REPUBLIC OF KENYA

NATIONAL OCCUPATIONAL STANDARDS

FOR

CIVIL ENGINEERING TECHNICIAN

LEVEL 6

TVET CDACC
P.O. BOX 15745-00100
NAIROBI

First published 2019

Council Secretary/CEO
TVET Curriculum Development, Assessment and Certification Council
P.O. Box 15745–00100
Nairobi, Kenya
Email: info@tvetcdacc.go.ke

FOREWORD

The provision of quality education and training is fundamental to the Government's overall strategy for social economic development. Quality education and training will contribute to achievement of Kenya's development blueprint, Vision 2030 and sustainable development goals.

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution of Kenya 2010 and this resulted to the formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 4 of 2016). A key feature of this policy is the radical change in the design and delivery of the TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery allows for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that these Occupational Standards were developed for the purpose of developing a competency-based curriculum for Civil Engineering Technology Level 6. These Occupational Standards will also be the bases for assessment of an individual for competence certification.

It is my conviction that these Occupational Standards will play a great role towards development of competent human resource for the Building and Construction sector's growth and development.

PRINCIPAL SECRETARY
VOCATIONAL AND TECHNICAL TRAINING
MINISTRY OF EDUCATION

PREFACE

Kenya Vision 2030 aims to transform the country into a newly industrializing, "middle-income country providing a high-quality life to all its citizens by the year 2030". Kenya intends to create a globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through life-long education and training. TVET has a responsibility of facilitating the process of inculcating knowledge, skills and attitudes necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency Based Education and Training (CBET).

The Technical and Vocational Education and Training Act No. 29 of 2013 and Sessional Paper No. 4 of 2016 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment and certification. This called for a shift to CBET in order to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

The TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), in conjunction with Construction Sector Skills Advisory Committee (SSAC) have developed these Occupational Standards for Civil Engineering Technician. These standards will be the bases for development of competency-based curriculum for Civil Engineering Technology Level 6.

The occupational standards are designed and organized with clear performance criteria for each element of a unit of competency. These standards also outline the required knowledge and skills as well as evidence guide.

I am grateful to the Council Members, Council Secretariat, Construction SSAC, expert workers and all those who participated in the development of these Occupational Standards.

CHAIRPERSON
TVET CDACC

ACKNOWLEDGMENT

These Occupational Standards were developed through combined effort of various stakeholders from private and public organizations. I am thankful to the management of these organizations for allowing their staff to participate in this course. I wish to acknowledge the invaluable contribution of industry players who provided inputs towards the development of these Standards.

I thank TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) for providing guidance on the development of these Standards. My gratitude goes to Construction Sector Skills Advisory Committee (SSAC) members for their contribution to the development of these Standards. I thank all the individuals and organizations who participated in the validation of these Standards.

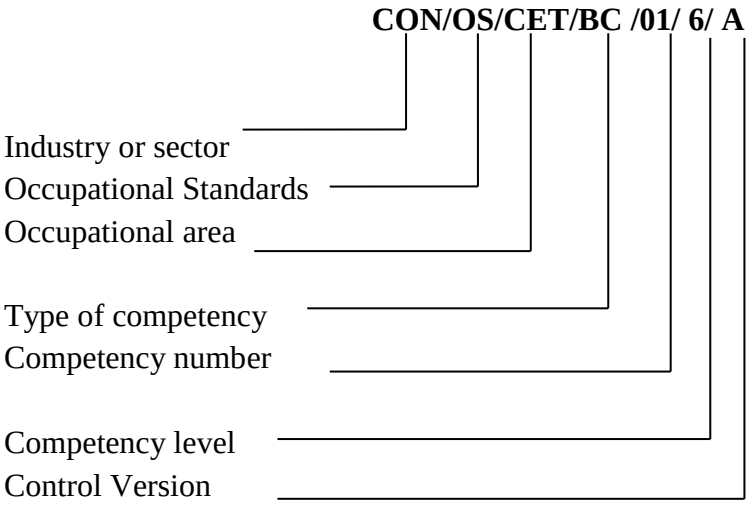
My gratitude also goes to the Ministry of Industrialization which enabled the development of these Standards through the industry experts.

I acknowledge all other institutions which in one way or another contributed to the development of these Standards.

CHAIRPERSON
CONSTRUCTION SECTOR SKILLS ADVISORY COMMITTEE

CONTENTS

KEY TO UNIT CODE



OVERVIEW

The Civil Engineering Technician Level 6 consists of competencies that a person must achieve to enable him/her to work in a Building and Construction Sector. It entails conducting material testing, performing highway survey, designing basic pavement structures, carrying out road construction works, designing engineering structures, producing building drawings, carrying out building works, managing water resources quality, designing wastewater collection and treatment infrastructure, constructing wastewater infrastructure, designing onsite sanitation facilities, constructing onsite sanitation facilities and managing civil engineering projects

BASIC UNITS OF COMPETENCY	
Unit of competency Code	**Units of competency**
CON/OS/CET/BC/01/6/A	Demonstrate Communication Skills
CON/ OS/CET/BC/02/6/A	Demonstrate Digital Literacy
CON/OS/CET/BC/03/6/A	Demonstrate Entrepreneurial Skills
CON/OS/CET/BC/04/6/A	Demonstrate Employability Skills
CON/OS/CET/BC/05/6/A	Demonstrate Environmental Literacy
CON/OS/CET/BC/06/6/A	Demonstrate Occupational Health and Safety
COMMON UNITS OF COMPETENCY	
CON/OS/CET/CC/01/6/A	Apply Mathematical Skills
CON/OS/CET/CC/02/6/A	Prepare And Interpret Technical Drawings
CON/OS/CET/CC/03/6/A	Perform Structural Design and Analysis
CON/OS/CET/CC/04/6/A	Apply Construction Material Science
CON/OS/CET/CC/05/6/A	Apply Workshop Technology Practices
CON/OS/CET/CC/06/6/A	Perform Measurement of Works and Cost Estimation
CON/OS/CET/CC/07/6/A	Apply Water and Wastewater Technology
CON/OS/CET/CC/08/6/A	Apply Water Resource, Water and Sanitation Services Management Principles

CORE UNITS OF COMPETENCY	
CON/CO/CET/CR/01/6/A	Conduct Material Testing
CON/CO/CET/CR/02/6/A	Perform Highway Survey
CON/CO/CET/CR/03/6/A	Design Basic Pavement Structures
CON/CO/CET/CR/04/6/A	Carry Out Road Construction Works
CON/CO/CET/CR/05/6/A	Design Engineering Structures
CON/CO/CET/CR/06/6/A	Produce Building Drawings
CON/CO/CET/CR/07/6/A	Carry Out Building Works
CON/CO/CET/CR/08/6/A	Manage Water Resources Quality
CON/CO/CET/CR/09/6/A	Design Wastewater Collection and Treatment Infrastructure
CON/CO/CET/CR/10/6/A	Construct Wastewater Infrastructure
CON/CO/CET/CR/11/6/A	Design Onsite Sanitation Facilities
CON/CO/CET/CR/12/6/A	Construct Onsite Sanitation Facilities
CON/CO/CET/CR/13/6/A	Manage Civil Engineering Projects

BASIC UNITS OF COMPETENCY

DEMONSTRATE COMMUNICATION SKILLS

UNIT CODE: CON/CO/CET/BC/01/6/A

UNIT DESCRIPTION

This unit covers the competencies required to demonstrate communication skills. It involves meeting communication needs of clients and colleagues, developing communication strategies, establishing and maintaining communication pathways, conducting interviews, facilitating group discussion and representing the organization.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the key outcomes which make up workplace function	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Meet communication needs of clients and colleagues	1.1 Specific communication needs of clients and colleagues are identified and met based on workplace requirements 1.2 Different communication approaches are identified and applied according to clients' needs 1.3 Conflict is identified and addressed as per the standards of the organization
2. Develop communication strategies	2.1 Strategies for effective internal and external dissemination of information are developed as per organization's requirements 2.2 Special communication needs are considered in developing strategies according workplace procedures 2.3 ***Communication strategies*** are analyzed, evaluated and revised based the workplace needs
3. Establish and maintain communication pathways	3.1 Pathways of communication are established as per organization policy 3.2 Pathways are maintained and reviewed according to organization procedures
4. Promote use of communication strategies	4.1 Information is provided to all areas of the organization as per strategy requirements 4.2 Effective communication techniques are articulated and modeled according work requirements 4.3 Personnel are given guidance about adapting communication strategies as per organization procedures
5. Conduct interview	5.1 A range of appropriate communication strategies are employed in ***interview situations*** based on the workplace requirements 5.2 Records of interviews are made and maintained in accordance with organizational procedures

	5.3 Effective questioning, listening and nonverbal communication techniques are used as per needs
6. Facilitate group discussion	6.1 Mechanisms to enhance ***effective group interaction*** are identified and implemented according to workplace requirements 6.2 Strategies to encourage group participation are identified and used as per organizations' procedures 6.3 Meetings objectives and agenda are set and followed based on workplace requirements 6.4 Relevant information is provided and feedback obtained according to set protocols 6.5 Evaluation of group communication strategies is undertaken in accordance with workplace guidelines 6.6 Specific communication needs of individuals are identified and addressed as per individual needs
7. Represent the organization	5.1 7Relevant presentation are researched and presented based on internal or external communication forums requirements 5.2 Presentation is delivered in a clear and sequential manner as per the predetermined time 5.3 Presentation is made as per appropriate media 5.4 Difference views are respected based on workplace procedures 5.5 Written communication is done as per organizational standards 5.6 Inquiries are responded according to organizational standard

RANGE

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

Variable	**Range**
1. Communication strategies may include but not limited to:	• Language switch • Comprehension check • Repetition • Asking confirmation • Paraphrase • Clarification request • Translation • Restructuring • Approximation • Generalization
2. Effective group interaction may	• Identifying and evaluating what is occurring within an interaction in a non-judgmental way

include but not limited to:	• Using active listening • Making decision about appropriate words, behavior • Putting together response which is culturally appropriate • Expressing an individual perspective • Expressing own philosophy, ideology and background and exploring impact with relevance to communication
3. Situations may include but not limited to:	• Establishing rapport • Eliciting facts and information • Facilitating resolution of issues • Developing action plans • Diffusing potentially difficult situations

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Communication
- Active listening
- Interpretation
- Negotiation
- Writing

Required Knowledge

The individual needs to demonstrate knowledge of:

- Communication process
- Dynamics of groups
- Styles of group leadership
- Key elements of communications strategy

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 Developed communication strategies to meet the organization requirements and applied in the workplace 1.2 Established and maintained communication pathways for effective communication in the workplace

	1.3 Used communication strategies involving exchanges of complex oral information
2. Resource Implications	The following resources should be provided: 2.1 Access to relevant workplace or appropriately simulated environment where assessment can take place 2.2 Materials relevant to the proposed activity or tasks
3. Methods of Assessment	Competency in this unit may be assessed through: 3.1 Direct observation 3.2 Oral questioning 3.3 Written texts
4. Context of Assessment	Competency may be assessed: 4.1 On-the-job 4.2 Off-the –job 4.3 During Industrial attachment
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

DEMONSTRATE DIGITAL LITERACY

UNIT CODE: CON/CO/CET/BC/02/6/A

UNIT DESCRIPTION

This unit describes competencies required to demonstrate digital literacy. It involves, identifying computer software and hardware, applying security measures to data, hardware, and software in automated environment, applying computer software in solving task, applying internet and email in communication at workplace, applying desktop publishing in official assignments and preparing presentation packages.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the key outcomes which make up workplace function	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Identify appropriate computer software and hardware	1.1 Concepts of ICT are determined in accordance with computer equipment 1.2 Classifications of computers are determined in accordance with manufacturers specification 1.3 Appropriate computer software is identified according to manufacturer's specification 1.4 Appropriate computer hardware is identified according to manufacturer's specification 1.5 Functions and commands of operating system are determined in accordance with manufacturer's specification
2. Apply security measures to data, hardware, software in automated environment	2.1 ***Data security and privacy are classified*** in accordance with the prevailing technology 2.2 ***Security threats*** reidentified ***and control measures*** are applied in accordance with laws governing protection of ICT 2.3 Computer threats and crimes are detected in accordance to Information Management security guidelines 2.4 Protection against computer crimes is undertaken in accordance with laws governing protection of ICT
3. Apply computer software in solving tasks	3.1 ***Word processing concepts*** are applied in resolving workplace tasks, report writing and documentation as per the job requirements 3.2 ***Word processing utilities*** are applied in accordance with workplace procedures

	3.3 Worksheet layout is prepared in accordance with work procedures 3.4 Worksheet is built and data manipulated in the worksheet in accordance with workplace procedures 3.5 Continuous data manipulated on worksheet is undertaken in accordance with work requirements 3.6 Database design and manipulation is undertaken in accordance with office procedures 3.7 Data sorting, indexing, storage, retrieval and security is provided in accordance with workplace procedures
4. Apply internet and email in communication at workplace	4.1 Electronic mail addresses are opened and applied in workplace communication in accordance with office policy 4.2 Office internet functions are defined and executed in accordance with office procedures 4.3 ***Network configuration*** is determined in accordance with office operations procedures 4.4 Official World Wide Web is installed and managed according to workplace procedures
5. Apply Desktop publishing in official assignments	5.1 Desktop publishing functions and tools are identified in accordance with manufactures specifications 5.2 Desktop publishing tools are developed in accordance with work requirements 5.3 Desktop publishing tools are applied in accordance with workplace requirements 5.4 Typeset work is enhanced in accordance with workplace standards
6. Prepare presentation packages	6.1 Types of presentation packages are identified in accordance with office requirements 6.2 Slides are created and formulated in accordance with workplace procedures 6.3 Slides are edited and run-in accordance with work procedures 6.4 Slides and handouts are printed according to work requirements

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variable	**Range**
1. Appropriate computer hardware	Collection of physical parts of a computer system such as: • Computer case, monitor, keyboard, and mouse

may include but not limited to:	• All the parts inside the computer case, such as the hard disk drive, motherboard and video card
2. Data security and privacy may include but not limited to:	• Confidentiality of data • Cloud computing • Integrity -but-curious data surfing
3. Security and control measures may include but not limited to:	• Counter measures against cyber terrorism • Risk reduction • Cyber threat issues • Risk management • Pass-wording
4. Security threats may include but not limited to:	• Cyber terrorism • Hacking

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Analytical skills
- Interpretation
- Typing
- Communication
- Computing (applying fundamental operations such as addition, subtraction, division and multiplication)
- Using calculator
- Basic ICT skills

Required Knowledge

The individual needs to demonstrate knowledge of:

- Software concept
- Functions of computer software and hardware
- Data security and privacy
- Computer security threats and control measures
- Technology underlying cyber-attacks and networks
- Cyber terrorism
- Computer crimes
- Detection and protection of computer crimes

- Laws governing protection of ICT
- Word processing;
  - ✓ Functions and concepts of word processing.
  - ✓ Documents and tables creation and manipulations
  - ✓ Mail merging
  - ✓ Word processing utilities
- Spread sheets;
  - ✓ Meaning, formulae, function and charts, uses and layout
  - ✓ Data formulation, manipulation and application to cells
  - ✓
- Database;
  - ✓ Database design, data manipulation, sorting, indexing, storage retrieval and security
- Desktop publishing;
  - ✓ Designing and developing desktop publishing tools
  - ✓ Manipulation of desktop publishing tools
  - ✓ Enhancement of typeset work and printing documents
- Presentation Packages;
  - ✓ Types of presentation Packages
  - ✓ Creating, formulating, running, editing, printing and presenting slides and handouts
- Networking and Internet;
  - ✓ Computer networking and internet.
  - ✓ Electronic mail and world wide web
- Emerging trends and issues in ICT;
  - ✓ Identify and integrate emerging trends and issues in ICT
  - ✓ Challenges posed by emerging trends and issues

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Identified and controlled security threats 1.2 Detected and protected computer crimes 1.3 Applied word processing in office tasks 1.4 Designed, prepared work sheet and applied data to the cells in accordance to workplace procedures 1.5 Opened electronic mail for office communication as per workplace procedure 1.6 Installed internet and World Wide Web for office tasks in accordance with office procedures 1.7 Integrated emerging issues in computer ICT applications 1.8 Applied laws governing protection of ICT

2. Resource Implications	The following resources should be provided: 2.1 Access to relevant workplace where assessment can take place 2.2 Appropriately simulated environment where assessment can take place
3. Methods of Assessment	Competency may be assessed through: 3.1 Observation 3.2 Oral questioning 3.3 Written test 3.4 Portfolio of Evidence 3.5 Interview 3.6 Third party report
4. Context of Assessment	Competency may be assessed: 4.1 On-the-job 4.2 Off-the –job 4.3 During Industrial attachment
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

DEMONSTRATE ENTREPRENEURIAL SKILLS

UNIT CODE : CON/CO/CET/BC/03/6/A

UNIT DESCRIPTION

This unit covers the competencies required to demonstrate understanding of entrepreneurship. It involves demonstrating understanding of an entrepreneur, entrepreneurship, and self-employment, identifying entrepreneurship opportunities, creating entrepreneurial awareness, applying entrepreneurial motivation, developing business innovative strategies and developing business plan.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT	PERFORMANCE CRITERIA
1. Demonstrate understanding of an Entrepreneur	1. 1 Entrepreneurs and Business persons are distinguished as per principles of entrepreneurship 1. 2 ***Types of entrepreneurs*** are identified as per principles of entrepreneurship 1. 3 Ways of becoming an Entrepreneur are identified as per principles of Entrepreneurship 1. 4 ***Characteristics of Entrepreneurs*** are identified as per principles of Entrepreneurship 1. 5 Factors affecting Entrepreneurship development are explored as per principles of Entrepreneurship
2. Demonstrate understanding of Entrepreneurship and self-employment	2. 1 Entrepreneurship and self-employment are distinguished as per principles of entrepreneurship 2. 2 Importance of self-employment is analysed based on business procedures and strategies 2. 3 ***Requirements for entry into self-employment*** are identified according to business procedures and strategies 2. 4 Role of an Entrepreneur in business is determined according to business procedures and strategies 2. 5 Contributions of Entrepreneurs to National development are identified as per business procedures and strategies 2. 6 Entrepreneurship culture in Kenya is explored as per business procedures and strategies 2. 7 Born or made Entrepreneurs are distinguished as per entrepreneurial traits

3. Identify Entrepreneurship opportunities	3.1 Sources of business ideas are identified as per business procedures and strategies 3.2 Business ideas and opportunities are generated as per business procedures and strategies 3.3 Business life cycle is analysed as per business procedures and strategies 3.4 Legal aspects of business are identified as per procedures and strategies 3.5 Product demand is assessed as per market strategies 3.6 Types of ***business environment*** are identified and evaluated as per business procedures 3.7 Factors to consider when evaluating business environment are explored based on business procedure and strategies 3.8 Technology in business is incorporated as per best practice
4. Create entrepreneurial awareness	4.1 ***Forms of businesses*** are explored as per business procedures and strategies 4.2 Sources of business finance are identified as per business procedures and strategies 4.3 Factors in selecting source of business finance are identified as per business procedures and strategies 4.4 ***Governing policies*** on Small Scale Enterprises (SSEs) are determined as per business procedures and strategies 4.5 Problems of starting and operating SSEs are explored as per business procedures and strategies
5. Apply entrepreneurial motivation	5.1 ***Internal and external motivation*** factors are determined in accordance with motivational theories 5.2 Self-assessment is carried out as per entrepreneurial orientation 5.3 Effective communications are carried out in accordance with communication principles 5.4 Entrepreneurial motivation is applied as per motivational theories
6. Develop innovative business strategies	6.1 Business innovation strategies are determined in accordance with the organization strategies 6.2 Creativity in business development is demonstrated in accordance with

	business strategies 6.3 ***Innovative business strategies*** are developed as per business principles 6.4 Linkages with other entrepreneurs are created as per best practice 6.5 ICT is incorporated in business growth and development as per best practice
7. Develop Business Plan	7.1 Identified Business is described as per business procedures and strategies 7.2 Marketing plan is developed as per business plan format 7.3 Organizational/Management plan is prepared in accordance with business plan format 7.4 Production/operation plan in accordance with business plan format 7.5 Financial plan is prepared in accordance with the business plan format 7.6 Executive summary is prepared in accordance with business plan format 7.7 Business plan is presented as per best practice

