



Partners for Water and Sanitation

Note on project reports

The following report has been prepared by Partners for Water and Sanitation in response to a project Terms of Reference.

The content of the report is based on the opinion of the author(s) and does not necessarily represent the opinions of the wider PfWS partnership, or the project funders.

Any extracts from the report should only be used with prior permission of the report author(s).

Exchange Visit

**Water Works Design and Supervision Enterprise
(WWDSE)**

and

Water Works Construction Enterprise (WWCE)

Minworth Wastewater Treatment Works

June – July 2008

Acknowledgment

We are deeply grateful to many individuals and firms who have supplied valuable documents and information to prepare this paper. Individuals are owed a particular debt of gratitude for their support and effort Mr Stuart Campbell, Mr Mark Lee, Ms Rebecca Scott, Ato Melkamu Jaleta, Mr David Rathmell, Mr Glynn Cunliffe, Mr Jim Claydon, and Ms Alex White who arranged this program and contributed to success of this document.

In addition specially, we wish to acknowledge the following firms for their support and provide information:

- North Midland Construction PLC
- Partners for Water and Sanitation (PAWS)
- NOMENCA
- Seven Trent Water
- ARUP
- Biwater
- Farrer Consulting
- Mott MacDonald
- Morgan=est
- Laing O'Rourke
- EarthTech and Morrison (ETM)

We would like to express our thanks for valuable comments provided by Mr Tony Cutner and the whole staff of Minworth Wastewater Treatment Project. Most importantly the producers of this document would like to thank all parties and professional involved in the construction projects who share their experience and knowledge taking over their valuable time.

Table of Content

EXECUTIVE SUMMARY	5
1 INTRODUCTION	6
1.2 BACK GROUND	7
1.3 OBJECTIVES.....	8
1.4 METHODOLOGY.....	8
2 OBSERVATION OF ACTIVITY	9
2.1 MINWORTH WASTEWATER TREATMENT WORKS	9
2.2 INTEGRATED MANAGEMENT OF PROJECTS	12
2.2.1 <i>Health and Safety</i>	12
2.2.2 <i>Environmental Protection</i>	14
2.2.3 <i>Quality Assurance</i>	15
3 CONTRACT MANAGEMENT PROCESS	16
3.1 NEED ASSESSMENT	16
3.2 STUDY AND DESIGN STAGE.....	16
3.3 PROCUREMENT STAGE	16
3.4 PROJECT PLANNING.....	17
3.5 CONSTRUCTION STAGE	19
3.5.1 <i>Construction checks</i>	19
3.5.2 <i>Method Statements</i>	20
3.5.3 <i>Construction Activity</i>	21
3.5.4 <i>Quality Control</i>	22
3.5.5 <i>Final Inspection and Test</i>	22
3.6 LESSONS LEARNED ON CONTRACT MANAGEMENT PROCESS	23
4 PRESENTATIONS AND WORKSHOP	24
4.1 NEW ENGINEERING CONTRACT (NEC).....	24
4.1.1 <i>General</i>	24
4.1.2 <i>Flexibility</i>	24
4.1.3 <i>Clarity and simplicity</i>	25
4.1.4 <i>Stimulus to good</i>	25
4.1.5 <i>Some other changes</i>	27
4.1.6 <i>Subcontracts</i>	27
4.1.7 <i>Application of the NEC</i>	27
4.1.8 <i>Arrangement of the NEC</i>	28
4.1.9 <i>Clause numbering</i>	28
4.1.10 <i>Project organization</i>	29
4.1.11 <i>Roles and duties</i>	29
4.1.12 <i>Project Manager</i>	30
4.1.13 <i>Designers</i>	32
4.1.14 <i>Supervisor</i>	33
4.1.15 <i>Adjudicator</i>	33
4.2 QUALITY MANAGEMENT	33
4.3 INFORMATION COMMUNICATION TECHNOLOGY (ICT).....	34
4.4 INTERNATIONAL STANDARDS ORGANIZATIONS (ISO).....	35
5. SITE VISIT REPORT	37
5.1 VISITED PROJECTS	37

5.1.1	<i>Under Operational Works</i>	37
5.1.2	<i>Visited Projects Under Construction</i>	40
5.1.3	<i>Visited Construction and Consulting Firms and Others</i>	41
5.2	LESSON LEARNED	41
6	RECOMMENDATION	47
	REFERENCES	49
	ANNEX: COMPANIES, MANAGEMENT AND SENIOR PROFESSIONALS MET DURING THE TWINNING	50

Executive Summary

This report is mainly deals with PAWS's six weeks exchange program on lessons learned and recommendation given during our stay in UK.

The Purpose the twinning program is to establish best practice through twinning with UK water companies and to increase the delivery capacity of the Enterprises so improving delivery value through improved efficiencies with quality assurance for WWDSE and contract management for WWCE that helps to take on a growing workload.

The twinning program has been carried out through site visit, workshops, presentation and discussion.

During this twinning program a lot of site visit has been carried out to observe how the operation and construction of the projects are going on, to have an interaction and discussion with operation and construction team of the projects.

Including Minworth Wastewater Treatment Works we have observed various projects which are under construction owned by different Water Utilities (Client, Engineers and Contractors). In general they have framework agreement based on mutual trust as target price cost. All projects design, planning and construction process are carried out on the basis of integrated health & safety, quality and environmental management system and they abide by the rules and regulations of UK.

During our visit we have observed that the current practice in UK on the application of principles of contract management process, Health & Safety, Quality Management, Environmental Protection and Construction Techniques are different from current practice in both Enterprises. We have learned that it has taken longer period to develop into the present best practices for the UK. Even though it took longer period to develop into the present best practices for the UK, by extending and establishing relationship with UK companies for sustainability of agreed action plan, it is possible to adopt relevant aspects of the UK current practice in a shorter period of time in both Enterprises.

1 INTRODUCTION

PAWS has arranged six weeks exchange program together with North Midland Construction Plc for four experts from WWDSE and WWCE. These exchange programs forms part of on going support to the WWDSE and WWCE by Partners for Water and Sanitation (PAWS).

Partners for Water and Sanitation is a UK tri-sector partnership organization, funded by the UK Department for International Development, comprising organizations from Government, the Privet Sector and Civil Society, working with organizations in Ethiopia, Nigeria and South Africa. It provides capacity building support to drinking water and sanitation needs in these countries through the shared expertise in the UK water sector.

PAWS through North Midland Construction have been supporting WWCE with contract management and through David Rathmell has been supporting WWDSE with quality assurance since 2006.

PAWS have been responsible for covering the cost of air flights and travel insurance for participants. In addition North Midland Construction has covered UK travel and subsistence costs while staying in UK.

