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PREVENTIVE MAINTENANCE of RURAL WATER SUPPLIES

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1. Introduction.

1.1 The International Drinking-Water Supply and Sanitation Decade 1981-1990, with the goal of providing, as far as is possible, safe and adequate drinking-water and appropriate sanitation for all, has stimulated the release of resources from governments, communities and external support agencies for the development of the sector. There is a universal awareness that such development is an essential prerequisite to the control of waterborne and water-related diseases and is therefore indispensable for the good health upon which rests personal well-being and national productivity and wealth. Such benefits will, however, accrue only if the facilities provided continue to function and to be utilized to their full potential. Unfortunately, there is growing evidence, and increasing concern within governments and the development agencies, that poor operation and maintenance (O & M) practices have in many instances largely contributed to a decreased utility, or even to an early failure of newly constructed water supply and sanitation facilities. The resulting need for the premature replacement of equipment, or for the rehabilitation of systems before they have been in service for the full span of their useful lives, thus imposes a burden which could well have been avoided or mitigated and involves the utilization of scarce resources which could otherwise have been employed for further development. The introduction of proper operation and adequate maintenance practices would relieve this situation and help ensure that the resources available are utilized in the most effective way to confer maximum and enduring benefits.

1.2 O & M practices are affected by a wide variety of factors, the most important of which have been identified in a recent WHO Booklet (ETS/83.9 1/). Matters concerning site conditions, socioeconomic factors in the supply area, the inclusion of O & M considerations during project planning and development, the institutional and management structure, the use of appropriate technology, resource availability, etc., etc., must all be considered when defining how O & M practices in a particular situation can best be established. To prepare complete guidelines on the subject of O & M would, therefore, be a complex task, and this Paper accordingly concentrates on one important element, the Preventive Maintenance of Rural Water Supplies, a title which in itself requires further definition.

1.3 Preventive maintenance is considered to be a systematized and periodic maintenance procedure applied to the components of a system in order to minimize breakdowns, ensure their efficient working, and prolong their respective lives. Such maintenance is not to be confused with the corrective action taken to repair or replace system components after a breakdown has occurred, as the latter is not the subject of a planned procedure but rather a response to an operational requirement. The definition of a rural water supply is more complex, but for the purpose of this paper it is considered to be one which employs the most simple technology possible, serves beneficiaries who are predominantly employed in basic agricultural, forestry, fishery or related pursuits, and supplies communities, often dispersed, which are not commonly self-sufficient in their technical or financial support of the system.

2. The Place of O & M in the Project Cycle.

2.1 O & M, including preventive maintenance, is recognized as an integral phase of the project cycle which is initiated by project identification and proceeds through phases concerned with its planning, design and construction, O & M and evaluation 2/. Despite this recognition, there has frequently been a tendency to look upon that part of the cycle which culminates in system construction as a self-contained achievement, overlooking the vital fact

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1/ "Rural Water Supply Operation and Maintenance - Eight Questions to Ask".

2/ Guidance on project evaluation is provided in WHO Booklet ETS/83.1, "Minimum Evaluation Procedure (MEP) for Water Supply and Sanitation Projects".

that uninterrupted operation and proper maintenance are essential to achieve the benefits for which the project was planned. It is accordingly stressed that the foundation for good operation and maintenance practices must be laid from the very start of the project cycle, and that full weight must be given to O & M considerations during project planning, design and construction. Some of the more important of these considerations are briefly discussed in the following paragraphs.

3. Planning Phase Decisions Relating to O & M.

3.1 Although a rural water supply commonly serves a community which is generally unable to assume full technical or financial responsibility for O & M, it is widely accepted that the beneficiaries should be kept fully informed and be consulted at all stages of the project's preparation and be encouraged to participate to the greatest practicable extent. Such participation should not only arouse their interest in and sense of ownership of the facilities but also encourage them to share in the recurrent resource burden which would otherwise have to be fully borne by the government as a social service. The extent of community involvement will vary from place to place, but an objective frequently sought is for the beneficiaries to:

(i) elect a Community Water Committee or its equivalent to act as the responsible local executive body;

(ii) provide workers for the operation and day-to-day maintenance of the system; and

(iii) bear as great a proportion of operational and maintenance costs as circumstances permit.

Experience has shown that the vesting of responsibility and authority within a specialized unit of the technical agency responsible for the development of the water supply system is often an appropriate solution for the provision of back-up support to the community for O & M. Such support would include:

(i) the training of staff provided by the community;

(ii) periodic inspection and advice; and

(iii) undertaking items of preventive and corrective maintenance which are beyond the means or the technical competence of the community.

For these services, the technical agency will require financial support, which is generally derived from community contributions and government subventions.

3.2 The division of institutional responsibility on the lines discussed above, frequently leads to the establishment of an O & M organization which distributes responsibility between some or all of the following groups:

(i) community workers responsible for day-to-day O & M;

(ii) technical support agency staff;

(a) working as mobile teams which visit facilities according to a routine pre-arranged schedule;

(b) attached to workshops to which items of equipment are brought at regular pre-determined intervals;

(iii) specialized contractors engaged to undertake specific items of maintenance on a routine basis.

3.3 Clearly the foregoing matters should not be left either to an ad hoc evolvement or to hasty decision on completion of the system's construction phase. Discussions, at an early stage of the project cycle, between the technical agency and community representatives, are required, so as to clearly define the division of administrative, technical and financial responsibility for O & M, as are additional discussions between the technical agency and the government ministry responsible for budget allocations so as to ensure the timely provision of recurrent government subvention for the agency's share of O & M expenditure. Early decision on these matters will allow:

(i) the sources and extent of recurrent funding to be determined and the necessary steps to be taken for their provision (e.g. drawing up of a local tariff schedule; definition of billing and collection procedures; agency budget provision);

(ii) manpower needs to be identified and the necessary recruitment and training procedures put into effect;

(iii) ancillary facility and equipment needs for O & M to be identified and provided (e.g. transport, tools, workshops, stores);

(iv) administrative actions to be taken (e.g. formation of Community Water Committee, preparation of O & M manuals and schedules; preparation of record books, sub-contracts arranged for the supply of items such as fuel and other consumable stores, and with local contractors for specific preventive maintenance tasks).

4. Design and Construction Phase Decisions Relating to O & M.

4.1 In the drawing up of design parameters, the design of physical facilities, the selection of equipment and the choice of constructional materials and methods due consideration should be given to future O & M implications of decisions made. Of particular relevance is the need to:

(i) ensure the adoption of a technology which can be understood and of equipment which is capable of being operated and maintained by community workers with the minimum of supervision and back-up support;

(ii) select equipment which is sufficiently reliable and robust to meet the operational demands imposed upon it. In this connection, the selection of equipment should be based not only on initial capital cost considerations but should include, also, for the capitalization of O & M costs over its expected life;

(iii) install equipment for which spare parts, and the tools and plant required for O & M, can be readily obtained;

(iv) consider, in circumstances where a number of installations are the responsibility of the agencies engaged in O & M, the savings likely to accrue from a standardization of equipment from, for example, simplified training programmes, reduced requirements for the range of spare parts to be held in stores, and the equipping of maintenance teams;

(v) incorporate, where possible, features which facilitate O & M, such as accessibility to plant, and the provision of standby equipment so as to allow continual operation when an item of equipment is out of operation for preventive maintenance. In the latter respect, where multiple installations utilizing standardized equipment are involved, circumstances may allow standby equipment such as pumps and engines to be held in workshops and to be rotated amongst the various supplies as corresponding installed items are immobilized for preventive maintenance;

(vi) incorporate adequate quality control of purchasing and installation, and adequate testing during installation and construction to detect defects before being placed in operation or before being buried.

5. Transition from Development to O & M.

5.1 A matter of major importance concerning the transition between the development and the O & M phases of the project cycle is that in most circumstances there will be a significant, if not total, change in the staff responsible for construction and those responsible for subsequent O & M. Continuity in the knowledge of system layout and equipment installed is therefore not guaranteed. To overcome this deficiency arrangements should be made for:

(i) O & M staff to be employed on site during at least the final stages of construction, so as to become familiar with the system and to participate when plant and equipment are being tested and run in;

(ii) the provision by the development agency of complete "as built" record drawings. These drawings should clearly show the layout of the total system, indicate the materials and diameters of the various pipes, the situations of valves, standposts, reservoirs and other structures, and the specifications for renewable items such as filter sand;

(iii) the preparation of an inventory of the components of the system and of the equipment installed. This information can conveniently be entered on a card index system, the card being designed for use, also, as a record card for maintenance/repair work subsequently carried out on the item concerned. Annex 1 is a typical example of an Equipment History Card which provides space for recording technical details of the item, together with information regarding its date of installation, location, etc., on one side, whilst space for recording maintenance/repair history is provided on the reverse. Cards should be purpose designed to ensure the recording of all relevant technical information pertaining to a specific item. Annex 2 is an example of a card used for recording details of a shallow well and its subsequent history of maintenance.

