



Development of a Groundwater Information & Management Program for the Lusaka Groundwater Systems

TECHNICAL NOTE NO. 2

CAPACITY BUILDING AND AWARENESS RAISING STRATEGY FOR PHASE II

(2010-2012)

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**Development of a Groundwater Information & Management
Program for the Lusaka Groundwater Systems**

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Table of Content

1	Background	1
2	Expected outputs of the project.....	4
3	Capacity Building Strategy	5
3.1	<i>Needs Assessment</i>	5
3.1.1	Department of Water Affairs	5
3.1.2	Lusaka Water and Sewerage Company and Lusaka City Council	6
3.2	<i>Recommended Training Measures</i>	7
3.2.1	Provincial level.....	7
3.2.2	District level	8
3.2.3	Water quality laboratory at Headquarters	8
3.2.4	Commercial Utility and City Council.....	8
4	Recommended Awareness Raising Activities.....	9
5	Conclusions	10
6	References	10
Annex 1	Proposed Training Module on Pumping Tests.....	11
Annex 2	Proposed Training Module on Water Quality	12
Annex 3	Proposed Training Manual for GeODin®	13
Annex 4	Tentative implementation schedule for capacity building and awareness activities.....	14

Abbreviations

BGR	Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources)
CU	Commercial Utilities
DWA	Department of Water Affairs
FNDP	Fifth National Development Plan
GIS	Geographical Information System
GReSP	Ground Water Resources for Southern Province
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
LCC	Lusaka City Council
LWSC	Lusaka Water and Sewerage Company
MEWD	Ministry of Energy and Water Development
MLGH	Ministry of Local Government and Housing
NRDC	Natural Resources Development College
UNZA	University of Zambia
WASAZA	Water and Sanitation Association of Zambia

Executive Summary

Capacity building is one of the main activities being implemented in the GReSP project. This Capacity Building and Awareness Raising Strategy for Phase II has been prepared to address the critical gaps of the partner organization and of key stakeholder institutions who are active in groundwater resource management. In order to identify these limitations and gaps in the counterpart institution Department of Water Affairs (DWA) and key stakeholders such as Lusaka City Council (LCC) and Lusaka Water and Sewerage Company (LWSC), a needs assessment was carried out. Therein, the following areas for capacity building were identified:

- Lack of sufficient capacity to carry out pumping tests and water quality sampling at the DWA provincial and district offices. In this regard the capacity development needs of the provincial offices should be given priority as the provincial officers are the key technical supporters of the district offices.
- In order to implement the national water sector development plan, specifically the groundwater sector development, adequate numbers of adequately trained drillers and drilling supervisors are needed.
- Structures and skills to document and manage groundwater data is a critical gap of the district water offices. Most of the district water offices lack trained officers, hand-held GPS devices, personal computers, and the necessary software to store and process the data.
- Lack of capacity in the DWA Water Laboratory at national level. Reliability of water quality monitoring results requires trained laboratory staff. Training is needed in basic laboratory management as well as specific analytical procedures.
- Adequate technical skills are required in LWSC for conducting and interpreting pumping tests as well as groundwater quality analysis and visualization, especially the production of thematic maps with GIS.
- LCC (Public Health Department) identified a gap in water quality monitoring and environmental health related topics, such as sanitation and its effect on groundwater quality.

Besides the training measures awareness raising activities in groundwater resource management are also mentioned in this report.

The designed plan is expected to improve the knowledge and skills with regard to groundwater management within the counterpart institution as well as stakeholders, where information for groundwater management is gathered and evaluated.

