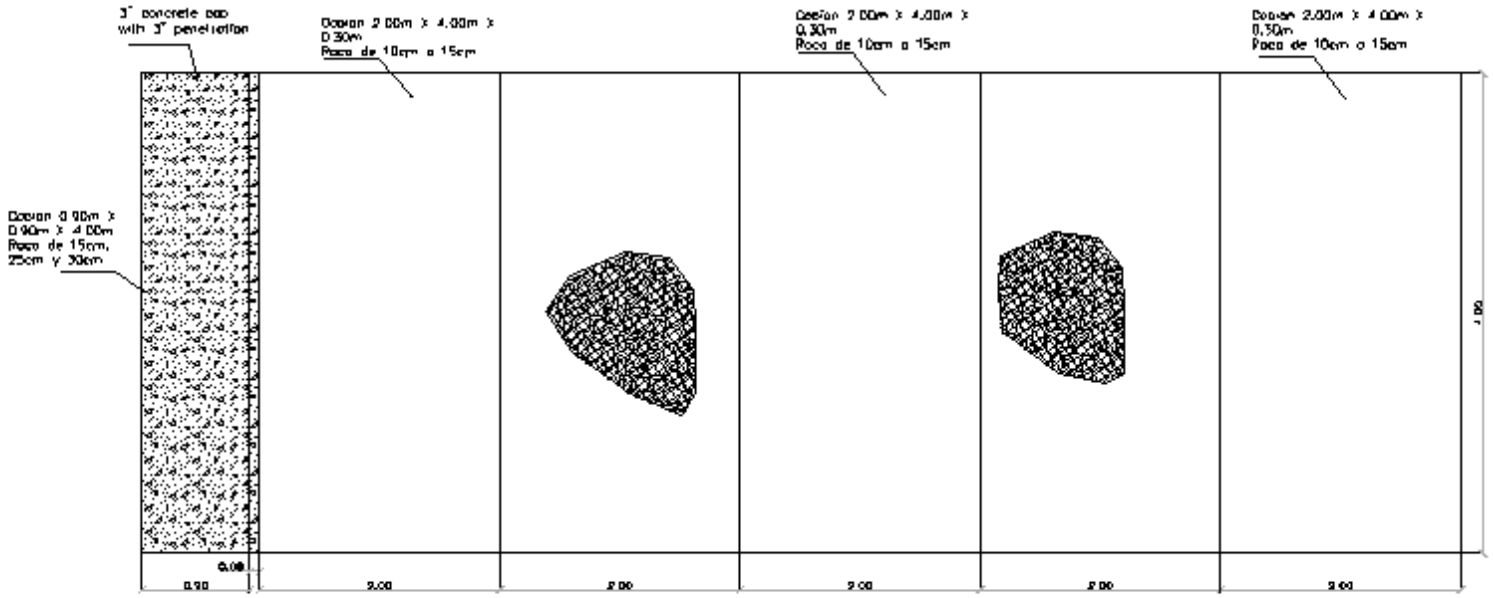
Section B-B

Descargo Emergencia

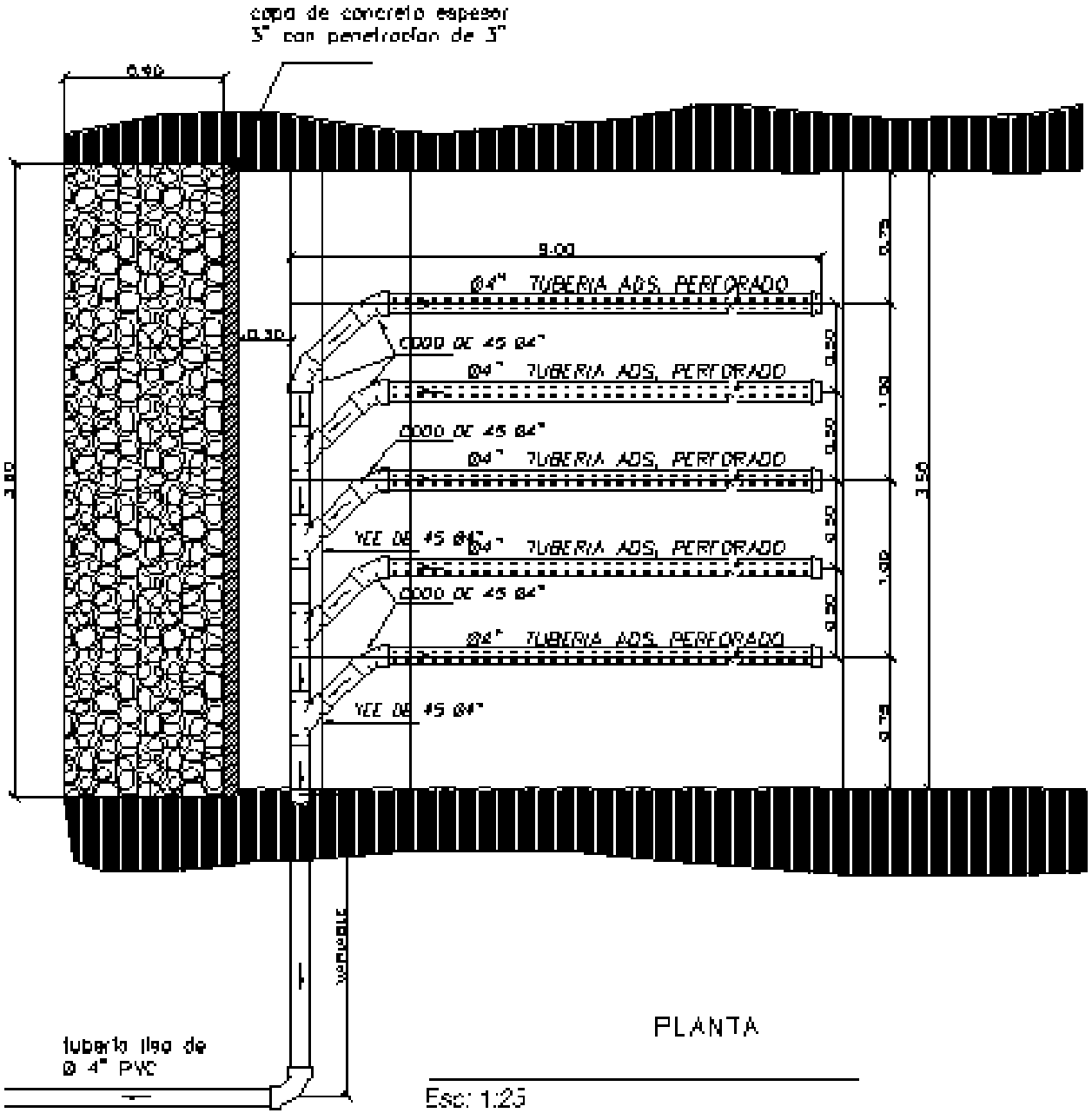


Section C-C — *Detalle de ingreso a*

Esc: 1:50 — *tuberia de irrigacion*

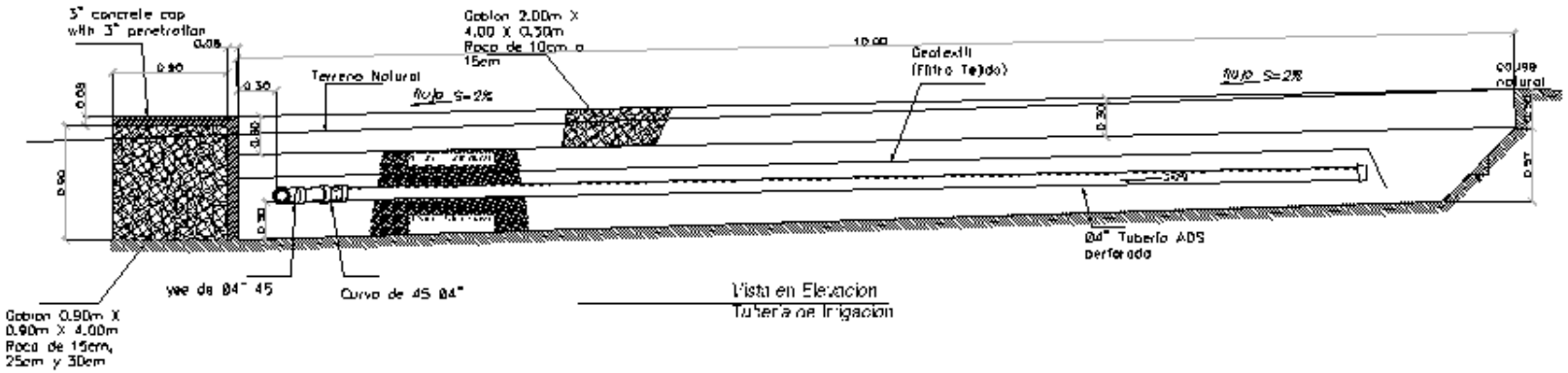


Vista en Planta

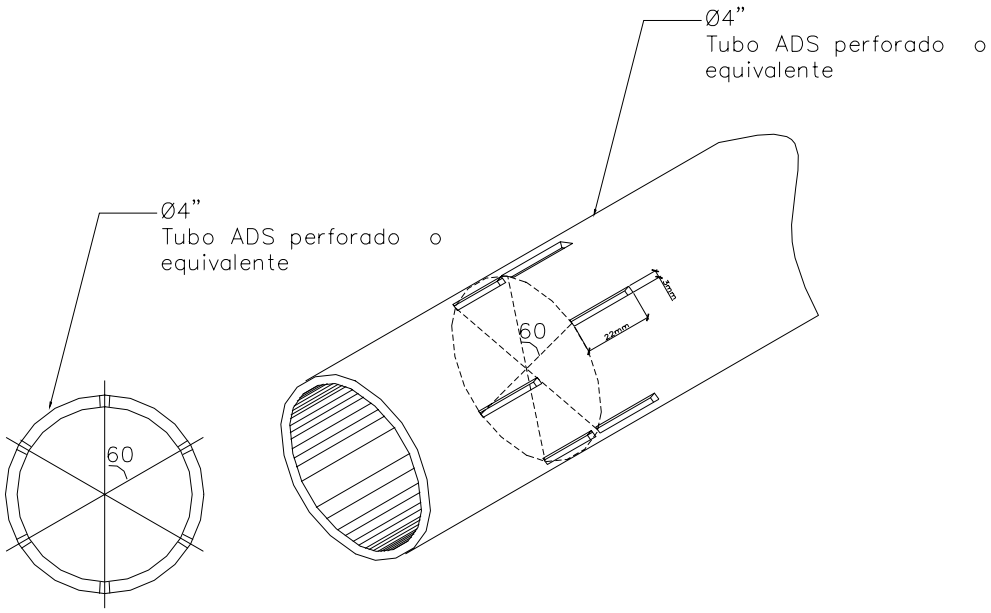


PLANTA

Esc: 1:25

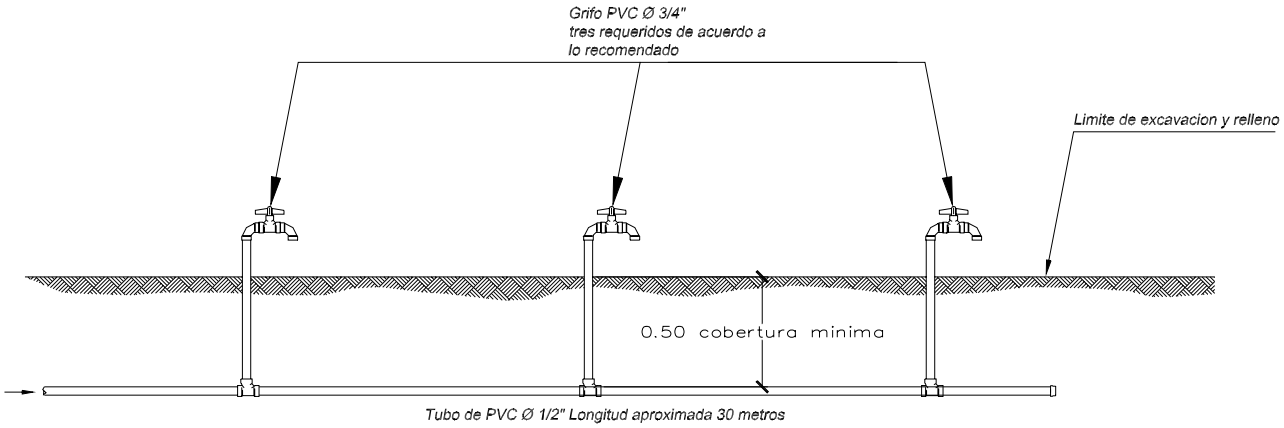


Vista en Elevacion
Tubería de Irrigación



Detalle de Perforaciones en Tuberia de Ø4"

Sin Escala



Detalle de Tuberia de Irrigacion

Esc: 1:20

APPENDIX B

MR. VICTOR FUNES INFILTRATION GALLERY, RESERVOIR AND DRIP IRRIGATION SYSTEM PHOTOS

Photo No. 1 Victor Funes. Gabion Wall at Infiltration gallery during construction (1)

Photo No. 2. Victor Funes. Pipeline layout and filter during construction (1)

Photo No. 3. V. Funes. Close up view of perforations in 4-inch diameter PE pipe. Slots measure about 1/8 by 1-in (1).

Photo No. 4 V. Funes Infiltration Gallery. View from downstream

Photo No. 5. V. Funes Infiltration Gallery. View from upstream. Observe the sediment deposited on top of the filter

Photo No. 6 V. Funes Gallery. Infiltration test

Photo No. 7. V. Funes Gallery. Filter material

Photo No. 8 V. Funes Gallery. Cleaning the sediment

Photo No. 9. V. Funes Gallery. About 0.30 m of fine sediment deposited on top of the gallery

Photo No. 10 V. Funes. Conveyance Pipeline

Photo No. 11 V. Funes Conveyance Pipeline. Valve control box

Photo No. 12 V. Funes Reservoir. Observe the soil-cement lining

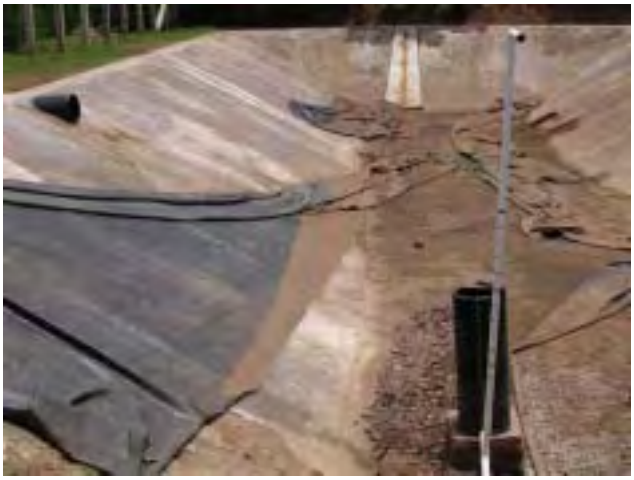


Photo No. 13 V. Funes Reservoir. Outlet detail

Photo No.14. V. Funes. Drip irrigation manifold outlet 1

Photo No. 15. V. Funes Infiltration Gallery. Gabion mattress being installed as a corrective action

Photo No. 16. V. Funes Infiltration Gallery. Gabion mattress

Photo No. 17. V. Funes Infiltration Gallery. The gabion mattress

APPENDIX C

MR. JOSE VARGAS INFILTRATION GALLERY, RESERVOIR AND DRIP IRRIGATION SYSTEM PHOTOS

Picture No. 1. J. Vargas Infiltration Gallery. View from downstream. Observe the tree left on the gallery

Picture No. 2. J. Vargas Infiltration Gallery. View of the masonry wall and the pipelines control box

Picture No. 3. J. Vargas Infiltration Gallery. Infiltration test

Picture No. 4. J. Vargas Infiltration Gallery. Cleaning up the sediment

Picture No. 5. J. Vargas Infiltration Gallery. A gabion mattress was built on top to protect the filter from being washed by the water. Observe that some sand has settled on top of the mattress

Picture No. 6. J. Vargas Conveyance Pipeline. Inlet box

Picture No. 7. J. Vargas Conveyance Pipeline. The PVC pipe is the drainage pipe

Picture No. 8. J. Vargas Reservoir. Rubber liner

Picture No. 9. J. Vargas Reservoir. Detail of the outlet

Picture No. 10. J. Vargas Roof Runoff Catchment. Detail

Picture No. 11. J. Vargas Drip Irrigation System. View of the filtersil

Picture No. 12. J. Vargas Drip Irrigation System. View of manifolds

Picture No. 13. J. Vargas Infiltration Gallery. Gabion mattress being installed

Picture No. 14. J. Vargas Infiltration Gallery. Sand deposited on top of the gabion mattress after a couple of weeks during the rainy

Annex W-3

Working Paper No. 3
Challenges to Marketing Vegetables in El Salvador

Analysis of Challenges to Marketing Vegetables in El Salvador

1. Introduction

The purpose of this document is to make suggestions to strengthen the commercialization strategies for the producers who benefited from the reservoir building project, outline alternatives on how to sell their production, and identify the most advantageous times to put products on the national market. We have included a general description of marketing vegetables in the country, but also, when available, specific information on the vegetables selected by the project. The marketing will be a key factor for the success of the project in the medium term; thus, it is important to recognize the challenges present in the country.

Often, deficiencies in the marketing of agricultural production are mentioned as some of the greatest weaknesses of the agricultural production systems. Many of their difficulties stem from market imperfections.

The agricultural product markets in developing countries, in general, suffer from an imbalance, having more sellers than buyers, which imbues the latter with greater negotiating power. They also lack market information systems that are broadly disseminated, which in turn deepens the inequalities between producers and buyers. Especially in the case of El Salvador, production atomization generates situations where the smaller producers do not have any opportunities to sell their products individually, except to the intermediary.

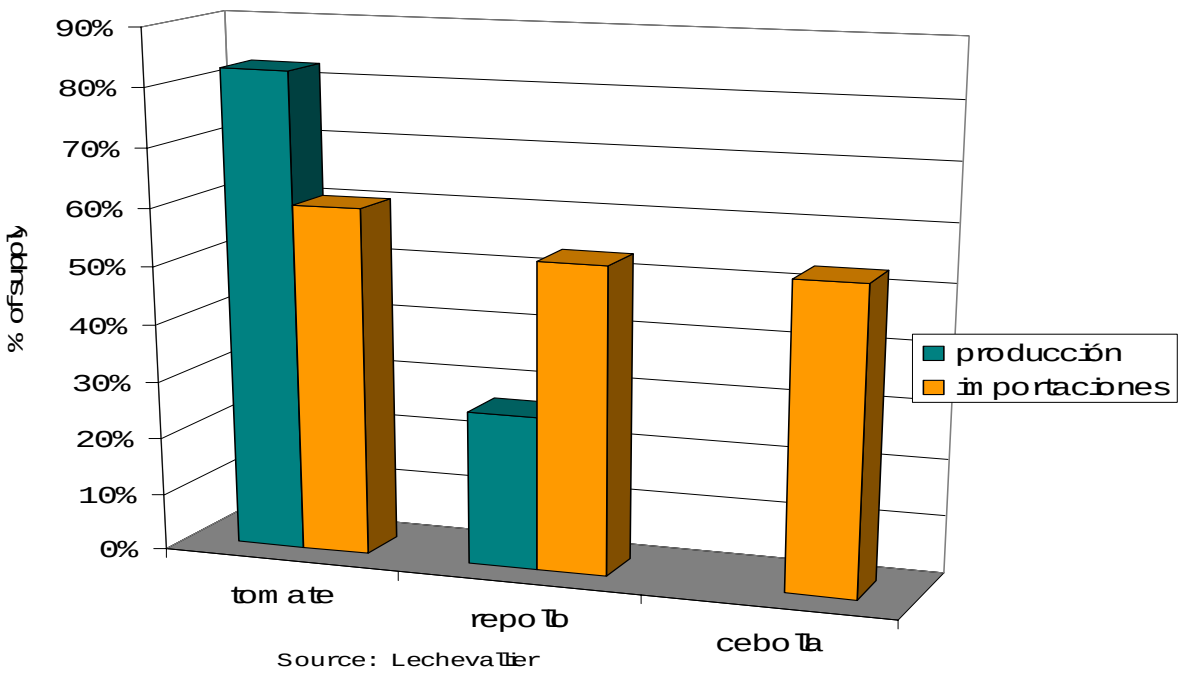
On the other hand, if there are not mechanisms to reduce the risk in the marketing of nontraditional products, the farmers will continue to cultivate traditional products that are less profitable but at the same time, less risky. The challenge of improving the marketing for non-traditional products is especially great for the most competitive products such as fruits and vegetables because the majority of them are perishable products with short windows for searching for alternative markets. Therefore, the absence of effective marketing mechanisms for the small producer is a major obstacle for diversification.

2. Marketing Channels

It has been estimated that more than 70% of the basic grain producers in El Salvador are subsistence producers, that is, they use a system of exclusive personal consumption or personal consumption with some sales. Despite consuming part of their production, producers usually are well integrated in the product markets and/or to the labor market, a condition which is similar to other developing countries (Binswanger and von Braun, 1991).
However the small basic grains producers, the great majority of which have less than 2.5 hectares, and in the case of fruits and vegetables, less than a hectare, do not produce sufficient surplus for the market so as to justify investing in transportation to market their own production. Thus, the important role played by the intermediaries, commonly known as "coyotes." These intermediaries provide services that producers do not want or cannot provide by themselves or obtain through other means, such as transportation, storage, marketing, and financing. In the

most remote areas, the intermediaries can have a monopsony power, and they usually have asymmetrical information. But, it is fair to recognize that they assume the marketing risk (IFAD, 2001).

Figure 1. Percentage of national production and imports targeted to the La Tiendona wholesale market



Tomato, Cabbage, Onion
Production
Imports

In order to reduce the power of the intermediaries or to make them less necessary, some producer associations have made efforts to carry out their own marketing. However, collection centers supported by different NGOs have not produced impressive results; they achieve low volume and little variety, and suffer from producer informality in the delivery and from difficulties in generating the buyers´ trust. There are two good exceptions in Las Pilas, Chalatenango, and in San Carlos Lempa, San Vincente, where groups of producers have packed vegetables for sale in supermarkets.

La Tiendona, the capital´s wholesale market plays a very important role in pricing for agricultural products, but it has many operational problems. A significant share of the national production and imports, especially of fruits and vegetables, is channeled through this market (Figure 1). La Tiendona was built in 1977 and is owned by the San Salvador Mayoralty. It has approximately 500 formal stands, as well as 1,500 retail businessmen who operate in the vicinity. Its infrastructure is in very poor condition, but it is very valuable land due to its prime location,

very close to downtown. It suffers from a lack of transparency in setting the prices offered to national producers, disorganization in the use of weights and measures, unhealthy conditions and insecurity (IAIAC, 2004). The growth of the city towards the market has reduced the available space for parking, and consequently, the market lacks space available to keep all the trucks of sellers interested in accessing it, and this greatly contributes to the controlling behavior of the wholesale dealers in the market (Lechevallier, 1997). Due to these factors, the producers´ direct access to the market is very limited.

In El Salvador, it is very common for products to be transported from rural areas to the capital wholesale market first and then to be sent to the local markets, sometimes even in the same area of origin (IAIAC, 2004). Due to this lack of linkages, the producers´ access to local markets is very poor. In order to improve this marketing process efficiency, it is useful to analyze its organization under the concept of intermediate cities (Paniagua, 1993). The linkages of the producers with the closest cities, that offer a growing demand, help promote regional markets, providing even investments in agricultural markets. The challenge here is to avoid market saturation because it still has a limited demand, but it should also offer a broad variety of products so that the buyers come often.

In recent years, the Ministry of Agriculture and Livestock has made efforts to develop 10 agricultural markets, commonly known as "Producer Fairs," in several cities in the country. Normally, these fairs take place every two weeks, except for Usulutan where it takes place on a weekly basis. The San Martin agricultural market, after being used as a shelter for earthquake victims, has recently reopened its doors. Because of its proximity to the capital, it receives more attention and is the best supplied. It is estimated that in each of these fairs an average of 40 producers participate (IAIAC, 2004). These markets are generally carried out at very low cost (the largest investment are the tents), and they produce good profits for participating producers, who definitively get better prices for their products, but the number of beneficiaries is still limited.

3. Participation in Value Chains

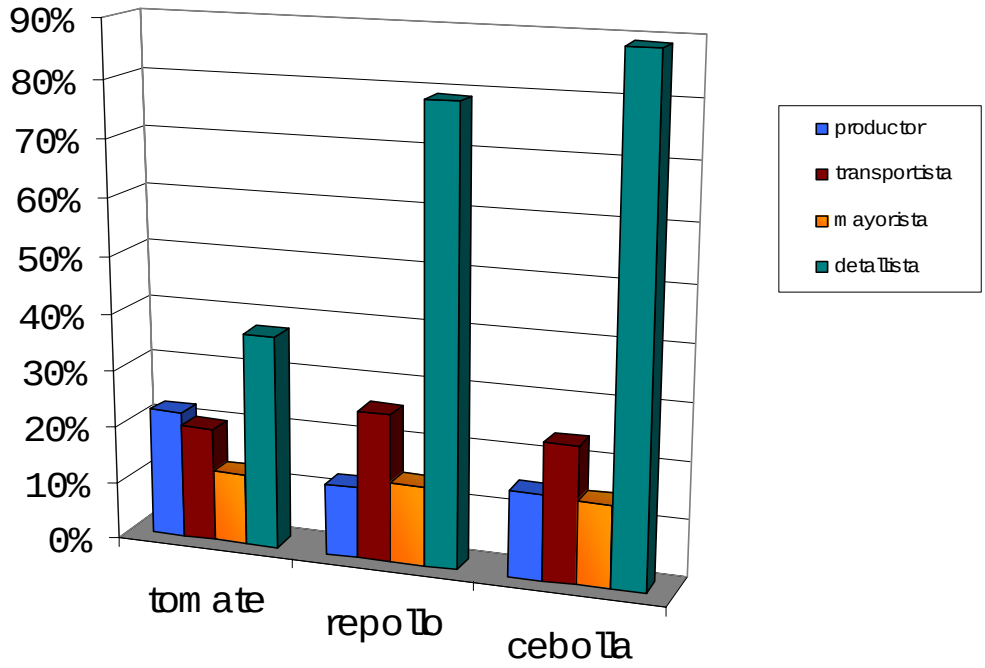
Agricultural products usually go through several links in the marketing chain before reaching the end consumer. Vegetable producers only receive 42% of the final price due to larger product losses or reductions, estimated in 3 to 5% in each link. After the producers, the largest participants in these value chains are the retailers, who in the case of several vegetables for example, obtain significantly greater profit margins in comparison with all the other chain links (See Figure 2).

4. The Role of Supermarkets

The last decade has seen a supermarket boom throughout Latin America. Supermarkets now represent between 50-60% of the food products sales to consumers. In this region, supermarkets purchase directly from producers 2.5 times the volume of fruits and vegetables compared to the volume this same region exports to the rest of the world (Reardon and Berdegué, 2002).

Due to strict supermarket standards and requirements, product sales to them usually generate a greater local added value because they demand that producers wash and pack their products for sale. Thus sellers, whether they are producers or intermediaries, have to develop new skills because transactions are often based on complying with specific and strict standards, and the commercial relationships are based on mutual trust. Therefore, producers need to formalize production and pay greater attention to the quality of their products.

Figure 2. Profit Margins in National Vegetable Chains



Source: Lechevallier

Tomato, cabbage, onion
Producer
Transporter
Wholesaler
Retailer

Currently, El Salvador has approximately 145 supermarkets and almost 90% of them are located in San Salvador, the capital. They are organized in only four groups or chains, two of which have foreign investments. The largest chain has 90 supermarkets, the second one 48, the third one has four, and the last group has three supermarkets.

The market concentration in El Salvador is not new at all, worldwide, the 30 largest companies capture more than 30% of supermarket sales, and at the individual country level, it is very

common that the largest five supermarkets capture more than 70% of the sales (Jacobsen, et al, 2003).

Salvadorian supermarkets purchase about 15 - 20% of the fruits and vegetables from La Tiendona wholesale market in San Salvador. It has been estimated supermarkets commercialize 30% of fruits and vegetables nationwide (MERCASA, 2001). Supermarket sales have created a strong competition for the retail markets in the capital. This is mainly due to retailers´ quality and price deficiencies (IAIAC, 2004). It has been estimated that supermarkets get a 25-40% profit margin from their sales (MERCASA, 2001).

In order to reduce their administrative costs and to order their supplies, supermarkets seek a small number of suppliers who can provide the large volumes of fresh product groups they need on a continuous basis. They demand better quality products, but do not assume any liability for losses because they return the damaged products to their suppliers; in other words, they receive products on consignment. On average, supermarket losses are 6% for fresh vegetables and about more than 10% for fresh fruits. This means their losses are twice than those of other participants in the marketing chains (IAIAC, 2004).

La Colima Farm produces a large variety of fruits and vegetables in the country and its experience dealing with losses is especially illustrative because in order to avoid larger losses it decided to send most of its products already packed in small trays ready for final sale at the supermarkets. Through this innovative method it reduced losses and at the same time avoided return of products that really belonged to other suppliers.

Supermarkets, in general, pay their supplies late. For example, chain payment terms officially are 30 days for perishable products, and 60 or 90 days for non-perishable products, but in reality, these terms are always delayed (IAIAC, 2004). Thus payment policies represent a high financial cost for producers, who have to face their debts and operating expenses on a daily basis while supermarkets benefit from their financial profits.

Studies conducted in other countries have also found serious difficulties for producer organizations supplying fresh fruits and vegetables to supermarket chains caused by payment terms, high rates of rejected products, forced discounts and fees charged for shelf space in the supermarket (Berdegué, 2001). There is not an adequate legal framework in place in El Salvador to define commercial relationships between suppliers or producers and traders on sensitive areas such as payment terms and handling of rejected products (IAIAC, 2004). In short, because of the lack of economies of scale and the high financial cost, supermarket commercialization is still an especially big challenge for small producers.

5. Contracts

Vertical coordination is an intermediate solution between a free market– which means big disadvantages especially for small producers– and the vertical integration– where the same company owns all or most of the value chain. Formal commercialization arrangements are

considered to be vertical coordination between producers and buyers. Vertical coordination degrees range from a simple bill of sale, setting the necessary price and quality specifications, to the provision of a part or all the products; delivery of whole or partial financing for the operation; provision of technical assistance; up to managerial support in programming agricultural activities (Schejtman, 1996).

The potential negative consequences of vertical coordination include, on the buyers´ side, high supervision and transaction costs for working with small producers, and on the producers´ side, sharing risks and profits based on their bargaining power and the possibility of opportunistic behaviors and chained transactions (Schejtman, 1996). However, despite these potential consequences, this is almost always a better solution than the free market.

Contracts demand an environment of cooperation and trust between all participants. At the end, only the agreements where all parties benefit equally will work out (Bohnstedt and Urbina, 2002). In the 1990s, attempts at promoting agriculture by contract were made in El Salvador, but they ended in bad experiences. What now exist are short-term bills of sale that provide very few advantages over the open market.

The use of contracts is incipient in the country, and it is an unknown practice for the majority of producers. In a recent study on the use of contracts in Salvadorian agriculture (Pérez, et al, 2002), it was found that the positive aspects of these formal mechanisms include the following:

- The producer sale is ensured as long as it satisfies the required quality.
- Prices are agreed upon in advance, reducing any financial uncertainty.
- They facilitate the acquisition of working capital loans.
- Agribusinesses ensure their raw material supply.
- Producers can receive several incentives in the contract, such as seeds, working capital, loan of equipment, and technical assistance.
- Agribusinesses can have greater control over the quality in the crop process, harvest, and transportation.
- Risks are reduced for all because there are clear rules for the commercial relationship.

However, there are also some significant negative findings:

- There are no set standards to establish product quality, which leads to the use of subjective parameters.
- A technical mechanism is very seldom used to determine the price, usually, all parties involved mutually agree on the price.
- When perishable products are concerned, usually the risks for any acts of God are not shared.
- The producer normally pays all notary expenses.
- In some cases, price setting is arbitrary and difficult to understand for the producer.
- Contractual relationships are temporary (3 to 5 months), which does not allow the producers a longer horizon for planning their production and their investments.

In general, among all contracts utilized in the country, producers are considered to be more disadvantaged because agriculture by contract is not a necessary practice due to the fact that mutual trust is a better way to do business, and because the legal framework is weak, inoperative and of questionable applicability (Pérez, et al, 2002). Above all, the negative aspects demonstrate that producers are inexperienced using contracts and also that there is certain inequality in the parties´ negotiation power.

Another concern is when there exists a lack of trust in the institutions supporting the vertical coordination mechanisms, such as the legal application of contractual clauses, or doubts about the contractors´ reliability this reduces the possibility of reaching a contractual arrangement leaving only the traditional sales options in the markets or of vertical integration (Schejtman, 1996).

In spite of past negative experiences, the use of contracts has potential in the country. The contract option is especially attractive for the small producers when they belong to an association because transaction costs are very small and the negotiation is more attractive for the agribusiness. Likewise, producer negotiation power is greatly improved when it is carried out jointly (Bohnstedt and Urbina, 2002).

6. Association

The trend toward less dependency on the government and more dependency on the markets places more responsibility on the producers but often they do not have the capability to face these new challenges individually. However, in the commercialization process, producers often have to accept the first offer they get. Some alternative options to improve their profitability are marketing cooperatives and other association schemes.

The last decade in El Salvador has witnessed the creation of a series of associations usually with a strong dose of international cooperation, and with variable results (See box 1 for some examples). Many of the new groups are related to the Community Development Associations (ADESCO, in Spanish), which were initially established for social purposes, but later started production organization activities. Some of the new groups are service-providing cooperatives

while others stem from different unions. Although there are many examples of non-formal associations, formal associations are beneficial because they allow the group to sign contracts and because they are good candidates to receive certain benefits from governmental technical assistance programs.

For producers, some of the advantages of belonging to an association are as follows:

- Improved negotiation power for purchasing inputs and services and for selling their products.
- Existence of economies of scale, which reduces costs for making joint investments, such as transportation, equipment, or infrastructure.
- Improved access to production support services, such as technical assistance, market information, and business support.
- Improved access and permanence in the markets because it allows more product availability and more continuity for the association members thus shortening the intermediation chain.
- Promotion of knowledge and experience exchange among association members, which in turn creates synergies for everyone's learning (ESEN, 2004; CENTA-FAO, 1999).

In recent years, a very important effort undertaken in El Salvador has been the creation of "Agricultural Enterprise Centers" that facilitate producer organizations for marketing, training on agribusiness administration and technology transfer. Studies have found that producers organized in these centers achieve greater profits, which argues that in the absence of these centers there would be a lack of market information as well as technical assistance. In addition, the centers facilitate product diversification towards more profitable non-traditional crops that in spite of being riskier for commercialization still offer better profits and encourage producers to try because these centers offer more punctual information and allow producers to take advantage of the centers to sell their products. The only constraint faced by the centers has been their financial sustainability during their initial years even though they tend to be profitable in the long run (Solis and Bravo-Ureta, 2004). Therefore, when the centers´ subsidy is evaluated, it is necessary to consider the social benefits they can provide all producers.

7. Selected Vegetables Production, Imports, and Prices

This section provides specific information on the vegetables the project has selected as recommended for the beneficiary producers to cultivate: squash, green pepper, hot pepper, green beans, cucumber, zucchini, radish, and tomato. We also review all available production figures, imports patterns, and price fluctuation in the national market.

Data on vegetable production in El Salvador is very limited even though the Ministry of Agriculture and Livestock is currently in the process of generating more accurate information on these crops in the coming months. Most of the existing data comes from extension workers estimations and not from a specific survey or sampling frame for vegetables. For the selected crops, tomato (industrial use), sweet chili pepper, and cucumber have the highest production levels (See Table 1). No data were found on radish land or production.

Box 1.

Examples of Associations in El Salvador

Asociación Cooperativa de Aprovisionamiento, Comercialización, Ahorro y Crédito de Productores de San Vicente de R.L. (ACOPROSAVI)–A producer association promoting contract marketing between small producers and agribusiness companies.

Asociación de Agricultores Puxtlecos de R.L. (AGROPUX)–A farmers association with more than one hundred families who sell their vegetable, coffee, and livestock production every Friday in the San Pedro Puxtla central park. These farmers received training on agribusinesses. In the future, they hope to establish their own market and extend their trade outside the municipality.

Asociación de Productores Agropecuarios Crecer de R.L. (AGROCRECER)–A producer association selling the basic grain production of its members and owns a store that sells them agricultural chemicals and improved seeds. It was created with the support of international cooperation and in coordination with CENTA extension workers.

Asociación de Productores de Loroco de El Salvador (APLORES)–A producer association with more than 100 producers marketing their crops through the association to LOROCOSAL, Inc. de C.V. , a export company selling Salvadorian products to the US market. All products are vacuum- packed fresh and bear their own brand names. LOROCOSAL Inc. is the property of 39 producers.

Cooperativa de Productores Orgánicos Los Planes, R.L. –A producer association that in order to differentiate its production from vegetable imports, specializes in organic production. It was started in 1993 with 20 associates, with the support of international cooperation and places great emphasis on technical assistance. Initially, its production was marketed through a service cooperative, PROEXSAL, in the national market, but later on the association decide to carry out its own marketing.

Sociedad Cooperatica Agroindustrial de R.L. de C.V. (SOCOAGRO)–An agribusiness association that promotes Tabasco chili pepper production among farmers and then purchase and process it to chili paste. The association usually signs a sales contract or a letter of purchase intent with the producer and payments are made two weeks after product reception. This association has received donations from international cooperation donors and in turn, it provides credit, technical assistance, and support to the producer´s irrigation systems.

Sources: CEPAL, 1999; IICA, 2004; MAG, 2004a; Moreno, 2004; Pérez and Molina, 1999; Santacoloma and Riveros, 2002.

Table 1.
Production of Selected Vegetables *

Product	Surface in Has	Production in Kg
Squash	33	n/a
Green pepper	630	10,500,000
Green beans	n/a	658,410
Cucumber	455	8,400,000
Zucchini	420	1,100,000
Tomato (industrial use)	839	19,976,413

Source: DGEA/MAL

Note: All data is for 1998, except for tomato, which is for 2003.

Due to customs controls available data on country imports are more extensive and up-to-date. After analyzing data on monthly imports for 2003 for the selected crops, except for zucchini, the tomato figures stand out and also show that they experienced the greatest import levels during the March to May period (See Table 2). Another important figure is that of green pepper imports which show a reduction during July and August.

Green beans and radish imports are the next in importance. Both showed reduced figures during the month of June, compared to the rest of 2003. The data showed that more Jalapeño chili peppers were imported in November and December compared with the rest of the period. Finally, it is noteworthy to point out that squash imports are very irregular and this underlines the importance of national production to supply the demand for this product.

In order to evaluate market prices for the selected crops, it is useful to analyze them in terms of their seasonality. Seasonality is defined as a systematic product movement that repeats itself every twelve months. These fluctuations are due, to a great extent, to changes in supply and demand. If product supply and demand were constant, that is, equal to a fixed amount every month (or week), no price changes should be observed from a month to the next, except for those created by the general price index movement which includes the inflation effect. In this case, the annual price average would be the same as each price per month. In percentage terms, the monthly price in relation to the average would equal one.

In reality however, the amounts supplied and demanded in each period (month or week) are unequal, which leads to price variations. During harvest periods, greater amounts of products are supplied to the markets, these amounts are greater than those usually demanded for consumption. In these cases, the market determines the price through supply and demand, and obviously, prices are relatively low, below the yearly average price. On the other hand, during non-harvest periods when supply is low – below the amount normally demanded – market prices are high, and reflect the relative scarcity of the product.

Table 2.
Monthly Data on Imports for Selected Vegetables, 2003 (Kg)

Month	Squash	Jalapeño Pepper	Green Pepper	Green Beans	Cucumber	Radish	Tomato
Jan	0	8,155	281,065	103,529	56,239	83,669	2,483,558
Feb	216	14,704	508,049	190,822	83,887	111,148	4,718,287
Mar	234	17,673	624,589	152,874	59,997	100,197	5,935,355
Apr	0	28,398	445,658	143,886	23,837	107,178	6,349,336
May	0	19,270	460,535	131,589	32,531	78,311	6,400,082
Jun	0	12,164	341,092	23,347	12,453	1,860	4,535,114
Jul	0	16,219	52,741	115,887	9,588	142,775	4,221,028
Aug	6,560	10,788	47,656	169,358	16,907	268,319	4,442,325
Sep	3,463	18,711	215,730	205,973	12,937	221,492	4,088,038
Oct	8,934	23,397	541,442	165,195	22,358	216,062	5,439,974
Nov	722	31,433	644,640	169,794	98,179	222,297	5,785,544
Dec	0	40,627	764,143	150,148	160,734	174,885	4,627,341
Total	20,129	241,539	4,927,340	1,722,402	589,647	1,728,193	59,025,982
Average	1,677	20,128	410,612	143,534	49,137	144,016	4,918,832

Source: DGEA/MAL

In order to measure price fluctuations for different months of the year, it is very useful to create seasonal indexes for a product. If we take the annual average price of a product it is obvious that prices for some months would be higher than this average, while prices in other months will be lower. In percentage terms, the average price in relation with itself will be equal to one; higher than average prices, in relation to this average, will be greater than one; and lower than yearly average prices will be lower than 1.

Even though this calculation method and the meaning of seasonal ratios or indexes for a product are simple, the results they offer are not the most accurate. A series of seasonal indexes for a product requires a more sophisticated estimation method, which offers better results. In this case, we used the changeable average method (See Annex A for the methodology of its calculation).

Information on seasonality for a product can be very useful for a producer who has an irrigation system because it allows him to program planting and harvesting dates so as to take advantage of the periods when prices are better. We can clearly see the price fluctuation patterns for the cases of green pepper (See Figure 3 and Annex Table A.1), green beans (See Figure 4 and Annex Table A.2), cucumber (See Figure 5 and Annex Table A.3), radish (See Figure 6 and Annex Table A.4), and tomato (See Figure 7 and Annex Table A.5). However, the Ministry of Agriculture´s information system does not report prices for squash. In some cases, price the variation throughout the year is less pronounced, such as in the case of cucumber, zucchini, and radish. For these specific products, a marketing strategy based on the seasonality for them offers a smaller benefit for the producer, but it does not hurt to have a strategy.

