DOE/NASA/0050-1
NASA CR-165551

NASA-CR-165551
19820011795

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Final Report

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Washington, D.C. 20545
Under Interagency Agreement DE-AI01-79ET20485

This report has been reviewed and approved by the Papago Tribe of Arizona.

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CHAPTER 1

INTRODUCTION

This is a report of the social impact of a solar-powered electrical system at the Papago Indian village of Schuchulik, Arizona. The village of thirteen households and about sixty residents had been largely without electricity for domestic and communal purposes prior to the installation of the new and somewhat experimental system in 1978. The system was experimental in that it was the first solar powered (photovoltaic) installation in the world intended for a broad spectrum of public (water pumping and communal building lighting) and private (house lighting, food refrigeration, clothes washing and sewing) purposes. In effect the system comprises a mini public utility. Other such systems might find uses in other communities, particularly in small communities located at some distance from commercial electric grids. With that possibility in mind, the present report describes the impact of the system on the village as fully as possible.

The authors did not discern a singular, well defined social impact resulting from the introduction of a solar electric system Schuchulik. Rather, we found the system to mean different things to different people, ranging from the village headman who had daily duties in metering the system and mediating between the village and various outside agencies, to a solitary adult man whose house was not hooked up to the village electrical circuit. We also saw that the impact of a new public utility changed through time. It was not a question of a sudden transition from a state of not having electricity to a state of having it, but of a gradual process passing through the following stages:

1) the planning of the system prior to its installation, in this case, from late 1977 to mid 1978;
2) the construction and installation of the system, in Schuchulik from mid 1978 to December, 1978;
3) the formal dedication or "switching on" of the system, in Schuchulik on December 16, 1978;
4) the modification, debugging, and coming to terms with the system, in Schuchulik from December 1978 through the duration of our study period until March 1980;
5) the eventual transfer of ownership and maintenance functions from the installing agency (NASA in this case) to the village or to some extra-village agency or agencies other than the installer. This event had not yet happened during the study period.

There were impacts of different sorts throughout the two and a half years of history sketched above. Each stage carried its own general problem which could be phrased as a kind of impact, ranging from a need for preplanning in the first stage, before the physical system was yet in existence, through minute and myriad changes in individuals' work habits in stage three, to a

hoped for steady state after stage five when the installing agency would have left a functioning system in the village.

It may be asked whether the word "impact" aptly describes the social process just outlined, or if there isn't some simpler way to define the system's impact. In our opinion the above process is more important than the terminology used to name it. If the reader prefers "incorporation" or "transfer" to "impact," we would be agreeable. The important point is that the residents of the village perceived the electrification process essentially as we have described it. They had difficulty understanding what we authors meant by "social impact," but they were quite clear in understanding that the electrical system was intended to fill their needs on a long term basis. They understood that the intention might not be fulfilled but in their view (as we understand it) if the system didn't work well or if it were removed prematurely the electrification project would be less than a success and its impact would be less than favorable. It must therefore be understood that the full impact, i.e. the arrival at stage five, had not yet occurred when our study ended.

The report has seven chapters, counting the present one, plus an appendix. Chapter 2, Village History, puts Schuchulik's technological and social development into a two hundred year context to show that the coming of electricity to the village was in a sense preordained. When electricity came, the village was in effect a neighborhood within a larger townlike governmental structure coextensive with the Papago tribe. How it got that way and how its physical structures have changed are the twin subject matters of this chapter.

Chapter 3, The World Outside the Village, places Schuchulik in its contemporary regional context as a settlement on the extreme west end of the Papago Indian Reservation in Arizona close to the International boundary between the United States and Mexico. The chapter briefly describes a number of extravillage settlements that Schuchulik people visit for various reasons nearly every day.

Chapter 4, Group Life, examines groups internal to the village with special emphasis on how the electric system affected them and how they articulate with the outside world. The groups considered are families, the church congregation, a cattlemens' association, and a tribally sponsored mens' work crew. In this small village those groups comprise the social world relevant to the electrification project.

Chapter 5, Energy Use, concentrates on the immediate cause of the project's coming to Schuchulik, the concept that the village needed electricity and that a photovoltaic system could fill the need. An important case of traditional Papago thought on energy is discussed (a theory of sickness articulated by medicine men), then contemporary Papago use of one old and two new energy

sources is treated, namely firewood, electricity, and propane. Quantitative data on Schuchulik's electric system are introduced and compared with data from Papago villages receiving conventional electricity.

Chapter 6, Use of the System, goes point by point through the entire system from the users' point of view. (Chapter 5 discusses the system in terms of aggregate energy consumption and hours of use.) The issue is, granting that the system was designed to take over various tasks that villagers had previously done in other ways, how much taking up or transfer took place during the first year and three months of the system's operation?

Chapter 7, Conclusions, summarizes the findings of the study based on the first fifteen months operation of the solar electric system, considers its possible future in the village, and briefly addresses the relevance of the Schuchulik experiment for energy planners elsewhere.

The Appendix, The Food System, investigates the possibility that one of the system's features, a bank of refrigerators, could affect the total food system of the village. Special emphasis is given to the end state or purpose of the food system, that is,the nutrional status of the villagers.

Description of the System

The system has been concisely described in reference 1 as follows:

> "The Schuchuli* village PV power system (Figure 1) became operational on December 16, 1978. It provides the residents of Schuchuli with electric power for potable water pumping, lights in the homes and community buildings, family refrigerators, and a communal washing machine and sewing machine.
>
> The power system consists of a 3.5 kW, 120 volt, DC PV array, 2380 ampere-hours of battery storage, controls, voltage regulation and instrumentation, and an overhead electrical distribution network. The battery and controls are located in an electrical equipment building (EEB), shown on the right in Figure 1.
>
> The system is all DC to avoid the losses associated with commercially available DC/AC inverters and to maximize system efficiency. The system voltage was set at 120 volts to limit distribution line losses and to enable use of commerically available DC switches and DC appliance motors. The load devices were individually selected on the basis of energy efficiency.
>
> System design, exclusive of the overhead distribution network, was performed by LeRC. The overhead distribution network was

* We spell the word with a "k" on the end which is how Papagos pronounce it. The name means "many chickens." It is pronounced "S-CHOU-choo-lick." The Papago words written in this report are spelled with an orthography adopted by the Papago Tribe. This orthography is described in Bahr, Gregorio, Lopez and Alvarez (1973).

designed by the Papago Tribal Utility Authority. A brief description of the major system components and features depiected in Figure 2 follows.

The PV array consists of 24, 1/22m-by-2.44m (4-ft-by-8-ft) panels. Each panel contains eight modules connected in series to make up a 120 VDC series string. The panels are arranged in three rows of eight and are located in a 21.3m-by-30.5m (70-ft-by-100-ft) fenced area. Panel frame and support structure are designed to withstand 161 km/hr (100 mph) wind loads and are fabricated from commercially available hardware.

The battery consists of 53, 2380-ampere-hour capacity cells [at a 500-hour, 25° C (77° F) discharge rate] connected in series. The cells were designed for operation with PV systems and have lead-calcium plates capable of deep discharge cycle operation. The batteries are housed in a separate, vented room in the EEB.

A two HP permanent magnet, 120 VDC motor powers a positive displacement water pump which delivers approximately 4165 liter/hour (1100 ga/hr) into the village water distribution system which includes a 41,635 liter (11,000 gallon) storage tank located approximately 365m (1200 feet) from the well. During normal operation, a control system limits pumping to daylight hours, roughly centered about mid-day.

A total of 47, 20 watt/120 VDC fluorescent lights are installed in the village. The lights employ a high-efficiency 120 VDC/23 kHz inverter-ballast which enables the lamp to produce the same number of lumens as a 120 VAC/60 Hz ballast.

A total of 15, 0.13m^3 (4.7-cubic-foot) refrigerators (with small freezing compartments) are installed in the domestic services building (DSB). These refrigerators are of a custom design developed by a manufacturer of marine refrigerators and are completely insulated with a minimum of 7.5cm (3-inches) of polyurethane foam. Each has an automatic door closer and a key lock. Three refrigerators are assembed as a unit and powered from a single compressor with a 1.4 HP, 120 VDC permanent magnet motor. The manufacturer reports that the duty cycle should be about 25% "on" in a 43° C (100° F) ambient environment based on test results from a similar unit.

A standard wringer-type washer was refitted with a 1.4 HP, 120 VDC permanent magnet motor. A wringer-type washer was selected for overall simplicity and to reduce water consumption. The washer is connected to a cumulative timer which allows up to twelve hours per day of washer operating time. At 1/2 hour/load, this provides for washing approximately 1.75 loads/person/week based on a village population of 96.

A commercially available sewing machine with a 1.8 HP, 120 V universal motor was also installed in the DSB."

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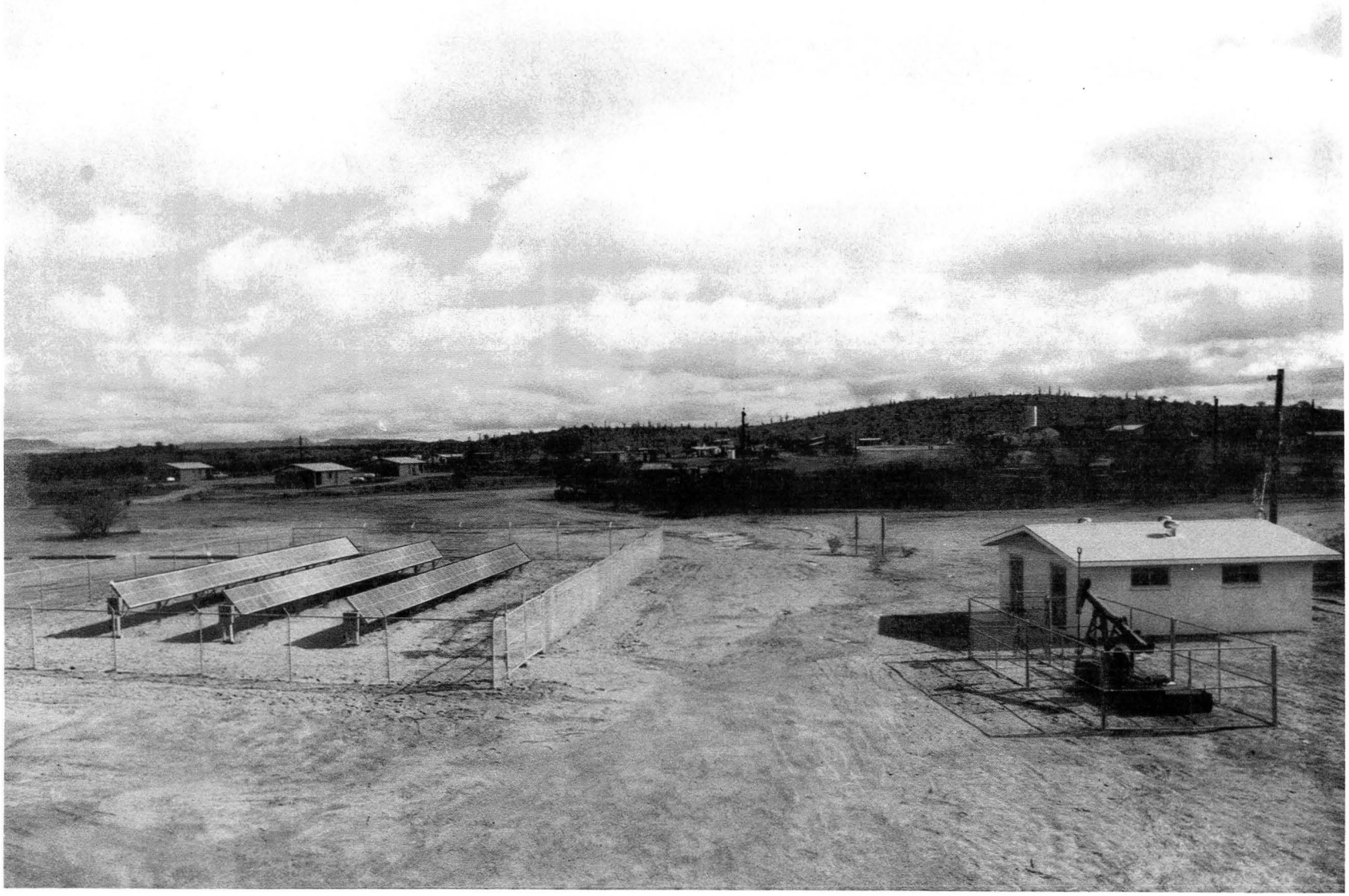


Figure 1 - Village Photovoltaic Power System, Schuchuli, Arizona

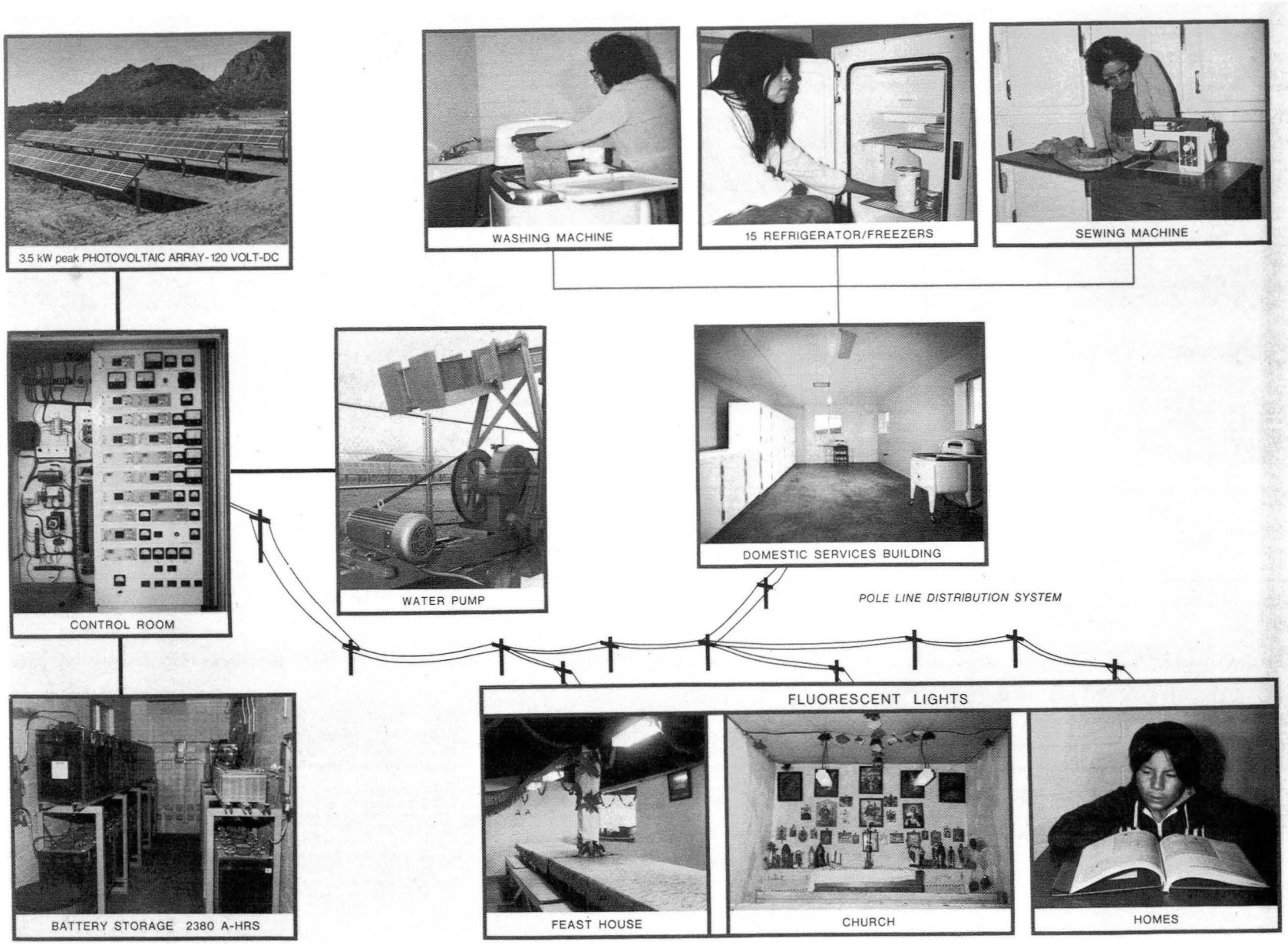


Figure 2 - Block diagram of Schuchuli village photovoltaic power system.

All electrical loads were hard-wired to the photovoltaic system. Furthermore, no provisions were included for connection of additional appliances.

Duration of Study, Personnel, and Acknowledgements

The study period ran from the summer of 1978 to March, 1980, with some data gathered between March and May, 1980, while the report was being drafted. Of the three co-authors, Bahr had overall responsibility for the study and report, and made the most visits to the village. (All three co-authors lived in Tempe, Arizona, 150 miles from Schuchulik.) Garrett specialized in the physical and social history of the village and Chrisman specialized in the impact of the system on nutrition and women's work. The primary writing assignments for the chapters were: Chrisman, Chapter 6 and the Appendix; Garrett, the second part of Chapter 2; and Bahr, the rest. Each person contributed some information for each chapter. The maps and many of the photographs in the report are Garrett's work.

Also making formal contributions to the project were Eleanor Santos as a field researcher and Mary Lynn Kasunic, Gordon Krutz, and John Martin as consultants. Virtually everyone who stayed in Schuchulik for any time during the study period, a total of perhaps 100 people, helped the study in some way. Seven different families put up one or more of the co-authors overnight at one time or another and we can only say that our welcome to the village was superb. A number of people outside the village also helped the study in various ways. Of those we would like to single out Hans Bart, Richard Chrisman, Alfred Gonzales, James McArthur, Noeimi Norris, Lorna Patricio and Johnnie Raley. Thanks are also due to the Papago Tribe and Hickiwan District for approving the study and to the Office of Cultural Resource Management at Arizona State University for administering it.

CHAPTER 2

VILLAGE HISTORY

The village electrification project at Schuchulik was formally dedicated on December 16, 1978. By noon on that bright, cool Saturday hundreds of guests had arrived -- their cars, trucks and buses filling the area west of the church. Papago Tribal Chairman Cecil Williams and U.S. Representative Morris Udall made speeches, NASA engineers answered questions about the system, children from a neighboring village performed Papago dances, and everyone enjoyed a barbecue and chili lunch in the village feasthouse. In the background television crews recorded the event for later transmission into homes throughout the country. As Papagos say, it was "big doings."

The dedication ceremony marks one of the most important events in the history of Schuchulik. As one resident later said, "That electrical project put Schuchulik on the map." Indeed, as the "world's first solar powered village", Schuchulik has attracted international attention. Most of this attention has been generated by the innovative technical features of the photovoltaic system.

The villagers have taken that attention in stride just as they took the photovoltaic system itself in stride as the most recent of many technological innovations they have accepted from the outside world. This chapter will provide an overview of the events which shaped Schuchulik and describe the physical and institutional setting of the photovoltaic installation. The chapter is in two parts, the first dealing with technology and the development of forms of Papago community organization in the abstract, the second dealing with the individual residents who built Schuchulik. The first, organizational, story was written by Bahr; the second, human, story was written by Garrett.

THE EVOLUTION OF PAPAGO VILLAGES FROM CAMP TO RANCHERIA TO NEIGHBORHOOD

Here we trace the historical development of Schuchulik as a type of community. There are two dimensions to the development, technological, with special emphasis on the physical structures in a village and the uses to which they are put; and sociological, with special emphasis on the political integration of villages into units larger than themselves. Technologically Papagos in general have changed over approximately the last two hundred years from a mode of life involving structures constructed from the local vegetation and dry earth (no water) to a mode involving the full range of modern American building materials. The electrical system's buildings and apparatus are the latest piece of this process whose roots are deep in the Papago past. By tracing the progression we hope to dispel inaccuracies in journalistic accounts of the village's historical experience such as the following excerpt from a film narrative entitled "Usable Electricity from the Sun: The Story of Schuchulik":

"That was yesterday. Today -- Schuchuli has entered the Age of Electricity. Now, this isolated, tiny village shares the wonder and utilization of electric power with all the great cities of the world." (Reference 2)

The inaccuracy in the above statement is not in the concept of significant technological change, but in the time perspective used. The correct perspective is two centuries, more or less, not yesterday and today, or 1975 (pre-electrification) and 1979 (post-electrification). This is an important difference because it means that the villagers or their ancestors had about 195 years of practice in incorporating technological innovations prior to the most recent one that came to them. One can truly say that Schuchulik was attuned to innovations by the late 1970's.

The sociological dimension concerns the political and economic context through which Schuchulik has obtained its technological innovations. Very briefly the problem faced by Schuchulik is how to incorporate new technology into its communal life while being incorporated by planning, governmental, and property holding bodies ever more distant from its home terrain. Again the process is of greater time depth than one might suppose. Our terms "camp, rancheria, and neighborhood" are meant to describe a progression of economic and political relations with the outside world as well as a progression of physical settlement types. A camp has its distinctive internal plan and set of physical structures, but it also has its distinctive integration in a broader social context, etc.

The reader will note that the word "village" is missing from our list of settlement types and modes of integration. This is intentional. All three types might be called villages and of course "village" is how Schuchulik has always been referred to in English. This makes the word too broad to describe the distinct stages we are interested in.

Camp

Schuchulik was founded as a Papago settlement in the early 1930's after its inhabitants had left behind their camping existence. Thus an archaeologist would find no traces in today's settlement of this original form of Papago community. Little is known in detail through history or archaeology about such settlements in the western part of the Papago reservation where Schuchulik is situated. The best general orientation is provided by Fontana (reference 3) who would classify Schuchulik's ancestors as border line between two regional adaptations to the Pimeria Alta portion of the Sonoran Desert. He calls one adaptation "Areneño" and the other "Two Village." The former was to the west of the latter. The former was purely nomadic. The latter involved annual shifts between summer field villages and winter mountain locations. The critical determining feature in the adaptations was rainfall, this being slighter in the Areneño territory than in the Two Villages, about 15 cm per year against about 30 cm per year, and not much rain in either case.

We would characterize both of Fontana's adaptations as "camplike" on the strength of the following shared features (with variation as stated):

1) All building was dry; water was not used as a "building material,"* to our best knowledge and so the following construction techniques, characteristic of the rancheria stage, were lacking: adobe bricks, mud walled "sandwich" houses, wattle and daub construction, and stone masonry with a mud mortar.

2) The most durable and labor intensive structures were round, brush walled houses with earth covered roofs. Such structures were present in the Two Village adaptation but absent in the Areneño adaptation. Building one required a maximum of sixteen man days' work, e.g., four men pooling their labor over four days. This estimate includes the labor spent in assembling or producing the building materials. Such houses could last for a generation. Apparently they were more often torn down following an adult occupant's death, than used until they fell down. Thus, while we call such settlements "camps," we do not mean that their most durable structures lacked solidity. In fact the houses of this era (where built) were probably as durable as the structures of the last and most modern era of Papago architecture, although they were smaller, less complex and made entirely of local vegetable materials and dry earth. The rest of the structures of this era, which we will not list, required less labor as we reconstruct the building practices of the time.

3) The one communal or public building in a "camp" community included a round house, an open walled sunshade, and a fire building area (ranged from west to east in the above order) in the Two Village adaptation. In the Areneno adaptation this public building complex was reduced to a fire building area alone.

4) People changed settlements at least twice a year (the Two Villages) meaning that there were no fully sedentary settlements. The Areneño adaptation was totally migratory.

Sociologically, the camp era political integration fell at a transition between bands and tribes [to use Price's classification (reference 4)]. The tribal units or manifestations were not as large as today's Papago Tribe, but corresponded to today's "dialect groups" of which there are seven in the present Papago Tribe (reference 5). Such camp or tribal groups tended to marry within themselves, to cooperate in large public ceremonies, and to cooperate in war (reference 6). The present tribe, then, represents a span of territorial integration and a complexity of functional integration far greater than existed in the late nineteenth century. The new tribe was ushered into existence by the United States Government in the 1930's.

Rancheria

The technology of ground water extraction, literally the mining of ground water, was the technical breakthrough that enabled camping settlements to grow into or be replaced by rancheria settlements. By our definition, every rancheria had a well dug into the ground and no camp had such a structure. These wells were sometimes individually and sometimes communally owned (that

* We do not wish to be dogmatic on this, but offer it to archaeologists as true of what Papagos have said to us.

is, owned by more than one household). Most often the ownership of Papago dug and used wells probably was a complex of individual and communal rights (e.g., the well was X's because he initiated the project, but Y and Z also helped and various of their relatives might also press a claim on the use of the well's water). The key technological point is that the water supply of camps was limited to natural springs and rainwater runoff (sometimes impounded in ponds). Dug wells with their vastly greater potential did not exist in this stage of Papago settlement history.

We do not know the full history of well digging in the Schuchulik region but feel certain that the digging awaited the arrival of steel tools. It appears that by the mid-nineteenth century wells were being dug in the region by Indians and Whites alike. The last Indian dug well was probably around the 1920's. From that time on well digging whether for themselves or for Indians was in the hands of Whites, the reason being that after the 1920's, shallow hand dug wells were things of the past. After this time all wells were deep and dug with drilling machinery, and all employed pumps powered by wind, internal combustion engines, or electricity.

While we don't know the exact history, we can be sure that the digging of wells was underway sometime in Papago territory by the start of the 1700's when the first Spanish missions were built. (The closest eighteenth century mission to Schuchulik was at Sonoyta -- see Chapter 3.) Thus the technical means for a transition to rancheria life has a considerable antiquity. It appears that Papagos felt no great urge to make the transition until White and Mexican ranchers and miners settled among them, developed their own water, and drew Papagos into a commerical economy of which the ranches and mines were outposts. (Papago monetary terminology is still largely derived from Spanish as are the names for the days of the week, another key feature of the new economic system.) Many Papago villages of which Schuchulik is one were founded around wells dug by non-Indian entrepreneurs.

The prime rancheria uses for well water were drinking, cooking, stock watering, and mud mixing for construction projects. Clothes washing and bathing followed not long behind as we envision the process. Field irrigation never happened on a broad scale except where specifically fostered by federal government programs, especially in the 1950's, and generally with short lived results.

The inventory of specifically communal (at least non-residential) structures significantly increased in the rancheria era. Besides the well, which one hesitates to call a building, there was a communal cattle corral with a water trough and, most importantly, a Christian church complex which at first supplemented and in many cases eventually supplanted the public building complex of the camp era (round house, sunshade, and fireplace). Like the earlier one, the church complex typically was (and still is) built on an east-west axis. An east facing mud or stone built church takes the place of the roundhouse. In front of the church is a dance ground, the analogue of the fireplace area in the roundhouse complex (roundhouse ceremonies commonly involved dancing around the fireplace, so the activity of dancing is common to both structures; and village meetings are commonly held at the dance ground of church complex just as they were around the fireplace at the roundhouse complex). In front of the church complex dance ground stands a

village cross of which the roundhouse complex had no permanent analogue but only a temporary one: at ceremonies sacred objects were commonly placed at the eastern extremity of the east-west axis. Two other structures complete the inventory of a church complex, a musician's shelter ("bandstand") and a feast house adjacent to the dance ground but usually off the east-west axis. Onto the bandstand devolves one function of the older sunshade -- the sheltering of musical performers during ceremonies. The feasthouse with a communal cooking and dining area represents a public structure without precedent in the older public building complex.

The rancheria church complex, while bearing a distinctively Papago stamp in building use and orientation, represents a new level of investment in public architecture, especially when one realizes that many villages maintained both the old and the new types of public building complex concurrently. We would estimate the labor cost of a Two Village roundhouse complex at twenty man days and would estimate the labor cost of an early church complex at eighty-four man days on the following basis: church, forty man days; dance ground, three man days; cross, one; bandstand, ten man days; feast house, thirty man days. It is emphasized that these are rough estimates intended primarily to show orders of difference, namely an order of about four between the two public architectural complexes.

Water was not the only new building material used in church complexes. The use of materials of non-Indian manufacture steadily increased: the plaster and printed images of Christian saints which were the churches' reason for being; milled lumber for doors, interior furnishings, window frames, and roofing; window glass; nails; paint; cement; water pipes to the feast house; electricity for the dance ground, feast house, and church, etc. As the construction became more complex and the materials more exotic, outside funding and skills were increasingly drawn upon to complete a church building program, to the limit that some recently built Papago church complexes are nearly indistinguishable in design and materials from churches built by non-Indians off the reservation. As a rule, the more Americanized the church complex, the more integrated it is with a religious hierarchy extending far beyond the village. Through its clergy and administrative and funding agents, the larger church organization maintains a tacit control over the church and its uses.

Rancheria domestic architecture also represents a palpable step beyond the "camp" stage. The typical rancheria household complex contained several buildings mostly rectangular in plan and commonly involving some form of mud or adobe construction. One or more building would be primarily for living. There might be separate structures for cooking and eating and one or more for storage houses. There would be a sunshade (watto), a family corral, and eventually a privy, shower room, dog houses, chicken coops, etc. As with church complex architecture, there was steady increase in the use of imported construction skills and materials. The distinctive trait separating "rancheria" from "neighborhood" villages is not in the technique or organization of church or household construction, but in the addition of a new class of structures to the village scene -- secular communal structures or which the Schuchulik electric system is one example.

Rancheria to Neighborhood

The digging of a well, a type of public structure, marks the transition from camp to rancheria. With the well came a church complex (we would say that no churches were built in Papagueria without wells already having been dug closeby), also a new type of public structure. In view of the final era of Papago community development, it is well to distinguish between churches as pertaining to communal superstructure and wells as pertaining to infrastructure. The rancheria phase saw additions on both levels, both stemming from non-Papago sources. The neighborhood phase saw a proliferation of infrastructure construction: schools, clinics, roads, water systems, electrical systems, police stations, motor pools, etc.

To understand the proliferation, which began around 1930 and continues until the present, one must shift focus from the individual village as the unit for development, to the reservation itself as a kind of supervillage or, better said, supermunicipality. The highest concentration of the new building projects was in the reservation headquarters at Sells (see Chapter 3) which has grown into the downtown or city hall of the emerging supermunicipality. Out in the hinterlands a school would be built in this village, a clinic in that one, a policeman's trailer would be installed at a third place. It is in the nature of the process that no village receives one of everything; if it did, it would be an autonomous unit, not a part of the tribal municipality.

Through the rancheria phase each village with its well and church complex looked like a self-contained yet underdeveloped community. Instead of evolving into towns, however, rancherias became neighborhoods. The moving force behind this evolution was the United States Government operating through various agencies (the Bureau of Indian Affairs, the Public Health Service, the Department of Housing and Urban Development, the Department of Energy, etc.), and operating through an increasing number of specialized tribal committees nominally under the Papago Tribal Council (see Chapter 3, Table 3-1). In effect the United States Government determined to give the Papagos an infrastructure of services equal to the rest of America, which task could only be accomplished by the implicit equation of tribe with town and village with neighborhood.

The coming of solar electricity to Schuchulik was part of this larger process. We would date the process' onset with the construction by the Government of the first non-well and non-church at a Papago rancheria -- some time in the 1920's. (The reader may ask, "What about the other hallmark of the modern American town landscape, the business district consisting of private commercial establishments?" We will not detail that development in the present report but will simply state that private business structures are very few on the reservation, partly because many of their functions are carried out by Government agencies and partly because Papagos do most of their shopping off the reservation.) Many of the detailed reactions of the village to the system, discussed in Chapter 6, stem from the facts that the village is not an independent community and that the photovoltaic system was not its first experience in imported technologies and energy sources. These facts and details set the context for the key issue in the photovoltaic project, namely whether the system's ownership and maintenance can be transferred to the village or to some combination of village and tribal (i.e., "municipal") agencies. Let

us therefore close the present discussion with a review of the types of ownership that have emerged through the rancheria and neighborhood phases. We will consider housing first, then church complexes, then the new order of neighborhood infrastructure developments.

Housing as we have noted has become progressively Americanized in design and materials. Since the 1970's Papago families have had basically three options in obtaining new housing:

1) They could build houses for themselves by buying selected modern building materials in town, making heavy use of local materials especially for wall construction, and by using their own or their friends' and relatives' labor in construction. A minority of Schuchulik's present houses were built by this method.

2) They could obtain the materials as above, but draw on local labor which is paid by the Tribal Work Experience Program (TWEP), a form of Government entry into village economies that began in the 1960's. In this case instead of the family paying the labor (or receiving it as free help, eventually to be repaid in kind), the TWEP program pays. Most of the dwellings (and some of the recent church complex additions) in Schuchulik fall into this category.

3) A family could contract with the tribal housing authority, based in Sells, to have a house built entirely from imported materials and by non-local, non-TWEP labor. This is the Papago tribal version of the standard American method of obtaining housing. Five such houses have been built in Schuchulik. They are the most recent houses to be built there, all during the 1970's.

Two federally financed, tribally administered housing programs exist on the reservation, one called HUD, the other called HIP. Each is targeted for eventual individual ownership of the newly constructed house, following the repayment of a government loan. So far only HIP houses have been built in Schuchulik. The loan in this case is on an insurance policy only, not on the labor and material cost of the new house. We understand that the amount of the loan is on the order of $300.00, with five to ten dollar monthly payments made over a three to five year period. Such houses are meant for disabled, elderly, or very low income individuals. The second program, called HUD, involves repayment of much of the labor and material cost of the house in monthly amounts commonly ranging from $50.00 to $100.00 over as long as a twenty-five year period, i.e., a total contracted repayment in the neighborhood of $25,000.00

Both HIP and HUD housing bind the new house owner to time payments. Until the payments are completed, the house is not truly his or hers, but is owned jointly by the Government and the purchaser. This trait separates the Government housing arrangements from the types 1) and 2) listed above. It is our impression that the recipients of the Government houses are aware of three things at once: first, that the repayment obligation especially for a HIP house does not cover the true dollar cost of the house; second, that the true costs are far higher than they would be if methods 1) or 2) had been employed in building them, so that the gap between what they pay and what the

house truly cost is not "really" their problem; and third, that even with the gap it is disconcerting to make regular payments over a long period on a house that may be difficult to repair or maintain once the new wears off.

The development of churches presents a contrasting picture because the targeted ownership is collective rather than individual and because Papago church construction has not reached the point of total use of extravillage labor and materials. Recent church construction approxmiates category 2) in house construction with some use of TWEP labor, some use of unpaid local labor, and with a priest or minister providing variable monetary and material support.

The redefinition of ownership in church construction is that priests and ministers do not encourage and in fact discourage the traditional idea that one person in a village "owns" a church (or church complex). Traditionally, the local initiator of a church construction project behaved much like the initiator of a category 1) house building project. He or she provided the materials, made the plans, and got other people to contribute labor; and he or she emerged as the "owner" of the new building.

Priests and ministers have taken over much of the planning and provisioning role but they haven't pressed their own claims for individual ownership nor have they encouraged villagers to do so. Rather they have taught that the church as a vast international body of worshippers owns a village church in company with God and the saints (if recognized). The day to day affairs of building and maintenance are worked out with those higher principles in mind. Most significant for this report's purposes, the weekly donations that worshippers make in church collections are not viewed as direct payments either for a church complex physical plant or for the religious services conducted therein. Also significant is that fiestas, which are major village social and economic events, are financed entirely from village funds and are entirely separate from the villagers' weekly collection offerings.

We turn now to municipal infrastructure improvements. They resemble church building projects in being targeted for collective ownership. In every case known to us on the reservation this ownership is formally vested in the Papago Tribe, not in a village based legal entity. In this respect the ownership of village municipal improvements is similar to the ownership of village churches. The tribe is similar to a religious denomination in another respect. There is a creation story explaining the ultimate origins of the tribal ancestors comparable to the creation account contained in the Bible. In effect Papagos can trace their ancient origins through two sacred traditions. As legally constituted, however, the tribe is not a religious body and the criteria for membership are through descent from known Papagos, not through adherence to certain religious beliefs.

A major difference between a church denomination and the Papago Tribe is the latter's close financial and legal relations with the United States Government. The tribe has the legal status of a dependent domestic nation (reference 7). Much of the tribe's income and many of its municipal improvement projects originate in that Government. A further difference is that many Papagos hold jobs working for the tribe while few hold jobs working for church denominations. Government is the largest employer on the reservation

while the church denominations' paid staff is small and mostly non-Papago.

This last difference helps explain why a villager's relation to a local church complex is different from his or her relation to a tribally owned municipal improvement project. Villagers donate their labor and often supply building materials for improvements in church complexes because if they did not the improvements probably would not be made. Building and maintaining trabally owned municipal improvements, however, is the livelihood of many Papagos as well as non-Papagos. Villagers not so employed tend to feel that such projects are properly left ot the salaried personnel who planned and brought them to the village.

A final note on ownership is needed in reference to a special category of municipal improvement, namely the village water systems built by the Public Health Service during the 1960's and 1970's and turned over to tribal ownership. In Schuchulik and many other villages these systems carried with them a monthly payment obligation assessed by the village headman on each family. In Schuchulik the fee was $3.00 per month. It was used to buy fuel for a diesel water pump which came as part of the system. (The payments ceased when the Schuchulik electric system took over powering the village pump.) The payments were not towards gaining individual or village legal title to the water system, which title was vested in the tribe. Nor were the payments set by legal contract or enforced by discontinuation of water service. They were informal obligations arrived at by consensus and enforced by conscience. In this respect they differed from the payments for a HIP or HUD house and resembled the contributions made in church collections or to finance village fiestas.

The Schuchulik electrical system is similar to the village's water system in all major respects. Both were installed as packages by a Government agency on contract with the tribe and with the consent of the villagers. The electrical system is slated for tribal ownership starting two years after its dedication, should the system prove successful and the tribe and village wish to continue with it. Like the water system, the electrical system includes communal structures as well as additions to private households (sinks and water faucets in the case of the water system, electric lights in the case of the electric system).

The Schuchulik electrical system differs from the manner all other Papago villages have received electricity. In the other villages individual families contracted with the Papago Tribal Utility Authority to extend service to their house, then contracted with an electrician to install an electrical service box and do any necessary house wiring, and finally contracted with private appliance vendors for their appliances as needed. In the Schuchulik electric system as in the water system, no individual families made contracts with the installing agency. It was understood that the parts of the system installed in private households would become family property. The extra household parts were to be the tribe's property. It was undecided at the end of study period whether some form of informal family contribution would eventually be required of the villagers, whether a tribal agency such as the Papago Tribal Utility Authority would take over maintenance responsibilities and issue formal bills similar to those issued to its regular customers, or whether no maintenance or service payments would be collected in the forseeable future.

THE BUILDING OF SCHUCHULIK

Schuchulik is located within the Gunsight Pass on the extreme western edge of the Papago Indian Reservation. Roughly speaking this pass, between the Ajo Mountains to the south and the Redondo Mountains to the north, represents a door between the Areneno and the Two Village adaptations of the "camping" era. Prehistorically the pass may have been used some for east-west travel, but it was certainly not on a major intergribal trade route (e.g., between eastern Arizona and California), nor was it the only way for Two Village Papagos to travel westward. The Gunsight Pass became important in the late nineteenth century because a silver mine called the Gunsight Mine was established there (the name supposedly comes from the shape of a hill near the mine). Schuchulik itself is sometimes called Gunsight or Gunsight Village due to its association with these late nineteenth century White commercial developments.

The mine began to be worked on July 7, 1880, after the prospectors who originally discovered the district sold their properties to a company based in Philadelphia. Encouraged by high assessments of their ore the company developed the mine in an aggressive manner. A town of more than 1500 was soon established. For a number of years the community was referred to as "Allen City" after the peripatetic merchant John Brackett ("Pie") Allen. In 1892 the official post office designation was changed to Gunsight. About 1886 the Philadephia firm encountered financial difficulties which shut the mine down for the first of many times. Although the claims were estimated to contain up to five million dollars in ore, a seccession of owners were unable to sustain the mine as a paying enterprise. Sporadic activity continued well into the twentieth century, but today only scant traces of the mine and Allen City remain.

During the course of its roller coaster fortunes the Gunsight Mine was, at times, important enough to justify expenditures for road construction and mail service. A wagon road from the town of Gila Bend (see Chapater 2) was the first transportation link to the mine (reference 8); another was built in 1883 from Casa Grande (reference 9). Mail service began in 1882 and continued until 1896.(reference 10). All of this traffic ran in a northerly direction toward the Southern Pacific Railroad and the old Cooke wagon road (reference 11). For most purposes access to Gila Bend and Casa Grande was adequate to meet the needs of the people at Gunsight, but in at least one respect the residents were seriously disadvantaged; to reach Tucson, the county seat, by way of Casa Grande was a circuitous trip of more than 180 miles.

A shorter route did exist between Tucson and Gunsight -- directly across the arid heart of the Papagueria -- but the traffic was insufficient during the nineteenth century to merit an outlay of county funds. By the 1920's conditions had changed. First, there was a greater need for Papagos to get to Tucson from the reservation with their wagon loads of wheat and firewood. Second, Indian Service employees had to be able to move between Tucson and Sells, headquarters of the newly created Papago Reservation. Third, there was pressure to connect the prosperous mining town of Ajo, located fifteen miles northwest of Gunsight, to Tucson.

In recognition of the potential traffic across the Papagueria, especially by automobile, the United States Geological Survey conducted a survey of roads and watering places in that region. First published in 1922, and reissued in an expanded form in 1925, the report documents the conditions which a driver could expect in Papago territory.

> "Except in the vicinity of towns little has been done to improve the roads of southern Arizona. They are usually only natural highways where first one and then another traveler has made his way across the country with good or ill fortune" (reference 12).

In another section the author describes the problem of navigating through Papago settlements.

> "The roads are a perfect maze in the vicinity of the villages or the rancherias. From each of the scattered houses there is a road to every other house and to every near-by rancheria.... The daily trampling of cattle often obliterates wagon tracks over the whole area of the village, and the stranger has much difficulty in getting out of a village and onto the right road" (reference 12).

Finally, in 1926, the Congress of the United States authorized an appropriation of $125,000.00 for construction of a road across the reservation. Like all of the routes between Tucson and Ajo recorded in the United States Geological Survey report, the road was designed to go through Gunsight Pass (references 12, 13).

Before construction of the so-called "Papago Road," the Gunsight area had become important to travelers for yet another reason; a small ranch located there had a well which supplied water on a year-round basis. The well was 115.4 feet deep and had water at a depth of 54 feet below the ground level (reference 12). A chemical analysis done in 1917 judged the water to be fair for domestic use, poor for boiler use and good for irrigation; the mineral content was considered to be moderate (reference 12). Although the ranch was only a mile north of the Gunsight Mine, the well was not part of that operation. According to the prospectus of the Gunsight Mining Company, their water source was four-and-a-half miles south of the workings. An article in the Arizona Enterprise of December 27, 1890, reported that a second well was being drilled two miles west of the mine. These locations are described in the water survey report under the names of Wall Well (reference 12) and Jaques Ranch (reference 12), respectively. As for the well at Gunsight Ranch, another issue of the Arizona Enterprise, December 20, 1890, reported the following situation:

> "Just now Bill Haine's well is the only one, save Tom Child's, twenty miles north, between here [Gunsight Mine] and Gila Bend. William is making a good thing out of his water at two cents per gallon, but this Silver Girt Company will spoil his business when their big Knowles pump starts up."

Presumably Haines was selling water to both travelers and the mining company.

Although physical development in the vicinity of Gunsight was dominated by Whites from 1880 to 1930, Papagos neither moved from the area nor relinquished their rights to what they considered to be part of their traditional homeland. In fact, Papago villages fairly well surrounded the Gunsight Ranch on its eastern side. To the north, about eight miles distant, was the settlement known as Pozo Redondo; fifteen miles northeast was Perigua; Charco de la Piedra was but five miles to the northeast; turning to the south there were Charco en Medio, Cubo (Guvo), and Kuakatch (references 12, 14). Numerous other places of temporary or intermittent occupation were scattered between these sites, particularly camps used for seasonal harvest of wild plants.

Perigua was the center of what we defined earlier as a Two Village "tribal" social unit. Late in the nineteenth century Perigua, like other village centers, began to break up. United States Government control of hostile groups, particularly the Apache, enabled the process of dispersal to begin but it was the economic shift to cattle raising which really encouraged resettlement (reference 15). Livestock require water and forage, neither of which were concentrated in the Papagueria. So new fields were located and additional water sources were sought out. Charco de la Piedra and Charco en Medio were established in this manner near natural catchments; Pozo Redondo was founded when Papagos took over an abandoned well which had been dug by the prominent Redondo family of Yuma; the cluster of Indian dwellings around the Walls Well became Kuakatch when Fredrick Wall left the area. A number of families from Perigua even moved to Guvo, once a village center in its own right (reference 16), but temporarily abandoned when insufficient rainfall failed to fill the pond on which the settlement depended (reference 6). As a result of these population losses Perigua declined in prominence until the mid-1930's when the Government drilled a well and started a school in the village. About the same time Perigua became commonly known as Hickiwan and Charco de la Piedra became Charco 27.

The well at Hickiwan was only one of many projects carried out by the government during the 1930s. One of the most important of the governmental actions was passage of a bill which authorized an appropriation of $165, 000 for purchase of non-Indian lands in and around the Papago reservation. At the time that the bill was introduced, the main reservation was composed of large areas separated from one another by tracts owned by White ranchers. Writing in defense of the proposed legislation, C.J. Rhoads, Commissioner of Indian Affairs, explained that the purpose of the bill was to consolidate the reservation.

> "The effect of this proposed appropriation and the acquisition of the privately owned lands within the strip and also the Santa Rosa ranch will tend to coordinate the three tracts composing the reservation and will work to the benefit of the Indians, in that they will be enabled to range their stock over the entire reservation without trespassing upon privately owned lands, and will operate to put an end to the encroachment by the white cattle owners on Indian reservation land. (reference 17).

During the course of the hearings on the bill, the Committee on Indian Affairs, acting upon the request of Papago leaders, ammended the proposed legislation to include a number of areas outside of the existing boundaries. As reported in the Congressional Record, May 23, 1930, the first area cited in the list of desired lands was "township 14 south, range 4 west:" the tract containing Gunsight Pass, Hayne's well, Blair's ranch and the Gunsight mine. On February 21, 1931, the ammended bill was signed into law (P709). Several months later title to the area was acquired by the government for inclusion in the Papago reservation.

The Gunsight area was a significant addition to the reservation. In a fundamental sense, the acquisition was no more than an assertion of traditional Papago rights to lands they had occupied for centuries, rights which had gone unrecognized when the American government assumed jurisdiction over the territory in 1854. Yet there must have been a reason why, in 1930, title to this particular piece of property was sought by the Indians and other portions of their aboriginal range were ignored. The potential wealth of the Gunsight Mine would be one possibility except that transfer of the mineral rights to the Papago was specifically prohibited in the legislation. Not until 1955 would the tribe acquire rights to any of the minerals within the reservation. Another favorable feature of the area was its proximity to the Ajo-Tucson highway. But without precedent for roadside commerce it was unlikely that the pass would become a Papago owned truck stop or tourist center, as in fact it has not. Finally, there is the matter of the ranch. Abundant crops had been successfully raised there, although the fields were irrigated from the well rather than with flood-water as was normally done by the Papago. But the well, by itself, also fit perfectly the growing demand for sources to water cattle. Bryan succinctly described the relationship between hydrology and land ownership prior to Public Law 709.

