FACT-FINDING STUDY

WASCO UTILITY MANAGEMENT SUPPORT

FOCUS: NON-REVENUE WATER

June 2014

DEUTSCHE GESELLSCHAFT FÜR
INTERNATIONALE ZUSAMMENARBEIT (GIZ) GMBH
# Table of Contents

1 **Introduction** ........................................................................................................... 5  
1.1 Background ........................................................................................................... 5  
1.2 Objective .............................................................................................................. 6  
1.3 The Strategic Alliance for Water Loss Reduction (STA) ...................................... 6  

2 **Baseline definition** ................................................................................................ 9  
2.1 Current NRW approach .......................................................................................... 9  
2.2 Activities during baseline assessment ..................................................................... 10  
2.3 Visited supply systems ............................................................................................ 10  
  2.3.1 Northern water supply scheme ........................................................................ 10  
  2.3.2 Roseau river dam (John Compton Dam) .......................................................... 11  
  2.3.3 Millet intake .................................................................................................... 13  
  2.3.4 Ciceron Water treatment plant ....................................................................... 14  
  2.3.5 Distribution network Castries town .................................................................. 14  
2.4 Summary of findings .............................................................................................. 15  
  2.4.1 GIS System ...................................................................................................... 15  
  2.4.2 Hydraulic Modelling ....................................................................................... 15  
  2.4.3 Energy Efficiency ......................................................................................... 15  
  2.4.4 Water Meter Management ............................................................................. 15  
  2.4.5 Staff and Equipment ...................................................................................... 16  
  2.4.6 Emergency crew/ staff on call ...................................................................... 16  
  2.4.7 Leak detection .............................................................................................. 16  
  2.4.8 Store management ......................................................................................... 16  
  2.4.9 Repair/ Corrective maintenance ................................................................... 16  
  2.4.10 Rehabilitation .............................................................................................. 17  

3 **Suggested measures for improved NRW management** ........................................ 18  
3.1 Road Map ............................................................................................................... 18  
3.2 Short-term measures ............................................................................................... 18  
  3.2.1 Training on valve maintenance ....................................................................... 18  
  3.2.2 Training on network repair ............................................................................. 21  
  3.2.3 Training on asset mapping ............................................................................. 24  
  3.2.4 Support on hydraulic modelling ..................................................................... 25  
  3.2.5 GIS coaching .................................................................................................. 27  
  3.2.6 On the job training on energy audits ................................................................. 30  
  3.2.7 Inspection and repair of installed flow & pressure measurement equipment .... 33  
3.3 Medium-term measures ......................................................................................... 34  
  3.3.1 Training on leak detection ............................................................................. 34  
  3.3.2 Optimisation of Store & Emergency Stock ....................................................... 37  
  3.3.3 Installation of new flow & pressure measurement equipment ....................... 38
3.3.4 Distribution zoning .................................................................39
3.3.5 Fact finding study on groundwater potential .........................40
3.3.6 Master Plan for Water Supply and Sanitation ..........................40
3.3.7 Optimisation of house connections .......................................41
3.3.8 Implementation of DMA’s ....................................................42
3.3.9 Installation of PRV’s .............................................................42

3.4 Long-term measures ................................................................43
3.4.1 Optimisation location of work and store house ....................43
3.4.2 Separation of transport and distribution ..............................44

4 Summary ......................................................................................45

5 Regional Training Centre for Water Loss Reduction ..................46

Table of Figures

Figure 1: Holistic approach strategic alliance for water loss reduction ........7
Figure 2: Overview Castries supply scheme .......................................11
Figure 3: Roseau water storage tank (left) Junction point of Roseau and Millet transmission lines (right) ......................................................11
Figure 4: Schematic overview Roseau River Dam intakes and raw water pumping scheme .................................................................12
Figure 5: Roseau river dam (photo credit: caribbean360.com) ..........12
Figure 6: Millet intake point (left) destruction caused by hurricane (right) ....13
Figure 7: One of the existing 11 air valves installations at Millet and wash out ....13
Figure 8: Schematic Ciceron WTP ....................................................14
Figure 9: Schematic overview of the distribution mains of Castries town area ....14
Figure 10: Road Map for improved NRW management ......................19
Figure 11: Leaking hydrant for feeding cruise liners (left) Test on leaking valve at HAMBURG WASSER (right) ..............................20
Figure 12: Execution of repair works ...............................................21
Figure 13: Tool box WASCO repair crew .........................................23
Figure 14: GIS applications within a modern water utility .................28
Figure 15: GIS work place (left) network clarification (right) ..........28
Figure 16: Steps of GIS implementation ..........................................29
Figure 17: Roseau raw water pumping station (left) Ciceron clear water pumping station (right) .........................................................31
Figure 18: E/M Flow meter at Outlet of Ciceron WTP, display not functioning ..33
Figure 19: Leak detection works in the field .....................................35
Figure 20: Unprotected house connection (left) meter installation made of gs pipes and protected by iron box Kigali, Rwanda (right) ..........41

Abbreviations
CAH  Consulaqua Hamburg Beratungsgesellschaft mbH
CARICOM  Caribbean Community
CAWASA  Caribbean Water & Sewerage Association Inc.
CARPHA  Caribbean Public Health Agency
DMA  District metering area
GIS  Geographic Information System
GIZ  Gesellschaft für Internationale Zusammenarbeit
GOSL  Government of St. Lucia
HW  HAMBURG WASSER Utility
ISO  International Organization for Standardization
IT  Information Technology
KPI  Key Performance Indicator
LCC  Life Cycle Cost
NPV  Nett Present Value
NRW  Non Revenue Water
ND  Nominal Diameter
PN  Pressure Nominal
PRV  Pressure reducing valve
SEWERIN  Hermann Sewerin GmbH
SOP  Standard Operating Procedure
STA  Strategic Alliance for Water Loss Reduction
ToR  Terms of Reference
VAG  VAG-Armaturen GmbH
WASCO  Water & Sewerage Company St. Lucia
WTP  Water Treatment Plant
1 Introduction

1.1 Background

The Government of Germany has commenced support to a regional twin programme in CARICOM member countries captioned “Adaptation of Rural Economies and Natural Resources to Climate Change” and “Management of Coastal Resources and Conservation of Marine Biodiversity”. Both programmes are being carried out under the umbrella of “Caribbean Aqua-Terrestrial Solutions”, which promotes site-specific action from Ridge to Reef. The umbrella programme is being implemented jointly between the Environmental Health and Sustainable Development Dept. of CARPHA (Caribbean Public Health Agency) and the GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit).

The partnership programme between the Federal Republic of Germany and the Caribbean Community (CARICOM), and GIZ and CARPHA respectively, has offered the Water & Sewerage Company Inc. (WASCO) of Saint Lucia to assist her in identifying feasible options for much improved utility management with a focus on non-revenue money.

