SECTION A							
QUALIFICATION DEVELOPER	**GABORONE UNIVERSITY COLLEGE OF LAW AND PROFESSIONAL STUDIES**						
TITLE	**DIPLOMA IN WATER ENGINEERING**				**NCQF LEVEL**	**6**	
FIELD	**MANUFACTURING, ENGINEERING AND TECHNOLOGY**		**SUB-FIELD**		**WATER ENGINEERING**		
New qualification	✓		Review of existing qualification				
SUB-FRAMEWORK	General Education		TVET	✓	Higher Education		
QUALIFICATION TYPE	Certificate		Diploma	✓	Bachelor		
	Bachelor Honours		Master		Doctor		
CREDIT VALUE					**375**		

RATIONALE AND PURPOSE OF THE QUALIFICATION

Rationale

Water Engineering is concerned with the planning, designing, realising, managing and maintaining of all types, water and waste treatment plants. Water Engineering as a profession deals with all these areas many more. The qualification proposed here therefore aims at producing technicians who have a solid grounding in a wide-ranging area of water engineering, with competencies in developing and improving contemporary societies and seeks alternative solutions that respect the built environment. The qualification develops technological problem-solving ability of water engineering technicians and the organisational, administrative and planning abilities of management in order to oversee the operational performance of complex water engineering projects.

Human Resource Development Council (HRDC) is the main authority in Botswana for determining priority skills needed by the economy for now and for the future. They do this in close collaboration with respective industries, both public and private sector, and there is no better authority than this to guide qualifications and programmes development to address needs of the economy. In their (HRDC) December 2016 document titled **"Top Occupations in High Demand"** and their subsequent March 2019 document titled **"Priority Skills (Current and Future)"** it is clear that construction related skill are in high demand and will continue to be required for the foreseeable future, or at least up to the year 2028. Some of the identified

top occupations in demand include Engineering Professionals with specific skills areas under Water Engineering, covering technical skills in Hydrology, Reticulation & Distribution, Water and Wastewater Management. Intended soft skill are Management, Teamwork, Supervisory, Health & Safety and Environment.

The proposed qualification possesses the professional, interpersonal and personal management skills necessary for a career in water engineering and construction management. The qualification develops the graduates to have awareness of their civic responsibilities and their role in sustaining and preserving the environment, as well as managing natural resources. The qualification is intended to train highly skilled technicians, knowledgeable in the implementation, management and control of the water engineering processes.

Purpose

Graduates of this qualification will be able to:

- Design a water pump station to specifics guided by needs in community.
- Illustrate knowledge of various materials used in water engineering projects.
- Apply pipefitting and pipe laying techniques
- Analyze survey reports, maps, and other data to plan water engineering projects.
- Establish, assess and analyze the characteristics of potable water, the need for treatment or otherwise, treatment options and come up with the optimum treatment process

ENTRY REQUIREMENTS (including access and inclusion)

i. A minimum entry of Certificate IV (NCQF level 4) or equivalent with Grade C or better D in English Language, grade C in Mathematics, Physics and Chemistry or an equivalent of grade BB in Science Double Award.
ii. Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) will be considered for access and inclusion of prospective candidates

QUALIFICATION SPECIFICATION: SECTION B	
GRADUATE PROFILE (LEARNING OUTCOMES)	**ASSESSMENT CRITERIA**
• Demonstrate advanced understanding of mathematics principles and	• Apply verbal quantitative situations algebraically and evaluate these expressions for given replacement values of the variables.

to prepare them for the engineering course which heavily relies on understanding various mathematical concepts.	• Apply the square roots and cube roots of whole numbers and the square root of a monomial algebraic expression in simplest radical form. • Solve multistep linear inequalities in two variables. • Graph linear equations and linear inequalities in two variables, including. • Investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically. • Solve functions trigonometrically by applying sectors, Pythagorean, double angle identities, circular functions and sinusoidal curves. • Deduce application of a variety of series including Power and Taylor series • Apply complex numbers into product, summation and special products. • Draw up different techniques of categorizing numbers • Apply basic introductory calculus.
• Apply basic skills and knowledge on the use of computers and computer applications.	• Recognize logical and physical organization of a general-purpose computer. • Apply different word processing techniques such as creating, editing saving and retrieving a document. • Add special features to a document, working with blocks, indenting and aligning text. • Draw up spread sheets commands to deduce formulas and other mathematical techniques. • Use and maintain a personal computer's database and storage facilities. • Demonstrate knowledge and understanding of communication technology.
• Illustrate knowledge of various materials used in water engineering projects.	• Demonstrate knowledge and understanding of properties of materials used in water engineering projects. • Evaluate the fabrication process of general for water projects • Determine all environmental impacts on materials used in water engineering projects.