List of reports compiled by the project

Date	Authors	Title	Type	Target group
Apr 2009	Museteka L. & R. Bäumle	<i>Groundwater Chemistry of Springs and Water Supply Wells in Lusaka - Results of the sampling campaigns conducted in 2008</i>	Technical Report	DWA, Counterparts, Stakeholder
Oct 2009	R. Bäumle. & S. Kang'omba	<i>Development of a Groundwater Information & Management Program for the Lusaka Groundwater System: Desk Study and Proposed Work Program Report</i>	Technical Report	DWA, Counterparts, Stakeholder
March 2010	Hahne K.	<i>Karstification, Tectonics and Land Use in the Lusaka region</i>	Technical Report	DWA, Counterparts, Stakeholder
Oct 2010	Mayerhofer C., Shamboko-Mbale B. & R.C. Mweene	<i>Survey on Commercial Farming and Major Industries: Land Use, Groundwater Abstraction & Potential Pollution Sources-</i>	Technical Report	DWA, Counterparts, Stakeholder
Oct 2010	Tena T., Mweene R.C., & R. Bäumle	<i>GeODin Manual</i>	Manual	DWA, Counterparts to be trained (in pilot provinces and districts)
Nov 2010	Tena, T., Nick. A.	<i>Capacity Building and Awareness Raising Strategy for Phase II (2010-2012)</i>	Technical Note	DWA, Counterparts
Nov 2010	Nick, A., Museteka, L., Kringel, R.	<i>Hydrochemical Sampling of Groundwater in the Lusaka Urban Area (April/May 2010) and Preliminary Findings</i>	Technical Note	DWA, Counterparts, Stakeholder

1 Background

The project “Development of a Groundwater Information and Management Program for the Lusaka Groundwater Systems” is being implemented since January 2010 by the Department of Water Affairs (DWA) in collaboration with the Federal Institute for Geosciences and Natural Resources (BGR), Germany. The cooperation is aimed at achieving efficient and sustainable use of groundwater resources in and around Lusaka through improved groundwater management and development.

The mission of the Ministry of Energy and Water Development is to “promote sustainable development and management of energy and water resources in order to ensure the availability of quality, affordable safe water and energy and enhance national socioeconomic development” (MEWD 2009). The Department of Water Affairs is vested with the sole responsibility of developing and managing water resources. It is responsible for the provision of sufficient and reliable data on water resources availability and demand in the country to allow for effective planning, utilization and management of the resource. It is also responsible for overseeing and controlling activities of water resource development and management in order to prevent the indiscriminate tapping of water resources. The DWA has structures present at Headquarters, provinces and district level to provide the required services in water resources management and development (Bäumle & Kangomba 2009).

Capacity building measures carried out by the project will focus on enhancing skills in hydrogeological investigations, groundwater information management and hydro-chemical methods. According to a sector capacity study commissioned by the Ministry of Local Government and Housing and the Danish Ministry of Foreign Affairs (Stoltz et al. 2007), the total number of professional staff of the DWA Headquarters in 2007 was 25 of which 12 had a university degree (BSc or MSc). According to the study, the capacity gaps, both in terms of number of staff and their qualifications, are greatest at district level (very few positions at the 76 district offices were filled by 2006 (Stoltz et al. 2007)) and in the Commercial Utilities. The Lusaka Water and Sewerage Company Ltd. as the Commercial Utility is the main supplier of water and sanitation services to the City of Lusaka’s residents. In 2007, 61 (11%) out of a total number of 546 employees had a university degree while 48 (9%) had a diploma (Stoltz et al. 2007). The Lusaka City Council has the mandate to develop strategies for water and sanitation, waste management and environmental development through its City Planning Department. The LCC is also mandated to execute a yearly water quality monitoring program through its Public Health Department. According to the water sector capacity study, however, there are serious capacity limitations in terms of staff and operational tools and insufficient financial resources to carry out water quality monitoring.

It is generally accepted that the capacity for water analyses and water quality monitoring in the present situation is insufficient in Zambia. Currently there are

laboratories at UNZA, Food and Drugs, DWA and five Commercial Utilities. The study by Stoltz et al. (2007) recommends to further support local water laboratories to increase the number and qualification of staff. The study also stresses the insufficient number of hydrogeologists and drilling supervisors with sufficient geological and hydrogeological background.

In order to enhance capacities, the GReSP Project, since its launch in May 2005, has followed a two-fold strategy within the DWA. On the one hand, on-the-job training was given to the counterparts attached to the project, on the other hand, technical courses on selected topics were offered to officers at all levels (headquarters, Lusaka and Southern Province including districts) and students at School of Mines, University of Zambia (Table 1). On-the-job training basically included fields of hydrogeological field investigations (geophysical methods and pumping test analysis), water sampling, groundwater database management (specifically, GeODin[®]) and querying, cartographic principles, ESRI ArcGIS and development of hydro-geological maps, as well as compilation of technical reports. On-the-job training was offered throughout the project duration. The technical courses held by GReSP are listed below.