5.2 Information from the manufacturers of equipment which has been installed, such as descriptive material, assembly manual, operational manual and spare parts list, should be carefully retained for future reference, and if not attached to the appropriate Equipment History Card, its location should be noted on the card. In this latter respect, it may be appropriate for such information to be retained by the supporting technical agency, as manuals are not always written in the local language and are frequently of a complexity which may not be easily understood by on-site staff. In these circumstances, simple, clearly understood instructions in the local language, supported as required by illustrative drawings, should be provided, as necessary, by the technical agency for on-site use.

6. Basis for Organizing and Managing a Preventive Maintenance Programme.

6.1 Essentially, a preventive maintenance programme consists of organizing and managing the activities required to carry out predetermined and periodic maintenance procedures to system components installed within a defined operational area. Such a programme will be based on:

(i) the identification of the frequency and location of the tasks to be performed, and the allocation of responsibility for undertaking these tasks;

(ii) the identification of the resources required to carry out the tasks, expressed in terms of finance, manpower, tools and plant, workshops, transport, consumable stores, etc.;

(iii) logistical arrangements to ensure the provision of the required resources and their deployment to enable the tasks to be carried out as planned; and

(iv) a reporting system which will enable programme performance to be assessed and any necessary adjustments introduced so as to improve efficiency.

6.2 Because of the many variables involved in the design of preventive maintenance programmes, including, for example, the size and complexity of the system, the technology employed, the allocation of institutional responsibility, etc., no generally applicable blueprint can be prepared. There are, however, certain common elements, which are discussed in the following paragraphs.

7. Identification of Tasks to be Performed.

7.1 The inventory of the components of the system and of the equipment installed (see para. 5.1 (iii)) serves as basic documentation from which to commence the process of task identification. The importance of preparing a comprehensive and detailed Equipment History Card for each and every item cannot therefore be over-stressed, as each Equipment History Card will require to be studied and the preventive maintenance tasks for that particular item determined on the basis either of established practice or to conform with manufacturers recommendations.

7.2 Annexes 3 and 4 give, as examples, the preventive maintenance tasks required for a diesel engine and a handpump, respectively, together with information regarding the frequency at which each task is carried out (daily, weekly, monthly, etc.), the materials required, and the level of staff responsible for undertaking the task. Annex 5 gives more general guidance on the preventive maintenance tasks required for a wide range of water supply components, including buildings, structures and plant.

7.3 In order to assess overall preventive maintenance requirements within a particular operational area, the components which make up each individual supply should be classified and entered on a form such as that shown at Annex 6. From the example used, it can be seen that in this particular operational area which covers 15 village supplies, preventive maintenance tasks will have to be carried out on 14 diesel engines, 16 gravity feed chlorinators, and 187 stand posts, etc..

From the composit listing of classified items, individual items can now be allocated an identification number as indicated by Annex 7. Thus, diesel engines Nos. J3 and J4 are located in Village C, storage tank N9 in Village K, etc.. These numbers should, where appropriate, be marked on the particular item of equipment and entered as the identification number on the corresponding Equipment History Card.

7.5 Completion of the foregoing steps will have assembled sufficient data to allow a preventive maintenance workplan to be drawn up as the following factors are known:

(i) the overall numbers of classified components of the installed facilities within the operational area (Annex 6);

(ii) the location of individual items within each classification (Annex 7);

(iii) the preventive maintenance tasks which have to be carried out for each item (Annexes 3, 4 and 5);

(iv) the timing of each task, the materials and spare parts required, and the staff inputs which will be needed (Annexes 3, 4 and 5).

7.6 With regard to para. 7.5 (iv) above, the material requirements derived should initially be regarded as estimates, as they will be refined over time in the light of actual operational demands. They will, however, be sufficiently accurate to allow annual schedules to be prepared for oils and lubricants, spare parts, etc.. The allocation of responsibility for carrying out the tasks will be decided either on the basis of the agreed institutional arrangements or to accord with the competence or the resources available (e.g. workshops, transport) to the various levels of responsibility. The volume of work related to specific categories will determine whether the establishment of facilities at a District workshop within the operational area is warranted, or whether the work should be compounded with similar work in adjoining operational areas for execution at a Regional workshop.

7.7 In general, the system components which will be subject to preventive maintenance, can be broken down into the following classifications:

(i) buildings and structures;

(ii) pipelines, valves and fittings; wells and handpumps

(iii) electrical equipment, motors, switchgear and wiring;

(iv) rotating machinery, engines, pumps, windmills, etc.;

(v) specialized equipment such as gauges, chlorinators, etc.;

(vi) transport, tools and plant.

Within any particular operational area, it will therefore be possible to compound the preventive maintenance tasks for all of the items which fall into a particular category of classification, and to identify the overall tasks which each level of responsibility will have to deal with under that classification. Such knowledge will serve as a basis for the determination of job descriptions and staff requirements, workshop and transport facilities, and overall material and stores needs.

8. Resources Required to Support a Preventive Maintenance Programme.

8.1 As noted in the foregoing paragraphs, the identification of the tasks required within the overall programme, their frequency and location, and the allocation of responsibility for undertaking them, forms the basis of the preventive maintenance programme. Clearly, however, no programme, no matter how well defined, will be successful if the resources required for its implementation are not available. Unfortunately and all too frequently, the root cause of ineffective preventive maintenance has been a neglect to properly identify the extent of these resources, to plan and to budget for their timely provision. The project cycle has been seen to finish with the completion of construction, and the recurrent resource implications and requirements have been ignored. In the following paragraphs, some common resource needs are discussed.

Basic Equipment and Clothing.

8.2 All personnel employed will require to be properly equipped with the necessary protective clothing (overalls, boots, gloves, goggles, face masks, etc., as required) and basic handtools (spanners, grease guns, oil cans, pipe wrenches, etc.) in order to carry out day-to-day duties. In addition, safety equipment (first aid kits, fire extinguishers, etc.) must be looked upon as standard on-site requirements, as should wall posters , clearly illustrated and in the local language, to advise on, as appropriate, safety precautions to be taken when working with items such as electrical equipment, gas chlorinators, etc.. Much of this material will be utilized for general O & M purposes, not specifically for preventive maintenance.

Stores and Spare Parts.

8.3 As noted in para. 7.6, an initial estimate of the materials required for preventive maintenance can be made at the time when the preventive maintenance tasks are identified. Yearly variations will arise, as some tasks, for example the re-printing of buildings, will not take place annually, and the frequency of others will depend on the number of hours for which a particular item of equipment, for example a standby generator, has operated. In general, however, reasonably close estimates will be possible for preventive maintenance material requirements. To these it will be necessary to add the requirements for normal operation (e.g. fuels and chemicals), and for corrective maintenance to assess overall O & M needs.

8.4 Without the availability of materials and spare parts when and where required, any preventive maintenance programme will immediately run into difficulties. The timely ordering, distribution and storage of items, together with stock control and procedures for issue, is an important administrative function which is commonly best handled by staff from the support agency rather than the local communities. Ordering in bulk may have financial advantages, and the purchase of specialized items, particularly those from overseas sources which may require special procedures because of foreign exchange controls, is a matter for trained stores staff not generally available at the community level. Where items are readily available from local suppliers at a competitive cost, it may be unnecessary to hold such items in store. Local purchase procedures must, however, be established and firmly applied, as this is an area which has frequently been found to be open to abuse.

8.5 Preventive maintenance includes the introduction of new parts in exchange for those which have been in operation for some time. In many cases it may be economical for old parts to be reconditioned and recycled through the stores organization for reuse. Such arrangements should be introduced where possible and procedures established for maintenance staff to be accountable for the return of old parts, for their examination prior to either write off or repair and for their return to stock after reconditioning has been completed.

8.6 Financing for the purchase of stores and spares is likely to be divided on the basis of the allocation of task responsibility. Daily, weekly and monthly tasks carried out by community workers will consume a proportion of the overall materials required. These can either be obtained locally or from the stores organization by monthly or quarterly requisition against payment from community resources, and can be stored on site because of their rapid turnover. Materials required by the supporting agency will normally be held in stores attached to workshops, and will be issued as required either to travelling maintenance gangs or to workshop-based personnel carrying out preventive maintenance tasks. These materials will normally be bought from central government recurrent subvention to the technical agency supplemented, as agreed in any particular circumstances, by community payments. The cost of the stores organization, including staff costs, is normally considered to be an agency administrative overhead chargeable in total to the recurrent budget.

Workshops.

8.7 The requirements for workshops and their location will depend largely on the institutional allocation of responsibility for the tasks to be carried out within the overall preventive maintenance programme. The objective should, however, be to establish a system which overall will provide effective maintenance at minimum cost through an avoidance of duplication of facilities or the over-sophistication of equipment, by ensuring that staff and equipment are provided only to the extent that they will be kept fully occupied and that annual workplans clearly demarcate the boundaries of responsibility.