The following professionals listed below have participated in the exchange program:

1. Ato Yilekal Worku, Deputy General Manager, WWCE
2. Ato Taye Sime, Project Manager, WWCE
3. Ato Ibrahim Dinku, Division Head, WWDSE
4. Ato Leulseged Abayneh, Division Head, WWDSE

1.2 BACK GROUND

PAWS was established following the World Summit on Sustainable Development (WSSD) in 2002. As WSSD the international community determined to fight water poverty by organizing in the Millennium Development Goal to reduce by half the 1.1 billion people without access to adequate water provision, with a subsequent commitment to halve the 2.4 billion people without access to safe sanitation.

PAWS support is directed toward projects that emphasises the importance of sustainability of service provision, and which can be replicated across other regions and partner countries. Projects are demand driven and responsive to the needs of water sector in the country.

In line with the Memorandum of Understanding 2006-07, PAWS has been supporting the Ministry of Water Resources in identifying the reduction of leakage and providing advice on the regulation of water resource. They also supported Water Works Design and Supervision Enterprise (WWDSE) and Water Works Construction Enterprise (WWCE) in improving coordinated thinking and in sharing best practices.

To this end PAWS has sent two experts from the UK to Ethiopia, to support WWCE in developing good practice and procedures, and WWDSE in achieving ISO quality assurance accreditation.

Detailed recommendations have been made to Design and Supervision Enterprise on measures to be taken to meet the ISO 9001 standard.

Recommendations have been made on streamlining of processes in Construction Enterprises.

Workshop held to bring together senior management at Design and Supervision Enterprise and Water Works Construction Enterprise to identify solutions to share challenges, particularly around communication.

In addition to the above PAWS has invited four senior professional staffs from the two enterprises for experience sharing, in the UK.

1.3 Objectives

The main objectives of the twinning support programme are:

- To establish best practice through twinning with UK water companies
- To have knowledge exchange visits with commercially independent water process design and construction companies, serving the public UK water sector
- To increase the delivery capacity of the Enterprises so improving delivery value through improved efficiencies with quality assurance with WWDSE and contract management with WWCE that helps to take on a growing workload.
- To establish a strategy for building technical and managerial capacity of the Enterprises and to improve communication between the design and construction Enterprises.

1.4 Methodology

The exchange program has engaged the participants as described below, to maximise the rapid exchange of experiences, working practices and lessons learnt.

Presentation on different topics by senior experts and specialists.

Participating in different workshop and exhibition

Field visits to experience project sites at different project phases, from construction to completion, and in operation.

Visits to various Construction and Consulting firms' offices.

Discussing with senior staffs of Minworth Wastewater Treatment Works.

Discussion with North Midland Construction plc, executive and senior management.

Discussion with ARUP and Mott MacDonald Consulting Firms.

2 Observation of Activity

2.1 Minworth Wastewater Treatment Works

The Minworth project is to upgrade the existing wastewater treatment plant to handle over 12 cubic m/s of waste water from the surrounding population of 1.7 Million people. Design and constructing with an estimated value of 140 M GBP, has the following principal assets are summarised below:

Complete new Inlet Works comprising screens and conveyor systems
22 reinforced concrete conical bottomed Primary Sedimentation Tanks (PST),
30.0m internal diameter with 3.42m sidewall depth and 10 degrees floor
slope. Each tank is fitted with a half bridge scraper and includes, automatic
pumped desludging with ram pumps discharging to an intermediate transfer
well.

6 number sludge transfer pumping stations (one for each bank of 4 nr PST's)
each with a dedicated rising main. Each pumping station will incorporate 2nr
(duty/standby) submersible sludge pumps and have a dedicated odour control
unit.

Numerous electrical Motor Control Center's (MCC's) and associated electrical
installation work to automate equipment.

Largest installed sludge belt building

Associated distribution chambers, pumping stations, feed/effluent pipelines,
channels and culverts.

Concrete roads around all structures carriageway drainage to liquors return
pumping station

Hard & soft landscaping

Type and Form of Contract

Severn Trent AMP 4 Framework Contract. ICE Conditions of Contract Term
Version (1st Edition) with Severn Trent Water Standard Amendments and
Additions version 1.0 February 2005.

Client of the Project is Severn Trent Water Limited

The Client appointed Project Manager.

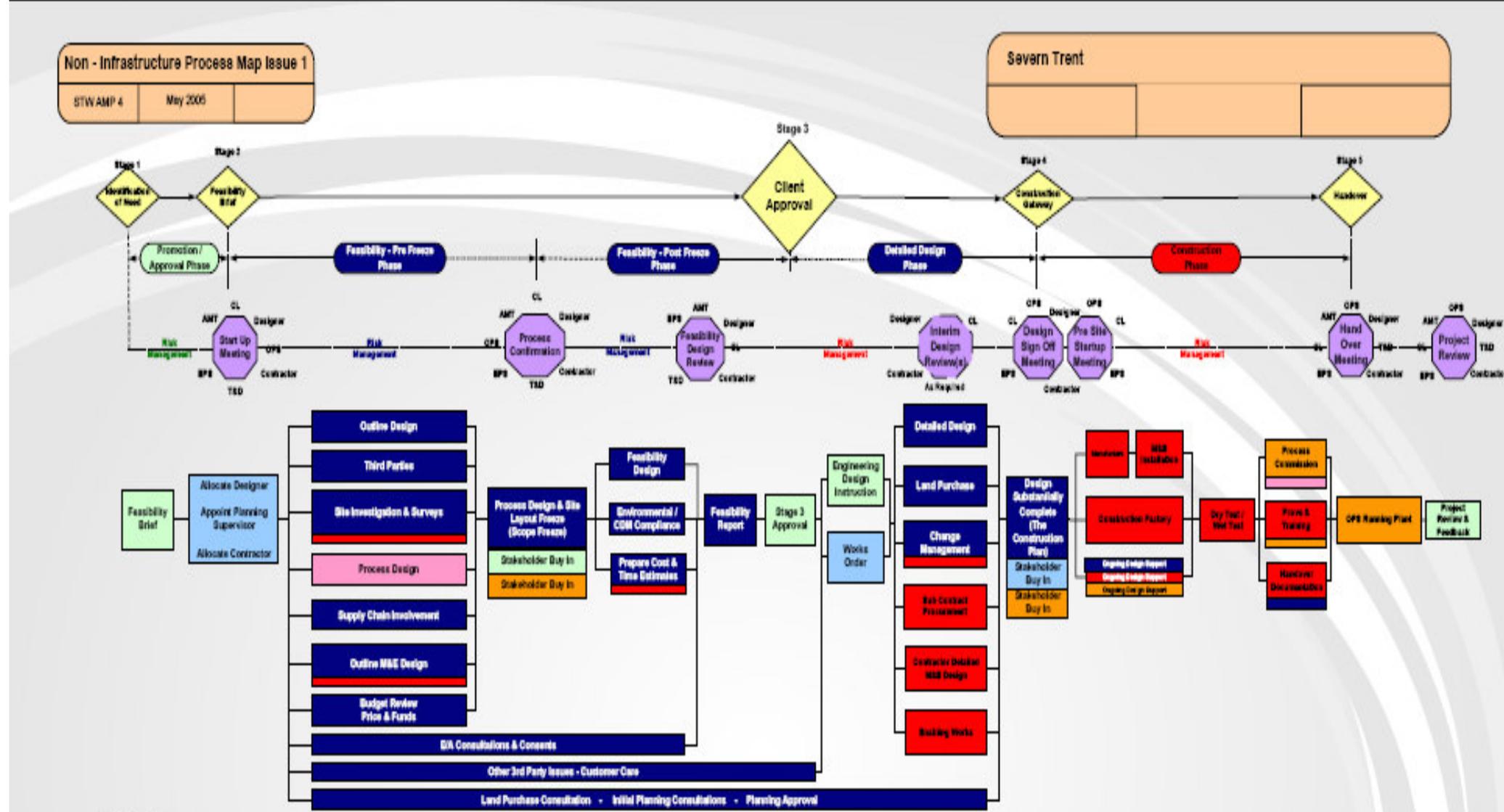
The main Contractor is the “*BNM Alliance*” which is a partnership between **B**iwater Treatment Limited and **N**orth **M**idland Construction (BNM Alliance). The BNMA in addition handles over 150 suppliers and 50 multi-discipline sub-contractors through a supply chain.