Figure 3. Seasonal Index for Peppers

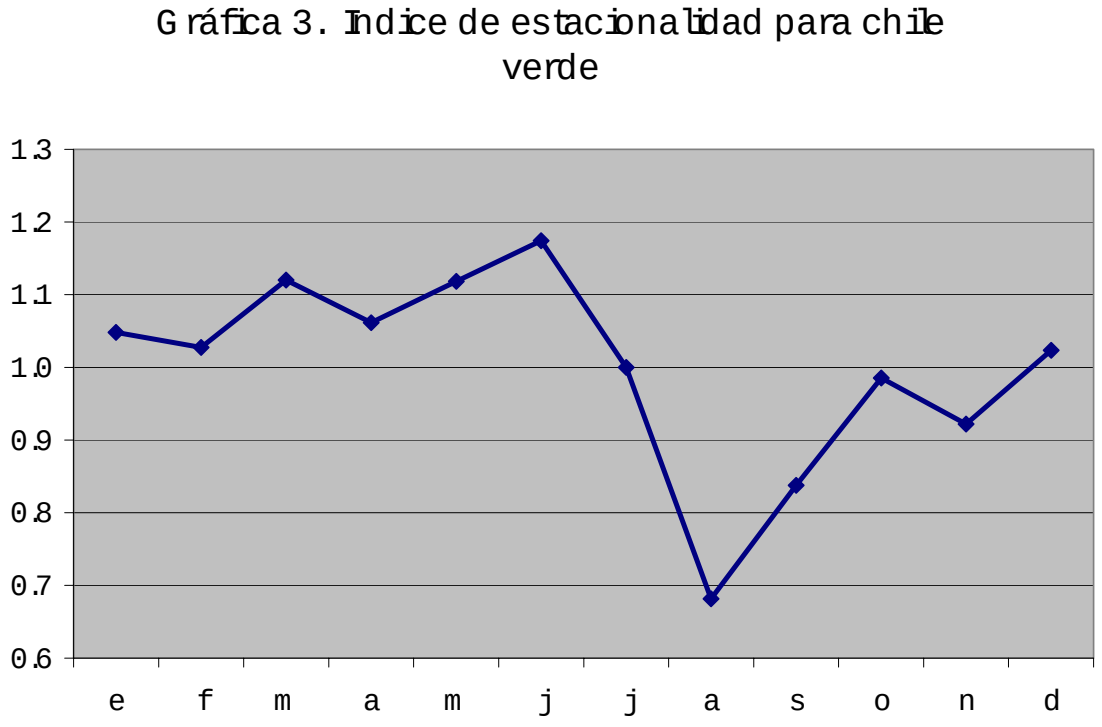


Figure 4. Seasonal Index for Squash

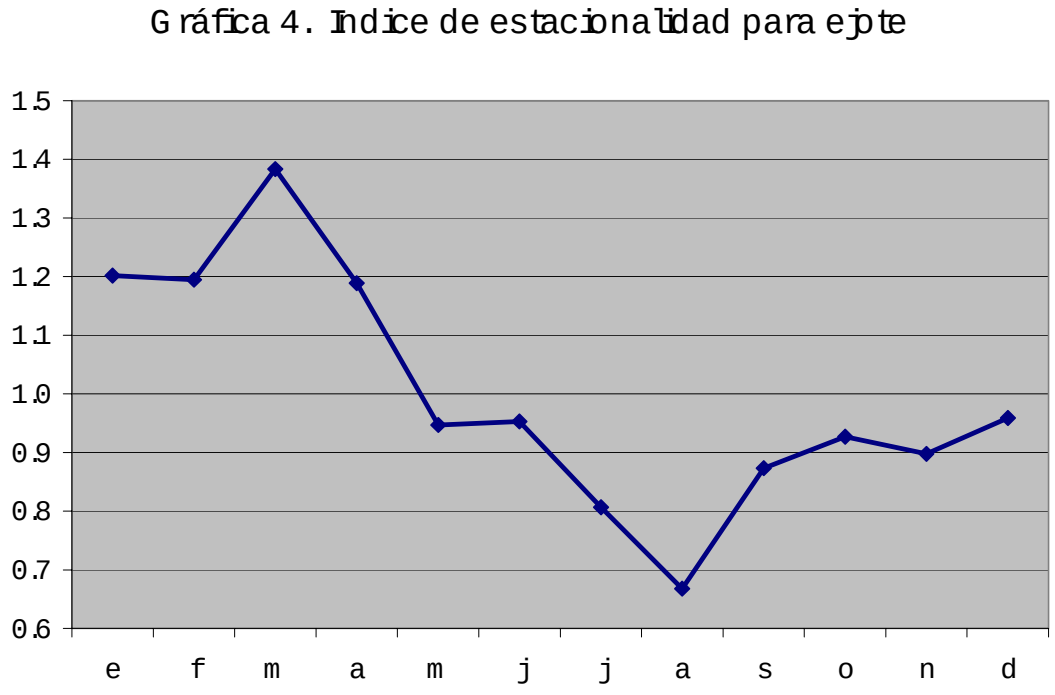


Figure 5. Seasonal Index for Cucumber

Gráfica 5. Indice de estacionalidad para pepino

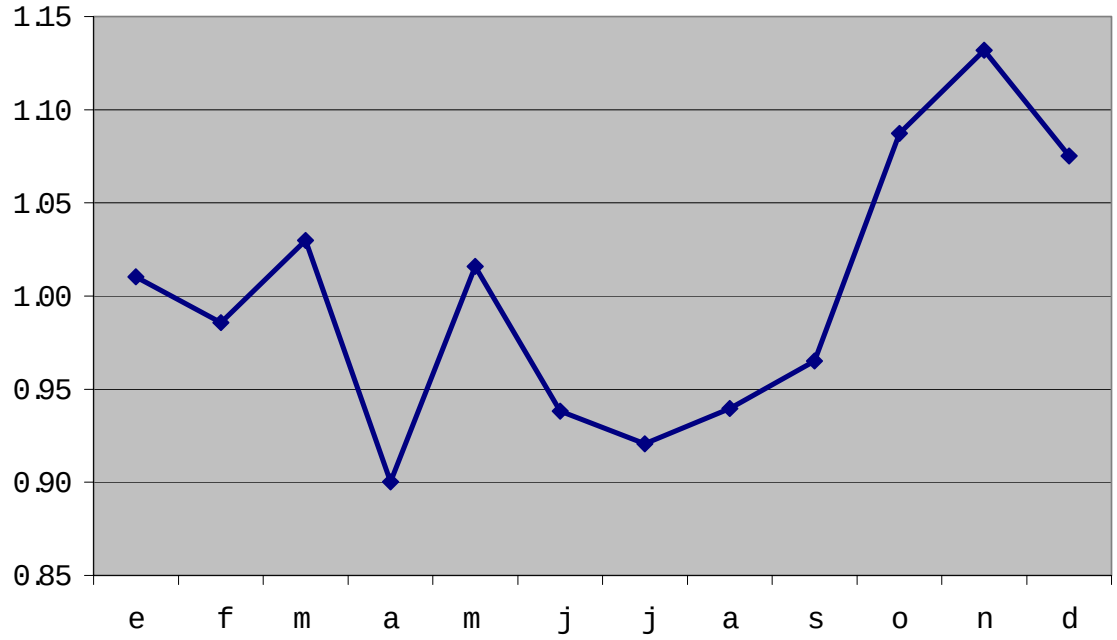


Figure 6. Seasonal Index for Zucchini

Gráfica 6. Indice de estacionalidad para pipián

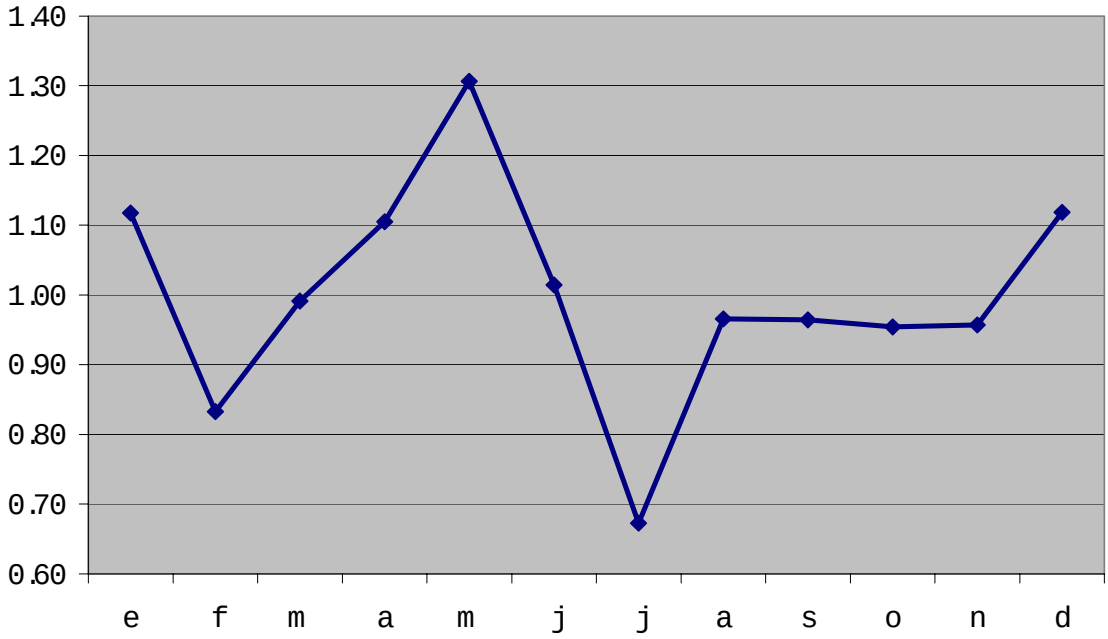


Figure 7. Seasonal Index for Radishes

Gráfica 7. Indice de estacionalidad para rábano

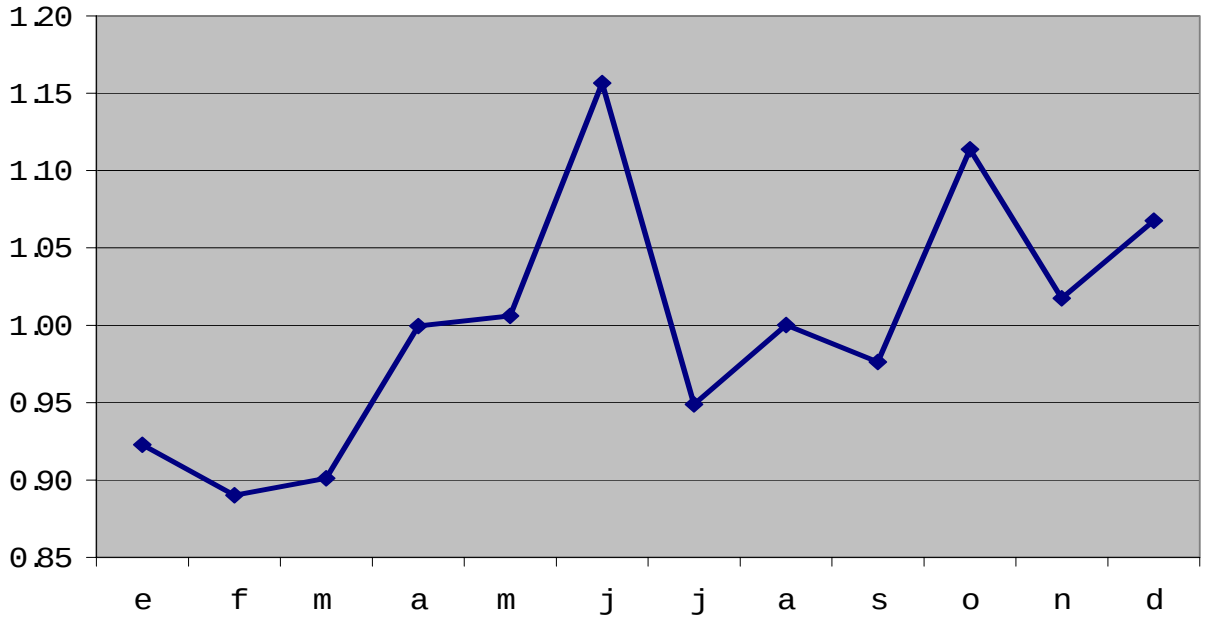
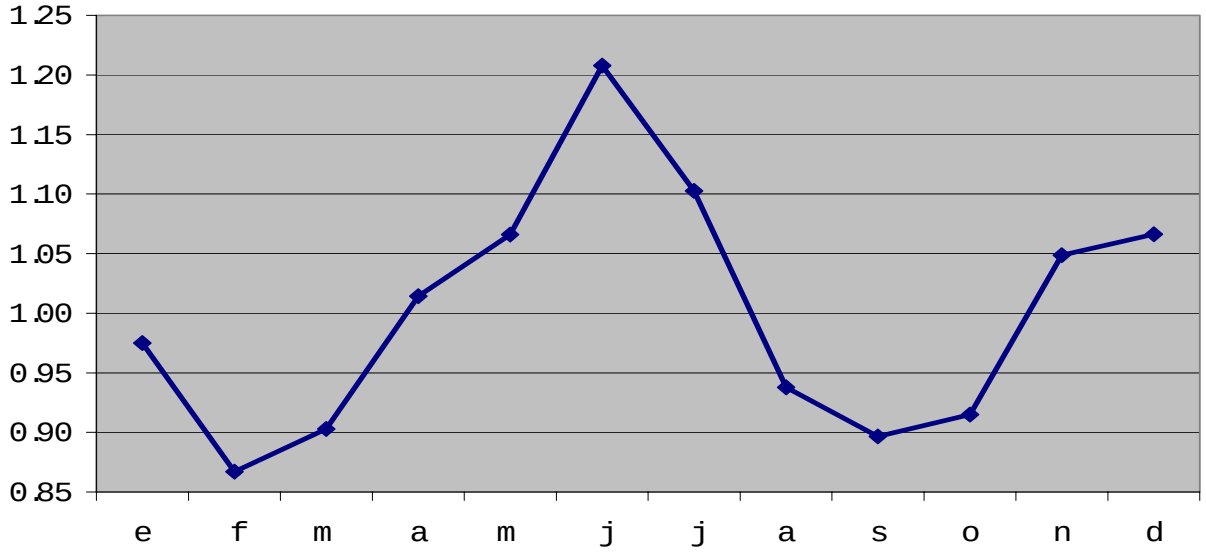


Figure 8. Seasonal Index for Tomato (industrial use)

Gráfica 8. Indice de estacionalidad para tomate de pasta



8. Conclusions and Recommendations

Table 3 shows a summary of the information on months with the best prices for the selected vegetables and corresponding planting periods. It is important to note that the information is exclusively based on prices, in other words, it is just a guide because the potential the producer will have to supply the demand during the higher price months will depend on water availability during certain time periods. In each case, a balance will have to be done between different crops, and in some cases, between more production with a lower price and less production with a higher price, based on water availability and utilization. In addition, producers' ability to participate in the market will depend on their production costs compared with prices, as well as their marketing method (directly, through an intermediary or an association).

For non-traditional crops promotion it is always important to consider the market capacity to take in larger production volumes. A common mistake is to recommend a crop for which there is little domestic market or where the current national production already covers most of the demand; therefore, a production increase of that crop would only displace other national producers or would not find any buyers. This analysis does not include any export possibilities, even though this would be a remote possibility for small producers.

Table 3.
Planting and Marketing Recommendations

Crop	Planting to Harvest Time (Months)	Recommended Months for Marketing	Planting Months
Green pepper	3 to 7	March, May to June	Nov. to Feb.
Green bean	3 to 4	January to April	Oct. to Dec.
Cucumber	3 to 4	October to December	July to Sept.
Zucchini	3 to 4	Dec. to January, April to May	October, February
Radish	3	June, October to December	March, July to Aug.
Tomato	3 to 7	June to July	Dec. to February

Source: Author's based on data from DGEA/MAL and Agribusinesses/MAL.

For the crops analyzed in this study, most of them have high importation levels indicating that there is a national market that domestic production cannot satisfy (See Table 4). Now, when we convert the volume of imported vegetables into surface of land that would be required to replace them, we can observe that green pepper, green beans, radish, and tomato present the best possibilities for promoting their production, although there is also some room for promoting spicy chili pepper production. The squash and cucumber markets seem to be– for the most part– served by the current domestic production. We recognize that the project land extensions are not large, but it is not the only effort being made in the country to promote vegetable crop production, therefore their marketing could be difficult in the future because they would face

lower prices. With respect to the other crops, they have better possibilities, but with some limitations for the spicy chilipepper.

Table 4.
Land Surface to Replace Imported Vegetables

Crop	Volume of Imported Vegetables, 2003 (Kg)	Average Yield (Kg/Has)	Land Surface to Replace Imported Vegetables (Has)
Squash	20,129	969	20.8
Green pepper	4,927,340	37,852	130.2
Jalapeño pepper	241,549	4,423	54.6
Green beans	1,722,402	5,443	316.4
Cucumber	589,647	34,274	17.2
Radish	1,728,193	3,379	511.5
Tomato	59,025,982	33,861	1,743.2

Source: Author´s, based on data provided by DGEA/MAL.

In Annex B we present a list of associations and other contacts for product marketing that can be of interest for the project. In order to achieve successful non-traditional crop production projects, such as vegetables, marketing is a critical factor. It is very important to explore different market options such as local agricultural markets, contracts with agribusinesses, and associations for product marketing for example. Although the project design did not include this type of activities, it is advisable to establish contacts between producers and other organizations or projects that could provide more assistance on the subject once the current project is completed.

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Appendix A.
Methodology to Calculate Seasonal Price Indexes

The changeable average method requires a series of real monthly prices, in other words, prices that should be indexed to inflation or deflated, for at least a three-year period. In this case, we will use a five-year period data from La Tiendona market, deflated by the Consumer Price Index.

The way to create seasonal period indexes or ratios is based on the use of changeable averages. Changeable averages control abrupt fluctuations, which allow us to clear a series of erratic or random fluctuation prices as well as to maintain those fluctuation that are systematic, recurrent, repetitive, and thus predictable.

The way to estimate changeable averages for each month can be summarized in the following formula:

$$PM_j = \frac{(0.5 * P_{j-6}) + P_{j-5} + P_{j-4} + \ldots + P_j + P_{j+1} + \ldots + P_{j+5} + (0.5 * P_{j+6})}{12}$$

Where:

PM_j	=	monthly average price during month j
P_j	=	price observed during month j
$P_{j+/-x}$	=	prices before and after price observed during month j

The number of months is given by number 12, as follows: 5 months preceding month j, five months after, the month j itself, and half of the sixth month before and after month j. Adding up and dividing by 12, is how the changeable average of 12 months is obtained for every month. These changeable averages for each month, PM j, are divided by the prices observed or the real prices of the referred month, meaning Pj, which results in gross seasonal ratios.

The following step of the method is about grouping gross ratios by month (those in January, those in February, etc.). Once grouped by month, the average ratio is obtained for every calendar month. The sum of all these 12 monthly ratios should be equal to 12, by formula. If it's not exactly 12, they are adjusted with a simple rule of three in order to have a sum equal to 12. The resulting ratios are the seasonal ratios used to analyze price fluctuation during the year.

Table A.1
Real Prices at Wholesale Leveland Seasonal Index for Green Pepper (col/hundred)

Month	1999	2000	2001	2002	2003	Average	Index
January	50.55	47.79	63.56	36.92	47.99	49.36	1.05
Feb	51.97	48.77	65.38	38.94	38.93	48.80	1.03
Mar	51.10	54.01	81.82	35.79	38.82	52.31	1.12
April	45.89	54.67	61.63	37.71	43.73	48.72	1.06
May	41.02	55.10	48.37	57.10	45.23	49.36	1.12
June	40.56	57.80	34.52	78.48	45.29	51.33	1.17
July	52.12	49.16	33.84	54.18	37.61	45.38	1.00
August	28.74	36.09	36.43	26.39	36.66	32.86	0.68
Sept	47.65	28.47	42.07	37.16	39.21	38.91	0.84
Oct	61.41	30.26	39.08	52.30	37.14	44.04	0.99
Nov	51.62	30.68	31.99	58.61	57.82	46.15	0.92
Dec	50.97	43.47	32.68	65.86	41.95	46.98	1.02

Table A.2
Real Prices at Wholesale Leveland Seasonal Index for Green Bean (col/12 lb)

Month	1999	2000	2001	2002	2003	Average	Index
January	64.23	62.89	47.89	36.36	36.54	49.58	1.20
Feb	41.16	53.07	55.49	37.31	36.09	44.62	1.20
Mar	44.31	44.08	53.69	56.50	52.84	50.28	1.38
April	47.42	33.53	40.96	43.36	59.31	44.92	1.19
May	50.84	34.40	33.09	42.02	31.86	38.44	0.95
June	40.56	32.49	37.39	38.63	32.58	36.33	0.95
July	38.50	27.08	32.91	25.88	31.72	31.22	0.81
August	31.80	36.47	18.06	16.90	30.22	26.69	0.67
Sept	35.74	39.74	23.64	34.29	32.57	33.20	0.87
Oct	35.23	37.58	31.28	37.29	32.47	34.77	0.93
Nov	40.26	33.66	36.39	27.12	28.91	33.27	0.90
Dec	50.20	41.40	27.72	28.34	30.90	35.71	0.96

Table A.3
Real Prices at Wholesale Leveland Seasonal Index for Cucumber (col/hundred)

Month	1999	2000	2001	2002	2003	Average	Index
January	40.57	54.88	39.60	53.07	37.21	45.06	1.01
Feb	46.16	48.16	46.46	44.89	39.03	44.94	0.99
Mar	30.08	44.08	54.20	45.51	41.81	43.14	1.03
April	44.17	38.13	44.94	42.04	36.41	41.14	0.90
May	49.63	47.49	43.87	46.09	43.27	46.07	1.02
June	30.58	43.11	44.23	55.95	25.47	39.87	0.94
July	44.12	42.73	46.50	36.17	37.14	41.33	0.92
August	52.12	46.22	49.98	25.21	33.16	41.34	0.94
Sept	43.01	45.43	53.47	36.08	38.23	43.24	0.97
Oct	48.16	47.34	50.24	53.29	39.34	47.67	1.09
Nov	48.70	53.81	54.97	49.69	41.78	49.79	1.13
Dec	52.12	51.17	46.72	45.86	39.44	47.06	1.08

Table A.4
Real Prices at Wholesale Leveland Seasonal Index for Zucchini (col/hundred)

Month	1999	2000	2001	2002	2003	Average	Index
January	68.25	41.93	63.60	38.49	51.31	52.71	1.12
Feb	40.35	38.65	47.26	29.62	31.90	37.56	0.83
Mar	42.04	50.93	53.99	40.02	30.21	43.44	0.99
April	55.82	45.02	62.52	50.45	35.69	49.90	1.11
May	56.53	50.54	75.22	57.10	45.75	57.03	1.31
June	49.31	43.11	46.26	47.79	37.93	44.88	1.01
July	29.32	30.42	32.24	29.19	41.84	32.60	0.67
August	54.42	50.92	46.48	24.20	46.91	44.58	0.97
Sept	52.60	42.05	43.09	35.58	45.07	43.68	0.96
Oct	51.71	42.25	33.11	42.20	45.91	43.04	0.95
Nov	49.35	42.95	41.59	35.04	44.65	42.72	0.96
Dec	52.12	52.07	45.18	45.73	45.63	48.15	1.12

Table A.5
Real Prices at Wholesale Leveland Seasonal Index for Radish (col/hundred bundles)

Month	1999	2000	2001	2002	2003	Average	Index
January	51.84	54.26	43.89	47.16	51.21	49.67	0.92
Feb	51.00	47.55	46.12	50.93	46.01	48.32	0.89
Mar	41.40	48.13	46.46	48.96	52.12	47.41	0.90
April	85.61	49.61	50.26	49.33	72.87	61.54	1.00
May	62.04	49.32	50.99	50.58	74.77	57.54	1.01
June	69.74	54.31	55.29	64.50	88.21	66.41	1.16
July	50.34	50.12	47.94	50.75	77.74	55.38	0.95
August	52.89	55.68	54.82	46.14	84.18	58.74	1.00
Sept	48.27	57.44	50.95	47.86	85.26	57.96	0.98
Oct	65.29	54.63	50.52	64.06	84.02	63.71	1.11
Nov	51.62	52.22	56.40	53.22	85.76	59.84	1.02
Dec	57.10	61.71	53.26	52.99	82.82	61.57	1.07

Table A.6
Real Prices at Wholesale Leveland Seasonal Index for Tomato (industrial use)
(col/50 lb.box)

Month	1999	2000	2001	2002	2003	Average	Index
January	92.72	32.37	92.67	51.71	97.49	73.39	0.98
Feb	57.94	42.33	74.10	47.33	79.72	60.29	0.87
Mar	27.49	69.68	72.66	55.49	58.61	56.79	0.90
April	27.91	106.12	56.98	74.08	46.77	62.37	1.01
May	36.54	95.59	53.84	72.91	71.41	66.06	1.07
June	54.14	99.43	65.90	79.73	90.58	77.96	1.21
July	79.06	71.74	54.53	99.80	43.86	69.80	1.10
August	93.50	48.45	65.43	47.95	59.01	62.87	0.94
Sept	94.68	35.65	67.73	45.49	63.44	61.40	0.90
Oct	96.32	40.10	75.09	43.30	64.99	63.96	0.91
Nov	82.47	80.17	89.26	47.79	63.20	72.58	1.05
Dec	52.50	107.66	57.50	87.83	79.81	77.06	1.07

Source: Author's based on data provided by DGEA/MAL and DIGESTYC.

Annex B.
Marketing Contacts

- Dirección de Agronegocios, MAG [Agribusiness Directorate, MAL]; Contact Engineer Rigoberto Soto, General Director at the following phone numbers: 241-1821, 241-1822, 241-1823, 241-1737.

- Productores de Hortalizas de Oriente, S.C. de R.L. (PHOC-CRS), [Vegetable Producers of Oriente, S.C. de R.L.] supported by Catholic Relief Services; it includes Corinto, Morazán. Contact José Angel Cruz at the following phone numbers: 298-1688, 654-1207.

- Unión de Productores y Exportadores de Usulután, S.A. de C.V. (UPREX) [Usulutan Producer and Exporters Union]. Contact Luis Rodolfo López, San Francisco Javier, Usulután at the following phone numbers: 628-1633, 822-2416.

- There is an agrimarket (producers fair) every Friday in San Pedro Puxtla. Contact: SALVANATURA, at phone number: 279-1515.

- Sociedad de Comercialización de Productos Diversificados de Morazán (SOPRODIM);: Contact Rosendo Ruiz at phone number: 654-0702.

- AGRONATURA (with emphasis on organic products), national coverage. Contact María Esperanza Rodríguez de Cuellar at phone number: 263-2244.

- Asociación CLUSA de El Salvador. [CLUSA Association of El Salvador]. It has activities in Ahuachapán and Usulután. Contat León Bonilla or Mario Urrutia at the following phone numbers: 264-7105, 264-7106, and 264-7046.

- Asociación de Desarrollo Bahía de Jiquilisco, Usulután, supported by Ayuda en Acción; Contact Manuel Vides Moreno at the following phone numbers: 245-5381, 245-5382, 223-7486.

- FINTRAC, it has activities in Ahuachapán y Usulután. Contact Dennis Lesnick at the following phone numbers: 257-9568 and 257-9571.

- Fundación Recuperación del Ecosistema de El Salvador (FREES); it has activities in Ahuachapán. Contact Juan Vega at phone number: 447-0461.

- Fundación para el Desarrollo Económico y Restauración Ambiental (FUNDESYRAM) [Foundation for Economic Development and Environmental Restauration]. It has activities in San Pedro Puxtla and Guaymango. Contact Pedro Guardado at phone number: 260-3026.

- Project Concern International (PCI). It has activities in Usulután. Contact Andrea Lamer; at the following phone numbers: 224-6005, 279-4667, and 298-6137.

- Programa de Reconstrucción y Modernización Rural (PREMODER) del MAG. [MAL´s Rural Reconstruction and Modernization Program]. It has activities in Ahuachapán. Contact Manuel Arístides Ponce Cornejo at the following phone numbers: 224-6905, 223-4651 and 223-4657.

- Proyecto de Desarrollo Agrícola para Pequeños Productores de la Región Paracentral (PRODAP II) del MAG [MAL´s Agricultural Development Project for the ParaCentral Region Small Producers]. It has activities in Usulután. Contact Frank Escobar at the following phone numbers: 393-0438, 393-2876.

- Proyecto de Desarrollo Rural para las Poblaciones del Nor-Oriente (PRODERNOR) del MAG. [MAL´s Rural Development Project for the Northeastern Populations] It has coverage in Morazán. Contact Eduardo Castillo at the following phone numbers: 654-0174, 654-0015, and 654-0465.

- Another possibility for zucchini and squash marketing are companies buying sedes for direct consumption such as Diana (Ricardo Paredes, 277-1233) or Casa Bazzini (Julio Tito Mancía, 220-3333), and those companies buying seed for their use in ethnic drinks or as spices, such as Industrias Lya (Contact Vicente Trigueros or Karl Trigueros at 282-0570), PROESAL (Contact Eleonora Bolaños at the following phone numbers 263-1638, 830-8454), PROINCA (Contact Karla de Ventura at 220-0083), La Canasta (contact Madeca del Barriere at 257-5763) and RACOR (Contac Claudia María de Guzmán at 222-4867).

Annex W-4

Working Paper No.4
Financial Feasibility Analysis

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FINANCIAL FEASIBILITY ANALYSIS OF THE SWDSU PROJECT

1 INTRODUCTION

The main purpose of the Surface Water Diversion, Storage, and Use (DAUAS, in Spanish) Project is the adoption and promotion of techniques that allow better management of water resources. Under the project's scope of work, 13 reservoirs for the collection and storage of irrigation water will be built in the departments of Ahuachapan, Usulutan, and Morazan.

The project also seeks the economic revitalization of beneficiary families through the provision of a safe water source during the dry season. This water would give the families the opportunity to continue practicing their agricultural activities during the dry season, thus expanding their income possibilities. As a part of this plan, the project identified alternative crops with a greater added value than beneficiary families could develop during both the dry season and the rainy season.

After conducting a project-financed market study of several products, we propose the following crops as the best alternatives: hot pepper (jalapeño pepper), green beans, squash, radish, cucumber, zucchini, tomato, and green pepper.

This analysis evaluates the financial feasibility of investment in the reservoirs and alternative crops, examining the additional income that these reservoirs are estimated to produce and the additional costs to be incurred in order to achieve said income. To this end we used the most appropriate financial criteria such as the net present value (NPV), and the internal rate of return (IRR), based on previously determined parameters and assumptions. It should be pointed out that this analysis is focused on the incremental flows generated by activities associated with the introduction of the reservoirs, not considering at all the other business activities of the beneficiaries.

2 PARAMETERS AND ASSUMPTIONS FOR THE ANALYSIS

The parameters and assumptions outlined below are the basis of this financial feasibility analysis. Consequently, the conclusions and recommendations derived from this analysis will be valid as long as the parameters and assumptions used adequately reflect the prevailing conditions in the economic, financial, and market environment of El Salvador, and particularly, in its agricultural sector.

Insofar as it is possible, figures provided by governmental institutions or specialized organizations were used as parameters. Nevertheless, since we did not have figures from specialized institutions for all the parameters needed, we were forced to develop several new parameters used in the analysis. To this end, we used assumptions that, according to our own criteria, reasonably reflect the underlying conditions related to them.

For the purpose of providing greater clarity to the analysis, below we outline the parameters used, their sources, and/or the assumptions on which they were based.

Rate of Inflation: The rate of inflation considered in this study is 5.4% per year. This rate comes from the level of cumulative inflation between January and December 2004, as reported by the Central Reserve Bank.

Discount Rate: One of the most difficult parameters to calculate and at the same time, one of the most important for the financial analysis, is the discount rate. This rate is a measurement reflecting the return associated with an investment that has a certain level of risk. It is important to emphasize that the investment risk level is the discount rate's determining factor and it rises as the risk of the financial flows derived from the investment rises. For example, the discount rate we would use to evaluate the decision to keep our money in a savings account in a bank will be substantially lower than that we would use in evaluating the investment of those same funds in a clothing manufacturing industry; this is because the expected return from a savings account is significantly more secure than that of the alternative investment.

Since there is no discount rate calculated by specialized institutions for the crop schedules the project proposes, we decided to use a value range from which the interested parties could evaluate the proposed investment feasibility based on their aversion to individual risk.

It is noteworthy to mention that the discount rate ranges used are expressed in real terms; that is, that they are values adjusted for the estimated inflation.

Market Conditions: Given the amount of the proposed crops, we assume the farmers will face conditions similar to those of perfect competition, where individually they will not have any influence on the market price of the products (they will be price takers), and that they will be able to sell all their production at market prices.

Useful Life of the System: The useful life of the structures to be built is 20 years or more. However, in this study, since the useful life of the irrigation system is limited to 10 years, we will consider a useful life horizon of 10 years.

Representative System: We selected as the representative system one with an infiltration gallery, a line of adduction, a 1000 m3 capacity reservoir, and an irrigation system. For this analysis, we also assume that the natural land topography does not have any inclination and that the cut and filling volumes are balanced.

Crop Schedules: Two crop schedules were analyzed: "Schedule A" crops produced during the first three months of the dry season, and "Schedule B" crops produced throughout the six-month dry season.

For illustrative purposes, this analysis compares the estimated useful levels generated by the alternative crops during the dry season and those generated during the rainy season. However, it should be taken into account that the incremental cash flows (of both investments and returns) are mainly related to the activities that will be carried out in the dry season and the mitigation of the negative impact generated by the hottest days of summer during the rainy season. In this regard, two scenarios were taken into account in order to estimate the project benefits. The first scenario, a conservative approach, takes into consideration as a part of the project financial profits 25% of the income generated by the harvest during the rainy season (here we assume the reservoir reduces by 25% the loss of harvest caused by the hottest days of summer). The second scenario, more optimistic, includes 50% of the income generated by the harvest during the rainy season as a part of

the profits (in this case, we assume the reservoir reduces by 25% the loss of harvest caused by the hottest days of summer). We believe these two scenarios provide a good basis to estimate the additional income the beneficiaries will get after reducing the negative impact caused by the hottest days of summer.

3 FINANCIAL ANALYSIS OF THE PROJECT

The financial feasibility analysis compares the project financial costs with the benefits it generates. Generally, a project is considered financially viable if the benefits generated in a given period, in addition to covering the initial investments and payments of normal costs of production, and the operation and maintenance of the infrastructure, generate a financial profit.

As mentioned at the beginning of this document, the financial feasibility indicators used in this analysis are the net present value (NPV) and the internal rate of return (IRR).

NPV basically provides the net value (profits minus investments) that all the financial flows associated with an investment would have today. For this, it uses a discount rate that reflects the minimum premium that we expect to receive for the associated risk of investing our financial resources in the analyzed activity. Given an associated discount rate, an investment will be feasible when the NPV of its financial flows is positive.

The IRR measures the average rate of return generated by the investment within the analyzed period. A project's feasibility is determined by comparing the IRR value with the minimum premium we expect to receive from our investment, determined by the discount rate. Basically, the investment will be feasible if the IRR is greater than the selected discount rate.

It is noteworthy to point out that the results obtained using both indicators are completely consistent.

4 PROJECT COSTS

The financial costs were calculated adding (1) the cost of construction, plus (2) the total production cost plus (3) the annual cost of operation and maintenance expenses.

4.1 Construction Costs

The works to be built are as follows:

1. Infiltration gallery
2. Adduction line
3. Water storage reservoir
4. Irrigation system

The estimated costs for each construction item, as well as the unit prices of reference were calculated based on the design for each one of these works presented in the bid. Unit prices include the contractor camp site, equipment, materials, labor, administration expenses and utility overhead costs.

In this study we did not include any pre-investment costs because we considered that when the experience of building the 13 reservoirs to be built by the DAUAS Project is developed/achieved, then the contractors will be able to include the cost of designs into the final work.

Table 1 shows the summary of the construction costs.

Table 1. Summary of Construction Costs

Work	Total Cost US$
Infiltration gallery	1,300.00
Adduction line	700.00
Reservoir	13,000.00
Irrigation system	2,000.00
Total	***17,000.00***

4.2 Operation and Maintenance Costs Per Year

The operation and maintenance costs per year have been assumed to be equal to 0.50% of the original investment or $85.00 based on common practices in irrigation systems of small farmers.

4.3 Production Costs Per Year

The annual crop and livestock production costs were calculated as average costs per hectare. The actual production costs will be prorated based on both the surface to be used by the reservoir and to the surface to be irrigated.

In the production cost analysis the labor cost has been considered because in spite of being a resource provided by the beneficiaries, it represents an opportunity cost that should be taken into account in the analysis.

We have also included the land lease value because it represents an opportunity cost that should be considered.

Crop production: The crops selected for this analysis are as follows:

1. Hot pepper (Jalapeño pepper)
2. Green beans
3. Squash (ayote)
4. Radish
5. Cucumber
6. Zucchini
7. Tomato
8. Green pepper

The advantages and disadvantages of having crops during the first three months of the dry season ("Schedule A") were analyzed as well as having crops throughout the dry season "Schedule B", that is to say, six months per year. With regard to crop water requirements

and the benefited area, we can conclude that with crops to be harvested in the first three months of the summer, they can be irrigated more than twice the area than for six-month crops. Table 2 shows the areas that can be benefited by a typical system with gallery and reservoir with a 1000 m 3 capacity for the Usulutan and Ahuachapan areas.

Table 2. Theoretical Areas Under Irrigation With a 1000 m 3 Reservoir in Usulutan and Ahuachapan

Scenarios	Usulutan m 2	Ahuachapan m 2
Schedule A Nov. to Jan. 3 months	1900	2400
Schedule B Nov. to Apr. 6 months	840	1020

The Annex shows the detailed cost analysis, and Table 3 shows a summary of the production costs "with the project".

Livestock production: In the livestock production "with the project" we only considered the Tilapia production, and Table 3 shows a summary of the production costs "with the project". The cost analysis details are shown in the Annex.

Table 3. Production Costs "With The Project"[1]

AGRICULTURAL PRODUCTION

Crop	Cultivated Area (m 2)	Production Costs $ Dry Season	Production Costs $ Rainy Season
Hot pepper	400	189.48	196.84
Green bean	200	18.16	18.44
Squash	100	6.35	6.57
Radish	200	21.07	20.55
Cucumber	200	40.19	40.39
Zucchini	100	7.70	7.84
Tomato	400	205.96	213.58
Green pepper	400	188.67	196.02
Total	2,000	677.57	700.22

LIVESTOCK PRODUCTION – Tilapia

1 and 6	600	151.48	151.48
2,3,4,5-7,8,9,10		75.48	75.48

1 Production and unit prices data taken from the Ministry of Agriculture and Livestock (MAG, in Spanish).

5 Project Benefits

The DAUAS Project's fundamental objective is to ensure water supply to the agricultural land of small farmers, which is exploited mainly during the rainy season. Through the introduction of water reservoirs, the exploitation of alternative crops will be possible in the dry season, in addition to covering the water deficit during the hottest days of summer.

The possibility of cultivating during the dry season in turn will result in an additional income for the beneficiaries, thus improving their economic situation and reducing poverty indexes and unemployment among them. Furthermore, the availability of water resources to cope with the hottest days of summer during the rainy season will reduce the inherent risk of crop production that the beneficiaries currently face.

Following the same methodology than for estimating annual costs, the crop production benefits per year have been calculated as average benefits. The actual production benefits will be prorated based on the surface to be irrigated and the volume of stored water.

The annual benefits considered include 100% of the estimated net profits from production during the dry season, plus a percentage of the production during the rainy season. The rainy season production share is estimated as the harvest percentage that will not be lost as a consequence of the hottest days of summer as a result of having the reservoirs. For our analysis we take into account two scenarios: the first (more conservative) estimating that the reduction in loss due to the hottest days of summer will be 25% and the second (more optimistic) estimating a 50% loss reduction.

5.1 Production Benefits "With The Project"

Agricultural production: The selected crops for this analysis are those listed on the agricultural production costs (4.2). As mentioned earlier, for this study we have considered that the system can irrigate an area of 2,000 square meters. We decided to devote 100 m2 for each of the two less profitable crops, 200 m2 for each of the three average income ones and 400 m2 for each of the three higher profitability crops. This allows us to have several crops, diversify production and minimize risk, but also to focus more on the most profitable crops. Table 4 shows a summary of production benefits in the assigned area "with the project". In addition, the Annex shows benefit analysis details.

Livestock production: For the livestock production, we only considered Tilapia production. The Appendix shows the benefit analysis details.

Table 4. Production Benefits in 2,000 m2 "With The Project"

AGRICULTURAL PRODUCTION

Crop	Cultivated Area (m2)	Net Profit Dry Season	Net Profit Rainy Season	Total Profit 100% Dry Season + 25% Rainy Season
Hot pepper	400	861.83	747.13	1238.09
Green beans	200	140.30	104.86	184.67
Squash	100	48.90	48.68	67.42
Radish	200	414.60	458.86	550.38
Cucumber	200	98.66	92.71	162.03
Zucchini	100	18.23	17.35	30.27
Tomato	400	534.48	524.97	871.68
Green pepper	400	832.64	747.95	1238.30
Total	2,000	2,979.64	2,742.51	4342.84

LIVESTOCK PRODUCTION - Tilapia^

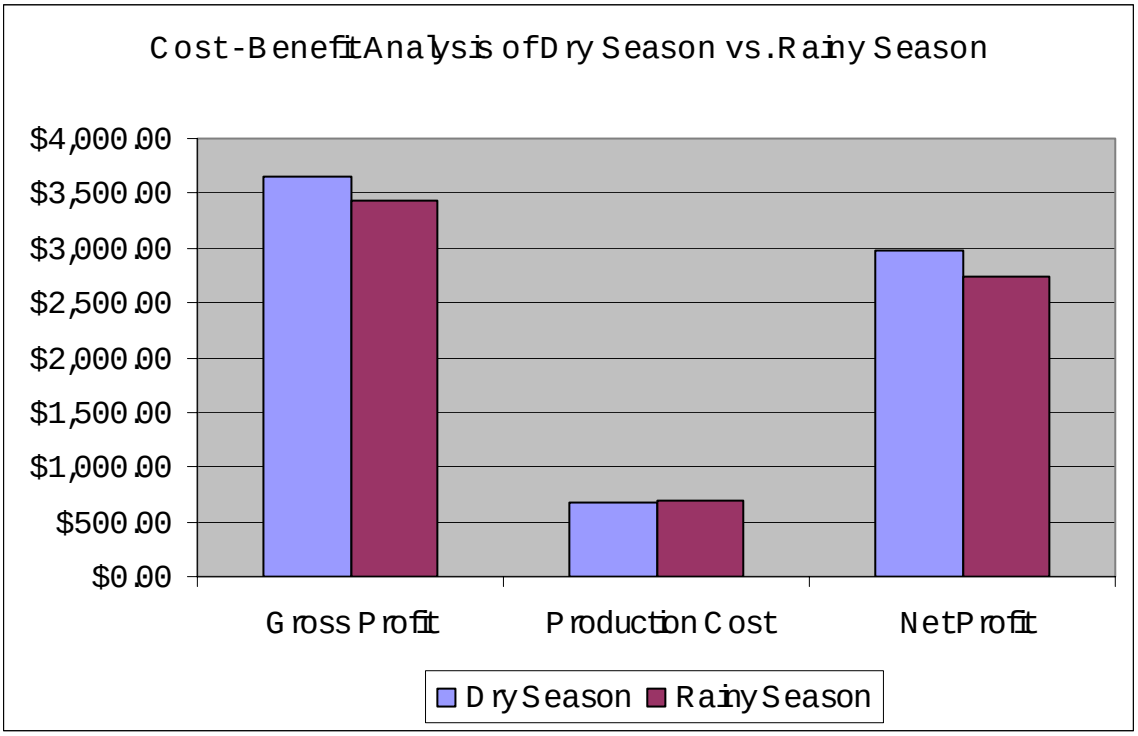
1 and 6	600	87.92	87.92	175.84
2,3,4,5-7,8,9,10	-	163.92	163.92	327.84

+ 50 Pound Box

^ Area: Water mirror

As it can be seen in the previous table and in the figure below, the dry season production shows a greater economic benefit than that which would be achieved during the rainy season. This is due mainly to the seasonal fluctuation of the prices of the selected products and to greater production costs during the rainy season as it can be seen in the Annex.

Figure 1. Harvest Costs and Profits



5.2 Project Indirect Benefits

The DAUAS Project, located in areas of chronic unemployment and inefficient water resource use during the dry season, will have important sociological and economic values for the beneficiary families. Currently there are very few employment opportunities during the dry months and the farmers either migrate to other areas or simply wait for the rains to come.

Having the reservoir systems, the farmers will be able to self-employ themselves using their own labor and that of their families. This will provide major economic, sociological, and nutritional benefits because families will improve their income; improve their family relationships as a result of being busy and productive; and will be able to improve their diet by having more products available for their own consumption.

5.3 Cash flow

Cash flow is the difference between annual financial benefits and financial costs, which in our case represents net profits. Table 5 shows a summary of cash flows during the dry season and the rainy season, respectively.

Table 5. Project Cash Flows

Year	Flow A Considering 25% of harvest during the rainy season	Flow B Considering 50% of harvest during the rainy season
0	(17,000.00)	(17,000.00)
1	3,668.19	4,353.82
2	3,744.19	4,429.82
3	3,744.19	4,429.82
4	3,744.19	4,429.82
5	3,744.19	4,429.82
6	3,668.19	4,353.82
7	3,744.19	4,429.82
8	3,744.19	4,429.82
9	3,744.19	4,429.82
10	3,744.19	4,429.82

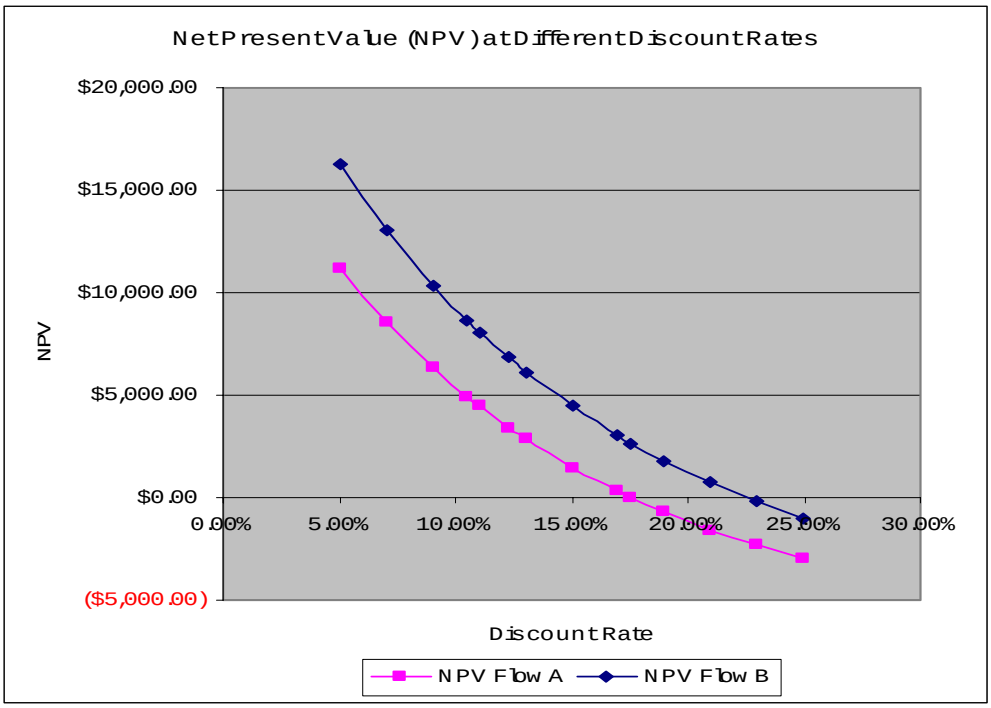
5.4 Net Present Value (NPV)

As mentioned earlier, the net present value was calculated using a range of Real Discount Rates and the cash flow values that are summarized in Table 5. The net present values obtained for the different Discount Rates and cash flow combinations both for the production during the dry season and during the rainy season are summarized in Table 6 and in the figure shown below.

Table 6. Discount Rates and NPV

Discount Rate	NPV Flow A	NPV Flow B
5.00%	$11,221.48	$16,263.61
7.00%	$8,575.66	$13,076.19
9.00%	$6,343.02	$10,379.84
10.49%	$4,904.93	$8,638.89
11.00%	$4,451.63	$8,089.31
12.24%	$3,424.41	$6,842.26
13.00%	$2,843.48	$6,135.86
15.00%	$1,471.55	$4,463.73
17.00%	$297.53	$3,027.51
17.56%	($0.14)	$2,662.40
19.00%	($709.94)	$1,789.97
21.00%	($1,576.68)	$720.50
23.00%	($2,324.02)	($206.23)
25.00%	($2,969.66)	($1,011.23)

Figure 2. NPV at Different Discount Rates



5.5 *Internal Rate of Return (IRR)*

The internal rate of return was calculated based on the cash flow summarized in Table 5. The IRR obtained in the analysis is 17.56%. However, we reiterate that the estimated flow is very conservative, which means that it is very likely that the project IRR is higher (i.e. if we take 50% of the rainy season harvest as attributable to the project, then the IRR we get is 22.53%)

6 INTERPRETATION OF RESULTS

6.1 *Investment Feasibility*

Based on the results obtained, we can see that taking a very conservative perspective, the reservoir and the alternative crop implementation is financially feasible for actual discount rates lower than 17.56% (or lower than 23.9% in nominal terms). If we take a little more optimistic perspective, and we assume that the project has an influence of 50% on the production profits during the rainy season, the reservoir and alternative crop implementation is financially feasible for actual discount rates lower than 22.53%, or in nominal terms, lower than 30.6%.

From the aforementioned summary, we can conclude that the reservoir-construction endeavor is a feasible alternative for those beneficiaries interested in obtaining a 17.5% to 22.5% return on their investment in real terms, or a 24% to 30.5% return in nominal terms.

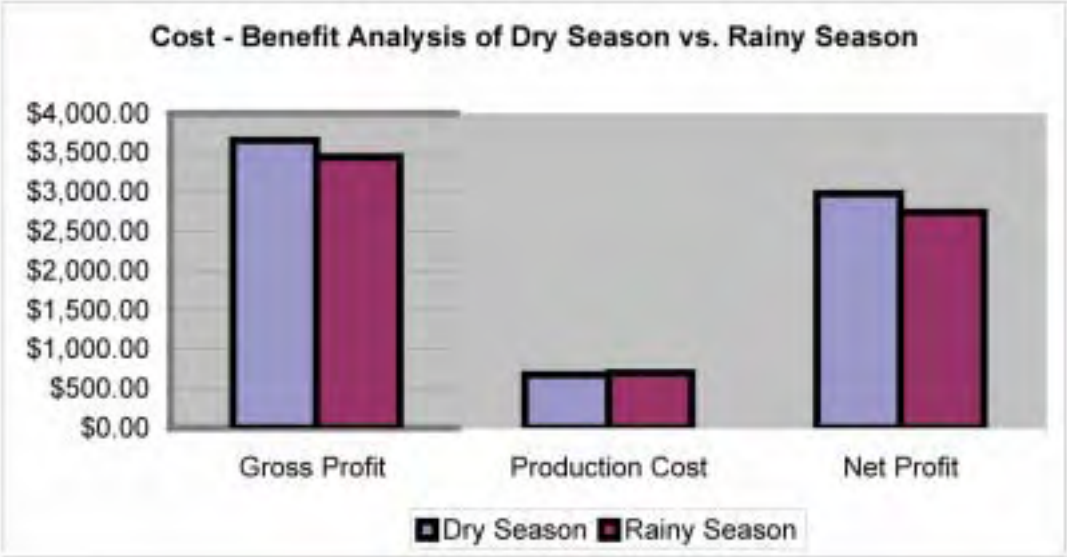
6.2 Subsidy

In the event that the results of our analysis indicated that the return on investment, shown by the IRR, was lower with regard to the benefits expected by the beneficiaries for this type of investment, then we would need to provide the beneficiaries with a subsidy for building the reservoir. The minimum value of this subsidy would be one that turns the NPV into a positive value, or that alternately, makes the internal rate of return increase itself up to the rate of return the beneficiaries would expect to get.

