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A METHODOLOGY FOR ASSESSING CONDITIONS OF WATER ASSETS IN SMALL TOWNS IN GHANA

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ABSTRACT

The sustainable delivery of water supply services in Ghana is important for the development of the country. The small towns' water supply sub-sector, which is relatively new has attracted a lot of interest to enhance its long-term sustainability. One of the important factors for the long-term sustainability is appropriate asset management planning, which has received little or no attention to date. Periodic assessment of the condition of water assets forms the basis for proper management and planning of water supply system assets, which is essential for long-term sustainability of the water systems. A grading method of assessment of the condition of water assets of small towns has been developed based on the grading of the defects and malfunctions likely to cause deterioration of the assets conditions and consequently decrease their performance. The method was pre-tested in three small towns (Juaben, Kokofu and Kuntenase in Ashanti Region of Ghana) and the results hereby presented reflect the situation on the ground. The implementation of the condition assessment method will provide database on the conditions of the water systems and scheduling of major rehabilitation in Ghana. The output can be the basis for organising training courses for the technical managers in all the various towns to increase their knowledge on asset management, assets condition grading and the effects of operation and maintenance on assets conditions. This could also be used to develop computer software for easy asset management of all the small towns' water system in Ghana.

Key words: Asset management, assets conditions, asset condition grading, small town piped water system,

1. INTRODUCTION

This paper presents a condition assessment methodology developed specifically for small towns' water supply systems in Ghana. The small towns' water supply sub-sector in Ghana is relatively new. It started in 1994 as part of the community water supply sub-sector, which is decentralised under the district assemblies and are owned and management by the communities and the districts. The approach used, mainly decentralisation and community ownership and management, implies that local capacity is important for the long-term sustainability of the systems.

The Community Water and Sanitation Agency (CWSA) is the government agency mandated to facilitate community water supply delivery and provide backstopping when necessary. CWSA intends to develop a computerised Management Information System (MIS) for monitoring and evaluation of Operation and Maintenance (O and M) to provide staff at the local, district, regional and national levels with relevant information for decision making on O & M (CWSA, 2003).

A systematic and accurate data collection, storage and retrieval of data would be required to ensure the effectiveness of the MIS. The integration of water asset condition and performance assessment in the MIS would provide comprehensive database to assist communities in the management of water supply systems, including planning for future expansion of the systems and scheduling of major rehabilitations and replacements of assets.

The initial emphasis of the small town water supply delivery was to ensure that water facilities were available to provide services to the inhabitants. The long-term sustainability of the water system already provided is yet to receive adequate attention. Recently, the CWSA has introduced training programmes for the water system operating staff and water board members, which is very commendable and would enhance the long-term sustainability.

In addition to the on-going training, adequate asset management is an important activity also critical for the achievement of long-term sustainability. The key requirements for the asset management are the compilation of asset register, and the assessment of the conditions and performance of the assets. The asset management system has many uses such as: strategic planning; decision making on financial sustainability of the system; and scheduling of major rehabilitations and replacements of assets.

The objective of this study was to develop and pre-test a methodology for assessing the conditions of the water supply assets in small town in Ghana. The emphasis is on an approach that can be used by the staff and consultants within the community water and sanitation sub-sector in Ghana.

2. WATER SUPPLY ASSETS MANAGEMENT

Water supply assets comprise the infrastructure to abstract, treat, store and distribute portable water to consumers. Before water assets can be managed the kind of assets at hand (asset inventory process) and the state or condition of the assets should be known. This information provides the basis for the scheduling of rehabilitations and replacements of assets. Water asset management involves the maintenance and improvement of assets, and operational strategies to ensure a reliable service, and in particular minimise the risk of interruptions to supply of water as a result of bursts and other asset breakdowns and, where these problems do arise, minimise the inconvenience caused to consumers. Asset management is a systematic process of maintaining, upgrading and operating physical assets cost-effectively. Thus, asset management provides a framework for handling both short- and long-term planning (McNeil S. Tischer M. L. and DeBlasio A., 2000). Asset inventory and condition assessment are conducted as part of asset management.