The client strategy embraces the Latham report ideas (Sir Michael Latham, 1994), of “early contractor involvement”, in which the contractor is involved from feasibility studies, outline design, and target price setting before a formal contract is awarded.



Minworth Wastewater Treatment Project

Process Map of Minworth Wastewater Treatment Project



2.2 Integrated Management of Projects

2.2.1 Health and Safety

The construction industry has a number of serious accidents and deaths resulting in major loss of human life due to operative lack of training, and awareness of construction dangers. These are significant factors contributing to this unacceptable accident. Many accidents occur because the same mistakes are repeated over and over again.

To reduce the above statistics, special attention is given for health and safety issues. The Alliance operates a Quality Management System in accordance with BS EN ISO 9001: 2000, an Environmental Management System to BS EN ISO 14001: 2004 and a Health and Safety Management System to OHSAS 18001: 1999.

All personals have familiarized themselves through Site Inductions, with the Health and Safety (H &S): Environmental Management: and Quality Management policy statements given out and also prominently displayed in the site office and site canteen areas.

Management and staff have the responsibility for implementing the policy and ensuring that all health and safety considerations are always given top priority in planning and day to day supervision of the work. To assure compliance with the policy, a dedicated Health and Safety Manager has been appointed reporting directly to the BNM Alliance Project Manager.

We have observed that the following Healthy and Safety measures are strictly applied for the workers as well as for visitors:

Before commencing work, visiting or entering the work site Health and Safety induction shall be introduced and orientation has been given.

Health and Safety induction is given by audio visual as well as by instruction and to ascertain familiarization with induction every body has been given a test on major aspects of H & S.

Compulsory wearing of, Personal Protection Equipment (PPE) as minimum on site: Helmet, High visibility coat, safety footwear, long trouser and gloves /has been provided for the workers as well as visitors and must be worn at all times.



After induction and test every worker and visitors sign in and authorized by health and safety officer and site rules and safety induction cards are given before entering the site. Health and Safety rules are based on the following main points:

- Safe system of work and safe working
- Incident and injury reporting
- Mobile plant, vehicle and transport
- Confined spaces
- Lifting equipment, lifting operation and manual handling
- Work at height, slips, trips and falls and safe access
- Excavations and safe digging practices
- Mechanical and electrical work
- House keeping
- Use of Personal Protection Equipment

Visitors shall not be allowed into the work area unless accompanied by a health and safety officer.

Site security

Preventing and minimizing the impact of security incidents: planning, implementation and reviewing of site security have been undertaken to minimize damage and theft so ensuring business continuity.

2.2.2 Environmental Protection

To comply with environmental legislation and regulation, impact assessments are completed during whole life of the project with particular emphasis on the following points:

- Waste – *reuse, recycle where possible*
- Water – *ensure all consents are in place*

- Conservation – *ensure all permissions are in place.*
- Noise and vibration – *switch off when equipment not in use.*
- Air Pollution – *reduce emissions*
- Resources – *switch of equipment*
- Environmental incidents – *report the incidents.*
- Compliant - *review or update the aspects and impacts.*
- Always display the site environmental preparedness plan.
- Use drip trays - *for fuel and oil, etc.*

2.2.3 Quality Assurance

The BNM Alliance management are responsible for insuring that efficient procedures are developed and implemented in their area and for setting appropriate objective at the relevant levels of the project. Every employee has responsibility for the quality of his or her own work and for contributing to the improvement of products or management processes. To ensure this the following procedures have been applied by BNM Alliance:

Identify the client's requirements and ensure that all personnel are aware of the importance of meeting these.

Set management objectives that will provide a focus for improvements in the performance and for increasing Client satisfaction.

Manage project processes and resources cost effectively.

Ensure that every one is aware of their role in meeting the project objectives and provide training and development to enable them to maximize their contribution.

Plan and execute work to achieve the Contract Requirements, on time, with best value and least risk.

Work with Client, Suppliers and Sub contractors to enhance mutual benefits.

Monitor performance and ensure that the Work satisfies Client's requirement and identify problem areas to initiate improvements.

3 CONTRACT MANAGEMENT PROCESS

3.1 *Need Assessment*

The Client initially carries out a “needs assessment”, feasibility study and preliminary design for government approval by a regulatory body. Upon approval by the government body, the client invites tenders from competent contractors with good reputation of performance, Integrated Management System (IMS) including financial performance.

3.2 *Study and Design Stage*

Study and Design stage involves all parties who are involved in the implementation of the project participating e.g. Operational Staff, Capital investment, and construction experts. The selected contractor would start with topographic surveying and geo-technical investigation works and carrying out revising, updating and working to create an agreed detail design of the project. Once the detail design is agreed, the target cost of the project is negotiated along with risk items.

The delivery team which consist of Project Manager, Designer and Contractor have a joint responsibility in the production and delivery of the Target cost.

3.3 *Procurement Stage*

The Construction Companies have procurement procedures for supply, subcontract and services at head office as well as site level and they have financial authorization limits of different items for procurement.

Requisitions orders and subcontracts specify the following information, as applicable: the scope of products and services required, for example design / supply / installation / commissioning, etc.

Check the requisition and resolve any queries with the originator. Prepare a Quotation Request to enable the potential vendors to quote for supply of the products and services required.

On receipt of the quotations, check that the information supplied covers the necessary technical, H&S, environmental, quality and commercial requirements. The Contract Engineer carries out technical evaluation and resolves any queries.

Based on the technical and financial evaluations, the contract agreement is awarded to the sub contractor offering best value, rather than just the lowest price.