• Illustrate objects in space, their interactions and disposition for better mastery of engineering drawings	• Demonstrate an understanding of basic terminology in graphics. • Interpret different scales used in engineering drawing. • Apply free hand drawing techniques and perspective drawing intersections. • Draw in three dimension and two dimensions. • Apply, orthogonal, axonometric and Isometric projections to 3D and 2D diagrams.
• Demonstrate knowledge of the dynamics, function and fitting of the plumbing and drainage and other services installations in buildings; with respect to design of installations norms and codes of installations as well as skills in the computation and choice of materials.	• Perform a basic plumbing installation in a residential home. • Apply design considerations in water supply, sanitary services and wastewater supply. • Analyze fire proofing, fire controlling, fire detection and fire warning systems. • Formulate logistics strategies for installing and using information technology and wireless form of communication.
• Demonstrate pipefitting and pipe laying techniques	• Apply all safety precautions in a workshop. • Perform different pipe joining techniques. • Select and use appropriate tools and materials for pipe fitting. • Set out using building line, steel pack/reinforce and club hammer.
• Apply mathematical concepts which are directly related to the application of engineering concepts	• Calculate Laplace transforms and inverses. • Apply Laplace transformations to solutions of differential and integral equations. • Calculate double and triple integrals, surface integrals and apply the Green's Stokes. • Deduce Divergence theorems and calculate complex integrals. • Apply physical significance of vector calculus, parameterize curves, calculate line integrals and use vector operators.
• Analyze survey reports, maps, and other data to plan water engineering projects.	• Measure height differences using levels by observing and recording of staff readings relative to datum/sea level using dump or automatic, digital level. Setting up tripod, centralizing bubble tube and carrying out a two-peg test.

	• Determine height differences across wide gaps using rectangular co-ordinates applying grid north, magnetic north, true north, orientation, whole circle bearings, rectangular co-ordinates. Adjustment should be made to bearings. • Demonstrate thorough knowledge of survey instrument and topographical and cadastral surveys. • Carry out leveling surveys in preparation of reticulation plans. • Carry out setting out of waterlines.
• Establish the characteristics of potable water, assess the need for treatment or otherwise, analyze treatment options and come up with the optimum treatment process	• Analyze the basic design considerations preconstruction of a water treatment structure. • Assess water treatment methods, selection criteria and chemical treatment processes. • Develop an understanding of special water treatment processes common practiced in the region. • Design and detail of hydraulic structures involved in water and waste engineering.
• Evaluate an OHS report, assess the suitability of the proposed occupational health and safety plan and assess the adequacy or otherwise of the proposed mitigation measures.	• Apply knowledge of Occupational Health And Safety legislation • Apply Hazardous Materials Management concepts in a water engineering reticulation site. • Understand all Occupational Health related diseases. • Implement all Environmental Safety precautions prior to a water engineering project.
• Apply knowledge in the mechanical properties of fluids (liquids and gases) under static and dynamic conditions, and their behavior under different loading conditions and variations in temperature and pressure	• Explain kinds of fluids-real, ideal shear stress, viscosity, Newtonian and non-Newtonian fluids, and fluid properties. • Assess fluids at zero motion using hydrostatic equation, pressure and density in gravitational field, fluid forces, and buoyancy and stability. • Assess fluids at motion by angular momentum, kinematics and general laws of motion. • Calculate mass conservation using, continuity equation and Reynolds' theorem.

