Technical Discussions

XIV Meeting

XV Meeting

Washington, D. C.
September 1963

Draft Agenda Item 22

CD14/DT/3 (Eng.)
10 September 1963
ORIGINAL: SPANISH

IDEAS FOR THE FORMULATION OF A PLAN FOR THE CONTROL OF GASTRO-INTESTINAL DISEASES, INCLUDING ENVIRONMENTAL SANITATION MEASURES, EPIDEMIOLOGY, HEALTH EDUCATION, AND EARLY DIAGNOSIS AND TREATMENT

ENVIRONMENTAL SANITATION MEASURES

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SUMMARY AND CONCLUSIONS

With the techniques and methodology now available, formulae that will produce spectacular results in a public health program within a short time and at a low cost cannot be expected. In this paper study is made of the role of environmental sanitation in the control of enteric infections, also known as diarrheal diseases, with special emphasis on water supply programs first, and second on the sanitary disposal of sewage and waste waters.

It should be reemphazized that in control programs the main effort should be aimed at environmental sanitation, since the available techniques of preventive medicine require certain prior or simultaneous conditions, which can be achieved through sanitation. On the other hand the techniques of curative medicine, though an important factor in reducing mortality rates, have no effect on morbidity rates.

The most important measure in the sanitation field, and the one of greatest priority, is water supply under certain conditions, which will be discussed in detail; sewage disposal is logically the next subject for the discussion. Insect and fly control can be instituted once the results of water supply have been obtained, since disease transmission by vectors will then begin to take first place. When insecticides capable of exterminating the vector population are not available, attempts to interrupt transmission may be made by indirect means, such as sewage and garbage disposal.

The physical and chemical quality of the water being supplied exerts no major influence on the control of the disease. However, standards of bacteriological control and potability should never be sacrified for economic reasons.

The two principal aspects of water supply are: sufficient quantity and direct service into the home. It must be categorically stated that without compliance with these two requisites, no favorable results can be expected in the diarrheal disease control program. There is little virtue in public outlets either from the point of view of control of enteric infections or of the self-financing, or partial recovery of the investment.

An adequate water supply has been defined as: a sufficient amount of water for drinking, cooking, personal hygiene, and cleanliness in the home. Depending on social and economic conditions, climate, etc., a per capita provision of from 100 to 150 liters per day seems to be the minimum necessary for rural areas in Latin America. The per capita provision for urban areas is normally somewhat higher.

Tables and figures are presented to show that the provision of water should not meet with major financial obstacles. House connections, however, costs almost twice as much as a primitive system of public outlets. But the social, economic, and health benefits accruing amply justify this higher cost, especially considering the fact that the investment can be recovered and that house connections are therefore readily financeable.

In order to obtain the maximum benefit from direct water supply, a campaign of psychological impact, to bring water into the home, should be conducted at among beneficiaries in rural areas. Such a campaign could be combined with others which are aimed at housing improvement, or community development, etc.

The problem of excreta and waste water disposal has five chief aspects: latrine construction; individual disposal of waste water through septic tanks, irrigation fields, etc.; provision of public sewerage systems; campaigns to make connections so as to take full advantage of existing sewerage systems; and treatment of waste waters.

Although the usefulness of the latrine for economic disposal of excreta is recognized, it should be considered a provisional solution, and its use should be limited to areas where the population is dispersed or to such sectors as for the moment are not able to benefit from the installation of direct water supply.

Individual waste water disposal requires greater attention than it has received up to now, since in certain areas, where conditions are favorable, significant and lasting results may be achieved through the direct contribution of beneficiaries. A campaign to this end may be conducted in a manner similar to that for latrine construction.

Properly conducted programs to provide sewerage in urban areas hold promise for the control of disease. Difficulties will arise out of the necessity for giving priority to development of the water works and out of the disorderly growth of fringe areas or poor districts around certain urban centers. But it is thought that the future beneficiaries' interest, their greater financial capacity, and the municipal governments' organization and potential will greatly facilitate this health activity.

The sewerage program in rural areas will necessarily be of limited scope during the first few years. It would nevertheless be desirable to advance it to the planning stage, preferably at the same time as the rural water supply program is being conducted, and later seek the opportunity to enter the construction phase, as funds become available.

The promotion of new connections in order to take maximum advantage of the sewerage network available can bring immediate benefits with a limited investment on the part of the public agencies in charge of the program.

One problem, the adverse effects of which are beginning to be felt and which will rapidly increase, is the discharge of waste waters without prior treatment. The danger that natural water resources may be destroyed urgently calls for undertaking study and evaluation, to be followed by suitable legislation and standards. It is recognized that the provision of waste water treatment in the next years will be limited to cities and industries with a certain financial potential, but some general preventive measures should be established in rural areas as soon as possible.

Each of the programs proposed for the activities discussed in this paper will no doubt require, as a first step, individual study and evaluation, immediately followed by suitable planning. Since considerable time, effort, and investment will be required, specific programs may be initiated to cover the most apparent and immediate needs, at the same time as long-range plans are being made. The importance of standardizing and mechanizing the processes at each stage, in order to achieve significant reduction in cost and in the use of personnel with limited experience, is obvious.

It should be remembered that the final step of the program -- construction-- is not the end but the means for attaining specific results, such as provision of safe water supply, sewerage systems, sanitary excreta disposal, and so forth. The stage of greatest practical importance, therefore, is that of public education and information so as to translate expenditures into practical benefits.

In discussing financial aspects, the paper points to the need for considering water supply systems as a service, in the true sense of the word. It is pointed out that one of the reasons for slow progress is the fact that there is frequent opposition, owing to social, economic, and political reasons, instead of the attempt to overcome existing difficulties.

With the capital resources at present available, the main problem is not financing as such, but rather the creation of a favorable climate for recoverable investments. In this connection the argument for direct water supply to homes as the only system capable of ensuring partial or total recovery of the investment takes on a new validity.

The paper and annexes further offer concrete ideas on the financial aspect, and certain figures on the average per capita cost of the various headings. There are detailed comments on community participation and contribution to financing during the various stages of the work.

IDEAS FOR FORMULATING A PLAN TO CONTROL ENTERIC INFECTIONS

ENVIRONMENTAL SANITATION MEASURES

I. RELATIVE IMPORTANCE OF ENVIRONMENTAL SANITATION IN THE CONTROL OF DIARRHEAL DISEASES

The statistical data gethered in past decades clearly indicate that no health measure undertaken in a single field, without the support of secondary health measures, has to date been able to eradicate enteric infections or to reduce them to low levels of endemicity. It is also evident that the relative importance that is given to certain measures which have proved to be effective in preventive medicine, curative medicine, and environmental sanitation will determine the efficacy of the control campaign in each case. Therefore a brief comment on the relative value of activities in the three fields is in order.

From the practical viewpoint, the really effective and economic, as well as the simplest, approach to the problem is mass vaccination of susceptible populations and the use of certain preventive drugs. In the past, important results were obtained in this way, and this method is the main hope of public health workers in future attacks on diseases. As to the diarrheal diseases, the hope of attaining rapid success has to date eluded the scientists.

Other measures available in this field cannot be considered independently from other factors and influences which are outside the scope of preventive medicine since they normally require a series of propiti us conditions to achieve optimum results. One of the most important of the conditions seems to be facilities for personal hygiene in the home, a condition which is attainable through environmental sanitation.

The importance of medical techniques in the reduction of mortality rates is indisputable. But this is a matter for another paper; the only obvious fact which needs to be underlined here is that sanitary techniques used in curative medicine do not affect the morbidity picture and do not wholly solve the mortality problem.

By the process of simple elimination, therefore, one arrives at the conclusion that in countries or regions where environmental sanitation is poor, the emphasis in plans to control enteric infections should be placed on specific environmental sanitation measures.

The truth of this conclusion is well known, since for over twenty years diarrheal diseases have been associated with poor environmental conditions. All the statistical data point in that direction, and outstanding improvement has come about only in countries where the environment has become comparatively sanitary.

II. RELATIVE IMPORTANCE OF ENVIRONMENTAL SANITATION MEASURES

WATER SUPPLY

Convincing data are available to prove that the mere change of this environmental factor can bring about a significant reduction in the prevalence of Shigella, the agent responsible for a high percentage of the cases. Therefore, this paper reaffirms the thesis held by most public health workers that the sanitation measure of highest priority for the control of diarrheal diseases is safe water supply. Since the pertinent programs have to be conducted under certain specific conditions, special attention will be given later on to a detailed discussion of these.

EXCRETA AND WASTE DISPOSAL

Although the mechanism of transmission of these diseases has not yet been established in full detail, excreta undoubtedly represent a link in the chain of transmission. Suitable disposal of excreta, with or without running water, seems to be an important means of interrupting that chain. For this reason, and because of the role which this measure plays in the control of other diseases as well, most public health workers give high priority to the sanitary disposal of excreta. Later on in this paper the important health aspects of diarrheal disease control will be discussed in detail.

CONTROL OF FLIES AND OTHER INSECTS

The campaign against flies and other insects is undoubtedly important, for when the vectors are eliminated one of the possible mechanisms of transmission is interrupted. Its relative importance becomes apparent when favorable results in the water supply program begin to appear, and transmission by vectors moves to first place.

Unfortunately, science to date has not been able to develop a truly effective weapon, that is, an insecticide capable of exterminating the vector population. The present campaign, therefore, is being conducted on two fronts: directly, through insecticides to reduce the vector population during peak periods; and indirectly, by attacking the breeding places through garbage collection, and both public and private cleanliness. Sanitary disposal of excreta and waste waters to a certain extent exerts indirect influence on the control of transmission by vectors.

HOUSING SANITATION

No one can deny the importance of sanitary housing, not only because healthful conditions in the home are valuable in themselves, but also because they are conducive to social and economic development. The role such sanitation plays in diarrheal diseases is manifest in the relationship between these diseases and personal hygiene and cleanliness in the home. One cannot conceive of a healthful and clean home environment without sufficient water available. On the other hand, it is possible to keep temporarily acceptable conditions in even the most humble home, if it has certain essential facilities for personal and domestic hygiene, the first among which is water. Therefore, programs of large scope aimed at solving the problem of sanitary housing cannot prosper without prior or concomitant programs of water supply. Yet water supply programs can be carried out by themselves since they bring immediate benefits, either directly or by opening the road to similar programs.

FOOD CONTROL

The importance of food control on the national scale is especially evident in countries where the food industry is highly developed. Since this is not the case in most of the Latin American countries, attention should be directed mainly towards improving the techniques of home preparation and suitable use of foods, especially of food intended for children under 4 years of age. Aside from the fact that this is basically a matter of health education, it requires certain minimum hygienic facilities, chiefly the availability of water. Thus we arrive once more at the conclusion that, in terms of relative importance, water supply comes first.

III. IMPORTANT ASPECTS OF THE WATER SUPPLY PROGRAM

The available statistical data and experience point to the fact that the quality of water, in contrast with quantity, has no great influence on the prevalence of disease, provided the water meets certain minimum conditions of potability. Experience seems to indicate that significant results can be obtained in controlling the disease if a sufficient amount of running water can be provided in the home. Water supply through public outlets will not produce the desired results, and the attitude of planners who consider such systems acceptable should be rejected if favorable results are desired.

QUALITY OF WATER FURNISHED

The relatively lesser importance of the quality of the water to be furnished is an advantage to water supply programs from both the financial and technical points of view, for it obviates the need for costly treatment in all cases where it is not required by the social and economic conditions of the beneficiaries. This is the case especially in rural areas where social and economic evolution is in its initial phase and where water supply is therefore chiefly a health measure.

Although the fact is obvious, it is worth underlining that in speaking of sacrificing quality in favor of quantity, what is meant is the physical and chemical quality of the water and not its bacteriological quality. Nevertheless, strict bacteriological control poses no unsurmountable problem in programs with limited funds since from the bacteriological viewpoint potability can be readily achieved in most cases through an adequate selection of sources and through chlorination.