Before assessing the actual condition of an asset, it is important to be clear on what condition the asset needs to be in to perform at an appropriate level. The required condition will vary between assets according to the asset's strategic importance, its specific function and its particular physical requirements. The purpose of establishing required condition is to provide a benchmark against which actual condition can be compared (Arnel, A. and Youdale G, 1997).

It is essential to understand the condition of the assets that are identified in the asset inventory so that their condition can be tracked over time and financial resources targeted at areas most in need. Where an asset is deemed critical, condition data are essential to ensure that the risk associated with the asset is managed appropriately.

Condition assessment measures the nature and extent of any gap between the actual and required condition of an asset. It also determines what action is needed to close the gap (Arnel, A. and Youdale G, 1997).

Condition assessment of assets is also the process where assets or components of a system are graded according to the condition or state of that asset. The focus is on the physical condition of assets in assessing the condition of assets. The grading usually ranges from whether the asset is in good condition to its worst situation. Usually the asset is assessed on a scale of 1(good) to 5 (worst).

The independent water supply regulator, the Office of Water Services (OFWAT) in UK has its own method for assessing the condition of water infrastructure assets. The grading method is based on the following infrastructure serviceability indicators (Banyard J.K. and Bostock J. W. 1998): Number of bursts per 1000km; Extent of low pressure problems; Scale of interruptions of supplies to customers; and Water Quality Compliance (Iron). Of these, the burst rate is the key indicator for measuring the state of the assets as it gives a broad measure to the condition of water infrastructure assets and the state of pipe networks. Assets are graded using condition grades, which range from 1 (best) to 5 (worst) by OFWAT (Banyard J.K. and Bostock J. W., 1998).

The methods of assessment are either based on prediction or direct inspection. They can vary from a study that comments on specific details of individual assets to a sample survey identifying broad trends. The asset condition can be inferred directly or indirectly.

The direct inspection means visual inspection of the asset. It can vary from a superficial walk-through to a detailed specialised inspection. It can also include physical measurement and non-destructive testing. A form with standard questions is often used to assist in data gathering and provides information that best supports operational decision-making. This is used when a realistic basis is required for setting immediate rehabilitation priorities.

3. METHOD FOR ASSESSING CONDITIONS OF WATER ASSETS

3.1 Asset Inventory and Register

The components of small towns' water supply schemes were grouped into five as follows:

- Civil engineering structures: steel tanks, concrete tanks, and water treatment plant
- Buildings: control buildings and pump house
- Electro-mechanical equipment: bulk meter, pump, motor, control panel, generator, solar panel
- Pipe appurtenances: isolating valves, wash out valves, air valves, valve chambers, stand pipe

Below ground assets: service pipes, distribution mains, and transmission mains. The various water supply assets in the five components were identified, classified and numbered to form an asset register. An asset register would be needed for each system so that the condition of each asset could be tracked every year. An asset inventory would be carried out for each town to compile data for the register. Presently most of the small towns' water supply systems do not have coding system for all the assets and therefore national coding system will be needed for the asset register.

3.2 Condition Grading Criteria

The method for assessing the condition of water infrastructure assets by Office of Water Services (OFWAT) was used as a guide. Field visits were made to small towns' water supply schemes to ascertain the kind of water supply assets present. A grading method of assessment was developed to rate the condition of water assets. The criteria of condition assessment were based on the defects and malfunctions likely to cause deterioration of the condition of the assets and consequently decrease the performance of the assets. Table 1 shows the defects and malfunctions of water assets considered in the assessment.

In order to reduce subjectivity in the condition grading,

Table 1. Defect and Malfunctions of Water Assets

Water Asset	Defects and Malfunctions
Valves	Valve body rusting, leakage, stuck stem, parts wear and tear, and faults frequency
Valve Chamber	Dirt or soil, rubbish and water in chamber, damaged cover, and rusting of steel covers
Bulk and Supply Meter	Reported meter error, parts damaged, faults frequency, and exposure to damage
Pumps and motors	Reduced Efficiency, leakage in wellhead installations, faulty pressure gauge, wear and tear of pump, faults frequency, burnt motor, choked pump
Control Panel	Blown indicator lights, blown fuses, faulty starter and contactor, faulty automatic control device, and frequency of minor faults.
Service Pipes, Water Mains	Exposed uPVC pipes, leakage and burst
Steel Tanks	Leakage, rusting of steel tank, rusting of ladder and guide rails, rusting of pipes, minor staining
Concrete tanks	Cracks, rusting of steel ladder, and guide rails, rusting of pipes, wet patches, minor staining
Standpipes	Leakages, choked drainage facility, tap damaged and inoperable, damaged platform,

