Development and Deployment of the Nile Basin Decision Support System

Inception Report

Nile Basin Initiative
Shared Vision Programme
Water Resources Planning and Management Project

Inception Report
December 2009

Development and Deployment of the Nile Basin Decision Support System

Agern Allé 5
DK-2970 Hørsholm
Denmark

Tel: +45 4516 9200
Fax: +45 4516 9292
dhi@dhigroup.com
www.dhigroup.com

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Client	Client's representative
Nile Basin Initiative	Dr. Abdulkarim H. Seid, Regional DSS Lead-Specialist

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Authors Henrik R.Sørensen Lars Christian Ekebjærg Lars Michael Jens Kristian Lørup Anders Klinging Mark Woodbury Larry Brazil	Date December 2009 Approved by

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0.1 Background

The Nile River at the Bujagali Falls, Uganda.The Bujagali Falls are located about 10 km downstream of the Owen Falls at Lake Victoria. A hydropower plant is being constructed near the Bujagali Falls. (Photo: J.K.Lørup, 2006)

The Nile Basin is a highly complex area and faces raising water scarcity, high poverty levels, high population growth rates, watershed degradation and loss of environmental services. In realization of the urgent need for economic development and improvement of environmental protection efforts, there has during the last decade been a strong concerted effort to improve inter basin relations and cooperation. The Nile Basin Initiative (NBI) is central in these efforts to achieve sustainable socio-economic-environmental development. The Nile River is the artery and proper management of Nile water resource is fundamental to sustainable development within the basin. Due to the many and varied water use requirements intertwined with upstream-downstream issues there is a pronounced need to address water resources management from a national as well as from a basin-wide perspective. Potential future changes in water quantity and quality, water levels and flows, their distribution in time and space will have important impacts on local and basin wide economies and environment. To address these and many other pertinent issues it will be important to firmly establish transparent and commonly agreed upon tools and procedures. Such tools can be applied to support decisions and to form basis for dialogues on development programs and projects – regionally and locally. The Nile Basin DSS (NB DSS) will constitute such a tool.

0.2 Objectives

The primary objective of the NB DSS, as formulated in the TOR, is "…to serve as a shared knowledge base, provide analytical capacity, and support stakeholder interaction, for cooperative planning and management decision making for the Nile River Basin… As such the NB DSS is expected to be an "agreed upon tool that will be accepted and used by all riparians in the management of the shared Nile water resources".

The objective of Work Package 1 (this project) is to develop and adapt, test and deploy the software for an integrated NB DSS, consisting of the water resources modelling system (main dynamic water budget, water resources management and allocation model, core process models), the information system (IMS) and MCA decision support tools. It includes software related documentation, calibration, training, final deployment and continuing user support.

The NB DSS will assist WRPM, sub-regional and National DSS Units in addressing the following priority concerns:

- Water Resources Development
- Optimal Water resources utilization
- Coping with floods
- Coping with droughts
- Energy development (hydropower)

Irrigated Land in the Nile Delta, Egypt. (Photo: J.K.Lørup, 2009)

- Rain fed and irrigated agriculture
- Watershed and sediment management, and
- Navigation

Climate change impacts and water quality issues are defined as cross-cutting issues and shall be considered across all 8 priority areas of concern.

0.3 Project Framework

This project "Development and Deployment of the Nile Basin DSS" is undertaken by the Nile Basin Initiative (NBI) - Water Resources Planning and Management Project (the Client). The project is funded through the World Bank.

The Nile Basin DSS shall be developed in 3 Work Packages:

- Work Package 1 (WP1): development and implementation of the software system
- Work Package 2 (WP2): data compilation, system testing and pilot applications
- Work Package 3 (WP3): supervision and monitoring to coordinate and synchronize WP1 and WP2

This project constitutes WP1. The project started on 15th may 2009 and is scheduled for completion within 36 months (i.e. 15th May 2012).

The project is carried out by a Consultant Team that consists of DHI Denmark (lead partner) in association with Riverside Technologies Inc (USA), Mott MacDonald Ltd (UK), and Tropics Engineering (Ethiopia).

The Project Management Unit (PMU) of the Water Resources planning and management project representing the Nile Basin Initiative is the Client for development of the

Nile Basin DSS. The PMU has established a team of riparian experts, the DSS core team, involving:

- Regional DSS Lead Specialist, Water Resources Modeler, Software Developer, and technical support staff at the Regional DSS center (at the PMU in Addis Ababa).
- National DSS Specialists, national IT/GIS/Database experts at the national DSS units, in all NBI countries.
- National counterpart staff; two per country in the respective NBI national focal point institutions.

The DSS Core Team will be involved in the development of the Nile Basin throughout the project.

0.4 The Inception Phase and the Inception Report

The primary focus of the Inception phase has been to elaborate the DSS requirements specified in the ToR; develop the overall system architecture and refining the Project Implementation Plan. The main deliverables are:

- Launching workshop (conducted in Addis Ababa, May 2009)
- Web based systematic issue tracking system developed and implemented (the SpiraTeam system implemented at DHI).
- Inception Report (this report) including the following main sections:
    - Software Requirement Specification (Inception Report, Appendix C)
    - Software Architecture Document (Inception Report, Appendix D)
    - Revised Project Implementation Plan (Inception Report, Chapter 7)
    - Data Requirements Document (Inception Report, Chapter 6 and Appendix E)
- Inception Workshop (conducted in Alexandria, August 2009).

Further, the Inception Report contains:

- Appendix A Project Handbook, which describes the software development procedures that will be employed by the Consultant
- Appendix B Use Cases, which includes all use cases that has been used for the requirement analysis, and

- Appendix F Feature Release Plan, which includes an NB DSS release plan with associated feature set.

- Appendix G SpiraTeam Release Report, which contains an autogenerated release report for development cycle 1.

0.5 Summary of Activities during the Inception Phase

The key activities during the Inception phase have been:

Launching workshop in Addis Ababa (May 2009) where Consultant staff worked with Client staff for 3 weeks to elaborate the software requirements specified in the ToR. During the launching workshop a number Nile Basin use cases were developed which has later been used for a detailed use case analysis (Inception Report, Appendix B).

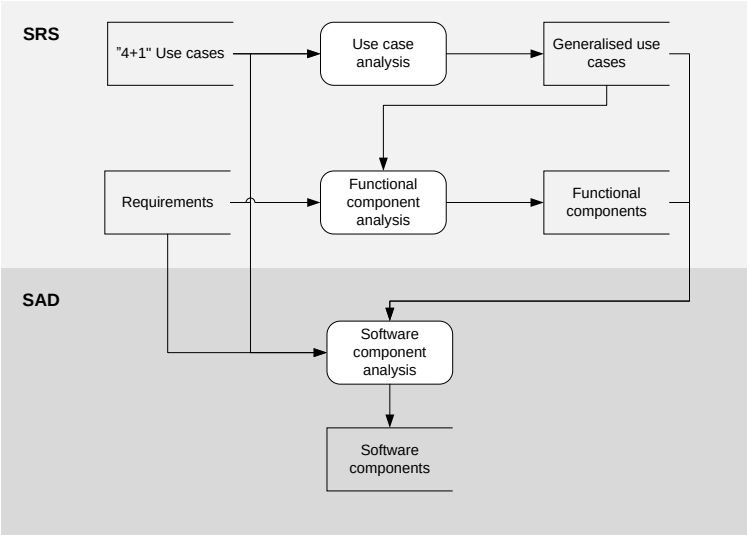
Inception Workshop (August 2009) in Alexandria followed by work sessions with the Client in Cairo. During the Inception workshop the deliverables of the Inception Phase were presented and discussed and the Consultant received formal feedback and recommendations regarding completion of the Inception Report.

Completion of the Inception Report including the very important technical annexes; the Software Requirement Specification (SRS) and the Software Architecture Document (SAD). The recommendations from the Inception Workshop led to substantial enhancement of the Final Inception Report. In particular, the Software Requirement Specification (SRS) and the Software Architecture Document (SAD) were enhanced. In continuation of the workshop in Alexandria the Client and the Consultant agreed on a report enhancement plan and a resubmission schedule for the Inception Report.

The Final Inception Report (this report) was submitted on 2nd December 2009. The Completion of the Inception phase has been more than 4 months delayed as compared to the TOR, where the Inception phase is scheduled for 3 months.

0.6 Software Requirements and Software Architecture

Key outputs of the Inception phase are the elaborated software requirements and the software architecture document. These constitute Appendix C and Appendix D of the Inception Report, respectively. Together these documents form the basis for the more detailed analysis and design that will take place during the NB DSS development phase. Most of the effort invested in the Inception Phase has been related to these two important documents.



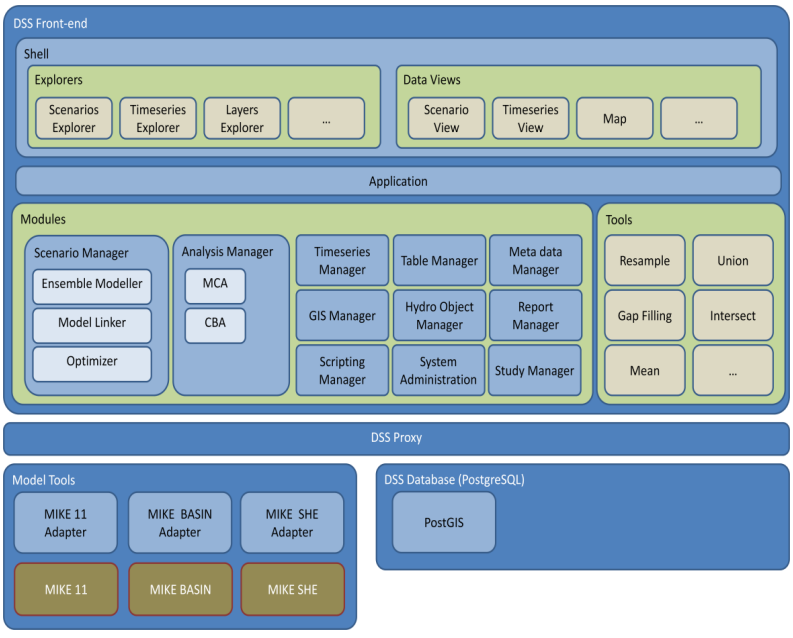
The "4+1" use cases and the functional and non-functional requirements identified in the TOR has been used to identify functional components. These functional components have then been translated into software components. As such the software components that make the NB DSS are established based on the NBI's requirements.

The TOR lists a number of functional and non-functional requirements. These requirements have been further elaborated through a use case analysis. During the launching workshop 19 use cases were developed. For practical purposes these were subsequently synthesised to the so-called "4+1" use cases which have been the basis for the use case analysis which is presented in the SRS (Appendix C). The key objective of this use case analysis was to understand the NBI business processes (represented by the use cases) and ensure that these are supported by NB DSS. As such the use cases and the requirements specified in the ToR have informed the architecture and design of the NB DSS. The Software Architecture Document is a key output of the Inception phase and will form the basis for the detailed requirement analysis and design which will then become the starting point the implementation (coding) of the NB DSS.

This SAD presents the NB DSS software architecture from four viewpoints.

The *Logical Viewpoint*, which is a logical representation of the key components within the software system and their interactions. It provides overview only and does not describe the presented components in more detail.

The *System Use Viewpoint*, which addresses the system from an end-user point of view. This viewpoint responds to the questions: How will



The Software Architecture Document has established a number of Software Components that will constitute the NB DSS. These software components will be further detailed during the detailed requirement analysis and design phases of three project cycles.

the interaction with the system be?, how can it be integrated with other systems? – or new systems? – within an organization?

The *Implementation Viewpoint*, which addresses the system from a software developer point of view. It responds to questions like: What technologies are used?, what applications tiers exist?, what client-server model is being used etc.?

The *Infrastructure Viewpoint*, which defines the way the actual software programs (processes) are instantiated and deployed on the physical hardware and how the processes communicate with each other.

0.7 Modeling in WP1

Some modelling activities will take place in WP1. The key objective of the modelling in WP1 will be "Proof of Concept" to test and demonstrate the functionality of the NB DSS to the client at each release of the system. More detailed modelling, data compilation and system testing will take place in WP2.

Murchison Falls. At the top of the falls, the Nile forces its way through a seven metre gap in the rocks and tumbles 43 metres down, then flows westward into Lake Albert (Photo: J.K.Lørup, July 2006)

The envisaged WP1 modelling activities are described in Chapter 6 of the Inception Report and in Appendix E. The WP1 modelling will focus on the more integrated use of the NB DSS. The testing will ensure that the different software components interact as intended and that the various typical user interactions and use cases are well supported by the NB DSS.

As part of WP1 a data requirement document has also been established (Appendix E) this document will be used by to guide the data collection in support of the WP1 modelling activities and the more comprehensive WP2 modelling.

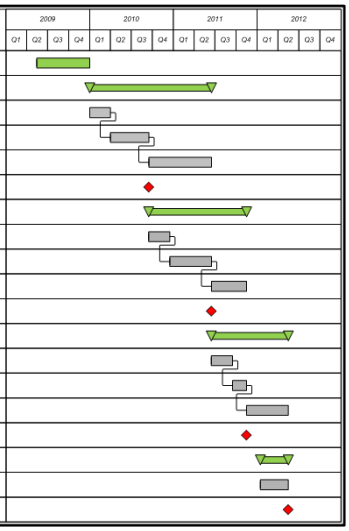
The following cases will be used for the WP1 modelling activities:

- A coarse model of the entire Nile which will cover the most significant basin features and which will serve as a framework model for more geographically detailed studies.
- Modelling in the Lake Victoria Basin with the focus of testing the NB DSS process models such as rainfall runoff modelling and soil erosion modelling.
- Modeling in the Blue Nile basin focusing on multi-criteria-analysis testing.

0.8 Project Implementation Plan

The project is sub-divided into five phases. The inception phase, followed by three software release cycles and a consolidation phase. Each software release cycle is further subdivided into a detailed requirement analysis and design phase, a system development phase and a testing and feedback phase. At the end of the system development phase an NB DSS release will be available for the testing and feedback phase (WP2). The final version of the NB DSS will be supplied with NB DSS release 3 (15th November 2011). This release is followed by a consoliation phase that includes system deployment and end user training. The latter will take place in each of the nine NBI countries.

ID	Activity Name	Project Month	Approx. Start	Approx. Finish
1	**Inception Phase**	**1-8**	15-05-2009	31-12-2009
2	**Cycle 1 – DSS Release 1**	**8-25**	**01-01-2010**	**15-06-2011**
3	Detailed requirement analysis and design	8-11	01-01-2010	31-03-2010
4	System development	11-16	01-04-2010	15-09-2010
5	Testing and Feedback	17-25	16-09-2010	15-06-2011
6	NB DSS Release 1	16	15-09-2010	15-09-2010
7	**Cycle 2 – DSS Release 2**	**16-30**	**15-09-2010**	**15-11-2011**
8	Detailed requirement analysis and design	16-19	15-09-2010	15-12-2010
9	System development	20-25	16-12-2010	15-06-2011
10	Testing and Feedback	26-30	16-06-2011	15-11-2011
11	NB DSS Release 2	25	15-06-2011	15-06-2011
12	**Cycle 3 – DSS Release 3**	**25-36**	**15-06-2011**	**15-05-2012**
13	Detailed requirement analysis and design	26-28	15-06-2011	15-09-2011
14	System development	29-30	16-09-2011	15-11-2011
15	Testing and Feedback	31-36	16-11-2011	15-05-2012
16	NB DSS Release 3	30	15-11-2011	15-11-2011
17	**Consolidation**	**33-36**	**15-01-2012**	**15-05-2012**
18	System Completion, Deployment and user training	33-36	15-01-2012	15-05-2012
19	Project Conclusion	36	15-05-2012	15-05-2012



The Project Includes three main development cycles each resulting in a DSS release. The first NB DSS release is scheduled for 15th September 2010.

It is anticipated that cycle 1 will commence on 1st January 2010. Immediately after the approval of the Inception phase Client and Consultant staff will discuss and agree in details, with due consideration of the ToR, on the scope for the detailed requirement analysis and design including:

- Approach and methodology to be used
- Type of documentation (level of details, technical diagrams) to be presented to the Client
- A detailed annotated table of contents for the Detailed Requirement Analysis and Design Document to be submitted (draft) two months after entering cycle 1 (i.e. scheduled for 1st March 2010).

Subsequently, Client and Consultant staff will work together in Addis Ababa on detailed requirement analysis and design.

1 INTRODUCTION

This Inception Report constitutes the main deliverable of the Inception Phase. The report summarizes the activities and findings of the Inception Phase and contains plans for the upcoming project activities.

Among the key deliverables are the Software Requirement Specification (SRS) which elaborates the software requirements specified in the TOR and the Software Architecture Document (SAD) which establishes the software architecture of the NB DSS.

1.1 Project Background

The Nile Basin is a highly complex area and faces raising water scarcity, high poverty levels, high population growth rates, watershed degradation and loss of environmental services. In realization of the urgent need for economic development and improvement of environmental protection efforts, there has during the last decade been a strong concerted effort to improve inter basin relations and cooperation. The Nile Basin Initiative (NBI) is central in these efforts to achieve sustainable socio-economic-environmental development. The Nile River is the artery and proper management of Nile water resource is fundamental to sustainable development within the basin. Due to the many and varied water use requirements intertwined with upstream-downstream issues there is a pronounced need to address water resources management from a national as well as from a basin-wide perspective. Potential future changes in water quantity and quality, water levels and flows, their distribution in time and space will have important impacts on local and basin wide economies and environment. To address these and many other pertinent issues it will be important to firmly establish transparent and commonly agreed upon tools and procedures. Such tools can be applied to support decisions and to form basis for dialogues on development programs and projects – regionally and locally. The NB DSS will constitute such a tool.

The Nile River at the Bujagali Falls, Uganda.The Bujagali Falls are located about 10 km downstream of the Owen Falls at Lake Victoria. A 200 MW Hydropower plant is being constructed near the Bujagali Falls. (Photo: J.K.Lørup, 2006)

1.1.1 Institutional Context

The following institutional levels are directly relevant for development and implementation of the NB DSS:

a) Regional level with the Regional Nile Basin DSS Centre at the WRPM Project Management Unit (PMU), which has the responsibility for providing the technical core team and modeling tools to support transboundary water management. The Regional center shall also be responsible for continuous maintenance, further development, user training and operational use of the DSS from basin-wide perspectives.

b) Sub-regional level: the Eastern Nile Technical Regional Office (ENTRO) and the Nile Equatorial Lakes Subsidiary Action Program Coordination Unit (NELSAP-CU) shall be engaged in the DSS development throughout the consultancy.

c) National level (9 riparian countries) within the already established National DSS Units, which are being engaged in DSS development and will be responsible for the operational use of the DSS at the national level for planning and management of cooperative projects, as well as for collating and analyzing technical, environmental and economic information / data. The National DSS Units, including National DSS Specialists and riparian experts, also facilitate the use of the DSS in the planning and management of cooperative projects. In addition there are DSS Counterpart Staff in all member countries, whose offices are generally situated in the line Ministry for Water Resources Management.

Irrigated Land in the Nile Delta, Egypt. (Photo: J.K.Lørup, 2009)

1.1.2 Objective of Services

The primary objective of the NB DSS, as formulated in the ToR, is "…to serve as a shared knowledge base, provide analytical capacity, and support stakeholder interaction, for cooperative planning and management decision making for the Nile River Basin… As such the Nile Basin DSS is expected to be an "agreed upon tool that will be accepted and used by all riparians in the management of the shared Nile water resources".

The situation assessment and stakeholder consultations confirmed that the range of requirements for such a tool proved to be complex. As a result, to be realistic, the NB DSS development will have to evolve gradually over time in an adaptive, phased approach. The immediate target of the first DSS development exercise shall then be "an operational water balance and allocation model, linked to a set of core models relevant to the priority areas of concern in the Nile Basin, and integrated with an information system and decision support tools for multi-criteria analysis (MCA)".

The objective of Work Package 1 (this project) is to develop and adapt, test and deploy the software for an integrated NB DSS, consisting of the water resources modelling system (main dynamic water budget, water resources management and allocation model, core process models), the information system (IMS) and as well as MCA decision support tools. It includes software related documentation, calibration, training, final deployment and continuing user support.

The NB DSS will assist WRPM, sub-regional and National DSS Units in addressing the following priority concerns as listed in the TOR:

- Water Resources Development
- Optimal Water resources utilization
- Coping with floods
- Coping with droughts
- Energy development (hydropower)
- rain fed and irrigated agriculture
- watershed and sediment management, and
- navigation

Climate change impacts and water quality issues are defined as cross-cutting issues and shall be considered across all 8 priority areas of concern.

1.1.3 Existing Software Systems at the Consultant

The Consultant will develop the NB DSS on the basis of a large number of well proven components that currently reside in standardised DHI software products. These products comprise:

- FloodWatch, for real-time flood forecasting and early warning systems
- Temporal Analyst for management and processing of spatial and temporal data
- MIKE BASIN for water allocation modelling and hydrologic modelling
- MIKE11 for hydraulic modelling

As part of the NB DSS software development activities a major part of these systems will be reengineered and brought into a new modern technology platform. In particular a large number of functional components that currently reside in FloodWatch and Temporal Analyst will be adapted and isolated as self-contained objects. The MIKE BASIN and MIKE11 models are specialised modelling systems that come with user interfaces and modelling tools. These systems are developed and maintained by DHI Software Products and marketed as part of the *MIKE by DHI* software systems. The NB DSS will interface the standardised software products in a user friendly manner, however, still maintaining them as stand-alone software products. Following the completion of the

project, the NBI shall enter a standard software license agreement with DHI (Appendix I) and maintenance and support agreement that will ensure technology upgrades for 11 years.

In addition to the standardised products listed above, a number of more in-house tools are also available. Some examples that may be relevant in a NB DSS context include:

- The MIKE Objects library for manipulating time-series data
- A library for parameter optimisation (DHI.Optimisation)
- The DashBoard Manager for producing web pages e.g. for providing access to certain NB DSS data or reports.

