

CLASSIFICATION
PROJECT EVALUATION SUMMARY (PES) - PART I

Report Symbol U-447

1. PROJECT TITLE USE OF TREATED SEWAGE FOR IRRIGATION			2. PROJECT NUMBER 527-0150	3. MISSION/AID/W OFFICE USAID/Peru
			4. EVALUATION NUMBER (Enter the number maintained by the reporting unit e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 each FY) <input checked="" type="checkbox"/> REGULAR EVALUATION <input type="checkbox"/> SPECIAL EVALUATION	
5. KEY PROJECT IMPLEMENTATION DATES			6. ESTIMATED PROJECT FUNDING	
A. First PRO-AG or Equivalent FY <u>77</u>	B. Final Obligation Expected FY <u>80</u>	C. Final Input Delivery FY _____	A. Total \$ <u>344,000</u>	7. PERIOD COVERED BY EVALUATION From (month/yr.) <u>April 1977</u> To (month/yr.) <u>August 1980</u> Date of Evaluation Review <u>8/80</u>
			B. U.S. \$ <u>220,000</u>	

B. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A. List decisions and/or unresolved issues; cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.)	B. NAME OF OFFICER RESPONSIBLE FOR ACTION	C. DATE ACTION TO BE COMPLETED
<p>1. An evaluation of all laboratory tests to date and future monitoring procedures should be undertaken by a qualified independent expert before the PACD.</p> <p>2. Progress and Development in equipment centralization and customs withdrawal procedures should be monitored by the USAID Project Manager.</p>	<p align="center">Proj. Manager E. Alarcón</p>	<p align="center">3/31/80</p> <p align="center">ASAP</p>

9. INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

<input checked="" type="checkbox"/> Project Paper	<input type="checkbox"/> Implementation Plan e.g., CPI Network	<input type="checkbox"/> Other (Specify) _____
<input type="checkbox"/> Financial Plan	<input type="checkbox"/> PIO/T	_____
<input checked="" type="checkbox"/> Logical Framework	<input type="checkbox"/> P/O/C	<input type="checkbox"/> Other (Specify) _____
<input checked="" type="checkbox"/> Project Agreement	<input type="checkbox"/> PIO/P	_____

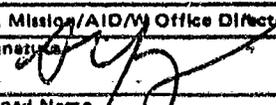
10. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

A.	<input checked="" type="checkbox"/> Continue Project Without Change
B.	<input type="checkbox"/> Change Project Design end/or
	<input type="checkbox"/> Change Implementation Plan
C.	<input type="checkbox"/> Discontinue Project

11. PROJECT OFFICER AND HOST COUNTRY OR OTHER RANKING PARTICIPANTS AS APPROPRIATE (Names and Titles)

Edilberto Alarcón, Project Manager
Danilo Cruz-DePaula, Evaluator/USAID Evaluation Officer
Alejandro Vincas Araos, Min. Housing & Construction

12. Mission/AID/W Office Director Approval

Signature: 

Typed Name: **Leonard Yaeger**

Date: **December 31, 1980**

PROJECT EVALUATION SUMMARY

Use of Treated Sewage for Irrigation

Project No. 527-0150

13. Summary

The purpose of the project is to demonstrate the economic and technical feasibility of producing significant quantities of foodstuffs by irrigating desert lands with treated sewage effluent. The project was signed on March 31, 1977 and the Project Agreement Completion Date of September 30, 1980 has been extended to March 31, 1981, to permit the continuation of laboratory testing.

Project implementation activities have been carried out. There are currently 136 hectares under cultivation in Tacna. For all crops, yields are higher than average for the Tacna valley. Forty families, a total of 350 people, have directly benefited from the project. Farmers' incomes exceed those projected in the PP. An important component of the project has been the monitoring and testing of crops and soils as well as the screening of participants to determine the health implications of the use of treated effluent for crop irrigation; to date, no detrimental effects have been found.

The internal rate of return (IRR) is approximately 43%; far exceeding the estimated opportunity costs of capital for Peru (15%) and indicating that the project is economically sound*. The most important factor in this high return to investment is the far-above-average yields obtained by participating farmers. For this reason, a separate IRR was calculated based on yields that were considerably lower than those estimated by GOP officials involved in project implementation and used in the first estimate (See section 18). The IRR for this second estimate was still a high 22%.