RANGE

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

Variable	Range
1. Types of entrepreneurs may include but not limited to:	• Innovators • Imitators • Craft • Opportunistic • Speculators
2. Characteristics of Entrepreneurs may include but not limited to:	• Creative • Innovative • Planner • Risk taker • Networker • Confident • Flexible • Persistent • Patient • Independent • Future oriented

	• Goal oriented
3. Requirements for entry into self-employment may include but not limited to	• Technical skills • Management skills • Entrepreneurial skills • Resources • Infrastructure
4. Internal and external motivation may include but not limited to:	• Interest • Passion • Freedom • Prestige • Rewards • Punishment • Enabling environment • Government policies
5. Business environment may include but not limited to:	• External • Internal • Intermediate
6. Forms of businesses may include but not limited to:	• Sole proprietorship • Partnership • Limited companies • Cooperatives
7. Governing policies may include but not limited to:	• Increasing scope for finance • Promoting cooperation between entrepreneurs and private sector • Reducing regulatory burden on entrepreneurs • Developing IT tools for entrepreneurs
8. Innovative business strategies may include but not limited to:	• New products • New methods of production • New markets • New sources of supplies • Change in industrialization

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Analytical
- Management

- Problem-solving
- Root-cause analysis
- Communication

Required Knowledge

The individual needs to demonstrate knowledge of:

- Decision making
- Business communication
- Change management
- Competition
- Risk
- Net working
- Time management
- Leadership
- Factors affecting entrepreneurship development
- Principles of Entrepreneurship
- Features and benefits of common operational practices, e. g., continuous improvement (kaizen), waste elimination,
- Conflict resolution
- Health, safety and environment (HSE) principles and requirements
- Customer care strategies
- Basic financial management
- Business strategic planning
- Impact of change on individuals, groups and industries
- Government and regulatory processes
- Local and international market trends
- Product promotion strategies
- Market and feasibility studies
- Government and regulatory processes
- Local and international business environment
- Relevant developments in other industries
- Regional/ County business expansion strategies

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	1. 1 Assessment requires evidence that the candidate: 1. 2 Distinguished entrepreneurs and businesspersons correctly 1. 3 Identified ways of becoming an entrepreneur appropriately

	1. 4 Explored factors affecting entrepreneurship development appropriately 1. 5 Analysed importance of self-employment accurately 1. 6 Identified requirements for entry into self-employment correctly 1. 7 Identified sources of business ideas correctly 1. 8 Generated Business ideas and opportunities correctly 1. 9 Analysed business life cycle accurately 1. 10 Identified legal aspects of business correctly 1. 11 Assessed product demand accurately 1. 12 Determined Internal and external motivation factors appropriately 1. 13 Carried out communications effectively 1. 14 Identified sources of business finance correctly 1. 15 Determined Governing policy on small scale enterprise appropriately 1. 16 Explored problems of starting and operating SSEs effectively 1. 17 Developed Marketing, Organizational/Management, Production/Operation and Financial plans correctly 1. 18 Prepared executive summary correctly 1. 19 Determined business innovative strategies appropriately 1. 20 Presented business plan effectively
2. Resource Implications	The following resources should be provided: 2.1 Access to relevant workplace where assessment can take place 2.2 Appropriately simulated environment where assessment can take place
3. Methods of Assessment	3.1 Written tests 3.2 Oral questions 3.3 Third party report 3.4 Interviews 3.5 Portfolio of Evidence
4. Context of Assessment	Competency may be assessed 4.1 On-the-job 4.2 Off-the –job 4.3 During Industrial attachment
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

DEMONSTRATE EMPLOYABILITY SKILLS

UNIT CODE: CON/CO/CET/BC/04/6/A

UNIT DESCRIPTON

This unit covers competencies required to demonstrate employability skills. It involves conducting self-management, demonstrating interpersonal communication, critical safe work habits, leading a workplace team, planning and organizing work, maintaining professional growth and development, demonstrating workplace learning, problem solving skills and managing ethical performance.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the key outcomes which make up workplace function.	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Conduct self-management	1.1 Personal vision, mission and goals are formulated based on potential and in relation to organization objectives 1.2 Emotional intelligence is demonstrated as per workplace requirements. 1.3 Individual performance is evaluated and monitored according to the agreed targets. 1.4 Assertiveness is developed and maintained based on the requirements of the job. 1.5 Accountability and responsibility for own actions are demonstrated based on workplace instructions. 1.6 Self-esteem and a positive self-image are developed and maintained based on values. 1.7 Time management, attendance and punctuality are observed as per the organization policy. 1.8 Goals are managed as per the organization's objective 1.9 Self-strengths and weaknesses are identified based on personal objectives
2. Demonstrate interpersonal communication	2.1 Writing skills are demonstrated as per communication policy 2.2 Negotiation and persuasion skills are demonstrated as per communication policy

	2.3 Internal and external stakeholders' needs are identified and interpreted as per the communication policy 2.4 Communication networks are established based on workplace policy 2.5 Information is shared as per communication policy
3. Demonstrate critical safe work habits	3.1 Stress is managed in accordance with workplace ppolicy. 3.2 Punctuality and time consciousness is demonstrated in line with workplace policy. 3.3 Personal objectives are integrated with organization goals based on organization's strategic plan. 3.4 ***Resources*** are utilized in accordance with workplace policy. 3.5 Work priorities are set in accordance to workplace goals and objectives. 3.6 Leisure time is recognized and utilized in line with personal objectives. 3.7 ***Drugs and substances of abuse*** are identified and avoided based on workplace policy. 3.8 HIV and AIDS prevention awareness is demonstrated in line with workplace policy. 3.9 Safety consciousness is demonstrated in the workplace based on organization safety policy. 3.10 ***Emerging issues*** are identified and dealt with in accordance with organization policy.
4. Lead a workplace team	4.1 Performance targets for the ***team*** are set based on organization's objectives 4.2 Duties are assigned in accordance with the organization policy. 4.3 ***Forms of communication*** in a team are established according to organization's policy. 4.4 Team performance is evaluated based on set targets as per workplace policy. 4.5 Conflicts are resolved between team members in line with organization policy. 4.6 Gender related issues are identified and mainstreamed in accordance workplace policy. 4.7 Human rights and fundamental freedoms are identified and respected as Constitution of Kenya 2010. 4.8 Healthy relationships are developed and maintained in line with workplace.

5. Plan and organize work	5.1 Work plans are prepared based on activities and budget. 5.2 Assigned tasks are interpreted and expectations identified as per the workplace instructions. 5.3 Task occupational safety and health requirements are identified and observed regulations. 5.4 Work resources are identified, mobilized, allocated and utilized based on organization work plans. 5.5 Work activities are monitored and evaluated in line with work plans and workplace policy. 5.6 Work plans are reviewed based on target and available resources.
6. Maintain professional growth and development	6.1 Personal training needs are identified and assessed in line with the requirements of the job. 6.2 ***Training and career opportunities*** are identified and utilized based on job requirements. 6.3 Resources for training are mobilized and allocated based organizations and individual skills needs. 6.4 Licensees and certifications relevant to job and career are obtained and renewed as per policy. 6.5 Work priorities and personal commitments are balanced and managed based on requirements of the job and personal objectives. 6.6 Recognitions are sought as proof of career advancement in line with professional requirements.
7. Demonstrate workplace learning	7.1 Learning opportunities are sought and managed based on job requirement and organization policy. 7.2 Improvement in performance is demonstrated based on courses attended. 7.3 Application of learning is demonstrated in both technical and non-technical aspects based on requirements of the job 7.4 Time and effort is invested in learning new skills based on job requirements 7.5 Initiative is taken to create more effective and efficient processes and procedures in line with workplace policy. 7.6 New systems are developed and maintained in accordance with the requirements of the job. 7.7 Awareness of personal role in workplace ***innovation*** is demonstrated based on requirements of the job.
8. Demonstrate problem solving skills	8.1 Creative, innovative and practical solutions are developed based on the problem

	8.2 Independence and initiative in identifying and solving problems is demonstrated based on requirements of the job. 8.3 Team problems are solved as per the workplace guidelines 8.4 Problem solving strategies are applied as per the workplace guidelines 8.5 Problems are analyzed and assumptions tested as per the context of data and circumstances
9. Manage ethical performance	9.1 Policies and guidelines are observed as per the workplace requirements 9.2 Self-worth and professionalism is exercised in line with personal goals and organizational policies 9.3 Code of conduct is observed as per the workplace requirements 9.4 Integrity is demonstrated as per legal requirement

RANGE

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

Variable	**Range**
1. Drug and substance abuse may include but not limited to:	Commonly abused • Alcohol • Tobacco • Miraa • Over-the-counter drugs • Cocaine • Bhang • Glue
2. Feedback may include but not limited to:	• Verbal • Written • Informal • Formal

3. Relationships may include but not limited to:	• Man/Woman • Trainer/trainee • Employee/employer • Client/service provider • Husband/wife • Boy/girl • Parent/child • Sibling relationships
4. Forms of communication may include but not limited to:	• Written • Visual • Verbal • Non verbal • Formal and informal
5. Team may include but not limited to:	• Small work group • Staff in a section/department • Inter-agency group
6. Personal growth may include but not limited to:	• Growth in the job • Career mobility • Gains and exposure the job gives • Networkings • Benefits that accrue to the individual as a result of noteworthy performance
7. Personal objectives may include but not limited to:	• Long term • Short term • Broad • Specific
8. Trainings and career opportunities may includes but not limited to	• Participation in training programs • Serving as Resource Persons in conferences and workshops
9. Resource may include may but not limited to:	• Human • Financial • Technology
10. Innovation may include but not limited to:	• New ideas • Original ideas • Different ideas • Methods/procedures • Processes • New tools
11. Emerging issues may include but not limited to:	• Terrorism • Social media

	• National cohesion • Open offices
12. Range of media for learning may include but not limited to:	• Mentoring • peer support and networking • IT and courses

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Interpersonal
- Communication
- Critical thinking
- Organizational
- Negotiation
- Monitoring
- Evaluation
- Record keeping
- Problem solving
- Decision Making
- Resource utilization
- Resource mobilization

Required Knowledge

The individual needs to demonstrate knowledge of:

- Work values and ethics
- Company policies
- Company operations, procedures and standards
- Occupational Health and safety procedures
- Fundamental rights at work
- Workplace communication
- Concept of time
- Time management
- Decision making
- Types of resources
- Work planning
- Organizing work
- Monitoring and evaluation
- Record keeping

- Gender mainstreaming
- HIV and AIDS
- Drug and substance abuse
- Professional growth and development
- Technology in the workplace
- Innovation
- Emerging issues

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 Conducted self-management 1.2 Demonstrated interpersonal communication 1.3 Demonstrated critical safe work habits 1.4 Demonstrated the ability to lead a workplace team 1.5 Planned and organized work 1.6 Maintained professional growth and development 1.7 Demonstrated workplace learning 1.8 Demonstrated problem solving skills 1.9 Demonstrated the ability to manage performance ethically
2. Resource Implications	The following resources should be provided: 2.1 Access to relevant workplace where assessment can take place 2.2 Appropriately simulated environment where assessment can take place
3. Methods of Assessment	Competency in this unit may be assessed through: 3.1 Observation 3.2 Oral questioning 3.3 Written test 3.4 Portfolio of Evidence 3.5 Interview 3.6 Third party report
4. Context of Assessment	Competency may be assessed: 4.1 On-the-job 4.2 Off-the –job 4.3 During Industrial attachment
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

DEMONSTRATE ENVIRONMENTAL LITERACY

UNIT CODE: CON/CO/CET/BC/05/6/A

UNIT DESCRIPTION

This unit specifies the competencies required to demonstrate environmental literacy. It involves, controlling environmental hazard and environmental pollution, demonstrating sustainable resource use, evaluating current practices in relation to resource usage, identifying environmental legislations/conventions for environmental concerns, implementing specific environmental programs, monitoring activities on environmental protection/Programs, analysing resource use and developing resource conservation plans

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the key outcomes which make up workplace function.	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Control environmental hazard	1. 1 Storage methods for environmentally hazardous material are strictly followed according to environmental regulations and OSHS. 1. 2 Disposal methods of hazardous wastes are followed according to environmental regulations and OSHS. 1. 3 ***PPE*** is used according to OSHS.
2. Control environmental Pollution	2.1 Environmental pollution ***control measures*** are implemented in accordance with international protocols. 2.2 Procedures for solid waste management are observed according Environmental Management and Coordination Act 1999 2.3 Methods for minimizing noise pollution is complied with based on *Noise* and Excessive Vibration *Pollution and Control Regulations*, 2009
3. Demonstrate sustainable resource use	3.1 Methods for minimizing wastage are complied with based on organizational waste management guide 3.2 Waste management procedures are employed following principles of 3Rs (Reduce, Reuse, Recycle) 3.3 Methods for economizing and reducing resource consumption are practiced as per the Constitution of Kenya 2010 Article 69 .

4. Evaluate current practices in relation to resource usage	4.1 Information on resource efficiency systems and procedures are collected and provided as per work groups/sector 4.2 Current resource usage is measured and recorded as per work group 4.3 Current purchasing strategies are analyzed and recorded according to industry procedures. 4.4 Current work processes to access information and data is analyzed following enterprise protocol.
5. Identify environmental legislations/conventions for environmental concerns	5.1 Environmental legislations/conventions and local ordinances are identified according to the different environmental aspects/impact 5.2 Industrial standard/environmental practices are described according to the different environmental concerns
6. Implement specific environmental programs	6.1 Programs/Activities are identified according to organizations policies and guidelines. 6.2 Individual roles/responsibilities are determined and performed based on the activities identified. 6.3 Problems/constraints encountered are resolved in accordance with organizations' policies and guidelines 6.4 Stakeholders are consulted based on company guidelines
7. Monitor activities on Environmental protection/Programs	7.1 Activities are periodically monitored and Evaluated according to the objectives of the environmental program 7.2 Feedback from stakeholders are gathered and considered in Proposing enhancements to the program based on consultations 7.3 Data gathered are analyzed based on Evaluation requirements 7.4 Recommendations are submitted based on the findings 7.5 Management support systems are set/established to sustain and enhance the program 7.6 Environmental incidents are monitored and reported to 7.7 concerned/proper authorities
8. Analyze resource use	8.1 All resource consuming processes are Identified as per the organizational work plan 8.2 Quantity and nature of resource consumed is determined based on processes

	8.3 Resource flow is analyzed as per different parts of the process. 8.4 Wastes are classified according to NEMA regulations on waste management.
9. Develop resource Conservation plans	9.1. Efficiency of use/conversion of resources is determined according to industry protocol. 9.2. Causes of low efficiency of use of resources are Determined based on industry protocol. 9.3. Plans for increasing the efficiency of resource use are developed based on findings.

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variable	Range
1. PPE may include but not limited to	• Mask • Gloves • Goggles • Safety hat • Overall • Hearing protector
2. Control measures may include but not limited to	• Methods for minimizing or stopping spread and ingestion of airborne particles • Methods for minimizing or stopping spread and ingestion of gases and fumes • Methods for minimizing or stopping spread and ingestion of liquid wastes

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Measuring
- Recording
- Analytical
- Monitoring

- Communication
- Writing

Required Knowledge

The individual needs to demonstrate knowledge of:

- PPEs
- Environmental regulations
- OSHS
- Pollution
- Waste management
- Principle of 3Rs
- Types of resources
- Techniques in measuring current usage of resources
- Environmental hazards
- Regulatory requirements

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Controlled environmental hazard 1.2 Controlled environmental pollution 1.3 Demonstrated sustainable resource use 1.4 Evaluated current practices in relation to resource usage 1.5 Demonstrated knowledge of environmental legislations and local ordinances according to the different environmental issues /concerns. 1.6 Described industrial standard environmental practices according to the different environmental issues/concerns. 1.7 Resolved problems/ constraints encountered based on management standard procedures 1.8 Implemented and monitored environmental practices on a periodic basis as per company guidelines 1.9 Recommended solutions for the improvement of the program 1.10 Monitored and reported to proper authorities any environmental incidents
2. Resource Implications	The following resources should be provided: 2.1 Workplace with storage facilities

	2.2 Tools, materials and equipment relevant to the tasks (e.g. Cleaning tools, cleaning materials, trash bags) 2.3 PPE, manuals and references 2.4 Legislation, policies, procedures, protocols and local ordinances relating to environmental protection 2.5 Case studies/scenarios relating to environmental Protection
3 Methods of Assessment	Competency in this unit may be assessed through: 3.1 Observation 3.2 Oral questioning 3.3 Written test 3.4 Portfolio of Evidence 3.5 Interview 3.6 Third party report
4 Context of Assessment	Competency may be assessed 4.1 On-the-job 4.2 Off-the –job 4.3 During Industrial attachment
5 Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

DEMONSTRATE OCCUPATIONAL SAFETY AND HEALTH PRACTICES

UNIT CODE: CON/CO/CET/BC/06/6/A

UNIT DESCRIPTION

This unit specifies the competencies required to demonstrate occupational health and safety practices. It involves identifying workplace hazards and risks, identifying and implementing appropriate control measures to hazards and risks and implementing OSH programs, procedures and policies/guidelines.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the key outcomes which make up workplace function.	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Identify workplace hazards and risk	1.1 ***Hazards*** in the workplace are identified ***based their indicators*** 1.2 Risks and hazards are evaluated based on legal requirements. 1.3 ***OSH concerns*** raised by workers are addressed as per legal requirements.
2. Control OSH hazards	2.1 Hazard prevention ***and control measures*** are implemented as per legal requirement. 2.2 Risk assessment is conducted and a risk matrix developed based on likely impact. 2.3 ***Contingency measures***, including ***emergency procedures*** during workplace ***incidents and emergencies*** are recognized and established in accordance with organization procedures.
3. Implement OSH programs	3.1 Company OSH program are identified, evaluated and reviewed based on legal requirements. 3.2 Company OSH programs are implemented as per legal requirements. 3.3 Workers are capacity built on OSH standards and procedures as per legal requirements 3.4 ***OSH-related records*** are maintained as per legal requirements.