The reengineered DSS platform will constitute a generic DHI DSS Platform that will serve different clients. The DSS platform will be customisable and may contain different functional components for different clients. The NBI has spent a long time and many resources in defining the NB DSS requirements. Similarly, DHI has spent a long time and many resources and experiences in defining DHI's vision for a DSS Platform. Together, NBI and DHI form a strong partnership with a compatible vision.

The NB DSS is a customised DSS for the NBI but will build on a generalised DSS platform which will be continuously developed and maintained and thereby ensure long term sustainability and expandability of the NB DSS.

1.2 Purpose and Contents of Report

The primary purpose of the Inception phase is to elaborate the NB DSS requirements based on the functional and non-functional requirements given by the TOR and the development of the overall system design (system architecture).

The Purpose of the Inception Report is to document the findings of the Inception phase and to formulate plans for the upcoming project development cycles.

The Inception report covers the work undertaken since the start of the project in May 2009 which includes:

- Conduct launching workshop
- Refine Project Implementation Plan
- Prepare data requirements (for WP1 and WP2 modelling).
- Provide overall system requirements analysis and elaboration of the preliminary DSS user requirements.

In addition the Consultant has:

- Established the Project Handbook in accordance with the agreed process improvement plan.

- Joined the launching workshop in Addis Ababa and conducted a number of subsequent work sessions with the NBI DSS Core Team and the Project Management Unit (PMU).

- Established a new issue management system (SpiraTeam).

The Inception Report is structured with a relatively brief Main Report and a number of more elaborate Appendices.

The main report contains 7 chapters as follows:

Chapter 1 Introduction; (this chapter) provides a brief introduction to the project including background and objectives of the project.

Chapter 2 Project Staffing and Management; Confirms the availability of Consultants key-experts and addresses various project management oriented issues.

Chapter 3 Requirement Elaboration; Describes the process and activities that were employed for the requirement elaboration.

Chapter 4 Software Requirements; Provides a brief outline of the Software Requirement Specification (Appendix C).

Chapter 5 Software Design; Provides a brief outline of the Software Design Specification (Appendix D).

Chapter 6 Modelling in WP1 and Data Requirements; Provides a list and a short description of modelling cases to be considered in WP1 and potentially also in WP2. In addition a list of data requirements in support of modelling and testing have been elaborated (Appendix E).

Chapter 7 Project Implementation Plan; contains the revised project implementation plan.

The following Appendices are included:

Appendix A Project Handbook; which described how the Software Projects will be managed and how the Project will work with Requirements.

Appendix B Use Cases; Contains a number of use cases to illustrate typical uses of the NB DSS. The so-called "4+1" use cases that were analysed in detail as part of the requirement elaboration, are also included in Appendix B.

Appendix C Software Requirement Specification (SRS); which is one of the key deliverables of the Inception Phase.

Appendix D Software Architecture Document (SAD); which describes the overall system architecture.

Appendix E Data Requirements and Modelling; which includes detailed information on data requirement and modelling activities.

Appendix F Feature Release Plan; which presents the feature set (requirements) associated with each of the three NB DSS releases.

Appendix G SpiraTeam Release Report; which contains a preliminary release report (development plan) autogenerated by SpiraTeam.

2 PROJECT STAFFING AND MANAGEMENT

This Chapter describes various issues related to the management of the NB DSS project. This includes a presentation of the Client´s team and the Consultant´s team and how these two teams will work together during the course of the project. Further the chapter presents the overall approach to software development (software project management and software development process). Finally, the chapter presents modalities for communication between WP1, WP2 and WP3.

2.1 Project Staffing

2.1.1 Consultant Staff (Key Experts)

The key expert staff list remains largely as in the Consultant's proposal, with the changes agreed during the contract negotiations (Appendix H of the Contract). However, Dr. Schneider (GIS Specialist) is no longer with the RTi and has been replaced by Mr. Nils Babel who is a Senior GIS analyst at RTi. Mr. Babel will be involved in requirement analysis in relation to the GIS functionality but will not be involved in software development.

The key project staff members are as listed in Table 2.1.

Table 2.1 List of Key International Staff Members.

Staff	**Position**	**Employer**
Henrik Refstrup Sørensen	Team Leader	DHI
Lars C. Ekebjærg	Deputy Team Leader/Senior Software Engineer	DHI
Dr. Larry Brazil	Senior Water Resources Management Specialist	RTi
Dr. Jens Kristian Lørup	Water Resources Modeller	DHI
Dr. Mark Woodbury	Decision Support System Specialist	RTi
Mr. Lars Michael	Software Developer/System Integrator	DHI
Dr. Anders Klinting	IMS/Database Expert	DHI
Mr. Nils Babel	GIS Specialist	RTi
Mr. Walton	Water Resources Economist	Mott MacDonald
Dr. Ballofet	Environmental Management / Bio-diversity Conservation Specialist	RTi

Mr. Babel, Mr. Walton and Dr. Ballofet have not yet been actively involved in the project. All other staff members have made significant contributions during the Inception period.

2.1.2 The Client's Team

The Project Management Unit (PMU) of the water resources planning and management project representing the Nile Basin Initiative is the Client for the development of the Nile Basin DSS. The PMU has put in place a team of riparian experts, the DSS core team, as given below:

- Regional DSS Lead Specialist, Water Resources Modeller, Software Developer and System Integrator, IT/DB/KM Specialist and Water Resources Specialist at the Regional DSS Center (at the PMU).
- National DSS Specialists, national IT/GIS/Database experts at national DSS units, in all NBI countries.
- National counterpart staff; two per country in the respective NBI national focal point institutions

The development of the NB DSS shall involve the DSS core team.

The Consultant shall work under the overall supervision of the Regional Project Manager. The Regional DSS Lead Specialist will be the day-to-day NBI project manager and will be the point of contact for the Consultant.

The Team of Experts at the Regional DSS centre in Addis Ababa will be the direct Consultant counterpart and will work closely with the Consultant during the project. The Team of Experts are listed in Table 2.2

Table 2.2 List of NBI staff at the PMU in Addis Ababa responsible for the implementation of the NB DSS

Staff	**Position**	**Employer**
Dr. Hesham A. Ghani	Regional Project Manager	NBI
Dr. Abdulkarim H. Seid	Regional DSS Lead Specialist	NBI
Dr. Mekuria Beyene	Water Resources Modeller	NBI
Dr. Elnaser Abdelwahab	Software Developer and System Integrator	NBI
Mr. Ephrem Getahun	IT/DB/KM expert	NBI
Mr. Solomon Tassew	Water Resources Specialist	NBI

2.2 Project Management

2.2.1 Project Management Team

The day-to-day management of the project is the responsibility of the Regional DSS Lead Specialist and the Consultant Team Leader. The Regional DSS Lead specialist and the Team Leader will form a project management team. The project management team will liaise frequently and make sure that the project is kept on schedule and mitigate risks in due time.

Key responsibilities of the project management team are:

- Day to day management and coordination including all staffing and activity issues.
- Consolidate project plans and deliverable schedules including change management.
- Define outline contents and structure of deliverables (reports)
- Schedule international assignments, workshops, meetings and software development sessions.
- Participate in Change Control Board meetings

2.2.2 Work Groups and Project Teams

In the Consultant's proposal it was suggested to form a number of thematic focus teams. The Client and the Consultant have, however, agreed on a more dynamic work group approach, where teams and workgroups are formed on demand. Teams and Workgroups may be staffed by relevant Client and Consultant experts depending on the specific objectives and activities.

2.2.3 Change Control Board (CCB)

A change control board (CCB) will be established. The CCB will be responsible for approving NB DSS requirements and defect fixes prior to implementation. Please refer to Appendix A (Project Handbook) for detailed information on the requirement management. The CCB tasks include:

- Approve requirements that have been analysed by the Product Area Managers and scheduled for implementation.
- Approve proposed requirement changes.
- Approve new requirements
- Approve feature set changes for software releases

The CCB will be composed by the Consultant Team Leader and Deputy Team Leader (Senior Software Engineer). NBI will be represented by the DSS Lead Specialist and the Software Developer and System Integrator. The CCB will be chaired by the Consultant Team Leader.

The CCB will work with due consideration of constraints such as time, budget and deviation from original requirements.

CCB meetings will be held in connection with joint development sessions in Addis Ababa or in Denmark or on-demand (i.e. if important changes to existing agreements are identified by the NBI or the Consultant). Minor change management issues may be handled through telephone/skype meetings.

One week prior to each CCB meeting the Consultant shall make a list of all issues to be treated at the CCB meeting. The CCB members may subsequently use the issue management system (SpiraTeam) for their preparations. At the CCB meeting each issue will be presented by the issue owner. Typically this will be the Consultant, but in some cases, e.g. in relation to a change request or a new requirement, it may also be the Client.

2.2.4 Administrative Reporting

The Consultant Team Leader will issue brief monthly progress reports. The reports will be submitted electronically by e-mail to the Regional DSS Lead Specialist with copies to the Regional Project Manager, the WRPM Finance and Procurements Officer and Operations officer. The progress reports shall consist of:

- Status and progress of work during the subsequent month
- Change management issues including CCB decisions
- Risk assessment and risk mitigation (Risk Management)
- Identification of problems that impede work progress
- Identification of opportunities to advance work progress more expeditiously
- Any other issues.

In addition, at the end of the consultancy, the Team Leader will issue a note that summarises the Consultant´s work on the consultancy, lessons learned, and recommendations about:

- Improving future similar undertakings
- Strengthening WRMP implementation.

2.3 DHI Software Project Management and Process Improvement

During NBI's visit at DHI from 16-19 March, 2009 NBI's software development process consultant reviewed DHI's software development process. A number of corrective measures were agreed for making DHI's software development process comply with the TOR. These corrective measures were agreed and a Process Improvement Plan was established for implementation during the Inception Phase. The Process Improvement Plan was approved by the NBI in April 2009. DHI's improved software development process was subsequently described in a Project Handbook in agreement with the Process Improvement Plan.

This Project Handbook defines the Consultant´s mode of operation in relation to Software Development activities. The Software Development Activities are organised as a large Software Development Project, which serves the NB DSS and refers to a Change Control Board established for the project.

The Project Handbook describes the software project organisation in terms of:

- Project organization – i.e. a description of the software development project in terms of roles, responsibilities and lines of references.
- Project scope – i.e. a description of the project in terms of a top-level work breakdown structure.
- Project life cycle – i.e. a description of the project in terms of phases and deliverables. The document deliverables falls in 2 categories:
    1. Documents identified as deliverables in the Agreement. Hereafter called external documents.
    2. The documents developed in order to internally manage the project. Hereafter called internal documents.
- Project plan – i.e. a description of the project in terms of its time line.

Further, the Project Handbook describes how the project works with:

- Software requirements and defects
- Project planning
- Tracking
- Quality Assurance
- Configurations

The Project Handbook is attached as Appendix A to the Inception Report.

2.4 Communication Modalities with WP2 and WP3

NBI is in the process of identifying a consultant for WP2. WP2 will be carried out by an independent consultant that has the following main tasks:

- Data Processing: Review available data, identify data needed and prepare the data for the DSS.
- Modelling: Set-up, calibrate and validate the models in the NB DSS.
- Scenario Analysis: Determine scenarios to be investigated, analyze and synthesize results.
- Software Testing: Test all relevant features of the system in terms of usability and functionality.

As such WP2 will do real-life applications using the NB DSS and as part of this work comprehensive testing will be carried out.

Some limited modelling will be carried out as part of WP1. The purpose of this modelling is entirely testing and proof-of-concept. In this context proof-of-concept should be understood as testing modelling functionalities of the NB DSS against the requirements of the ToR. Detailed model calibration and validation exercises are not part of WP1.

2.4.1 Training of WP2 staff

The Consultant is ready to cooperate with the WP2 consultant as per the requirements of the assignment and according to the modalities to be agreed with the NBI.

It is important that a good, constructive working relation is established between WP1 and WP2 and that a good off-set for WP2 is established. It is required that the WP2 consultant gets some training using the NB DSS and the embedded Model Tools. To facilitate the process the Consultant recommends that:

- One or two specialised training sessions is organised for WP2 staff. The Consultant should be pleased to organise these training sessions at DHI in Denmark. The basic training courses would be focused on the usage of the Model Tools supplied by DHI (would require additional funding e.g. through WP2). It is suggested that both NBI staff and WP2 staff join the training sessions.

- Alternatively WP2 staff could join the training sessions scheduled at the end of each release cycle. These are according to the ToR dedicated for the DSS Core Team. If joined also by WP2 staff the training courses may grow too large and require extra consultant staff presence to ensure maximal benefit for the Core Team (may require additional funding e.g. through WP2).

- Co-operation on WP1 modelling. Some modelling activities are scheduled as part of WP1 (see Chapter 6). It is proposed that WP2 engineers take part in some of this work. As such they would be working with WP1 and NBI engineers. WP2 may subsequently continue the work on the WP1 test cases and elaborate them in more details (add more data, calibrate, validate, and run scenarios).

It is assumed that the WP2 Consultant will provide qualified and experienced modelling experts. However, specialised training of WP2 staff will be beneficial for the co-operation between WP1 and WP2 and ensure a more efficient test process.

Any specialised training for WP2 or the DSS Core team, in addition to the ones covered by the current contract, shall be handled by the NBI. The Consultant shall be happy to cooperate whenever needed.

2.4.2 Communication with WP2 and WP3.

The Consultant suggests that meetings with WP2 and WP3 be organised in connection with the joint software development sessions and, if needed, in connection with other Consultant assignments in Addis Ababa.

Further the Consultant will always welcome that WP2 staff works at DHI for an extended period of time. This may be particularly useful during the early stage of the WP2

project to ensure a good start for the WP2 staff and to create a good working relation between WP1 and WP2.

Once WP2 is running effectively defects and test results will be reported to the Requirement Management system (SpiraTeam). In this regard it is assumed that the NBI acts as a filter between WP1 and WP2. This implies that NBI PMU staff enters WP2 outputs such as test results, defects, and change requests into SpiraTeam where they are then handled as part of the normal issue/requirement management process.

3 REQUIREMENT ELABORATION

The TOR lists a number of functional and non-functional requirements. Seen as individual requirements these requirements are generally well described and understood by the consultant. One of the purposes of the launching workshop was to provide insight in the more specific usage of the NB DSS as an integrated system and thereby elaborate NBI's requirements and inform the architecture and the design of the NB DSS.

During the launching workshop, which was held in May 2009, the Consultant worked with the DSS Core Team to establish nineteen NB DSS use cases. Subsequently, these use cases were synthesized into 5 (4+1) use cases by the NBI PMU. The 4+1 use cases represent the broad usage of the NB DSS and have been carefully designed to address all functionalities of the NB DSS. The 4+1 use cases were subsequently UML formatted and analysed in detail by the Consultant. The purpose of the use case analysis was to identify additional (generalised) use cases and create logical groups of use cases to form functional components which then have been translated into software components. As such the use cases constitute important information which informs the design of the NB DSS.

All use cases are included in Appendix B. The use case analysis and the resulting functional components are described in the SRS (Appendix C).

3.1 Launching Workshop

The key-activities during the launching workshop were related to:

1. Elaboration of use cases (user stories and use case tables presented in Appendix B.3)

2. Refinement of tables with priority concerns (presented in Appendix B.2)

3.1.1 User Stories and Use Cases

Nineteen draft user stories were produced by the national DSS experts during the launching workshop. These draft user stories were all focused on important water resources management issues within the nine NBI countries. The use cases were presented by the national DSS experts and subsequently discussed and elaborated in work groups. Following the Launching Workshop the User stories were further elaborated and reformatted by the NBI and the national DSS experts. Finally, based on the original nineteen user stories, five (4+1) representative use cases were selected and expanded to cover the aspects that were identified by the original nineteen user stories and which involves most of the functional requirements. The number was reduced to limit redundancy and repetitiveness in the subsequent use case analysis process. The 4+1 resulting user cases are enclosed in Appendix B.1.

The Consultant has converted the 4+1 use cases into UML formatted use-case diagrams, which have subsequently been used to elaborate the user requirements and thereby inform the design of the NB DSS (presented in the SRS (Appendix C)

During this process it may be recognized that there are missing requirements. For instance, a use-case may not be possible or very cumbersome to complete due to a missing requirement. In such cases the missing requirement shall enter the requirement management flow (a new requirement request) where it will be addressed by the CCB.

3.1.2 Refinement of Tables with Priority Concerns

In addition to the User Stories a number of "Priority Concern" tables were produced. These tables were organised by:

- Water management objectives
- Possible alternatives/interventions
- Sample decisions
- DSS questions
- DSS outputs, and
- A reference relating the DSS output to the Requirement ID in the TOR.

The NBI had, prior to the Launching Workshop, produced a table for each of the eight priority concerns and the two cross-cutting issues. The intension was to refine the original tables by mapping the use-case tables into each priority concern. The last activity is still pending. If deemed useful for the project the tables may be refined at a later stage in the project. All tables, in their current form, are attached in Appendix B.2.

4 SOFTWARE REQUIREMENTS

The elaboration of the preliminary software requirements specified in the ToR and the establishment of the NB DSS software architecture has been the major challenge during the Inception phase.

The TOR lists a number of functional and non-functional requirements. These requirements have been further elaborated through a use case analysis. During the launching workshop 19 use cases were developed. For practical purposes these were subsequently synthesised to the so-called "4+1" use cases which have been the basis for the use case analysis which is presented in the SRS (Appendix C). The key objective of this use case analysis was to understand the NBI business processes (represented by the use cases) and ensure that these are supported by NB DSS. As such the use cases and the requirements specified in the ToR have informed the architecture and design of the NB DSS as outlined in Figure 4.1.

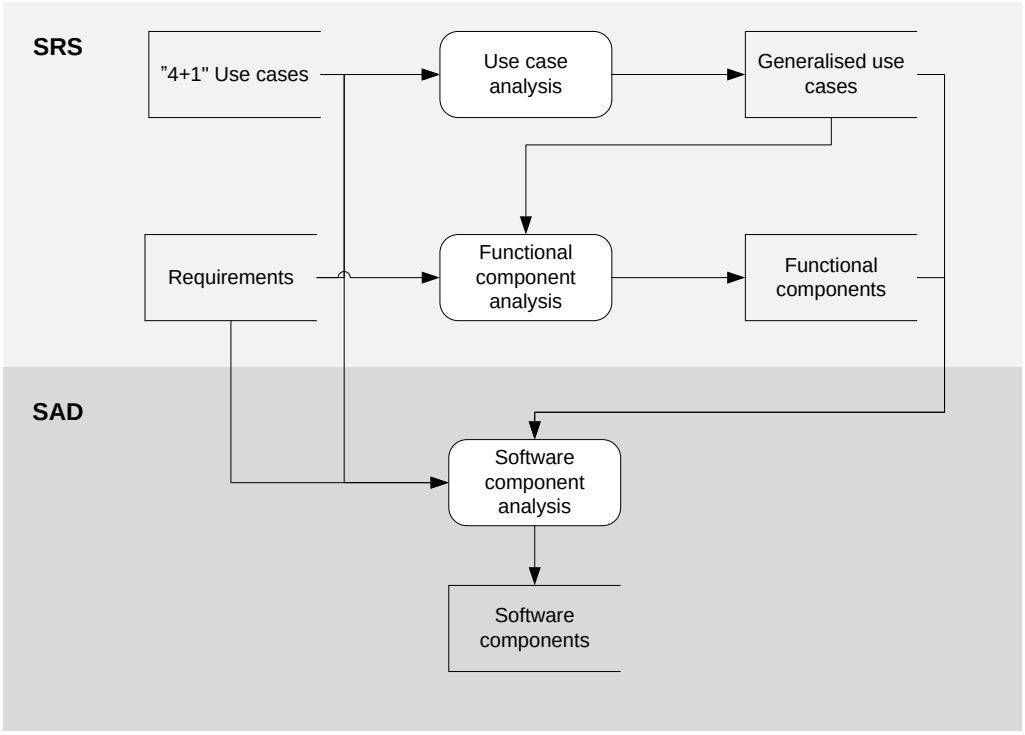


Figure 4.1 From Use cases and requirements to functional and software components

The use case analysis in the SRS has identified 72 generalised use cases and 16 functional components. Both the generalised use cases and components have been mapped with the requirements stated in the ToR. This provides for bi-directional traceability between use cases and functionality, use cases and requirements and functionality and requirements. Additionally the SRS has proposed a number of other requirements related to the identified components. Typically requirements related to architectural aspects of the solution, e.g. organisation of the database in study-related entities. The proposed requirements shall be accepted by the Change Control Board before being taken into consideration.

Main output from the SRS is thus the identified functional components, the generalised use cases and the traceability. These will be used during the coming development cycles for further analysis of the requirements, for discussing user interface interactions and not least for defining the entry points in the test plan.