QUANTITY OF WATER FURNISHED

It should be noted that when reference is made to quantity, the term is relative and the amount of water will vary according to the social and economic status of the beneficiaries. From the viewpoint of diarrheal disease control, sufficient quantity is the amount necessary for drinking, cooking, personal hygiene, and cleanliness in the home.

In the case of urban water supplies, which furnish from 165 to 200 liters per person each day --a rate adapted to normal social and economic conditions-- the problem is automatically solved. The problem yet to be solved is that of certain rural water mains designed to distribute water through public outlets on the basis of a per capita consumption of 50 to 70 liters per day or less.

Annex A of this paper shows some interesting aspects of the relationship between distribution system costs and per capita provision in 247 different systems of the rural water supply program conducted by the Ministry of Health and Social Welfare of Venezuela.

The conclusion is reached that a minimum per capita provision of 100 to 135 liters per day can be achieved without major financial sacrifice, and that optimum rural water provision is from 150 to 200 liters per capita daily. The use of arithmetical devices in making cost estimates is suggested as a means of reducing costs. It is pointed out that systems designed to provide only 50 to 70 liters per capita will not fulfill the role of water in the control of diarrheal diseases. Moreover, their usefulness in other areas will be only temporary since subsequent population growth will require the partial or total reconstruction of such systems.

DIRECT WATER SUPPLY

The statement that considerable variations in per capita supply of water will result in only small variations in the total cost of a distribution system is a valid statement, provided a complete pipeline network, which theoretically will permit making connections to all houses of the system, is taken as a standard.

However, the temptation to save costs in water supplies by reducing the amount of pipelines installed and supplying instead through a few public outlets is very strong. A water supply system built in this manner will have only a poor and temporary impact on the beneficiaries. The only visible improvement would lie in shortening the distance for piping water into the house; but in all other respects the same primitive conditions would prevail as existed before the water main was introduced. The use of contaminated sources would possibly have been avoided, but this type of system will not prevent contamination while the water is being transportated to the home and during home storage in primitive containers. Nor does such a system succeed in inducing people to use sufficient water for personal and domestic hygiene. In other words, the sanitation aspect of distribution systems based on public water outlets is very limited, and its usefulness in diarrheal disease control is statistically insignificant.

Apart from the health implications, the difference between the two distribution methods in the social and economic plane is obvious. It is not the primitive water main, but running water in the home which will really raise the standard of living, dignify the existence of man, and contribute to his well being. Moreover, it is only when water inside the homes becomes first a wish and then a necessity that the suitable financing of water supply services will become possible.

Apart from difficulties in obtaining initial funds, one of the main reasons for the slow progress in some countries may be attributed to the failure to recognize the validity of the previous statement. The water supply system built for distribution through public outlets invariably is a non-recoverable investment, which will have to be made over again when the system has outlived its usefulness. In addition, most of such systems become a financial burden in operation and upkeep, since by providing a service of limited value, the revenue derived from water rates which they bring in is nil, or only negligible. On the other hand, it is possible to finance the operation and maintenance of really useful water supply systems providing adequate service, and to recover part or all of the initial investment or the system can be self-financed, depending on the size and social and economic status of the group benefited.

It may therefore be said that primitive systems of water supply should be undertaken only as a temporary means and for specific purposes, such as bringing together and stabilizing a dispersed population to prevent its migration to cities, or in cases where a direct service would be financially prohibitive because of the scattered and irregular location of the houses.

Annex B contains an analysis of the implications of direct water supply and divides the problem into three parts: the expansion of a distribution network; the installation of house connections; and piping water from the sidewalk into the home. It should be noted that the greatest expenditure lies in expanding the distribution network beyond the original size meant for distribution through public outlets. The benefits to health and to the economy which direct service brings fully justify the additional expenditure.

The installation of house connections is a logical consequence of this approach, especially since the added investment is only 6 per cent of the total cost of the water supply system. This figure can be further reduced by using local materials and economic construction methods, depending on the local conditions and the experience available.

One of the most important aspects of the problem of the direct provision of water is the effort to make the beneficiaries undertake the work necessary to pipe water into the house.

The organization of a campaign for this purpose should receive maximum attention from the agencies responsible for water supply programs. The coordination of such campaigns with other similar ones such as housing improvement, community development, and so forth, could bring about the most favorable health, social, and economic results.

IV. DISPOSAL OF EXCRETA AND WASTE WATERS

There are several aspects of this problem. First, there is the population group which as yet has no direct water supply service, so that the sanitation activity indicated is the promotion of latrine construction. The second population group is the one which has direct water service but has the problem of waste water disposal, either individually through septic tanks, sumps, or irrigation fields, etc., or collectively through a sewerage system. Then there is the large number of sewerage networks which serve only a part of the population, and the problem in this case lies in promoting the largest possible number of house connections. And, finally, save for a few exceptions, the great majority of existing sewerage networks in Latin America dispose of their sewage without prior treatment. This practice is alarming as it will lead to the destruction of natural hydraulic resources within a few years.

LATRINE CONSTRUCTION

It must be emphasized that this is a provisional solution and that it is inacceptable both technically and from the health point of view, wherever there is a direct water supply service. There is no denying its usefulness to a dispersed population, or in population groups which for the moment cannot benefit from a direct supply, but efforts and investments in latrine campaigns should not be made at the cost of the water supply program.

In latrine construction the direct collaboration of the beneficiaries is essential, since it takes place on their property. Education and promotion are effective activities, coupled with giving technical advice and aiding in the acquisition of inexpensive building materials. A variation of this approach, used in some countries, consists in providing prefabricated pieces contributed by the agencies in charge of the program, the beneficiaries

contributing their labor. The per capita cost varies between $5 to $15 per latrine; the additional sum required for the campaign itself varies greatly.

DISPOSAL OF WASTE WATERS

The possibility of disposing of waste waters by individual methods such as septic tanks, sumps, irrigation fields, and so forth, is limited by the nature of the terrain, availability of space, and the number of persons served. This aspect should be borne in mind when planning on the national and local scale, in both urban and rural areas, since the problem can be solved through partial or total financing by the beneficiaries themselves. Under favorable conditions significant results can be attained in such areas as housing development of the rural type, rural housing programs, housing improvement, community development, and so forth, through educational campaigns, together with technical advice to promote the construction of individual disposal systems in selected areas, after a prior study of local conditions. Such a campaign could be conducted in a manner similar to that for latrine construction.

The provision of a public sewerage service in large cities seems to be a reasonable objective, provided a suitable water supply system is available and the urban development is more or less orderly, as is not the case in most Latin American cities. There is usually, nevertheless, a deep seated desire for this service, together with some financial capacity on the part of future beneficiaries, as well as an economic structure and economic potential on the part of municipal Governments which will facilitate obtaining the funds needed for a strong initial investment. The per capita costs vary greatly, but they are comparable to those of the water supply program, i. e., about $50 per capita.

The greatest problem lies in small cities or rural areas, where it will be necessary to conduct the water supply program first in order to awaken in the beneficiaries the realization of the need and the desire for a sewerage service. Even so, great difficulties will be met in financing the sewerage program, because it is not a productive financial investment, and total or partial recovery of the investment is far more difficult, at least in the initial stages. It is nevertheless desirable to plan the sewerage program at the same time as the water supply program, and then to await the proper opportunity to introduce a partial sewerage construction program, to be conducted by stages as funds become available.

PROMOTION OF CONNECTIONS

The operation of sewarage networks at only partial capacity owing to the fact that not all the properties that could be served have been connected with them is the least of the problems. An educational campaign, together with certain legal action in urban areas of sufficient economic

capacity, can produce favorable results within a short time. In areas of limited financial capacity, it would be advisable to draw up a financing plan that will permit interested parties to pay for the cost of connections by installments, with the property serving as guarantee.

TREATMENT OF WASTE WATERS

The disposal of waste waters without prior treatment in water receptors is beginning to present a problem in most Latin American countries as it is having an adverse effect on the natural hydraulic resources. This problem will undoubtedly increase with the expansion of sewerage services and will require proper attention.

Waste water control is an activity to which a certain amount of human and financial resources should be devoted. This activity might begin with a study and evaluation of the problem taking into consideration future needs for disposal of domestic and industrial waste waters. Depending on the results of this study, the necessary legislation should be promulgated or existing legislation modified, predicated on the awareness that the immediate financing of treatment plants will be within the reach of only cities or of industries that have considerable financial potential.

V. EXECUTION OF PROGRAMS

The basic requisite for the succesful conduct of any program is planning, after evaluating the situation in the country. It would seem logical to organize and finance, as the first activity, a study and exact evaluation of present and future problems, immediately followed by short and long-term planning. The initial phase may require time, effort, and a certain amount of investment, depending on the existing situation.

However, short-term planning to begin the program immediately is possible without exact or thorough knowledge of the nation-wide situation. In fact, several countries initiated programs to meet the most immediate and obvious needs, and organized evaluation and long-term planning at the same time.

The mechanisms for conducting programs in general were already widely discussed on previous occasions (see Document TFH/2 of 31 January 1963). Nevertheless, it is believed advisable to make some additional suggestions for the phase covering the study of localities and the preparation of the projects in question.

The water supply and sewerage systems of large cities essentially require individual action in each instance, both in the study and in the design and preparation of plans for the project. Depending on the magnitude of the problem and the availability of trained technical personnel, it may be necessary to resort to the use of private sanitary engineering specialists, either regularly or as temporary consultants.

There should be a different approach to the rural area because of the large number of small localities to be served. In such cases it is advisable to set up mass production methods; this will permit using personnel with limited experience, and will also considerably reduce the cost of drawing up plans, and yet retain the high technical quality of the designs. It is possible to standardize the process from the presentation of the field report up to the preparation of models and typical design details. A classical example of such logical steps, using the "production line type" of organization may be found in the Section on Projects of Rural Water Supplies of the Ministry of Health and Social Welfare of Venezuela.

Another aspect of practical value is the grouping of several localities into one central system with a common source and common water lines, which could bring considerable savings in per capita costs. It has the added advantage of facilitating the supply of services to small localities or groups of houses, as their inhabitants could not afford to install these services individually.

The construction phase should be organized according to local conditions in each country. The experience available indicates that large-scale programs for urban areas operate better under autonomous agencies or semi-official institutions which have their own specific statutes for the program. Most countries have recognized the necessity for submitting large-scale building programs to bidding by private construction companies. In the case of rural water supplies the great number of "small" problems and the difference in the approach make it advisable to establish separate programs, with due coordination and exchange of information with the large-scale programs. The advantages of private construction under the bidding system apply here as well, although in the case of works of little importance it would be acceptable to use methods of direct administration and construction with local human resources, and community development. The latter method will require special attention, since it permits the direct contribution of the beneficiaries.

Although the program's direct and immediate results are determined by the efficiency of the construction phase, there is another aspect of equal importance: the transformation of the health activity into practical benefits will depend on the administration. The building of the works is not an end itself, but the means of achieving specific results, and only an adequate service can ensure these.

VI. FINANCING OF THE WATER SUPPLY PROGRAM

On numerous previous occasions, each time the subject of financing came up, emphasis has been placed on the fact that water supply should be regarded as a service enterprise in the truest sense of the word. On the one hand, suitable service must be provided in keeping with the needs of the beneficiaries, and on the other, the service must pay for itself according to the basic requirements of a sound business. So long as this basic principle is not accepted in Latin America, any discussion of financing will be useless. Efforts must therefore not be directed towards changing the thinking through using social, economic, and political arguments, but rather efforts must be made to overcome the difficulties which at present prevent the transformation of the water supply into a true business enterprise. It may be said that with the capital resources now available the main problem is no longer getting the funds for financing, but rather the creation of conditions indispensable to the economic soundness of the investment, since this is a prerequisite for mobilizing such capital.

Once this principle has been accepted, favorable financing can be obtained in urban areas without great difficulty. In rural areas it will be necessary to change radically the present approach to the problem and establish firmly the policy of direct service as essential to recovery of the investment. This implies revising the objectives and costs in the Charter of Punta del Este, and the recommendations of the Advisory Committee on Environmental Sanitation which met in Washington, D. C., in November 1961.