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variable	Range
1. Hazards may include but not limited to:	• Physical hazards – impact, illumination, pressure, noise, • vibration, extreme temperature, radiation • Biological hazards- bacteria, viruses, plants, parasites, mites, molds, fungi, insects • Chemical hazards – dusts, fibers, mists, fumes, smoke, gasses, vapors • Ergonomics • Psychological factors – over exertion/ excessive force, awkward/static positions, fatigue, direct pressure, • varying metabolic cycles • Physiological factors – monotony, personal relationship, work out cycle • Safety hazards (unsafe workplace condition) – confined space, excavations, falling objects, gas leaks, electrical, poor storage of materials and waste, spillage, waste and debris • Unsafe workers' act (Smoking in off-limited areas, Substance and alcohol abuse at work)
2. Indicators may include but not limited to:	• Increased of incidents of accidents, injuries • Increased occurrence of sickness or health complaints/ symptoms • Common complaints of workers related to OSH • High absenteeism for work-related reasons
3. OSH concerns may include but not limited to:	• Workers' experience/observance on presence of work hazards • Unsafe/unhealthy administrative arrangements (prolonged work hours, no break time, constant overtime, scheduling of tasks) • Reasons for compliance/non-compliance to use of PPEs or other OSH procedures/policies/guidelines

4. Safety gears /PPE (Personal Protective Equipment) may include but not limited to:	• Arm/Hand guard, gloves • Eye protection (goggles, shield) • Hearing protection (ear muffs, ear plugs) • Hair Net/cap/bonnet • Hard hat • Face protection (mask, shield) • Apron/Gown/coverall/jump suit • Anti-static suits • High-visibility reflective vest
5. Appropriate risk controls may include but not limited to:	• Appropriate risk controls in order of impact are as follows: • Eliminate the hazard altogether (i.e., get rid of the dangerous machine) • Isolate the hazard from anyone who could be harmed (i.e., keep the machine in a closed room and operate it remotely; barricade an unsafe area off) • Substitute the hazard with a safer alternative (i.e., replace the machine with a safer one) • Use administrative controls to reduce the risk (i.e., train workers how to use equipment safely; train workers about the risks of harassment; issue signage) • Use engineering controls to reduce the risk (i.e., attach guards to the machine to protect users) • Use personal protective equipment (i.e., wear • gloves and goggles when using the machine)
6. Contingency measures may include but not limited to:	• Evacuation • Isolation • Decontamination • (Calling designed) emergency personnel
7. Incidents and emergencies may include but not limited to:	• Chemical spills • Equipment/vehicle accidents • Explosion • Fire • Gas leak • Injury to personnel • Structural collapse • Toxic and/or flammable vapors emission.
8. OSH-related Records may include but not limited to:	• Medical/Health records • Incident/accident reports • Sickness notifications/sick leave application • OSH-related trainings obtained

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Communication
- Interpersonal
- Presentation
- Risk assessment
- Evaluation
- Critical thinking
- Problem solving
- Negotiation

Required Knowledge

The individual needs to demonstrate knowledge of:

- General OSH Principles
- Occupational hazards/risks recognition
- OSH organizations providing services on OSH evaluation and/or work environment measurements (WEM)
- National OSH regulations; company OSH policies and protocols
- Systematic gathering of OSH issues and concerns
- General OSH principles
- National OSH regulations
- Company OSH and recording protocols, procedures and policies/guidelines
- Training and/or counseling methodologies and strategies

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Identified hazards in the workplace based their indicators 1.2 Evaluated workplace hazards based on legal requirements. 1.3 Addressed OSH concerns raised by workers as per legal requirements. 1.4 Implemented hazard prevention and control measures as per legal requirement. 1.5 Conducted risk assessment as per legal requirement. 1.6 Developed risk matrix based on likely impact. 1.7 Recognized and established contingency measures in accordance with organization procedures.

	1.8 Identified, evaluated and reviewed company OSH program based on legal requirements. 1.9 Implemented company OSH programs as per legal requirements. 1.10 Capacity built workers on OSH standards and procedures as per legal requirements 1.11 Maintained OSH-related records as per legal requirements.
2. Resource Implications	The following resources should be provided: 2.3 Access to relevant workplace where assessment can take place 2.4 Appropriately simulated environment where assessment can take place
3. Methods of Assessment	Competency in this unit may be assessed through: 3.1 Observation 3.2 Oral questioning 3.3 Written test 3.4 Portfolio of Evidence 3.5 Interview 3.6 Third party report
4. Context of Assessment	Competency may be assessed: 4.1 On-the-job 4.2 Off-the-job 4.3 During Industrial attachment
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

COMMON UNITS OF COMPETENCY

APPLY MATHEMATICAL SKILLS

UNIT CODE: CON/OS/CET/CC/01/6/A

UNIT DESCRIPTION:
This unit describes the competencies required by a technician in order to apply a wide range of mathematical skills in their work; apply ratios, rates and proportions to solve problems; estimate, carry out measurement; collect, organize and interpret statistical data; use common formulae and algebraic expressions to solve problems.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT This describes the key outcomes which make up workplace functions	**PERFORMANCE CRITERIA** These are assessable statements specify the required level of performance for each element. ***Bold and italicised terms are elaborated in the range***
1. Apply algebra	1.1 Calculations involving Indices are performed as per the concept 1.2 Calculations involving Logarithms are performed as per the concept 1.3 Scientific calculator is used in solving mathematical problems in line with manufacturer's manual 1.4 Simultaneous equations are performed as per the rules 1.5 Quadratic equations are calculated as per the concept
2. Apply Trigonometry and hyperbolic functions	2.1 calculations are performed using trigonometric rules 2.2 calculations are performed using hyperbolic functions
3. Apply complex numbers	3.1 complex numbers are represented using Argand diagrams 3.2 Operations involving complex numbers are performed 3.3 Calculations involving complex numbers are performed using De Moivre's theorem
4. Apply Coordinate Geometry	4.1 Polar equations are calculated using coordinate geometry 4.2 Graphs of given polar equations are drawn using the Cartesian plane 4.3 Normal and tangents are determined using coordinate geometry

5. Carry out Binomial Expansion	5.1 Roots of numbers are determined using binomial theorem 5.2 Errors of small changes are determined using binomial theorem
6. Apply Calculus	6.1 Derivatives of functions are determined using Differentiation 6.2 Derivatives of hyperbolic functions are determined using Differentiation 6.3 Derivatives of inverse trigonometric functions are determined using Differentiation 6.4 Rate of change and small change are determined using Differentiation. 6.5 Calculation involving stationery points of functions of two variables are performed using differentiation. 6.6 Integrals of algebraic functions are determined using integration 6.7 Integrals of trigonometric functions are determined using integration 6.8 Integrals of logarithmic functions are determined using integration 6.9 Integrals of hyperbolic and inverse functions are determined using integration
7. Solve Ordinary differential equations	7.1 First order and second order differential equations are solved using the method of undetermined coefficients 7.2 First order and second order differential equations are solved from given boundary conditions
8. Carry out Mensuration	8.1 Perimeter and areas of figures are obtained 8.2 Volume and of Surface area of solids are obtained 8.3 Area of irregular figures are obtained 8.4 Areas and volumes are obtained using Pappus theorem
9. Apply Power Series	9.1 Power series are obtained using Taylor's Theorem 9.2 Power series are obtained using Maclaurin's 's theorem

10. Apply Statistics	10.1 Identification, Collection and Organization of data is performed 10.2 Interpretation, analysis and presentation of data in appropriate format is performed 10.3 Mean, median, mode and Standard deviation are obtained from given data 10.4 Calculations are performed based on Laws of probability 10.5 Calculation involving probability distributions, mathematical expectation sampling distributions are performed 10.6 Sampling distribution methods are applied in data analysis 10.7 Calculations involving use of standard normal table, sampling distribution, T-distribution and Estimation are done 10.8 Confidence intervals are determined 10.9 Testing hypothesis using large samples and small samples are performed 10.10 Calculations involving Correlation and regression are done 10.11 Calculations involving rank correlation coefficient and equations of regression line are done
11. Latitudes and Longitudes	11.1 Latitudes and longitudes are determined 11.2 Distance and time between two points along small and great circle are determined 11.3 Speed is determined
12. Apply Vector theory	12.1 Vectors and scalar quantities are obtained in two and three dimensions 12.2 ***Operations*** on vectors are performed 12.3 Position of vectors is obtained 12.4 Resolution of vectors is done
13. Apply Matrix	13.1 Determinant and inverse of 3x3 matrix are obtained 13.2 Solutions of simultaneous equations are obtained 13.3 Calculation involving Eigen values and Eigen vectors are performed

14. Apply Numerical methods	14.1 Roots of polynomials are obtained using iterative numerical methods 14.2 interpolation and extrapolation are performed using numerical methods

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variable	Range
1. Operations may include but not limited to:	• Addition • Subtraction
2. Hyperbolic functions may include but not limited to:	• Sinh x • Cosh x • Cosec x • Coth x • Tanh x • Sech x

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Applying fundamental operations (addition, subtraction, division, multiplication)
- using and applying mathematical formulas
- logical thinking
- problem solving
- applying statistics
- drawing graphs
- Using different measuring tools

Required knowledge

The individual needs to demonstrate knowledge of:

- Fundamental operations (addition, subtraction, division, multiplication)
- calculating area and volume
- Types and purpose of measuring instruments
- Units of measurement and abbreviations
- Rounding techniques
- Types of fractions
- Types of tables and graphs

- Presentation of data in tables and graphs
- Vector operations
- Matrix operations

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 Applied Trigonometry and hyperbolic functions 1.2 Applied complex numbers 1.3 Applied Calculus 1.4 Solved Ordinary differential equations 1.5 Carried out mensuration 1.6 Applied Power Series 1.7 Applied Latitudes and Longitudes 1.8 Applied Vector theory 1.9 Applied Matrix 1.10 Applied Numerical methods
2. Resource Implications	The following resources should be provided: 2.1 Access to relevant workplace or appropriately simulated environment where assessment can take place 2.2 Measuring equipment 2.3 Materials relevant to the proposed activity or tasks
3. Methods of Assessment	Competency in this unit may be assessed through: 1.1 Direct Observation 1.2 Demonstration with Oral Questioning 1.3 Written tests
4. Context of Assessment	Competency may be assessed individually in the actual workplace or through accredited institution
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

PREPARE AND INTERPRET TECHNICAL DRAWINGS

UNIT CODE: CON/OS/CET/CC/02/6/A

UNIT DESCRIPTION

This unit covers the competencies required to prepare and interpret technical drawings. It involves competencies to select, use and maintain drawing equipment and materials. It also involves producing plain geometry drawings, solid geometry drawings, pictorial and orthographic drawings and application of Computer Aided Design (CAD) packages.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT This describes the key outcomes which make up workplace functions	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1. Use and maintain drawing equipment and materials	1.1 ***Drawing equipment*** are identified and gathered according to task requirements 1.2 Drawing equipment are used and maintained as per manufacturer's instructions 1.4 Drawing materials are used as per workplace procedures 1.5 Waste materials are disposed in accordance with workplace procedures and ***environmental legislations*** 1.6 ***Personal Protective Equipment*** is used according to occupational safety and health regulations
2. Produce plane geometry drawings	2.1 Different types of lines used in drawing and their meanings are identified according to standard drawing conventions 2.2 Different types of ***geometric forms*** are constructed according to standard conventions 2.3 Different types of angles are constructed according to principles of geometry 2.4 Different types of angles are measured using appropriate measuring tools 2.6 Angles are bisected according to standard conventions 2.7 Freehand sketching of different types of geometric forms, tools, equipment, diagrams is conducted

3. Produce solid geometry drawings	3.1 Drawings of patterns are interpreted according to standard conventions 3.2 Patterns are developed in accordance with standard conventions
4. Produce orthographic and pictorial drawings	4.1 Symbols and abbreviations are identified, and their meaning interpreted according to standard drawing conventions 4.2 First and third angle orthographic drawings are interpreted and produced in accordance with the standard conventions 4.3 Orthographic elevations are dimensioned in accordance with standard rules 4.4 Isometric drawings are interpreted and produced in accordance with standard conventions
5. Apply CAD packages	5.1 CAD packages are selected according to task requirements 5.2 CAD packages are applied in production of building drawings

RANGE

Variable	**Range** ***May include but is not limited to:***
1. Drawing equipment may include but not limited to:	Drawing boards, T and set squares, drawing sets, computers with CAD packages
2. Drawing materials may include but not limited to:	Drawing papers, pencils, erasers, masking tapes, paper clips
3. Environmental legislations may include but not limited to:	EMCA 1999
4. Personal Protective Equipment may include but not limited to:	Dust coats, closed leather shoes
5. Geometric forms may include but not limited to:	Circles, triangles, rectangles, parallelogram, polygons, pyramids, conic sections, prisms, loci

6. Standard conventions may include but not limited to:	• Anatomy of engineering drawing (title block, coordinate grid system, revision block, notes and legends) • Drawing scale (paper size and drawing symbols) • International drawing standards

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required skills

The individual needs to demonstrate the following skills:

- Critical thinking
- Drawing
- Interpretation
- Drawing equipment handling
- Analysis and synthesis
- Communication
- Inter personal

Required knowledge

The individual needs to demonstrate knowledge of:

- Drawing equipment and materials
- Freehand sketching
- Lettering
- Geometrical constructions
- Types of drawings
- Types of lines
- Isometric drawing conventions, features, characteristics, components
- Orthographic drawing conventions, features, characteristics, components
- Sketches and drawings of simple patterns

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Applied and adhered to safety procedures 1.2 Cared and maintained drawing equipment 1.3 Interpreted circuit, assembly and lay out diagrams

	1.4 Applied appropriate technical standards, used proper tools and equipment for a given task 1.5 Produced sketches and drawings 1.6 Applied CAD packages in production of drawings
2. Resource Implications	Resources the same as that of workplace are advised to be applied. 2.1 Drawing room 2.2 Drawing equipment and materials 2.3 Computers 2.4 CAD packages
3. Methods of Assessment	Competency may be assessed through: 3.1 Practical tests 3.2 Observation
4. Context of Assessment	Competency may be assessed individually in the actual workplace or a simulated work place setting or during industrial attachment.
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

PERFORM STRUCTURAL DESIGN AND ANALYSIS

UNIT CODE: CON/OS/CET/CC/03/6/A

UNIT DESCRIPTION

This Unit describes the competencies required to Perform Structural Design and Analysis. It involves analysing structural designs, designing structural elements, preparing structural drawings interpreting structural drawings and applying structural drawings.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT This describes the key outcomes which make up workplace functions	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1. Analyse structural elements	1.1 ***Methods used in analyses*** of structural members are determined according to building codes 1.2 Loadings are worked on according to the structure 1.3 Structural members are sketched as per the drawings and support requirements 1.4 Maximum moments in each section are determined in accordance with appropriate methods 1.5 Shear force and bending moments diagram are drawn according to structural design requirements
2. Design structural elements	2.1 ***Design recourses*** are gathered according to standard design requirements 2.2 Types of structural elements are identified as per building codes 2.3 Different ***methods of designs*** are identified as per the design manuals 2.4 Different types of standard ***design codes*** are identified according to construction materials 2.5 Maximum moments used in design are determined according to standard specification manuals 2.6 Design tools and equipment are identified and gathered according to standard design manuals 2.7 Structural elements are designed as per the design codes 2.8 Schedules for different elements is prepared in accordance with designs

3. Prepare structural drawings	3.1 Drawing resources are identified and gathered according to structural elements designed. 3.2 Methods of drawing for structural members are determined as per the designs 3.3 Standard working structural drawings for various elements are prepared as per designs 3.4 Materials schedules are prepared as per design codes
4. Interpret structural drawings	4.1 Project is identified according to the contract documents 4.2 Structural drawings are identified and obtained as per design manuals 4.3 Steel schedules are obtained, and materials schedules prepared according to construction procedures
5. Apply and use structural drawings	5.1 Construction resources are identified and obtained as per the tender documents 5.2 Statutory documents are gathered as per the project requirements 5.3 Setting out activities are determined according to the approved drawings and standard construction processes 5.4 Foundation is established as per the working drawings and standard construction procedures 5.5 Structural members are prepared in accordance with the working drawings 5.6 Working drawing, steel schedules and materials schedules are developed and adhered according to standard construction processes

RANGE

Variable	Range
1 Methods used in analyses may include but not limited to:	• Determinate • Inter-determinate
2 Design resources may include but not limited to:	• Marking tools • Laptop • Desktop • Graphic software

	• LCD Projectors • Drawing board • Hard drive • Graphic tablet and stylus • Quality sketchpad • Monitor calibrator • Ergonomic chair
3 methods of designs may include but not limited to:	• Elastics • Plastic
4 Design codes may include but not limited to:	• BS 8110 • BS 6399 • CP 110 • EURO Code

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required skills

The individual needs to demonstrate the following skills:

- Critical thinking
- Creativity and innovation
- Time management
- Typography
- Accuracy
- Arithmetic
- Presentation
- Problem solving
- Sketching
- Teamwork
- Assertion
- Color sense
- Flexibility
- Initiative
- Drawing
- Interpretation
- Analysis and synthesis

- Communication
- Interpersonal
- Multitasking

Required knowledge

The individual needs to demonstrate knowledge of:

- Drawing equipment and materials
- Freehand sketching
- Lettering
- Structural drawing and analyses
- Standard relevant manuals
- Geometrical constructions
- Types of drawings
- Types of lines
- Isometric drawing conventions, features, characteristics, components
- Sketches and drawings of simple patterns

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

1 Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Prepared sketches and structural drawings 1.2 Analysed structural designs 1.3 Interpreted structural drawings 1.4 Applied appropriate technical standards, used proper tools and equipment for a given task 1.5 Applied CAD packages in production of drawings 1.6 Demonstrated understanding of structural designs and analysis
2 Resource Implications	Resources the same as that of workplace are advised to be applied. 2.1 Drawing room 2.2 Drawing equipment and materials 2.3 Computers

		2.4 Computer software e.g. CAD packages 2.5 Drawing tools and equipment
3	Methods of Assessment	Competency may be assessed through: 3.1 Oral 3.2 Observation 3.3 Written
4	Context of Assessment	Competency may be assessed individually in the actual workplace or a simulated work place setting
5	Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

APPLY CONSTRUCTION MATERIAL SCIENCE

UNIT CODE: CON/OS/CET/CC/04/6/A

UNIT DESCRIPTION

This unit describes the competence in applying building materials science. It involves identifying essential construction materials, selecting quality construction materials, testing construction materials and demonstrating knowledge in use of construction materials.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT This describes the key outcomes which make up workplace functions	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1 Identify essential construction materials	1.1 Bills of quantities and working drawings are obtained and interpreted 1.2 Essential ***construction materials*** are identified based on construction requirements and project scope
2 Identify properties of construction materials	2.1 ***Physical properties*** of construction materials are identified based on the type of construction material and codes of practice 2.2 ***Chemical properties*** of construction materials are identified based on the type of construction material and codes of practice 2.3 ***Mechanical properties*** of construction materials are identified based on the type of construction material and codes of practice
3 Manufacture construction materials	3.1 Raw materials are identified based on construction materials to be produced 3.2 Construction materials are manufactured as per manufacturing procedures
4 Select quality construction materials	4.1 Cost implications of construction materials are evaluated and analyzed 4.2 Quality construction materials are selected based on their costs, availability and project requirements
5 Use construction materials appropriately	5.1 Construction materials, tools and equipment are assembled based on construction methods 5.2 Construction materials are used based on construction process
6 Test construction materials	6.1 Construction materials are sampled randomly as per SOPs 6.2 ***Test parameters*** are identified as per the construction requirements and engineer's instructions 6.3 Construction materials are tested as per the SOPs

7 Handle construction materials safely	7.1 Construction materials to be handled are identified according to their uses 7.2 Safety requirements are identified based on the construction materials 7.3 Construction materials are handled safely based on the safety requirements