In view of the fact that our analysis shows that the reservoir and alternative crops implementation is economically feasible for 24% to 30.5% rates of return on investment in nominal terms, we believe that the project in itself will generate interest for the interested parties without any need for granting any type of subsidy. However, given the target beneficiary socioeconomic level, we believe that the greatest limiting factor for the implementation will be the lack of capital for the initial investment in the reservoirs. In this regard, we believe that in order to make the project replication feasible, we will need to support the interested parties in identifying soft sources of financing and long-term financing sources that will provide the beneficiaries with resources for building the reservoirs.

APPENDIX

Year	Cash Flow ssuming 25% reduction in crop loss during the rainy season	Cash Flow Assuming 50% reduction in crop loss during the rainy season
0	(17,000.00)	(17,000.00)
1	3,668.19	4,353.82
2	3,744.19	4,429.82
3	3,744.19	4,429.82
4	3,744.19	4,429.82
5	3,744.19	4,429.82
6	3,668.19	4,353.82
7	3,744.19	4,429.82
8	3,744.19	4,429.82
9	3,744.19	4,429.82
10	3,744.19	4,429.82



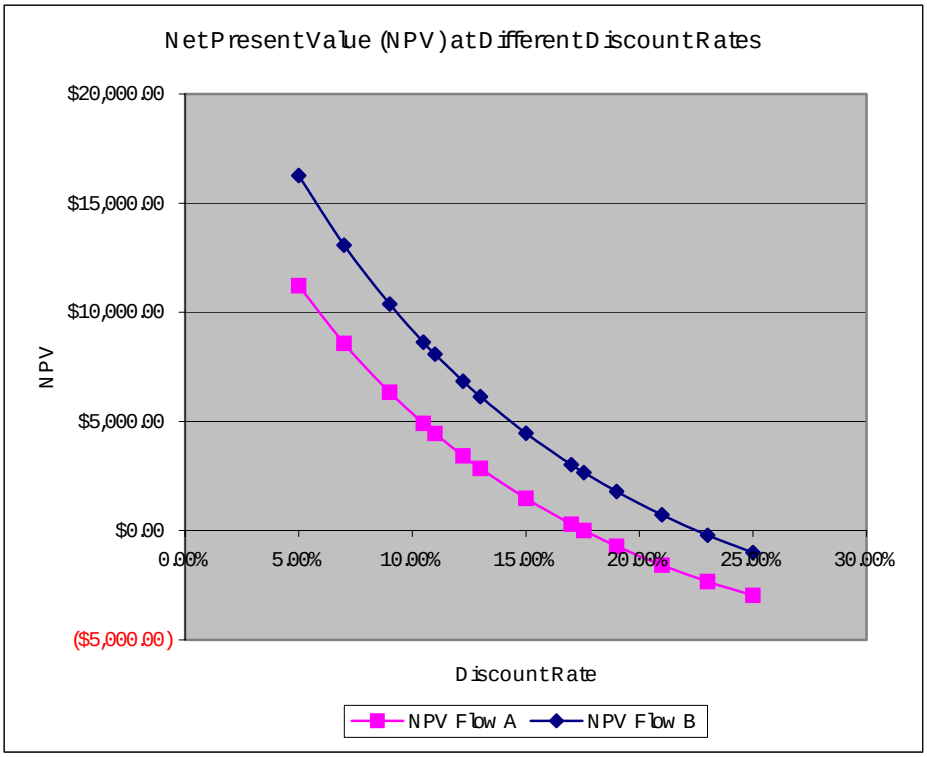
	Gross Profit	Production Cost	Net Profit
Dry Season	$3,657.22	$677.57	$2,979.64
Rainy Season	$3,442.73	$700.22	$2,742.51

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Cash Flow Sensitivity Analysis

Net Present Value at Different Discount Rates

Discount Rate	NPV Flow A	NPV Flow B
5.00%	$11,221.48	$16,263.61
7.00%	$8,575.66	$13,076.19
9.00%	$6,343.02	$10,379.84
10.49%	$4,904.93	$8,638.89
11.00%	$4,451.63	$8,089.31
12.24%	$3,424.41	$6,842.26
13.00%	$2,843.48	$6,135.86
15.00%	$1,471.55	$4,463.73
17.00%	$297.53	$3,027.51
17.56%	($0.14)	$2,662.40
19.00%	($709.94)	$1,789.97
21.00%	($1,576.68)	$720.50
23.00%	($2,324.02)	($206.23)
25.00%	($2,969.66)	($1,011.23)



EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Financial Analysis (Scenario A)

Beneficiary _____

Place AN SALVADOR
Date Jan-05

	Year 0	1	2	3	4	5	6	7	8	9	10
With Project											
Rubros de Producción											
Expenses											
Agricultural											
Jalapeno Pepper		189.48	189.48	189.48	189.48	189.48	189.48	189.48	189.48	189.48	189.48
Green Bean		18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16
Squash		6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35
Radish		21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07
Cucumber		40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19
Zucchini		7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
Tomato		205.96	205.96	205.96	205.96	205.96	205.96	205.96	205.96	205.96	205.96
Sweet Chili Pepper		188.67	188.67	188.67	188.67	188.67	188.67	188.67	188.67	188.67	188.67
Livestock											
Tilapia		151.48	75.48	75.48	75.48	75.48	151.48	75.48	75.48	75.48	75.48
Total Expenses		829.05	753.05	753.05	753.05	753.05	829.05	753.05	753.05	753.05	753.05
*Revenues***											
Agricultural											
Jalapeno Pepper		1424.88	1424.88	1424.88	1424.88	1424.88	1424.88	1424.88	1424.88	1424.88	1424.88
Green Bean		210.89	210.89	210.89	210.89	210.89	210.89	210.89	210.89	210.89	210.89
Squash		79.59	79.59	79.59	79.59	79.59	79.59	79.59	79.59	79.59	79.59
Radish		665.10	665.10	665.10	665.10	665.10	665.10	665.10	665.10	665.10	665.10
Cucumber		185.20	185.20	185.20	185.20	185.20	185.20	185.20	185.20	185.20	185.20
Zucchini		34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61
Tomato		1002.93	1002.93	1002.93	1002.93	1002.93	1002.93	1002.93	1002.93	1002.93	1002.93
Sweet Pepper		1425.28	1425.28	1425.28	1425.28	1425.28	1425.28	1425.28	1425.28	1425.28	1425.28
Livestock											
Tilapia		239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40
Total Revenues		5267.87	5267.87	5267.87	5267.87	5267.87	5267.87	5267.87	5267.87	5267.87	5267.87
Total Net Benefit		4438.82	4514.82	4514.82	4514.82	4514.82	4438.82	4514.82	4514.82	4514.82	4514.82

Costs: Total Project Subsidies											
Gallery	1300.00										
Pipeline	700.00										
Reservoir	13000.00										
Drip Irrigation System	2000.00										
Operation and Maintenance		85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Total Investment	17000.00										
Total Cost	17000.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Investment Flow	-17000.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Financial Flow	-17000.00	4353.82	4429.82	4429.82	4429.82	4429.82	4353.82	4429.82	4429.82	4429.82	4429.82
Financial Costs	17000.00	914.05	838.05	838.05	838.05	838.05	914.05	838.05	838.05	838.05	838.05
Finanicial Benefits		5267.87	5267.87	5267.87	5267.87	5267.87	5267.87	5267.87	5267.87	5267.87	5267.87

	Year 0	1	2	3	4	5	6	7	8	9	10
Cash Flow	**-17000.00**	**4353.82**	**4429.82**	**4429.82**	**4429.82**	**4429.82**	**4353.82**	**4429.82**	**4429.82**	**4429.82**	**4429.82**

Internal Rate of Return	**22.53%**

All costs are in US dollars.

** We included in the revenues of the project a 25% increase coming from the harvest obtained during the dry season given that we assumed that the reservoir will contribute to reduce crop loss created by "caniculas" or dry spells only minimally with respect to the overall percentage.

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Financial Analysis (Scenario B)

Beneficiary _____

Place AN SALVADOR
Date Jan-05

	Year 0	1	2	3	4	5	6	7	8	9	10
With Project											
Production Parameters											
Expenses											
Agricultural											
Jalapeno Pepper		189.48	189.48	189.48	189.48	189.48	189.48	189.48	189.48	189.48	189.48
Green Bean		18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16	18.16
Squash		6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35
Radish		21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07
Cucumber		40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19	40.19
Zucchini		7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
Tomato		205.96	205.96	205.96	205.96	205.96	205.96	205.96	205.96	205.96	205.96
Sweet Chili Pepper		188.67	188.67	188.67	188.67	188.67	188.67	188.67	188.67	188.67	188.67
Livestock											
Tilapia		151.48	75.48	75.48	75.48	75.48	151.48	75.48	75.48	75.48	75.48
Total Expenses		829.05	753.05	753.05	753.05	753.05	829.05	753.05	753.05	753.05	753.05
Revenues**											
Agricultural											
Jalapeno Pepper		1238.09	1238.09	1238.09	1238.09	1238.09	1238.09	1238.09	1238.09	1238.09	1238.09
Green Bean		184.67	184.67	184.67	184.67	184.67	184.67	184.67	184.67	184.67	184.67
Squash		67.42	67.42	67.42	67.42	67.42	67.42	67.42	67.42	67.42	67.42
Radish		550.38	550.38	550.38	550.38	550.38	550.38	550.38	550.38	550.38	550.38
Cucumber		162.03	162.03	162.03	162.03	162.03	162.03	162.03	162.03	162.03	162.03
Zucchini		30.27	30.27	30.27	30.27	30.27	30.27	30.27	30.27	30.27	30.27
Tomato		871.68	871.68	871.68	871.68	871.68	871.68	871.68	871.68	871.68	871.68
Sweet Pepper		1238.30	1238.30	1238.30	1238.30	1238.30	1238.30	1238.30	1238.30	1238.30	1238.30
Livestock											
Tilapia		239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40
Total Revenues		4582.24	4582.24	4582.24	4582.24	4582.24	4582.24	4582.24	4582.24	4582.24	4582.24
Total Net Benefit		3753.19	3829.19	3829.19	3829.19	3829.19	3753.19	3829.19	3829.19	3829.19	3829.19

Costs: Total Project Subsidies											
Gallery	1300.00										
Pipeline	700.00										
Reservoir	13000.00										
Drip Irrigation System	2000.00										
Operation and Maintenance		85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Total Investment	17000.00										
Total Cost	17000.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Investment Flow	-17000.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Financial Flow	-17000.00	3668.19	3744.19	3744.19	3744.19	3744.19	3668.19	3744.19	3744.19	3744.19	3744.19
Financial Costs	17000.00	914.05	838.05	838.05	838.05	838.05	914.05	838.05	838.05	838.05	838.05
Financial Benefits		4582.24	4582.24	4582.24	4582.24	4582.24	4582.24	4582.24	4582.24	4582.24	4582.24

	Year 0	1	2	3	4	5	6	7	8	9	10
Cash Flow	-17000.00	3668.19	3744.19	3744.19	3744.19	3744.19	3668.19	3744.19	3744.19	3744.19	3744.19

Internal Rate of Return	**17.56%**

All costs are in US dollars.

** We included in the revenues of the project a 25% increase coming from the harvest obtained during the dry season given that we assumed that the reservoir will contribute to reduce crop loss created by "caniculas" or dry spells only minimally with respect to the overall percentage.

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Costs and Benefits of Vegetable and Fish Production in US Dollars

Dry Season

With Project

Agricultural Production

Crop	Area (m2) Cultivated	Time (Crop Months)	Yield per Hectare	Unit	Unit Price	Gross Profit	Production Cost	Net Profit
Jalapeno Pepper	400	6.00	2928.0	hundreds/ha.	8.98	1,051.31	189.48	861.83
Green Bean	200	3.00	120.0	qq	66.02	158.46	18.16	140.30
Squash	100	3.00	221.0	hundreds/ha.	25.00	55.25	6.35	48.90
Radish	200	3.00	2154.0	hundreds/ha.	10.11	435.67	21.07	414.60
Cucumber	200	3.00	834.0	hundreds/ha.	8.32	138.85	40.19	98.66
Zucchini	100	3.00	308.0	hundreds/ha.	8.42	25.93	7.70	18.23
Tomato	400	6.00	1493.0	boxes/ha.+	12.40	740.44	205.96	534.48
Sweet Pepper	400	6.00	2928.0	hundreds/ha.	8.98	1,051.31	188.67	862.64
Total	2,000					3,657.22	677.57	2,979.64

Livestock Production - Tilapia^

1 y 6	600	10.00	350.00	Lb	1.14	239.40	151.48	87.92
2,3,4,5-7,8,9,10						239.40	75.48	163.92

+ 50 pound box

^ Area: Surface Water Area

Without Project

Agricultural Production

Crop	Area (m2) Cultivated	Time (Crop Months)	Yield per Hectare	Unit	Unit Price	Gross Profit	Production Cost	Net Profit
Corn	1000	10.00	70.0	QQ/ha	11.81	82.67	56.14	26.53

Livestock Production

Pasture+	1000	12.00	1.00	ha	179.83	17.98	11.11	6.88

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Costs and Benefits of Vegetable and Fish Production in US Dollars

Rainy Season

With Project

Agricultural Production

Crop	Area (m2) Cultivated	Time (Crop Months)	Yield per Hectare	Unit	Unit Price	Gross Profit	Production Cost	Net Profit
Jalapeno Pepper	400	6.00	2928.0	hundred/ha.	8.06	943.97	196.84	747.13
Green Bean	200	3.00	120.0	qq	51.37	123.30	18.44	104.86
Squash	100	3.00	221.0	hundred/ha.	25.00	55.25	6.57	48.68
Radish	200	3.00	2154.0	hundred/ha.	11.13	479.40	20.55	458.86
Cucumber	200	3.00	834.0	hundred/ha.	7.98	133.10	40.39	92.71
Zucchini	100	3.00	308.0	hundred/ha.	8.18	25.19	7.84	17.35
Tomato	400	6.00	1493.0	boxes/ha.+	12.37	738.55	213.58	524.97
Sweet Pepper	400	6.00	2928.0	hundred/ha.	8.06	943.97	196.02	747.95
Total	2,000					3,442.73	700.22	2,742.51

PRODUCCION PECUARIA - Tilapia^

1 y 6	600	10.00	350.00	Lb	1.14	239.40	151.48	87.92
2,3,4,5-7,8,9,10						239.40	75.48	163.92

+ 50 pound box

^ Area: Surface Water Area

Without Project

Agricultural Production

Crop	Area (m2) Cultivated	Time (Crop Months)	Yield per Hectare	Unit	Unit Price	Gross Profit	Production Cost	Net Profit
Corn	1000	10.00	70.0	QQ/ha	11.81	82.67	56.14	26.53

Livestock Production

Pasture+	1000	12.00	1.00	ha	179.83	17.98	11.11	6.88

+ For raising cows

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Rainy Season Financial Analysis

Beneficiary _____

Place AN SALVADOR
Date Jan-05

	Year 0	1	2	3	4	5	6	7	8	9	10
With Project											
Production Parameters											
Expenses											
Agricultural											
Jalapeno Pepper		196.84	196.84	196.84	196.84	196.84	196.84	196.84	196.84	196.84	196.84
Green Bean		18.44	18.44	18.44	18.44	18.44	18.44	18.44	18.44	18.44	18.44
Squash		6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57
Radish		20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55	20.55
Cucumber		40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39	40.39
Zucchini		7.84	7.84	7.84	7.84	7.84	7.84	7.84	7.84	7.84	7.84
Tomato		213.58	213.58	213.58	213.58	213.58	213.58	213.58	213.58	213.58	213.58
Sweet Chili Pepper		196.02	196.02	196.02	196.02	196.02	196.02	196.02	196.02	196.02	196.02
Livestock											
Tilapia		151.48	75.48	75.48	75.48	75.48	151.48	75.48	75.48	75.48	75.48
Total Expenses		851.70	775.70	775.70	775.70	775.70	851.70	775.70	775.70	775.70	775.70
*Revenues***											
Agricultural											
Jalapeno Pepper		943.97	943.97	943.97	943.97	943.97	943.97	943.97	943.97	943.97	943.97
Green Bean		123.30	123.30	123.30	123.30	123.30	123.30	123.30	123.30	123.30	123.30
Squash		55.25	55.25	55.25	55.25	55.25	55.25	55.25	55.25	55.25	55.25
Radish		479.40	479.40	479.40	479.40	479.40	479.40	479.40	479.40	479.40	479.40
Cucumber		133.10	133.10	133.10	133.10	133.10	133.10	133.10	133.10	133.10	133.10
Zucchini		25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19	25.19
Tomato		738.55	738.55	738.55	738.55	738.55	738.55	738.55	738.55	738.55	738.55
Sweet Pepper		943.97	943.97	943.97	943.97	943.97	943.97	943.97	943.97	943.97	943.97
Livestock											
Tilapia		239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40	239.40
Total Revenues		3682.13	3682.13	3682.13	3682.13	3682.13	3682.13	3682.13	3682.13	3682.13	3682.13
Total Net Benefit		2830.43	2906.43	2906.43	2906.43	2906.43	2830.43	2906.43	2906.43	2906.43	2906.43

Costs: Total Project Subsidies											
Gallery	1300.00										
Pipeline	700.00										
Reservoir	13000.00										
Drip Irrigation System	2000.00										
Operation and Maintenance		85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Total Investment	17000.00										
Total Cost	17000.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Investment Flow	-17000.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
Financial Flow	-17000.00	2745.43	2821.43	2821.43	2821.43	2821.43	2745.43	2821.43	2821.43	2821.43	2821.43
Financial Costs	17000.00	936.70	860.70	860.70	860.70	860.70	936.70	860.70	860.70	860.70	860.70
Financial Benefits		3682.13	3682.13	3682.13	3682.13	3682.13	3682.13	3682.13	3682.13	3682.13	3682.13

	Year 0	1	2	3	4	5	6	7	8	9	10
Cash Flow	**-17000.00**	**2745.43**	**2821.43**	**2821.43**	**2821.43**	**2821.43**	**2745.43**	**2821.43**	**2821.43**	**2821.43**	**2821.43**

Internal Rate of Return	**10.31%**

All costs are in US dollars.

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Jalapeno Peppers

Estimated Production Costs

	Dry Season		
Area (m 2)	400	Crop Production Time (months)	6

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.36	3.22	1.16
Planting					
Replanting	daily wage	20	0.80	3.22	2.58
Transplanting	daily wage	1	0.04	3.22	0.13
Cultural Practices	daily wage				
First Fertilization	daily wage	4	0.16	3.22	0.52
Second Fertilization	daily wage	3	0.12	3.22	0.39
Third Fertilization	daily wage	3	0.12	3.22	0.39
Fourth Fertilization	daily wage	3	0.12	3.22	0.39
Fifth Fertilization	daily wage	3	0.12	3.22	0.39
Sixth Fertilization	daily wage	3	0.12	3.22	0.39
Seventh Fertilization	daily wage	3	0.12	3.22	0.39
Eighth Fertilization	daily wage	3	0.12	3.22	0.39
First Weeding	daily wage	13	0.52	3.22	1.67
Second Weeding	daily wage	13	0.52	3.22	1.67
Third Weeding	daily wage	12	0.48	3.22	1.55
Fourth Weeding	daily wage	10	0.40	3.22	1.29
Fifth Weeding	daily wage	3	0.12	3.22	0.39
Sixth Weeding	daily wage	3	0.12	3.22	0.39
Seventh Weeding	daily wage	3	0.12	3.22	0.39
First Harvest	daily wage	11	0.44	3.22	1.42
Digging Stakeholes	daily wage	13	0.52	3.22	1.67
Staking	daily wage	14	0.56	3.22	1.80
Setting Rope Lines	daily wage	17	0.68	3.22	2.19
Limestone Application	daily wage	3	0.12	3.22	0.39
Chicken Manure Application	daily wage	6	0.24	3.22	0.77
Pesticide Application	daily wage	84	3.36	3.22	10.82
Irrigation	daily wage	5	0.20	3.22	0.64
Harvest					
Cutting and Handling	daily wage	58	2.32	3.22	7.47
Subtotal Labor		323	12.92		41.60
Tractor Rent					
Heavy Disking	Pass	2	0.08	20.00	1.60
Furrowing	Pass	1	0.04	17.00	0.68
Subtotal Traction			0.12		2.28
Land Lease	Fraction Ha.	1	0.04	80.00	3.20
Plants	Unit	20500	820.00	0.07	57.40
Formula	qq	10	0.40	13.70	5.48
Urea	qq	10	0.40	11.00	4.40
Stakes	Unit	1500	60.00	0.23	13.80
Rope	Roll	37	1.48	9.00	13.32
Limestone	Global	0	0.00	63.00	-
Chicken Manure	Global	0	0.00	152.00	-
Foliar Fertilizer	Global	0	0.00	100.00	-
Insecticides	Global	1	0.04	800.00	32.00
Fungicides	Global	1	0.04	400.00	16.00
Herbicides	Global	1	0.04	0.00	-
Subtotal Inputs					145.60
Total Cost					189.48
Dry Season Projection					
Yield/price	hundreds/ha.	2928.00	117.12	8.98	1051.31
Net Profit	$US				861.83

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Jalapeno Peppers

Estimated Production Costs

	Rainy Season		
Area (m 2)	400	Crop Production Time (months)	6

			With Project		
Concept	Unit	Amount per Hectare	Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.36	3.22	1.16
Planting					
Replanting	daily wage	20	0.80	3.22	2.58
Transplanting	daily wage	1	0.04	3.22	0.13
Cultural Practices	daily wage				
First Fertilization	daily wage	4	0.16	3.22	0.52
Second Fertilization	daily wage	3	0.12	3.22	0.39
Third Fertilization	daily wage	3	0.12	3.22	0.39
Fourth Fertilization	daily wage	3	0.12	3.22	0.39
Fifth Fertilization	daily wage	3	0.12	3.22	0.39
Sixth Fertilization	daily wage	3	0.12	3.22	0.39
Seventh Fertilization	daily wage	3	0.12	3.22	0.39
Eighth Fertilization	daily wage	3	0.12	3.22	0.39
First Weeding	daily wage	13	0.52	3.22	1.67
Second Weeding	daily wage	13	0.52	3.22	1.67
Third Weeding	daily wage	12	0.48	3.22	1.55
Fourth Weeding	daily wage	10	0.40	3.22	1.29
Fifth Weeding	daily wage	3	0.12	3.22	0.39
Sixth Weeding	daily wage	3	0.12	3.22	0.39
Seventh Weeding	daily wage	3	0.12	3.22	0.39
First Harvest	daily wage	11	0.44	3.22	1.42
Digging Stakeholes	daily wage	13	0.52	3.22	1.67
Staking	daily wage	14	0.56	3.22	1.80
Setting Rope Lines	daily wage	17	0.68	3.22	2.19
Limestone Application	daily wage	3	0.12	3.22	0.39
Chicken Manure Application	daily wage	6	0.24	3.22	0.77
Pesticide Application	daily wage	84	3.36	3.22	10.82
Riego	daily wage	0	0.00	3.22	0.00
Harvest					
Cutting and Handling	daily wage	58	2.32	3.22	7.47
Subtotal Labor		318	12.72		40.96
Tractor Rent					
Heavy Disking	Pass	2	0.08	20.00	1.60
Furrowing	Pass	1	0.04	17.00	0.68
Subtotal Traction			0.12		2.28
Land Lease	Fraction Ha.	1	0.04	80.00	3.20
Plants	Unit	20500	820.00	0.07	57.40
Formula	qq	10	0.40	13.70	5.48
Urea	qq	10	0.40	11.00	4.40
Stakes	Unit	1500	60.00	0.23	13.80
Rope	Roll	37	1.48	9.00	13.32
Limestone	Global	0	0.00	63.00	-
Chicken Manure	Global	0	0.00	152.00	-
Foliar Fertilizer	Global	0	0.00	100.00	-
Insecticides	Global	1	0.04	600.00	24.00
Fungicidas	Global	1	0.04	600.00	24.00
Herbicidas	Global	1	0.04	200.00	8.00
Subtotal Inputs					153.60
Total Cost					196.84
Rainy Season Projection					
Yield/price	hundreds/ha.	2928.00	117.12	8.06	943.97
Net Profit	$US				747.13

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Green Beans

Estimated Production Costs

	Dry Season		
Area (m 2)	200	Crop Production Time (months)	3

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.18	3.22	0.58
Planting					
Planting	daily wage	14	0.28	3.22	0.90
Cultural Practices					
Fertilizing	daily wage	4	0.08	3.22	0.26
Weeding	daily wage	11	0.22	3.22	0.71
Harvest	daily wage	6	0.12	3.22	0.39
Irrigation	daily wage	5	0.10	3.22	0.32
Pesticide Application	daily wage	13	0.26	3.22	0.84
Harvest					
Cutting and Handling	daily wage	40	0.80	3.22	2.58
Subtotal Labor		102	2.04		6.57
Tractor Rent					
Plowing	Pass	1	0.02	20.00	0.40
Light Disking	Pass	1	0.02	29.10	0.58
Furrowing	Pass	1	0.02	13.66	0.27
Subtotal Traction			0.04		1.26
Land Lease	Fraction of ha.	1	0.02	57.14	1.14
Seed	Lbs	74	1.48	2.10	3.11
Formula	qq	7.5	0.15	11.89	1.78
Foliar Fertilizer	Global	1	0.02	50.00	1.00
Insecticides	Global	1	0.02	110.00	2.20
Fungicides	Global	1	0.02	55.00	1.10
Herbicides	Global	1	0.02	0.00	-
Subtotal Inputs					10.33
Total Cost					18.16
Dry Season Projection					
Yield/price	qq	120	2.40	66.02	158.46
Net Profit	$US				140.30

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Green Beans

Estimated Production Costs

	Rainy Season		
Area (m 2)	200	Crop Production Time (months)	3

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.18	3.22	0.58
Planting					
Planting	daily wage	14	0.28	3.22	0.90
Cultural Practices					
Fertilizing	daily wage	4	0.08	3.22	0.26
Weeding	daily wage	11	0.22	3.22	0.71
Harvest	daily wage	6	0.12	3.22	0.39
Irrigation	daily wage	0	0.00	3.22	0.00
Pesticide Application	daily wage	13	0.26	3.22	0.84
Harvest					
Cutting and Handling	daily wage	40	0.80	3.22	2.58
Subtotal Labor		97	1.94		6.25
Tractor Rent					
Plowing	Pass	1	0.02	20.00	0.40
Light Disking	Pass	1	0.02	29.10	0.58
Furrowing	Pass	1	0.02	13.66	0.27
Subtotal Traction			0.00		1.26
Land Lease	Fraction of ha.	1	0.02	57.14	1.14
Seed	Lbs	74	1.48	2.10	3.11
Formula	qq	7.5	0.15	11.89	1.78
Foliar Fertilizer	Global	1	0.02	50.00	1.00
Insecticides	Global	1	0.02	82.50	1.65
Fungicides	Global	1	0.02	82.50	1.65
Herbicides	Global	1	0.02	30.00	0.60
Subtotal Inputs					10.93
Total Cost					18.44
Rainy Season Projection					
Yield/price	qq	120	2.40	51.37	123.30
Net Profit	$US				104.86

*Minimum wage according to Ministerial Decree No.46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Squash

Estimated Production Costs

	Dry Season		
Area (m 2)	100	Crop Production Time (months)	3

			With Project		
Concept	Unit	Amount per Hectare	Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	6	0.06	3.22	0.19
Planting					
Planting	daily wage	3	0.03	3.22	0.10
Cultural Practices	daily wage				
First Fertilization	daily wage	3	0.03	3.22	0.10
Second Fertilization	daily wage	3	0.03	3.22	0.10
First Weeding	daily wage	10	0.10	3.22	0.32
Second Weeding	daily wage	10	0.10	3.22	0.32
First Tillage	daily wage	10	0.10	3.22	0.32
Second Tillage	daily wage	7	0.07	3.22	0.23
Pesticide Application	daily wage	17	0.17	3.22	0.55
Harvest					
Cutting and Handling	daily wage	14	0.14	3.22	0.45
Subtotal Labor		83	0.83		2.67
Tractor Rent					
Plowing	Pass	1	0.01	32.64	0.33
Light Disking	Pass	1	0.01	29.11	0.29
Subtotal Traction			0.02		0.62
Land Lease	Fraction of ha.	1	0.01	57.14	0.57
Seed	Lbs	4	0.04	4.00	0.16
Formula	qq	6	0.06	11.89	0.71
Urea	qq	3	0.03	9.72	0.29
Foliar Fertilizer	Global	1	0.01	0.00	-
Insecticides	Global	1	0.01	88.00	0.88
Fungicides	Global	1	0.01	44.00	0.44
Herbicides	Global	1	0.01	0.00	-
Subtotal Inputs					3.06
Total Cost					6.35
Yield/price	hundreds/ha.	221	2.21	25.00	55.25
Profit	$US				48.90

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Squash

Estimated Production Costs

	Rainy Season		
Area (m2)	100	Crop Production Time (months)	3

			With Project		
Concept	Unit	Amount per Hectare	Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	6	0.06	3.22	0.19
Planting					
Planting	daily wage	3	0.03	3.22	0.10
Cultural Practices	daily wage				
First Fertilization	daily wage	3	0.03	3.22	0.10
Second Fertilization	daily wage	3	0.03	3.22	0.10
First Weeding	daily wage	10	0.10	3.22	0.32
Second Weeding	daily wage	10	0.10	3.22	0.32
First Tillage	daily wage	10	0.10	3.22	0.32
Second Tillage	daily wage	7	0.07	3.22	0.23
Pesticide Application	daily wage	17	0.17	3.22	0.55
Harvest					
Cutting and Handling	daily wage	14	0.14	3.22	0.45
Subtotal Labor		83	0.83		2.67
Tractor Rent					
Plowing	Pass	1	0.01	32.64	0.33
Light Disking	Pass	1	0.01	29.11	0.29
Subtotal Traction			0.02		0.62
Land Lease	Fraction of ha.	1	0.01	57.14	0.57
Seeds	Lbs	4	0.04	4.00	0.16
Formula	qq	6	0.06	11.89	0.71
Urea	qq	3	0.03	9.72	0.29
Foliar Fertilizer	Global	1	0.01	0.00	-
Insecticides	Global	1	0.01	66.00	0.66
Fungicides	Global	1	0.01	66.00	0.66
Herbicides	Global	1	0.01	22.00	0.22
Subtotal Inputs					3.28
Total Cost					6.57
Yield/price	hundreds/ha.	221	2.21	25.00	55.25
Profit	$US				48.68

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Radish

Estimated Production Costs

	Dry Season		
Area (m 2)	200	Crop Production Time (months)	3

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.18	3.22	0.58
Hoeing	daily wage	22	0.44	3.22	1.42
Construction of Growing Beds	daily wage	22	0.44	3.22	1.42
Furrowing Growing Beds	daily wage	8	0.16	3.22	0.52
Planting					
Planting	daily wage	31	0.62	3.22	2.00
Cultural Practices					
Fertilization	daily wage	7	0.14	3.22	0.45
Weeding	daily wage	20	0.40	3.22	1.29
Harvest	daily wage	14	0.28	3.22	0.90
Irrigation	daily wage	5	0.10	3.22	0.32
Pesticide Application	daily wage	13	0.26	3.22	0.84
Harvest					
Cutting and Handling	daily wage	21	0.42	3.22	1.35
Subtotal Labor		172	3.44		11.08
Tractor Rent					
Plowing	Pass	1	0.02	32.64	0.65
Light Disking	Pass	1	0.02	29.11	0.58
Subtotal Traction			0.04		1.24
Land Lease	Fraction of ha.	1	0.02	57.14	1.14
Seed	Lbs	14	0.28	10.50	2.94
Formula	qq	10	0.20	11.89	2.38
Urea	qq	1	0.02	9.72	0.19
Foliar Fertilizer	Global	1	0.02	0.00	-
Insecticides	Global	1	0.02	70.00	1.40
Fungicides	Global	1	0.02	35.00	0.70
Herbicides	Global	1	0.02	0.00	-
Subtotal Inputs					8.76
Total Cost					21.07
Projection for Dry Season					
Yield/price	hundreds/ha.	2154	43.08	10.11	435.67
Net Profit	$US				414.60

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Radish

Estimated Production Costs

	Rainy Season		
Area (m 2)	200	Crop Production Time (months)	3

			With Project		
Concept	Unit	Amount per Hectare	Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.18	3.22	0.58
Hoeing	daily wage	22	0.44	3.22	1.42
Construction of Growing Boxes	daily wage	22	0.44	3.22	1.42
Furrowing Growing Boxes	daily wage	8	0.16	3.22	0.52
Planting					
Planting	daily wage	31	0.62	3.22	2.00
Cultural Practices					
Fertilization	daily wage	7	0.14	3.22	0.45
Weeding	daily wage	20	0.40	3.22	1.29
Harvest	daily wage	14	0.28	3.22	0.90
Irrigation	daily wage	0	0.00	3.22	0.00
Pesticide Application	daily wage	13	0.26	3.22	0.84
Harvest					
Cutting and Handling	daily wage	21	0.42	3.22	1.35
Subtotal Labor		167	3.34		10.75
Tractor Rent					
Plowing	Pass	1	0.02	32.64	0.65
Light Disking	Pass	1	0.02	29.11	0.58
Subtotal Traction			0.04		1.24
Land Lease	Fraction of ha.	1	0.02	57.14	1.14
Seed	Lbs	14	0.28	10.50	2.94
Formula	qq	10	0.20	11.89	2.38
Urea	qq	1	0.02	9.72	0.19
Foliar Fertilizer	Global	1	0.02	0.00	-
Insecticides	Global	1	0.02	55.00	1.10
Fungicides	Global	1	0.02	25.00	0.50
Herbicides	Global	1	0.02	15.00	0.30
Subtotal Inputs					8.56
Total Cost					20.55
Projection for Rainy Season					
Yield/price	hundreds/ha.	2154	43.08	11.13	479.40
Net Profit	$US				458.86

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Cucumber

Estimated Production Costs

	Dry Season		
Area (m2)	200	Crop Production Time (months)	3

			With Project		
Concept	Unit	Amount per Hectare	Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.18	3.22	0.58
Planting					
Planting	daily wage	12	0.24	3.22	0.77
Cultural Practices					
First Fertilization	daily wage	4	0.08	3.22	0.26
Second Fertilization	daily wage	4	0.08	3.22	0.26
Third Fertilization	daily wage	3	0.06	3.22	0.19
First Weeding	daily wage	17	0.34	3.22	1.09
Second Weeding	daily wage	11	0.22	3.22	0.71
Tillage	daily wage	4	0.08	3.22	0.26
First Harvest	daily wage	8	0.16	3.22	0.52
Second Harvest	daily wage	3	0.06	3.22	0.19
Digging Stakeholes	daily wage	7	0.14	3.22	0.45
Staking	daily wage	7	0.14	3.22	0.45
Setting Rope Lines	daily wage	13	0.26	3.22	0.84
Pesticide Application	daily wage	50	1.00	3.22	3.22
Irrigation	daily wage	3	0.06	3.22	0.19
Harvest					0.00
Cutting and Handling	daily wage	66	1.32	3.22	4.25
Subtotal Labor		221	4.42		14.23
Tractor Rent					
Heavy Disking	Pass	1	0.02	38.00	0.76
Furrowing	Pass	1	0.02	13.66	0.27
Subtotal Traction			0.02	38.00	1.03
Land Lease	Fraction of ha.	1	0.02	80.00	1.60
Seed	Lbs	4	0.08	110.00	8.80
Formula	qq	10	0.20	13.70	2.74
Sulfate	qq	0	0.00	13.37	0.00
Urea	qq	3	0.06	11.00	0.66
Stakes	1	2000	40.00	0.12	4.80
Rope	roll	14	0.28	9.00	2.52
Foliar Fertilizer	Global	1	0.02	70.00	1.40
Insecticides	Global	1	0.02	80.00	1.60
Fungicides	Global	1	0.02	40.00	0.80
Herbicides	Global	1	0.02	0.00	-
Subtotal Inputs					24.92
Total Cost					40.19
Projection for Dry Season					
Yield/price	hundreds/ha.	834	16.68	8.32	138.85
Net Profit	$US				98.66

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Cucumber

Estimated Production Costs

	Rainy Season		
Area (m 2)	200	Crop Production Time (months)	3

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.18	3.22	0.58
Planting					
Planting	daily wage	12	0.24	3.22	0.77
Tilling					
First Fertilization	daily wage	4	0.08	3.22	0.26
Second Fertilization	daily wage	4	0.08	3.22	0.26
Third Fertilization	daily wage	3	0.06	3.22	0.19
First Weeding	daily wage	17	0.34	3.22	1.09
Second Weeding	daily wage	11	0.22	3.22	0.71
Tillage	daily wage	4	0.08	3.22	0.26
First Harvest	daily wage	8	0.16	3.22	0.52
Second Harvest	daily wage	3	0.06	3.22	0.19
Digging Stakeholes	daily wage	7	0.14	3.22	0.45
Staking	daily wage	7	0.14	3.22	0.45
Setting Rope Lines	daily wage	13	0.26	3.22	0.84
Pesticide Application	daily wage	50	1.00	3.22	3.22
Irrigation	daily wage	0	0.00	3.22	0.00
Harvest					0.00
Cutting and Handling	daily wage	66	1.32	3.22	4.25
Subtotal Labor		218	4.36		14.04
Tractor Rent					
Heavy Disking	Pass	1	0.02	38.00	0.76
Furrowing	Pass	1	0.02	13.66	0.27
Subtotal Traction			0.02	38.00	1.03
Land Lease	Fraction of ha.	1	0.02	80.00	1.60
Seed	Lbs	4	0.08	110.00	8.80
Formula	qq	10	0.20	13.70	2.74
Sulfate	qq	0	0.00	13.37	0.00
Urea	qq	3	0.06	11.00	0.66
Stakes	1	2000	40.00	0.12	4.80
Rope	roll	14	0.28	9.00	2.52
Foliar Fertilizer	Global	1	0.02	70.00	1.40
Insecticides	Global	1	0.02	60.00	1.20
Fungicides	Global	1	0.02	60.00	1.20
Herbicides	Global	1	0.02	20.00	0.40
Subtotal Inputs					25.32
TOTAL COSTO					40.39
Projection for Rainy Season					
Yield/price	hundreds/ha.	834	16.68	7.98	133.10
Net Profit	$US				92.71

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Zucchini

Estimated Production Costs

	Dry Season		
Area (m 2)	100	Tiempo de Cultivo (meses)	3

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.09	3.22	0.29
Planting					
Planting	daily wage	6	0.06	3.22	0.19
Cultural Practices	daily wage				
First Fertilization	daily wage	3	0.03	3.22	0.10
Second Fertilization	daily wage	3	0.03	3.22	0.10
First Weeding	daily wage	14	0.14	3.22	0.45
First Harvest	daily wage	4	0.04	3.22	0.13
Second Harvest	daily wage	3	0.03	3.22	0.10
Pesticide Application	daily wage	21	0.21	3.22	0.68
Irrigation	daily wage	2	0.02	3.22	0.06
Harvest					
Cutting and Handling	daily wage	36	0.36	3.22	1.16
Subtotal Labor		101	1.01		3.25
Tractor Rent					
Heavy Disking	Pass	1	0.01	29.10	0.29
Furrowing	Pass	1	0.01	38.00	0.38
Subtotal Traction			0.02	67.10	0.67
Land Lease	Fraction of ha.	1	0.01	80.00	0.80
Seed	Lbs	5	0.05	4.00	0.20
Formula	qq	4	0.04	13.70	0.55
Sulfate	qq	0	0.00	13.37	0.00
Urea	qq	3	0.03	11.00	0.33
Foliar Fertilizer	Global	1	0.01	70.00	0.70
Insecticides	Global	1	0.01	80.00	0.80
Fungicides	Global	1	0.01	40.00	0.40
Herbicides	Global	1	0.01	0.00	-
Subtotal Inputs					3.78
Total Cost					7.70
Projection for Dry Season					
Yield/price	hundreds/ha.	308	3.08	8.42	25.93
Net Profit	$US				18.23

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Zucchini

Estimated Production Costs

	Rainy Season		
Area (m 2)	100	Crop Production Time (months)	3

			With Project		
Concept	Unit	Amount per Hectare	Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.09	3.22	0.29
Planting					
Planting	daily wage	6	0.06	3.22	0.19
Cultural Practices	daily wage				
First Fertilization	daily wage	3	0.03	3.22	0.10
Second Fertilization	daily wage	3	0.03	3.22	0.10
First Weeding	daily wage	14	0.14	3.22	0.45
First Harvest	daily wage	4	0.04	3.22	0.13
Second Harvest	daily wage	3	0.03	3.22	0.10
Pesticide Application	daily wage	21	0.21	3.22	0.68
Irrigation	daily wage	0	0.00	3.22	0.00
Harvest					
Cutting and Handling	daily wage	36	0.36	3.22	1.16
Subtotal Labor		99	0.99		3.19
Tractor Rent					
Heavy Disking	Pass	1	0.01	29.10	0.29
Furrowing	Pass	1	0.01	38.00	0.38
Subtotal Traction			0.02	67.10	0.67
Land Lease	Fraction of ha.	1	0.01	80.00	0.80
Seed	Lbs	5	0.05	4.00	0.20
Formula	qq	4	0.04	13.70	0.55
Sulfate	qq	0	0.00	13.37	0.00
Urea	qq	3	0.03	11.00	0.33
Foliar Fertilizer	Global	1	0.01	70.00	0.70
Insecticides	Global	1	0.01	60.00	0.60
Fungicides	Global	1	0.01	60.00	0.60
Herbicides	Global	1	0.01	20.00	0.20
Subtotal Inputs					3.98
Total Cost					7.84
Projection for Rainy Season					
Yield/price	hundreds/ha.	308	3.08	8.18	25.19
Net Profit	$US				17.35

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Tomato

Estimated Production Costs

	Dry Season		
Area (m 2)	400	Crop Production Time (months)	6

			With Project		
Concept	Unit	Amount per Hectare	Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.36	3.22	1.16
Planting					
Replanting	daily wage	21	0.84	3.22	2.70
Transplanting	daily wage	1	0.04	3.22	0.13
Cultural Practices					
First Fertilization	daily wage	4	0.16	3.22	0.52
Second Fertilization	daily wage	3	0.12	3.22	0.39
Third Fertilization	daily wage	3	0.12	3.22	0.39
Fourth Fertilization	daily wage	3	0.12	3.22	0.39
Fifth Fertilization	daily wage	3	0.12	3.22	0.39
Sixth Fertilization	daily wage	3	0.12	3.22	0.39
Seventh Fertilization	daily wage	3	0.12	3.22	0.39
First Weeding	daily wage	13	0.52	3.22	1.67
Second Weeding	daily wage	8	0.32	3.22	1.03
Third Weeding	daily wage	7	0.28	3.22	0.90
Fourth Weeding	daily wage	2	0.08	3.22	0.26
Fifth Weeding	daily wage	2	0.08	3.22	0.26
First weeding for the harvest	daily wage	6	0.24	3.22	0.77
Second weeding for the harvest	daily wage	2	0.08	3.22	0.26
First earth up	daily wage	11	0.44	3.22	1.42
Second earth up	daily wage	6	0.24	3.22	0.77
Digging Stakeholes	daily wage	11	0.44	3.22	1.42
Staking	daily wage	11	0.44	3.22	1.42
Setting Rope Lines	daily wage	13	0.52	3.22	1.67
Limestone Application	daily wage	0	0.00	3.22	0.00
Chicken Manure Application	daily wage	0	0.00	3.22	0.00
Pesticide Application	daily wage	107	4.28	3.22	13.78
Irrigation	daily wage	3	0.12	3.22	0.39
Harvest					
Cutting and Handling	daily wage	99	3.96	3.22	12.75
Internal Transport	daily wage	7	0.28	3.22	0.90
Subtotal Labor		361	14.44		46.50
Tractor Rent					
Plowing	Pass	1	0.04	20.00	0.80
Heavy Disking	Pass	1	0.04	38.00	1.52
Furrowing	Pass	1	0.04	13.66	0.55
Subtotal Traction					2.87
Land Lease	ha	1	0.04	80.00	3.20
Plants	Unit	20500	820.00	0.06	49.20
Formula	qq	10	0.40	13.70	5.48
Sulfate	qq	0	0.00	13.37	-
Urea	qq	10	0.40	11.00	4.40
Stakes	Unit	3700	148.00	0.23	34.04
Rope	Roll	23	0.92	9.00	8.28
Limestone	Global	0	0.00	52.00	-
Chicken Manure	Global	0	0.00	92.00	-
Foliar Fertilizer	Global	1	0.04	100.00	4.00
Insecticides	Global	1	0.04	800.00	32.00
Fungicides	Global	1	0.04	400.00	16.00
Herbicides	Global	1	0.04	0.00	-
Subtotal Inputs					156.60
Total Cost					205.96
Projection for Dry Season					
Yield/price	Boxes/ha.+	1493.00	59.72	12.40	740.44
Net Profit	$US				534.48

+ 50 pound box

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998 Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Tomato