3.4 Project Planning

Up on approval of final design, detail planning is done by the planning team following under listed steps:

Tender Stage Program Development:

- Scope of work
- Assumed works order date
- Contractual end date
- Target end date
- Copies of drawings
- Major suppliers/ Subcontractors /manufacture duration or their proposed program if available
- Constraints between tasks and operational interface constraints
- Deliverables of project specific process map agreed with Client
- Current progress on process map
- List of contacts and roles

Contract Stage Program Development:

- Confirmation of scope of works
- Projected /Actual works order date

- Contractual end date
- Target end date
- Interface with other site programs
- Copies of revised drawings to date
- Copies of any orders /Subcontracts already placed together with attendant quotations
- Copies of any supplier's /Subcontractor's programs
- Confirmation of and/or additional constraints between tasks and operational interfaces
- Current progress
- Deliverables expected from planning
- List of contacts and roles

Inputs required throughout the contract for Civil and M&E:

- Copies of any orders /Subcontracts already placed together with attendant quotations
- Copies of any supplier's /Subcontractor's programs
- Update of suppliers / sub contractor's progress against their programs/
- Advice of dates when supplier or sub contractor design drawings received, commented, issued, or approved.
- Buy-in and agreement of order and duration of tasks, prior to base line program production by those who are responsible for design, procurement, and installation and commissioning.
- Advice on any change investigated by client, internally or through suppliers/sub contractors.
- Update of completion data on all tasks, relative to the period under review, on a fortnightly bases agreed as appropriate to each contract.
- Deliverables expected from planning.

Suggested Deliverables from Planning

- Production of baseline program for issuing to Client for approval.
- List of planned percentage complete by date "x" according to the baseline program.

- Look ahead program(no. of weeks to be agreed)
- Update of program with actual start date and remaining duration input.
- Reschedule current program after update data has been input in order to show the effect of current status on the rest of the program.
- Production of resources related mini-program(e.g. Design, Procurement etc) where requested
- Highlight of potentially critical status items and suggested possible solution.

The planning and tracking of work progress during construction is done with Primavera software and progress reports are evaluated by activity unit verses time.

3.5 Construction Stage

During construction stage for each activity the following procedures are required:

3.5.1 Construction checks

Obtain the relevant “**FOR CONSTRUCTION**” drawings and relevant work instructions, e.g. Quality Plan, Method Statements, specifications, etc. as applicable.

Check that any drawings that have been marked “**FOR CONSTRUCTION - PENDING CLIENT APPROVAL**” have been ‘approved’ and signed by the Site Manager (or nominee).

Ensure that any materials and equipment required are available and are satisfactory.

Ensure that information relating to the use of materials and equipment is available, e.g. instructions for use, COSHH information, installation instructions, etc.

Ensure that the necessary plant and tools are available.

Ensure that the necessary personnel are available and that any special requirements for qualifications and training have been satisfied.

Check that the any preceding work has been completed and that the necessary QC checks have been carried out and are satisfactory.

Issue the necessary drawings and instructions to the workforce. Instructions may be given verbally or in writing, as appropriate.

Supervise the work to the extent necessary to ensure that it is carried out safely and to the required quality standards.

Carry out in process inspections at the hold points specified in the Quality Control Plan and / or Method Statement and record the results, or advise the nominated inspector accordingly. If necessary, notify the RE.

If work is found to be unsatisfactory ensure that the appropriate remedial measures are carried out and it is re-inspected before the work is allowed to proceed.

Raise a Non-Conformance Record in accordance with the contract procedures.

Ensure that a Quality Control Plan has been prepared and approved by the Engineer.

Ensure that a Method Statement has been prepared and approved by the Engineer

3.5.2 Method Statements

To enhance safety, Method Statements are prepared to define:

The required method, or sequence, of work where this is not obvious from the drawings, etc.

Any special quality requirements.

Any special control measures identified from the Health & safety and Environmental Risk Assessment for each activity.

The method of carrying out work that interfaces with the Clients operations.

Or as otherwise required by the Clients Resident Engineer.

Where appropriate, consult operatives to determine methodology and if reviewers identify areas requiring revision, make appropriate amendments, change document revision and internal approval.

Request the Client for approval and under cover of a transmittal note clearly detailing reference number and revision, formally issue complete, signed and dated document.

Advise the operatives of the risks involved with the work being performed, and agree that it is the safest method of completing that work.

3.5.3 Construction Activity

After the approval of the Method Statement the construction work is carried out after ensuring the skill and resource availability for the required tasks. A standard template helps with the preparation of the Method Statement with the following headings:

Scope of the work

Procedures to follow

Records of construction activities

Responsible person for each step

Stages which requires the approval of Resident Engineer

The works are undertaken using appropriate equipment depending on the particular site condition taking into account Health & Safety and environmental protections.

To make the project more cost effective, efficient and to increase productivities most of the work is machine oriented and use pre-fabricated products such as spacer (plastic and concrete), formwork, reinforcement bars, etc.

3.5.4 Quality Control

The contractor, suppliers and sub contractors are fully responsible to deliver products to the specification in the contract document. Client supervision and Inspection is carried out during the work ensuring compliance.

3.5.5 Final Inspection and Test

These inspections should be carried out to ensure that work is satisfactory before it is offered to the Client (Resident Engineer).

As specified in the Project Management Plan and Quality Plan carry out inspections to verify that the work complies with the specified requirements, or is complete. Record the results.

If work is found to be unsatisfactory: ensure that the appropriate remedial measures are carried out and a Non-Conformance Record in accordance with contract agreement and possible financial responsibility

Testing, to be carried out after joint Completion Inspections with the Client (Resident Engineer).

3.6 Lessons Learned on Contract Management process

On the application of principles of contract management process we have observed that there are difference between what we have learned during our visit and the current practice what we have exercising in both Enterprises. The difference and the possibility of application of these principles are described below.

Item No	Process	Current Practice		Applicability to both Enterprises	Remark
		<i>In UK</i>	<i>In WWDSE & WWCE</i>		
1	Need Assessment	The same	The same		
2	Study and Design Stage	Early involvement of contractor	No early involvement of contractor	Could be applicable	Being public enterprises & serving the same client (MoWR) it is easy to apply
3	Procurement Stage	Use mostly IT Efficient and reliable suppliers Involvement of specialized subcontractors	More of hard copy Inefficient and unreliable suppliers At early stage of specialized subcontractors	Time taken It needs external involvement Applicable but limited	
4	Planning	Tender stage detail program development Detail construction program development and inputs	At tender stage detail program is not critically addressed Construction program and inputs are not critically addressed	It could be applicable It could be applicable	Attention should be given by the client It needs change in attitude & involvement of three party
5	Construction Stage	Thorough and formatted construction checks Detail H & S and environmental risk assessment Construction activity and quality control is the same	Limited construction checks Limited H & S and environmental risk assessment Construction activity and quality control is the same	It could be applicable It could be applicable	It needs change in attitude & involvement of three party

4 Presentations and Workshop

4.1 New Engineering Contract (NEC)

We have participated in NEC training workshop and understood that it is a newly adopted type of contract that has clarity, simplicity, flexibility, situated to good management. This has been confirmed with those visited projects which have used NEC form of contract. For further information, the following sections 4.1.1 to 4.1.15 are extracted from the Engineering and Construction Contract Guidance Note (<http://www.neccontract.com>, NEC2).