In drawing conclusions about the replicability of the pilot project in other sites, it must be observed that the Tacna project area has benefited from several factors that may not be found in other areas. For instance, a modern fluent treatment plant already existed near the project site. Another important factor is that pumping for irrigation has not been necessary which has reduced investment costs considerably. To measure the impact of this factor on the project's financial return to investment, hypothetical pumping costs were also considered. Even with these costs, the project is economically viable.

* It should be noted that this does not take into account the cost of land, since it was a GOP contribution with little economic value at the time the project was initiated. Considering the cost of land would, of course, reduce the IRR. In addition, it should be noted that the 15% figure for the opportunity cost of capital in Peru is a widely used estimate, although, due to a number of economic factors, the real opportunity cost of capital in Peru is not known.

This evaluation points out several recent problems related to health monitoring and testing and recommends that a thorough assessment of laboratory tests to date be undertaken and future plans for health monitoring activities be made by a qualified expert.

14. Evaluation Methodology

This is the third formative evaluation undertaken since the initiation of project activities. The first evaluation took place in August of 1978 and a subsequent evaluation was undertaken in March of 1979. The purpose of this evaluation, in accordance with the Project Paper's Evaluation Plan, is to examine the project purpose and overall output progress to date and to analyze the possibility of replicating the pilot project in other locations in Peru. The evaluation consisted of a review of existing project documentation in USAID/Peru and on-site inspection.

The Evaluation Officer, the USAID Engineer responsible for project implementation, and a GOP official from the Ministry of Housing and Construction met in Tacna on August 21-23 to assess project performance and meet with local officials from the Ministry of Agriculture and Food (MAF), Ministry of Health (MOH), and key personnel from the MAF's Office of Investment Projects (OPI) which are directly involved in project implementation. Site visits were made to the effluent treatment plant, the agricultural production area, including experimental plots, and the cooperative grounds where farmers participating in the project discussed progress and problems encountered to date. Interviews were also conducted at the parcelas (plots) of a number of participating farmers.

15. External Factors

No major changes have been encountered in project setting or in GOP priorities which have had a significant effect on project implementation. To date, all project assumptions, as stated in the PP's Logical Framework have proven valid. At the Output level these include:

- Construction materials available without major delays*.
- Willingness of farmers to form a coop and participate in the project.
- Availability of agricultural credit from the Agrarian Bank for participating farmers.

* The first evaluation (8/78) noted that there had been some problems with the procurement of construction materials. It appears that these problems were adequately resolved.

At the Purpose Level they include:

- Adequate support for the project (by Agrarian Zone VII of the MAGF).
- GOP agencies involved in the project (MAGF, MOH, etc.) will continue to support the project.
- Continued adequate operation of the Tacna sewage treatment plant.

Several logistical problems have been encountered, however, which may affect the future operation of the project:

A. Delays in withdrawing equipment from customs. In February of this year, laboratory equipment worth S/.4,000,000 (US\$13,300), donated by USAID/Peru, was imported from the United States. The equipment was donated to carry out tests in Lima (through the National Institute of Health) which were not possible with equipment in the Tacna facilities. The equipment has been in customs since its arrival in February. The delay has been caused by a required Duty Free Exemption Certification (Certificación de Exoneración de Impuestos). In the past, the certification was processed by the MAGF which has considerable experience in this process. Due to bureaucratic reorganization, however, the Regional Development Organization-Tacna/Moquegua (ORDETAM) is now in charge of the project and must process its own certifications. Since the reorganization took place, an informal agreement between MAGF and ORDETAM has been used to retrieve equipment from customs. Misunderstandings regarding this informal arrangement have caused the present delay. At the meetings with officials from both institutions, the USAID project manager recommended that to avoid future delays, ORDETAM should process the certification on its own.

B. Conflict regarding the centralization of laboratory equipment and personnel. In the past, local laboratory experiments were carried out at the MOH's Regional Hospital and the University of Tacna. However, the OPI has recently built a laboratory near the project site where it hopes to centralize laboratory tests to be performed in Tacna. This centralization, particularly removing project laboratory equipment from the Regional Hospital, has been resisted by the MOH. During the site visit, the evaluation team met jointly with OPI personnel and the Regional Director of Health who stated in the meeting that there had been some lack of communication on the centralization issue, but that the matter could be "easily cleared up." It was strongly recommended by USAID participants that the issue be settled so that soil and effluent testing can proceed normally. USAID will need to follow-up progress on this issue.