8.8 For a typical rural water supply, it is unlikely that any highly skilled tasks will be undertaken by workers provided by the community. At the local level, it is, therefore, often found adequate to provide only a simple workbench, fitted with a sturdy vice and equipped with a few tools dictated by circumstances, but including, for example, a hacksaw, sledgehammer, files, pipethreaders, etc..

8.9 Regional or district workshops staffed by the technical support agency will be more sophisticated, and will require to be equipped with the tools necessary to carry out the tasks demanded by the facilities they are provided to service. Circumstances may show that in addition to central workshops, there will be a requirement for travelling workshops, equipped, for example, to withdraw the drop pipes from deep boreholes or to re-grind engine valves. It will often prove to be financially attractive to have a single well-equipped workshop centrally located, which can be kept fully occupied by servicing all facilities within the operational area rather than to have a number of smaller workshops, duplication of equipment and under-employment of the staff.

8.10 In determining the extent of facilities to be provided at either the community or support agency level, sight should not be lost of the possible benefits of utilizing the private sector. For example, if local garages can be utilized to decarbonize engines, the cost of their use in relation to the direct employment of preventive maintenance staff, and the equipping of workshops, should be examined.

Transport.

8.11 To accomplish the tasks to be carried out by community employed staff, it has frequently been found that the provision of transport is neither necessary nor affordable. In cases where transport is clearly required, hand or tricycle-drawn carts may provide the simple answer if distances are not excessive and only hand tools have to be carried. Any tendency to introduce mechanized transport must be fully justified, as not only would initial costs be high, but the maintenance needs and operating costs of the vehicles could well prove to be as demanding as those of a simple water supply.

8.12 The transport requirements of district or regional workshops will of necessity be more demanding, the overall tasks to be accomplished within the operating area largely determining actual needs. Depending on circumstances, specialized equipment may be required, such as truck mounted heavy lifting tackle or mobile workshops, but the objective will be to minimize and simplify requirements within the framework of an effective programme which is planned to keep travelling time to a minimum.

Human Resources.

8.13 Human resources requirements, in terms of numbers, qualifications and training needs, duties and location, will depend on the size of the service area, the technology employed and the demarcation of responsibility between the benefiting communities and the supporting technical agency.

8.14 Operational staff employed by the community will normally also be responsible for predetermined items of preventive maintenance, selected from the list of identified tasks discussed in paragraph 7 above. Frequently these items will be simple basic tasks such as the tightening of bolts and the lubrication of pivot points on handpumps; the changing of standpost tap washers; the inspection of pipelines to detect leakage; the periodic opening of washout valves, etc. The importance of such work should, however, not be underestimated as it is on the basis of regular simple preventive maintenance of this type by locally employed staff that system life can be significantly extended at minimum cost, early recognition made of matters requiring corrective maintenance and proprietary community interest aroused and developed.

8.15 On the basis of the operational duties required for a particular situation plus the preventive maintenance tasks selected as the responsibility of the operating staff, job descriptions for on-site personnel can be prepared. These job descriptions will serve as guidelines for the number of persons needed and the knowledge which they will require to successfully operate and maintain the facilities for which they are responsible.

8.16 Small rural water supply systems which utilize appropriate technology do not normally require highly qualified or specialized resident staff. In general, such staff will be required to perform a wide range of relatively simple tasks. Highly skilled technical expertise is therefore often less important than the possession of general manual skills and the ability to adapt and improvise in the absence of close supervision. Additionally, the village operator or caretaker, who will frequently be chosen from the local community, should have a personality which will allow him or her to ensure, with support from the community Water Committee, that instructions regarding public usage of the facilities are followed.

8.17 It will normally be necessary to provide training for local staff after their selection, the extent of instruction required depending largely on the technology employed and the identified tasks. As already noted (paragraph 5.1(i)) there are decided advantages to be gained if O & M staff are recruited prior to the completion of construction so that they can familiarize themselves with the system and participate in plant operation during running in periods. Training can best be undertaken under the supervision of the technical support agency, or by representatives from equipment supplies if their contract calls for them to be responsible for plant start-up and operation for a running in period. External support agencies may add prestige to training programmes by initiating and funding them, as a concomitant of their capital aid for project design and construction.

8.18 Community workers should be provided with clear and precise instructions which detail their operational and maintenance duties. Such instructions, provided by the techncial support agency, must be simple and easy to follow, written in the local language and supported by any necessary drawings or sketches. Of equal importance is the necessity for O & M staff to be provided with operational log books and record cards (see paragraph 5.1 (iii)) and to be instructed in how to record the information required. The importance of such records cannot be over-emphasized as it is possible to determine from them the actual performance and reliability of the various items of equipment, the quantities of spare parts required and the time which is needed to carry out various maintenance tasks.

8.19 Staff employed by technical support agencies will also be identified by job descriptions based on the preventive and corrective maintenance duties for which they will be responsible. In general such duties will be of a more specialized and technical nature than those undertaken by on-site staff and it is accordingly likely that trade tested personnel will be required, supported as necesary by ancillary staff. An important function of support agency staff is to inspect and advise on the O & M of the facilities to which they are providing back-up support and in this respect mature, well experienced and qualified persons are required who can command confidence and respect from the communities with whom they work. The difficulty of obtaining staff of the required calibre to work in rural areas should not be under-estimated. It may be necessary to offer incentives such as subsidized housing or field allowances to attract and retain the level of personnel desired.

8.20 Support agency staff, through their regular visits to community facilities for inspection and training purposes, are in an ideal position to constantly emphasize the public health advantages of a well operated and maintained water supply. The provision of appropriate training and the inclusion of public health related matters in the job description of senior support agency staff will accordingly enhance the maximizing of health benefits to the recipient populations.

Finance.

8.21 As noted in paragraph 3.3 (i), it is essential that agreement be reached prior to implementation of project construction regarding recurrent funding requirements and the sources from which these funds will be provided. Numerous instances can be quoted where failure to do so has resulted in rapid deterioration, intermittent operation, and/or early abandonment of systems. As a result, capital investments are lost, public health and other social benefits are unrealized, and the expectations of the benefiting communities, which may have contributed to capital investment in cash or in kind, remain unfulfilled. It is accordingly incumbent upon the promoting technical agency to provide accurate estimates for

capital costs and for the various items of recurrent expenditure which will be required to operate, maintain and ultimately replace the facilities proposed and to meet debt service commitments. Negotiations with government, the benefiting communities, and possibly the external agency which is financing the capital development, should follow in order to obtain firm commitments that will fully cover recurrent cost requirements. A basic policy should be that a project will not be built until its recurrent funding requirements are guaranteed.

8.22 In most developing countries, governments have found that it is not possible for them to fully underwrite rural water supply recurrent costs as a social service on a national basis. Conversely, the situation in rural communities is such that they are generally unable to fully meet these costs from their own resources. As a result a sharing of the costs is frequently found to be the solution. A common practice which has emerged is for the community to provide system operators or caretakers and to contribute in whole or in part towards the cost of operation and maintenance, any balance required being provided as a subvention by Government through the technical support agency. Apart from rare examples (e.g. the Barangay Rural Water Supply Programme in the Philippines), communities are not generally able to service the debt, this item commonly being borne in its entirety by the govenment.

8.23 In-so-far as preventive maintenance costs are concerned, expenditures related to those tasks defined as the responsibility of community employed staff should normally be met by the community as should the cost of materials provided by the technical support agency when undertaking its support functions. Other support agency costs, for staff, transport and overheads, will be the subject of negotiation during the planning phase of the project and are frequently resolved by agreeing on a fee for each visit by agency staff.

8.24 To meet the cost of recurrent community commitments, which can be closely estimated during the negotiations for cost apportionment, water charges can be raised from the beneficiaries. This is a matter which it is again essential to resolve prior to project implementation as revenues must be guaranteed if a satisfactory service is to result. Many methods are used for charging for water, ranging from cash payments at water points, the introduction of flat rates per head or per dwelling, metering where high service levels allow the introduction of individual connections to the system, etc..

8.25 An important consequence of the involvement of the beneficiaries in cash payments is the need for a community structure which will be responsible for financial matters. This is generally a function of the locally elected or appointed Water Committee, and is an area where training will be required to establish simple and effective accounting procedures.

9. Logistical Arrangements for Preventive Maintenance.

9.1 Much of what has been written in the preceding paragraphs lays emphasis on the advance planning which is required to establish a successful preventive maintenance programme. The identification of the tasks which have to be performed, the reaching of agreement on the division of responsibility for technical, administrative and financial matters and the provision of the human, material and monetary resources required to undertake the maintenance tasks identified are all essential elements on which to base a successful programme. It should not be expected that these matters can be resolved or provided quickly -- time is required to conclude agreements between concerned parties, to procure the equipment and materials required, to prepare job descriptions, recruit and train staff and to prepare manuals. The message conveyed in paragraph 2.1 accordingly bears repeating -- the foundation for good operation and maintenance practices must be laid from the very start of the project cycle. To ensure that this is done, it is essential that the technical unit responsible for the provision of support (para. 3.1) be identified as quickly as possible, as much of the onus for pursuing the above matters will rest with it.