WASCO is responsible for the provision of potable water and sanitation services for the whole of Saint Lucia. Due to the prevailing geographical and climatic conditions, sustainable water supply is at a knife’s edge. Matters were made even worse as a result of hurricane Tomas in 2010 and the low-level trough heavy rains in December 2013. Most of the water supply systems have been affected and severe damage was done to the water supply infrastructure: Intakes, transport mains, reservoirs and pumping stations where flooded and partly damaged and the continuity of supply disturbed. Furthermore part of the infrastructure is old and needs to be replaced. According to a study on NRW executed by the consulting firm St. Lucia Water Partners in 2013, the non-revenue water was calculated at more than 56 %.

The following general performance indicators were used in 2013 by WASCO to illustrate the risks for the water supply systems:

- Drinking water supply outages (duration; frequency; geographical area)
- Drinking water system reliability (some water supply systems are plagued by problems due to old and inadequate infrastructure)
- Water quality complaints (not a major issue for WASCO, 95% meets standards)
- Drinking water compliance rate 100% (Ministry of health standards for potable water)
- The degree of turbidity in the water (high turbidity levels at water sources after heavy rains)
- Number of customer complaints (inadequate water supply & leaks)
• The monthly operational expenses are still higher than the operational revenues although the water tariff has been increased by 66% in April 2013. The actual cost coverage has increased from 64% before the tariff increase to approximately 95% after the tariff increase.

At present WASCO has more than 302 employees but only 4 engineers, who are also managers. There is no formal operation and maintenance management system in place and therefore no complete asset inventory available. WASCO is in the process of developing a GIS system and the Department charged with developing a strategic plan and asset mapping and developing an asset management plan consists of four (4) individuals trying to work in an environment without the supporting policies and procedures and standards.

1.2 Objective

The objective of this contract is:

To carry out a 2-week fact-finding study in Saint Lucia and to compile all resultant data and information into a comprehensive and convincing strategy proposal (roadmap) on vastly improved utility management (Identification of short-, medium-, and long-term measures to be undertaken in order to strengthen WASCOs management capacities) with a focus on reducing non-revenue water significantly.

The above overall objective is also meant to assist WASCO in improving her institutional and human resources capacities through the provision of a reliable and affordable water supply as well as adequate sanitation services to all people in Saint Lucia, and to efficiently and effectively reduce the currently unacceptably high and unaccounted for water losses.

1.3 The Strategic Alliance for Water Loss Reduction (STA)

The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) has formed a Strategic Alliance for Water Loss Reduction (STA) with three globally operating German partners. The STA follows a holistic approach for water loss reduction that aims at capacity development in water sector institutions and offers tailor made solutions for planning and implementation of measures to reduce physical water losses. In the Figure below the four basic methods for managing real water losses is presented.
Figure 1: Holistic approach strategic alliance for water loss reduction

The STA can provide the following services:

1. Support for the establishment of a regional training centre for NRW and train the regional trainers on all aspects of physical NRW. The STA can also provide an internet platform for communication and learning.
2. The STA training materials and toolboxes can be used including i.e. the “Generic Proposal for the Implementation of Measures by Water Utilities to Reduce Water Losses”.
3. HAMBURG WASSER can provide utility expertise including network management analysis, GIS support, leakage repair and on the job peer to peer training by experienced engineers and master technicians.
4. VAG can provide training on hydraulic modelling, pressure management and specification and supply of high quality valves and appurtenances.
5. SEWERIN can provide training on all aspects of leakage detection including specification and supply of state of the art pipe and valve location equipment as well as leak detection equipment.
In order to investigate possibilities for water loss reduction in St. Lucia a two week fact finding mission with the following key experts from Germany was conducted:

*Table 1: Key Experts*

<table>
<thead>
<tr>
<th>Position / Company</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager, Water Supply Expert / CONSULAQUA</td>
<td>Mr. Kees de Jong</td>
</tr>
<tr>
<td>Operation &amp; Maintenance Utility Expert (HAMBURG WASSER)</td>
<td>Mr. Peter Hoppe</td>
</tr>
<tr>
<td>Hydraulic Modelling &amp; Pressure Management Expert (VAG)</td>
<td>Mrs. Deepa Vethaviyasar</td>
</tr>
<tr>
<td>Leak Detection Expert (SEWERIN)</td>
<td>Mr. Michael Kersting</td>
</tr>
</tbody>
</table>
2 Baseline definition

The base line for the fact finding study was WASCO’s current strategy for water loss reduction (refer to section 2.1) and a qualitative analysis of 10 important aspects on water loss reduction (refer to section 2.4).

2.1 Current NRW approach

The following is WASCO’s non-revenue water (NRW) reduction strategic plan:

Strategies for reducing NRW physical losses:

1. Development of a geographic information system (GIS) including supporting data bases which will be the foundation for:
   - Establishing District Metered Areas (DMAs);
   - Redesigning the system and developing a hydraulic model to facilitate:
     - The creation of clear distribution zones;
     - Pressure management;
     - Locating tanks to provide effective storage;
     - Effective location of pumps to assist in power reduction;
     - Asset mapping;

2. Establish a comprehensive asset management (CAM):
   - This initiative requires an asset inventory, emphasis on pipe types, diameters, condition date of installation and supervise and crew/contractor responsible for installation and/or repair;

3. Establish a comprehensive operations and maintenance management (OMM) system:
   - Emphasis on speedy responses to reported leaks and systematic changes of pipes;
   - Rehabilitate tanks to eliminate overflows and leakage;
   - Implement preventative maintenance on pumps, valves, meters, and tanks.

4. Meter all facilities to assess system input flows and flow into the water distribution zones;

Strategies for reducing commercial losses:

5. WASCO’s DOS based billing program to be changed in order to be more effective corresponding to the NRW programme;
6. Obtain and install automated meter reading (amr) to eliminate human error in meter reading; the analysis for effecting this activity effectively and the plan for executing the changeover will be undertaken during WASCO’s 2014 work programme;

7. Monitor and evaluate the meterisation process and all relative aspects and adjust to ensure targets are met;

8. More effective supervision of residential developments implementation and newly established developments;

2.2 Activities during baseline assessment

Activities took place primary in the northern part of the Island starting from the Rouseau dam and Millet intake, following the flow of the water along the transmission line to the Ciceron water treatment plant. From there the focus was on the main transport and distribution system between the Ciceron treatment plant and the northern part of the Island of Gros Islet. Special attention was paid to the gravity supply zone of Castries, where the network consists of mainly old pipelines. A number of valve chambers were inspected. Several field visits were conducted together with WASCO staff. Amongst others the 16” transport line between the Millet intake and the junction where the 24” transport line arriving from Rousseau dam was inspected. The leak detection team was interviewed and existing leak detection equipment was tested in the field together with the responsible staff. Furthermore the service department was visited, two leak repair sites were assessed and the central store of WASCO was visited. The mapping of the main distribution lines of Castries distribution zone has been conducted with experienced supervisors from WASCO.