4.1.1 General

NEC contract is a newly adopted type of contract that has clarity, simplicity, flexibility, situated to good management, which is an improvement on existing standard contracts in a number of ways.

NEC is based on accelerating the change in the construction industry by eroding the traditional approach, by working together and through greater integration.

4.1.2 Flexibility

The flexibility of NEC documentation enables it to be used by integrated project team. It could be achieved by adopting construction management as procurement route. This provides a structure and facilitate communications between contractor, consultant and project management on design, cost and program issues.

The NEC is intended

To be used for engineering and construction work containing any or all of the traditional disciplines such as civil, electrical, mechanical and building work.

To be used whether the Contractor has some design responsibility, full design responsibility or no design responsibility.

To provide all the normal current options for types of contract such as competitive tender (where the Contractor is committed to his offered prices), target contracts, cost reimbursable contracts and management contracts.

The key contractor could be engaged on the NEC engineering and construction contract with a contract manager.

4.1.3 Clarity and simplicity

The NEC is written in ordinary language, it uses only words which are in common use. It has few sentences to permit easier understanding. It is arranged and organised in a structure which helps the user to gain familiarity with its contents. More importantly, the actions by the parties which follow from use of the NEC are defined precisely so that there should be few disputes about who is to do what and how.

A fundamental objective of the NEC is that its use should minimise the incidence of disputes. Thus words like 'fair', 'reasonable' and 'opinion' have been used as little as possible. This does mean that administering the contract correctly involves more administration.

NEC will attract for its efficiency and timely completion. The contract is a mechanized that will ensure quality, time and cost is met, through a collaboration integrated team approach.

4.1.4 Stimulus to good

This is perhaps the most important characteristic of the NEC. Every management procedure has been designed so that its implementation should contribute to rather than detract from the effectiveness of management of the

work. This aspect of NEC is founded upon the proposition that foresighted, cooperative management of the interactions between the parties can shrink the risks inherent in construction work. With the NEC, it is now possible to build arrangements for the different parties to contribute to the management of a project upon improved practices and to motivate all parties, by means of the contract, and to apply such practices to their work.

4.1.5 Some other changes

The NEC is intended to provide a modern method for employers, designers, contractors and project managers to work collaboratively. It also enables them to achieve their own objectives more consistently than has been possible using older forms of contract. Use of the NEC is intended to lead to a much reduced risk to the Employer of cost and time overruns and of poor performance of the completed projects. It should also lead to a much increased likelihood of achieving a profit for the Contractor, subcontractors and suppliers and best value to the client.

4.1.6 Subcontracts

The NEC has been designed on the assumption that work may be subcontracted. A standard form of subcontract called the NEC Engineering and Construction Subcontract (ECS) has been also included. This uses appropriate names for the parties and has a small number of additional provisions appropriate to a subcontract. The subcontract has the convenience that Contractors' and Subcontractors' staffs do not have to become familiar with two different sets of text and procedure.

4.1.7 Application of the NEC

The NEC procedures are based on good management practice and often differ from current practice in some engineering and building disciplines.

The NEC is drafted in a simple and clear style, but its differences from current practice mean that some explanation and consideration of how it will work is necessary when it is first used. It is useful in training people coming into the management of projects in how to make best use of the Engineering and Construction Contract as part of the NEC System.

4.1.8 Arrangement of the NEC

The NEC includes the following sections of text:

- the core clauses,
- the main option clauses,
- the secondary option clauses,
- the Schedules of Cost Components and
- the Contract Data formats.

Other documents when using the NEC will include:

- the Works Information
- the Site Information
- the Accepted Programme

Documents resulting from choosing secondary options such as

- Performance Bond (if submitted before Contract Date)
- An activity schedule or a bill of quantities.

The Schedule of Cost Components is a complete identification of components of cost which is not varied from one contract to another. It is used to avoid uncertainty where Actual Cost, has to be assessed in connection with any of the procedure of the contract. It is not priced.

The Contract Data are selected and completed for each contract. These data identify such things as the completion dates, the contract specific documents (e.g. specifications and drawings), interest rates and price adjustment indices to be used.

4.1.9 Clause numbering

The NEC is arranged in nine sections:

1. General
2. The Contractor's main responsibilities

3. Time
4. Testing and Defects
5. Payment
6. Compensation events
7. Title
8. Risks and insurance
9. Disputes and termination

4.1.10 Project organization

The project organisation assumed in the NEC involves the participants. The NEC is used for the contract between the Employer and the Contractor. The ECS may be used for the Contractor's subcontracts. The NEC Professional Services Contract may be used for contracts with the Project Manager, the designers or the Supervisor. The NEC Adjudicator's Contract is used for the contract between the Employer and Contractor (jointly) and the Adjudicator. It may also be used in subcontracts using the ECS and in NEC Professional Services Contracts.

The roles of the Project Manager, designers and Supervisor may be combined where the objectives of the Employer are served by so doing. Similarly, any or all of these three roles may be taken by employees of the Employer. The role of the Adjudicator should neither be combined with another role nor taken by an employee of the Employer.

4.1.11 Roles and duties

The NEC sets out the responsibilities and roles of the following parties:

- the Employer,
- the Project Manager,
- the Supervisor,
- the Contractor,
- the Subcontractor and
- the Adjudicator

Separate functions of Employer's designer and Contractor's designer are assumed but not mentioned in the contract.

The role played by the Engineer, Architect or Supervising Officer in other standard forms is divided between the Project Manager, the Supervisor, the Employer's designer and the Adjudicator.

4.1.12 Project Manager

The Project Manager is appointed by the Employer, either from his own staff or from outside. His role within the NEC is to manage the contract for the Employer with the intention of achieving the Employer's objectives for the completed project.

The Employer will normally appoint a project manager in the feasibility study stages of a project. His duties may then also include acting on behalf of the Employer and advising him on the procurement of design, on estimates of costs and time, on the merits of alternative schemes and on choosing the most appropriate contract strategy.

As contracts are placed for construction work, it is preferable to appoint the person or organisation already appointed for the whole project to act as the Project Manager on a particular contract. However, it is essential that the Project Manager for a particular contract is sufficiently close to the work and has the time and authority to carry out his duties effectively. On very large projects, especially those including several contracts, it may be necessary to appoint a different Project Manager for each contract or for the Project Manager to delegate his responsibilities for some of the contracts.

The NEC places considerable authority in the hands of the Project Manager. It assumes that he has the Employer's authority to carry out the actions and make the decisions which are required of him. If his contract with the Employer constrains him in any way, as for example in the case of a limit on the amount

which the Project Manager may authorise as a compensation event assessment, it is the responsibility of the Project Manager to ensure that all the approvals are given in time to enable him to comply with the time periods set out in the NEC. If such approvals by the Employer are not given, the Contractor has the right to raise the matter with the Adjudicator. It is not advisable to state limits on the Project Manager's authority in the additional conditions of contract as this will make settlement of disputes difficult.