Estimated Production Costs

	Rainy Season		
Area (m 2)	400	Crop Production Time (months)	6

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.36	3.22	1.16
Planting					
Replanting	daily wage	21	0.84	3.22	2.70
Transplanting	daily wage	1	0.04	3.22	0.13
Cultural Practices					
First Fertilization	daily wage	4	0.16	3.22	0.52
Second Fertilization	daily wage	3	0.12	3.22	0.39
Third Fertilization	daily wage	3	0.12	3.22	0.39
Fourth Fertilization	daily wage	3	0.12	3.22	0.39
Fifth Fertilization	daily wage	3	0.12	3.22	0.39
Sixth Fertilization	daily wage	3	0.12	3.22	0.39
Seventh Fertilization	daily wage	3	0.12	3.22	0.39
First Weeding	daily wage	13	0.52	3.22	1.67
Second Weeding	daily wage	8	0.32	3.22	1.03
Third Weeding	daily wage	7	0.28	3.22	0.90
Fourth Weeding	daily wage	2	0.08	3.22	0.26
Fifth Weeding	daily wage	2	0.08	3.22	0.26
First weeding for the harvest	daily wage	6	0.24	3.22	0.77
Second weeding for the harvest	daily wage	2	0.08	3.22	0.26
First earth up	daily wage	11	0.44	3.22	1.42
Second earth up	daily wage	6	0.24	3.22	0.77
Digging Stakeholes	daily wage	11	0.44	3.22	1.42
Staking	daily wage	11	0.44	3.22	1.42
Setting Rope Lines	daily wage	13	0.52	3.22	1.67
Limestone Application	daily wage	0	0.00	3.22	0.00
Chicken Manure Application	daily wage	0	0.00	3.22	0.00
Pesticide Application	daily wage	107	4.28	3.22	13.78
Irrigation	daily wage	0	0.00	3.22	0.00
Harvest					
Cutting and Handling	daily wage	99	3.96	3.22	12.75
Internal Transport	daily wage	7	0.28	3.22	0.90
Subtotal Labor		358	14.32		46.11
Tractor Rent					
Plowing	Pass	1	0.04	20.00	0.80
Heavy Disking	Pass	1	0.04	38.00	1.52
Furrowing	Pass	1	0.04	13.66	0.55
Subtotal Traction					2.87
Land Lease	ha	1	0.04	80.00	3.20
Plants	Unit	20500	820.00	0.06	49.20
Formula	qq	10	0.40	13.70	5.48
Sulfate	qq	0	0.00	13.37	-
Urea	qq	10	0.40	11.00	4.40
Stakes	Unit	3700	148.00	0.23	34.04
Rope	Roll	23	0.92	9.00	8.28
Limestone	Global	0	0.00	52.00	-
Chicken Manure	Global	0	0.00	92.00	-
Foliar Fertilizer	Global	1	0.04	100.00	4.00
Insecticides	Global	1	0.04	600.00	24.00
Fungicides	Global	1	0.04	600.00	24.00
Herbicides	Global	1	0.04	200.00	8.00
Subtotal Inputs					164.60
Total Cost					213.58
Projection for Rainy Season					
Yield/price	Boxes/ha.+	1493.00	59.72	12.37	738.55
Net Profit	$US				524.97

+ 50 pound box

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Sweet Pepper

Estimated Production Costs

	Dry Season		
Area (m 2)	400	Crop Production Time (months)	6

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.36	3.22	1.16
Planting					
Replanting	daily wage	20	0.80	3.22	2.58
Transplanting	daily wage	1	0.04	3.22	0.13
Cultural Practices	daily wage				
First Fertilization	daily wage	4	0.16	3.22	0.52
Second Fertilization	daily wage	3	0.12	3.22	0.39
Third Fertilization	daily wage	3	0.12	3.22	0.39
Fourth Fertilization	daily wage	3	0.12	3.22	0.39
Fifth Fertilization	daily wage	3	0.12	3.22	0.39
Sixth Fertilization	daily wage	3	0.12	3.22	0.39
Seventh Fertilization	daily wage	3	0.12	3.22	0.39
Eighth Fertilization	daily wage	3	0.12	3.22	0.39
First Weeding	daily wage	13	0.52	3.22	1.67
Second Weeding	daily wage	13	0.52	3.22	1.67
Third Weeding	daily wage	12	0.48	3.22	1.55
Fourth Weeding	daily wage	10	0.40	3.22	1.29
Fifth Weeding	daily wage	3	0.12	3.22	0.39
Sixth Weeding	daily wage	3	0.12	3.22	0.39
Seventh Weeding	daily wage	3	0.12	3.22	0.39
First Harvest	daily wage	11	0.44	3.22	1.42
Digging Stakeholes	daily wage	13	0.52	3.22	1.67
Staking	daily wage	14	0.56	3.22	1.80
Setting Rope Lines	daily wage	17	0.68	3.22	2.19
Limestone Application	daily wage	3	0.12	3.22	0.39
Chicken Manure Application	daily wage	6	0.24	3.22	0.77
Pesticide Application	daily wage	84	3.36	3.22	10.82
Irrigation	daily wage	5	0.20	3.22	0.64
Harvest					
Cutting and Handling	daily wage	58	2.32	3.22	7.47
Subtotal Labor		323	12.92		41.60
Tractor Rent					
Heavy Disking	Pass	2	0.08	38.00	3.04
Furrowing	Pass	1	0.04	13.66	0.55
Subtotal Traction			0.12		3.59
Land Lease	Fraction Ha.	1	0.04	80.00	3.20
Plants	Unit	20500	820.00	0.07	57.40
Formula	qq	10	0.40	13.70	5.48
Urea	qq	10	0.40	11.00	4.40
Stakes	Unit	1500	60.00	0.23	13.80
Rope	Roll	20	0.80	9.00	7.20
Limestone	Global	0	0.00	63.00	-
Chicken Manure	Global	0	0.00	152.00	-
Foliar Fertilizer	Global	1	0.04	100.00	4.00
Insecticides	Global	1	0.04	800.00	32.00
Fungicides	Global	1	0.04	400.00	16.00
Herbicides	Global	1	0.04	-	-
Subtotal Inputs					143.48
Total Cost					188.67
Projection for Dry Season					
Yield/price	hundreds/ha.	2928	117.12	8.98	1051.31
Net Profit	$US				862.64

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Production Costs for Sweet Pepper

Estimated Production Costs

	Rainy Season		
Area (m 2)	400	Crop Production Time (months)	6

Concept	Unit	Amount per Hectare	With Project Amount	UNIT Price*	TOTAL $US.
Preparation of the Land					
Brush Clearing	daily wage	9	0.36	3.22	1.16
Planting					
Replanting	daily wage	20	0.80	3.22	2.58
Transplanting	daily wage	1	0.04	3.22	0.13
Cultural Practices	daily wage				
First Fertilization	daily wage	4	0.16	3.22	0.52
Second Fertilization	daily wage	3	0.12	3.22	0.39
Third Fertilization	daily wage	3	0.12	3.22	0.39
Fourth Fertilization	daily wage	3	0.12	3.22	0.39
Fifth Fertilization	daily wage	3	0.12	3.22	0.39
Sixth Fertilization	daily wage	3	0.12	3.22	0.39
Seventh Fertilization	daily wage	3	0.12	3.22	0.39
Eighth Fertilization	daily wage	3	0.12	3.22	0.39
First Weeding	daily wage	13	0.52	3.22	1.67
Second Weeding	daily wage	13	0.52	3.22	1.67
Third Weeding	daily wage	12	0.48	3.22	1.55
Fourth Weeding	daily wage	10	0.40	3.22	1.29
Fifth Weeding	daily wage	3	0.12	3.22	0.39
Sixth Weeding	daily wage	3	0.12	3.22	0.39
Seventh Weeding	daily wage	3	0.12	3.22	0.39
First Harvest	daily wage	11	0.44	3.22	1.42
Digging Stakeholes	daily wage	13	0.52	3.22	1.67
Staking	daily wage	14	0.56	3.22	1.80
Setting Rope Lines	daily wage	17	0.68	3.22	2.19
Limestone Application	daily wage	3	0.12	3.22	0.39
Chicken Manure Application	daily wage	6	0.24	3.22	0.77
Pesticide Application	daily wage	84	3.36	3.22	10.82
Irrigation	daily wage	0	0.00	3.22	0.00
Harvest					
Cutting and Handling	daily wage	58	2.32	3.22	7.47
Subtotal Labor		318	12.72		40.96
Tractor Rent					
Heavy Disking	Pass	2	0.08	38.00	3.04
Furrowing	Pass	1	0.04	13.66	0.55
Subtotal Traction			0.12		3.59
Land Lease	Fraction Ha.	1	0.04	80.00	3.20
Plants	Unit	20500	820.00	0.07	57.40
Formula	qq	10	0.40	13.70	5.48
Urea	qq	10	0.40	11.00	4.40
Stakes	Unit	1500	60.00	0.23	13.80
Rope	Roll	20	0.80	9.00	7.20
Limestone	Global	0	0.00	63.00	-
Chicken Manure	Global	0	0.00	152.00	-
Foliar Fertilizer	Global	1	0.04	100.00	4.00
Insecticides	Global	1	0.04	600.00	24.00
Fungicides	Global	1	0.04	600.00	24.00
Herbicides	Global	1	0.04	200.00	8.00
Subtotal Inputs					151.48
Total Cost					196.02
Projection for Rainy Season					
Yield/price	hundreds/ha.	2928	117.12	8.06	943.97
Net Profit	$US				747.95

*Minimum wage according to Ministerial Decree No. 46 y 47 of April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday).

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

PRODUCTION COSTS FOR CORN WITH MID-LEVEL TECHNOLOGY WITHOUT IRRIGATION

Area (m 2) 1000 Crop Production Time (months) 10

CONCEPT	UNITS	Amount per Hectare	WITH PROJECT AMOUTN	UNIT PRICE $US	TOTAL $US.
Land Preparation					
Brush clearing	daily wage	6.00	0.60	3.22	1.93
Planting					
Planting	daily wage	7.00	0.70	3.22	2.25
Cultural Practices					
First fertilization	daily wage	3.00	0.30	3.22	0.97
Second fertilization	daily wage	3.00	0.30	3.22	0.97
First weeding	daily wage	6.00	0.60	3.22	1.93
Second weeding	daily wage	2.00	0.20	3.22	0.64
Pesticide application	daily wage	10.00	1.00	3.22	3.22
Harvest					
Doubling	daily wage	3.00	0.30	3.22	0.97
Picking	daily wage	10.00	1.00	3.22	3.22
Drying and bagging	daily wage	3.00	0.30	3.22	0.97
Subtotal Labor		53	5.30		17.07
Traction					
Plowing	pass	1.00	0.10	32.64	3.26
Heavy disking	pass	1.00	0.10	29.1	2.91
Furrowing	pass	1.00	0.10	13.66	1.37
Threshing and shelling	qq	70.00	7.00	0.5	3.50
Internal transport	hauls	1.50	0.15	7.26	1.09
Subtotal Traction					12.13
Inputs					
Land lease	Ha.	1.00	0.10	57.14	5.71
Certified seed	Lbs	37.00	3.70	0.89	3.29
Formula	qq	6.25	0.63	11.89	7.43
Sulfate	qq	5.50	0.55	9.72	5.35
Pesticides and Foliar	Global	1.00	0.10	51.59	5.16
Subtotal inputs					26.94
TOTAL COST					56.14
Yield/price	QQ/ha	70.00	7.00	11.81	82.67
PROFITS	$US				26.53

*Minimum wage according to Ministerial Decree No. 46 and 47, April 22, 1998
Ministry of Labor and Social Welfare. Includes food and day of rest (5 hr. workday)

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

PRODUCTION COSTS FOR TILAPIA

(COSTS PER RESERVOIR)

Surface Area of Exposed Water (m 2) 600

Crop Production Time (months) 10

Year 1

CONCEPT	UNIT	AMOUNT per 1000 m 2	WITH PROJECT AMOUNT	WITH PROJECT UNIT PRICE $US.	WITH PROJECT TOTAL $US.
Reservoir preparation					
Cleaning	daily wage	1	0.60	3.2	1.92
Alevine transport	daily wage	1	0.60	3.2	1.92
Sowing	daily wage	2	1.20	3.2	3.84
Cultural Practices					
Feeding	daily wage	2	1.20	3.2	3.84
Monitoring disease	daily wage	1	0.60	3.2	1.92
Monitoring growth and weight	daily wage	1	0.60	3.2	1.92
Harvest					
Capture	daily wage	2	1.20	3.2	3.84
Preparation	daily wage	2	1.20	3.2	3.84
Sale	daily wage	1	0.60	3.2	1.92
Internal Transport	daily wage	1	0.60	3.2	1.92
Subtotal		14.00	8.40		26.88
Production inputs					
Fish	Alevine	2000	1200	0.05	60.00
Pellets	qq	1	0.60	27	16.20
Fishnet	unit	0	0	30	0.00
Harvesting net	unit	1	1	35	35.00
Germicides	Lts	0	0.00	25	0.00
Fungicides	Lts	0	0.00	25	0.00
Limestone	qq	1	0.60	4	2.40
Equipment					
Scale	unit	0	0	20	0.00
Net	unit	0	0	25	0.00
Buckets	unit	2	1	4	4.00
Guacal buckets	unit	2	1	2	2.00
Floating tube	unit	1	1	5	5.00
Subtotal Inputs					124.60
Total Direct Costs					151.48
Yield/Price	Lb	350.00	210	1.14	239.40
PROFIT	$US				87.92

*Minimum wage according to Ministerial Decree No. 46 and 47, April 22, 1998
Ministry of Labor and Social Welfare. Includes food and day of rest (5 hr. workday)

PRODUCTION PARAMETERS

Sowing density is 2 alevines per m 2 of surface water.
Average purchase weight of alevine: 10 gm.
Harvest at 150 days (5 months)
Number of units per pound: 4 to 5 tilapias.
Percentage production process loss: 10% to 15% of the population.
Water availability: without the possibility of renewing during dry season.
Low oxygen concentration
Purchase of male tilapias: to obtain the best size and weight for sale.
No use of concentrates as improved feed
(accelerated growth of algas and reduce oxygen from the decomposition of organic waste.
Type of production: auto-consumption and commercialization of surplus.
Produced with multiple crops by beneficiary families.

MANAGEMENT OF PRODUCTION

Sowing: when the pond is at 80% to 90% capacity with rain water.

Daily monitoring (parasites and diseases), pond and fish conditions.
Harvest.

ALEVINE

SUPPLIERS:

Cooperative Hoja de Sal; Santiago Nonualco; La Paz, weight of 10 to 12 grams per male alevine; price/unit $ 0.05.
Santa Cruz Porillo, CENDEPESCA; La Paz, weight of 8 to 10 grams per alevine; price/unit Donations, for repopulating.
Las Américas; Suchitoto, weight of 8 to 10 grams per alevine; price/unit $ 0.05.
CENDEPESCA; Ilopango, weight of 8 to 10 grams per alevine; price/unit $ 0.05.
Cristiani Burkard.: Suchitoto, weight of 1 to 2 grams per male alevine; price/unit $ 0.05.

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

PRODUCTION COSTS FOR TILAPIA

(COSTS PER RESERVOIR)

Surface Area of Exposed Water (m 2) 600

Crop Production Time (months) 10

Year 2

CONCEPT	UNIT	AMOUNT per 1000 m 2	WITH PROJECT AMOUNT	WITH PROJECT UNIT PRICE $US.	WITH PROJECT TOTAL $US.
Reservoir preparation					
Cleaning	daily wage	1	0.60	3.2	1.92
Alevine transport	daily wage	1	0.60	3.2	1.92
Sowing	daily wage	2	1.20	3.2	3.84
Cultural Practices					
Feeding	daily wage	2	1.20	3.2	3.84
Monitoring disease	daily wage	1	0.60	3.2	1.92
Monitoring growth and weight	daily wage	1	0.60	3.2	1.92
Harvest					
Capture	daily wage	2	1.20	3.2	3.84
Preparation	daily wage	2	1.20	3.2	3.84
Sale	daily wage	1	0.60	3.2	1.92
Internal Transport	daily wage	1	0.60	3.2	1.92
Subtotal		14.00	8.40		26.88
Production inputs					
Fish	Alevine	1000	600	0.05	30.00
Pellets	qq	1	0.60	27	16.20
Fishnet	unit	0	0	30	0.00
Harvesting net	unit	0	0	35	0.00
Germicides	Lts	0	0.00	25	0.00
Fungicides	Lts	0	0.00	25	0.00
Limestone	qq	1	0.60	4	2.40
Equipment					
Scale	unit	0	0	20	0.00
Net	unit	0	0	25	0.00
Buckets	unit	0	0	4	0.00
Guacal buckets	unit	0	0	2	0.00
Floating tube	unit	0	0	5	0.00
Subtotal Inputs					48.60
Total Direct Costs					75.48
Yield/Price	Lb	350.00	210	1.14	239.40
PROFIT	$US				163.92

*minimum wage according to Ministerial Decree No. 46 and 47, April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday)

PRODUCTION PARAMETERS

Sowing density is 2 alevines per m 2 of surface water.
Average purchase weight of alevine: 10 gm.
Harvest at 150 days (5 months)
Number of units per pound: 4 to 5 tilapias.
Percentage production process loss: 10% to 15% of the population.
Water availability: without the possibility of renewing during dry season.
Low oxygen concentration
Purchase of male tilapias: to obtain the best size and weight for sale.
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Type of production: auto-consumption and commercialization of surplus.
Produced with multiple crops by beneficiary families.

MANAGEMENT OF PRODUCTION

Sowing: when the pond is at 80% to 90% capacity with rain water.

Daily monitoring (parasites and diseases), pond and fish conditions.
Harvest.

ALEVINE

SUPPLIERS:

Cooperative Hoja de Sal; Santiago Nonualco; La Paz, weight of 10 to 12 grams per male alevine; price/unit $ 0.05.
Santa Cruz Porillo, CENDEPESCA; La Paz, weight of 8 to 10 grams per alevine; price/unit Donations, for repopulating.
Las Américas; Suchitoto, weight of 8 to 10 grams per alevine; price/unit $ 0.05.
CENDEPESCA; Ilopango, weight of 8 to 10 grams per alevine; price/unit $ 0.05.
Cristiani Burkard.: Suchitoto, weight of 1 to 2 grams per male alevine; price/unit $ 0.05.

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

PRODUCTION COSTS FOR NATURAL PASTURE

Field Area (m 2) 1000

Crop Production Time (months) 12

Year 1

CONCEPT	UNITS	Amount per Hectare	WITH PROJECT AMOUNT	UNIT PRICE $US	TOTAL $US.
Field Maintenance					
Clearing	daily wage	6.00	0.60	3.2	1.92
Fencing	daily wage	5.00	0.50	3.2	1.60
Seeding					
Pasture transplant	daily wage	3.00	0.30	3.2	0.96
Cultural Practices					
Fertilizing	daily wage	2.00	0.20	3.2	0.64
Clearing (by hand)	daily wage	2.00	0.20	3.2	0.64
Subtotal Labor		18.00	1.80		5.76
Supplies					
Sulfate	qq	5.50	0.55	9.72	5.35
Subtotal Inputs					5.35
TOTAL COST					11.11
Yield/price (rent)	ha	1.00	0.10	179.83	17.98
PROFITS	$US				6.88

*Minimum wage according to Ministerial Decree No. 46 & 47, April 22, 1998
Ministry of Labor and Social Welfare. Includes food and Sunday payment (5 hour workday)

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Nominal wholesale prices of green pepper (100 count)

Month	1999	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003	Average	Average $us
Nov		79.50	48.87	52.50	96.17	98.70	75.15	8.59
Dec		78.24	69.56	53.04	106.89	71.75	75.90	8.67
Jan	78.50	73.81	103.55	60.15	81.03		79.41	9.08
Feb	80.50	75.71	106.32	63.33	65.89		78.35	8.95
Mar	79.00	83.91	133.34	58.33	65.89		84.09	9.61
Apr	70.53	85.00	100.56	61.53	74.20		78.36	8.96
May	62.63	86.19	79.05	93.33	76.65		79.57	9.09
Jun	61.90	91.43	56.50	128.44	77.00		83.05	9.49
Jul	80.00	77.66	55.37	88.64	63.70		73.07	8.35
Aug	44.12	57.25	59.81	43.33	62.30		53.36	6.10
Sep	73.33	45.25	69.07	61.00	66.68		63.07	7.21
Oct	95.00	48.10	63.57	85.07	63.35		71.02	8.12

Source: DGEA/MAG

Dry Season
Rainy Season

Average Dry Season Price	8.98
Average Rainy Season Price	8.06

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Nominal wholesale prices for green beans (qq)

Month	1999	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003	Average	Average $us
Nov		516.66	446.75	497.58	370.83	411.25	448.61	51.27
Dec		642.16	552.08	375.00	383.33	440.41	478.60	54.70
Jan	831.25	809.50	650.25	493.58	514.06		659.73	75.40
Feb	531.25	686.50	752.08	505.58	508.96		596.87	68.21
Mar	570.83	570.66	729.08	767.33	747.39		677.06	77.38
Apr	607.41	434.50	557.00	589.58	838.54		605.41	69.19
May	646.91	448.41	450.75	572.25	449.89		513.64	58.70
Jun	515.83	428.25	509.91	526.83	461.56		488.48	55.83
Jul	492.41	356.50	448.75	352.92	447.71		419.66	47.96
Aug	406.83	482.16	247.00	231.17	428.02		359.04	41.03
Sep	458.33	526.41	323.33	469.08	461.56		447.74	51.17
Oct	454.16	497.66	423.91	505.41	461.56		468.54	53.55

Source: DGEA/MAG

Dry Season
Rainy Season

Average Dry Season Price	66.02
Average Rainy Season Price	51.37

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Nominal wholesale prices for radishes (100 bunches)

Month	1999	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003	Average	Average $us
Nov		79.50	83.17	92.55	87.33	146.39	97.79	11.18
Dec		87.65	98.75	86.44	86.00	141.66	100.10	11.44
Jan	80.50	83.81	71.50	76.83	86.45		79.82	9.12
Feb	79.00	73.81	75.00	82.83	77.88		77.70	8.88
Mar	64.00	74.78	75.71	79.79	88.46		76.55	8.75
Apr	131.58	77.14	82.02	80.50	123.64		98.98	11.31
May	94.74	77.14	83.33	82.67	126.70		92.92	10.62
Jun	106.43	85.91	90.48	105.56	149.98		107.67	12.31
Jul	77.27	79.17	78.43	83.03	131.69		89.92	10.28
Aug	81.18	88.33	90.00	75.74	143.06		95.66	10.93
Sep	74.29	91.30	83.64	78.57	144.99		94.56	10.81
Oct	101.00	86.83	82.17	104.20	143.33		103.51	11.83

Source: DGEA/MAG

Dry Season
Rainy Season

Average Dry Season Price	10.11
Average Rainy Season Price	11.13

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Nominal wholesale prices for cucumber (100 count)

Month	1999	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003	Average	Average $us
Nov		75.00	85.71	90.20	81.53	71.31	80.75	9.23
Dec		80.00	81.88	75.83	74.44	67.46	75.92	8.68
Jan	63.00	84.76	64.52	86.46	62.83		72.31	8.26
Feb	71.50	74.76	75.56	73.00	66.06		72.18	8.25
Mar	46.50	68.48	88.33	74.17	70.96		69.69	7.96
Apr	67.89	59.29	73.33	68.60	61.78		66.18	7.56
May	75.79	74.29	71.70	75.33	73.33		74.09	8.47
Jun	46.67	68.18	72.38	91.56	43.31		64.42	7.36
Jul	67.73	67.50	76.08	59.17	62.91		66.68	7.62
Aug	80.00	73.33	82.04	41.39	56.35		66.62	7.61
Sep	66.19	72.20	87.78	59.23	65.01		70.08	8.01
Oct	74.50	75.24	81.71	86.67	67.11		77.05	8.81

Source: DGEA/MAG

Dry Season
Rainy Season

Average Dry Season Price	8.32
Average Rainy Season Price	7.98

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Nominal wholesale prices for zucchini (100 count)

Month	1999	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003	Average	Average $us
Nov		76.00	68.41	68.24	57.50	76.21	69.27	7.92
Dec		80.00	83.33	73.33	74.22	78.05	77.79	8.89
Jan	106.00	64.76	103.61	62.70	86.63		84.74	9.68
Feb	62.50	60.00	76.86	48.17	53.99		60.30	6.89
Mar	65.00	79.13	87.99	65.21	51.28		69.72	7.97
Apr	85.79	70.00	102.02	82.33	60.55		80.14	9.16
May	86.32	79.05	122.94	93.33	77.53		91.83	10.50
Jun	75.24	68.18	75.71	78.22	64.49		72.37	8.27
Jul	45.00	48.06	52.75	47.76	70.88		52.89	6.04
Aug	83.53	80.78	76.30	39.72	79.71		72.01	8.23
Sep	80.95	66.83	70.74	58.41	76.65		70.72	8.08
Oct	80.00	67.14	53.86	68.64	78.31		69.59	7.95

Source: DGEA/MAG

Dry Season
Rainy Season

Average Dry Season Price	8.42
Average Rainy Season Price	8.18

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Nominal wholesale prices for tomato paste (50 lb box)

Month	1999	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003	Average	Average $us
Nov		127.00	127.70	146.47	78.42	107.89	117.50	13.43
Dec		80.59	172.29	93.33	142.56	136.50	125.05	14.29
Jan	144.00	50.00	150.98	84.25	164.59		118.76	13.57
Feb	89.75	65.71	120.51	76.98	134.93		97.58	11.15
Mar	42.50	108.26	118.40	90.42	99.49		91.81	10.49
Apr	42.89	165.00	92.98	120.88	79.36		100.22	11.45
May	55.79	149.52	88.00	119.17	121.01		106.70	12.19
Jun	82.62	157.27	107.86	130.48	154.00		126.45	14.45
Jul	121.36	113.33	89.22	163.28	74.29		112.30	12.83
Aug	143.53	76.86	107.41	78.72	100.28		101.36	11.58
Sep	145.71	56.67	111.18	74.68	107.89		99.23	11.34
Oct	149.00	63.73	122.14	70.43	110.86		103.23	11.80

Source: DGEA/MAG

Dry Season
Rainy Season

Average Dry Season Price	12.40
Average Rainy Season Price	12.37

EL SALVADOR SURFACE WATER DIVERSION, STORAGE AND USE

Nominal wholesale prices for tomato paste (50 lb box)

Month	1999	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003	Average	Average $us
Nov		127.00	127.70	146.47	78.42	107.89	117.50	13.43
Dec		80.59	172.29	93.33	142.56	136.50	125.05	14.29
Jan	144.00	50.00	150.98	84.25	164.59		118.76	13.57
Feb	89.75	65.71	120.51	76.98	134.93		97.58	11.15
Mar	42.50	108.26	118.40	90.42	99.49		91.81	10.49
Apr	42.89	165.00	92.98	120.88	79.36		100.22	11.45
May	55.79	149.52	88.00	119.17	121.01		106.70	12.19
Jun	82.62	157.27	107.86	130.48	154.00		126.45	14.45
Jul	121.36	113.33	89.22	163.28	74.29		112.30	12.83
Aug	143.53	76.86	107.41	78.72	100.28		101.36	11.58
Sep	145.71	56.67	111.18	74.68	107.89		99.23	11.34
Oct	149.00	63.73	122.14	70.43	110.86		103.23	11.80

Source: DGEA/MAG

Dry Season
Rainy Season

Average Dry Season Price	12.40
Average Rainy Season Price	12.37

Annex W-5

Working Paper No. 5
Design Manual

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EXECUTIVE SUMMARY

The USAID Surface Water Diversion, Storage and Use (SWDSU) project will install and build infrastructure to capture rainwater from gorges and natural runoffs, transporting it by gravity to a reservoir in order to store it for irrigation during the summer months. The captured water will be used for planting crops during the dry season, thus contributing to improving the country's economy and family nutrition.

The SWDSU project will be implemented in the Departments of Ahuachapan, Usulutan, and Morazan, in support of the Water Access, Management and Rational Use (AGUA, in Spanish), project financed by USAID and implemented by the CARE-FUNDAMUNI–SACDEL-SALVANATURA Consortium, which is currently being carried out in these Departments.

Specifically, the project includes the construction of an infiltration gallery to capture rainwater from natural runoff; the construction of an excavated reservoir for water storage; and the installation of a trickle irrigation system to irrigate agricultural crops. The reservoir can fulfill a dual role, in the rainy season Tilapia can be farmed in it and in the summer, the water can be used for irrigating agricultural crops.

An Environmental Impact Evaluation (EIE) was conducted to select potential reservoir sites and to design an Environmental Management Plan based on the technical and environmental evaluation in the project site and surrounding area.

The Environmental Management Plan contains general technical recommendations about seeding, planting, and maintenance of different vegetable species; costs of materials and labor; and a calendar of activities for seeding and planting. These measures should contain specific steps that will help to improve existing environmental conditions. This Plan should be carried out and financed by the beneficiary.

1. PROJECT BACKGROUND

Many of the intended beneficiaries of the USAID Water Access, Management, and Rational Use (AGUA, in Spanish) project are farmers who live in the lower and middle regions of the Departments of Ahuachapan, Usulutan, and the Northern part of Morazan. These beneficiaries live at poverty levels that make them vulnerable to climate changes, especially droughts. Economic revitalization of these families, who support themselves with less than two hectares of arable land, is essential for basin development and conservation activities leading to increased access to clean water. Most of these small farmers are economically active only during the rainy season (six months per year) when they can devote themselves to agriculture. For the rest of the year they are inactive or are seeking employment. Access to a reliable source of water during the dry season would give these families the opportunity to continue working their farms during these months. It would also allow them to market their products during the dry season, when prices are higher.

In El Salvador, in addition to the six-month dry season, there are also periodic droughts (within the rainy season), also known as "caniculas," (periods of more than two-month during the rainy season when precipitation is limited or nonexistent), which have drastic effects on farmers who lack reliable access to water. In 1992, for example, the rainy season began four months later than normal. These dry periods are highly destructive as they tend to ruin crops and leave affected farmers with very few possibilities of producing another harvest.

In El Salvador, surface waters from rain, small streams, gorges and rivers are usually not considered a resource by the local population. The primary use for these waters is drainage and waste transportation. Solid and liquid waste are often placed in these water sources and transported downstream, causing serious environmental pollution problems and health problems for populations living in low lying areas. The poor quality of these waters makes them unsuitable for human consumption and promotes environmental degradation because there is no incentive for their conservation.

In addition, sediment from soil erosion caused by years of deforestation is a severe problem in surface water management. Projects including conventional water diversion through channels and storage structures (dams) should take into consideration the large amounts of sediment deposited every year that can fill channels and dams, and that dredging them is very costly. There are numerous examples of unsuccessful water storage systems of this nature.

USAID Water and Environment Office officials in El Salvador believe that an effective way to increase economic growth in rural and agricultural areas is to promote management of surface water sources and to provide drought mitigation through the implementation of surface water diversion systems and water storage in reservoirs. These water diversion and storage systems could be used to support agriculture during the dry season. The water storage systems being built under SWDSU will serve to effectively demonstrate the technologies being used and attract foreign research. USAID is currently testing these technologies and already has two pilot projects being implemented.

1.1 Project Objectives and Goals

Through this project, USAID intends to achieve the following main objectives in order to help El Salvador to promote surface water conservation and improved utilization:

1. In pre-selected areas, develop combined diversion/storage interventions for a minimum of 10,000 cubic meters of surface water in 12 pre-selected sites, as per the specifications and techniques outlined in the project's scope of work.

2. Identify and construct/put in place appropriate income generation activities in each subproject, in consultation with beneficiaries and USAID personnel.

3. Provide promotion, training, and technical assistance to beneficiaries, in order to guarantee project interventions' acceptance, proper operation, and sustainability in each subproject.

The project seeks to improve the living conditions of beneficiaries and their families´ by increasing and improving their agricultural production and productivity, through the availability of water for irrigation.

Within the context of the general objective specific project objectives are targeted to achieve the following:

1. Provide permanent and sufficient irrigation for an average area of 1000 m² of arable land, through the construction of an infiltration gallery that will capture runoff waters on beneficary property, and a reservoir to store these waters.

2. Expand the country's agricultural horizon to two harvests per year, diversify livestock production, and improve marketing conditions for all products produced.

3. Increase productivity of irrigated crops through timely water provision, which encourages improvement of production systems, use of adequate inputs, and natural resources conservation.

The goals of each subproject are as follows:

1. Build an infiltration gallery on the beneficiary's property in order to intercept water runoff for irrigation.

2. Construct a reservoir for rainwater storage on the beneficiary's property.

3. Set up a trickle irrigation system.

4. Provide both male and female beneficiaries and their families with training in horticultural production and Tilapia farming for personal consumption.

2. WATER BALANCE

2.1 Climate Data

Climate data can be obtained from either the National Service of Territorial Studies (SNET in Spanish) or directly from the "Almanaque Salvadoreño". The last edition of this document was published twelve years ago in 1993, and is out of date. However, based on information obtained during several visits to a number of government projects and institutions, the SWDSU team learned that only limited data was collected during this period. Given the project's magnitude, it was concluded that the Almanac data is valid for the SWDSU project studies.

2.1.1 Precipitation and Evapotranspiration

SWDSU obtained climate data on average monthly precipitation and evapotranspiration for weather stations in 13 Salvadoran Departments. As an example, the table below shows information from the weather station located in Santa Cruz Porrillo, which is considered representative for the Department of Usulutan.

Table 1.
Average Monthly Climate Data for the Department of Usulutan

No.	Month	Average Precipitation Mm	ETP Hargreaves mm
1	Jan	2	146
2	Feb	1	150
3	Mar	6	184
4	Apr	38	183
5	May	174	180
6	Jun	302	158
7	Jul	275	172
8	Aug	266	164
9	Sept	368	145
10	Oct	273	143
11	Nov	53	137
12	Dec	5	143
Annual		1763	1905

2.1.2 Precipitation Intensity

The Almanaque Salvadoreño also presents data on intensities of absolute maximum precipitation from approximately 25 weather stations. As an example, the data from the Santa Cruz Porrillo weather station for the Department of Usulután is presented below.

Table 2
Absolute Maximum Rain Intensity Data for the Department of Usulutan.
Santa Cruz Porrillo Weather Station (30 years of data)

PRECIPITATION INTENSITY		
No.	**Duration**	**Intensity**
	Min	**mm/min**
1	5	5.82
2	10	4.47
3	15	3.89
4	20	3.05
5	30	2.81
6	45	2.27
7	60	1.8
8	90	1.34
9	120	1.02
10	150	0.83
11	180	0.7
12	240	0.49
13	360	0.43

2.1.3 Evaporation

Unfortunately, the Almanaque Salvadoreño does not provide any data on evaporation and it is the understanding of the SWDSU team that this information is not available from any other institutions recording climate data. However, during the literature review and data collection phase of the SWDSU project, the SWDSU team was able to obtain information on evaporation for the Type A Evaporation-meter Tank from the study titled *Informe de Factibilidad – Proyecto de Olomega en el Rio Grande de San Miguel* by Harza and García-Prieto, 1967. This information is presented in the table below:

Table 3.
Average Monthly Evaporation for the Department of Usulutan

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
154	145	199	159	154	139	146	143	130	132	126	132	1759

To calculate evaporation at other weather stations, the following formula can be used:

$$Ev_{station\ x} / ET_{station\ x} = Ev_{Usulutan} / ET_{Usulutan} \qquad (1)$$

Where:

EV = Average monthly evaporation in mm
ET = Average monthly evapotranspiration in mm
station x = weather station under study

Therefore, the average monthly evaporation value for a station "x" can be calculated multiplying the monthly evapotranspiration value by the evaporation/evapotranspiration ratio for Usulutan, which is given in the table below:

Table 4.
Ev Usulutan/ ET Usulutan Ratio

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1.05	0.97	1.08	0.87	0.86	0.88	0.85	0.87	0.90	0.92	0.92	0.92

2.2 Basic Information to Calculate Crop Irrigation Requirements

After choosing the crops to be cultivated in the project area, the project team proceeded to calculate the gross and net irrigation requirements and the respective weighted provisions for each proposed crop.

The irrigation requirements were calculated based on the potential evapotranspiration (ETP), obtained using the Hargreaves Method. Appendix 1 provides the evapotranspiration results reported for the area under study.

The potential evapotranspiration data affected by the crop factor Kc, allowed the SWDSU team to calculate the consumptive use or real evapotranspiration (ET). The Kc factors used have a seasonal variation, based on the percentage of development of each crop. To determine this, SWDSU applied the FAO method, adapted to the particular conditions of the project's irrigation area.

Irrigation needs were calculated from the consumptive use, reducing the effective precipitation. This effective precipitation is a fraction of the monthly precipitation and depends on the soil characteristics and on the selected crop. The utilization fraction of any given rain was set at 75%, assuming that this depth is held in the soil. The formula used for calculating the effective precipitation is as follows:

$$EP = (PP - 15) \times 0.75 \qquad (2)$$

Where:

EP = effective precipitation in mm
PP = average precipitation in mm
15 = value in mm corresponding to losses due to surface interception and runoff.
0.75 = percentage of rain being used by the plant

Based on this formula, the team obtained data for reliable (or effective) precipitation for the project area.

2.2.1 Crop Irrigation Requirements

To calculate the crop irrigation water requirements the SWDSU team applied the following formula:

$$ET = Kc * ETP \qquad (3)$$

Because experimentally determined crop coefficients (Kc) are not available for the project area, the values used for calculating the potential evapotranspiration correspond to FAO-determined values and to the experience of SWDSU project personnel, adjusted to the project area's agro-climatic conditions.

2.2.2 Calculation of the Area Under Optimum Irrigation

Based on the simulation results of the water supply provided by the gallery, the reservoir, and the balance in the irrigation area (precipitation – evapotranspiration), the team used ABRO software to establish the balance between the water supplied and demanded "with" the project in order to determine the optimum project area (shown in Appendix 1).

2.2.3 Reservoir Water Balance Model

The reservoir's water balance during the year can be represented through the following equation:

$$V_i = V_{i-1} + V_c - I_L - E_L - I_d \qquad (4)$$

Where

V_i = Volume at the end of month "i"
V_{i-1}= Volume at the end of month "i-1"
V_c= Volume of water captured (gallery + reservoir surface) during the month "i"
E_L= Losses due to infiltration during month "i"
I_L= Losses due to evaporation during month "i"
I_d= Irrigation demand during month "i"

Appendix 2 shows the results of this equation.

3. CIVIL WORKS DESIGN

3.1 Works General Description

Below the project infrastructure works, which make it possible to capture rainwater from natural gorges and runoffs, and transport that water by gravity through a pipeline to a reservoir for storage and subsequent use for agricultural irrigation during the summer months, are described. Appendix 3 shows typical infrastructure designs.

Infiltration gallery:

The objective of infiltration galleries is to capture surface runoff and to filter water to be channeled to the reservoir. To achieve this, the gallery layout design should include the following parameters:

- Pipelines with grooves distributed in such a way to allow water to pass, while preventing passage of particles that can clog the pipeline and cause serious sediment build up in the reservoir.

- Filtering material (gravel), the main function of which is to work as a filter, entirely covering the grooved pipelines (perimeter and length).

- A gabion retention wall and a concrete slab, which protect the pipes and the filtering material, preventing them from being swept away by a flood. The gallery's highest level should be the same as the gorge or runoff bed level.

Conveyance pipelines

These pipes, which can be made of PVC, or galvanized iron, connect the gallery to the reservoir, and their main function is to convey the water. The pipeline has additional accessories that guarantee its operation, safety, and quality; such as: control valves, mud purging valves, flushing valves, valve boxes, anchorages, fittings, energy dissipators, level-retention walls, and pipe fittings.

Reservoir

A rainwater storage reservoir is a structure made of earth, cutting on one side and filling on another or an earth dike all around, which should be lined with a waterproof material. The function of the liner is to avoid water loss by infiltration caused either by soil cracking or by soil absorption. The reservoir will store the water coming from the gallery and it will be used to irrigate the parcels or agricultural land where crop activities will be carried out.

The waterproof material selected for this project is the flexible EDPM (Ethylene Propylene Diene Monomer) rubber blanket. This blanket was used in one of the AGUA Project pilot systems (José Vargas, El Cerrito) with excellent results. In addition, consultant John Moore, an official with the United States Department of Agriculture (USDA), recommended this blanket.

Complementary works

These include all those works that guarantee the safety, quality, and good operation of the constructed infrastructure.

3.2 Infiltration Gallery Layout Design

3.2.1 Maximum discharge computations

In order to calculate the maximum discharge at the point where the infiltration gallery is located, the SWDSU team used the Rational Equation, expressed as follows:

$$Q = CiA/360 \qquad (5)$$

Where:

Q = Maximum discharge in m3/s
C = Runoff coefficient
i = Design precipitation intensity, which should correspond to the time of concentration mm/hr.
A = Watershed area for the micro-basin, ha.

The time of concentration, tc was calculated using the Kirpich equation

$$t_c = 0.0195\ k\ L^{0.77} / S^{0.385} \qquad (6)$$

Where:

t_c= Time of concentration in min
k = Kirpich factor
L = Distance from the furthest point away from the basin down to the gallery, in m
S = Average longitudinal slope of L

Appendix 4 provides calculation details.

3.2.2 Captured Monthly Volume

The runoff water volume that can be collected monthly by the gallery is not easily quantifiable because there is no available field data to determine this parameter. However, the SWDSU team made an approximation based on a document written by engineer John Moore (2) from the United States Department of Agriculture (USDA). Moore reports that the monthly runoff in El Salvador is about 20% of the average monthly precipitation. In this study it was estimated that the water that could be captured by the gallery is equal to 10% of the total runoff, that is, 2% of the average monthly precipitation that falls over the gallery's micro-basin.

3.2.3 The Gallery

Appendix 5 provides details about this calculation.

Gallery length: The gallery length can be calculated using a variation of the formula proposed in the publication Soil Conservation Service NEH-16

$$Q = 0.0896 * (K (m^2 + 2am))^{0.5} * L \qquad (7)$$

Where:

Q = Gallery flow, in lps
K = Hydraulic conductivity, in m/h
L = Gallery length, in m
m = Height measured from the gallery's centroid up to the filter's higher level, in m
a = Height measured from the gallery's centroid up to the filter's lower level or base, in m

Orifices: The orifice area per linear meter is estimated with the following equations:

$$to_b = f_t * q/(V_i * C_c) \qquad (8)$$

Where:
a_b= Total area of the orifices per gallery linear meter (m2/m). The acceptable maximum value is 6% of the pipe's area.
f_t= Clogging factor 1.2
q = Flow per linear meter of gallery *(*m^3//s/m)
V_i= Orifice incoming velocity, 0.10 m/s (Halcrow)
C_c= Contraction flow ratio at the orifice entrance, 0.55 (Halcrow)

$$n_b = a_b/a_t \qquad (9)$$

Where:

n_b= number of orifices per gallery linear meter
a_t= orifices area (m2)

Filters: Two filters will protect the structure; the first one (next to the gallery) is the thick filter, which is also covered by the fine filter. The filter design criteria are as follows:

- Particle size distribution for thick filter: D_{85}filter/Diameter of the Orifices > 2
- Particle size distribution for fine filter: D_{15} filter/D_{15} aquifer > 5
- D_{15}filter/D_{85}aquifer < 5

Filter thickness can range from 0.20 m to 0.50 m.

3.2.4 Scour Depth Computations

For the scour depth calculation the SWDSU team used the Lacey Method, which is a simple method that produces reasonable data, broadly acceptable for the structures under study. The Lacey equation can be expressed the following way:

$$Ds = 0{,}473\ (Q/f)^{1/3}\ Sf \qquad (10)$$

Where:

Ds = Scour depth, in m
Q = Flow, in m3/s
f = Lacey Factor
Sf = Safety coefficient equal to 2 for the structures under study.

The Lacey factor can be calculated using the following equation:

$$f = 1.76\ (D_{50})^{0.5} \qquad (11)$$

Where:

D_{50} = Average bed material particle size, in mm

Appendix 6 provides the details of this calculation.

3.3 Supply and Conveyance Pipeline Hydraulics

The pipeline hydraulics were calculated using the Hazen Williams Equation for conduits under pressure. This equation can be expressed as follows:

$$hf = 10.64\ L\ Q^{1.852} / (Chw^{1.852}\ D^{4.87}) \qquad (12)$$

Where:

hf = Friction head loss, in m
L = Pipeline length, in m
Q = Flow, in m3/s
Chw = Hazen Williams coefficient
D = Pipe diameter, in m

Minor losses

Minor losses can be calculated using the following equation:

$$hi = Ki\ v^2 / 2g \qquad (13)$$

Where

hi = Minor head loss *i* in m
Ki = Constant of minor loss caused by fitting *i* in m
v = Water velocity inside the pipeline, in m/s
g = Gravity acceleration (9.8 m/s2)

Table 5
Minor Losses Constant, Ki

Minor Losses	Ki
Grid	0.25
Entrance	0.50
Valves	0.70
Elbow pipes	0.30
Tees	0.40
Diameter changes	0.60
Other	0.5

Appendix 7 provides calculation details.

3.4 Reservoir Layout Design

One of the priorities of this project is to assist small farmers who own less than 2 hectares of arable land. Due to the limited availability of land, as well as the rugged topography of the areas identified for the works, the reservoirs are small. On the other hand, one of the project objectives is to provide 12 beneficiaries with a minimum of 10,000 cubic meters of stored water for irrigation. For these reasons, the average reservoir size is approximately 850 m3.

3.4.1 Reservoir Measurements

The pilot reservoirs built in the El Cerrito, Usulutan area have 2.10 meters of water depth, and 2.40 meters of total depth. These reservoirs are mainly in cut; where the fill was minimized. The side slopes in cut and fill are 2:1, that is, 2 horizontal length units per each vertical length unit.

3.4.2 Side Slopes

For side slopes SWDSU followed the regulation set forth by the following documents:

- *Ley de Urbanismo y Construcción*
- *Reglamento a la Ley de Urbanismo y Construcción en lo Relativo a Parcelaciones y Urbanizaciones Habitacionales*
- *Febrero de 1992*
- *Viceministerio de Vivienda y Desarrollo Urbano El Salvador*

The regulation refers to side slopes in cut and fill for urban areas as follows:

> "*Chapter Three–Regarding lots or parcels–Lot protection*
> *Art. 49.-*
> *Paragraph 3: Any and all real estate developers who carry out cuts or fillings in land bordering lots which do not belong to the project should protect them with walls or slopes, which should be developed or built without affecting or reducing the area of the neighboring terrain. The terrain affected by these slopes will be the protection area within the parceling out. See Annex No. 1*
> *Paragraph 4: In all cases, slopes shall have a maximum ratio of 1.5 horizontal by 1.0 vertical where grass should be planted and protected against erosion. Another alternative to this structure can be accepted if the interested party proves the stability of such structure through reliable soil studies"*

The maximum side slope adopted by the SWDSU project is 2:1 horizontal to vertical, for both cuts and fills, which is the same ratio used for the existing pilot reservoirs. This ratio is more stable than the one set by the regulation, which means that the safety factor is higher. Moreover, since these systems will be built in rural areas, the risk factor is lower than in urban areas—which is the case referred to by the aforementioned regulation. Appendix 8 presents relevant pages of this document.

3.4.3 Masonry Walls

There are basically two stability analysis conditions for small masonry walls, which are used by the project. They are (1) turning stability and (2) sliding stability.

Turning Stability

The wall turning stability is calculated using the following expression:

$$R = \Sigma M / \Sigma V \qquad (14)$$

Where:

R = Resultant
ΣM = Sum of moments with respect to the wall base (upstream)
ΣV = Sum of vertical forces

The resultant should fall in the base middle third to be considered stable.

Sliding Stability

Sliding stability is based on a safety factor (SF) as a measure to determine the structure's resistance against sliding. The following table shows the recommended values for this factor.

Table 6.
Sliding Stability Factors*

Load Condition	Minimum SF
Normal	2.0
Unusual	1.7
Extreme	1.3

* Source: US Corps of Engineers Gravity Dam Design. June 1995.

The formula to calculate the SF factor is the following:

$$FS = T_F / T \qquad (15)$$

Where:

T_F= Maximum resistance power
T = Power applied throughout the sliding plane.