2.3 Visited supply systems

2.3.1 Northern water supply scheme

The northern part of St. Lucia is supplied from the Roseau river dam and the Millet river intake. These surface water sources are very much influenced by seasonal changes. The dry season at St. Lucia lasts from December to May and the rainy season is from June to November. During the last years the climate has changed enormously. Tropical storms and hurricanes have become more unpredictable, for example December 2013. Furthermore the period of dry season is increasing. Due to that capacity of existing water sources have to be re-examined and enlarged.

From both water sources the water is transported further to Ciceron WTP from where it is supplied to Castries network (Figure 2).
Raw water from the Roseau dam is first pumped into a storage tank at a level of 168 msl and then further transported by gravity through a transmission line DN 600. From Millet intake the water also arrives by a gravity line DN 400.

The pressure levels of the Roseau storage tank and the Millet intake are balanced at the junction point where the two transmission lines are joining. From the junction point the raw water is reaching Ciceron WTP through Vanard and Sarot by gravity. Between Vanard and Sarot the diameter of the transmission line widens from 600 to 800 mm.

Figure 2: Overview Castries supply scheme

2.3.2 Roseau river dam (John Compton Dam)

Based on WASCO’s statement water from Roseau was abstracted from two intake points. However, with the time the lower intake point has been blocked by siltation. Currently water is taken only by the upper intake point which causes trouble when the
water level falls beneath this intake point during dry season. A look on the existing dam drawings revealed that another intake point was foreseen. Actually the middle of the three intake points is covered with a blind flange but could be taken into operation once the water level sinks beneath the upper one.

Figure 4: Schematic overview Roseau River Dam intakes and raw water pumping scheme

Figure 5: Roseau river dam (photo credit: caribbean360.com)

The nominal diameter of Roseau water intake line is DN750. The diameter after pumping station changes to DN 600
2.3.3 Millet intake

The water intake capacity at the Millet intake depends on the seasonal fluctuations. During the dry season the water capacity is under the required demand.

Figure 6: Millet intake point (left) destruction caused by hurricane (right)

The intake point is not properly constructed or protected (Figure 6). The ductile cast iron transmission line follows a valley and is partly covered with rocks. Maintenance and repair works are difficult because the location is almost impassable for machines. No flow or pressure measurement devices are recording the exact values of the water source.

Figure 7: One of the existing 11 air valves installations at Millet and wash out

The plan of Millet transmission line shows 9 air valve installations. Following the pipeline 11 air valve installations were found. Random opening of the air valve chambers showed that more than 50 percent the chambers were filled with water (Figure 7).
2.3.4 Ciceron Water treatment plant

The Ciceron WTP consists of two plants. Plant I was constructed 1993 and plant II in 2007. Both plants are of different capacity. The treatment process includes coagulation, flocculation, sedimentation, filtration and disinfection.

![Schematic Ciceron WTP](image)

Figure 8: Schematic Ciceron WTP

The treated water is stored in two concrete reservoirs. One part of the water is transported by gravity to Castries town and port. Another part is pumped to consumers in the North of St. Lucia (Figure 8).

2.3.5 Distribution network Castries town

The schematic diagram presented in Figure 9 gives a first overview of the Castries water supply scheme.

![Schematic overview of the distribution mains of Castries town area](image)

Figure 9: Schematic overview of the distribution mains of Castries town area
Several changes have been made in the course of time without being documented. Together with WASCO´s responsible staff this preliminary overview of the main distribution lines was developed. As it can be found the distribution systems of Castries town are fed by two distribution mains, the blue and the red one, which are enclosing the supply area. The blue transmission main DN 500 feds into Choc tank which acts as balancing reservoir. Big parts of the network are not equipped with measurement devices. The pressure in the gravity supplied zone of Castries was reported to be very high, 6.5 Bar.

### 2.4 Summary of findings

Below a brief qualitative assessment is presented for each of the aspects invested.

#### 2.4.1 GIS System

- GIS hardware & software available (ARC-GIS) 😊
- GPS equipment available 😊
- Staff training ongoing (GIS + GPS) 😊
- Workflows not yet clear and institutionalised 😐
- Limited availability of qualified staff 😐

#### 2.4.2 Hydraulic Modelling

- Hydraulic modelling software available 😊
- Staff training ongoing (InfoWater) 😊
- Workflows not yet clear and institutionalised 😐
- Limited availability of qualified Engineers 😐
- Hydraulic model(s) for supply zones non existent 😐

#### 2.4.3 Energy Efficiency

- E&M maintenance department available 😊
- High energy cost > XCD 1.000.000 per month 😐
- High potential for reduction of energy cost 😊
- Energy audits for pumping stations not yet implemented 😊
- Staff for conduct of energy audits not yet trained 😐
- Workflows not yet clear and institutionalised 😐
- Limited availability of qualified Staff 😐

#### 2.4.4 Water Meter Management

- Bulk water meters only partially installed and partially functional 😊
• Distribution zoning system (DMA's) partially isolated 😊
• Reliability of house water meters doubtful 😊
• Preparation of water balance not possible 😊
• At many places spaghetti house connection lines exist: vulnerable and easy to manipulate 😊
• Test bench available but not regularly used 😊
• Workflows not yet clear and institutionalised 😊

2.4.5 Staff and Equipment

• Organisation structure is being optimised 😊
• Staff training ongoing 😊
• Several management positions are still vacant 😊
• Limited availability of qualified Engineers 😊
• Equipment is available but not properly handled 😊

2.4.6 Emergency crew/ staff on call

• Emergency crew available 😊
• Long response time 😊

2.4.7 Leak detection

• Leak detection services department available 😊
• Leak detection equipment partly available 😊
• Staff familiar with leak detection equipment 😊
• Workflows not yet clear and institutionalised 😊

2.4.8 Store management

• Central store available 😊
• Store management functioning 😊
• Many different repair materials are in stock 😊
• Many old materials are not removed 😊

2.4.9 Repair/ Corrective maintenance

• Skilled staff available 😊
• Repair materials available 😊
• Repair workflow not efficient 😊
• Long response time 😊
2.4.10 Rehabilitation

- Asset condition assessment not systematically implemented 😞
- Asset Management Plan not available 😞
3 Suggested measures for improved NRW management

3.1 Road Map

After two weeks of intensive collaboration between WASCO and STA Staff a Road Map for future operation and NRW management was jointly developed. The Road Map which is presented in Figure 10 shows different measures and comprehensive tasks ordered according to their expected magnitude of investments and the point of time suggested for their implementation.

*Short term measures* are measures that should be implemented within the first 12 months after this fact finding study. Some items can immediately be implemented without high cost.

Short term measures also help to prepare the ground for the following medium- and long term measures.

*Medium and long term measures* require more comprehensive planning, bigger investments and sometimes additional staff.

3.2 Short-term measures

3.2.1 Training on valve maintenance

Most of the valves and appurtenances at WASCO are installed in valve chambers. At some locations valves are directly installed in the ground without use of chambers.