The Project Manager is free to seek the Employer's views as much or as little as his relationship and contract with the Employer requires. He will normally maintain close contact with the Employer so that his decisions reflect the Employer's business objectives.

He has authority to change the work, to instruct the Contractor, and generally to apply his managerial and engineering judgement. Positive management from both sides is encouraged.

The contractual role of the Project Manager is defined in terms of the actions and decisions he is to take. He is constrained from acting unreasonably in this role by statements of the basis on which he is to make each type of decision but not what decisions he is to make. If the Contractor believes that any of the Project Manager's actions or decisions is not in accordance with the contract, he may refer it to the Adjudicator.

Perhaps the strongest feature of the NEC which stimulates cooperation rather than adversarial activity is the fact that the Contractor is little concerned with the way the Project Manager decides to deal with problems which are the Employer's responsibility. If the Contractor's eventual payment is largely secure, he is not encouraged to make the worst of any problems which arise, either as regards their effect upon cost or upon the timing of the work. This feature is strengthened by the flexibility available to the Employer and the Project Manager in their precontract choice of main option for a particular contract ranging from price

commitment to cost reimbursable. The NEC permits this choice of contract strategy without the need to resort to different standard forms.

4.1.13 Designers

Designers for the Employer's design are appointed by the Employer. If several designers are appointed, possibly covering different disciplines, a lead designer should be appointed.

The designer's role is to develop the design to meet the Employer's objectives to the point where tenders for construction are to be invited.

If a 'design and construct' contract is envisaged, the Employer's designer's role is restricted largely to providing a performance specification together with standards for design and materials which he may wish to specify for inclusion in the Works Information.

Under the NEC the Employer's designer is not referred to in the contract between the Employer and the Contractor. However, the Employer should ensure that the Project Manager's brief includes management of the designer's activities. The Project Manager should have ready access to the designer for advice.

4.1.14 Supervisor

The Supervisor is appointed by the Employer for a particular contract. He can be an in-house person or someone from outside.

Essentially, his role is to check that the works are constructed in accordance with the contract. It is similar to that of a resident engineer or architect who may be assisted by an inspector or clerk of works.

In some circumstances it would be appropriate for the clerk of works to carry out this role like those of Project managers,

4.1.15 Adjudicator

The Adjudicator is appointed jointly by the Employer and the Contractor for the contract and only involved when a dispute is referred to him.

If either Party does not accept his decision, they may proceed to the tribunal (either arbitration or the courts).

Under the Adjudicator's Contract, payment of the Adjudicator's fee is shared equally by the Parties.

4.2 Quality Management

Quality system helps the organization to derive all the process in the right track and it is based on:

- ❖ Policies and objectives
- ❖ High level process maps and individual maps
- ❖ Mandatory written procedures
- ❖ Use standard formats
- ❖ Standardization of products
- ❖ Internal and External Auditing
- ❖ Continuous improvement
- ❖ Feedback
- ❖ And so on

Regarding the Quality management all the firms which we have visited have set their policy, objectives, well defined process maps and all other principles are implemented well in practice. Whereas, in our enterprises we are at the initial stage and not well organized, hence, it needs more emphasise in implementing the Quality Management System. To alleviate the short coming, training and technical support is necessary.

4.3 Information Communication Technology (ICT)

All visited consulting and construction firms have been using ICT as a tool to maximize their efficiency and to easy their day to day activities in the design, procurement, planning and construction as well as operation processes.

As identified by the UK's ICT National Platform Working Group, the main benefits of ICT in the construction industry are:

Use of a virtual environment to create prototype or model solutions that meet all the various dimensions of the brief – functionality, aesthetics, logistics, easy and safety of construction, operation and maintenance, whole life cost, sustainability, etc.

Manufacturers and suppliers (already involved in the design process) reusing model information for offsite fabrication of the required components in the optimum sequence for just-on-time delivery to the facility.

All project personnel wearing small devices that monitor their exact position, giving warnings, where necessary, regarding the individual's safety and security.

Those with managerial responsibility being able to interrogate the online environment to get real time updates on schedules, project costs and other performance parameters.

Upon completion, using the building model as a powerful asset management tool, linking the facility owner/operator with relevant suppliers

or maintenance contractors, with all repairs or replacement automatically recorded.

(Source: Howard, 2008)

It is worth to mention that both enterprises are not using ICT as compared to what we have seen during our visit in UK. As such it has to be well addressed during the establishment of quality management of both enterprises.

4.4 International Standards Organizations (ISO)

The requirements to achieve ISO accreditation have been presented to us to show a “best practice” site. A family of ISO standard documents exist, the major ones are:

- ❖ ISO 9001 Quality Management System
- ❖ ISO 14001 Environmental Management System
- ❖ OHSAS 18001 Health & Safety Management System

There are also a number of supporting documents covering related subjects such as internal audits etc.

Accreditation to ISO standards

Accreditation (not certification) shows that a company has decided to base its “quality” management systems on these standards and have proven their ability to meet the requirements via independent external auditing.

To achieve accreditation to international Quality Standard ISO 9001: 2000 “Quality Management Systems – Requirements”, an assessment of Quality Assurance Procedure and practice has been carried out for WWDSE. This has been undertaken by Partners for Water and Sanitation (PAWS) through David Rathmell (David Rathmell, July 2006).

Requirements to ISO accreditation

- Understand the standards (e.g. ISO 9001, ISO 140001)
- Get top management backing typically board level
- Find certification body (e.g. BSI, LRQA)
- Set up project plan
- Define policy identify main processes
- Check legislation for your activities
- Set Key Performance Indicator's (KPI's) and start measuring performance
- Start communication
- Select and train internal auditors
- Do a gap analysis
- Write procedures/work instructions as required
- Start internal auditing
- Set certification date
- Carry out management review
- Carry out any changes highlighted
- Carry out certification audit
- Continue to audit and update system.

Benefits of ISO standards

Implementing the ISO standards are really about changing the culture of the company. There will be resistance to some of these new ideas and requirements. It is important that the management team communicate their aims and progress achieved to all staff. For further information please refer PAWS Visit Report on WWDSE Quality Management System by David Rathmell (David Rathmell, July 2006). Some of the major benefits of ISO standards are:

- An opportunity to truly integrate the management system to drive and support operational performance
 - Increased customer confidence
 - Increased efficiency and effectiveness
 - Reduced risk and liability
 - Quality system contributing to the overall success of the business.

5. Site Visit Report

During this exchange program site visits were arranged to share experience from different construction and consulting companies to observe how the construction and operation of the projects are going on and to have interaction and discussion with design, construction and operation teams of the projects.

The visited project sites; contractors and consulting firms as well as lessons learned from them are briefly described below.