The per capita costs proposed in those recommendations no longer suffice in view of the new criterion, and the $7.50 to $15 per capita figures given should be doubled, or in other words, the average per capita cost would be $15 to $30 for rural water supplies with direct service. Although these figures may seem high, such water supplies will make it possible to recover the investment partially or totally and will therefore greatly facilitate their financing. The advantages to public health and welfare have already been discussed here.

Needless to say, programs of direct water supply to the home will not benefit the entire population for the next 10 to 15 years. It should also be recognized that it will not be possible to conduct such programs economically in areas where the population is dispersed. It will therefore be necessary to create parallel programs for certain specific purposes, limited to these areas, because it will not always be possible to postpone the solution for so many years. For example, the Ministry of Health and Social Welfare of Venezuela is conducting a pilot program for dispersed localities of up to 500 inhabitants, since direct service for such localities would be financially prohibitive. In such cases there is prior acceptance of the fact that the investment will not be recovered and that the program's benefits will be limited. The main purpose of the health activity is to supply drinking water in order to prevent the use of contaminated sources; it will, moreover, prevent migration to the cities through improved

living standards and through the fact that a common water supply tends to hold a dispersed population together. The financing of such programs is done through a 50 per cent contribution of the total cost by the regional Government and by the beneficiaries, the latter mainly through labor, a 25 per cent contribution by the Ministry of Health and Social Welfare, and another 25 per cent by UNICEF, mainly in materials, the cost of which need not be repaid.

Annex C indicates certain aspects of financing the water supply program.

IDEAS FOR FORMULATING A PLAN TO CONTROL ENTERIC INFECTIONS

ENVIRONMENTAL SANITATION MEASURES

A N N E X E S

A. Relationship between the cost of distribution systems and amount of water provided per capita

B. Implications of direct water supply

C. Financing of water supply programs

ANNEX A

RELATIONSHIP BETWEEN THE COST OF DISTRIBUTION SYSTEMS AND THE AMOUNT OF WATER PROVIDED PER CAPITA

Table 1 of the Annex shows the relative costs of pipes of different diameters and materials compared with their transport capacity. While unit and labor costs may vary greatly from country to country and this variation affect all items in the table, relative costs will remain more or less the same. The table shows that a comparatively small increase in the cost of the pipe will produce a substantial increase in transport capacity.

Tables 2, 3, 4, 5, and 6 cover a study of 247 distribution systems serving 272,538 persons in localities of up to 5,700 inhabitants. These have been divided into the following groups: 0-500; 501-1,000; 1,001-1,500; 1,501-2,000; and 2,001-5,700 inhabitants and these distribution systems were designed to supply water directly to all houses that could be connected to the network. Localities covered are part of the Rural Water Supply Program of the Ministry of Health and Social Welfare of Venezuela during the period 1 July 1959 - 31 December 1962, and most of the systems are either in full operation or in the construction stage. The pertinent data are summarized in Table 7.

Since ambitious standards of design and optimum building materials were used, the per capita cost is higher than average for Latin America, but the main purpose is to show that in the small localities approximately 70 per cent of all pipes are 2" to 3" in diameter and these represent about 60 per cent of the cost of all pipes. The water provided per capita by these aqueducts is 150-200 liters per day, an amount considered sufficient to take care of all the needs of inhabitants in rural areas.

Assuming that for reasons of economy a smaller pipe is used, it will reduce the per capita amount of water to one third of the amount above, or 50-70 liters per day. A comparison of the relative cost and capacity of pipes in Table 1 with the relative cost of the distribution systems summarized in Table 7 shows that the use of a smaller pipe theoretically reduces the cost by 24 per cent - 26 per cent. However in practice this saving amounts to 20 per cent at the most, since the cost of pipes 2" in diameter, the minimum size acceptable, is only 16-33 per cent of the total cost of the distribution system. Moreover, the reduced per capita provision resulting from this saving will not suffice to meet all the needs of the beneficiaries. Therefore, aqueducts designed for such reduced provision will not fulfill their function in the control of diarrheal diseases, and their usefulness in other areas will be only temporary, since population growth will eventually require their total or partial reconstruction.

Assuming that the original amount of water provided by the system is reduced to two-thirds, or 100-135 liters daily per capita, a savings of some 10 per cent is obtained. This amount of water may be considered sufficient under certain social and economic conditions of the population in question, but the possibilities of a gradual expansion or improvement of the distribution service to subsequently reach the proportions of an urban water supply will be limited.

The other factor which influences the diameter of distribution pipes is variation in consumption, since the systems are designed to take care of maximum hourly demands. The supply systems discussed in the preceding tables were designed for an hourly consumption of 250-300 per cent of the average volume, or the amount planned. By ignoring this feature, the pipe diameter could be reduced and similar cost reductions could be achieved as in the former case. Therefore, within certain limits, cost reductions can be achieve by this simple artifice in mathematical calculation instead of by reducing the amount of water provided. The adverse effect of reducing the cost of design will show up only during the brief periods of maximum consumption which will cause a reduction in residual pressures. In other words, the adverse effect will appear in certain less favorable points of the network during the few minutes of peak consumption, whereas reduction of the amount provided is a perpetual defect; it affects not only the functioning of the water system as a means of controlling diarrheal diseases but also the possibility of bettering and extending the service so as to effect a gradual transition to the urban-type system.

Another factor affecting pipe diameter is the method used to estimate the losses of head. Planners tend to use simple, approximate estimates for rural systems, since the systems are also simple. In essence this method consists in estimating the main lines, without regard to the favorable effects of secondary pipelines. Nevertheless, as stated, in small localities about 70 per cent of the pipes are 2 to 3" in diameter; that is to say, the secondary pipelines are similar in diameter to those supposed to be main lines. Therefore more precise calculations could, in some cases, result in savings comparable to those obtained through a reduction in the amount of water supplied.

Table 8 contains a summary of the relationship between the cost of the distribution system and the per capita amount of water provided. It is difficult to make generalizations as to this relationship in the case of the remaining components of the water supply system, such as the conduction line, pump station, and storage tanks, since it depends on many features in the design, but in principle it is possible to estimate an average variation similar to the one above.

The conclusion is that a minimum amount of 100 to 135 liters per capita per day may be provided in rural supply systems without great financial sacrifice, and a daily amount of 150-200 liters per capita may be achieved with an increase in cost that is slight when compared with the benefits resulting to every feature of the water supply system.

TABLE 1: COMPARATIVE COST AND TRANSPORT CAPACITY OF DIFFERENT TYPES OF PIPELINE

Material and diameter	Relative Capacity	Cost in US$			Relative Cost (%)		
		Material	Labor	Total	Material	Labor	Total
Ø 2" C.I. class 150	1.00	1.54	1.54	3.08	100	100	100
Ø 3" C.I. class 150	2.93	2.31	1.76	4.07	150	114	132
Ø 4" C.I. class 150	4.01	3.12	1.95	5.07	202.6	126.6	164.6
Ø 6" C.I. class 150	17.52	4.46	2.58	7.04	289.5	167.5	228.6
Ø 8" C.I. class 150	55.07	5.91	3.33	9.24	383.8	216.2	300
Ø 3" A.C. class 150	3.92	1.40	1.67	3.07	90.9	108.4	99.6
Ø 4" A.C. class 150	5.36	1.86	1.78	3.64	120.7	115.6	118.1
Ø 6" A.C. class 150	23.38	3.17	2.29	5.46	205.8	148.7	177.2
Ø 8" A.C. class 150	73.60	4.73	2.95	7.68	307.1	191.6	249.4
Ø 2" G.C. class 150	1.00	1.58	1.48	3.06	102.6	96.1	99.9
Ø 3" G.C. class 150	2.93	3.09	1.65	4.74	200.6	107.1	153.9
Ø 4" G.C. class 150	4.01	4.35	1.87	6.22	282.5	121.4	201.9
Ø 6" G.C. class 150	17.52	7.36	2.64	10.00	477.9	171.4	324.7
Ø 8" G.C. class 150	55.07	9.84	2.97	12.81	639	192.9	415.9

NOTE

1. SYMBOLS USED:
   - C.I. CAST IRON
   - A.C. ASBESTOS CEMENT
   - G.C. GALVANIZED CEMENT

2. COST OF MATERIAL WAS ESTIMATED ON PRICES OF IMPORTS FROM THE U.S.A. ON 1 JANUARY 1963, CIF, PUERTO CABELLO, VENEZUELA; IMPORTS FROM EUROPE, THE FAR EAST AND LATIN AMERICA ARE LOWER BY UP TO 30% OR MORE.

3. COST OF LABOR WAS CALCULATED ON THE AVERAGE DAILY WAGE OF $3.60 FOR UNSKILLED AND $7.90 FOR SKILLED LABOR, INCLUDING SOCIAL WELFARE DEDUCTIONS.

4. LOCAL VARIATIONS IN COST OF MATERIALS AND LABOR WILL HAVE LITTLE EFFECT ON THE RELATIVE COSTS OF PIPES OF DIFFERENT SIZES MADE FROM THE SAME MATERIALS.

TABLE 2: LOCALITIES WITH UP TO 500 INHABITANTS

Locality and State	No. of inhabit.		Cost in Bolivars		Per cap. cost (Bs)	Source	Length of pipe in distribution system (kms)				
	Pres.	Fut.	Labor	Suppl. and Equip.			Ø2"	Ø3"	Ø4"	6"	Total length Ø6"
Playa Grande (Zulia)	291	582	58,413	50,478	455	S*		0.8	0.8	0.4	2.0
Gibraltar (Zulia)	455	910	74,200	76,000	402	U*	0.9	1.2	0.3		2.4
Las Majadas (Bolivar)	500	1000	63,283	72,845	314	U	0.3	0.2	0.8		1.3
Las Bonitas (Bolivar)	311	650	62,225	70,933	485	U	0.6	1.3	0.1		2.0
Sta. Rosalia (Bolivar)	400	800	68,751	80,838	425	U	0.4	1.6	0.2		2.2
Papelon (Portuguesa)	450	900	52,000	68,000	311	U	0.9	1.2	0.3		2.4
Campo Ajure (Sucre)	100	200	60,000	42,000	1125	S	0.6	0.5	0.2	0.1	1.4
Las Toscanas (Sucre)	146	292	75,000	70,000	1065	S	1.0	1.1	0.3	0.2	2.6
Nva. Colombia (Sucre)	150	300	52,000	44,000	710	S	0.3	0.5	0.4		1.2
El Limon (Sucre)	252	504	60,000	70,000	557	S	0.3	0.1	1.4	0.6	2.4
Juan Sanchez (Sucre)	230	460	60,000	70,000	611	S	0.2	0.1	1.4	0.6	2.3
Coporito (T.D.A.)	331	660	33,000	63,000	365	S		0.3	2.8		3.1
Sacupana (T.D.A.)	277	560	42,000	76,500	566	S	0.7	0.5			1.2
El Jabillo (Cojedes)	230	460	38,827	66,944	560	U	1.5	0.5			2.0
El Pintado (T.D.A.)	80	600	13,000	28,000	625	U		0.4			0.4
Aldea Cedeño (Tachira)	350	700	56,622	40,582	172	S	2.9				2.9
Sabaneta y El Pozo (Sucre)	274	548	38,436	41,102		S&U	0.9				0.9
Payares (Yaracuy)	300	600	17,986	23,083	150	S	0.6	1.4			2.0
Las Guacas (Apure-Barinas)	400	800	48,527	91,328	430	U	1.3		0.1		1.4
Tunapuicito (Sucre)	398	796	51,884	47,185	320	S&U	0.3	0.6	0.7		1.6
Choro-Choro - Pueblo Nuevo (Sucre)	333	666	41,484	44,190	342	S&U	1.2				1.2
Sta. Rosalia (Miranda)	350	700	31,200	22,400	177	U	0.3	0.4	0.6		1.3
Buena Vista (Nonagas)	380	760	47,313	55,638	331	S	0.8	2.2	0.8		3.8
C. Coromoto (T.Am.)	325	650	44,500	50.000	346	S	1.5	1.1	0.1		2.7
Valle Morin (Aragua)	416	832	45,000	35,131	250	S		0.9	0.1		1.0
Guaimaral (Tachira)	370	740	50,000	70,500	370	U	0.8	0.7			1.5
Campo Barinas (Tachira)	274	548	81,230	98,000	734	U	0.4	1.1			1.5
Las Palmas (Tachira)	120	250	20,300	25,000	413	S	1.3	0.1			1.4
Los Taparos y Boqueron (Falcon)	168	340	33,000	41,100	476	S	2.5	0.1			2.6
Cachipo (Anzoategui)	275	550	12,000	70,000	337	U	1.4	0.1			1.5
S. Dgo. de Cab. (Anz.)	475	950	29,500	120,000	387	U	1.7	1.1			2.8
Santa Rosa (Apure)	170	400	14,450	29,095	287	U	0.6		0.3		0.9
Puerto Infante (Apure)	170	400	17,910	35,506	345	U	0.6		0.8		1.4
Cogollar (Aragua)	200	400	18,320	12,777	258	U	1.1				1.1
Payita (Aragua)	250	500	17,917	16,914	224	U	1.1				1.1
Soledad (Barinas)	248	500	46,000	49,400	456	S	2.5	1.1			3.6
El Castillo (Barinas)	248	500	46,000	49,400	456	S	2.5	1.2			3.7
La Barinesa (Barinas)	314	700	40,000	97,500	495	S	2.6	1.2			3.8
Aripao (Bolivar)	236	500	45,000	75,000	606	U	1.4	0.3			1.7
Sta. Rosalia (Bolivar)	320	640	71,800	66,800	610	S	1.4	0.6	0.1		2.1
Palmasola (Falcon)	250	500	43,628	34,137	358	U	0.8		0.3		1.1
Espino (Guarico)	432	864	55,375	101,959	378	S	2.3	0.7			3.0
Las Lajitas (Guarico)	350	800	29,129	69,093	310	U	1.4	1.7			3.1
La Esperanza (Guarico)	250	800	25,977	60,509	362	S	0.9	0.8	0.5		2.2