RANGE

Variable	**Range** *May include but is not limited to:*
1. Construction materials may include but not limited to:	1.1 stones 1.2 bricks 1.3 clay and clay products 1.4 lime 1.5 cement 1.6 timber and timber products 1.7 metals and alloys 1.8 paints and varnishes 1.9 roofing materials 1.10 Aggregates
2. physical properties may include but not limited to:	2.1 porosity 2.2 surface texture 2.3 strength 2.4 density 2.5 thermal conductivity 2.6 wear and tear
3. chemical properties may include but not limited to:	3.1 corrosion resistance 3.2 chemical resistance
4. Mechanical properties may include but not limited to:	4.1 Toughness 4.2 Hardness 4.3 Fatigue 4.4 Stress and strain 4.5 Creep and stress rapture 4.6 Strength
5. Test parameters	5.1 Compression 5.2 Weathering 5.3 Durability 5.4 Water absorption 5.5 Impurity tests 5.6 Tensile tests 5.7 Workability

	5.8 Plasticity 5.9 Aggregates crushing value 5.10 Optimum moisture content

SKILLS

- Analytical
- Quality control analysis
- Complex problem solving
- Critical thinking
- Engineering drawings interpretation
- Monitoring
- Numeracy

REQUIRED KNOWLEDGE

- Applied science
- Construction materials
- Materials testing
- Quality assurance
- Management of material resources
- Engineering mathematics
- Bills of quantities
- Materials handling safety procedures

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Identified essential construction materials 1.2 Selected quality construction materials 1.3 Tested construction materials 1.4 Manufactured construction materials 1.5 Identified properties of construction materials 1.6 Appropriately used construction materials 1.7 Handled construction materials safely
2. Resource Implications	The following resources should be provided: 2.1 Samples of construction materials 2.2 Material Testing Laboratories 2.3 Safety equipment 2.4 Computers

		2.5 Calculators 2.6 Materials testing tools and equipment
3.	Methods of Assessment	Competency may be assessed through: 3.1 Written text 3.2 Interview 3.3 Observation
4.	Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.
5.	Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

APPLY WORKSHOP TECHNOLOGY PRACTICES

UNIT CODE: CON/OS/CET/CC/05/6/A

UNIT DESCRIPTION

This unit describes the competence in applying workshop technology practices. It entails performing masonry, plumbing and carpentry tasks. It also involves performing electrical and mechanical operations.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT This describes the key outcomes which make up workplace functions	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1 Perform masonry tasks	1.1 Safety requirements in the workshop environment are identified 1.2 ***Masonry hand tools*** are used appropriately to perform tasks in masonry workshop 1.3 ***Masonry machine tools*** are used appropriately to perform tasks in masonry workshop 1.4 Masonry tools used in construction works are maintained as per manufacturer's specifications
2 Perform plumbing tasks	2.1 Safety requirements in the workshop environment are identified 2.2 ***Plumbing hand tools*** are used appropriately to perform tasks in plumbing workshop 2.3 ***Plumbing machine tools*** are used appropriately to perform tasks in plumbing workshop 2.4 Plumbing tools used in construction works are maintained as per manufacturer's specifications
3 Perform carpentry tasks	3.1 Safety requirements in the workshop environment are identified 3.2 ***Carpentry hand tools*** are used appropriately to perform tasks in carpentry workshop 3.3 ***Carpentry machine tools*** are used appropriately to perform tasks in carpentry workshop 3.4 Carpentry tools used in construction works are maintained as per manufacturer's specifications
4 Perform electrical operations	4.1 Safety requirements in the workshop environment are identified as per SOPs 4.2 ***Conventional tools*** used in electrical workshop are identified as per SOPs 4.3 Power supply sources are identified as per SOPs 4.4 Basic electrical circuits are installed and maintained as per IEE regulations

5 Perform mechanical operations	5.1 Safety requirements in the workshop environment are identified as per SOPs 5.2 ***Mechanical hand tools*** are used appropriately to perform tasks in mechanical workshop 5.3 Diesel and petrol engine components are identified based on their functions and engine system 5.4 Diesel and petrol engines are operated based on manufacturer's manual 5.5 Simple engine maintenance is performed as per manufacturer's specifications 5.6 ***Water pumps*** are identified based on working principle 5.7 Basic maintenance is performed on water pumps as per SOPs

RANGE

Variable	**Range** *May include but is not limited to:*
1. Masonry hand tools may include but not limited to:	1.1 Masons trowel 1.2 Wood float 1.3 Cold chisels 1.4 Masons square 1.5 Spade 1.6 Shovel 1.7 Plumb bob
2. Masonry machine tools may include but not limited to:	2.1 Concrete mixer 2.2 Block cutter 2.3 Vibrator 2.4 Pneumatic hammer 2.5 Compactors
3. Plumbing hand tools may include but not limited to:	3.1 Bench shears 3.2 Anvil 3.3 Pipe wrench 3.4 Pliers
4. Plumbing machine tools may include but not limited to:	4.1 Bending machine 4.2 Welding 4.3 Sheet metal holding machine 4.4 Portable power drill 4.5 Hand grinder
5. Carpentry hand tools may include but not limited to:	5.1 Saws 5.2 Planes 5.3 Hammer 5.4 Carpenter square 5.5 Marking gauges 5.6 Hand drill

	5.7 Screw drivers
6. Carpentry machine tools may include but not limited to:	6.1 circular saw 6.2 Thicknesser 6.3 Portable sander 6.4 Close cut saw 6.5 Portable drill machine
7. Conventional tools may include but not limited to:	7.1 phase tester 7.2 screw driver 7.3 pliers 7.4 long nose 7.5 side cutter 7.6 draw in wire 7.7 electrical knife 7.8 electrical hammer
8. Mechanical hand tools may include but not limited to:	8.1 Arc welding shields 8.2 Leather gloves 8.3 Chipping hammers 8.4 Welding goggles 8.5 Tongs 8.6 Hand vices 8.7 Mole punch 8.8 Pliers 8.9 Vernier callipers 8.10 Scribers 8.11 Hacksaw 8.12 Tinsnips 8.13 Pullers
9. Water pumps may include but not limited to:	9.1 Centrifugal 9.2 Submersible 9.3 Reciprocating pump 9.4 Hand pumps

SKILLS

- Analytical
- Critical thinking
- Problem solving
- Firefighting
- Quality control
- Circuit interpretation

REQUIRED KNOWLEDGE

- Tools and equipment
- Safety regulations
- Mathematics
- Electrical installation
- Power supply
- Engine operations
- Plumbing
- Water pump operation
- Masonry
- Mortar mixing
- Carpentry and joinery
- Firefighting
- Circuit interpretation

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Identified safety requirements in the workshop environment 1.2 Performed masonry tasks 1.3 Performed plumbing tasks 1.4 Performed carpentry tasks 1.5 Identified power supply sources 1.6 Installed basic electrical circuits 1.7 Identified diesel and petrol engine components 1.8 Operated diesel and petrol engines 1.9 Identified water pumps 1.10 Demonstrated knowledge on maintenance of water pumps and engines 1.11 Appropriately used workshop tools
2. Resource Implications	The following resources should be provided: 2.1 Working tools and equipment 2.2 Diesel and petrol engines 2.3 Water pumps 2.4 Electrical appliances 2.5 Training Workshops 2.6 Plumbing materials 2.7 Masonry materials 2.8 Carpentry materials

3.	Methods of Assessment	Competency may be assessed through: 3.1 Written text 3.2 Interview 3.3 Observation
4.	Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.
5.	Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

PERFORM MEASUREMENT OF WORKS AND COST ESTIMATION

UNIT CODE: CON/OS/CET/CC/06/6/A

UNIT DESCRIPTION

This unit describes competencies required to perform measurement of works and Cost Estimation. It involves preparing tender documents, taking off quantities, working up dimensions and abstracting measured quantities

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT This describes the key outcomes which make up workplace functions	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1. Prepare tender documents	1.1 ***Working drawings*** are prepared as per client requirements 1.2 ***Specifications*** are prepared as per SOPs 1.3 Bill of quantities is prepared based on specifications and working drawings 1.4 Schedule of rates are prepared as per SOPs 1.5 Condition of contract is prepared based on nature of the project 1.6 Form of agreement is prepared as per the conditions of the contract 1.7 Form of tender is prepared based on the nature of the contract
2 Take off quantities	2.1 Dimension sheet/paper is prepared based on the standard format 2.2 Quantities checklist is prepared based on items to be measured 2.3 ***Quantities*** are calculated based on the unit of measure 2.4 Dimensions are booked based on the principles of measurement 2.5 Booked items are described based on the standard method of measurement/CESMM
3 Work up dimensions	3.1 Timesing of dimensions is carried out as per SOPs 3.2 Dimensions are squared as per SOPs
4 Abstract measured quantities	4.1 Abstracting sheet is prepared based on the standard format 4.2 Description of booked items are transferred to the abstracting sheet as per SOPs 4.3 Squared quantities are transferred to the abstracting sheet 4.4 Net quantities are calculated as per SOPs

	4.5 Dimensions are run through as per SOPs

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variable	Range
1. Working drawings may include but not limited to:	• Architectural • Structural • Electrical • Mechanical • Civil
2. Specifications may include but not limited to:	• Material • Workmanship
3. Quantities may include but not limited to:	• Volumes • Areas • Linear meters • Numbers (enumeration) • Items

REQUIRED KNOWLEDGE

- Mathematics
- Tender documents
- Technical drawings
- Construction technology
- Quanty survey practice and procedres
- Stanadrd documents (CESMM and SMM)
- Units of measurement
- Estimation and costing
- Abstraction
- Technical terminologies

SKILLS

- Analytical
- Critical thinking
- Computer
- Construction

- Structural detailing
- Scaling
- Design
- Problem solving

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1 Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Prepared tender documents 1.2 Demonstrated knowledge on measurement of works 1.3 Appropriately used workshop tools 1.4 Take off quantities 1.5 Worked up dimensions 1.6 Abstracted measured quantities
2 Resource Implications	The following resources should be provided: 2.1 Computer 2.2 Computer labs 2.3 Computer software 2.4 IT technician 2.5 Stationery 2.6 Computer accessories
3. Methods of Assessment	Competency may be assessed through: 3.1 Written text 3.2 Interview 3.3 Observation
4. Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

APPLY WATER AND WASTEWATER TECHNOLOGY

UNIT CODE: CON/OS/CET/CC/07/6/A

UNIT DESCRIPTION

This unit describes the competence required to apply water & wastewater technology practices. It involves applying basic water supply principles, principles of wastewater collection & treatment and basic irrigation & drainage principles.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT This describes the key outcomes which make up workplace functions	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1. Apply basic water supply principles	1.1 ***Water demand*** is calculated based on particular use 1.2 ***Sources of water*** are identified based on demand and particular ***use.*** 1.3 ***Water abstraction methods*** are identified based on the water source 1.4 ***Water treatment processes*** are identified based on water characteristics and water quality. 1.5 ***Water pipes and appurtenances*** are identified based on the design 1.6 ***Water supply symbols*** are identified based on international standards 1.7 ***Water distribution systems*** are identified based on design 1.8 ***Water storage structures*** are identified based on water system 1.9 Work safety is observed based on code of practice
2. Apply principles of wastewater collection and treatment	2 .1Need for wastewater collection and disposal are identified based on water quality standards 2 .2***Sources of waste water*** are identified based on water quality standards 2 .3***Sewer system layout*** is illustrated based on sewerage design manual 2 .4***Sewerage systems*** are identified based on the design 2 .5***Sewer appurtenances*** are illustrated based on sewer code 2 .6***Wastewater is characterized*** based on **effluent discharge regulations** (NEMA). 2 .7***Wastewater treatment processes*** are identified based on wastewater characteristics

	2 .8***Principles of Wastewater treatment*** are described based on treatment unit. 2 .9 ***Wastewater symbols*** are identified based on international standards 2 .10 ***Wastewater colour coding*** for pipes and exhauster trucks are identified based on international standards. 2 .11 Work safety is observed based on code of practice
3. Apply basic irrigation and drainage principles	3.1 Crop water requirement is determined based on agronomic requirements. 3.2 Land is prepared based on the crop, type of irrigation method, size of the land, topography and available technology 3.3 Irrigation farm layout is identified based on design principles 3.4 ***Quality of irrigation water*** is identified based on the standards 3.5 ***Irrigation methods*** are identified based on the type of crop, type of soil, resources available, quantity and quality of water 3.6 ***Methods of drainage*** are identified based on crop water requirement, type of soil, quantity and quality of water. 3.7 Work safety is observed based on code of practice

RANGE

Variable	**Range**
1. Water demand may include but not limited to:	• Industrial • Domestic • Irrigation • Livestock • Commercial • Recreation
2. Sources of water may include but not limited to:	• Surface • Ground • Rain water
3. Water abstraction methods may include but not limited to:	• River intake & diversion structures • Simple submerged intakes • Intake towers (wet and dry) • Intake for sluice-ways of dams • Roof and rock catchments • Boreholes and shallow wells

	• Floating water intake
4. Water treatment processes may include but not limited to:	• Household treatment methods (boiling, disinfection, ceramic filters, filtration, SODIS, sand filtration, flocculation). • Filtration and membrane technologies e.g. reverse osmosis, • Conventional processes (Screening and aeration, sedimentation, filtration, coagulation and flocculation, disinfection
5. Water pipes may include but not limited to:	• Metallic (GI, Steel, ductile iron, cast iron) • Plastic (PVC, uPVC, CPVC, PE,PPR, PEX) • Cement (RC pipes)
6. Appurtenances may include but not limited to:	• Valves (gate valve, sluice valves, ball valves, globe valves, butterfly valves, taps, check valves, PRV, pressure relive valves, float valves, air valves, washouts) • Meters (displacement meters, velocity meters, ultra sonic, electromagnetic.) • Fittings (couplings, adapters) • Valve Chambers
7. Water supply symbols may include but not limited to:	• Valves • Meters • Pumps
8. Water distribution systems may include but not limited to:	• Grid iron • Radial • Dead end
9. Water storage structures may include but not limited to:	• Weirs and Dams • Tanks (elevate, surface and sub-surface) • Water pans& ponds
10. Types of sewers may include but not limited to:	• outfall sewer, • intercepting sewer, • lateral sewer, • main sewer, • relief sewer, • Sewer systems, • private sewer
11. Characteristics of wastewater may	• physical, • biological, • chemical

include but not limited to:	
12. Effluent discharge Regulations may include but not limited to:	• Public sewers • Environment
13. Sewer appurtenances may include but not limited to:	• Manholes (Shallow, Deep, Drop), • Inlet, • catch basins • clean out, • flushing tank, • flushing units, • lamp holes,
14. Wastewater symbols may include but not limited to:	• manhole • sewer lines • pumps
15. sources of waste water may include but not limited to:	• Industrial • domestic, • storm, • Agricultural
16. Sewerage System layout may include but not limited to:	• Sewage • sewerage, • sewer, • outfall sewer, • intercepting sewer, • lateral sewer, • main sewer, • relief sewer, • Sewer systems, • private sewer
17. Sewerage systems may include but not limited to:	• Separate, • Combined, • Partially separate
18. Treatment processes may include but not limited to:	• Screening, • Grit removal, • Primary sedimentation, • Filtration – trickling, • Secondary sedimentation, • Sludge digestion, • Sludge drying

	• Waste stabilization ponds (Anaerobic, Facultative, Maturation)
19. Wastewater colour coding may include but not limited to:	• Black • Yellow • Brown
20. Sources of water for irrigation	• Surface • Ground • Rain • Technological water
21. Quality of irrigation water may include but not limited to:	• Physical • Chemical • biological
22. Irrigation methods may include but not limited to:	• surface methods • subsurface methods • overhead methods
23. Method of drainage may include but not limited to:	• surface • sub-surface

REQUIRED KNOWLEDGE

- Tools and equipment
- Safety regulations
- Mathematics
- Water cycle
- Water pipes
- Plumbing
- Water pump operation
- Pipe fitting

SKILLS

- Analytical
- Critical thinking
- Problem solving
- Firefighting
- Quality control
- Circuit interpretation

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Calculated water demand based on the particular water use 1.2 Identified the sources of water based on the water demand and particular use 1.3 Identified abstraction methods based on the water sources 1.4 Identified water treatment processes based on water characteristics and water quality 1.5 Identified water pipes and appurtenances based on design 1.6 Identified water supply symbols based on international standards. 1.7 Identified water distribution systems based on the design. 1.8 Identified water storage structures based on water system 1.9 Identified Need for wastewater collection and disposal based on water quality standards 1.10 Identified sources of waste water based on water quality standards 1.11 Illustrated Sewer system layout based on sewerage design manual 1.12 Identified sewerage systems based on the sewerage design Manual 1.13 Illustrated Sewer appurtenances based on sewer codes 1.14 Characterized Wastewater based on effluent discharge regulations (NEMA). 1.15 Identified Wastewater treatment processes based on wastewater characteristics 1.16 Described Principles of Wastewater treatment based on treatment process 1.17 Identified wastewater symbols based on international standards. 1.18 Identified wastewater colour codes based on international standards. 1.19 Observed work safety based on code of practice. 1.20 Determined crop water requirements based on agronomic requirements. 1.21 Prepared Land based on the crop, type of irrigation method, size of the land, topography and available technology

	1.22 Identified Irrigation farm layout based on design principles 1.23 Identified Quality of irrigation water based on the standards 1.24 Identified Irrigation methods based on the type of crop, type of soil, resources available, quantity and quality of water 1.25 Identified Method of drainage based on crop water requirement, type of soil, quantity and quality of water. 1.26 Work safety is observed based on code of practice
2. Resource Implications	The following resources should be provided: 2.1 Scientific calculator 2.2 Water distribution system models 2.3 Population forecasting charts 2.4 Water supply symbols charts 2.5 Masonry and plastic tank models 2.6 Model sewer system 2.7 Wastewater laboratory 2.8 Wastewater pipes 2.9 Pipework & plumbing workshop 2.10 Water quality laboratory 2.11 Wastewater symbols chart 2.12 Demonstration farm 2.13 Models of farm implements 2.14 Soil water, plant relationship chart 2.15 Drainage models 2.16 Irrigation laboratory 2.17 Demonstration safety gear
3. Methods of Assessment	Competency may be assessed through: 3.1 Written text(s) 3.2 Interview(s) 3.3 Observations
4. Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment or during industrial attachment.
5. Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

APPLY WATER RESOURCE, WATER AND SANITATION SERVICES MANAGEMENT PRINCIPLES

UNIT CODE: CON/OS/CET/CC/08/6/A

UNIT DESCRIPTION

This unit describes the competencies required to apply water resource management principles. It involves determination of hydrological processes, quantification of surface water, mapping of rock types and aquifers, establishment of suitable site for wells. It also involves conservation of environment and development of water harvesting structures. It also involves application of water policy, water and environmental law in water resource, water policy, water and sanitation services management and application of integrated water resources management (IWRM) principles.