C. Agrarian Bank Credit. To date, the Agrarian Bank has reserved approximately S/.40,000,000 for production credits under the project. Of this amount, S/.17,000,000 is available as medium-term credit for the purchase of cattle and alfalfa production at an 18% rate of interest while the rest will be provided at the commercial rate of 31% (still a negative interest rate). To date, however, only 20 farmers (50% of participative farmers) have been willing to solicit bank credit. (accounting for approximately S/.23,000,000 in medium and short-term credit). Since profits for the first year of production exceeded their expectations, and they had enough working capital to begin the production for the second year, some farmers have not needed bank financing. This does not in itself represent a problem at the present time. Agrarian Bank officials have said, however, that they will lend the reserved project credit fund to other area farmers. As future profits are reinvested in their lands, farmers may find a need for credit and those farmers without established credit may have difficulties obtaining financing.

16. Inputs Findings

Required inputs have been provided without major problems. Detailed description of the use of USAID and GOP funds have been presented in previous evaluations.

USAID

Grant funds have been used as planned for the project design and for the construction of the irrigation infrastructure. Concurrently, the grant has financed research activities to determine the adequacy of the sewage treatment and the effect of the effluent on soils. Epidemiology controls have been implemented.

Original Life-of-Project Grant funding was \$200,000. Accrued expenditures to date amount of \$199,000 or 99% of project funding. USAID approved the allocation of \$20,000 of additional grant financing and the extension of the PACD to March 31, 1981. This amount will continue to support research and epidemiology testing.

GOP

GOP counterpart contribution of approximately S/.26,000,000 has exceeded original commitment of S/.11,500,000. In addition, USAID/Peru reached an agreement with the GOP for the allocation of \$30,000 of PL 480 Title I funds for the project.

Counterpart contributions covered part of the personnel, operation and construction costs. Participating GOP agencies are the Ministry of Agriculture and Food, the Ministry of Health, the Tacna Regional Hospital, the National Health Institute and the Agricultural Bank.

17. Output Findings

Programmed Outputs have been met and, in most cases, greatly exceeded programmed targets. Projected and actual outputs are summarized in Table I.

Other completed activities included the construction of drains and water intakes and the preparation of blocks for housing construction. In addition, a Cooperative Service Center has been built which includes an administrative center and a school. This infrastructure was not contemplated in original PP. Construction was completed in August 1979.

As Table I indicates, yields for all crops have been greater than projected in the PP. They have also been greater than Tacna valley averages. OPI agronomists told the evaluation team that these were yields for project plots and were actually higher in those parcelas with better soil conditions.

A demonstration/experimental plot of approximately six hectares was established prior to delivery of land to farmers. Under OPI supervision, the sanitary conditions of crops grown in the experimental plot are being tested. These include garden crops, e.g., which by Peruvian law are not permitted to be cultivated in fields using treated effluent for irrigation. Experiments also include appropriate fertilizer use and cropping techniques.

All laboratory testing, consisting of bacteriological, biological and virus research, has been undertaken in accordance with the health monitoring parameters outlined in the project implementation plan. No detrimental health conditions have been found. Efforts have been made to undergo enterovirus testing of project participants.

Health status of participants was examined at the initiation of the project and tests are performed periodically. The last exam will be completed in the fall of 1980. A high rate of parasite incidence has been found among participants tested so far but health examiners point out that this is a typical condition of poor farmers in Tacna as in the rest of the country, and is unrelated to the project. Negative laboratory tests of soils and crops indicate that this is probably the case.

TABLE I

OUTPUTS

	<u>Programmed</u>	<u>Actual</u>	
A. <u>Civil Construction</u>			
Primary Irrigation Canals (concreted lined)	5 km	7.2 km	
Secondary Canals	11 km	15.0 km	
Feeder Roads	9 km	12.0 km	
Potable Water Tubing	-	5.2 km	
Fencing	-	5.2 km	
B. <u>Cultivated Hectarage</u>	120 ha*	136**	
C. <u>Production of Selected Crops</u>			<u>% Increase</u>
Corn (38 ha)	3.0 mt/ha	3.6 mt/ha	20%
Squash (59 ha)	8.0 mt/ha	20 mt/ha	150%
Sweet Potatoes (1.5 ha)	-	20 mt/ha	-
Alfalfa (19 ha)	55 mt/ha	96 mt/ha	75%
Potatoes (10 ha)	12 mt/ha	20 mt/ha	66%
Peppers (1 ha)	-	12 mt/ha	-

* For 1978, cultivated hectarage will be incrementally expanded to 200 ha, by the time treatment plant reaches full capacity by 1985.