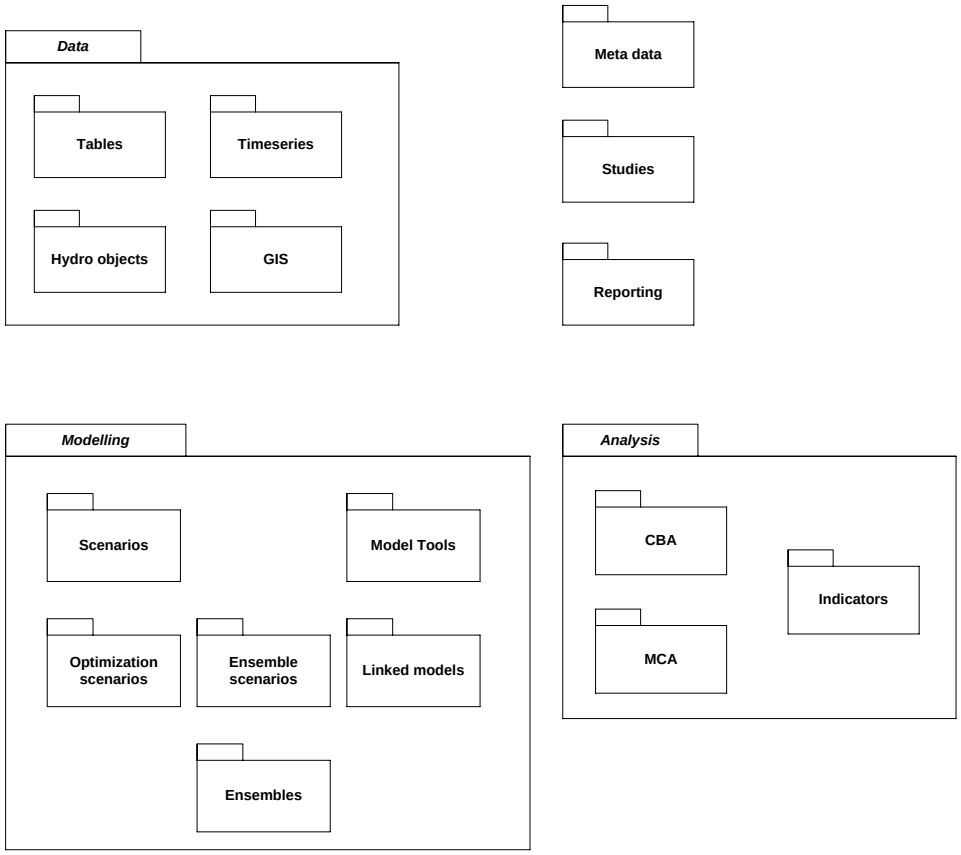


Figure 4.2 Functional Component derived through the Requirement Analysis

Note the following Figure 4.2:

- The figure uses a grouping mechanism where functional components are grouped in packages, i.e. the Data group consists of the Time series, Tables, GIS and Hydro objects functional components.
- All functional components persists their definitions and data in logical partitions within the DSS database called Studies.
- The Data functional component refers to the functionality provided for the time series, GIS, Hydro objects and Tables data types.

Table 4.1 - Table 4.4 provides a short description of the functional components. Further details regarding the requirement elaboration process and the derived functional components are provided in the SRS (Appendix C).

Table 4.1 Data related functional components

Functional component	Short description
GIS	Functionality for visualizing, persisting, querying and processing GIS data.
Time series	Functionality for visualizing, persisting, querying and processing time series data.
Tables	Functionality for visualizing, persisting, querying and processing tables. Tables are 2-dimensional matrices of data, used, e.g., for storing corresponding Q/H values for deriving rating curve. Tables are in this context not to be mistaken for database tables.
Hydro objects	Functionality for visualizing, persisting, querying and processing hydro objects. Hydro objects are objects related to the modelling of water related processes, e.g. reservoirs and irrigation schemes.

Table 4.2 Modelling related functional components

Functional component	Short description
Scenarios	Functionality for registering models, creating and executing and comparing scenarios (through variations in input data) on top of registered models.
Optimization scenarios	Functionality for managing scenarios that include simulation based optimization.
Ensemble scenarios	Functionality for managing scenarios that involve ensemble modelling.
Linked model	Functionality for managing configuration (linking) and execution of linked models A linked model involves execution of more than one model tool. Typically, the first model tool simulation generates output time series to be used as input time series for the next model tool simulation.
Ensembles	Functionality for managing and creating ensembles of time series, i.e. groups of time series.
Model tools	Represents the functionality provided by modelling tools like MIKE BASIN, MIKE 11 and MIKE SHE Studio.

Table 4.3 Analysis related functional components

Functional component	Short description
Indicators	Functionality for defining and creating indicators that are being used by the CBA and MCA functional components.
CBA	Functionality for creating and running cost benefit analyses.
MCA	Functionality for creating and running multi-criteria analyses.

Table 4.4 Other functional components

Functional component	Short description
Meta data	Functionality for creating, editing, querying and displaying meta data. Meta data are typically attributes describing data entities.
Studies	Functionality for creating studies and managing studies. A study is a logical partition of data in the database that shares the same security model and logically belongs together. Study management comprises activities related to associating users to a Study and defining access rights.
Reporting	Functionality for creating, publishing and storing reports over data stored within the DSS Database

5 SOFTWARE ARCHITECTURE

The Software Architecture Document is a key output of the Inception phase and will form the basis for the design which will then be the starting point for the implementation (coding) of the NB DSS.

The Software Architecture is presented in detail in the Software Architecture Document (Appendix D). The scope of the software architecture document is to provide a design and technical specification of the overall system architecture of the NB DSS system. This implies that the document does not provide a detailed analysis or design of the components constituting the system.

Software architecture is a term that conveys different connotations for different people. Some people might picture a very detailed blue print of the inner mechanisms of a system others very high-level descriptions of the technologies and concepts ("patterns") applied. This software document aims at following the definitions provided by the Software Engineering Institute (SEI).

> *Software architecture is a sketchy map of the system. Software architecture describes the coarse grain components (usually describes the computation) of the system. The connectors between these components describe the communication, which are explicit and pictured in a relatively detailed way. In the implementation phase, the coarse components are refined into "actual components", e.g., classes and objects. In the object-oriented field, the connectors are usually implemented as interfaces.*
>
> *Wahab Ahmen, www.sei.cmu.edu/architecture/start/community.cfm*

Given this definition, the document demonstrates to the Client how the system will be decomposed into components and how these components interact with each other to provide the required functionality outlined in the Software Requirement Specification (Appendix C). The design of the individual components will be conducted at the beginning of the respective cycle for each release of the NB DSS system. However, in order to accommodate NBI's request for fairly detailed information concerning model integration certain aspects have been described in a level of detail similar to a implementation design.

This SAD presents the NB DSS software architecture from four viewpoints.

The *Logical Viewpoint*, which is a logical representation of the key components within the software system and their interactions. It provides overview only and does not describe the presented components in more detail.

The *System Use Viewpoint*, which addresses the system from an end-user point of view. This viewpoint responds to the questions: How will the interaction with the system be?, how can it be integrated with other systems? – or new systems? – within an organization?

The *Implementation Viewpoint*, which addresses the system from a software developer point of view. It responds to the question: What technologies are used?, what applications tiers exist?, what client-server model is being used etc.?

The *Infrastructure Viewpoint*, which defines the way the actual software programs (processes) are instantiated and deployed on the physical hardware and how the processes communicate with each other.

The SAD identifies 24 software components (see Figure 5.1 and Table 5.1) and discusses how they interact in order to provide a coherent system for NBI. Each of identified components has been mapped with the generalised use cases established in the SRS and the requirements from the ToR; i.e. providing full bi-directional traceability between software components and use cases and between software components and requirements.

The guiding architectural principles in designing these components and their interactions are briefly described below.

It is the Consultants experience that flexibility with respect to model tools is very important. Model tools are becoming increasingly advanced and multi-disciplinary and a DSS system needs to be able to integrate with many different kinds of such tools, not all of which are known at the time of the initial system development.

> *Guiding architectural principle: Establish well-defined interfaces for integrating model tools with the DSS Front-end.*

The DSS Front-end is where the Information Management part of the system is situated, i.e. the capabilities for processing and analysing data, for creating scenarios, performing multi-criteria analysis etc. A proper DSS Front-end should be designed it such a way that it can be extended with new functionality over time by adding new components to the live system. This includes, for example, adding functionality for displaying simulated results on top of Google Maps or integrating the NB DSS with AutoCAD for coupling infrastructure data with structural design drawings.

> *Guiding architectural principle: Establish well-defined interfaces and protocols for DSS Front-end modules. Distributing DSS Front-end functionality amongst the software components should strictly adhere to the separation of concern patterns – similarly with the component internals.*

The database in the NB DSS system is a data warehouse, i.e. a consolidation of all applicable water resources data related to the mission of the NBI. This also implies that, over time, the database will grow very large. In order to prevent users of the system from 'drowning' in data, the database should provide logical views of the data entities that are of particular interest for the specific work situation.

> *Guiding architectural principle: Apply the data warehouse principle of providing (logically or physically) data marts*[1] *for specific, subject oriented data designed to answer specific questions to a specific set of users.*

Users of the system will have varying roles in their interactions with the system. One user might be responsible for the modelling part in one study, the data part in another, reviewer in a third and study manager in a fourth. I.e. control of access to data can eas-

[1] For the NB DSS the term Study is used

ily become unmanageable if this has to be based on a direct mapping between user and data entities.

> *Guiding architectural principle: Base access control on work roles seen in relation to specific studies.*

During the detailed analysis phases of the coming development cycles, each of the identified software components will be broken down in smaller units and designed for implementation. In this work the generalised use cases established in the SRS and subsequently refined through the detailed analysis, will provide important information on the flow of control and flow of data among the components. Figure 5.1 provides a conceptual diagram of the NB DSS and including all NB DSS software components. Table 5.1 provides a brief description of each software component. Details are provided in the SAD (Appendix D).

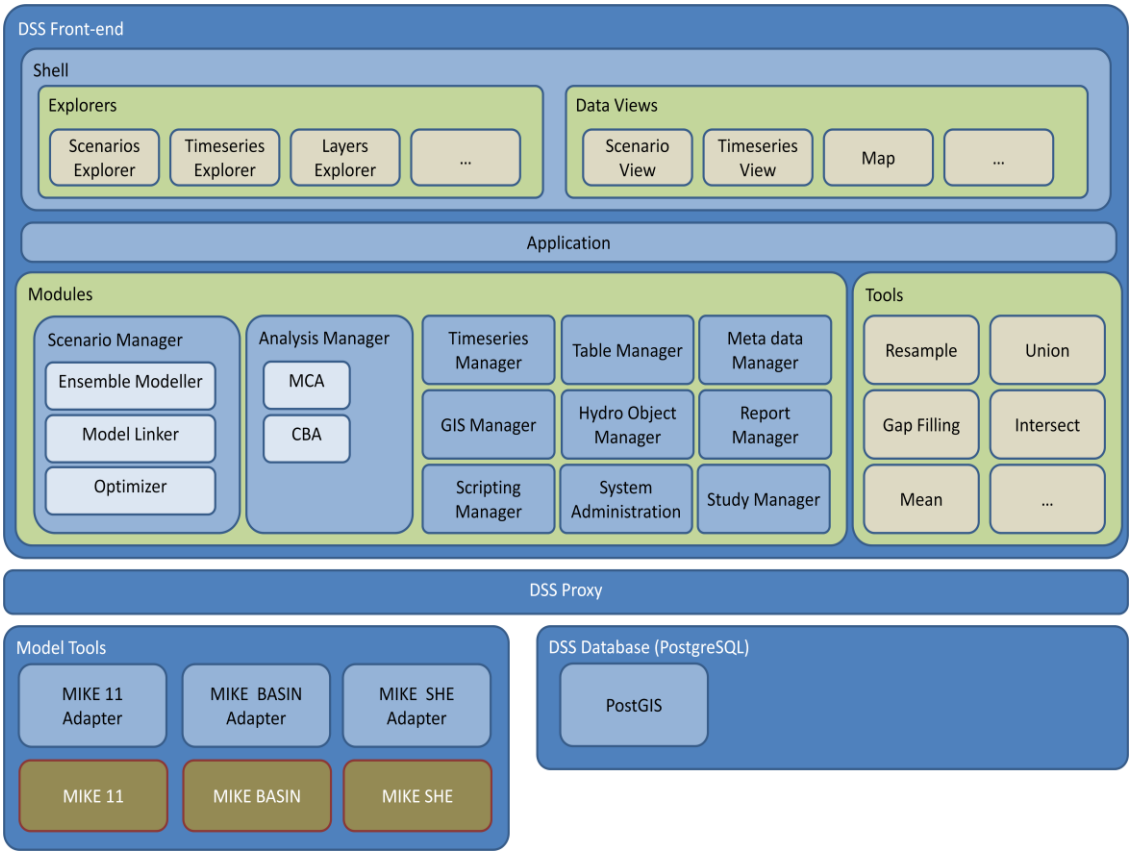


Figure 5.1 NB DSS Software Components

Table 5.1 Software component descriptions

Software Component	Description
Analysis Manager	The Analysis Manager provides a framework for analysis tools like MCA and CBS. Common facilities like Indicators reside in this component.
Application	The application component is the top level functional component as it via the modules represent en entry point for functionality in the system.
CBA	The CBA component encapsulates the CBA analysis tool
Database	The Database component implements the physical database
DSS Proxy	The DSS Proxy component implements a piece of the NB DSS allowing distribution of batch tasks.
DSS Tools	The DSS Tools is a common component including all implemented tools (time series tools, GIS tools, analysis tools etc.) as well as a framework for further expansion of the system with respect to tools.
Ensemble Modeller	This component assists the Scenario Manager in definition scenarios using time series ensembles
GIS Manager	GIS Manager provides GIS layer management functionality but primarily handling of data access for GIS data. Visualisation of GIS data is in the hands of the Map Component and GIS tools are in the DSS Tools component
Hydro Object Manager	The Hydro Object Manger controls creation, editing, searching for and deleting of Hydro Objects.
Map Component	The Map Component implements the visualisation of GIS data (currently ThinkGeo) in a common manner
MCA	The MCA component encapsulates the advanced analysis tool, MCA
Meta data Manager	The Meta Data Manager defines a common framework for handling meta data across entities in the system. A Meta data browser also resides here.
Model Linker	This component assists the Scenario Manager in handling definition and execution of linked models and scenarios
Model Tool Adapter	The Model Tool Adapter component assist the Model Tools component in encapsulating model specific logic, making external model “pluggable” into the NB DSS
Model Tools	The Model Tools component contains the actual model tools in the system(whether known or unknown at time of delivery)
Optimizer	This component assists the Scenario Manager in handling definitions and execution of optimization scenarios
Report Manager	The Report Manager allows a user to create and handle documents and pieces of documents.
Scenario Manager	The Scenario Manager provides functionality to register models, define (and edit) scenarios, execute and compare scenarios. Subcomponents will provide specialized logic where required (e.g. Optimizer)
Script Manager	The Script Manager controls creation, storage and execution of scripts wherever they are used in the application.
Shell	The Shell component provides the framework for the application to interact with the Modules. It ties application, user interface and module functionality together. It contains the executables of the system.
Study Manager	The Study Manager gives an interface for the user to administer data and user permissions for logical data compartments.
System Administration	This component is used for system administration tasks like adding new users to the system and changing access control lists.

Software Component	Description
Table Manager	The Table manager contains logic to support handling of tabular data (i.e. rating curves) in a manner allowing users to specify layout and content and the application to refer and operate on the data.
Timeseries Manager	The Timeseries Manager provides time series management functionality. This includes time series data access, logic related to time series and visualisation of time series. Time series tools are NOT part of this component but part of the DSS Tools component.

6 MODELLING IN WP1 AND DATA REQUIREMENTS

This Chapter describe the modelling activities that will be conducted in WP1. The Chapter also provides guidelines for data requirements. The latter will serve as a guideline for WP2 in collecting and preparing data for modelling. Further details on data requirements and data formats are given in Appendix E.

6.1 Overview of Modelling Activities

The modelling that will be undertaken as part of the development of the NB DSS will be of two general types: 1) Feature oriented modelling undertaken in WP1 intended to demonstrate model capability; and 2) Study oriented modelling undertaken in WP2 intended both to exercise and test the NB DSS as well as to develop the base models that will form the foundation for studies to be conducted in the future by NB DSS users. Each of these types of modelling can be further subdivided into basic water allocation modelling, specific process models and modelling activities which are designed to facilitate the decision-making process such as MCA and CBA tools. An important component of WP1 is the preparation of models and data as test cases for use in development and testing of the NB DSS through its three releases. WP2 will include more thorough testing of the system and active employment of it in compiling and implementing important datasets and models that will form the basis for future application of the NB DSS in water resources planning and development in the Nile Basin.

Villagers collecting water in Lake Bunyonyi (Uganda) (Photo: J.K.Lørup,July 2006)

WP1 will run in parallel with WP2 and WP3. WP2 will provide basic test protocol templates (substantive parts) and quality assured test data sets to WP1. WP1 will provide the successive NB DSS Releases to WP2 for testing as they become available; WP3 will be responsible for the communication and exchange of data and tools between WP1 and WP2.

6.2 Modelling Activities in WP1

6.2.1 Objective of the Modelling in WP1

The key objective of the modelling in WP1 will be "**Proof of Concept**" to test and demonstrate the functionality of the NB DSS to the client at each release of the system.

The tests will cover the functional requirements and relevant non-functional requirements. All functional and non-functional requirements listed in the ToR, will be tested as individual features, as part of the software development process.

The WP1 modelling will focus on integration system testing making sure that individual features also work properly when employed as part of the NB DSS. The testing will ensure that the different software components interact as intended and that the various typical user interactions and work flows are well supported by the NB DSS.

The WP1 modelling will involve all functional and non-functional requirements. The WP1 modelling will however not ensure 100% coverage at all features of the NB DSS. For instance time-series tools for processing and analysing data will be used as appropriate for the various test cases, but all possible time-series statistics will not be tested. The latter is done as part of the software development process (functional tests / unit tests).

The datasets and models used for this testing may also be useful to the WP2 consultant as a starting point for the development of more comprehensive and complete model datasets.

While the main objective is testing of functionalities, it is expected that there will be a high degree of synergy between the modelling work in WP1 and the training to take place after each of three releases of the NB DSS a the model test cases may also serve as training test cases. The experience gained during the modelling test cases can therefore be applied and addressed during the subsequent training activities.

Furthermore, the experience derived from the modelling activities will provide a solid basis and input for discussion on the final design and functionalities of the system.

6.2.2 Scope of Work for Modelling in WP1

With the "Proof of Concept" being the key objective, the WP1 modelling will consist of a number of model test cases to be carried out. These will focus on the **functionality** of the system, with priority on *functional* coverage rather than *spatial* coverage. As a guideline the WP1 modelling shall include all existing infrastructures relevant for the respective test cases. Specific issues, such as the Sudd, shall be handled using adequate conceptual approaches making use of the functionalities and features of the MIKE BASIN.

A model setup with a rigorous and detailed representation of the river basin will be the task of WP2. Thus, the WP1 modelling will involve model setup and calibration sufficient to demonstrate the software and generate sound results, but will not involve a detailed or refined calibration effort.

The Consultant will develop and apply the model test cases concurrent with the development of and prior to the release of the NB DSS at the end of each of the three release cycles to ensure that the required functionality of the NB DSS in each cycle is properly tested.

Because the WP1 modelling will be for testing purposes and not for the purpose of water management and planning, it will not be targeted to specific periods and does not have to run longer periods that are climatic representative, which depending on the cli-

matic variability may require 20-30 years or more. The modelling periods can therefore be flexible and will to a large extent be guided by the timely availability of data.

The criteria for selection of modelling test cases, and the proposed modelling test cases are described in Section 6.3. For each of the test cases, it is the role of the consultant to identify the specific data need, based on the general data requirement list provided in Appendix E. Based on the list it is then the responsibility of the NBI, with assistance from the staff in the individual Nile Basin countries, to collect the requested data and carry out the necessary quality assurance of the data before it is delivered to the consultant. The client has made it clear that the consultant should not use the limited time and resources allocated for modelling in WP1 on data compilation, checking, gap-filling and quality assurance. NBI will arrange for these tasks so that the consultant can concentrate on the modelling work itself. However, for a few time series NBI might provide some data with gaps in order to test the gap-filling tools of the system.

For each of the three release versions, there will be a similar cycle of modelling related activities. These will include the following key activities:

1. Preparation of a list of data required for the test cases to be including in testing in a given release cycle

2. Collection of data for the relevant test cases

3. Modelling of the test cases, including setup of models, running models and testing of functionalities.

4. Solving / correcting identified bugs, problems, etc.

5. Release of the new version of the system.

The client's role in the modelling and testing shall be to inspect the outcomes of these activities. However where appropriate and necessary the client shall avail its staff for technical discussion sessions with the consultant as well.

6.2.3 Managing and Documenting the Modelling Test Cases

It is important to establish a system for planning and monitoring the modelling and testing activities. The SpiraTeam issue tracking system will be used for this purpose. SpiraTeam is already used to manage requirements, software development, feature testing and defects. It will be an advantage to integrate all testing activities in SpiraTeam. SpiraTeam is web-based and shall provide access for the NBI staff so that they can monitor the progress of the testing. SpiraTeam is described in more details in Appendix A in the Project Handbook.

In an early stage of the modelling testing activities, a functionality testing matrix will be established. It will be used to provide an overview of the modelling testing tasks and how the testing has progressed. The content of this may be partly or fully or auto-generated by the report facilities in SpiraTeam, and may include information as indicated in Table 6.1.

Table 6.1 Anticipated Contents of the Functionality Test Matrix

User requirement (from ToR)	Test area 1	Test area 2	Test area 3	Input data / setup	Test case	Tester	Date	Version	Passed (P) / Failed (F)
2.1.3.2 Time series analysis tools									
2.1.7.1 Rainfall-runoff models									

Initially, it will be decided in which of the test case areas the various NB DSS requirements will be tested. NBI will then identify specific sites / catchments within the test case area where the tests can take place. Based on a discussion with the consultant the specific sites will be agreed upon and NBI will initiate the data collection. Test cases can then be defined and models can be built. An example: All the process modelling functionalities may be tested in the Lake Victoria Basin. However, they cannot all be tested in the same catchment but may have to be tested in two different catchments. While two functionalities (e.g. rainfall-runoff and catchment process modelling) may be tested in the same catchment, they may be tested in three individual test cases, one for soil erosion, one for lumped RR modelling and one for semi distributed RR modelling.

6.3 Modelling Test Cases in WP1

6.3.1 Selection of Modelling Test Cases

A number of discussions and consultations have been held between the consultant and the client in order to identify suitable test cases. In order to select appropriate test cases a number of selection criteria were defined. This included the following criteria and considerations of which the first three are the most important:

1. The primary focus of the test cases is to test the functionalities of the NB DSS. To focus the work on testing rather than collecting data and preparing setups, it should be aimed at using as few test cases / setups as possible to test the required functionalities. This requires that much functionality can be tested in each of the identified test case and that the test cases complement each other to minimize duplication.