5.1 Visited projects

5.1.1 Under Operational Works

Whitacre Water Treatment Works

Campion Hills Water Treatment Works

The Whitacre and Campion Hills Water Treatment Works are designed and constructed for the supply of potable water to Birmingham City. We have observed that the H & S is well carried out. Moreover, the technologies under use to treat water are Granular Activated Carbon (GCA) and Ozone plant to produce quality water. To meet the quality standard laboratory test is conducted with fully automated equipment.

Elan Valley Dams Site

Elan Valley Dams were built to supply sustainable potable water to Birmingham City. We have observed that the engineering site selection, design and construction works were completed over 100 years ago and still they are serving. It can be witnessed that the importance of environmental protection (proper land use, land cover by vegetation, social awareness etc.) which contributes for the

longer lives of storage dams. In addition to this the dams have been used as multipurpose like fishing and recreation.



One of the Elan Valley Dams

Dinorwig Hydropower Station, *Llanberis, North Wales*

During our visit to Dinorwig Hydropower Station, we have observed the integration of all types of engineering works. The power station was built on the principles of pumped storage. A large volume of water is stored at height and when released, the kinetic energy of the falling water is used to drive turbines which, in turn, power generators to create electricity. The used water is then captured in a lower reservoir and pumped back to the upper reservoir to be stored until the next requirement for generation.

The power station gives immediate response for peak demand which is not possible to satisfy by base load plants. The other important thing is it uses the excess power during low demand at low cost to pump the water using the same power generating units.

During construction and operation the power station responds positively to the social and environmental values. Social and environmental values mainly gave more job opportunity for local people and virtually all works are located inside Elider mountain ensured that power station blends sympathetically with its landscape and planting and preserving indigenous plants and protecting fishes. In general we have seen the engineering values such as selection of the ideal site for pumped storage, the utilization of the same system for both power generation and pumping back to upper reservoir, and huge underground work which keep all works inside the mountain. These encourage us to continue and think in doing more big projects.

Ulley Valley Dam Rehabilitation Project

The dam was constructed in 1874 as main storage of water supply system for Rotherham Village and now it serves as a recreation park. During our visit and discussion with professionals at the site, we came to understand that the dam has not had sedimentation problem for the last 134 years of its life due to the fact of social awareness and proper management of the land use within the catchment area (i.e. due to environmental protection).

The shortfall of this dam is that the spillway capacity was not adequate to accommodate the peak flood, so that there was a danger of damage and washing out of the small portion of downstream slope of the dam in June 2007 flood period. In the mean time experts are assigned to investigate and study in detail the remedial measures to be taken to offer longer existence for the dam to keep it as historical heritages. This gives us more practical evidence that the importance of environmental protection could grant longer life period of the dams.



Ulley Valley Dam Rehabilitation Project

5.1.2 Visited Projects Under Construction

Including Minworth Wastewater Treatment Works we have observed various projects which are under construction owned by different Water Utilities (Client, Engineers and Contractors). In general they have framework agreement based on mutual trust as target price cost. All projects design, planning and construction process are carried out on the basis of integrated health & safety, quality and environmental management system and they are abide by the rules and regulations of UK. As all follow the same procedure as detailed in section 2 of this report, hence only the outcome of visits are summarized and listed out in section 5.2 of this report.

Manchester City Flood water Treatment Project

Wrexham Integrated Waste Recycling Project

Frankley Water Treatment Project

Harrogate Wastewater Treatment Project

Cheam Water Treatment Project
Yorkshire Wastewater Treatment project

5.1.3 Visited Construction and Consulting Firms and Others

North Midland Construction PLC Head Office
ARUP Consulting Firm Head Office
Biwater Plc Head Office
Farrer Consulting Firm (Workshop)
Severn Trent Water: Annual Exhibition (Quality Day)
EarthTech and Morrison (ETM) Contractor Head Office
Mott MacDonald Consulting Firm Head Office
PAWS Head Office at the Water, Engineering and Development Centre
(WEDC), Loughborough University

5.2 Lesson Learned

Integrated Management

All of the construction companies and Consulting Firms have been certified for Quality Management System in accordance with BS EN ISO 9001: 2000, Environmental Management System to BS EN ISO 14001: 2004 and Health and Safety Management System to OHSAS 18001: 1999.

In all of the visited sites before entering to the office the visitors has to signed in and leaving the office or the site they have to sign out.

In all of the visited sites before entering the work site Health and Safety induction has been given by audio visual as well as by instructors and depending on the site condition, Personal Protection Equipment (PPE) should be worn.

Most of the visited construction works in UK are adopting the form of contract agreement design-built, i.e. Contractor is responsible for the design as well as construction works of the project.

Working in alliance, partnership with mutual trusts that driven to deliver quality products for the employer (Client). This will avoid blaming each other and sort out the cause of problems jointly and to learn out of it, not to replicate it again.

Office and office facilities have been arranged in such way that improves the team work spirit among employer, designers and construction teams.

Environmental protection on Existing and Ongoing Works

Determination and vision of policy makers, engineering value, environmentally friendly works, economical viable and address and respond well the interests and value of local people.

Foresighted us to look ahead to shoulder more responsibility.

Elan Valley and Ulley Valley dams impacted us old engineering and environmental protection value which give longer life to the dams (more than 100 years without sedimentation), thanks to this more than four hundred thousand visitor annually enjoy it as recreation area and hopefully in the future too. Due attention is also given to preserve heritage.



Major steps were taken to safeguard the flood damage that occur during June 27, 2007 and steps are underway to give a long lasting solution.

Based on the rules and regulations, the existing dams are operating for multipurpose.

Importance of social awareness and sense of belonging

Environmental Protection has to be given due emphasis to protect the ecosystem, for example in Wrexham Integrated Waste Recycling Project to safeguard Newts from construction activities, the penalty amount of about £ 50,000 and the work may suspended for a month or more until the protection means is in place to the satisfaction of the requirement and the regulatory body.



Protection for Rare Species of Newts

Management and Project Planning

As discussed with higher officials and professionals of the visited companies to share experience, we have learned that:

The companies are composed of different groups that have same objectives and shared value to give quality services and products to the customers.

Every employee of the Companies have a feeling of belonging to the firm

The Companies have well organized planning system, which can handle the planning process:

- Overall strategic programme showing summary activities for the key disciplines of client briefing, design, cost planning, procurement, construction, commissioning, handover.
- Summary programmes for design (all disciplines), procurement and construction.
- Detailed level of design programmes, procurement programmes, pre-construction works, construction work, test and commissioning and handover.
- Detailed construction programmes: covering day by day, week by week activities.

Resources Management and Control

They have effective and efficient resources management system like:

- Transport service is cost centred and they use modern technology for the control and service maintenance.
- Construction equipment (plant) is also cost centred and the firms have key equipment to facilitate the construction work internally in house rental base.
- The maintenance of plant is done strictly following the manufacturer's maintenance manual, and this attribute to low cost of maintenance during the life cycle of the equipment or plant. We have seen the record that one plant has served for about 20 years without any breakage.