Locality and State	No. of inhabit.		Cost in Bolivars		Per cap. cost (Bs)	Source	Length of pipe in distribution system (kms)				
	Pres.	Fut.	Labor	Suppl. and Equip.			Ø2"	Ø3"	Ø4"	6"	Total length Ø6"
Vericallar (Sucre)	500	1000	56,000	95,860	344	S	0.6	0.5	0.4		1.5
Chacaracual (Sucre)	500	1000	11,700	45,000	127	U		0.4	0.1		0.5
Alto Amara (Sucre)	417	833	33,333	61,000	255	S		0.3	0.7	0.8	1.8
El Algarrobo (Sucre)	417	833	33,333	61,000	255	S		0.3	0.7	0.8	1.8
Pueblo Viejo (Sucre)	417	833	33,333	61,000	255	S		0.3	0.7	0.8	1.8
Punta Brava (Sucre)	250	500	15,500	39,000	256	S		0.6	0.6	0.3	1.5
La Meseta (Sucre)	250	500	15,500	39,000	256	S		0.6	0.6	0.3	1.5
Ño Carlo (Sucre)	300	600	77,598	52,417	502	S	0.4	0.9	1.5	1.3	4.1
Platanito (Sucre)	300	600	77,598	52,417	502	S	0.4	0.9	1.5	1.3	4.1
Aldea Cedeño (Tachira)	350	700	60,000	45,000	376	S	2.4				2.4
Hernandez (Tachira)	276	580	59,184	42,623	429	S	0.2	0.8	0.6		1.6
Cas. La Mesa (Tachira)	276	580	59,184	42,623	429	S	0.2	0.8	0.6		1.6
Cas. San Fdo. (Tachira)	276	580	59,184	42,623	429	S	0.2	0.8	0.6		1.6
Cas. La Hoyada (Tach.)	276	580	59,184	42,623	429	S	0.2	0.8	0.6		1.6
Las Vegas (Tachira)	110	220	16,058	28,725	496	S	0.8	0.1			0.9
Palmasera (Tachira)	110	220	16,058	28,725	496	S	0.8	0.1			0.9
La Llamada (Tachira)	110	220	16,058	28,725	496	S	0.8	0.1			0.9
Cañaveral (Tachira)	110	220	16,058	28,725	496	S	0.7	0.1			0.8
Cantarrana (Tachira)	110	220	16,058	28,725	496	S	0.7	0.1			0.8
Cas.Monte Carmelo (Tach)	146	290	18,000	28,000	370	S	1.3	0.4			1.7
Zilgara (Tachira)	47	95	7,500	11,600	478	S	0.8				0.8
El Morro (Tachira)	47	95	7,500	11,600	478	S	0.7				0.7
San Francisco (Tachira)	34	68	6,000	9,500	559	S	0.5				0.5
La Aduana (Tachira)	34	68	6,000	9,500	559	S	0.6				0.6
Cas. Curacao (Tachira)	168	340	14,000	16,700	226	S	0.7				0.7
Cas.La Victoria (Tach.)	167	335	19,000	23,700	311	S	1.2	0.3			1.5
La Puerta (Trujillo)	467	1073	55,000	50,000	263	S	1.5	0.9	0.2	0.3	2.9
La Flecha (Trujillo)	467	1073	55,000	50,000	263	S	1.5	0.9	0.2	0.3	2.9
El Molino (Trujillo)	467	1073	55,000	50,000	263	S	1.5	0.9	0.2	0.3	2.9
Carabobo (Yaracuy)	305	763	34,800	27,800	245	S	0.3	0.8	0.1	0.3	1.7
Santa Rosa (Yaracuy)	305	763	34,800	27,800	245	S	0.3	0.8	0.1	0.3	1.7
La Peliciana (Yaracuy)	305	763	34,800	27,800	245	S	0.3	0.8		0.3	1.6
Cerro Azul (Yaracuy)	305	763	34,800	27,800	245	S	0.3	0.8		0.3	1.6
Guarataro (Yaracuy)	305	763	34,800	27,800	245	S	0.3	0.8		0.3	1.5
San Antonio (Zulia)	450	900	70,000	50,000	158	U		1.8			1.8
S.Fco. del Pino (Zulia)	316	650	40,000	30,500	139	U		0.5			0.5
Boscan (Zulia)	200	400	49,000	33,500	247	U		0.8			0.8
Sta. Catalina (T.D.A.)	450	1200	29,987	92,479	325	S	1.1		0.2		1.3
La Horqueta (T.D.A.)	390	1000	27,000	80,000	300	S	0.4	0.3	0.4		1.1
Piacoa (T.D.A.)	470	1000	34,100	90,000	290	S	0.8	0.7			1.5
Osma (Dtto. Federal)	205	500	57,000	81,000	809	S	0.4				0.4
Las Cocuizas (Guarico)	400	800	36,628	68,268	294	S		1.9			1.9
El Desecho (Lara)	202	404	24,352	19,860	311	U	0.2	1.4			1.6
Marcelo (Miranda)	250	500	27,200	12,500	184	U	0.8				0.8
Las Morochas (Miranda)	380	760	57,396	33,302	261	U	0.3	0.6	0.4		1.3
Pueblo Nuevo (Miranda)	280	600	35,000	35,495	391	U	0.3		1.4		1.7
Aguas Calientes (Sucre)	500	1000	78,762	67,461	320	S	0.6	2.4			3.0

* U = underground
S = surface

TABLE 3: LOCALITIES WITH FROM 501 TO 1,000 INHABITANTS

Locality and State	No. of inhabit.		Cost in Bolivars		Per cap. cost (Bs)	Source	Length of pipe in distribution system (kms)				
	Pres.	Fut.	Labor	Suppl. and Equip.			Ø2"	Ø3"	Ø4"	6"	Total length Ø6"
Cata (Aragua)	700	1400	40,172	69,459	188	U*	0.1	0.8	0.1		1.0
Los Tanques (Aragua)	560	1120	24,817	24,780	125	U		0.8	0.7		1.5
Los Arroyos (Sucre)	863	1726	60,774	98,098	217	S&U	2.3		0.2		2.5
Guarancos (Sucre)	774	1548	57,187	95,068	233	S&U	1.3	1.3	0.3	0.1	3.0
Qda. de Monos (Sucre)	677	1354	74,631	71,886	258	S&U	1.2	0.3	0.5	0.7	2.7
Cancabito, La Seca y El Guineo (Carabobo)	510	1020	56,000	49,000	241	S	1.8	2.8	0.2		4.8
Rio Salado y San Juan (Sucre)	950	1900	94,402	75,974	192	S	0.2	1.2	1.0	0.2	2.6
La Chispa (Portuguesa)	600	1200	24,049	45,523	165	U		1.1	0.1		1.2
Boca de Uchiro (Anzoategui)	600	1200	70,000	82,000	298	U	1.2	1.2	1.0	0.7	4.1
Belen (Miranda)	514	1028	50,100	58,707	252	U		2.2	0.1		2.3
Col. Chirgua (Carabobo)	900	1800	87,500	93,900	244	S	1.2	2.1	1.5	0.1	4.9
San Vicente (Nonagas)	1000	2000	58,344	78,623	160	U	1.2	0.5	2.2	0.1	4.0
Capadare, Qda. Honda (Falcon)	580	1160	70,100	88,300	308		1.5	0.5	0.2		2.2
Los Altos de Santa Fe (Sucre)	923	1850	65,000	80,820	174	S	0.3	0.8	0.5	1.3	2.9
La Julia (Aragua)	700	1400	50,100	55,536	171	U		1.6	0.5		2.1
Andres E. Blanco (Ar.)	800	1600	38,539	100,996	195	U	1.6	0.4	1.3		3.3
Obispo (Barinas)	967	2000	47,000	74,000	147	U	3.1	1.9	0.3	0.1	5.4
El Conbur (Carabobo)	717	1429	79,505	97,383	282	S	1.6	1.3	0.1	0.4	3.5
Carlos Felipe (Car.)	717	1429	79,505	97,383	282	S	1.6	1.3	0.1	0.4	3.5
El Marron (Car.)	717	1429	79,505	97,383	282	S	1.6	1.3	0.1	0.3	3.4
Cas. El Castaño (Car.)	717	1429	79,505	97,383	282	S	1.6	1.3	0.1	0.3	3.4
Casigua (Falcon)	600	1200	46,923	71,562	221	U				3.1	3.1
El Rastro (Guarico)	732	1500	82,187	99,302	282	U	2.7	1.6	0.7		5.0
El Calvario (Guarico)	536	1100	57,000	61,000	260	U	2.7	2.1	0.4	0.2	5.4
Sosa (Guarico)	600	1200	27,260	68,665	177	U	1.5	1.7			3.2
Anzoategui (Lara	850	1700	102,137	80,760	260	S	2.7	1.0	0.3		4.0
Las Gonzalez (Miranda)	1000	2000	14,878	22,623	46	U		0.4	0.9		1.3
Las Martinez (Miranda)	1000	2000	36,294	53,504	101	U	0.2	0.6	0.5	0.8	2.1
El Cafe (Miranda)	608	1200	29,739	35,638	140	U	0.7	0.3	0.2		1.2
Tahuayas (Nonagas)	1000	2000	53,802	62,585	128	U		1.7	0.3	0.4	2.4
Guacuco (Nva. Esparta)	900	1800	28,000	27,300	73	U		1.0	0.2	0.7	1.9
V. del Esp. Santo (N.E.)	801	1650	23,691	30,287	77	S		1.2	0.2	0.9	2.3
Cas. Las Piedras (N.E.)	801	1650	23,691	30,287	77	S		1.1	0.2	0.8	2.1
El Poujil (Sucre)	1000	2000	82,000	52,500	157	S		1.9	0.5	0.7	3.1
El Pao (Anzoategui)	585	1200	58,126	93,593	292	U		0.4	1.4	0.2	2.0
La Morita (Aragua)	600	1200	50,500	53,560	237	U		1.9	3.0		4.9
Guayabita (Aragua)	700	1400	50,330	58,664	195	U		2.0	0.2		2.2
Buena Vista (Lara)	656	1400	124,000	157,000	544	S	2.8	0.7	0.2		3.7
Miton (Trujillo)	800	1600	20,773	32,011	79	S	0.3	1.3	0.5		2.1
Monte Carmelo (Trujillo)	1000	2000	26,980	40,403	95	S	1.3		0.9		2.2
Zuata (Anzoategui)	791	1582	59,352	71,569	203	U	0.4	1.7	0.1		2.2
Aguas de Obispo y Las Matas (Carabobo)	588	1176	92,427	46,402	285	U		4.9	1.8		6.7
Apartadero (Cojedes)	905	1800	81,000	117,000	243	U	2.9	0.9	0.1		3.9
Chimpire (Falcon)	525	1050	54,585	49,235	243	S		1.0	2.0	0.7	3.7
San Jose y Bella Vista (Falcon)	659	1318	73,536	87,059	287	U		5.3	1.0		6.3
San Fco. de Macaira (Guarico)	850	1700	76,874	106,142	261	U	2.9	1.9			4.8
Sotillo y Col. de Sotillo (Miranda)	659	1318	68,612	78,176	281	U	0.1	1.3	0.8	0.7	2.9
Mesa de Cavacas (Port.)	800	1600	64,316	94,890	120	U	0.9	0.4	1.6	0.1	3.0
El Rincon (Sucre)	940	1800	56,375	53,213	131	S	0.7	0.8	0.5		2.0
Rio Casanay (Sucre)	632	1264	60,000	42,000	178	S	0.5	0.4	0.2		1.1
Guarapiche (Sucre)	677	1354	75,000	70,000	230	S	1.0	1.1	0.3	0.2	2.6
El Cangrejal (Sucre)	640	1280	60,000	70,000	480	S	0.2	0.1	1.4	0.6	2.3
Pto. Nuevo (Tachira)	575	1725	34,000	82,000	237	U		0.8	0.9	0.7	2.4
Salem (Yaracuy)	953	1906	137,541	135,847	322	S	0.7	4.4	1.9	0.8	7.8
Abejales (Tachira)	687	2060	79,100	105,320	307	U		1.9	1.5		3.4
Crucito (Yaracuy)	830	1660	53,100	60,000	168	U	0.3	1.5	0.5		2.3
Palmarito (Merida)	1000	2000	55,665	86,115	160	U	0.8	0.5	0.7		2.0
Santo Domingo (Merida)	890	1730	66,176	77,243	138	S	2.5	2.3	0.2		5.0
Rio Chiquito (Sucre)	520	1040	95,000	100,000	425	S		1.5	0.7	0.5	2.7
Cordero (Tachira)	850	1700	93,500	123,000	286	S	2.0	0.3	0.9	0.6	3.8
Pan de Azucar (Tachira)	850	1700	93,500	123,000	286	S	1.9	0.3	0.8	0.7	3.7
Paticcito (Tachira)	903	1800	58,000	100,500	207	S	1.4	1.8	0.1		3.3
Burbusay (Trujillo)	550	1100	97,353	88,854	417	S	1.1	0.9	0.4		2.4
La Ensenada (Zulia)	657	1314	72,759	70,294	243	S	2.2	1.9	0.1	0.7	4.9
El Potrero (Zulia)	657	1314	72,759	70,294	243	U	2.2	1.8	0.2	0.6	4.8
San Jose (Zulia)	570	1140	58,000	39,000	103	U		1.0	0.1		1.1
Santa Maria (Zulia)	550	1100	73,000	45,000	127	U	0.3	1.1	0.1		1.5
San Fdo. de Atabapo (T. Amazonas)	943	2000	54,026	164,405	264	S	1.5	1.9	0.7		4.1
Tacuato (Falcon)	765	1530	49,288	68,334	180	S			4.0	0.1	4.1