an assessment criteria of the various assets were develop. The condition grading form and grading criteria were developed for each asset. For instance the grading criteria for valves and control panel are presented in Tables 2 and 3 respectively. The grading criteria for concrete tank, pipes and pump/motor are presented in Tables 4, 5 and 6 respectively. The condition of each asset was graded using condition grades, which range from 1 (best) to 5 (worst). The criteria were chosen in such a way that the grading of an asset would not be subjective, that is, it would not be dependent on the judgement of the individual ratter. The conditions of the assets were graded during the field survey using grading forms (for filling the asset code, description, location and grade), condition criteria and visual inspection of assets.

Table 2. Valve Condition Grading Criteria

Grading Criteria	Grade
Rusting of valve body (1: no rusting to 5:100% rusting)	1 to 5
Leakages (1: no water in chamber to 5: depth of water>30cm)	1 to 5
Stuck stem or valve inoperable (from 1: operable to 5: inoperable)	1 to 5
Stem wear and tear (to 1: no stem worn to 5: stem worn)	1 to 5
Number of faults in a year (1: none to 5: >8)	1 to 5

Table 3. Control Panel Condition Grading Criteria

Grading Criteria	Grade
Number of blown indicator lights (1: none to 5: all blown)	1 to 5
Number of blown fuses in a year (1: none to 5: > 8)	1 to 5
Faulty starter, contactor and automatic control devices in a year (1: none to 5: > 8)	1 to 5

3.3 Condition Score Calculation

The overall condition grade of the assets of the same kind is the average of all the individual grades of the assets of the same. For example the condition grade of all isolating valves in a water supply system could be determined from the condition grades of all the individual isolating valves in the water supply system. The condition score (CS) of the water supply system was computed from the overall condition grades of the different assets and weighting factors. The condition score is an aggregate index used to estimate and report the average condition of a homogenous infrastructure (GTZ, 2000). The weighting factors used in this methodology are the authors own values based on the importance attached to the assets in term of the consequences of structural and functional failures. For instance pumps, motor and control panel were assign maximum weighting values of 2.4 since failure of any of these components will lead to interruption of supply to consumers for days if funds are inadequate to repair or replace them. The weighting factors for the assets are given in Table 8. The condition scores of water supply system are calculated using the following formula.

$$CS = 100 - \sum WF \times CG$$

Where WF is the weighting factor and
CG is the overall condition grade of assets of the same kind. The value of $\sum WF \times CG$ is the deduct value presented in Table 8.

Table 4. Concrete Tank Condition Grading Criteria

Grading Criteria	Grade
Cracks and wet patches (1: no cracks to 5: > 5 local cracks/wet patches)	1 to 5
Rusting of ladder/handrail (1: no rusting to 5: 75% < rusting < 100%)	1 to 5
Rusting of pipe network and tank (1: no rusting to 5: 75% < rusting < 100%)	1 to 5
Minor leakage (1: no leakage to 5: >30 drops per minute)	1 to 5

Table 5. Service Pipes and Water Mains Condition Grading Criteria

Grading Criteria	Grade
Exposed PVC pipes (1: pipe not exposed to 5: exposed >3 per km of pipe)	1 to 5
Leakages/burst (1: no leakage to 5: leakage/ burst >3 per km of pipe)	1 to 5

Table 6. Pump and Motor Condition Grading Criteria

Grading Criteria	Grade
Pump/motor efficiency (1: designed efficiency to 5: <50% of design efficiency)	1 to 5
Condition of pressure gauge (1: reading ± 2% of design head to 5: error > ± 20%)	1 to 5
Reported number of pump faults (wear, tear and choked) in a year (1: none to 5:> 5)	1 to 5
Number of cable and motor faults in a year (1: none to 5: > 5)	1 to 5

The condition of each water supply system was categorised as good, fair or poor based on condition ranges and narrative summary presented in Table 9. The ranges for the categorization were based on the defects and malfunctions characteristics of water supply system in good, fair or poor condition. The categorization of condition scores would form the basis for maintenance and major rehabilitation decisions in the water sub-sector. The pre-test of the methodology was conducted in two newly constructed and one old water supply systems to verify their conditions as good, fair or poor according to the narrative summary.

