



Professional Engineers
and Geoscientists of BC

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2004 ENVIRONMENTAL ENGINEERING SYLLABUS

and

Checklist for Self-Evaluation

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INTRODUCTION

Nineteen engineering disciplines are included in the Examination Syllabi issued by the Canadian Engineering Qualifications Board (CEQB) of the Canadian Council of Professional Engineers (CCPE).

Each discipline examination syllabus is divided into two examination categories, compulsory and elective. A full set of Environmental Engineering examinations consists of nine, three-hour examination papers. Candidates will be assigned examinations based on an assessment of their academic background. Examinations from discipline syllabi other than those specific to the candidate's discipline may be assigned at the discretion of the constituent Association/Ordre.

Before writing the discipline examinations, candidates must have passed, or have been exempted from, the Basic Studies Examinations.

The constituent Association/Ordre will supply information on examination scheduling, textbooks, materials provided or required, and whether the examinations are open or closed book.

NOTE TO CANDIDATES: THE LISTED TEXTBOOKS BELOW ARE ONLY SUGGESTED READING. THE LIST DOES NOT DEFINE OR LIMIT THE SYLLABUS.

**The Association of
Professional Engineers and Geoscientists
of British Columbia**

2004 ENVIRONMENTAL
ENGINEERING SYLLABUS
Checklist for Self-Evaluation

Candidate Name: _____ ID# _____

Exam Number and Name	Applicant's Self-Evaluation – Course Equivalent	For Office Use Only
Basic Studies (6 Required)		
04-BS-1 – Mathematics		
04-BS-2 – Probability & Statistics		
04-BS-7 – Mechanics of Fluids		
04-BS-12 – Organic Chemistry		
04-BS-13 – Biology		
04-BS-14 - Geology		
Basic Studies (2 Required)		
04-BS-3 – Statics and Dynamics		
04-BS-4 – Electric Circuits and Power		
04-BS-5 – Advanced Mathematics		
04-BS-6 – Mechanics of Materials		
04-BS-10 – Thermodynamics		
04-BS-11 – Properties of Materials		
04-BS-15 – Engineering Graphics and Design Process		
Group A (6 required)		
04-Env-A1 – Principles of Environmental Engineering		
04-Env-A2 – Hydrology and Municipal Hydraulics Engineering		
04-Env-A3 – Geotechnical & Hydrogeological Engineering		
04-Env-A4 – Water & Wastewater Engineering		
04-Env-A5 – Air Quality & Pollution Control Engineering		

04-Env-A6 – Solid Waste Engineering & Management		
Group B (3 Required)		
04-Env-B1 – Environmental Assessment & Management Systems		
04-Env-B2 – Water Resources		
04-Env-B3 – Contaminant Transport		
04-Env-B4 – Site Assessment & Remediation		
04-Env-B5 – Industrial & Hazardous Waste Management		
04-Env-B6 – Agricultural Waste Management		
04-Env-B7 – Environmental Sampling & Analysis		
04-Env-B8 – Instrumentation & Process Control		
04-Env-B9 – Environmental Chemistry & Microbiology		
Complementary Studies		
98-CS-1 – Engineering Economics		
98-CS-2 – Engineering in Society – Health, Safety, and the Environment		
98-CS-3 – Management Concepts for Engineers		

ENVIRONMENTAL ENGINEERING

GROUP A

COMPULSORY EXAMINATIONS (SIX REQUIRED)

04-Env-A1 Principles of Environmental Engineering

Population, economic growth, industrialization, urbanization and energy-use, as causes of environmental pollution. Mass and energy balance for environmental engineering systems under steady state and unsteady state conditions. Physical and transport properties of homogeneous and heterogeneous mixtures. Contaminant partitioning and transport in air, water and solids. Characteristics of particles, chemistry of solutions and gases, material balances, reaction kinetics, microbiology and ecology, as related to the environment. Application of environmental principles (technical and non-technical) to: water resource management, water and wastewater treatment, air pollution control, solid waste management, environmental impact assessment, and environmental ethics. Thermal pollution, noise pollution, greenhouse effect, acid precipitation, ozone depletion, air toxics, and ground-level ozone and fine particulates (photochemical smog). Sustainable development, life cycle analysis, and principles of environmental quality objectives, standards and guidelines.