** Including 5 ha. experimental area.

16. Purpose Findings

The purpose of the project is to demonstrate the economic and technical feasibility of producing significant quantities of foodstuffs by irrigating desert lands with treated effluent. The End-of-Project Status (EOPS) conditions are:

- Establishment of on-going demonstrations site.
- At least 120 hectares of Tacna pilot site under cultivation.
- Economic returns to small producers of the magnitudes indicated in the financial analysis.

The first two conditions are project outputs. As indicated in the previous section, demonstration and cultivation conditions have been met. Income to farmers will be discussed in Section 20.

Cost and Value of Production along with the Internal Rate of Return (IRR) are calculated in Annex I and II respectively. The IRR is approximately 44% (not including land), far exceeding the opportunity costs of capital for Peru (15%)* and indicating that the project is economically sound. The most important factor contributing to this high IRR is the far above-average yields obtained by participating farmers. As noted in Table I, these yields are considerably higher for some crops (squash, potatoes and alfalfa). It is expected, however, that as hectarage is increased substantially, yields will decrease as cultivation becomes less intensive. To test sensitivity of estimated yields on cash flows and financial returns, a second IRR was calculated utilizing yields which were only 10% above area averages (this resulted in net reductions of 34%, 27%, 15% in the yields of squash, potatoes and alfalfa respectively). This second estimate for yields is considered "realistic" since the irrigation being used contains a natural fertilizer (effluent) and thus yields would be expected to be somewhat higher than average. Utilizing these yields, the IRR of 33% is still quite high.

To further measure the economic feasibility of replicating the project, hypothetical pumping costs (initial investment and yearly operating expenses) were taken into account**. As illustrated in Annex II even with these costs, the IRR is 23% considering yields estimated by MAG/OPI and 15% with the reduced yields.

* See footnote, page one, regarding the opportunity cost of capital for Peru.

** Hypothetical initial investment of \$500/ha and \$5,000/year operating expenses. The fact that these are only hypothetical costs must not be overlooked. In reality, pumping costs will be determined by the project site, reflecting the distance that pumping is required, land level and grade, etc. Pumping costs in another site could be lower, or considerably higher, than those estimated here.

Cost/benefit analysis (see Annex III) were conducted for the different yield and cost estimates which were considered for the IRR calculations. A summary of these C/B ratios as well as IRR estimates appear below:

TABLE II
FINANCIAL ESTIMATES

	<u>IRR</u>	<u>Cost/Benefit Ratio</u>
1. Cash flow based on OPI yields, no pumping costs considered.	45%	1.46
2. Cash flow based on OPI yields, with pumping costs.	34%	1.32
3. Cash flow based on reduced yields, no pumping costs.	23%	1.12
4. Cash flow based on reduced yields, considering pumping costs.	15%	1.01

Considering the range of these estimates, it appears that the project purpose has been met.

19. Goal Findings

The goal of the project is to increase food production through the expansion of arable land along Peru's populated coastal desert. A secondary goal is to reduce environmental sewage contamination along Peru's coast. Measures of goal achievements are:

- Increase in arable coastal hectarage available for food production of food of 6,000 hectarage by 1985.
- Construction of sewage treatment systems for six principal coastal cities, including Lima, by 1983.

It is difficult at this time to estimate specific hectarage and sewage systems which may be constructed by certain target dates. Given GOP priorities and other factors, it is unlikely that actual goal targets will be met. However, the GOP has expressed interest in replicating

the project in the Lima area and in other coastal cities, particularly Chinbote and Trujillo. GOP officials who have visited the pilot project site have instigated preliminary discussions with USAID/Peru to replicate the project in an 800 ha area near the "Villa El Salvador" pueblo joven in Lima. The Ministry of Housing and Construction (MOHC) has begun work on a reforestation project, using sewage effluent, near the Lima site. The MOHC has also expressed interest in a more ambitious project which calls for the irrigation of 5,000 ha, southeast of Lima between Lurin and San Bartolomeo.