During the project review held during September 2009 it was concluded that considering the possibilities and limitations of capacity building within this technical cooperation project, the existing two-fold approach on-the-job training of counterparts and provision of training courses to a larger number of officers, has proved adequate and should therefore be continued and extended. It was agreed that a capacity building strategy is to be developed which results are found in this document.

Table 1 Technical courses held by GReSP from 2005 to 2009

Course Topic	Lecturer (Institution)	Participant's Institution	Date (Duration)
Working with GeODin groundwater database	T. Fyfe (Fugro)	Headquarters, Lusaka Province, Southern Province	11/2005 (1 week)
Introduction into ESRI ArcGIS, Part 1	K. Kelly (Kelly & Kelly)	Headquarters, Lusaka Province	03/2006 (1 week)
Map projections with practical applications in ArcGIS	U. Philipp (BGR)	Headquarters, Lusaka Province,	04/2006 (1 week)
Introduction into ESRI ArcGIS, Part 2	A. Banda (MoL/ Kelly & Kelly)	Headquarters, Lusaka Province	04/2006 (2 days)

Course Topic	Lecturer (Institution)	Participant's Institution	Date (Duration)
Querying databases in GeODin, ArcMap and MS Access	R. Bäumle (BGR)	Headquarters	11/2006 (2 days)
Introduction to geophysical field methods and pumping test analysis	F. Schildknecht & R. Bäumle (BGR)	Headquarters, District Officers, UNZA	11/2007 (2 weeks)
Principles in hydrogeology, water sampling and geophysics	R. Bäumle (BGR) & J. Nkhoma (DWA)	DWA and GAUFF Eng., Eastern Province	01/2009 (1 week)

In general, BGR offers a wide range of topics in which training measures can be conducted. Depending on demand the most suitable fields for training include:

- Basic hydrogeology and groundwater inspection
- Working with a groundwater database
- Aquifer mapping, groundwater contouring
- Geochemistry, water quality assessment, groundwater sampling
- Basics of isotope hydrology
- Introduction to groundwater vulnerability assessments
- Principles of cartography and GIS
- Hydrometric principles (introduction in field measurements)
- Introduction to remote sensing techniques
- Basics of soil science

2 Expected outputs of the project

During a planning workshop held in April 2008, the Ministry of Energy and Water Development (MEWD) together with all relevant stakeholders in the sector developed a proposal of the extension of the project after its first phase. Therein, six outputs were mentioned which were reconfirmed by the project evaluation in September 2009 as contributions towards the overarching development results defined by Zambia's Vision 2030 and the FNDP. The outputs identified during the planning process read as follows:

- 1) A groundwater information system is established and regularly updated.
- 2) The amount of groundwater that can be safely abstracted is quantified.
- 3) The quality of groundwater and its vulnerability to pollution is known.

- 4) Capacity building interventions focusing on critical skills development related to groundwater management are implemented.
- 5) Groundwater Advocacy, Awareness building in sustainable management of groundwater
- 6) A groundwater protection and management strategy is developed and the process of its implementation initiated.

In order to accomplish the aim of the project various activities are carried out in the program. Capacity building is one of the main activities being implemented in the project focusing at sustainable groundwater information and management. It is expected to further improve the knowledge and skills with regards to groundwater management within the counterpart institution as well as in other partner institutions, where information for groundwater management is gathered and evaluated.

The DWA with support of the project makes efforts to strengthen the links between the CUs, NGOs operating regionally in the water sector and DWA district offices as well as DWA headquarters. Nevertheless, harmonization efforts need to be continued. This aims at an improved quality of the hydrogeological data collected as well as at an automatization and harmonization of the collection and transfer of data. In summary, it is important to facilitate a continuous update of the established groundwater information system.

3 Capacity Building Strategy

3.1 Needs Assessment

3.1.1 Department of Water Affairs

The needs assessment has been carried out during the first half of 2010 through discussion with relevant section heads in the DWA and a review of previous studies in the water sector. The Sector Capacity Study performed in 2007 by Stoltz et al. indicated the lack of required number of hydrogeologists and drilling supervisors with sufficient geological and hydrogeological background, which is likely to affect the development of the water sector. Similarly, this needs assessment identified critical gaps, especially at district and provincial level. The identified capacity needs are listed below:

- Lack of sufficient capacity to carry out pumping tests and water quality analysis at Provincial and District offices. In this regard the capacity development needs of the Provincial Offices should be given priority as the provincial officers are the key technical supporters of the District Offices.
- Lack of trained drillers and drilling supervisors. In order to implement the national water sector development plan, specifically the groundwater sector

development, adequate numbers of trained drillers and supervisors are needed. Besides the existing drillers in DWA, private drilling companies and other institutions have insufficient technical skills in basic borehole construction, exploration and groundwater investigation and sampling techniques.