	• Calculate momentum conservation using external forces, momentum equation, momentum for steady state and uniform flow, unsteady state and uniform flow.
• Design a water pump station to specifics guided by needs in community.	• Design and detail a water pump using limit state method including pump machinery requirements. • Apply knowledge in wiring to electrical systems of a water pump. • Assess wastewater system maintenance including sewage systems. • Assess water and wastewater treatment process and systems involved.
• Apply basic concepts of solid mechanics in particular stress, strain and stability.	• Explain the different types of forces and the reaction of solids to external force. • Calculate the reaction of solid bodies when subjected to external forces • Draw shear-force diagrams and bending moment diagrams. • Compute geometrical properties of sections by drawing by calculating moment of inertia • Apply and calculate normal stresses in pipes of different materials, and plastic bending of pipes. •
• Apply contract law and dispute resolution.	• Assess and interpret employment contracts in a construction project. • Spearhead dispute resolutions on site. • Demonstrate all steps involved through arbitration and due process in a construction project.
• Illustrate proficiency in apprentice skills of plumbing and pipe fitting.	• Install taps and fit valves. • Cut and bend GS pipes to required or proper specifications. • Join and assemble GS pipes, PVC and Polyethylene (PEH)pipes and fittings. • Join and fit PVC ND PEH and Cast-iron fittings/concrete pipes • Service connections and design sewer connections. • Construct valve chambers.
• Demonstrate advanced knowledge on the use of	• Draw basic diagrams using auto cad draw and modifying commands

computers in graphic design and have understanding on how to create and edit 2-dimensional drawings as well on how to create and edit 3-dimensional drawings.	• Apply and use database information for objects in order to modify, store, manipulate and detailing. • Work with line type styles, modify and manipulate line sizes.
• Asses the design of foundation for pump house and dranage systems.	• Design and detailing of Pump House foundations using limit state method. • Asses the treatment and contamination implications of the foundations. • Assess ground improvement techniques.
• Identify sources of pollution and how they can be mitigated.	• Assess all environmental risk considerations in a construction project. • Apply knowledge in sources of water pollution and water pollution control under country's legislation • Demonstrate knowledge in sources of air pollution and air pollution control under country's legislation •
• Design artificial water bodies applying limit state method for RCC structures.	• Design of simple hydraulic structures. • Assess the effects of horizontal forces including and not limited to wind pressure, liquid pressure, soil pressure and abnormal forces. • Critically analyze structural stability taking into account all possible modes of failure. • Design of prestressed structures using limit state method.
• Demonstrate knowledge by setting up and running a business/practice based or related to water engineering.	• Demonstrate through knowledge in set up a construction company or firm. • Demonstrate through knowledge in all the preliminary processes required when setting up business. • Assess and interpret different grades of construction and civil engineering projects. • Manage a business small scale construction company.

• Prepare tender documents for Water Engineering project.	• Take off quantities using dimension under standard unit of measurement. • Draw up a qualified bill of quantities using dimension paper. • Draw up an estimation of expected costs in a project. • Produce a pre-tender programme for use by the Estimating Department. • Reviewing technical submissions.
• Demonstrate knowledge in designing water construction projects manually by studying project concept, architectural drawings, and models	• Design all structural elements using limit state method not limited to timber, RCC, structural steel. • Interpret structural designs. • Produce bending schedule for steel design.
• Provide sound technical advice to all stakeholders.	• Liaise with various agencies and individuals, including local authorities, government agencies, clients, contractors, residents, suppliers, technical experts, and consultants. • Use project management skills to resolve technical conflicts in civil or construction project. • Organize coordination meetings for construction project. • Organize site meetings with all key stakeholders. • Produce detailed project program with constant updates. • Control of budgets at the project level ensuring that work is completed to a deadline. • Supervise the operation and maintenance of water and sewage infrastructure. • Maintain and expanding clientele, by developing professional relationships that lead to secure repeat business.

QUALIFICATION STRUCTURE: SECTION C			
FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	**Title**	**Level**	**Credits**
	Computer Fundamentals	5	8
	Technical Communication	5	6
	Occupational Health and Safety	5	6
	Environmental Biology	5	12
	Applied Physics	5	12
	Mathematics I	5	15
	Technical Drawing	5	8
	Environmental Chemistry	5	12
CORE COMPONENT Subjects / Units / Modules /Courses	CAD for Civil Engineering	6	10
	Mathematics II	6	15
	Water Engineering I	5	12
	Construction materials and Building Construction	6	8
	Introduction to Land Surveying	6	12
	Mathematics III	6	15
	Fluid Mechanics	6	12
	Surface Hydrology	6	12
	Workshop Practice and Technology I	6	12
	Computer Applications in Civil Engineering	6	10
	Mechanics of Materials and Theory of Structures	6	12
	Pipeline and network Construction	6	12
	Water Engineering II	6	12
	Water systems Management	6	12
	Water Analysis	6	10
	Water Pumping	6	12
	Hydraulics	6	12
	Professional Practices and Ethics	6	6
	Water Harvesting Technologies and Conservation	6	12
	Final Year Project	6	20
	Workshop Practice and Technology II	6	12
	Supervised Industrial Attachment	6	40
	Choose 1		

ELECTIVE COMPONENT Subjects / Units / Modules /Courses	Entrepreneurship	6	6
	Construction Management	6	6
Rules of combinations, Credit distribution			
FUNDAMENTAL COMPONENT – 79 credits **CORE COMPONENT –** 290 credits **ELECTIVE COMPONENT –** 6 credits (learners choose to electives) **Total - 375 credits**			

ASSESSMENT AND MODERATION ARRANGEMENTS

Assessment Arrangements

Assessment shall be conducted by BQA accredited assessors.