As part of a Condition Precedent to the disbursement of the \$20,000 project extension, MAG/OPI will present USAID/Peru with a report on the possible replicability of the project in provincial cities in the coastal desert.

20. Beneficiaries

The direct beneficiaries of the project are the cooperative members and their families (40 families; approximately 350 people). Successful replication of the project will expand the number of direct beneficiaries in addition to increasing food production. Replication in the proposed Lima site, for example, could provide arable land for over 12,000 people.

The social composition and status of the direct beneficiaries is described in detail in the PP. Only 26% of the group (migrants from neighboring rural departments with little training outside the agricultural sector) were considered economically active prior to participating in the project. Over half of these worked primarily during the limited planting and harvest seasons.

The project has provided these families with arable land and with access to a steady source of future income. Average net income for the participating forty families is approximately \$3,000/year* Projected family income in the PP was \$2,384/year. Per capita income is not far from the PP level of \$350/year even though there are approximately 8.75 people/family compared to PP estimates of 6 people/family. Empirical evidence that the figures are not overestimated is provided by the fact that eleven of the forty families have been able to purchase used pick-up trucks, on a cash basis, with earnings from the first year's crops. While this was possible because many of the inputs used in the first year were USAID financed grant, their purchase indicates that actual incomes may be much higher than the one calculated here. In fact, MAG/OPI income estimates are much higher than the ones presented above.

* Considering an exchange rate of \$1 = S/.300 at the time the evaluation took place. If the exchange rate of \$1 = S/.250 is used (exchange rate during the first harvest) dollar incomes are of course much higher.

In addition to direct beneficiaries, the population of Tacna has benefited through the increased availability of foodstuffs. By 1985, over 200 ha. of increased foodstuffs will have been brought into production.

21. Unplanned Effects

From the economic point of view of the direct beneficiaries, the project has been a clear success. However, GOP personnel involved in project implementation have expressed concern about the social conditions and attitudes of the participants.

The primary concern is that the participants' improved financial condition has not resulted in similar gains in their attitudes towards sanitation, shelter and other social conditions. For example, the construction of latrines has been suggested and sanitary education programs undertaken but there is little interest on behalf of the farmers. Participants were provided with construction materials and plans to build "adequate" homes but the farmers have elected to, at least initially, build the traditional one-room rudimentary homes (although at least partially of concrete blocks) shared by all family members and some animals. These conditions, GOP personnel suggest, make them susceptible to many health problems unrelated to treated effluent irrigation but which may affect the project's health monitoring, i.e. the project staff is concerned that the participants may eventually suffer health problems unrelated to but blamed on the use of treated effluent irrigation.

In the discussions that the Project Evaluation team undertook with the project staff, it was agreed that considering the "rags to riches" story of the participants, it would be unrealistic to expect cultural attitudes to change quickly. Attempts to modify these attitudes should continue, particularly by means of creative education campaigns that would attract participants' interest.

Another concern of officials interviewed is that there has been a certain degree of paternalism in project implementation. In their opinion, participating farmers have been given agricultural inputs, potable water, a school, etc., and now "demand" and expect the project staff to provide additional services. For example, despite the success of the first year's harvest, several farmers are upset that the Agrarian Bank will no longer provide concessionary interest rates for annual crops.

The level of services provided has been influenced by the nature of the project, i.e. a pilot program. It should be noted, however, that the farmers have continued to provide maintenance services for the treatment plant, as agreed and have continued to cooperate with the project staff in most endeavors.

22. Lessons Learned

According to the GOP project staff, one of the keys to project success has been the creation of an independent project unit under MAG/OPI. This unit has been uniquely dedicated to the project since its inception and has been responsible for all project components such as health monitoring and testing, agricultural extension, etc. In the staff's opinion, the creation of an independent project unit is necessary for the success of similar projects.

23. Special Comments or Remarks

The project is a success in terms of the implementation of outputs and the benefits of direct beneficiaries. However, its success must be measured in terms not only of the accomplishment of an engineering feat, the benefits for forty families and increased food production for one community. The real success of the project will be determined by: (1) the economic feasibility of its replication in other sites, and (2) the continuation of adequate health monitoring where no negative results are found.