Many of the valve chambers visited are properly locked, but nevertheless very dirty inside. A significant part of the valves and appurtenances, especially at the gland packing’s, is leaking. Because of these small leakages the chambers are partly filled with water.

The small leakages are not considered as defects by the WASCO staff although they cause considerable physical water losses. During a test conducted at HAMBURG WASSER leaking volumes of 101 Imp. Gal/day or 36.900 Imp. Gal/year was measured for one single valve.

At WASCO the condition and functioning of the valves is not regularly checked, except for the valves that are used for rationing of the water supply.
Figure 10: Road Map for improved NRW management
On short notice we recommend to start a valve chamber rehabilitation and mapping campaign consisting of the following activities for each valve chamber:

- Coding of the valve chamber and valve(ID)
- Cleaning of the valve chamber
- Check the condition and functioning of the valves and appurtenances (if possible from operation point of view)
- Check and if necessary replace the flange sealing gaskets
- Repair of the gland packing
- Measurement of the valve position in relation to the existing infrastructure
- Documentation of the activity on a standardised form
- Import the information from the standardised form into GIS

Figure 11: Leaking hydrant for feeding cruise liners (left) Test on leaking valve at HAMBURG WASSER (right)

It is further recommended to start these activities in the old centre of Castries where the network is old and a high pressure in the system exists (100 PSI). After having a good overview on the location and condition of the valves and other appurtenances further activities can be executed such as: Pressure management (reduction), rehabilitation works, and optimization of house connections.

The collected information shall immediately be imported in the GIS system and will form the basis for the valve and appurtenances data base and asset inventory.
3.2.2 Training on network repair

During the fact finding mission two repair sites on clear water pipelines were visited. The works were professionally executed under the supervision of a WASCO supervisor. One problem observed was the bad compaction of the soil after completion of the repair works, while compactor was available but would had to be collected from the central store. The number of supervisors and workers of the water services department is limited. Therefore the staff should be employed as effective as possible.

Figure 12: Execution of repair works

S-1: The works on the valves and appurtenances, especially the systematic work-flow, can be supported and trained on the job by HAMBURG WASSER Network experts. The following training is proposed:

- Sensitization of the supervising staff and workers on the magnitude of water losses caused by leaking gland packing’s, gaskets and other sealing materials
- Implementation of the valve chamber rehabilitation campaign in Cas-tries
- Repair works for valves and other appurtenances
- Conduct a workshop for development of a standardised valve condition assessment form
- Implementation in the field of the new form
- Measurement of the valves and appurtenances
- Development of a valve and appurtenances inventory list
During the execution of the repair works the following two weak points were observed:

- Organisation of the works, and
- Insufficient availability of tools and equipment

Basic conditions for an effective repair work flow are:

1. registration of repair notice;
2. preparation of work order for technical crew; and
3. Feed back notice after completion of the repair – thus representing a repair works cycle.

The information of the repair crew on the leakage is incomplete as there are hardly any up-to-date network drawings available. So the repair work starts with a site visit and on site the organisation of the repair works is discussed and organised. The organisation of the works is not clearly arranged: Different trips are needed to organise the right equipment, to obtain the required working materials from the central store, and to organise and instruct the workers.

It becomes clear that lack of information prevents an effective repair work. For future works on the network it is crucial to collect and record all relevant data of the repair works, to measure the location of the repair sites in relation to the existing infrastructure and to insert these points including the data into the GIS.

We recommend to jointly (HAMBURG WASSER and WASCO staff) develop an optimised work flow that minimises travel times by e.g.:

- having standardised equipped vehicles with all necessary tools, equipment and basic repair materials on board,
- invoicing and further administration works done after the repair works are completed,
- executing field surveys for several reported leakages one day prior to execution of repair works including organising of the repair works,
- supplying materials by a separate vehicle,
- etc.

Also with an effective equipment of the repair vehicles repair works can be optimized. During an inspection of the equipment remaining materials were identified, that will probably not be used for future repair works (Figure 13).
Figure 13: Tool box WASCO repair crew

The equipment of the repair vehicle is dependent from:

- Task to be executed / experience of the crew
- Pipeline material
- Diameter of pipe lines
- Number of workers / Type of vehicle

There exists no uniform equipment of the repair vehicles, the equipment should be tailored to the needs as mentioned above and should be adjusted to the available vehicles at WASCO.

**Important:** The equipment of the repair vehicles should be documented on a inventory list for each vehicle that must be checked by the supervisors on a regular basis (at least once a week).

**S-2:** On short notice we recommend to start on the job training by HAMBURG WASSER Network Experts including the development of a work flow diagram on repair works and the transfer of the data into the GIS:

- Analysis of the actual organisation, frequency of repair assignments, type of repair works, materials’ need
- Structuring of the communication during water supply disturbances
- Optimisation of travel time
- Workshop on development of the work flow diagram on repair works
- Workshop on equipment of repair vehicles
- Workshop on assessment of leakages/damages, & documentation
- Transfer of the knowledge in the field
3.2.3  Training on asset mapping

The water distribution system of WASCO is characterised by the fact that there are hardly any (reliable / updated) network maps available. The network knowledge mainly exists in the mind of the WASCO network engineers and technicians.

At present a GIS system for the network is being developed. It will require a financial and time consuming process to document the verbally available information into the GIS. In order to streamline this process it is crucial to start immediately with the documentation of every repair job and every new house connection as well as setting data standards for new network extensions.

HAMBURG WASSER approach to asset mapping:

A data inventory shows the different forms and qualities of data sources to be entered into GIS. Existing digital data for example can be used for a migration into the new system (after data evaluation and improvement). Pipe documentation on paper plans must be examined and digitized. All data and objects not yet in GIS can be completed by field survey. Thus, three methods of data completion in GIS have to be worked out:

1. Migration of existing digital data + improvement
2. Digitization of analogue data
3. Field survey

After these steps standard operation of GIS can start.

To get and to keep a reliable GIS-System it is very important to have complete and correct data in the GIS database. For meeting this essential requirement a few things have to be done:

- New *network construction* must be entered in the GIS. A technical *standard specification* has to be designed and to be made obligatory for construction documentation so that asset data can be migrated into GIS easily and always in the same way.

- All changes to the network such as repairs must be entered in the GIS. *(Repair documentation)*

- Sites with inaccurate or incomplete information in the GIS must be re-recorded in order of importance. *(Field survey)*

- Continual *rectifications* of data, which can be data base errors or logical errors to be cleared on screen by technical know how.
3.2.4 Support on hydraulic modelling

A hydraulic model is a valuable tool for successful water network operation. Once established a hydraulic model helps to

- Better understand the function and behaviour of the supply system
- Identify actual flow and pressure conditions
- Get to know the weaknesses and shortcomings of the systems
- Facilitate future planning
- Achieve energy efficient operation

WASCO currently does not have a hydraulic network model of the existing water supply system. However, hydraulic modeling software is in place and some staff already received training in hydraulic modeling. For the moment the biggest challenge is, to get a reliable database for first simplified models of selected water supply schemes.
To achieve this, the IT, GIS staffs and the responsible staffs of the different pipeline sections have to come together and start to reconstruct the existing network situation. A work plan and on-site visits including reading of measurement devices and GPRS recordings have to accompany this. The investigation of the network has to start at the water sources. Transport- and distribution lines should be investigated independently from each other - one after another. Model building should always start with the primary networks. Once the database gets better, also modeling can go into deeper details.