9.2 The preventive maintenance tasks identified (para. 7.5) and assigned to each of the groups noted in para 3.2, will be detailed in the job descriptions of the employees concerned, thus enabling the basic qualifications of each employee to be identified, as well

as areas in which specialized supplementary training will be needed. Additionally, provision should be made for corrective maintenance or repairs to be carried out by them, and sufficient flexibility allowed in work plans and time schedules to enable this to be accommodated. In this respect, lines of communication should be established between on-site staff and base workshops which ensure that emergency breakdowns can be notified for corrective action to be taken with a minimum of delay. A breakdown card system has been introduced with success in some areas for this purpose, the plant operator indicating on a pre-printed card the item which requires attention before transmitting the card, by post or otherwise, to the workshop.

9.3 The aggregation of similar tasks within any operational area which are assigned to each of the responsible groups, will define the overall magnitude of the annual work load for this specific activity, and allow staffing levels to be determined. For example, if there are 1,000 handpumps within a dispersed operational area, which each has to be visited twice per year (see Annex 4, last item) by a travelling maintenance team which can cater for 60 well checks per month, then three such teams will be required.

9.4 The overall logistical arrangements for preventive maintenance within an operational area will involve the integration of the task specific activities into a composite workplan. The objective of such a plan must be to keep staff, equipment and transport as fully employed as possible, and to avoid duplication of effort by a rigid allocation of resources. For example, transport allocated for stores distribution could also bring items scheduled for workshop overhaul back to a base rather than return empty, only to be followed within a few days by empty transport allocated to the workshops visiting the sites to pick up the items concerned.

9.5 Analysis of the total annual work load for specific tasks will also provide an indication of where it might be economical to use the private sector, if available, rather than to employ staff who will be under-utilized. For example, if there are 100 deep-well pumphouses in a supply area which each require re-decoration during a five-year cycle, the task requiring one week of a painter's time, then clearly even one painter would be idle for half of each year, and it would probably be advantageous to employ a contractor.

9.6 Based on the example presented in Annexes 5, 6 and 7, an annual preventive maintenance programme for the work allocated to the technical support agency is presented in Annex 8. This programme provides a plan showing for each working day of the year, the location to be visited and the tasks which are to be accomplished. Thus, the two diesel engines J3 and J4 located in Village C will be visited every month for one or more days between the 9th and 12th day to have monthly maintenance tasks performed; in January, April and October the additional quarterly tasks will be carried out, whilst in July the annual tasks will be undertaken. Daily and weekly tasks will be undertaken by the community worker and are not covered in the support agency workplan.

9.7 It must be emphasized that the example given above is only intended to illustrate the methodology for designing a preventive maintenance programme. Local circumstances which involve matters such as distances to be travelled and seasonal access to sites will have to be borne in mind; the composition of both static and mobile teams and their equipment will be tailored to technological demands; and flexibility to absorb demands for breakdown repairs should be allowed for.

9.8 Annual workplans must be kept under constant scrutiny to ensure that best use is being made of the resources available and that anomalies, such as the one quoted as an example in paragraph 9.4, are avoided. For the typical rural water supply operational area, particularly one in which equipment is standardized and appropriate, and where communities accept resonsibility for many of the preventive maintenance duties to be performed, an efficient preventive maintenance organization can readily be put into effect provided the resources are assured, and provided as much effort is put into its planning and implementation as into the development of the facilities which it is designed to protect.

10. Reporting and Evaluation.

10.1 Equipment history cards (see paragraph 5.1 (iii)) form the basis for preventive maintenance records relating to specific items of equipment. Operational log books (see paragraph 8.18) give an overview of the functional state of any particular system, detailing the quantity and quality of water being delivered and the reasons for breakdowns, their frequency and duration. Together, these records will contribute towards judgements to be made on the effectiveness or otherwise of the equipment installed, the operational and maintenance procedures being followed and the performance of the staff involved.

10.2 To be effective, the programme must be subjected to evaluation, so as to allow necessary modifications to be introduced in the frequency of task performance, the use of better materials and tools, improved utilization of staff and equipment, optimum stock levels of items held in store, and apportionment of responsibility with the objective of minimizing breakdowns and prolonging the life of the system.

Annex 1

SAMPLE EQUIPMENT HISTORY CARD

FRONT OF CARD

District:

Name of Supply:

Location of Equipment:

Equipment Identification No.: Date of Installation:

Description of Equipment:

Details of Technical Specifications:

Location of Assembly Manual: Operational Manual: Spare Parts List:

REVERSE OF CARD

Record of Maintenance/Repair					
Date	Work carried out	Materials, Spares, etc., used	Time taken for work	Cost	Signature

Annex 2

SAMPLE EQUIPMENT HISTORY CARD FOR A SHALLOW WELL

FRONT OF CARD

District: Name of Village:

Date of Installation: Location of Well:

Well Identification No.: Number of Users:

Water Quality Laboratory Reference Number and Date of Sample:

Location of Hand Pump Spare Parts List:

Technical Data:

A. Well		B. Hand Pump	
1. Hand Dug/Mechanically Dug		1. Name:	
2. Inner Well Diameter:	m	2. Type:	
3. Depth of Well:	m	3. Serial No.:	
4. Average Wet Season Depth of Water:	m	4. Cylinder Diameter:	mm.
		5. Depth of Cylinder:	m.
5. Average Dry Season Depth of Water:	m		

REVERSE OF CARD

Date	Work carried out	Record of Maintenance/Repair: Materials, Spares, etc., used	Time taken for work	Cost	Signature

Annex 3

PREVENTIVE MAINTENANCE CHECK LIST FOR A DIESEL ENGINE

Maintenance Period	Task to be performed	Materials Required	Allocation of Responsibility
Daily	(i) Check oil level and top up as necessary	Engine Oil	On-site operator
	(ii) Lubricate as per manufacturer's instructions	Lubricating Oil	
	(iii) Check all nuts and bolts and tighten as necessary	-	
	(iv) Clean outside parts of engine	Cotton Waste	
	(v) Enter up following data in operational log book	-	
	(a) Oil Pressure		
	(b) Running temperature		
	(c) Revs.per minute		
	(d) Battery Charge		
	(e) Number of hours of operation		
	(f) Total operating hours since last oil change		
	(g) Total operating hours since last overhaul		
	(h) Litres of diesel fuel consumed		
1 week	(i) Wash and clean air filter		On-site operator

Maintenance Period	Task to be performed	Materials Required	Allocation of Responsibility
1 month	(i) Dismantle injector, test spray, replace defective nozzles	Injector nozzles	On-site operator (plus maintenance team depending on level of training and competence of on-site staff)
	(ii) Check and adjust transmission belt tensions/coupling alignments	-	
3 months	(i) Check and clean injectors and valves	-	On-site operator plus maintenance team
	(ii) Check and clean oil filters	-	
	(iii) Renew fuel filter elements	Fuel Filter Elements	
	(iv) Check starting system (battery operated)	Distilled Water	
	(v) Change engine oil	Engine Oil	
1 year	(i) Check and re-grind valves as necessary and adjust valve clearances		On-site operator plus maintenance team
	(ii) Clear deposits from cylinder heads and pistons		
	(iii) Check and adjust clutch system		
2 years	(i) Complete overhaul - dismantle and replace worn and defective parts	Spare parts as required	Workshops

Annex 4

PREVENTIVE MAINTENANCE CHECK LIST FOR A SHALLOW WELL/HANDPUMP INSTALLATION

Maintenance Period	Task to be performed	Materials Required	Allocation of Responsibility
Daily	(i) Check operation of the pump	-	On-site caretaker
	(ii) Check all nuts and bolts and tighten as necessary	-	
	(iii) Clean the concrete slab	-	
	(iv) Clean the wastewater drain and check that water is not leaking back into the well	-	
	(v) Inspect and repair protective fence	-	
	(vi) Control use of area as playground/work area	-	
Monthly	(i) Check for damage, rotting of wooden handle (if fitted), etc.	-	On-site caretaker
	(ii) Grease and oil all pivot points, oil wooden handle (if fitted)	Lubricating Oil	
	(iii) Check concrete slab for cracks and make temporary repairs as necessary	-	
6 months	(i) Remove and dis-assemble pump unit, rising main, cylinder, etc.. Inspect and repair as necessary	Spare parts as required	On-site caretaker plus maintenance team
	(ii) Pump out well, remove all debris and disinfect with bleaching powder	Bleaching Powder Plastic Buckets	
	(iii) Repair all cracks in well slab, base and wastewater drain	Cement	