Suggested Text:

Kiely, G., Environmental Engineering. McGraw Hill, 1996. ISBN: 007091272

04-Env-A2 Hydrology and Municipal Hydraulics Engineering

Components and processes of natural hydrologic systems. Precipitation and snow melt, runoff, infiltration, storm frequency and duration analysis, conceptual models of runoff, stream flow and hydrograph analysis, frequency and probability with application to precipitation, floods and droughts; evaporation and evapotranspiration. Hydraulics of closed pipe systems and open channel flow including flow under uniform and gradually varied conditions, sediment transport. Water distribution systems, storage reservoirs and wastewater collection systems, pipe networks and network design, sanitary sewer and storm water collection system design, basic pumps/prime movers, urban drainage and runoff control.

Suggested Texts:

Wanielista, M., Kersten, R., and R. Eaglin.. Hydrology: Water Quantity and Quality Control. Wiley Interscience, 1996. ISBN: 0471072591

Zipparro, V.J., Davis' Handbook of Applied Hydraulics Fourth Edition. McGraw Hill, 1993. ISBN: 0070730024

Franzini, J., Freyberg, D., Linsley, R., and G. Tchobanoglous, Water Resources Engineering. McGraw Hill, 1991. ISBN: 0070380104

04-Env-A3 Geotechnical and Hydrogeological Engineering

Soil composition, properties, identification and classification. Particle size distribution. Seepage and permeability. Concepts of pore water pressure and effective stress. Compressibility. Capillary pressure and hydraulic head. Principles of effective stress, stress-deformation and strength characteristics of soils, consolidation, compaction, slope stability, infiltration, stress distribution with soils and settlements.

Fundamental physics and properties of groundwater flow in porous geologic material; anisotropy, heterogeneity. Introduction to the theory of groundwater flow; groundwater flow equations and patterns, recharge and discharge, flow nets, aquifer pumping, two-phase flow, well hydraulics and non-aqueous phase liquids. Numerical modeling concepts. Aquifer development and management. Wellhead protection.

Suggested Texts:

Cernica, J.N., Geotechnical Engineering: Soil Mechanics. Wiley Interscience, 1995. ISBN: 0471308846

Fredlund, D.G. and H. Rahardjo., Soil Mechanics for Unsaturated Soils. Wiley Interscience, 1993. ISBN: 047185008X

Spitz, K. and J. Moreno., A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience, 1996. ISBN: 0471136875

LaMoreaux, P.E., and LaMoreaux, J.W., Environmental Hydrogeology. Lewis Publishers, 1997. ISBN: 0873719492

04-Env-A4 Water and Wastewater Engineering

Characteristics of water: physical, chemical and biological parameters, standard methods of water analyses, biodegradable waste and agricultural runoff in streams, population forecasting, prediction of water demand and wastewater generation, water and wastewater quality, water and wastewater treatment plants and systems: physical, chemical and biological systems, primary, secondary and tertiary treatment, sedimentation, coagulation, flocculation, filtration, adsorption, ammonia removal, aeration, anaerobic and aerobic digestion, activated sludge and trickling filter, ion exchange, lagoons, disinfection, natural treatment systems, sludge treatment and disposal, industrial wastewater treatment: characteristics of industrial wastewater, treatment levels and available technologies.

Suggested Texts:

Casey, T.J., Unit Processes in Water and Wastewater Engineering. Wiley Interscience, 1997. ISBN: 0471966932

Weber, W.J. and DiGiano, F.A. Process Dynamics in Environmental Systems. Wiley Interscience. ISBN: 0471017116

McCarty, P., and Rittmann, B., Environmental Biotechnology: Principles and Applications. McGraw Hill, 2000. ISBN: 0072345535

Metcalf & Eddy, Inc., Wastewater Engineering: Collection and Pumping of Wastewater. McGraw-Hill, 1981. ISBN: 007041680X

Burton, F., Metcalf and Eddy Inc, Tchobanoglous, G., Wastewater Engineering: Treatment, Disposal and Reuse. McGraw Hill, 1991. ISBN: 0070416907

Reed, S.C. and Crites, R.W., Natural Systems for Waste Management and Treatment. McGraw Hill, 1996. ISBN: 0071346627

Eckenfelder, W.W. (Jr.), Industrial Water Pollution Control, (2nd Ed). McGraw-Hill, 1989. ISBN: 007018903X.

Guyer, H.H., Industrial Processes and Waste Stream Management. Wiley Interscience, 1998. ISBN: 0471299847.