> "The well dug at Pozo Redondo....commands most of the range in the [Pozo Redondo] valley within the Papago Indian Reservation. The supply is inadequate, however, and a new well was being dug near by in 1917. The arm of the Quijotoa Valley north of the Gunsight Hills is largely occupied by the strip of land between the two parts of the Indian reservation and is open to settlement. The western part of this range is controlled by the well at Gunsight ranch. Deep wells would be necessary to develop water [in the eastern part of the valley] (reference 12).

Thus, it was water for livestock that almost certainly prompted the tribe to reassert its claim to the site of the Gunsight ranch and its improvements. And around this well Schuchulik would be established.

Papago Development of Schuchulik

Schuchulik is quite different today from the ranch which was bought by the Government in 1931. Then, the center of activity was probably the ranch house which was located southeast of the present village corral. The older residents of the village remember this building as a small, two room, brick

structure with pitched roof and porches on both the front and the back. The well, with its windmill, was due west of the house. North of the well were about ten acres planted in corn, sorghum and milo maize (reference 12). These fields extended west almost to the conjunction of the two washes which border the present community. The main road into the ranch evidently ran along the south side of the fields between the well and the joining of the arroyos (reference 12). Thus the road crossed the north wash several hundred feet to the west of the existing main entrance to the village.

In addition to the house, fields, well and road the ranch undoubtedly had a few outstructures and some fenced enclosures. This assumption is based on the fact that several types of livestock were raised at the ranch during the course of its operation. Clotts, who traveled through the area in 1914, noted that the owner had 730 goats (reference 18). Bryan recorded that cattle had replaced the goats by 1917 (reference 12). And just prior to acquisition by the Papagos, the ranch had shifted to chickens for its major income source. Although all the fowl -- and all equipment -- were removed after the Government purchase, it was this latter use which gave the village its current name. Schuchulik means "many chickens."

The first Papagos to move to the ranch site were Juan Luis, his wife and their children. About 29 years old at the time, Juan Luis was one of the few Papago employees of the Indian Service. His job was apparently to recruit children for government boarding schools and, should they run away, to return the truants to their respective educational institutions. This post may have given him advance knowledge about acquisition of the ranch and access to those responsible for its disposition. However, regardless of such occupational prerogatives, Juan Luis had a clear right as a member of the Pozo Redondo-Perigua (Hickiwan) village unit to consider the ranch as part of his family's range and to settle there.

The pattern and substance of life at Schuchulik during the earliest years is undocumented but can be partially outlined using descriptions by older village residents and accounts of Papago culture from the 1930s. Initially Juan Luis and his family lived in the house built by the White rancher. To make the property better fit their needs they probably put up a sun shade (watto) with a cooking area near the dwelling; they may have also built a small storage building although there is no evidence of this structure. The function of these facilities was to allow domestic activities to take place outside the house and to hold equipment and goods required for raising livestock and crops. What Juan Luis did in addition to his government job is rather vague. But if he was at all typical of other Papago men of the time he probably had several head of cattle, a few horses and a favored field location -- selected for access to good water runoff. Another important aspect of domestic life would have been visits to and from relatives and friends. Since his father's family was from Caborca, Mexico, and his wife's family was from Pozo Verde, far to the southeast and also in Mexico, Juan Luis saw much more of his maternal relatives from Pozo Redondo and Hickiwan. These included three aunts, three uncles, numerous cousins, nephews and nieces -- in addition to three sisters and two brothers. Without the security of a government job, many of these kin worked off the reservation at least part of the year. But even those with full-time jobs outside the Papagueria usually returned to the area periodically. Some of these relatives would have stayed with Juan Luis.

Two of the more frequent visitors were Carlos Santos and his wife, Flora, a sister of Juan Luis. Carlos was from Cowlic, on the eastern side of the reservation. He had attended school at St. Michaels before taking a job working in the New Cornelia mine at Ajo. During this latter period he met and married Flora; eventually they would have six children. In 1929 Carlos bought a Model A Ford which greatly simplified transportation from Ajo to the reservation; by contrast, most other Papagos were still traveling in horse-drawn wagons.

During one of their visits Carlos and Flora talked with Juan Luis about building a house at Schuchulik. By most accounts Juan Luis initiated the discussion because he wanted control of the ranch to be firmly established in his family. Construction of permanent houses and occupation of them was the surest means to that end. Carlos Santos agreed with the idea. In 1933 the Ajo mine closed; a year later he joined hundreds of other Papagos in the Indian Branch of the Civilian Conservation Corps (CCC). However, this job did not interfer with plans to build the new house.

Most if not all of the work on the building was done in 1934. Those working on the project included Juan Luis, Carlos Santos, Jose Juan and Fernando Santos. Jose Juan was married to another of Juan Luis's sisters, Ascencia; Fernando Santos was a brother of Carlos Santos. The building they constructed was rectangular in plan and measured about 32 feet by 20 feet, the roof was gabled, and the walls were of local uncut stone laid in irregular courses. Carlos Santos, who had helped a Mexican stonemason build a church at Covered Wells (35 miles east of Schuchulik), directed the erection of the walls. Inside, the house was divided into two rooms: one used for cooking, the other for sleeping and general family activity. Since completion the house has undergone only two significant changes, the addition of two more rooms on the rear and replacement of the pitched roof with a flat one after the original was damaged by fire.

Juan Luis was never to live in the new house; he died about the time that it was finished. Juana, his widow, remarried shortly thereafter and moved to Ajo where she raised the children. None of them ever returned to live in the village. As for the ranch house, it was abandoned as a residence and used only for storage of hay and farm equipment until it was demolished in 1977.

The sudden demise of the village founder did not deter growth of the community. By the end of the 1930s three more dwellings had been built at Schuchulik. The first of these houses was located about 30 feet west of the stone house. It was a frame structure of planed lumber measuring 12 feet wide by 30 feet long; the walls were plastered on the outside with portland cement over chicken wire; the roof was gabled with a low pitch. Further west, next to the ranch house, a small frame building was put up toward the end of the decade. The structure had actually been moved from Ajo where it had originally been built. The third building was situated about 110 feet north of the stone house. Since this structure was torn down within less than 10 years its size and configuration are not certain; what is known is that the house was a traditional "jacal" structure.

Jacal is a form of wattle-and-daub construction in which adobe is plastered to the inner and outer sides of a wood frame. The frame is made of common, often crude, materials: posts of mesquite wood, metal pipe, used railroad ties or old telephone poles form the main supports; ribs of saguaro cactus or weathered one-by-fours are used as the horizontal braces; ocotillo branches placed upright constitute the internal lattice. Bailing wire ties the entire structure together. Because of the limitations of these materials, particularly in generating roof spans, most jacal structures are no more than 10 feet by 12 feet in size. Larger buildings can be made, however, by adding units end-to-end or side-to-side.

All of the people who were counted as residents of Schuchulik in the 1940 census were closely related. The stone house was occupied by Jose Juan, Ascencia, their children, and Margaret Luna (mother of Ascencia). Occasional members of the household included two daughters of Jose Juan by a previous marriage, the family of Carlos and Flora Santos, and the family of John Lewis (younger brother of Juan Luis, Ascencia and Flora). Next door was the residence of yet another brother, Romero Ramon. The jacal house was used by the family of Martin Luna. As his mother was a sister of Margaret, he was a cousin to Juan Luis, Ascencia, Flora and John Lewis. In addition to his wife (Serafina) and five children, Martin Luna'a household included an elderly aunt (Mary Jessie). George Curley, Martin Luna's brother, owned the second-hand house, but it was Hawford Curley (Martin Luna's son) who was listed as being the resident of the building. To complicate this situation further, Hawford Curley actually lived most of the year at Welton, Roll or Coolidge where he worked as a farm hand.

The last significant building accomplishment of the 1930s was the erection of the church of St. Martin. Built during the summer of 1939, the project was conceived and funded by Carlos and Flora Santos. About this time Carlos would have finished his work with the CCC and would be preparing to return to the mine at Ajo. Two skilled workmen of his acquaintance assisted with the construction. One was John Mike, a stone mason from Hickiwan; the other was Harry Miguel, a carpenter from Comolik. The church was built with stone walls similar to the first house. It was rectangular in plan, measuring about 15 feet wide by 27 feet long. The roof was a simple double pitch with a triangular gable on the west end and a round-topped facade on the east. Adjoining the facade on the south was a domed bell tower which was later removed when it started to separate from the main building.

Building development during the 1940s was limited by comparison with the previous decade and marked by several setbacks. In the spring of 1942 Martin Luna died. His son, Bill Curley, subsequently began construction of an adobe house just to the east of the old jacal structure. This work may have been initiated, in part, to assist Serafina, Bill Curley's stepmother. Forty-four at the time of her husband's death, Serafina had four children to care for, ranging in age from an infant to a 14-year-old. In addition to needing food and clothing for the children, she may have been temporarily without a home. Traditionally the house of a dead person was abandoned and destroyed (reference 6). Since this practice had fallen into disuse by the 1940s (reference 6), Serafina could have continued to use the jacal until her new house was ready.

Disaster struck the village in the summer of 1945, just as the adobe building was nearing completion. A tremendous storm with rain and high winds -- called a tornado by the victims -- toppled the new structure, crushed George Curley's second-hand frame house, tore shingles off of Romero Ramon's house and lifted up the corner of Jose Juan's roof. The church was evidently unharmed. Personal injuries were avoided simply because all of the people in residence at the time took shelter in the most secure structure, the stone house. Bill Curley cleared away the ruins of his house and that of his father and relocated in the area south of the ranch house. There he built two jacal structures which were used for more than 15 years by various members of his family.

Misfortune resulted in the relocation of yet another structure, the feasthouse. Erected in the early forties a dozen or so yards east of Martin Luna's house, the first feasthouse was burned to the ground after only a few years of use. For several years the village did without the communal facility. Then, in 1946, yet another fire destroyed the outdoor kitchen attached to the old stone house. (This was the same conflagration which damaged the original roof.) Rather than put up both another kitchen and a separate feasthouse, a single facility was located next to Jose Juan's house. The new feasthouse consisted of a fairly spacious ocotillo frame and an attached watto. A watto resembles the structure for a jacal house; it is rectangular in plan with heavy vertical members spaced five to six feet apart and a roof of earth over branches. The ocotillo frame of the new feasthouse was even closer to a jacal, leaving off only the mud coating of the walls. Together these two structures were sufficient to meet the needs of the village at times of special public events while, by proximity to the stone house, the feasthouse was also able to serve the occupants of that residence.

The final building project of the forties was construction of a separate house for John Lewis and his family. The site of Bill Curley's adobe was selected as the location for the project. Similar in size and appearance to the house of Jose Juan, the building measured about 38 feet wide by 20 feet deep and was made of stone. Initially the house was covered with a single shed roof, but this was soon changed to the existing double-pitched configuration. Inside the space was divided into two rooms in the typical manner. On the outside a number of different structures were attached to the house at one time or another. One, the kitchen, was eventually added as a permanent fixture on the northwest side of the building. Completion of the work in 1949 must be considered a historical event for the village since it marked the first of many building projects initiated by the Lewis family.

On March 20, 1950, a son was born to Helen Lewis in the new stone house. This birth, the last of John Lewis's six children, was recorded in the census taken that year. In addition to the Lewis household, three other families were then counted as residents of the village. They included the households headed by Jose Juan, Ramero Ramon and Serafina Luna: a total of 20 people. Although these statistics would indicate a decrease in village population of 12 persons over the decade, the 1950 census did not include intermittent residents whereas the 1940 count did. The census also provides an indication of village economy: all of the families had farms, two at Guvo and two near Pozo Redondo; two of the families also owned livestock; four individuals earned

income as hired farm workers; one person held a government job. The average reported annual family income was $1904; the actual totals ranged from $1250 to $2448.

Margaret Luna, mother of Juan Luis and several other Schuchulik residents, was among those not listed in the 1950 census. She had died in the latter part of the 1940s. Several other deaths were soon to affect the community; one in particular would lead to the creation of the village cemetery. Like so many other "public" actions in the history of the community, the decision to establish a local burying ground was made by a single individual. In this case it was Ramero Ramon who, before his death in 1954, decided that he wanted to be buried near Schuchulik rather than some other place. Up to this time all other residents had been returned to an older Papago settlement. Margaret Luna, for example, was interred at Pozo Redondo. Not content to leave the particulars to chance, Ramero Ramon identified the specific site: on the far side of the hill just east of the village, in a sheltered area bounded by palo verde and black volcanic rock but with a clear view toward the Quijotoa Valley. Sixteen people in addition to Ramero Ramon now have graves in the cemetery; by personal choice one is slightly outside the common fenced enclosure.

Sina Narcia, a granddaughter of Margaret Luna, returned to Schuchulik late in 1950 following the death of her husband. Although she had been raised in the village, she had moved to Ak Chin after her marriage. Having secured a job as a cook at the Vaya Chin school, she asked John Lewis to build a house for her and her two daughters. Put up in 1951, the new residence employed a modification of "sandwich wall" construction. Sandwich wall construction usually consists of two wood forms within which adobe is packed to make a solid core. John Lewis changed this technique, first, by using a predominance of rock in the core and, second, by removing the boards after the adobe in the core had dried. Both interior and exterior surfaces were finished with cement over chicken wire. White clay from a nearby deposit was added to the plaster to give it a lighter appearance. In plan as well as building method the house departed from village precedent. It was ell-shaped rather than rectangular and consisted of three rooms: one main bedroom, one secondary bedroom, and a kitchen. Addition of a secondary bedroom was probably done for Ascencia, Sina's mother. Jose Juan had also died about this time and rather than staying in the old stone house by herself, Ascencia agreed to move in with Sina and care for the children while their mother was at work.

After completion of Sina Narcia's house there was a break in major construction until about 1959. Then, in the space of about 36 months, three new houses were erected. One of these projects was again directed by Bill Curley. The primary beneficiary of the work this time was Lillian Montana, one of the daughters of Serafina and Martin Luna. Like Sina Narcia, Lillian Montana had been raised in the village, relocated during her marriage and returned upon the death of her spouse. She also brought two young children back to her home. Located in the vicinity of the jacal houses put up for Serafina Luna in 1945, the new building evidently used a conventional sandwich wall method of construction. Measuring a spacious 15 feet by 37 feet, the house was initially divided into two rooms; later additions eventually expanded the room count to five.

About the same time that this work started, yet another family established a permanent residence in the village. Josephine Segundo was related to many Schuchulik residents through a second of Margaret Luna's sisters. Ralph Segundo, her husband, was raised in Topawa and the Mexican village of Sokoksik, where he later acquired a house. Since Josephine and her brother, Jose Garcia, frequently visited Schuchulik, Ralph Segundo arranged for John Lewis to put up a new house for him. Measuring roughly 12 feet deep by 20 feet wide, the structure was located on the east side of the village facing the church. Modified sandwich wall construction was used throughout; a simple double-pitched roof covered the two rooms of the building. Several years later a large room and an attached watto with kitchen were added to the rear of the house.

The third big building project of the period was a new house for George Curley. Although his little frame structure had been demolished in 1945, George Curley had continued to reside in the village on an intermittent basis. During these periods he would have been able to stay with almost any of the more permanent households. However, having retired in 1962, George Curley determined that he should have a place of his own. The next year work was begun by a group of men including John Lewis, Carlos Santos, Ralph Segundo, and Bill Curley. Each of these men had a specific area of the job for which they were particularly responsible. Carlos Santos, for example, handled the carpentry of the roof, doors, windows and ceiling; John Lewis built the walls in his typical manner.

Laid out in the form of a three-room ell, the building was carefully detailed with the explicit intent to create a pleasing appearance. To this end the two entry areas were covered with a little roof and enclosed with a white picket fence; the gables were closed with serrated trim boards; exterior walls were plastered with light colored cement which set off the bright blue of the window frames. Behind this building a watto was later put up which had scalloped ocotillo walls and a trussed roof system. Situated northeast of the church between the houses of John Lewis and Ralph Segundo, George Curley's new residence was an ornament to the village.

A new religious structure was also built in the early 1950's. Situated behind the dwelling house of John Lewis, this private chapel has the appearance of a residence. The chapel houses a reclining image of Saint Francis Xavier, a saint much venerated by the Papagos. It was obtained in Magdalena, Mexico (see Chapter 3). Once installed, the saint was celebrated every year or at most every two years in May, giving the village a late springtime fiesta to balance its November fiesta for the image of Saint Martin housed in the church built by Carlos and Flora Santos. The new religious structure was a simple one-room house of stone construction measuring about twelve feet in width and twenty-four feet in length. Besides housing the saint, which people from near and far might visit to pray to, this house was sometimes used for over night guests of the Lewis family.

In 1963 Richard Jones, a graduate student from the University of Arizona, conducted a census and inventory of buildings in the village. Jones found 25 people living in Schuchulik on a more or less permanent basis. Ranging in age from three months to 68 years, the population was divided into seven households which had as few as one member and as many as six. One of the

households was headed by David Santos, son of Carlos and Flora Santos. He had moved to the village in 1957 after serving a tour in the Army and was living with his wife and children in the old stone house. Like the 1950 census, Jones's accounting fails to include the many temporary residents of the village and those Papagos living off the reservation who considered Schuchulik as their tribal "address." By way of contrast, the Papago Register File -- compiled by the Bureau of Ethnic Research at the University of Arizona for about the same time period -- counted 28 persons as residents; however, at least six known residents were not included and five unknown persons are.

Jones did not ask for specific amounts of income but he did inquire into the major sources of household support. The answers clearly indicate a break from earlier subsistence patterns. Two individuals worked as hired farm labor; only one reported cattle as a significant source of income; one was receiving retirement checks; three were recipients of benefits from social security or welfare programs; and two were government employees. Although a few families still pursued traditional agriculture for supplemental purposes, all of the residents had abandoned the Papagueria as the primary, and direct, basis for existence. In recent discussions villagers explained this shift, in part, as the result of drought and a grass infestation of the old fields.

In addition to this population and income data, Jones made sketches of each household complex and recorded information about utilities such as domestic water. In fact, a village-wide water distribution system had just been installed that year. The work concluded a three-year long improvement program which had been initiated by the Public Health Service. To begin with the original government windmill and belt-driven pump had been replaced with a new gas powered pump. The next year the old ranch well was redrilled an additional 100 feet in depth. And finally, in 1963, the loop line to the houses was put in. Water pressure was maintained with the still existing cylindrical tank which replaced a much smaller 1500 gallon unit. This system operated until 1972 when the Public Health Service moved the well to its present location, put into operation a new jack and diesel pump, and replaced the old distribution network. Except for a change from the diesel motor to a DC motor for the photovoltaic system, this "utility" has since been unchanged.

There have been other "civic" improvements over the years in addition to the water system. The road pattern of the Gunsight ranch was one of the first changes, having been realigned to better meet the volume and direction of Papago traffic. By 1935, only four years after Juan Luis moved there, an aerial photograph by the Fairchild Company clearly showed a new road running northeast from the old well site, toward Pozo Redondo. The photograph also suggests that the fields planted by the White rancher had been allowed to go fallow. As trips to and from Ajo increased on the recently built State Road 86, the current turnoff to the village was established. Because livestock have been part of the community's economy since its beginning, a means to hold horses and cattle was undoubtedly present as well. Jones shows a corral as part of the household complex of John Lewis and there may have been others. But by the mid-1960s these personal structures had been supplemented if not replaced by a communal one. A sheet metal shed used to protect the belt-driven water pump was salvaged during the work on the well and moved over to the corral where it now provides shelter for men at the stock scales. Facilities for public ceremonies and fiestas were also built. In front of

the church a concrete dance plaza with lights and a roofed musicians stand were put up; to the east of this area a village cross was erected. Telephone poles are evidence for yet another utility, although the equipment which connected Schuchulik to the rest of the reservation and the outside world has been disconnected for many years. The most recent, and comprehensive utility installation was the village electrification project discussed in this report.

By the early 1970s community improvements and new government work programs provided strong inducements for young Papagos to return to Schuchulik after completion of boarding school and, perhaps, a few years of employment in the White world. Coupled with these economic and technical factors -- although sometimes independent of them -- was a desire by many individuals to maintain contact with their families and to assure themselves of a place in the community should they want to move back on a permanent basis. As one man urged his daughter, "You should have a house here in case something happens." In response to such influences many people did return to the village or, at least, had a house built for their use.

The largest group of relatives to establish new residences in the village were the six grownup children of John Lewis. By 1975 all but one of the Lewis family had their own houses. The eldest son, who lived in Los Angeles, had both a small Papago-style house and a mobile home in his domestic complex. Three of the other children had houses built of the modified sandwich wall construction. These buildings were all built by men employed by the Tribal Work Experience Program (TWEP) with materials supplied either by the government or bought by the owner from a salvage yard in Ajo. A fifth had an ocotillo frame structure put up; he then plastered it with cement over chicken wire rather than with the usual adobe. The last of the Lewises got her house in 1978, a government-sponsored project.

Designed and built by people from outside the village and erected entirely with materials imported to the community, the last Lewis house represented a major change in local building activity. Measuring about 34 feet wide by 28 feet deep, the slump block structure contained three bedrooms (each with a built-in closet), a full bathroom, and a combined kitchen-living room. A roofed recess on the corner of the building provided the only structured outside area. Floors were finished with vinyl tile, window frames were of aluminum, and asphalt shingles covered the roof. A total of three such buildings were put up: one for the Lewis daughter, another for the eldest of Sina Narcia's daughters, and the third for the widow of Eddie Santos.

Eddie Santos, son of Carlos Santos, had actually built one house and was working on another when he died. The finished building was taken over by his father who used it for guests and as a personal retreat; the unfinished structure was left untouched. To the north of Eddie Santos's household complex Sina Narcia's younger daughter also built a house, but it has been vacant for most of the time since its completion. In addition to these efforts at new construction, a few returning residents made use of existing buildings. In one instance, the son of Lillian Montana came back to occupy his mother's house after her death; in another case, the daughter of Ralph and Josephine Segundo moved into her parents' house after they died. For several years the Montana household included Lillian Montana's

sister and her husband, but they acquired another government-built house in 1978 and left the old building to their nephew and his growing family. Likewise, Ralph Segundo's daughter had a new government house built for her one year later.

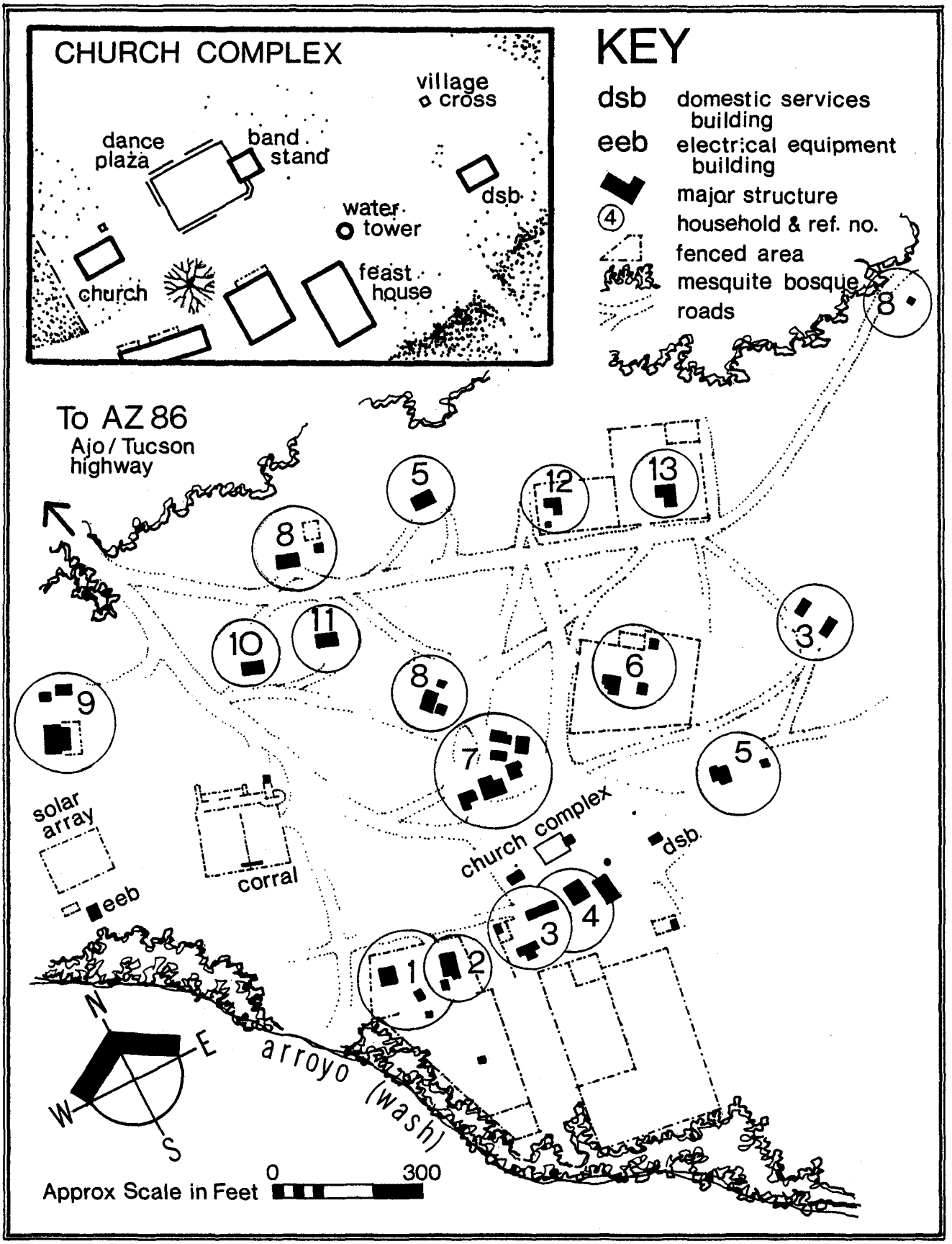
Village Plan

Approached today on the Ajo Tucson highway, State Road 86, Schuchulik is screened by a dense thicket of mesquite trees which line a sandy wash just to the south. Leaving the pavement, one enters the village on a graded dirt road which crosses first a cattle guard and then the wash before reaching the cleared area of the settlement. Unmarked except by traffic volume, the road divides into a network of tracks which crisscross the community, tying each cluster of buildings to several others. With the exception of purposefully planted trees and shrubs and a few well pruned mesquites, the space between the buildings is devoid of all vegetation except patches of native grass and small bushes. Immediately adjacent to houses the ground is usually free of even these plants and all litter is carefully raked up at least once a week. Only the periphery are large indigenous plants such as palo verde, ocotillo, cactus and creosote to be found.

Occupying an area of approximately sixteen acres, Schuchulik is roughly wedge-shaped in plan. The triangular shape is dictated by two washes which form the northern and southern boundaries of the village; these water courses flow to the west where they eventually converge. The ground between the arroyos slopes upward toward the east where a low, undulating hill marks the extent of building development. The only other significant topographic feature in the village is a smooth rocky ridge which extends southwest from the hill through the southern part of the site. This ridge is not so much a narrow crest as a general uplift which breaks off sharply leaving a flat plain next to the wash and an elevated area within the settlement.

Nearly all of the structures in the village can be seen from the highest part of the ridge. That part of the site contains the church of St. Martin, the community feasthouse, the dance plaza, and band stand. Further to the east, in line with the center of the church is the village cross. Nearby is the Domestic Services Building, built as part of the electrification project, and the tall cylindrical tank which stores the community water supply. To the southwest of this complex, following the general line of the ridge, is a succession of houses with their attendant outbuildings and support structures. Below them, in the plain between the ridge and the wash, are a number of fenced fields and corrals, interspersed with a few outhouses and storage sheds. Directly west of the buildings on the ridge and separated from them by a wide expanse of open ground is another concentration of community oriented structures: the corral of the cattle association, the water pump, the photovoltaic array and the Electrical Equipment Building for the electrical system. North and east of the properties which have been described to this point are thirteen domestic settings. Irregularly located but with separations ranging from thirty to one hundred feet, these households convey a marked sense of informality to the overall character of the village. The households, church complex, community structures and major geographic features of the village are shown on Figure 2-1.

Figure 2-1. Village Map



Residence Patterns

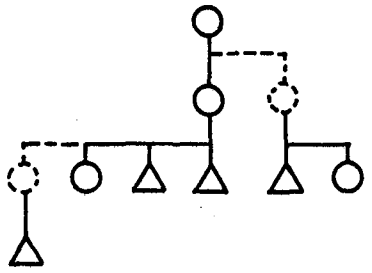
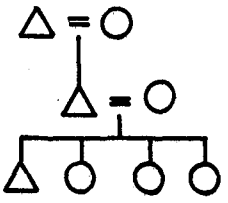
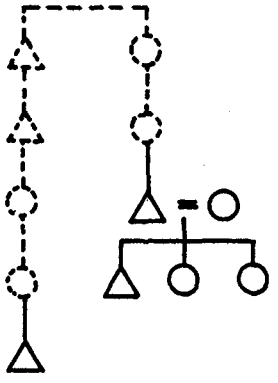
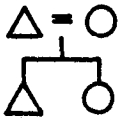
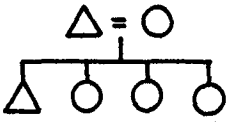
Many individuals have contributed to the development of Schuchulik. Some are still living in the village, others have left buildings or descendants in the community as evidence of their presence. This legacy -- the right to live in the village, inheritance of places to live in, and opportunities for a livelihood -- forms the basis for decisions to reside in the village. With this in mind, we can summarize the physical, social and economic conditions which have come to be residential parameters.

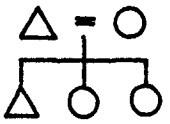
Housing stock in Schuchulik is limited. To take up residence it is necessary to get permission to use one of the unoccupied or seldom used houses, or to arrange for a house to be built. Housing sites which can be easily connected to water lines and the electrical network are at a premium if traditional distances are to be maintained between households. Use of an existing structure is normally granted if the request comes from a close relative and if the building is truly not needed by the people already in the village. Of the twenty dwellings in use in the village in April, 1980, eleven were less than ten years old, three each were built during the 1950's and 1960's, one was built during the 1940's, and two date from the 1930's.

The twenty domestic structures are not synonymous with "home" or "family setting" in the Anglo sense of those words. Rather, the buildings are organized into thirteen "households." As there are more residential structures than households it follows that some households are composed of several structures whereas others may have only one "house." The basis for organization of these clusters, or conversely the isolation of a single unit, is primarily social. Physical proximity and genesis typically support the thirteen designations but the definition of each household is ultimately a matter of the residential property owned by individuals in a given family. As everyone in the village is related in some way to all the other residents, the "family" associated with each household is distinguished by the fact that these kin eat together on a daily basis. The diversity of family composition is revealed in Table 2-2; the pattern of kinship bonds between households is shown on Figure 2-2.

Households, therefore, are composed of one or more dwellings with their associated site improvements and support structures. The character of these domestic settings is quite varied. Five of the thirteen households have more than one structure used primarily for residential purposes: sleeping, eating and socializing. Of these only one has the physical proximity necessary to appear as a compound -- that is, as a single unit. On the other hand, two other clusters of buildings appear to be compounds but are actually composed of two households each. Five of the residential structures have been vacant during most of the period from 1978 to 1980. In terms of structural technique, the most common building type is one which employs a modified sandwich wall: large stones and mud are used to fill a cavity formed by wood slats; later the siding is removed after the rocks are set in place -- much as one would in rammed earth construction. In descending order of use, other construction systems found in Schuchulik include: concrete block, ocotillo sandwich wall, lumber sandwich wall (boards are left in place), stone masonry, wood frame and prefabricated mobile home. In addition to these residential buildings the households also contain storehouses, usually of frame or jacal

Table 2-2. Household Composition

FAMILY	
1 & 2 (See Table 2.4)	
3 & 4	
5	
6	
7	

FAMILY	
8	
9	
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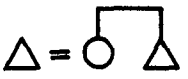
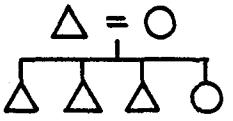
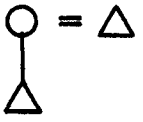
11	
12	Vacant
13	
14	

KEY

△ : male

○ : female

= : married to

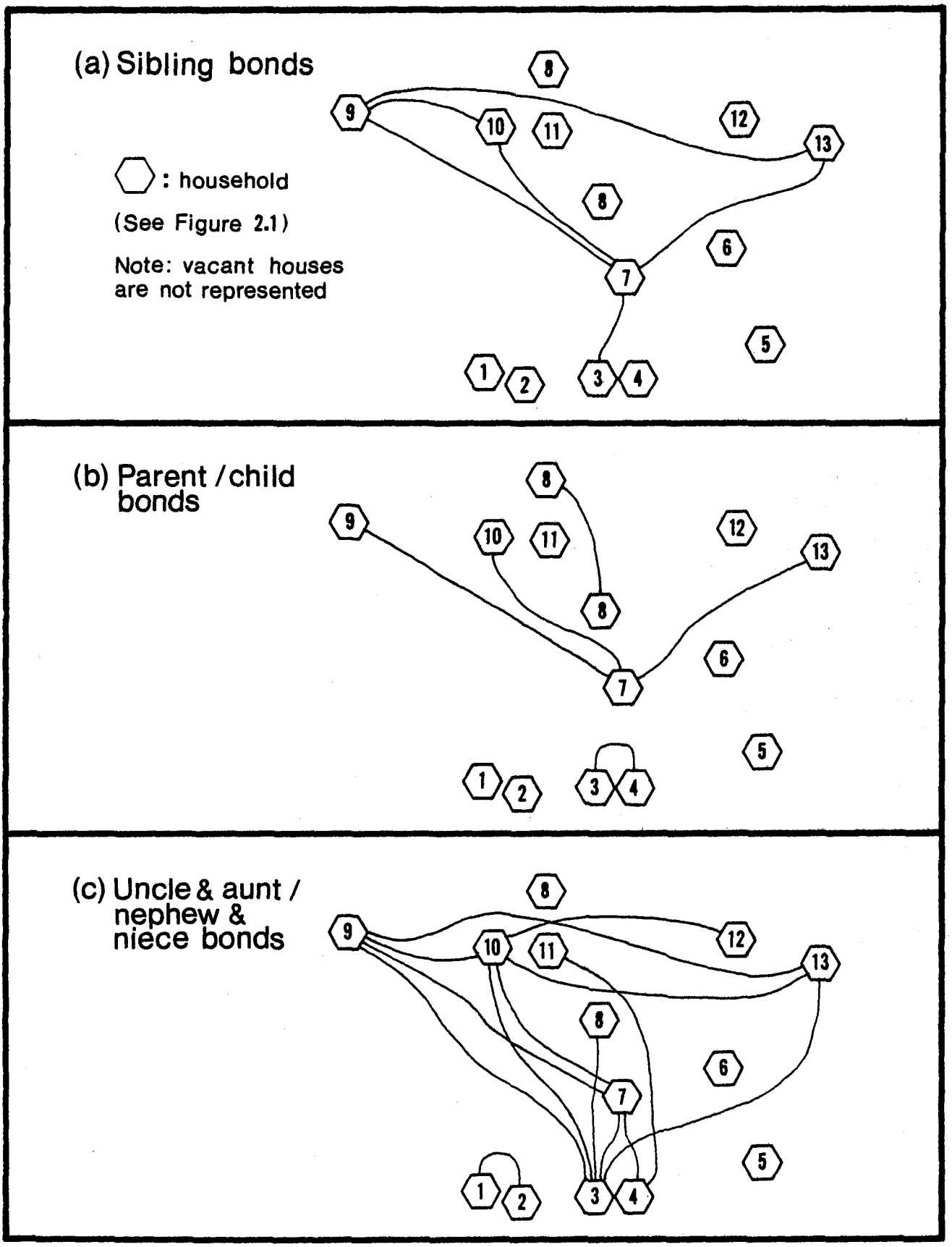
| : child of

— : brother or sister of

Solid line : resident in family

Dotted line : a linking relative not resident in family

Figure 2-2. Kinship Bonds Between Households



construction, wattos, and a number of other features such as fences, plants and cooking hearths. An enumeration of these household components is made in Table 2-3.

TABLE 2-3
HOUSEHOLD STRUCTURES AND SITE IMPROVEMENTS

FEATURE	NUMBER	FEATURE	NUMBER
Dwelling house	20	Storehouse	12
Watto, free standing	7	Watto, attached to house	2
Outhouse	14	Bathhouse	3
Cooking hearth, outside	9	Clothes line	6
Garden	5	Fenced areas	10
Corral	4	Fields	2
Use of shade trees	10	Wood piles	10
Number of junked cars	12	Electrical generators	6
Butane tanks	7	Horse trailers	1
Chicken coop	1	Religious shrine, private	1

Because households are delineated on the basis on family organization, changes in family groupings may alter the identification of households. In fact, during the photovoltaic study period extensive fluctuation occurred within families and four families combined to form two new domestic units. This pattern of change was revealed by censuses made in August 1978, August 1979, February 1979 and February 1980. The censuses tried to freeze the flux of family comings and goings for four one-month periods. That is, we asked, "Who was here in this house for most of the time?" during the month in question. "Here" meant a combination of "slept here" and "ate here" (usually supper and breakfast). Because a number of people had jobs that took them out of their homes and out of the village during the working hours of the day, those were the common denominators of Schuchulik's family life.

The one main seasonal difference caught by the census period, which counts as a kind of migration, was the movement of older children to and from boarding schools off the reservation. Such children were counted into the August censuses and out of the February ones. One other annual mass movement is the pilgrimage to Magdalena, Sonora, which nearly empties the village for about a week in October. Both migrations are caused by cultural, not natural, events, the opening of schools in the one case and the coming of a saint's day in the other.

Results of the four censuses are tabulated in the two following tables. To preserve privacy, the family numbers used in the tables have nothing to do with the household numbers used in Figure 2-1. For example, Family Number 1 in the tables is simply the largest family recorded in the August 1978 census; Family Number 2 was the second largest, and so on. As for the content, Table 2-4 shows the number of resident persons in each family or household.

TABLE 2-5
TURNOVER OF INDIVIDUALS BETWEEN CENSUS PERIODS

FAMILY	AUGUST 1978-FEBRUARY 1979	FEBRUARY 1979-AUGUST, 1979	AUGUST 1979-FEBRUARY 1980
1	9	8 }	5
2	8	6 }	
3	0 }	1	0
4	3 }		
5	2	3	3
6	4	2	3
7	1	3	0
8	2	2	1
9	0	0	0
10	2	1	1
11	1	2	1
12	1	-	-
13	5	0	1
14	-	5	4
TOTAL PERCENT TURNOVER OF FAMILY MEMBERSHIP	59%	62%	28%

NOTE: " } " means that two groups which formerly ate separately have combined into one.

Sources of money income for the villagers include pensions, full-time jobs, tribal public works programs, social security, welfare/food stamps, short term Government jobs and home industry. Based on the August 1978 survey, the resident population of twenty-six adults derived income from a total of forty-seven sources, thirteen of which fall under the broad heading of hourly jobs. The remaining sources are home industry or some category of financial assistance -- including pensions or social security. All but seven of the income sources stem from the Tribal or Federal Government. The annual household income was found to average about $7,000.00. Cattle raising provides a small supplemental income for some families; five households own cattle. Cattle and wild game also represent an occasional supplemental source of food.

More income figures were secured in the survey of February 1980. These figures are summarized in Table 2-6. To protect the identity of the residents the figures are arranged in ascending amount rather than by household reference.

On the basis of the eleven reporting households, the lowest annual income was $1080.00 and the highest was $23,500.00. The average income was around $8,225.00.

TABLE 2-6
REGULAR ANNUAL INCOME
(February 1980)

HOUSE NUMBER	AMOUNT	HOUSE NUMBER	AMOUNT
1	$1080.00	7	$8436.00
2	2616.00	8	8496.00
3	4392.00	9	11368.00
4	4800.00	10	12000.00
5	5400.00	11	23498.00
6	8400.00		

Figure 2-3. The Village Center (Church Complex) seen from various angles and distances

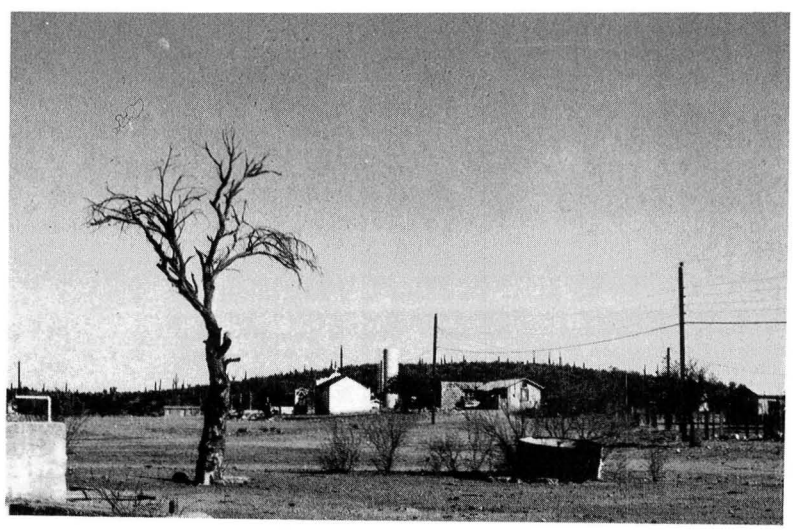
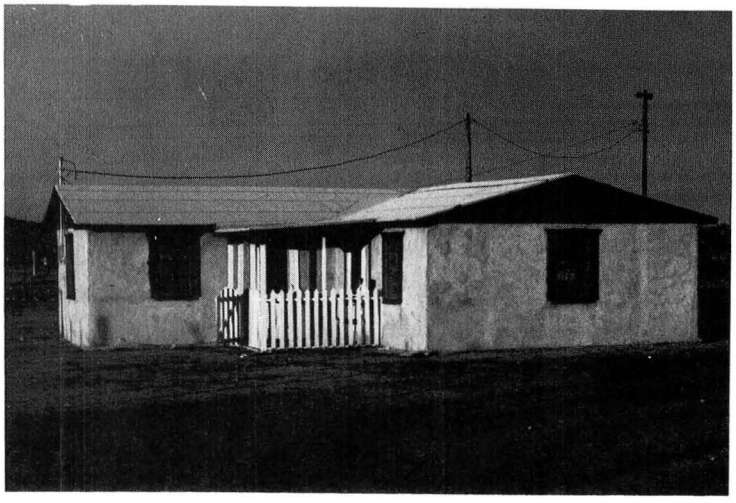
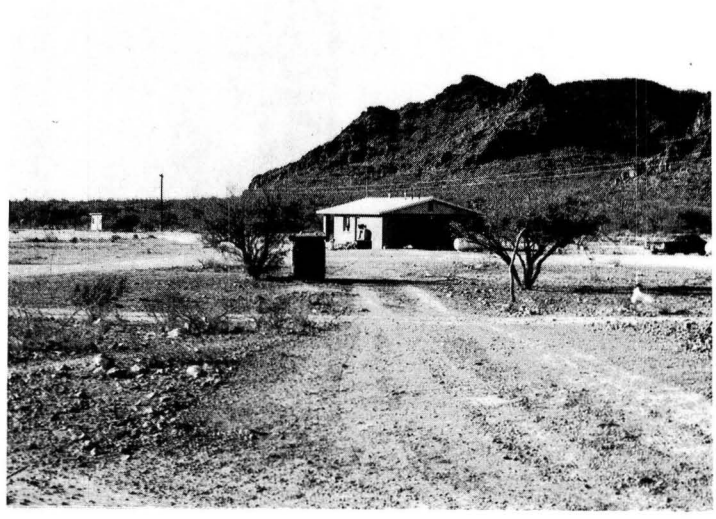


Figure 2-4. Old and New Housing in the Village





CHAPTER 3

THE WORLD OUTSIDE THE VILLAGE

As Figure 3-1 shows, Schuchulik is situated on a highway at the extreme west end of the Papago reservation. The present chapter takes the reader on an imaginary car tour leaving the reservation to the west, stopping at spots to the north and south, and returning to the village across the reservation from the east. It would be too long a trip to actually drive in one day, but nearly every day someone from Schuchulik goes to some of the places. The village is very much of a car culture and this chapter is to give the reader a sense of where people go in their cars and why.

Y, or Why. In the 1960s a road junction five miles west of Schuchulik got its own post office and changed its name from "the Y," meaning the hiving off of one highway from another, to "Why," a pun. Papagos had long been in the habit of calling the place "wai," without the article, a usage which may have facilitated the change. The junction had been in existence as a trading center for Papagos and a gas stop for tourists on the way to Mexico, since the 1940s at least. By 1980 there were a number of houses, four places with gas pumps of which just two were operating, two bars, both of which had closed in the previous year, but would open again if a new buyer came along, one cafe which also sold groceries, beer, and wine, a general store with a post office, a defunct vegetabe store, and a large campground for "snowbirds" (out of state visitors who pull trailers or drive self-contained recreational vehicles south for the winter). Two of the establishments had outside pay phones which were much used through the nights by snowbirds and Papagos alike.

The list of facilities gives a rough idea of how Schuchulik people and other Papagos make use of the place: for car repairs, to buy gas, kerosine, propane, ice and groceries, to get mail, to cash checks, to eat out, to buy drinks, and to use the telephone. There are places similar to Y near two other points where highways cross a reservation boundary, one on the same highway to the east of the reservation, called Three Points (also named for the road configuration), and a newer, smaller one north of the reservation that so far doesn't have a name. There is no such place to the south because the south border of the reservation is an international boundary and is officially closed to traffic. (The roads hiving off from both Y and Three Points go to official border crossing points with border towns, Sonoyta to the west and Sasabe to the east.)