Each of these terms can be calculated using the following expressions:

$$T_F = (W - U) \tan\Phi + cL \qquad (16)$$

$$T = ½ H_w^2 Pe_w \qquad (17)$$

$$U = ½ H_w L Pe_w \qquad (18)$$

Where

W = Structure weight
U = Upward force
Φ = Internal friction angle
c = Cohesion
L = Base length, transverse to the wall axis
H_w= Water height
Pe_w= Specific water weight

The values of "Φ" and "c " are within the range presented in the following table:

Table 7.
Values of "Φ" and "c" *

Sliding Plane Location		Cohesion (MNm^{-2})	Friction Tan Φ
Massive Concrete	Intact	1.5 – 3.5	1.0 – 1.5
	Joint Horizontal Construction	0.8 - 2.5	1.0 – 1.5
Concrete-Rock Interface		1.0 - 3.0	0.8 - 1.8
Massive Rock	Solid	1.0 - 3.0	1.0 - 1.8
	Lower Quality	< 1.0	< 1.0

* Source: Hydraulic Structures by P. Novak, A.I.B. Moffat, C. Nalluri, and R. Narayanan. Spoon Press, 2001.

4. TRICKLE IRRIGATION SYSTEM LAYOUT DESIGN

Details on the design computations and layout distribution in the farming area are presented in Appendix 9.

4.1 Description of the Basic Components of the Micro Irrigation System

The proposed irrigation system using micro irrigation or trickle irrigation consists of the following elements: water source, filtering system, mainline pipes, secondary (multiple) or manifold pipes, tertiary or lateral pipes, and water emitters or drip devices.

- ***Water source.*** This is the water stored in the reservoir that will provide water for the irrigation system.
- ***Control head.*** It consists of valves to control water discharge and pressure for the whole network.
- ***Filter systems.*** This unit is very important because without filters the drip devices may become clogged. Therefore, depending on the type of suspended solids or water impurities in the area all irrigation systems should have some type of filters.
- ***Mainline pipes.*** Are those pipelines transporting the water from the control head to the irrigation units.
- ***Secondary or manifold pipes.*** Are those pipelines within an irrigation unit that provide water to all sub-units.
- ***Tertiary or lateral pipes.*** Are the pipelines that have the water emitters or drip devices connected to them.
- ***Water emitters or drip devices.*** Are the devices that control the water discharge from the lateral pipelines to the crop area where the water comes out “drop by drop.”

4.1.1 Emitter Characteristics and Classification

The configuration of water emitters or drip devices is highly variable, the SWDSU project will use *integrated water emitters or drip devices*, where the drip devices are placed inside the pipelines.

4.1.2 Sensitivity to Clogging

The sensitivity of the emitter to clogging principally depends on the diameter of its minimum passage section, on the water velocity through this section, and on its design.

4.1.3 Filtering Equipment

The most serious and frequent problem in irrigation installations and, in particular, in trickle irrigation is clogging. Therefore, depending on the type of suspended solids or water impurities in the area, irrigation systems should have some type of filtering equipment.

If we consider the nature of clogging, we can distinguish:

- Clogging caused by organic and inorganic particles
- Clogging caused by precipitations and / or bacteria build-up

Based on the time factor we can classify clogging as:

- Current or immediate
- Potential or slow

Usually, current or immediate clogging is identified with organic and inorganic particles. Similarly, potential or slow clogging is commonly associated with precipitations or bacteria. The latter are prevented using chemical injection treatments. In order to avoid the former, different filters are used.

The type or types of filters needed in a localized irrigation installation will depend on the nature and size of polluting particulate matters. The following table provides guidelines for selecting a filtering device.

Table 8.
Filter Type Selection Depending on Polluting Element Type

Pollutant	Sand Separator	Sand and Gravel Filter	Mesh Filter	Other
Sand	X	---.---	X	Sediment
Silt and Clay	---.---	X	X	Sedimentation and Flocculation
Organic Substances	---.---	X	X	Chemical Injection Treatments

Sand Separators

The reservoir will work as a sand separator stopping any sand particulates transported by the supply line to the reservoir or any particulates that fall into it.

Sand and Gravel Filters

The sand filter proposed for eliminating organic particles (algae, bacteria) found in the irrigation water consists of a plastic container full of specially selected sand. The water enters the container from the upper part and flows through the sand, where all organic particles are trapped. Since the sand particles and the emitter openings are the same size, all particles bigger than or equal in size to the openings are trapped, as they may cause clogging of the orifices. These filters have the advantage of holding a large quantity of particles before they need to be flushed or cleaned. The head loss when water passes through them is 1 to 3 m of water column (0.1 to 0.3 kg/cm2) when the filters are clean.

Mesh Filters

Mesh filters provide a simple, practical, and efficient way to filter irrigation water. The orifice size and total area determine the efficiency and operational limitations of these filtering systems. Mesh filters are efficient for filtering very fine sand and small amounts of algae. Since algae and organic material could clog mesh filters it is recommended that they be installed in series, with strainers that gradually reduce the expected sediment and algae loads in order to control cases where a significant amount of algae is expected.

The filter proposed for the SWDSU project will be cleaned manually for two main reasons, lack of hydraulic head and lower costs to the beneficiaries.

Mesh and Disk Filters

Mesh and / or disk filters will be used at the lateral pipeline entrance.

4.2 Agronomic Design[1]

Design parameters and their respective definitions are presented below:

4.2.1 Area Wetted

Trickle irrigation systems wet only a part of the soil, where Pw is the percentage of wetted area.

Area Wetted , Aw (m2). Aw is the area wetted by each water emitter, at an approximate depth of 30 cm under the surface.

4.2.2 Pw[2] Calculation

Pw is in relation to the following parameters:

- *Emitter Spacing, Se (m).* The spacing between water emitters or emission points along a lateral.
- *Optimum spacing between emitters, Se' (m).* Eighty percent of Se.
- *Wetted width, Sw (m).* Width of a strip wetted by emitters on a lateral spaced Se' or closer. Sw is also equal to the diameter of the area wetted by an isolated water emitter.
- *Spacing between laterals, Sl (m).* The spacing between the laterals.

[1] The methodology used is mainly based on the book titled *Sprinkle and Trickle Irrigation Design*, by Jack Keller & Ron D. Bliesner, published by Blackburn Press in 2000.

[2] The abbreviations used are those used by the United States Soil Conservation Service,and are accepted internationally.

- *Spacing between plants, Sp (m).* The distance between plants in a furrow.
- *Spacing between furrows, Sr (m).* The distance between furrows.
- *Number of water emitters per plant, (e).* The number of emitters irrigating each plant.
- *Single Laterals*. For single laterals where Se < = Se,' the percentage of wetted area, Pw can be calculated using the following formula:

$$Pw = 100\ (e\ Se\ Sw)/(Sp\ Sr) \qquad (19)$$

If Se > Se' then Se should be replaced with Se'

- *Double Laterals.* When there are two laterals (a single lateral on each side of the crop), the distance between them should be equal to Se' in order to maximize the wetted area.

4.2.3 Irrigation Depth, I (mm)

The following parameters should be considered in order to calculate the irrigation depth:

Field Capacity, FC (mm). The moisture remaining in the soil after a cycle of saturation and subsequent free drainage of the soil.

Point of Permanent Wilt, WP (mm). The moisture content in the plant root area after plants can no longer extract any moisture for their survival.

Available Moisture Capacity, Wa (mm). The moisture held between the Field Capacity, FC and the Permanent Wilt Point, WP.

$$Wa = FC - WP \qquad (20)$$

Available Moisture, Sma (mm). The difference (at any time) between the soil moisture content and the Permanent Wilt Point, WP.

Soil Moisture Deficiency, Smd (mm). The difference (at any time) between the Field Capacity, Fc and the moisture content in the plant root area. In other words, it is the amount of water necessary to reach Field Capacity, FC.

$$Smd = FC - Sma \qquad (21)$$

Management-allowed Deficit, Mad (%). The percentage of soil moisture deficit of Wa at the time of irrigation. In other words, it is the maximum percentage of Wa in terms of irrigation depth.

4.2.4 Maximum Net Irrigation Depth, Ix (mm)

The maximum net irrigation depth that will replace Smd when Smd = Mad * FC. Ix is calculated as a water depth on the entire crop area and not only on the wetted area; however, the Pw factor should be considered in the following way:

$$Ix = (Mad/100)\ (Pw/100)\ Wa\ Z \qquad (22)$$

Where: Z is the plant root depth (m)

4.2.5 Water Demand

Average Daily Transpiration Rate, Td (mm). The Td factor in trickle irrigation systems, is in relation to the average rate during the peak month and a parameter related to the crop canopy. The following equation let us estimate Td

$$Td = ETd\ (Ps/100 + 0.15\ (1.0 - Ps/100)) \qquad (23)$$

Where: ETd (mm) is the daily average rate of evapotranspiration during the peak month.
Ps (%) is the percentage of area that is covered by the crop shade in relation to the total crop area. This can be measured in the field.

Seasonal Transpiration, Ts (mm). This can be calculated, replacing the value for ETd in the previous equation with the value of the seasonal crop evapotranspiration, ETs (mm).

$$Ts = ETs\ (Ps/100 + 0.15\ (1.0 - Ps/100)) \qquad (24)$$

4.2.6 Net Irrigation Depth, In (mm)

The net irrigation depth can be calculated using the following expression:

$$In = Td\ Fi \qquad (25)$$

Where: Fi is the frequency of irrigation (days)

For the irrigation network design and sizing, the Td value should be used for adult crops (maximum Ps).

4.2.7 Gross Irrigation Depth, Ig (mm)

The gross irrigation depth should take into account the system's inefficiencies. When water losses are greater than the depth of water required for salt leaching,

$$TR => 1/(1.0 - LRt) \text{ or } LRt <= 0.1 \qquad (26)$$

$$Ig = In\ Tr\ /\ (EU/100) \qquad (27)$$

And when:

$$Tr < 1/(1.0 - LRt) \text{ and } LRt\ 0.1 \qquad (28)$$

$$Ig = In\ /\ (EU/100\ (1.0 - LRt)) \qquad (29)$$

Where: Tr: (fraction) is the ratio between the peak use and the transpiration (represents the extra water that should be applied during the peak use period in order to counteract unavoidable losses caused by profound percolation)
EU: (%) is the emission uniformity percentage
LRt: (fraction) is the water requirement for salt flushing (radio)

Table 9
Tr Value

VALUES FOR THE Tr RATIO				
Plant Root Depth (m)	**Soil Texture**			
	Gravel (Coarse)	**Sandy**	**Medium**	**Fine**
Superficial < 0.80 m	1.10	1.10	1.05	1.00
Middle 0.8 m to 1.5 m	1.10	1.05	1.00	1.00
Deep 1.5 m	1.05	1.00	1.00	1.00

4.2.8 Gross Daily Water Volume Demand per Plant, G (lt/d)

In order to be able to choose the emitters discharge rate, G (liters per day), the following parameter is very useful:

$$G = Sp\ Sr\ Ig / Fi \qquad (30)$$

4.2.9 Net Annual Irrigation Depth, IN (mm)

The annual irrigation depth takes into account the remaining moisture from the previous crop period, as well as the actual precipitation during the crop period. It can be estimated using the following expression:

$$I_N. = (ETs - Re - Ws)\ (Ps/100 + 0.15\ (1.0 - Ps/100)) \qquad (31)$$

Where: Re is the effective precipitation (mm)
Ws is the previous residual moisture (mm)

4.2.10 Seasonal Irrigation Efficiency, Es (%)

Seasonal irrigation efficiency is based on water losses and the *seasonal transpiration ratio, TRs (fraction)*. It can be estimated using the following equation:

When $TRs <= 1/(1.0 - LRt)$ (32)

$Es\ (1.0 - LRt) = EU\ (1.0 - LRt)$ (33)
And $Es = EU$ (34)

When $TRs\ 1/(1.0 - LRt)$ (35)

$Es\ (1.0 - LRt) = EU/TRS$ (36)

Since part of the water losses due to TRs are necessary in order to do salt flushing:

$$Es = EU / (TRs (1.0 - LRt) \quad (37)$$

Where: TRs is the seasonal transpiration ratio

Table 10.
TRs Ratio Values

TRs* RATIO VALUES				
Climate and Soil Depth	**Soil Texture**			
	Coarse (Gravel)	**Sandy**	**Medium**	**Fine**
Arid < 0.75 m	1.15	1.10	1.05	1.05
0.75 to 1.50 m	1.10	1.10	1.05	1.00
1.50 m	1.05	1.05	1.00	1.00
Humid < 0.75 m	1.35	1.25	1.15	1.10
0.75 to 1.50 m	1.25	1.20	1.10	1.05
1.50 m	1.20	1.10	1.05	1.00

* *The given values are for emitters of the dripping type.*

Irrigation Depth for the Irrigation Season, I_G. (mm) This can be calculated in the following way:

$$I_G. = 100\ I_N./ (It\ is\ (1.0 – LRt)) \quad (38)$$

Irrigation Volume for the Irrigation Season, V_G (m3)

$$V_G. = 1000\ I_N.\ A / (Es\ (1.0 – LRt)) \quad (39)$$

Where: A = area in hectares

4.2.11 Crop Salinity Tolerance

Trickle irrigation systems produce areas of concentrated water salts where the water is applied. These salts remain diluted due to the high frequency of water application that this system demands.

The *electric conductivity of irrigation water , ECw* and the *electric conductivity of saturated soils , ECe* are useful parameters for managing crop salinity tolerance.

In order to estimate any production reduction due to salinity in trickle irrigation systems when Ecw > Ece, the following expression can be used:

$$Y = 100\ (Ecw – min\ ECe)/(max\ ECe – min\ ECe) \quad (40)$$

Where: Y is the theoretical yield reduction (%)

Salt Leaching, LRt (fraction). In the SWDSU areas of intervention, precipitation during the rainy season is very high. Therefore, the application of more water for salt flushing is not considered necessary.

4.3 Emitter Selection and Design Criteria

The efficiency of trickle irrigation systems depends, to a great extent, on water emitter selection and the criteria used to establish parameters for designing the system. The following are some of the water emitter characteristics that most affect efficiency:

1. Discharge rate variations due to manufacturer´s tolerances, (v).
2. Discrepancy between the pressure-flow ratio and the specifications of design.
3. Exponent of emitter discharge, (x).
4. Coefficient of emitter discharge, (Cq).
5. Possible range of acceptable hydraulic head variation, (Δh).
6. Head losses on laterals due to emitter connections, (fe).
7. Sensitivity to blockage or chemical deposits.
8. Long-term pressure-flow ratio stability.

4.3.1 Orifice Emitters

The orifice emitters were selected in the SWDSU Project. The water flows through the orifice where pressure is lost. The flow is of the turbulent type and its discharge rate can be estimated using the following equation:

$$q = 15.94 \text{ to } Cq\ h^{0.5} \qquad (41)$$

Where: a is the orifice area (mm^2)
Cq is the orifice discharge coefficient. Its value fluctuates between 0.6 and 1.0
q is the water emitter discharge (lph)

4.3.2 Emitter Selection Criterion

The quality and safety of trickle irrigation systems are directly proportional to water emitter design and quality, the percentage of the area wetted, permissible pressure variations, adequate filtration, degree of automation and reliability in system management, labor, the energy source, spare parts, and water availability.

The two most important parameters are (1) the percentage of wetted area and (2) the emitter quality to prevent blockage and malfunctioning.

A reasonable objective for designing a trickle irrigation system is to have a sufficient number of water emission points to wet at least one third to one half of the cross section of the potential root area.

The SWDSU project selected *Single Emitters*. They can be used to water small patches or can be placed around large plants or trees so that crops use more than one water emission point.

4.3.3 Clogging Sensitivity

This is a very important consideration when selecting emitters. There are two parameters guiding clogging sensitivity: (1) the size of the water opening and (2) the speed of water through that opening. The relationship between the cross section and the clogging sensitivity is the following:

1. Very sensitive, less than 0.7 mm
2. Sensitive, between 0.7 mm and 1.5 mm
3. Relatively insensitive, greater than 1.5 mm

In the case of SWDSU, the drippers selected fall within the sensitive to low sensitive classification.

4.3.4 Pressure-Discharge Relationship

The pressure-discharge relationship is the most important emitter characteristic where the discharge exponent (x) is the indicator of the flow variation according to the pressure. The lower the value of x, the lower the flow variation will be and therefore, irrigation uniformity will be higher.

4.3.5 Losses at Connection Points, fe

SWDSU will use the *in-line* connection where the drip source is a part of the lateral. Despite the fact that the water losses caused by this type of dripping source are negligible, for the calculation of water losses caused by the connections, the equivalent lateral length (in friction), fe = 0.10 m will be estimated.

4.3.6 Average Emitter Pressure, ha, and Discharge, qa

The pressure-discharge relationship for average values should be provided by the manufacturer, as well as the recommended pressure range. From this information one can calculate the discharge exponent value, x and the discharge coefficient, Cq. In any case, one must determine the average flow values, qa and the average pressure, ha.

Based on this information, one can estimate the application time

$$Ta = G\ Fi / (e\ qa) \qquad (42)$$

Where Ta is the time of application (hrs) during peak demand
G is the gross daily volume (lit/day) needed to satisfy the crop requirements.
Fi is the irrigation frequency (days)
e is the number of emitters per plant
qa is the average discharge (lph)

\

4.3.7 Water Application Uniformity, EU

The water application efficiency in a previously installed system can be measured in the field. However, during the design phase, this efficiency should be estimated and can be done using the following equation:

$$EU = 100\ (1.0 - 1.27\ v/(e')^{0.5})\ qn/qa \qquad (43)$$

Where EU is the application uniformity (%)
v is the manufacturing variation coefficient
e' is the minimum number of emitters per plant
qn is the minimum flow, calculated by means of the pressure-discharge relationship (lph)
qa is the average discharge (lph)

Acceptable range of hydraulic head variation, ΔH

The value of ΔH it can be estimated by using the following expression:

$$\Delta H = 2.5\ (ha - hn) \qquad (44)$$

However the hn value should be known beforehand. This can be obtained resolving equation No. 43, where the acceptable values of EU are the following:

1. For emitters in crops which are permanent and semi-permanent with little separation

   a) uniform topography, EU from 86 to 90%
   b) undulant topography, EU from 84 to 90%

4.3.8 The GIC-A-GOTEO Calculation Template (Localized Agronomic Irrigation Design)

The GIC-A-GOTEO Calculation Template, based on the aforementioned theory allows one to make the agronomic calculations in order to design a localized irrigation system. It is a "user friendly" table where one has to input the information requested on an ongoing basis. The table requires some parameters, which are not necessarily easy to obtain, such as the discharge ratio "*x*" for the dripping sources. Emitter manufacturers normally provide this type of information.

The template user should select the parameter that, according to his or her criteria, better represents the conditions of the system being designed.

The GIC-A-GOTEO Calculation Template is complemented with the GIC-H-GOTEO Calculation Template, which does the hydraulic calculations for the lateral pipes, the secondary or manifold pipes, and the pump (centrifugal) close to the main or central line.

5. PIPELINE HYDRAULICS

5.1 Pipeline Flow Equations

5.1.1 Hazen-Williams

hf = 1.21*10 10 (Q/Chw) 1,852 D - 4.87 L (45)

Where: hf is the head loss (m)
Q is the flow (lps)
Chw is the Hazen-Williams friction coefficient

Chw for plastic is 140 for main lines and 120 for lateral and manifold pipes.
D is the inside diameter (mm)
L is the pipeline length (m)

5.1.2 Darcy-Weisback

hf = f L/D V2/2g (46)

Where f is the Darcy-Weisback friction factor
V is the water velocity (m/s)
G is the gravity acceleration (9.8 m/s2)

5.1.3 Minor Losses

The minor losses hf' can be estimated using the following equation:

hf' = kf V2/2g (47)

Where hf' are the minor losses (m)
kf is the minor losses factor

Minor losses caused by water emitter connections can be calculated using equation No. 48 where the fe values are obtained using the equations shown in the following table.

Fe Values

Fe Calculation for On-Line Connections	
Connection Size	**fe in Meters**
Large	fe = 22.7 $d^{-1.83}$ d in mm
Medium	fe = 20 $d^{-1.88}$ d in mm
Small	fe = 12.15 $d^{-1.77}$ d in mm
In-line Emitters	fe = 0.02 m

L' = L (Se + fe)/Se (48)

Where: L' is the pipeline length equivalent to load losses due to friction at the connection points (m)

5.1.4 Lateral and Manifold Pipeline Flow

Equation No. 46 can be complemented with the Blassius equation in order to get coefficient f

$$f = 0.32\ Re\ -0.25 \qquad (49)$$

For Re values between 3000 and 10 5

Where $$Re = 4\ Q\ /\ (\pi\ \upsilon\ D) \qquad (50)$$

Re is the Reynolds Number
υ is the water viscosity

Combining equations (46), (49) and (50) we then obtain

$$hf = 7.87*105\ L*Q\ 1.75/D\ 4.75 \qquad (51)$$

In trickle irrigation systems water flow is not constant and declines at each drip source. Assuming that the flow lost at each drip source is constant, Christiansen proposed the following equation that modifies equation No. 51

$$F = 1/(m+1) + 1/(2N) + (m - 1)0.5/(6\ N2) \qquad (52)$$

Where F is the Christiansen factor
m = 1.85 for Hazen-Williams
1.75 for Darcy-Weisback
N is the number of drip sources in the lateral pipe

If one introduces the losses due to emitter connections, represented by equation No. 48 and the Christiansen factor, into equation No. 51, then the equation that rules the water flow on lateral pipes is obtained.

$$hf = 7.87*105\ F*L'*Q\ 1.75/D\ 4.75 \qquad (53)$$

or $$hf = 7.87*105\ F*L*(Se + fe)/Se\ Q\ 1.75/D\ 4.75 \qquad (54)$$

Where hf is in meters
Se is in meters
faith is in meters
Q is in lps
D is in mm

This equation can be adapted to calculate losses caused by friction in any point x throughout the lateral pipe

$$hfx = 7.87*105\ F*L*(x/L)*(Se + fe)/Se*(Q(x/L))\ 1.75/D\ 4.75 \qquad (55)$$

5.1.5 Lateral Pipeline Layout Design on Slopped Terrain

Downstream Lateral Pipelines

When water flows in the same direction than the slope, it gains pressure. The following equations describe water flow:

$$he = ha + \tfrac{3}{4}\, hf + \Delta EL/2 \qquad (56)$$

Where he is the pressure to the lateral pipe entrance (m)
ha is the emitters average work pressure (m)

ΔEL is the elevation difference between the water's point of entry to the lateral pipe and the end of the pipe, which is to say, the closed end (m) is negative when the closed end is located at a lower elevation than the entry end.

$$hc = he – hf - \Delta EL \qquad (57)$$

Where hc is the pressure at the closed end (m)

The pressure at any point "x " throughout the lateral pipeline will be:

$$hx = he – hfx - \Delta EL*x/L \qquad (58)$$

Upstream Lateral Pipelines

The same equations used for the downstream lateral pipeline flow can be applied. However, one only has to take into consideration the ΔEL term's sign. When the lateral pipeline is carrying water against the slope, the ΔEL term is positive. The equation below can also be used in both cases:

$$hc = ha – \tfrac{1}{4}\, hf - \Delta EL/2 \qquad (59)$$

5.2 The GIC-H-GOTEO Calculation Template (Drip Irrigation Hydraulic Design)

Laterals Hydraulic Calculation

The template for the hydraulic calculation of lateral pipes has all the grid-cells protected where the calculations are done automatically. The grid-cells in which user intervention is required are unprotected and can be identified by a light green color.

The data required for the Template come from the GIC-A-GOTEO software and should be inputted into the calculation template. GIC-H-GOTEO can calculate lateral hydraulics on both ends of the secondary or manifold pipeline when the slope is zero, as well as when the slope is not zero. Calculations for the "downstream" lateral pipes and for the "upstream" lateral pipes are made separately, but in the same template.

Since the system gains pressure in the downstream lateral pipes, the length of these pipes should be greater than the length of the upstream lateral pipes. However, the pressure in the secondary pipes does need to be the same because it is common to both. This is achieved by testing both lengths until the inlet pressure for both lateral pipes is equal.

When there are lateral pipes running in just one direction (regardless of the slope) the information about the lateral pipeline length should be inputted into one of the boxes (either downstream or upstream) and a length equal to zero should be inputted for the other lateral pipeline.

Secondary or Manifold Pipeline Hydraulic Calculation

The secondary pipeline calculation is very similar to that of the laterals, except that the "downstream" or "upstream" condition is not there. The secondary pipelines minimum pressure is equal to the average calculated for the entry pressure into the lateral pipeline (this is why one should introduce a zero value when the lateral pipelines only irrigate land on one side of the secondary pipeline).

The inlet pressure of the secondary pipeline is used to calculate the pump water pressure.

Pump and Mainline Matrix Calculation

The pump calculated by the GIC-H-GOTEO Calculation Template is a centrifugal pump. GIC-H-GOTEO first calculates the suction load and compares it with the maximum permissible suction for the altitude where the system is to be installed. Then it calculates the main pipes friction losses, allowing the user to have two pipe diameters.

The static load is the difference between the water entry elevation into the secondary or manifold pipeline and the elevation where the pump is located. For the case of submersible pumps, this elevation should be the water Template dynamic level elevation.

The friction water losses caused by filters and/or the system of adding fertilizer to irrigation water can be fed into the grid-cell labeled "other."

Since the SWDSU project does not include the use of hydraulic pumps, the use of this template was limited to calculating the friction losses and the energy requirements.

APPENDIX Nº 1.

WATER BALANCE

AHUACHAPAN RESERVOIRS OPERATION SIMULATION

SCENARIO Reservoir + Gallery

Initial Water Volume in April	0	m3
Annual Evaporation	1924	mm
Infiltration Losses	0	lps/ha
Reservoir Total Capacity	630	m3
Weighted Annual Irrigated Depth	343.63	mm/ha
Global Efficiency	0.80	
Roof Runoff Coefficient	0.95	
Gallery Runoff Coefficient	0.02	

Initial Water Level in April	0.00	m Depth
Irrigated Area	1480.00	m2

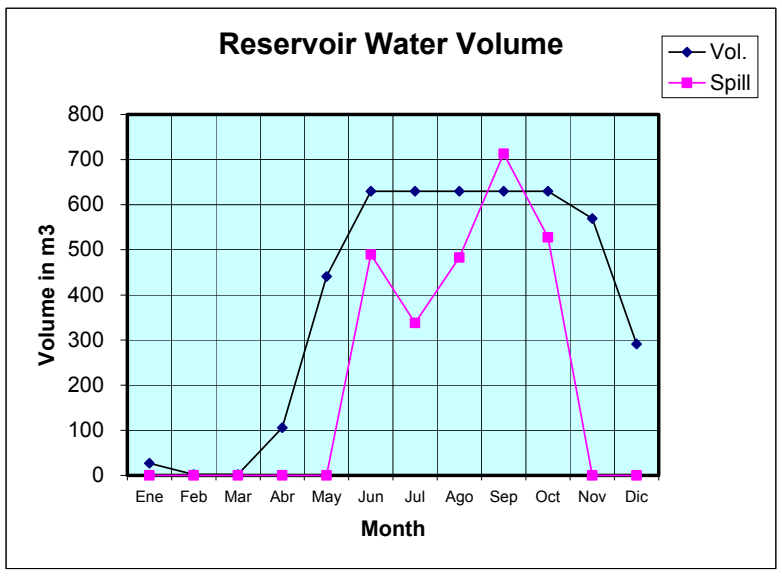
Rainfall Catchment Area		
Reservoir	486.164	m2
Roof	0	m2
Gallery Watershed	5	ha

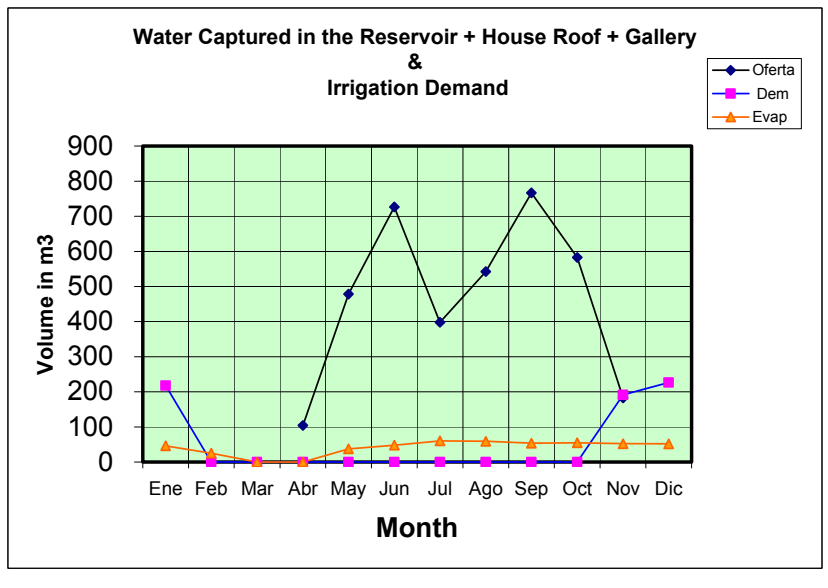
Reservoir Dimensions			
Top Length (m)	25.06	Bottom Length (m)	15.46
Top Width (m)	19.4	Bottom Width (m)	9.8
Depth (m)	2.4		
Side Slope H:1	2		
Bottom Area (m2)	151.508		

No.	Month	Days/Mo	Precip. mm	CAPTURED VOLUME (m3) Reser.	Roof	Gallery	TOTAL	Fac.Ea (%)	Ea (mm)	Surface Water (m2)	Ev (m3)	Inf. (m3)	Fac.Ir. (%)	Ir. (m3)	Vol Reservoir (m3)	Prof. (m)	Spill (m3)
1	Jan	31	3					8.75	168.4	275.1	46	0	34.28	218	27	0.17	0
2	Feb	28	6					8.24	158.6	158.3	25	0	0.00	0	2	0.04	0
3	Mar	31	26					11.31	217.7	0.0	0	0	0.00	0	2	0.04	0
4	Apr	30	70	34	0	70	104	9.04	173.9	0.0	0	0	0.00	0	106	0.57	0
5	May	31	322	157	0	322	479	8.75	168.4	222.1	37	0	0.00	0	441	1.88	0
6	Jun	30	489	238	0	489	727	7.90	152.0	317.0	48	0	0.00	0	630	2.37	490
7	Jul	31	268	130	0	268	398	8.30	159.7	379.3	61	0	0.00	0	630	2.37	338
8	Aug	31	365	177	0	365	542	8.13	156.4	379.3	59	0	0.00	0	630	2.37	483
9	Sep	30	516	251	0	516	767	7.39	142.2	379.3	54	0	0.00	0	630	2.37	713
10	Oct	31	392	191	0	392	583	7.50	144.4	379.3	55	0	0.00	0	630	2.37	528
11	Nov	30	123	60	0	123	183	7.16	137.8	379.3	52	0	30.07	191	569	2.24	0
12	Dec	31	2					7.50	144.4	357.8	52	0	35.65	227	291	1.36	0
		365	2582	1237	0	2545	3782	100.00	1924.0		490	0.00	100.00	636			2551

P = Mean Monthly Precipitation Station Santa Cruz Porrillo
Q = Reservoir Inflow m3
Fac.Ea = Evaporation monthly distribution factor mm
Ea = Evaporation
Surface Water = Top water area m2
Ev. = Evaporation losses
Inf. = Infiltration losses

Fac.Ir = Irrigation demand monthly factor
Ir = Monthly irrigation demand
Vol Reservoir = Water Volume at the end of the month
Spill = Water spilled out of the reservoir





Referencias
Evaporación de una superficie libre de Harza: Factibilidad Olomeca 1967
Precipitación del Almanaque de El Salvador 1993. Página No. 53

APPENDIX Nº 2.

RESERVOIR WATER BALANCE

San Pedro Puxtla

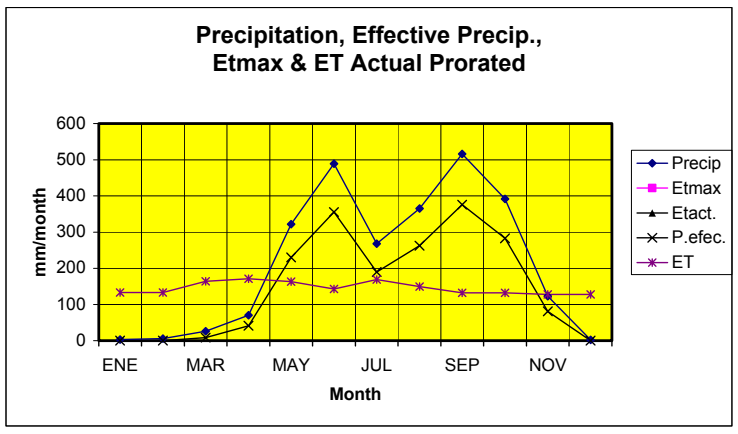
AG. HYDROLOGY BALANCE - DEMAND SCENARIO FOR 1000 m3 RESERVOIR

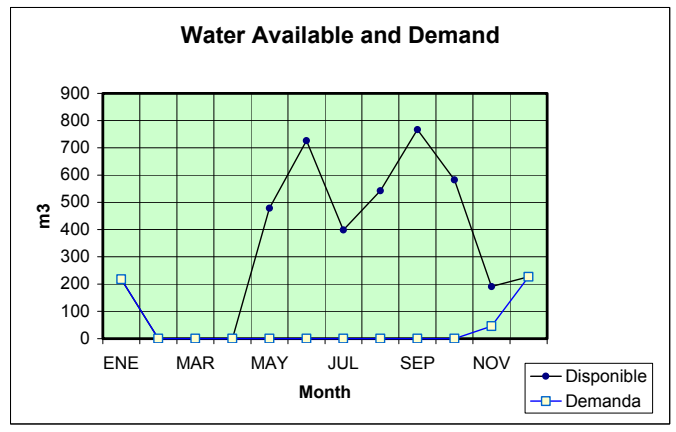
AHUACHAPAN, EL SALVADOR | **PROYECTO: RESERVORIOS** | **AREA (m2) 1480**

1a	CROP	Green Pepper	Jalapeño	Tomatoes	Zucchini	Squash	Cucumbers					TOTAL	
1b	AREA UNDER CULTIVATION, ha	0.100	0.100	0.100	0.100	0.100	0.200	0.000	0.000	0.000	0.000	0.7000	
	AREA UNDER OPTIMUM IRRIG, ha	0.021	0.021	0.021	0.021	0.021	0.042	0.000	0.000	0.000	0.000	0.1480	
	Yield Target (fraction)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
	Yield Factor Ky (FAO 33)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

2a	Perim. Max. Ha	10.00
2b	Factor Area	0.2114
2c	Cap. Canal lps	40.00

			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	CROP AREA (HA)
			31	28	31	30	31	30	31	31	30	31	30	31	365	
3a	ET (mm/day)		4.29	4.75	5.29	5.70	5.26	4.77	5.45	4.81	4.40	4.26	4.27	4.13		
3b	ET (mm/month)		133.00	133.00	164.00	171.00	163.00	143.00	169.00	149.00	132.00	132.00	128.00	128.00	1745.00	
4a	Prec. (mm.)		3.00	6.00	26.00	70.00	322.00	489.00	268.00	365.00	516.00	392.00	123.00	2.00	2582.00	
4b	Prec. Efec. (mm.)		0.00	0.00	8.25	41.25	230.25	355.50	189.75	262.50	375.75	282.75	81.00	0.00	1827.00	
5a	Kc (Crop No.1)	Green Pepper	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax		119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual		119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr. Req.(mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)		0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.021
	Net Req. (m3)		25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.29	24.35	61	
6a	Kc (Crop No.2)	Jalapeño	0.90	0.00	0.00	0.00	0.00	0.60	0.90	1.05	1.05	1.05	1.05	0.90		
	ETmax		119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	ETactual		119.70	0.00	0.00	0.00	0.00	85.80	152.10	156.45	138.60	138.60	134.40	115.20	1040.85	
	Irr. Req.(mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.40	115.20	288.30	
	Area (ha)		0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.021
	Net Req. (m3)		25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.29	24.35	61	
7a	Kc (Crop No.3)	Tomatoes	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.95	1.15	1.15	0.90		
	ETmax		106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20		
	ETactual		106.40	0.00	0.00	0.00	0.00	0.00	0.00	89.40	125.40	151.80	147.20	115.20	735.40	
	Irr. Req.(mm.)		106.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.20	115.20	287.80	
	Area (ha)		0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02		0.021
	Net Req. (m3)		22.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.99	24.35	61	
8a	Kc (Crop No.4)	Zucchini	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr. Req.(mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)		0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02		0.021
	Net Req. (m3)		25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.06	52	
9a	Kc (Crop No.5)	Squash	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr. Req.(mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)		0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02		0.021
	Net Req. (m3)		25.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.06	52.36	
10a	Kc (Crop No.6)	Cucumbers	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.00		
	ETmax		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00		
	ETactual		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.80	128.00	324.50	
	Irr. Req.(mm.)		119.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	128.00	247.70	
	Area (ha)		0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04		0.042
	Net Req. (m3)		50.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.12	105	
	Area Total (ha.)		0.15	0.00	0.00	0.00	0.00	0.04	0.04	0.06	0.06	0.06	0.15	0.15	**0.15**	Correcto
	Net Req. (m3)		174	0	0	0	0	0	0	0	0	0	37	181	392	Sum
	Net Irrig. Req. (mm)		117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.71	122.51	265.03	Sum
	Consumo Ponderado (mm)		117.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.31	122.51	343.63	
	Factor Demanda Riegos %		34.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.07	35.65	100.00	
A	Net Irrig. Req. (l/s)		0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.01	Avg
B	Net Irrig. Req. (l/s/ha)		0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.46	0.083	Avg
	WATER DEMAND															
15a	Efic. Diversion		1.00													
15b	Efic. Conveyance Main Canal		1.00													
15c	Efic. Distribution		1.00	EFFICIENCY												
15d	Efic. Aplication		0.80	0.80												
	Gross Irrig. Req. (mm)		147.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	30.893	153.143	331.286	Sum
C=A*Ef	Gross Irrig. Req. (l/s)		0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.015	Avg
	Gross Irrig. Req. (m3)		218	0	0	0	0	0	0	0	0	0	46	227	490	Sum
D=B*Ef	UNIT IRRIG. REQ. (l/s/ha.)		0.550	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.572	0.103	Avg
	WATER AVAILABLE															
16a	Name…	(m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16b	Reservoirs	(m3)	218	0	0	0	479	727	398	542	767	583	191	227	4,131	Sum
16c	River	(m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
16d	Groundwater	(m3)	0	0	0	0	0	0	0	0	0	0	0	0	0	Sum
E'	TOTAL	(m3)	218	0	0	0	479	727	398	542	767	583	191	227	4,131	Sum
E"	TOTAL	(l/s)	0.08	0.00	0.00	0.00	0.18	0.28	0.15	0.20	0.30	0.22	0.07	0.08	0.130	Avg
17a	Third Parties Water Rights (l/s)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	Avg
E=E"-17a	Actual Water Available (l/s)		0.08	0.00	0.00	0.00	0.18	0.28	0.15	0.20	0.30	0.22	0.07	0.08	0.130	Avg
	Actual Water Available (m3)		218	0	0	0	479	727	398	542	767	583	191	227	4,131	Sum
	BALANCE															
C/D	Irrigation Area (ha)		0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15		
F=E-C	Exceeding/Deficit Water (l/s)		0.00	0.00	0.00	0.00	0.18	0.28	0.15	0.20	0.30	0.22	0.06	0.00		
	Exceeding/Deficit Water (m3)		0	0	0	0	479	727	398	542	767	583	145	0	3,641	Sum
G=E/D	Max.Irrig. Area (ha)		0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.15		
H=F/D	Additional Area (has.)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00		
I	DEFICIT AREA (has.)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	NO DEFICIT





APPENDIX Nº 3.

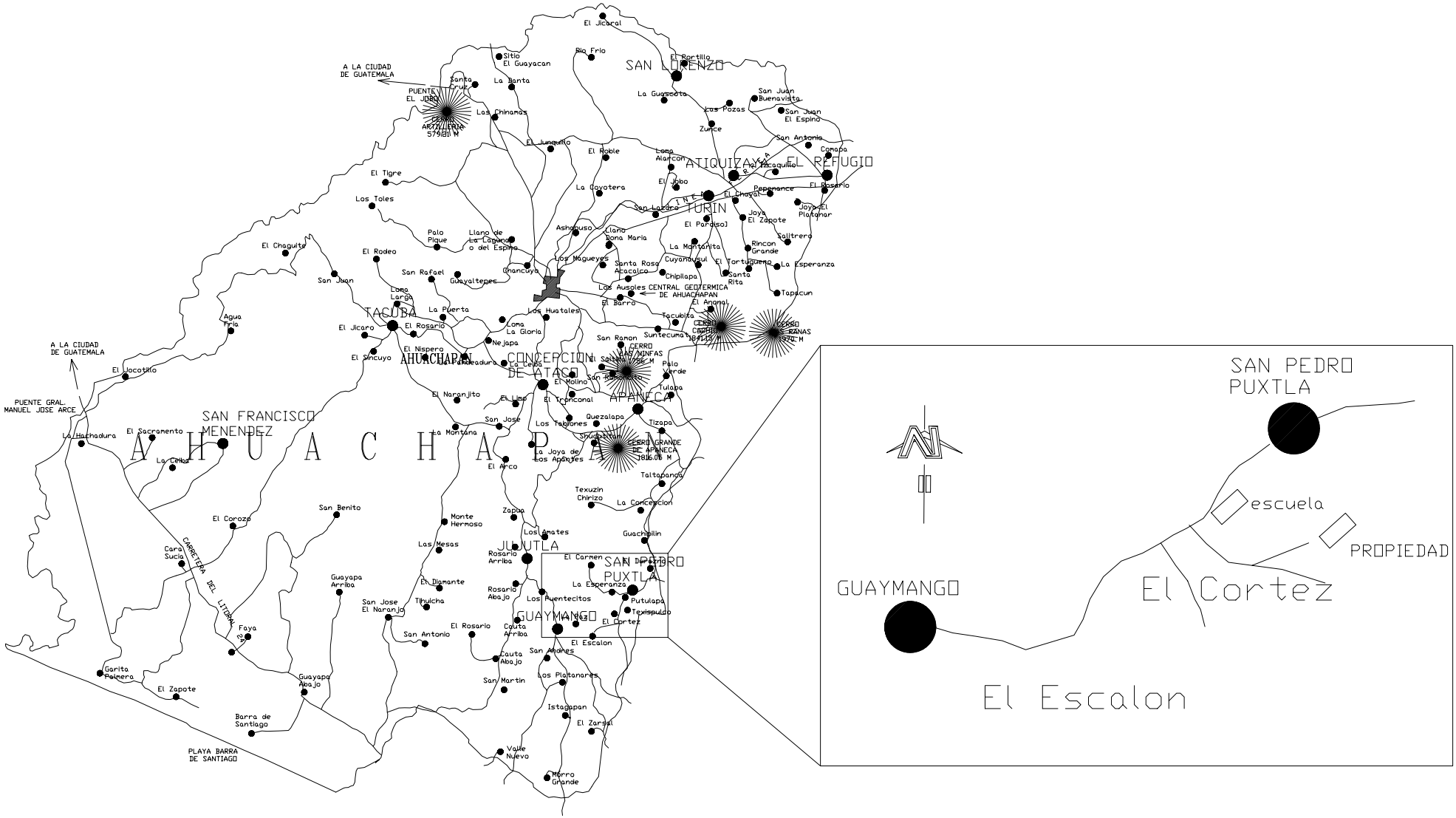
BID DRAWINGS

ANNEX R-1

RESERVOIR SYSTEM No. 1

MARGARITA JIMENEZ

Sistema		R-1
Nombre del Beneficiario		MARGARITA JIMENEZ DE LOPEZ
DUI		00494628-2
Domicilio		
Cantón		El Cortéz
Municipio		San Pedro Puxtla
Departamento		Ahuachapán
Volúmen Almacenado m3		652
Area de Riegos m2		1100
Costo de la Manta Impermeable	$	2,670.75
Costo del Movimiento de Tierras	$	6,943.01
Costo de la Galería	$	1,235.60
Costo de la Tubería	$	356.81
Costo del Cerco	$	1,838.24
Costo del Sistema de Riego	$	479.88
Costo Total	**$**	**13,524.30**
Costo por m3 de Agua Almacenada	$	20.74
Costo por m2 de Tierra Regada	$	12.29



DAUAS

care

CONTENIDO:

ESQUEMA DE UBICACION DE RESERVORIO

UBICACION

Caserìo Los Jimenez, Cantòn El Cortez
San Pedro Puxtla, Ahuachapan

BENEFICIARIA

MARGARITA JIMENEZ

CODIGO

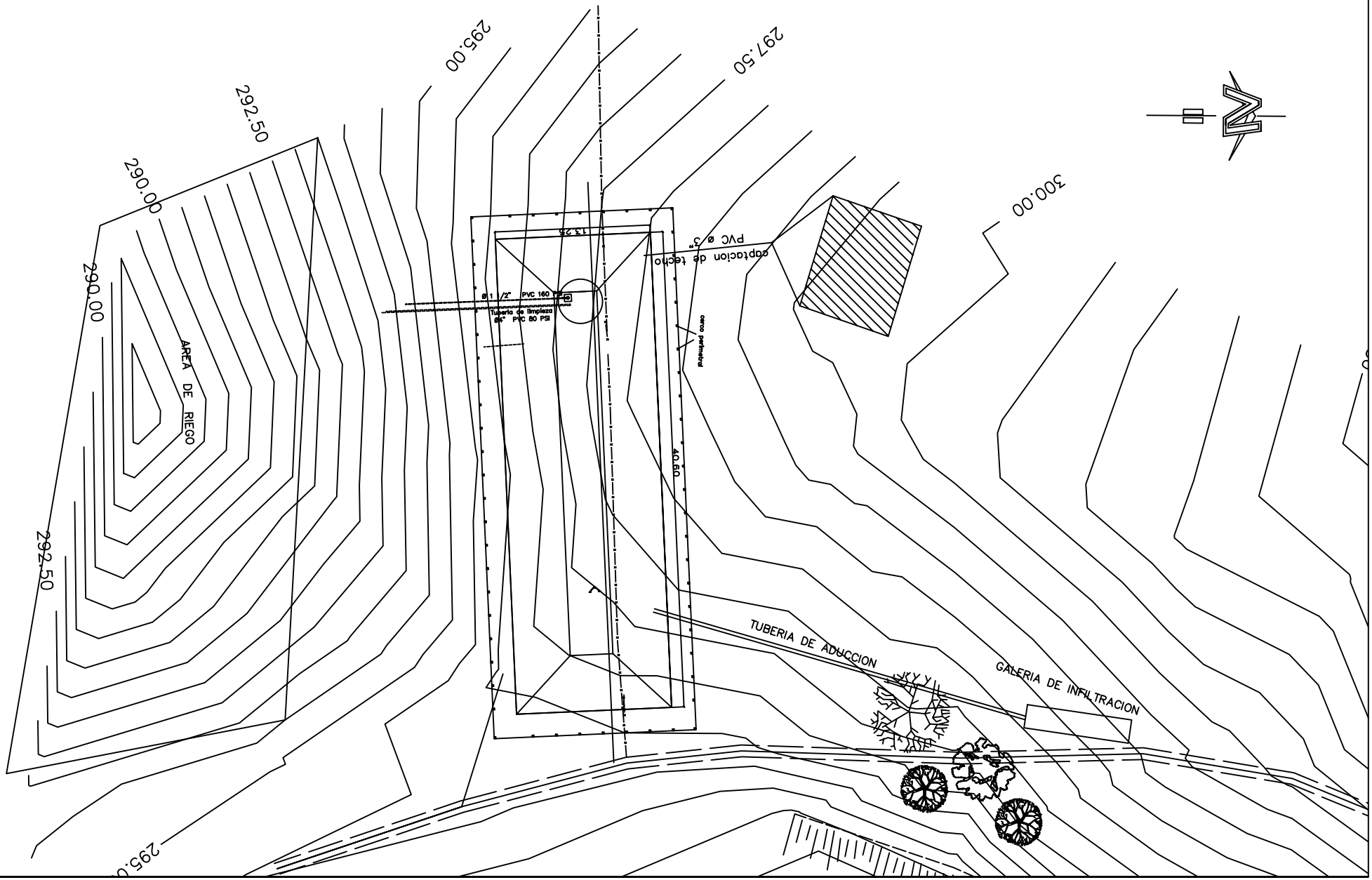
MJ—1109

FECHA

martzo de 2005

PLANO GENERAL DE UBICACION

sin escala



DAUAS / care	CONTENIDO: DETALLES DE RESERVORIO Volumen: 637.39 m3	UBICACION: Caserìo Los Jimenez, Cantòn El Cortez San Pedro Puxtla, Ahuachapan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: octubre de 2004
		BENEFICIARIA: MARGARITA JIMENEZ — CODIGO: MJ—1109	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIA

MARGARITA JIMENEZ DE LOPEZ

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **MARGARITA JIMENEZ DE LOPEZ**, con documento Unico de Identidad numero cero cero cuatrocientos noventa y cuatro mil seiscientos veintiocho guión dos, con domicilio en Caserío Los Jimenez, Cantón El Cortez, Municipio de San Pedro Puxtla, departamento de Ahuachapan, en calidad de beneficiaria-propietaria. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación:

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerias de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que la señora **Margarita Jimenez de Lopez,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agricola y piscicola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberias primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galeria de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. La beneficiaria se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. La beneficiaria se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. La propietaria se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. La propietaria da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. La propietaria se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. La propietaria dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve días del mes de septiembre del año Dos mil cuatro.