* U = underground
S = surface

TABLE 4: LOCALITIES WITH FROM 1,001 TO 1,500 INHABITANTS

Locality and State	No. of inhabit.		Cost in Bolivares		Per cap. cost (Bs)	Source	Length of pipe in distribution system (kms)				
	Pres.	Fut.	Labor	Suppl. and Equip.			Ø2"	Ø3"	Ø4"	6"	Total length Ø6"
S. Rafael de Onoto (P)	1500	3000	94,020	142,860	202	U*	2.4	1.5	0.9	0.6	5.4
Torococo (Trujillo)	1100	2200	177,240	151,010	319	S*	0.2	1.4	1.3		2.9
Caja Seca (Zulia)	1306	2620	134,559	149,782	246	U	1.3	3.4	4.2		8.9
La Urbana (Bolivar)	1100	2200	60,000	75,000	146	U	1.2	0.9	1.6		3.7
Urana (Carabobo)	1312	2926	85,945	91,239	144	U	0.7	2.2	1.2	0.1	4.2
Borburata (Carabobo)	1307	2800	64,926	75,794	123	S	0.1	3.8	0.2	0.1	4.2
Humocaro Alto (Lara)	1223	2450	107,000	154,000	242	S	4.3	0.5	1.1	0.6	6.5
Nueva Bolivia (Merida)	1100	2200	63,500	95,000	164	U	0.3	2.9	1.2		4.4
Sabana de Piedra (Mo)	1500	3000	121,000	146,000	229	S	0.1	4.2		0.1	4.4
Pantoño (Sucre)	1005	2010	57,000	95,000	162	S			1.5	0.3	1.8
El Tigre (Zulia)	1400	2800	91,590	129,680	187	U	2.5		2.7	2.7	7.9
Granados (Trujillo)	1500	3000	75,818	128,800	154	U	0.2	2.0	0.4	0.2	2.8
El Canton (Barinas)	1195	2390	50,727	130,157	169	U	0.9	1.4	0.4	0.3	3.0
Altamira (Barinas)	1500	3000	120,528	100,054	177	S		0.9	0.6		1.5
Boca del Toc. (Falcon)	1127	2300	91,483	113,510	216	S	1.3	2.8	0.9	0.4	5.4
Suata (Aragua)	1328	2656	90,931	65,188	140	U	0.9	3.8	0.4		5.1
Chiguara (Merida)	1250	2500	253,560	210,800	424	S	4.0	3.1	0.5	0.2	7.8
Sinamaica (Zulia)	1288	2576	179,533	251,240	362	U	0.2	1.5	1.6	0.2	3.5
Aguada Grande (Lara)	1411	2822	134,605	187,195	261	U		6.4	1.9	0.3	8.6
Sabana de Uchire (An)	1375	2750	262,650	209,668	447	S	2.0	0.9	0.9	0.3	4.1
El Toco II (Carabobo)	1425	3565	104,676	124,529	182	U	0.8	1.3	0.8	2.1	5.8
Ortiz (Guarico)	1400	3000	89,002	176,686	223	SS**	2.9		2.9		5.8
La Miel (Lara)	1447	3000	162,091	134,494	243	S	2.9	2.3	1.4	0.6	7.2
Barbacoas (Lara)	1136	2272	104,000	142,619	258	S	4.4	1.2	1.1	0.2	6.9
San Miguel (Lara)	1032	2000	152,200	212,900	400	S	3.5	0.5	0.7		4.7
Caño Zancudo (Merida)	1107	2214	167,902	156,212	333	S	5.9	2.8		0.3	9.0
El Corozo (Nonagas)	1200	2400	112,255	124,580	222	U	3.9		2.0	0.2	6.1
S. Ant. de Irapa (S)	1250	2500	130,000	156,000	254	S		1.2	0.6	0.3	3.2
Delicias (Tachira)	1320	2640	119,000	165,900	250	S	1.2	1.5	0.9	0.2	3.8
Potrerito (Zulia)	1208	2416	134,830	142,430	254	U	5.4	0.5	1.8		7.7
La Sabana (D.F.)	1050	2100	83,000	153,500	259	S	0.9	1.0	0.3	0.1	2.3
Mendoza Fria (Truj.)	1314	2628	96,683	75,660	156	S	1.1	0.9	0.9	0.4	3.3

* U = underground
S = surface

** SS = sub-surface

TABLE 5: LOCALITIES WITH FROM 1,501 TO 2,000 INHABITANTS

Locality and State	No. of inhabit.		Cost in Bolivars		Per cap. cost (Bs)	Source	Length of pipe in distribution system (kms)				
	Pres.	Fut.	Labor	Suppl. and Equip.			Ø2"	Ø3"	Ø4"	6"	Total length Ø6"
Humocaro Bajo (Lara)	2000	4000	200,386	182,909	218	S	5.1	1.1	2.0	0.4	9.0
Cubiro (Lara)	1520	3040	126,479	98,746	183	S	4.3	0.6	0.4	0.2	5.5
S.J. de Lagunillas (Merida)	1570	3200	226,560	291,347	412	S	7.5	1.1	0.4	0.6	9.6
Cuicas (Trujillo)	1760	3520	88,726	97,188	115	S		2.3	0.3		2.6
Guanape (Anzoategui)	1578	3160	92,000	140,700	174	U	2.6	1.1	2.3	0.1	6.1
El Empedrado (Lara)	1893	2840	167,200	183,280	194	U	0.7	2.3		0.1	3.1
Teresen (Nonagas)	2000	4000	150,841	195,393	203	S	1.2	3.1	2.9	1.2	8.6
Paraguaipoa (Zulia)	1853	3706	58,775	159,400	130	U	0.2	2.4	1.9	0.3	4.8
Sabana Libre (Truj.)	1790	3580	93,112	83,652	104	S	3.1	2.4	0.3	0.4	6.2
La Mata (Trujillo)	1778	3556	66,013	49,213	69	S	0.6	1.9	0.3	0.2	3.0
Pedro Gonzalez (N.E.)	1682	3364	75,200	91,700	118	Inos		4.0	0.8	2.0	6.8
Arapuey (Merida)	2000	4000	135,496	122,356	150	U	1.4	3.9	0.8	4.5	10.6
El Toco (Carabobo)	1750	4000	194,100	191,300	248	U	3.2	3.9	4.3	2.1	16.4
San J. de los Cayos (Falcon)	1890	3780	212,900	265,500	288	S		0.5	2.8	0.8	4.1
Boca de Mangle (F)	1686	3380	184,500	233,600	283	S		1.1	1.7	0.1	2.9
Santa Barbara (Bar.)	2000	4000	345,279	489,721	485	S	0.3	7.0	3.3	2.6	13.5
Araira (Miranda)	1750	3500	171,089	196,040	254	S	1.0	1.7	0.4	0.2	3.3
Campo Claro (Sucre)	1600	3200	159,500	209,500	255	S	0.3	1.5	1.5	0.4	4.2
Agua Santa (Truj.)	1705	3410	123,846	163,433	190	S	0.2	3.1	3.2	0.2	6.7