2. The identification of the test cases should take their point of departure from the User Test Cases identified during the launching workshop in May 2009.

3. The required data should be available in the area. It is expected, however, that it may be difficult to acquire some of the required data and that approximations / estimations therefore will be made.

4. The test cases should cover different parts of the basin so as many stakeholders as possible are considered / included in the test cases. This will however to a certain extent be counterbalanced by the fact that it was agreed to reduce the number of test cases to a reasonable number, in order to optimize the limited time and resources available for the model test cases.

5. It will be an advantage to identify areas where similar studies / modelling have taken place. This will increase the likelihood of acquiring the necessary data and the possibility to compare output of tests with previous results.

6. The consultant will take into considerations the tests that will need to be carried out under WP2 and WP3

Based on these criteria the outcome of the discussions between the client and the consultant was a mutual proposal for the following three modelling test cases:

1. **Coarse river basin model of the whole Nile basin:** This test case may be the main test case for release cycle 1, but also will be used as a foundation for preparation of test case 3.

2. **Process modelling in the Lake Victoria Basin:** This may be used mainly during release cycle 2, focusing on process modelling including rainfall-runoff modelling and soil erosion assessment.

3. **Multi-criteria-analysis focusing on water development on the Blue Nile:** This may be used mainly during release cycle 3, with focus on MCA. It will build on the coarse model (test case 1) but will be expanded to include more details on parts of the Blue Nile that will be used to demonstrate MCA, including upstream and downstream impacts of development.

An appropriate test case area for the 1D hydraulic modelling is still being considered. Kagera is one possibility but another likely possibility is parts of Egypt at the main irrigation diversions. Thus, NBI will make further investigation about the areas and the availability of data to facilitate the decision on which of these areas are most suitable for the 1D hydraulic modelling.

Each of the three proposed modelling test cases are described in more detail in the following sections.

6.3.2 Modelling Test Case 1: Coarse Setup of the Entire Nile Basin

While the aim of the WP1 modelling is to test functionality, it was decided to have a coarse model of the whole basin, so that one of the test cases would cover the whole basin, corresponding to approximately 3,000,000 km^2.

Table 6.2 Key information for modelling Test Case 1

	Issue	Description
1	**Main Objective of model test**	• Make a model setup that – although a very coarse simplification of the basin entities – will cover the whole basin • Create a model setup, which can form the basis for some of the detailed test cases that will include modelling of a specific area which links up to other parts of the basin
2	**Release version for which it will be used**	DSS 1 DSS 3 (The model is planned to be used for Test Case 3, where a smaller area of the basin will be modelled in details and, among other things, used for MCA testing.
3	**Modelling period**	To be decided. It will depend on the availability of input data.
4	**Model area**	The whole Nile Basin
5	**Size of model area**	Approximately 3,000,000 km^2
6	**Use cases involved**	Presently, it has not been decided that this setup should focus on any particular Use Case
7	**Type of functionalities to be tested**	• Graphical User Interface • IMS: Database Management System & Communication • IMS: Pre- and Post-Processors and Data Analysis Tools • IMS: Embedded GIS functionality • **Dynamic Water Budget and Allocation Model** • **General Utilities**

IMS: Information Management System

Apart from having a model of the whole area, this model serves a few other purposes:

- This test case will provide an appropriate way to test the general functionalities of the DSS, such as the Graphical User Interface, IMS functionalities and not least the Dynamic Water Budget and Allocation model and the general utilities.

- This coarse model will be used in one or more of the more detailed modelling test cases, where a smaller area of this coarse model for the whole basin will be refined and modelled. Having a detailed setup for this smaller part of the basin to be modelled as nested in the coarse model will allow assessment of the impact on downstream users of modelling scenarios (development) in the smaller area of concern.

- This coarse model for the whole Nile Basin will serve as a good modelling example during the training to take place after the first NB DSS release.

Table 6.2 provides some key information on Test Case 1, while a more detailed description of the model setup and representation of the basin are given below. The modelling test case is primarily to be used for testing during Release Cycle 1, but will also be used for building the model for Test Case 3 in relation to Release cycle 3. Thus, in building the coarse model in this test case, the need for accessing downstream effects of water development on the Blue Nile in test case three should be taken into account.

Details of the coarse model setup of the whole Nile Basin

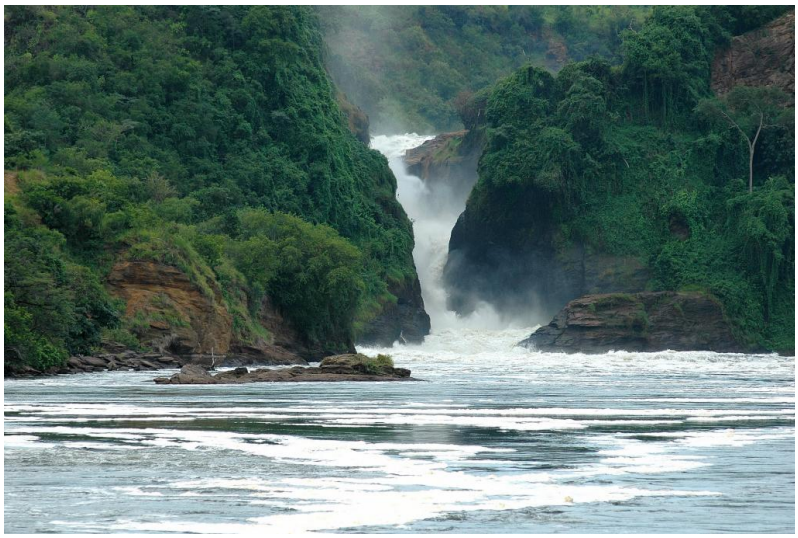
During the meetings with NBI core staff, the level of details / complexity of the coarse model for the whole basin were discussed. Below is given a brief description of the major objects proposed to be included in the test model and the form and level of details in which they will be used.

1. **The equatorial lakes**

Lake Victoria, Lake Kyoga and Lake Albert will be included as objects in the model. Lake George and Lake Edwards may be included as well or represented in the model through the inflow from the lakes to Lake Albert through the Semliki River.

The inflow to Lake Victoria may be represented by 1) The inflow from Kagera River, 2) Aggregated inflow from other major river systems.

Inflow to Lake Kyoga may be aggregated into one or two inputs in the model.



Murchison Falls. At the top of the falls, the Nile forces its way through a seven metre gap in the rocks and tumbles 43 metres down, then flows westward into Lake Albert (Photo: J.K.Lørup, July 2006)

2. **The Sudd**

The hydrological processes in the Sudd are complex. Previous studies have addressed this challenge, including the Sutcliffe & Park study suggested in the late 1980s. The NBI and the consultant will assess the suitability of this approach. In the coarse model the approach by Sutcliffe & Park may be adopted. Alternatively, other previous modelling approached in the Sudd may be applied or the Sudd may be represented as a reservoir/lake as it was done successfully for the Inner Delta in West Africa in a previous MIKE BASIN model setup of the Niger River Basin.

3. **Bahr El Ghazal**

Although the catchment area of this basin is large and the upper catchment areas receive the highest annual rainfall amount in Sudan (1200-1400 mm/yr), it only provides a minor contribution to the White Nile. It should still be represented in the coarse model. However, there may not be regular and reliable flow data from this tributary, and if that is the case, inflow from this tributary may eventually be excluded from the coarse model.

4. Sobat (Baro-Akobo)

The Sobat River, which is mainly made up of the two rivers of Baro and Pibor / Akobo coming from the Ethiopian highlands, joins the White Nile just south of Malakal and contributes an average annual flow of 13.5 BCM.

Many development scenarios exist in the River Sobat basin that includes: hydropower generation, rain fed and irrigated agriculture, rainfall harvesting, water conservation, wetland management, etc. The River Sobat will be presented in this Scenario as a single output to the White Nile, while, the complete schematization of the river "existing and potential development scenarios", will be dealt with through WP2 during the testing and calibration processes (i.e. please refer to the TOR of WP2 - Section 2.3 Scenario Analysis). This work will be done in collaboration between mainly WP2, WP1 and the DSS Core Team.

The Integrated Development of River Sobat was one of the use cases developed during the launching meeting (Annex B). The Scenarios mentioned in Annex B will be further fine tuned and polished through the planned regional and national consultation of WP2.

5. The Blue Nile

The Blue Nile is the sub-basin within the whole Nile Basin that has the highest mean annual specific runoff. It contributes with approximately 60% of the flow in the main Nile. Furthermore, the Blue Nile together with Atbara, are the main tributaries responsible for the seasonal flow variations in the main Nile.

It has not yet been decided how the Blue Nile should be represented in the model. But the following may be included:

1. 3-4 major rivers draining into Lake Tana
2. Lake Tana (to be modelled as a reservoir)
3. 6-7 of the major tributaries in Ethiopia between Lake Tana and Sudan (such as Beshilo, Didessa, Angereb, Guder, Dinder and Rahad).
4. Aggregation of the contribution from minor tributaries.
5. Irrigation schemes at the lower part of the Blue Nile will be included (see below) and therefore flow records upstream and downstream of these irrigation schemes will be very useful if they exist.

Thus, compared to the other tributaries to the main Nile, substantial stream flow data will be required for the Blue Nile, including: 1) Flow records for rivers flowing into Lake Tana, 2) Flow records for the tributaries flowing into the Blue Nile, 3) Flow records upstream and downstream of the major irrigation schemes, and 4) Flow records at the confluence with the main Nile. A more simple representation of the Blue Nile may also be used, depending on the time available and especially if the above-mentioned data not are available.

6. Irrigation schemes upstream of Khartoum

There are two major irrigation schemes (including two reservoirs) on the Blue Nile upstream of confluence with the White Nile at Khartoum. Both of the reservoirs may be represented in the model, and the two irrigation schemes may also be represented individually.

7. Atbara

The River Atbara is known as Tekezze in Ethiopia drains the adjacent highlands north of the Blue Nile Basin. It joins the River Nile at Atbara town in the Sudan and discharges an annual flow of 12 BCM into the Nile, which is estimated to be equivalent to 11.5 BCM at Aswan. Most of the annual flow of the Blue Nile and the Atbara rivers originates from the rainfall over the western highlands of Ethiopia and Eritrea during the three months between mid-June and mid-September.

River Atbara is considered the last main tributary to the Main Nile joining it between Khartoum and Wadi Halfa and is the most seasonal of the main tributaries which drains the mountains north of Lake Tana and part of Eritrea.

There are many existing and planed development scenarios in River Atbara, including hydropower development, irrigation schemes, etc. Those projects are also in one of the user case studies (Annex B).

However, the presentation of the river Atbara in this test scenario is planned only to be represented by the outflow to the Main Nile. While the existing major irrigation schemes in the lower Sudanese part of the Atbara basin, Khashem Girba Dam in Sudan, TK5 Dam in Ethiopian Highlands and the other planned projects will be dealt with through Software testing and Model Application and Validation, as a part of WP2 work.

8. Irrigation scheme on Atbara upstream of confluence with the Main Nile

There is a large irrigation scheme and associated dam in Sudan at the lower part of the Atbara river (to be checked). This will be included in the model.

9. High Aswan Dam

The High Aswan Dam (HAD) should be included in the model, including hydropower production at the HAD. This will require that the necessary data are released.

10. Irrigation in Egypt between HAD and the Nile Delta

Irrigation in Egypt between HAD and the Nile Delta are to be represented by aggregating into a few model irrigation schemes.

11. Irrigation schemes in the Nile Delta

A large part of the irrigation in Egypt is concentrated around the Nile Delta

The model will include a few irrigation objects to represent these irrigation schemes. Very big irrigation schemes may be represented separately, whereas small scale irrigation schemes will be aggregated into a few irrigation schemes in the model.

6.3.3 *Modelling Test Case 2: Process Modelling of the Lake Victoria Basin*

Process modelling tools are to be developed as part of release-cycle 2. These tools focus to a large extent on the interaction between land and water resources, including rainfall-runoff modelling (lumped and semi-distributed), irrigation water demand estimation, water quality modelling and catchment erosion process modelling.

Table 6.3 Key information for modelling Test Case 2

	Issue	Description
1	**Main Objective of model test**	Testing the process modelling tools in the Nile Basin DSS
2	**Release version for which it well be used**	DSS 2 – this will be the time of delivery of this model. However, the work should be started during the Release Cycle 1.
3	**Modelling period**	To be decided. It will depend on the availability of input data.
4	**Model area**	The Lake Victoria Basin focusing on the Kagera Basin
5	**Size of model area**	Approximately 60,000 km^2 (The Kagera Basin) + Lake Victoria (68,000)
6	**Use cases involved**	• Use Case 1: Lake Vic Water levels • Use Case 3: Deterioration of Lake Victoria water quality • Use Case 15: Development Plan for HPP, Irrigation and Navigation in the Nile. • Use Case 18: Understanding the processes in Kagera Wetland (Rwanda)
7	**Type of functionalities to be tested**	• **Process models, including** o Rainfall-runoff modelling o Irrigation water demand estimation & crop production model o Water quality model o Catchment erosion process modelling o Multiple evapotranspiration estimation method

IMS: Information Management System

Based on the criteria for selection of test cases outlined in Section 6.3.1, the Lake Victoria Basin has been considered a suitable area for Modelling Test Case 2, which is intended to focus on and cover the functionalities related to process modelling. This area is considered suitable for a number of reasons: 1) A number of use cases are located in this basin, including Use Case 1, 3, 15 and 18, 2) A substantial number of previous studies have been carried out in this region, and data and reports should be available, according to the client, 3) The consultant is involved in a project in Uganda where MIKE BASIN will be used allowing for possible synergy, and 4) By selecting this basin all five upstream countries will be represented in the test cases. Table 6.3 outlines the key characteristics of the proposed test case.

A substantial number of studies have been carried out in this basin including the Lake Victoria Environmental Management Project (LVEMP), studies in relation to the proposed Regional Rusumo Falls Hydropower and Multipurpose Project (RRFP) in the Kagera River Basin, and numerous studies of the Hydrology of the Lake Victoria Basin.

Sunset at Kalangala Island, Lake Victoria, Uganda. (Photo: J.K.Lørup, July

The testing focuses on functionalities and to allow sufficient time for that, the test case is expected to focus on small areas / catchments within the basin. In this respect, the Kagera River Basin may be suitable as a substantial amount of data is available for this basin. These include the Kagera Database, where different types of data and reports/studies have been compiled, including data on topography, geology/soils, land use, hydrometeorology, etc. This is also an area with severe soil erosion and sediment transport problems, and it therefore looks like an ideal area for testing of catchment erosion process modelling. During the inception workshop the Nzoia catchment in Kenya was also mentioned as suitable for testing of soil erosion modelling as good data exists. NBI and the consultant will jointly assess the suitability of the different options. However, to the extent possible the process modelling should be carried out within the same area or as few areas as possible, to reduce the time required for collecting data and building the models.

Therefore, it will be attempted to identify an area where all or at least most of the process modelling functionalities can be tested, including water quality and reservoir sedimentation.

Regarding 2D water quality modelling it was emphasised during the inception workshop discussions that this is not part of the scope of the DSS but should be done using other applications.

Groundwater-surface water interaction and use of groundwater for irrigation will also be tested in this test case using the modelling approaches available within the NB DSS.

Where data and results from other studies are available a comparison between the model testing results and results from previous studies may be made.

If it is found that it is not feasible to test some of model processes in this test area, one of the other two proposed test cases might be used. Alternatively, another area within the Nile Basin may have to be identified and used.

6.3.4 Modelling Test Case 3: Multi-Criteria-Analysis Focusing on Water Development on the Blue Nile

Multi-criteria analysis tools are to be developed as part of release-cycle 3. These tools will require a test case that permits multiple alternatives to be compared, and that includes non-commensurate evaluation criteria to be transformed for comparative analysis. This test case will therefore include the preparation within the DSS framework of several water development alternatives that are currently under evaluation in the Eastern Nile region for power development and for other purposes, including flood control, irrigation, water supply, and water quality improvement. Table 6.4 outlines the key characteristics of the proposed test case. The setup used in this test case will build on the coarse model from test case one. Further details will be added for part of the Blue Nile to accommodate the testing. As release cycle three is relatively short as compared to release cycle one, the work with detailing the model for the Blue Nile should already start prior to release cycle three to allow for sufficient time to undertake the testing in release cycle three.

Table 6.4 Key information for modelling Test Case 3

	Issue	Description
1	**Main Objective of model test**	Testing of the Multi-Criteria-Analysis (MCA) tools in the Nile Basin DSS, including the ways to get to the MCA.
2	**Release version for which it well be used**	DSS 3 - However, it should be aimed starting the work during the Release Cycle 1, where it should be aimed at setting up the water allocation modelling features necessary for the MCA testing
3	**Modelling period**	To be decided. It will depend on the availability of input data. However, part of the period 1960-1996 is likely to be selected as this is the period with best data for the Blue Nile.
4	**Model area**	The Blue Nile – this will be the focus modelling area. However, it will be nested into the coarse model for the whole Nile Basin (See Test Case 1), in order to be able to assess the impact of water development in the Blue Nile on downstream users.
5	**Size of model area**	Exact model area not yet decided.
6	**Use cases involved**	• Use Case 8: Evaluating trade offs of the dams planned in the Eastern Nile Power trade program • Use Case 19: Eastern Nile Joint Multi-Purpose Project
7	**Type of functionalities to be tested**	**Multi-Criteria-Analysis (MCA) Tools:** • Multiple MCA methods • User defined open list of criteria • Automatic model linkage • Yield and reliability analysis • Model nesting (i.e. refinement of a coarse model through detailed discretization)

IMS: Information Management System

The alternatives modelled will not be comprehensive, nor necessarily include all of the features that are included in the actual alternatives under consideration, but they will include a sufficient number of alternatives with a sufficient level of detail to permit the demonstration of the MCA tools, as well as a reasonable evaluation of how the evalua-

tion metrics generated by the NB DSS compare to those that are developed in the current on-going project planning framework.

The source data will be based on readily available reports, input data, and study results from current projects being evaluated in the Eastern Nile region. Time series ensembles (stochastically generated) will also be used in order to analyze yields and reliabilities, as well as the features of the NB DSS dealing with stochastic. In order to link physical features to socio-economic impacts virtual criteria / formula can be used to proof this functionality of the MCA analysis tools.

The MCA analysis that is developed as part of the test case will include the quantification of downstream impacts on the Main Nile, based on information available either from the current planning process or from the overall basin model that will have been developed under test case 1 for Release 1.

6.4 Data Requirements in Support of Modelling and Decision Making

During the modelling testing in WP1 and the more comprehensive model setup in WP2, a large amount of different types of data will be required for the different models and modules in the NB DSS.

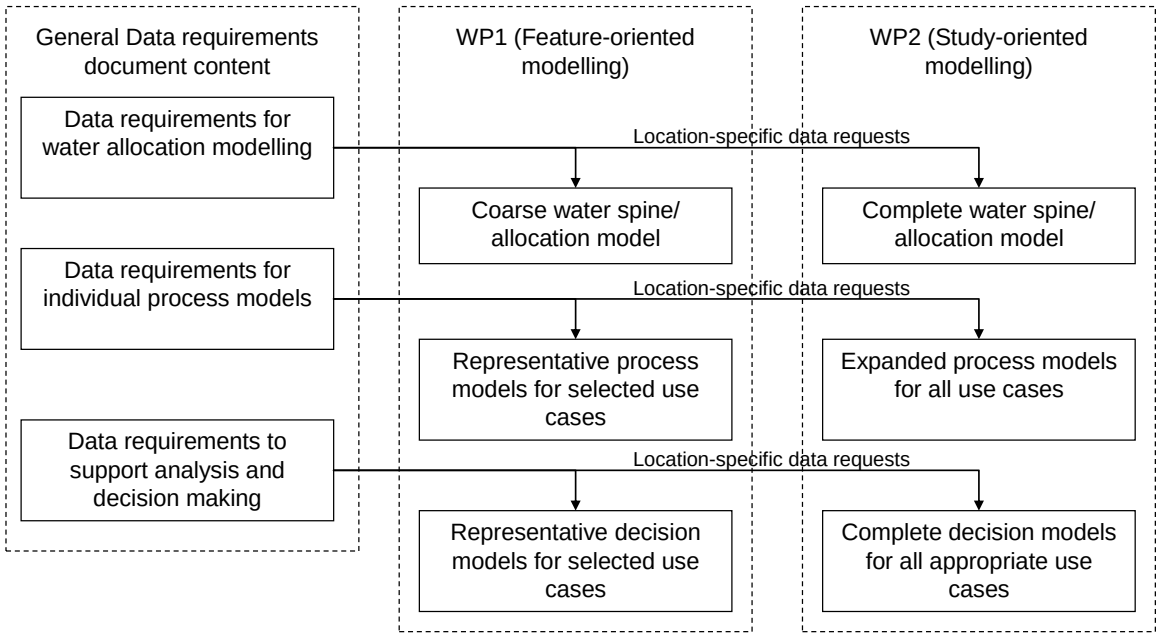


Figure 6.1 Expected application of the General Data Requirement document in relation to WP1 and WP2.

While the data requirements for the testing in WP1 will be limited compared to the comprehensive amount of data (both in time and space) that will be required in WP2, it is the same type of data that will be needed. Thus, there is a need for a common document, which lists the possible data that may be required to represent the Nile River basin and the processes and decisions associated with its development within the framework of the NB DSS.

Such a General Data Requirement document will be worked out during WP1. It will be a dynamic document, which will develop parallel to the development of the three release cycles of WP1. The document will therefore be updated with the incrementally evolving data requirements related to each release of the NB DSS. An initial version of this document is attached in **Annex E**. It emphasizes data required for water allocation modelling and draws upon past experience using MIKE BASIN at individual country levels as well as on large river basins such as the Niger River Basin. As the DSS development and modelling progress toward detailed process modelling and scenario analysis, additional data requirements will be elaborated based on the associated processes and experience with other modelling tools.