The assessment for this qualification shall comprise of both formative and summary assessments weighted according to institutional guidelines and policies. Both formative and summative assessment processes are accounted for to monitor progress during the qualification and to determine competence of the learners at the end of the qualification.

The formative assessment shall consist of contribute 60%.

Summative assessment shall make up the remaining 40%.

Moderation Arrangements

Moderation shall be conducted by BQA accredited moderators.

RECOGNITION OF PRIOR LEARNING

There will be provision of RPL for award of the qualification using ETP RPL Policy in line with the National RPL Policy.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

LEARNING PATHWAYS

Vertically, learners may articulate to;

- Bachelor of Engineering in Building and Construction Engineering
- Bachelor of Civil Engineering Technology in Construction
- Bachelor of Architectural Sciences

Horizontally to:

- Diploma in Civil Engineering
- Diploma in Building and Construction Engineering
- Diploma in Structural Planning

EMPLOYMENT PATHWAYS

Upon successful completion of diploma in construction the graduate can be absorbed in the following disciplines at entry level

- Site Engineer
- Resident Engineer
- Principal Agent
- Estimator
- Site Agent
- Road Engineer
- Facilities Manger
- Geotechnical Engineer
- Materials Testing Engineer
- Water Engineer
- Environmental Engineer

QUALIFICATION AWARD AND CERTIFICATION

Upon successful completion the candidate will be awarded a qualification of Diploma in Water Engineering, (NCQF Level 6). A candidate is considered successful when they have achieved the stipulated 375 credits. The graduate will be issued a transcript and a certificate.

REGIONAL AND INTERNATIONAL COMPARABILITY

The proposed qualification has been benchmarked against only two identified similar qualifications regionally and internationally. Most were either short courses or higher qualifications and others were drifting away from the core subfield of water engineering.

The benchmarking was looking at title of the qualification, entry requirements, credits allocation, NQF level at country of origin and either exit level outcomes or modules. The table below shows how the proposed qualification compares to the one benchmarked against.

Diploma in Water Engineering - Kyambogo University (Uganda)

The NQF level of this qualification is not indicated. Credit value is 90 whereas of the proposed qualification is 375. Minimum entry requirement is Advanced Level Examination which is equated to NCQF Level 5 and

minimum entry requirements for the proposed qualification is NCQF Level 4. The qualification module structure is equally the same with that of the proposed qualification; from generic skills to core modules:

- Introduction to Computer Science
- Engineering Mathematics I
- Sanitation and Drainage
- Fluid Mechanics
- Introduction to Engineering Surveying
- Engineering Drawing
- Communication Skills and Humanities
- Industrial Training I
- Engineering Mathematics II
- Engineering Surveying
- Engineering Mechanics
- Construction Materials
- Electricity and Thermodynamics
- Advanced Calculus and Probability Theory
- Hydraulics and Hydrology
- Engineering Construction
- Principles of Measurement of Water Works
- Strength of Materials
- The Construction Profession and Society
- Entrepreneurship Skills
- Industrial Training II
- Water Supply
- Hydraulic Structures/Equipment
- Measurement of Water Engineering Works
- Community Project Implementation Workshop Practice
- Elementary Design of Structures
- Site Administration

Water Engineering Technology - Okanagan College (British Columbia-Canada)

The NQF level and credits are not stated. Minimum entry requirement is B.C. secondary school graduation or equivalent. The core modules include hydrology, hydraulics, water quality, biology and chemistry, Technical Writing & Communications, Mathematics for Water Engineering Technology, Surveying which are similar to those of the proposed qualification. The qualification also has capstone work project which is similar to internship or industrial attachment. This qualification also has specialization options which the proposed qualification does not have.

Therefore, the proposed qualification compares favourably to this similar qualification regionally.

REVIEW PERIOD

The qualification will be reviewed every 5 years.