TABLE 6: LOCALITIES WITH FROM 2,001 TO 5,700 INHABITANTS

Locality and State	No. of inhabit.		Cost in Bolivars		Per cap cost (Bs)	Source	Length of pipe in distribution system (kms)					Locality and State	No. of inhabit.		Cost in Bolivars		Per cap cost (Bs)	Source	Length of pipe in distribution system (kms)				
	Pres.	Fut.	Labor	Suppl. and Equip.			Ø2"	Ø3"	Ø4"	6"	Total length Ø6"		Pres.	Fut.	Labor	Suppl. and Equip.			Ø2"	Ø3"	Ø4"	6"	Total length Ø6"
El Vigia (Merida)	5500	11000	175,310	273,318	107	U*	2.5		4.4	1.5	9.1	Caripe (Monagas)	4364	8728	282,400	286,000	147	S	1.3	5.5	1.8	0.8	9.8
Barranoas (Monagas)	5700	8590	336,840	461,402	160	U		5.8	2.0	1.7	13.0	Toc. de la Costa (P)	4134	8300	185,637	400,144	159	S	0.8	5.5	2.2	0.9	9.4
Biscucuy (Portuguesa)	5000	10000	130,000	480,000	150	S*	0.8	0.2	3.2	1.0	6.3	El Pilar (Sucre)	3531	7062	174,037	280,014	136	S	7.1	2.8	2.6	0.7	13.3
Pampanito (Trujillo)	2690	5380	129,974	158,107	119	U		3.2	0.7	0.6	4.5	Tunapuy (Sucre)	2613	5226	154,455	132,732	121	S	2.7		1.0	0.2	4.1
El Chaparro (Ans.)	2150	5375	245,942	272,566	280	S	0.4	5.1	2.5	0.6	8.7	Canoabo - El Naranjo (Carabobo)	2340	4680	213,000	222,000	210	S	5.7	1.0	3.5	0.4	10.6
San Casimiro (Aragua)	3000	6000	151,000	197,500	134	S	3.3	3.1	0.9	0.4	7.7	Escuque (Trujillo)	3397	6794	155,400	164,203	99	S	0.4	6.1	2.3	0.4	9.7
Piritu (Falcon)	2766	5532	640,938	621,217	555	S	1.9		1.8	0.6	4.3	El Dorado (Bolivar)	2620	5240	85,000	216,600	135	U	1.6	1.4	1.3	0.9	5.3
S. Jose de Guaribe (Guarico)	2687	5374	236,578	223,749	204	S	0.6	6.7	2.1	0.5	10.1	Santa Ana (Tachira)	3957	7850	215,000	312,000	156	S	6.1	2.4	1.9	1.0	12.0
Sarare (Lara)	2300	4600	314,000	338,400	318	S	1.8	8.8			10.6	Serobuco (Tachira)	2700	5400	162,089	214,143	165	S	2.1	2.7	1.0	0.1	5.9
Guaronas (Miranda)	6200	12400	181,200	380,800	99	U	2.4	1.7	2.0	1.8	7.9	Altagracia (N.Esp.)	2372	4744	87,500	129,000	123	Inos		2.4	2.2	2.9	7.5
Aragua de Maturin (Monagas)	5500	11000	218,784	330,553	121	S	0.3	2.3	2.2	2.3	7.4	Valle Guanapo (Anz.)	3500	7000	337,000	455,800	249	S	2.3	4.0	2.9	0.6	10.6
Comenay (Sucre)	5341	6682	148,000	280,000	163	S		6.7	3.8	0.6	11.4	S.Fco. de Asis (Arag)	2586	5172	176,717	195,581	164	U	2.8	2.0	4.0	0.1	9.1
Carucho y La Playa (Trujillo)	4000	8000	197,000	288,000	133	S&U	1.8	3.1	1.9	0.3	7.1	Sta. Maria de Ipiro (Guarico)	3110	4665	191,560	358,278	195	S	10.3	3.2	3.2	0.2	16.9
Arca (Yaracuy)	3842	7684	192,985	241,021	132	S	1.2	1.9	6.3	1.1	10.7	Sarare (Lara)	4100	8200	288,788	252,404	151	S	7.7	4.5	2.6	1.0	16.8
Sab. de Parra (Yarac)	2500	5000	215,100	323,676	242	S	3.5	6.1	2.7	1.4	13.7	Coloncito (Tachira)	2050	4500	134,176	166,294	171	S	3.2	2.3	0.7	0.6	7.2
Sabana Grande (Truj.)	2200	4400	103,958	147,600	130	U	3.0	1.6	0.6	0.1	5.3	Palmira (Tachira)	2076	4150	217,000	462,500	363	S	2.7	2.8	0.5	0.4	6.4
Sab.de Mendoza (Truj)	4156	8312	279,476	419,214	200	U	0.1	3.6	0.8	2.1	6.8	Dividive (Trujillo)	2720	5440	174,081	274,461	186	U	5.7	2.9	1.9	0.3	11.3
La Pica (Aragua)	2160	5782	190,078	145,460	176	U	4.4	4.0	1.0	0.7	10.3	San Juan (Zulia)	2216	4432	190,163	172,782	184	U	0.4	0.2	0.3	0.2	1.2

* U = underground
S = surface

TABLE 7: SUMMARY OF LENGTH OF PIPELINES IN THE DISTRIBUTION SYSTEM, BY DIAMETER AND BY SIZE OF LOCALITY

		0 - 500 inhabitants	501 - 1000 inhabitants	1001 - 1500 inhabitants	1501 - 2000 inhabitants	2001 - 5700 inhabitants	Total 0 - 5,700 inhabitants
Total number of localities		91	69	32	19	36	247
Total number of inhabitants		26,266	51,673	40,716	33,805	120,078	272,538
Average number of inhabitants per locality		289	749	1,272	1,779	3,335	1,103
Total cost of all water systems	Bs	9,462,804	11,084,020	9,523,500	7,286,593	20,387,745	57,744,662
	$	2,084,318	2,441,414	2,097,687	1,604,976	4,490,692	12,719,087
Average cost per system	Bs	103,987	160,638	297,609	383,505	566,326	233,784
	$	22.9	35.4	65.5	84.5	124.7	51.5
Average per capita cost	Bs	360	215	234	216	170	212
	$	79	47	52	48	38	47
Total length of dist. pipelines	Kms	160.5	219.3	161.9	127.0	322.0	990.7
Length of 2" pipes	Kms	69.9	64.8	55.5	31.7	90.9	312.8
	%	43.6	29.5	34.3	25.0	28.2	31.6
Length of 3" pipes	Kms	54.0	89.3	56.8	45.0	115.6	360.7
	%	33.6	40.7	35.1	35.4	35.9	36.4
Length of 4" pipes	Kms	25.8	45.3	36.9	29.6	74.8	212.4
	%	16.1	20.7	22.8	23.3	23.3	21.4
Length of 6" pipes	Kms	9.9	19.5	10.8	16.4	29.0	85.6
	%	6.2	8.9	6.6	12.9	9.0	8.7
Length of pipes 8" and over	Kms	0.9	0.4	1.9	4.3	11.7	19.2
	%	0.5	0.2	1.2	3.4	3.6	1.9
Relative cost of 2" pipes		33.5%	21.3%	25.1%	16.7%	19.4%	22.5%
Relative cost of 3" pipes		34.0%	38.8%	33.8%	31.2%	32.6%	34.2%
Relative cost of 4" pipes		20.4%	24.7%	27.5%	25.6%	26.4%	25.1%
Relative cost of 6" pipes		10.9%	14.7%	11.0%	19.7%	14.2%	14.2%
Relative cost of pipes 8" and over		1.2%	0.5%	2.6%	6.8%	7.4%	4.0%
Relative cost of all pipes		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 8: VARIATIONS IN THE COST OF THE DISTRIBUTION NETWORK, BY AMOUNT SUPPLIED AND BY DESIGNED CAPACITY

AMOUNT PER CAPITA	DESIGNED FOR MAXIMUM HOURLY CONSUMPTION	RELATIVE COST OF THE DISTRIBUTION NETWORK
150 - 200 lts/day	250 - 300% of amount supplied	100%
100 - 135 lts/day	250 - 300% of amount supplied	90%
50 - 70 lts/day	250 - 300% of amount supplied	80%
150 - 200 lts/day	200 - 250% of amount supplied	96%
100 - 135 lts/day	200 - 250% of amount supplied	86%
50 - 70 lts/day	20 - 250% of amount supplied	77%
150 - 200 lts/day	165 - 200% of amount supplied	90%
100 - 135 lts/day	165 - 200% of amount supplied	81%
50 - 70 lts/day	165 - 200% of amount supplied	72%

NOTE:

1. THE WATER SUPPLY SYSTEMS IN TABLES 2 TO 7 WERE DESIGNED TO PROVIDE 150 - 200 LITERS A DAY PER CAPITA
2. THE VARIATION IN THE MAXIMUM HOURLY CONSUMPTION WAS ASSUMED TO BE FROM 250 TO 300% OF THE AVERAGE DAILY CONSUMPTION
3. ALL COMPONENTS OF A SYSTEM WERE INCLUDED IN THE TOTAL COST FOR WATER SUPPLY SYSTEMS
4. DISTRIBUTION WAS DESIGNED FOR DIRECT SERVICE TO ALL HOUSES THAT COULD BE CONNECTED TO THE SYSTEM
5. THE DESIGN COVERS A PERIOD OF 20 YEARS WITH A MINIMUM INCREASE OF 100% OF THE POPULATION BENEFITED
6. 75% OF THE PIPELINES IN THE WATER MAINS ANALYZED ARE OF CAST IRON, CLASS 150, AND THE REMAINING 25% ARE OF ASBESTOS CEMENT

ANNEX B

RESULTS OF PROVIDING DIRECT WATER SUPPLY

There are several aspects to the problem of piping water direct into the home. The construction of works for the purpose of bringing water from the source to the center of a locality will not be discussed here, since such works are a common component of any system. Discussion here will be limited for the most part to systems and methods of distribution in rural localities, since the need for direct service into the home in urban areas is never questioned.

From the technical and financial point of view, the most important aspect is the pipeline network, and reference will again be made to the distribution systems studied and summarized in Table 7. The present cost of distribution pipelines in the 247 systems in question is about 35 per cent of the total cost of the complete water supply service. This figure includes the cost of house connections, which will be discussed further on. It is most difficult to estimate the probable cost of pipelines in cases where the systems were designed to supply water through public outlets. Depending on the number of branches or gridirons used, to feed such strategically located public outlets, the cost of the supply system could probably be reduced to one-half or one-third of the present cost. A reduction of about 20 per cent could be achieved in the rest of the works as a result of the considerably reduced consumption. In this way, the total cost of the water supply system would be something like 50 to 60 per cent of the present cost. However, this apparently great savings would mean converting systems of this kind into non-recoverable investments and permanent financial burdens. On the other hand, in their present form, these systems do cover the operating and maintenance costs and make possible the direct or indirect recovery of about 50 per cent of the original investment within the first ten years of operation. In addition, they act as the backbone for other public health programs and, it is hoped, will effectively contribute towards the control of diarrheal diseases and of water-borne diseases in general. For all of these reasons, it is believed that an increased investment is more than justified from every point of view.

The second aspect of the matter lies in the direct house connections from the distribution pipeline to the front of the house. Table 9 shows a study make of 187 water supply systems, which serve 228,448 inhabitants, and were designed with a total capacity for 460,000 persons. These systems come under the same Rural Water Supply Program for localities of up to approximately 5,000 inhabitants, mentioned earlier. According to the policy of the Ministry of Health and Social Welfare of Venezuela, they were designed to pipe water direct into the home by means of house connections, insofar as possible. The table shows the percentage of population with such direct service in each locality. The population living on the fringe of the locality is supplied through a small number of public outlets.

Table 10 is a summary of the data contained in the previous table. As may be seen, an average of 83 per cent of the total population benefited is served through house connections; these cost 6 per cent of the total cost of the water supply system. The percentage of the population with direct service is considered close to the maximum that can be economically handled since the remaining beneficiaries live outside the center of the locality and are so dispersed that the extension of direct service to them would result in injustifiable increases in cost. However, as experience has shown, once the water supply service begins to operate efficiently it attracts dispersed population to the center of the locality or arouses the wish for water piped direct into the house to such a degree that in some cases the beneficiaries paid the cost of building the pipelines leading to their homes although they were several hundred meters long.

Needless to say, once the idea of a complete system of direct water supply is accepted, the additional cost of house connections is more than justified, since it comes as the logical sequence to the guiding principle of the program.

These, then, are the two so-called "public" parts of a water supply system whereby the services are placed at the disposal of the beneficiaries in front of their homes. Bringing the water from there into the home is the third aspect of the problem. Remarks here will be limited to supplies for rural areas or for urban fringe areas with rural characteristics, since the customs and socio-economic conditions of most urban populations will automatically promote the construction of the necessary water works by the interested parties. The cost of installations in rural areas is estimated at 2 to 5 per cent of the total cost of the water supply system, depending on the distance of the house from the street, and on the number of taps --up to 3 or 4-- to be installed in the house.