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYSTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS ETC, REQUIRED
I SOURCE OF SUPPLY-SURFACE	A	Impounding Reservoir	3 months	L	o,a	Clean intake and adjacent area, cut tall grass	
			1 year	D,L	e,m,o	Inspect sanitary conditions, inspect structure and repair as necessary	Building materials
	B	Mountain stream	3 months	L	o,a	Clean intake and adjacent area, cut tall grass near access road.	
			1 Year	D,L	e,m,o	Inspect sanitary condition, inspect structure and repair as necessary.	Building materials
	C D	Lake River	3 months	L	o,a	Clean intake and adjacent area, cut tall grass near access road, clean intake channel, clean collection chamber and disinfect with chlorine	HTH solution
			1 year	D,L	e,m,o	Inspect sanitary condition, inspect structure and repair as necessary.	Building materials
	E	Coarse Screens	1 day	L	o	Remove floating material attached to screen	
			6 months	L	o	Inspect lifting gear and oil or grease as required	Oil and grease
			1 year	D,L	e,m,o	Inspect for signs of corrosion and paint if necessary. Inspect lifting gear for signs of wear and repair if necessary.	Anti corrosion paint
	F	Fine Screens	1 day	L	o	Remove floating material attached to screens	
			6 months	L	o	Inspect lifting gear and oil or grease as required	Oil and grease
			1 Year	D,L	e,m,o	Inspect for signs of corrosion and paint if necessary. Inspect lifting gear for signs of wear and repair if necessary.	Anti corrosion paint
	G	Penstocks/Valves	6 months	L	o	Open and close, apply grease to spindles and guide surfaces above water level	Grease
			1 year	D,L	m,o	Inspect for signs of wear and repair if necessary.	

KEY:

Level: L = Local, D= District, R= Region

Crew: e = engineer/technical officer, m= maintenance team, o= plant operator, a = additional labour (or contract labour) as required

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYSTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS ETC, REQUIRED.
I SOURCE OF SUPPLY GROUND	H	Boreholes	3 months	L	o,a	Clean adjacent area, cut tall grass near access road.	
	I	Dug Wells	1 year	R,L	e,w,m,o,a	Clean casing and screens with appropriate tools and chemicals. Measure well output before and after cleaning, recording total flow and specific capacity. Check pipes and guide bearings	Chemicals, special tools and equipment
			3 years	R,D,L	e,w,m,o	Remove pumping unit for complete overhaul at Regional workshops. Replace with spare unit	Spare parts as required. Spare pumping unit of similar type.
	J	Infiltration Gallery	5 years	D,L	e,m,o,a	Examine pipes and repair if necessary	

KEY:

Level: L= Local, D= District, R= Region

Crew: e= engineer/technical officer, m= maintenance team, o = plant operator, el= motor/switchgear electrician, a= additional labour(or contract labour) as required, w= special team for servicing deep wells/boreholes.

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYSTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	Materials, spare parts, Lubricants, etc. required
II	D	Diesel Engines	1 day	L	O	Check oil level and top up if necessary Lubricate all lubrication points, Record oil pressure, temperatures, speed and battery charge. Record working hours and total since last oil change/last overhaul. Clean outside parts, check nuts and bolts for tightness.	lubricating oil
			1 week	L	O	Wash and clean air filter	
			1 month	D,L	m,o	Dismantle injectors and test spray, replace defective nozzles if necessary. Check and adjust V belt tension /coupling alignment as applicable.	Injector nozzles as necessary
			3 months	D,L.	m,p,o.	Clean and inspect injectors and valve clearances, check and clean oil filters. Fit new fuel elements. Check starting system, Change engine oil or in accordance with manufactures manual.	Fuel filter elements, engine lubricating oil.
			1 year	D,L	m,p,o.	Check and regrind valves and adjust valve clearances. Clean deposits from cylinder head and pistons. Disassemble and check clutch system, if applicable.	
			2 years	R,D,L.	m,p,o.	Remove engine for complete overhaul in Regional workshops. Replace with spare reconditioned engine.	Spare parts as required

RAW WATER PUMPING

KEY:

Level: L = Local, D= District, R = Region

Crew: e = engineer/technical officer, m = maintenance team, o = plant operator, p = pump/engine mechanic

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYSTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS LUBRICANTS, ETC REQUIRED
II RAW WATER PUMPING	A	Pump House	1 day	L	O	Clean and sweep floor, wipe and clean walls and piping clean and sweep exterior site, tend lawn and garden.	Cleaning materials
			2 years	D,L	e,m,o,a	Check and repair any leaks in roof. Paint inside and outside walls and piping.	Building materials, Paint
	B	Fuel tanks	1 day	L	O	Check fuel level and refill if necessary. Record fuel consumed during previous day. Clean outside.	
			6 months	L	O	Drain and wash fuel tank, wash and clean filter, clear fuel tank vent pipe.	
	C	Pumps	1 day	L	O	Record readings of suction and delivery gauges. Check packing glands to leak slightly during operation. Check tightness of nuts and bolts, check lubrication of bearings	
			6 months	D, L	m, p, o	Replace grease/oil in bearings without disassembly check alignment of coupling, replace packing in galnds.	Grease/oil packing material
			* 3 years (depending on circumstances)	R,D,L	e,m,p,a	Remove pump for complete overhaul in Regional workshops. Repalce defective parts as necessary	spare parts as required.

KEY :

LEVEL : L = Local, D, = District, R, = Region

CREW : e = Engineer/technical Officer, m = maintenance team

o = plant operator, p = pump mechanic

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYSTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS, ETC. REQUIRED
RAW WATER PUMPING II	E	Electric Motors	1 day	L	O	Check motor bearings	
			6 months	D, L	m,o,el	Check alignment of coupling, change lubricating oil/grease without dismantling	Lubricating oil/grease
			5 years	R,D,L	m,el,o	Remove motor for complete overhaul at regional workshops. Replace motor of similar type, if available.	Ball/roller bearings, if necessary.
	F	Switchgear	1 day	L	O	Record voltage, current and KW hr meters	
			3 months	D, L	m,el	Check starter and clean contacts. Check setting of overload relays.	
			1 year	D	m,el	Clean/replace contacts as necessary. Calibrate measuring instruments	Starter contacts, if necessary
	G	Measuring Instruments	3 years	R,D	e,m.	Dismantle and send to specialized contractor for calibration and/or repair	
	H	Water master meters	3 years	R, D,	m	Dismantle and send to Regional workshops for checking and calibration	
	I	Mains	1 year	L	O	check for leaks and repair if necessary	
			3 years	D,L	m,o	Paint exposed pipes with anti-corrosive paint	Anticorrosive paint
	J	Valves	1 year	L	O	Check valve gland and repack if necessary Close fully and open	Packing materials

KEY :

LEVEL : L = Local, D = District, R = Regional

CREW : e = engineer/technical Officer, m = maintenance team,

o = plant operator, el = motor, switchgear electrician.

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFOMED	MATERIALS, SPARE PARTS, LUBRICANTS, ETC. REQUIRED
III CHEMICALS	A	Chemicals store	1 week	L	O	Clean and sweep floor, clean outside, replenish stocks.	Chemicals
			1 year	D,L	e,m,o	Inspect structure, check all lifting gear	
	B D F	Alum preparation tanks Hypochlorite (HTH)Prep.tanks Soda Ash Preparation Tanks	1 day	L	O	Prepare correct strength solutions,clean outside of tanks and valves	
			1 year	D,L	m,o	Inspect structure and protective paint /lining and repair as necessary.Examine valves, pipe connections and repair as necessary	Paint, lining material.
	C E	Alum Dosing Hypochlorite (HTH)Dosing	6 months	D,L	m,o	Dismantle gravity feed doser, clean and reassemble	
	G	Soda Ash Dosing	1 year	R,D,L	e,m,el	Overhaul: dismantle dosing pumps and replace defective parts. Examine electric motors and switchgear. Paint all metal surfaces	Spare parts as necessary, Paint
III SEDIMENTATION	H I	Flocculators Sedimantation Tanks	1 year	D,L	e,m,o	Inspect structure, clean walls inside and outside, disinfect inside walls, paint metal surfaces, paint outside walls	HTH solution, paint
III FILTRATION	J	Slow Sand Filters	1 year	D,L	e,m,o,a	Inspect sanitary condition, inspect structure. Clean adjacent area, close valves fully and open, tighten valve glands and add packing material,if necessary	Packing material
			5 years	R,D,L	e,m,o,a	Stop filter,rake off top filtering sand layer and replace with new filter sand of correct grade, disinfect and run filtered water to waste for 1day using enough HTH solution	

KEY:
Level: L= Local, D= District, R= Region
Crew: e= engineer/technical officer, m = maintenance team, O = operator, el=motor/switchgear electrician, a = additional labour (or contract labour) as required.