The IRR indicates that in the Tacna site the project is economically sound. This site, however, has several advantages that other possible sites might not have. First, the modern treatment plant had previously been built; second, no pumping of the effluent was required which would have elevated project costs, although hypothetical pumping costs have been considered. Land costs have not been considered since the land had no agricultural value before irrigation. The land may have some commercial value since the project site is directly across from Tacna Municipal Airport. At any rate, since there appears to be no significant shortage of commercial land in Tacna's outskirts, its value was probably quite low. This may not be true in other, more crowded, coastal cities, particularly Lima. Here, land that would be brought under irrigation may directly compete with urbanization and its value must be carefully calculated. Economic and cost analyses of other projects will have to take these factors into account and will be further complicated by other external factors. For example, the economic analysis of a proposed site in the Lima area where pumping will be required (and costs will be greater) must also consider other alternatives such as the costs of pumping the effluent beyond Lima's beaches and coastal waters. These factors imply both financial and economic costs which must be weighted against benefits, e.g. employment, income, etc.

Continued health monitoring is needed. It will be particularly important to determine the feasibility of expanding the categories of crops that can be cultivated using treated effluent. Peruvian law does not presently permit cultivation by treated effluent irrigation of high value garden crops which are eaten uncooked.

It is notable that two of the external factors cited in Section 15 are related to health monitoring: the delay in recovering laboratory equipment from customs and the centralization of laboratory testing. An independent evaluation of all laboratory tests to date and future monitoring procedures should be undertaken by a qualified expert. While the Institute of Public Health and the Ministry of Health will continue to monitor laboratory results, an independent evaluation by an outside expert would be a good investment. If USAID is going to participate in the replication of the project, such an evaluation will be very useful in answering health-related questions that will certainly be raised during project reviews, as well as allaying fears in Peru of utilizing treated effluent for crop production, one of the primary goals of the project; an evaluation of this type may also encourage the expansion of alternative crops.

A N N E X I

COSTS AND VALUE OF PRODUCTION ^{1/}

FIGURES IN PERUVIAN SOLES \$1 = S/.300

<u>Crop</u>	<u>No. has</u>	<u>Yield ^{2/} kg/ha</u>	<u>Price S./kg</u>	<u>Total Value S/.</u>	<u>Cost of Production^{3/}</u>	<u>Net Value</u>
Corn	40	3,600	80	11,520,000	7,200,000	4,320,000
Squash	59	20,000 (13,200)	20	23,600,000 (15,576,000)	11,800,000	11,800,000 (3,776,000)
Potatoes	10	19,000 (13,750)	90	17,100,000 + 8,550,000 ^{3/} (12,375,000 + 6,187,500)	7,500,000 + 3,750,000 ^{4/}	9,600,000 + 4,800,000 ^{4/} (4,875,000 + 2,437,500)
Alfalfa ^{3/}	19	68,400 (58,140)	6	7,798,000 (6,627,960)	4,750,000	3,048,000 (1,977,960)
Sweet Potatoes	1.5	19,000	30	855,000	450,000	405,000
Peppers	1.0			650,000	300,000	350,000
TOTAL	130.5			70,073,000 (53,791,460)	35,750,000	34,323,000 (18,041,460)

^{1/} MAG/OPI Data: Yields, total and net value in parenthesis are considering yields 10% above area averages.

^{2/} Yields considered an average of 5% spoilage.

^{3/} For alfalfa, yields, production costs and total income represent a 4 year cycle average.

^{4/} Second crop rotation.

ANNEX II

CASH FLOW I ^{1/}
(thousands of soles)

<u>Without Pumping</u>	<u>Year</u>	<u>Investment^{4/} and Maintenance</u>	<u>Production Costs</u>	<u>Total Costs</u>	<u>Income</u>	<u>Cash Flow^{2/}</u>
	1	75,000 ^{6/}	-	-	-	(75,000)
	2-6	450	35,750	36,200	70,073	33,873.
	7-11	540	35,750	36,290	70,073	33,783
	12-16	648	35,750	36,398	70,073	33,675
	17-21	778	35,750	36,528	70,073	33,545
	22-25	993	35,750	36,683	70,073	33,390
	IRR: (45%)					
<u>With 3/ Pumping</u>	1	95,400	-	-	-	(95,400)
	2-6	1,950	35,750	37,700	70,073	32,373
	7-11	2,040	35,750	37,790	70,073	32,283
	12-13	2,148	35,750	37,898	70,073	32,175
	14 ^{5/}	22,548	35,750	58,298	70,073	11,775
	15-16	2,148	35,750	37,898	70,073	32,175
	17-21	2,278	35,750	38,028	70,073	32,045
	22-25	2,433	35,750	38,183	70,073	31,890
	IRR: 34					

1/ Considers income based on yields reported by MAG/OPI.