This standard applies in water sector.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the key outcomes which make up workplace function.	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range.***
1. Determine hydrological Processes	1.1 ***Concepts of Hydrological cycle*** are identified based on WMO guidelines 1.2 ***Precipitation types and forms*** are identified based on WMO guidelines 1.3 Precipitation is determined based on the WMO guidelines 1.4 Evaporation rate is determined based on WMO guidelines 1.5 Stream flow is determined based on the WMO guidelines 1.6 Safety in hydrometry is observed based on OSH
2. Quantify surface water	2 .1Sites for installation of hydrological instruments are identified based on WMO guidelines 2 .2***Hydrological Instruments*** are identified and installed based on WMO guidelines 2 .3***Hydrological data*** is collected based on parameters to be measured 2 .4Hydrological data is analyzed and quantified based on the collected parameters
3. Map rock types and aquifers	3 .1***Tools and equipment*** for mapping are identified based on physical properties and user preference

	3 .2 ***Rock types*** are identified based on their origin 3 .3 ***Aquifer types*** are identified based International Association of Hydro-geologists (IAH) guidelines 3 .4Rock types and aquifers are mapped based on their formation 3 .5Aquifers are mapped based on rock units
4. Establish suitable site for wells	4 .1 Suitable sites for wells are identified based groundwater potential 4 .2 ***Suitable methods for well site establishment*** are identified based on user preference 4 .3 Suitable well sites are established based on groundwater potential 4 .4 Well site establishment report is prepared based on Water Resource Management rules (WRM) 2007*
5. Conserve the Environment	5 .1 Factors affecting water and soil conservation are identified based on natural and artificial activities. 5 .2 Water and soil conservation measures are identified based on the identified factors 5 .3 Types of land degradation are identified based on environment 5 .4 Causes of land degradation are identified based on degradation types identified 5 .5 Effects of land degradation are identified based on degradation types identified 5 .6 Control measures are identified based on the identified factors
6. Develop water harvesting structures	6 .1***Water harvesting techniques*** are identified based on site conditions 6 .2Suitable sites for ***water harvesting reservoirs*** are identified based on geological structures 6 .3Simple water harvesting structures are designed based on the need 6 .4 Simple water harvesting structures are operated and maintained based on standard operating procedures

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variable	**Range**
1. Concepts of Hydrological cycle may	• Evaporation • Condensation

include but not limited to:	• Precipitation • Transpiration • Surface run-off • Infiltration • Percolation
2. Precipitation types may include but not limited to:	• Orographic • Convective • Cyclonic
3. Precipitation forms may include but not limited to:	• Rain • Hail • Sleet • Drizzle • Fog • Mist • Snow
4. Hydrological Instruments may include but not limited to:	• Rain gauges • Evaporation pans • Current meters
5. Hydrological data may include but not limited to:	• Rainfall data • Evaporation data • Stream flow data
6. Rock types may include but not limited to:	• Igneous • Metamorphic • Sedimentary
7. Aquifer types may include but not limited to:	• Confined • Unconfined • Perched • Leaky
8. Methods of well site establishment include but not limited to:	• Metallic rod pegs • Hard wood pegs • Concrete pegs • Protected dug holes
9. Water harvesting techniques include but not limited to:	• Rock catchment • Roof catchment • Surface water catchment
10. Water harvesting reservoirs may include but not limited to:	• Dams (Earth, sand, concrete) • Water pans • Ponds

	• Man- made lakes
11. Types of laws may include but not limited to:	• Criminal • Civil
12. Water laws may include but not limited to:	• Riparian • Prior appropriation

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Applying fundamental operations (addition, subtraction, division, multiplication)
- Using and applying mathematical formulas
- Logical thinking
- Problem solving
- Applying statistics
- Drawing graphs
- Using different measuring tools
- Communication
- Analytical
- Organizing
- Decision making
- Planning
- Supervising
- Time management
- Technical skills:
  - Reporting
  - Mapping
  - Data logging
  - Data analysis
  - Instrumentation
- First aid
- Performance appraising
- Record keeping
- Operation and maintenance

Required knowledge

The individual needs to demonstrate knowledge of:

- Hydrology
- Hydrogeology

- Geology
- Meteorology
- Community development
- Instrumentation
- Technical specifications
- Statutory regulations
- Occupational health, safety
- Quality Assurance
- Standard operating procedures
- Analytical methods
- Statistics

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

Critical aspects of Competency	Assessment requires that the candidate: 1.1 Identified Concepts of Hydrological cycle based on WMO guidelines 1.2 Identified Precipitation types and forms based on WMO guidelines 1.3 Determined Precipitation based on the WMO guidelines 1.4 Determined Evaporation rate based on WMO guidelines 1.5 Determined Stream flow based on the WMO guidelines 1.6 Observed Safety in hydrometry based on OSH. 1.7 Identified sites for installation of hydrological instruments based on WMO guidelines 1.8 Identified hydrological instruments and installed based on WMO guidelines. 1.9 Collected hydrological data based on parameters to be measured. 1.10 Analyzed and quantified hydrological data based on the collected parameters 1.11 Identified tools and equipment for mapping based on physical properties and user preference 1.12 Identified rock types based on their origin 1.13 Identified aquifer types based International Association of Hydro-geologists (IAH) guidelines. 1.14 Mapped rock types and aquifers based on their formation

	1.15 Mapped aquifers based on rock units 1.16 Identified suitable sites for wells based groundwater potential 1.17 Identified suitable methods for well site establishment based on user preference 1.18 Established suitable well sites based on groundwater potential 1.19 Prepared well site establishment report based on Water Resource Management rules (WRM), 2007* 1.20 Identified factors affecting water and soil conservation based on natural and artificial activities. 1.21 Identified water and soil conservation measures based on the identified factors 1.22 Identified types of land degradation based on environment 1.23 Identified causes of land degradation based on degradation types identified 1.24 Identified effects of land degradation based on degradation types identified 1.25 Identified control measures based on the identified factors 1.26 Identified ***water harvesting techniques*** based on site conditions 1.27 Identified suitable sites for ***water harvesting reservoirs*** based on geological structures 1.28 Designed simple water harvesting structures based on the need 1.29 Operated and maintained simple water harvesting structures based on standard operating procedures 1.30 Identified types of laws based on the legal system 1.31 Identified types of water laws based on Constitution of Kenya 2010*,Water Act 2016* and Water Resource Management Rules (WRM) 2007* 1.32 Applied water laws based on Kenya constitution 2010, Water Act 2016* and Water Resource Management Rules (WRM) 2007* 1.33 Identified pillars of IWRM as per Dublin guidelines 1.34 Identified principles of IWRM based on Dublin principles

	1.35 Applied principles of IWRM based on Dublin guidelines 1.36 Adhered to gender mainstreaming based on IWRM principles 1.37 Identified applications/Implications of IWRM in Kenyan Context based on the situation/ need
2.0 Resource Implications	The following resources should be provided: 2.1 Access to relevant workplace or appropriately simulated environment where assessment can take place 2.2 Measuring equipment 2.3 Materials relevant to the proposed activity or tasks 2.4 Geolab 2.5 Field equipment 2.6 Petrographic microscope 2.7 Hand lens 2.8 Clinometer 2.9 GPS receiver 2.10 Maps 2.11 Steel file / steel knife 2.12 Metal rod
3.0 Methods of Assessment	Competency in this unit may be assessed through: 3.1 Direct Observation 3.2 Demonstration with Oral Questioning 3.3 Written tests 3.4 Interview 3.5 Oral questions 3.6 Third party report
4.0 Context of Assessment	Competency may be assessed through:- 4.1 Accredited institution 4.2 On–the–job 4.3 Off-the –job 4.4 Industrial attachment 4.5 Field study report
5.0 Guidance information for assessment	Holistic assessment with other units relevant to the water sector, workplace and job role is recommended.

CORE UNITS OF COMPETENCY

CONDUCT MATERIAL TESTING

UNIT CODE: CON/OS/CET/CR/01/6/A

UNIT DESCRIPTION

This unit specifies the competencies required to Conduct Material Testing. It involves preparing for material testing, sampling construction materials, performing tests on alignment soils, concrete, structural steel, bitumen materials and timber. It also includes documenting test results.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up workplace function (to be stated in active)	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1 Prepare for material testing	1.1 Preliminary site investigations are conducted as per contract document 1.2 Material laboratory is provided and maintained according to contract document 1.3 Material testing manuals and contract documents are obtained based on project requirements 1.4 ***Material testing equipment*** are acquired according to contact document and material testing manual 1.5 Material laboratory personnel are identified according expertise and qualifications 1.6 Sampling procedures are developed according to standard tests procedures 1.7 Types of material tests are determined according to test procedures and requirements 1.8 Testing equipment are operated and maintained as per the SOPs
2 Sample construction materials	2.1 ***Sources of road construction materials*** are identified based on contract document 2.2 Sample procedures and manuals are obtained as per standard sampling procedures 2.3 Sampling tools and equipment are identified and assembled according to standard procedures 2.4 Sampling is carried out as per standard sampling procedure 2.5 Samples awaiting analysis are stored based on test requirements

	2.6 Testing equipment are operated and maintained as per the SOPs
3 Undertake tests on the alignment soils	3.1 ***Soil tests*** are identified according to contract document 3.2 Standard manuals and procedures are obtained in accordance with test requirement 3.3 Soil testing tools and apparatus are identified and gathered based on test requirements 3.4 Alignment soil samples are obtained according to test requirement 3.5 ***Soil tests*** are conducted as per standard procedures 3.6 Results are recorded and analysed according to standard procedures 3.7 Report is prepared and presented based on contract document requirement 3.8 Testing equipment are operated and maintained as per the SOPs
4 Perform concrete tests	4.1 ***Concrete tests*** are identified according to contract document 4.2 Standard manuals and procedures are obtained in accordance with test requirement 4.3 Concrete testing tools and apparatus are identified and gathered based on test requirements 4.4 Samples are obtained as per test requirement and contract document 4.5 Samples are prepared according to standard test procedures 4.6 Cubes are casted as per standard test procedures 4.7 Cubes are cured as per standard test procedures 4.8 Cubes are tested, and results are obtained and recorded according to standard procedures 4.9 Analysis of test result is carried out and reported according to standard procedure and contract document 4.10 Testing equipment are operated and maintained as per the SOPs
5 Carry out structural steel tests	5.1 Structural steel sample is obtained based on structural designs 5.2 Tensile testing machines are identified, obtained and calibrated as per test requirement and manufacturers manual 5.3 Test is conducted according to standard test procedures

	5.4 Results are recorded and analysed as per standard procedures 5.5 Report is prepared and presented according to the contract document 5.6 Testing equipment are operated and maintained as per the SOPs
6 Perform bitumen tests	6.1 ***Bitumen tests*** are identified according to contract document 6.2 Standard manuals and procedures are obtained in accordance with test requirement 6.3 Testing tools and apparatus are identified and gathered based on test requirements 6.4 Samples are obtained as per test requirement and contract document 6.5 ***Samples are prepared*** in accordance with test procedures. 6.6 Test are conducted according to standard procedures and contract document 6.7 Test results are recorded and analysed according to standard procedures 6.8 Report is prepared and presented as per contract document 6.9 Testing equipment are operated and maintained as per the SOPs
7 Perform timber tests	7.1 ***Timber tests*** are identified according to contract document 7.2 Standard manuals and procedures are obtained in accordance with test requirement 7.3 Testing tools and apparatus are identified and gathered based on test requirements 7.4 Samples are obtained as per test requirement and contract document 7.5 Samples are prepared in accordance with test procedures. 7.6 Test are conducted according to standard procedures and contract document 7.7 Test results are recorded and analysed according to standard procedures 7.8 Report is prepared and presented as per contract document 7.9 Testing equipment are operated and maintained as per the SOPs

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

VARIABLE	RANGE
1 Material testing equipment may include but not limited to:	• Moulds • Tamping rods • CBR test machine • Rammer • Ruffle box • Casa grande apparatus • Penetrometer • Weighing machine • Oven • Measuring cylinder • Cone cups • Bowl • Stirring stick • Crushing machine • Moisture bags • Funnels • Standard sieves
2 Sources of road construction materials may include but not limited to:	• Borrow pits • Quarries • River beds • Timber yard • Manufacturers
3 Soil Tests may include but not limited to:	• CBR • Atterberg limit • Liquid limit • Plastic limit • Proctor/compaction • Field density • Particle size distribution
4 Concrete Tests may include but not limited to:	2.1 Compressive strength 2.2 Slump 2.3 Cleanliness 2.4 Particle size distribution
5 Steel tests may include but not limited to:	• Tensile/Strength

6	Bitumen Test may include but not limited to:	• Penetration • Cleanliness • Viscosity • Ductility • Flash and Fire Point • Float Test • Loss on Heating • Specific Gravity • Softening Point • Spread Rate
7	Samples are prepared may include but not limited to:	• Weighing • Drying/burning • Mix
8	Timber tests may include but not limited to:	• Tensile/Strength • Compressive • Shear • Size

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Technical
- Interpretation
- Reporting
- Analytical
- Sample handling
- Interpersonal
- Observation
- Time management
- Leadership
- Numeracy
- Computer

Required Knowledge

The individual needs to demonstrate knowledge of:

- Material testing laboratory
- Sampling procedures
- Standard manuals and procedures

- Contract documents
- Material testing equipment
- Road construction materials
    - Types
    - Sources
    - Properties
- Material sampling
- Test parameters
- Analysis and interpretation
- Sample preparation
- SOPs

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1 Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Prepared for material testing 1.2 Identified and obtained required tools and equipment 1.3 Sampled test materials 1.4 Tested alignment soils 1.5 Performed concrete test 1.6 Carried out structural steel tests 1.7 Prepared samples for analysis 1.8 Performed bitumen test 1.9 Prepared and presented test reports 1.10 Demonstrate ability to use different testing tools and equipment 1.11 Performed timber tests
2 Resource Implications	The following resources should be provided: 2.1 Workstation 2.2 Well-equipped material testing laboratory 2.3 Test samples 2.4 Standard manuals 2.5 PPEs 2.6 Stationery 2.7 Computer
3 Methods of Assessment	Competency in this unit may be assessed through: 3.1 Observation 3.2 Oral 3.3 Projects 3.4 Written 3.5 Third party report

		3.6 Case study 3.7 Portfolio
4	Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment or during industrial attachment.
5	Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

PERFORM HIGHWAY SURVEY

UNIT CODE: CON/OS/CET/CR/02/6/A

UNIT DESCRIPTION

This unit specifies the competencies required to Perform Highway Survey**.** It involves undertaking preliminary site survey, performing levelling activities, conducting tacheometry works and drafting road cross-sections. It also includes carrying out setting out activities, performing traversing works and performing traffic engineering survey.

It applies in Road construction sector.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up workplace function (to be stated in active)	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1. Undertake preliminary site survey	1.1 Preliminary site survey plan is prepared in accordance with contract document 1.2 ***Survey resources*** are identified and mobilized as per the contract document 1.3 Survey drawings are obtained and interpreted as per the contract document 1.4 ***Site conditions*** are assessed, and findings recorded according to standard road construction procedures 1.5 Original ground level (OGL) is established and documented as per standard road construction procedures 1.6 Reference points are established based on standard road construction procedures 1.7 Preliminary survey report is prepared according to SOPs
2 Perform levelling activities	2.1 ***Levelling tools and equipment*** are identified and selected according to contract document 2.2 Levelling tools and equipment are calibrated according to manufacturer's manual 2.3 Road levels are set according to the design data 2.4 Monitoring and control of road levels is carried out as per the standard construction requirements

3 Conduct tacheometry works	3.1 ***Tacheometry tools and equipment*** are identified and selected according to contract document 3.2 Calibration of tools and equipment is carried out according to manufacturer's manual 3.3 Horizontal distances are determined based on datum coordinates 3.4 Vertical distances are determined based on datum coordinates 3.5 Tacheometry data is collected based on standard procedures 3.6 Data collected is documented based on standard road construction procedures
4 Draft road cross-sections	4.1 Road levels are recorded and computed based on SOPs 4.2 Reduced levels are produced based on computed road levels 4.3 ***Road cross-sections*** are drafted based on road levels 4.4 Road cross-sections are interpreted as per standard procedures 4.5 Road designs is established based on interpreted road cross-sections and profiles
5 Carry out setting out activities	5.1 ***Setting out tools and equipment*** are identified and selected according to contract documents 5.2 Calibrations of equipment is carried out according to manufacturer's manual 5.3 Proposed alignment is determined in accordance with preliminary survey report 5.4 Horizontal alignment is set out based on OGL 5.5 Vertical alignment is set out based on OGL 5.6 Alignment data is booked and computed as per the standard construction procedures
6 Perform traversing works	6.1 ***Traversing tools and equipment*** are identified and selected according to contract documents 6.2 Tools and equipment are calibrated according manufacturers manual 6.3 Horizontal and vertical angles are determined based on datum bearings and datum coordinates respectively. 6.4 Bearings are determined according to standard procedures 6.5 Distances are measured according to standard procedures

	6.6 Traverses are plot according to bearings and distances
7 Perform traffic engineering survey	7.1 Pavement location is identified 7.2 Traffic survey is prepared for as per SOPs 7.3 Traffic counts are carried out 7.4 Traffic and road characteristics are estimated

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

VARIABLE	RANGE

1. Survey resources may include but not limited to:	• Human resources
	• Tools
	  • Driving hammers
	  • Pegs
	  • Measuring tapes
	  • Cutting tools
	• Equipment
	  • Electric Distance Measurement (EDM) machines
	  • Theodolite (CWT)
	  • Total Station (TS)
	  • Dumpy level
	  • Levelling staff
	• Stationery
	  • Surveyors filed notebooks
	  • Pencil
	  • Grid papers
	• Legal documents
	  • Field permits
	  • Registration certificates
	• Power back-ups
	• Location maps

2. Site conditions may include but not limited to:	• Topography
	• Soil type and profiles
	• Vegetation
	• Settlements
	• Drainage
	• Weather conditions
	• Utility services
	  • Underground electric cables
	  • Pipe lines
	  • Data cables
	• Water table

3. Setting out tools and equipment may include but not limited to:	• Strings • Tape measures • Ranging rods • Pegs • Cutting tools • Driving tools • Angle measuring tools • Plumb bob • Marking tools and equipment
4. Tacheometry tools and equipment may include but not limited to:	• Theodolite • Levelling staff • Total station and accessories • Cutting tools • Driving tools
5 Traversing tools and equipment may include but not limited to:	• Traverse kits • Compass • GPS Survey equipment
6 Levelling tools and equipment may include but not limited to:	• Dumpy level, tilting levels and automatic levels • Levelling staff • Tilting levels • Automatic levels • Tape measure • Pegs • Ranging rods
7 Road cross-sections	• Cut and fill

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Drafting skills
- Drawings
- Computer literacy
- Leadership
- Reporting
- Communication
- Creativity and innovation
- Interpersonal
- Problem solving
- Interpretation
- Analytical

Required Knowledge

The individual needs to demonstrate knowledge of:

- Type and use of different survey tools and equipment
- Care and maintenance of survey equipment
- Road construction site conditions
- Standard road construction procedures
- Contract document
- Legal and statutory requirements
- Survey drawings
- Setting out tools and equipment
- Setting out methods
- Manufacturer's manual
- Survey data booking and computation
- Documentation of data
- Tacheometry tools and equipment
- SOPs
- Levelling tools and equipment
- Road levels
- Quality control operations
- Road cross-sections

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1	Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Prepared preliminary site survey plan 1.2 Conducted successful preliminary survey 1.3 Prepared preliminary survey report 1.4 Carried out setting out activities 1.5 Conducted tacheometry works 1.6 Booked and computed tacheometry data 1.7 Set road levels 1.8 Established road designs from road cross-sections and profiles 1.9 Demonstrated ability to use different engineering survey tools and equipment 1.10 Carried out traffic survey
2	Resource Implications	The following resources should be provided: 2.1 Workstation 2.2 Stationery 2.3 Manuals and guidelines 2.4 Standard of specifications
3	Methods of Assessment	Competency in this unit may be assessed through: 3.1 Observation 3.2 Oral questioning 3.3 Projects 3.4 Written tests 3.5 Third party 3.6 Portfolio
4	Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.
5	Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