The merchants and residents of Y are not Papagos for the most part yet, like missionaries, they would not have located there if they didn't want to deal with members of the tribe. They make loans, extend credit, and conduct their small businesses with a personableness and courtesy that used to characterize corner grocery stores throughout the U.S. The best way to describe Y is as Schuchulik's corner grocery store. Most residents make the 15-minute round trip drive several times a week. Some days some people hang around all day and into the night, other Schuchulik people

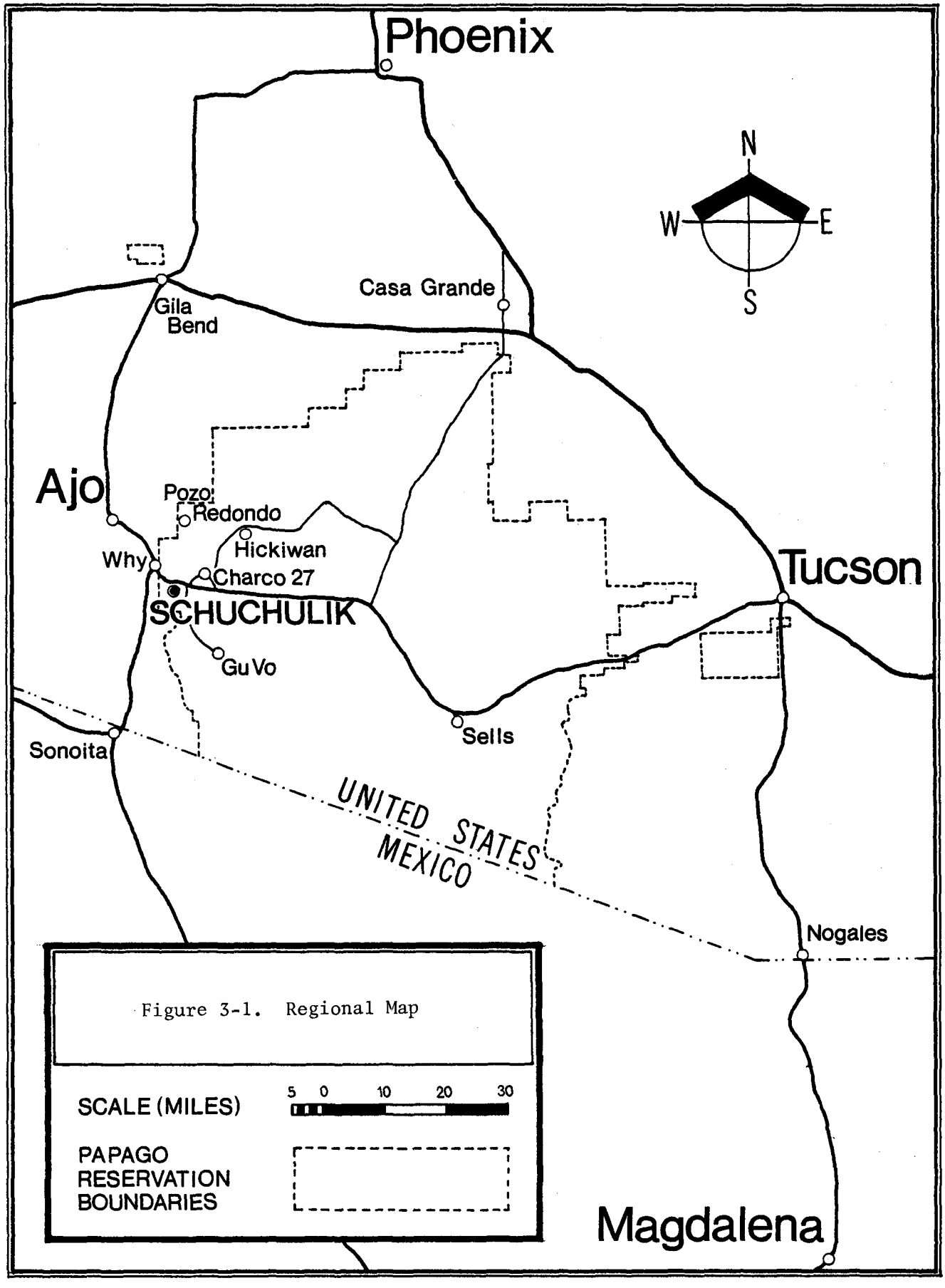


Figure 3-1. Regional Map

hardly ever go there -- if, for example, they prefer the slightly larger stores in the next west town of Ajo. Y's prices for gasoline and beer are quite competitive with the metropolitan areas of the state. Its grocery and general merchandise prices are somewhat higher (see Appendix).

While it may be Schuchulik's corner grovery store, Y is also, especially on weekends, a magnet that draws Papagos from throughout the western part of the reservation. People fuel up there prior to driving to a dance on the reservation and when the bars were open, there was weekend dancing at Y itself. Because Schuchulik is just across the border from the place, some of the traffic to Y, especially on the return trip, gets diverted for shorter or longer visits to people in the village. Cars may stop in or walkers may drop by on their way to their final destinations. Schuchulik undoubtedly gets visited more than other villages due to its proximity to Y.

Sonoyta, called son in Papago, is the Mexican border town 28 miles south of Y. (There is an American town on the north side of the border called Lukeville.) Sonoyta is a free trade town meaning that one doesn't need special papers to go there; one is simply waved through in going to the town, but must pass through customs on returning.

First an ancient Papago settlement and site of an 18th century mission (of which almost nothing now shows and which is little publicized), Sonoyta was a sleepy border town until the 1950s when increasing border traffic started its growth to a 1980 population of 15,000 -- more people than live on the entire Papago reservation. Being old, it figures into many Papago songs such as the following two sung by a Schuchulik man:

Alas my children
Alas my children
Prostitute doings overlook me:
Shrill shrieking.
Far Sonoyta land reaching;
Shrill shrieking.

And I drunkly ran
And I drunkly ran
Far Sonoyta land:
From it wind blows.
It will reach me
Make my heart drunk.

These drinking songs testify to the tempting aspect of Sonoyta (or Y, too, for that matter, although no songs were heard about it). Besides that aspect, which perhaps has little to do with why most people go there nowadays, the town is the most economical place accessible to Schuchulik for flour (which is judged superior to most American brands for making tortillas), gas, block ice, dried chilis, hair cuts, hard liquor (regulated at the border crossing), and kerosine lamp parts. In the winter of 1979-80 it was a source of large green onions which were much prized in Schuchulik. In fact one can buy nearly anything in Sonoyta that one can get in a medium-sized American town, the only drawbacks being that the products are not

always cheaper (some are imported from the U.S.) and knowing how to find or ask for them.

Some middle aged or older people in Schuchulik speak effective Spanish and nearly everyone knows words and phrases. No one was raised in the language, however, and the young have had few opportunities to hear it unlike in former times when Papagos spent a good part of the year as farm workers among Spanish speakers. People seem more intimidated by Sonoyta than by the Y where the pace is slower, the language of commerce is English, and Papagos are far more in evidence. Sonoyta is the Babylon of Schuchulik; many people go there every month.

Ajo and Gila Bend are a mining and a farming community 20 and 60 miles west and north of the village. Ajo is a shopping center for Schuchulik second only to Y. It has more and larger stores and somewhat cheaper grocery prices. Especially noted are its movie theater, two laundromats, bank, loan companies, new and used auto dealers, dance halls and a high school. One resident village student attended the Ajo high school in 1979-80 in preference to the several distant boarding schools normally attended by Schuchulik high schoolers. Her family had to drive her there and pick her up each day.

One family with a house at Schuchulik lives at Ajo, another at Gila Bend. Several other people who have lived at Schchulik, or whose close relatives do, live at one of the other towns. There is a separate small Papago reservation at Gila Bend which comprises a district (see below) of the tribe; in addition some Papagos live in the town and many live and work on farms near to it.

The large copper mine at Ajo historically had a large contingent of Papago workers although no Schuchulik person presently works there (some did in the past). There is no Indian reservation at Ajo proper nor is there, as there once was, a special section of town set aside by the Company to house Papagos. Papagos live in Ajo on the same footing as anybody else.

Casa Grande is a farming town 100 miles from Schuchulik via a highway that passes through the northern reservation boundary. Just as people from the north part of the reservation are sometimes drawn to Schuchulik, Y, Sonoyta, and Ajo, so are Schuchulik people sometimes drawn to this northern town, especially for large shopping trips. One village person lived there during the study period. Another resident in the village occasionally played weekends in an orchestra there. The down-to-earth shopping advantage of Casa Grande over Ajo or Gila Bend is the presence of chain supermarkets and some discount stores in this larger town. Casa Grande is an outpost of American shopping center civilization while Ajo and Gila Bend are a notch below that.

Besides its up-to-date commercialism, Casa Grande has a tradition of merchants like those at Y who cater especially to Indians. There was the Chinese grocer who talked perfect Papago, a man with the taxi fleet (two

or three cabs) who bought baskets, a shoe repair man who would tool leather belts, and a gas station owner who kept pet monkeys which were felt well worth seeing. In general the town has more to offer Indians than Ajo or Gila Bend, and less to overwhelm or intimidate them than the larger places next considered.

Phoenix and Tucson are metropolitan areas, each with small Pima or Papago reservations nearby. Phoenix in addition has a Public Health Service hospital often visited by Schuchulik people and a Bureau of Indian Affairs boarding school attended by some Schuchulik students. Schuchulik people live in both cities which offer employment opportunities, for example hospital and factory work not found in smaller towns. The cities' main shopping advantage may be large discount department stores where back-to-school clothes, tools, housewares, etc. can be bought more cheaply than in small towns. Except for such stores, the cities offer little that cannot be found about as cheaply in Casa Grande. (Certain specialized products are available in Phoenix at good prices, such as cut flowers or fresh citrus, but it would be rare to make a special trip just for them.)

It can be said concerning all the above off-reservation places that America has done well in bringing its products to the village's doorstep. The farthest of the places is less than a three-hour drive from the village. What is striking compared with the past is not just the reduction in travel time (it used to take three hours to reach Ajo by wagon), but the declining economic motive to go to metropolitan centers. This is due to the efficient provision of goods and services at the closer smaller towns. One can get the same banking services at Ajo as at Phoenix, from branches of the same banks; the canned pop and potato chips at Y are the same as at Phoenix. When gasoline was in short supply in the spring and summer of 1979, the worst places in the state to be with a car probably were Mexican, Black or Indian neighborhoods in Phoenix or Tucson. The waiting lines were the longest there. Ajo and Y, being rural and on main tourist routes, were far less affected by the gasoline shortage. Thus the reasons for Schuchulik people to travel long distances are more social (to see somebody) than material.

Magdalena. This town in Mexico about 200 miles from the village represents the farthest place that most people go in a year. (Some go to farther places such as to Los Angeles but these are exceptional trips.) Magdalena is the site of a fiesta in October for the same saint Schuchulik celebrates in May, St. Francis Xavier. Those who are able, make a weeklong pilgrimage with a half-day of driving either way. Those with jobs and tighter schedules may confine the pilgrimage to whichever weekend falls closest to the key day of October 4.

The Magdalena fiesta is celebrated by Mexicans, Mexican-Americans, Yaquis, and Pimas, as well as Papagos, but it is perhaps more special to Papagos than to any other group. The town started as a Papago settlement and the Papago tradition of pilgrimage to it goes back farther than anyone can remember. They used to go by wagon caravans. They stay in

specific Papago camping places, each family normally returning to the same place, owned by a Mexican family, year after year. When they are there, Magdalena is as Papago a place as Y, only sanctified by immemorable past pilgrimages. People visit a reclining statue of St. Francis, obtain sacred objects (saints' pictures, statues, ribbons, and holy water), ride carnival rides, celebrate among themselves, hire musicians to serenade each other, try out their Spanish in comfort, and shop for useful or frivolous items. During the Magdalena feast only one or two people may remain at Schuchulik or perhaps none at all.

Magdalena is not only visited at fiesta time. Persons may go there at any time "to see the saint." Parents increasingly take their children there prior to sending them to boarding school, or during vacations, to ask or repay for the saint's help concerning the children's travels. Sick people or those who have been sick also go there in increasing numbers now that the roads are good and transportation is abundant.

Nor is the only Saint Francis at Magdalena. There is one in the village which people from other places sometimes visit; there are others in other villages, especially in the western part of the reservation; there is one at Sonoyta, another in Phoenix and there are probably others elsewhere in the itineraries of Schuchulik people. All are kept in private santuaries more or less like the private chapel at Schuchulik. All derive their power from the original statue at Magdalena.

Sells, 60 miles east of Schuchulik and perhaps 90 miles as the crow flies north of Magdalena, is the administrative center of the Papago reservation. The tribal council meets there and most federal bureaus with an interest in the tribe maintain offices there. The largest settlement on the reservation, Sells is not a place like Schuchulik with a distinct center of sacred architecture. There are churches of many denominations in Sells including one Catholic church with a feast house, dance ground, and cross; and many Protestant churches with feast houses but without the other items. (Protestants frown on dancing, at least on church premises.)

The historical center of Sells is a compound of buildings, still standing, which were built in the 1930's to house the reservation superintendent and a small administrative staff. The years have seen such profileration in the physical plant of Sells that the old center has been eclipsed by newer structures on what used to be pure desert. Chief among these additions are a hospital, an elementary school, and a high school, each with its owned fenced grounds and with self-contained housing for its staff -- in effect, villages within a village. In addition there are entire new housing additions modeled on American suburbs, and numerous other offices and private businesses without their own housing compounds. The result is a patchwork of separate domains in Sells as a physical settlement. The organizational plan that holds them all together is shown in Table 3-1, taken from reference 19. In explanation of the two tables of organization it is noted that the superintendent's office gives final approval to all decisions taken by the tribal council.

Several Schuchulik people live in Sells and several residents' jobs are supervised directly from there (see TWEP, Chapter 4).

TABLE 3-1

TRIBAL GOVERNMENT: COUNCIL AND COMMITTEES

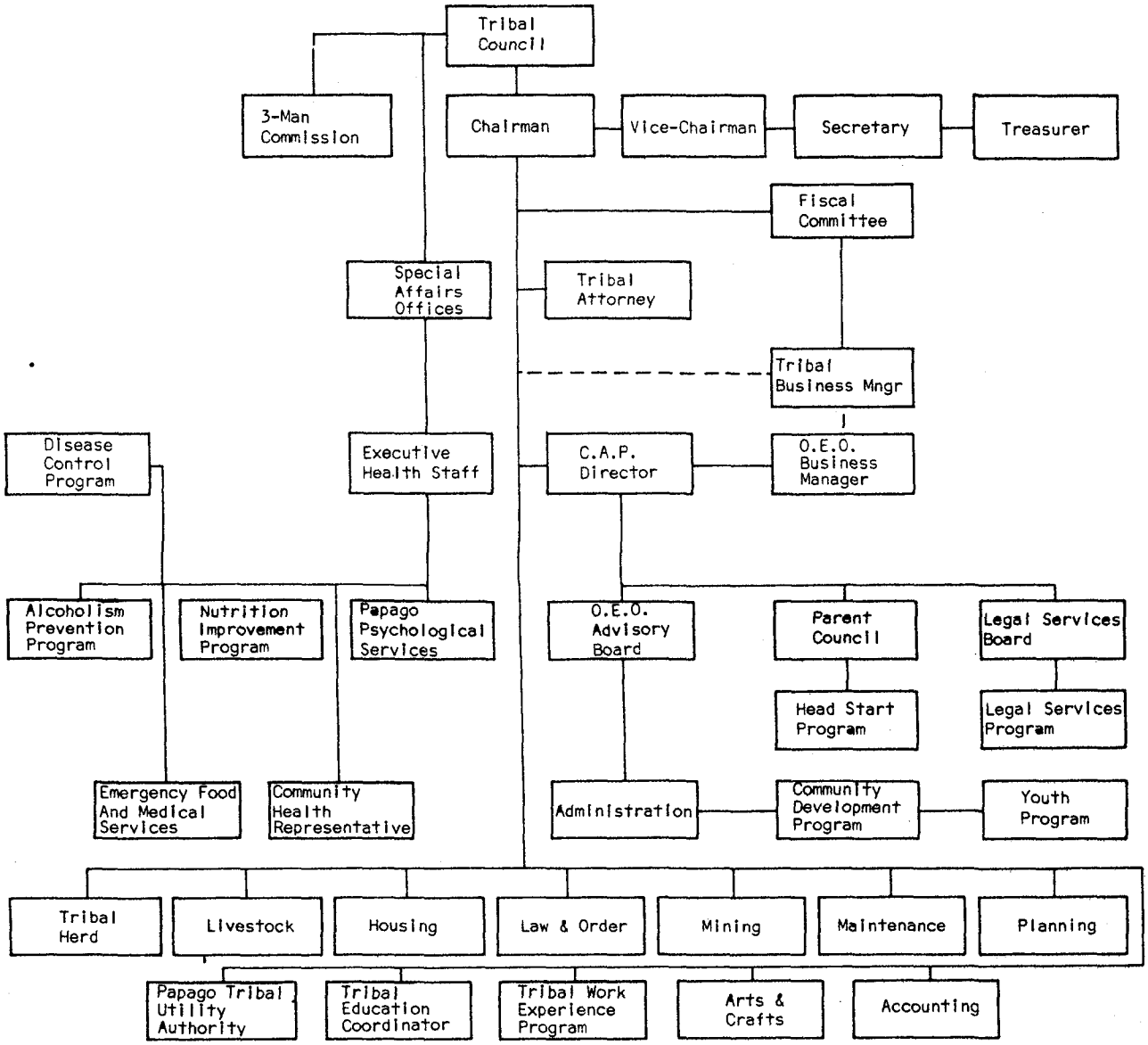
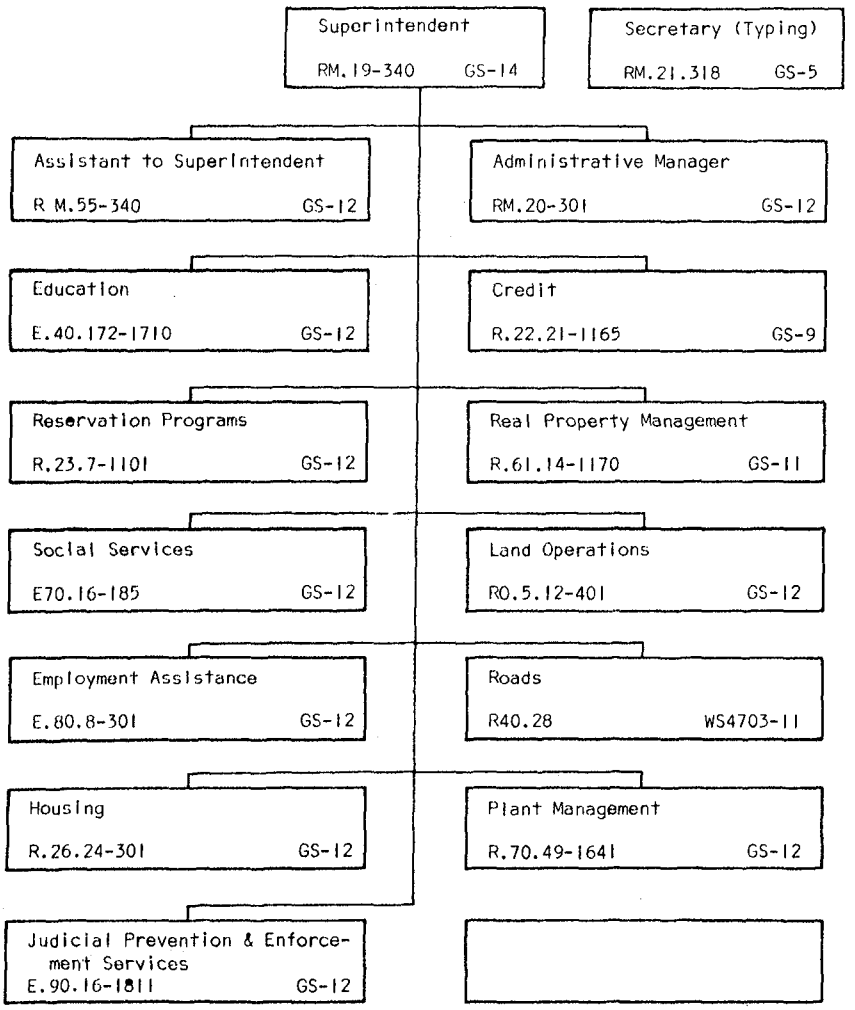


TABLE 3-1
(continued)

THE PAPAGO AGENCY
BUREAU OF INDIAN AFFAIRS



San Simon is a village 20 miles east of Schuchulik on the highway that goes to Sells and Three Points and Tucson beyond. It is Sells-like in having a school with a residential compound, but the school is not contiguous with the village (and cannot even be seen from it due to a mesquite thicket, and the village, while sprawling, has only one church.

The San Simon school is the major employer of Schuchulik's resident labor force. Schuchulik people work there as janitor, teacher aide, bus driver, and cook (two individuals). Schuchulik's children attend it from kindergarten through sixth grade as do children from several other nearby villages. It is a regional day school with all the children bused in, even those from San Simon.

San Simon's people belong to a different historical (camp era) grouping of villages from Schuchulik and the village belongs to a different governmental district of the present Papago tribe. The reason so many Schuchulik people work there is not tradition, but because most of the same people had worked previously at school in their own district. This school closed when the San Simon school opened and the Schuchulik employees were reassigned by the educational bureau located at Sells.

Charco 27, Hickiwan, Vaya Chin, Ventana, and Kaka are Schuchulik's mates in one governmental district of the Papago tribe. The old school was at Vaya Chin; the former school building is now used for meetings of the district government (see below). The five villages are more closely related to each other in kinship and history than any is with any other village. Thus Schuchulik people have more to do with Vaya Chin than with San Simon even though Vaya Chin is farther away.

In Papago representative government there are three levels: Tribal, District and Village. As villagers people send representatives to a district-level council; as citizens of a district they elect representatives to the tribal council; and as citizens of the tribe they elect tribal officers. The system was designed to include a full electoral process of nominations, campaigning, and balloting on each level. In practice there is little formal competition for the district council positions and only somewhat more for seats on the tribal council. Politics American style are mostly reserved for the tribal-wide elections of Tribal Chairman, Vice Chairman, Secretary and Treasurer.

If every adult Papago is served in principle by elected representatives on three levels, we have next to see where and when this service is carried out. The tribal officers' services are based in Sells and the officers are expected to work for the tribal good nearly all the time; whenever something pertaining to their work comes up, they should attend to it. Much of this work, especially the chairman's, consists in traveling between the tribal office in Sells and the offices of the innumerable federal, state, and private bureaus which have an interest in the tribe. The officers report the results of their travels at monthly tribal council meetings in Sells. This then is the first field of service, that of the officials. It traverses territory between the non-Papago world and the tribal council chambers.

The second field of service belongs to the tribal council members, two from each of the 11 districts of the tribe. The councilmen or women are based in their home districts, not at Sells. They come to Sells for monthly meetings to hear the tribal officials' news or to hear outsiders who approach the council directly. They may act on the news in Sells if approval is required; or they may simply receive the news and carry it to their home districts to report at a district council meeting. In either case their field of service is between the council chamber at Sells and the council chamber of their home district.

The third field belongs to the district council members who hear news from returning tribal council representatives, deliberate on it, and carry it back to their home villages. District council meetings follow tribal council meetings by about a week. Normally, in Schuchulik at least, the transmission of news from district council to the village does not require a regularly scheduled village meeting but is simply a matter of telling people. The village representative to the district council is also the village headman.

There is no representative village council analogous to the tribal and district council. Anyone who is in the village on a long term basis, has the right to hear the news. Table 3-2 summarizes the above discussion of fields of service and shows how each elected official is expected to carry news between two places. As just described, Papagos have a very from-the-top-down system of government. This may not be absolutely true, but it represents the manner in which the electrical system was handled. If it is not the only mode of Papago formal government, it is certainly a major one, due to the heavy dependence of Papago public life on programs originating from outside the tribe.

TABLE 3-2
PAPAGO REPRESENTATIVE GOVERNMENT

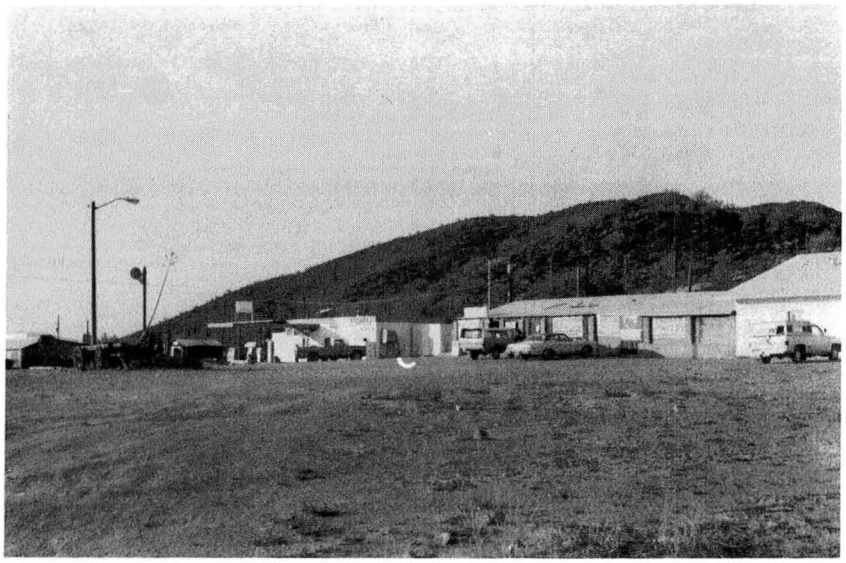
PLACES	OFFICIALS
non-Papago world	
	tribal official
tribal council	
	tribal councilman
district council	
	district councilman
village	(= village headman)

Conclusion

This chapter started with an off reservation shopping stop at Y and ended with a disquisition on the formal structure of Papago government.

The transition reflects the dominant functions of each of the places on our imaginary itinerary. West of Schuchulik is the outside world of shopping, east of it is the world of programs and bureaus.

Figure 3-2. The Y and St. Francis at Magdalena



CHAPTER 4

GROUP LIFE

This chapter takes up the theme established in Chapter 2 of the evolution of Schuchulik into neighborhood status. The theme is most clearly expressed in two special purpose groups discussed at the end of the chapter, a cattlemens' association and a tribally financed mens' work crew called TWEP. The latter is a product of the modern tribal government, the former is heavily affected by it. Both could play supportive roles in the future of the electric system. Before we discuss those possibly key institutions, we will proceed through kinds of groupings which Schuchulik carries over from the rancheria era and before:family and church. They remain the core of the village life and are the prime consumers of the electricity produced by the system. We will describe them as they existed during the study period.

FAMILY LIFE

During the study period Schuchulik had families ranging in size from one individual to twelve. There was a high rate of turnover from census to census as people moved between village households and locations off the reservation, and even as people reshuffled themselves between households in the village. It is recalled that Papagos never were a sedentary people. Their architecture has gotten more substantial from the camp era to the present, but they have not lost their readiness to move. Then and now the movements were not of the nature of complete fresh starts in a new place, but were confined to a field of known people, namely relatives. The first part of this section investigates the meaning of kinship, residence, visiting, and family in Papago culture today. Then we take up the times of day and places in households where family members routinely congregate. We then consider how the electrical system affects daily routines. Finally we consider the role of automobiles in contemporary family and village life.

Kinship

Papagos think they may all be related by blood in some close or distant manner. The thoughtful Anglo-American or European reader will say, "Our scientific tradition holds that all life is ultimately related and the Bible holds that all mankind is descended from Adam and Eve, so what is unusual about the Papagos?" They are unusual from the European perspective because they envision the universe as being about three hundred years old. Papagos prior to White schooling traced history about six generations or one hundred twenty years back in time from any particular "now." At the other end of time they traced about six generations forward from the moment of creation. The tracing of "now" back was via calendar records cut in saguaro cactus ribs; the tracing from creation forward was via sacred stories. Putting the two ends together we have a history of about twelve human generations plus an indeterminant gap in the middle. Into that gap would fall the evidence on exactly how all Papagos are related. Because all Papagos tell essentially the same sacred stories, the impression is given that the gap was not long --

a few "lost" generations at the most. Furthermore the sacred stories generally have an episode in which an original pair of tribal ancestors was created from mud. If we accepted the twelve generation concept, discounting the gap, then all Papagos would be at most tenth cousins to each other.

The above is not meant to prove the antiquity of the Papago people, but simply to show the oral historical sense behind the concept of a universe only about three hundred years old. If we dated Adam and Eve at three hundred years ago, we would undoubtedly feel more of one family than we do. That apparently is the Papago feeling.

It may be asked how much force this "young universe" concept has among Papagos today where everyone has been exposed to the Biblical rendition of world history with its 6000-year old universe, and to Anglo-American schooling. Or to put it differently, 1980 A.D. minus 300 years equals 1680 A.D. which was six years before Father Kino, founder of the church at Magdalena, received his assignment to missionize the Indians of Sonora (1686). By the turn of the 21st Christian century, the Papagos will have been under European influence for longer than their self-conceived universe is old.

The logical reconciliation of the two time systems is not at issue in this report. Our interest is in the social effects of the young universe idea, that is, how it effects peoples' sense of kinship. It is our impression, although we have not sat down to confirm it, that the older people in Schuchulik know on the order of five hundred other Papagos by name and can identify a link of kinship with about half of them. A common occurrence as Papagos sit and talk together is just this effort to establish how two people who think they are related, are in fact related. The ground covered is the six "from-now-back" generations, that is, back through the grandparents of the present grandparental generation. When the effort succeeds, it shines the light back to the mid-nineteenth century. The effort abets the young universe idea. Each new link makes the tribal world that much smaller. But what are the social gains? When two people ascertain kinship, they have cause to go and see each other. People are constantly saying, "I know I have relatives there (some other village), but I never see them." Kinship is an excuse to travel and visit them.

Language on Residence

What is the difference between residing and visiting? In Papago the first is called ki:, "to live someplace; reside; have a house," and the second is called oimmed, "to wander; sojourn; visit." It is a clearly different thing to ask Ba: o ki: g huan, "Where does Juan live," and Ba: o oimmed go huan, "Where is Juan wandering." The first question asks for Juan's residence, the second for where he has gone from his residence. A person who goes to another village to see relatives for a few hours is clearly wandering/sojourning/visiting; a person who goes to stay there for a month might be referred to as "living" there, although people would be disinclined to say so unless the person had first spoken that way about himself. Until people have really settled in, which with the few possessions that Papagos carry around is more a matter of invisible understandings than of visible evidence, the question is moot. To give another example, people are inclined to refer to their off-reservation stays at Gila Bend or Los Angeles as "wandering" and to state that they really "live" at a village on the reservation but this, too, becomes ambiguous as the stays become longer and the returns home less frequent.

Residence versus visiting are made ambiguous by several factors. First as indicated above Papagos move with relatively little baggage and are able to move into a place and return for large items such as saddles or metal trunks when they are needed. An important symbolic expression of residence is the placement of one's own saints' pictures on a household altar, but even this is not clearcut because on the one hand people can take pictures with them while visiting, and on the other they may leave pictures at home even though for all intents and purposes they have moved somewhere else.

Secondly, Papago houses are designed to minimize the difference between visiting and residing. Houses have a two-room basic plan which is discussed at length below. Missing from this plan is a clear differentiation between "visitor space" and "resident space" such as one finds in a middle class American houseplan -- a living room as distinct from bedroom and kitchen, each with its own proprieties as to visitorship; a master bathroom as distinct from guest bathroom, etc. Papagos accord formalities to guests, to be sure, such as fetching them a chair, or addressing them in certain ways at mealtime (see below), but these formalities serve primarily to distinguish very short term guests from family members.

After a day at a house, there is little difference between the treatment of a visitor and a long term resident. We may say that American domestic architecture is specialized in elaborating resident/guest distinctions, and Papago architecture is specialized in reducing them. There is reason for this with the Papagos, for it permits them to cultivate relations with several households and to change quickly from the status of visitor to resident among them; it lets people have more than one family in the narrow, coresident sense.

A third and final point on this subject is corollary to the second, that houses are not so much owned by specific individuals as used by whomever stays there. People do not have deeds to houses, they almost never buy and sell them, and rarely rent them. One can say that the person who initiated the construction of a building and paid for most of the building materials, "owns" the building, but as years go by, this ownership tends to be covered by other claims through use or upkeep of the building. (A common item of contention is why X has a better claim to stay in a house than Y even though X is temporarily "out" of the house and Y is "in" it.) This tradition of ambiguous ownership could be modified by the new HUD and HIP houses which require a more or less long contractual relation between an individual and the central government (Chapter 2).

Language on Family

"To be coresident with" is expressed in Papago as "to live with" (we:m ki:). This expression nominalized as we:m ki:kam ("with livers") is the Papago way to say "family" in the sense of coresidents of a given house. The ki: in the expression does not mean "to be alive" in the sense of living and breathing, but rather "to be housed." Ki: as a noun means "house," not "life." (There is another Papago word that means "to be

alive," s-du'a, so if you want to ask if Juan whom you haven't seen for a long time is alive and well, you say No s-du'a g huan, not No ki: g huan. The latter question would be interpreted as "Does Juan live someplace," and would be viewed as a silly question since everybody lives someplace.)

We:m ki:kam, "family," means any coresident family member whether husband, wife, child, parent, uncle, cousin, etc. The term does not discriminate between blood relatives and in-laws.*

There is a different word for "family" in the broad sense of all one's blood relatives whether coresident or not. This is hajuň, a word which cannot easily be reduced like we:m ki:kam into meaningful subparts. When Papagos discover new relatives, they use the expression hajuň, not we:m ki:kam. Hajuň, then, designates the pool of people from which co-resident families group and regroup.

Meals as Family Events

The Schuchulik eating norm is three meals a day on the Anglo-American pattern. Each family has a kitchen with a stove, eating table, sink, and food storage facilities. The kitchen is one of the two rooms of the basic Papago houseplan. The other room is a bedroom. Built on a two-room plan and lacking what Anglo-Americans term a living room, Papago kitchens and bedrooms have more living done in them than their American counterparts; one might almost call them kitchen/living rooms and bedroom/living rooms. Here we are concerned with the living, centered in meals, done in the former.

If there is a woman in the family, she cooks. Other family members may be in the kitchen with her at this time or they may be elsewhere tending their own business. The greatest likelihood of finding other family members in the kitchen while a meal is being prepared is on a weekday winter evening in a family that cooks with wood. Only four of the 11 resident families cooked that way in February, 1980; it is the "old way." When wood stoves are used, people outside the house, whether family or not, can see that a family's cooking has begun by the puff of smoke that issues from a house chimney when the supper fire is lit. The mesquite wood burned in Schuchulik makes a whitish, fragrant smoke for the first five minutes after it is lit. Once well lit, the fire is nearly smokeless.

Winter mornings stand at the opposite pole from winter evenings in regard to the chance of finding family members in the kitchen while a meal is cooked. It is cold and people prefer to stay in bed. The cook's starting the morning fire is a welcome event and a kind of self-sacrifice on her part.

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* But a very common usage which we may call the unmarked form has we:m ki:kam interpreted as "spouse." People say that the expression does not have to mean "spouse," but if they hear it without explanation, "spouse" is the first interpretaiton they will put on it. If one wants to be clear in using we:m ki:kam for a blood relative, one should say "my father who is my coresident," etc.)

Families eat together. If they are not already in the kitchen, the cook summons them when the food is set out with Oigk.amo i e-gegos, "Come and get fed." Once the eaters are assembled, the next act normally is a recitation of what has been prepared to eat. If no outside guest is present, the cook makes the recitation, e.g., "Beans. Coffee. Tortillas. Green onions," or whatever the meal will consist of. If there is a guest, the male head of the family normally does the recitation. (An invitation to a meal is phrased as "to drink coffee," not because coffee is the most important or impressive part of the meal, but on the contrary because it is a minor yet universal part. Thus, after a guest is seated, it is proper to follow the "drinking coffee" invitation with a verbal pointing out just what the meal will consist of.)

People serve themselves. There is no ceremonial dishing out of portions by the host. The only help is that the host or cook may wordlessly slide food containers into other peoples' reach. Meals are leisurely with much conversation. They are as much times for imparting information as times for taking nutrition, especially since people tend to be scattered when they are not eating.

As families congregate for meals, they also isolate themselves from non-family. This is what makes meals truly family occasions. An indication of the isolating tendency at meals is in the following joking exchange between a mealtime visitor and a disturbed household head:

Head (to invite the visitor to come in and eat): "Ñ̃-ba'icu apt ñ-keis" ("You stepped on my throat.")

Visitor (to refuse the invitation): "Ñ̃-u:m ed ant ñ-ke'ihi" ("I kicked my own thigh.")

In this exaggerated exchange the disgruntled host says in effect, "Your interruption is killing me -- thanks to you I can't eat or talk any more." The guest says in effect, "Not only has my coming killed you, but it has crippled me so I can't walk away -- nonetheless I won't stay here and eat with you." The moral of the exchange is not that guests aren't allowed inside if they arrive at mealtime, or that surprise guests are supposed to refuse. It is that a person coming at such a time should be very sure of the goodwill of the people inside. Whoever comes will be offered food and invited into the family exchange of news around the meal table. The newcomer had better have interesting news, should not be looking for a handout, etc.

The Watto as a Gathering Place

Two other well defined places in the typical household serve to draw family members together. One is inside and one is outside the dwelling house. The outside gathering place is the watto, or sunshade, a roofed but open-walled structure that shields the sun and lets in the breeze. Ten of the 20 Schuchulik dwelling houses had wattos. The traditional form is free-standing; there were seven of these. An additional three houses had wattos attached to them as porches with three exposed sides. Still another

three houses, designed for the HIP program, had roofed indentations at one corner to form a two-sided shaded area. These last were deficient for watto purposes, being too small to cast much shade and, with one corner open and the opposite corner closed, unsuitable for cross-ventilation.

In the summer it gets hot outside by about 9 a.m. and continues to feel hot until about 10 p.m. Papago houses absorb heat from the sun all day and radiate it through the night with the result that the hot time within the house begins at about noon, after the sun has been up six or seven hours, and lasts until about 2 a.m.; a house's hot period starts a bit later than the outside heat of the day and lasts considerably longer. By late morning or noon it is usually hotter inside a house than outside under a watto, a condition that lasts until the next dawn. Thus the watto is the coolest place to be from late morning through the afternoon. With the coming of night it is no longer cooler to be under the watto, just so long as one is outside.

A watto is only good for stationary activities such as resting, sewing, for fixing things like axe handles, or for washing clothes in a tub or minding babies. All of the above are individual activities and all could equally be done somewhere else, such as the kitchen or bedroom, if the conditions were more comfortable there -- which they are in winter. Thus, unlike the kitchen and bedroom (see below), there is no reason why families ought to unite for some purpose each day under the watto. It is a place to go if one doesn't have more pressing business elsewhere. Indeed to spend too much time under the watto may imply that one has nothing better to do. The between-meals daylight hours are times when industrious people, especially men, should be away from home bettering themselves or picking up information to report back at the next meal.

The Living Room/Bedroom as a Gathering Place

There is one more place where family members congregate in a typical daily round, the living room/bedroom. In the typical two room houseplan, this room is used for more than sleeping. Normally it has a couch and some comfortable chairs, a closet or wardrobe and trunks for clothes, an altar (see below), and perhaps a stove. Of architectural importance in distinguishing Papago from Anglo-American bedrooms, is the fact that the former normally have a door to the outside which is the main or "front" door to a house. The Papago practice concisely shows that the bedroom has the functions that Anglo-Americans assign to the living room. The bedroom is the most common place to be when one is not in the kitchen or under the watto; those places are the trinity of Papago domestic architecture.

Only one of the trinity of places lends itself to dupli- or triplification in Papago households, the bedroom. Fully 16 of the 20 dwelling houses of the village have multiple bedrooms while none have multiple kitchens and only one has a multiple watto. The housing program dwellings have multiple bedrooms plus a standard American living room, bathroom, and kitchen. This separation of living from sleeping functions

has been respected by the families living in such units, except for the use of living room couches by overnight guests. Interestingly, none of the locally planned multiple bedroom houses has a distinct living room. The local plan is more efficient: it is easier to heat and light a three-room house (kitchen, bedroom/living room, bedroom) than a four-room one (kitchen, living room, bedroom, bedroom). It takes less stoves and light fixtures, there is less temptation to leave rooms lit when nobody is in them, and each room is more spacious. We may add that the electrical system was planned to give each dwelling house two light fixtures. This was suitable for the basic Papago house plan, but it leaves the American style house plans seriously underlit.

Families differ in how much time they spend between supper and going to bed. People generally do not work out of doors after dark, but they may sit outside, sit inside, go to church (Tuesday nights), go visiting, or go to the Y or to Ajo. These are the freest hours of the day among Papagos as among Anglo-Americans and for the same reason, that many family members are at work or at school during the rest of the waking day.

House electrification makes it possible to stay up longer especially in winter when people are more likely to stay indoors and it gets dark sooner. Our "hard" information discussed in detail in Chapter 5 indicates that overall electricity consumption for light is about four times greater in December than in June, the average domestic light units in Schuchulik being burnt about an hour a day in June and four hours in December. We consider this to be a hefty use and would concur with the residents' own assessment that electricity lets them stay up at home longer in the winter.

The Altar in the (Main) Bedroom

Most houses have religious pictures in the kitchen, typically The Last Supper and a calendar showing the Catholic feast days, and most have a family altar in the single or main bedroom. This altar has saints' pictures, statues, rosaries, holy water, and candles on it. The candles are of special importance here. One is normally burned all night for the double purpose of devotion to the saints and of slightly illuminating the room. If the house has just one bedroom, the candle keeps all the assembled sleepers company. It has a third effect as well which we would not consider to be a conscious purpose: it signals to outsiders that the family is in session although asleep. The burning of candles is not being replaced by the electric lights for understandable reasons: lights are not devotional and they are too bright to sleep by.

Altars are congregating points for family or individual praying, sometimes on feast days and sometimes for curing. These personally important but temporally infrequent in-the-house events will be left aside in the present report. We may simply note that they are at the extreme small end of a continuum of fiesta activities discussed later in this chapter.

The Electrical System and Family Life

It is useful at this point to sketch how the electrical system impacts on family life. The activities involved are food storage, clothes washing, sewing, and house lighting. Two points may be made about the activities. First, food storage and house lighting are essentially passive activities from the human point of view; they are not work for people but for the machine (if any) that does them. The human work concerning these two activities is indirect, i.e., getting to and from and maintaining the machine. A full discussion of the electrical system's impact on a given activity involves three questions:

1) Does the new way to the job better from the user's point of view?

2) Does it reduce the user's direct work ?

3) Does it reduce indirect work?

Those questions are discussed at length in Chapter 6. Here it is enough to note that an important increment of indirect work comes from the relocation of three activities to the Domestic Services Building. People must leave home to use the new appliances. We consider the travel implications immediately below because they involve a point of interest about Papago culture in general. Before starting we may look back and conclude that peoples' trips to the domestic services building would take place in the "dispersed" periods of the day -- between meals -- and the trips would relate to womens', not mens', activities during those periods.

Family and Car, 1: Driving and "Running"

Special note is here taken of a propensity of Schuchulik people and Papagos in general to drive (or, they say, "run," med) not walk between places in a village. It is relevant because the Domestic Services Building is normally driven to by the residents of all the houses except 4, 5, 7, 12, and 13 (Figure 2-2), and the latter three sometimes drive to it. Very simply, Papagos prefer driving to walking. Why would this be?

First, as noted above the Papago expression for such car trips is "to run." In pre-horse times running in fact was the preferred mode of long distance traveling, especially for men. Papagos were inveterate runners partly to save time we may suppose, and partly also for pride. When horses came, the word "run" was applied to that form of travel; people say "I will run on the horse," not "I will ride the horse." In fact, the concept of "ride" never caught on in Papago; there is no easy way to say it. Cars and trucks augmented horses and the same word-and-meaning was extended to them. Any car trip is expressed as "to run."

An interesting question is why trips within the village but between households came to be made by "running" cars rather than by walking on foot. It is doubtful that pre-horse Papagos habitually ran between houses -- that would have looked silly as if there were an emergency -- so the language and culture question is, Why was a formerly extravillage

word and meaning for travel seized upon for intravillage travels? The proposed answer is that taking a car or horse makes a trip look official. It lets everyone see where you have gone because you leave the horse or car standing outside your destination as a public sign that you are inside. The "real" meaning of med, "to run," we think, is not simply to go fast, but to go openly, with clear purpose, and with nothing to hide.

To walk when you could "run" carries the implication that you may be slinking and not want to be observed. Of course this applies mostly to trips alone. Two people walking together offer less cause for speculation. Also, it applies more to night trips than to day -- but day trips are not exempt. It applies to trips to the Domestic Services Building. The location of this building outside the households puts a pressure on people either not to use it at all, or to expend gasoline in "running" to it, or to send children on errands rather than to go oneself. The effect is to reduce the appliances' use.

Family and Car, 2: Family Travels

Schuchulik families do a good deal of traveling together, especially on weekends. Nowadays they use automobiles. Before the automobile it was the wagon that made family traveling an institution. Before that, we don't know the rate or nature of family traveling. The 1980's may represent the historic peak of Papago car culture if fuel and other car ownership costs continue to rise faster than Papago incomes.

Transportation costs represented a major portion of most families' cash budget during the study period, either as time payments for vehical ownership and fuel purchases, or as payments for rides in other peoples' cars. There were normally from five to eight running vehicles in the village during the study period, plus similar number of more or less long term disabled vehicles. They ranged from pickup trucks purchased new with monthly payments of $150.00 to $200.00, to ten-year-old sedans or station wagons purchased used for a few hundred dollars cash or for monthly payments on the order of fifty dollars. The average gasoline mileage we would estimate at about fifteen miles per gallon. Local gasoline prices were $.60 per gallon in the summer of 1978 and $1.20 per gallon in the spring of 1980. The only two odometers we checked, for two-year-old pickup trucks purchased new, indicated about 30,000 miles driven per year. This is a very high figure by American standards and may have higher than average for Schuchulik, but we would suggest that the far flung nature of Papago settlement and peoples' propensity to travel, especially on weekends, make for substantially more miles per vehicle per year than the American national average.

A family with monthly car payments of $100.00 might easily spend another hundred dollars on gasoline (15 miles per gallon, 1500 miles per month, $1.00 per gallon). And there are other vehicle expenses besides. Vehicle purchases are the villagers' main entry into the modern American life of contract purchasing. Vehicle expenses and food purchases are the villagers' main category of cash expenditures. (It is recalled that the average family yearly income was about $7000.00 in 1978 and about $8200.00 in 1980.)

Paying other people for rides was not cheap. Typical amounts paid were $1.00 to and from Y; $3.00 to and from Ajo; as much as $40.00 to and from Phoenix or Tucson. The fee was usually for the trip regardless of how many riders went along. Close relatives of different households were sometimes given rides for free.

Families were inclined to travel together on weekend shopping trips or to weekend fiestas (see below) or to both destinations on a given weekend. During the week five villagers depended on vehicles to transport them to their jobs at the San Simon school. Nearly daily trips were made by each vehicle to Y, the closest source of gasoline, and weekday trips were commonly made to Ajo and Sells. Nearly every running vehicle in the village went somewhere outside the village every day.

PUBLIC LIFE

Nearly every public place in Schuchulik, that is, every place that is not part of a household, is a meeting place for villagers and outsiders. The events of the public places are never wholly Schuchulik events; they are at Schuchulik and may be for Schuchulik, but they are not entirely of Schuchulik personnel. Somebody from outside must be there as guest with local people in the role of host.

A church service needs a priest or sister who come from the mission station at Pisinimo village, the next village south from San Simon, about a 35 mile drive from Schuchulik. A cattle sale at the corral needs an outside cattle buyer. A fiesta needs guests, a tribal commodity food distribution needs a distribution team from Sells. Not all these visitors see themselves as guests, especially if they feel that they are doing a favor to the village by coming there, but they are guests in the sense that the village could order them to leave or, more likely, not turn out to meet them.