Being a general data requirement list, it will serve as a checklist for both WP1 and WP2 (as well as any future setup of the NB DSS). For each individual application, the data requirement will depend on the type, extent and details of the planned model of the NB DSS, its target group, the type of output required, etc. (cf. Figure 6.1). Although this list eventually will aim at cover the possible data that may be required for most model setups, there may be special cases where types of data which are not mentioned in the document may be needed. If data listed in the document are not available, it will also try to advice on alternative secondary data which may be used to make estimations and approximations.

The document will list the different types of data required such as time series data, spatial / GIS data and various other types of data that will be required. Templates will also be developed where relevant to ensure uniform and target-oriented preparation of data input.

The data required for testing of system functionalities in WP1 will be identified as a joint effort between the client and the consultant, taking advantage of the client's knowledge of data availability and previous studies that have been conducted in the Nile Basin. It is then the responsibility of the client, with assistance from the staff in the Nile Basin countries, to compile and quality assure the data which has been identified for the modelling test cases in WP1.

7 PROJECT IMPLEMENTATION PLAN

As part of the Inception phase the Consultant shall refine the preliminary Project Implementation Plan that was submitted as part of the Consultant´s proposal (ToR, section 2.2.3).

The Project Implementation Plan describes the Consultant´s approach to the development of the NB DSS with due consideration of the ToR, the Consultant´s Proposal and the constraints given by the Consultant´s contract with the NBI.

7.1 Commencement of Services

The Contract was signed by the NBI and DHI on May 13th 2009. The official Commencement of Services is May 15th 2009. The duration of the project is 36 months implying that the project completion date is 15th May 2012.

7.2 Inception Phase Milestones

The key mile-stones during the Inception phase include:

- 15th May: Commencement of Services.
- 19th May – 5th June: Launching workshop and working sessions with the Core Team.
- 4th July: Draft Inception Report submitted (excluding the SAD)
- 18th August: Draft SAD submitted.
- 23rd – 31st August: Inception workshop in Alexandria and working sessions with the PMU in Cairo.

All submissions by the Consultant have been made in accordance with agreements made with the Client.

Following the Inception Workshop it was agreed to enhance the Inception Report substantially. In particular the Software Requirement Specification and the Software Architecture Document needed further elaboration in order to meet NBI's requirements. A revised submission plan was agreed and a revised Draft Inception Report was submitted (late October 2009) and followed by a thorough review process involving the NBI PMU, the DSS Core Team and a number of NBI advisors (consultants). The Final Inception Report (this report) was submitted on 2nd December 2009. It has further been agreed that Cycle 1 will commence at 1st January 2010 (following approval of the Inception phase). The actual Duration of the Inception phase consequently comes close to 7½ months which is 4½ months more than identified by the ToR.

7.3 Contents of the Project Implementation Plan

The Project Implementation Plan contains the following elements:

- The Project Organisation and Management Plan
    - Project Management
    - Project Staffing
    - Project Change Control Board

- A Delivery and Installation Plan which include:
    - A Project Deliverable schedule
    - Software Release schedule
    - Feature sets (functional/non-functional requirements) associated with each software release

- Task, Time and Resource schedules, which for each development cycle includes:
    - A Deliverable Schedule
    - An Activity Schedule
    - Task Assignments and Staffing Schedules

- A Training Plan
    - A schedule and objectives of training activities

- A Warranty Service Plan

- A Post-Warranty Technical Support Plan

The starting point is the preliminary PIP included in the Consultants proposal. The revised PIP has been revised based on information, agreements and lessons-learned during the Inception Phase. The PIP will be a "live" document and will be revisited regularly to reflect the actual project progress and plans. The latest version of the PIP will be

made available on the Project Web Site (to be established on completion of the Inception Phase).

7.4 Project Organisation and Management Plan

The Project Organisation and Management Plan is included as Chapter 2 of this Inception Report.

7.5 Delivery and Installation Plan

All project deliverables including software installations are described as part of the detailed work plan presented for each project phase in Section 7.6.3 - 7.6.7.

A feature release plan for each of the three NB DSS releases is presented in Section 7.7. This feature release plan presents a slightly modified release plan as compared to the ToR. In agreement with the Client, some reduction of the feature set for NB DSS release 1 has been made in order to avoid an unacceptable delay of the first NB DSS release. Missing features in NB DSS release 1 will be carried over to NB DSS release 2 and 3.

7.6 Task, Time and Resource Schedules

This section outlines the key deliverables and the related activity- and staffing schedules for each project cycle.

As described earlier, the Inception phase has been delayed by approximately 4½ months. A very substantial amount of work has been invested in the Inception Phase activities and in producing an Inception Report that meets the Client´s requirements.

The Consultant is highly committed to minimize the negative impacts on the subsequent project phases caused by the Inception phase delay and to deliver the final NB DSS release on schedule. In agreement with the Client the Consultant has established a revised project work plan which is presented in this Section. The revised project work plan involves postponement of intermediate deadlines but delivers the final NB DSS on schedule.

7.6.1 Overall Project Work Plan

The project is sub-divided into five phases. The inception phase, followed by three software release cycles and a consolidation phase. Each software release cycle is further subdivided into a detailed requirement analysis and design phase, a system development phase and a testing and feedback phase. At the end of the system development phase an NB DSS release will be available for the testing and feedback phase (work package 2). Prior to each NB DSS release the Consultant will test new software both as an integral part of the software development process and as a more integrated system test as part of the WP1 modelling activities.

The revised overall time-schedule with the three NB DSS releases are is shown in Figure 7.1.

ID	Activity Name	Project Month	Approx. Start	Approx. Finish
1	**Inception Phase**	**1-8**	15-05-2009	31-12-2009
2	**Cycle 1 – DSS Release 1**	**8-25**	**01-01-2010**	**15-06-2011**
3	Detailed requirement analysis and design	8-11	01-01-2010	31-03-2010
4	System development	11-16	01-04-2010	15-09-2010
5	Testing and Feedback	17-25	16-09-2010	15-06-2011
6	NB DSS Release 1	16	15-09-2010	15-09-2010
7	**Cycle 2 – DSS Release 2**	**16-30**	**15-09-2010**	**15-11-2011**
8	Detailed requirement analysis and design	16-19	15-09-2010	15-12-2010
9	System development	20-25	16-12-2010	15-06-2011
10	Testing and Feedback	26-30	16-06-2011	15-11-2011
11	NB DSS Release 2	25	15-06-2011	15-06-2011
12	**Cycle 3 – DSS Release 3**	**25-36**	**15-06-2011**	**15-05-2012**
13	Detailed requirement analysis and design	26-28	15-06-2011	15-09-2011
14	System development	29-30	16-09-2011	15-11-2011
15	Testing and Feedback	31-36	16-11-2011	15-05-2012
16	NB DSS Release 3	30	15-11-2011	15-11-2011
17	**Consolidation**	**33-36**	**15-01-2012**	**15-05-2012**
18	System Completion, Deployment and user training	33-36	15-01-2012	15-05-2012
19	Project Conclusion	36	15-05-2012	15-05-2012

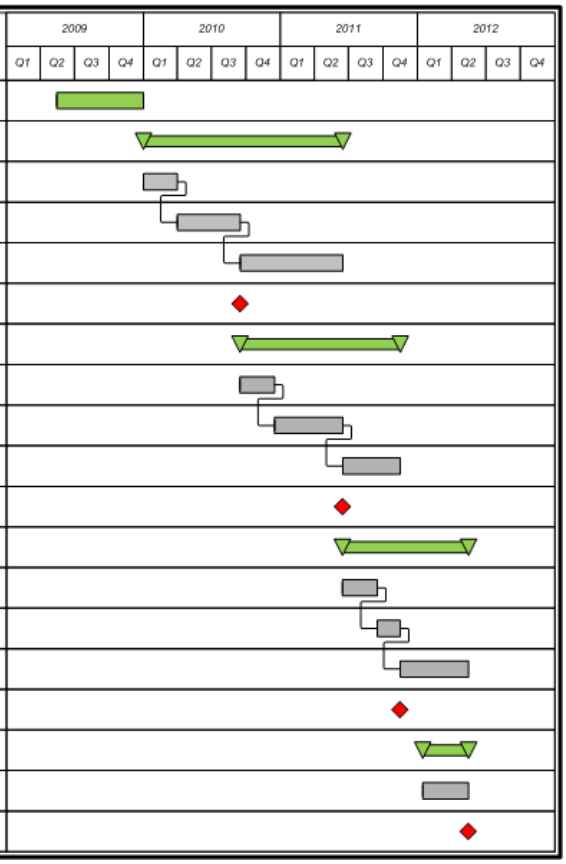


Figure 7.1 Project Implementation Plan with high level project tasks and NB DSS releases (start and finish dates are approximate)

7.6.2 Overview of Project Staffing and Time Allocations

The following section outlines the approximate time allocations for the Consultant key staff members. Subsection 7.6.3 - 7.6.7 provides more detailed information on staff schedules and assignments for each project phase. It should be emphasized that the staff schedules proposed by the Consultant are tentative schedules. These will be revisited regularly by the Client and Consultant in order to optimise the usage of staff resources.

During the Inception phase the Consultant has obtained more information regarding NBI's requirements and expectations. On this basis the Consultant has revisited the staffing- and task allocation schedule that was presented in the Consultant´s proposal. This has lead to some redistribution of time and task allocations among the key-staff members. These redistributions are proposed in due consideration of the ToR, the Consultants proposal and the Contract including the available budget, with the purpose of optimising the usage of Consultant staff and competencies to ensure timely deliveries to the satisfaction of the Client.

The reasoning behind the proposed reallocations is provided later in this section. In summary the proposed redistribution of time are:

- Deputy Team Leader/Senior Software Developer (Mr. Ekebjærg) – 3 additional person months.
- IMS/Database Specialist (Dr. Klinting) – 2 additional person-months.

- Senior Water Resources Specialist (Dr. Brazil) – 2 additional months.

These additional person months are obtained by:

- Reducing the input of the GIS Specialist from 4 to 1 person-month.
- Reducing the input of the DSS Specialist from 8 to 6 person-months.
- Reducing the pool-of-expert time from 12 to 10 person-months.

Table 7.1 shows the resulting allocated time for Consultant's key-experts. For comparison purposes, the table also shows the original allocation as per the Consultant´s proposal. In total the Consultant´s budget (International staff) amounts to 66.5 person months. Redistribution of time among the consultant key-staff is done in an attempt to optimise the use of staff resources and to ensure as much field-time (face-to-face) as possible within the constraints given by the Consultant´s budget.

Team Leader (Mr. Sørensen): Mr. Sørensen's time allocation remains at 12 person-months on total. It is proposed that Mr. Sørensen will spend more time at the home office. The Inception phase has proven a large need for co-ordination and client liaison and substantial reporting requirements. These activities require an increased home office allocation for Mr. Sørensen. Further, more field time is required for some of the more technical staff members, which then require a reduction of field time elsewhere. In practice the reduction of field time for Mr. Sørensen will imply that Mr. Sørensen will join most or all work sessions with the NBI but not always stay for the full duration of the work-sessions. For instance, Mr. Sørensen will join the detailed requirement analysis sessions in the beginning of each development cycle, but will not stay for the full period.

Senior WRM Specialist (Dr. Brazil) Dr. Brazil will play an important role on the project. He will contribute with substantial domain knowledge and past DSS implementation experiences. Further his past experiences with the NBI have proven valuable for the Consultant team as well as for the NBI. Dr. Brazil will also play an important role in the DSS design - in particular in relation to the MCA and CBA aspects where he will work closely with the DSS specialist. Dr. Brazil's time will largely be spent on field-time in connection with requirement analysis, review workshops and training. Dr. Brazil has been allocated two additional man-months. The extra man-months have been transferred from the time allocated for the DSS specialist. To optimise staff usage, Dr. Brazil will represent the DSS Specialist during the detailed requirement analysis and design phases in cycle 1 and cycle 2 and work as required with the DSS Specialist at the home office (RTi). The DSS Specialist (Dr. Woodbury) will join the last requirement analysis session where MCA and CBA will be essential.

Deputy Team Leader/Senior Software Engineer (Mr. Ekebjærg). It is proposed to increase Mr. Ekebjærg's time allocation by 3 person months. Mr. Ekebjærg is essential for the co-ordination of the software development activities and he is responsible for the overall software architecture and design decisions. His experience in building similar large, integrated software systems has proven invaluable for the NB DSS Project. Based on the findings of the Inception Phase the Consultant´s does not consider it realistic that his duties can be covered within the original time allocation. Further, additional field

time is required to enable Mr. Ekebjærg to spend sufficient time with the NBI staff in connection with the detailed requirement analysis and design activities. It is proposed to allocate additional 2 field months and 1 home-office month for Mr. Ekebjærg. This time is provided by reducing the allocation for the pool of experts (2 months) and the GIS specialist (1 month). Mr. Ekebjærg will, in co-operation with Dr. Klinting, take over the GIS related software development activities.

Water Resources Modeller (Dr. Lørup) Dr. Lørup´s time remains unchanged. Hi´s primary role will be to work with the proof-of-concept test cases (modelling in WP1). Further, he will be involved in all training activities throughout the project.

DSS Specialist (Dr. Woodbury). Dr. Woodbury's time has been reduced by 2 person-months which has been transferred to Dr. Brazil. Dr. Woodbury will be involved in the MCA and CBA developments with focus on requirement analysis and design phases. Dr. Woodbury will join the detailed requirement analysis in development cycle 3 (with focus on CBA/MCA). At the home-office Dr. Woodbury will work with the software development team in regard to MCA software development and testing. In addition Dr. Woodbury will take part in the WP1 modelling and training activities and will play important role in regard to system testing. Dr. Brazil will join all the detailed software requirement work sessions and will take over Dr. Woodbury's role (DSS specialist) in the cycle 1 and cycle 2 sessions.

Software Developer/System Integrator (Mr. Michael). Mr. Michael´s total time allocation remains unchanged. One month has been moved from home to field work to accommodate for his participation in detailed requirement analysis and design sessions in all cycles.

IMS Database Specialist (Dr. Klinting). Dr. Klinting has been allocated two extra person-months (field time) to accommodate for his participation in detailed requirement analysis and design work sessions. Dr. Klinting will work closely with Mr. Ekebjærg and Mr. Michael throughout the project. The extra two person months have been transferred from the GIS Specialist allocation. Dr. Klinting will take over the GIS software development activities, in co-operation with Mr. Ekebjærg.

GIS Specialist (Nils C. Babel). Mr. Babel is, in agreement with the Client, replacing Dr. Schneider who is no longer with the RTi. Mr. Babel has been approved by the NBI. It is further proposed to reduce the time allocated for the GIS expert from 4 months to 1 month. The Consultant does not foresee a need for GIS specialist inputs in the order of 4 months. Many staff members have good GIS working experience both in regard to using GIS tools and using GIS components as part of software development. Most GIS functionality in the NB DSS will be provided by ThinkGeo and PostGIS. The GIS specialist will primarily be reponsible for the GIS tools that are not already included in ThinkGeo/PostGIS (e.g. Catchment delineation). The GIS specialist will be involved only in the requirement analysis and design stages while software development (implementation) will be carried out by the software development team.

Water Resources Economist (Mr. Walton). Mr. Walton's input remains at one month. His participation is not expected until development cycle two. His input is mainly seen in relation to CBA and MCA where economic indicators will be important. Mr.

Walton's input is not considered important in regard to the overall software architecture and design. Therefore, Mr. Walton has not yet contributed to the project.

Environmental Management/Bio-diversity Conservation Specialist (Dr. Ballofet). Dr. Ballofet's's input remains at one month. His participation is not expected until development cycle two. His input is mainly seen in relation to CBA and MCA where environmental and ecological indicators will be important. Dr. Ballofet's input is not considered important in regard to the overall software architecture and design. Therefore, Dr. Ballofet has not yet contributed to the project.

Pool of Experts. The time available for the pool-of-experts has been reduced from 12 to 10 man-months. These 2 person-months are allocated to Mr. Ekebjærg to accommodate for his increased involvement in the software management and development activities.

Table 7.1 Allocation of Key Expert Staff Months as per the Consultant's Contract and as Suggested following the findings of the Inception Phase.

			Contract	Revised
Team leader	DHI	[home]	3	5
Mr. Henrik R. Sørensen		[field]	9	7
		[total]	12	12
Senior WRM Specialist	Rti	[home]	1	2
Dr. Larry Brazil		[field]	4	5
		[total]	5	7
Deputy Team Leader/Senior Software Engineer	DHI	[home]	2	3
Mr. Lars C. Ekebjærg		[field]	4	6
		[total]	6	9
Water Resources Modeler	DHI	[home]	1	1
Dr. Jens K. Lørup		[field]	4,5	4,5
		[total]	5,5	5,5
DSS Specialist	Rti	[home]	2	2
Dr. Mark Woodbury		[field]	6	4
		[total]	8	6
Software Developer System Integrator	DHI	[home]	4	3
Mr. Lars Michael		[field]	2	3
		[total]	6	6
IMS Database Specialist	DHI	[home]	3	3
Dr. Anders Klinting		[field]	3	5
		[total]	6	8
GIS Specialist	RTi	[home]	3	0,25
Mr. Babel		[field]	1	0,75
		[total]	4	1
Water Resources Economist	Mott	[home]	0	0
Mr. Walton		[field]	1	1
		[total]	1	1
Environmental Management Specialist	RTi	[home]	0	0
Dr. Ballofet		[field]	1	1
		[total]	1	1
Pool of Experts		[home]	8	8
		[field]	4	2
		[total]	12	10
Total person months		[home]	27	27,25
		[field]	39,5	39,25
		[total]	66,5	66,5

Additional Project Staff

During the inception phase the Consultant has made important observations regarding key project tasks and achieved detailed understanding of the client's requirements. These observations are primarily achieved through the use case analysis (requirement elaboration) which has revealed the need for a highly flexible and expandable system. This has led the consultant to the reassessment of critical success factors for the remain-

ing parts of the DSS development consultancy. One of these critical success factors is the project staffing.

The consultant has identified that some critical project tasks need more emphasis than originally expected. In this regard, for the remaining parts of the NB DSS development cycle, the consultant sees the need for additional staff competencies to complement the project team. These extra tasks and competencies were not originally considered in the TOR. As such the Consultant considers them findings of the Inception Phase which are critical in order to meet NBI's requirements. In summary the findings are:

- **Complex and flexible architecture for NB – DSS**: The NB DSS is a complex system that involves a high number of different software components that interact with each other and with the database. The software components that shall be integrated with the NB DSS shall not be limited to those covered by the current contract but also enable additional components to be plugged-in by NBI in the future. Such components may include additional modelling tools or any other relevant NB DSS component. To meet these requirements, state-of-the-art plug-and-play technologies are required to ensure sufficient flexibility.

- **DSS-Database has specialized requirements**: NB DSS will build on top of a very large and complex database which must be designed for performance, robustness and maintainability. On top of the software system complexity the NBI requires a very highly detailed documentation. The level of documentation is crucial for the level of confidence to the system as well as for the future possibilities for expanding and enhancing the system (e.g. adding new software components and model tools).

- **Highly detailed technical documentation:** The complex and flexible architecture including the plug-and-play options require software (code) documentation at a level which is sufficiently detailed for software development purposes that may occur after the conclusion of the current contract. The level of details and the formalism related software documentation (detailed design, system documentation) is very high and is not fully supported within the current project staffing and budget.

The Consultant does not believe that the current project staff composition will enable the Consultant to meet NBI's requirement related to the above software development and documentation issues. The Consultant considers this as an important finding of the Inception Phase which has implications only on additional staff expertise requirement as proposed here and only for subsequent phases of the DSS development exercise. Therefore, the Consultant recommends that the NBI pursues funding options that would allow the following two additional project staff members:

A Solution Architect (software developer) with substantial experience in solution architecture and design of large software systems similar to the NB DSS. The Solution Architect will work closely with the Senior Software Developer (Mr. Ekebjærg) as well as the rest of the software development team. Key responsibilities and tasks will relate to:

- Architecture adherence
- Architecture and system documentation
- Data and business layer architecture

- Determine adequate Interfacing techniques (like plug and play technologies), including those for wrapping legacy software and/or third party products.

- Contribute substantially in producing technical documents that meets the requirements of the Client.

A Very Large Database Expert (software developer) with substantial experience database design patterns as well as their implementation. The VLDB Expert will work closely with the rest of the software development team and complement the work of the IMS/Database expert. Key responsibilities and tasks will relate to:

- Technical lead for database optimisation tasks such as creating and implementing design patterns, database interfacing techniques and design of static structures of the database.

- Participated in Database / GIS related activities.

7.6.3 Inception Phase

The duration of the Inception phase is, in the ToR, scheduled for 3 months following the Commencement of services (May 15th 2009). Assuming that the Inception phase will be approved by mid December 2009 and that Cycle 1 will start 1st January 2010, the project is approximately 4½ months delayed.

Deliverables and Activities

Table 7.2 lists the deliverables of the Inception phase. Activities during the Inception phase are listed in Table 7.3.

Table 7.2 Deliverable Schedule for the Inception Phase as defined by the ToR.

No.	Process/Deliverable	Comments	Approx. delivery time (Project Month)
1	Launching Workshop	First joint coordination meeting to be held back-to-back with the Launching Workshop.	PM 1
2	Web-based systematic issue tracking system	- System made available at the time of submitting inception report - Orientation to be provided during review workshop.	PM 2 PM 3
3	Data requirements document	Preliminary data requirements document to be delivered during launching workshop	PM 3
4	Inception report with technical annexes o Detailed Requirement Specification	The Inception Report shall be enhanced based on the comments from the client and re-submitted for review and approval.	PM 3

	(SRS) o Software Architecture and Design Specification (SAD)		
5	Review Workshop	Consultant shall avail its relevant key staff to participate and present the deliverables of the Inception Phase. o Document deliberations of the workshop in a formal workshop minutes.	PM 3

Due to the required modifications of the Inception Report and the agreed resubmission schedule the final Inception Report (deliverable #4) was not been submitted until project month 7.