DESIGN BASIC PAVEMENT STRUCTURES

UNIT CODE: CON/OS/CET/CR/03/6/A

UNIT DESCRIPTION

This unit specifies the competencies required to design basic pavement structures. It involves conducting site visit, designing highway drainage and hydraulic structures, designing road geometrics, designing pavement structure, designing pedestrian and cyclist path and designing for road furniture.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up workplace function (to be stated in active)	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1. Conduct site visit	1.1 Pavement location is determined based on contract documents 1.2 Preparation for site visit is undertaken as per contact document 1.3 ***On site data*** is collected according to standard procedures
2. Design highway drainage and hydraulic structures	2.1 Preliminary site visit is conducted 2.2 Surface run-off is estimated 2.3 Highway drainage structures are designed as per the design manuals and procedures 2.4 Bridges are designed as per the design manuals and procedures 2.5 Drifts and causeways are designed as per the ***design manuals*** and procedures 2.6 Retaining walls are designed as per the design manuals and procedures 2.7 Construction materials are determined

3. Design road geometrics	3.1 ***Resources*** are acquired in accordance with geometric design requirements 3.2 OGL (Original Ground Levels) are obtained according to standard road construction procedures 3.3 Horizontal alignments are designed based on standard road construction procedures 3.4 Vertical alignments are designed based on standard procedures 3.5 ***Road intersections*** are designed as per standard road construction procedures 3.6 Drawings are produced as per design data 3.7 Report is prepared and presented as per contract document
4. Design pavement structure	4.1 Resources are acquired in accordance with pavement structure requirements. 4.2 Traffic load is estimated as per traffic survey information. 4.3 ***Road/pavement type*** is determined as per client/developer/financier requirements and nature of the ground. 4.4 ***Pavement structures*** are designed based on traffic engineering analysis outputs and material testing results 4.5 Pavement structural drawings are produced as per design outputs 4.6 Materials schedules are developed according to design results 4.7 Detailed report and specifications are prepared and presented as per the contract document
5. Design pedestrian and cyclist paths	5.1 Required resources are identified and gathered as per design requirements 5.2 Pedestrian and cyclist traffic are estimated in accordance with traffic survey information 5.3 Pedestrian and cyclist path location is determined according to road profile 5.4 Pedestrian and cyclist paths are designed as per design manuals and procedures 5.5 Drawings are produced according to design output 5.6 Report and material specifications are prepared and presented according to contract document

6. Design road furniture	6.1 Required resources are gathered according to design needs 6.2 ***Type of road furniture*** is determined based on road type and relevant manuals 6.3 Location of road furniture is determined as per geometric road design 6.4 Road furniture is designed according standard road construction procedures 6.5 Drawings are produced based on design requirements 6.6 Report and material specifications are prepared and presented as per contract document requirement

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

VARIABLE	RANGE
1 Design manuals may include but not limited to:	• Ministry of Works road design manuals • AASHTO Standards
2 On site data may include but not limited to:	• Datum points • Settlement • Natural features • Soil type • Water catchment areas • Accessibility of utility services • Land marks • Road reserve
3 Resources may include but not limited to:	• Geometric tools • Straight edge • Ruler • Compass • Protractor • Computers • Auto Cad Software • Civil 3D • ARCH CAD • GIS

4	Road intersections may include but not limited to:	• Y-junctions • T-junctions • Under-pass • Round about • Overpass • Cross junctions • Interchange
5	Road/pavement type may include but not limited to:	• Rigid • Flexible
6	Pavement structures may include but not limited to:	• Sub-grade • Sub-base • Base • Surface
7	Type of road furniture may include but not limited to:	• Road markings • Information signs • Warning signs • Street lights • Traffic lights • Guard rails

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Technical
- Drawings
- Interpretation
- Creativity
- Innovation
- Time management
- Leadership
- Numerical
- CAD
- Interpersonal

Required Knowledge

The individual needs to demonstrate knowledge of:

- Horizontal alignments
    - Curves

    - Straights
- Interpretation of drawings
- Vertical alignments
- CAD
- Road construction drawings
    - Road Profiles
    - Maps
- Pavement structure
    - Sub-grade
    - Sub-base
    - Base
    - Surfacing
- Types of pavements
- Traffic engineering
- Material testing
- Runways
- Methods of structural designs
- Alternative construction procedures
- Design lifespan
- Behaviour of different pavement materials
- Design manuals and procedures
- Types of paths
- Types of road furniture
    - Road markings
    - Information signs
    - Warning signs
    - Street lights
    - Traffic lights
    - Guard rails
- Relevant manuals
- Engineers Code of Ethics
- Engineer's Act
- Basic Mathematics and Physics

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1 Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Designed highway drainage and hydraulic structures 1.2 Conducted preliminary site visit and collected on site data 1.3 Demonstrated understanding of road furniture

		1.4 Developed geometric drawings 1.5 Produced structural drawings 1.6 Designed road furniture 1.7 Designed pavement structure 1.8 Designed pedestrian and cyclist paths 1.9 Prepared and presented report
2	Resource Implications	The following resources should be provided: 2.1 Workstation 2.2 Computer 2.3 Software 2.4 Stationery
3	Methods of Assessment	Competency in this unit may be assessed through: 3.1 Observation 3.2 Oral 3.3 Projects 3.4 Written 3.5 Third party report 3.6 Case study 3.7 Portfolio
4	Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment or during industrial attachment.
5	Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

CARRY OUT ROAD CONSTRUCTION WORKS

UNIT CODE: CON/OS/CET/CR/04/6/A

UNIT DESCRIPTION

This unit specifies the competencies required to perform road construction works. It involves carrying out earthwork activities, constructing road/pavement structure layers and constructing parking, walkways and cyclist lanes, footbridges and bus bays. It also includes installing road furniture, construction of erosion prevention structures, constructing highway drainage and hydraulic structures and undertaking highway maintenance.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up workplace function (to be stated in active)	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1 Carry out earthwork activities	1.1 Relevant legal documents are obtained as per the contract requirements 1.2 ***Earthwork resources*** are identified and mobilized as per the contract document 1.3 ***Site clearance and demolition activities*** is carried out based on contract document and construction procedures 1.4 Drawings are interpreted as per construction procedures 1.5 Setting out for earthworks is conducted based on design output 1.6 ***Statutory requirements*** are obtained based on contract document and standard construction procedures 1.7 Road formation is established based on standard construction procedures 1.8 Ground levels are taken and documented according to SOPs 1.9 Volumes of ***cut and fill materials*** is determined in accordance with contract document 1.10 Haulage and disposal of waste material is carried out as per the standard construction procedures 1.11 Construction tools and equipment are operated and maintained as per the SOPs

2 Construct road/pavement structure layers	2.1 Required ***road construction resources*** are acquired and mobilized as per contract document 2.2 Drawings are interpreted as per construction procedures 2.3 ***Levelling activities*** are carried out as per standard construction procedures 2.4 Sub-grade pavement layer is constructed according to contract document and standard road requirements 2.5 Sub-base pavement layer is constructed as per contract document and standard road requirements 2.6 Base layer is constructed according standard road construction procedures and contract document 2.7 Ground levels are documented as per standard procedures 2.8 Road surfacing is constructed as per the contract document and standard construction procedures 2.9 ***Quality control operations*** are carried out according standard construction procedures 2.10 Maintenance of road/pavement structures is undertaken as per maintenance procedures 2.11 Construction tools and equipment are operated and maintained as per the SOPs
3 Construct parking walk ways and cyclist lanes, foot bridges, bus bays	3.1 Required resources are acquired and mobilized as per contract document 3.2 Drawings are interpreted as per standard construction procedures 3.3 Parking are constructed according to contract document, design manuals and standard construction procedures 3.4 Walk ways, cyclist lanes and bus bays are constructed according to contract document, design manuals and standard construction procedures 3.5 Foot bridges are constructed according to contract document, design manuals and standard construction procedures 3.6 Levelling activities are carried out as per standard construction procedures 3.7 Ground levels are documented as per standard procedures 3.8 Quality control operations are carried out according standard construction procedures

	3.9 Maintenance of parking, walk ways and cyclist lanes, foot bridges, bus bays is undertaken as per maintenance procedures 3.10 Construction tools and equipment are operated and maintained as per the SOPs
4 Install road furniture	4.1 ***Road furniture*** are mobilized according to contract document and designs 4.2 Interpretation of drawings is carried out according to the contract document and relevant manuals 4.3 Location of road furniture on the road is determined according to standard road procedures and legal requirements 4.4 Road furniture for installation are identified and acquired as per contract document 4.5 Road furniture are installed on the road based on standard construction procedures 4.6 Quality control procedures on road furniture installation are undertaken as per relevant manuals 4.7 Maintenance activities on road furniture are carried out based on standard maintenance procedures 4.8 Traffic signs are reviewed according to standard requirements 4.9 Maintenance of road furniture is undertaken as per maintenance procedures 4.10 Construction tools and equipment are operated and maintained as per the SOPs
5 Construct erosion prevention structures	5.1 Construction resources are mobilized as per contract document 5.2 ***Erosion control structures*** for construction are determined based on prevailing site conditions 5.3 Location of erosion prevention structures is established according to contract document 5.4 Interpretation of drawings is carried out as per standard construction procedures 5.5 Construction of erosion prevention structures is carried out in accordance with standard construction methods 5.6 Quality control procedures are undertaken according standard procedures 5.7 Maintenance of erosion prevention structures is undertaken as per maintenance procedures 5.8 Construction tools and equipment are operated and maintained as per the SOPs

6 Construct highway drainage and hydraulic structures	6.1 Highway drainage and hydraulic structures construction is planned for 6.2 Culverts are constructed 6.3 Side drains, mitre drains and cut-off drains are constructed 6.4 Sub-surface drains and gullies are constructed 6.5 Bridges are constructed 6.6 Drifts and causeways are constructed 6.7 Retaining walls are constructed 6.8 Maintenance of highway drainage and hydraulic structures is undertaken as per maintenance procedures 6.9 Construction tools and equipment are operated and maintained as per the SOPs
7 Undertake highway maintenance	7.1 Pavement conditions are assessed 7.2 Maintenance activities are prepared for 7.3 Emergency maintenance works are carried out 7.4 Routine maintenance activities are performed 7.5 Periodic maintenance works are carried out 7.6 Construction tools and equipment are operated and maintained as per the SOPs

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

VARIABLE	RANGE
1 Earthwork resources may include but not limited to:	• Bull dozers • Graders • Back hoes • Tippers • Shovels • Excavators • Grabbers • Rollers • Compactors • Cranes • Dump trucks • Off-highway dumpers

2	Site clearance and demolition activities may include but not limited to:	• Tree felling and stump removal • Boulders removal • Bush clearing • Grass cutting • Stripping • Removal cotton soil • Isolation and diversion of live services • Demolition of buildings, walls and bridges • Removal of existing pipelines, public and privately-owned services or supplies • Removal of fencing and hedges
3	Statutory requirements may include but not limited to:	• Approved site working drawings • Licenses • Permits • Agreement • Bill of Quantities
4	Road construction resources may include but not limited to:	• Machinery • Materials • Human resources • Plant
5	Levelling activities may include but not limited to:	• Setting out • Excavation • Cutting and filling • Reading and booking levels • Computing levels

6	Quality control operations may include but not limited to:	Include but not limited to:
		• Tests
		  ○ Maximum dry density
		  ○ Cone penetration
		  ○ Plasticity index
		  ○ California Bearing Ratio (CBR)
		  ○ Shear tests
		  ○ Marshall test
		• Monitoring and evaluation

7	Cut and fill materials may include but not limited to:	• Rocks • Soils 7..1 Gravel 7..2 Volcanic

8	Road furniture may include but not limited to:	• Traffic signals • Traffic warning signs • Information signs • Street lightings • Road markings • Pedestrian crossing • Guard rails • Road barriers • Road islands • Road kerbs • Bollards
9	Types of erosion control structures may include but not limited to:	• Gabions • Retaining walls • Vegetation • Scour check • Dykes • Benches • Catch basins

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Technical
- Interpretation
- Numerical
- Basic management
- Leadership
- Analytical
- Problem solving
- Communication
- Creativity
- Innovation
- Interpersonal

Required Knowledge

The individual needs to demonstrate knowledge of:

- Construction plant and equipment
  - Types
  - Uses

    - Housekeeping
- Setting out
    - Horizontal alignment
    - Vertical alignment
- Site clearance activities
    - Tree and stump removal
    - Boulders removal
    - Bush clearing
    - Grass cutting
    - Vegetable soil removal
- Cut and fills
- Standard road construction procedures e.g. excavation, cut material disposal, compaction
- Types of pavement
    - Rigid
    - Flexible
- Road layers' construction procedures
- Contract document
- Interpret drawings
- Quality control procedures
- Levelling activities
- Types of road construction materials
- Alternative construction methods
- Statutory requirements e.g. NCA, NEMA
- Construction procedures
- Types of walk ways and cyclist lanes, parking and bus bays
- Types of foot bridges and their design
- Road furniture types
- Interpret drawings
- Maintenance procedures
- Relevant manuals
- Statutory requirements
- Types of erosion prevention structures
    - Gabions
    - Catch basins
    - Scour checks
- Quality control procedures
- Use of Personal Protective Equipment

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1	Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Interpreted drawings and designs 1.2 Demonstrated the ability to mobilize machines and construction resources 1.3 Obtained and observed statutory requirements 1.4 Performed site clearances and demolition activities 1.5 Carried levelling activities 1.6 Constructed road/pavement structures 1.7 Carried out quality control operations accordingly 1.8 Constructed Parking, walk ways and cyclist lanes, foot bridges, bus bays 1.9 Installed road furniture 1.10 Constructed erosion prevention structures as required 1.11 Constructed highway drainage and hydraulic structures 1.12 Carried out highway maintenance
2	Resource Implications	The following resources should be provided: 2.1 New road under construction 2.2 Road under maintenance 2.3 Workstation 2.4 Road construction resources 2.5 Stationery 2.6 Standard manuals 2.7 Contract documents 2.8 Human resource 2.9 Schedule of works
3	Methods of Assessment	Competency in this unit may be assessed through: 3.1 Observation 3.2 Oral 3.3 Written 3.4 Third party Report 3.5 Case study 3.6 Portfolio
4	Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment or during industrial attachment.
5	Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

DESIGN ENGINEERING STRUCTURES

UNIT CODE: CON/OS/CET/CR/05/6/A

UNIT DESCRIPTION

This unit specifies the competencies required to design engineering structures. This involves load estimation, designing structural elements, assessing of cost effectiveness of designs, analysing site test data and modifying structural designs.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up workplace function (to be stated in active)	**PERFORMANCE CRITERIA** These are **assessable statements** which specify the required level of performance for each of the elements (to be stated in passive voice) ***Bold and italicized terms are elaborated in the Range***
1. Calculate load estimates	1.1 ***Intended use*** of the structure is determined as per client needs 1.2 ***Layout*** of the structure is created from the architectural drawings as per design standards and structural use 1.3 ***Codes of practice/manuals*** required to obtain the required loading are determined based on structural use. 1.4 Load analysis/estimation is carried out as per code procedures
2. Design structural elements	2.1 ***Design methods*** are selected based on cost effectiveness and client needs as per code standards 2.2 ***Design software*** are determined as per organizational standards. 2.3 ***Structural elements*** are designed as per design standards
3. Assess cost effectiveness of the design	3.1 Alternative cost saving design methods and materials are determined based on site conditions 3.2 Preliminary designs are reviewed to determine elements that can be reduced or replaced as per design standards.
4. Modify structural designs	4.1 ***Preliminary designs*** are modified to suite site conditions as per code of practice standards. 4.2 Preliminary hypotheses are retested for practicality to site conditions as per design standards 4.3 New hypotheses are established to support new designs and reflect site conditions as per the required conditions

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

VARIABLE	**RANGE** May include but are not limited to:

1 Intended use	• Commercial • Residential • Industrial
2 Layout	• Foundation layout • Beam layout • Slab layout • Column layout
3 Codes of practice/manuals	• British Standard Codes • Euro codes
4 Design methods	• Frame Analysis • Wall Bearing structural analysis • Wind analysis • Earthquake analysis
5 Software	• Excel spreadsheets • AutoCAD Structural Design Software • Prokon • Revit • Rendering software • Robot
6 Structural elements	• Slabs • Columns • Beams • Walls • Foundations • Stairs
7 Preliminary designs	• Slab design • Beam design • Column design

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Skills

The individual needs to demonstrate the following skills:

- Structural design methods
- Load analysis methods and procedures
- Engineering Surveying
- Layout design
- Data interpretation and analysis
- Computer Aided Design
- Measurement
- Critical thinking
- Problem solving
- Interpersonal

Knowledge

The individual needs to demonstrate knowledge of:

- Engineering CAD software
- Codes of practice.
- Quantitative data analysis
- Research methods
- Engineers Code of Ethics
- Finance
- Occupational safety and health
- Materials Science
- Laboratory operation and procedures
- Building regulations
- Basic Mathematics and Physics
- Geography
- Basic Survey Knowledge
- Engineers Act

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1.	Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Created a layout of the structure from architectural drawings 1.2 Determined the codes of practice required to obtain relevant loadings 1.3 Analysed loading for the structure 1.4 Selected a cost effective design method 1.5 Determined software to be used in the design process 1.6 Designed structural elements 1.7 Conducted research and selected alternative design methods and materials 1.8 Established hypotheses for use in modifying preliminary design 1.9 Reviewed preliminary designs and modified the design to reflect site conditions
2.	Resource Implications	The following resources should be provided: 2.1 Computer laboratories 2.2 Civil engineering software 2.3 Civil Engineering laboratories 2.4 Writing materials 2.5 Legal documents (Engineers Act, NCA Act, Engineers code of ethics) 2.6 Civil engineering codes of practice and manuals 2.7 Qualified trainers
3.	Methods of Assessment	Competency in this unit may be assessed through: 3.1 Observation 3.2 Projects 3.3 Written tests

		3.4 Oral presentation
4.	Context of Assessment	Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.
5.	Guidance information for assessment	Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended.