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS ETC, REQUIRED
III FILTRATION	K L	Rapid gravity Filters Pressure Filters	3 months	L	o	Inspect sanitary condition, disinfect inside of structure above level of sand bed	Hypochlorite (HTH) solution
			5 years	R,D,L	e,m,o,a	Overhaul: Remove filtering media, inspect laterals and strainers and repair as necessary. Disinfect inside walls. Wash, screen, disinfect filtering media and replace in filter adding new filtering media as necessary	Hypochlorite(HTH)solution, filter laterals and strainers as necessary, filtering media.
	M N	Filter valves & controls Loss of Head Gauges	6 months	L	O	Examine filter valves and controls for correct functioning,repack glands as necessary.	Gland packing material
			2 years	R,D	e,m	Calibrate loss of head gauges and flow recorders by specialized contractor,paint all valves	Paint
	O	Air Blowers/ Compressors	1 day	L	O	Check motor and compressor bearings	
			1 year	D,L	m,el,o	Change lubricating oil/grease without dismantling, check alignment of coupling, examine and clean motor and switchgear contacts.	Lubricating oil/grease
			5 years	R,D,L	e,m el,O	Overhaul: Complete dismantling, cleaning and replacement of defective parts	Spare parts as required

KEY:

Level: L = Local, D = District, R= Region
Crew: e =engineer/technical officer, m = maintenance team, O = Plant operator , el = motor/switchgear electrician.

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYSTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS, ETC, REQUIRED
IV TREATED WATER PUMPING	A	Pump House	1 day	L	o	Clean and sweep floor, wipe and clean walls and piping, clean and sweep exterior site, tend lawn and garden	Cleaning materials
			2 years	D,L	e,m,o,a	Check and repair any leaks in roof, paint inside and outside walls and piping.	Building materials, paint.
	B	Fuel tanks	1 day	L	o	Check fuel level and refill if necessary.Record fuel consumed during day. Clean outside.	
			6 months	L	o	Drain and wash fuel tank, wash and clean filter, clear fuel tank vent pipe	
	C	Pumps	1 day	L	o	Record readings of suction and delivery gauges. Check packing glands to leak slightly during operation. Check tightness of nuts and bolts. Check lubrication of bearings	
			6 months	D,L	m,p.o.	Replace grease/oil in bearings without dismantling Check alignment of coupling. Replace packing in glands	Grease/oil Packing material
			3 years	R,D,L	e,m,p,o	Complete overhaul: Remove pump for overhaul in Regional workshops. Clean and replace all defective parts.	Spare parts as required

KEY:

Level: L= Local, D= District, R= Region
Crew: e= engineer/technical officer, m= maintenance team, o=plant operator, p=pump mechanic.

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS ETC. REQUIRED
IV TREATED WATER PUMPING	D	Diesel Engines	1 day	L	O	Check oil level and top up if necessary Lubricate all lubrications points. Record oil pressure, temperatures, speed and battery charge. Record working hours and total since last oil change/last overhaul. Clean outside parts, check nuts and bolts for tightness.	Lubricating oil
			1 week	L	O	Wash and clean air filter	
			1 month	D,L	m,o	Dismantle injectors and test spray. Replace defective nozzles if necessary. Check and adjust V belt tension/ coupling alignment as applicable	Injector nozzles as necessary
			3 months	D,L	m,p,o	Clean and inspect injectors and valve Clearances. Check and clean oil filters. Fit new fuel filter elements. Check starting system. Change engine oil or in accordance with manufactures manual.	Fuel filter elements, engine lubricating oil.
			1 year	D,L	m,p,o	Check and regrind valves and adjust valve clearances. Clean deposits from cylinder heads and pistons. Dismantle clutch system, if applicable.	
			2 years	R,D,L	m,p,o	Remove engine for complete overhaul in Regional workshops. Replace with spare reconditioned engine	Spare parts as required

KEY:

Level: L = Local, D = District, R = Region
Crew: e = engineer/technical officer, m = maintance team, o = plant operator, p = pump/engine mechanic

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYSTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS, ETC, REQUIRED
IV	E	Electric Motors	1 day	L	O	Check motor bearings	
			6 months	D,L	m,o	Check alignment of coupling, change lubricating oil/grease without dismantling.	Lubricating oil/grease
			5 years	R,D,L	m,el,o	Remove motor for complete overhaul at Regional workshops, replace with motor of similar type, if available.	Ball/roller bearings if necessary.
	F	Switchgear	1 day	L	O	Record voltage, current and KWhr meter	
			3 months	D	m,el	Check starter and clean contacts. Check setting of overload relays.	
			1 year	D	m,el	Clean/replace contacts as necessary. Calibrate measuring instruments	Starter contacts, if necessary.
	G	Measuring Instruments	3 years	R,D	e,m	Dismantle and send to specialized contractor for repair and calibration	
	H	Water Master Meters	3 years	R,D	m	Dismantle and send to Regional workshops for repair and calibration	
	I	Mains	1 year	L	O	Check for leaks and repair, if necessary	
			3 years	D,L	m,o	Paint exposed pipes with anticorrosive paint	Anticorrosive paint
	J	Valves	1 year	L	O	Check valve gland and repack, if necessary.	Packing material

TREATED WATER PUMPING

KEY:

Level: L = local, D= District, R= Regional

Crew: e = engineer/technical officer, m= maintenance team, O= plant operator, el = motor/switchgear electrician.

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TSAK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS ETC REQUIRED
V STORAGE	A C D	Service Reservoirs Valves and Level gauges	1 month	L	O	Check float vlave, check leaks in piping and repair if necessary	
			1 year	D,L	m,o,a	Inspect structure. Drain reservoir, wash and clean inside and outside. Disinfect floor and walls with hypochlorite(HTH) solution. Check all valves, open and close and repair, if necessary. Check level gauges. Paint outside of steel reservoirs.	Hypochlorite (HTH) solution.Gland packing. Paint.
	B C D	Elevated Reservoirs Valves and Level gauges	1 month	L	O	Check float valve, check leaks in piping and repair, if necessary	
			1 year	D,L	m,o,a	Inspect structure. Drain reservoir, wash and clean inside and outside. Disinfect floor and walls with hypochlorite (HTH) solution. Check all valves, open and close and repair, if necessary. Check level gauge. Paint outside and supporting structure of steel reservoirs.	Hypochlorite (HTH) solution. Gland packing. Paint
	E	Water Master Meters	3 years	R,D	m	Dismantle and send to Regional workshops for repair and calibration	

KEY:
Level: L = Local, D= District, R = Regional
Crew: e= engineer/technical officer, m= maintenance team, o= plant operator, a = additional labour (contract labour), as necessary.

PREVENTIVE MAINTENANCE CHECK LIST FOR WATER SUPPLY SYSTEMS BUILDINGS, STRUCTURES AND EQUIPMENT

GROUP		DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY		TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS, ETC, REQUIRED
				LEVEL	CREW		
VI DIESEL ENGINE GENERATING SETS	A B C	Diesel engine Generator Switchgear	1 day	L	O	Check oil level and top up, if necessary Lubricate all lubricantion points. Record oil pressure, temperatures, speed and battery charge.Record working hours and total since last oil change/last overhaul. Clean outside parts.Check nuts and bolts for tightness. Check alternator bearings. Check fuel level in fuel tank and refill	Lubricating oil Fuel oil
			1 week	L	O	Wash and clean air filter	
			1 month	D,L	m,o	Dismantle injectors and test spray, Replace defective nozzles if necessary.	Injector nozzles
			3 months	D,L	m,p,el,o	Clean and inspect injectors,check valve clearances.Check and clean oil filters. Fit new fuel filter elements. Check starting system. Change engine oil or in accordance with manufacturers manual. Check switchgear and setting of overload relays	Fuel filter element Engine oil
			1 year	D,L	m,p,o	Check alignment of coupling. Check and regrind valves and adjust valve clearances.Clean deposits from cylinder heads and pistons	
			2 years depending on running hours	R,D,L	e,m,p,el,o	Overhaul: Complete dismantling, cleaning and replacement of defective parts	Spare parts as necessary

KEY:

Level: L=Local, D=District, R=Region
Crew: e=engineer/technical officer, m=maintenance team, p= engine/pump mechanic, el= electrician, o=plant operator.

GROUP	DESCRIPTION	MAINTENANCE PERIOD	RESPONSIBILITY LEVEL	RESPONSIBILITY CREW	TASK TO BE PERFORMED	MATERIALS, SPARE PARTS, LUBRICANTS ETC, TO BE USED
VII	Wind Mills	3 months	L	o	Clean adjacent area, cut tall grass	
		1 year	R,D,L	e,m,w,o,a	Clean casing and screens with appropriate tools and chemicals. Measure well output before and after cleaning, recording total flow and specific capacity. Change oil in gearbox. Examine superstructure for signs of corrosion and paint	Lubricating oil. Anti corrosion paint
		5 years	R,D,L	e,m,o,a	Complete overhaul: Dismantle pump and gearbox and recondition at Regional workshops	Spare parts, as necessary.

KEY:

Level: L = Local, D = District, R = Region.

Crew: e = engineer/technical officer, m = maintenance team, o = plant operator, a = additional labour (or contract labour) as required, w = special team for servicing deep wells.