4. PRE-TEST RESULTS AND DISCUSSIONS

4.1 Results

Trips were made to three small towns (Kokofu, Kuntenase and Juaben) with piped water supply scheme in place to prepare asset inventory. Subsequent trips were made to pre-test the methodology using the assessment criteria and condition grading forms. The percentages of water assets sampled for the condition assessment for each town are presented in Table 7. In order to ensure fair judgement, all the water assets in the small towns can be sampled and inspected during the field survey.

Table 7. Percentage of Water Assets Sampled for Assessment

Assets	Kuntenase	Juaben	Kokofu
Isolating valves	75	67	50
Washout	67	60	50
Air valves	67	70	50
Valve chambers	70	68	50
Bulk meter	100	75	100
Pump or motor	100	100	100
Control panel	100	100	100
Concrete/steel tanks	100	100	100
Pipelines	100	100	100
Stand pipes	67	58	50

The overall condition grade of the Juaben water supply system is fair (CS of 56%) whiles that of Kokofu (CS of 74%) and Kuntenase (CS of 76%) is good based on the condition score ranges given in Table 8 (Gyasi-Duku K. A. 2004). The conditions obtained were the true reflection of the condtions of the systems since Kokofu and Kuntenase are three years old, and refurbishment and expansion studies is on going to bring Juaben water system to its original ('as new') condition. The breakdown maintenance is done most of the time in the small towns' water supply system. In order to maintain the condition of Kokofu and Kuntenase systems as good planned preventive maintenance of water assets would be needed.

4.2 Discussions

4.2.1 Valves and Valve Chambers.

There was no sign of leakages from the joints and valves stems in the three towns. The degree of rust on most of the valves was minimal. Soil levels in the chambers were low, but the stagnant water levels in some of the chamber were a bit high. The levels were even much higher after rains due to the fact that covers to the chambers do not flash with the edges of the chamber, as a result gaps and spaces are created. The presence of soil and stagnant water in the valve chambers with the pipe and fittings covered with water is a threat to water quality. There were no stuck stems of valves; the valves were easier to operate in Kokofu and Kuntenase. Some of the valve in Juaben could be operated with difficulty. Valve stems may be stuck due to lack of preventive maintenance and greasing of the stem. There was no report of occasional valve faults. There were no visible signs of wear and tear of stem. Cover to the valve chambers in Kokofu and Kuntenase were in place and also in good condition but some of the covers in Juaben were partly damaged and some chambers uncovered. The steel covers to the valve chambers in Kokofu and Kuntenase did not show any signs of rusting since they have been painted.

4.2.2 Bulk and Supply Meters.

The condition grade of 1 for bulk meters in all the towns means that the bulk meters were in good condition and were working properly. There was no report of serious fault on the supply meters on customer service lines. The meters in the towns are in chambers to protect them from damage. The standpipe meters were well protected from damage or danger. This was evident from all the sites.

4.2.3 Pump.

The efficiency of the pumps was good. There were no signs of leakages from wellhead installations. There was no report of faults, wear and tear of the pumps. The pressure gauge in Kokofu was faulty.

4.2.4 Control Panel.

The control panels were in good conditions. There were no blown indicator lights and fuses in Kuntenase. Some of the indicator lights were blown in Juaben and Kokofu.

Table 8. Condition Scores (CS) of three Small Town Water Supply Systems

Water Assets	Weighting Factor	CONDITION GRADE		
		Juaben	Kokofu	Kuntenase
Isolating Valves	1.2	2	1	1
Air Valves	1.2	2	1	1
Washout Valves	1.2	3	2	1
Valve Chamber	1.2	3	2	1
Bulk and Supply Meter	2	1	1	1
Pumps and motors	2.4	2	2	1
Control Panel	2.4	1	1	1
Service Pipes	2	3	1	1
Transmission Mains	2	3	1	1
Distribution Mains	2	3	1	1
Steel and Concrete Tanks	1.6	2	1	1
Standpipes	0.8	2	2	2
Deduct Value		44	26	21
Overall Condition Score (%)		56	74	79