PRODUCE BUILDING DRAWINGS

UNIT CODE : CON/OS/CET/CR/06/6/A

UNIT DESCRIPTION

This unit describes the competencies required to produce building drawings. It involves interpreting architectural drawings, preparing structural and civil drawings, preparing plumbing layouts, interpreting electrical and mechanical drawings.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENTS These describe the key outcomes which make up workplace function	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements *(Bold terms are elaborated in the Range)*
1. Interpret architectural drawings	1.1. ***Construction dimensions*** are identified according to the size of the proposed site, construction regulations, planning requirements and client specifications 1.2. Architectural drawings are interpreted in accordance with the architectural code of design, ***building code***, local authority by laws, regulatory requirements and client specification
2. Prepare structural and civil drawings	2.1. ***Structural elements*** are designed according to the codes of practice 2.2. Detailed plans and sections of designed elements are drawn as per dimensions and relevant standards 2.3. Bar bending schedule is prepared as per the code of practice 2.4. Structural drawings are produced in accordance with ***building code***, local authority by laws, regulatory requirements and client specification
3. Interpret electrical drawings	3.1. Electrical circuits drawings are sketched in accordance with the electrical code of practice and the architectural layout 3.2. Electrical connection layout is drawn in accordance with the electrical code of practice
4. Prepare plumbing layout	4.1. Building dimensions are identified as per the architectural drawings, structural and electrical drawings 4.2. Pipe sizes are determined as per ***consumption requirements*** and design requirements 4.3. ***Pipe types*** are determined according to the design requirements

ELEMENTS These describe the key outcomes which make up workplace function	PERFORMANCE CRITERIA These are assessable statements which specify the required level of performance for each of the elements *(Bold terms are elaborated in the Range)*
	4.4. ***Pipe fittings*** are determined according to the mode of connection or the pipe layout plan 4.5. Pipe layout plan is drawn as per the building design
5. Interpret mechanical drawings	5.1. Mechanical component dimensions are obtained as per structural and architectural drawings 5.2. ***Mechanical components*** are identified as per architectural and structural drawings 5.3. Mechanical drawings are interpreted as per specifications

RANGE

Variable	Range
1. Construction dimensions may include but not limited to:	• vertical dimensions • horizontal dimensions
2. building codes may include but not limited to:	• BS 8110 • Eurocodes • Kenya Building Codes, 1968 • Civil engineering codes
3. structural elements may include but not limited to:	• Slabs • Beams • Columns • Foundation • Stairs
4. Consumption requirements may include but not limited to:	• Residential • Commercial • Institution • Hospitals
5. Pipe types may include but not limited to:	• PVC • GI pipes • Mild steel • PPR
6. Pipe fittings may include but not limited to:	• Union • Bends • Sanitary fittings

Variable	Range
7. Mechanical components may include but not limited to:	• Gas supply • Cold and hot water supply systems • Plumbing layout • Sewer system • Firefighting • Ventilation system • Water treatment system • Refrigeration • Building automation system

REQUIRED KNOWLEDGE AND SKILLS

Knowledge

- Construction dimensions
- Architectural drawing
- Local authority by-laws
- Building code
- Structural elements
- Codes of practice
- Basic arithmetic
- Measurement
- Engineering drawing
- Plumbing
- Structural design
- Mechanical systems
- Engineering software
- Civil engineering drawings

Skills

- Measurement
- Basic arithmetic
- Design
- Computer Aided Design
- planning

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Interpreted architectural drawings 1.2 Prepared structural drawings 1.3 Interpreted civil engineering drawings 1.4 Interpreted electrical drawings 1.5 Designed plumbing layout 1.6 Identified mechanical service requirements 1.7 Sketched mechanical drawings 1.8 interpreted sections, layout, elevations and as fixed drawings of mechanical items
2. Resource Implications	2.1 Measuring and drawing tools 2.2 Laptops 2.3 Desktop PCs 2.4 Printer/plotting device 2.5 Calculator 2.6 Internet 2.7 Codes of practice 2.8 Mechanical conventions 2.9 CAD Software
3. Methods of Assessment	Competency may be assessed through: 3.1 Demonstration 3.2 Practical assignment/project 3.3 Interview/Oral Questioning 3.4 Written
4. Context of Assessment	Competency may be assessed in an off and/or on the job setting or during industrial attachment
5. Guidance information for assessment	Holistic assessment with other units relevant to the building sector workplace and job role is recommended.

CARRY OUT BUILDING WORKS

UNIT CODE : CON/OS/CET/CR/07/6/A

UNIT DESCRIPTION

This unit describes competencies required to carry out building works. It involves executing site preliminary works, building temporary works, substructure works, superstructure works, building finishes and external works.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENTS These describe the key outcomes which make up workplace function	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements *(Bold terms are elaborated in the Range)*
1. Execute site preliminary works	1.1. Building site is surveyed as per standard construction procedures 1.2. Site boundary is determined as per standard construction procedures 1.3. Building site is hoarded/screened as per standard construction procedures 1.4. Unwanted structures are demolished as per standard construction procedures 1.5. Building site is cleared as per standard construction procedures 1.6. Site layout is prepared as per standard construction procedures 1.7. Site preliminary report is prepared as per standard construction procedures 1.8. ***Site utilities*** are identified and constructed as per standard construction procedures 1.9. Storage facilities are constructed as per standard construction procedures
2. Execute building temporary works	2.1. Trench timbering are constructed and dismantled according to standard construction procedures 2.2. Building formwork/shuttering is constructed and dismantled according to standard construction procedures 2.3. Building scaffold is erected and dismantled according to standard construction procedures 2.4. Building shores are erected and dismantled according to standard construction procedures

ELEMENTS These describe the key outcomes which make up workplace function	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements *(Bold terms are elaborated in the Range)*
3. Execute substructure works	3.1. Building is set out according to standard construction procedures 3.2. Building foundation is excavated according to standard construction procedures 3.3. Building foundation is laid according to standard construction procedures 3.4. Foundation walls are erected according to standard construction procedures 3.5. Solid ground floor is constructed according to standard construction procedures
4. Execute superstructure works	4.1. Superstructure columns are set out and constructed based on the construction method 4.2. Superstructure walling are set out and erected based on the construction method 4.3. Superstructure beams, stairs and upper floors are set and constructed based on the construction method 4.4. Building roof is set and erected according to standard construction procedures 4.5. Fireplace is constructed according to standard construction procedures 4.6. ***Fixtures*** and ***fittings*** are installed according to standard construction procedures
5. Execute building finishes	5.1. ***Floor finishes*** are applied according to standard construction procedures 5.2. Building surfaces are painted according to standard construction procedures 5.3. Building facings are applied according to standard construction procedures 5.4. ***Wall finishes*** are applied according to standard construction procedures 5.5. ***Ceiling finishes*** are applied according to standard construction procedures 5.6. Pointing and jointing is carried out according to standard construction procedures 5.7. Building rough casting is performed according to standard construction procedures
6. Execute building external works	6.1. External paving is laid based on the mode of construction

ELEMENTS These describe the key outcomes which make up workplace function	PERFORMANCE CRITERIA These are assessable statements which specify the required level of performance for each of the elements *(Bold terms are elaborated in the Range)*
	6.2. Soft landscaping is performed based on the mode of construction 6.3. Drainage system is constructed based on the mode of construction 6.4. ***Fences*** and gates are constructed based on the mode of construction

RANGE

Variable	Range
1. Site utilities may include but not limited to:	• Temporary washrooms • Source of water • Storage • Site office
2. Fixtures may include but not limited to:	• electric sockets • light fixtures • plumbing installations • Security and fire alarm systems
3. Fittings may include but not limited to:	• Furniture • hand driers • soap dispensers • towel hangers • cabinets
3. floor finishes may include but not limited to:	• Tiles • Cement sand screed • Terrazzo • Wood parquets • Carpets
4. Wall finish may include but not limited to:	• wall mastering • wall lining • clad building walls
5. Ceiling finish may include but not limited to:	• boards • T and G • Gypsum board • Acoustic ceilings
6. Fence may include but not limited to:	• Masonry walls • Live fence

Variable	Range
	• Reinforced concrete walling • Wooden post and chain link/barbed wire • Steel post and chain link • Concrete post and chain link

REQUIRED KNOWLEDGE AND SKILLS

Knowledge

- Measurement
- Formwork
- Scaffolding
- Wall construction
- Basic arithmetic
- Technical drawings
- Structural design
- Timber properties
- Steel properties
- Plan interpretation
- Occupational safety and health
- Codes of practice
- Roofing materials
- Types of roofs
- Materials science
- Concrete mix ratio
- Construction machines, tools and equipment
- Types of bonds
- Carpentry and joinery
- Waterproofing
- Types of fireplace
- Admixtures and additives
- Fixtures and fittings

Skills

- Estimating and costing
- Measurement
- Basic mathematic
- Communication
- Management
- Structural design
- Problem solving

- Critical thinking
- Construction tools handling
- Technical drawing
- Bonding
- Bar bending
- Interpreting
- Cutting and fixing

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Executed site preliminary works 1.2 Executed building temporary works 1.3 Executed substructure works 1.4 Executed superstructure works 1.5 Executed building finishes 1.6 Executed building external works
2. Resource Implications	2.1 Measuring and drawing tools 2.2 Laptops 2.3 Mechanical conventions 2.4 Site office 2.5 Codes of practice and manuals 2.6 Construction materials 2.7 Construction tools and equipment 2.8 Human resource 2.9 Personal Protective Equipment 2.10 Building construction site 2.11 Qualified trainers
3. Methods of Assessment	Competency may be assessed through: 3.1 Demonstration 3.2 Practical assignment/project 3.3 Interview/Oral Questioning 3.4 Written
4. Context of Assessment	Competency may be assessed in an off and/or on the job setting or during industrial attachment
5. Guidance information for assessment	Holistic assessment with other units relevant to the building sector workplace and job role is recommended.

MANAGE WATER RESOURCES QUALITY

UNIT CODE: CON/OS/CET/CR/08/6/A

UNIT DESCRIPTION

This unit covers the competencies required to manage water resources quality. It involves monitoring, managing water resources quality, managing groundwater quality, managing wastewater quality, treating, and disposing wastewater.

This standard applies in water sector.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up **workplace function**	**PERFORMANCE CRITERIA** These are **assessable** statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Monitor water resources quality	1.1 Water quality reconnaissance survey is done based on the need 1.2 ***Environmental Water sampling sites*** and ***water resource quality indicators*** are identified based on the reconnaissance survey 1.3 ***Matrices*** for water resource quality monitoring are identified based on the reconnaissance survey 1.4 ***Tools and equipment*** are identified based on the need 1.5 Tools and equipment are operated and maintained based on standard operation procedures 1.6 Water quality ***monitoring protocol*** is prepared based on need 1.7 Water quality monitoring ***schedules*** are implemented based on the monitoring protocol 1.8 Water quality monitoring report is prepared and submitted based on best practice
2. Surface Water quality management	2.1. Surface ***water quality challenges and issues*** are identified based on management need 2.2. Surface water resources quality is characterized based on challenges and issues identified 2.3. Surface water quality management plan is developed based on challenges and issues identified 2.4. Surface water quality management plan is implemented based on challenges and issues identified
3. Ground Water quality management	3.1. ***Ground water quality challenges and issues*** are identified based on management need 3.2. Groundwater resources quality is characterized based on challenges and issues identified

	3.3.Groundwater quality management plan is developed based on challenges and issues identified 3.4.Groundwater quality management plan is implemented based on challenges and issues identified
4. Manage wastewater quality	4.6 ***Sources*** of wastewater identified based on characteristics 4.7 Wastewater quality assessed based on selected parameters 4.8 Wastewater quality assessment report prepared based on monitoring sites 4.9 Wastewater is treated and disposed as per the environmental standards 4.10 Wastewater quality assessment report interpreted based on monitoring plan 4.11 Wastewater quality assessment report submitted based on best practices

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variables	**Range**
1. Surface water quality sampling sites may include but not limited to:	• Upstream • Hot spots • Effluent discharge points • Boreholes and wells • Regular gauging stations (RGS)
2. Groundwater quality sampling sites may include but not limited to:	• Boreholes • Wells • Springs
3. Water resources quality indicators may include but not limited to:	• Physico-chemical (e.g. pH, EC, TDS, DO, temperature, colour) • Inorganic chemical indicators (nitrates, phosphates) • Organic chemical (e.g. pesticides, detergents) •Microbial indicators (e.g. total coliforms E.coli, phytoplankton's, zooplanktons
4. Water resources quality matrices may include but not limited to	• Water •Macro organisms (e.g. fish, benthic macro-invertebrates, aquatic flora) • Sediments

5. Tools and equipment for monitoring water resources quality may include but not limited to:	• Portable water quality meters (pH, EC, TDS, thermometer, coli meter, DO meters • Water quality testing instruments: UV-Vis • GPS receiver • Samplers (manual, motorized, automated) • Remote sensing and GIS
6. Monitoring protocol may include but not limited to:	• Surveillance • Pollution control • Emergence preparedness and disaster response
7. Schedules may include but not limited to	• Monthly • Quarterly • Annual
8. Water resources quality challenges and issues may include but not limited to:	• Soil erosion • Human settlement (e.g. anthropogenic pollutants, deforestation, • Agricultural activities (e.g. fertilizers, pesticides etc.) • Industrial activities (e.g. industrial chemical pollutants, thermal pollution etc) • Municipal waste (e.g. solid waste, leachates etc.) • Extreme weather events (e.g. flooding, siltation) • Over abstraction (e.g. sedimentation)
9. Sources	• Industries • Hospitals • Residential

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

General skills:

- Communication
- Computer
- Analytical/research
- Organizing
- Data collection
- Decision making
- Planning
- Problem solving
- Supervising
- Time management

- Occupational Safety and health

Technical skills:

- Mapping
- Water sampling
- Water quality testing
- Instrumentation
- Data analysis
- Reporting
- Record keeping
- Operation and maintenance

Required Knowledge

The individual needs to demonstrate knowledge of:

- Instrumentation
- Water resources management
- Technical specifications
- Statutory regulations
- Occupational health and safety
- Quality Assurance
- Standard operating procedures
- Hydrology
- Integrated Water Resources Management
- Environmental science
- Water quality
- Water Act 2016

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Monitored water resources quality 1.2 Managed Surface Water quality 1.3 Ground Water quality management 1.4 Manage wastewater quality
2. Resource Implications	The following resources should be provided: 2.1 Functional water quality laboratory (e.g. sampling devices, portable water testing kits and equipment, preservation devices, laboratory reagents) 2.2 Computers with GIS software 2.3 Digital cameras

	2.4 GPS 2.5 Personal Protective Equipment
3. Methods of Assessment	Competency may be assessed through: 3.1 Written tests 3.2 Observation 3.3 Interview 3.4 Oral questions 3.5 Third party report(supervisor)
4. Context of Assessment	Assessment may be done: 4.1 On–the–job 4.2 Off-the –job 4.3 Industrial attachment 4.4 Field studies 4.5 Course work 4.6 Laboratory practice
5. Guidance information for assessment	Holistic assessment with other units relevant to the building sector workplace and job role is recommended.

DESIGN WASTEWATER COLLECTION AND TREATMENT INFRASTRUCTURE

UNIT CODE: CON/OS/CET/CR/09/6/A

UNIT DESCRIPTION

This unit covers the competencies required to design wastewater collection and treatment infrastructure. It involves collection of wastewater infrastructure design data, analysis of wastewater infrastructure design data, and calculation of wastewater infrastructure design parameters, drawing wastewater infrastructure units and compiling wastewater infrastructure design report.

This standard applies in Water Industry.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up **workplace function**	**PERFORMANCE CRITERIA** These are **assessable** statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1 Apply hydraulic engineering principles	1.1 ***Properties of fluids*** are identified based on standards 1.2 ***Tools and equipment*** for measurement of pressure, velocity and discharge are identified based on fluid properties 1.3 Hydraulic principles are applied based on the types of fluids
2 Analyse structural elements	2 .1***Properties of materials*** are identified based on the job requirements 2 .2***Section properties*** are analyzed based on the materials, loading and sizes 2 .3***Structural elements*** are analyzed based on material and loadings
3 Design structural elements	3.1 Structural elements are identified based on the requirements 3.2 Structural elements are designed based on design codes 3.3 Structural drawings are produced based on the design.
4 Collect wastewater infrastructure design data	4.1 Area to be surveyed is mapped out based on job requirements/specification. 4.2 ***Tools for data collection*** are prepared based on information required. 4.3 ***Data and information*** is collected based on tools prepared.

5	Analyse wastewater infrastructure design data	5.1 Data and information is arranged based on various themes. 5.2 Data is cleaned as per best practice. 5.3 Data is presented based on various themes.
6	Calculate wastewater infrastructure design parameters	6.1 ***Design Parameters*** to be calculated are identified based on wastewater design manual. 6.2 ***Tools for parameter calculation*** are identified based on the parameter to be calculated. 6.3 Various wastewater infrastructure design parameters are calculated based on design codes.
7	Draw wastewater infrastructure units	7.1 ***Drawing tools, equipment, supplies and materials*** are identified and gathered based on available resources and complexity of the design. 7.2 ***Wastewater infrastructure units*** are drawn based on the design parameters. 7.3 Wastewater infrastructure drawings are submitted for approval as per legal requirements.
8	Compile wastewater infrastructure design report	8.1 Design report format is obtained from the wastewater design manual. 8.2 Design report is prepared based on identified format. 8.3 Design report is submitted to the client as per best practice.

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variables	**Range**

Hydraulic principles may include but is not limited to:	• Flow in pipes
	• Flow in open channels
	• Hydrostatics
	  ○ Statement of Pascal's law,
	  ○ Hydraulic jack,
	  ○ Total pressure and centre of pressure; horizontally immersed plane surface, vertically immersed plane surface, inclined immersed plane surface),
	• Hydrodynamics
	  ○ Basic definitions; area of flow, mean velocity, rate of flow.
	  ○ Types of flow in pipes; steady and unsteady, uniform and non- uniform, laminar and turbulent, compressible and incompressible flow.
	  ○ Flow equations; discharge equation, continuity equation, Bernoulli's equation.)
	  ○ Flow in pipes
	• Flow in open channels

Structural elements may include but is not limited to:	• Stress • strain • General slope and deflection formula, • Double integration • McCauley's method • Mohr's theorems
Fluid properties may include but is not limited to:	• Density • Surface Tension • Viscosity • Specific Weight • Specific Gravity • Compressibility • Capillarity • Specific Mass

Tools and equipment may include but is not limited to:	• Manometers • Venturi meter • Orifice meter • Pitot Tube • Weirs • Notches • Mouth Pieces • Orifices • Hydrostatic Bench • Open Channel Models
Properties of material may include but not limited to	• Stress • Strain • Elasticity • Plasticity • Stiffness • Young's modulus
Section Properties of materials may include but not limited to	• Centroids • Centre of gravity • 1st moment of area • 2nd moment of area • Section modulus • Radius of gyration

Structural elements may include but not limited to	• Beams (Simply supported Beams) • Columns (Short columns, centrally, axially, loaded and eccentrically loaded, uniaxial, biaxial bending) • (Floors) Slabs (one way spanning and two way spanning, suspended slabs) • Foundations (isolated footing/ pad footing and strip footing) • Timber Grading (Visual, machine, stress grading, Stresses: Grade, Basic, wet, dry timber, permissible strength) • Struts • Ties • Purlins • Joists • Steel • Struts • Ties • Purlins • Joists • Connections (welded)
Wastewater infrastructure units may include but not limited to:	• Sewer • Screen • Grit chamber-horizontal, aerated/spiral • Sedimentation tanks • Activated sludge system • Trickling filters(rock and plastic) • Ponds • Oxidation ditch • Aerated lagoons • Storm water drains • Equalization tank • Sequential Batch Reactor • Rotating biological contactors • Oil and grease trap

Drawing tools, equipment, supplies and materials may include but not limited to:	• Software • Pencils • Ruler • T-square • Scale rule • Eraser • Set square • Drawing board • Masking tapes • Drawing paper • Photocopying /printing papers • Computer • Printer • Photocopiers
Tools for parameter calculation may include but not limited to:	• Theodolite • Dumpy level • GPS • Total station • Levelling staff • Booking sheet • Soil sampler • Adequately equipped soil mechanics laboratory • Flow Measuring structures and devices • Stop watch • Questionnaires
Tools for data collection may include but not limited to:	• Stop watch • Checklists • Questionnaires • Stationery • Sampling equipment
Data and information may include but not limited to:	• Population size • Flow rate

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

- Communication
- Analytical
- Organizing
- Decision making
- Planning
- Record keeping
- Problem solving
- First aid
- Supervising
- Organizing
- Time management
- Analysis
- Reporting
- Performance appraising
- Trouble shooting
- Data logging
- Surveying
- Technical drawing
- Computer Aided Design

Required Knowledge

The individual needs to demonstrate knowledge of:

- Technical specifications
- Statutory regulations
- Occupational health and safety
- Quality Assurance
- Wastewater treatment technologies
- Statistics
- Wastewater treatment processes
- Soil analysis methods
- Hydraulics skills
- Statutory regulations and legislation in water

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Applied hydraulic engineering principles 1.2 Analysed structural elements 1.3 Designed structural elements 1.4 Collected wastewater infrastructure design data 1.5 Analysed wastewater infrastructure design data 1.6 Calculated wastewater infrastructure design parameters 1.7 Drew wastewater infrastructure units 1.8 Compiled wastewater infrastructure design report
2. Resource Implications	The following resources **must** be provided: 2.1 Computer lab 2.2 Plumbing and pipefitting workshop 2.3 GIS Software 2.4 Water laboratory 2.5 Drawing room 2.6 CAD software 2.7 Printer
3. Methods of Assessment	Competency may be assessed through: 3.1 Practical 3.2 Verbal assessment 3.3 Written assessment 3.4 Design reports 3.5 Oral interview 3.6 Presentation
4. Context of Assessment	Assessment may be done: 4.1 On job training 4.2 Course work 4.3 Projects (design/research projects) 4.4 Industrial assessment
5. Guidance information for assessment	Holistic assessment with other units relevant to the building sector workplace and job role is recommended.