Existing measurement devices should be checked and reactivated, if necessary. Additional measurement devices (flow & pressure) should be installed at strategic points. All meters and pressure loggers have to be read and analysed on a regular basis.

The results of a first intervention should be an actualised plan of the primary network and data to identify the consumption pattern. With this information a first hydraulic model of the transport line and distribution mains of Castries town area can be developed.

**Network clarification and adoption of measures**

At the Roseau dam the number of intakes points has to be determined. If a third intake exists, this has to be used, because during the dry season Millet intake is restricted. The flow and pump operation at Roseau during seasonal changes have to be monitored by measurements (water level at Roseau reservoir, pressure before and after pumping station and flow).

The topographical situation and the water resource availability in the catchment area of the Millet intake has to be analysed before any plans for a dam at Millet will be developed. The influence of the seasonal changes has to be recorded to determine the available water capacity at Millet. All existing air valve installations have to be checked and a surge analysis should be made, as Millet is gravity line. Further the line has to be cleaned for maintenance works.

At the junction point of Roseau and Millet a chamber including measurement devices has to be built. The current situation at the junction point does not allow any maintenance works or operation strategy.

The cause for the pipeline diameter changes after the junction point to the WTP has to be investigated. At the treatment plant the in- and outlets have to be monitored.

In the box below the proposed short term support activities related to hydraulic modeling are summarised:
S-4: On short notice we recommend to start on the job training and coaching by VAG Hydraulic Modeling Experts on data management, hydraulic modeling and pressure management with the following activities:

Roseau-Millet-Ciceron transport system:

- Collection and verification of existing data on: water levels, elevations, reservoirs, pumps, pipe lengths, pipe diameters, washouts, air valves, flows, pressures, etc.
- Proposal for additional measurements and execution of measurements campaign
- Hydraulic analysis → maximum capacity of the existing lines
- Proposal for capacity increase of the transport system
- Proposal for maximisation of Millet gravity water supply

Castries gravity distribution zone:

- Collection and verification of existing data on: water demand, elevations, reservoirs, pipe lengths, pipe diameters, washouts, air valves, flows, pressures, etc.
- Proposal for additional measurements and execution of measurements campaign
- Hydraulic analysis → preparation and calibration of network model.
- Proposal for fixed supply zone boundaries (DMA)
- Proposal for pressure reduction, installation of PRV’s

3.2.5 GIS coaching

A geographic information system (GIS) is a computer system designed to capture, manipulate, analyze, manage, and display all kind of spatial data.

Historically GIS was used in first place to document and map the utilities pipes systems and facilities. Nowadays, with increasing capability of computer systems and better availability of spatial data GIS is used for a wide range of applications within a modern water utility (Figure 14).
Currently there is no comprehensive digital documentation of the water network system in St. Lucia. Available are AutoCad drawings and project plans which WASCO has started to migrate into GIS with the beginning of this year. Two WASCO IT technical staffs are trained in GIS and entrusted with this task.

In the course of time, changes have been made in the network infrastructure due to damages and network extension. Pipe materials were replaced or new pipes were installed to counteract population growth and increasing water demand (tourism). As a result of that the age and material of the pipes vary widely from old cast iron, ductile iron, PVC and asbestos cement.
However, changes are rarely proper documented. Long-term experienced staffs at WASCO responsible for the different network sections and involved in the network changes are the only persons who are holding this knowledge. Clear and plausible knowledge about the network status is very much restricted within WASCO.

**HAMBURG WASSER approach for successful GIS implementation:**

The implementation of a GIS has to be done in several stages that are built on each other.

1. **Identify/develop processes**
2. Development of a **data model**
3. Development of a **organizational concept**
4. **Customize** the system to meet individual requirements
5. **Build/implement** organization and hire/terrain employees

*Figure 16: Steps of GIS implementation*

A careful analysis of the present state is the necessary preparation before a GIS will be implemented. It clarifies the needs of a future GIS with regard to supported processes, data model, data organization and system requirements. The initial situation determines, what has to be worked out precisely in the individual stages reflected in Figure 16.

Following Figure 16 the processes (e.g. mapping, asset management or customer billing) to be supported by the GIS have to be identified at first. The process definition will be developed in workshops together with all involved stakeholders and staffs. Important is to directly integrate routines for documentation and continuous up- dating of data into theses processes.

Depending on the processes different kind of objects (pipes, customers etc.) will be managed and analyzed with the help of the future GIS. On the basis of the selected objects a data model is developed. Related object classes and attributes are defined in order to design the future geo- database.
Afterwards the organizational concept for the consistent implementation and integration of GIS needs to be developed and established. The organizational concept includes all rules and structures for the use, maintenance and updating of the future GIS.

Depending on the individual tasks and processes for which the future GIS shall be applied a customization of soft- and hardware might become necessary.

For the development, implementation and integration of GIS a separate department with clearly defined tasks and goals is needed. This will require employees with IT skills and comprehensive knowledge of the tasks and organization of the water utility. These staffs have to be hired or existing one have to be trained.

Furthermore different groups of users and helpers from all involved departments need to be trained in the following topics:

1. System maintenance
2. GIS use (update, analysis, map production)
3. Field survey

System maintenance by own staff is important for a sustainable GIS use. Therefore GIS technicians of all departments need continuous training.

**S-5: On short notice we recommend to start on the job training by HAMBURG WASSER GIS Experts on asset mapping including the development of a work flow diagram on collection and transfer of the data into the GIS:**

- Identify/develop processes
- Development of a data model
- Establish organizational concept
- Customize the system to meet individual requirements
- Build/implement organization and train employees

### 3.2.6 On the job training on energy audits

During the site investigations the two largest pumping stations at WASCO have been visited:

**Roseau Dam Raw Water Intake Pumping Station**

In section 2.3.2 the hydraulic aspects on the Roseau dam raw water intake pumping are described. The pumping station consists of 5 raw water transport pumps operated in parallel, with one pump out of operation. The Pumps manufacturer is PEERLESS PUMP from Indianapolis, USA. The pumps are from 2007. The operating range of the
pumps is very wide due to the fluctuating water levels of the Roseau reservoir during the year. The condition of the pumping station is good although the performance of the pumps is not evaluated on a regular basis.