The one exception to the rule of public places as sites for host-guest relations is a village meeting called by the headman at the feast house or dance ground. Such meetings are of the village, but they are normally to plan a local event such as a fiesta where outsiders will be present, or to convey messages from the outside world to the village.

No one has kept accurate count, but the number of non-Papagos visiting the village to see the electric system since it was installed in December 1978 must exceed 2,000. The nearest Papago equivalent to Schuchulik in this respect is the Papago community at San Xavier near Tucson whose eighteenth century church draws several thousand visitors annually. San Xavier grew up with this fame, however, and it is one church, not a whole electrified village, that the visitors come to see. Further, the church has a paid staff to treat the guests, while Schuchulik has only an unpaid headman.

Official visits to the village were conducted as follows. Typically, prior arrangements were made through representatives of NASA in Cleveland and cleared through the village headman. The visiting delegation would arrive by plane in Tucson or Phoenix and make their own way to the village to be met by the headman for a conducted tour of the solar array, the Electric Equipment Building, and the Domestic Services Building.

Other people in the village keep to their houses as a tour is in progress. The visitors see what looks like a town with a water works, an electric works, a vacant village center (the church complex), and a network of empty car tracks. It is not that the people are hiding, but that they have delegated to the headman the role of leading visitors through the village's public places.

The Public Religious Life

The heart of a rancheria village was its church complex. Now we discuss how this complex functions in modern times, especially in the all important Papago institution of the fiesta. Fiestas are the prime present day examples of villages organizing themselves for concerted, economically significant action. There is a fiesta or dance nearly every weekend at some Papago village.

Fiestas are different from weekly church services. In Schuchulik there is a Catholic mass each week at the village church. It takes about an hour and involves no building other than the church. A fiesta involves the whole church complex and takes several weeks from its planning stages to its cleanup. Church services and fiestas are not the whole of contemporary religious life. No attempt is made to describe the whole here which includes public and private events stemming from the native as well as the Christian religious tradition. We will give considerable attention to the sizes and types of fiestas, and to certain other religious events that share elements with them, because they show the kind of communal organization that Papagos are capable of.

The two regularly scheduled fiestas at Schuchulik occur just six months apart, a feast for St. Francis Xavier in May and one for St. Martin in November. They honor images kept in a private chapel and the village church, respectively. That the chapel is private does not make its saint's feast less public. Except for the image's place of residence, the Saint Francis fiesta follows the same pattern as the one for Saint Martin.

St. Martin's feast day falls when it should according to the Christian calendar, November 11th (actually the closest Saturday to the 11th). The generally accepted feast day for St. Francis, however, is October 4. As was stated in Chapter 3, most Papagos go to Magdalena, Sonora, at that time; then in the ensuing weekends, a great many villages celebrate their home feasts for the same saint. There are usually three or four St. Francis feasts per week at different villages through the busy month of October.

Schuchulik could have celebrated St. Francis then, too, but that would have placed it very close to the feast for St. Martin. The day celebrated in Schuchulik is not the saint's "real" feast day, but the anniversary of the arrival of the saint's image in the village, which happened close to the Anglo-American holiday of Memorial Day. Thanks to the latter coincidence, the "St. Francis of Schuchulik" celebration receives a long weekend in the secular American calendar, the better to celebrate with.

While the Memorial Day slot may have helped draw the St. Francis celebration to May, the selection was further aided by the end of May's being a relatively free time in the Christian calendar as observed by Papagos. The busy Easter period is over and the next busy period is not until various villages celebrate St. John the Baptist on June 24. Thus the placement of the two Schuchulik feasts six months apart makes good sense. It meshes with other villages' feast calendars so that relatively more people can attend each other's feasts and it lets the two village saints balance each other in the course of a year.

A notable feature of the Papago feast year is its accomodation to the wage workers' calendar of five work days and two-day weekends. This is a necessary accomodation because many of the people needed to produce a fiesta have jobs; and when they are not helping produce feasts they want to be free to attend other villages' feasts as guests. We would estimate that the average Papago family with its own transportation participates in twenty fiestas a year either as host or guest.

We have used the terms "dance," "feast," and "fiesta" without definition. Let us now distinguish them. A dance is couples skipping or gliding to musical accompaniment. A feast is hosts providing guests with a free meal with a characteristic menu featuring red chili. By fiesta we mean a larger event that includes both. There can be feasts without dances and dances without feasts -- neither are fiestas by the definition just used.

Examples of the former are wakes prior to funerals where there is never a dance, and birthday parties where the standard feast menu is served and dancing is a (now increasingly popular) option. Examples of the latter are less common. Feastless dances occur in villages under church club or athletic team club sponsorship: the dance is free but the club sells food (hamburgers, fried bread, etc. -- so far as we know the standard fiesta menu is never reproduced for sale, but always spells "gift"). Analogously, bars off the reservation sometimes hire a Papago orchestra for an outside dance and far more commonly hire an orchestra to play inside the bar so the patrons can dance. Again, the motive is commercial.

Among fiestas, it is necessary to distinguish between holy day ones where the occasion is the annual honoring of a saint or an aspect of the Holy Trinity (Christmas, Easter, etc.), and life passage ones where the occasion is a villager's birthday, graduation, wedding, etc. The difference between the two fiesta types is inobvious from the liturgy -- it comes to the presence of a procession in the first type and the absence of such in the second. This slight liturgical difference bespeaks a major organizational cleavage, however, between an event staged by the village and one staged by a family.

Before exploring that cleavage, let us note that fiestas of both types come in different sizes and that the second type only, the life passage, may be located at different places in a village. The size differences are direct functions of the time allowed for feasting and dancing. The longest time is all night. Next longest is from sundown (roughly) to midnight, the shortest is from about noon to about sundown.

The peak hours for fiesta attendance are from about 11 o'clock at night until about two a.m., hence the all-night length guarantees the largest attendance. Turning to place, holy day fiestas are invariably sited at a church complex. Life passage fiestas may either be there or they may be at a family's house. House fiestas tend to be small, that is, to end at sundown or midnight.

Schuchulik has been averaging two large-sized life passage fiestas each year in addition to its two holy day ones. The honorees of the former tend to be chosen from the same families that sponsor the latter, for example a graduation dance for a granddaughter of the senior couple of the village church, or a wedding dance for a grandson of the private chapel's owner. This is not to say that other Schuchulik families cannot sponsor fiestas; they can and have sponsored big life passage ones, and they have had small holy day and life passage feasts without dancing at their houses.

The interesting point is that the main fiesta sponsoring family groups feel it is becoming more difficult to give their holy day fiestas each year -- the senior couples are getting older, costs are rising, etc. -- yet they do put up large versions of the other type of fiesta each year. Why wouldn't they scale down the other type and save their energies for the holy days?

A plausible answer takes us back to the small liturgical but large organizational difference between the two types of fiesta. At an early point in a holy day fiesta, an image of the honored supernatural is carried with the village in file from its "house" (village church or private chapel) to the village cross east of the orchestra house. The image may either remain there through the night (St. Francis), or it may be returned directly to the church to signal the official commencement of the fiesta. In either case the procession stopping at the cross forms an eloquent picture: there are the village people, there is the village cross to which they have prominaded their saint. God is in the heavens and the guests from other villages are all around.

Life passage fiestas lack processions. It is not a saint that is honored but a live Papago. The host group is not a village but a network of relatives, some from within the village and some from without. As noted above, such fiestas need not be at the village center, they may be at a family's house.

Processions are rituals which speak more with movements than sounds. There is usually orchestral accompaniment to a procession and hymns may be sung or prayers said during the pause at the cross, but these "sound parts" only embellish the message of the marchers' formation, the carried image, and the cross. The orchestra soon will be playing dance music; the saint already has and soon again will be serenaded by similar hymns and prayers; and the villagers soon will disperse into the crowd. Their brief ceremonial convergence says, "We did it again." Sometimes fireworks are shot off.

The procession culminates a long process of preparations for the fiesta, discussed below. There is a feeling that holy day fiestas require

village-wide cooperation -- not that they always attain it, but in the best of worlds they require it. If the village is short of time or socially fragmented, people may opt for the other type of fiesta which waives that requirement, being nothing more than the Joneses honoring a Jones. It is felt that this is why villages give large life passage fiestas while doubting their ability to give the others, that it is not a question of money but of social integration. It is doubtful that this is a new feeling: village integration is never easy.

We turn now to what it takes in time and goods to put on a large fiesta. If the dance is to be on Saturday, the material preparations could begin on Wednesday or Thursday with the baking of bread by women and the catching of one or two cattle by men. A large fiesta uses 1000-plus five-ounce "bun-loaves" of yeast bread made from white flour. Midway between the English breadstuffs termed "bun" and "loaf," these "breads" as we will call them are the shape of hamburger buns but are dense like bagels.

The meat requirement for a large fiesta is one or more commonly two cattle each weighing about 500 pounds on the hoof. The cattles' red meat is cooked in large into red chili stew, the bones are cooked into "bone stew," the stomach into menudo (tripe soup), the head is barbequed, etc. Essentially the entire cow is converted into one menu item or another. The baking generally is completed by Friday evening when the butchering and cooking begin, but the meat work may be delayed until Saturday morning, the relevant considerations being that women be free to cook as men supply the meat, and that the meat be fresh. (No refrigeration is used -- see below.)

The cattle are killed and cut into large pieces (legs, rib slabs, etc.) which are cut in turn in smaller pieces (e.g., diced red meat for chili) through Saturday and the wee hours of Sunday as batches of food are prepared. Fifteen minutes after a cow is killed, before it is fully skinned, its first cooked pieces are served broiled to the butchers as a snack. Eighteen hours later the last pieces of the animal may be diced for the last batch of chili cooked for the feast.

Schuchulik departs from the above schedule in substituting wheat flour tortillas made throughout Saturday for much of the yeast bread. This requires a corps of women tortilla makers for Saturday, but it obviates the need for baking so much bread earlier in the week. Women from other villages are hired for the tortilla making -- it is a case of buying time with money, the weekday time having become scarce because of womens' wage jobs.

A cow when sold to a cattle buyer in the village was worth about 70 cents a pound in 1980, bringing the market value of the meat on the hoof used for a large fiesta to about $700. Traditionally and still commonly, cattle are donated by somebody in the group of families sponsoring a fiesta. (Although holy day fiestas are symbolically village-wide, they still have prime sponsors.) The donor is usually not one of the the senior couples who are spoken of as a fiesta's prime sponsors, who are usually in their sixties or seventies, but a child, brother, sister, cousin, etc. to one of the senior couple. In general the leading old

people of a village do not have many cattle or much other property. Their wealth is in relatives, either children or age mates with smaller families. The honored old have usually invested their money in raising children and being generous to all on a day-to-day basis, not in accumulating cattle for old age.

A new way of obtaining cattle has developed in the last 10 years. Instead of receiving a donation from a cattle owner, a sponsor or sponsor's relative may buy a cow from the local cattlemen's association (see below). These "association cows" are former strays that the association branded. The price for such a cow in Schuchulik is $80, a good bargain against an on-the-hoof market price that could reach $350, so most of Schuchulik's two cow fiestas during the study period included one owner donated cow and one purchased from the association. This meant that the cash payment for the meat consumed (discounting the donated beast) was just $80. We might place the grocery store value of all the meat in butchered form (counting the donated labor) at $1400.

Feast meals are served "family style" at long tables seating up to 30 people. Individual guests and families eat in shifts of about half an hour (or less during peak periods when there is a waiting line). A man watches the door to admit new shifts and others serve the food, reset the table between shifts, and replenish the supplies of food on the table. The meat dishes are served in large bowls. Pinto beans cooked with lard and water, potato salad, and green salad are also served in bowls. Mounds of breads and tortillas are conveniently placed on the tables, plus pots of hot coffee and pitchers of kool-aide. For desert there are normally bowls of canned fruit and store-bought cakes.

The only strictly local ingredients are the meat and the water. This is not the result of a shift from self-sufficiency to dependence on stores, although such a shift has certainly occurred over the last two generations. It appears that fiestas have always used a town-like menu with town-bought ingredients, that is, that "festive" has always meant "like town." The original menu was Mexican; and that core remains with additions that might be described as "Anglo-American-family-reunion" -- potato salad, kool-aide, and bakery cakes. If there has been a shift in meaning regarding the fiesta menu, it probably is that what started as a "town" menu now is seen as native or traditional Papago. Thus, especially in feasts where White guests are honored, certain native foods like cholla buds are served now, which probably were the last thing the old time feast-goers wanted to see at feasts, being common fare to them.

If fiesta meals were matched at a modest Phoenix restaurant at a la carte prices but in Papago quantities, the price would probably be $7.50 per meal putting the restaurant value of a big fiesta at $3750 to $5250 (500 to 700 meals served in the feast house from early afternoon Saturday when serving starts but before most guests have arrived, to near dawn on Sunday). In addition to the food serving, much food from slabs of raw meat to cooked chili sandwiches is given to workers and guests to eat off the premises or to take home.

The latter gifts are part of the reward for the up to 40 people who may work at one time or other during the (as early as) Wednesday to Sunday

period. The only workers normally paid cash are the tortilla makers/ cooks' helpers, musicians, and specialists who recite prayers and sing hymns (see below). In general cash payments are restricted to outsiders from the village who are not relatives or at least not close ones. If a local orchestra is used, it is less likely to be paid; if an outside tortilla maker is closely related she may not be paid. The payments made, usually $10 or less, are in any case spoken of as gifts to defray expenses (e.g., for gas) rather than as wages.

During peak fiesta periods (Easter, June, and October) some people may help at a fiesta each week for a month, receiving food and lodging from Friday night to Sunday noon, perhaps a little money, and some food to bring home with them. This arrangement appeals especially to the old who enjoy the company of their fellow elderly at other villages and whose skills make a material contribution to the weekend village restaurant industry.

Fiestas scale according to whether they involve two cows, one, or none. The menu is essentially the same, only in a very small scale feast the meat is bought in town by one or several donors. Such feasts are rarely accompanied by dancing, but they sometimes are, e.g., by dancing at a house through the afternoon to a local band. Such events are at the boundary between fiesta and simple "feast." They may be held for holy days as well as life passages.

We may finally note that house feasts at the small end of the scale resemble a class of life passage events which never have dancing: funerals and the anniversary dinners held a year after a funeral. In former times (up to the 1950s) these and to a lesser extent weddings were the life passages celebrated with Christian ritual. (There were native rites for birth and a girl's coming of age.) Wedding celebrations tend to take place entirely at the church complex, but funerals have a more complex pattern which needs to be contrasted with a full scale fiesta: a night-long wake at home (or, rarely, at church), a brief rite the next morning at church (a mass or rosary), a procession to the cemetery for burial, and a return home. A funeral may take 24 hours but its nighttime period is before the "funeral" in the narrow sense (the movement from church to cemetery), the reverse of a fiesta where the church activities (prayers and procession) are at dusk before a night of dancing.

The two nightlong periods have distinct feels. During a fiesta night, a group of young male musicians play Mexican-derived dance music in multi-song "sets" that segment the night into seemingly endless 20-minute to half-hour portions. Couples dance to orchestral music, the typical instruments now consisting of electric guitar, electric base guitar, saxophone, trumpet, accordion, and drums. The nonelectrified instruments are amplified via microphones and loud speakers. The occasion is outdoors. The dance ground is lit but the light ends at its periphery. Beyond the dance ground is an encircling mass of cars, beyond which are the village houses and finally the desert night. There is considerable movement of people through all those zones.

A nightlong wake is held in a dwelling house or at a temporary enclosure beside a house. Those in attendance sit facing an altar

erected for the occasion, a vertical sheet with holy pictures above a table surface with candles and other objects. The event is led by a group of mostly old women singers and prayers, the traditional liturgy being a rosary in Spanish and Spanish hymns. Nowadays English and Papago rosaries and hymns are also appearing, but the real old hymn form is Spanish. (It is not known what Papago funerals prior to Christianity would have been like.)

Where musicians are loud, the singers/prayers are soft, the one instrumental and amplified, the other vocal and muted. The verbal liturgy of a wake is divided into segments analogous to those found at a dance, only the pauses are longer and in the long middle part of the night, sporadic. At a wake one leaves the area by the altar to wake up (and goes into the "yard" part of the house compound), at a dance one enters the central area (the dance ground) for that purpose. One can go and get fed at both events, into the house kitchen at a wake or into the feast house at a dance.

Musicians for dances and prayers/singers for wakes (and other events) are the two performing specialties of Papago Christianity. Schuchulik harbors one of each kind of group, complementarily based, as are so many other things, in the "village church" families on the one hand and the private chapel families on the other. Each serves in the other's rituals. The one specialty seems less religious than the other, but the two are best viewed as parts of one system. It happens that musicians never play and people never dance at wakes or death anniversaries (the scenario of which is very like a wake), while singers/prayers do have a role, though a variable one, in fiestas. The latter may participate in the procession, they normally pray and sing as the cows are being killed, and they may pray and sing in church as an alternative or supplement to a priest's saying mass there prior to the procession which formally starts a fiesta.

Musicians represent a major cash cost for a fiesta. A good orchestra may be paid $200 for a nightlong dance. Even so the pay per performer is not very high. Prayers/singers work more to serve than for profit; each may receive $5 or even less for a night's service.

No one pays for attending a fiesta, but the transportation cost may be considerable and small items such as confetti-filled eggs, pop, cigarettes, and hamburgers may be purchased there either from clubs (see below) or enterprising individuals. A good deal of drinking is also done, almost always as a social form in which one shares drinks with others. There are generally people selling drinks (either beer or sherry wine) to keep the drink-givers supplied. A family of five might spend $30 on gas, hamburgers, and drinks in going to a large fiesta at another village, a modest price for a weekend's entertainment.

The dollar cost to the hosts is born by the several families who contribute cows, musician fees, decorations, and perhaps $600 worth of groceries. Usually there is no central accounting. The total host expenditures not counting gas for buying trips is probably under $1000.

To get a sense of the value added at a large fiesta, we should compare the total estimated dollar cost to the hosts of $1000 against the estimate restaurant value of the meals served in the feast house, $3750 to $5250. In fiestas Papago time pays big dividends.

Effects of the Electrical System of Fiestas

The Papago fiesta complex developed before there was electricity on the reservation and can do fairly well without it, at least in the cooking aspect. What every village finds it needs for a proper fiesta, is electricity for the orchestra, for lighting the dance ground, and for lighting the feast house and church.

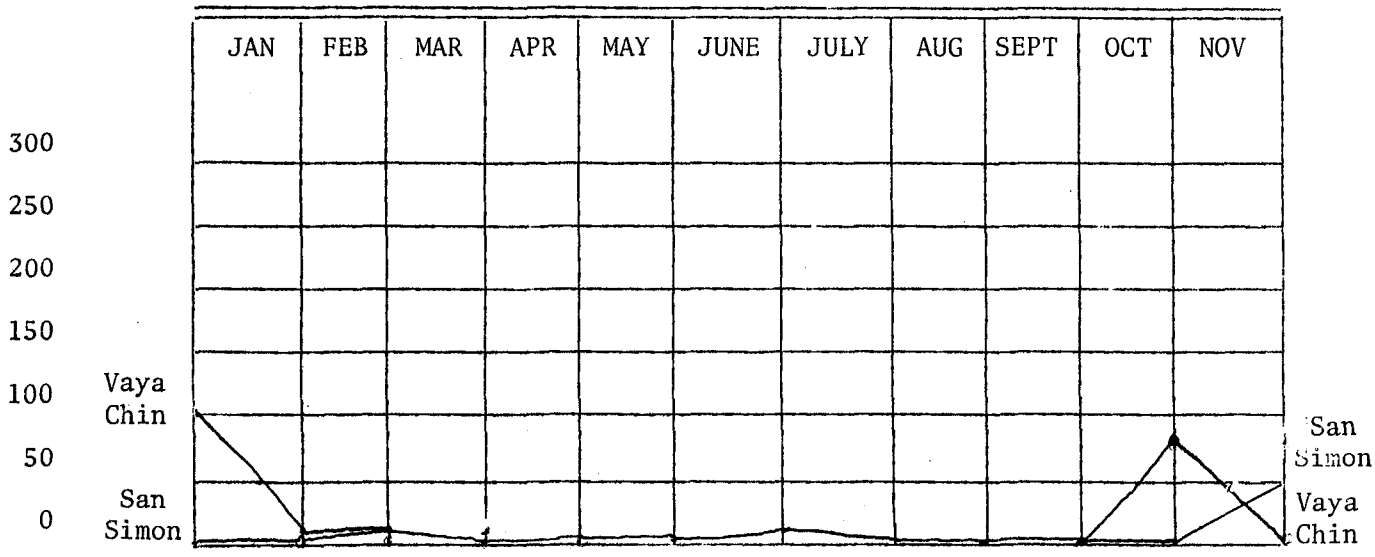
The Schuchulik photovoltaic system was designed to carry the feast house and church lighting functions, but not the other two. When Schuchulik has a fiesta, a gas generator is used to power the orchestra and light the dance ground (see Chapter 5 for a discussion on generators).

The generators supply 120 volt a.c. electricity which is imperative for the musicians' equipment and may be preferred for the dance ground lighting as well. The generator is normally run for the duration of the dance, about ten hours. The typical village generator is rated at three kilowatts which would mean a potential power production of thirty kilowatt hours (and a gas consumption of five gallons).

To get an idea of the total power demand of a fiesta, we obtained monthly electric meter readings for two church complexes served by conventional a.c. power. These readings are graphed in Figure 4.1 They cover church and feast house lighting as well as the two functions not carried by generators in Schuchulik. The graph shows practically nil electricity use except for months when there is a fiesta (January and October in Vaya Chin and November in San Simon). This suggests that the routine weekly power demand for church services is a small matter. In evaluating the forty to one hundred kilwatt hours needed for a fiesta, we would note that the demand would be spread over a four day period with the heftiest demand on the night of the feast and dance.

From observing several fiestas during the present system's operation, we would not say that the refrigerators made a substantial contribution. The butchering and cooking processes are worked out so refrigerators are not necessary. Some ingredients, e.g., large bowls of raw, diced meat, were stored in refrigerators, but this wasn't done consistently and indeed could not have been done considering the quantities of meat involved. Elsewhere on the reservation a different use of refrigeration is developing, namely to freeze large quantities of meat from cows killed far in advance of a fiesta (e.g., two weekends before). This change makes sense considering the tight schedules of some fiesta workers, but it requires large "home" freezers and could not be done with the small freezer compartments in the refrigerators at Schuchulik.

Figure 4-1. Church Complexes: Monthly Electricity Consumption



The lights in the feast house have been a boon. Since the system was installed it has not been necessary to run a generator until about sundown on the night of a dance. Previously a generator was needed to light the feast house day or night, whenever people were working there. Once a generator is started nowadays on the night of the dance, however, it appears to use as much fuel in powering the bandstand and dance ground lights as it previously used in powering them plus lighting the feast house. The generator runs through the night regardless of how many loads are attached to it.

Cattle Association and Community Fund

The central government at Sells has long encouraged villages within districts to band together in cattlemens' associations. There was a tradition for intervillage cooperation in ranching in any case because the range is sparse and vast and the villages are interrelated. The associations simply made the cooperation formal and gave local cattlemen access to forms of aid, assistance, and guidance that they wouldn't have had on their own.

The most important fact about the associations from our point of view is that they were given their own brands and they use these brands to take possession of stray cattle encountered during roundups. Prior to the formation of associations, such cattle apparently were left to live their lives as nobody's property. It is difficult to know how many stray cattle there were, say in 1920. Their number probably has increased through the range management practices that the associations fostered, for example, the building of wells and charcos (rain water catchment basins) in remote places where cowboys rarely penetrate. In any case in recent times a certain number of cows and calves always slip through the

roundups. These calves, left unbranded, become next year's strays which, if caught, become the wealth of a cattle association.

The Hickiwan District of which Schuchulik is a part has had a cattle association for its northern villages for a number of years. Recently Schuchulik and its closest neighbor Charco 27 banded together to form a separate, southern one. This new association doesn't have by-laws or its own bank account yet. Lacking those formal features, the proceeds from selling association cattle are divided equally between the two villages, e.g., an $80 sale for a fiesta yeilds $40 to each village. Schuchulik's share of the money goes into a community bank account administered by the headman.

In the past the community fund seems to have been used exclusively for financing fiestas and maintaining or adding to the physical church complex, both of which expenditures are normally associated with individual families. The fund's income prior to the cattle association was wholly or largely derived from an international child welfare organization, the Save The Children Foundation. A certain amount of Save The Children money is designated for communal betterment purposes and some of that was allocated to Schuchlik's fund -- with the understanding that it would be used as it was.

TWEP

TWEP (Tribal Work Experience Program) jobs are wage jobs in the village. For able-bodied working age men only, they are the only form of wage work available within many villages including Schuchulik. A man's pay is determined by the number of people he has to support, but is never as high as the pay for a regular job, even janitor, at a government installation. To qualify for a TWEP job one's family must be in need of money so, for example, a man whose wife has a regular job cannot qualify. TWEP is a form of relief work.

The program is 15 years old. It began in the Great Society years of American national politics and came to the reservation at a time when migrant farm working jobs in the region were drying up. Essentially it let men and their families come home to a guaranteed if minimum livelihood. At the same time as these families came home, and new families were forming as their children married, the number of regular jobs on the reservation increased through school, clinic, road, and house building programs. Thus TWEP was part of a larger shift in Papago work life. It functioned for returning heads of family as dish washing and stoop labor jobs function for immigrants to U.S. cities, as a way to live while looking for a better job in the local economy. Schuchulik had a total of six different men in TWEP during the study period with a maximum of four and minimum of two working at any one time.

The TWEP job experience is different from the regular jobs held by Schuchulik residents in the first place, as noted above, because TWEP jobs are lower paid and have the negative qualification that one must be money poor in order to obtain them. Second, they are in the village and lack

the feature of travel to a different and specialized work place. The work one does for TWEP is everyday Papago work: repairing and cleaning up around houses, small scale construction projects, cutting firewood, etc. The tools TWEP men use are the same as most households have and in fact usually are the workers' own tools. At times they must borrow tools from a family in order to do a job, for it, if, for example, one is to chop wood for the X family and one's own axe is broken. The job assignments change every day.

This contrasts with the holders of regular jobs who do the same task every day, are sent on government sponsored workshops for in-service training, and who use specialized tools provided by the employer as part of the job. Compared with the jobs Papagos get off the reservation, the regular reservation jobs are perhaps oversupplied with physical wherewithal, making them seem very special, while the TWEP jobs are undersupplied. This undersupply and the delays it entails may be one reason why TWEP workers are called ba:ban pion, "coyote workers," throughout the reservation.

The Work Experience Program is administered centrally from Sells. One man in each village is designated as in charge of organizing projects and keeping track of workers' time. This man is visited periodically by a supervisor from Sells who collects time cards and checks to see that all is well. Thus the program is administratively separately from the system of district and local government described in Chapter 3. In particular the village headman/district councilman has no jurisdiction over the local TWEP unless he happens to be the TWEP boss of the village, i.e., a "coyote worker" himself. The program is an example of the tribe forming itself as a supermunicipality in control of village-level public works, and with good reason: the payrolls could not be met with village or district funds.

TWEP in the village has the effect of removing many formerly family-level tasks to the level of village coordination through the TWEP boss. In principle it creates a kind of dual headmanship, part being vested in the "traditional" headman/village councilman, part in the TWEP boss. The village TWEP has played no role so far in maintaining the electrical system. Presumably it could have, for example in cleaning the Domestic Services Building or in erecting a clothesline that the women of the village requested outside that building. (The clothesline was erected by non-village labor several months after the women had first requested it.)

Conclusion

Schuchulik has no public physical structures which are owned and maintained solely by the village. We can rate the public structures as relatively locally owned and maintained versus relatively outside owned and maintained. At the local end are the corral with its cattle scale and the church complex. At the outside end are the water and electrical systems.

We found the cattle association to be a producer of local funds and the village as church congregation to be a collector and productive user of local money, including some cattle association funds at least in the form

of wealth on the hoof. This cross financing from the association to the church is the exception rather than the rule in the village's treatment of communal improvements. The rule is to treat the labor and funding requirement for each improvement as a separate issue. This is how the church complex was built, item by item, and it is how the water system payments were treated.

Viewing the village's social development historically we may say that it has been tooling up for a more integrated method of handling public works, first by establishing a community fund that might be used for multiple purposes, and second by accepting TWEP as a multipurpose work crew. Both developments have occurred in the last fifteen years. It would be premature to conclude that those developments will lead to communal management of the electric system. Such management would add work to the village as a social system. The villagers had not determined by the end of the study whether the fund and TWEP would be up to the tasks that might be assigned to them or even whether they would favor making such assignments in principle.

CHAPTER 5

ENERGY USE

Solar electricity came to Schuchulik because it was felt that the village needed electricity and that photovoltaic technology could fill the need. That feeling was articulated at a village meeting attended by NASA and Public Health Service representatives in the spring of 1978. The first part of this chapter provides a historical and cultural background to the decision to install the system, namely a brief account of how conventional electrification came to the reservation but not to Schuchulik, and an inquiry into traditional Papago thought on energy. The second part of the chapter treats contemporary energy use in Schuchulik and other Papago villages, especially the use of electricity, firewood and propane.

Background

The process by which Schuchulik was electrified began outside the villagers' consciousness decades ago. The first step starting in 1951 was the electrification of a number of villages under an electrical cooperative called Trico which served Indians as well as non-Indians in the region around Tucson. Next in 1970 came the formation of a specifically Papago electric company, under White management, called the Papago Tribal Utility Authority. This authority buys most or all of its electricity from an outside source and resells it to residential, governmental, commercial, and one main industrial user (a copper mine) on the reservation. Among the PTUA's goals is the electrification of as many Papago villages as possible, hence its coming on the scene foreshadowed the coming of electricity to Schuchulik.

It was a long shadow, however, because Schuchulik is remotely situated in regard to the PTUA's electric grid. In many respects as noted in Chapter 3, Schuchulik is not a remote Papago village. It is five miles from an electrified off-reservation commercial settlement and close enough to a town for most of its people to do their clothes washing there. It is only remote from the center of the reservation and from the direction in which Trico's and the PTUA's electricity penetrated the reservation.

Few people in Schuchulik understand why they were electrically remote in 1978. They did not participate in the planning that brought Trico and then the PTUA into existence. Nor do they understand the final phase of the story which is why it was NASA and the Public Health Service, not the PTUA, that finally brought electricity to their village. We reconstruct the process as follows. The PHS had previous experience in installing complete, modern, public service facilities in villages, namely water and sewer systems. When NASA proposed a complete village electrification unit, the PHS was interested in cooperating. Schuchulik was selected as a site because it was of an appropriate size and was not due for conventional electrification in the near future. The PTUA agreed to install power poles and distribution lines in the village and another tribal agency, the Papago

Construction Company, agreed to construct the buildings. These arrangements had been made in preliminary form before the meeting in the spring of 1978 when the project was formally presented to the villagers.

Schuchulik was not idle in electrical matters. Its people had bought cars and trucks with self contained electrical systems since the 1930's. Most vehicle owners in the village make minor electrical repairs such as changing starters and alternators, changing ignition points, "jumping" batteries, etc. They tinker with their cars more than the average American. More significantly, there were three gas powered a.c. generators and one d.c. generator in the village when the electrical system was installed, and five a.c. units plus the d.c. one in April of 1980. These units had been purchased new or used or had been scavenged by individuals -- each had its story. Rather unreliable machines, there were rarely more than two working at one time and, like the cars discussed in the previous chapter, they often sat broken down for months awaiting a decision on repair or replacement.

One generator is a standard item in a village without conventional electricity. It is used to provide electricity for fiestas. What seems unusual about Schuchulik was the presence of the other units for purely domestic use. They were used for running TV sets (this was the most frequently mentioned use "so the kids can watch cartoons"), stereos, irons, blenders (the preferred method of grinding red chili for the main fiesta dish), and a washing machine. The wiring from generator to appliance was makeshift, via extension cords either laid on the ground or strung through the air. In April, 1980, a mini power system of this kind connected four households to one generator which, until it burned, was housed in a specially built wooden "power house" midway between the houses it served. The system worked, requiring no outside technical or economic assistance. We are not aware of such an elaborate system in the village prior to the photovoltaic project and would imagine that the coming of the project stimulated its construction.

Schuchulik's gasoline generators range in power production from 2.5 to 3.5 kilowatts. Bought new a 3.5 kilowatt unit costs around $1,200 (June 1979). According to a Phoenix area tool rental agency, such units when rented to people off the street can be expected to run about 500 hours before needing an overhaul or a new engine. A new eight horse power engine for such a unit costs $180.00. The rental unit's gas consumption is about

a gallon an hour. This is the same consumption reported by users in Schuchulik. The average life of the generators in Schuchulik appears to be less than a year.

Also in the village when the photovoltaic system was installed were a wide selection of battery operated devices and one impressive set of electronic gear for an orchestra -- microphones, amplifiers, speakers, etc. We conclude that Schuchulik was more than ready for electrification when the system came to it through a planning process of which the villagers were largely unaware. The remainder of this section considers the nature of traditional Papago thought on energy. The next section takes up the present use of one old and two new sources of energy -- firewood, electricity, and propane.

Pre-twentieth century Papagos had at least one far-reaching theoretical system on energy. This system connected a non-human form of energy to human sickness and death on the one hand, and to a wide varity of natural objects on the other. It may not have been the only elaboration of native energy thinking, but it was probably the most systematic and comprehensive one. It was elaborated by medicine men who were the main thinkers on theoretical or philosophical matters in the native tradition. It is treated in a book by Bahr, Gregorio, Lopez and Alvarez (reference 20). Its salient points are that 30 to forty natural kinds of species, mostly animals but also including some plants and "spirits," were endowed with person rights vis-a-vis Papagos at the time of creation; when Papagos violate those rights they are sickened with the "strength," "power," or "energy" of the species (the same word, gewkdag, can take each of those meanings, depending on context).

Sickness-causing gewkdag is a distinctly non-human form of energy. It invades humans and makes them sick for as long as they harbor it. In effect it exists to keep mankind "off the backs of" the species in question. It enforces interspecies separations and underwrites something not unlike what the ecologist Odum calls an ecological system:

> "An ecological system is a network of food and mineral flows in which the major pathways are populations of animals, plants, and microorganisms, each specialized to live in a different way, doing a different job for the energy flows of the system. A species of living organism is a population that is insulated and kept separate by various means so that the pathways of its food and mineral flows are not entangled with other species" (reference 21).

There are important differences, however. First, the Papago theory does not account for all interspecies relations, but only a select number, and it is difficult to tell what the principle of selection is -- according to Papagos it is history. Second, the theory is human-centered in that the dangerous species are only claimed to sicken humans, not each other. Third while gewkdag as an abstraction resembles Anglo-American abstractions of power and energy, it is not reckoned in countable units. Fourth, the system is more personal than most American thinking on energy. Gewkdag only comes into action when humans have violated the rights of one of the

40-odd protected species. The theory extends human rights to members of the non-human world. The method of curing is to sing songs and plead with the species whose rights have been transgressed. Fifth and final, gewkdag as elaborated in this system is a distinctly harmful substance. Its presence in a human being produces sickness and eventually death. It is not the kind of thing that an energy planner would want to stockpile.

The gewkdag-caused sicknesses are an important part of Papago life. Schuchulik during the study period had two persons capable of curing certain of the sicknesses and virtually every adult in the village considered the system an important part of the "Indian way." No one thought the system covered everything in their health life or their dealings with energy -- especially modern forms of energy -- but no one completely discounted it.

From an Anglo-American perspective the native energy theory is remarkable for being tied to the particular human experience of sickness. One may say that Papago medical thinking was very broad, since it looks outward and across species for the cause of human affliction, or one may say that their energy thought was very narrow and human-centered. The system apparently served Papagos well during their independent existence as what Anglo-Americans would call a "low energy society," that is, a subsistence oriented society dependent primarily on human energy for the harvest of local plants and animals. Apparently it worked well up to the 1930's when a tribe was formed to oversee the Papago's transition to far higher levels of energy consumption based on newly introduced, imported energy sources. Since then Papagos have had a philosophically mixed system.

CONTEMPORARY ENERGY USE

The principal non-human sources of energy now used in Schuchulik are: gasoline (gaes), kerosine (saidi, butane (ku:ps), electricity (wepgi), and firewood (kuagi). None of the above is directly regulated by the theory of sickness. As a first approximation as to why, none of them are perceived as creatures with minds and with "person rights" against human incursion. They are true "things" in the perjorative, amoral sense. It is not that the native theory has left them entirely alone. Firewood, the one energy source which is a carryover from low energy times, is regulated by a sickness called wuihom, "lightning being." The idea is that some or all forms of lightning stem from a kind of person, wuihom, who shoots it as arrows. When these arrows strike a tree, the tree must not be cut as firewood. "Normal" firewood is not dangerous and has no sickness producing strength of its own; wuihom-struck trees are dangerous and, if burned, would set a sickness in motion.

The "lightning word" wepgi applied to electricity has nothing to do with wuihom. It is formed from the word "red" (s-wegi) and refers to the color of some or all of the "lightning beings" products. So far as we know there is nothing dangerous in the sense of sickness-producing about electricity; it may burn, shock, or kill one, but its hazards are not regulated by the theory of sickness outlined above.

Ku:ps, "propane," is an extension of the meaning of a pre-existing word for "smoke" or "dust" (propane tanks are called ku:ps ha'a. "smoke

pots"). Gaes and saidi are from English "gas" and Spanish aceite ("oil," "kerosine") respectively.

Compared with other Papago villages Schuchulik was low and perhaps frustrated in its use of electrical energy prior to the electrification project. We say "frustrated" because of the trouble and cost that some of its residents went through to obtain gas powered generators. Expensive to buy, difficult to maintain, and expensive and noisy to run, the gas generators showed the village was ripe for a cheaper and more dependable source of electric power.

Post-electrification we would say that Schuchulik has approached a level of electric use characteristic of some Papago villages. The frustration is still there as is evidenced by the continued and even increased use of generators. In terms of sheer kilowatt hours however, the per household photovoltaic electricity production at Schuchulik comes close to the per household consumption of at least one Papago village presently wired for conventional electricity. We regard this as an important finding and a challenge for Papago resource thinkers of the 1980s. It means that if many Papagos are willing to live like the people of Ak Chin, photovoltaic power might fill their needs.

Turning from electricity to other energy sources, Schuchulik differs from most Papago villages in the extent to which it has replaced firewood with propane for cooking, space heating, and water heating. This gives Schuchulik a relatively modern "energy profile," a fact which needs to be understood in terms of costs, labor, and seasonal needs. This will be the second major thrust of the discussion to follow, again keyed like the discussion of electricity consumption to an imaginary agenda for Papago resource thinking for the decade to come. Third we will examine specific aspects of photovoltaic electricity consumption in Schuchulik, to set the stage for the remaining chapters of this report.

We have earlier noted a high use of gasoline in Schuchulik for powering motor vehicles. While Papago vehicle use is doubtless higher than for Americans in general, we do not think there is anything unique about Schuchulik among Papago villages in this respect. The tribe is simply highly motorized American population, a fact which deserves greater attention than we have been able to give it in this report which is aimed primarily at energy use for home, not travel. We have said our piece on cars in Chapter 3. Nor will we discuss the fourth of today's purchased energy sources, kerosine, in the present chapter beyond noting here that it is used for houselighting (now largely displaced by electric lights) and for starting wood cooking fires. It is a minor but necessary item. The same goes for candles.

Electricity Consumption

The photovoltaic power experiment included the metering of various functions of the Schuchulik system from dedication day throughout the two year period of the project. Below we deal with an eleven-month period,

January to November 1979. We are concerned with overall consumption plus the specific consumptions of the village lighting circuit (includes all lights), the pump, and the washing machine. The readings were taken on an almost daily basis by the village headman David Santos. For comparison, the PTUA has made available to us the meter readings of all the households plys a pump in four other reservation communities served with conventional electric power. These readings cover the same eleven months, January through November 1979.

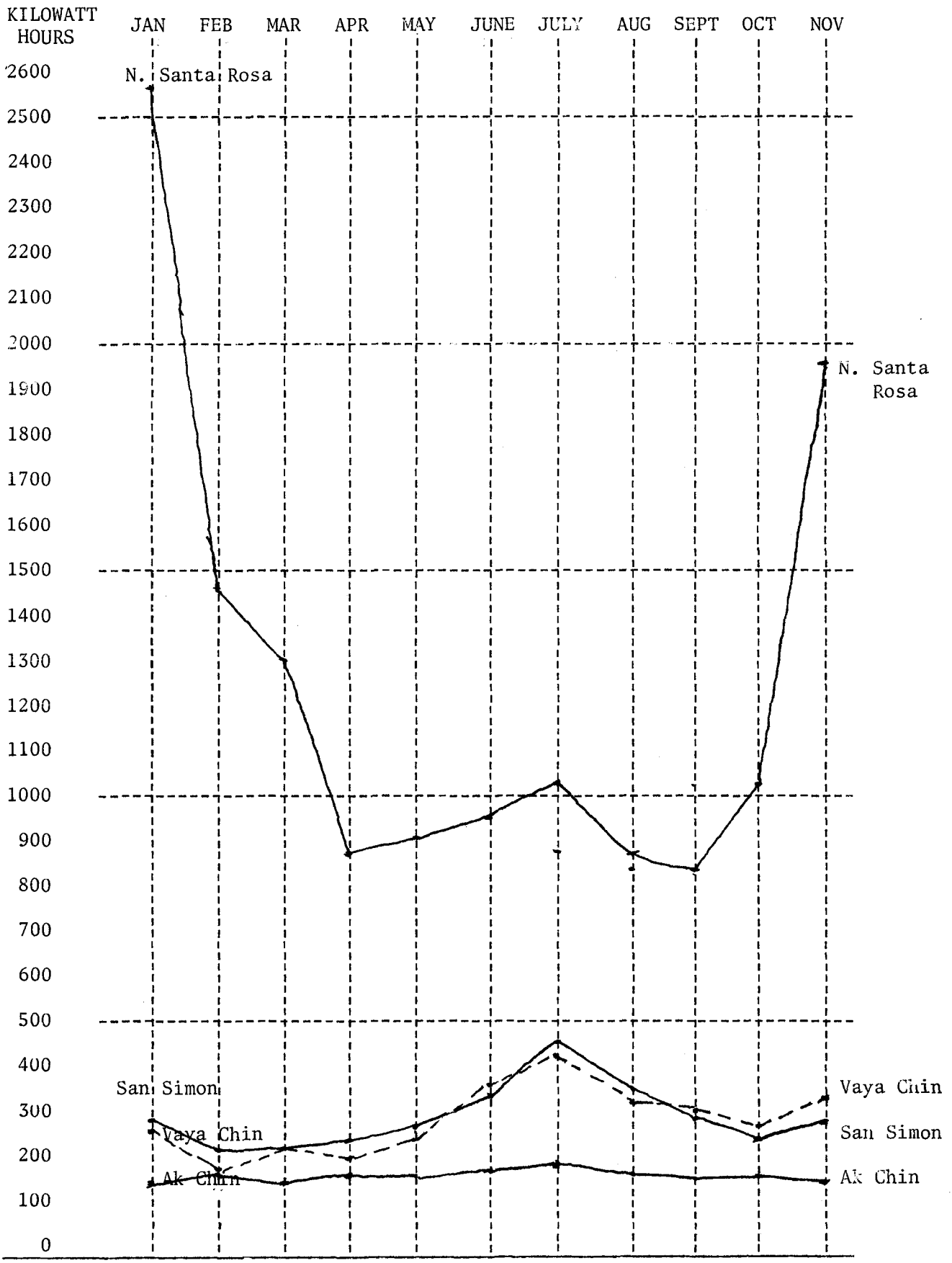
Figure 5-1 graphs average household monthly electric consumption for the villages of North Santa Rosa, San Simon, Vaya Chin, and Ak Chin. San Simon and Vaya Chin have been mentioned earlier in this report as relatively close neighbors of Schuchulik. They were selected for comparison for that reason. North Santa Rosa was selected as a recently built Papago HUD "subdivision" consisting of American-style three- and four-bedroom houses with "total electric" appliances: furnace, water heater, refrigerator, stove, evaporative cooler, light fixtures, and wall outlets. Electric consumption in North Santa Rosa is an indication of what Papagos will do on moving into total electric housing. Most of the families in this subdivision had young children. Nearly every family had at least one member with a "regular" job. Nearly everyone came from villages where electricity had been added to small Papago-built houses.

Ak Chin, a neighbor to North Santa Rosa, was selected to show consumption in a village from which some North Santa Rosa residents came. This village was electrified in the mid-1970s, it is said after a period of resistance from some of the older residents. Its housing is the most traditional of the villages under comparision, having so far as we know no houses built on the multi-bedroom-and-separate-living-room HUD or HIP plan. Certainly its use of electricity is the lowest of the villages under comparison, a fact that will be important in the discussion to follow.

We know of no prior studies of Papago household electricity consumption. Ours is based on a mere few hours spent copying meter readings at the PTUA office and on Bahr's personal acquaintance with a few families at Ak Chin and North Santa Rosa. A better study would cover a longer span of time, would learn exactly what appliances are in use in a sample of households, and would learn the floor plan and number of people living in those households. The interpretations below are best viewed as preliminary to such a study.

Discounting the wide differences in level, and leaving aside for the moment the high ends of the North Santa Rosa graph, we see a peak in electric consumption in all villages in July, the month of the hottest and longest days. Bearing in mind that our monthly figures are averages for all the households of a village, we would explain the various "sizes" of the July peak, relative to the preceding and succeeding troughs, as a function of the number of evaporative coolers in a village. Ak Chin has relatively fewer coolers among its households, so its curve is flatter than the others, etc.

Figure 5-1. Average Household Electric Consumption By Month, 1979



Coolers appear to be a "second generation" electrical appliance in Papago households. "First generation" appliances, i.e., the ones a family would buy soon after electrification, include: stereos, TV sets, irons, portable electric space heaters, refrigerators, toasters, blenders, and washing machines. Coolers are distinct from the above because they go with a more indoor style of summer life than Papagos traditionally are accustomed to (you have to stay indoors to enjoy a cooler), and because they require rather more extensive carpenter and plumbing work than any of the above. Thus we believe that most families with coolers already have refrigerators and washing machines, but many families with those two major appliances would not have coolers.

The most dramatic feature of Figure 5-1 is that the July peak of one village, North Santa Rosa, is dwarfed by a winter (January) peak. Two of the other villages swing up in January, but not so high as in July. We would explain the very high North Santa Rosa winter peak primarily by the electric furnaces installed only in that community and secondarily by the relatively large number of electric lights in North Santa Rosa houses. That January and probably December are peak heating months needs no explanation. Being also the season of the longest nights they are peak lighting months (see the graph of Schuchulik's light use, below).