CONSTRUCT WASTEWATER INFRASTRUCTURE

UNIT CODE: CON/OS/CET/CR/10/6/A

UNIT DESCRIPTION

This unit covers the competencies required to construct wastewater infrastructure. It involves analysis of soil properties, construction of the wastewater infrastructure units, organization of the construction site, and preparation of construction schedule

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up **workplace function**	**PERFORMANCE CRITERIA** These are **assessable** statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Analyse soil properties	1.1 ***Soil analysis tools, supplies and materials*** are identified and gathered based on available resources and the tests to be conducted 1.2 Engineering properties of soils are identified based on the soil classification 1.3 Properties of soils are analysed based on the standard procedures 1.4 Soil analysis report is prepared based on the results.
2. Prepare construction schedule	2.1 Engineering drawings are Interpreted based on the engineering codes 2.2 ***Construction activities*** are identified based on scope of work 2.3 Project management timelines are prepared based on project specifications
3. Organize construction Site	3.1 Site is cleared and secured based on the contract document. 3.2 Human resources construction plant and equipment are identified and mobilized based on the contract document 3.3 ***Site infrastructures*** are put in place based on contract document and legal requirements.
4. Construct wastewater infrastructure units	4.1 ***Construction materials and tools*** are sourced and mobilized based on the bill of quantities 4.2 Infrastructure is set out based on the engineering drawings. 4.3 ***Wastewater infrastructure units*** are constructed based on the design drawings 4.4 Labour payments are done based on the progress report and attendance. 4.5 As built drawings are prepared and submitted based on the actual construction 4.6 Payment certificate is prepared based on progress report.

	4.7 Completion certificate is prepared based on the legal requirements 4.8 Site personal health and safety is observed as per the OSH Act and site regulations

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variables	**Range**
Construction activities may include but not limited to:	• Concrete works • Steel works • Earth work • Form works • site clearance • Trenching and excavation • Backfilling
Soil analysis tools, supplies and materials	• Sieve analysis e.g. • PI index • Moisture content • CBR • Proctor • Triaxial test • Oedometer tests • Cassagrande • Cone penetrometer • Sand Replacement • California Bearing Ratio
Site infrastructures may include but not limited to:	• Site office • Site store • Ablution block • Fence • Signage/safety signs • Hoarding

construction materials and tools may include but not limited to:	• Cement • Aggregates (course and fine) • Steel • Stones /blocks • Timber • Tape measure • Hack saws • Pipe wrenches • Leveling tools e.g. Hammer • Set of protective gear
Wastewater infrastructure units may include but not limited to:	• Screen • Grit chamber-horizontal, aerated/spiral • Sedimentation tanks • Activated sludge chamber • Trickling filters • Ponds • Oxidation ditch • Aerated lagoons • Storm water drains • Equalization tank • Sequential Batch Reactor • Rotating biological contactors • Oil and grease trap

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

Generic skills:

- Communication
- Analytical
- Organizing
- Decision making
- Planning
- Record keeping
- Problem solving
- First aid
- Supervising

- Organizing
- Time management

Technical skills:

- Analysis
- Reporting
- Performance appraising
- Trouble shooting
- Data logging
- Technical specifications
- Safety measures
- Statutory regulations
- Occupation Safety and Health
- Construction
- Hydraulics
- Surveying
- Computer Aided Design

Required Knowledge

The individual needs to demonstrate knowledge of:

- Technical specifications
- Statutory regulations
- Construction management
- Occupational health, safety
- Quality Assurance
- Wastewater treatment technologies
- Statistics
- Wastewater treatment processes
- Soil analysis methods
- Hydraulics
- Statutory regulations and legislation in water
- Sewer construction
- Measurement and costing
- Construction documents
- Contract document development

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Analysed soil properties 1.2 Prepared construction schedule 1.3 Organised construction site 1.4 Constructed wastewater infrastructure units
2. Resource Implications	The following resources **must** be provided: 2.1 Adequately equipped concrete lab 2.2 Adequately equipped soils laboratory 2.3 Surveying equipment store 2.4 Construction tools and equipment 2.5 Adequately equipped timber workshop 2.6 Plumbing and pipe workshop 2.7 Electro mechanical workshop 2.8 Software 2.9 Computers
3. Methods of Assessment	Competency may be assessed through: 3.1 Practical 3.2 Verbal assessment 3.3 Written assessment 3.4 Construction reports 3.5 Industrial attachment 3.6 Project 3.7 Presentations
4. Context of Assessment	Assessment may be done: 4.1 On job training 4.2 Off the job 4.3 Coursework 4.4 Industrial assessment
5. Guidance information for assessment	Holistic assessment with other units relevant to the building sector workplace and job role is recommended.

DESIGN ONSITE SANITATION FACILITIES

UNIT CODE: CON/OS/CET/CR/11/6/A

UNIT DESCRIPTION

This unit covers the competencies required to design onsite sanitation facilities**.** It involves Collection and analysis of onsite sanitation design data, calculation of onsite sanitation design parameters, drawing onsite sanitation units, designing shit flow diagram and compilation of onsite sanitation design report

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up **workplace function**	**PERFORMANCE CRITERIA** These are **assessable** statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Collect onsite sanitation design data	1.1 Area to be served is mapped out based on job requirements/specification. 1.2 ***Tools for data collection*** are prepared based on ***onsite sanitation facility*** to be designed. 1.3 Data and information is collected based on tools prepared.
2. Analyse onsite sanitation design data	2.1 Data and information is arranged based on onsite sanitation facility to be designed. 2.2 Data is presented based on onsite sanitation facility to be designed.
3. Calculate onsite sanitation design parameters	3.1 ***Design parameters*** to be calculated are identified based on wastewater design manual. 3.2 ***Tools for design parameter calculation*** are identified based on the parameter to be calculated. 3.3 Various onsite sanitation facility design parameters are calculated based on design codes.
4. Draw onsite sanitation units	4.1 ***Drawing tools, supplies and materials*** are identified and gathered based on available resources and complexity of the design. 4.2 Onsite sanitation facilities are drawn based on the design parameters. 4.3 Onsite sanitation facility drawings are submitted for approval as per legal requirements
5. Design shit flow diagram	5.1 Data required for SFD preparation is identified according to standards 5.2 Methodology for data collection is identified as per the standards

	5.3 Tools, supplies and materials are identified and gathered based on available resources 5.4 Data is collected, sorted and analysed based on methodology identified 5.5 SFD is prepared based on the data collected.
6. Compile onsite sanitation design report	6.1 Design report format is obtained from the wastewater design manual. 6.2 Design report is prepared based on identified format. 6.3 Design report is submitted to the client as per best practice.

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variables	**Range**
1. Tools for onsite data collections may include but not limited to:	• Questionnaires • Stationery • GPS • Cameras • Check list • Sampling equipment • Maps • Measuring instruments • Safety equipment • Safety box • First aid kits
2. onsite sanitation facility to be design may include but not limited to:	• Septic Tanks • Bio-Digesters • Anaerobic Baffled Reactors • Latrines • Soak Pits • Ecosan toilets • Imhoff tank
3. Tools for design parameter calculation may include but not limited to:	• Laptops • Calculator • Stationery • Software

4. Drawing tools, supplies and materials for onsite sanitation facilities may include but not limited to:	• Software • Pencils • Ruler • T-square • Scale rule • Eraser • Set square • Drawing board • Masking tapes • Software • Drawing paper • Photocopying /printing papers • Stationery • Computer • Printer • Photocopiers • Calculator

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

Generic skills:

- Communication
- Analytical
- Organizing
- Decision making
- Planning
- Record keeping
- Problem solving
- First aid
- Supervising
- Organizing
- Time management

Technical skills:

- Analysis

- Reporting
- Performance appraising
- Trouble shooting
- Data logging
- Technical specifications
- Safety measures
- Statutory regulations
- Surveying skills
- Drawing skills

Required Knowledge

The individual needs to demonstrate knowledge of:

- Technical specifications
- Statutory regulations
- Quality Assurance
- Computer Aided design
- Occupational health, safety
- Statistics
- Wastewater treatment processes
- Soil analysis methods
- Surveying
- Statutory regulations and legislation in water
- Engineering mathematics
- Technical drawing
- Onsite sanitation facilities
- Waste water characteristics

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Mapped out the area to be served based on job requirements/specification. 1.2 Prepared tools for data collection based on onsite sanitation facility to be designed. 1.3 Collected data and information based on tools prepared. 1.4 Arranged data and information based on onsite sanitation facility to be designed.

	1.5 Presented data based on onsite sanitation facility to be designed. 1.6 Identified design **p**arameters to be calculated based on wastewater design manual. 1.7 Identified tools for parameter calculation based on the parameter to be calculated. 1.8 Calculated various onsite sanitation facility design parameters based on design codes. 1.9 Identified drawing tools, supplies and materials and gathered based on available resources and complexity of the design. 1.10 Drawn Onsite sanitation facilities based on the design parameters. 1.11 Submitted on-site sanitation facility drawings for approval as per legal requirements 1.12 Obtained design report format from the wastewater design manual. 1.13 Prepared design report based on identified format. 1.14 Submitted design report to the client as per best practice.
2. Resource Implications	2.1 Surveying equipment 2.2 Drawing room 2.3 Human resource 2.4 Computer lab 2.5 Design software
3. Methods of Assessment	3.1 Verbal assessment 3.2 Written assessment 3.3 Observation 3.4 Presentation
4. Context of Assessment	Assessment may be done: 4.1 Project 4.2 On the job 4.3 Off-the job 4.4 Industrial attachment 4.5 Course work
5. Guidance information for assessment	Holistic assessment with other units relevant to the building sector workplace and job role is recommended.

CONSTRUCT ONSITE SANITATION FACILITIES

UNIT CODE: CON/OS/CET/CR/12/6/A

UNIT DESCRIPTION

This unit covers the competencies required to construct onsite sanitation facilities. It involves Preparing construction schedule, organizing the construction site and construction of the various onsite sanitation facilities

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENT These describe the **key outcomes** which make up **workplace function**	**PERFORMANCE CRITERIA** These are **assessable** statements which specify the required level of performance for each of the elements. ***Bold and italicized terms are elaborated in the Range***
1. Prepare construction schedule	1.1 Engineering drawings are Interpreted based on the engineering codes 1.2 ***Construction activities*** are identified based on scope of work 1.3 Project management timelines are Prepared based on project specifications
2. Organize the construction Site	2.1 Site is cleared and secured based on the contract document. 2.2 Human resource, construction plant and equipment are identified and mobilized based on the contract document 2.3 ***Onsite infrastructure*** is put in place based on contract document and legal requirements
3. Construct the various onsite sanitation facilities	3.1 ***Construction materials*** are sourced and mobilized based on the bill of quantities 3.2 Onsite sanitation facilities are set out based on the engineering drawings. 3.3 ***Onsite sanitation facility units*** are constructed based on the design drawings 3.4 Labor payments are done based on the progress report and attendance list. 3.5 As-built drawings are prepared and submitted based on the actual construction works 3.6 Substantial completion certificate is prepared based on FIDIC regulations 3.7 Payment certificate is prepared based on progress report. 3.8 Completion certificate is prepared based on the legal requirements

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

Variables	Range
Construction activities on construction schedule may include but not limited to:	• Surveying • Excavation • Laying and jointing • Setting out • Alignment and gradient • Timbering to trenches • Backfilling • Concrete works • Steel works • Timber works • Roofing • Electrical works • Plumbing works • Finishes
On-site infrastructures in the construction Site may include but not limited to:	• Stores • Site office • Fences • Site latrine
Construction materials and tools may include but not limited to:	• Cement • Aggregates(course and fine) • bricks • stones • timber • steel • Tape measure • Hack saws • Pipe wrenches • Leveling tools • Hammer • Set of protective gear
Onsite sanitation facility units may include but not limited to:	• Septic Tanks • Bio-Digesters • Anaerobic Baffled Reactors • Latrines- pit, VIP, Aqua privy • Soak Pits • Imhoff tank

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

Required Skills

The individual needs to demonstrate the following skills:

Generic skills:

- Communication
- Analytical
- Organizing
- Decision making
- Planning
- Record keeping
- Problem solving
- First aid
- Supervising
- Time management

Technical skills:

- Analysis
- Reporting
- Performance appraising
- Trouble shooting
- Data logging
- Technical specifications
- Safety measures
- Statutory regulations
- Surveying skills
- Plumbing and Pipefitting
- Construction skills
- Site organization

Required Knowledge

The individual needs to demonstrate knowledge of:

- Technical specifications
- Statutory regulations
- Quality Assurance
- Computer Aided design

- Occupational health, safety
- Statistics
- Wastewater treatment processes
- Soil analysis methods
- Surveying
- Statutory regulations and legislation in water
- Engineering mathematics
- Technical drawing
- Onsite sanitation facilities
- Waste water characteristics
- Construction management

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Prepared construction schedule 1.2 Organised construction site 1.3 Constructed various onsite sanitation facilities
2. Resource Implications	The following resources **must** be provided: 2.1 Concrete lab 2.2 Soil laboratory 2.3 Surveying equipment 2.4 Construction plant 2.5 Timber workshop 2.6 Plumbing and Pipe workshop 2.7 Electro mechanical workshop 2.8 Human resource
3. Methods of Assessment	Competency may be assessed through: 3.1 Practical 3.2 Verbal assessment 3.3 Written assessment 3.4 Construction reports 3.5 Industrial attachment 3.6 Project
4. Context of Assessment	Assessment may be done: 4.1 On job training 4.2 Coursework 4.3 Industrial assessment

5. Guidance information for assessment	Holistic assessment with other units relevant to the building sector workplace and job role is recommended.

MANAGE CIVIL ENGINEERING PROJECTS

UNIT CODE : CON/OS/CET/CR/13/6/A

UNIT DESCRIPTION

This unit describes the competencies required to manage civil engineering projects. It involves managing project time, managing construction project quality, managing project site safety, health and security, managing construction project cost, managing project labour, managing project contracts and managing construction materials, plant, tools and equipment.

ELEMENTS AND PERFORMANCE CRITERIA

ELEMENTS These describe the key outcomes which make up workplace function	**PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements *(Bold terms are elaborated in the Range)*
1. Manage project time	1.1. Work schedules and time programmes are prepared based on the project specifications 1.2. Project timelines are monitored and evaluated based on the project specifications 1.3. Project time schedules are controlled based on the project specifications 1.4. Project timeline reports are prepared and disseminated based on the project specifications
2. Manage construction project quality	2.1. Construction project quality plans are developed according to the contract specifications 2.2. Construction project methodology are developed according to the contract specifications 2.3. Construction project resources are acquired according to the contract specifications 2.4. Construction project quality control are undertaken according to the contract specifications 2.5. Construction project quality reports are prepared according to the contract specifications
3. Manage project site, safety, health and security	3.1. Project health, safety and security guidelines are developed in line with the OSH Act 3.2. Site health, safety and security inspections are conducted in line with the OSH Act 3.3. Project site security is coordinated and monitored in line with the OSH Act
4. Manage construction project cost	4.1. Project budget is prepared according to the scope of the project

ELEMENTS These describe the key outcomes which make up workplace function	PERFORMANCE CRITERIA These are assessable statements which specify the required level of performance for each of the elements *(Bold terms are elaborated in the Range)*
	4.2. Site resource utilization are procured, allocated and monitored according to the project scope 4.3. Project cost variation is controlled as per SOPs 4.4. Project financial report is prepared
5. Manage project labour	5.1. Project labour guidelines is developed in line with Labour laws and FIDIC regulations 5.2. Labour levelling plan is established 5.3. Staff is allocated 5.4. Labour welfare is managed 5.5. Project labour report is prepared
6. Manage project contracts	6.1. Project documentation are managed 6.2. Project stakeholders are engaged 6.3. Construction project works are inspected 6.4. Project information is managed 6.5. ***Project implementation report*** is prepared
7. Manage construction materials, plant, tools and equipment	7.1. Site storage facility is prepared 7.2. ***Construction materials*** schedule is prepared 7.3. ***Construction equipment*** schedule is prepared 7.4. Construction materials and equipment are procured 7.5. Construction materials and equipment are issued

RANGE

Variable	Range
1. Project implementation report may include but is not limited to:	• Daily • Monthly • Project progress report
2. Construction materials may include but is not limited to:	• Roofing • Walling • Flooring • Finishing • Reinforcing
3. Construction equipment may include but is not limited to:	• Excavation • Lifting • Transporting

REQUIRED KNOWLEDGE AND SKILLS

Knowledge

- Construction dimensions
- Interpretation of Architectural drawing
- Local authority by-laws
- Building code
- Structural elements
- Codes of practice
- Basic arithmetic
- Measurement
- Engineering drawing
- Plumbing
- Structural design
- Mechanical systems
- Engineering software
- Civil engineering drawings
- Safety practices
- First Aid
- Occupation Safety and Health
- Engineers Act
- Code of Ethics
- CAD

Skills

- Measurement
- Basic arithmetic
- Design
- Computer
- Computer aided design
- Planning

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Managed project time 1.2 Managed construction project quality 1.3 Managed project site safety, health and security 1.4 Managed construction project cost 1.5 Managed project labour 1.6 Managed project contracts
2. Resource Implications	2.1 Measuring and drawing tools

	2.2 Laptops 2.3 Desktop PCs 2.4 Printer/plotting device 2.5 Calculator 2.6 Internet 2.7 Codes of practice/manuals 2.8 Mechanical conventions 2.9 Human resource 2.10 CAD Software 2.11 Project Management software and tools
3. Methods of Assessment	Competency may be assessed through: 3.1 Demonstration 3.2 Practical assignment/project 3.3 Interview/Oral Questioning 3.4 Written
4. Context of Assessment	Competency may be assessed in an off and/or on the job setting
5. Guidance information for assessment	Holistic assessment with other units relevant to the building sector workplace and job role is recommended.