Bishop, P., Pollution Prevention: Fundamentals and Practice. McGraw Hill, 2000. ISBN: 0073661473

American Water Works Association, Water Treatment Plant Design, (3rd Ed.). McGraw-Hill, 1997. ISBN: 0070016437.

American Water Works Association, Water Quality and Treatment: A Handbook of Community Water Supplies. McGraw Hill, 1998. ISBN: 0070015406

Kawamura, S., Integrated Design and Operation of Water Treatment Facilities. Wiley and Sons, 2000. ISBN: 0471350931

Nyer, E.K., Groundwater Treatment Technology, (2nd Ed.). Wiley Interscience, 1992. ISBN: 0471284149.

04-Env-A5 Air Quality and Pollution Control Engineering

Sources and classification of atmospheric pollutants, indoor and outdoor air pollutants, health and ecological impacts, meteorology: influence of solar radiation and wind fields, lapse rate and stability conditions, characteristics of stack plumes, Dispersion and deposition modeling of atmospheric pollutants: Eddy and Gaussian diffusion models, Puff models, effective stack heights and spatial concentration distributions, Measurement techniques. Characteristics of various air pollutant particulates, health and nuisance/aesthetic considerations (PM_{2.5} and PM₁₀) and gaseous pollutants (CO, SO_x, NO_x, etc.), their behaviour in the atmosphere, monitoring., Control of particulates: collection mechanisms and efficiencies. Control of gases and vapours: adsorption, absorption, combustion, incineration. Control of sulphur oxides and oxides of nitrogen, desulphurisation, kinetics of NO_x formation. Photochemical reactions, role of nitrogen and hydrocarbons in photochemical reactions, air toxics, mobile sources of air pollutants, noxious pollutants, and odour control. Emissions trading.

Suggested Texts:

Alley, E.R, Stevens, L.B., and Cleland, W. L., Air Quality Control Handbook. McGraw-Hill, 1998. ISBN: 0-07-001411-6.

Buonicore, A.J. (ed) and W.T. Davis (ed), Air Pollution Engineering Manual. Air & Waste Management Association. Wiley-Interscience, 1992. ISBN: 0-471-28441-6.

04-Env-A6 Solid Waste Engineering and Management

Engineering design and operational aspects of waste generation, collection, storage, transfer, processing, including composting of organic waste, treatment and disposal. Engineering evaluation of: integrated waste management, solid waste characterization and classification, reduction, reuse and recycling, resource recovery and utilization. Life cycle assessment of waste, physical and chemical treatment methods and composting. Landfill design and operation including: site selection, engineered sites, liners and covers, leachate control and treatment, gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation.

Suggested Texts:

Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience, 1994. ISBN: 0-471-30681-9.

Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.

GROUP B

ELECTIVE EXAMINATIONS (THREE REQUIRED)

04-Env-B1 Environmental Assessment and Management Systems

Applicable federal and provincial environmental regulations. Analysis of environmental impact using technical and non-technical parameters. Environmental impact assessment legislation and regulatory framework. Environmental impact assessment applied to solid and liquid waste management, effluent control, air pollution control, urban development, and transportation systems. Environmental audits. Introduction to geographical information systems (GIS). Environmental management systems (EMS) ISO 14000/14001 standards, and applications. Principles of sustainable development and implications of finite biosphere and complexities for engineering design and decision-making. Design of controlled environments to enhance health and protection of natural resources for sustainable development. Resource problems and design with ecological, economic, demographic and social dimensions. Techniques to integrate knowledge and define policy. Risk analysis. Life cycle analysis. Risk management.

Suggested Texts:

Canter, L., Environmental Impact Assessment. McGraw Hill, 1996. ISBN: 0070097674
Bartell, S., Kolluru, R., Pitblado, R., and Stricoff, S., Risk Assessment and Management

Hanbook: For Environmental, Health and Safety Professionals. McGraw Hill, 1996.
ISBN: 0070359873

Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN:
0071372660

McGraw, D., Environmental Auditing and Compliance Manual. Wiley Interscience, 1993.
ISBN: 0471285854

Woodside, G. Yturri, J. and Aurricho, P., ISO 14001 Implementation Manual. McGraw
Hill, 1998. ISBN: 0070718520

Curran, M., Environmental Life-Cycle Assessment. McGraw Hill, 1996. ISBN:
007015063X

Dorf, R.C., Technology, Humans and Society: Toward a Sustainable World. Academic
Press, 2001. ISBN: 0122210905

Pearce, D. and Barbier, E., Blueprint for a Sustainable Economy. Earthscan
Publications, 2000. ISBN: 1853835153

04-Env-B2 Water Resources

Nature and response of waste inputs to water systems, point and non-point source loading rates. River flow and reservoir analysis. Availability of groundwater resources. Diffusion, dispersion and pollutant transport mechanisms, including two phase flow.