2/ Per year

3/ Based on Initial Investment of \$500 (S/.150,000)/ha. (150,000 x 136 = S/.20,400,000) and operating costs of S/.1,500,000/year.

4/ Maintenance costs of 450,000 increased by 20% every five years.

5/ New investment required due to depreciation.

6/ Considers total project investment (GOP/AID) for infrastructure construction. Does not consider laboratory testing and other non-production investments such as potable water, school construction, etc. This investment reflects the original investment (\$250,000) in present soles (S/.300 = \$1). It should be noted however, that between project design and project implementation, a significant devaluation of the sol took place. Hence, it is possible that the local "purchasing power" of \$250,000 may have been much greater at that time due to the lag between the devaluation and subsequent increased in construction costs.

C A S H F L O W II ^{1/}
-

(thousands of soles)

<u>Without Pumping</u>	<u>Year</u>	<u>Investment and Maintenance</u>	<u>Production Costs</u>	<u>Total Costs</u>	<u>Income</u>	<u>Cash Flow</u>
	1	75,000	-	-	-	(75,000)
	2- 6	450	35,750	36,200	53,791	17,591
	7-11	540	35,750	36,290	53,791	17,501
	12-16	648	35,750	36,398	53,791	17,393
	17-21	778	35,750	36,528	53,791	17,263
	22-25	933	35,750	36,683	53,791	17,108
	IRR:	23%				
<u>With Pumping</u>	1	95,400	-	-	-	(95,400)
	2- 6	1,950	35,750	37,700	53,791	16,091
	7-11	2,040	35,750	37,790	53,791	16,001
	12-13	2,148	35,750	37,898	53,791	15,893
	14	22,548	35,750	58,298	53,791	(4,507)
	15-16	2,148	35,750	37,898	53,791	15,893
	17-21	2,278	35,750	38,028	53,791	15,763
	22-25	2,433	35,750	38,183	53,791	15,608
	IRR:	16				

^{1/} Considers yields based on yields 10% above area averages, all other calculations based on data in Cash Flow I.

Annex III

Benefit Cost Ratio I ^{1/}

<u>Year</u>	Present Worth		Present Worth
	(Costs)	(soles)	(Income)
	<u>15 %</u>	(000)	<u>15 %</u>
1	65,250		0
2	27,367		52,975
3	23,820		46,108
4	20,706		40,082
5	17,991		34,826
6	15,638		30,272
7	13,645		26,347
8	11,867		22,914
9	10,306		19,900
10	8,964		17,308
11	7,802		15,065
12	6,806		13,103
13	5,933		11,422
14	5,132		9,880
15	4,477		8,618
16	3,895		7,498
17	3,397		6,517
18	2,959		5,676
19	2,557		4,905
20	2,228		4,274
21	1,936		3,714
22	1,687		3,223
23	1,467		2,803
24	1,284		2,453
25	1,100		2,102
	<u>268,214</u>		<u>391,985</u>

^{1/} With present estimated yields and no pumping costs

$$\text{RATIO } \frac{\text{Benefit}}{\text{Cost}} = \frac{391,985}{268,214} = 1.46$$

Annex III

Benefit Cost Ratio II ^{2/}

<u>Year</u>	<u>Present Worth (Costs) 15 %</u>	<u>Present Worth (Income) 15 %</u>
1	82,998	---
2	28,501	40,666
3	24,806	35,394
4	21,564	30,768
5	18,737	26,734
6	16,286	23,237
7	14,209	20,010
8	12,357	17,590
9	10,732	15,276
10	9,334	13,286
11	8,125	11,565
12	7,087	10,059
13	6,177	8,768
14	8,220	7,585
15	4,661	6,616
16	4,055	5,756
17	3,537	5,003
18	3,080	4,357
19	2,662	3,765
20	2,320	3,281
21	2,015	2,851
22	1,756	2,474
23	1,527	2,152
24	1,336	1,883
25	1,146	1,614
	<u>297,228</u>	<u>300,690</u>

$$\text{RATIO} \frac{\text{Benefit}}{\text{Costs}} = \frac{300,690}{297,228} = 1.01$$

^{2/} With yields 10 % above area average and hypothetical pumping costs.