If we are correct in assigning the major cause of the North Santa Rosa winter peak to the furnaces, then that convenience would cost the average household about $67.50 for the month of January (figuring 3/4 of the difference between April and January as the heating part, and using a price of $.05 per kilowatt hour). With the air-tight "Scandinavian" wood burning stoves now on the market, the same amount of heat could probably be had for the price of a cord of mesquite firewood -- $10.00 in Schuchulik (the price may be slightly higher in the Santa Rosa region, e.g., $20.00 a cord, but this is against a Phoenix price of $80.00 to $100.00 for mesquite firewood). The North Santa Rosa houses are not designed for stove heating so the same amount of heat would not produce the same amount of comfort. Nonetheless some families from there report a still less efficient method of trying to beat their winter electric bills, by using the fireplace with which each living room is equipped.

Concerning winter house lighting, the North Santa Rosa houses, being multi-room and lit to American standards, probably have five times as many lights as the average house in Ak Chin, e.g., 10 to two or 15 to three. A question we cannot answer is, To what extent do Papagos, like Whites, leave bulbs burning in rooms they are not using?

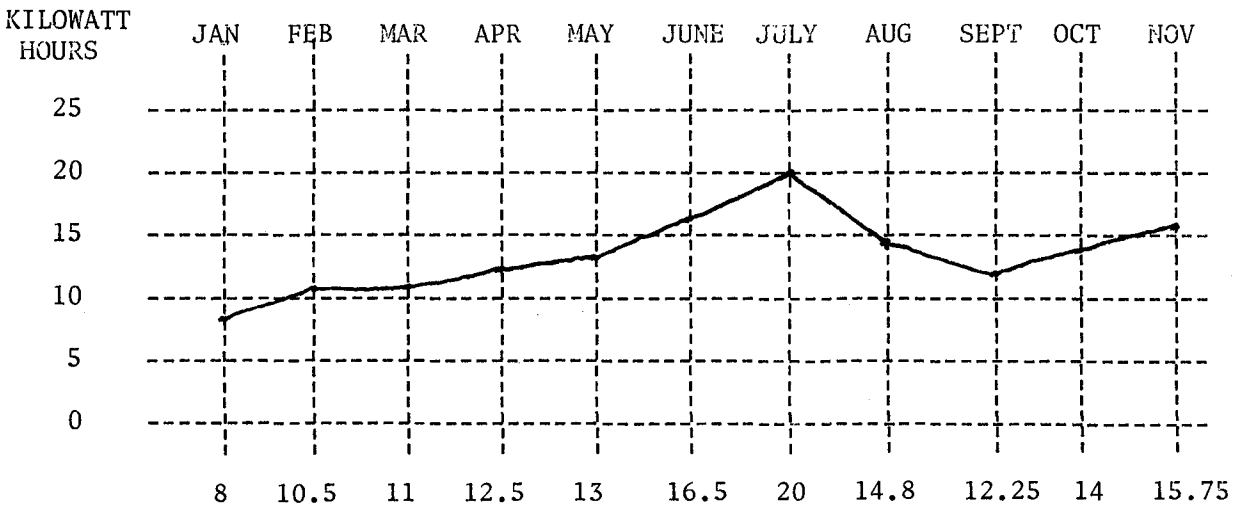
The few residents of North Santa Rosa with whom Bahr talked about electricity were upset about their electric bills and unsure where to lay the blame. The most commonly blamed appliance was the TV set, perhaps because a running TV set is so spectacular that it seems it ought to take a lot of power. In fact a small black-and-white set uses only about 50 watts and a medium-size color one uses only 150: both are in the "light bulb range." The real culprits are the furnace, water heater, and stove -- what we may call the third generation of Papago electric

appliances, more complex to install than a cooler and generally lacking in the houses Papago families build and equip for themselves.

Schuchulik and Other Villages

Figure 5-2 gives the average village photovoltaic electricity consumption per day per month in Schuchulik. (The figures were provided to us as bar graphs on a per day basis; the reader can make them comparable to the amounts in Figure 5-1 by multiplying times 30. We do not do that so as to avoid introducing a "roundabout derived" figure into print.) Again we see a July peak. The difference in level between the January and November ends of the graph probably is due to the newness of the system in January, just a month after it was dedicated and before all the parts of it were fully operational. When we examine specific consumption patterns below, it will become apparent that the first year of the Schuchulik system really was a breaking-in period, and that a proper study of the village's accomodation to the system should extend over at least two full years.

Figure 5-2. Average Daily Photovoltaic Electricity Consumption in Schuchulik, by Month



A first observation about the Schuchulik system is that the whole village gets less electricity than one house in North Santa Rosa: Schuchulik's maximum consumption, in July, was 20 kilowatt hours a day or in other words about 600 kilowatt hours a month, and there was not a month in the year when the average single household consumption of North Santa Rosa fell to that level. It would have taken four Schuchulik systems to meet the electric

needs of each North Santa Rosa family during the month of January!

Either Schuchulik is way too low to be a part of the Papago energy future, or North Santa Rosa is way too high. A look at the Ak Chin figures suggests that the latter is the case. Ak Chin's monthly average household consumption is slightly less than 150 kilowatt hours. Let us put that into per day terms -- five kilowatt hours. Let us now divide the peak period consumption at Schuchulik -- that is, the July consumption -- by the number of resident households in the village: 20 kilowatt hours per day divided by 12 households is something better than one-and-a-half kilowatt hours per household per day.

The argument at this point is that the Schuchulik system could provide that much electricity to its separate households, if getting electricity to households, a la conventional electric service, were its prime mission. Pursuing the argument we see that the per household servicing ability of the Schuchulik system differs from the per household demand at Ak Chin by something less than a factor of four. If Ak Chin's families could halve their consumption, and if a Schuchulik type photovoltaic system could double its service ability, the two levels would cross each other.

The above gap is large, but it is a far cry from the one that separates North Santa Rosa from Schuchulik, a factor of 53 for the month of January and of 26 on an annual household average basis. Let us continue with the Ak Chin/Schuchulik comparison. How realistic would it be to halve Ak Chin's consumption? A total of nine households were included in the Ak Chin calculations (eight more electrified households were excluded either because they clearly were not resident for all 11 months or because suspiciously low readings for certain months suggested only parttime residence), making a total of 99 monthly readings. Fully a third of those monthly readings were within the "target" consumption of 90 kilowatt hours per month or less. If a third of the readings hold up Ak Chin's side of the imaginary bargain, it is just possible that the other two thirds might come into line with an incentive such as free electricity and if non-electric means were available to do certain tasks.

And how hard would it be to double the photovoltaic production of a Schuchulik-style system? That is an engineering and economic question that the authors are not qualified to judge. Among the factors are:

1) The Schuchulik system produces d.c. electricity, so the first step from an Ak Chin consumer's point of view would be to convert that current to a.c. so some conventional "first generation" appliances could be plugged into it. Such a conversion would entail a loss in efficiency and equipment cost.

2) Schuchulik's d.c. electricity is stored in batteries. These batteries are necessary if the system is to be used at night, among other reasons. The batteries at Schuchulik store about 280 kilowatt hours of electricity even though the system is designed for a maximum daily "turnover" of only about 20

kilowatt hours. At times, (e.g., during the summer) the batteries are fully charged. At these times, unless there is a demand for power, the photovoltaic cells are actually shut down. Is it possible that a more liberal use of the batteries plus the use of a backup gas generator could hold up Schuchulik's side of the bargain in doubling the electricity released for use? We are not qualified to make that judgment.

We will close with this comment on Papago energy planning for the 1980s. The installed cost of the Schuchulik photovoltaic system was something more than $100,000, in other words about the cost of two of the large multi-bedroom houses built with tribal and federal funds at North Santa Rosa. The tribe probably anticipates seeing a large number of such houses built through the 1980s. If a certain number of those houses were built at half the cost by using TWEP labor and traditional house plans, the savings would pay for a-certain-number-divided-by-four Schuchulik-style photovoltaic systems. By cutting out the third generation electric appliances such houses would probably reach electricity consumption levels at least as low as Vaya Chin and San Simon. We cannot prophesy whether they would settle naturally to the level that we have tentatively selected as appropriate, three kilowatt hours per household per day.

Firewood and Propane (and Solar Water Heating)

The relation between firewood and propane in Schuchulik is that the latter is replacing the former in the functions of space heating, cooking, and water heating. Also barely on the near side of the horizon is the replacement of both energy sources for water heating with solar water heaters. We will take up this newest prospect later and commence now with the firewood to propane conversion. The reason for the conversion is convenience: one has to chop firewood twice at Schuchulik, first in the desert into big pieces for transport home, and then at home into "stove lengths" (ideally about the size of a lady's shoe) for burning. The Papago desert produces an excellent firewood in mesquite, but its twisty limbs are not easy to split and chop.

There is not much difference in the local cost of appliances for one or the other energy source, nor are wood- or gas-burning appliances much different in their maintenance requirements. There is one difference, that a family using propane must invest in a storage tank, while no special storage facilities are needed for firewood. On our information the cost of purchasing the energy source itself is the following: a Schuchulik family wholly dependent on purchased firewood pays about $3.50 per week in winter; a family wholly dependent on propane pays about $6.00 a week in winter. In short, propane is competitive. The $3.50 cost of the wood basically pays somebody else to chop it in the desert and transport it to one's house. The roughly $2.50 saving in firewood over propane is not much pay for the estimated two hours of additional fine chopping that firewood requires (per week) which propane doesn't. The fine chopping, at about $1.25 an hour, is the convenience factor.

In BTU terms, again roughly, the week's ration of mesquite firewood yields about seven million BTU's, the week's ration of propane yields about seven hundred thousand. (We are figuring 21,000,000 BTU's for a cord of mesquite firewood with a household consumption of a third of a cord per week; and 100,000 BTU's for a gallon of propane with a consumption of a gallon a day. These consumption estimates are in line with our information from Schuchulik, but "for safety" one might wish to double the figure for propane consumption, thus raising the "wage" for fine chopping to $2.50 per hour, and changing the heat ratio of the firewood and propane rations from ten-to-one to five-to-one.) We conclude that firewood makes more heat than propane in everyday Papago life, a conclusion that is in line with the following everyday experience: a wood stove when burning makes the whole room or even house warm, but a gas stove doesn't. And we might add that much of the heat in the wood stoves used at Schuchulik, goes up the stovepipe. (The gas space heaters used at Schuchulik presumably get more usable heat from their BTU's by operating via convection rather than radiation as in the case of wood stoves.)

The great majority of Schuchulik households use a combination of wood and gas, and their combination varies seasonally. Table 5-1 gives the breakdown for the functions we are interested in.

Table 5-1. Numbers of Households Using Wood and Propane in Schuchulik

A. COOKING

	Wood Only	Both	Propane Only
WINTER	4	5	2
SUMMER	7	1	3

B. HEATING

	Wood Only	Both	Propane Only
WINTER	2	4	6
SUMMER	-	-	-

C. WATER HEATING

	Wood Only	Both	Propane Only
WINTER	7	-	4
SUMMER	7	-	4

These figures are for the summer of 1979 and the winter of 1979-80. Slighly different breakdowns were given in an earlier report (February, 1979) but the present ones are felt to be essentially correct for the entire study period. (The difference was in the number of "boths" in various categories.)

To understand Papago heating and cooking practices, one must start with the principles 1) that it is desirable to have heat in the house in winter and out of the house in summer, and 2) that it is desirable to be inside a fire-heated house in winter and to be outside a sun-heated house in summer. Most households have a kitchen inside a main house, but most also have at least rudimentary cooking facilities outside. One Schuchulik house has its main cooking are outside under a watto adjoining the house kitchen; in this case the kitchen is not a cooking area at all, but a place to eat, to store dishes and groceries, etc. This "minority" practice in Schuchulik (one other house has a slightly similar arrangement) makes good sense for the hot season when both people and cooking fires are inclined to be outside. The "majority" practice in Schuchulik, especially if wood is used for cooking, makes good sense for the cold season.

The outside cooking fuel is always wood. There are a number of reasons for this. People like to cook with wood outside; certain things, especially tortillas, are more successfully cooked on wood-burning facilities than on gas ones; and it would be difficult and would look silly to set a gas stove outside. The inside cooking fuel may be wood or gas. Counterbalancing the convenience advantage of gas (see above) there are seasonal comfort factors for and against its use: gas is better for inside cooking in summer because it releases less heat into the room, and it is worse than wood for the same reason in winter.

Only one family has both a gas and a wood-burning cookstove in its kitchen. Several families supplement gas cookstoves with gas space heaters or furnaces for winter use, which is of course the standard American practice, whatever the energy source, of having a "furnace" as distinct from a "stove." Other families with gas cookstoves bring burning coals into the house on winter evenings ("braziers"). On the reverse side, several families with wood cookstoves do a certain amount of summer cooking outside, and one family as previously noted has picked a basically summer adapted cooking plan with no inside stove but with its main cooking facility outside. (This family uses a brazier to heat the house in winter.)

We conclude that there is no one best way to solve the winter/summer, gas/wood equation. The most elegant and least costly way is the traditional one with no gas at all and with separate wood-burning facilities inside and out. What has weaned people from that way, we think, is the competitive price and greater convenience of gas. We would add that the recent government-built houses in the village make no provisions for inside wood-burning appliances, and nobody has yet converted to such appliances. Each family in such a house uses some firewood outside, however, especially for summer cooking.

In Schuchulik there are two levels of provisioning for both energy sources. The high level of wood provisioning is by the pickup truck load. This involves a drive far enough from the village to get abundant supplies of dry (dead) mesquite wood. People prefer not to cut green wood because it is more work and must be left to dry for two or three weeks after cutting. Rather one looks for stands of mesquite trees with considerable dead wood among them, ideally stands of trees that have not recently been "harvested" for firewood. A pickup truck load (= a cord by our reckoning, ideally a 4 x 4 x 8 foot load) sells for $10.00.

The low level of wood provisioning is to make short forays to the outskirts of the village with a wheel barrow, sedan, or station wagon. Such trips are good only for a few days' supply and are commonly used to supplement a household that also uses gas.

On the gas side, the high level of provisioning is via 100-200 gallon tanks that are filled by a propane truck on its monthly or bimonthly rounds through the reservation. The trucks come from Gila Bend or Casa Grande. People using this method need roughly 100 gallon resupplies roughly every two-and-a-half months. They pay cash at the rate of 75 to 80 cents a gallon (April 1980).

The low level of gas supply is by weekly or more frequent fillings of five to 10 gallon tanks that people themselves detach and transport to the Y. The rate per gallon is about the same, only it takes less cash each time.

In general, households heavily dependent on propane use the high level or provisioning, and the same is true of those heavily dependent on wood. Yet even those families with large tanks and "all gas" inside appliances (stove, space heater, water heater), sometimes count on wood -- if they run out of gas, for example, or can't pay for it when the truck comes. They either cook outside or eat with another family.

We turn finally to water heating. The "wood" method is simply by heating water on a stove. Hot water is a much needed item for baths, dish washing, and clothes washing. Several people in the village have expressed interest in having a shower added to the Domestic Services Building (it has hot water for the washing machine and for a wash basin). Such people sometimes go all the way to Ajo in search of a hot shower.

The four government-built houses in the village have gas water heaters. A fifth government-built house, not yet occupied at the end of the study period, has a solar hot water heater, as does the domestic services building. It should go without saying that solar hot water heaters are a "natural" for the next decade of Papago energy planning. Water heaters are among the third generation electric appliances contributing to the high consumption of North Santa Rosa, and their time has come.

Returning to the particulars of Schuchulik, water heating is the one heating function that wood cannot accomodate in a modern house. When a HIP house family is forced back onto wood for whatever reason, they are simply

out of luck when it comes to hot water. Food they can cook outside, space heating they can do without or accomplish with braziers, but no one wants to carry buckets of outside heated hot water into the bathtub as part of getting ready to go to town or to a dance.

Solar technology advocates should understand that Papagos already use solar energy to heat bath water in the summer. Most Schuchulik houses have outside "shower rooms" served by shallow pipes or garden hoses which provide a very satisfactory bath on hot summer evenings. The effect is rather the opposite of a Finnish sauna: one stands in warm outside air under a stream of tepid water, with the memory of a long hot day behind one and the thought of a cool evening ahead. Thus, the adoption of solar water heaters will not do "everything" for Papagos, but like all things will only fit "somewhere."

Specifics of the System's Performance

It remains to look briefly at the monthly levels of use of certain parts of the Schuchulik system, namely the pump, lights and washing machine. Chapter 7 contains information on how the system worked in the eyes of the villagers. Here, we concentrate on the meter readings that were logged in the Electrical Equipment Building on an almost daily basis. We put that information in a planning framework.

We start with the village pump whose switch from diesel to electric power did not, to our knowledge, alter the villager's habits on water use. The only change was that they were no longer expected to pay a monthly contribution to support those habits. Figure 5-3 graphs the number of gallons pumped through the eleven-month period and Figure 5-4 graphs the number of kilowatt hours per day per month expended in pumping. For comparison, Figure 5-5 gives the kilowatt hours per month charged against the pump at the neighboring village of San Simon. (We have no pump data from other villages.)

The major finding from the figures is a not unexpected July peak in water consumption. We cannot explain for certain why there should be a still higher April peak at San Simon, and minor ones in May, September, and November at Schuchulik. We understand that there was a leak in the water system in May at Schuchulik and there were large fiestas in the village in May and November. We have no similar information for San Simon and no record of a fiesta there in April, but would imagine that fiestas with their hundreds of guests coming to a village, could have a significant effect on village water consumption.

Taking an average Schuchulik winter population of fifty and a summer one of seventy, and discounting the cattle that come to drink at the village trough, we find a per person water consumption of from 22 gallons a day in January to 85 gallons in July -- modest figures on the whole. It is easy to see how an influx of fiesta guests with a raised level of cooking, dishwashing and shower taking could make a graph bulge, even if the calculated effect is spread over a month.

Figure 5-3. Average Total Daily Water Consumption
In Schuchulik by Month

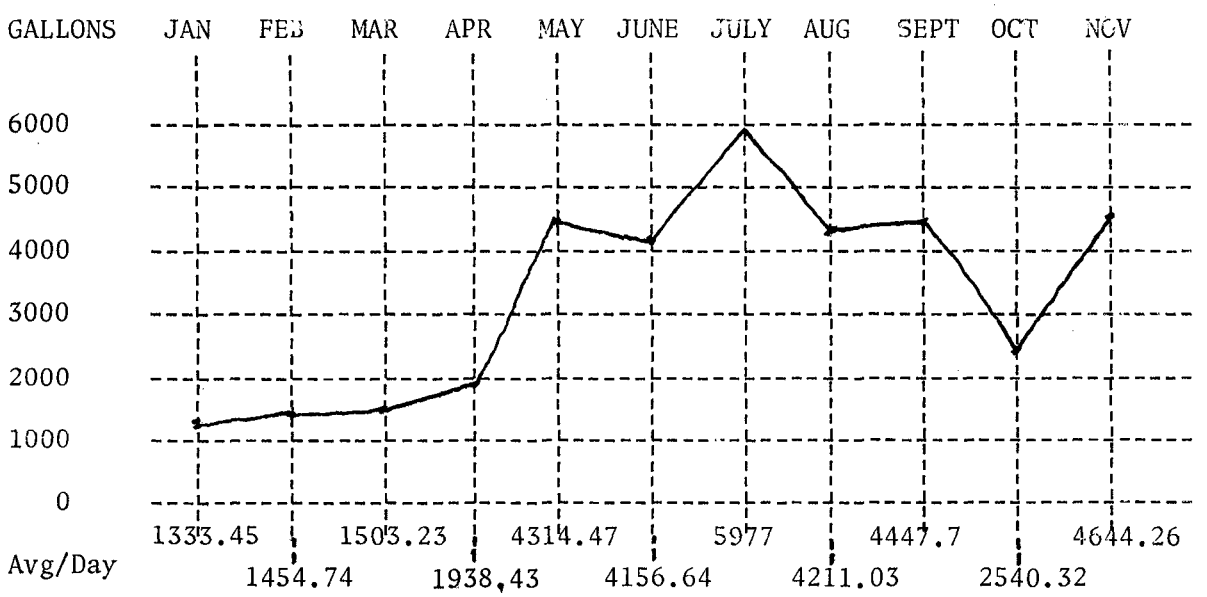


Figure 5-4.Kilowatt Hours Per Day (Per Month) To Operate Schuchulik Pump

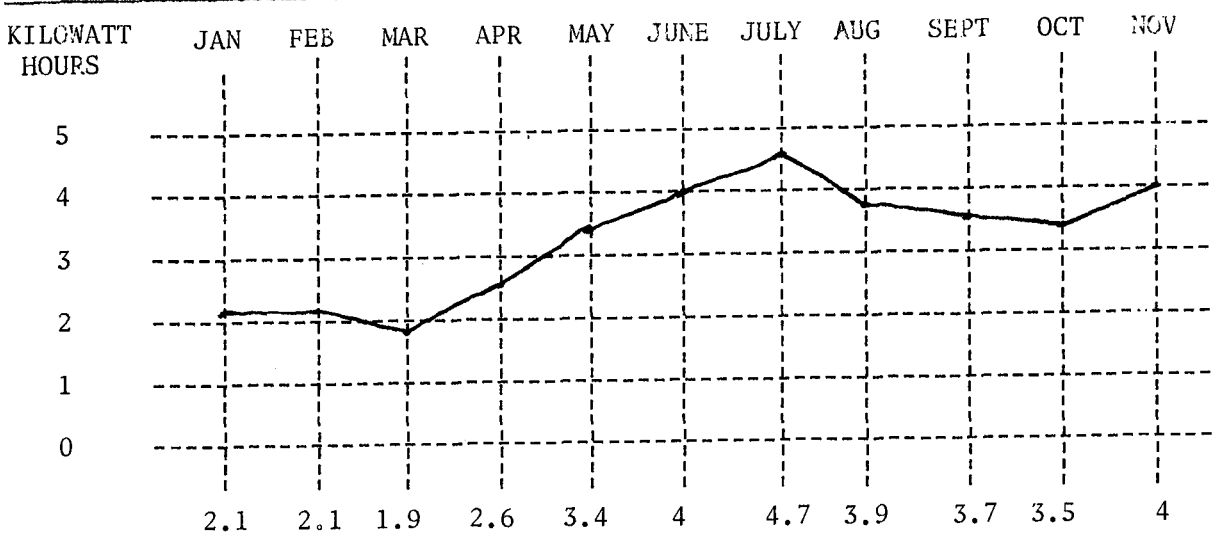


Figure 5-5. Kilowatt Hours Per Month to Operate San Simon Pump

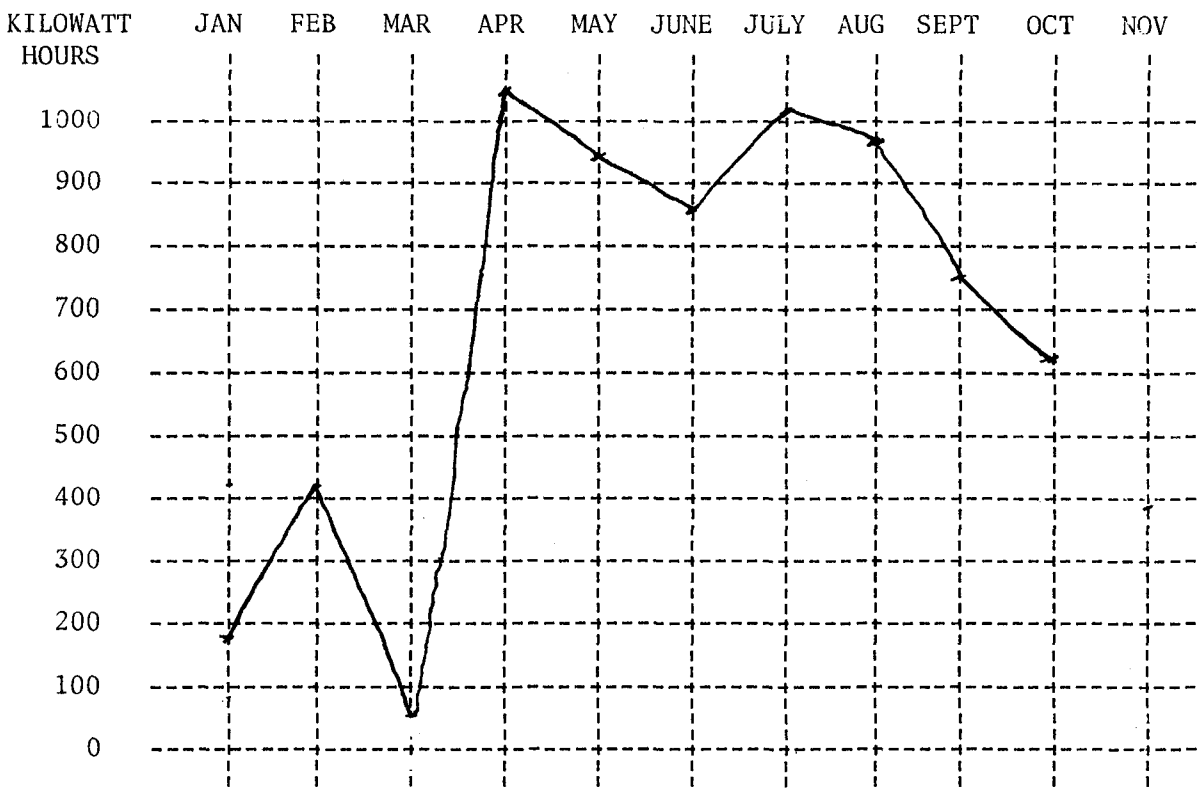
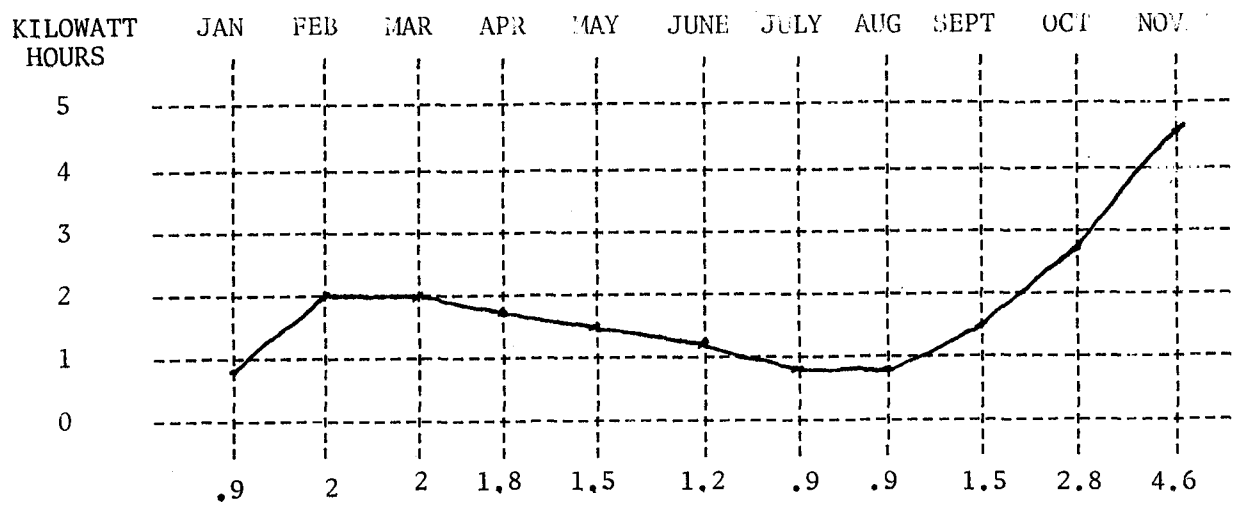


Figure 5-6. Schuchulik's Lights
(kw hr/day/month)



A further puzzle on the pump data concerns inconsistencies between the record of gallons pumped and the record of kilowatt hours used by Schuchulik's pump. Readings from the water meter are suspect for the months of January through April and the month of October due to equipment malfunction. Readings for these months appear to be about half of the actual expected consumption based on ampere-hour readings.

In any event, what we deem significant about the water system is that water use peaks in July (and there was no fiesta in that month), and at peak use about 4.5 kilowatt hours per day were needed to power the system. Those 4.5 kilowatt hours represent about a quarter of all the electricity produced each day during that month.

Turning now to the light system, we have a first and welcome example of a consumption graph that slumps rather than peaks in the long hot days of summer (Figure 5-6). The graph is also a clear indication of how the Schuchulik system was "catching on" through its first year -- the January end of the graph in no way matches the November (and by inference, December) end. It is safe to say that the village was getting into the swing of electric light use by the fall of 1979. In November roughly a quarter of the system's daily capacity (4.6 kilowatt hours) was devoted to lighting the village. (It so happened that the lights were often "shed" from the system in late November and December due to the low state of charge of the batteries. The result was that every family had to return to kerosine lighting much to its chagrin. This low state of charge was not due to overconsumption in the village, but to an unanticipated shut-down of the photovoltaic cells.)

It is felt that the smooth upward curve in light use through the fall will be a regular phenomenon, and that the low light use in summer will also be regular. In other words, the village was in a stable seasonal rhythm of light use by late spring. If so, then the graph of the light use is almost a perfect complement for the graph of the pump. Only the alleged "fiesta bulges" produce a double high demand on the system.

It is fair to say that those two aspects of the Schuchulik system worked better than any others during the first year. They were the two most automatic parts of the system, that is, their use did not require active manipulation by the users. We turn now to the washing machine which stood at the opposite end of the continuum because its success depended on people's active use. Figure 5-7 gives average hourly use per day per month. Again we see a July peak, of slightly more than three hours per day (= about one kilowatt hour on a quarter horsepower 312 watt motor). Because the machine was periodically out of service (an effort was made to factor out those periods from the figures given in Figure 5-7), and people reported that they often did not know whether it was working or not, and because virtually every family did clothes washings at Ajo laundromats throughout the study period, we cannot say that the village washing machine found its level or proved itself during the system's first year. (In the original sizing of the system, it was assumed that the washing machine would be used up to twelve hours per day.)

The washing machine, refrigerators, and sewing machine are the most problematic parts of the system. In our judgment none of them became stable factors of village life during their first year, partly because of breakdowns and partly because of sheer newness. Thus it is premature to discuss their energy requirements as part of a stable system. Figure 5-8 gives the combined per day per month kilowatt hour consumption for all three components of the system.

Figure 5-7. Washing Machine (Average Hours Per Day Per Month)

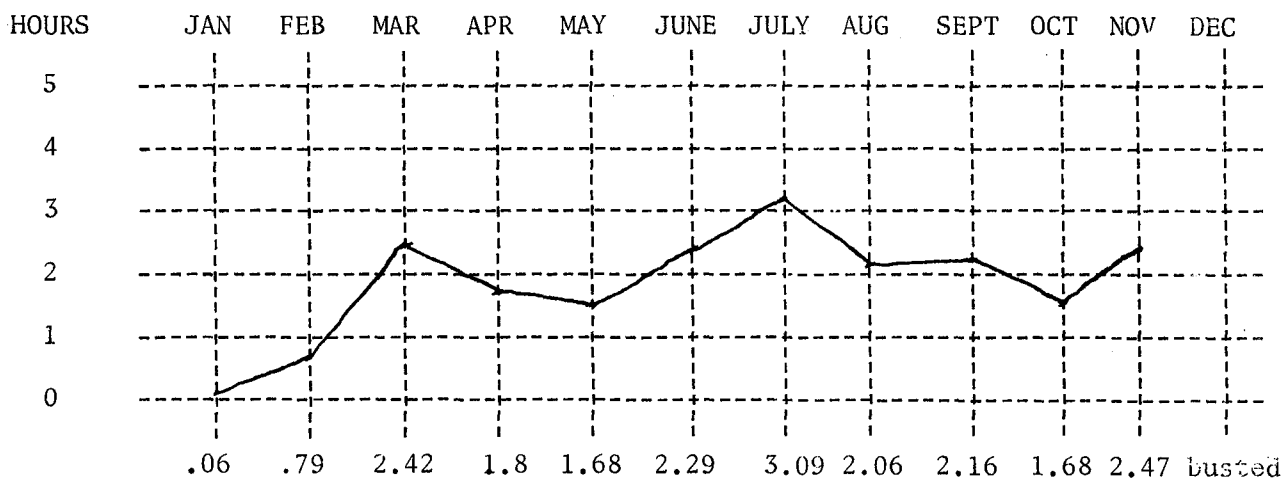
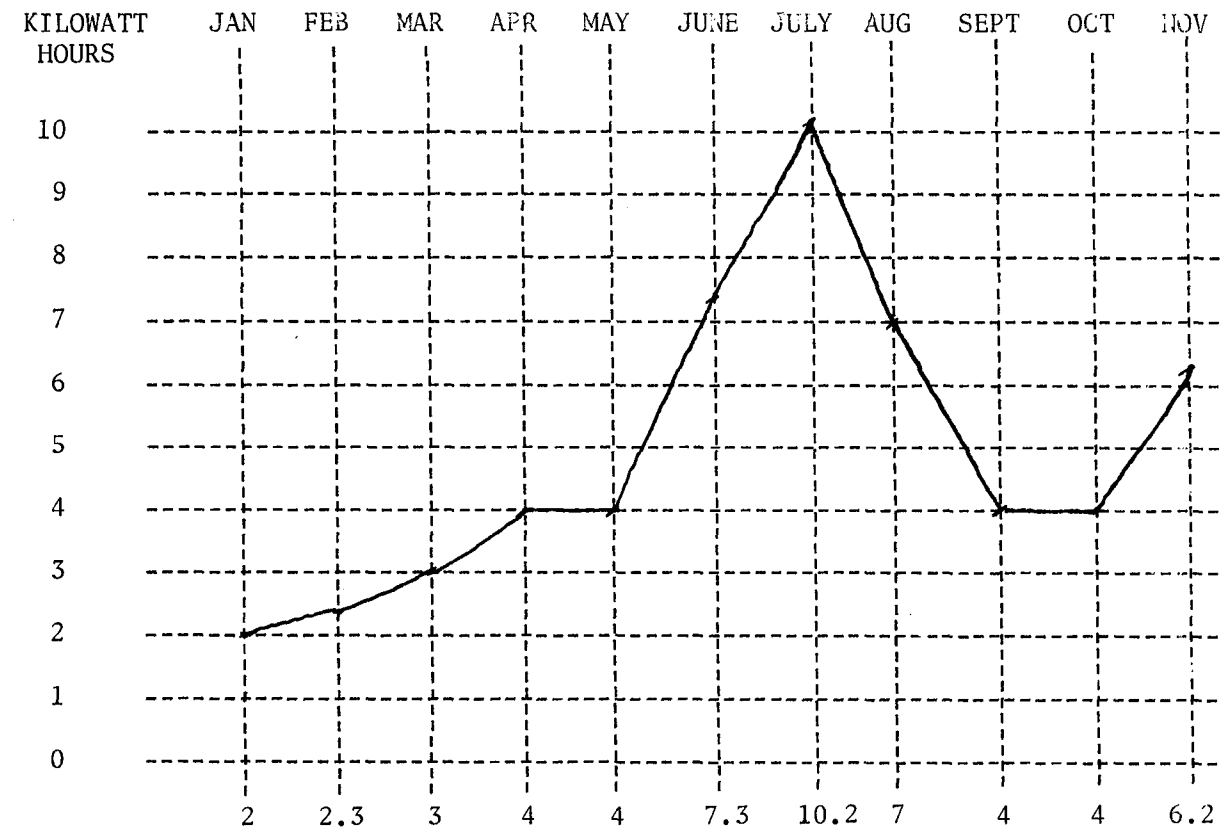


Figure 5-8. Average Per Day Per Month Power Use Of Washing Machine, Refrigerators, and Sewing Machine



CHAPTER 6

USE OF THE SYSTEM

The focus of this chapter is the solar electricity experiment as perceived and used by the people of Schuchulik. We will take up each of the activities affected by the system in turn: clothes washing, sewing, cool food storage, house lighting, and water pumping. We take them in that order so as to put first the activities involving the greatest changes in direct and indirect work (see below). It so happens that those activities centered on appliances placed in the domestic services building and they pertained primarily to women. Following the sequential discussion we will consider the villagers' reaction to the system as a whole.

In Chapter 4 a distinction was made between direct and indirect work. By direct work we mean the muscle work required of a person in using one of the new appliances. We would compare this with the amount of direct work required to do the same job prior to the installation of the new appliance. By indirect work we mean transportation to and from the work place and user maintenance (including fueling) of the tool or appliance used for a given job. Our rough and ready estimates on these matters for the "average user" (not the headman or a specialist repairman) are given in Table 6-1 in terms of high, medium, and low levels of work for each activity done before the system was installed and as done with the system's appliances.

The judgments on direct work levels rest on a combination of two factors, first the "heaviness" of a job, and second the amount of attentiveness involved in doing it. When both factors are high, as in washing clothes by hand, we rate the job as "high;" when just one level is high, as in sewing by hand or with a machine, we rate the job as "medium;" when neither is "high" we rate the job as "low." We consider this to be a rough and ready, not a refined way of discussing levels of direct work, yet it refers to something very real, namely that it is one thing to "use" electric lights by flicking a switch and another thing to choose between a wringer washing machine and a laundromat's automatic washer.

The judgments on indirect work levels refer primarily to travel but sometimes to fuel. When a trip to Ajo was involved, we rank the job as high. A trip to the Domestic Services Building is ranked medium, a job done at home is ranked low. The "fueling" aspects we figured in were ice for ice chests and kerosine for lamps -- the first warranting a "high" score for indirect work, the second a "medium." Other significant aspects of indirect work, such as gaining information about the working state of an appliance and questions of maintenance, are discussed below. We exclude them from the table because they were unsettled matters from the users' point of view and we feel they are best discussed separately. Thus, we do not offer Table 6-1 as a summation of the whole story of the work impact of the appliances, but only as an instructive starting point.

Table 6-1. Direct and Indirect Work
In Shifting to New Appliances

LEVELS OF WORK	BEFORE ELECTRIC SYSTEM		WITH SYSTEM APPLIANCES	
	Direct Work	Indirect Work	Direct Work	Indirect Work
HIGH	Clothes wash (hand)	Clothes wash (laundromat) Cool food storage (ice chest)		
MEDIUM	Sewing (hand, treadle)	House lighting (lamp)	Clothes wash (wringer) Sewing (elec.)	Clothes wash (DSB) Sewing (DSB) Cool food storage (DSB)
LOW	Cool food storage (ice chest) House lighting (lamp) Water pump (diesel) Clothes wash (laundromat)	Water pump (diesel) Clothes wash (hand) Sewing (hand, treadle)	Cool food storage (refrig.) House lighting (elec.) Water pump (elec.)	House lighting Water pump

A final comment is in order on the relation between the table and the discussion to follow. Many of the old ways were retained after the system was installed. Only water pumping was completely shifted from a non-electric to an electric means. House lighting was almost totally shifted, and the other activities are best understood as impacted by a new option wherein the "old methods" were still resorted to in significant degree. Much of the following discussion is to explain the varying degrees of transfer or shift onto the new appliances.

Solar Electricity and Women's Work

During the study period 14 families kept their primary residence in Schuchulik, living there more or less on a full-time basis. Thirteen of them had at least one adult woman with primary responsibility for cooking, cleaning, child care, and other household chores. She did this sometimes with the assistance of other household members, sometimes by herself. Beyond the fact that certain household tasks fell primarily to each of 14 women, there were no instances of any two women handling those responsibilities in exactly the same way. Each organized her time as best she could, making sure to leave time for relaxation to complement her work. These 14 women were the most affected by the utilities in the Domestic Services Building and it was up to them to decide the way in which the appliances were to be used.

When a woman was ill, aging, or away from home, her sisters or daughters living nearby took over many of her responsibilities including cooking, laundry, and house cleaning. Household reponsibilities were also shared simply as a matter of convenience. The jobs were not always taken over by the same person but were sometimes shared among several women. Men also assisted in household chores when necessary as there was no stigma against men cooking or helping clean and wash clothes occasionally. Of all the tasks that a Schuchulik woman performed, mending was the least likely to be performed by anyone else or shared between families.

Daily scheduling is important in understanding the patterns of appliance use that developed. Meal preparation and outside employment were the most rigorously scheduled activities regularly engaged in by the village women. Other chores were allocated to convenient time slots around these activities. A woman's scheduling of her own time was important in how she used the appliances in the Domestic Services Building. This was less true for the refrigerators, which required little direct work for their use, as it was for the other two appliances, the washer and the sewing machine. Time allocation became even more important for the two "high direct work" appliances because only one person could use either appliance at a time. The users had to coordinate their schedules with each other as well as with their own families. The time factor while important to all, was most crucial for three of the fourteen women who held full-time jobs outside of the village. They were absent from the village for most of the daylight hours, during which time they were either at work or traveling to and from work. They were left with only early mornings, evenings, and weekends to take care of household chores, relax, and participate in social activities.

Health problems interfered with complete use of the Domestic Services Building and its appliances for five other Schuchulik women. Two of the five suffered from leg injuries which prevented them from traveling the distance required. Another suffered from unpredictable seizures and tried to minimize the amount of time spent away from home. Age and past injuries limited activities for two additional women. This left six women as the most likely regular users of the appliances. This number was further reduced to five potential regular users, as one resident woman preferred, on principle, to perform her domestic chores at home or in Ajo and made no use of the Domestic Services Building whatsoever. Three of the remaining five women made the most extensive use of both the washer and the sewing machine. These three prime users were all strong and healthy and spent most of their time in the village.

In sum, a very limited pattern of usage developed for the appliances in the Domestic Services Building. Only about one-fifth of the adult women of the village made any significant use of the two "direct activity" appliances. Use of the refrigerators was even more restricted. While some of the reasons for this limited use pattern have already been discussed, a better understanding may be had by considering each of the appliances individually.

Washing Machine

By the end of the study period the washing machine was one of the most appreciated aspects of NASA's experiment for some Schuchulik women. They had even begun to refer to the Domestic Services Building as the "Laundromat." Why then, was the use pattern restricted to only one-fifth of the women? To answer this question we will look first at the recent history of Schuchulik's laundry habits and second, at the details of the use pattern that developed.

Prior to the introduction of the electric washer, Schuchulik residents had two alternatives for doing laundry. One alternative was to wash by hand at home using a tub and washboard. The other alternative was to drive about 20 miles to a laundromat at Ajo and spent on the average, three dollars for machine use in addition to the cost of gas for the trip. The frequency of Ajo laundry trips varied with the size of the family and the number of regular trips made to Ajo for other reasons. On the low end of the scale, one household made laundry trips once every two weeks. At the other end, a family reported doing laundry in Ajo four times a week. Only two resident households initially opted to wash most or all of their laundry at home by hand, though many used this method for an occasional supplementary washing. Eleven full-time resident households relied almost exclusively on Ajo's laundromat. The most important factors influencing a family's choice were access to transportation and the necessary cash. Those who had transportation and felt they could afford it chose the more time-efficient and easier method of using the distant laundromat.

The washer in the Domestic Services Building performs exactly the same function as hand washing and laundromat washing. The machine is not fully automatic, but has a wringer for partial drying (see Figure 1-2). The system was planned so it could be used up to 12 hours each day, at which rate it could do 168 loads a week. This capacity is theoretically more than sufficient to handle all of Schuchulik's laundry needs which ranged from about 60 to about 80 loads per week. A consideration of the pros and cons of the changes required by the electric washer sets the stage for the understanding of the actual changes that took place in the laundry habits.

For those who previously washed by hand, the village washer involved less direct work, but for those accustomed to the fully automatic machines in Ajo, it required more. The laundromat's fully automatic machines wring by spin drying and need no help from the user. Automatic dryers were available in the laundromat and offered another convenience not found in the village. Hanging the wash was an additional direct activity required of women who converted from the laundromat.

In terms of indirect activity, use of the village washer requires an increase for the home washers and a decrease for Ajo washers (see Table 6-1). All who use the new machine must transport their laundry to the domestic services building. This they do either by car or on foot. Those who walk usually enlist the assistance of others for help in carrying or use some sort of cart. For those who usually wash at home the increase in indirect activity is made worthwhile by the relative time efficiency of the electric washer.

The indirect work involved in transporting laundry is considerably decreased for Ajo washers by using the village machine. However, as most of the Ajo washers do more than four loads of laundry each trip, they find the village machine much less time efficient than the laundromat even when driving time is taken into account. Only one load can be done at a time in the village. Even so, the women who wash out of town welcome the opportunity to avoid the cost and tedium of a laundry excursion to Ajo.

Between September, 1978 and February, 1980, both women who previously did most of their wash by hand at home came to rely almost exclusively on the washing machine in the Domestic Services Building. This change-over in laundry habits occurred for only one of the women who previously relied mainly on the Ajo laundromat. On the other hand, all but one of the adult women in the village had at least tried the new washer but, for various reasons, 10 of those women had used it relatively little. Two of the 10 were prohibited from using the machine regularly by physical handicaps. As their conditions are corrected over time, they may get around more and start using the Domestic Services Building on their own. The other eight would make much more use of the new washer if certain problems that developed were ironed out.

As far as we know the washing machine operated well for the first seven months after its installation in December, 1978. During its peak use period in July, 1979, as many as 10 village families reported doing at least some of their washing in the Domestic Services Building on a regular basis. Use of the machine tapered off in the early fall largely because of mechanical problems and seemed to have stabilized at the end of the study period at a much lower level with only three women out of 14 washing regularly on the new machine. They washed on the average about 10 loads a week or 2/3 loads per person per week. This figure is only six per cent of the machine's theoretical 168 loads per week capacity and about a quarter of the total village laundry needs at that time.

While the washer was never fully out of commission during our study, there were times when it was diagnosed by the villagers as "broken." The wringer has proven to be the most problematic part of the machine. People found out about the working status of the washer primarily through rumor and observation, and secondarily through trial and error and direct notification. One of the eleven women not using the washer regularly at the end of the study relied solely on rumor for information because she could not observe the Domestic Services Building from her home. She was never notified that the machine was usable and had no reason to try it herself since her inquiries brought forth the response that the washer was still "broken." The woman claims she uses the new washer "when she knows it's working."

The root of the problem lay in an incompatibility between the wringer design and the types of washloads that occasionally had to be done. In September, 1979, soon after people began to wash blankets and quilts in preparation for the coming cold weather, the word was spread that the washer was broken. As time passed a few venturesome souls found ways to use the machine in spite of the problems. Eventually others took notice and began using the machine. During the winter months our research team

also served as a vehicle of information on the status of the washer. When asked, we told the people that the machine worked, but required a little more effort on the part of the user. When a clothesline was provided next to the Domestic Services Building, the working status of the washing machine became even more obvious. However, it was not until February 1980, almost five months after the initial information was spread, that women without a view of the building became aware that the machine was not totally out of order. It is quite likely that the cold weather contributed to the lack of effort on their part to seek out information through trial and error or contacting the headman.