Figure 17: Roseau raw water pumping station (left) Ciceron clear water pumping station (right)

The energy reduction potential at Roseau Dam depends in the first place on the operational efficiency of the raw water pumps and motors. Another interesting aspect is that the Millet raw water intake lies more than 90 metres above the Roseau reservoir water level. This means that during the rainy season energy cost at Roseau Dam can be saved when the gravity flow from Millet intake is maximised. Life cycle cost calculations are needed for several scenarios to obtain the economic and energetic optimum solution for the future.

Ciceron Clear Water Distribution Pumping Station

A part of the treated water of the Ciceron WTP's is pumped to higher zones in the north of St. Lucia. The pumping station consists of 5 clear water transport pumps in parallel. The Pumps manufacturer is PEERLESS PUMP from Indianapolis, USA, The pumps are also from 2007. The operating range of the pumps varies to the fluctuating water levels of the clear water reservoirs at Ciceron and the discharge losses in the clear water transport lines. The condition of the pumping station is good although the performance of the pumps is not evaluated on a regular basis.

HAMBURG WASSER approach for operation and energy audits at pumping stations:

To assess the correct and efficient operation of a pumping station experts will compare the pump designs with the operating conditions found in the field.

Flow and pressure of the pumps are measured and from these data the occurring operating points of the pumps are determined. A comparison with the manufacturers pump data reveals, whether the pump is operated in a sustainable and efficient way or not.
Additional measurements of the electric power consumption allow the calculation of the overall efficiency of the pump units and enable the experts to express the performance with comparable performance indicators.

On the one hand energy audits by HAMBURG WASSER experts shall give the management of WASCO a first, reliable baseline of the condition and performance of their pumping stations. On the other hand selected staff of WASCO will be trained on how to organize and execute energy audits by themselves to continuously monitor the performance of their pumps.

Below the recommended actions are described:

S-6: On short notice we recommend to start on the job training by HAMBURG WASSER Pump Experts on execution of energy audits for the two largest pumping stations at WASCO namely the Roseau dam raw water intake pumping station and the Ciceron clear water pumping station. The following activities are proposed to be executed:

- Conduct site inspection at both pumping station(s)
- Appoint and install relevant measuring equipment (Flow, Pressure, Power)
- Calculate hydraulic system curves and retrieve design pump curves
- Conduct field measurements at both pumping station(s)
- Analyse pump operation and potential for energy reduction
- Determination of key performance indicator (Wh / m$^3$/ m$^1$ pump head)
- Execution of Life Cycle Cost (LCC) calculations based on Nett Present Value (NPV)
- Identify and prioritize energy efficiency measures
- Training on energy and performance monitoring
- Training on pump design and pump lay out (best operation point),
- Preparation of an standard operating procedure (SOP) on implementation of energy audits
3.2.7 Inspection and repair of installed flow & pressure measurement equipment

During the various site visits conducted by the STA team it was observed that at several vital locations flow meters are installed, even electromagnetic (E/M) flow meters, but the meters are not always operational and displays are sometimes broken. At most pumping stations mechanical pressure gauges are installed but it is not clear how the flow and pressure data is recorded.

Figure 18: E/M Flow meter at Outlet of Ciceron WTP, display not functioning

Analogue to the valve maintenance campaign as described in section 3.2.1 a similar campaign should be conducted for all bulk flow meters and pressure gauges installed in the transport and distribution systems as well as at pumping stations, treatment plants and reservoirs.

On short notice we recommend to start with a flow meter and pressure gauge rehabilitation and mapping campaign consisting of the following activities for each valve chamber:

- Coding of the valve chamber, flow meter(s) and pressure gauges(ID)
- Cleaning of the valve chamber
- Check the condition and functioning of the flow meters and pressure gauges and if necessary execute repair works or replacement of pressure gauges
- Check and if necessary replace the flange sealing gaskets
- Measurement of the flow meter and pressure gauge position in relation to the existing infrastructure
- Documentation of the activity on a standardised form
- Import the information from the standardised form into GIS
3.3 Medium-term measures

3.3.1 Training on leak detection

The initial conditions at WASCO for detecting water leaks in the operated distribution networks is a lot better than expected. The following summary presents the strengths and weaknesses of the existing leak detection practise:

**Strengths:**

- Three teams with two persons each are working in an autonomous department focused on doing leak detection.
- The related staff has a good knowledge working in the field with electro acoustic instruments and knows how to interpret environmental influences and indications.
- Water is mainly supplied 24/7 so that the network is continuously under pressure and leak detection works can be done at any time.
- Flexible working hours, e.g. working in the night times, where less environmental influences appear, are already implemented.
Weaknesses:

- At the moment one team is working with only one person.
- The wages of the employees are fixed and do not include a bonus.
- The detection work itself often is hampered by various reasons. Materials like for example PVC which is used for house connections, reduce the sound transmission and make it difficult to identify leak noises easily.
- Technical equipment is existing but as seen on site only one complete set for one team. The rest of teams is sharing or working with inadequate instruments.
- Statistics are not used to identify problems in the organisation structure or to increase the working efficiency. The time between locating a leak and the final repair seems, based on the statements of the staff, to be ok but it is not measured yet.

Figure 19: Leak detection works in the field

In summary it can be stated that the base for efficient leak detection is given. The teams have a good knowledge about the principles and the way how to use the instruments. Nevertheless some additional training in the usage of correlators and the final interpretation will help to be more efficient and finally successful. The same applies to the use of pipe and cable detectors.

Recommendations:

To complete the third team the missing team member has to be hired soon.

The fixed wages should be expanded by a bonus which is given for every found leak. This bonus will help to increase the motivation especially at the beginning. Later when the number of leads decreases the system can be changed into another model.
The cooperation between the leak detection teams should be optimized. A possible solution might be to give the responsibility for both departments to one executive, so that the time between localisation of a leak and the final repair can be reduced to a minimum.

Further the following statistics about detected leaks should be collected:

- Date of localisation.
- Date of repair.
- The place respectively the address where the leak was found.
- The pipe material and diameter.
- What kind of damage it is. (e.g. damaged seal of a house connection)
- Estimated loss. (Can be done simply with a bucket and a watch)

These statistics can be used to evaluate if the repair process is running properly and to understand where the most defects appear.

**Additional equipment:**

All teams should be equipped with an electro- acoustic instrument which can be used with different ground microphones and a test rod for checking valves, a simple portable correlator, a ferromagnetic metal detector and a simple pipe and cable detector. This equipment will let the teams operate independent from each other and make the work more efficient. Additionally one set of 20 noise loggers should be used. These loggers can be spread over night in the network and will support the teams in the pre-localisation systematically.

**Additional training:**

Together with the instruments an intensive training should be done. The training will be divided into two parts each one week. The first week should be used to teach the people to operate the instruments properly in the field and to share experience. The second week will be used to share experience and to answer questions which came up after the first training when working alone.
3.3.2 Optimisation of Store & Emergency Stock

The central stock for spare parts was visited twice during the short mission. A part of the materials was stored accurately while another part was laying in the yard.