Table 9. Categories Condition Scores and Meanings

Condition Score Range	Condition Description	Meaning
65<CS<100	Good	Water supply system is in good condition: Sound and well maintained asset, all assets fully operable, minimal or no sign of deterioration and failures, asset performs to design specification, newly constructed or recently refurbished assets.
35≤CS≤65	Fair	Functionally sound assets but moderate levels of deterioration and regular minor failures, significant defects affect service, superficial and obvious wear and tear,
0<CS<35	Poor	Functionally asset but localized and significant problems, severe deterioration, frequent failures, asset requires immediate capital expenditure (replacement/ refurbishment) within one to two years

4.2.5 Pipelines.
There were no reports of leakages, burst or exposed uPVC pipes in Kokofu and Kuntenase. The case in Juaben was different as the degree of burst; leakages and exposed uPVC pipes were high.

4.2.6 Water Tanks.
The concrete tanks in Kuntenase and Kokofu were in good condition and there were no signs of wet patches, minor staining or rusting of the ladders and guide rails. Minor stains were observed on the steel tank in Juaben. Rusting of the ladder, handrail and parts of the tanks was minimal. There was no sign of rusting of tank pipework. The leakages from the tank were a bit high. One of the two tanks in Juaben was in operation but the other was not in used due to its poor condition.

4.2.7 Stand Pipes.
The condition grade of 2 for standpipes in all the towns was due to the poor drainage around the standpipe. Most of the standpipes in Juaben have no drainage channel to drain wasted water. In Kuntenase and Kokofu, most of the drainage channels to the soakaway at the standpipe sites were choked. The standpipes taps in the towns were in good condition. There was no sign of leakage on the taps.

4.3 Implementation and Training in Condition Survey
The implementation of the condition assessment method will provide database on the conditions of the water systems. This can be used for scheduling of major rehabilitation in Ghana. The output from the monitoring of the water system conditions can be the basis for organising training courses for the technical managers in all the various towns. This will increase their knowledge on asset management, assets condition grading and the effects of operation and maintenance on assets conditions. This could also be used to develop computer software for easy asset management of all the small towns' water system in Ghana.

Subjectivity will be reduced through development of data collection manual and training of ratters prior to the assessment. The manual shall indicate for all defects to be rated and description of condition grades from one to five with pictures. Initial and annual refresher trainings will be needed for raters on rating of defects of water assets and data collection prior to the water asset condition survey. The purpose of the training is:

⇒ To refresh and update skills in organizing, rating and collecting data on water supply system conditions.
⇒ To train the raters to input field data into a computer based software to be developed for the calculation of the condition score and reporting.
⇒ To provide a feedback on the condition survey and data collection for the water supply systems in the district, correct the shortcomings with the aim of sensitising them to collect accurate data and the use of the data.

The training will be made up of 20% classroom instructions and 80% field rating as part of the data collection every year. The technical instructor will monitor and ensure the success of the data collection during the fieldwork. The quality assurance through rating of the same water system by the technical instructor to provide feedback to raters to improve on rating will be necessary. This will ensure data reliability, reduce subjectivity and ensure consistency among different raters. The District Water and Sanitation team and Technical Managers in the various small towns will require training to rate the system conditions.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions
A methodology capable of being used by the small towns' operators for the asset condition assessment has been developed. The methodology apart from its use in assets management planning can be used as a tool to identify poor maintenance practices easily.

The testing of the methodology in the three towns revealed overall condition score of the Juaben water supply system as fair whiles that of Kokofu and Kuntenase was good. This methodology could be used to assess the condition of water assets in small towns in Ghana to ensure long-term sustainability of the systems.

The methodology would provide basis for proper preventive maintenance of the assets. The prudent use of financial resources would prevent stripping or running down of assets so that systems could be utilized throughout their useful lives.

5.2 Recommendations
Based on the methodology developed and the results of the testing, the following recommendations are made:
CWSA should adopt this methodology for training and implementation in a selected number of small towns for a review to improve it.

The updated methodology based on the review could be used for developing computer software for data storage and dissemination of information on all the small town water supply systems in Ghana.

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