Construction Techniques

The importance of 3D computer modelling before final design to visualize all parts of the structures easily and that facilitates operation and maintenance work after handing over.

The prepared drawing by the consultant or Engineer is reviewed by the Contractor before issuing of the Drawing, this reduce the back and fro and minimized time elapsed.

Most of the construction work executed on the material provided or supplied by various subcontractors or suppliers, such as rebar, form work, concrete scaffolding, etc that will reduce the burden on the main contractor.

Concrete spacer cube for rebar placement for floor slab and wall were manufactured and supplied to use on site. It could be concrete block, plastic or shaped reinforcement bar.

The activity and progress of the project work is displayed to by LCD.

To bind old and new concrete they use Green Cut which is roughening of the surface of the concrete by pressure of air and water.

Unsuitable material for foundation could be used by treating the weak formation by lime, cement and compacting layer by layer. They could also use the unsuitable material by using special; admixture and special machine for this purpose. The trenchmod machine transforms excavated material into reusable trench fill for utilities reinstatement or sub base for highway works.

On road construction work for the side curb stones they use **plastic prefabricated** curb stones instead of concrete or masonry curbs.

7 meters height of wall is directly filled by concrete pumps, and vibrated properly, in our case to avoid segregation allowable drop high is 1.5 meters.

To reduce the cost of scaffolding for erecting of rebar, they manufacture it on the ground and they erect it by crane.

Water stops are used for vertical construction joints only, for horizontal joint at the junction with vertical walls they are not using, because there is no movement in vertical direction. See BS 8007 option.

They are using HDPE pipes of large Diameter for pipe laying, DN 315 X 28.6 also DN 900 mm, fusion is made by 233 °C.

Drawings are issued to the contractor with soft copy by ICT (Information Communication Technology).

6 Recommendation

To meet the intended objectives, the ongoing Business process Reengineering (BPR) of WWDSE and WWCE, and the policy maker commitment to enhance change in the public enterprise will promote and give fertile conditions to implement the learned lessons during our visit. Hence, to do so the following methodologies have been recommended:

- 1) Disseminate the report and other relevant documents to the respective process owner at head office and project level.
- 2) New Offices Building design and construction will start soon in both Enterprises, so it is right time to look whether they satisfy all requirements for modern offices which promote integrated quality management.
- 3) For new incoming projects standard office building and camp facilities will be established and implemented, while for the existing projects some modification shall be made as much as possible.
- 4) Organize meeting to discuss on the improvement of the communication between the two enterprises and to share idea how both can work as a team to give quality services and products to the client.
- 5) Immediately with or after BPR start to introduce quality management by hiring a change consultant.
- 6) Gain from the UK experience, and avoid the time it took for the UK to develop into the present “best practices”. Extended the established relation with sustainable use of ICT.
- 7) We proposed an action plan to take these recommendations forward, subject to review and approval of all concerned bodies.

**Action Plan: Taking Forward PAWS/NMC Twinning Support to WWCE and
WWDSE**

References

- Engineering and Construction Contract (<http://www.neccontract.com>, **NEC2**).
- Howard, P. (2008), *ICT in the construction industry*, available from www.contractjournal.com/Articles/2008/03/26/58278/ict-in-the-construction-industry.html (accessed August 2008)
- Sir Michael Latham, *Constructing the Team*, Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry, July 1994.
- PAWS Visit Report, Water Works Design and Supervision Enterprise Quality Management System, David Rathmell, Ethiopia, July 2006.

Annex: Companies, Management and Senior Professionals met during the Twinning

S. No	Name	Company	Position	Address	
				E-mail	Telephone
1	Paul Fisher	Severn Trent Water	Project Manager	paul.fisher@bnmalliance.co.uk	44(0) 1213 134159
2	Mark Lee	BNM Alliance	Project Manager	mark.lee@bnmalliance.co.uk	44(0) 1213 136279
3	Jeremy Blom	BNM Alliance	Health & Safety Manager	jeremy.blom@bnmalliance.co.uk	44(0) 1213 137048
4	Tony Cutner	BNM Alliance	Design Manager	tony.cutner@bnmalliance.co.uk	44(0) 1213 137058
6	Peter Brewis	BNM Alliance	Chief Engineer	peter.brewis@bnmalliance.co.uk	44(0) 1213 136821
7	John Aldridge	BNM Alliance	Project Planning Manager	john.Aldridge@bnmalliance.co.uk	
8	Robert Moyle	North Midland Construction	Chairman and Chief Executive	www.northmid.co.uk	44(0) 1623 515008
9	Gary J. Catignani	North Midland Construction	Commercial Manager Power	gary.catignani.northmid.co.uk	44(0) 1623 515008
10	Andrew Lacey	North Midland Construction	Contract Manager	andy.lacey@northmid.co.uk	44(0) 1623 515008
11	Gavin W Clegg	North Midland Construction	Operation Manager	gavin.clegg@northmid.co.uk	44(0) 1623 515008
12	Chris Butler	North Midland Construction	QESH Manager	Chris.butler@northmid.co.uk	44(0) 1623 515008
13	Richard L Patterson	Mott MacDonald	New Engineering Contract Specialist	richard.patterson@mottmac.com	44(0) 1223 463606 44(0) 1223 463500
14	Jim Claydon	Freelancer	All Reservoir Panel Engineer	james.claydon@ntlworld.com	44(0) 1484 421943 44(0) 7962 665677
15	Jim Perry	Mott MacDonald		www.mottmac.com	44(0) 1223 463660
16	Giles Jackson	Biwater	Regional Commercial Director – Africa	giles.Jackson@biwater.com	44(0) 1306 746067
17	Andreas Koall	Biwater	Project Finance Manager	andreas.koall@biwater.com	44(0) 1306 746195
18	Paul L Turner	Mott MacDonald		paul.turner@mottmac.com	44(0) 1223 463434
19	Ciaran Kelly	Severn Trent Services International	Operation & Maintenance Manager	ciaran.kelly@stwi.co.uk	44(0) 1217 226130
20	Gerd Cachandt	ARUP		gerd.cachandt@arup.com	44(0) 1132 428498
21	Matt Douglas	ARUP		matt.douglas@arup.com	44(0) 1132 428498
22	Peter Jarema	Farrer Consulting	Director	peter.jarema@farrerconsulting.com	44(0) 1706 626331
23	Mark Townshend	Farrer Consulting	General Manager	mark.townshend@farrerconsulting.com	44(0) 1706 626117
24	Simon Turgoose	Farrer Consulting	Manager - Water Network Engineer	simon.turgoose@farrerconsulting.com	44(0) 1706 626351
25	Prashant Julka	Saftronics Control Systems	Framework Manager	prashant.julka@saftronics.co.uk	44(0) 7887 697117
26	David Rathmell	Freelancer	Quality System Expert	drathmell716@btinternet.com	