Public cooperation can be enlisted at the outset of the water supply construction program only through the beneficiaries' direct collaboration. Public interest should be directed mainly towards promoting the desire to have water in the home. The cooperation given by beneficiaries will vary all the way from contributing unskilled labor to defraying the entire cost of the installations. This is one of the most important aspects of water piped direct into the home, for in the final analysis, the success of the program will depend on the people's response. In fact, this factor is of such great importance that it deserves a separate campaign either under the water supply program, or conducted at the same time, so as to create a favorable climate. A campaign of this kind could be included in community development movements, health education programs, establishment of water boards, public information, and so on. An interesting possibility would be to organize housing improvement campaigns in conjunction with campaigns for piping water direct into the home. This could be accomplished almost entirely through the efforts of the beneficiaries themselves, except for technical guidance and possible provision of low-cost materials. A true psycologic impact could be made in this way -- an impact that would mark the beginning of a rapid social and economic development in backward areas, with obvious beneficial results to public health.

TABLE 9: COST OF HOUSE CONNECTIONS IN LOCALITIES OF UP TO 5,700 INHABITANTS

Locality and State	No. of inhabitants		Per cent served by house connections	Total cost in Bs. Material & Labor	Cost of house connect. in Bs.	House connections - % of total costs	Cost of Materials in Bs.	House connections - cost as % of materials cost
	Pres.	Fut.						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pedro Gonzalez (N. Esp.)	1,682	3,364	100	198,600	22,680	11	91,700	25
Altagracia (Nva. Esparta)	2,372	4,744	96	257,000	30,780	12	129,000	24
La Chispa (Portuguesa)	600	1,200	40	99,072	3,240	3	45,523	7
Boca de Uchire (Anz.)	600	1,200	100	179,200	12,150	7	82,000	15
Buena Vista (Nonagas)	380	760	100	125,776	7,290	6	55,638	13
Belen (Miranda)	514	1,028	93	129,674	6,480	5	58,707	11
Col. Chirgua (Carabobo)	900	1,800	100	220,000	12,150	6	93,900	13
Arapuey (Merida)	2,000	4,000	62	299,166	16,405	5	122,356	13
San Vicente (Nonagas)	1,000	2,000	60	160,000	8,100	5	78,623	10
Coromoto (T. Amazonas)	325	650	92	112,500	4,050	4	50,000	8
Valle Morin (Aragua)	416	832	100	103,957	5,670	5	35,131	16
El Toco (Carabobo)	1,750	4,000	100	434,400	29,800	7	191,300	16
Suata (Aragua)	1,328	2,656	100	185,900	25,920	14	65,168	40
Quaimaral (Tachira)	370	740	24	137,600	1,215	1	70,500	2
Campo Barinas (Tachira)	274	548	55	201,000	2,025	1	98,000	2
S. J. de los Cayos (Falcon)	1,890	3,780	63	545,700	16,200	3	265,500	6
Boca de Mangle (Falcon)	1,686	3,380	71	478,300	16,200	3	233,600	7
Las Palomas (Falcon)	120	250	100	49,600	2,025	4	23,000	8
Capadare y Q. Honda (Falcon)	580	1,160	100	179,000	8,910	5	88,300	10
Los Taperos y Boqueron (Falcon)	168	340	100	80,100	3,240	4	41,100	8
Chiguara (Merida)	1,250	2,500	100	530,000	25,920	5	210,800	12
Los Altos de Santa Fe (S)	923	1,850	100	161,500	12,960	8	80,820	16
Sinamaica (Zulia)	1,288	2,576	84	467,100	14,580	3	251,240	6
Aguada Grande (Lara)	1,411	2,822	100	369,000	24,300	7	187,195	13
Valle Guanapo (Anzoategui)	3,500	7,000	69	872,800	32,400	4	455,800	7
Cachipo (Anzoategui)	275	550	100	92,658	3,978	4	70,000	6
S. Rgo. de Cabrutica (Anz.)	475	950	82	184,000	6,240	3	120,000	5
Sabana de Uchire (Anz.)	1,375	2,750	70	614,625	12,960	2	209,668	6
Santa Rosa (Apure)	170	400	88	48,795	2,000	4	29,095	7
Pto. Infante (Apure)	170	400	100	58,666	3,840	7	35,506	10
S. Fco. de Asis (Aragua)	2,586	5,172	100	425,028	49,734	12	195,581	25
La Julia (Aragua)	700	1,400	100	119,756	10,296	9	55,536	19
Andres E. Blanco (Aragua)	800	1,600	100	156,171	13,365	9	100,996	13
Santa Barbara (Barinas)	2,000	4,000	100	970,000	28,350	3	489,721	6
Obispo (Barinas)	967	2,000	50	142,000	7,600	5	74,000	10
La Barinesa (Barinas)	314	700	54	155,500	2,660	2	97,500	3
Aripao (Bolivar)	236	500	100	143,000	5,670	4	75,000	8
Santa Rosalia II (Bolivar)	320	640	94	195,000	4,050	2	66,800	6
El Toco II (Carabobo)	1,425	3,565	100	259,840	14,361	6	124,529	12
Casigua (Falcon)	600	1,200	90	132,474	7,290	6	71,562	10
Palmasola (Falcon)	250	500	100	89,384	3,888	4	34,137	11
Espino (Guarico)	432	864	100	163,334	7,560	5	101,959	7
El Rastro (Guarico)	732	1,500	100	206,338	33,210	16	99,302	33
El Calvario (Guarico)	536	1,100	100	140,000	10,854	8	61,000	18
Las Lajitas (Guarico)	350	800	87	108,585	3,850	4	69,093	6
Sosa (Guarico)	600	1,200	85	106,151	6,545	6	68,661	10
La Esperanza (Guarico)	250	800	100	90,487	4,000	4	60,509	7
Sta. Maria de Ipiro (Guarico)	3,110	4,665	100	605,548	94,000	16	358,278	26
Las Cocuizas (Guarico)	400	800	100	117,478	5,600	5	68,268	8
Anzoategui (Lara)	850	1,700	95	221,000	10,935	5	80,760	14
Sarare (Lara)	4,100	8,200	73	620,193	41,000	7	252,404	16
La Miel (Lara)	1,447	3,000	100	351,899	22,680	6	134,494	17
El Descecho (Lara)	202	404	65	62,933	1,694	3	19,861	9
Barbacoas (Lara)	1,136	2,272	100	294,640	19,926	7	142,619	14
San Miguel (Lara)	1,032	2,000	100	415,500	17,670	4	212,900	8
Caño Zancudo (Merida)	1,107	2,214	98	368,438	14,580	4	156,212	9
Las Gonzalez (Miranda)	1,000	2,000	72	45,733	9,840	21	22,623	43
Las Martinez (Miranda)	1,000	2,000	60	101,242	8,280	8	53,504	15
Marcelo (Miranda)	250	500	84	46,200	2,835	6	12,500	23
El Cafe (Miranda)	608	1,200	99	85,378	7,800	9	35,639	22
Las Morrocoas	380	760	100	99,298	6,480	7	33,302	19
Pueblo Nuevo (Miranda)	280	600	100	109,495	6,630	6	55,495	12
Araira (Miranda)	1,750	3,500	86	445,129	20,250	5	196,040	10
Tahuayas (Nonagas)	1,000	2,000	78	128,260	10,530	8	62,585	17
El Corozo (Nonagas)	1,200	2,400	67	266,521	10,318	4	124,580	8
Guacuco (Nueva Esparta)	900	1,800	100	660,000	17,100	3	273,000	6
Rio Chiquito (Sucre)	520	1,040	100	221,000	8,000	4	100,000	8
Varicallar (Sucre)	500	1,000	72	172,000	4,860	3	95,860	5
Chacaracual (Sucre)	500	1,000	72	63,800	4,860	8	45,000	11
No Carlo y Platanito (Sucre)	600	1,200	100	301,888	10,670	4	155,196	7
Hernandez (Tachira)	1,103	2,320	98	474,061	14,580	3	170,493	9
Coloncito (Tachira)	2,050	4,500	100	352,566	29,160	8	166,294	18
Delicias (Tachira)	1,320	2,640	100	329,600	21,000	6	165,900	13
Cordero (Tachira)	1,700	3,400	94	486,000	25,632	5	246,000	10
Palmira (Tachira)	2,076	4,150	100	753,500	38,880	5	462,500	8
Paticelitos (Tachira)	903	1,800	100	187,000	15,456	8	100,500	15
Burbusay (Trujillo)	550	1,100	100	229,884	8,100	4	88,854	9
Mendoza Fria (Trujillo)	1,314	2,628	100	205,025	24,300	12	75,660	32
Agua Santa (Trujillo)	1,705	3,410	70	324,279	16,200	5	163,433	10
La Puerta (Trujillo)	1,400	3,220	100	369,500	27,300	7	150,000	18
El Dividive (Trujillo)	2,720	5,440	100	504,615	38,540	8	274,451	14
Carrabobo y caseríos (Yaracuy)	1,825	3,813	98	374,030	20,250	5	139,000	15
San Juan (Zulia)	2,216	4,432	76	407,323	22,680	6	172,782	13
La Ensenada y Potrero (Z)	1,314	2,628	100	319,467	18,630	6	140,587	13
Potrerito (Zulia)	1,208	2,416	100	307,516	17,820	6	142,430	13
San Antonio (Zulia)	450	900	100	143,000	12,240	9	50,000	24
San Fco. del Pino (Zulia)	316	632	100	88,000	5,760	7	30,500	19
Boscan (Zulia)	200	400	100	99,000	5,040	5	33,500	15
San Jose (Zulia)	570	1,140	100	118,000	10,080	9	39,000	26
Santa Maria (Zulia)	550	1,100	100	140,000	10,800	8	45,000	24
San Fdo. de Atabapo (T. Am.)	943	2,000	95	249,438	12,300	5	164,405	7
Santa Catalina (T.D.A.)	450	1,200	100	146,322	7,708	5	92,479	8
La Horqueta (T.D.A.)	390	1,000	100	116,800	8,928	8	80,000	11
Piacoa (T.D.A.)	470	1,000	100	136,300	7,776	6	90,000	9
La Sabana (Distrito Fed.)	1,050	2,100	100	272,000	21,120	8	153,500	14
Osma (Distrito Federal)	205	500	94	166,000	3,072	2	81,000	4