The broken wringer was cited by three women as the main reason for not using the village washing machine. In order for a family to do all of its laundry on the village machine, the washer must be able to handle all cloth goods that need periodic cleaning. This includes the heavy quilts and blankets used in cold weather. The present machine's wringer is not sturdy enough for the heavier tasks and has been broken when people try to use it to wring their bulky laundry. Another problem with the wringer concerned the safety pedal that powers it. The pedal became less and less functional over time, and finally died. For those two reasons, all subsequent wringing was done by hand, a method which was more time consuming and strenuous than if the wringer was working properly. Two village women found the hand wringing too difficult because of slight physical handicaps. Another felt that wringing by hand was not worth the time or trouble involved.

The washing machine would receive more use if the wringer problems were corrected. If the present wringer cannot be made to work, it could be replaced with a hand crank or a heavy duty wringer might be made available for bulky laundry. Such modifications would increase the utility of the appliance.

Once the wringer difficulty is solved another problem comes to the fore in preventing full use of the washer. The working women of Schuchulik had difficulty finding the village washer free at the same time they were free to do their laundry. The people who already used the machine regularly had developed different use patterns according to their own preferences. Some liked to do a little bit of laundry at a time, for example one load every other day, but others preferred to do an entire week's laundry at once, tying up the washer for several hours at a time. At least six of the 12 hours theoretically available to village women for washing on the new machine were taken up by other activities such as food preparation, meals, and house cleaning. The prime times for doing wash were between breakfast and lunch and also between lunch and supper. It was rare for wash to be done after supper in the village as that was a time for relaxation. While the women's schedules did not overlap completely, the theoretical capacity of the washer was considerably reduced by the scheduling factor, possibly by as much as one-half. Even so, the machine would still handle the current laundry needs of the village but for the fact that some women's washing schedules were more restricted than others. Working women were largely limited to the two weekend days for washing and competed with each other, in addition to the rest of the villagers, for time on the machine. Women with large loads and limited time simply could not wait all day, nor could

they spend an entire day doing laundry. Several women of Schuchulik have suggested that another washer would be a most welcome addition to the present set-up. An alternative solution would be to schedule each woman's time on the washing machine.

Before moving to the other appliances, another factor which limited the use of the washer should be mentioned, namely, weather. As cold weather approached in late 1979, it became necessary to disconnect the solar water heater in the Domestic Services Building. A protective heater, powered by the solar electric system, malfunctioned and exposed the solar heater to the danger of nighttime freezes. Those who felt they needed hot water for their wash, or had an aversion to hand wringing cold laundry in cold weather, switched back to the Ajo laundromat. A more satisfactory protective heater, subsequently installed, will enhance the year-round use of the village washer. The only remaining deterrent to washing in the village would be rain, which prevents people from hanging wash out to dry. Several consecutive days of rain can drive even the most reluctant to Ajo's laundromat.

In sum, the use of the washing machine was limited due to several problems. None of the problems is unsolveable. The manner in which each problem is handled will contribute to the eventual success or failure of this aspect of the experiment. In several instances, communication problems interfered with the use of the washer. People learned about the functional status of the washing machine indirectly in most cases, and received only incomplete information as to the details and reasons for malfunctions. Furthermore, much of the maintenance and repair of the washer was in the hands of outsiders. These communication and maintenance problems ramify to effect the use of almost all of the new appliances and will receive more extensive treatment below.

Sewing Machine

Sewing is exclusively a woman's activity in Schuchulik; it is an activity engaged in by women as individuals and requires no assistance from others. Each adult woman performs the necessary mending for her immediate family, aside from which she has considerable freedom in deciding what else, if anything, she will sew. No one in the village sews for commercial profit. Because of the individual nature of the activity and the relative lack of involvement either of the family or outsiders we will concern ourselves here with the adult women of Schuchulik as individuals and not with the households they represent.

A good deal of the sewing that was done in Schuchulik both before and after the introduction of the community sewing machine was done by hand. Some women, one in particular, perennially made quilts of patches; others did embroidery; and some crocheted. All mended by hand occasionally. These sewing tasks, like basket making, could be done at home in a very relaxed atmosphere, often while visiting with friends, minding children, or watching television. Skilled machine seamstresses with their own treadle machines could sew in a similarly casual manner at home. Time was devoted to sewing between meals and, with the new electric lights, in the evenings when other work was done or could be set aside.

No one in Schuchulik was in the position of having to make their own clothes. The purchase of already made material goods provided a convenient alternative to sewing them, and most clothing and other cloth items were originally purchased. Prior to the introduction of the new sewing machine clothing was occasionally made on treadle machines by three of the village women who also used the treadle machines for their mending. Women without access to sewing machines made few items and did any mending necessary by hand. To our knowledge no one sought the use of sewing machines of friends and relatives outside the village. The introduction of the new sewing machine slightly increased the amount of sewing done in the village. Several types of behavior changes were involved in the adoption of the new machine including skill development, transportation to the domestic services building, and social interaction.

Sewing on a machine is an activity that requires a good deal of skill and patience. Free time and some degree of good health are necessary but not sufficient characteristics of a seamstress. There must also be a strong desire to sew. Without this desire, few people will suffer through the frustrations involved in developing their sewing skills. Those who choose to develop their skills gain an additional benefit in being able to save money on clothing, though few people without the predisposing quality of patience are likely to learn to sew for the sole reason of saving money. In terms of their inclinations toward sewing on a machine, Schuchulik's women fell into four categories at the installation of the electric system: 1) three women had access to treadle machines; 2) three had sewing machine skills, but no equipment; 3) two expressed the desire to acquire such skills; and 4) six had little interest in using a sewing machine at all.

The use of the new sewing machine also required the transfer of a previously private activity to a communal building. The seamstress physically transports everything she will need, including material, pins, scissors, and thread, across the village to sew. For a few months after the installation of the system attempts were made to keep a chair handy with the sewing machine. The chair was so frequently borrowed to accomodate guests at various households that the early attempts were soon abandoned, leaving the seamstress with an additional and rather bulky item to add to her load. In spite of the distance and the load, sewing on the electric machine was still more efficient than sewing by hand. However, women with access to treadle machines were less likely to make the extra effort involved in transporting a chair.

In addition to the physical transfer is the social transformation of a private household activity into a public one. The types of social interaction engaged in while sewing at home and sewing in the Domestic Services Building are quite different. Sewing at home allows a woman to entertain visitors, to keep track of children, and to monitor other household activities while doing productive work. Use of the communal sewing machine can be seen as either allowing or requiring a break from the normal routine of the household. Women who sew on the communal sewing machine work in relative solitude, temporarily removed from some of their other responsibilities. Very young children must be taken along while the older ones can be left behind. Seamstresses interact mainly with whomever else happened to be using the other solar appliances at the same time, usually not more than one or two people, if any.

Before the communal sewing machine was actually installed in the Domestic Services Building, eight of Schuchulik's fourteen women expressed an interest in using it. Three of the eight already had access to treadle machines, but looked forward to being able to increase their speed and stitch diversity with the new electric machine. The direct activity needed to run the electric sewing machine was only slightly less than that required for treadle machine sewing (see Table 6-1). Once the sewing machine was installed it became evident that some women were essentially precluded from regularly using the machine. The three working women of the village found the time requirements prohibitive of their making much use of the machine, though one of them did take time to make curtains for her house. Other necessary tasks usually kept these women from pursuing many optional domestic activities and their jobs kept them away from the village during week days when sewing and craft lessons were offered. Three other women were prevented from using the new machine because of the physical requirements of traveling to and sewing on it. Another woman has yet to use any of the appliances in the domestic services building for any reason.

To our knowledge the sewing machine was in good working order throughout the study period. Initially very little use was made of the machine even though a group demonstration was given on proper use. The more experienced seamstresses were the first to try the new machine. As of April, 1979, however, four months after the electrical system's installation, the only items that had actually been made on the machine were curtains for two houses. Several women had also used the new machine for a small amount of mending. At this time many women were still unsure about how to use the machine and were also unequipped to do so. Sewing supplies original provided soon became depleted. Hence, it was decided to provide each womanwith bobbins and thread. Names and addresses were taken so that a tribal extension worker could notify the women of craft classes planned for the Domestic Services Building.

Classes started in the fall of 1979. In the interim the use of the sewing machine tapered off. Apparently mending was the only sewing that was done during that period. Since that time, however, a class was held nearly every month and the use of the village sewing machine picked up. Each class was structured around a particular project and was attended by from three to six village women. One of the earliest projects introduced the women to the use of the sewing machine to make simple carrying bags. Later projects did not involve the use of the machine. One of the reasons for holding the classes was to provide an atmosphere where the women of the village could get together and possibly talk about their experiences using the solar appliances. As sewing on a machine is an activity that can be performed by only one woman at a time, there was a need to shift to other activities more amenable to group experience.

Many of Schuchulik's women were already quite sophisticated in their knowledge and use of the new appliances from experiences outside the village and previous use of gas generated electricity. These women and the extension worker were able to share their knowledge concerning the use of the appliances in an informal setting as issues arose. Thus, the

tribe's extension worker devised an ingenious low pressure setting for communication about the system to take place, both among the village women and between them and an outsider. Such good rapport developed between the extension worker and the women attending the classes that, as cold weather made the Domestic Services Building an unsuitable location, the crafts were taught in one of the village homes. Widespread attendance at the classes could help alleviate some of the communication problems to be discussed in a later section of this chapter. Full attendance, however, is probably unattainable. In regards to the use of the sewing machine, these craft classes made little impact. It was hoped that the women who attended the early sewing class would follow through and develop their skills on their own initiative.

Though the extension worker's lessons shifted away from using the sewing machine, another learning situation arose in the village in which the machine was frequently used. A Sister of the Catholic Church began to help some women become more confident in their sewing skills by assisting those interested in making a variety of more complicated clothing items. The women started on the projects under the Sister's guidance and were left to complete them on their own spare time. The Sister's lessons were attended by those women who felt the need and desire for assistance and could spare the time involved.

Most of the items sewn on the village machine since September, 1979, resulted directly from participation in classes offered by interested outsiders. Between September, 1979 and February, 1980, three women of the village made between them: five carrying bags, two robes, four nightgowns, and a blouse. Unlike the curtains made in the early months of our study, these items required less actual sewing time and more time for careful cutting and pinning. The sewing machine provided a quick mending service throughout the study, with the exception of the cold winter days. Cold weather mitigated against using the sewing machine at all as the domestic services building has no heater.

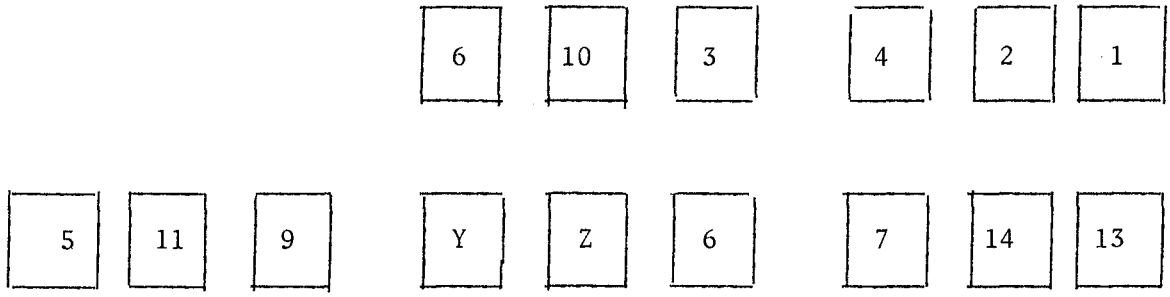
An interesting comparison can be made between our presentation of the history of the use of the sewing machine and the use time as recorded by the systems meters. Figure 6-2 shows the total hours per month of sewing machine use as metered in the Electrical Equipment Building. The graph gives the appearance of an innovation that didn't catch on, that is, it shows a peak in February soon after the system was established and a subsequent trailing off to near nothing. Average use across the graph is slightly less than half an hour per week, or about four minutes per day. We assume the small peak in September was due to the commencement of craft and sewing classes in that month, and the post-September decline is due to the shift of the craft classes to projects not involving the sewing machine and the onset of cold weather.

It may be that the February peak resulted from the early curtain making efforts which required a good deal of machine running time as compared to the more complicated items made in the fall. Whether the interest stimulated by the fall sewing lessons catches on in any significant way remains to be seen. So far, the curtains represent the only items made on any woman's own initiative.

Refrigerators

The use of the fifteen refrigerators in the Domestic Services Building falls mostly under the supervision of Schuchulik's adult women who are also the major cooks of the village. The fifteen refrigerators came to be divided among eleven resident families (Figure 6-2; 1-11) and the two non-resident families (Figure 6-2; Y and Z). When family Y is in the village it essentially contributes all of its food storage, preparation and procurement efforts to family 4. One resident and one non-resident family have no access to refrigerators. The resident family reports never having been issued a refrigerator. The non-resident gave up his refrigerator key to the village, knowing that he would have little use for a refrigerator. The key passed from the headman into the hands of a woman whose own refrigerator was out of order. At the end of this study this woman had access to two refrigerators as did another family that consisted of two previously separate familes temporarily combining cooking resources.

Figure 6-2. Refrigerator Ownership by Family*



* Families numbered as in Table 2-4, placement of refrigerators as installed in the domestic services building.

Of all the new appliances of the electrical system, the refrigerators had the least impact during our study. Largely because of repeated breakdowns, people grew to have little confidence in the reliability of the refrigerators and consciously minimized their use. This was not because people felt they didn't need refrigerators. Rather, the machine malfunctions were unpredictable and the Domestic Services Building so distant from the homes that problems could not be immediately detected. People simply preferred not to count on the refrigerators if they could avoid it.

In spite of the operational problems there is a generally positive attitude toward the refrigerators in Schuchulik. People look forward to the time when they can rely on the machines, sometimes with impatience. Apparently all of the refrigerators have received at least some use,

even those of the non-resident households. Eight women relied on their households' refrigerators rather heavily at various times. On this basis we can make some observations of the refrigerator use when functioning. We will then proceed to examine the use pattern that actually developed.

Families who cooked together on a daily basis tended to share refrigerator storage space. Those who cooked together only occasionally or only shared already prepared foods kept their refrigerator space separate in spite of close kinship ties. The refrigerators of non-resident families were not used when those families were away from the village.

In the past no food had been stored any great distance from the cooking area. When using an inside kitchen, food was usually kept in the same or an adjacent room. When cooking outside, stored food was to be had at a distance of no more than about fifty feet. As refrigeration is a passive activity in terms of human involvement, one of the greatest adjustments to the new refrigerators was the increased time and energy involved in travelling back and forth to the Domestic Services Building. The effort required was greatest for those living farthest away. Momentary forgetfullness of a single item in preparing food or sending it to storage cost a cook or her helpers repeated trips.

Three modes of transportation were commonly used to transport food to the refrigerators. The cooks sometimes walked and sometimes drove the distance themselves, but by far the most common method was to have children help out by doing the necessary running. Since refrigerator keys changed hands frequently, their use often became problematic and many were eventually lost. Two locks broke during our study. In the interim between lock and key replacements there was no mention of any food actually being stolen, though some attempts were made not to store pop in unlocked refrigerators for fear that children would drink it. Some people did, however, report the disappearance of ice cubes.

During the coldest winter months there was little need for the cooling capacity of the refrigerators. Most items in danger of spoiling could be kept cool enough in cool areas of a house or in tight storage containers, such as ice chests, outside. If extra cooling was needed ice in ice chests was often preferred to the refrigerators because of the distance factor and because the ice melted so slowly in the winter. The unreliability of the refrigerators probably compounded the tendency to use ice chests and air temperatures for cooling. Had larger freezer space been included in the refrigerator design the appliances would have received greater winter use. Meat and milk were the items most commonly mentioned as needing winter cooling. Without a good way to freeze quantities of meat, most people found the cool air sufficient for their cooling needs.

It is in the summer, when keeping an ice chest cool can run a family about $10.00 a week and uncooled perishables can spoil within a single day, that the people of Schuchulik feel the most need for refrigerators. The 4.7 cubic feet of the refrigerators can keep more food cool than most ice chests though it comes nowhere near the 15 cubic foot capacity of a

typical American household refrigerator. The refrigeration of half a watermelon takes up most of a refrigerator's cooling space, and watermelon is a favorite summer fruit in Schuchulik. The new refrigerators free their owners from the nuisance of trying to keep food from getting soggy as cooler ice melts. Without a refrigerator it is really an uphill battle to keep food cool, one that involves daily trips for ice, constant draining of ice chests, and serious attempts to minimize cooling needs. The refrigerators in the Domestic Services Building, when working, offer a considerable improvement in Schuchulik's summer food storage situation in spite of the distance. Those who continue to use ice chests more than double their previous cool storage resources and are also able to supplement ice purchasing trips with ice from their refrigerators' two ice trays, provided that they do not try to freeze anything else.

The summer of 1979 was a period of great frustration for many villagers as almost everyone's refrigerator went out of commission at least once and some as many as three times. Each time a refrigerator went out there was a wait of several weeks before it was repaired. Most families had food spoil because of the breakdowns. Even if the problem was discovered only a day after it happened it was often too late for such foods as meats, dairy products, and eggs because of the high summer temperatures.

The repeated refrigerator breakdowns eventually led NASA to call for design modifications in September, 1979. Refrigerators that ceased functioning after September were left unrepaired until the modifications could be put into effect. Thus, six refrigerators remained out of commission from September until March, 1980. Two of these belonged to non-resident families. Two others belonged to two resident families as their sole refrigerators and two more belonged to families with a working machine also assigned to them.

Thus, five of the eleven resident families with refrigerators stopped using them by September 1979. By November, two other resident families had stopped using their refrigerators almost completely. During December, 1979, and January 1980 four households used ice in ice chests for cooling. They purchased ice about twice a week at a cost of more more than $2.00 per week. Three households made some minor use of their refrigerators, such things as storage for holiday and fiesta foods. Four households reported using no additional cooling method whatsoever. Two of the non-functional refrigerators were used during this period to store canned and dried goods, relatively unperishable food items.

By the end of the study in the spring of 1980, outside temperatures were beginning to increase. Nine of the fifteen refrigerators were working at the time but only four of those working were being used. Two refrigerators were used fairly extensively to keep meat, eggs, milk, cheese, lettuce, tomatoes and a variety of sandwich spreads and relishes. Those units had worked consistently for over the preceding four months. The families who used the machines had ceased buying ice altogether whereas other households had just started to increase dairy products. One of their owners used ice as well. The owners of these four refrigerators and one other reported with certainty that their refrigerators were working. The women of three other households

claimed that their refrigerators were not working and only in one instance were they in error; one of the machines was actually working. Three women did not know if their refrigerators were working or not. One of them explained that she did not bother to keep track because she did not feel she could trust her refrigerator. Two other refrigerators belonged to non-residents and probably were not working.

Thus, in more than one way, the refrigerators were still experimental by the end of our study. Technical problems had not yet been solved and consequently little adjustment had been made toward full use of the refrigerators. Had they been placed in individual homes they would have received more use as it would have been easier to monitor on their functioning. Only when necessary design modifications have been instituted and the refrigerators made consistently reliable will there be a chance of a significant impact on the villagers' food habits.

Lighting

The lights provided for each Schuchulik family and for several of the public buildings are widely reported as the best part of the system. People of all ages enjoy using the lights for various activities including reading, sewing, mending, basket making, writing, drawing, homework, and playing cards. The most common system of lighting prior to the electric lights involved reliance on kerosene lamps. The new lights are not only easier to use, but give off brighter light, thus making the previously listed activities more appealing during the dark hours. Most people state that electric lights have allowed them to extend the length of their working days. A few have made their days longer by getting up earlier, before dawn, and using the lights but most stay up later instead. Meals can easily be prepared and eaten by the new electric lights and sometimes fall later in the day than before. A few families occasionally lit their homes with electricity from gas-powered generators before the lights were installed, but even for those families, the new abundance of bright lighting was unprecedented.

The lights worked reliably except for that two-week period in December 1979. When the lights failed, people fell back on the old system of kerosene lighting only to find that their idea of what constituted sufficient light had changed considerably. They found that they needed twice as many kerosene lamps as before to satisfactorily light the same activities. The solar powered lights had been so reliable that failure caught some families unprepared. Their kerosene lamps needed repair and they had no fuel. The stores in Why lacked some of the necessary supplies and several people had to travel to Ajo or Sonoita for the items they lacked.

Two observations made in Chapter 5 deserve further comment here. Concerning the relative increase in energy used for lighting between the first and second winters of the study it should be pointed out that the process of lighting the village was a gradual one. In March, 1979 half of the houses were still without their two allotted lights. This state of affairs had been remedied by the following winter (although in February, 1980 a light cover and switch cover were still missing from one house).

It was proposed in Chapter 5 that the residents of Schuchulik adjusted quickly to the use of their new source of lighting. By the end of the study period a pattern had been established in which the new electric lights completely replaced kerosene lamps in two rooms of each house. Kerosene has not been totally replaced, however, as families with more than two rooms still find them useful. Lamps are transported for lighting outside activities in the summer as well. Flashlights, previously used extensively as a versatile light source, were largely displaced by the solar lights in two rooms of each house. Like the kerosene lamps, the flashlights still serve a function in unlit areas. It is only the amount of unlit area that has changed. Both sources of light now play minor roles in comparison with the electric lights under normal conditions, but provide a back-up system in case of an occasional power failure.

Maintenance and repair of the electric lights falls partly on the owners houses and partly on NASA, the PHS, and tribal workers. The division of labor is not yet fully understood by the villagers largely because there have been few lighting problems to date. A problem with battery storage caused everyone's lights to fail periodically for about a two-week period. The correction of this problem clearly called for extra-village assistance. Ther smaller problems, such as the replacement of light bulbs, are the responsibility of the individual villagers. This responsibility was not clear to one family which had light bulbs burn out. The confusion resulted from the fact that in the case of the only other minor light problem that occurred, a fuse replacement, the problem was handled free of charge by NASA or tribal employees, who had an extra fuse on hand. As more routine problems arise and are dealt with, the division of responsibility will be worked out and understood within the village.

Water Pump

The idea of replacing Schuchulik's diesel water pump with a cost-free solar pump was what sold the solar experiment to the village headman to begin with. Faced with the opportunity to free himself from the task of collecting money from his relatives and the responsibility of keeping the diesel engine running, the headman accepted the offer to make his village the site of the experiment. Ironically, the water pump that played a key role in bringing the rest of the system to Schuchulik became the most taken for granted aspect of the project. The new pump performs exactly the same function as the old pump and elicits no change whatsoever in people's water use habits. In the course of our research, people sometimes even had to be reminded that the pump was a part of the project. It pumps water to indoor and outdoor taps at all dwellings, the feast house, and to flush toilets in the newer houses. The only difference is the addition of the sinks, flush toilet, and washing machine in the Domestic Services Building. The additional appliances do not seem to have increased village water use appreciably.

The electric pump is automatic and does not require hand refueling. It continues to work no matter how long the headman remains away from the village and has required little repair. The headman has exchanged the old job of catering to the pump for that of catering to the entire system.

His work load was not lightened during the study period, in fact it was greatly increased due to the many things besides the automatic pump that the system entailed.

Acceptance and Use of the System as a Whole

The electric system may be thought of as a thing which was first planned, then constructed, and then dedicated and turned on with the flick of a switch. According to this line of thought the planning stage had stopped when the use stage began -- there was no overlap. We will follow this line of thought in the discussion below, but two qualifications are necessary. First, the system was not entirely finished by dedication day and some additional originally unplanned parts were added to it through the first year of the system's operation. Second, some installed parts of the system did not function properly through the first year. On balance those are minor provisos and the notable thing about the system is the extent to which it came to the village as a unit.

The co-authors of this report did not participate in or observe the early planning stages, but this is now we reconstruct them. The original idea, dating from late 1977 or early 1978, was for a photovoltaic system to run the village pump and nothing else. At this stage the headman was the only villager with formal knowledge of the electrification project, although some other villagers may have learned of it informally.

By the spring of 1978 the idea had expanded to include a full village photovoltaic system more or less as was later installed. We assume the proposed expansion originated from NASA, not from the headman or any other villager. A village meeting was called to consider what kind of "full" system would be agreeable both to the villagers and to NASA. Prior to the meeting, however, certain important parameters had already been established, namely:

1) The power would be direct current.

2) The amount of power would be small, but, being a "village" power system, some of the power would reach each family's house in the village, and certain domestic activities would be electrified.

3) The appliances that would use the power would be supplied as part of the project.

Those parameters being fixed prior to the village meeting, the purposes of the meeting were to decide whether to go ahead with the system under those conditions and, if so, to decide on a set of appliances that would meet the requirements of parameter 2. The villagers reportedly arrived at the meeting in agreement with the condition and with the following prioritized list of appliances (a copy of which was sent by the Public Health Service to NASA):

1) Lights in each kitchen.

2) Lights in a second room of each house.

3) Lights in the feast house and church.

4) Refrigerators.

5) Washing machine.

6) Food freezer.

7) Irons.

8) Sewing machine

9) Television

Of the proposed items, irons and television were dropped on NASA's advice for reasons of system capacity. For similar reasons it was agreed at the meeting that all components except the lights would be installed in a specially constructed Domestic Services Building. Concerning the refrigerators and food freezer, the solution reached at the meeting was for one of each appliance to be installed at the Domestic Services Building. This was changed by late May, 1978, to a final plan for fifteen refrigerators each with a small freezer. At this point the planning was complete and construction proceeded.

After dedication day, December 1978, the lighting system had two or three more houses added, and a clothesline was constructed. These additions were in response to requests from the village.

When asked about the system at the end of the study period, many people of Schuchulik expressed the feeling that they found out about the electrification project after it had already been accepted for them. This feeling may have derived from confusion over just what was being accepted -- a water pump, a pump plus lights, or the above plus one or another rendition of the Domestic Services Building appliances. No one recalled a systematic inquiry into people's electrical needs, though everyone was informed of the fact that the village was to receive solar electricity.

People's hopes or expectations for the system often proved inaccurate. The most common hopes were that the appliances would be placed in the homes, that a few plugs would be provided, that the refrigerators would be larger, and that there would be a separate freezer. The few who mistakenly expected full electrification were disappointed by the limitations of the new system. Nevertheless, everyone took advantage of at least some parts of the system. The appliances in the Domestic Services Building were eagerly received, especially the refrigerators. On our information the heaviest use of the refrigerators and the sewing machine occurred in the first few months after the electrical system was installed. Then for different reasons this use tapered off. The washer, on the other hand, caught on more gradually but more effectively. As visitors began coming from far-off places and the news media showed an interest in the village, many people developed a feeling of pride and appreciation about the solar electricity and spoke of it as a good thing that had come to them.

An already busy person, the headman had the responsibility of serving as liason between the village and relevant outsiders involved in the project. He took daily readings on the various meters and reported problems to the appropriate officials. As the only villager with direct contact with NASA and with keys to the locked parts of the system, the headman also took the role of tour guide and message bearer, showing the system to groups of interested people and informing the villagers of pertinent information from NASA.

Public transfer of information about the system occurred at occasional village meetings. The agenda for these meetings usually included items of village-wide importance, such as the fact that the solar electricity was to be installed in the first place, rather than specific bits of information relevant to only a few. The wide scope of community meeting agendas may be one reason why the meetings served mainly to relay messages from NASA to the village rather than in the reverse direction. People might have been reluctant to bring up their own particular problems at a community get-together. The infrequency of village meetings also mitigated against regular exchange of information about the system. We authors of this report did not attend or keep a log on the frequency of the meetings, although we were normally informed about them afterwards and sometimes ahead of time. We would guess that there were five to ten such meetings during the history of the project to date.

NASA representatives attended several of the village meetings. Though infrequent, these get-togethers provided face to face contact between the users and planners of the system. The villagers who attended the meetings gained a basic understanding of the operation of the system and its world-wide importance. They also had opportunity to air some of their concerns directly to those responsible for the system. Some individuals, for instance, pursued the issue of the solar energy possibly impeding the advent of conventional electricity in the village. The tribal utility company was made aware of the fact that Schuchulik was only partially electrified. The company responded that power lines could be extended to the village according to previous schedules, regardless of the solar electricity.

Communication was more problematic in regard to the day-to-day use of the system. The nature and infrequency of public meetings about the project resulted in a situation in which only people with regular contact with the headman were well informed. They knew the most about the project in general and were also able to stay informed about the operating status of the different appliances. In the case of the washing machine wringer or the refrigerators, those with close contact with the headman knew that the problem would not be solved immediately. They could make other arrangements. Others had difficulty finding him with a free moment and were reluctant to trouble him with their personal problems with the appliances. For instance, the lighting safety features in one house were still incompletely installed at the end of our study, apparently because the problem had not been reported.

The majority of the villagers obtained day-to-day information through trial and error, rumor, and observation of the Domestic Services Building. The building is within view of many homes, and, if one happens to be looking, one can observe the comings and goings of repairmen. Such indirect means were not conducive to maximal use or satisfaction with the appliances. This

issue must be faced in any instance of communal appliance and equipment use. It is less important in the use of private appliances. Repairmen cannot come and go from private property without the owner's knowledge as they can on public ground, nor is it likely that people will go for days without seeing the appliances in their own homes.

During our study, the time required for information to spread throughout the village varied considerably, in one instance taking five months. In September 1979 the washing machine was labelled "broken" by the villagers because of a bad wringer even though, as it turned out, the machine was still usable. The washer went virtually unused for several weeks until experimentation proved that it still worked if one was willing and able to exert a bit more effort. Use of the washer gradually increased as the information spread. The information flow may have been impeded by the fact that fewer users meant less competition for time on the machine. At any rate, only in Febrary did a woman whose house lacks a view of the Domestic Services Building find out that the washer really worked.

Another instance in which communication was even more crucial and yet was absent involved the refrigerators. Food spoiled many times because people were unaware that their refrigerators had gone out. It was impossible to tell without going to the Domestic Services Building whether one's refrigerator was working or not. In the summer even a few hours of 100°+ weather is enough to damage food. The sooner someone knows their refrigerator is out the greater the chance that they can rescue the food by immediate consumption or alternate storage. Periodic food spoilage is probably the most important factor contributing to the marginal incorporation of the refrigerators into people's food habits, outweighing even the distance factor.

At the end of the study period the villagers still lacked a formal means of contributing their ideas and suggestions to the people in control of the project. They felt they had little imput in the decision making so far. They wondered what the future of the project would be and how it would eventually affect them. Some of the unanswered questions on their minds were: Who would eventually foot the bill for the system? What would the bill be? Who would maintain and repair the system after the two year experimental period was over? Many villagers wondered whether they would have a voice in future decisions, whether they would have the information they needed to choose between alternatives, or indeed, whether there would be alternatives.

CHAPTER 7

CONCLUSIONS

The conclusions reached in this study are presented in the following terms:

1) How the system has worked in the village to date, that is, from its installation to the end of the study period in April, 1980.

2) The long-term future of the system in Schuchulik either as installed or with modifications.

3) The likelihood that a Schuchulik-type system would work elsewhere in the world.

Item 3 cannot be discussed at length because the authors do not know the circumstances of thousands of other places where photovoltaic electricity might be considered. It is hoped that our discussion of the first two items will permit planners from other places to make translations from Schuchulik's experience to their own. It will also be seen that we approach items 1 and 2 in steps, forming conclusions first in terms of system capacity, machine operations, and levels of use; and then in terms of the transfer of technical knowledge and responsibility. The rationale behind the steps was stated in the Introduction, that the ultimate issue of impact is whether the system can become a long-term part of people's lives.

1. How the Schuchulik System Has Worked

To date the parts of the system that have worked best and been used the most are the pump and electric lights. Concerning the other appliances we may say that the sewing machine has worked well but has received little use, and the washer and refrigerators have worked less than well which fact has limited their use. There are really two issues in the use story: Will a new appliance work if it is used, and will people use it if it works? Thus, to summarize the findings reported in detail in the last chapter:

Pump and Lights. As delivered to the village and used there, there was little that could go wrong with these appliances. People wanted to use each.

Sewing Machine. The machine was fully up to the use it received which, as described in the previous chapter, was little.

Washing Machine and Refrigerators. Mechanical and communication problems greatly restricted the use of these appliances.

Concerning the transfer of knowledge and ownership responsibility to the village, we would say that there has been little ot date and there is a long distance to go before the system will be a stable part of the community life. We refrain from saying "too little" because we do not know how much

or what rate of progress was considered suitable by the parties involved. Nor do we have an absolute formula to tell what a proper rate would be.

We have some observations, however, which may help future rate setters. First, it is understood that the electrical system operates on a yearly cycle. One might properly conclude that it should run through several annual cycles before the time would be right for transfer to the tribe or village -- not one, but several. One would not turn a toaster over to a new and unpracticed owner until he had toasted several slices of bread with it, which cycle luckily takes only about 30 seconds. Ditto a car, until the owner has made several trips in it similar to the types of trip he expects to make on his own. We suggest the analogous shakedown period for the Schuchulik electric system is several years. By this logic the progress after a year and a half has not necessarily been too slow.

Second, there must be signs by both parties of their realistic intent to see the system transferred. The ground must be prepared socially and culturally as the system's running time accumulates. In our judgment this project has not been marked by strenuous efforts to prepare that ground. To date, the villagers and the installers have concentrated on remedying mechanical problems more than on planning for a tribal takeover with some degree of local responsibility for the system. The process as we observed it is described at the end of the previous chapter. In retrospect there were points throughout the process where more responsibility could have been placed on or taken by the villagers, for example a study of electricity consumption in other Papago villages could have been made in the planning stage, or the villagers could have been required to learn enough about kilowatt hours to propose their own appliance inventories in the planning stage and a year afterwards. We do not say that such efforts would have yielded better transfer conditions than the procedure that was followed -- they might have been sterile exercises -- but they would have yielded quicker readings on the liklihood of successful transfer. In reviewing the transfer process to date, it appears that care was taken to impose the least burden of choice and cost on the village. This was a wise path if there was no hurry, if the system was viewed as highly experimental, and if getting the system in was seen as more important than getting it understood and owned. It was not a wise path if one envisions a social impact in terms of "making waves in the community" or of "galvanizing the people to action."

We close this discussion with a list of points of knowledge raised by villagers to us at different times during the study period. The points indicate areas of uncertainty about the system.

1) Although there were six generators in the village in April, 1980, none of the owners admitted to understanding how the kilowatt output of those generators (written on a plate on each unit) compared with the kilowatt output of the solar array. They knew how to use the generators but they didn't know that a generator could be integrated with the photovoltaic system as a back-up to guarantee a higher kilowatt hour consumption per day than the present system provides for. They did not know whether a photovoltaic system with no moving parts should prove more reliable than a gas

generator full of moving parts. They did not know who could fix the former.

2) A linguistic usage arose in the village whereby conventional electricity was called "strong electricity" (s-gewk wepgi). Photovoltaic electricity was called "this thing on the other hand" (implicitly "not strong"). One can see from this effort that people's minds are not idle, but they do not yet know what to make of the new kind of electricity. It is doubtful whether lectures or users' manuals would bring about the resolution. (A manual on how to use the appliances was given to each family around dedication day.) Far more important would be the demonstration of what photovoltaic electricity can do by modifying the hardware in place in the village.

3) A rumor circulated early after the system was installed, at a time when there were news stories about protests at a nuclear power facility under construction in the state, that the Schuchulik system was radioactive. No one in the village could say with certainty yes or no, but when the outside protests stopped and no one had died in the village, the idea had faded away. Presumably people trusted in their tribal government and NASA not to send radioactive hardware into the village.

4) The village fund and TWEP exist as potential aids in maintaining the system, and everyone knows it, but it remains unclear how much money and skill are needed to maintain it and whether the above means out to be so used.

2. The Long Term Future of the Solar Electric System in Schuchulik

In terms of the system's capacities and equipment, the first step of our discussion, the issue hinges on:

1) Whether a reasonable number of first and second generation household appliances can be hooked up to the system in people's houses.

2) Whether the bandstand and dance ground can be hooked up to it.

If those are answered in the affirmative, the system could have a long term future as the sole electricity supplier in the village. This would be its clearest and most impressive future. The comparative study reported in Chapter 5 indicates a fourfold gap between the designed per family electricity production at Schuchulik and the average per family use in a village with traditional housing. Possible ways of closing that gap were suggested.

Short of sole supplier the system might find a niche in filling a well defined portion of the village's electrical needs over the next decade or so, for example by:

1) Providing the village's strictly communal electric needs (church complex and pump).

2) Giving lights only -- but sufficient light -- to a number of households which might not choose conventional "full service" electric power if and when that power becomes available via the Papago Tribal Utility Authority.

3) If more capacity is left, the system could power two washers, or a large communal freezer, or medium capacity ice making machine in the Domestic Services Building.

In short, decisions could be made about how to give the photovoltaic system a valid supporting role in a village electrical economy also served by conventional electricity. The proposals sketched above are not necessarily the best ones, but are indicative of the alternatives which might be pursued.

In terms of an eventual successful transfer, we would say that the first task is to make a use plan for the system as full or partial supplier over a reasonable future period. Then provision should be made for a villager other than the headman to look after the system by reading the gauges, communicating to the villagers, and doing routine maintenance. In the long run these tasks should not fall on the headman alone -- any headman -- because no one person should be tied to the system seven days a week. Furthermore, it is in the nature of a headman's role to have many responsibilities elsewhere. Certainly the headman at Schuchulik was one of the busiest persons in the village. It made sense for the system to come to the village through him, but it makes sense for the system to become stabilized under the responsibility of someone with more time.

That "someone" could be a non-resident employee of the central tribal municipality, either Papago or White, or it could be a villager. Probably in terms of cost, including transportation, the best choice would be a villager. Last is the question of money. The villagers did not enjoy paying contributions to fuel the water pump prior to electrification, and probably would not enjoy contributions for electricity. Neither would they enjoy paying a possibly higher rate for conventional electricity. (The monthly minimum charge is $5.00 and some families with totally electric homes experience winter monthly rates of over a hundred dollars.) Some families might prefer the impersonality of mail billings over the personality of face to face payments, etc. We would not make that judgment, but would point to the discussion in Chapter 4 of the ways in which local labor and funds might be directed towards a self-maintained electrical utility.

3. The Likelihood that a Schuchulik Type System Would Work Elsewhere in the World

Schuchulik is not really an isolated place. In particular it is a car culture and it is an advanced stage of incorporation into a larger, high energy way of life. In this respect it is like many American Indian reservations and many non-Indian parts of rural America. We suspect that analogous situations exist but are rather rare in other countries of the world. It is possible that a photovoltaic system would have greater impact and a better

future where car culture and high energy infra-structure development have not proceeded so far.

Schuchulik's people can buy ice rather than use their refrigerators, can wash in Ajo rather than at the communal washing machine, can buy a generator rather than depend fully on the photovoltaic system, etc. They have many options because historically photovoltaic electricity was the last of many technological innovations to come to them. We imagine that planners in other countries would have to think how photovoltaic electricity makes sense at a much earlier phase in a village's development or modernization process. Again this is a question we do not presume to answer for the people involved.

APPENDIX I

THE FOOD SYSTEM

This chapter deals with the five stages of the subsistence process: procurement, preparation and cooking, consumption, storage and diet related health status. The electrical system's refrigerators pertain directly to the food storage stage, but have the potential to affect all the others. Our goal is to define the possible nature of those effects. We say "possible" because mechanical and communication difficulties militated against extensive use of the refrigerators during the study period.

Food Procurement

The people of Schuchulik chose from three basic types of food procurement methods during our study: traditional, cash purchase, and government assistance. Traditionally Papagos hunted and gathered wild foods in the desert for most of their subsistence. Summer farming of corn, beans, and squash provided additional food when rains were sufficient. When food was scarce Papagos exchanged their labor for sustenance among neighboring peoples such as the riverine Pimas, who lived in more geographically favored food producing areas. The second strategy, cash purchase of food involved the use of one's general income (see Chapter 2). A variety of procedures were involved in following the third strategy of seeking government assistance. During the study period, each family practiced its own combination of the food procurement strategies.

During the study period very little food was gathered or hunted in the desert. The older people of the village still possessed the knowledge needed to utilize the desert foods, but as long as sufficient food was available from other sources there was no need to use the traditional lore. Any desire to use the desert flora and fauna was countered by the five day work week which crowded other activities onto weekends. This schedule left little time for the long food gathering ventures common in the past. Only ranching, not really an indigenous activity, has continued from the food getting activities of the village's past. The children of Schuchulik were so unfamilier with the native desert foods that they seldom ate them on the rare occasions that they were offered.

Though some gardening was done, it was not enough to make a substantial nutritional contribution to any family's diet. We know of four men tending small plots during the study period. Two of the gardens were dug but not yet planted by the time our study ended in February, 1980. One man successfully grew some chilis and tomatoes in 1979 on several plants beside his house. Another kept an onion garden irrigated with seepage from the village water pump. Both men maintained fruit trees issued to them by the Papago tribe. Yields from the mens' gardening activities served as a very minor supplement to the food resources.

The people of Schuchulik procured almost all their food by the other two methods: cash purchase and government assistance. Both methods removed the procurers from direct participation in production. Some procurement methods made fewer demands on the consumers than others. Older children obtained cooked meals as the result of attendance in government schools and Papago Commodities distributed food to qualified applicants, requiring only that they fill out the proper forms. Other food aid programs involved the use of some form of currency and allowed recipients to obtain food at regular grocery outlets. The cash to purchase food came from wage work and economic assistance checks. In all of these activities, as opposed to traditional food procurement, food production and consumption were carried out by different people.

All Schuchulik households purchased some food with cash or food stamps. This activity was directed by women. They did the purchasing themselves or told others what was needed. Spontaneous contributions by other family members were always welcome, however unanticipated. There was no grocery store in the village. Food was sometimes brought in by peddlers but, for the most part, was purchased some distance away.

Food was peddled in the village on occasion by both residents and non-residents. The women of one Schuchulik family occasionally provided quantities of tortillas and tamales for sale all around the vilalge. Though widely appreciated, the sales occurred spontaneously and no more frequently than once a month. Mexican, Anglo, and Papago peddlers visited the village , each selling different but limited ranges of foodstuffs. The combined efforts of all the peddlers provided a wide variety of goods to the village in any given month. The wares ranged from empty calorie foods such as candy, soda pop, snow cones, and chips to more substantial items such as fruit, eggs, beans, bread and rabbits, and finally to prepared foods such as tamales, tortillas, and empanadas (a Mexican pastry, normally with a squash filling).

Even the most consistent peddler visited Schuchulik no more than once a month. Peddlers offered their goods to familiar clients rather than to each household. Their visits could not be anticipated or relied on as a major source of food. People perceived the peddlers' prices to be considerably higher than even the most expensive grocery and therefore minimized their purchases. No peddler depended on Schuchulik for the major part of his business. Indeed, some arrived at the end of a day's selling at a roadside stand in order to dispose of leftover goods.

Grocery stores in Why, Ajo, and Sonoita supplied most of the food eaten in Schuchulik. Villagers occasionally shopped in more distant cities. The women of Schuchulik ranked the stores in terms of relative prices. They perceived the stores in distant large cities as offering the lowest food prices and the Why general store as the highest. A survey comparing the prices of several popular food items was conducted for four stores -- two in Why, one in Ajo, and one in Phoenix. The survey revealed that the pricing issue was actually more complex. The predicted pattern, with Phoenix prices the lowest and Why prices the highest, held for most items, though the Why general store prices were often lower than expected. For other items Ajo offered the best bargains. Apparently, considerations of the types of bargains usually available at the various locations also figured into household shopping decisions. A woman wishing to stock up on canned goods might travel to

Phoenix, whereas staples such as sugar or lard could be most economically purchased in Why.

Most Schuchulik residents made daily trips to Why for gas, food, mail, and also to socialize with their friends. People without cars easily purchased rides for the cost of gas. The general store in Why sold crafts and miscellaneious household necessities in addition to groceries and housed a post office. Credit was readily extended to regular customers. The use of the store's easily extended credit drew some Schuchulik shoppers into a credit cycle that they were well aware and apprehensive of. One villager had escaped the cycle and was quite proud of the accomplishment. In 1978 a nearby cafe began to compete with the general store for their grocery business by offering a limited range of necessities at lower prices. People shopped less frequently at the cafe as credit was not readily extended and the choice of goods was limited. Only those people without their own transportation relied heavily on the Why stores. Others did their major shopping elsewhere and restricted their Why purchases to short term needs.

Ajo and Sonoita were the next most distant places where food could be purchased. Every Schuchulik family but one occasionally bought food in Sonoita, Mexico. The frequency of the trips varied from about once a month to twice a year. Sonoita was seen as a source for goods that either could not be obtained or were much more expensive in the United States. Sonoita flour was not only cheaper than U.S. brands, but was regarded as the best flour for making tortillas. Good deals were also to be had in Mexico for such items as green chilis, coffee, and large ice blocks. The highly regarded Mexican white cheese, corn tortillas, and delicacies from the Sonoita bakery were not consistently available north of the border. The need for a grocery run to Sonoita sometimes provided the impetus for weekend social outings. Families enjoyed the trips to Mexico and did not seem to view them as women's shopping chores.

The frequency of shopping trips to Ajo ranged from every other day for one household to once a month for others. Prices were thought to be comparable at both Ajo grocery stores, but higher than those in Casa Grande, Phoenix, and Tucson. Peoples' reported shopping habits indicated that the Ajo stores offered the best compromise between bargains and distance. The farthest distance traveled for the sole purpose of buying groceries was to Casa Grande, about 80 miles from Schuchulik. Food was purchased in the more distant cities of Tucson (110 miles) and Phoenix (150 miles) during trips made there for other reasons. At the beginning of the study period people seemed more inclined to travel farther for groceries than at the end of the period, possibly in response to rising fuel costs.

Already prepared foods were available from restaurants and fast food outlets in all the above places. These provided an additional source of food for some Schuchulik residents. Access to transportation and its cost were important factors in determining the frequency of fast food purchases.

Government assistance programs made a significant contribution to the diets of eligible Schuchulik families. Each weekday during the school year, all elementary and junior high children received two balanced meals at school. Three government assistance programs 1) WIC vouchers (Women, Infants and Children), 2) Papago Commodities Program, and 3) food stamps are administered

from Sells. Food stamps and Commodities programs required similar application procedures. Eligibility was determined according to household size and income. Recipients periodically updated their applications for recertification. The two programs were linked in such a way that recipients could switch between the two types of aid upon request, but could only be enrolled in one of them at any given time. The WIC vouchers program, on the other hand, was only available for mothers of very young children. Individual diets received a good deal of attention in planning the specific eligibility category of each applicant. Recipients of vouchers participated in regular health screenings which monitored the effectiveness of assigned diet supplements. During our study Schuchulik residents ranked the food assistance programs on the basis of their flexibility and the amount of food choice allowed. Food stamps ranked first; vouchers, second; and commodities, last.

The WIC vouchers program has as its goal the improvement of diets of young children and breast-feeding mothers. WIC vouchers, issued monthly, allowed mothers to purchase specified combinations of dairy products, fortified cereals, and fruit juices directly from regular grocery stores. Five Schuchulik households received the benefits of the WIC program under the names of nine individual women, infants, and young children. During the study, the number of individual receipients increased with the birth of two new infants. The existence of the WIC program was common knowledge among Schuchulik mothers and all eligible residents were either enrolled or in the process of applying at the time our study ended.