The delivery of spare parts to the repair teams is documented in form sheets. It was noticed that certain spare parts and fittings where available in a great number, while others were missing.

Some parts of the Fittings, pipes and equipments are damaged or useless and have to be disposed or could be sold. Plastic materials, like PE and PVC pipes as well as gaskets, which have been wrongly stored in the sun are useless and should not be put into operation.

Emergency stock:

For the repair of damages and pipe bursts spare parts like fittings, repair clamps and pipes have to be kept in stock. For any installed material and for any installed dimension spare parts have to be available. For the moment it is not clear, if such a complete Emergency stock is available.

M-1: On medium term we recommend to start on the job training by SEWERIN Leak Detection Experts. The training should be divided into two parts of one week each. The following activities are proposed to be executed:

- Optimization of work preparation and organization
- Additional training on the use of correlators
- Training on the use of pipe and cable detectors
- Introduction of noise loggers, training on the job
3.3.3 Installation of new flow & pressure measurement equipment

Based on the development of the transport and distribution systems in Saint Lucia and guided by the hydraulic network calculations, distribution zoning concepts will be jointly developed and additional measurement equipment will be required.

Preferably E/M flow meters and pressure transducers with data loggers shall be installed at the following locations:

- Raw water intake pipe lines
- Pumping station outlet lines
- Water treatment plant inlet pipe lines
- Water treatment plant outlet pipe lines
- Distribution zone inlet pipe lines
- Distribution zone outlet pipe lines
- DMA zone inlet pipe lines
- DMA zone outlet pipe lines
- Pressure transducers at typical points in the respective distribution zones

The prioritisation for the specification, procurements and installation of the measuring instruments depends on the development of the transport and distribution system.

M-2: On medium term we recommend to improve stock keeping practise with a on the job training by HAMBURG WASSER experts. The following activities are proposed to be executed:

- Assessment of economical stock according to demand of materials and spares
- Guidance in proper storage of certain materials (rubber gaskets, plastic materials, etc.)
- Check of critical spare parts for usability
- Definition of emergency stock
- Improvement of work flows and stock documentation
3.3.4 Distribution zoning

For the main distribution system of the northern part of Saint Lucia a distribution zoning concept will be jointly developed with WASCO based on the following criteria:

- To minimise the total number of distribution zones
- To minimise the total energy cost for clear water pumping
- To create isolated distribution zones with only one or two inlet and outlet points
- To use clear topographic boundaries as zone boundaries such as i.e.: rivers, main roads, etc.
- To have minimum pressure of 2 Bar in the distribution zone
- To have maximum pressure of 6 Bar in the distribution zone
- To separate transport lines from main distribution lines were possible

The distribution zoning concept will be jointly developed with the help of hydraulic modeling. For each distribution zone a separate hydraulic model will be developed jointly with the WASCO strategic planning department.

M-4: On medium notice we recommend to conduct on the job training and coaching by VAG Hydraulic Modeling Experts on distribution zoning with the following activities:

- Conduct a workshop on distribution zoning for the main water distribution system of the northern part of Saint Lucia starting with the Castries distribution zone
- Advanced training on hydraulics and hydraulic modeling
3.3.5 Fact finding study on groundwater potential

At present surface water is the main water resource for water supply on the island of Saint Lucia. Due to the severe climatologic changes the raw water availability is at risk during periods of heavy rains and chemicals cost for treatment of the raw water are very high.

On the other hand desalination of sea water or brackish water is a very expensive alternative.

Interesting alternative options like river bank filtration or ground water abstraction might be very attractive to WASCO for the following reasons:

- Increased supply reliability
- Reduced chemical costs for treatment
- Reduced transport costs due to decentralised water supply

M-5: On medium term HAMBURG WASSER is ready to assist WASCO in executing a fact finding study for exploring the potential of bank filtration and ground water abstraction including water treatment options:

Main activities fact finding study:
1. Inventory of available literature
2. Analysis of potential sites for river bank filtration
3. Analysis of geology and potential aquifers for ground water abstraction
4. Development of a ground water model for potential aquifer(s)

3.3.6 Master Plan for Water Supply and Sanitation

Development of a national master plan for water and wastewater is an important prerequisite for the sustainable development of the St. Lucia. The master plan will be prepared by WASCO in collaboration with the Government of Saint Lucia (GOSL).
M-6: On medium term the STA is ready to assist WASCO in developing the ToR for the water supply master plan focussing on its expertise:

Main activities master plan:
1. Assessment of the existing situation
2. Definition of planning and design basis
3. Elaboration of options and conceptual design of measures
4. Project economic analysis, Financing and implementation plans

Optional accompanying measures:
1. Emergency response plan
2. NRW strategy and action plan
3. Asset management plan

3.3.7 Optimisation of house connections

During the filed trip some house connections have taken into sight.

- Most of the installed house connection pipes have diameters less than 1 inch although the length of the pipes often is considerable.
- Often the pipes are laid openly without protection. Crossing cars or other forces can damage the pipes easily

![Unprotected house connection (left) meter installation made of gs pipes and protected by iron box Kigali, Rwanda (right)]

Figure 20: Unprotected house connection (left) meter installation made of gs pipes and protected by iron box Kigali, Rwanda (right)

In order to avoid damages and illegal connections the following measures should be taken into account:

- Water meter should be located as close to the distribution line as possible and at the same time well accessible.
• To avoid damages water meter should be protected with concrete chambers or metal boxes.
• The pipe sections immediately before and after the water meter should be manufactured without any kind of fitting and preferable made from steel. This practise shall at least hinder the establishment of illegal connections.
• Standards for house installations have to be developed and practised

3.3.8 Implementation of DMA’s
After the distribution zones have been established as described in Section 3.3.3, including installation of adequate flow and pressure measurement equipment, possibilities will be studied to divide each distribution zone into several district metering areas (DMA’s). This will allow for better control of the water balance and better understanding of the NRW in each of the DMA’s. However, creating DMA’s only makes sense if it is physically possible to separate the autonomous distribution zone into two or more areas that can be separately monitored. This means again that all inflows and outflows from the DMA as well as all consumer metering data of the same DMA can be matched and monitored.

3.3.9 Installation of PRV’s
In gravity supplied distribution zones with high pressure levels during normal operation Pressure Reducing Valves (PRV’s) will be installed. The exact location of the PRV’s
will be determined through hydraulic modeling. By introducing smart PRV’s that can even further reduce the system pressures during the night NRW levels will be reduced.

M-9: On medium notice we recommend to conduct on the job training and coaching by VAG Hydraulic Modeling Experts on design, specification and implementation of PRV’s with the following activities:

- Conduct a workshop on design of PRV’s
- Training on correct specification of PRV’s
- Assistance during procurement of PRV’s
- On the job training during installation of PRV’s
- Development of work flow on water balance establishment on DMA level
- Training on work flow implementation

3.4 Long-term measures

3.4.1 Optimisation location of work and store house

The central store is located north of Castries on an old water works side. The terrain is slightly elevated yet, but nevertheless on risk to be flooded in the case of strong storm water falls. Especially the access roads cannot be used, if floodwaters occur.