Deliverable #1 Launching Workshop

The launching workshop and the subsequent coordination meetings were held in Addis Ababa during the period 19th May – 5th June. Work sessions with the DSS Core Team to refine the functional requirements listed in the ToR were one of the key activities during the workshop. In this regard a number of user stories were elaborated by the DSS Core Team. A summary of these activities are provided in Section 3.1. Use cases are included in Appendix B.

Deliverable #2 Issue Management System

Originally DHI proposed using DHI's standard issue tracking system (TestTrack). Following presentations and discussions at the Launching Workshop the Client expressed concerns regarding the relatively low level of integration between the different processes (requirements, test cases, issues and tasks) provided by the TestTrack system. In agreement with the Client the Consultant has replaced TestTrack by a different system (SpiraTeam) which meets the Client's recommendations. SpiraTeam is ready for use during development Cycle 1. The Consultant has subsequently received additional recommendations from the Client regarding the use of SpiraTeam. These are:

- Integrate the .net development environment (link with code) – this will be done using "ChangeLists". Using ChangeLists requirements and/or defect fixes will be linked to the source code (in the version control system) and vice-versa.

- Integrated UML editing tool. Currently we are using MS Visio - at DHI the EnterpriseArchitect tool is also available. The Consultant will, in consultation with the Client, evaluate if a change to this more sophisticated tool is useful (decision to be made early in the first cycle).

- Integrated testing framework/environment (function and unit testing) with all its sub-tools – is integrated in SpiraTeam.

Deliverable #3 Data Requirements Document

A preliminary data requirements document was presented at the Launching Workshop. The final document is submitted as Appendix E of this Inception Report.

Deliverable #4 Inception Report

The Inception Report (this report) was submitted 2nd December 2009. The Detailed Requirement Analysis Document and the Software Design Document that are requested by the TOR, are replaced by the Software Requirement Specification (SRS) and the Software Architecture Document (SAD) which constitute Appendix C and Appendix D of this Inception Report.

Deliverable #5 Review Workshop

The Review Workshop (Inception Workshop) was conducted in Alexandria during August 24 – 26.

Table 7.3 List of Inception Phase Activities (as scheduled in Consultant's Proposal)

ID	Activity / Description	Start (PM)	End (PM)
1.1	Consultancy Start	1	1
1.2	Launching workshop	1	1
1.3	Web-based issue tracking system	1	2
1.4	Data Requirements Document	1	3
1.5	Work plan, project activities and staffing schedule	1	3
1.6	Inception Report with technical annexes (detailed requirement analysis document, software design)	2	3
1.7	Review workshop (Inception workshop)	3	3

Task Assignments and Staffing Schedule

Task assignments during the Inception Phase are shown in Table 7.4. A staffing schedule for assignments in NBI countries is shown Table 7.5.

Table 7.4 Task Assignments during the Inception Phase for International Staff. Numbers in brackets indicate deviations from the schedule submitted with the Consultant´s proposal.

Staff / Position	**Activities**	**Remarks**
Team Leader Mr. Henrik Refstrup Sørensen	1.1, 1.2, 1.4, 1.5, 1.6, 1.7	
Senior WR Management Specialist Dr. Larry Brazil	1.1, 1.2, 1.4, 1.5, 1.6, 1.7	
Deputy TL/ Senior Software Engineer Mr. Lars C. Ekebjærg	1.2, 1.3, 1.6, 1.7	
Water Resources Modeller Dr. J. K. Lørup	1.4, 1.6, (1.7)	Participation in 1.7 was not scheduled in the Consultant's proposal, but deemed necessary for the completion of task 1.4.
Decision Support System Specialist Dr. Mark Woodbury	(1.2),1.4, 1.6	Joined launching workshop (1.2) in part but key assignment was the working sessions following the launching workshop.
IMS Database Specialist/Analyst Dr. Anders Klinting	(1.2), (1.3), 1.6. (1.7)	Mr. Klinting has played a key-role in the software requirement and design activities during the Inception phase and has participated in non-scheduled workshop activities (1.2, 1.7). This was deemed necessary both by the Client and the Consultant. Further, he has worked with Mr. Ekebjærg on (1.3) (issue tracking system).
Software Developer/System Integrator. Mr. Lars Michael	1.6	My Michael did not contribute significantly to the writing of the Draft Inception report. He did review the Inception Report and he has worked with the developer team at the Consultant's home-office in regard to software requirements and design. He has provided substantial input to the writing of the final Inception Report.
GIS Specialist. Mr. Babel	(1.6)	Mr. Babel has not been involved in the Inception phase. GIS expertise, in relation to overall software requirements and architecture, are well covered by other staff members. Further, GIS processing has not been a focal point during the Inception phase. It is anticipated that Mr. Babel will be involved in the detailed requirement analysis and design (cycle 1).

Staff / Position	Activities	Remarks
Water Resources Economist Mr. Walton	(1.6)	Mr. Walton has not been involved in the Inception phase. His expertise may be needed in during the detailed requirement analysis and design activities.
Environmental management/Bio-diversity Conservation Specialist. Dr. Ballofet	(1.6)	Dr. Ballofet has not been involved in the Inception phase. We see Dr. Ballofet's role mainly in relation to the establishment of to environmental/biological indicators which will be part of the MCA activities later in the project.

Table 7.5 International Staff Assignments in NBI Countries during the Inception Phase.

			Project Month		Sørensen	Brazil	Ekebjærg	Lørup	Woodbury	Michael	Klinting	Babel	Walton	Ballofet
ID	ToR deliverable no.	Activity / Description	Start	End	Consultant Staff Assignments during the Inception Phase									
1.1		***Inception Phase***	***1***	***8***										
1.1		Consultancy Start	1	1										
1.2	1	Launching workshop	1	1	✓	✓	✓				✓			
1.2.1		Working sessions with DSS Core Team (in continuation of launching workshop)	1	1	✓	✓	✓	✓	✓		✓			
1.3	2	Web-based issue tracking system	1	3										
1.4	3	Data Requirements Document	1	3										
1.5		Work plan, project activities and staffing schedule												
1.6	4	Inception Report with tecnical Annexes	3	4										
1.7	5	Inception/Review Workshop and follow up meetings with the PMU (3 days workshop + follow up meetings with the Client)	4	4	✓	✓	✓	✓			✓			
1.7.1		Working sessions following the Inception Workshop	4	4	✓	✓	✓	✓		✓	✓			
1.7.2		Completion of Inception Report	4	7										

Table 7.5 shows the assignment of Consultant staff in NBI countries during the Inception phase. A total of about 6 person-months divided among 7 Consultant staff members, have been spent in Addis Ababa and in Alexandria/Cairo in connection with the launching workshop (~ 3 weeks in Addis Ababa) and the inception workshop and related work sessions with the DSS core team and the PMU (~ 2 weeks in Alexandria/Cairo). A very substantial amount of time has been spent at the home office, primarily related to producing the Software Requirement Specification (Appendix C) and the Software Architecture Documents (Appendix D) which constitute key deliverables

of the Inception phase. Home office activities during the Inception Phase have mainly been related to the following issues:

- Preparations for launching workshop and inception workshop.
- Web based issue tracking system.
- Draft software requirement specification and draft software architecture and design document.
- Data requirement document.
- Work plan and remaining parts of the Inception report.
- Completion of final Inception Report following comments and recommendations received at the Inception Workshop.

7.6.4 Development Cycle 1

System development cycle 1 is entered upon Client approval of the Inception Report. In agreement with the Client the scheduled Cycle 1 entry date is 1st January 2010.

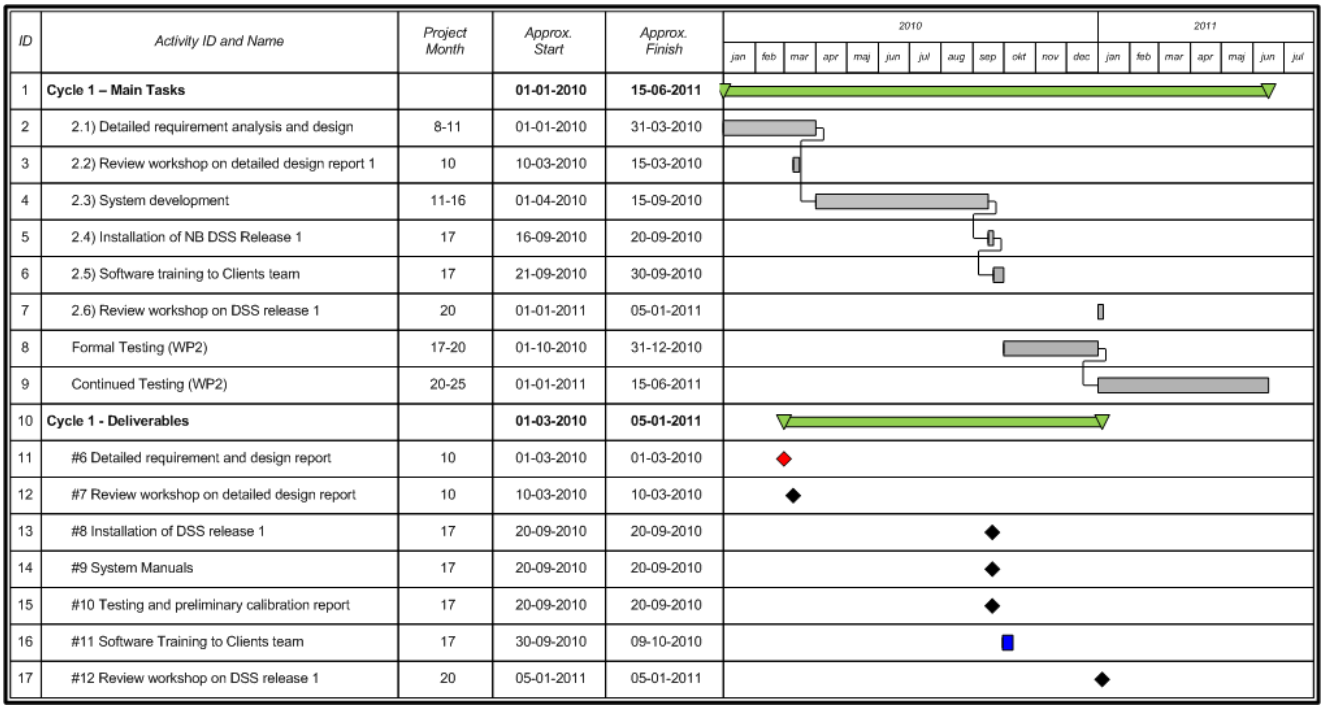
Deliverables and Activities (Cycle 1)

The deliverables of System Development Cycle 1, as described in the ToR, are listed in Table 7.6. A schedule of deliverables and activities is provided in Figure 7.2.

Table 7.6 Deliverable Schedule for System Development Cycle 1.

Deliverable No.	Process/Deliverable	Comments
6	Detailed Requirement Analysis, Specification and Design Report 1.	*Note: Draft Report to be submitted approximately 2 months after entering Cycle 1. Review of the deliverables and the Review Workshop shall be completed approximately 1 month after submission of the Draft Report.*
7	Review workshop on detailed design report 1	Consultant shall: • Avail its relevant key staff to participate and present deliverables. • Document deliberations of the workshop in a formal workshop minutes. *Note: Approximately 2 day workshop to present deliverables and consolidate comments for the draft detailed requirement analysis and design report.*
8	DSS Release 1	○ To be submitted in 15 installation CD's ○ Consultant shall install DSS Release 1 at the WRPM PMU.

9	System Manuals	
10	Testing and Preliminary calibration Report	*Note: It is anticipated that this deliverable will summarise the activities related to testing and WP1 modelling. Test results will, to a large extent, be auto generated as SpiraTeam reports.*
11	User Training (DSS Release 1)	7 days training of Client staff at the NBI PMU in Addis Ababa.
12	Review Workshop on DSS Release 1	Approximately 4 day workshop in the Nile Basin. The Consultant shall: • Avail its key staff to participate in the workshop • Provide live demonstration of the DSS Release 1 • Prepare documentation of the deliberations of the workshop.



ID	Activity ID and Name	Project Month	Approx. Start	Approx. Finish
1	**Cycle 1 – Main Tasks**		**01-01-2010**	**15-06-2011**
2	2.1) Detailed requirement analysis and design	8-11	01-01-2010	31-03-2010
3	2.2) Review workshop on detailed design report 1	10	10-03-2010	15-03-2010
4	2.3) System development	11-16	01-04-2010	15-09-2010
5	2.4) Installation of NB DSS Release 1	17	16-09-2010	20-09-2010
6	2.5) Software training to Clients team	17	21-09-2010	30-09-2010
7	2.6) Review workshop on DSS release 1	20	01-01-2011	05-01-2011
8	Formal Testing (WP2)	17-20	01-10-2010	31-12-2010
9	Continued Testing (WP2)	20-25	01-01-2011	15-06-2011
10	**Cycle 1 - Deliverables**		**01-03-2010**	**05-01-2011**
11	#6 Detailed requirement and design report	10	01-03-2010	01-03-2010
12	#7 Review workshop on detailed design report	10	10-03-2010	10-03-2010
13	#8 Installation of DSS release 1	17	20-09-2010	20-09-2010
14	#9 System Manuals	17	20-09-2010	20-09-2010
15	#10 Testing and preliminary calibration report	17	20-09-2010	20-09-2010
16	#11 Software Training to Clients team	17	30-09-2010	09-10-2010
17	#12 Review workshop on DSS release 1	20	05-01-2011	05-01-2011

Figure 7.2 Activity and Deliverable schedule for Cycle 1 (start and finish dates are approximate).

Task Assignments and Staffing Schedule, Development Cycle 1.

The task assignments for International Staff, during development Cycle 1 is outlined in Table 7.7 which also summarise any deviations from the preliminary task assignments presented in the Consultant´s proposal. Table 7.8 provides a tentative assignment schedule for International Staff working in the NBI countries (field-time) during development cycle 1.

Table 7.7 Task Assignments during the Inception Phase for International Staff. Numbers in brackets indicate deviations from the schedule submitted with the Consultant´s proposal.

Staff / Position	**Activities**	**Remarks**
Team Leader Mr. Henrik Refstrup Sørensen	2.1, 2.2, (2.3), 2.4, 2.5, 2.6	(2.3) In the Consultant's proposal Mr. Sørensen is not involved in the Software Development Activities. In practice Mr. Sørensen will be involved (at a software management level). Mr. Sørensen's involvement is important for the communication with the Client's project management.
Senior WR Management Specialist Dr. Larry Brazil	2.1, 2.2, (2.3), (2.4), 2.6.	(2.3 + 2.4) As compared to the consultants original implementation plan activity (2.4) has been reduced to installation only. Testing is an integral part of the system development (activity 2.3.3). Dr. Brazil will be involved in these testing activities (home office activity).
Deputy TL/ Senior Software Engineer Mr. Lars C. Ekebjærg	2.1, 2.2, 2.3, (2.4), 2.6	(2.4) Installation of software will be handled by two of the IT experts on the project (i.e. Mr. Ekebjærg, Dr. Klinting and Mr. Michael). Thus Mr. Ekebjærg may not be involved in installation of all 3 DSS releases.
Water Resources Modeler Dr. J. K. Lørup	(2.1), (2.3), 2.5	(2.1) No field time allocated for Dr. Lørup for this activity. His hydrological and hydraulic modelling expertise is well covered by Dr. Brazil and Mr. Sørensen. Dr. Lørup will be involved at the home office. (2.3) Dr. Lørup will be involved in testing activities which are also considered part of the software development activities.
Decision Support System Specialist Dr. Mark Woodbury	(2.1), 2.5	(2.1) It is proposed not to involve Dr. Woodbury in the detailed requirement analysis of cycle 1. He will be involved in cycle 3 where MCA, which will be his main responsibility, is included. In cycle he is well covered by Dr. Brazil and Mr. Sørensen.
IMS Database Specialist/Analyst Dr. Anders Klinting	2.1, 2.3, 2.4, 2.5	
Software Developer/System Integrator Mr. Lars Michael	2.1, 2.3, (2.4)	(2.4) Mr. Michael was not involved in installation of software in the consultant´s proposal. He will supplement Mr. Ekebjærg and Dr. Klinting (see comment at Mr. Ekebjærg).
GIS Specialist Mr. Babel	2.1, (2.3)	(2.3) Mr. Babel will not be involved in Software Developments but only in detailed requirement analysis and design. Software development activities will be carried by DHI's software development team.

Water Resources Economist Mr. Walton		
Environmental Management/Bio-diversity conservation specialist Dr. Ballofet		

Table 7.8 Assignment Schedule for International Staff in NBI Countries (Cycle 1).

			Project Month		Sørensen	Brazil	Ekebjærg	Lørup	Woodbury	Michael	Klinting	Babel	Walton	Ballofet
ID	ToR deliverable no.	Activity / Deliverable Cycle 1	Start	End	Assignment Schedule for Consultant Staff working in NBI Countries									
Development Cycle 1 - DSS Release 1			***8***	***25***										
Detailed Requirement Analysis and Design Stage			*8*	*11*										
2.1		detailed requirement analysis and design	8	11	✓	✓	✓			✓	✓			
	6	Detailed Requirement Analysis and Design Report	10	10										
2.2	7	Review workshop on detailed design report 1	10	10	✓	✓	✓			✓				
2.2.1		Enhance Report and Submit Final Report	10	11										
2.2.2		Client Approval	11	11										
System Development Stage			***11***	***17***										
2.3		Software Development (DSS Rel. 1)	11	16										
2.3.1		Joint development session in Denmark	13	13										
2.3.2		Joint development session in Addis Ababa	15	15	✓		✓			✓	✓			
2.3.3		Testing and Proof of Concept (WP1 modelling)	11	16				✓	✓					
2.4	8	Installation of DSS release 1	17	17			✓			✓				
	9	System Manuals	17	17										
	10	Testing and preliminary calibration report	17	17										
2.5	11	Software Training to Client´s team in Addis Ababa	17	17	✓			✓	✓		✓			
Testing Stage			***17***	***25***										
WP2 activity		Formal Testing (by WP2)	17	20										
2.6	12	Review workshop on DSS release 1	20	20	✓	✓	✓							
WP2 activity		Continued Testing (by WP2)	20	25										

Table 7.8 provides an overview of the scheduled staff input for Consultant staff working in NBI countries. It is anticipated that a total of 7-8 person-months will be spent in Addis Ababa during development cycle 1. Further, a substantial amount of work will be spent at the Consultant´s home office related to software development, project management, reporting and documentation.

Activity 2.1 Detailed Requirement Analysis and Design

Consultant staff will work closely with Client staff during the detailed requirement analysis and design stage. As part of Activity 2.1 relevant Consultant staff will work with Client staff in Addis Ababa for a period of 2-3 weeks as indicated in Table 7.8.

Prior to the assignment the NBI PMU and the Consultant will agree on detailed contents of the detailed requirement analysis and design report and on the methodology to be used during the detailed requirement analysis and design phase. Subsequently, NBI and Consultant staff will meet in Addis Ababa and work jointly on the detailed requirement analysis and design.

It is anticipated that Consultant staff and the PMU works for 4-5 days on detailing the contents of the detailed requirement analysis and design report and on requirement analysis on selected topics. The DSS Core team will then join for 2-3 days where initial findings will be presented and discussed with the DSS Core Team. Subsequently, key consultant staff and the PMU will continue with work sessions on detailed requirement analysis and design. Key Consultant software development staff will work with the PMU for the full 3 weeks while other staff members may only be involved in the requirement analysis activities. It is anticipated that the main focus during the assignment in Addis Ababa will be on requirement analysis. Subsequently, the consultant will continue with detailed design.

The detailed requirement analysis and design report will be completed at the Consultant's home office. Frequent interactions with the PMU will be take place via telephone / skype communication. The draft report is due approximately 2 months after entering cycle 1. Hence, following the workshop with the PMU in Addis Ababa, the Consultant will have approximately 1 calendar month to complete the draft report.

The ToR stipulates that three joint work sessions should be carried out during the development phase of cycle 1 (two in Denmark and one in Addis Ababa). Due to the delayed entry and reduced duration of development cycle 1, the Consultant has scheduled only two joint work sessions (activity 2.3.1 and 2.3.2) during the software development phase of Cycle 1. The Consultant proposes that the third joint work session be held in Denmark during the detailed requirement analysis and design phase. The focus of the joint development session would be status and discussion on the detailed design. This will be agreed in more detail with the Client immediately after the approval of the Inception phase.

Activity 2.2 Review Workshop on Detailed Requirement Analysis and Design

The Draft Detailed Requirement Analysis and Design Report will be submitted approximately two months after entering cycle 1. The Review workshop will be held approximately two weeks after submitting the draft report. Prior to the workshop the Client will provide preliminary comments in writing. These comments will then be consolidated as part of the review workshop and a final report will be submitted.

It is anticipated that the Review workshop will last 2 days and involve the DSS core team and key consultant staff as indicated in Table 7.8. Following the review workshop consultant staff will work for 3 days with the PMU to consolidate the comments and findings of the review workshop and agree on a report revision plan.

Activity 2.3 Software Development – NB DSS Release 1.

Software development and software testing is a continuous activity during the system development phase. The software development activities are carried out in accordance with the Project Handbook (Appendix A) which describes the Consultant´s internal software development procedures. All software documentation and test results will be entered into SpiraTeam which will be accessible by the NBI PMU through a web client. A brief description of the approach to software development and planning of software development activities is provided in Section 0. This section also provides an overview of the current level of planning for cycle 1. Detailed software development plans will be established in parallel with the detailed requirement analysis and design. Software development plans will also be available in SpiraTeam.