Annex 6

FORM FOR COMPILATION AND CLASSIFICATION OF INSTALLATIONS AND EQUIPMENT

Type of installation or equipment → / Location ↓	INTAKES							Pump house	Centr. pumps	Diesel engines	Elect. motors	CHLORINATION		TANKS		Stand posts	MAIN AND DISTRIBUTION SYSTEM PIPELINES							WATER METERS	
	Well			Stream													Pipe length in meters (dia. mm)								
	Hand Dug																								
	Plain	With filter	Bored	Perforated pipe	Direct	Spring	Pipe connection to main					Gravity feeder	Test kit	Storage	Break pressure		150	100	75	63	50	38	25	Main	Domestic
Group →	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q							R	S
Village A							1							1		15		4 501	1 275	351					124
Village B			1					1	2	2		1	1	1		9					4 210	1 067	381	1	80
Village C	2							1	2	2		1	1	1		13			311	1 088	253	850		1	13
Village D	3							1	2	2		3	2			8					3 752	680	259	1	8
Village E	1							1	2	2		1	1	1		11			1 362		788	930	91	1	11
Village F		1						1	2	2		1	1	1		10	140	1 131	777		204	341		1	45
Village G	1							1	2	2		1	1	1		11			1 214	371	1 067	1 043	262	1	61
Village H	1							1	2	2		1	1			3					2 454			1	3
Village I				1								1	1	1	1	16			593	1 096	1 020	680			49
Village J				1								1	1	1		25		279	948	750	900	2 402	190	1	112
Village K				1								1	1	1	2	15		1 045	1 219	305	396	731			49
Village L				1								1	1	1		15		6 663	6 379	2 073		1 236		1	124
Village M					1							1	1	1	1	21	305	1 346	803	457	2 003	1 542		1	136
Village N						1						1	1	1		7			2 077	1 829	567	1 714		1	25
Village O		1						1	2		2	1	1	1		8	274	488	174		326			1	53
Total	8	2	1	4	1	1	1	8	16	14	2	16	15	13	4	187	719	15 453	17 332	8 320	17 940	13 217	1 183	12	893

Annex 7

FORM FOR ALLOCATION OF IDENTIFICATION NUMBERS FOR INSTALLATIONS AND EQUIPMENT

Type of installation or equipment → / Location ↓	INTAKES											CHLORINATION		TANKS			MAIN AND DISTRIBUTION SYSTEM PIPELINES							WATER METERS	
	Well			Stream													Pipe length in meters (dia. mm)								
	Hand Dug																								
	Plain	With filter	Bored	Perforated pipe	Direct	Spring	Pipe connection to main	Pump house	Centr. pumps H.S.	Diesel engines	Elect. motors	Gravity feeder	Test kit	Storage	Break pressure	Stand posts	150	100	75	63	50	38	25	Main	Domestic
Group →	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q							R	S
Village A							G1							N1		P1-15				Q1					S1-124
B			C1					H1	11,12	J1,J2		L1	M1	N2		P16-24				Q2				R1	S125-204
C	A1,A2							H2	13,14	J3,J4		L2	M2			P25-57				Q3				R2	S205-217
D	A3-A5							H3	15,16	J5,J6		L3-L5	M3,M4			P38-55				Q4				R3	S218-225
E	A6							H4	17,18	J7,J8		L6	M5	N4		P46-56				Q5				R4	S226-236
F		B1						H5	19,110	J9,J10		L7	M6	N5		P57-66				Q6				R5	S237-281
G	A7							H6	111,112	J11,J12		L8	M7	N6		P67-77				Q7				R6	S282-342
H	A8							H7	113,114	J13,J14		L9	M8			P78-80				Q8				R7	S343-345
I				D1								L10	M9	N7	O1	P81-96				Q9					S346-394
J				D2								L11	M10	N8		P97-121				Q10				R8	S395-506
K				D3								L12	M11	N9	02,03	P122-136				Q11					S507-555
L				D4								L13	M12	N10		P137-151				Q12				R9	S556-679
M					E1							L14	M13	N11	O4	P152-172				Q13				R10	S680-815
N						F1						L15	M14	N12		P173-179				Q14				R11	S816-840
O		B2						H8	115,116		K1,K2	L16	M15	N13		P180-187				Q15				R12	S841-893

EXAMPLE OF PREVENTIVE MAINTENANCE CALENDAR FOR INSTALLATIONS AND EQUIPMENT

Annex 8

Month: January			Month: February			Month: March			Month: April		
Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed
1,2	A	G1-1y N1-1y P1-15-1y Q1-1y	1	A	N1-1m	1	A	N1-1m	1	A	N1-1m
			2,3	F	B1-3m H5-3m J9-3m	2	F	J9-1m J10-1m L7-1m N5-1m	2	F	J9-1m J10-1m L7-1m N5-1m
3	F	J9-1m J10-1m L7-1m N5-1m			J10-3m L7-1m N5-1m	3	B	J1-1m J2-1m L1-1m N2-1m	3,4,5	B	C1-1y H1-1y I1-1y I2-1y J1-1y J2-1y L1-1y L2-1y P16-24-1y Q2-1y
4,5	B	C1-3m H1-3m H1-3m J2-3m L1-1m N2-1m	4	B	J1-1m J2-1m L1-1m N2-1m	4	G	J11-1m J12-1m L8-1m N6-1m			
			5,6	G	A7-3m H6-3m I11-6m I12-6m J11-3m J12-3m L8-1m N6-1m	5	L	D4-3m L13-1m N10-1m	6	G	J11-1m J12-1m L8-1m N6-1m
6	G	J11-1m J12-1m L8-1m N6-1m				6,7,8	M	E1-1y L14-1y N11-1y O4-1y P152-172-1y Q13-1y	7	L	L13-1m N10-1m
7	L	L13-1m N10-1m	7	L	L13-1m N10-1m				8	M	L14-1m N11-1m O4-1m
8	M	L14-1m N11-1m O4-1m	8	M	L14-1m N11-1m O4-1m	9	H	J13-1m J14-1m L9-1m	9	H	J13-1m I14-1m L9-1m
9	H	J13-1m J14-1m L9-1m	9,10	H	A8-3m H7-3m J13-3m J14-3m L9-1m	10	C	J3-1m J4-1m L2-1m N3-1m	10,11	C	A1-3m A2-3m H2-3m I3-3m J4-3m L2-1m N3-1m
10,11	C	A1-3m A2-3m H2-3m I3-6m I4-6m J3-3m J4-3m L2-1m N3-1m	11	C	J3-1m J4-1m L2-1m N3-1m	11	I	L10-1m N7-1m O1-1m			
			12,13,14	I	D1-1y L10-1y N7-1y O1-1y P81-96-1y Q9-1y	12,13	N	F1-3m L15-1m N12-1m	12	I	L10-1m N7-1m O1-1m
12	I	L10-1m N7-1m O1-1m				14	D	J5-1m J6-1m L3-1m L4-1m L5-1m	13	N	L15-1m N12-1m
13	N	L15-1m N12-1m	15	N	L15-1m N12-1m				14,15	D	A3-3m A4-3m A5-3m H3-3m I5-6m I6-6m J5-3m J6-3m L3-1m L4-1m L5-1m
14,15	D	A3-3m A4-3m A5-3m H3-3m J5-3m J6-3m L3-1m L4-1m L5-1m	16	D	J5-1m J6-1m L3-1m L4-1m L5-1m	15,16	O	B2-3m H8-3m I15-6m I16-6m K1-6m K2-6m L16-1m N13-1m			
			17	O	L16-1m N13-1m						
16	O	L16-1m N13-1m	18	E	J7-1m J8-1m L6-1m N4-1m	17	E	J7-1m J8-1m L6-1m N4-1m	16	O	L16-1m N13-1m
17,18,19	E	A6-1y H4-1y I7-1y I8-1y J7-1y J8-1 L6-1y N4-1y P46-56-1y Q5-1y	19	J	D2-3m L11-1m N8-1m	18	J	L11-1m N8-1m	17,18	E	A6-3m H4-3m J7-3m J8-3m L6-1m N4-1m
			20	K	D3-3m L12-1m N9-1m O2-1m O3-1m	19	K	L12-1m N9-1m O2-1m O3-1m	19	J	L11-1m N8-1m
20	J	L11-1m N8-1m							20	K	L12-1m N9-1m O2-1m O3-1m
21	K	L12-1m N9-1m O2-1m O3-1m									

*It is assumed that there are 20 working days per month. Actual dates should be used when known.

EXAMPLE OF PREVENTIVE MAINTENANCE CALENDAR FOR INSTALLATIONS AND EQUIPMENT (Contd.)