- Lack of structures and skills to document and manage groundwater data is a critical gap of the district water offices. Most of the district water offices lack trained officers, Personal Computers, hand-held GPS devices and the necessary software to store and process the data.
- Lack of capacity in the DWA Water Laboratory at headquarters. The protection of groundwater resources depends on the reliability of water quality monitoring results. It is therefore crucial for the resource management that laboratory staff is trained in basic laboratory management as well as specific analytical procedures.

3.1.2 Lusaka Water and Sewerage Company (LWSC) and Lusaka City Council (LCC)

To identify the capacity gaps of two important stakeholders of the project a needs assessment was also carried out in Lusaka Water and Sewerage Company (LWSC) and Lusaka City Council (LCC). Interview partners were the directors of the relevant departments in both institutions, namely the Department of Engineering at LWSC and the Department of Public Health at LCC. Based on the discussions the following critical capacity needs have been identified and agreed upon:

LWSC

At the Commercial Utility for Lusaka City the assessment identified a lack of adequate technical skill (specifically for junior staff) in conducting and interpreting pumping tests as well as groundwater quality analysis and visualization, especially production of thematic maps with GIS. Furthermore insufficient capacity to monitor groundwater in both quality and quantity remains a challenge (data collection, analysis and interpretation of the information from monitoring wells).

LCC

The groundwater related capacity needs of the Public Health Department in LCC were identified mainly for water quality monitoring and environmental health related topics, such as sanitation and its effect on groundwater quality. The need for training was especially mentioned regarding junior environmental health officers in the areas of water and sanitation and water quality monitoring.

As a further step including all three institutions, a harmonization of the groundwater monitoring programs from DWA, LCC and LWSC should be targeted.

3.2 Recommended Training Measures

Based on the needs assessment and according to the project's capacity to carry out training measures, areas for involvement have been identified as listed below. Although other courses may be of equal importance, a selection needed to be done according to the thematic focus of the project as well as the financial framework. In its initial work program the project commits to undertake two trainings per year, equal to approximately three weeks per year. The actual design and further refinement of these trainings depend on further input from the DWA, partly also regarding co-financing.

Training modules

The project has developed two modules on performing and evaluating pumping tests and on water quality sampling and analysis. Their contents are summarized in Annex 1 and Annex 2. These modules can be held as stand-alone courses for any target group with basic geo-scientific knowledge (for example provincial or district water officers or commercial utility staff) or they can be included in larger trainings or even certificate courses, e.g. at University of Zambia (UNZA) or the Natural Resources Development College (NRDC).

3.2.1 Provincial level

A number of trainings mainly for provincial officers involving the above mentioned modules had been planned by the Department of Water Affairs in cooperation with the project for the second half of 2010. While the original plan of the project targeted only representatives from the pilot areas (Lusaka and Southern Province), DWA showed interest and the ability to co-finance the training program in order to incorporate all provinces and broaden the content of the courses. Due to insecurities regarding the co-financing by DWA the trainings have been rescheduled to an undefined date.

The trainings comprise a two-week course for water engineers/officers from DWA provincial offices as well as staff of the Ministry for Local Government and Housing (MLGH), and a one-week course on groundwater data management with the database GeODin[®] with hydro-informatics officers as the main target group. It was discussed to extend this training measure to an eight-week certificate course for government officials, drillers and drilling supervisors offered by UNZA in which the modules prepared by the project were to be included. If and when all or part of these training measures can take place is still subject to discussions. The courses are considered an indispensable measure to strengthen the capacities in the decentralized structure of the two line ministries in the water sector and are therefore key to the rural water supply structures.

In future, beyond the project's current duration, the certificate course at UNZA could be established as a regular training for both the ministries (and their offices in the provinces and districts) and the private drilling sector, and could serve as a means for certification of drillers.