The Papago Commodities Program delivered food staples to individuals at Schuchulik and other delivery points. People obtained their commodities at the nearest delivery point on a designated day of each month. Since Schuchulik itself was a delivery point, picking up the commodity package was not a problem for the villagers. A single type of food package was available to all recipients, modified only by the rejection of part of the package. The standard package included basic staples such as flour, dried beans, butter, lard, and canned goods. Limited amounts of fresh produce were offered when in season. At the beginning of the study period four Schuchulik families received commodities. This number decreased to one recipient. The other three shifted their enrollment to the food stamp program. Whether the shift was an instance of oscillation between the two programs, the commodities being used to build up staples and the food stamps to increase dietary diversity, or whether it reflected the appeal of a new food stamp policy is not known.

A new food stamp policy was initiated in 1979 under which people no longer had to purchase food stamps. The new policy may have caused a relatively permanent shift to food stamps, which offer a wider range of food choice than do commodities. Six Schuchulik families supplemented their incomes with food stamps in February, 1980. Food stamp recipients received cards by mail which they exchanged for food stamps in Ajo, at a branch of the Sells office. Trips to Ajo for food stamps were usually accompanied by major grocery purchases the same day.

An additional method of food procurement was available to villagers through fiestas. Normally four large fiestas were held in Schuchulik each year, plus an equal or greater number of feasts (see Chapter 4). These, plus

fiestas of other villages, made a significant dietary contribution for those individuals in regular attendance. People who assisted in giving a feast were rewarded with additional food to take home. If labor contributions were frequent, a considerable amount of food could be provided through the gifts.

Once food was obtained exchanges regularly occurred with members of other families. Food commonly flowed between members of closely related families regardless of residence. Papago Commodities were generally shared between close relatives but seemed to be available to more distant relatives in the village upon request. Those with few close kinship ties within the village relied on more distant kin, or close kins outside the village for food exchanges.

Food Preparation

The fate of foods once they enter the household is the topic of this section. Topics to be addressed include cooking paraphenalia, cooking habits, the cook's responsibilities, special meals, and meals as daily events.

Some foods like fruit and vegetables require no cooking. Foods such as potato chips or loaves of bread, required even less attention and virtually no equipment to make them ready for serving. When cooking was necessary, two types of stoves were commonly employed. Each home was equipped with either a wood or gas stove in its kitchen, but several Schuchulik families used a combination of inside and outside gas and wood facilities (see Chapter 5). When only one type of stove was used, the wood stove was strongly preferred as it provided the perfect griddle for making tortillas. Those cooks with a gas stove baked, roasted, and even boiled their food more easily than on a wood stove. Wood cooking required a great deal more skill and supervision. It was not uncommon for a family to have two wood stoves, one in the indoors kitchen and one outside, for summer cooking. Outdoor wood stoves were easily constructed from bricks or even old washtubs.

Coffee, tortillas, and beans were the most commonly prepared foods in Schuchulik. A tortilla maker needed only a large mixing bowl and a good griddle besides her ingredients. Large aluminum pots were kept for boiling beans, or for heating water. A three to four inch deep frying pan (usually cast iron) and a coffee pot were also essentials in Schuchulik cookery. Each household had at least one and often several of these three essential pieces of cooking equipment and used them regularly. Beyond this, each household had its own variety of smaller pots, pans, trays and bowls. Cooking measures were seldom used; judgments as to the proper amounts of ingredients rested solely with the expert eye of the cook. Knives and large cooking spoons were the most frequently used cooking utensils. Long forks aided in the manipulation of meats and popovers while frying.

Lard and salt were generously used in the preparation of most foods. Apparently the cooking (hidot) of foods with water, fat and salt is a Papago custom of long standing; store bought lard merely replaced deer tallow and purchased salt replaced that previously obtained by Papagos in yearly salt pilgrimages to the Gulf of California. Women of Schuchulik used both iodized and non-iodized salt. Though the two replacements affected no change in

cooking practices, their use resulted in a change in the nutritional quality of the diet.

Both lard and salt are ingredients of the ever-present tortilla. The women claimed that the texture and consistency of the Mexican flour was superior to that available in the United States, however, Mexican flour was not secondarily enriched after bleaching as was United States flour under the restrictions of the USDA. Popovers were often substituted for tortillas in a meal. They are smaller and fatter than tortillas but made with similar ingredients. When pattered round and flat the popover dough is deep fried in lard rather than toasted on a griddle.

The preparation for any specific meal fell under the supervision of a single head cook, usually a woman. Some households had only one cook. In households where several women could cook, the head cook was simply the one who took the initiative in starting a particular meal's preparation. She was assisted by any bystanders capable of leanding a hand. The kitchen could easily take on the aura of a mini-fiesta as friends and relatives joined in meal preparations and conversations. Men took charge of cooking when necessary to to prepare themselves a snack. They rarely supervised household meal preparations.

School and work schedules figured importantly into a cook's planning. For a family in which both parents worked outside the village and all children attended school, the cook prepared only one meal at home each week day. At the other extreme was the family in which all members were usually in the village at meal times. Most families fell somewhere between the extremes. The ideal meal pattern consisted of three meals a day, whether the meals were eaten at home or away. Breakfast normally fell between 8:00 and 10:00 AM; lunch, 12:00 noon and 3:00 PM; and supper, 5:00 and 8:00 PM. School children and school employees received two balanced meals each school day, then joined their families for supper at home. Those who remained in the village followed the same general three meal pattern as the children on week days.

Most cooks adjusted their cooking habits on weekends to accomodate larger numbers of people. In addition to the fact that children and wage earners were home, the weekends were also the most likely times for visiting. Interestingly, some households changed to a pattern of meal timing similar to that practiced in Mexico and in United States holidays with a large early afternoon supper, and a light, informal evening meal.

Meal timing and cooking responsibilities were also subject to the annual cycling of the school year. Boarding school children and day school children home for the summer placed a heavier burden on about three-fourths of Schuchulik's head cooks. Average family size increased roughly from five to seven in the summer months. Summer was also the time when the heat of cooking became the most uncomfortable, foods, spoiled most readily, and cooling ice melted the quickest.

Schuchulik cooks often prepared large quantities of food, not only to feed large numbers of people, but also to have something on hand for later meals and snacks. Tortillas, for instance, were usually made in quantities

meant to last at least two days. It was not uncommon for tortilla making to become a household event involving all of the skilled women available. The same was true for popovers. A basketful of popovers and a pot of beans standing ready in the kitchen could free up a good deal of a cook's time, especially on a weekend when something important was going on.

Beyond the widespread preparation of tortillas, beans, and coffee, each household developed its own preferences combining Indian, Mexican and modern Anglo cuisine. Prepared mixes and canned foods were used to some extent by all, but never to our knowledge did their use constitute an entire meal. Whatever meats and vegetables were served were often salted and fried in lard or a combination of lard and water.

Whatever diversity developed in daily eating habits, the people of the village essentially agreed as to the proper menus for special occasions. Birthdays, baptisms, feasts, funerals and All Soul's Day called for the predominanly Mexican menu described in Chapter 4. Easter, Thanksgiving, and Christmas seemed to call for more explicityly Anglo menus with ham or turkey -- complete with dressing and gravy, rather than chili stew. There seemed to be no hard and fast rule, however, and items from the various cooking traditions -- Mexican, Anglo and Indian -- were frequently combined. For instance, the Anglo dish, potato salad, was offered side by side with tamales, tortillas and chili stew at a fiesta; and tamales were sometimes included in a Christmas dinner centered around turkey with mashed potatoes. All Soul's Day menus were catered to the tastes of lost loved ones. Each year on November 2 a meal is traditionally set for the dead and left for them to eat during the night in a secluded area near their descendants' homes. The meal is set for them just as it would be for the living except that it is more likely to include predominantly Indian and Mexican foods.

Once any meal, festive or otherwise, was prepared it was set on the table with appropriate condiments. The most commonly used condiments were salt, sugar, chilis, green onions, and Mexican hot sauce. A dish was provided for each person as was either a coffee cup or glass. Spoons and forks were made available, though for some people tortillas served as the sole eating utensil. When all was ready the family and guests assembled. When the number of adults present was large, children were often preempted from seats at the table. Attempts were made to see that everyone had access to food and utensils whether they were seated or not. When not seated, children could come and go, filling their plates or tortillas often with the assistance of an adult at the table. This informal feeding of children lent itself to a tendency for playmates to join in a family meal. Children seemed to be able to find sustenance at virtually any house in the village simply by making an appearance at mealtime. Adults, too, were likely to be served when they arrived during a meal, but they tended not to intrude very often.

Families linked by parent-child ties seemed entitled to a great deal of freedom in one another's kitchens and frequently cooked or ate together. Such ties existed between ten families. Of these, five traced a parent-child relationship to a single senior couple of the village. These five regularly combined and coordinated resources with the senior couple to provide food for as many of the family members -- plus the members of a sixth family currently residing in Ajo -- who happened to be present. The result was an ambience of informality in which adults respectfully shared food resources and grandchildren knew of a sure source of food outside their own homes.

Two other pairs of families united by parent-child kinship ties complete the ten. The kitchens of each pair were shared whenever necessary and family members shared freely of the meals and other foods that were prepared. Several other cases existed where a child from one family regularly took meals with another family on the basis of friendship or more distant kinship ties such as uncle-nephew. Those instances differ from the sharing between more closely related families in having less free access to food and kitchen facilities.

Meals lasted from one-half to one hour. If the number of adults eating was too large for the table eating was done in shifts as exemplified in the extreme by the village fiestas (Chapter 4). For smaller families on normal days, however, the most common reason for eating in shifts was to accomodate latecomers. Once everyone had had their fill, decisions were made as to what to do with leftovers. Good-sized quantities were often set aside, especially in the winter, for stragglers and snacks. Frequently leftovers were offered to nearby relatives or friends who did not attend the meal. Another alternative, especially if there was a high risk of the food going bad, was to offer the leftovers to the village dogs. Only rarely were attempts made to keep leftovers for consumption some days later.

Consumption

Having given some attention to food consumption as the basis of the social event known as the "meal," we turn now to the nutritional content of meals. As the impact of the refrigerators was minimal by the end of the study period, the following discussion of consumption is offered as a yardstick against which the eventual nutritional impact of the refrigerators may be measured. The data for this section were collected using a combination of techniques commonly used in nutritional studies; direct observation, 12-hour recall, and food diaries. Data collection was carried out between December 1, 1979 and February 29, 1980. It is likely that data collected during the summer would yield somewhat different results.

A few general comments are in order before moving on to specific nutritional analyses. First, the above discussion was limited to "home-cooked" meals. Chapter 4 considers "village-cooked" feast meals. Meals were regularly eaten by Schuchulik residents in two other contexts as well, both located outside the village. Day schools provided two well balanced meals a day, five days a week, for the school children and the adults employed there. Some junior high and high school age villagers received all their meals at boarding schools. A second source of extra-village meals was the fast food industry in neighboring towns. These restaurants offered a variety of menus ranging from Mexican to All-American to Pizza Parlor in style. Six percent of all the meals we recorded originated in fast food outlets. Children seemed to eat more restaurant meals than their Schuchulik grandparents. Their parents fell somewhere in between the two in terms of frequency of fast food meals. Access to transportation was the crucial factor in determining the frequency of the outings. Once information was out that a car was destined for a restaurant, it filled up quickly. Children took special pleasure in the trips and often tried to accompany any aunt, uncle, brother, cousin, or acquaintance who was going the right direction.

Another important issue is extra-meal food consumption. Snacking between meals was not uncommon. Snacks often consisted of empty calorie foods such as soda pop, candy bars, and chips. Such items were often picked up and eaten during trips to town. Fresh fruits were also regularly eaten as snacks, being consumed almost as soon as they were brought into a household. Alcoholic beverages were shared in a similar way although less by women than by men. In the following analyses attempts were made to be as accurate as possible about extra-meal consumption, but it is likely that our data are somewhat under-reported in some cases.

Table A-1 represents the balance of certain basic food types in the winter diet of Schuchulik as a whole. Data for this table were gathered by observation and 12-hour recall for as broad a sample of villagers as possible. Each household contributed at least one day's worth of data to the sample, and two households, one week's worth. Our results are expressed in terms of the percentage of meals in which each type of food appeared. The adjusted total percentage figures were calculated as if the data were for an equal number of each type of meal, rather than different numbers of breakfasts, lunches, and suppers as was actually the case. We were interested in what was served at particular meal events rather than what individuals actually chose to eat. School meals were not included in this survey.

The actual food items included under each category in Table A-1 follow, each food item listed in order of the frequency of its occurrence:

1) Meat - beef; pork; baloney; chicken; spam; hot dogs; tuna; burro; bone soup.

2) Eggs.

3) Meat alternatives - pinto beans; pork-n-beans; chili beans; black-eye peas; peanut butter.

4) Dark green or yellow fruits and vegetables - chilis; canned peaches; squash; tossed salad; cantaloupe.

5) Vitamin C rich foods - tomato sauce; koolaide; orange juice; Hawaiian puch; fruit salad; tomatoes; oranges; cole slaw; watermelon.

6) Dairy products and Calcium rich foods - yellow cheese; milk; white cheese; chocolate milk; ice cream.

7) Potatoes and other fruits and vegetables - potatoes; onions; corn; apple juice; apples; bananas; green beans; plums.

8) Cereals - macaroni; spaghetti; breakfast cereal.

9) Bread/Tortilla - white bread; tortillas; popovers; biscuit; burro.

Table A-1

Meal Composition
Numbers represent the percentage of meals in which an item appeared

	1. Meat	2. Eggs	3. Meat Alternatives	4. Dark green/ yellow fruits & vegetables	5. Vitamin C rich foods	6. Dairy products	7. Potatoes & other fruits & vegetables	8. Cereals	9. Bread/Tortillas	10. Empty calorie foods	11. Beer	12. Coffee/Tea
Breakfast	77	74	26	11	29	29	31	29	100	6	0	86
Lunch	66	0	52	24	24	14	59	7	100	59	7	34
Supper	96	0	44	40	80	44	76	32	100	44	4	44
Adjusted Total	80	25	41	25	44	29	55	23	100	36	4	55

10) Empty calorie foods - soda pop; diet pop; cookies; candy bars; cheetos; doughnuts; marshmallows; cake; sweet rolls.

11) Beer.

12) Coffee/Tea.

The percentage scores give a crude index of the nutritional adequacy of the winter diet. For each category a total percentage of thirty-three would indicate that the type of food was served approximately once a day. Higher scores indicate that a food was served more frequently; lower scores, less frequently. A daily diet which contained one item from each of categories one through nine would be fairly adequate nutritionally. From the adjusted total percentages, it tentatively appears that the diet might be lacking in foods rich in vitamin A (#4), Calcium (#6), and possibly such nutrients as Iron and B vitamins (#8) since cereals are usually enriched with these and other important nutrients. Protein (#1-3) was served regularly, and high caloric foods (#9-11) were served more frequently than essential for good nutrition. The fact that only two foods included in this analysis, eggs and milk for one family, had spent any time in the new refrigerators serves as a reminder of the minimal incorporation of the refrigerators into Schuchulik's food system at the time.

The food diaries kept by two Schuchulik cooks are felt to be highly accurate in representing the actual food intake of two families. They form the major data source for the following nutrient composition analysis. The food diary method was preferred to weighing procedures as the latter tend to elicit greater changes in eating habits. The conscientious recording required in keeping the diaries was felt to be superior to recall methods in estimating quantities, and the cooks of two selected families seemed best suited to the task. Though the activity of keeping a food diary may have altered food habits, we felt it to be the best method for this study as it did not require people to make abstract generalizations about their diet.

No claim is made that the sample for which we have data is statistically representative of the whole village. However, some tentative conclusions can be drawn as the individuals included in the sample were not noticeably deviant from other villagers in their food habits. Our results may be found useful in future, possibly more comprehensive dietary intake studies in Schuchulik, and also in comparison with past studies of Papago diet.

Table A-2 presents daily intake of eleven different nutrients by individuals grouped according to age and sex. USDA Recommended Daily Allowance (RDA's) are shown in parentheses where appropriate for comparison. Because of the small and varied size of the samples, a coefficient of variation is used rather than a standard deviation to indicate the amount of daily variability. If we consider each column separately we find that caloric intake was low for most adults and either high or adequate for children. Protein intake was consistently high in all categories. Calcium intake was low for all except school children (ages 4 through 10). Iron intake was generally high, as was the intake for ascorbic acid (vitamin C). Vitamin A intake

Table A-2

Nutrient Intake Analysis for Selected Schuchulik Residents
(1980 Recommended Daily Allowances are indicated in parentheses)

	Calories	Protein (g)	Fat (g)	Carbohydrates (g)	Calcium (mg)	Iron (mg)	Vitamin A (IU)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic Acid (mg)
Child 1-3	1266 ± 16% (1300)	43.3 ± 39% (23)	39 ± 49%	189 ± 35%	324 ± 55% (800)	11.68 ± 81% (15)	1934 ± 56% (2000)	.65 ± 55% (.7)	.77 ± 56% (.8)	8.74 ± 37% (9)	153 ± 100% (45)
Child 4-6	2117 ± 25% (1700)	72.3 ± 24% (30)	92 ± 47%	255 ± 23%	851 ± 33% (800)	13.74 ± 50% (10)	6675 ± 92% (2500)	1.16 ± 24% (.9)	1.60 ± 36% (1.0)	13.45 ± 36% (11)	175 ± 67% (45)
Child 7-10	2857 ± 6% (2400)	97.6 ± 6% (34)	138 ± 10%	321 ± 6%	1168 ± 4% (800)	18.05 ± 11% (10)	2774 ± 11% (3300)	1.61 ± 0% (1.2)	2.13 ± 0% (1.4)	19.40 ± 14% (16)	83 ± 30% (45)
Male 23-50	2318 ± 18% (2700)	109.9 ± 27% (56)	88 ± 19%	240 ± 34%	579 ± 24% (800)	21.40 ± 32% (10)	4896 ± 90% (5000)	1.55 ± 31% (1.4)	1.59 ± 40% (1.6)	21.69 ± 30% (18)	63 ± 100% (60)
Male 51+	1828 ± 27% (2400)	77.7 ± 2% (56)	36 ± 11%	277 ± 32%	651 ± 16% (800)	22.25 ± 5% (10)	1913 ± 39% (5000)	1.08 ± 9% (1.2)	.91 ± 0% (1.4)	12.91 ± 48% (16)	14 ± 100% (60)
Female 23+	1366 ± 64% (2000)	50.3 ± 67% (44)	51 ± 78%	179 ± 60%	408 ± 68% (800)	a 9.97 ± 96% (18) b 16.58 ± 12% (10)	2040 ± 60% (4000)	.85 ± 79% (1.0)	.78 ± 47% (1.2)	10.36 ± 74% (13)	77 ± 100% (60)
Female Lactating	2558 ± 20% (2500)	103.5 ± 24% (64)	95 ± 35%	305 ± 30%	574 ± 28% (1200)	18.20 ± 26% (18)	4522 ± 82% (6000)	1.07 ± 26% (1.5)	1.31 ± 37% (1.7)	19.17 ± 37% (18)	229 ± 100% (100)

a = for women age 23 to 50

b = for women age 51+

was low for most adults and older school children (ages 7 through 10). Thiamin and riboflavin intake levels were adequate or high for children and men under age 50 and low for other adults. Niacin intake followed a similar pattern with the exception of lactating women for whom niacin intake was slightly elevated. Table A-3 indicates those categories for which average nutrient intake levels were less than two-thirds of the RDA.

Table A-3

Nutritional Risk Categories as Calculated from Table 11

Category	Calcium	Vitamin A	Riboflavin	Vitamin C	Iron
Child 1-3	X				
Male/23-50					
Male/51+		X	X	X	
Female/23+	X	X	X		
Female/23-50					X
Female/lactating	X				

The values given in the tables are not intended to be perfect representations of nutrient intake. Under estimation may have occurred for snacks and alcohol consumption; and overestimation, for school meals for which we had no choice but to calculate nutrient intake from menus rather than observation. Thus the conclusions reached from this data are only tentative. It should be noted that nutrient intake varied considerably from day to day in Schuchulik especially for vitamin A and ascorbic acid. Daily fluctuation in food intake was not unusual, especially for women, who frequently attempted to limit their food intake. In spite of these sources for error and variation, our nutrient intake analysis is in fairly close agreement with the results of our meal survey as presented in Table A-1 in that intake of calcium, vitamin A, and B vitamins was often low, especially for those categories of people taking most of their meals at home (i.e., adults and preschoolers).

Table A-4 compares Schuchulik data on protein, fat, and carbohydrate consumption to desired values set for the United States as a whole. The standard for comparison is not a mean but a goal in comparison to which the average American diet is heavy in fats and proteins, but light in carbohydrates (reference 22). Our table shows that Schuchulik follows a similar trend. In general, carbohydrates comprise less than the desirable percent of calories consumed while fats and proteins comprise more than the desirable values.

Table A-4

Average Percent of Calories from Protein, Fat, and Carbohydrate as compared with U.S. Dietary Standards

Sex/Age	Protein	Fat	Carbohydrate
Child 1-3	14	28	60
Child 4-6	14	39	48
Child 7-10	14	43	45
Male/23-50	19	34	41
Male/50+	17	18	61
Female/23+	15	34	52
Female/lactating	16	33	48
STANDARD	12	30	58

Food Storage

Food that is not immediately consumed must be safely stored. Traditionally Papagos stored dried foods and sealed liquids in ceramic jars. During our study food was always available from the distant markets. Time and distance involved in running back and forth to the food market served as the incentive to store foods. The amount of food in storage fluctuated according to each family's economic schedule. Monthly fluctuations occurred for those enrolled in commodities, food stamps, and vouchers programs; other fluctuations depended on the timing of pay checks and other income. Cooperative food storage practices corresponded with preparation and meal patterns that form the basis of our classification of families in Table 2-4.

From April through October fresh and cooked foods spoil easily if uncooled. (July and August daytime temperatures can reach 120°F and are frequently above 110°F.) In those hot months dried and canned foods can be stored fairly well, while perishables must be either consumed soon after procurement or stored in cool places. Prior to the introduction of the refrigerators, ice in ice chests was the most common method for cooling food. While several families owned either gas or electric refrigerators, the cost and inconvenience of fuel purchases, maintenance, and repairs made regular use impractical.

One family used no form of cool food storage; they found it possible to rely on dried and canned goods. Rapid consumption of fresh foods helped

minimize spoilage. Attempts were made to prolong the life of fresh foods through the use of tightly sealed containers such as tupperware. Meat was often cooked soon after it was bought. Fresh beef from fiestas could be dried and preserved for several weeks as beef jerky.

Families who used ice chests spent anywhere from $2.00 to $20.00 per week on ice in the summer, an average of about $10.00 per week. For some, cool food storage was an occasional option, for others it was a necessity. Older villagers with no young children used ice less frequently. The most common reason mentioned for using cool food storage was to keep fresh milk for children. Ice cooling was accomplished using either blocks or bags purchased once to twice daily in the summer, usually in Why or Ajo. Items commonly kept in an ice chest included: milk, meat, cheese, butter, eggs, soda pop, juice, lettuce, fruits, and on occasion, beer. The summer pattern of ice use was apparently unaffected by the introduction of the new refrigerators for the summer of 1979 (Chapter 7).

In cold weather five families bought ice twice a week for an average weekly cost of $2.00. Other families simply stored food in cool places in or near their kitchens. The food item most often cited as requiring cooling was milk. Eggs, cheese, and beverages could remain for days outside ice chests. Even milk could be left out for a day or so without going bad, as the temperatures regularly fall below 45°F but rarely go below freezing. We were able to conduct an intensive survey of winter food storage for three households in late January, 1980 (Tables A-5, A-6). Only one household used ice. Information was recorded in each household as to the amount, type, and location of every stored food item.

Virtually all food was stored within a few steps of the family preparation and dining areas. Food storage places were distinguished on the basis of their temperatures. A storage area above or beside the wood stove kept leftovers warm. The cold space was either a room, a cold area near a window, or outside. Food in the cold areas was protected from direct sun. Cold storage space could be extended almost indefinitely in the cold months through use of the out-of-doors. The only requirement was that food be protected from animals and small children. This was accomplished through the use of sturdy containers and by placing food beyond reach. Sturdy ice chests were used outside without ice for this purpose. Between the extremes of warm and cold storage areas was usually a fairly warm transition area where many dried and canned foods were safely stored. The location of the stove or heater determined the amount of food regularly subjected to warm temperatures.

Table A-5 represents the amounts and types of food storage space in the three households surveyed. We allowed for regular fluctuations in food supply by measuring the amount of space regularly set aside for food storage whether food was actually being stored there or not. As can be seen in the table, most food was stored in warm, dry areas. Without refrigerators we estimate the amount of cool storage space to decrease by 87% to 100% in the summer for our three households. Cool storage space reduces to only that available with ice chests. Even with the addition of 4.7 cubic feet of cool storage provided by the refrigerators in the Domestic Services Building, cool storage still undergoes an 81% to 92% reduction with the onset of the summer heat.

Table A-5

Cubic Feet of Food Storage Space in Three Households

NO. OF PEOPLE IN HOUSEHOLD	WINTER				SUMMER*		
	Warm (dry)	Cool (dry)	Ice Chest (damp)	Total	Warm (dry)	Ice Chest (damp)	Total
8+	49	42	6	97	91	6	97
6	51	32	2	85	83	2	85
3-4	2	51	-	53	53	-	53

*Summer values are only estimated.

The actual food stored in the three households during the survey can be viewed in two different ways. With regard to the type of processing a food underwent prior to storage we can group the goods into three categories: fresh, dried, and canned. No household kept any frozen foods. Table A-6 shows that dried foods predominated in terms of number of items. Canned foods were second and fresh foods were least common. The scarcity of fresh foods in storage does not necessarily reflect a scarcity in the diet. As was previously noted, fresh foods were often eaten soon after they were obtained or shared among friends and relatives when there was a surplus.

Table A-6

Types of Food Stored in Three Households, Winter 1979-80

PEOPLE IN HOUSEHOLD	DRIED FOOD ITEMS	CANNED FOOD ITEMS	FRESH FOOD ITEMS	TOTAL
8+	52	43	23	118
6	64	62	57	183
3-4	41	36	18	95
TOTALS	157	141	98	396

The stored foods can also be classified according to the same groups used in the Meal Composition Analysis (see Table A-1) with the exception of the replacement of "cooking aids" for "beer" as category #11. No beer was in storage at the time of our survey. The foods included in each category were, in order of their prevalence:

1) Meats - beef; pork; tuna; spam; sandwich spread; sardines.

2) Eggs - fresh eggs; instant (dried) eggs.

3) Meat alternatives - pinto beans; lima beans; dried peas; peanut butter; pork-n-beans; peanuts; refried beans; kidney beans; blackeye peas.

4) Dark Green or Yellow Fruits and Vegetables (rich in Vitamin A) - green chilies (fresh); chilies (canned); carrots; spinach; peaches; asparagus; squash; vegetable soup; yams.

5) Vitamin C rich foods - orange juice; oranges; tomatoes; tomato sauce; pineapple juice; grapefruit juice; sauerkraut; instant Hawaiian punch; Tang; grapefruit; watermelon.

6) Dairy Products - evaporated milk; fresh milk; powdered milk; cheese.

7) Potatoes and other fruits and vegetables - green beans; corn; fresh potatoes; peas; onions; instant potatoes; apples; pears; canned fruit; pineapple; raisins; lettuce.

8) Cereal - fortified breakfast cereal; oatmeal; flour; spaghetti; cream of wheat; macaroni; crackers; rice; pancake mix; waffle mix; cornmeal.

9) Bread/Tortilla - tortillas; bread crumbs; biscuits.

10) Empty calorie foods - cocoa; syrup; soda pop; diet pop; preserves; candy; pudding; molasses; popcorn; cheetos; cheese krisps; onion snacks; potato chips; jello; cake mix.

11) Cooking Aids - gravy mix; iodized salt; baking powder; lard; hot sauce; shake-n-bake; shortening; sugar; non-iodized salt; pepper; tiny chilies; chili powder; catsup; salad dressing; pickles; sweet-n-low; butter; mustard; margarine; horse radish; relish; Heinz 57 sauce; coffeemate; A1 sauce; mayonnaise; vinegar; brown sugar; cooking oil; cinnamon; olives.

The following observations can be made on the basis of the information provided in Table A-1 and our food storage survey:

1) Most of the items in storage were cooking aids and condiments (#11).

2) Fortified cereals (#8) and dark green and yellow fruits and vegetables (#4), which were relatively scarce in our meal composition analysis, were well represented in food storage.

3) Foods such as bread, tortillas, meat and Vitamin C rich foods (#1, 5, 9) which commonly occurred in meals, were rarely stored.

Thus, foods that were the most regularly consumed were purchased or made as needed rather than kept in storage, whereas other items which seemed to be lacking in the diet were stored. Eating habits seemed to mitigate against the regular use of some stored items, particularly canned vegetables (#4, 7) canned milk (#6) and breakfast cereals (#8), all of which would be indicated as nutritionally desirable by our consumption and also health status data (see below).

While the food procurement pattern of the people of early Schuchulik was no doubt drastically changed with Anglo contact, our storage survey and composition analyses show that the diet itself has not been totally changed from the traditional Papago diet reported by early ethnographers. All households kept substantial amounts of beans on hand. Squash, pumpkin, corn, melon, and jerked meat were also stored. All of these items with the exception of the jerky were readily purchased and need not be produced. No use was made in the three households of traditional food storage containers, however. All food was either stored in its original container or transferred to glass jars, tins, or tupperware containers.

Diet-related Health Status

The particulars of a people's diet are only important as they ultimately affect physiological well-being, or health status. Here we will concern ourselves with the diet-related community health status of the people of Schuchulik. The physiological evidence of any health impact the new refrigerators might have will surface only gradually rather than all at once. Thus, the following discussion presents the community health status prior to any detectable physiological impact. A later section of this chapter consists of a preliminary examination of the impact of electricity on health status by comparing health statistics from two Papago villages near Schuchulik, one with conventional electricity, and one without.

We have already discussed the fluctuation of the village population (Chapter 2). Visiting families, boarding school children, and other assorted people with various ties to the village could be considered by broad criteria as part of the Schuchulik community. Public Health Services (PHS) statistics, the source of our health data, include some of the former people in their population estimations for the village while excluding others who actually resided in the village during our study. Those people who were excluded in PHS statistics often had stronger ties to other reservation villages and considered their Schuchulik residency as something less than permanent.

Figure A-1 compares the PHS population figures to our own data for February, 1980 in terms of age and sex categories. The criterion for our February census was actual residency. As shown in the graph, the two censuses do not agree. The contrasts diminish somewhat when boarding school children and some members of non-resident families with strong village ties are added to the estimates (Figure A-2). This brings the two censuses into agreement for children under age 15. At best, however, the PHS listed twenty-four people for which we have no information, and overlooked nine which we included on the basis of actual residency, house ownership, or boarding school attendance. The PHS population figure for February, 1980 exceeds our own estimate, even when the broadest criteria for inclusion were employed, by about 17%, and there is disagreement as to the actual individuals making up another 10% of the population. These discrepancies are pointed out not merely to remind the reader of the difficulties encountered when defining communities, but also to define the meaning of the term "community" as used here with regard to health status. In the remainder of this discussion the "community", unless counterindicated, will be "those people claiming Schuchulik as their reservation residence when using PHS medical facilities."

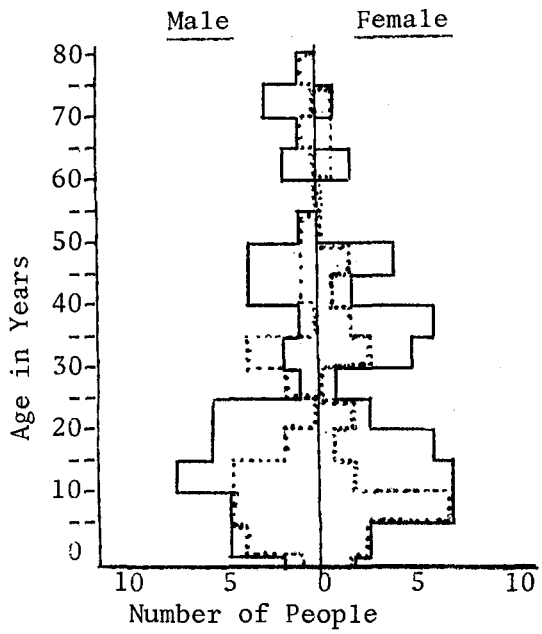


Figure A-1. Census Comparison

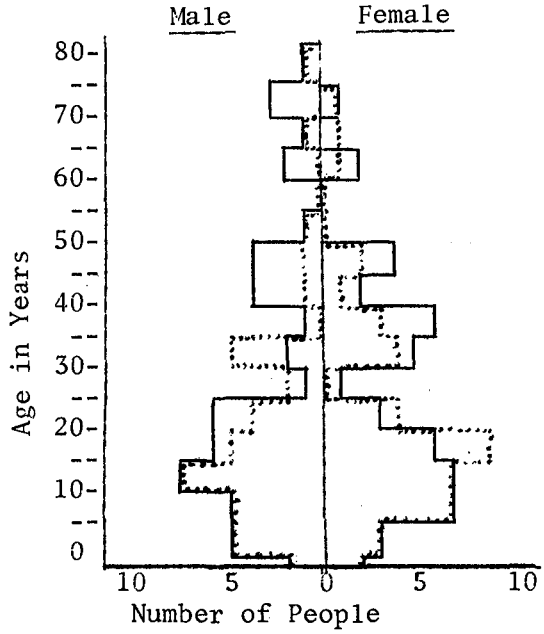


Figure A-2. Adjusted Census Comparison

PHS records covering the years from 1970 through 1979 form the substantive base for the following discussion. They provided a wealth of health status information on a longitudinal basis that was not otherwise obtainable. While ideally we would use a longitudinal survey of health statistics taken on a routine basis for each resident, the PHS statistics are the next best thing.

Figure A-3 shows Schuchulik's population growth between 1970 and 1980, and Figure A-4 shows the percent age and sex composition for the 1980 population. The wide base of Figure A-4 (age 1-20) signals the potential for population growth. As seen in Figure A-3, the population was growing during the ten year period. Growth would have been greater were it not for frequent outmigration from the village. This outmigration, which often occurred for purposes of securing employment, probably explains the constriction in the 25-40 age bracket of the population pyramid, especially among males. Mean age in Schuchulik in 1980 was approximately 25 years.

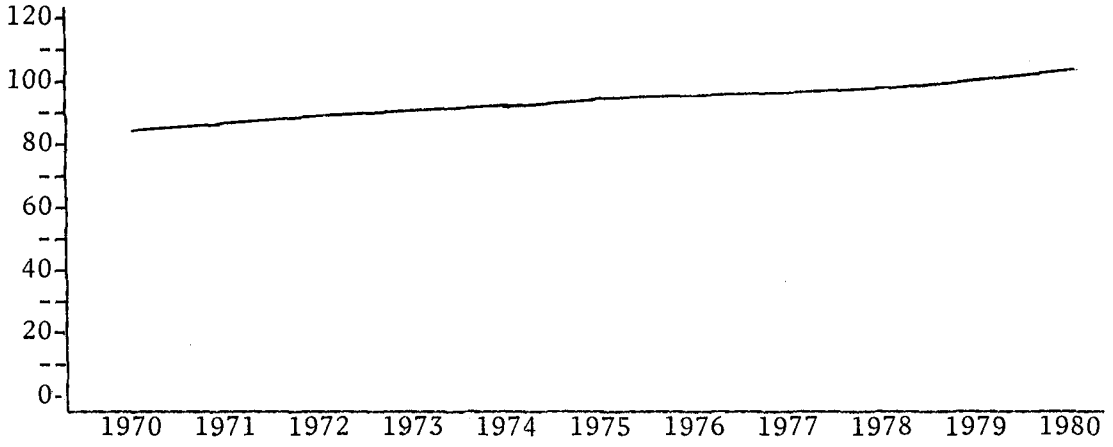


Figure A-3. Schuchulik population 1970 - 1980

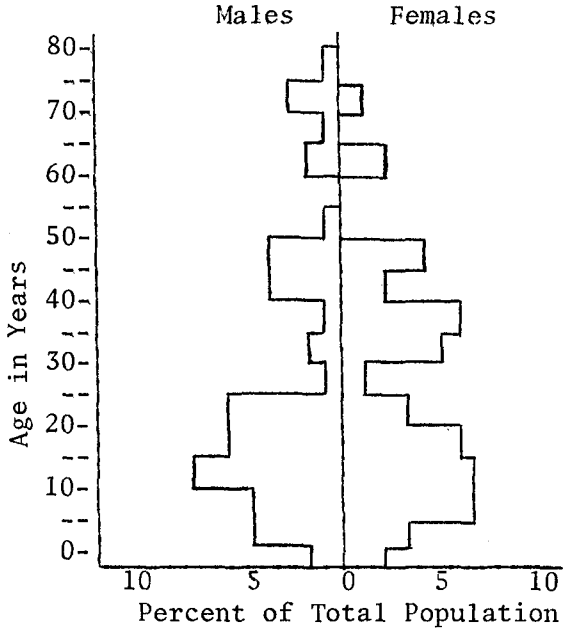


Figure A-4. Age and Sex Composition of Schuchulik's Population in February, 1980

Figure A-5 compares the numbers of Schuchulik people using the reservation's PHS medical facilities for routine health services from 1970 to 1979. Over the ten year period the percentage of the population using the PHS fluctuated between 53% and 74% with a general tendency toward increased use. We detect no change in the general pattern since electrification at the end of 1978; that is, the increase in PHS usage in 1979 is probably related to a similar tendency in previous years in which the village was not electrified. The 1979 figure of 73% of the village population using the PHS corresponds roughly to the 72% of the PHS population that we would count as either residing in the village full time, or attending boarding school as a child of a village family. Thus the percent use of PHS facilities might serve as a rough indicator of resident population. There are still some people, however, who rarely, if ever, use the PHS. The upward slope of the graph could indicate that the village population is growing progressively less healthy. Alternatively, the observed increase in PHS might reflect an increasing confidence in white man's medicine, increasing visits for health maintenance rather than sickness treating purposes, or greater accessibility to modern medical technology as transportation networks are improved. The only conclusive statements we can make at this time are : 1) there is a tendency toward increased use of PHS medical care for routine health maintenance, management of chronic diseases, and initial diagnoses; and 2) this tendency does not seem to be directly related to electrification. Inferences concerning those health needs requiring hospitalization cannot be made here as critical cases are treated in Phoenix and Tucson hospitals.

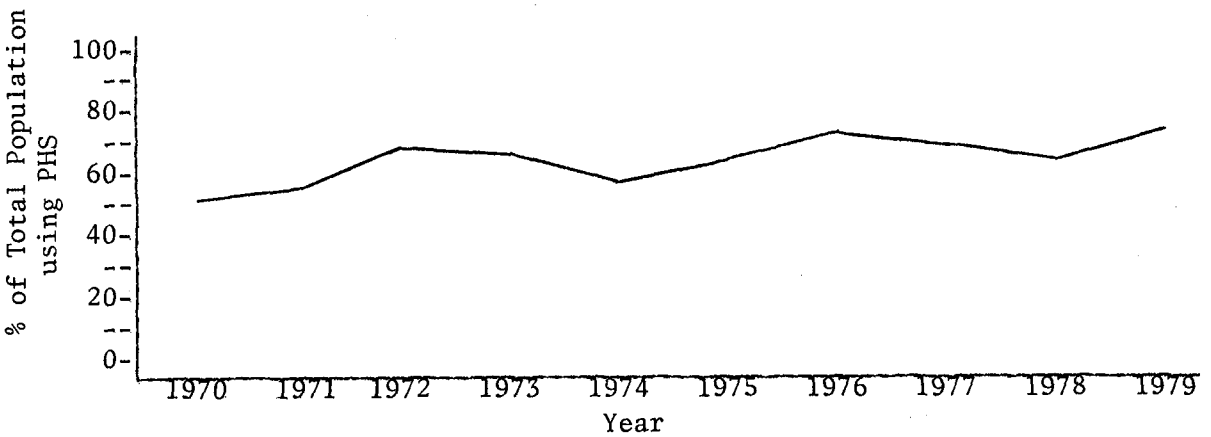


Figure A-5. Percent Use of PHS, 1970-1979

The number of visits made by Schuchulik patients between 1970 and 1979 have been averaged in Figure A-6. The visit per patient ratio increased during this period. Again, the trend can be variously explained, by a lowering of the general level of health or by increased acceptance and availability of non-Indian medical treatment. Study of the visit per patient ratio for subsequent years will help determine if the downward shifts in 1973 and 1979 reflect real improvements in health status or lifestyle changes.

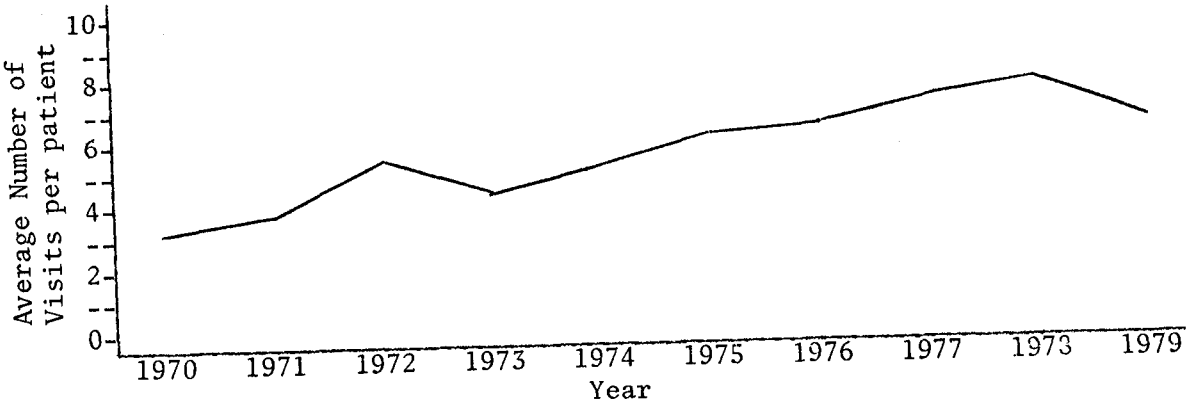


Figure A-6. Average Number of PHS visits by Schuchulik patients, 1970-1979.

One way in which electricity might affect health would be by altering sanitation practices. For instance, food stored in a refrigerator might get less exposure to bacteria than in an ice chest or on a shelf, and bacteria would multiply less rapidly. On the other hand, use of a refrigerator might lead people to try to keep food so much longer that the bacteria content would increase. Figure A-7 documents the frequency of PHS treatment for tuberculosis and intestinal infectious diseases over a ten year period, both of which may be spread through infected food (although the most frequent mode of tuberculosis transmission is through the air). It appears from the graph that electrification in late 1978 might have improved sanitation practices. A more likely explanation for the observed fluctuations, however, might be found by examining contagious disease instances in nearby villages. The peaks for the two types of contagious health problems represented in Figure A-7 coincide not only with each other, but in many cases with instances of contagious diseases in other villages (see Figures A-21, A-22 below). This observation is not surprising in light of the extent of inter-village feasting and visiting.

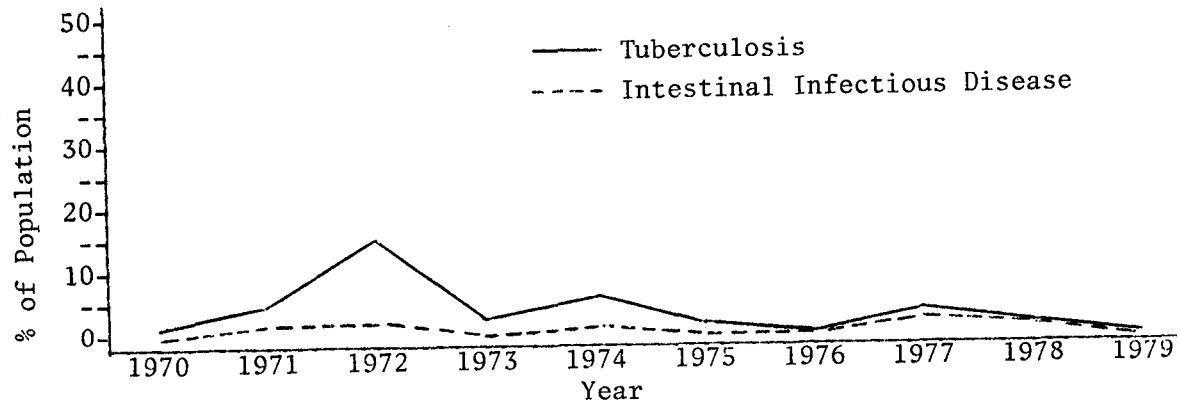


Figure A-7. Incidence of Tuberculosis and Intestinal Infectious Disease in Schuchulik, 1970-1979.

Hypertension has been found to be related to salt intake by some nutritional researchers. Other etiological factors include stress and aging. PHS data reveals a low incidence of hypertension in Schuchulik, averaging only .5% of the population for 1970 through 1979 (Figure A-8). The highest incidence, 2% was reached in 1976. Blatant vitamin deficiencies were also apparently rare in Schuchulik during the ten year period. Only six cases were reported for those years: two in 1972, and one for each of the years 1970, 1974, 1975, and 1977. No vitamin deficiency cases were reported in 1971, 1973, 1976, 1978 and 1979.

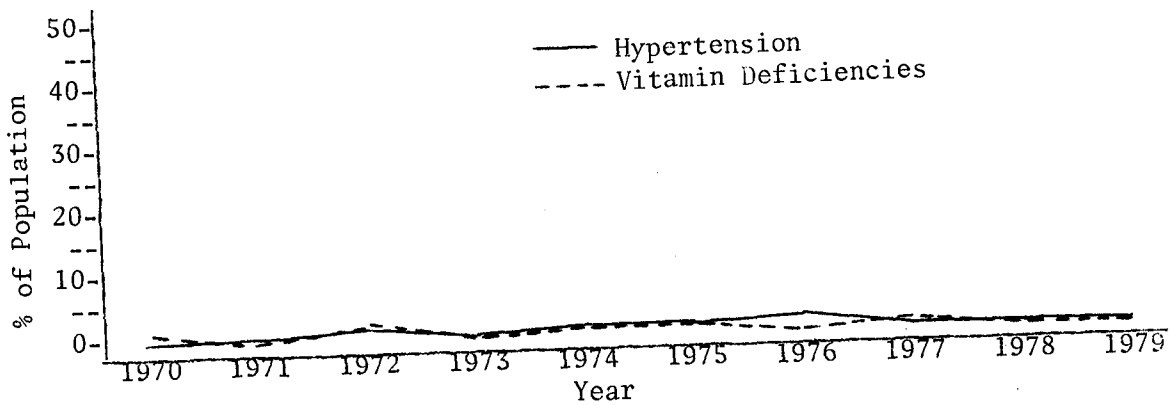


Figure A-8. Incidence of Hypertension and Vitamin Deficiencies in Schuchulik, 1970-1979.