Locality and State	No. of inhabitants		Per cent served by house connections	Total cost of Bs Material & Labor	Cost of house connect. in Bs.	House connections - % of total cost	Cost of Materials in Bs.	House connections - cost as % of materials cost
	Pres.	Fut.						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
El Pao (Anzoategui)	585	1,200	82	171,157	6,800	4	93,593	7
Humocaro Bajo (Lara)	2,000	4,000	90	437,615	29,400	7	182,909	16
Buena Vista (Lara)	656	1,400	64	357,000	4,550	1	157,000	3
Cubiro (Lara)	1,520	3,040	100	279,629	22,100	8	98,746	22
S.J. de Laguzillas (Mar.)	1,570	3,200	83	648,189	14,170	2	291,347	5
Barrancas (Nonagas)	5,700	8,550	95	916,193	58,500	6	461,402	13
Torococo (Trujillo)	1,100	2,200	71	350,775	11,102	3	151,010	7
Quicas (Trujillo)	1,760	3,520	51	203,700	9,750	5	97,188	10
Pampanito (Trujillo)	2,690	5,380	94	320,600	30,240	9	158,107	19
Miton (Trujillo)	800	1,600	68	63,188	5,850	9	32,011	18
Playa Grande (Zulia)	291	582	100	132,500	3,000	2	50,478	6
Gibraltar (Zulia)	455	910	100	183,000	6,960	4	76,000	9
Caja Seca (Zulia)	1,306	2,620	70	321,570	12,750	4	149,782	9
Zuata (Anzoategui)	791	1,582	91	160,568	9,720	6	71,569	14
El Chaperro (Anzoategui)	2,150	5,375	67	603,114	19,440	3	272,566	7
Guanape (Anzoategui)	1,578	3,160	57	274,700	12,150	4	140,700	9
San Casimiro (Aragua)	3,000	6,000	80	402,000	32,400	8	197,500	16
Las Majadas (Bolivar)	500	1,000	72	156,858	4,860	3	72,845	7
Las Bonitas (Bolivar)	311	650	87	150,935	3,645	2	70,933	5
Santa Rosalia (Bolivar)	400	800	75	170,077	4,800	3	80,388	6
La Urbana (Bolivar)	1,100	2,200	55	160,700	8,100	5	75,000	11
Urama (Carabobo)	1,312	2,926	54	189,704	10,030	5	91,239	11
Borburata (Carabobo)	1,307	2,800	83	161,155	15,300	9	75,794	20
Aguas de Obispo y Las Matas (Carabobo)	588	1,176	71	167,902	4,550	3	46,402	10
Apartadero (Cojedes)	905	1,800	80	220,000	8,880	4	117,000	8
Piritu (Falcon)	2,766	5,532	48	1,537,040	17,820	1	621,217	3
Chimpire (Falcon)	525	1,050	100	127,721	7,290	6	49,235	15
S. Jose y Bella Vista (Falcon)	659	1,318	68	189,071	6,075	3	87,059	7
S. Fco. de Macuria (Guarico)	850	1,700	56	221,850	6,400	3	106,142	6
S. Jose de Guaribe (G)	2,687	5,374	71	549,164	25,920	5	223,749	12
Humocaro Alto (Lara)	1,223	2,450	100	296,000	19,440	7	154,000	13
Sarare (Lara)	2,300	4,600	100	731,000	48,600	7	338,400	14
Nueva Bolivia (Merida)	1,100	2,200	55	180,000	8,100	5	95,000	9
Sotillo y Col. Sotillo (Miranda)	659	1,318	100	185,442	9,720	5	78,176	12
Arag. de Maturin (Non.)	5,500	11,000	16	664,299	12,150	2	330,953	4
Sab. de Piedra (Nonagas)	1,500	3,000	96	342,600	19,440	6	146,000	13
Teresen (Nonagas)	2,000	4,000	75	405,344	20,250	5	195,393	10
Papelon (Portuguesa)	450	900	100	140,000	5,200	4	68,000	8
Mesa de Cavacas (Port.)	800	1,600	83	192,195	8,910	5	94,890	9
El Rincon (Sucre)	940	1,880	75	123,570	8,190	7	53,213	15
Casanay (Sucre)	3,341	6,682	18	438,550	8,100	2	280,000	3
Campo Ajure y Rio Casanay (Sucre)	732	1,464	16	225,100	1,620	1	84,000	2
Guarapiche y Las Toscanas (Sucre)	823	1,646	15	311,100	1,620	1	140,000	1
Nueva Colombia (Sucre)	150	300	40	106,550	810	1	44,000	2
El Limon, Juan Sanchez, El Cangrejal (Sucre)	1,122	2,244	16	421,650	2,430	1	210,000	1
Pantoño (Sucre)	1,005	2,010	18	162,550	2,430	1	15,000	3
Puerto Nuevo (Tachira)	575	1,725	52	136,360	4,050	3	82,000	5
Arca (Yaracuy)	3,842	7,684	94	507,000	48,600	10	241,021	20
Salem (Yaracuy)	953	1,906	77	307,510	8,540	3	135,847	6
Sabana de Parra (Yaracuy)	2,500	5,000	56	605,334	24,990	4	323,676	8
Coporito (T.D.A.)	331	660	91	121,000	3,600	3	63,000	6
Sacupana (T.D.A.)	277	560	100	157,000	4,050	3	76,500	5
El Jabillo (Cojedes)	230	460	68	126,685	2,106	2	66,944	3
El Tigre (Zulia)	1,400	2,800	75	262,647	14,175	5	129,680	11
El Pintado (T. Amazona)	80	600	60	50,000	648	1	28,000	2
Sabana Grande (Trujillo)	2,200	4,400	98	285,000	29,160	10	147,600	20
Granados (Trujillo)	1,500	3,000	100	231,000	21,060	9	128,800	16
Sab. de Mendoza (Trujillo)	4,156	8,312	100	931,200	77,900	9	419,214	19
Paraguaipoa (Zulia)	1,853	3,706	91	241,440	22,680	9	159,400	14
San Antonio de Rio Chico	500	1,000	19	99,420	1,296	1	56,060	2
El Canton (Barinas)	1,195	2,390	100	201,644	29,484	15	130,157	23
Abejales (Tachira)	687	2,060	100	211,000	12,150	6	105,320	12
Crucito (Yaracuy)	830	1,660	72	140,000	9,700	7	60,000	16
Palmarito (Merida)	1,000	2,000	100	160,000	13,770	9	86,115	16
Santo Domingo (Merida)	890	1,780	100	167,806	12,150	7	77,243	16
Sabaneta y El Pozo (S)	274	548	66	107,673	2,430	2	41,102	6
Cata (Aragua)	700	1,400	69	132,162	6,480	5	69,459	9
La Pica (Aragua)	2,160	5,782	100	379,689	36,700	15	145,459	39
Los Tanques (Aragua)	560	1,120	49	64,917	3,706	6	24,700	15
Altamira (Barinas)	1,500	3,000	88	265,413	17,820	7	100,055	18
Caripe (Nonagas)	4,364	8,728	69	541,000	40,500	6	286,000	14
Payares (Yaracuy)	300	600	50	44,855	2,025	5	23,083	9
Las Guacas (Apure-Barinas)	400	800	100	172,194	10,125	6	91,328	11
Too. de la Costa (Falcon)	4,134	8,300	73	660,000	40,500	6	400,144	10
Boca del Toc. (Falcon)	1,127	2,300	69	243,400	10,530	4	113,510	9
El Pilar (Sucre)	3,531	7,062	100	482,186	64,800	13	280,014	23
Tunapuy (Sucre)	2,613	5,226	100	315,322	36,450	12	132,732	27
Los Arroyos (Sucre)	863	1,726	100	187,006	12,150	6	98,098	12
Guarauno (Sucre)	774	1,548	100	180,390	10,530	6	95,159	11
Qda. de Monos (Sucre)	677	1,354	100	174,652	9,720	6	71,886	14
Tunapuicito (Sucre)	398	796	100	127,205	8,100	6	47,185	17
Chorro Chorro y Pueblo Nuevo (Sucre)	333	666	54	113,810	2,430	2	44,191	5
Cancabito, La Seca y El Guineo (Carabobo)	510	1,020	41	123,000	2,835	2	49,000	6
Canoabo, El Naranjo (Carabobo)	2,340	4,680	59	489,000	18,630	4	222,000	8
Rio Salado y San Juan (Sucre)	950	1,900	100	182,376	16,200	9	75,974	21
Esmuque (Trujillo)	3,397	6,794	100	335,143	56,700	17	164,203	35
Sabana Libre (Trujillo)	1,790	3,580	100	186,075	28,350	15	83,652	34
La Mata (Trujillo)	1,778	3,556	100	121,827	24,300	20	49,213	49
Santa Rosalia (Miranda)	350	700	100	62,100	6,804	11	22,400	30
Santa Ana (Tachira)	3,957	7,850	98	618,000	32,265	8	312,000	17
Seboruco (Tachira)	2,700	5,400	100	446,038	36,450	8	214,143	17

TABLE 10: SUMMARY OF RELATIVE COST OF HOUSE CONNECTIONS

Number of localities studied		187
Average percentage served by locality		83
Total cost of projects studied	Bs.	50,732,610
	$	11,174,583
Total cost of all house connections	Bs.	2,894,002
	$	637,445
Average cost of connection by project	Bs.	15,475
	$	3,409
Average percentage represented by house connections in the total cost		6%
Cost of materials for all projects under study	Bs.	24,205,187
	$	5,331,538
Average percentage represented by cost of connections in total cost of materials		12%
Total number of inhabitants		228,448
Per capita cost of house connections	Bs.	13
	$	2.86

ANNEX C

FINANCING OF WATER SUPPLY PROGRAMS

Part VI of this paper contains a definition of the basic requirements for plans to finance water supplies.

The per capita cost, estimated at from $50 to $60, as an average, for urban water supplies in Latin America should be financed by the national, regional, or municipal government through either budget allocations or long-term loans. Under favorable circumstances the entire investment should be considered recoverable. The installation of house connections and private plumbing will require no special financing since the former can be built together with the water supply system, and the latter will be paid for direct by the beneficiaries.

In the case of rural water supplies, the financing plan will vary according to local conditions. The cost of the study, plan, and supervision is estimated at from 5 to 8 per cent of the total cost of the water supply system and should normally be contributed direct by the agency in charge of conducting the program.

Construction of the works, excluding house connections, represents from 86 to 89 per cent of the total cost. About one-half of this is for material and equipment, which invariably should be financed by public funds, normally either national or state, or else through an international loan. The other half, that is to say, 43 to 45 per cent of the total cost, is for labor and local transportation, which can be partially contributed by the beneficiaries or financed by short-term loans from local enterprises, through national or state budget allocations.

The installation of house connections, about 6 per cent of the total cost, can be financed locally through relatively short-term loans, with the municipal or state government contributing the initial cost and subsequently collecting from the users in easy monthly or quarterly installment payments, or during their periods of income (at harvest time, for example). The same applies to financing the installations needed to bring water from the sidewalk into the house.

The Rural Water Supply Program of the Ministry of Health and Social Welfare of Venezuela is one example of the possible systems of financing. A long-term loan, granted by the Inter-American Development Bank, and backed by the Government of Venezuela, covered up to a maximum of 50 per cent of the cost of the works. This amount was mainly for the cost of pipelines, accesories, equipment, and transportation from the port to the building site.

The balance, which in practice should be approximately 55 per cent of the total cost of the works, was shared by the Ministry of Health and Social Welfare and the regional governments. The Ministry contributed the study, plan, and the supervision of construction, while labor is the responsibility of the regional governments, either through contracts with private building firms or through direct construction, in cooperation with the interested parties. Well drilling, and the supply of pumps and storage tanks are items which may be contributed by both Ministry and regional government, depending on local conditions. The initial cost of house connections is similarly shared and may later be collected by either the regional government or the board in charge of administering the water supply system.

The installation of plumbing inside the home has not yet been organized into formal campaigns, but the beneficiaries themselves have undertaken it with help from the regional government in the form of materials.

Water rates are established beforehand, depending on the financial capacity of the beneficiaries, on the total cost of the water supply system, operating costs, and so forth. The theoretical recovery of the initial investment includes operating and maintenance costs, and exceeds 50 per cent. In view of the fact that the administration of water supplies is the responsibility of the boards established and chosen for that purpose, the recovery of the invested funds is indirect, since the collection remains in the hands of those boards, which use the income they receive to operate, maintain, and expand the service, to establish reserve funds, etc.

Table 11 is a summary of the entire discussion of means for financing water supply systems.

TABLE 11

VARIOUS METHODS FOR FINANCING WATER SUPPLY PROGRAMS

Item	Costs (% of total cost) (per capita cost)	Method of Financing
Complete system of urban water supply	100% $50 - $60.0	National, state, or municipal budget; bonds; long-term loans
Plumbing in the home in urban areas	Varied	Direct by beneficiaries
Study, plan, and supervision in rural areas	5 - 8% $0.75 - $2.4	Budget of agency in charge of the program; occasionally some international agencies.
Provision of materials and equipment for rural water supplies	43 - 45% $6.45 - $13.50	National or state budget; long-term loans; limited contribution of municipalities
Provision of labor in rural areas	43 - 45% $6.45 - $13.50	State budget; building enterprise (short-term) varied contributions from beneficiaries; limited contribution from national budget
Installation of house connections in rural areas	6% $0.9 - $2.4	National, state and municipal budget, with charge to beneficiaries by installments of part or all the investment.
Plumbing in the home in rural areas	2 - 15% (in addition to total cost) $0.30 - $2.00	National, state, and municipal budget (cost of campaign and possibly materials); beneficiaries (labor as a minimum); non-profit organizations and campaigns

Note: For sources of international capital see: documents relating to the Charter of Punta del Este; the Alliance for Progress; and Boletín of PASB, Vol. XLVIII, No 5, November 1959.