Activity 2.3.1 and 2.3.2 Joint Development Sessions.
Two joint development sessions (Activity 2.3.1 and 2.3.2) are scheduled during the System Development Stage. One session will be held in Denmark and one at the PMU in Addis Ababa. Each session will have duration of 4-5 days and involve key Consultant and PMU staff. The ToR suggests a 3rd development session (in Denmark). Due to the delayed entrance to development cycle 1 the Consultant suggests that this last session is moved to the detailed requirement and analysis stage (see Activity 2.1 description above).

The most important purpose of the joint development sessions is, for the Client, to get an early impression of the actual feature implementations prior to each NB DSS release. The joint development sessions will typically focus on the following issues:

- Status on on-going software development activities including software demonstrations.
- Plans for up-coming activities.
- Technical discussion (on specific issues)
- Change management (change control board meeting whenever required).

Activity 2.3.3 Testing and Proof-of-Concept
The Testing and Proof-of-concept activities will include internal testing (WP1) as well as external testing (formal and continued testing WP2). Testing and Proof of concept will go on in parallel with software developments and the internal release of new intermediate versions. Basic (pre-release) software testing will take place at the Consultants home office. One work-session focusing on WP1 modelling is scheduled in Addis Ababa and will involve the Consultant´s Water Resources Modeller and DSS Specialist. Frequent, (remote) interactions with the PMU are envisaged during the WP1 modelling activities. The Testing and preliminary calibration report (deliverable #10) will include the test results (all tests) and document the work on the WP1 modelling.

Activity 2.4 Installation of DSS release 1.
Two Consultant staff members will install NB DSS release 1 at the Client´s office in Addis Ababa. It is anticipated that the installation can be completed within 2-3 days. As part of the installation the Consultant will test the NB DSS using one or more of the models established as part of Activity 2.3.3.

Activity 2.5 Software Training to Client´s Team in Addis Ababa
Three Consultant staff members (Water Resources Modeller, DSS Specialist and one of the IT experts) will conduct a 7 day training course in Addis Ababa. The training will involve the DSS Core team. The training will be focused on the test cases used for the WP1 modelling activities. Consultant staff will meet with the PMU in Addis at least 1 day prior to the start of the training in order to ensure that all model data sets and installation are working correctly. The Consultant Team Leader will join the last part of the training in order to get feed backs from the participants.

Activity 2.6 Review workshop on DSS release 1.
Three Senior Consultant staff members will join the review workshop on DSS release 1 (Team Leader, Senior Water Resources Management Expert and Senior Software Engineer). The objectives and contents of the workshop will be as per the ToR.

Comments and refinements suggested at the review workshop will be entered in to SpiraTeam and evaluated by the Change Control Board.

7.6.5 Development Cycle 2.

Development cycle 2 is scheduled to start mid September 2010 (project month 17) and will end with the release of DSS Release 3 (scheduled for 15 Nov 2011 (project month 30). NB DSS Release 2 is scheduled for 15 Jun 2010 (project month 25). The structure (deliverables and activities) of Development cycle 2 is largely identical to the structure of development cycle 1. Therefore, the activities are described in less detail than in Cycle 1 or they simply refer directly to the description provided in Development Cycle 1.

Deliverables and Activities
Table 7.9 lists the deliverables of System Development Cycle 2 as defined by the ToR. Figure 7.3 provides a schedule of activities and deliverables.

Table 7.9 List of Deliverables, Development Cycle 2.

Deliverable No.	Process/Deliverable	Comments
13	Detailed Requirement Analysis, Specification and Design Report 2.	*Note: Draft Report to be submitted approximately 2 months after entering Cycle 2. Review of the deliverables including the Review Workshop shall be completed approximately 1 month after submission of the Draft Report.*
14	Review Workshop on Detailed design report 2.	Consultant shall: o Avail its relevant key staff to participate and present the deliverables. o Document deliberations of the workshop in a formal workshop minutes. *Note: 2-3 day workshop in the Nile Basin.*
15	DSS Release 2	o To be submitted in 15 installation CD's o Consultant shall install DSS Release 2 at the WRPM PMU.
16	System Manuals	
17	Testing and Preliminary calibration Report	*Note: Limited model calibration will be conducted in WP1. The primary purpose of WP1 modelling is testing and proof of concept. An outline of expected modelling activities is provided in Chapter 6.*
18	User Training (DSS Release 2)	7 days training of Client staff at the NBI PMU in Addis Ababa.

19	Review Workshop on DSS Release 2	Approximately 4 day workshop in the Nile Basin. The Consultant shall: • Avail its key staff to participate in the workshop • Provide live demonstration of the DSS Release 1 Prepare documentation of the deliberations of the workshop.

ID	Activity ID and Name	Project Month	Approx. Start	Approx. Finish
1	**Cycle 2 – Main Tasks**		**15-09-2010**	**15-11-2011**
2	3.1) Detailed requirement analysis and design	17-19	15-09-2010	15-12-2010
3	3.2) Review workshop on detailed design report 2	19	01-12-2010	06-12-2010
4	3.3) System development	20-25	16-12-2010	15-06-2011
5	3.4) Installation of NB DSS Release 2	26	16-06-2011	20-06-2011
6	3.5) Software training to Clients team	26	21-06-2011	30-06-2011
7	3.6) Review workshop on DSS release 2	28	05-09-2011	09-09-2011
8	Formal Testing (WP2)	26-28	17-06-2011	16-09-2011
9	Continued Testing (WP2)	29-31	17-09-2011	15-11-2011
10	**Cycle 2 - Deliverables**		**15-11-2010**	**09-09-2011**
11	#13 Detailed requirement and design report	18	15-11-2010	15-11-2010
12	#14 Review workshop on detailed design report	19	25-11-2010	25-11-2010
13	#15 Installation of DSS release 2	26	20-06-2011	20-06-2011
14	#16 System Manuals	26	20-06-2011	20-06-2011
15	#17 Testing and preliminary calibration report	26	20-06-2011	20-06-2011
16	#18 Software Training to Clients team	26	30-06-2011	09-07-2011
17	#19 Review workshop on DSS release 2	28	09-09-2011	09-09-2011

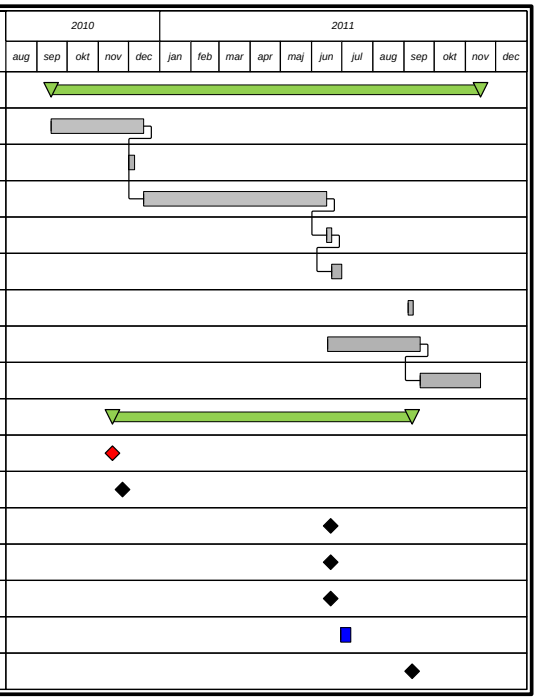


Figure 7.3 Activity and Deliverable schedule for Cycle 2 (start and finish dates are approximate).

Task Assignments and Staffing Schedule, Development Cycle 2.
Task assignments during cycle 2 are listed in Table 7.10 and a tentative schedule for international staff assignments in NBI countries are provided in Table 7.11.

The task assignments for International Staff, during development Cycle 2 is outlined in Table 7.10 which also summarise any deviations from the preliminary task assignments presented in the Consultant´s proposal. Table 7.11 provides a tentative assignment schedule for International Staff working in the NBI countries (field-time) during development cycle 1.

Table 7.10 Task Assignments during Cycle 2 for International Staff. Numbers in brackets indicate deviations from the schedule submitted with the Consultant´s proposal.

Staff / Position	**Activities**	**Remarks**
Team Leader Mr. Henrik Refstrup Sørensen	3.1, 3.2, (3.3), 3.5, 3.6	Same as in cycle 1 (see Table 7.7).
Senior WR Management Specialist Dr. Larry Brazil	3.1, 3.2, (3.3),(3.4), 3.6	Same as in cycle 1 (see Table 7.7).
Deputy TL/ Senior Software Engineer Mr. Lars C. Ekebjærg	3.1, 3.2, 3.3, 3.4, 3.6	
Water Resources Modeller Dr. J. K. Lørup	(3.1), 3.5	Same as in cycle 1 (see Table 7.7).
Decision Support System Specialist Dr. Mark Woodbury	3.1, 3.5	
IMS Database Specialist/Analyst Dr. Anders Klinting	3.1, 3.3, 3.4, 3.5	
Software Developer/System Integrator Mr. Lars Michael	3.1, 3.3	
GIS Specialist Mr. Babel	3.1, 3.3	
Water Resources Economist Mr. Walton	(3.1)	Consultant´s proposal does not contain scheduled input for Mr. Walton in cycle 2. It is proposed to involve Mr. Walton in the requirement analysis in cycle 2. His work will mainly be directed towards CBA and MCA which will be developed during cycle 3. It is however proposed to involve Mr. Walton at an earlier stage to be well prepared for the MCA activities in cycle 3.
Environmental Management/Biodiversity Conservation specialist Dr. Ballofet	(3.1)	Same as for Mr. Walton (above). Dr. Ballofet´s role will be related to defining environmental/biological indicators which may provide input for the MCA activities.

Table 7.11 Tentative Assignment Schedule for International Staff in NBI Countries (Cycle 2).

ID	ToR deliverable no.	Activity / Deliverable Cycle 2	Project Month Start	Project Month End	Sørensen	Brazil	Ekebjærg	Lørup	Woodbury	Michael	Klinting	Babel	Walton	Ballofet
					Assignment Schedule for Consultant Staff working in NBI Countries									
Development Cycle 2 - DSS Release 2			***17***	***30***										
Detailed Requirement Analysis and Design Stage			*17*	*19*										
3.1		detailed requirement analysis and design	17	19	✓	✓	✓			✓	✓	✓	✓	✓
	13	Detailed Requirement Analysis and Design Report	18	18										
3.2	14	Review workshop on detailed design report 2	18	19	✓	✓	✓							
3.2.1		Enhance Report and Submit Final Report	18	19										
3.2.2		Client Approval	19	19										
Software Development Stage			***20***	***26***										
3.3		System Development - Release Cycle 2	20	25										
3.3.1		Joint development session in Denmark	21	21										
3.3.2		Joint development session in Addis Ababa	22	22	✓		✓			✓	✓			
3.3.3		Testing and Proof of Concept (WP1 modelling)	20	25				✓	✓					
3.3.4		joint development session in Denmark	24	24										
3.4	15	DSS Release 2, incl. Installation	26	26			✓			✓				
	16	System Manuals	26	26										
	17	Testing and preliminary calibration report	26	26										
3.5	18	Software Training to Client´s team in Addis Ababa	26	26	✓			✓	✓		✓			
Testing Stage			***26***	***31***										
		Formal Testing (by WP2)	26	28										
3.6	19	Review workshop on DSS release 2	28	28	✓	✓	✓							
		Continued Testing (by WP2)	29	31										

A detailed description of individual activities during cycle 2 is not provided. The activities are largely identical to equivalent Cycle 1 activities. Thus, please refer to Subsection 7.6.4 for a description of equivalent Cycle 1 activities.

It is anticipated that the Consultant will spend around 8 person-months with the NBI in Addis Ababa during development cycle 2. A large portion is related to the detailed requirement analysis (Activity 3.1) in the early stage of Cycle 2 and to training activities (Activity 3.5).

As for Cycle 1 a substantial amount of time will also be spent at the consultant's home office. Home office work will primarily be related to software development, project management, reporting and documentation.

Two joint working sessions (Activity 3.3.1 and 3.3.2) are expected (one in Denmark and on in Addis Ababa). One work session (Activity 3.3.3) focusing on WP1 modelling is scheduled in Addis Ababa. It is anticipated that each of these sessions will have duration of 4-5 days.

7.6.6 Development Cycle 3.

Development cycle 3 is scheduled to start mid June 2011 (project month 25) and will continue throughout the remainder of the project. NB DSS Release 3 is scheduled for 15 Nov 2011 (project month 30). The structure (deliverables and activities) of Development cycle 3 is largely identical to the structure of development cycle 1. Therefore, please refer to equivalent activity descriptions for cycle 1 (Subsection 7.6.4), the activi-

ties are described in less detail than in Cycle 1 or they simply refer directly to the description provided in Development Cycle 1.

Deliverables and Activities

The deliverables of System Development Cycle 3, as described in the ToR, are listed in Table 7.12. A schedule of deliverables and activities is provided in Figure 7.4.

Table 7.12 Deliverable Schedule for Development Cycle 3.

Deliverable No.	Process/Deliverable	Comments
20	Complete DSS detailed design report	o To be enhanced and re-submitted for approval after the review workshop. o Approved document to be submitted in 30 hard copies and 11 original CDs. *Note: Draft Report to be submitted approximately 2 months after entering Cycle 3. Review of the deliverables including the Review Workshop shall be completed approximately 1 month after submission of the Draft Report.*
21	Review Workshop on Detailed design report 3.	Consultant shall: o Avail its relevant key staff to participate and present the deliverables. o Document deliberations of the workshop in a formal workshop minutes. *Note: 2-3 day workshop in the Nile Basin.*
22	DSS Release 3	o To be submitted in 15 installation CD's o Consultant shall install DSS Release 3 at the WRPM PMU.
23	System Manuals	
24	Testing and Preliminary calibration Report	*Note: Limited model calibration will be conducted in WP1. The primary purpose of WP1 modelling is testing and proof of concept. An outline of expected modelling activities is provided in Chapter 6.*
25	User Training (DSS Release 3)	7 days training of Client staff at the NBI PMU in Addis Ababa.
26	Review Workshop on DSS Release 3	

Due to the delays of the Inception phase the start of Cycle 3 is approximately 3 months delayed. The Consultant will attempt to recover the remaining 3 month delay during development Cycle 3. This will require that some Cycle 3 activities (MCA/CBA) will be launched during development cycle 1 or 2. The details in this regard will be discussed

and agreed with the Client during project cycle and a revised plan for Cycle 3 will be established. Currently it is assumed that requirement analysis and design will be done during cycle 1 and/or 2 so that cycle 3 developments can start immediately after the completion of NB DSS Release 2. This is reflected in Figure 7.4.

ID	Activity ID and Name	Project Month	Approx. Start	Approx. Finish
1	**Cycle 3 – Main Tasks**		**15-01-2011**	**15-05-2012**
2	4.1) Detailed requirement analysis and design	- 26	15-01-2011	15-06-2011
3	4.2) Review workshop on detailed design report 3	28	25-06-2011	30-06-2011
4	4.3) System development	28-30	16-06-2011	15-11-2011
5	4.4) Installation of NB DSS Release 3	30	16-11-2011	20-11-2011
6	4.5) Software training to Clients team	31	21-11-2011	30-11-2011
7	4.6) Review workshop on DSS release 3	32	10-01-2012	14-01-2012
8	Formal Testing (WP2)	31-32	17-11-2011	15-01-2012
9	Continued Testing (WP2)	33-36	16-01-2012	15-05-2012
10	**Cycle 3 - Deliverables**		**15-06-2011**	**14-01-2012**
11	#20 Complete NB DSS Detailed requirement and design report	26	15-06-2011	15-06-2011
12	#21 Review workshop on detailed design report	26	01-07-2011	01-07-2011
13	#22 Installation of DSS release 3	30	20-11-2011	20-11-2011
14	#23 System Manuals	30	20-11-2011	20-11-2011
15	#24 Testing and preliminary calibration report	30	20-11-2011	20-11-2011
16	#25 Software Training to Clients team	31	30-11-2011	09-12-2011
17	#26 Review workshop on DSS release 3	32	14-01-2012	14-01-2012

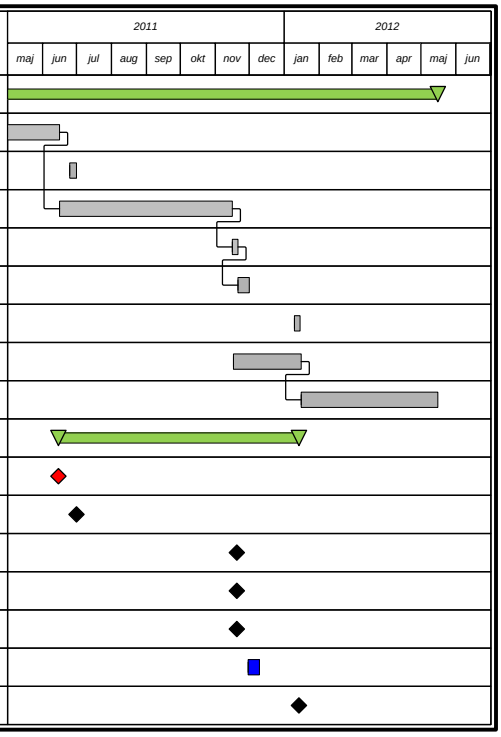


Figure 7.4 Activity and Deliverable schedule for the Cycle 3 (start and finish dates are approximate. The plan assumes that requirement analysis and design is completed earlier in the project)

Task Assignments and Staffing Schedule, Development Cycle 3.

Task assignments during cycle 3 are provided Table 7.13. The tentative staffing schedule for International Staff, during the System Development Cycle 3 is outlined and Table 7.14.

Table 7.13 Tasks assigned to International Staff in Cycle 3.

Staff / Position	**Activities**	**Remarks**
Team Leader Mr. Henrik Refstrup Sørensen	4.1, 4.2, (4.3), 4.5, 4.6	Same as in cycle 1 (see Table 7.7).
Senior WR Management Specialist Dr. Larry Brazil	4.1, 4.2, (4.3),(4.4),(4.5), 4.6	Same as in cycle 1 (see Table 7.7). In addition Brazil will join the training (4.5) reflecting the focus on MCA.
Deputy TL/ Senior Software Engineer Mr. Lars C. Ekebjærg	4.1, 4.2, 4.3, 4.4, 4.6	
Water Resources Modeler	(4.1), 4.5	Same as in cycle 1 (see Table 7.7).

Staff / Position	Activities	Remarks
Dr. J. K. Lørup		
Decision Support System Specialist Dr. Mark Woodbury	4.1, 4.5	
IMS Database Specialist/Analyst Dr. Anders Klinting	4.1, 4.3, 4.4, 4.5	
Software Developer/System Integrator Mr. Lars Michael	4.1, 4.3	
GIS Specialist Mr. Babel	4.1, (4.3)	(4.3) not involved in software development.
Water Resources Economist Mr. Walton	(4.1)	(4.1) will be involved in requirement analysis (CBA/MCA).
Environmental Management/Biodiversity Conservation specialist Dr. Ballofet	(4.1)	(4.1) will be involved in requirement analysis.

Table 7.14 Tentative Assignment Schedule for International Staff in NBI Countries (Cycle 3). The schedule is incomplete due to the lack of a firm plan for the Detailed Requirement analysis and design in Cycle 3.

			Project Month		Sørensen	Brazil	Ekebjærg	Lørup	Woodbury	Michael	Klinting	Babel	Walton	Ballofet
ID	ToR deliverable no.	Activity / Deliverable Cycle 3	Start	End	Assignment Schedule for Consultant Staff working in NBI Countries									
Development Cycle 3 - DSS Release 3			***26***	***36***										
Detailed Requirement Analysis and Design Stage				*26*										
4.1		detailed requirement analysis and design		26	✓	✓	✓		✓	✓	✓	✓	✓	✓
	20	Detailed design report 3 (complete DSS)		26										
4.2	21	Review workshop on detailed design report 3 (3 days workshop + 2 days follow up with PMU)		26	✓	✓	✓			✓				
4.2.1		Enhance Report and Submit Final Report		26										
4.2.2		Client Approval		26										
System Development Stage			***26***	***31***										
4.3		System Development - Release Cycle 3	26	30										
4.3.1		Joint development session in Denmark	27	27										
4.3.2		Testing and Proof of Concept (WP1 modelling)	26	30				✓	✓					
4.4	22	DSS Release 3, incl. Installation	30	30			✓			✓				
	29	Draft maintenance and support plan	30	30										
	23	System Manuals	30	30										
	24	Testing and preliminary calibration report	30	30										
4.5	25	Software Training to Client´s team in Addis Ababa	31	31	✓	✓		✓	✓		✓			
Testing Stage			***31***	***36***										
		Formal Testing (by WP2)	31	32										
4.6	26	Review workshop on DSS release 3 (3 days workshop + 3 days for preparations and follow up)	32	32	✓	✓	✓							
		Continued Testing (by WP2)	33	36										

A detailed description of individual activities during cycle 3 is not provided. The type of activities is largely identical to equivalent Cycle 1 activities. Thus, please refer to Sub-section 7.6.4 for a description of equivalent Cycle 1 activities.

As described earlier in this section it will be attempted to recover the remaining 3 months delay during Cycle 3. This will require that some Cycle 3 activities are completed earlier in the project. A firm plan for these activities will be discussed and agreed with the Client during project Cycle 1. Therefore, the tentative assignment schedule presented in Table 7.14 will likely be revised.

NB DSS Release 3 remains scheduled for Project Month 30 as requested by the ToR. Details regarding the Cycle 3 development schedule will be agreed with the Client during development cycle 1.

Tentatively the Consultant expects to spend around 8 person-months with the NBI in Addis Ababa during development cycle two.

As for cycle 1 and cycle 2 a substantial amount of time will be spent at the home office. In Cycle 3 one of the main activities will be related to the development of the MCA tool.

One joint development session is scheduled in Denmark (Activity 4.3.1) and one work session on WP1 modelling is scheduled in Addis (Activity 4.3.2).

7.6.7 Consolidation Phase

The Consolidation phase will start upon successful completion of the testing of DSS release 3. The duration of the Consolidation phase will be 4 months. During this final phase of the NB DSS development some final adjustments of the NB DSS software may be carried out based on user feed-backs and results of WP2.