Margarita Jimenez
Beneficiaria
Margarita Jimenez de Lopez
DUI 00494628-2

Por DAUAS
Roney Gutiérrez
Pasaporte No. USA : 701584131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

MARGARITA JIMENEZ DE LOPEZ

SAN PEDRO PUXTLA, MARZO DE 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, MARGARITA JIMENEZ DE LOPEZ, de treinta y ocho años de edad, con documento Único de Identidad Numero cero cero cuatrocientos noventa y cuatro mil seiscientos veintiocho guión dos, con domicilio en Cantón El Cortez, Municipio de San Pedro Puxtla, departamento de Ahuachapan, en calidad de beneficiaria, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado "*Desviación, Almacenamiento y Uso de Aguas Lluvias*" y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en San Pedro Puxtla, a los veintinueve días del mes de marzo del año Dos mil cinco.

x Margarita Jiménez

Beneficiaria
Margarita Jiménez de Lopez
DUI No. 00494628-2

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

MARGARITA JIMENEZ

Ms. Margarita Jiménez signing an agreement to participate in the Project

Earth moving equipment during the construction of the reservoir

The reservoir is ready to have the impermeable liner installed. The trench will be used for anchoring the liner.

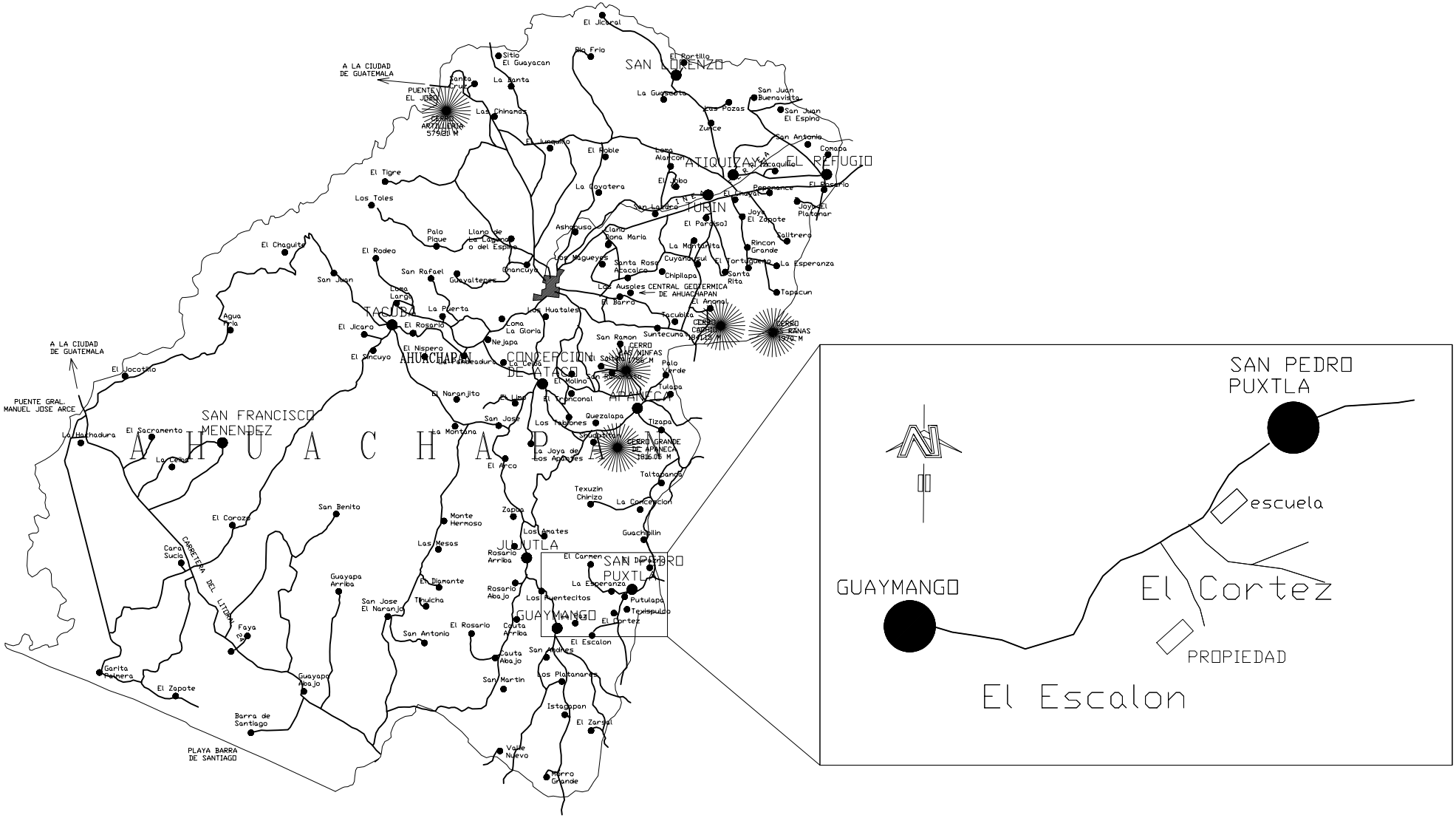
The reservoir with the liner and the irrigation water inlet tower installed.

ANNEX R-2

RESERVOIR SYSTEM No. 2

HERNAN GARCIA

Sistema		R-2
Nombre del Beneficiario		HERNAN GARCIA
DUI		0126866-2
Domicilio		
Cantón		El Cortéz
Municipio		San Pedro Puxtla
Departamento		Ahuachapán
Volúmen Almacenado m3		630
Area de Riegos m2		1300
Costo de la Manta Impermeable		2580,64
Costo del Movimiento de Tierras		6231,80
Costo de la Galería		840,00
Costo de la Tubería		487,92
Costo del Cerco		1068,34
Costo del Sistema de Riego		621,21
Costo Total	**$**	**11.829,91**
Costo por m3 de Agua Almacenada	$	18,78
Costo por m2 de Tierra Regada	$	9,10



DAUAS

care

CONTENIDO:

ESQUEMA DE UBICACION DE RESERVORIO

UBICACION

Caserìo Los Cortez, Cantòn El Cortez
San Pedro Puxtla, Ahuachapan

BENEFICIARIA

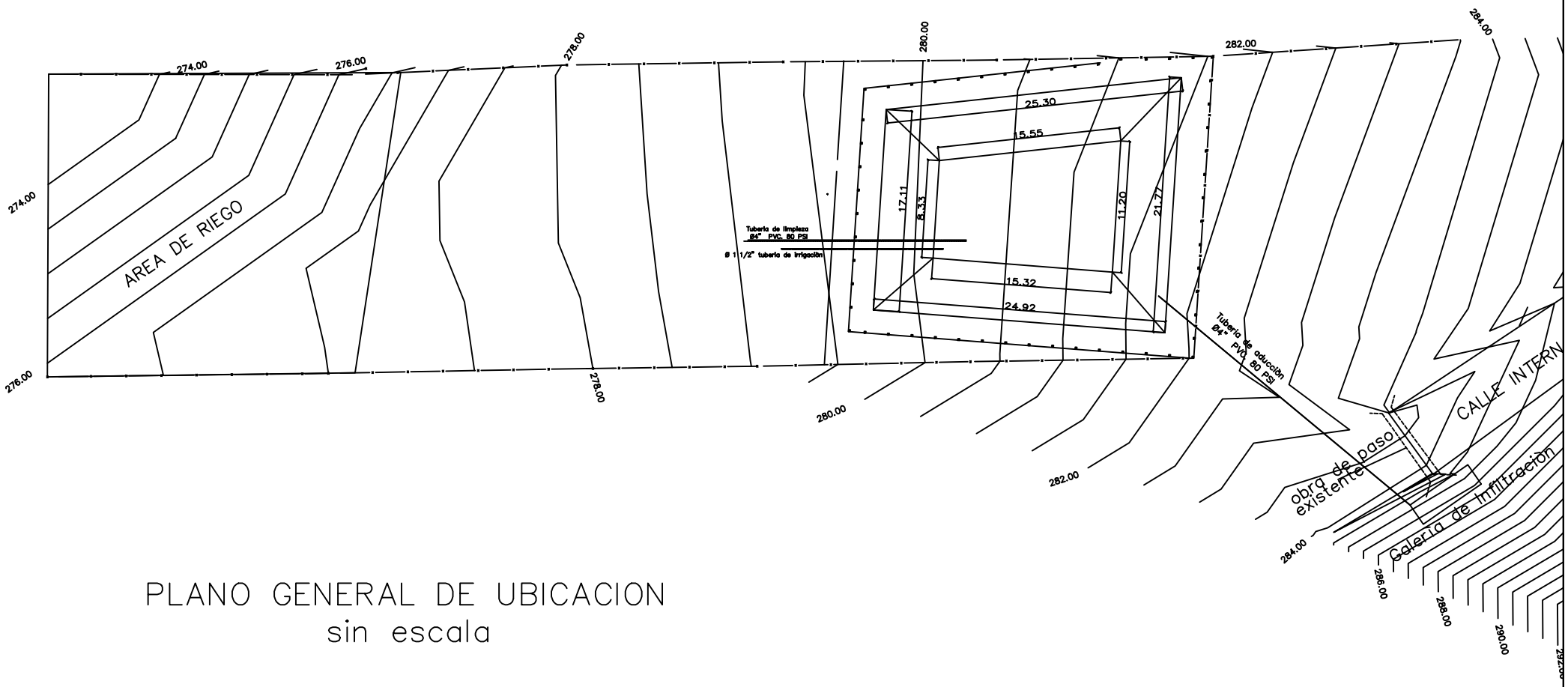
HERNAN GARCIA

CODIGO

HG—1109

FECHA

martzo de 2005



PLANO GENERAL DE UBICACION
sin escala

DAUAS / care	CONTENIDO: DETALLES DE RESERVORIO Volumen: 723.82 m3	UBICACION: Caserìo Los Cortez, Cantòn El Cortez San Pedro Puxtla, Ahuachapan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: octubre de 2004
		BENEFICIARIA: HERNAN GARCIA — CODIGO: HG—1109	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 1/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

HERNAN GARCIA

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **HERNAN GARCIA**, con documento Unico de Identidad numero cero un millón doscientos noventa y seis mil ochocientos sesenta y seis guión dos, con domicilio en Caserio Las Dos Ceibas, Cantón El Cortez, Municipio de San Pedro Puxtla, departamento de Ahuachapan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación:

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales"** a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerías de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscicolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las caniculas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **Hernan Garcia,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agricola y piscicola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve días del mes de septiembre del año Dos mil cuatro.

Beneficiario
Hernan García
DUI 01296866-2

Por DAUAS
Roney Gutiérrez
Pasaporte No. USA: 701584131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

HERNAN GARCIA

SAN PEDRO PUXTLA, MARZO DE 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, HERNAN GARCIA, de cincuenta y cinco años de edad, con documento Único de Identidad Numero cero un millón doscientos noventa y seis mil ochocientos sesenta y seis guión dos, con domicilio en Cantón El Cortez, Municipio de San Pedro Puxtla, departamento de Ahuachapan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado "*Desviación, Almacenamiento y Uso de Aguas Lluvias*" y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en San Pedro Puxtla, a los veintinueve dias del mes de marzo del año Dos mil cinco.

Beneficiario
Hernan Garcia
DUI No. 01296866-2

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

HERNAN GARCÍA

Infiltration Gallery under construction.

The gabions wall can be seen in the first plane

Pipeline to covey the water from the Gallery to the Reservoir

Reservoir’s side ditches to control the rainfall runoff

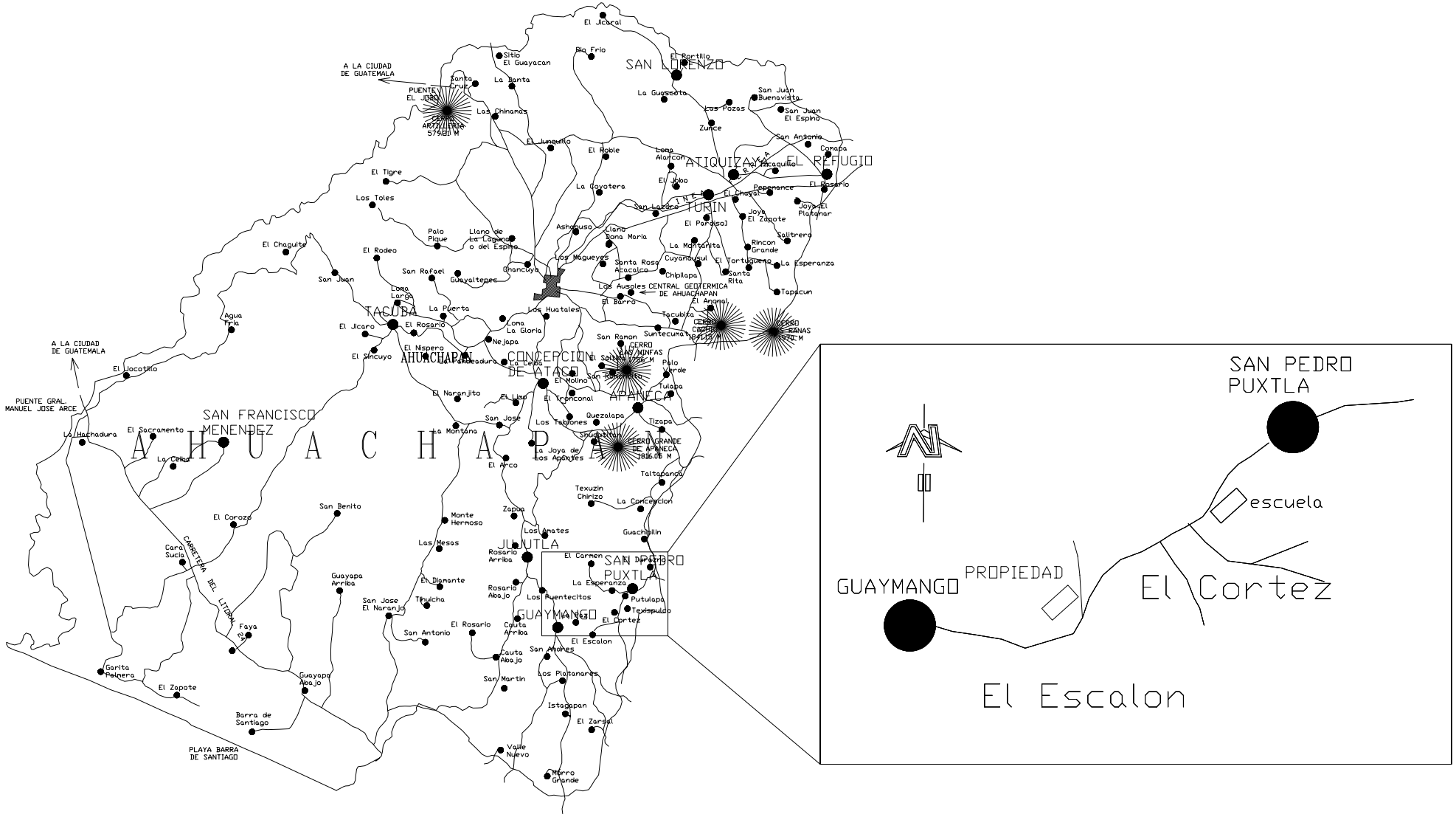
The construction work completed

ANNEX R-3

RESERVOIR SYSTEM No. 3

SANTIAGO AMAYA

Sistema		R-3
Nombre del Beneficiario		SANTIAGO AMAYA
DUI		02649151-2
Domicilio		
Cantón		Escalante
Municipio		Guaymango
Departamento		Ahuachapán
Volúmen Almacenado m3		929
Area de Riegos m2		1900
Costo de la Manta Impermeable	$	3.805,41
Costo del Movimiento de Tierras	$	8.156,31
Costo de la Galería	$	1.174,80
Costo de la Tubería	$	509,81
Costo del Cerco	$	1.306,40
Costo del Sistema de Riego	$	631,23
Costo Total	**$**	**15.583,96**
Costo por m3 de Agua Almacenada	$	16,77
Costo por m2 de Tierra Regada	$	8,20



DAUAS

care

CONTENIDO:

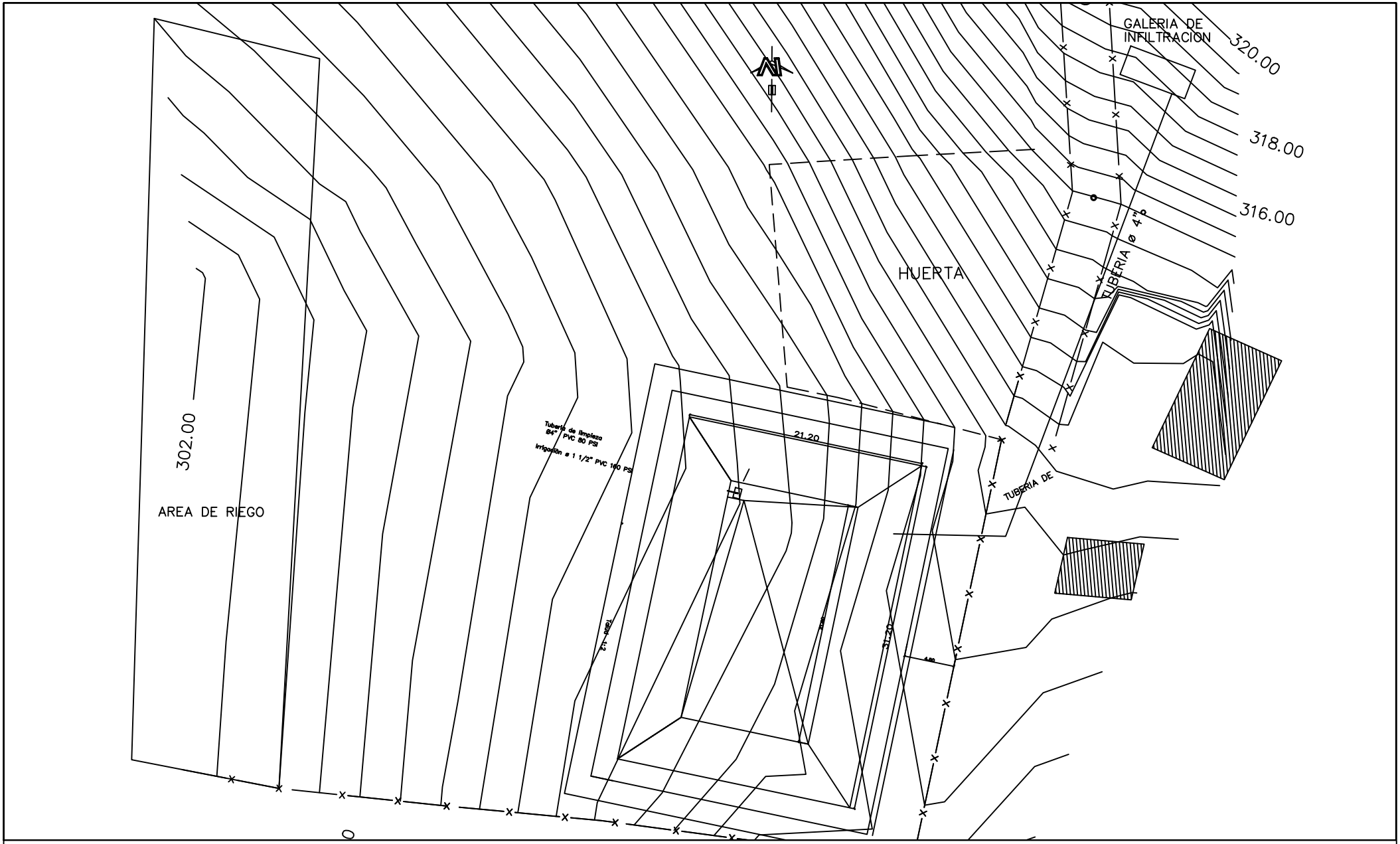
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION
Caserìo Los Ascencios, Cantòn El Escalon
Guaymango, Ahuachapan

BENEFICIARIA
SANTIAGO AMAYA

CODIGO
SA-1107

FECHA
martzo de 2005



DAUAS / care	CONTENIDO: DETALLES DE RESERVORIO Volumen: 1057.63 m3	UBICACION: Caserìo Los Ascencios, Cantòn El Escalon Guaymango, Ahuachapan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: octubre de 2004
		BENEFICIARIA: SANTIAGO AMAYA — CODIGO: SA-1107	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 1/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

SANTIAGO AMAYA

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **SANTIAGO AMAYA**, con documento Unico de Identidad numero cero dos millones seiscientos cuarenta y nueve mil ciento cincuenta y uno guión dos, con domicilio en Caserio Los Ascencios, , Cantón Escalón, Municipio de Guaymango, departamento de Ahuachapan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales"** a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerias de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las caniculas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **Santiago Amaya,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve días del mes de septiembre del año Dos mil cuatro.

Beneficiario	Por DAUAS
Santiago Amaya	Roney Gutiérrez
DUI 02649151-2	Pasaporte No. 7015 84131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

SANTIAGO AMAYA

GUAYMANGO, MARZO DE 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, SANTIAGO AMAYA, con documento Único de Identidad Numero cero dos millones seiscientos cuarenta y nueve mil ciento cincuenta y uno guion dos, con domicilio en Cantón Escalante, Municipio de Guaymango, departamento de Ahuachapan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado "*Desviación, Almacenamiento y Uso de Aguas Lluvias*" y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en Guaymango, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiario
Santiago Amaya
DUI No. 02649151-2

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

SANTIAGO AMAYA

Reservoir earthworks

Earthworks nearly completed. The shape of the reservoir can be observed.

The beneficiary pumped water from a nearby river to fill the reservoir.

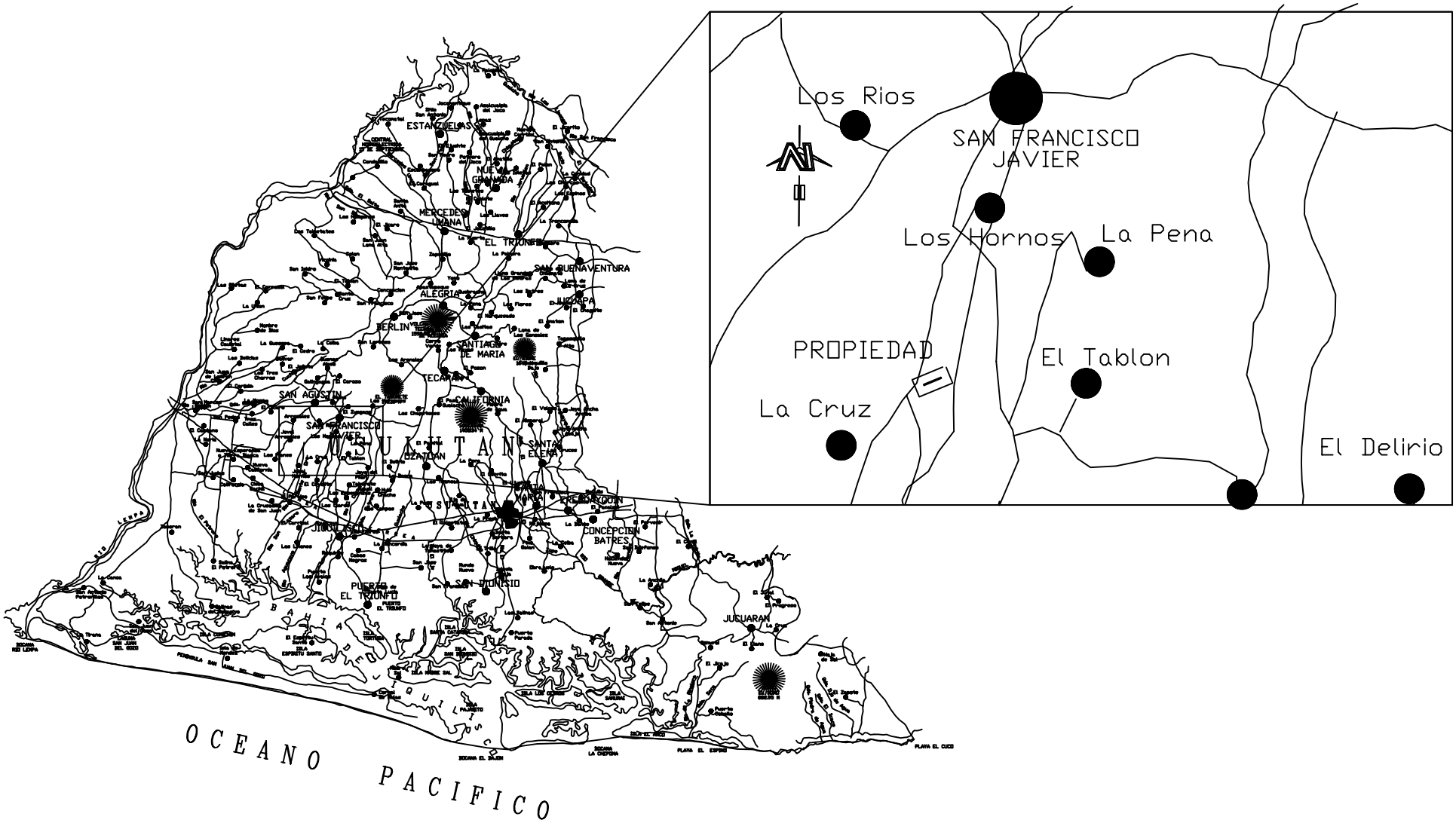
The trickle irrigation pipe network being installed

ANNEX R-4

RESERVOIR SYSTEM No. 4

DOMINGO ESCOBAR

Sistema		R-4
Nombre del Beneficiario		JOSE DOMINGO ESCOBAR
DUI		02841072-4
Domicilio		
Cantón		Los Hornos
Municipio		San Francisco Javier
Departamento		Usulután
Volúmen Almacenado m3		830
Area de Riegos m2		1500
Costo de la Manta Impermeable	$	3.399,89
Costo del Movimiento de Tierras	$	5.255,32
Costo de la Galería	$	1.192,19
Costo de la Tubería	$	675,09
Costo del Cerco	$	3.169,83
Costo del Sistema de Riego		624,2847
Costo Total	**$**	**14.316,60**
Costo por m3 de Agua Almacenada	$	17,25
Costo por m2 de Tierra Regada	$	9,54



DAUAS

care

CONTENIDO:

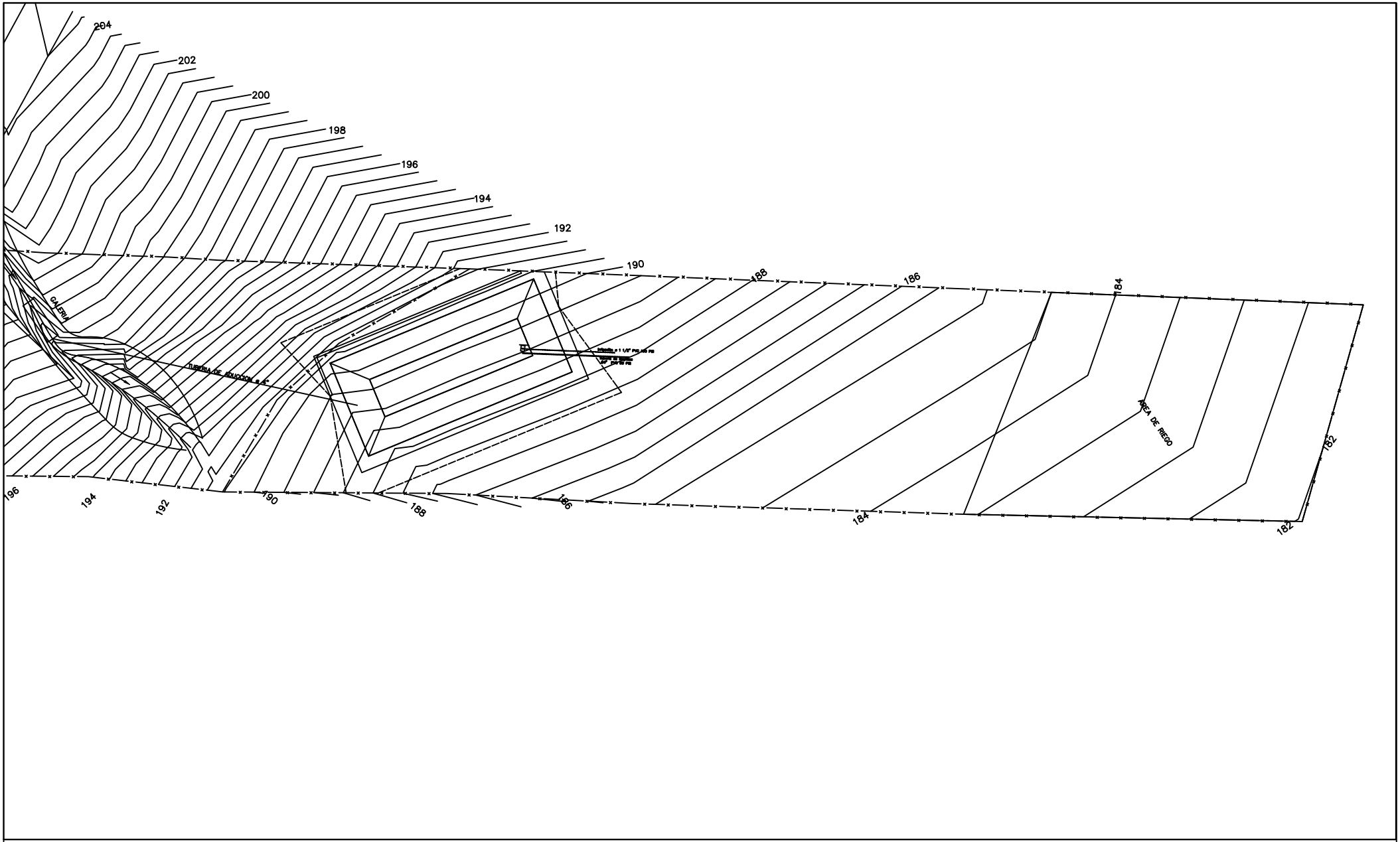
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION
colonia Santa Fe, Cantòn Los Hornos
San Francisco Javier, Usulutan

BENEFICIARIO
DOMINGO ESCOBAR

CODIGO
DE- 0514

FECHA
martzo de 2005



DAUAS

care

CONTENIDO:

DETALLES DE RESERVORIO
Volumen: 830.30 m3

UBICACION: colonia Santa Fe, Cantòn Los Hornos San Francisco Javier, Usulutan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: noviembre de 2004
BENEFICIARIO: DOMINGO ESCOBAR — CODIGO: DE- 0514	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

JOSE DOMINGO ESCOBAR

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **JOSE DOMINGO ESCOBAR**, con documento Unico de Identidad numero cero dos millones ochocientos cuatro y un mil setenta y dos guión cuatro, con domicilio en Caserio Santa Fe, Cantón Los Hornos, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación:

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerías de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **José Domingo Escobar,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cria de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve días del mes de septiembre del año Dos mil cuatro.

Beneficiario
José Domingo Escobar
DUI 02841072-4

Por DAUAS
Roney Gutiérrez
Pasaporte No. USA 70158131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

JOSE DOMINGO ESCOBAR

SAN FRANCISCO JAVIER, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, JOSE DOMINGO ESCOBAR, de cuarenta y nueve años de edad, con documento Único de Identidad Numero cero dos millones ochocientos cuarenta y un mil setenta y dos guión cuatro, con domicilio en Cantón Los Hornos, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado *"Desviación, Almacenamiento y Uso de Aguas Lluvias"* y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en San Francisco Javier, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiario
José Domingo Escobar
DUI No. 02841072-4

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

DOMINGO ESCOBAR

Reservoir site alter clearing the organic soil.

The pipeline from the gallery to the reservoir, where the flow diversion valve can be observed.

The reservoir construction works completed

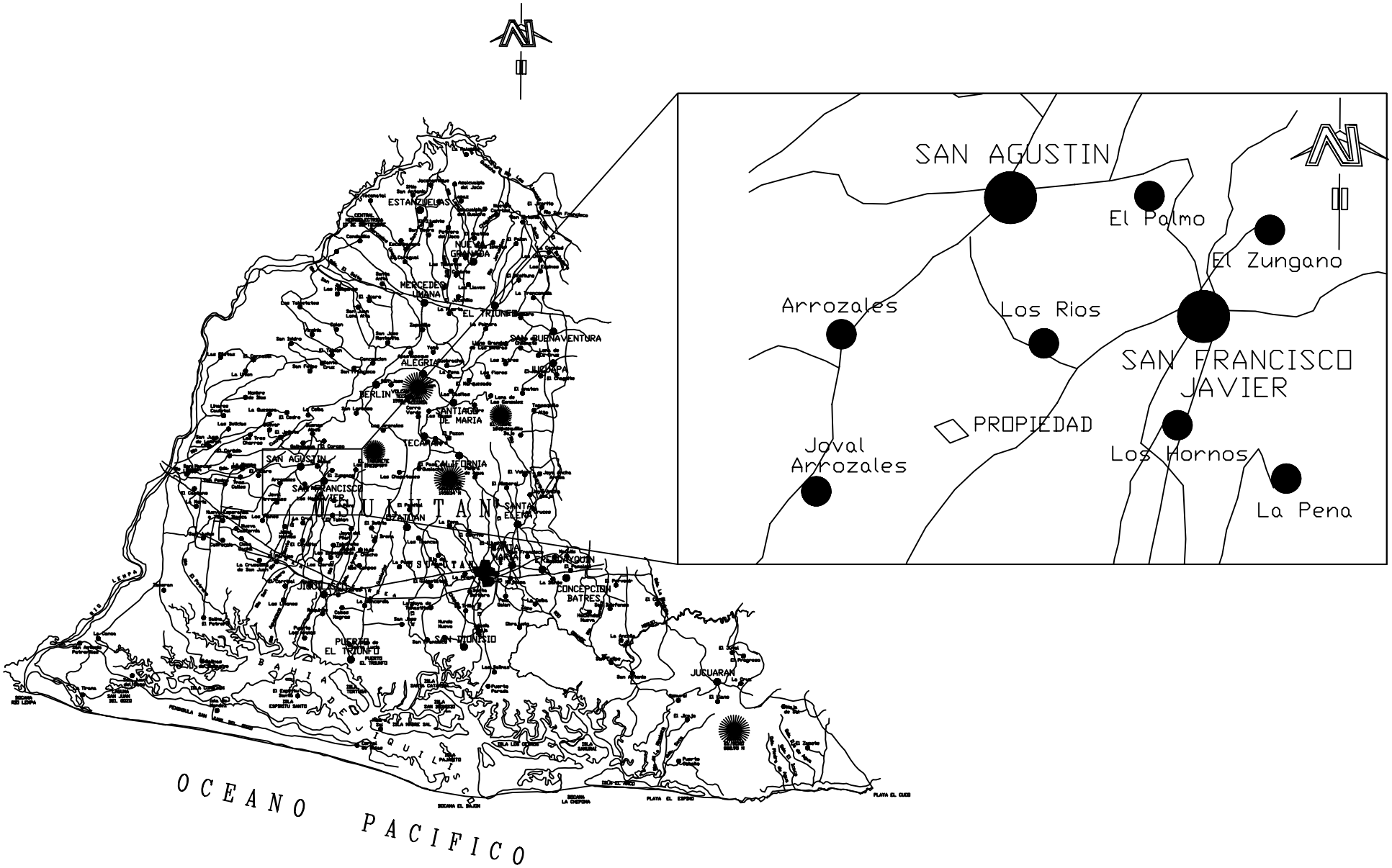
USAID sign with the basic information about the system.

ANNEX R-5

RESERVOIR SYSTEM No. 5

LEONARDO QUINTANILLA

Sistema		R-5
Nombre del Beneficiario		OSCAR LEONARDO QUINTANILLA CASTILLO
DUI		01162571-9
Domicilio		
Cantón		Jobal Hornos
Municipio		San Francisco Javier
Departamento		Usulután
Volúmen Almacenado m3		811
Area de Riegos m2		1700
Costo de la Manta Impermeable	$	3.322,06
Costo del Movimiento de Tierras	$	4.940,14
Costo de la Galería	$	1.437,41
Costo de la Tubería	$	675,09
Costo del Cerco	$	3.274,27
Costo del Sistema de Riego	$	367,80
Costo Total	**$**	**14.016,76**
Costo por m3 de Agua Almacenada	$	17,28
Costo por m2 de Tierra Regada	$	8,25



DAUAS

care

CONTENIDO:

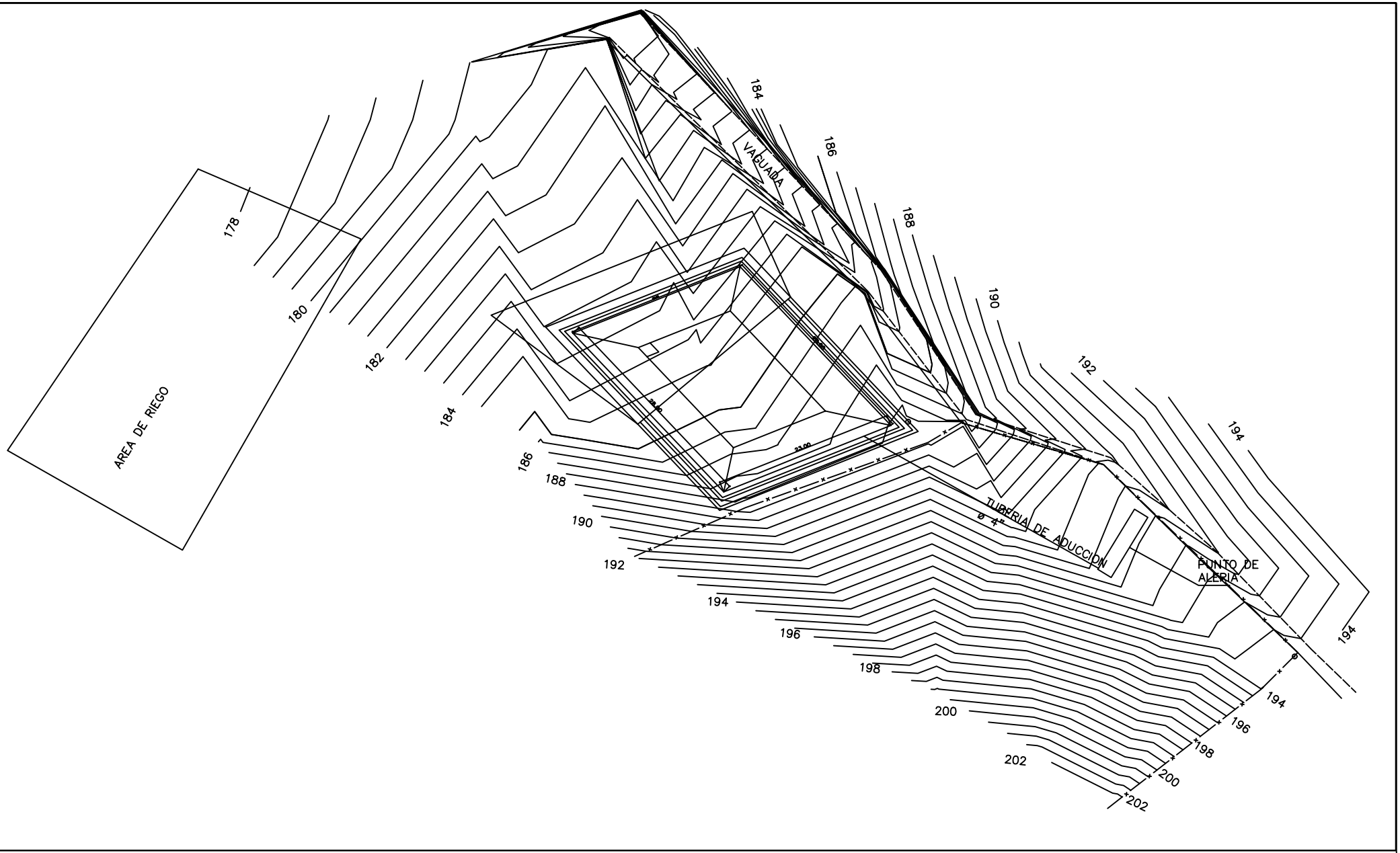
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION:
Caserio Palo de Agua, Cantòn Joval Hornos
San Francisco Javier, Usulutan

BENEFICIARIO:
OSCAR LEONARDO QUINTANILLA

CODIGO
OQ- 0514

FECHA
martzo de 2005



DAUAS

care

CONTENIDO:

DETALLES DE RESERVORIO
Volumen: 926.76 m3

UBICACION: Caserio Palo de Agua, Cantón Joval Hornos San Francisco Javier, Usulutan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: noviembre de 2004
BENEFICIARIO: OSCAR LEONARDO QUINTANILLA — CODIGO: OQ- 0514	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

OSCAR LEONARDO QUINTANILLA CASTILLO

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS),* ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **OSCAR LEONARDO QUINTANILLA CASTILLO**, con documento Unico de Identidad numero cero un millon ciento sesenta y dos mil quinientos sesenta y uno guión nueve, con domicilio en Caserío Joval Hornos, Cantón Joval Hornos, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación:

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerías de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **Oscar Leonardo Quintanilla Castillo,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y

mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve dias del mes de septiembre del año Dos mil cuatro.

Beneficiario	Por DAUAS
Oscar Leonardo Quintanilla	Roney Gutiérrez
DUI 01162561-9	Pasaporte No: 70158413

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

OSCAR LEONARDO QUINTANILLA CASTILLO

SAN FRANCISCO JAVIER, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, OSCAR LEONARDO QUINTANILLA CASTILLO, de cincuenta años de edad, con documento Único de Identidad Numero cero un millón ciento sesenta y dos mil quinientos sesenta y uno guión nueve, con domicilio en Cantón Jobal Hornos, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado *"Desviación, Almacenamiento y Uso de Aguas Lluvias"* y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.

3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en San Francisco Javier, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiario
Oscar Leonardo Quintanilla Castillo
DUI No. 01162561-9

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

LEONARDO QUINTANILLA

The agreement to participate in the Project is being signed.

The reservoir under construction

The infiltration gallery works completed.

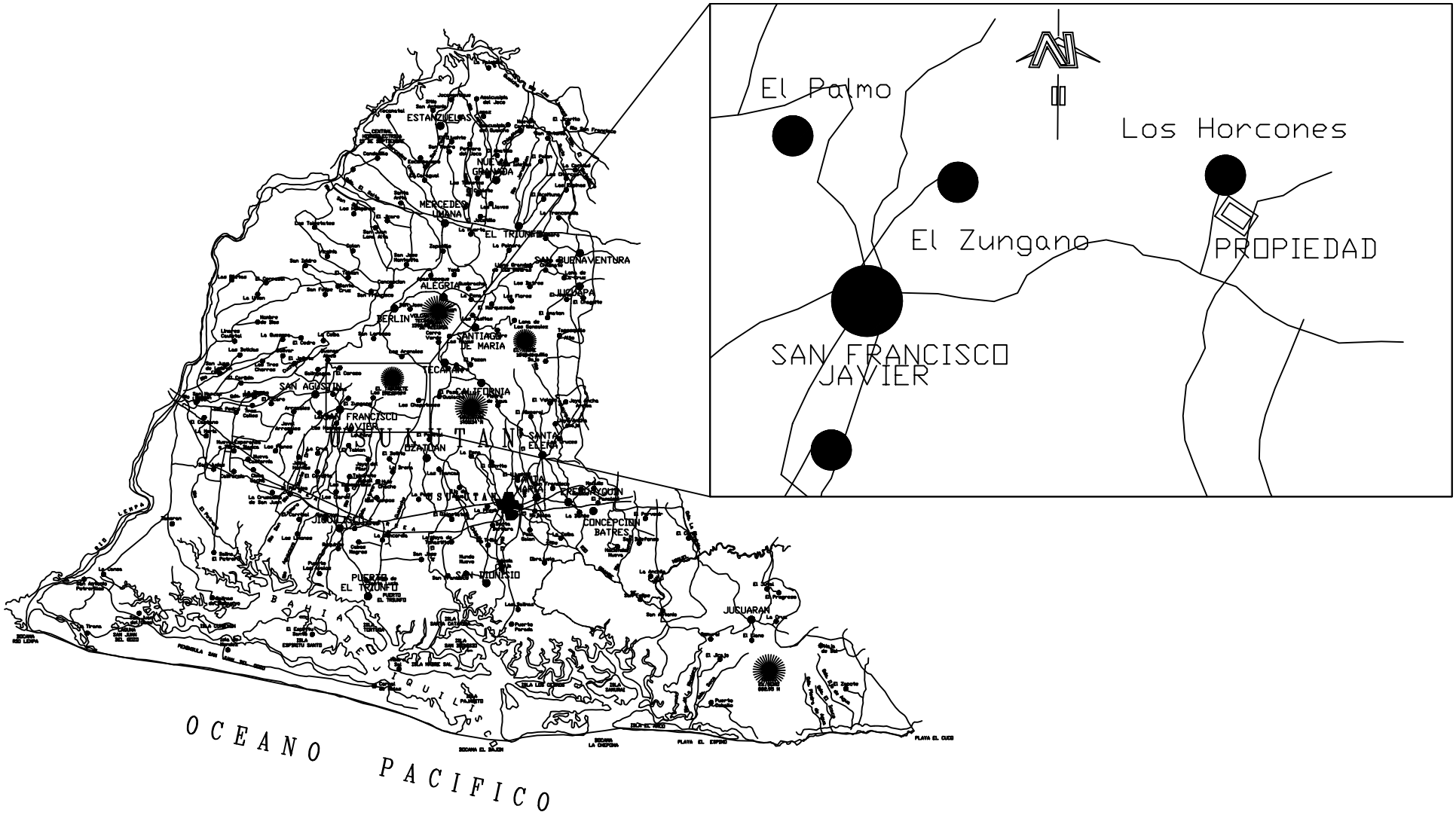
The liner on the reservoir can be observed.