The number of PHS patients treated for adult onset diabetes mellitus gradually increased from 2% of the population in 1970 to 5% in 1979 (Figure A-9). Diabetes, although it cannot be cured, can be controlled through medication, diet, and weight control. Thus, the number of people seen for diabetes in a given year reflects the number of incidences where patients sought regular medical attention or were not in control of their disease rather than the actual disease prevalence. In 1979, eleven Schuchulik people probably suffered from diabetes (11% prevalence). This represents about 28% of the PHS population over age 30. Ten of the adults who actually resided in Schuchulik were diagnosed diabetics, yielding a 12% prevalence figure using our "expanded" census estimates (Figure A-9). Thus, diabetics made up about 43% of Schuchulik's resident population over age 30 in 1980. The individuals apparently exercised various degrees of control over their condition. The use to which the new refrigerators are eventually put, whether primarily for such items as soda pop as opposed to fresh fruits, vegetables, and meats, may exert an influence on diabetes prevalence by changing food consumption patterns.

Blood and urine glucose levels are often used to identify diabetics and prediabetics. PHS laboratory glucose results show that Schuchulik children (age 17 and under), though rarely tested, always had glucose levels under 160mg/100ml, which is generally considered to be safe. The story was quite different for adults as shown in Table A-7. An average of 27% of those adults for which glucose levels were analyzed yielded results above 200mg/100ml in any given year between 1970 and 1979. While we are not familiar with the exact glucose testing procedures used by the PHS, it is safe to say that values

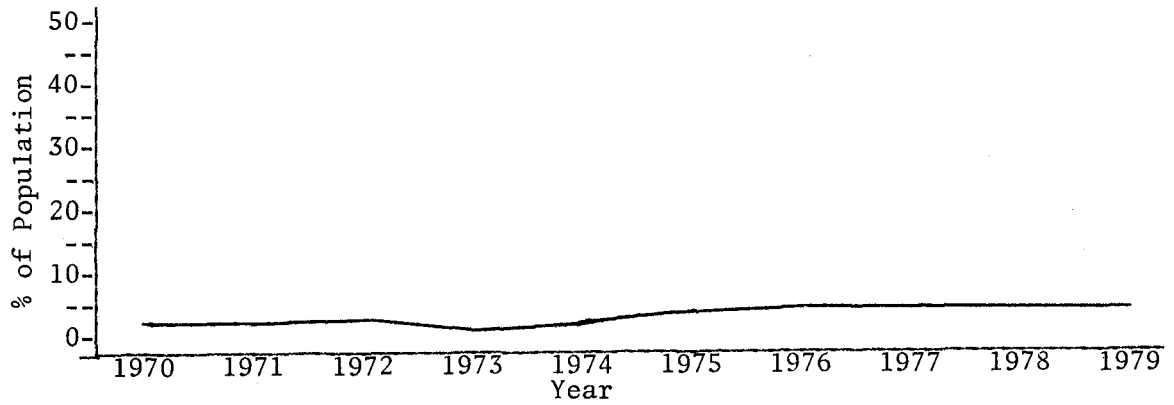


Figure A-9. Treatment for Adult Onset Diabetes Mellitus in Schuchulik, 1970-1979.

higher than 200mg/100ml are abnormal and can indicate a diabetic condition (references 23, 24). By this criterion, no cases of diabetes were indicated for 1970 and 1973. The general trend was for a higher percentage of those tested to yield results above the 200 mark through time (Figure A-10). The sample for which we have glucose test data may not be representative of the adult population as those who appeared at risk of diabetes or exhibited characteristic symptoms might have been those most regularly tested. Using the entire PHS population as our sample we can say that the elevated glucose levels characteristic of diabetes occurred for at least 5% of Schuchulik's adult population in 1974, 1976 and 1977.

Table A-7

Number of Schuchulik adults with elevated or non-elevated glucose levels, 1970-1978

	1970	1971	1972	1973	1974	1975	1976	1977	1978
Glucose level above 200mg/100ml	--	1	2	--	3	2	5	4	2
Glucose level at or below 200mg/100ml	1	5	6	4	5	5	5	5	3

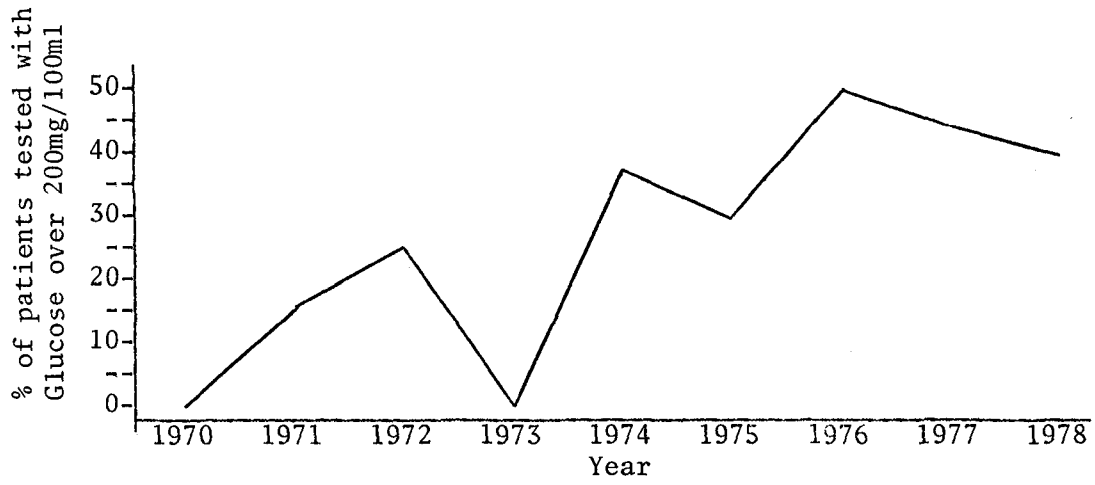


Figure A-10. Incidence of elevated glucose levels for Schuchulik adults, 1970-1978

Tables A-8 and A-9 deal with weights and heights of Schuchulik children age 2 through 20. Table A-8 uses the most recent measurements for each individual to categorize them in terms of U.S. percentile standards. Though most of the measurements were made in 1979, it was necessary to go as far back as 1975 in order to include as many children as possible. About 95% of the 1980 population under 20 and over 2 years of age is represented in the table. Our intention is to provide a general profile of the anthropometric status of Schuchulik children. Percentile scores result from the comparison of boys and girls, regardless of age, to the U.S. population as a whole. A score of 50% represents the average or mean for U.S. children surveyed by the National center for Health Statistics (NCHS) in 1977. Other percentile scores can be interpreted as follows: a score of X% indicates that an individual is heavier (or taller) than X% of the U.S. population of the same age and sex. It appears that Schuchulik boys and girls are roughly average in height by general U.S. standards. The mean height for Schuchulik boys was in the 50-75% range, while the mean height for Schuchulik girls was in the 25-50% range. Thus, Schuchulik boys were slightly taller and Schuchulik girls, slightly shorter in general than average American boys and girls of the same age. In terms of weight, both boys and girls from Schuchulik were generally heavier than the U.S. average. Mean values for both sexes fell in the 75-90 percentile range.

A comparison is made in Table A-9 of our Schuchulik data with the results of a 1941 height-weight survey of Papago school children (reference 25). For comparison, the data are expressed in terms of the percent of each sex-measurement category rather than actual numbers of individuals as in the previous table. From the table it appears that Schuchulik boys are generally somewhat taller and girls somewhat shorter than the 1941 Papago school children. These height differences may be tied to nutrition, but it is difficult to say for sure without more information. Schuchulik boys and girls both tended to be heavier in 1979 than the 1941 Papago children. It seems reasonable to conclude that more food was available to Schuchulik children than the 1941 population as they grew up.

Table A-9

Height and Weight Comparison for Schuchulik, 1979
and Papago School Children, 1941

		0-5	5-10	50-25	25-50	50-75	75-90	90-95	95+
MALE HEIGHT	Schuchulik 1979	--	--	7%	33%	40%	7%	7%	7%
	Papago 1941	7%	5%	18%	25%	22%	12%	5%	5%
FEMALE HEIGHT	Schuchulik 1979	--	5%	10%	50%	10%	10%	5%	10%
	Papago 1941	--	--	16%	31%	27%	18%	5%	3%
MALE WEIGHT	Schuchulik 1979	6%	--	--	6%	25%	31%	--	31%
	Papago 1941	4%	5%	9%	26%	30%	16%	3%	7%
FEMALE WEIGHT	Schuchulik 1979	--	--	--	8%	36%	28%	12%	16%
	Papago 1941	--	1%	4%	22%	43%	22%	4%	4%

Table A-8

Last Measurement

	0-5	5-10	10-25	25-50	50-75	75-90	90-95	95+
Male Weight	1	--	--	1	4	5	--	5
Female Weight	--	--	--	2	9	7	3	4
Male Height	--	--	1	5	6	1	1	1
Female Height	--	1	2	10	2	2	1	2

Though we had no comparative data for the current Papago population as a whole it is our intuition based on casual observation that Schuchulik children were not noticeably different in weight and stature from other Papago children. Without standards constructed specifically for Papagos it is impossible to be precise on the issue of desirable weights for the children. It is likely that such standards would differ somewhat from those of the general U.S. population, but probably not to the extent that the need for better weight control would be erased. Any tendencies toward obesity could, if continued into adulthood, predispose individuals to diabetes and other health problems.

Height and weight measurements for Schuchulik were also monitored for 1978 and 1979, the years just before and just after electrification, in order to test for any changes that might have occurred. Table A-10 shows the number of children who: 1) moved to a higher percentile category; 2) stayed in the same percentile category, and 3) moved to a lower percentile category as revealed in consecutive height and weight measurements thoughout the two year period. As can be seen in the table, most children for whom we had data stayed in the same percentile category. This was as was expected since, even if there had been significant dietary and exercise pattern changes, these would only gradually be reflected in the anthropometric indicators. Any movements between categories tended to be toward a higher percentile category for female heights and weights, and male heights. Movement for male weights tended towards a lower percentile ranking. In short, our information on heights and weights indicates a general sufficiency of protein in the diet and an overabundance of calories for most Schuchulik children.

Lab results of tests for serum albumin confirm the height and weight indications, as well as those of our nutritional analysis, that protein nutrition was generally adequate in Schuchulik. Under normal conditions, serum albumin makes up 50 to 65% of the total blood protein concentration (reference 26). Deviations can be used to indicate mild protein malnutrition when more obvious clinical signs have not yet occurred. It can be seen in Figure A-11 that average serum albumin levels for those Schuchulik adults tested between

Table A-10

1978-1979 Trends

	to higher %	same %	to lower %
Male weight	1	10	3
Female weight	5	17	2
Male height	2	5	1
Female height	2	8	1

1973 and 1978 (the only years for which PHS data was available) usually fell in the low risk range. Only one individual for the entire period could be classified as being at high risk for possible protein malnutrition. Again we stress that the sample for which we have PHS data is not statistically representative of the entire village. However, we observed no clinical indications of protein malnutrition in any villager during our study.

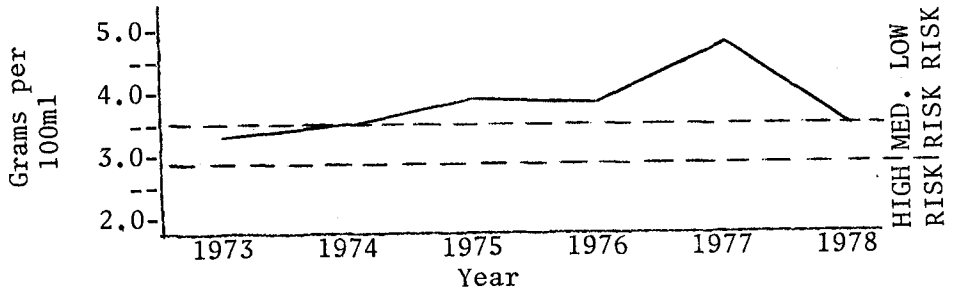


Figure A-11. Average Serum Albumin Levels for Schuchulik, 1973-1978.

Iron nutriture can be evaluated using hematocrit and hemoglobin blood test results. Standards for both tests vary, not only with the age and sex of the individual, but also with altitude. Taking such considerations into account, we found that almost all laboratory results were above the acceptable levels for villagers age 17 and under, regardless of sex for 1970 through 1979. Adults, both male and female were more likely to have low hematocrit and hemoglobin levels indicative of mild anemia. Only four cases occurred in the ten year period, two males and two females, in which laboratory results were low enough to indicate a more serious anemic condition. The low incidence of

anemia is consistent with our observation, based on the nutrient analysis of food consumption of a segment of the village population, that iron intake was generally adequate with exceptions among women. Because of the generally insufficient sampling inherent in the use of PHS statistics, it would be difficult to document any trends at this point. Suffice it to say that childhood iron nutriture in Schuchulik prior to the complete incorporation of the refrigerators into the dietary pattern appears to be superior to adult iron nutriture. The difference may have to do with the iron content of meals provided to school children as compared with adult diets.

PHS calcium test results reveal that those Schuchulik adults who were tested generally had low normal or even lower than normal values for 1973 through 1978 (Figure A-12). No calcium data were available for village children. The findings for adults were not surprising since, as was already mentioned, native foods were not in general usage in Schuchulik, and high calcium native foods such as cholla buds have not been replaced by other foods with equivalent calcium content. Our dietary observations indicate that while Schuchulik children drink milk, adults do not, nor do the adults regularly consume other foods rich in calcium.

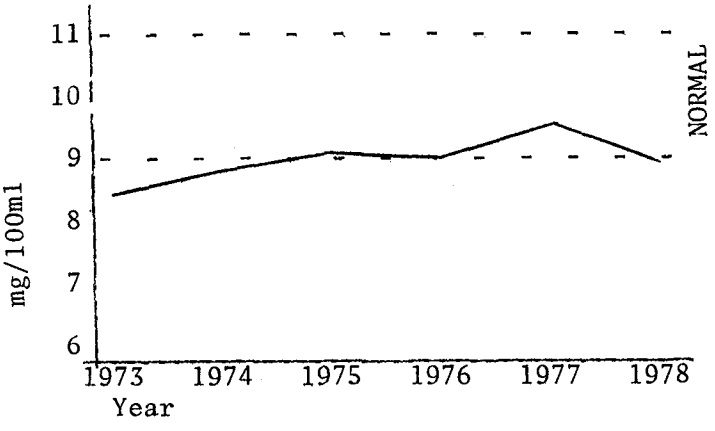


Figure A-12. Average Calcium Level in Schuchulik, 1973-1978.

Average adult cholesterol levels are shown in Figure A-13. In general, PHS lab results for Schuchulik adults were close to or even lower than the 200mg/100ml level considered optimal (reference 24). Only three instances out of a total of twenty-four were recorded of cholesterol levels higher than 240mg/100ml (12.5%). More extensive testing would be necessary to determine whether the general upward tendency of the curve in Figure A-13 is the result of a real rise in cholesterol levels among adult villagers, or simply a byproduct of selective sampling.

The results of our investigation into Schuchulik health status can be summarized as follows: no drastic changes in health were evident in the year immediately following electrification, nor were they expected. We expect

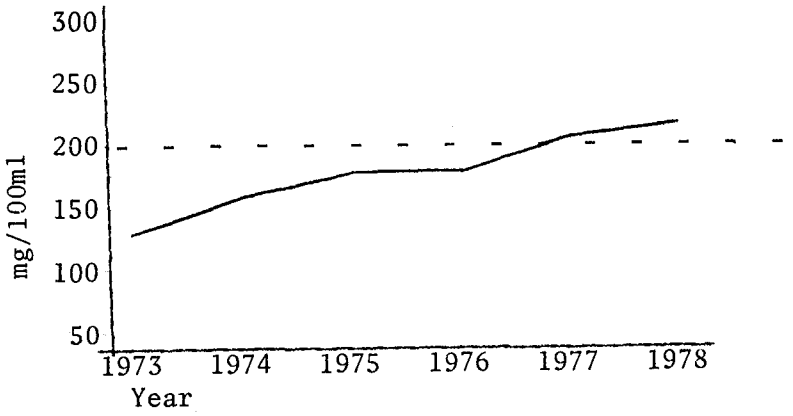


Figure A-13. Average Cholestorol Level in Schuchulik, 1973-1978.

any changes to be gradual in nature and have attempted to establish the best baseline possible from which future trends may be assessed. Future research may indicate that refrigerators have very little or even negligible effect on diet and health. The question then becomes one of convenience rather than necessity. If, on the other hand, the refrigerators are found to exert a beneficial effect on health, the use of solar electricity to provide cool storage may be highly desirable in many technologically isolated communities, especially those in which seasonal fluctuation of food supply regularly occurs. To our knowledge, no comparable studies as to the effect of refrigerative food storage on health status exist other than the very tentative treatment at the end of this chapter. Though we would have liked to have been more conclusive here, we must leave the opportunity to future researchers. The issues under consideration are admittedly complex and, unfortunately, our presentation has raised more questions than it has answered. We conclude this chapter with a comparison of health statistics from two other Papago Reservation villages.

Comparison of Health Status for an Electrified and a Non-electrified Village

In this section we compare some basic health statistics provided by the Public Health Service (PHS) for two villages in order to examine the effect of electricity on health. The actual health indicators used here were chosen on the basis of data availability and processing time. A better comparison would use all the types of data found in the previous discussion of diet-related health status in Schuchulik and more, preferably obtained from a systematic longitudinal health survey. We will look first at identifiable health status differences, if any, and second, at possible causes. Information from Schuchulik will be used to add a further point of comparison whenever possible. The health status comparison proceeds after the following presentation of relevant background information about the two control villages.

Two populations located near Schuchulik were chosen for our comparison in attempt to minimize the influence of such factors as genetic composition,

differential resources, and distance to groceries and health facilities. San Simon, approximately twenty miles from Schuchulik in the direction of Sells, received conventional electricity from the PTUA in the 1950's. The people of San Simon commonly kept refrigerators in their homes whereas the people of Charco 27, a village without conventional electricity as of 1980, rarely used refrigerators. Charco 27 is located approximately fifteen miles to the north east of Schuchulik and is slightly closer to San Simon, where most children from all three villages attend elementary school. People of the three villages travel to Sells for most of their routine health services, often with the assistance of district health officials. More serious conditions are treated in Phoenix and Tucson hospitals and are not included here.

Figure A compares the populations of San Simon and Charco 27 on the basis of age and sex composition for February, 1980. Based on our observations in Schuchulik we would suspect that the PHS population statistics used here are somewhat higher than would be found in a door to door census survey of either village. High school children of both Charco 27 and San Simon, like those of Schuchulik, attend boarding schools throughout most of the year. These and other people who reside most of the time off the reservation or in other reservation villages often maintain strong ties to their home village, and are eligible to use PHS medical facilities. They are also likely to be included in PHS population statistics. Throughout this discussion the graphs represent results from Charco 27 with a solid line and results from San Simon with a broken line.

According to Figure A-14 San Simon has a higher percentage of its population under age 15, between 30 and 39, and over 50 than does Charco 27, whose percentages are higher for those people between ages 15 and 29 and also 40 and 49. The average age for Charco 27's population is 30 years; and for San Simon's, 28 years. If permanent outmigration is relatively infrequent and mortality fairly low, it would appear that both populations have a potential for expansion as evidenced in the high proportion of young people in both villages. Both populations have indeed been growing over the past ten years as shown in Figure A-15.

Our first health status comparison concerns the percentage of each population which made use of the PHS for their medical needs. Figure A-16 shows that, in general, the percent use of the PHS increased for both San Simon and Charco 27 between 1970 and 1979. Use of the PHS increased unevenly, but proceeded at approximately the same rate for both villages. A higher percentage of Charco 27's population used the PHS for five of the ten years; whereas a higher percentage of San Simon's used the PHS for four of the years. Percent use of the PHS was the same for both villages in 1971. From Figure A-5 (p. 139) we observe that the percent use of the PHS in Schuchulik was generally higher than either of the other two villages for most of the time period in question. The Schuchulik curve was similar to those in Figure A-15 in that it was irregular and tended toward an increased use of the PHS through the 1970's.

In terms of the number of visits made by each PHS patient in any given year, San Simon surpassed Charco 27 for seven of the years from 1970 to 1979 (Figure A-17). From the graph we see that San Simon's visits per patient ratio increased far more rapidly than that of Charco 27. The most dramatic divergence between the two villages occurred from 1977 to 1979. We noted previously that Schuchulik's visit per patient ratio also increased through time at an

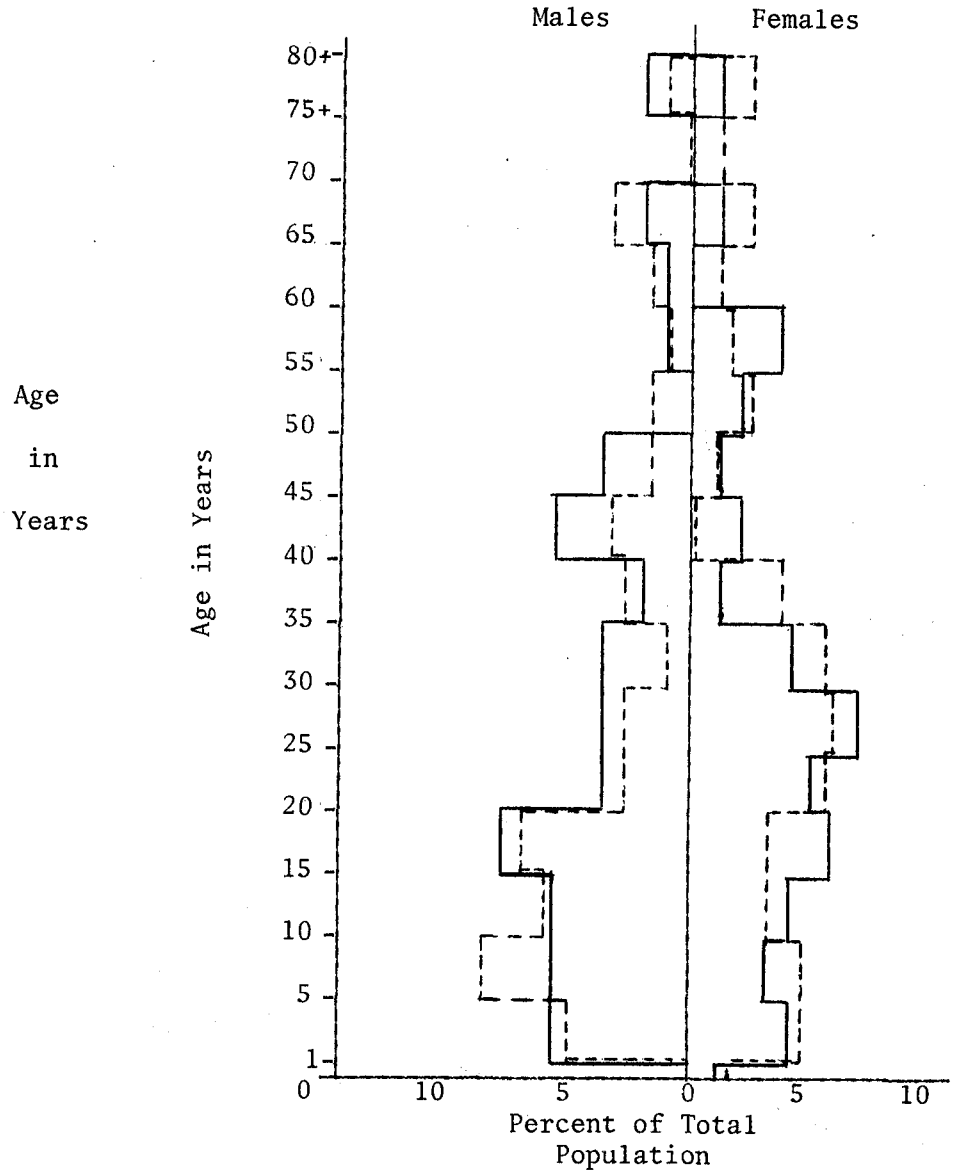


Figure A-14 Population Composition for Charco 27 and San Simon, 1980

irregular rate, similar to the pattern of the other two villages (Figure A-6). The Schuchulik visit per patient ratio was similar to those of the other two villages, though generally slightly lower until the 1977 divergence, after which Schuchulik's ratio was intermediate, approximating the San Simon curve up until a sharp decline occurred in 1979.

Analysis of PHS records as to the frequency of treatments for certain diet-related health problems helps specify some of the factors contributing to the general health picture presented in Figures A-17 and A-18. It also serves as a first step toward identifying the dietary impact of refrigerators and the resultant health impact. The categories of health data examined here

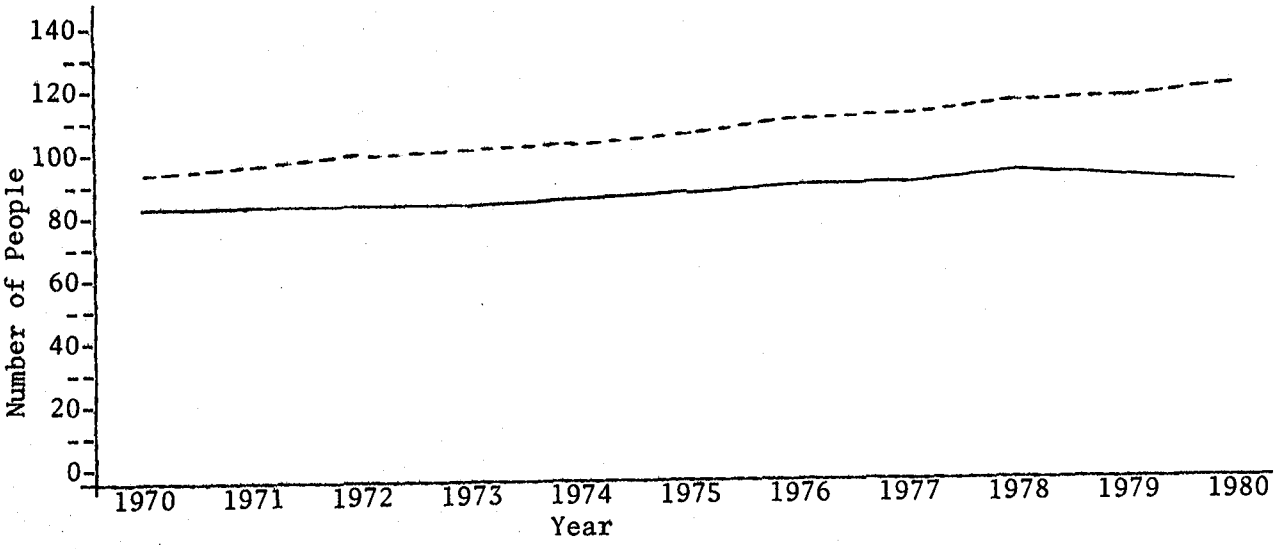


Figure A-15. Population Growth in Charco 27 and San Simon, 1970-1980.

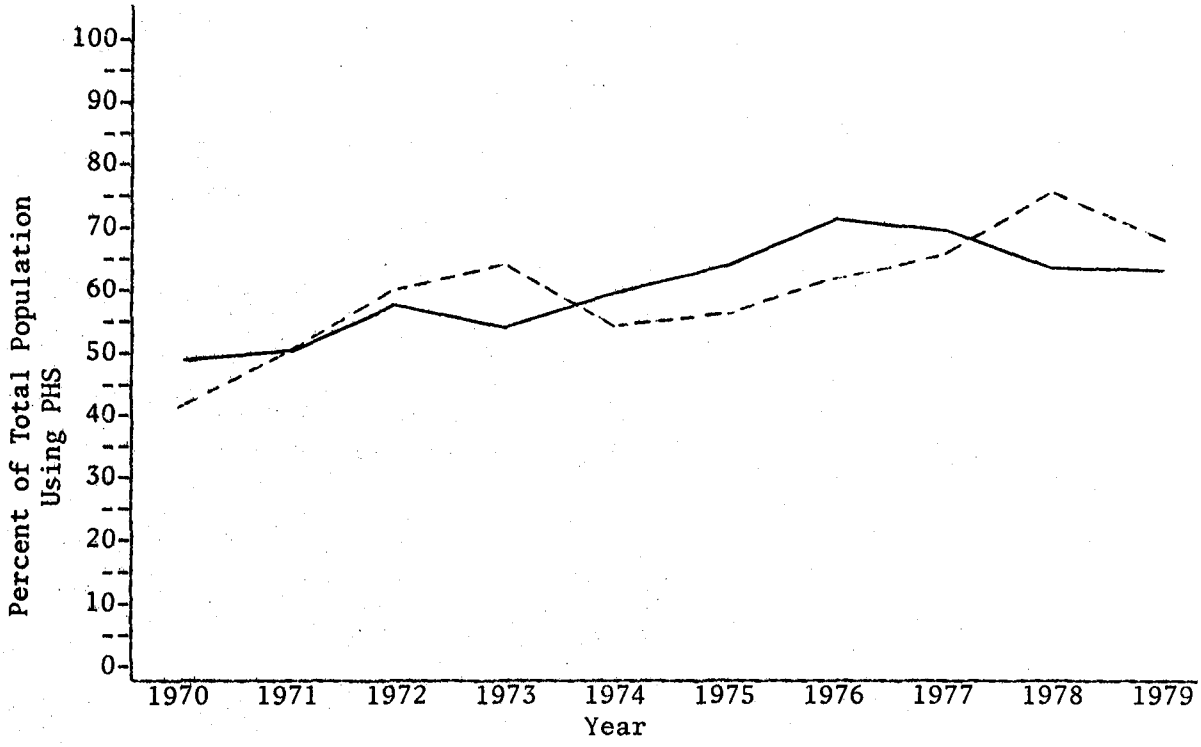


Figure A-16. Percent Use of PHS Medical Facilities for Charco 27 and San Simon, 1970-1979.

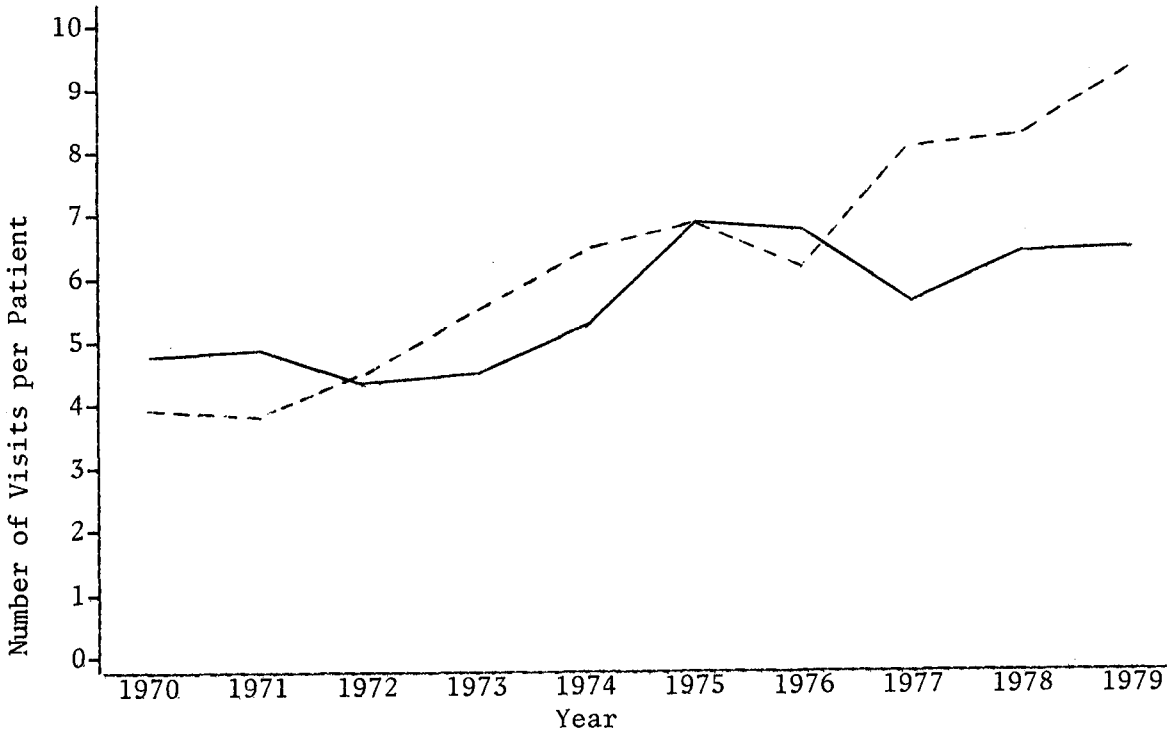


Figure A-17. Average Number of Visits made by each PHS patient from Charco 27 and San Simon from 1970-1979.

include vitamin deficiencies, diabetes, hypertension, intestinal infectious disease, and tuberculosis, in order of the strength of the relationship to diet.

Very few people from either village were seen by the PHS for vitamin deficiencies in the 1970's; three individuals from San Simon during the years from 1973 through 1975, and two individuals from Charco 27 during 1978 and 1979. Schuchulik surpassed both villages, as six vitamin deficiency cases were recorded between 1970 and 1977. Critical vitamin malnutrition is apparently not a problem in any of the three villages. Any existing differences in vitamin nutriture might better be detected in an extensive survey of appropriate laboratory test results, such as those examined previously in regard to diet-related health status in Schuchulik. Vitamin intake can be low enough to cause physiological problems, such as the lowering of disease resistance without causing the symptoms of specific deficiency diseases seen in extreme cases.

Incidence of adult-onset diabetes, closely related to diet, weight, age and genetic heritage, is examined in Figure A-19 which represents the percentages of the two respective populations seen by the PHS for diabetes each year from 1970 through 1979 as calculated from the population statistics used in Figure A-15. The resultant values cannot be used to determine the actual prevalence of the disease in the two villages as those diagnosed diabetics who gain control of their condition through dieting and weight loss become invisible for our study -- they do not seek regular treatment. It appears from Figure A-19 that treatment for diabetes is increasing through time in both San Simon and

Charco 27. It can also be seen that diabetes was more of a problem in San Simon than in Charco 27. On average, San Simon had more than twice the Charco 27 percentage seeking treatment for diabetes in any given year. Percent treatment for diabetes in Schuchulik approximated the San Simon curve more closely than that of Charco 27 as seen in Figure A-9 (p. 142). These findings are somewhat surprising as the Charco 27 population is, on average, older than that of San Simon. From PHS statistics we know that the 1979 prevalence of diabetes in Charco 27 was approximately four percent of the total PHS population; and in San Simon was approximately nine percent of the total PHS population. The eleven percent diabetes prevalence noted for Schuchulik is most similar to that of San Simon even though the population is the youngest of the three villages. No comparative data was available for diet, weight, or genetic background.

Hypertension, or consistently elevated blood pressure has tentatively been linked to excessive salt intake. If the causal linkage holds among Papagos, from Figure A-20 we would expect salt consumption to be highest in Charco 27, lower in San Simon, and lowest in Schuchulik (see Figure A-8, p. 141). In other words, the greatest difference is between Charco 27 and Schuchulik, neither of which was conventually electrified during most of the ten year period for which data were available.

Examination of the frequency of treatment for infectious diseases yields information on sanitation practices, an important part of a group's food pattern, and general disease resistance, which is often linked to the quality of the diet. Both tuberculosis and infectious intestinal diseases can be transmitted through food handling. The incidence of both types of health problems fluctuated considerably through time for both control villages (Figures

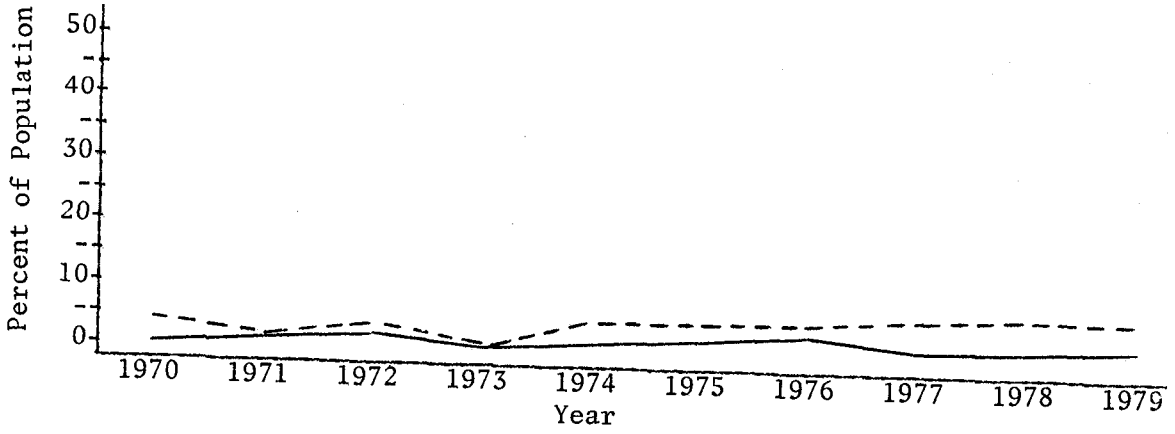


Figure A-19. Percent of total Charco 27 and San Simon populations seen by the PHS for diabetes, 1970-1979.

A-22, A-23) and for Schuchulik as well (Figure A-7, p. 140). Tuberculosis averaged 2.23% in Charco 27 and 2.93% in San Simon for the 1970-1979 populations. Intestinal infectious disease averaged 1.46% for Charco 27 and 1.06% for San Simon over the same time period. Comparable figures for Schuchulik

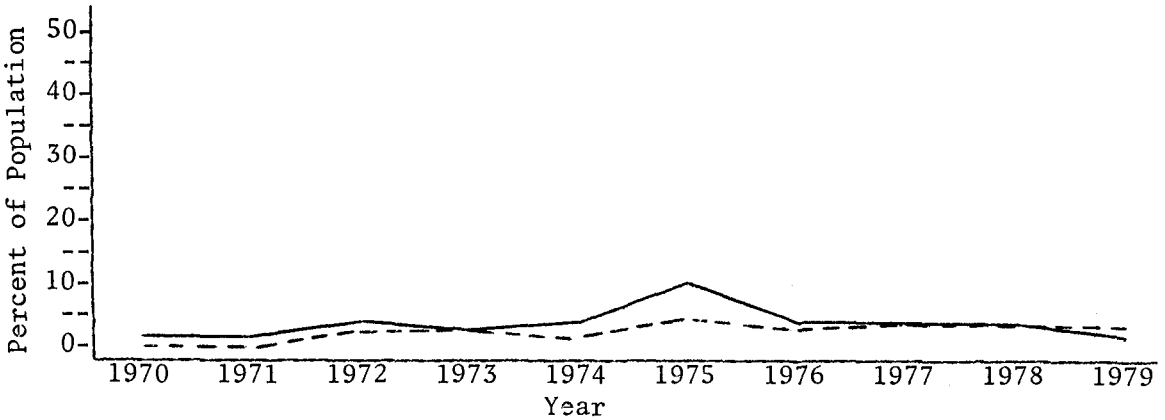


Figure A-20. Treatment for Hypertension in Charco 27 and San Simon, 1970-1979.

are 3.7% average for tuberculosis and 1.4% average for intestinal infectious disease. It appears that sanitation practices and disease resistance were not appreciably different in the three villages. Alternatively, it could be that enough community events, such as fiestas, were open to all three villages that the infectious disease patterns were similar. The coincidence of many of the peaks in the three graphs indicate that such might well be the case.

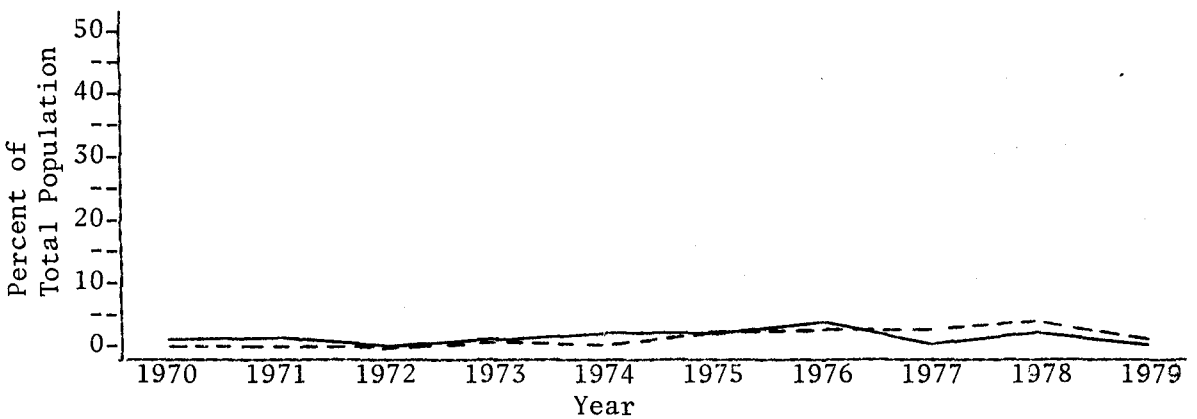


Figure A-21. Treatment for Intestinal Infectious Disease in Charco 27 and San Simon, 1970-1979.

In sum, our survey of PHS health statistics shows that San Simon clearly surpasses Charco 27 in terms of visits per patient and frequency of treatment for diabetics. Both villages had similar curves for the percent of the population who were PHS patients, or suffered from vitamin deficiencies, intestinal infectious disease, or tuberculosis. Charco 27 surpassed San Simon for hypertension. The general trend for both villages and Schuchulik as well has been toward increasing use of the PHS medical facilities, in terms of both the percentage of the population and also the number of visits made by each patient. Diabetes in particular seems to be increasingly problematic in all three villages. General trends were not clearly evident for the other

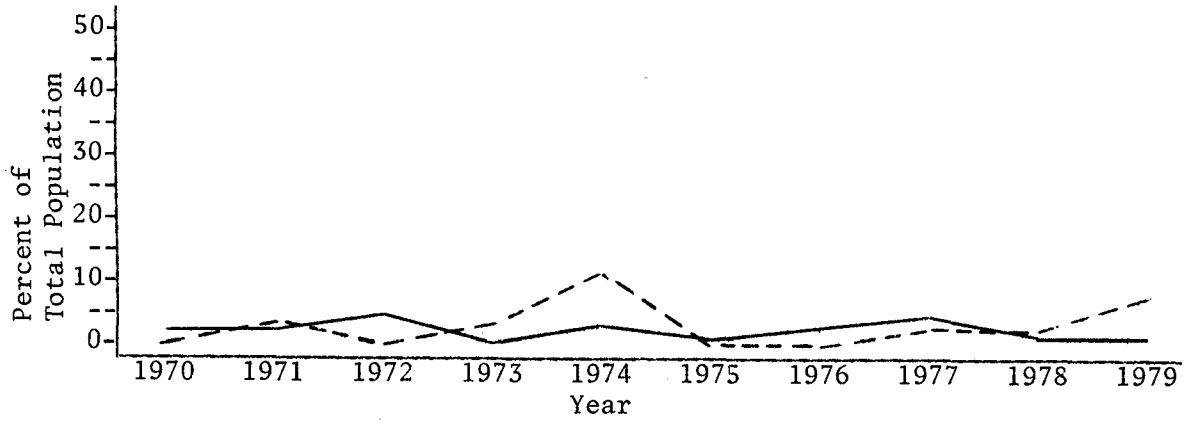


Figure A-22. Treatment for Tuberculosis in Charco 27 and San Simon, 1970-1979.

diet-related health problems: vitamin deficiencies, intestinal infectious disease, tuberculosis and hypertension.

All three of the Papago villages considered here experienced increasing access to modern American conveniences during the ten year period in question, though only one of them, San Simon, had conventional electricity. Electricity is only one part of a larger process of Papago modernization. Other parts of the process, common to the three villages include: 1) the provision of domestic water systems; 2) the bussing of children to day schools; 3) the extension of outpatient health care programs to the villages; and, 4) the extension of a variety of economic and food assistance programs.

To conclude, the presence or absence of domestic electricity does not correlate uniformly with better or worse diet-related health states. This will surprise only those readers who expect health miracles from single technological innovations. On balance one might conclude from the above comparisons that electrified San Simon enjoys worse health than pre-electrified Schuchulik, but it would be presumptuous to say that electrification is the cause of this. Rather we would suggest that modernization as a broad process has brought some health problems to Papagos and electrification is part of this larger process. By itself electrification may be neutral or even benign in regard to health, for example, electricity lets people have refrigerators but it doesn't dictate what food will be kept in them. All that we can say at present is that the Papagos of San Simon on the aggregate have not yet used the benign potential of electrification to offset the negative effects that we subsume under the broad heading of modernization.

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA CR-165551		

4. Title and Subtitle	5. Report Date
SOCIOECONOMIC IMPACT OF PHOTOVOLTAIC POWER AT SCHUCHULI, ARIZONA	October 1980
	6. Performing Organization Code: 776-52-41

7. Author(s)	8. Performing Organization Report No.
Donald Bahr, Billy G. Garrett, and Linda Chrisman	

9. Performing Organization Name and Address	10. Work Unit No.
Arizona State University Tempe, Arizona 85281	
	11. Contract or Grant No.: DEN 3-50

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U.S. Department of Energy Division of Photovoltaic Energy Systems Washington, D.C. 20545	Contractor Report
	14. Sponsoring Agency Report No.: DOE/NASA/0050-1

15. Supplementary Notes

Final Report. Prepared under Interagency Agreement DE-AI01-79ET20485. Project Manager, W. J. Bifano, Solar & Electrochemistry Division, NASA Lewis Research Center, Cleveland, Ohio 44135.

16. Abstract

Schuchuli, a small remote village on the Papago Indian Reservation in southwest Arizona, is 27 kilometers (17 miles) from the nearest available utility power. In some respects, Schuchuli resembles many of the rural villages in other parts of the world. For example, it's relatively small in size (about 60 residents), composed of a number of extended family groupings, and remotely situated relative to major population centers (190 km, or 120 miles, from Tucson). Its lack of conventional power is due to the prohibitive cost of supplying a small electrical load with a long-distance distribution line. Furthermore, alternate energy sources are expensive and place a burden on the resources of the villagers. On December 16, 1978, as part of a federally funded project, a solar cell power system was put into operation at Schuchuli. The system powers the village water pump, lighting for homes and other village buildings, family refrigerators and a communal washing machine and sewing machine. The project, managed for the U.S. Department of Energy by the NASA Lewis Research Center, provided for a one-year socio-economic study to assess the impact of a relatively small amount of electricity on the basic living environment of the villagers. This paper presents the results of that study and includes chapters on village history, group life, energy use in general and the use of the photovoltaic-powered appliances. No significant impacts due to the photovoltaic power system were observed.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Village photovoltaic power system; socioeconomic impact of solar power	Unclassified - unlimited STAR Category 44 DOE Category UC-63d

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified		

* For sale by the National Technical Information Service, Springfield, Virginia 22161

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