Month: May			Month: June			Month: July			Month: August		
Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed
1	A	N1-1m	1	A	N1-1m	1	A	N1-1m	1	A	N1-1m
2,3,4	F	B1-1y	2	F	J9-1m	2	F	J9-1m	2,3	F	B1-3m
		H5-1y			J10-1m			J10-1m			H5-3m
		I9-1y			L7-1m			L7-1m			J9-3m
		O10-1y			N5-1m			N5-1m			J10-3m
		J9-1y									L7-1m
		J10-1y	3	B	J1-1m	3,4	B	C1-3m			N5-1m
		L7-1y			J2-1m			H1-3m			
		N5-1y			L1-1m			J1-3m	4	B	J1-1m
		P57-66-1y			N2-1m			J2-3m			J2-1m
		Q6-1y						L1-1m			L1-1m
			4	G	J11-1m			N2-1m			N2-1m
	B	J1-1m			J12-1m						
		J2-1m			L8-1m	5	G	J11-1m	5,6,7	G	A7-1y
		L1-1m			N6-1m			J12-1m			H6-1y
		N2-1m						L8-1m			I11-1y
			5	L	D4-3m			N6-1m			I12-1y
6,7	G	A7-3m			L13-1m						J11-1y
		H6-3m			N10-1m	6	L	L13-1m			J12-1y
		J11-3m						N10-1m			L8-1y
		J12-3m	6,7	M	E1-3m						N6-1y
		L8-1m			L14-1m	7	M	L14-1m			P67-77-1y
		N6-1m			N11-1m			N11-1m			Q7-1y
					O4-1m			O4-1m			
8	L	L13-1m							8	L	L13-1m
		N10-1m	8	H	J13-1m	8	H	J13-1m			N10-1m
					J14-1m						
9	M	L14-1m			L9-1m			L9-1m	9	M	L14-1m
		N11-1m									N11-1m
		O4-1m	9	C	J3-1m	9,10,11	C	A1-			O4-1m
					J4-1m			A2-1y			
10,11	H	A8-3m			L2-1m			H2-1y	10,11	H	A8-3m
		H7-3m			N3-1m			I3-1y			H7-3m
		113-6m						I4-1y			J13-3m
		114-6m	10	I	L10-1m			J3-1y			J14-3m
		J13-3m			N7-1m			J4-1y			L9-1m
		J14-3m			O1-1m			L2-1y			
		L9-1m						N3-1y	12	C1	J3-1m
			11,12,13	N	F1-1y			P25-37-1y			J4-1m
12	C	J3-1m			L15-1y			Q3-1y			L2-1m
		J4-1m			N12-1y						N3-1m
		L2-1m			P173-179-1y	12	I	L10-1m			
		N3-1m			Q14-1y			N7-1m	13	I	D1-3m
								O1-1m		I	L10-1m
13	I	D1-3m	14	D	J5-1m						N7-1m
		L10-1m			J6-1m	13	N	L15-1m			O1-1m
		M7-1m			L3-1m			N12-1m			
		O1-1m			L4-1m				14	N	L15-1m
					L5-1m	14,15	D	A3-3m			N12-1m
14	N	L15-1m						A4-3m			
		N12-1m	15,16	O	B2-3m			A5-3m	15	D	J5-1m
					H8-3m			H3-3m			J6-1m
15	D	J5-1m			L16-1m			J5-3m			L3-1m
		J6-1m			N13-1m			J6-3m			L4-1m
		L3-1m						L3-1m			L5-1m
		L4-1m	17	E	J7-1m			L4-1m			
		L5-1m			J8-1m			L5-1m	16	O	L16-1m
					L6-1m						N13-1m
16	O	L16-1m			N4-1m	16	O	L16-1m			
		N13-1m						N13-1m	17	E	J7-1m
			18	J	L11-1m						J8-1m
17	E	J7-1m			N8-1m	17,18	E	A6-3m			L6-1m
		J8-1m						H3-3m			N4-1m
		L6-1m	19	L	L12-1m			I7-6m			
		N4-1m			N9-1m			I8-6m	18	J	D2-3m
					O2-1m			J7-3m			L11-1m
18,19,20	J	D2-1y			O3-1m			J8-3m			N8-1m
		L11-1y						L6-1m			
		N8-1y						N4-1m	19,20,21	K	D3-1y
		P97-121-1y									L12-1y
		Q10-1y				19	J	L11-1m			N9-1y
								N8-1m			O2-1y
21	K	D3-3m									O3-1y
		L12-1m				20	L	L12-1m			P122-136-1y
		N9-1m						N9-1m			Q11-1y
		O2-1m						O2-1m			
		O3-1m						O3-1m			

*It is assumed that there are 20 working days per month. Actual dates should be used when known.

PREVENTIVE MAINTENANCE CALENDAR FOR INSTALLATIONS AND EQUIPMENT (Contd.)

Month: September			Month: October			Month: November			Month: December		
Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed	Working* Day No.	Location Village	Task to be performed
1	A	N1-1m	1	A	N1-1m	1	A	N1-1m	1	A	N1-1m
2	F	J9-1m	2	F	J9-1m	2,3	F	B1-3m	2	F	J9-1m
		J10-1m			J10-1m			H5-3m			J10-1m
		L7-1m			L7-1m			I9-6m			L7-1m
		N5-1m			N5-1m			I10-6m			N5-1m
3	B	J1-1m	3,4	B	C1-3m			J9-3m			
		J2-1m			H1-3m			J10-3m	3	B	J1-1m
		L1-1m			I1-6m			L7-1m			J2-1m
		N2-1m			I2-6m			N5-1m			L1-1m
					J1-3m						N2-1m
					J2-3m	4	B	J1-1m			
4	G	J11-1m			L1-1m			J2-1m	4	G	J11-1m
		J12-1m			N2-1m			L1-1m			J12-1m
		L8-1m						N2-1m			L8-1m
		N6-1m	5	G	J11-1m						N6-1m
					J12-1m	5,6	G	A7-3m			
5	L	D4-3m			L8-1m			H6-3m	5,6,7	L	D4-1y
		L13-1m			N6-1m			J11-3m			L13-1y
		N10-1m						J12-3m			N10-1y
			6	L	L13-1m			L8-1m			P137-151-1y
6,7	M	E1-3m			N10-1m			N6-1m			O12-1y
		L14-1m									
		N11-1m	7	M	L14-1m	7	L	L13-1m	8,9	M	E1-3m
		O4-1m			N11-1m			N10-1m			L14-1m
					O4-1m						N11-1m
8	H	J13-1m				8	M	L14-1m			O4-1m
		J14-1m	8	H	J13-1m			N11-1m			
		L9-1m			J14-1m			O4-1m	10	H	J13-1m
					L9-1m						J14-1m
9	C	J3-1m				9,10,11	H	A8-1y			L9-1m
		J4-1m	9,10	C	A1-3m			H7-1y			
		L2-1m			A2-3m			I13-1y	11	C	J3-1m
		N3-1m			H2-3m			I14-1y			J4-1m
					J3-3m			J13-1y			L2-1m
10	I	L10-1r			J4-3m			J14-1y			N3-1m
		N7-1m			L2-1m			L9-1y			
		O1-1m			N3-1m			P78-80-1y	12	I	L10-1m
								Q8-1y			N7-1m
11,12	N	F1-3m	11	I	L10-1m						O1-1m
		L15-1m			N7-1m	12	C	J3-1m			
		N12-1m			O1-1m			J4-1m	13,14	N	F1-3m
								L2-1m			L15-1m
13	D	J5-1m	12	N	L15-1m			N3-1m			N12-1m
		J6-1m			N12-1m						
		L3-1m	13,14,15	D	A3-1y	13	I	D1-3m	15	D	J5-1m
		L4-1m			A4-1y			L10-1m			J6-1m
		L5-1m			A5-1y			N7-1m			L3-1m
14,15,16	O	B2-1y			H3-1y			O1-1m			L4-1m
		H8-1y			I5-1y						L5-1m
		I15-1y			I6-1y	14	N	L15-1m			
		I16-1y			J5-1y			N12-1m	16,17	O	B2-3m
		K1-1y			J6-1y						H8-3m
		K2-1y			L3-1y	15	D	J5-1m			L16-1m
		L16-1y			L4-1y			J6-1m			N13-1m
		N13-1y			L5-1y			I3-1m			
		P180-187/1			P38-45-1y			L4-1m	18	E	J7-1m
		Q15-1y			Q4-1y			L5-1m			J8-1m
											L6-1m
17	E	J7-1m	16	O	L16-1m	16	O	L16-1m			N4-1m
		J8-1m			N13-1m			L13-1m			
		L6-1m	17,18	E	A6-3m				19	J	L11-1m
		N6-1m			H4-3m	17	E	J7-1m			N8-1m
					J7-3m			J8-1m			
16	J	L11-1m			J8-3m			L6-1m	20	K	L12-1m
		N8-1m			L6-1m			N4-1m			N9-1m
					N4-1m						O2-1m
19	K	L12-1m				18	J	D2-3m			O3-1m
		N9-1m	19	J	L11-1m			L11-1m			
		O2-1m			N8-1m			N8-1m			
		O3-1m									
			20	K	L12-1m	19	K	D3-3m			
					N9-1m			L12-1m			
					O2-1m			N9-1m			
					O3-1m			O2-1m			
								O3-1m			

*It is assumed that there are 20 working days per month. Actual dates should be used when known.