ANNEX R-6

RESERVOIR SYSTEM No. 6

SANTIAGO RIVAS

Sistema		R-6
Nombre del Beneficiario		SANTIAGO DE JESUS RIVAS
DUI		01290271-3
Domicilio		
Cantón		Los Horcones
Municipio		San Francisco Javier
Departamento		Usulután
Volúmen Almacenado m3		985
Area de Riegos m2		2000
Costo de la Manta Impermeable		4034,803665
Costo del Movimiento de Tierras		6615,51
Costo de la Galería		1322,92
Costo de la Tubería		821,5
Costo del Cerco		3347,63
Costo del Sistema de Riego		748,9042
Costo Total	**$**	**16.891,27**
Costo por m3 de Agua Almacenada	$	17,15
Costo por m2 de Tierra Regada	$	8,45



DAUAS

care

CONTENIDO:

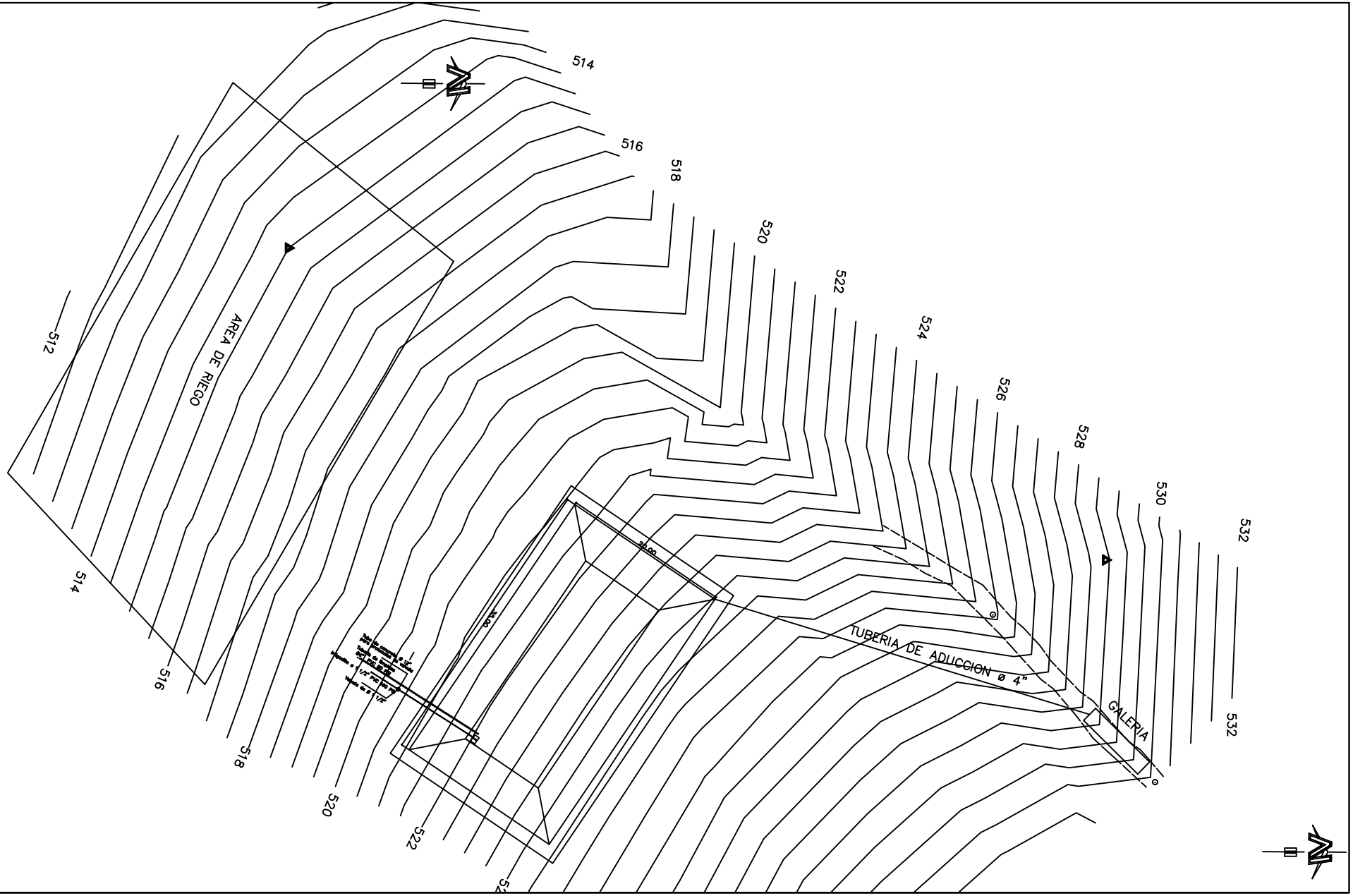
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION: Caserìo Los Horcones, Cantòn Los Horcones
San Francisco Javier, Usulutan

BENEFICIARIO: JESUS SANTIAGO RIVAS

CODIGO: JR- 0514

FECHA: martzo de 2005



DAUAS

care

CONTENIDO:

DETALLES DE RESERVORIO
Volumen: 1120.23 m3

UBICACION: Caserìo Los Horcones, Cantòn Los Horcones San Francisco Javier, Usulutan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: octubre de 2004
BENEFICIARIO: JESUS SANTIAGO RIVAS — CODIGO: JR- 0514	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

SANTIAGO DE JESUS RIVAS

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **SANTIAGO DE JESUS RIVAS**, con documento Unico de Identidad numero cero un millon doscientos noventa mil doscientos setenta y uno guión tres, con domicilio en Caserío Los Horcones, Cantón Los Horcones, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación.

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerías de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **Santiago de Jesus Rivas,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve días del mes de septiembre del año Dos mil cuatro.

Beneficiario	Por DAUAS
Santiago de Jesus Rivas	Roney Gutiérrez
DUI 01290271-3	Pasaporte No. UA7015 84131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

SANTIAGO DE JESUS RIVAS

SAN FRANCISCO JAVIER, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y
COMPROMISO DE USO Y MANTENIMIENTO

YO, SANTIAGO DE JESUS RIVAS, de cuarenta y un años de edad, con documento Único de Identidad Numero cero un millón doscientos noventa mil doscientos setenta y uno guión tres, con domicilio en Cantón Los Horcones, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado *"Desviación, Almacenamiento y Uso de Aguas Lluvias"* y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en San Francisco Javier, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiario
Santiago de Jesús Rivas
DUI No. 01290271-3

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

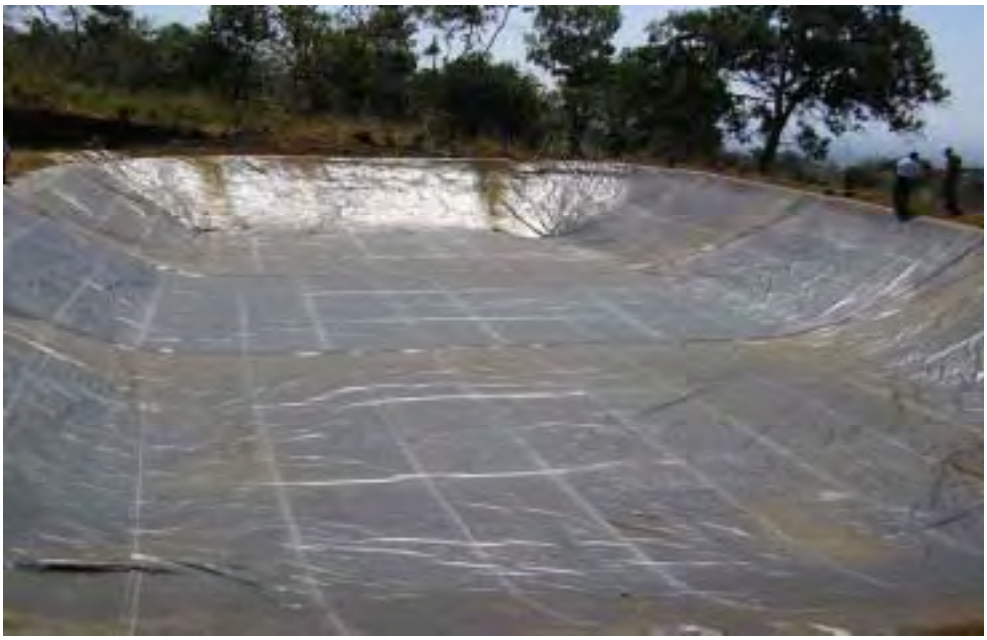
Por USAID

Doc.

SANTIAGO RIVAS

The reservoir under construction.

The impermeable membrane being installed.



The earthwork and liner installation are completed.

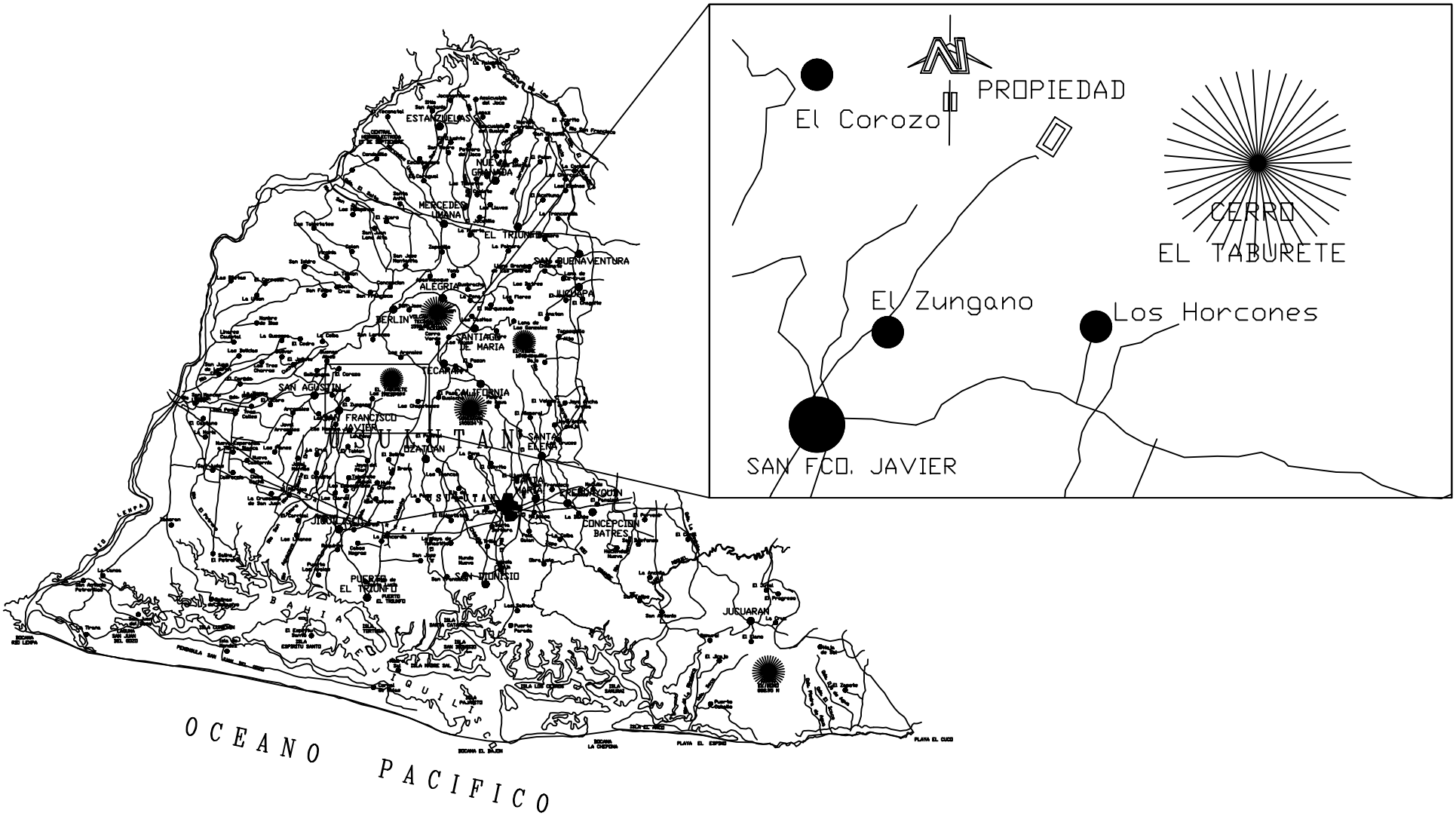
Detail of the reservoir spillway under construction.

ANNEX R-7

RESERVOIR SYSTEM No. 7

DAVID LOPEZ

Sistema		R-7
Nombre del Beneficiario		LUIS DAVID LOPEZ SANCHEZ
DUI		00951351-3
Domicilio		
Cantón		El Zúngano
Municipio		San Francisco Javier
Departamento		Usulután
Volúmen Almacenado m3		643
Area de Riegos m2		1300
Costo de la Manta Impermeable	$	2.633,89
Costo del Movimiento de Tierras	$	6.037,65
Costo de la Galería	$	1.322,98
Costo de la Tubería	$	1.331,84
Costo del Cerco	$	3.015,87
Costo del Sistema de Riego	$	562,37
Costo Total	**$**	**14.904,59**
Costo por m3 de Agua Almacenada	$	23,18
Costo por m2 de Tierra Regada	$	11,47



DAUAS

care

CONTENIDO:

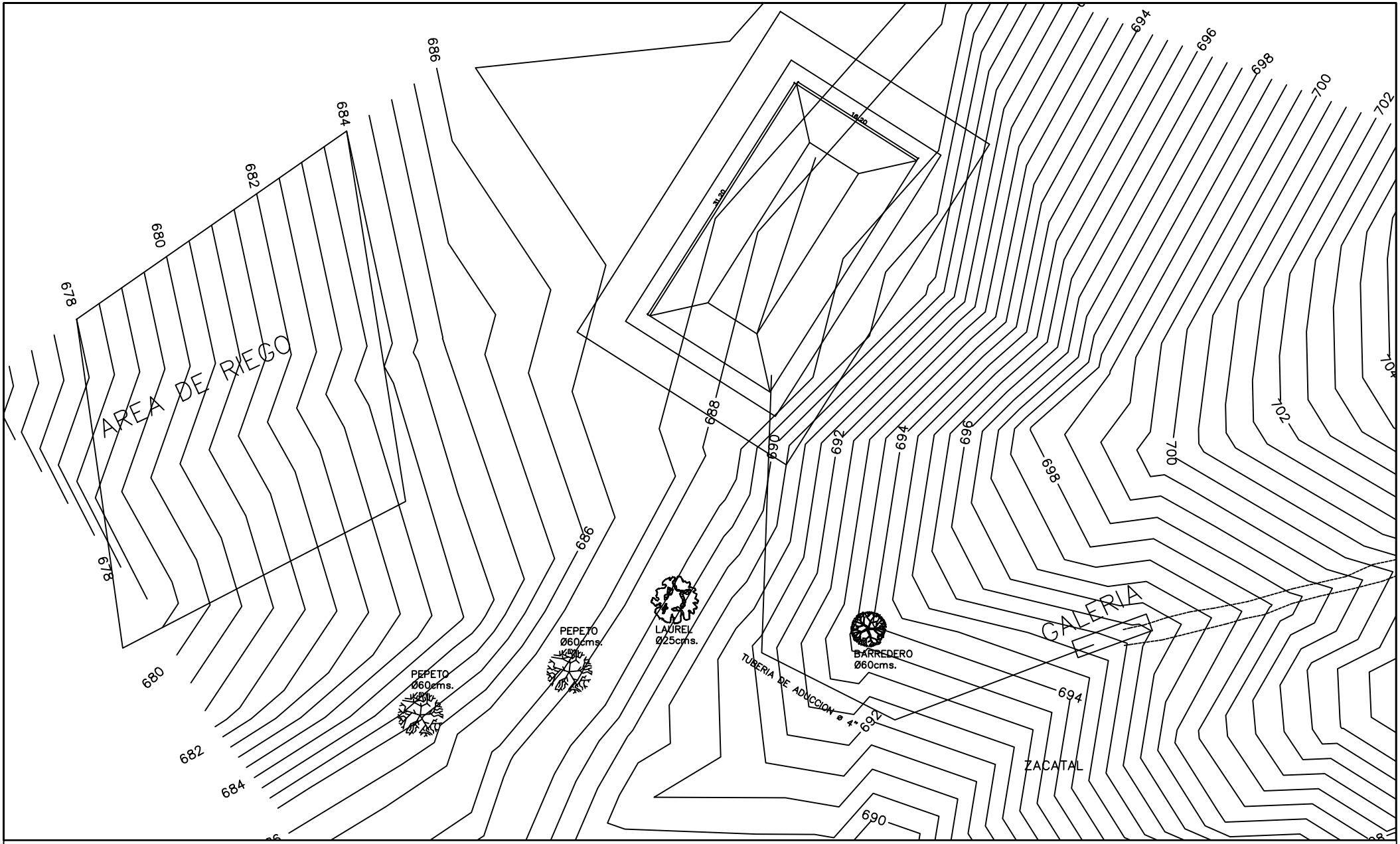
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION
Caserìo El Zùngano, Cantòn El Zùngano
San Francisco Javier, Usulutan

BENEFICIARIA
LUIS DAVID LOPEZ

CODIGO
LL- 0514

FECHA
martzo de 2005



DAUAS

care

CONTENIDO:

DETALLES DE RESERVORIO
Volumen: 740.82 m3

UBICACION: Caserìo El Zùngano, Cantòn El Zùngano San Francisco Javier, Usulutan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: octubre de 2004
BENEFICIARIA: LUIS DAVID LOPEZ — CODIGO: LL- 0514	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

LUIS DAVID LOPEZ SANCHEZ

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **LUIS DAVID LOPEZ SANCHEZ**, con documento Unico de Identidad numero cero cero novecientos cincuenta y un mil trecientos cincuenta y uno guión tres, con domicilio en Caserío El Zungano, Cantón El Zungano, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación.

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerias de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las caniculas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **Luis David López Sanchez,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve días del mes de septiembre del año Dos mil cuatro.

Beneficiario
Luis David Lopez Sanchez
DUI 00951351-3

Por DAUAS
Roney Gutiérrez
Pasaporte No. USA: 701584B1

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

LUIS DAVID LOPEZ SANCHEZ

SAN FRANCISCO JAVIER, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, LUIS DAVID LOPEZ SANCHEZ, de cincuenta y un años de edad, con documento Único de Identidad Numero cero cero novecientos cincuenta y un mil trescientos cincuenta y uno guión tres, con domicilio en Cantón El Zungano, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado "*Desviación, Almacenamiento y Uso de Aguas Lluvias*" y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las caniculas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentia, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerias de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en San Francisco Javier, a los veintinueve días del mes de marzo del año Dos mil cinco.

× _____
Beneficiario
Luís David López Sánchez
DUI No. 00951351-3

_____
Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

_____
Por USAID

_____

Doc._____

LUIS DAVID LOPÉZ

A view of the infiltration gallery

The reservoir being inspected

Details of the liner anchor trench

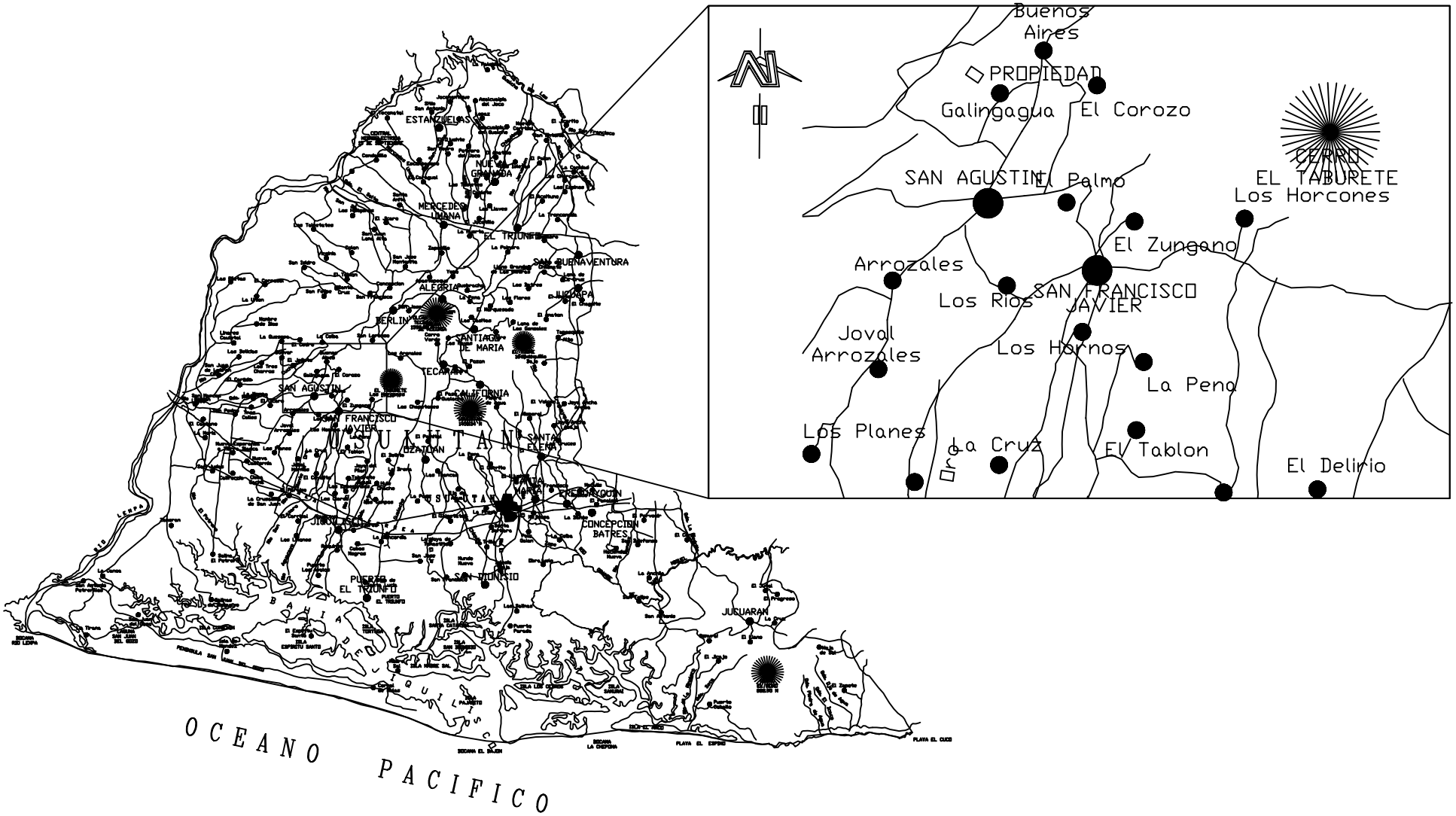
A general view of the reservoir

ANNEX R-8

RESERVOIR SYSTEM No. 8

CARLOS MELENDEZ

Sistema		R-8
Nombre del Beneficiario		COOPERATIVA LA BOMBA
Representante Legal		José Carlos Melendéz Merino
DUI		02800598-5
Domicilio		
Cantón		Galingagua
Municipio		San Agustín
Departamento		Usulután
Volúmen Almacenado m3		2177
Area de Riegos m2		4400
Costo de la Manta Impermeable	$	8.917,53
Costo del Movimiento de Tierras	$	8.039,89
Costo de la Galería	$	2.696,40
Costo de la Tubería	$	557,29
Costo del Cerco	$	4.335,69
Costo del Sistema de Riego	$	1.149,27
Costo Total	**$**	**25.696,07**
Costo por m3 de Agua Almacenada	$	11,80
Costo por m2 de Tierra Regada	$	5,84



DAUAS

care

CONTENIDO:

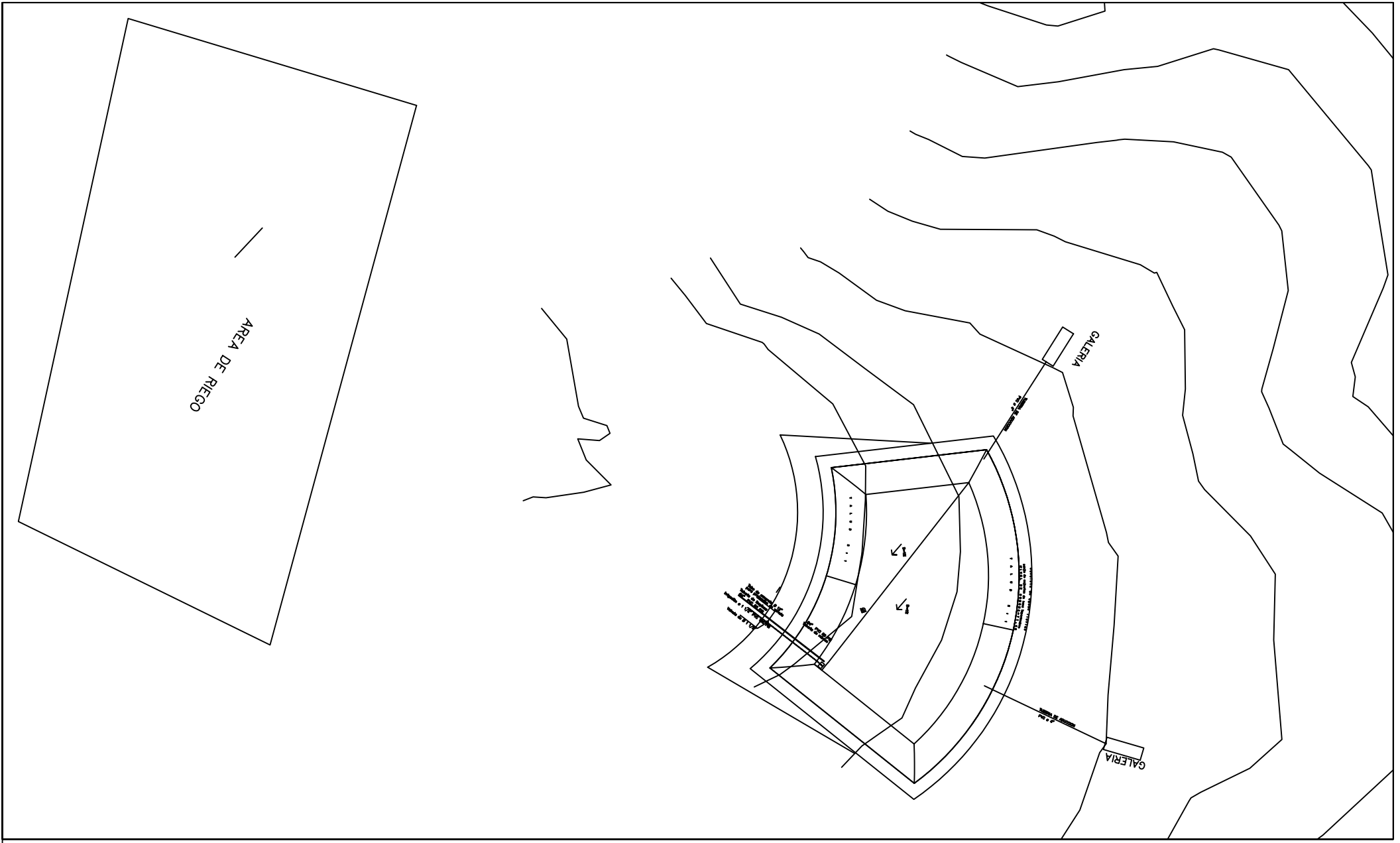
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION
Caserìo Los Patios, Cantòn Galingagua
San Agustìn, Usulutan

BENEFICIARIA
COOPERATIVA LA BOMBA

CODIGO
MJ–1109

FECHA
martzo de 2005



DAUAS

care

CONTENIDO:

PLANTA GENERAL DE DISTRIBUCION

VOLUMEN=2438.20 m3

UBICACION: Caserìo Los Patios, Cantòn Galingagua San Agustìn, Usulutan

BENEFICIARIA: COOPERATIVA LA BOMBA

CODIGO: MJ-1109

DISEÑO	APROBO	FECHA
Jorge Sosa	Carlos Gandarillas	diciembre de 2004
REVISO	DIBUJO	ESCALA
Jorge Herrera	Jorge Sosa	indicadas

HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

JOSE CARLOS MELENDEZ MERINO
REPRESENTANTE LEGAL
COOPERATIVA LA BOMBA

SAN AGUSTIN, NOVIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **JOSE CARLOS MELENDEZ MERINO**, con documento Unico de Identidad Numero cero dos millones ochocientos mil quinientos noventa y ocho guión cinco, con domicilio en Caserio Los Patios, Cantón Galingagua, Municipio de San Agustin, departamento de Usulutan, en calidad de beneficiario-Representante Legal de la Cooperativa La Bomba. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación:

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerías de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos horticolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que los socios y socias de **La Cooperativa La Bomba,** tienen un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y

mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en San Agustín, a los veinticuatro días del mes de noviembre del año Dos mil cuatro.

Beneficiario
José Carlos Melendez
DUI # 02800598-5
Representante Legal Cooperativa La Bomba.

Por DAUAS
Roney Gutiérrez
Pasaporte US #. 701584131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

JOSE CARLOS MELENDEZ MERINO
REPRESENTATE LEGAL
COOPERATIVA LA BOMBA

SAN AGUSTIN, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, JOSE CARLOS MELENEZ MERINO, de cincuenta y tres años de edad, con documento Único de Identidad Numero cero dos millones ochocientos mil quinientos noventa y ocho guión cinco, con domicilio en Cantón Galingagua, Municipio de San Agustin, departamento de Usulutan, en calidad de Representante Legal de la Cooperativa Agropecuaria La Bomba, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado "*Desviación, Almacenamiento y Uso de Aguas Lluvias*" y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.

3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en San Agustin, a los veintinueve días del mes de marzo del año Dos mil cinco.

Representante legal Coop. La Bomba
José Carlos Melendez Merino
DUI No. 01804813-5

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

COOPERATIVA LA BOMBA

Earthworks during the early stages of construction.

A bulldozer erecting the embankment.

A general view of the reservoir during construction. This is the largest reservoir

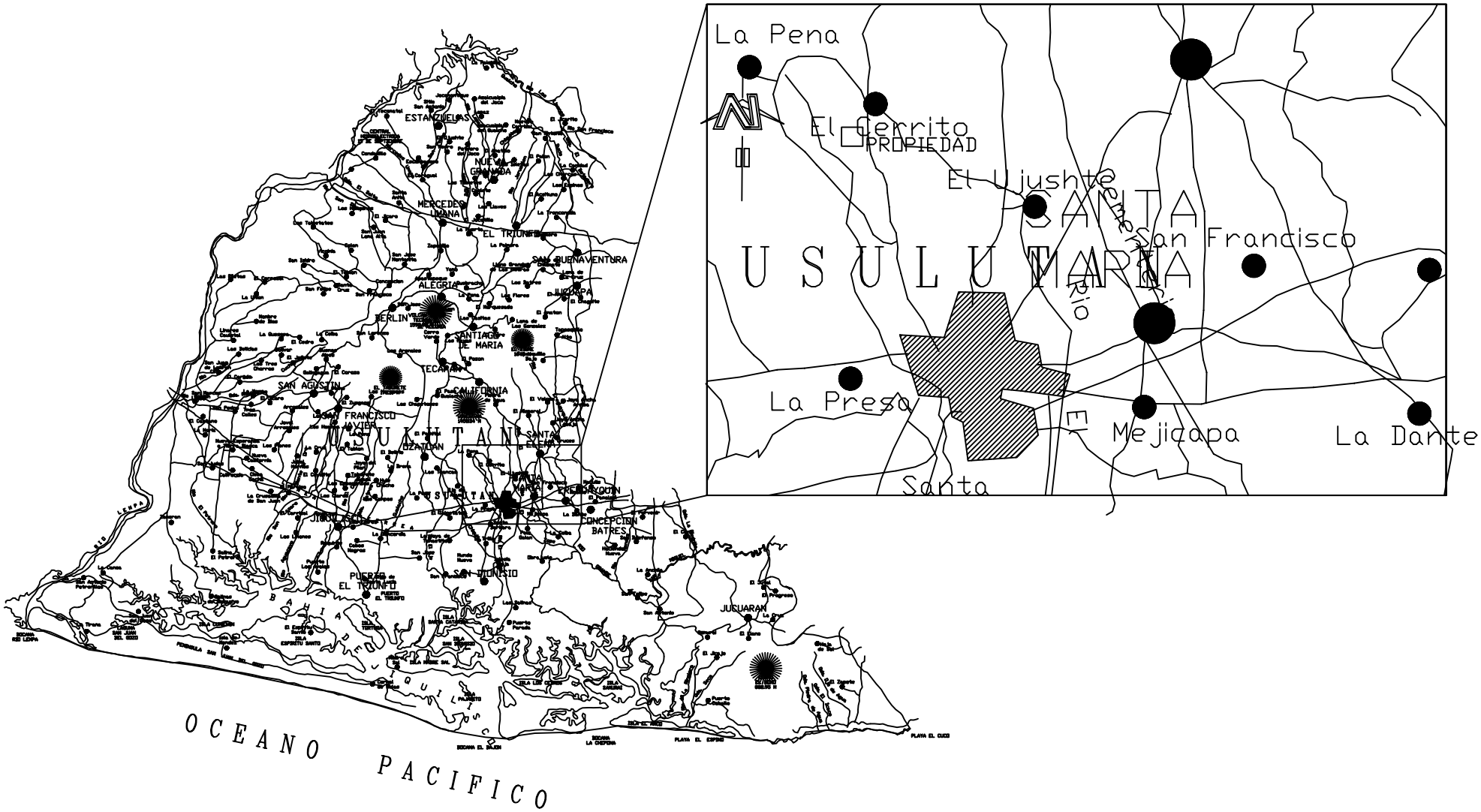
One of the two infiltration galleries.

ANNEX R-9

RESERVOIR SYSTEM No. 9

ARNOLDO PARADA

Sistema		R-9
Nombre del Beneficiario		JOSE ARNOLDO PARADA GIRON
DUI		01804813-5
Domicilio		
Cantón		Los Chapetones
Municipio		Tecapán
Departamento		Usulután
Volúmen Almacenado m3		822
Area de Riegos m2		1580
Costo de la Manta Impermeable	$	3.367,12
Costo del Movimiento de Tierras	$	5.637,48
Costo de la Galería	$	2.631,66
Costo de la Tubería	$	1.374,24
Costo del Cerco	$	3.862,12
Costo del Sistema de Riego	$	640,75
Costo Total	**$**	**17.513,36**
Costo por m3 de Agua Almacenada	$	21,31
Costo por m2 de Tierra Regada	$	11,08



DAUAS

care

CONTENIDO:

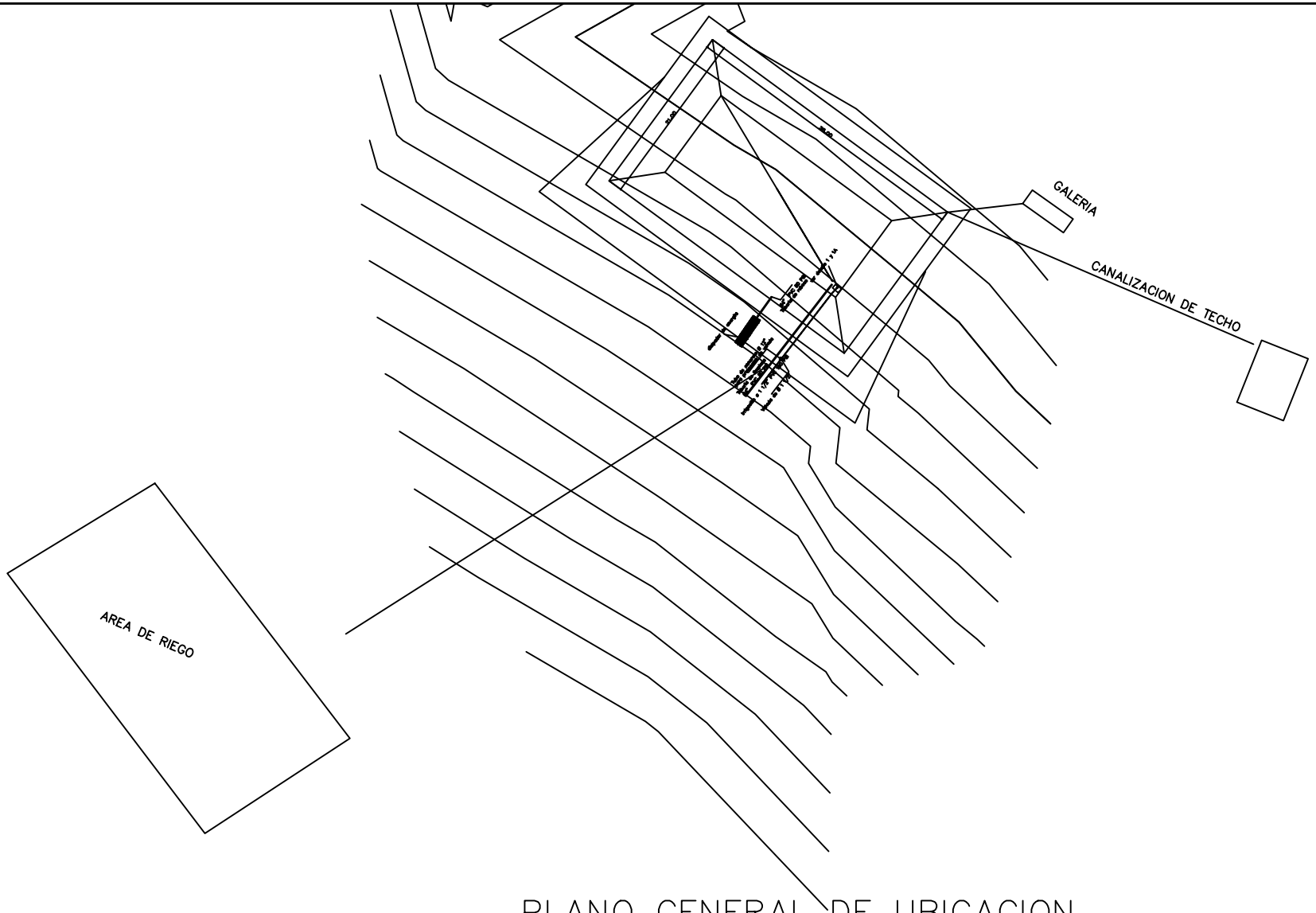
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION
Caserìo El Cerrito, Cantòn El Cerrito
Usulutan, Usulutan

BENEFICIARIA
JOSE LEONIDAS CAMPOS

CODIGO
JC- 0501

FECHA
martzo de 2005



PLANO GENERAL DE UBICACION
sin escala

DAUAS / care	CONTENIDO: DETALLES DE RESERVORIO Volumen: 1192.70 m3	UBICACION: Caserìo El Cerrito, Cantòn El Cerrito Usulutan, Usulutan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: diciembre de 2004
		BENEFICIARIA: JOSE LEONIDAS CAMPOS — CODIGO: JC- 0501	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

JOSE ARNOLDO PARADA GIRON

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **JOSE ARNOLDO PARADA GIRON**, con documento Unico de Identidad numero cero un millon ochocientos cuatro mil ochocientos trece guión cinco, con domicilio en Caserio El Jovalito, Cantón Los Chapetones, Municipio de Tecapan, departamento de Usulutan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación:

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales"** a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerias de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **José Arnoldo Parada Giron,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve dias del mes de septiembre del año Dos mil cuatro.

Beneficiario
José Arnoldo Parada Giron
DUI 01804813 - 5

Por DAUAS
Roney Gutiérrez
Pasaporte No USA 701584131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

JOSE ARNOLDO PARADA GIRON

TECAPAN, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, JOSE ARNOLDO PARADA GIRON, de treinta y dos años de edad, con documento Único de Identidad Numero cero un millon ochocientos cuatro mil ochocientos trece guión cinco, con domicilio en Cantón Los Chapetones, Municipio de Tecapan, departamento de Usulutan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado *"Desviación, Almacenamiento y Uso de Aguas Lluvias"* y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en Tecapan, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiario
José Arnoldo Parada Giron
DUI No. 01804813-5

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

ARNOLDO PARADA

Construction details of the Infiltration Gallery. The gravel filter can be seen.

The reservoir under construction. A large volume of boulders were found on this system

Borrow material was used to cover the rocks to protect the liner.

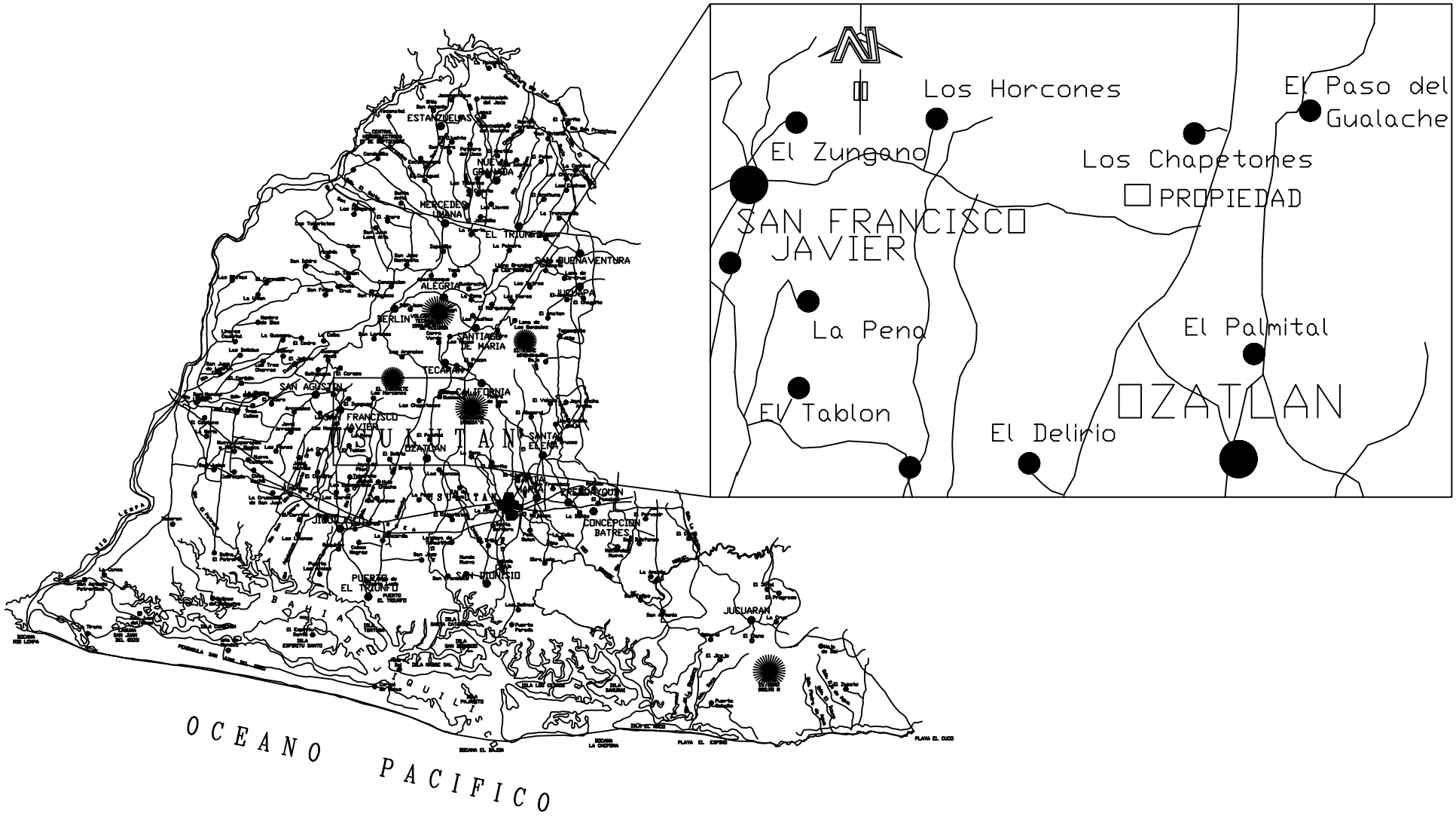
The embankment had to be built with rock covered with borrow material and the fence poles had to be replaced with galvanized iron pipes resting on a concrete unreinforced slab.