On the long term a new location for the central store should be realized. It has to be considered whether two de-central stores, one in the north and one in the south of the Island, could be an option. Furthermore it is recommendable to join the central store together with the service car pool and the work shop to one organizational unit.

L-1: On long term we recommend to the location and organization of the central workshop and store house by HAMBURG WASSER experts. The following activities are proposed to be executed:

- Evaluation of the structure of the water supply systems in order to identify hot spots
- Evaluation of failure history
- Regard of emergency response plan (if available)
3.4.2 **Separation of transport and distribution**

For the effective operation of water supply systems it makes sense to completely separate transport and distribution systems. This is the only way to have a clear and separated water balance. However, in the field it often happens that consumers are supplied directly from transmission mains for various reasons.

In order to have manageable water transport and distribution systems the STA strongly recommends to strictly separating the two. It is also advised to minimise the number of direct tappings to primary and secondary distribution lines.

Only by doing so the water supply systems can be divided into isolated distribution zones and DMA’s.

After hydraulic analysis of the water supply system of the north of Saint Lucia areas with mixed supply will be identified. In these areas new transport lines will be needed in order to separate the transport and distribution lines.

---

**L-2: On long term notice we recommend to completely separate the transport and distribution lines in Saint Lucia and provide training and coaching by VAG Hydraulic Modeling Experts on design principles for transport and distribution systems with the following activities:**

- Conduct a workshop on design of transport systems
- Conduct a workshop on design of distribution systems (Looped and branched) systems and the function of reservoirs
- Conduct a workshop on design of reticulation systems
4 Summary

The paper in hand provides the reader with the results of a fact finding mission on NRW management conducted from the 27th of May to the 5th of June 2014. The mission was done by a team of international experts of the strategic alliance for water loss reduction (STA).

During the short mission the most important aspects and fields of work for successful NRW management have been assessed. A quick summary of the assessment is presented in section 2.4 on page 15.

Based on the findings a road map for NRW management was elaborated jointly with the WASCO management. This road map presents different kind of measures and activities which can be implemented on short, medium and long term and which require little, medium and higher investments. To obtain an overview please refer to Figure 10 on page 19.

All of the measures which are described in more detail in section 3 require support by the international consultants of the STA. To provide a quick overview each description ends with an info box of possible consultancy and assistance.

The concept of the STA is to always work in close cooperation with the staffs of the client. To guaranty sustainability, solutions always will be developed and practised by WASCOs own staff - with the support and guidance of the consultants.

We hope that the paper in hand will contribute to improve the NRW situation at St. Lucia and looking forward to be of service to you.
5 Regional Training Centre for Water Loss Reduction

One further aim of the STA is to further disseminate and share its practical knowledge on water loss reduction in the CARICOM region.

The first step is to invite CARICOM water utility staff to participate in the bi-annual training courses in Germany. The next training course will be held at the premises of HAMBURG WASSER between October 13th and 16th 2014. For on line registration see website: www.waterlossreduction.com

The second step would be to develop a regional training centre in Saint Lucia and to conduct a ToT programme for senior utility staff in the CARICOM region.

A further step could be to conduct on the job vocational training in Saint Lucia for staff of other CARICOM water utility staff.

The development of this regional training centre for water loss reduction needs to be further discussed between the stakeholders: WASCO, CAWASA, GIZ and the STA.

Hamburg, 23rd of June
Appendix 1: Activity Schedule
<table>
<thead>
<tr>
<th>Date</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>27. May 2014</td>
<td>▪ arrival</td>
</tr>
<tr>
<td></td>
<td>▪ meeting of the fact-finding team (Mr Kees, Mr Hoppe and Mr Kersting)</td>
</tr>
<tr>
<td></td>
<td>▪ with Mr Ignatius, MD of WASCO and Mr Sealy at WASCO together with Mr Vogel</td>
</tr>
<tr>
<td></td>
<td>▪ from GIZ</td>
</tr>
<tr>
<td>28. May 2014</td>
<td>▪ meeting with the entire management of WASCO and the fact-finding team</td>
</tr>
<tr>
<td></td>
<td>▪ (Mr Kees, Mr Hoppe, Mr Kersting and Ms. Vethaviyasar)</td>
</tr>
<tr>
<td></td>
<td>▪ introduction and clarification about further steps</td>
</tr>
<tr>
<td></td>
<td>▪ visit of the expert team to Roseau Dam and the water treatment plant in</td>
</tr>
<tr>
<td></td>
<td>▪ Cicero</td>
</tr>
<tr>
<td>29. May 2014</td>
<td>▪ Mr Kees and Ms. Vethaviyasar visited the Millet water intake</td>
</tr>
<tr>
<td></td>
<td>▪ Mr Hoppe and Mr Kersting joined the leakage detection team</td>
</tr>
<tr>
<td></td>
<td>▪ of WASCO on the field</td>
</tr>
<tr>
<td>30. May 2014</td>
<td>▪ Mr Kees and Ms. Vethaviyasar verified the existing network plans in</td>
</tr>
<tr>
<td></td>
<td>▪ WASCO</td>
</tr>
<tr>
<td></td>
<td>▪ Mr Hoppe and Mr Kersting final clarification with the leakage</td>
</tr>
<tr>
<td></td>
<td>▪ team in WASCO</td>
</tr>
<tr>
<td></td>
<td>▪ departure of Mr Kersting</td>
</tr>
<tr>
<td>31. May 2014</td>
<td>▪ Clarification of the Castries town area network structure with</td>
</tr>
<tr>
<td></td>
<td>▪ Mr Reese and Mr Sealy</td>
</tr>
<tr>
<td>01. May 2014</td>
<td>▪ Sunday off</td>
</tr>
<tr>
<td>02. June 2014</td>
<td>▪ Mr Hoppe joined Mr Grieffith, WASCO supervisor for the finding of</td>
</tr>
<tr>
<td></td>
<td>▪ damaged on pipes and the observation of repair works</td>
</tr>
<tr>
<td></td>
<td>▪ Mr Kees and Ms. Vethaviyasar clarification of the network in WASCO</td>
</tr>
<tr>
<td></td>
<td>▪ office</td>
</tr>
<tr>
<td>03. June 2014</td>
<td>▪ presentation of the results of the fact-finding study to Mr Ignatius,</td>
</tr>
<tr>
<td></td>
<td>▪ the Management and the key staffs in WASCO and discussion</td>
</tr>
<tr>
<td>04. June 2014</td>
<td>▪ press meeting at WASCO</td>
</tr>
<tr>
<td>05. June 2014</td>
<td>▪ meeting with Mr Ignatius, Mr Sealy and Mr Ali</td>
</tr>
<tr>
<td></td>
<td>▪ departure of the fact-finding team</td>
</tr>
</tbody>
</table>