Eutrophication reduction in natural water systems. Contaminant decay modeling. Oxygen sag equation and modifications, water quality and contaminant transport in rivers. Functions of watershed models for hydraulic design, environmental assessment and flood warning. Global and national water problems, laws and legislation. Water resources and sustainable development. Technology and impacts of water conservation practices and policies on municipal service infrastructure. Storm water models and management systems.

Suggested Texts:

Mays, L., Water Resources Handbook. McGraw Hill, 1996. ISBN: 0070411506

Biswas, A., Water Resources: Environmental Planning, Management, and Development, McGraw Hill, 1997. ISBN 0070054835

Ward, R.C., Loftis, J.C. and McBride, G.B., Design of Water Quality Monitoring Systems. Wiley Interscience, 1990. ISBN: 0471283886

Veissman, W. and Hammer, M., Water Supply and Pollution Control (6th Ed.) Addison Wesley, 1998. ISBN: 032101460X

04-Env-B3 Contaminant Transport

Major types of contaminants in air, surface water and ground water. Physical phenomena governing the transport of contaminants in different environments: advection, dispersion, diffusion, sorption, ion exchange, precipitation, dissolution, volatilization, equilibrium partitioning of contaminants amongst air, water, soil, sediments and biota. Development of governing transport equations, initial and boundary conditions, completely mixed and plug flow systems. Analytical and numerical solutions, model development, calibration, verification, sensitivity analysis, prediction and post audit.

Suggested Texts:

Fetter, C.W., Contaminant Hydrogeology. 2nd Ed., Prentice Hall, 1998.

Schnoor, J.L., Environmental Modeling: Fate of Chemicals in Water, Air and Soil. John Wiley & Sons, New York, 1996

Wark, K., C.F. Warner and W.T. Davis, Air Pollution: Its Origin and Control. Addison and Wesley, 1998.

Zheng, C. and G. D. Bennett, Applied Contaminant Transport Modeling, Theory and Practice. Van Nostrand Reinhold, New York, 1995.

04-Env-B4 Site Assessment and Remediation

Introduction to engineering, regulatory and management aspects of site assessments and restoration. Fundamentals and interactions between soils, groundwater, contaminants, and microorganisms. Site characterization and investigations. Monitoring and sampling strategies and techniques. Remedial action screening. Engineered solutions for site remediation including: physical, chemical, biological and in-situ and ex-

situ techniques. Risk assessment. Brownfields. Computer modeling for assessment and remediation.

Suggested Texts:

Ewels, J., Bioremediation Principles. McGraw Hill, 1998. ISBN: 0070577323

Lerch, I. And Paleologos, E., Environmental Risk Analysis. McGraw Hill, 2001. ISBN: 0071372660

Spitz, K. and Moreno, J., A Practical Guide to Groundwater and Solute Transport Modeling. Wiley Interscience, 1996. ISBN: 0471136875

Cookson, J.T., Jr., Bioremediation Engineering - Design and Application. McGraw-Hill, New York, NY, 1995.

Ott, W., Environmental Statistics and Data Analysis. Lewis Publishers, 1994. ISBN: 0873718488

04-Env-B5 Industrial & Hazardous Waste Management

Definition and characteristics of industrial and hazardous wastes. Industrial and hazardous waste generation rates and prevention. Introduction to I&H waste collection, transportation, treatment, monitoring, and disposal. Applicable international, federal and provincial regulations and initiatives. Municipal services and planning associated with industrial and hazardous waste management. Physical, chemical and biochemical treatment technologies, and disposal methods, including landfilling and incineration. Environmental impact of industrial and hazardous waste management. Radioactive, nuclear and biomedical waste.

Suggested Texts:

Freeman, H.M., and Harris, E.F., Hazardous Waste Remediation – Innovative Treatment Technologies. Technomic Publishers Lancaster P.A., 1995.

Bagchi, A., Design, Construction, and Monitoring of Landfills, (2nd Ed). Wiley Interscience 1994. ISBN: 0-471-30681-9.