3.2.2 District level

According to the needs assessment, capacity gaps at district water offices are most challenging. Thus, training of the District Water Officers (under DWA) in the pilot areas of the project, namely Southern and Lusaka Province, should be given priority. The aim is to train relevant officers at district level (such as engineering assistants from both DWA and MLGH) in collecting and documenting field data, including GPS measurements with hand-held devices, groundwater data management using the groundwater database GeODin[®], and standardizing the data capturing in the process of hydrogeological field investigation. For this training a GeODin[®] manual was established which can be used in future trainings. Its content can be found in Annex 3.

Jointly with the training, personal computers and hand-held GPS devices are provided to the 15 DWA district offices by the project. While the training is offered to staff from all interested institutions (mainly DWA and the councils under MLGH) the equipment will be under the responsibility of DWA. In order to secure the sustainable use of the equipment, it is recommended that DWA Headquarters develops a concept for its management, maintenance and correct use. This could involve senior staff members of the respective Provincial Water Offices.

The trained water officers are expected to improve and strengthen the capacity of the district offices in groundwater data management (collection and processing). Thereby more reliable data will contribute to a better groundwater monitoring and provide sound information to stakeholders.

3.2.3 Water quality laboratory at Headquarters

The improvement of the water quality analysis capacity of the DWA Water Laboratory remains a challenge which is crucial for the reliability of monitoring results. The project should look into options to further strengthen the laboratory capacity in terms of qualification of staff in basic laboratory management as well as specific analytical procedures.

3.2.4 Commercial Utility and City Council

The success of the project relies very much on the use of its products by the relevant institutions, in this case Lusaka Water and Sewerage Company as the Commercial Utility and the city planning body, Lusaka City Council. It is therefore recommended that the capacity building activities of the project are extended onto these two institutions. This will ensure a sound understanding of the products, e.g. guidelines, groundwater model and management plan, and enable the institutions to integrate them into their planning. According to the needs identified with the heads of LWSC Engineering Department and LCC Public Health Department the focal areas for trainings were identified as

- Groundwater resource management with special focus on groundwater monitoring in both quantity and quality (data collection, analysis and

interpretation, as well as visualization, especially production of thematic maps with GIS)

- Groundwater protection in regard to sanitation

The proposed one-week training course with LWSC can comprise a condensed version of the two existing training modules combined with training in GIS. The measure is expected to improve the efficiency of the company in the sustainable use and management of groundwater resources in Lusaka as LWSC takes 58% of Lusaka's public drinking water supply from the ground. Thus, the trained staff is expected to strengthen the capacity of the company in data interpretation and visualization such as the preparation of thematic maps.

The identified capacity needs of LCC will also be the topic of the first awareness raising workshop (see next chapter) in which LCC representatives will be participating. It is therefore recommended to further discuss the need for training at LCC after the workshop.

4 Recommended Awareness Raising Activities

Besides the training measures, specific activities are to be conducted in order to raise awareness on groundwater issues and to enhance the information exchange between different stakeholders and the project. It is proposed to carry out the following activities:

- Technical Forum meetings: A Technical Forum was established consisting of the stakeholder institutions relevant to the project. It will meet quarterly to discuss relevant technical topics as well as to disseminate information and products produced in the project.
- Workshop on Groundwater Protection and Sanitation: In cooperation with gtz and the Water and Sanitation Association of Zambia (WASAZA) an interactive workshop will be conducted in 2011 to establish a strategy for the improvement of the sanitation situation and thereby contributing to groundwater protection. Participants will be asked to develop a list of tasks which need to be tackled for an improved land-use planning and management including interdisciplinary strategies in defined case study areas in Lusaka. The workshop will foster an improved awareness and understanding of the link between sanitation and groundwater.
- For 2012, a workshop is planned in which guidelines for groundwater management produced by the project are communicated to a wider range of stakeholders.

The tentative implementation schedule for capacity building and awareness activities is found in Annex 4.

5 Conclusions

The capacity building and awareness raising measures elaborated in this technical note are expected to contribute largely to output 4 (Capacity building measures focusing on critical skills development related to groundwater management are implemented) and partly output 6 (Relevant planning authorities are advised in the use of data for the implementation of sustainable groundwater management plans). The implementation of these measures is expected to be beneficial as it strengthens the use of outputs by the stakeholders of the project.