Deliverables and Activities

The deliverables of the Consolidation phase, as described in the ToR, are listed in Table 7.15. A schedule of deliverables and activities is provided in Figure 7.5.

Table 7.15 List of deliverables of the Consolidation phase.

Deliverable No.	Process/Deliverable	Comments
27	NB DSS v.01:	○ 50 licenses of Corporate Edition ○ 100 licenses of Professional edition
28	Complete System Documentation and manuals	
29	Maintenance and Support Plan	
30	User Training	At Regional DSS Center and NBI countries
31	Project Critique	

ID	Activity ID and Name	Project Month	Approx. Start	Approx. Finish
1	**Consolidation phase – Main Tasks**		**15-01-2012**	**15-05-2012**
2	5.1) Finalisation and submission of the first official version of the NB DSS	33-34	15-01-2012	01-03-2012
3	5.2) Deployment of the first version of the NB DSS	34-35	01-03-2012	15-04-2012
4	5.3) User Training	34-35	02-03-2012	15-04-2012
5	5.4) Certification of the first version of the NB DSS	36	10-05-2012	15-05-2012
6	5.5) Project Critique	36	10-05-2012	15-05-2012
7	**Consolidation phase - Deliverables**		**01-03-2012**	**15-05-2012**
8	#27 NB DSS v.1.0	34	01-03-2012	01-03-2012
9	#28 Complete System Documentation and Manuals	34	01-03-2012	01-03-2012
10	#29 Maintenance and Support Plan	34	01-03-2012	01-03-2012
11	#30 User Training	35	15-04-2012	15-04-2012
12	#31 Project Critique	36	15-05-2012	15-05-2012

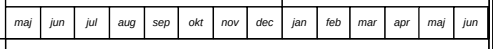


Figure 7.5 Activity and Deliverable schedule for the Consolidation phase (start and finish dates are approximate).

Task Assignments and Staffing Schedule, Consolidation Phase

Task assignments during the Consolidation phase are provided in Table 7.16. The tentative staffing schedule for International Staff, during the Consolidation phase is outlined and Table 7.17.

Involvement in Activity 5.2 and 5.3 (Deployment and Training)

Many of the Consultant staff members will be involved in (5.2 Deployment) and (5.3 Training). These two activities will take place during one assignment where two staff members will deploy the DSS and subsequently conduct training at each of the regional DSS centres and in the riparian countries. Together 5.2 and 5.3 represents a very substantial workload and it can only be completed in one calendar month by using all project resources in combination (key-experts). The consultant will group team members so that the two consultant staff members will be composed by an IT proficient and a DSS/water domain proficient person. Together they will deploy the DSS and conduct the training. Many staff members (see Table 7.16) will therefore be involved in activities (5.2) and (5.3) although not scheduled in the Consultant´s preliminary task assignment plan.

Table 7.16 Tasks assigned to International Staff in the Consolidation Phase

Staff / Position	**Activities**	**Remarks**
Team Leader Mr. Henrik Refstrup Sørensen	5.1, (5.2), 5.3, 5.4	
Senior WR Management Specialist Dr. Larry Brazil	(5.2), (5.3), 5.4	
Deputy TL/ Senior Software Engineer Mr. Lars C. Ekebjærg	5.1, 5.2, (5.3), 5.4	
Water Resources Modeler Dr. J. K. Lørup	(5.2), 5.3	
Decision Support System Specialist Dr. Mark Woodbury	(5.2), 5.3	
IMS Database Specialist/Analyst Dr. Anders Klinting	5.2, 5.3	
Software Developer/System Integrator Mr. Lars Michael	(5.2), (5.3)	
GIS Specialist Mr. Babel		
Water Resources Economist Mr. Walton		

Staff / Position	Activities	Remarks
Environmental Management/Bio-diversity Conservation specialist Dr. Ballofet		

Table 7.17 Tentative Assignment Schedule for International Staff in NBI Countries (Consolidation phase).

			Project Month		Sørensen	Brazil	Ekebjærg	Lørup	Woodbury	Michael	Klinting	Babel	Walton	Ballofet
ID	ToR deliverable no.	Activity / Deliverable Consolidation phase	Start	End	Assignment Schedule for Consultant Staff working in NBI Countries									
Consolidation phase			***33***	***36***										
5.1		Finalization and Submission of the first version of the NB DSS	33	34										
5.1.1	27	NB DSS v.1.0	34	34										
5.1.2	28	Complete system documentation and manuals	34	34										
5.1.3	29	Maintenance and Support plan	34	34										
5.2		Deployment of the first version of the NB DSS	34	35	✓	✓	✓	✓	✓	✓	✓			
5.3	30	User Training (regional center and NBI countries)	34	35	✓	✓	✓	✓	✓	✓	✓			
5.4		Certification of the first version of NB DSS (through WP2)	36	36										
5.5	31	Project critique	36	36	✓	✓	✓							

The Consultant anticipates that around 6 person-months will be spent in NBI countries during the Consolidation phase. These are almost entirely allocated for deployment and training activities at the regional DSS centre in Addis Ababa and in the riparian countries (10 locations).

Home office activities during the consolidation phase will primarily be related to project management and documentation tasks.

Activity 5.1 Finalisation and Submission of the first version of the NB DSS
Following the final testing of the NB DSS and other user feedbacks the Consultant will incorporate pending issues and finalise and release NB DSS v.1.0. This activity will also include the completion of all related system documentation and submission of the maintenance and support plan.

Activity 5.2 Deployment of the first version of NB DSS
Prior to the final user training (activity 5.3) the Consultant will install and test the NB DSS at the Regional DSS center in Addis Ababa and in the NBI Countries. As part of the deployment Consultant staff will train relevant NBI IT staff in important system tasks such as installation, restart, back-up, restore and system monitoring (log). These system tasks will be documented in an Operator's Guide which will be supplied with the final NB DSS. It is anticipated that two consultant staff members will spend 3 days at the regional DSS centre and in each of the riparian countries.

Activity 5.3 User Training
Consultant staff will conduct user training at the regional DSS centre and in each of the riparian countries. Each training session will be conducted by two Consultant staff

members (a water domain expert and an IT expert). The duration of a training session will be 5 days.

Activity 5.4 Certification of the first version of NB DSS

Once submitted and deployed, the NB DSS v.01 will be peer reviewed by an independent panel of experts to be engaged by the Client.

Activity 5.5 Project Critique

Consultant staff will meet with the Client and other relevant stakeholders for a short project critique workshop.

7.7 Feature Release Plan

The NB DSS development phase consists of three development cycles each resulting in a new DSS release. The 3rd release will be followed by a consolidation phase focusing on full scale system deployment, documentation, training and finalization of the system maintenance plan.

Assuming that Development cycle 1 will commence on 1st January 2010, the Inception Phase is about 4½ months delayed. This obviously has impacts on the NB DSS Release plan. The Client has requested the Consultant to draw up an implementation plan that delivers the final NB DSS on schedule.

The Consultant is highly committed to deliver the final NB DSS on schedule and has developed the following revised NB DSS release schedule.

NB DSS Release 1 is scheduled for release on 15th September (Project Month 16). This is approximately 3 months later than the original release schedule. As such the development phase of Cycle 1 will be about 1½ months shorter than defined by the ToR. Some features that were originally planned for NB DSS Release 1 have been moved to NB DSS Release 2 in order to avoid unacceptable delays of the first NB DSS release.

NB DSS Release 2 will include many new features and contain some carry-over features from NB DSS Release 1. As such the duration of development cycle 2 cannot be reduced. NB DSS Release 2 is scheduled for release nine months after NB DSS Release 1 (i.e. Project Month 25/15th June 2011).

The Consultant will attempt to recover the remaining 3 month delay during development Cycle 3. This will require that some Cycle 3 activities (MCA/CBA) will be launched, at least at a design stage, during development cycle 2. NB DSS Release 3 remains scheduled for Project Month 30 as requested by the ToR. Details regarding the Cycle 3 development schedule will be agreed with the Client during development cycle 1.

The SRS has established a complete set of requirements. These requirements are elaborated through the 4+1 use cases combined with the functional and non-functional requirements listed in the ToR. The full set of requirements is listed in Appendix C (SRS, Chapter 4).

On approval of the Inception phase all requirements will enter the SpiraTeam requirement management system. Requirement will be associated with an NB DSS release to

form a detailed feature release plan (to be approved by the Client). The detailed feature release plan will be maintained in SpiraTeam. Any changes of the detailed feature release plan are considered Change Management which will be subject to Change Control Board approval.

The following sections provide an overview of the anticipated contents of the three NB DSS releases. This overview is provided by comparing the proposed feature release plan with the feature release plan provided by the ToR (i.e. identify deviations from the ToR). Further, Appendix F provides a mapping between the three NB DSS releases and the generalised use cases, with the related functional components and software components as well as the associated requirements. The use cases (Appendix F) provides a useful "functional" image of the contents of the content of the three NB DSS releases.

7.7.1 Release 1 Feature Set

It has been agreed that the first NB DSS release (deliverable #8) will be released 15th September 2010 (Project Month 16). As compared to the ToR, the duration of development cycle is consequently reduced by approximately 1½ months. This has lead to some reductions of the feature set that will be delivered with the first release. Any postponed features will be delivered with NB DSS release 2 or 3.

Release 1 will enable user to:

- Work with NB DSS GUI to access functionality delivered with NB DSS release 1.
- Store data in the database and interact with the database through the NB DSS GUI.
- Use Pre- and Post-processing tools to process, analyse and compare data including simulation outputs as well as field data.
- Use GIS functionality to visualise and process spatial data.
- Use the Dynamic Water Budget and Allocation Model to build models and run simulations.
- Calibrate models supported by embedded tools for error statistics/goodness-of-fit.
- Establish and manage scenarios including options for direct comparison of scenario outputs.
- Access system documentation (on-line)

All functionality areas (functional components) that were originally intended for NB DSS release 1 (ToR) will be included in NB DSS release 1. Within some of the functional components specific functionality (requirements) has been postponed from NB DSS release 1 to release 2. These are indicated in Table 7.18 as a deviation from the ToR.

Table 7.18 Overview of the Contents of DSS Release 1 as per the ToR and with indication of any deviations from the ToR as proposed by the Consultant.

Feature/ Requirement ID	**Remarks**
Graphical User Interface (2.1.1)	The GUI shall evolve throughout the three cycles. *Deviations from ToR: None.* *The GUI will continue to develop as new functionality (software components) are added to the DSS in DSS release 2 and 3.*
<u>Information Management System:</u> 2.1.2 Database Management System 2.1.3 Pre- and Post Processing Tools 2.1.4 Embedded GIS functionality	Tools for user defined report generation (Req. 2.1.2.4) shall evolve throughout the three cycles. *Deviations from ToR:* *(Req. 2.1.2.3) standard meta-data model will evolve during the first two releases. Will be fully implemented in DSS release 2.* *(Req. 2.1.2.5) System performance statistics will be available in DSS release 3.* *(Req. 2.1.4.3) Catchment delineation will be added in release 2.* *(Req. 2.1.4.4) Raster operations including spatial interpolation will be added in release 2.*
Dynamic water budget and allocation model (2.1.5)	Req. 2.1.5.1.11 – Tools for economic analysis of scenarios, and Req. 2.1.5.12 – Tools for converting model outputs, shall be added in Cycle 3. *Comments/Deviations from ToR:* *The GUI for the Water Allocation model will be implemented as agreed in the Contract negotiations (Appendix H of Contract). This implies that the first release of NB DSS will work with the existing MIKE BASIN GUI (ArcGIS based). A new (non ArcGIS) GUI will be available with release 2.* *Sediment transport (2.1.5.16) is available in MIKE11 (physically based methods) while simpler approaches are not available in MIKE BASIN. The latter will be available with NB DSS release 2.*
General Utilities (2.1.6)	*Comments/Deviations from ToR:*

	Req. 2.1.6.4 Simulation based optimisation and Req. 2.1.6.5 Sensitivity analysis will be available with DSS release 2.
Relevant Documentation (2.2.3)	*Comments/Deviations From ToR: None.*

7.7.2 Release 2 Feature Set

DSS release 2 (deliverable #15) is scheduled for project month 26 (June 2011).

The DSS release 2 will focus on adding the general utilities (2.1.6) and the process modules (2.1.7) to the NB DSS. The overall contents of DSS release 2 is listed in Table 7.19. Details are provided in Appendix F.

Table 7.19 Contents of DSS Release 2

Functional components/Requirement ID	**Remarks**
All features of DSS release 1	• Incorporates all corrections/refinements as per comments reported on DSS Release 1. • Additional features on the Graphic user Interface (Req. 2.1.1). • Additional Features on the tools for user defined report generation (Req. 2.1.2.4). *Comments/deviations from ToR:* *Postponed issues (see Table 7.18) will be implemented in NB DSS Release 2.*
Process Models (Req. 2.1.7)	Implemented in full. *Comments/deviations from ToR: None.*
Relevant Documentation (Req. 2.2.3)	Updated to support all features of DSS release 2. *Comments/deviation from ToR: None.*

7.7.3 Release 3 Feature Set

DSS release 3 (deliverable #22) is scheduled for project month 30 (November 2011).

The DSS release 3 will add all remaining functionality including the MCA and cost-benefit-analysis to the NB DSS.

The contents of DSS release 3 is listed in Table 7.20. Further details are provided in Appendix F.

Table 7.20 Contents of DSS Release 3

Functional components/Requirement ID	**Remarks**
All features of DSS release 2	• Incorporates all corrections/refinements as per comments reported on DSS Release 2. • Additional features on the Graphic user Interface (Req. 2.1.1). • Additional Features on the tools for user defined report generation (Req. 2.1.2.4). *Comments/deviations from ToR: None.*
Economic analysis of scenarios (CBA) (2.15.11)	*Comments/deviations from ToR: None.*
Tools for converting model outputs into desired criteria using user-defined methods (Req. 2.1.5.12)	*Comments/deviations from ToR: None.*
MCA Tools (Req. 2.1.8)	*Comments/deviations from ToR: None.*
Advanced statistical methods (Req. 2.1.3.4). Stochastic modelling (error distribution) (Req. 2.1.6.6)	These requirements are optional and require prior agreement with the consultant. *Comments/deviations from ToR: None.*
Documentation (2.2.3)	Updated to support all features in DSS release 3. *Comments/deviations from ToR: None.*

7.8 Software Development Planning

Detailed software development plans will be elaborated during the early phase of development cycle 1. Initially high level plans are available. These are formulated at use case level and associated with preliminary time/ressource estimates. Following the detailed requirement analysis and design more detailed plans will gradually be established. These will work at individual requirement level. Full bidirectional traceability from requirements, to use cases, to feature projects, to NB DSS releases will be established.

The implementation work will be organised through a number of feature projects. The feature projects, in this context, is simply a practical way of organising the implementation of a set of requirements (in development teams). The feature projects do not have any relation to specific software development processes (such as agile or waterfall). For

more details regarding the development process and the project management please refer to Appendix A (Project Handbook).

The first release (NB DSS release 1) is scheduled for 15th September 2010. The Consultant intends to establish a number of internal releases that can be used for the Consultant's testing (WP1 modelling) and which can also be used for demonstrating working software to the Client. Within NB DSS release 1 the Consultant anticipates four internal releases (in the Project Handbook these are denoted minor releases). The first internal release is scheduled for 23rd April 2010 while the last release will coincide with NB DSS release 1 (as such it is also a major release)

A minor release will, among other things, be associated with a deadline and with a number of use-cases and requirements that should be covered by the minor release. Appendix G contains an example of an auto-generated SpiraTeam report which reflects the current level of planning in SpiraTeam. The SpiraTeam report identifies four minor releases (release 0.0.1, 0.0.2, 0.0.3 and 0.0.4) each associated with deadlines and use cases with due consideration to the agreed feature release plan (Appendix F).

The SpiraTeam Integrated Application Lifecycle Management system (ALM) will be used for all aspects of software development including issue and defect management, software planning and tracking, task allocation and as well as a software document repository. The Client will have access to SpiraTeam and may monitor progress directly through the system. In addition the Consultant and the Client will configure reports that will be used for progress monitoring and planning purposes and for issuing monthly progress reports (administrative reporting requirement). As such SpiraTeam plays a central role in the software development project management process.

7.9 Training and Technology Transfer Plan

WP1 has allocated time and budget for training in accordance with the TOR. The TOR includes the following training sessions:

Deliverable	**Description**
11. DSS 1 User Training	7 days training in Addis Ababa
18. DSS 2 User Training	7 days training in Addis Ababa
25. DSS 3 User Training	7 days training in Addis Ababa
30. Training at regional/national centres	5 days in 9 countries + 5 days at the regional DSS enter

The 7 days training courses are synchronised with each DSS release and will focus on the particular features related to the DSS releases. The training course will include the PMU team and the DSS Core Team. According to the TOR the training should include:

- Background information
- Theory and algorithms of the software
- Hands on exercises and synthetic test cases

The training will be carried out by two Consultant staff members (the Water Resources Modeller and the DSS specialist).

The Consultant has some concerns that the time allocated for training may be insufficient. The Consultant expects that substantial training, in particular, in using the Model Tools (Process Models, Water allocation models, hydraulic models) is required in order to become an expert user of the NB DSS. Based on the use-cases developed during the launching workshop many of the NB DSS application will involve working with these Model Tools. The Model Tools remain expert engineering tools and a high level of understanding about basic hydrological process and modelling techniques are required to build, calibrate and validate such models.

The Danida Fellowship Center (DFC) has allocated funds in 2010 for extended overseas training of 10 NBI staff members. The DFC funds cover all costs for 10 trainees for 6 weeks in Denmark. The DFC funds provide a very good opportunity for expanding the training activities to the DSS Core Team.

The DFC training will focus on the Model Tools and on-the-job training and may include:

- Basic theory and understanding of relevant processes
- Hydrologic, Hydraulic and water allocation modelling aspects.
- Comprehensive hands-on training, preferably to be conducted as on-the-job training with close interactions between Consultant staff and NBI staff.

During development cycle 1, a training needs assessment will be done in cooperation with the NBI PMU. Subsequently, a detailed training plan will be established considering:

- An assessment of the training needs (types of training, who to train)
- An assessment of the available resources for training in WP1, WP2 supplemented by the DFC funds.

7.10 Warranty Service Plan

The warranty period covers the first 12 months following the conclusion of the NB DSS project. During the warranty period the NBI will continue to report defects to the SpiraTeam established under the project. Defects and support will be handled by the project team. As such the warranty service plan will make a “soft” transition from the project to post-project conditions. Beyond the 12 months warranty period the NB DSS will be supported by the Post-Warranty Technical Support Plan which extends for another 10 years.

7.11 Post-Warranty Technical Support Plan

Maintenance and support of NB DSS will be required following the 3 year project period. As part of the contract negotiations the NBI and the Consultant has agreed on an extended service and maintenance agreement covering 10 years following expiry of the warranty period (12 months after project conclusion). The maintenance and support plan covers, as described in Appendix H of the contract:

- Technology upgrades (updates, service packs, patches) comprising all DSS components and the MIKE by DHI Software Products (MIKE11 and MIKE BASIN).

- Access to DHI's Help-desk for error reporting and hot-line support

7.11.1 Technology Upgrades

The technology upgrade agreement encompasses the standard DHI Software Products (MIKE BASIN and MIKE11) as well as other components of the NB DSS.

- The NBI will get regular upgrades of the MIKE BASIN and MIKE11 software systems. Each release will introduce new functionalities while retaining backwards compatibility. Basing **NB DSS** on such standardized modelling software components and a program for regular updates of other software components, including GIS components, will ensure that **NB DSS** will continue to constitute a robust, viable and modern solution.

- The remaining components of the NB DSS will be maintained and upgraded so that it is always compatible with the latest release of the above DHI Software Products and with new Windows operating systems and similar. New tools, for instance for data processing, graphical presentation etc. will be made available to NBI.

7.11.2 Help Desk and Hot-line Support

During the project execution (3 years) the Consultant will employ the SpiraTeam system for reporting and managing all incidents related to the DSS development and testing. After the project the Consultant propose to use the global DHI Software support centre.

Error Reporting

The help desk receives reports from all DHI software users and assigns them to DHI engineers or software developers. Errors are reported by e-mail to software@dhigroup.com. DHI will normally respond to error reports within 24 hours. If a solution or a by-pass advice cannot be provided, DHI will inform NBI regarding the defect handling process.

24/7 hotline support

Help-desk (software@dhigroup.com) will also serve as a hotline support at DHI Denmark with remote access to **NB DSS** as relevant and technically possible. The hotline support will be able to provide support 24/7 and, if required, pull on the resources of the Consultant's global technical software centre with main hubs in Denmark, USA and Australia, hence being accessible round the clock.

In regard to Error Reporting and hot-line support it has been agreed that the NBI PMU will serve as a filter for DHI's help-desk. Hence, errors and support requests will be handled through the NBI PMU. The NBI PMU, with expert users, may be able to handle some support questions without involving DHI or they may direct the request or error report to dhisoftware@dhigroup.com.

Model Upgrades

Refinement and calibration of existing regional and national models will continuously be carried out by the regional and national DSS units supported by the **WRPM PMU** and potentially also by the DHI Consulting Team. To this end, the NBI may consider entering a post project modelling support plan, for instance, including model refinement inputs by the Consultants modelling experts with regular intervals. The refinement and calibration of the models will be supervised by Consultant's key experts and carried out jointly with National DSS Units and **WRPM PMU** staff, thus building on the partnership approach established in the course of the project.

Refresher training courses

In order to compensate for staff turn-over/circulation and to keep staff up to date with new developments, some training will be needed in the years that follow after the project has been completed. With our partnership approach the DHI Consulting Team remain dedicated to ensuring the sustainability of **NB DSS**. Such an approach with post-project training and support has been adopted by the Consultant in earlier projects and has proven very valuable.

A P P E N D I C E S