ANNEX R-10

RESERVOIR SYSTEM No. 10

LEONIDAS CAMPOS

Sistema		R-10
Nombre del Beneficiario	JOSE LEONIDAS CAMPOS PORTILLO	
DUI	00020818-7	
Domicilio		
Cantón	El Cerrito	
Municipio	Usulután	
Departamento	Usulután	
Volúmen Almacenado m3		1050
Area de Riegos m2		2100
Costo de la Manta Impermeable	$	4.301,06
Costo del Movimiento de Tierras	$	6.871,19
Costo de la Galería	$	1.439,45
Costo de la Tubería	$	1.146,87
Costo del Cerco	$	3.468,24
Costo del Sistema de Riego	$	755,63
Costo Total	**$**	**17.982,44**
Costo por m3 de Agua Almacenada	$	17,13
Costo por m2 de Tierra Regada	$	8,56



DAUAS

care

CONTENIDO:

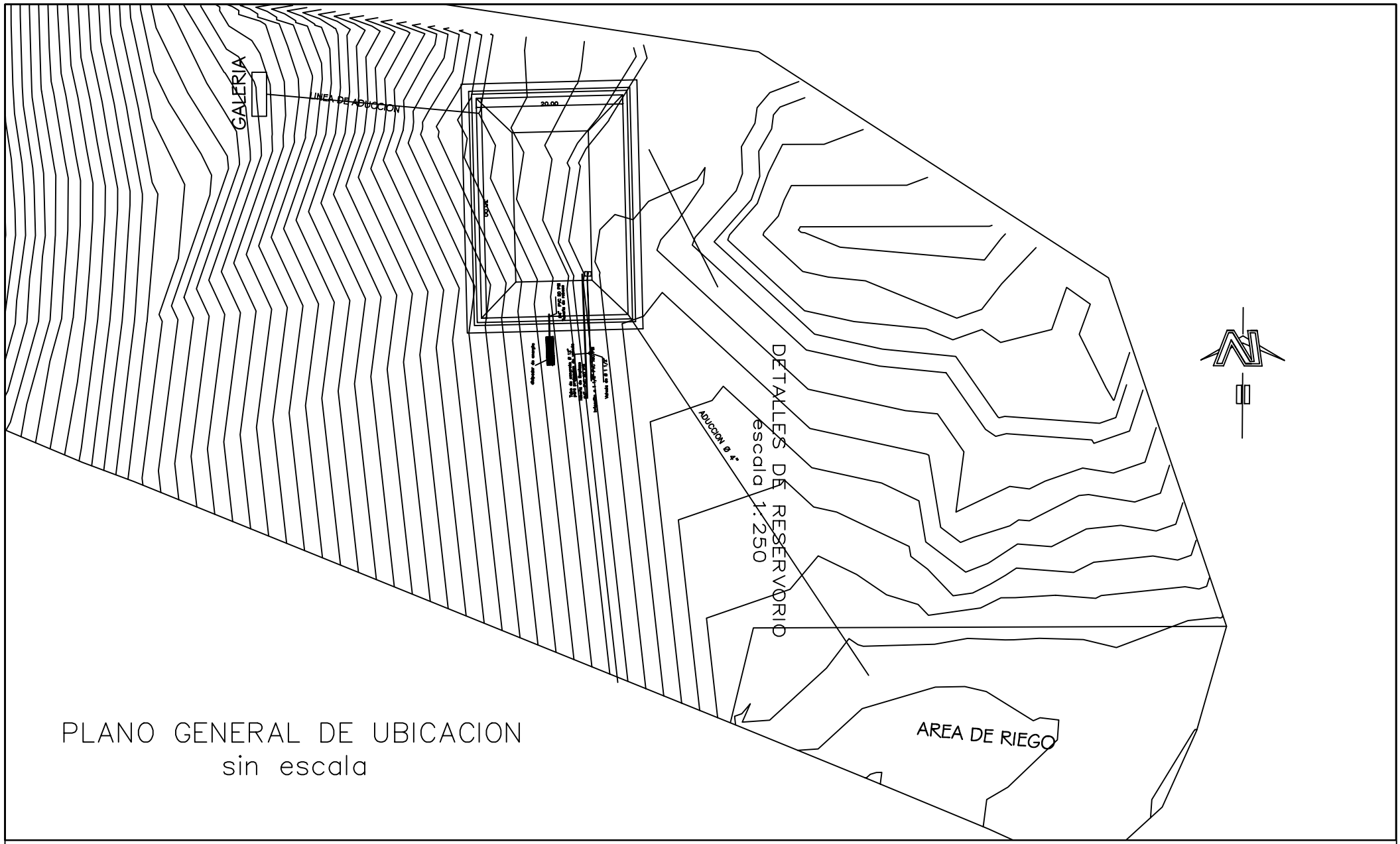
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION
Caserìo El Jovalito, Cantòn Paso Gualache
Tecapan, Usulutan

BENEFICIARIA
ARNOLDO PARADA

CODIGO

FECHA
martzo de 2005



PLANO GENERAL DE UBICACION
sin escala

DAUAS / care	CONTENIDO: DETALLES DE RESERVORIO VOLUMEN=937.783 m3	UBICACION: Caserìo El Jovalito, Cantòn Paso Gualache, Tecapan, Usulutan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: diciembre de 2004
		BENEFICIARIA: ARNOLDO PARADA — CODIGO: AP- 0516	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

JOSE LEONIDAS CAMPOS PORTILLO

EL SALVADOR, SEPTIEMBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **JOSE LEONIDAS CAMPOS PORTILLO**, con documento Unico de Identidad numero cero cero cero veinte mil ochocientos dieciocho guión siete, con domicilio en Caserío El Centro, Cantón El Cerrito, Municipio de Usulutan , departamento de Usulutan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación:

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerías de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **Jose Leonidas Campos Portillo,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Usulután, a los veintinueve días del mes de septiembre del año Dos mil cuatro.

Beneficiario
José Leonidas Campos Portillo
DUI 00020818-7

Por DAUAS
Roney Gutiérrez
Pasaporte No. USA: 701584131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

JOSE LEONIDAS CAMPOS PORTILLO

USULUTAN, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, JOSE LEONIDAS CAMPOS PORTILLO, de cuarenta y nueve años de edad, con documento Único de Identidad Numero cero cero cero veinte mil ochocientos dieciocho guión siete, con domicilio en Cantón El Cerrito, Municipio de Usulutan, departamento de Usulutan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado "*Desviación, Almacenamiento y Uso de Aguas Lluvias*" y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las caniculas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en Usulutan, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiario
José Leonidas Campos Portillo
DUI No. 00020818-7

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

LEONIDAS CAMPOS

The infiltration gallery nearly completed. The rainfall runoff will be collected by means of hill contour ditches.

Concrete fence poles being mounted

A view of the reservoir's side ditch to collect and dispose the rainfall runoff

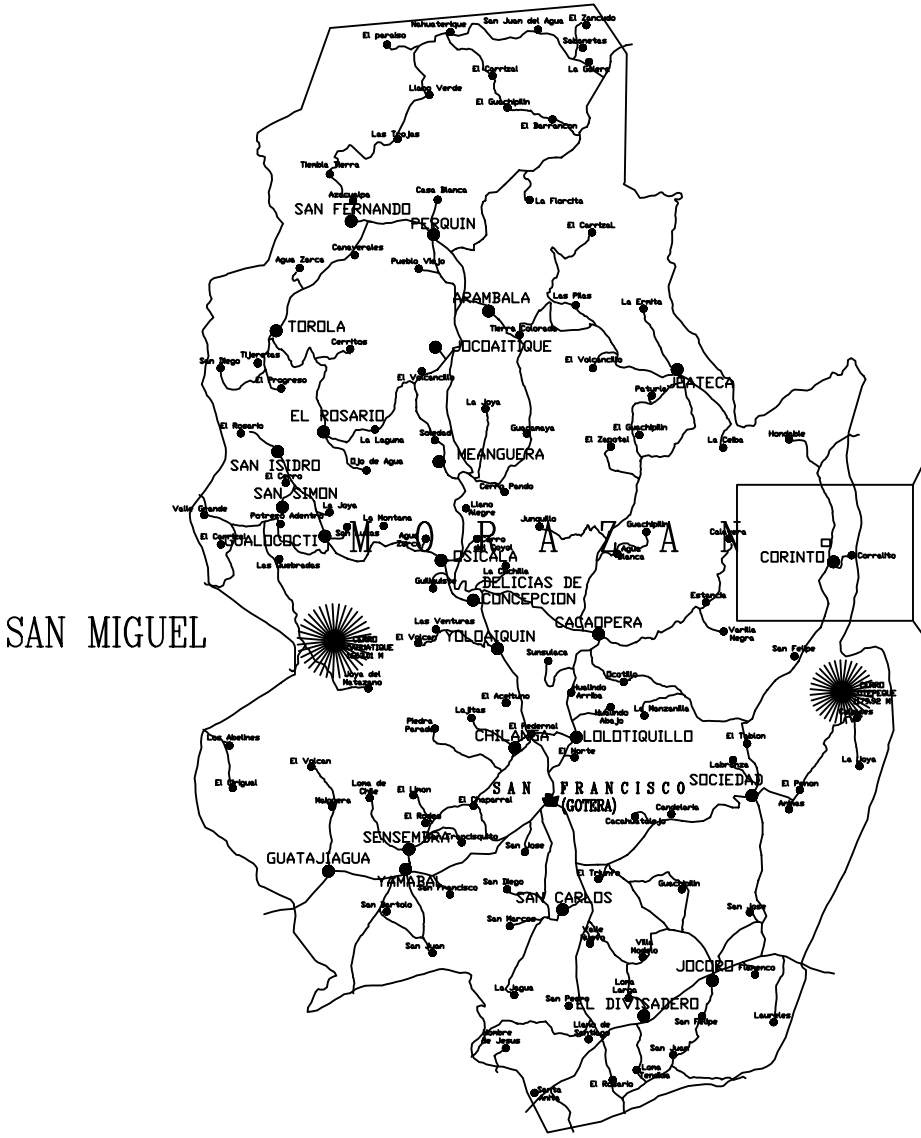
A general view of the reservoir nearly completed.

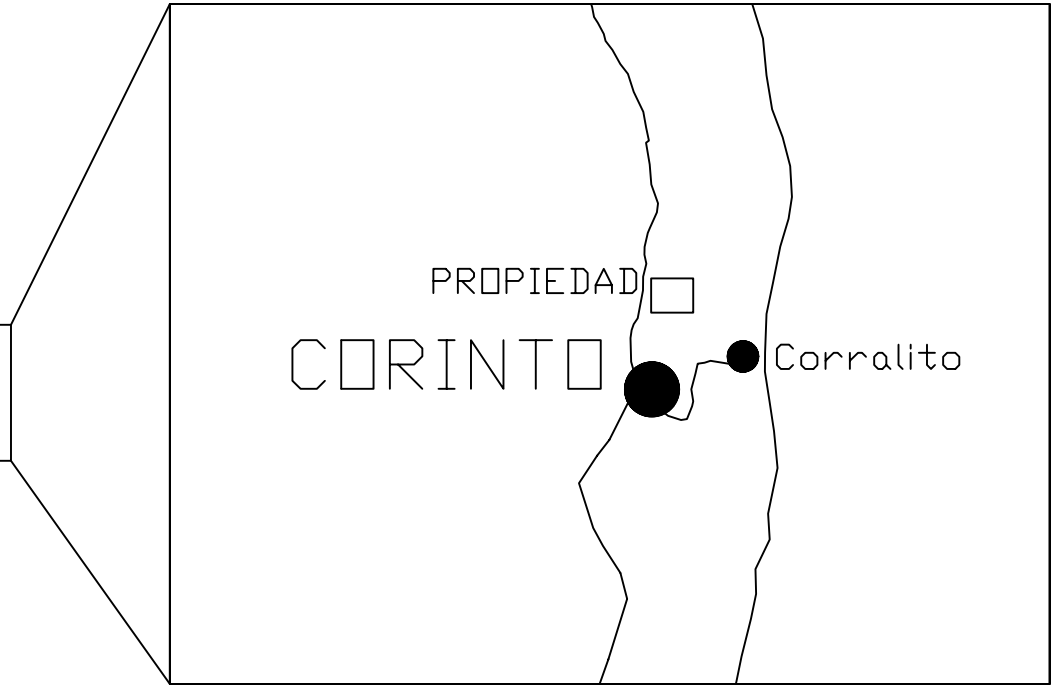
ANNEX R-11

RESERVOIR SYSTEM No. 11

TOMAS HERNANDEZ

Sistema		R-11
Nombre del Beneficiario	JOSE TOMAS HERNANDEZ VILLATORO	
DUI	01916915-4	
Domicilio		
Cantón	Corralito	
Municipio	Corinto	
Departamento	Morazán	
Volúmen Almacenado m3		615
Area de Riegos m2		1400
Costo de la Manta Impermeable	$	2.519,19
Costo del Movimiento de Tierras	$	12.605,00
Costo de la Galería	$	1.006,00
Costo de la Tubería	$	716,00
Costo del Cerco	$	1.655,00
Costo del Sistema de Riego	$	755,63
Costo Total	**$**	**19.256,82**
Costo por m3 de Agua Almacenada	$	31,31
Costo por m2 de Tierra Regada	$	13,75





DAUAS

care

CONTENIDO:

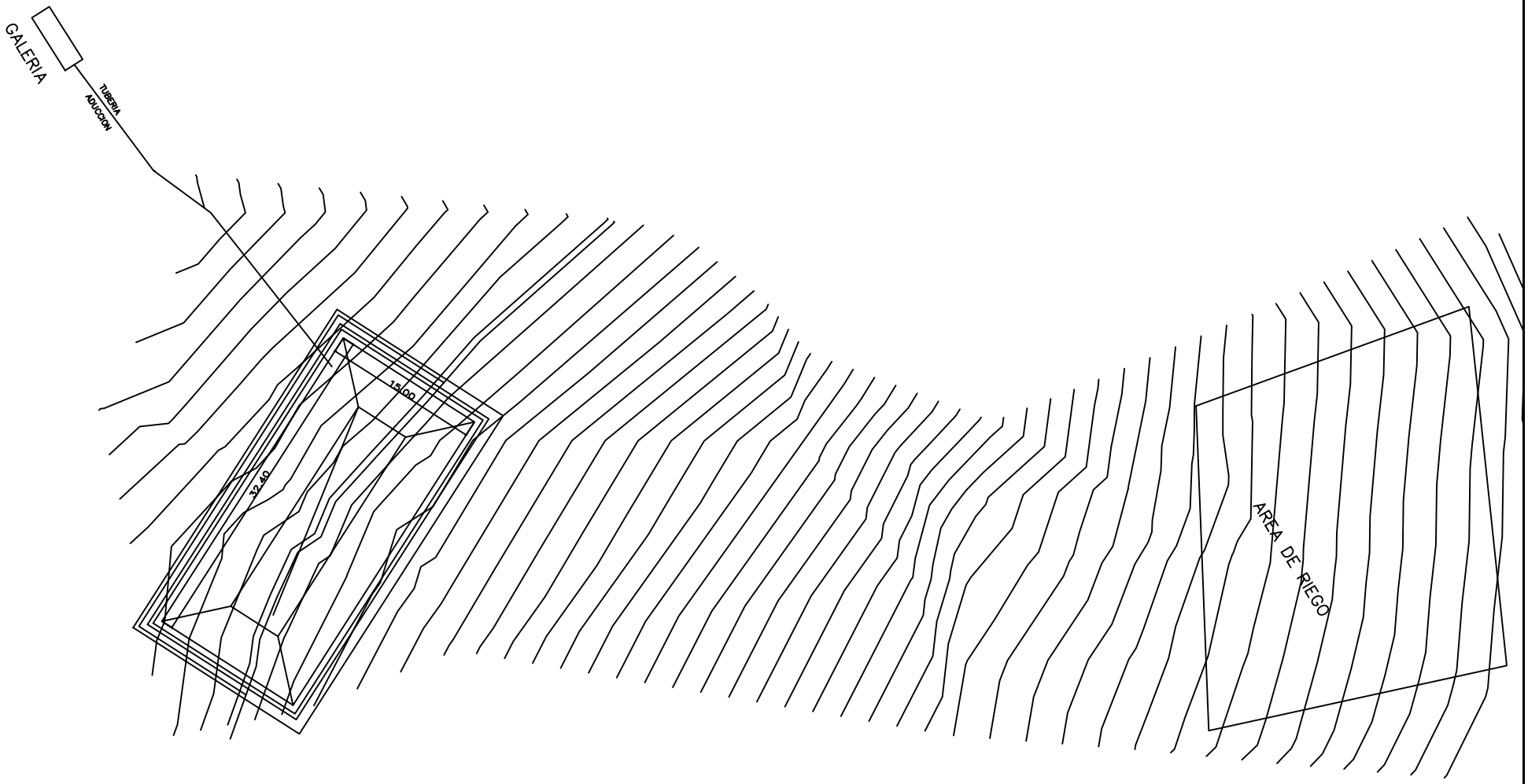
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION
Caserìo Cerro de Nube, Cantòn Corralito
Corinto, Morazan

BENEFICIARIA
Tomas Hernández Villatoro

CODIGO
TH- 1203

FECHA
martzo de 2005



DAUAS

care

CONTENIDO:

DETALLES DE RESERVORIO

VOLUMEN=694.17 m3

UBICACION: Caserìo Cerro de Nube, Cantòn Corralito Corinto, Morazan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: diciembre de 2004
BENEFICIARIA: Tomas Hernández Villatoro — CODIGO: TH- 1203	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 4/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

JOSE TOMAS HERNADEZ VILLATORO

EL SALVADOR, OCTUBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **JOSE TOMAS HERNANDEZ VILLATORO** con documento Unico de Identidad numero cero un millón novecientos dieciseis mil novecientos quince guión cuatro, con domicilio en Caserío Cerro de Nube, Cantón Corralito, Municipio de Corinto, departamento de Morazan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerias de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos horticolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **José Tomas Hernandez Villatoro,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cria de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Corinto, a los trece días del mes de octubre del año Dos mil cuatro.

Beneficiario
Jose Tomas Hernandez Villatoro
DUI # 01916915-4

Por DAUAS
Roney Gutiérrez
Pasaporte US #. 701584131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

JOSE TOMAS HERNANDEZ VILLATORO

CORINTO, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, JOSE TOMAS HERNANDEZ VILLATORO, con documento Único de Identidad Numero cero un millón novecientos dieciséis mil novecientos quince guión cuatro, con domicilio en Cantón Corralito, Municipio de Corinto, departamento de Morazan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado *"Desviación, Almacenamiento y Uso de Aguas Lluvias"* y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en Corinto, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiario
José Tomas Hernández Villatoro
DUI No. 01916915-4

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

TOMAS HERNÁNDEZ

A backhoe excavating the ground to build the reservoir.

The pipe valve control at the Infiltration Gallery

A general view of the system after construction.

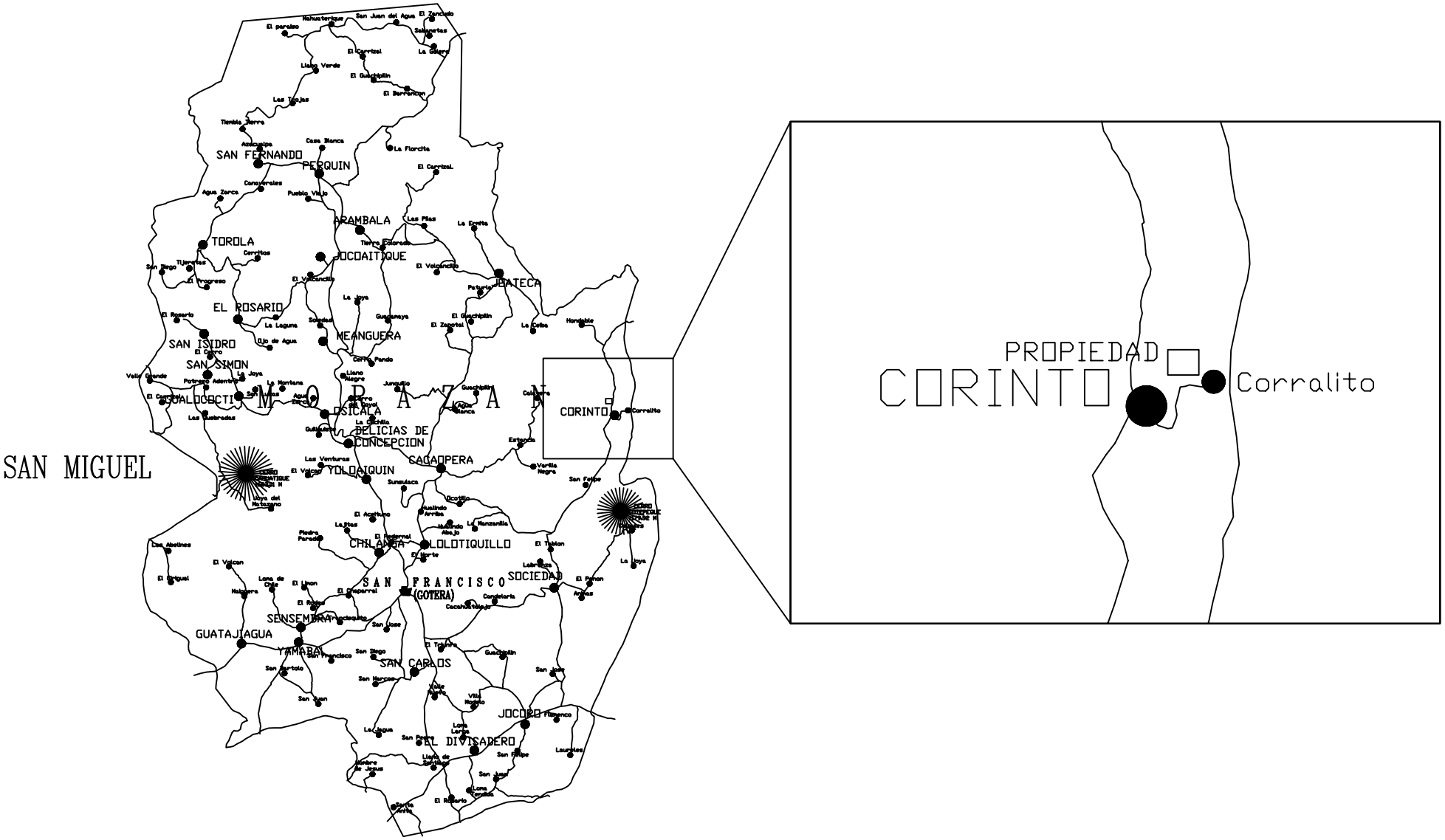
The irrigation conveyance pipeline before it was covered with earth and stones to protect it against the sun rays.

ANNEX R-12

RESERVOIR SYSTEM No. 12

NEFTALI BERRIOS

Sistema		R-12
Nombre del Beneficiario	JOSE NEFTALY BERRIOS JOYA	
DUI	00392633-6	
Domicilio		
Cantón	Corralito	
Municipio	Corinto	
Departamento	Morazán	
Volúmen Almacenado m3		565
Area de Riegos m2		1200
Costo de la Manta Impermeable	$	2.314,38
Costo de Muros de Mampostería	$	12.345,63
Costo de la Galería	$	1.006,00
Costo de la Tubería	$	246,00
Costo del Cerco	$	997,70
Costo del Sistema de Riego	$	424,94
Costo Total	**$**	**17.334,65**
Costo por m3 de Agua Almacenada	$	30,68
Costo por m2 de Tierra Regada	$	14,45



DAUAS

care

CONTENIDO:

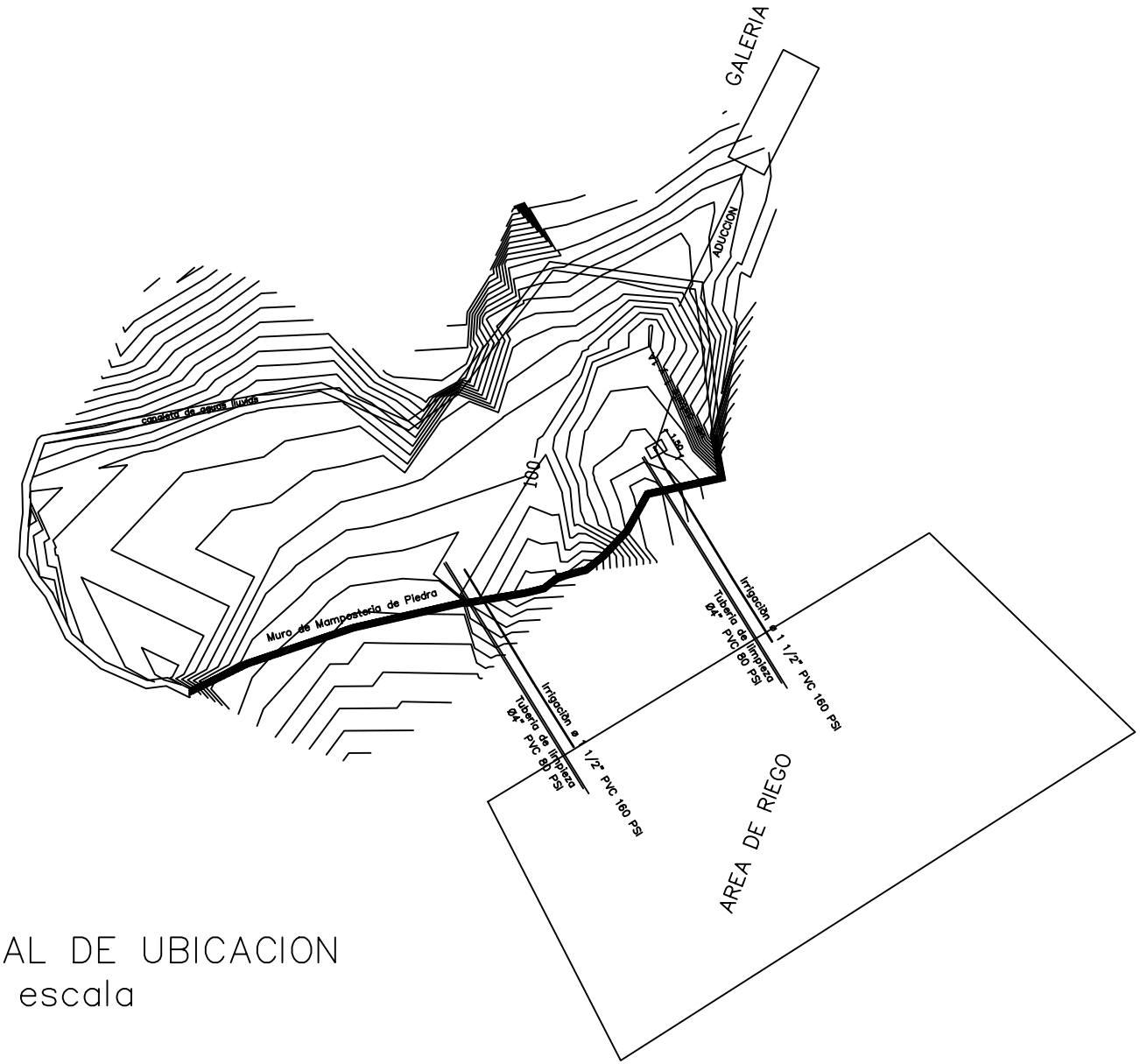
ESQUEMA DE UBICACION DE RESERVORIO

UBICACION
Caserìo Portillo El Junco, Cantòn El Corralito
Corinto, Morazan

BENEFICIARIA
José Neftalí Berrios

CODIGO
JB- 1203

FECHA
martzo de 2005



PLANO GENERAL DE UBICACION
sin escala

MODIFICACION 1

DAUAS / care	CONTENIDO: DETALLES DE RESERVORIO Volumen: 637.39 m3	UBICACION: Caserìo Portillo El Junco, Cantòn El Corralito Corinto, Morazan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: diciembre de 2004
		BENEFICIARIA: José Neftalí Berrios — CODIGO: MJ—1109	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 1/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIO

JOSE NEFTALI BERRIOS JOYA

EL SALVADOR, OCTUBRE 2004

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **JOSE NEFTALI BERRIOS JOYA** con documento Unico de Identidad numero cero cero trescientos noventa y dos mil seiscientos treinta y tres guión seis, con domicilio en Caserío Portillo-El Junco, Cantón Corralito, Municipio de Corinto, departamento de Morazan, en calidad de beneficiario-propietario. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerias de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que el señor **Jose Neftali Berrios Joya,** tiene un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agricola y piscicola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberias primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos al beneficiario directo y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los limites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en Corinto, a los trece días del mes de octubre del año Dos mil cuatro.

Beneficiario
Jose Neftali Berrios Joya
DUI # 00392633-6

Por DAUAS
Roney Gutiérrez
Pasaporte US #. 701584131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO
Y
COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

JOSE NEFTALY BERRIOS JOYA

CORINTO, MARZO 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, JOSE NEFTALY BERRIOS JOYA, con documento Único de Identidad Numero cero cero trescientos noventa y dos mil seiscientos treinta y tres guión seis, con domicilio en Cantón Corralito, Municipio de Corinto, departamento de Morazan, en calidad de beneficiario, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado "*Desviación, Almacenamiento y Uso de Aguas Lluvias*" y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.
3. **Mantenimiento de sistema de riego:** Consistente realizar tareas de limpieza en sistema de riego por goteo instalado en el campo. Conformado por tuberías

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en Corinto, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiario
José Neftaly Berrios Joya
DUI No. 00392633-6

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

NEFTALY BERRIOS

The site before construction. This was the only masonry walls reservoir.

A detail of the construction activities of the masonry dikes.

A view of the masonry works. It can be observed that the site is conformed by rock, where soil for embankments and agriculture is nonexistent.

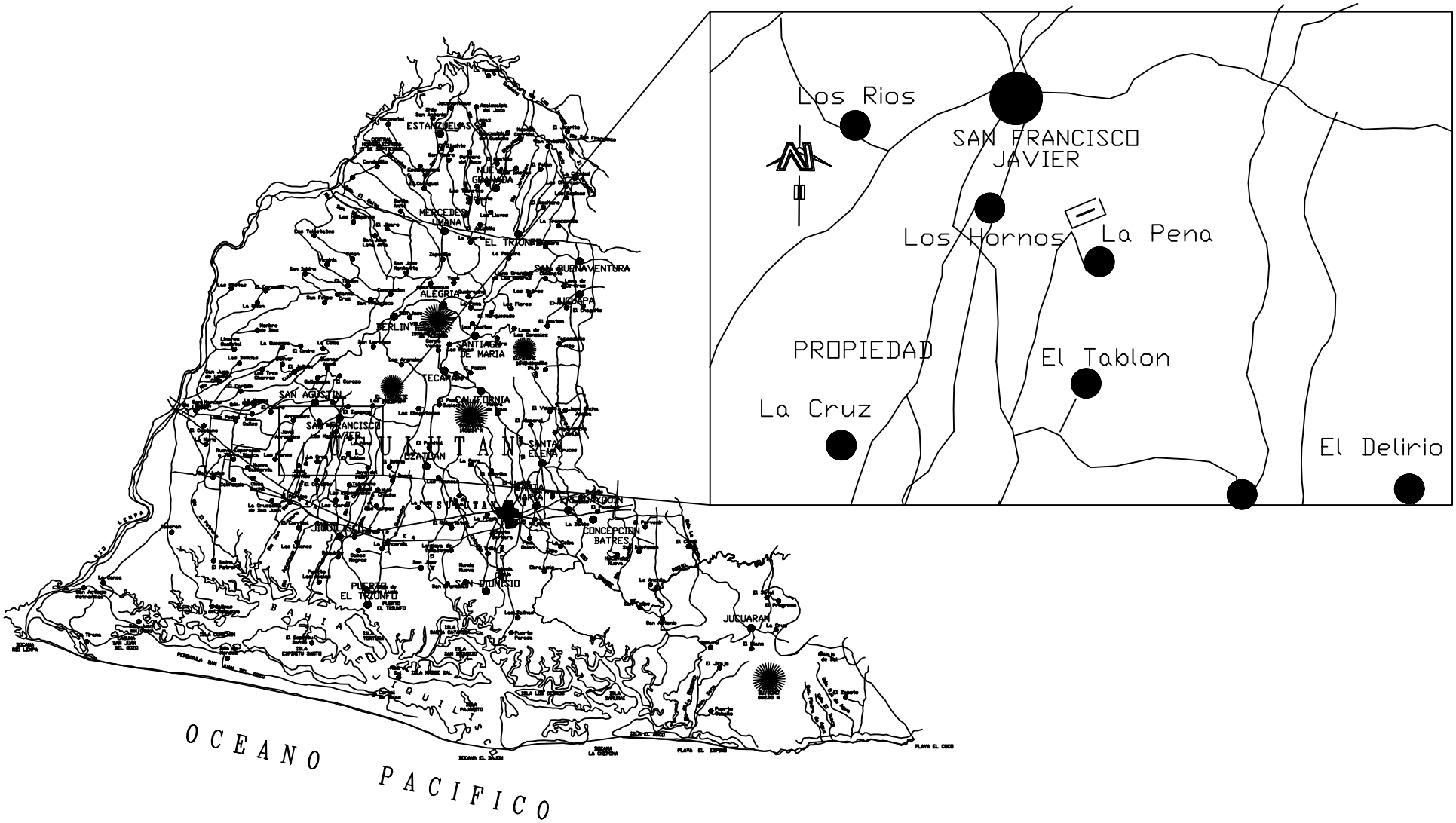
The impermeable membrane was placed because the presence of rock was not a guarantee against seepage losses.

ANNEX R-13

RESERVOIR SYSTEM No. 13

TRANCITO PINEDA

Sistema	R-13
Nombre del Beneficiario	MARIA TRANSITO PINEDA DE LEMUS
DUI	01888258-9
Domicilio	
Cantón	La Peña
Municipio	San Francisco Javier
Departamento	Usulután
Volúmen Almacenado m3	723
Area de Riegos m2	1700
Costo de la Manta Impermeable	$ 2.961,59
Costo del Movimiento de Tierras	$ 8.072,27
Costo de la Galería	$ 1.185,00
Costo de la Tubería	$ 600,00
Costo del Cerco	$ 1.680,00
Costo del Sistema de Riego	$ 575,08
Costo Total	**$ 15.073,93**
Costo por m3 de Agua Almacenada	$ 20,85
Costo por m2 de Tierra Regada	$ 8,87



DAUAS

care

CONTENIDO:

ESQUEMA DE UBICACION DE RESERVORIO

UBICACION

Caserìo La Peña, Cantòn La Peña
San Francisco Javier, Usulutan

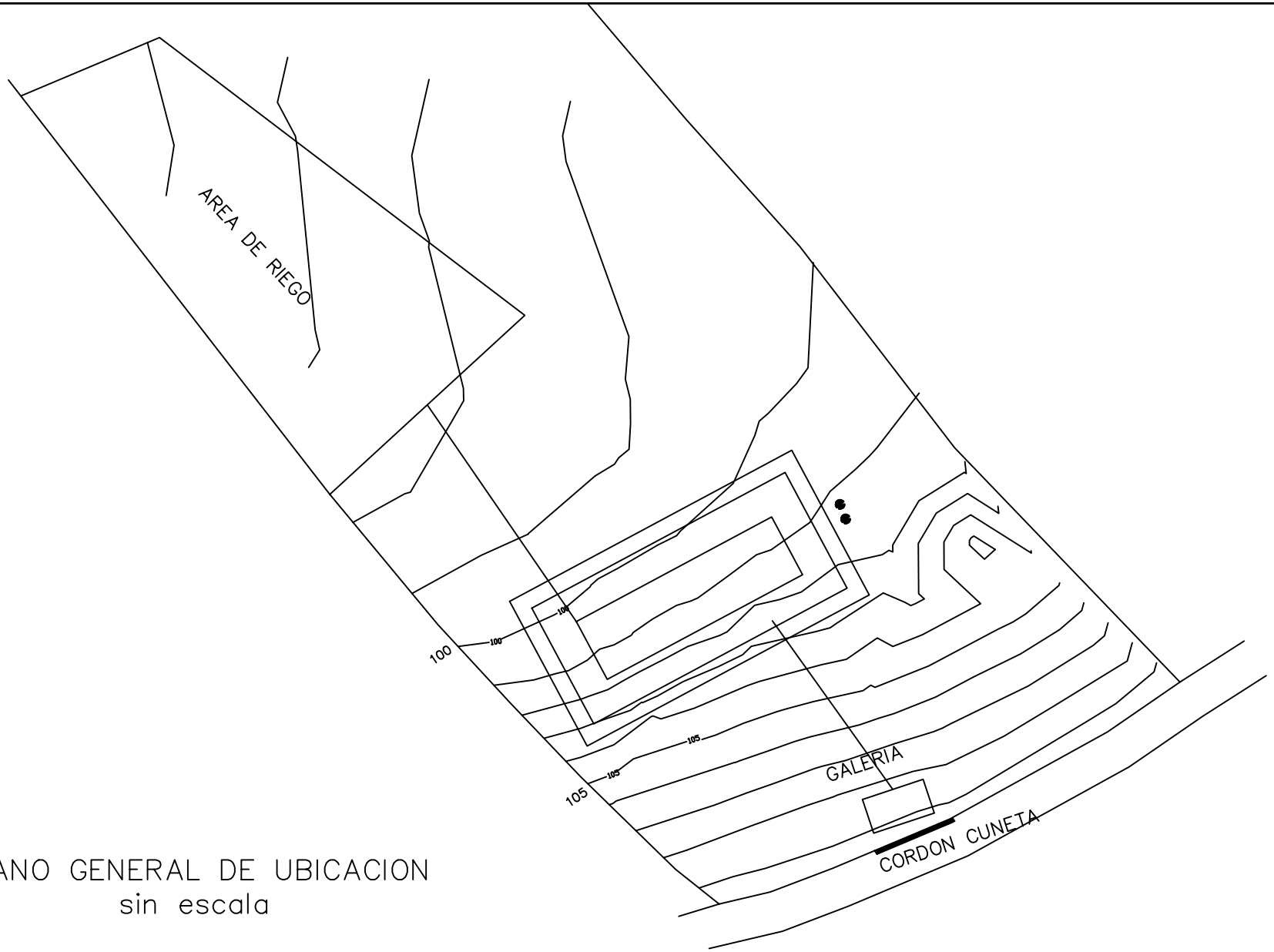
BENEFICIARIA

MARIA TRANSITO PINEDA

CODIGO

FECHA

martzo de 2005



PLANO GENERAL DE UBICACION
sin escala

DAUAS care	CONTENIDO: DETALLES DE RESERVORIO Volumen: 830.30 m3	UBICACION: Caserìo La Peña, Cantòn La Peña San Francisco Javier, Usulutan	DISEÑO: Jorge Sosa	APROBO: Carlos Gandarillas	FECHA: octubre de 2004
		BENEFICIARIA: Maria del Transito Pineda — CODIGO:	REVISO: Jorge Herrera	DIBUJO: Jorge Sosa	ESCALA: indicadas — HOJA: L 1/4

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE ACEPTACION DE PROYECTO

BENEFICIARIA

MARIA TRANCITO PINEDA DE LEMUS

SAN FRANCISCO JAVIER, FEBRERO 2005

ACTA DE ACEPTACION DE PROYECTO

Nosotros, **RONEY GUTIERREZ**, representante del proyecto *Desviación, Almacenamiento y uso de aguas lluvias (DAUAS)*, ejecutado por las organizaciones Chemonics Inc. y Care El Salvador con el financiamiento de USAID, y **MARIA TRANCITO PINEDA DE LEMUS**, con documento Unico de Identidad Numero cero un millón ochocientos ochenta y ocho mil doscientos cincuenta y ocho guión nueve, con domicilio en Canton La Peña, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiaria. Hemos decidido firmar la presente Acta de Aceptación de proyecto, de acuerdo a los términos que se detallan a continuación:

I Considerando:

1. Que el propósito del proyecto es apoyar el objetivo estratégico de USAID El Salvador, "**Mejorar el Acceso de Agua Limpia a la Familias Rurales**" a través de la promoción y adopción de un mejor manejo del agua superficial.

2. Que este proyecto llevará a cabo la implementacion de subproyectos que con éxito deriven, almacenen y hagan uso económico del agua superficial en diversas áreas geográficas en El Salvador, por medio de la derivación y captación de aguas a través de pozos horizontales (galerias de infiltración), para su almacenamiento en reservorios excavados y ser utilizada en actividades productivas que utilicen y conviertan el agua almacenada en ingresos (cultivos hortícolas con riego por goteo y producción de Tilapia).

3. Que al finalizar el proyecto, los beneficiarios de los sistemas manejaran apropiadamente las estructuras de derivación, captación, almacenamiento de agua y sistemas de riego. Desarrollando habilidades para trabajar cultivos hortícolas bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.

4. Que combinando la disponibilidad de agua para riego y beneficiarios capacitados, se conseguirán los siguientes productos:

- Agua disponible para completar los requerimientos de los cultivos durante las canículas.
- Agua para riego disponible para suplir los requerimientos de los cultivos bajo riego en el periodo de noviembre a mayo.
- Agua disponible para la crianza de peces.
- Los beneficiarios(as) de los sistemas desarrollaran habilidades en producción agrícola bajo riego y peces.
- Los beneficiarios desarrollarán habilidades para el mercadeo de su producción.
- Los beneficiarios seleccionaran cultivos más rentables para las nuevas condiciones y la demanda del mercado.
- Los beneficiarios serán capacitados en la operación y mantenimiento de las estructuras de derivación, almacenamiento de agua y los sistemas de riego.

5. Que la señora **Maria Trancito Pineda de Lemus,** tienen un alto interés en participar en el proyecto.

II. Acordamos:

1) **Construir una Galería de infiltración**: Consistente en una estructura para filtrar el agua lluvia de escorrentia, para luego ser despositada por gravedad en el reservorio.
2) **Construir un reservorio:** Consistente en una estructura para el almacenamiento de agua lluvia, para uso agrícola y piscícola.
3) **Establecimiento de un sistema de riego:** Consistente en la instalación de un sistema de riego por goteo en el campo de producción conformado por tuberías primarias y secundarias, filtros y válvulas. Funcionando por gravedad.
4) **Desarrollo de Capacitaciones:** Consistente en la implementación y participación de capacitación sobre los temas de manejo y mantenimiento del sistema de captación y almacenamiento de aguas lluvias; manejo y mantenimiento de sistemas de riego por goteo; producción de hortalizas; cultivo de Tilapia y comercialización de la producción.

III. Compromisos:

De parte del proyecto DAUAS

1. El proyecto DAUAS, construirá y establecerá: Una Galería de infiltración, un reservorio e instalara un sistema de riego.
2. Desarrollara jornadas de capacitación y asistencia técnica continua en los temas antes mencionados, dirigidos a la beneficiaria y su familia, durante la vida del proyecto.

De parte del beneficiario o beneficiaria:

1. El beneficiario se compromete a participar en todas las actividades antes mencionadas, dar el uso y mantenimiento adecuado a toda la infraestructura que establecerá el proyecto.
2. El beneficiario se compromete a implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras.
3. Adquirir insumos para producción de hortalizas y cría de peces.
4. El propietario se compromete a no iniciar ningún tipo de negociación o traspaso sobre su inmueble mientras dure el proyecto DAUAS.
5. El propietario da su total consentimiento y autorización al proyecto DAUAS, para que se lleven a cabo obras de construcción dentro de los límites de su propiedad.
6. El propietario se compromete a obtener las respectivas autorizaciones de los dueños de las propiedades colindantes, en el caso de ser necesario.
7. El propietario dará aviso al personal del proyecto DAUAS para cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como: Litigios sobrevivientes a la propiedad y daños al equipo proporcionado.

IV. La validez de lo contenido en esta Acta, esta sujeta al cumplimiento los requisitos, legales y sociales de parte del beneficiario y aspectos técnicos constructivos y

agronómicos a ser determinados por el Equipo Técnico de DAUAS. En caso de no cumplir lo anterior se dará sin efecto el compromiso.

V. Causas de terminación de compromisos: Incumplimiento de cualquiera de los compromisos adquiridos, por mutuo acuerdo por escrito de ambas partes y por disposición del donante.

VI. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será mientras duren las actividades del Proyecto DAUAS.

Dado en San Francisco Javier, a los veinticuatro días del mes de febrero del año Dos mil cinco.

Beneficiara
Maria Trancito Pineda de Lemus
DUI No. 01888258-9

Por DAUAS
Roney Gutiérrez
Pasaporte US No.701584131

PROYECTO

DESVIACION, ALMACENAMIENTO Y USO DE AGUAS LLUVIAS

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

BENEFICIARIO

MARIA TRANCITO PINEDA DE LEMUS

SAN FRANCISCO JAVIER, MARZO DE 2005

ACTA DE RECIBO DE PROYECTO Y COMPROMISO DE USO Y MANTENIMIENTO

YO, MARIA TRANCITO PINEDA DE LEMUS, de sesenta y cuatro años de edad, con documento Único de Identidad Numero cero un millón ochocientos ochenta y ocho mil doscientos cincuenta y ocho guión nueve, con domicilio en Cantón La Peña, Municipio de San Francisco Javier, departamento de Usulutan, en calidad de beneficiaria, por medio de la presente Acta hago constar que en esta fecha recibo a mi entera satisfacción las edificaciones y equipo que el proyecto denominado "*Desviación, Almacenamiento y Uso de Aguas Lluvias*" y que puede abreviarse *(DAUAS)*, se comprometió a ejecutar a través de las organizaciones Chemonics Inc. y Care El Salvador, financiado por USAID, de conformidad al acuerdo contenido en **Acta de Aceptación de proyecto**, firmada al inicio del mencionado proyecto, por lo que desde esta fecha me comprometo a proporcionar el uso y mantenimiento adecuado al sistema, en los siguientes términos:

I Utilizar el agua del reservorio para las siguientes actividades:

1. Completar los requerimientos de agua de los cultivos durante las canículas.
2. Suplir los requerimientos de agua de los cultivos bajo riego en el periodo de noviembre a mayo.
3. Establecer crianza de peces.

II. Mantenimiento de estructuras:

1. **Dar mantenimiento a Galería de infiltración**: Consistente en realizar tareas de limpieza al inicio de la época de lluvia y cada vez que sea necesario en la estructura para que cumpla con su función de filtrar el agua lluvia de escorrentía, y ser conducida sin problemas al reservorio.
2. **Dar mantenimiento al reservorio:** Consistente en realizar tareas de limpieza al iniciar la época de lluvia y cuando sea necesario en la estructura de almacenamiento de agua lluvia. Revisar periódicamente para evitar fugas de agua, reparando agujeros y cualquier daño que existiera.

primarias y secundarias, filtros y válvulas. Revisar diariamente en la época de riego y guardar en lugar seguro cuando no se utilice.

III. Obras de conservación

1. Implementar y dar mantenimiento a las obras de mitigación de impacto ambiental. Tales como barreras vivas y muertas, acequias y otras. Para evitar la erosión del suelo, dirigir las escorrentías hacia las galerías de infiltración, disminuir la velocidad de las escorrentías o desviarlas para disminuir caudales.

IV. Producción.

1. Adquirir insumos para producción de hortalizas y cría de peces.
2. Desarrollar habilidades en producción hortícola bajo riego, sistemas piscícolas y nuevas oportunidades de mercado.
3. Desarrollar habilidades para el mercadeo de su producción.
4. Seleccionar cultivos más rentables para las nuevas condiciones y la demanda del mercado.
5. Llevar control de costos de producción, volúmenes de producción e ingresos obtenidos de las actividades hortícola y piscícola y otra que implemente utilizando el agua del reservorio.

V. RELACION CON EL DONANTE

1. El propietario-beneficiario(a) da su total consentimiento y autorización a la agencia donante (USAID) para que monitoree el funcionamiento, uso y mantenimiento de las estructuras construidas por el proyecto.

2. El beneficiario(a) dará aviso a USAID de cualquier situación que pudiera afectar el normal desarrollo de las actividades del proyecto, tales como daños al equipo e instalaciones donados por el proyecto.

IV. La Presente Acta surtirá efectos desde el momento mismo de su firma, y su vigencia será de cinco años.

En fe de lo cual firmamos la presente en San Francisco Javier, a los veintinueve días del mes de marzo del año Dos mil cinco.

Beneficiaria
Maria Trancito Pineda de Lemus
DUI No. 01888258-9

Por DAUAS/CARE/Chemonics
Roney Gutiérrez
Pasaporte US No.701584131

Por USAID

Doc.

TRANSITO PINEDA

The reservoir site during the early stages of construction.

A combination of a diversion wall with orifices to minimize the entrance of sediment and the infiltration gallery.

The site during the final inspection

The irrigation pipenetwork, where the main line and the laterals can be seen.