6 References

- (1) Bäumle R. & S. Kang'omba (2009): Development of a Groundwater Information & Management Program for the Lusaka Groundwater Systems, Report No. 2, Desk Study & Proposed Work Program Report.- Ministry of Energy and Water Development - Department of Water Affairs and Federal Institute for Geosciences and Natural Resources; 101 pages; Lusaka.
- (2) Stoltz H., Jørgensen, M., Mutale M., Zulu, A., Sijuma R., & W.K. Lumba (2007): Sector Capacity Study Water and Sanitation.- Government of Republic of Zambia, Ministry of Local Government and Housing & Ministry of Foreign Affairs, Denmark, Royal Danish Embassy, Lusaka; Final Report (unpublished) Oct. 2007.; 113 pages; Lusaka.

Annex 1 Proposed Training Module on Pumping Tests

Principles of Groundwater Flow

- Pumping Test Terminology
- Groundwater Flow Regimes

Types of Hydraulic Tests

- Slug Tests
- Well Performance Test (Step Drawdown Test)
- Aquifer Test (Constant-Discharge Tests)
- Injection Test

Pumping Test Equipment

- Pump Types
 - Positive Displacement pumps
 - Dynamic (or “velocity”) pumps
 - Other pumps
- Methods of measuring discharge rates
 - Volumetric measurement
 - Weirs
 - Other devices for flow measurements
- Instruments to measure groundwater levels
 - Water level dippers
 - Float-operated chart devices
 - Pressure transducers
 - Measuring artesian pressures

Practical Aspects of Designing a Hydraulic Test

- Basic principles of fluid flow
- Hydraulic scaling of a pump system
 - Dimensioning of pumps
 - Dimensioning of pipes
- Common errors in designing hydraulic tests
- Test Preparation
- Test Design

Step Test Analysis

- Wellbore Skin
- Well Loss Equation
- Well Efficiency
- Solutions for Step Test Analysis
 - Graphical analysis
 - Analytical solutions

Aquifer Test Analysis

Annex 2 Proposed Training Module on Water Quality

Water quality sampling

- Introduction to water chemistry
- Field parameters
- Preparations for sampling
- Sampling sheet / field protocol
- Exercise: Calibration of probes
- Field work: In-situ-measurements and sampling procedure
- Exercise: Bacteriological test
- Data filing, analysis and storage
- Overview on possible measuring results

Water quality analysis

- Groundwater pollution and pollutant transport
- Groundwater monitoring
- Zambian drinking water quality standards
- Exercise: Reliability check of analysis data
- Presentation of results
- Water quality data interpretation

Annex 3 Proposed Training Manual for GeODin®

Part 1 GeODin

- Introduction
- The GeODin Help Function
- First Steps in GeODin
 - Starting the program and open an existing database
- Creating a new database
- Viewing and editing water point information
- Layer Data
- Well Design Data
- Measurement Data
- Document Management
- Visualising data: Page Layouts
- Advanced Options
- Glossary

PART 2 GPS & Coordinate Systems

- Geographic Coordinate System
 - Geographic Latitude and longitude
 - The Universal Transverse Mercator (UTM)
 - Converting Between Decimal Degrees and Degrees, Minutes and Seconds
- Degrees, Minutes and Seconds to Distance
- Handling the GPS
 - Settings
 - GPS Error
 - Using GPS
- Data Management

Annex 4 Tentative implementation schedule for capacity building and awareness activities

S/N	Description of activity	Quantity	Duration	Implementation period			Remark
				2010	2011	2012	
Capacity Building							
1	Training for District officers from DWA and MLGH in groundwater data management, specifically groundwater data base (GeODin)	15	6+2 weeks	Southern Province	Lusaka Province		
2	Training modules on pumping test analysis and water quality analysis for DWA provincial staff	15 (or more?)	2 weeks in a bigger framework				Depending on potential co-financing institutions
3.1	LWSC production engineers and GIS experts	5	1 week				
3.2	LCC Environmental Health Officers	2	3 days				
4	Training for DWA laboratory staff	5					On the job training
Awareness Raising							
1	Technical Forum Meeting	1+4+4	1 day				1 st Meeting held Sep.2010
2	Workshop on Groundwater protection and sanitation to create awareness and advocate for groundwater protection	30	3-4 days				
3	Workshop to advocate for groundwater management and protection guidelines	30	3 days				