Sharma, H.D., and Lewis, S.P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation. Wiley Interscience, 1994. ISBN: 0471575364.

Bellandi, R. (ed), Hazardous Waste Site Remediation: The Engineer's Perspective. Wiley Interscience, 1995. ISBN: 0471286931.

04-Env-B6 Agricultural Waste Management

Agricultural sources of pollution (pesticides, commercial fertilizer, on-farm food processing wastes and animal manure) and their effect on the total environment. Physical, chemical and biological properties of agricultural waste materials. Design of storage and pumping systems for manure holding facilities. Physical, chemical and biological treatment processes of agricultural wastes in relation to pollution control and

waste utilization. Various methods of land application of agricultural wastes in relation to pollution problems and fertilizing value. Technologies for utilization of agricultural wastes for biogas production and animal feed. Air pollution and greenhouse gas emissions control. Water quality parameters and lake and river water quality management.

Suggested Text:

Unger, P.W., Managing Agricultural Residues. Lewis Pub., 1994. ISBN: 0-873-71730-9.

04-Env-B7 Environmental Sampling And Analysis

Practical and essential principles of water, soil and air sampling. Basic concepts in quantitative analyses of physical, chemical, and biological parameters. Tolerable levels of contaminants in air, water and soil. Sampling, sample preparation and preservation techniques, and quality assurance and quality control. Development of optimum monitoring strategy, scheduling, and sampling frequency. Database management, data analysis, statistical treatment of data, sources of error, and seasonal effects. Instrumental methods of analysis for organic and inorganic contaminants in air, water, and soil: colorimetry, chromatography, spectroscopy, electrochemical probes, remote sensing and bioassays. Basic concepts of resolution, accuracy, precision, sensitivity, calibration and control of error. Laboratory certification and standardization.

Suggested Texts:

Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada. Canadian Council of Ministers of the Environment The National Contaminated Sites Remediation Program March 1996.

Shugar, G.L., S.L. Bauman, D.A. Drum and J. Lauber, Environmental Field Testing and Analysis Ready Reference Handbook.

Montgomery, D C, Design and Analysis of Experiments. (5th Ed.), Wiley, New York, 2000.

04-Env-B8 Instrumentation and Process Control

Basic concepts of resolution, accuracy, precision, sensitivity, calibration and control of error. Analysis and interpretation of data. Transducers for the sensing of strain, displacement, velocity, acceleration, pressure, flow, temperature, humidity, moisture content, and electromagnetic radiation. Signal conditioning for noise reduction and control. Operational amplifiers. Systems for data acquisition, telemetry, display, recording and processing. Computer interfacing. Concept of transfer functions. Response of simple chemical processes to step, ramp, and sinusoidal inputs. Transient response of interacting elements in series. Frequency response analysis of simple systems. On-off control, proportional, integral, derivative, and combinations of these control actions. Feed-back and feed-forward control. Controller tuning and algorithms. Simple stability analysis. Dynamics and control of common chemical process units.

Suggested Text:

Nachtigal, C.L., Instrumentation and Control - Fundamentals and Applications. John Wiley & Sons, Inc., NY, 1990.

04-Env-B9 Environmental Chemistry and Microbiology

Chemistry of organic and inorganic contaminants in the environment. Natural chemical cycles in the biosphere, geosphere, hydrosphere and atmosphere, and consequences of anthropogenic disturbances. Chemical equilibrium and kinetics. Fundamentals of aquatic, atmospheric and soil chemistry. The fate of hazardous, refractory and heavy metal pollutants in the environment. Introduction to microbial taxonomy, ecology and growth kinetics of microorganisms. The microbes of public health importance in water, soil and air, including their detection, occurrence, transport, and survival in the environment. Introduction to the application of different processes to remove contaminants in natural and engineered systems.

Suggested Texts:

McCarty, P., Parker G. and C. Sawyer, Chemistry for Environmental Engineering. McGraw Hill, 1994. ISBN: 0070549788

Connell, D.W., Basic Concepts of Environmental Chemistry. Lewis Publishers, 1997. ISBN: 0873719980

Evangelou, V.P. Environmental Soil and Water Chemistry: Principles and Application. Wiley Interscience, 1998. ISBN: 0471165158

Maier, R.M., Pepper, I. and Gerba, C. Environmental Microbiology. Academic Press, 2000. ISBN: 012497570-4