SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE TITLE: ENVIRONMENTAL ANALYSIS (OUTLINE & LAB MANUAL)

CODE NO.: FOR 364-6 SEMESTER: V

PROGRAM: FISH AND WILDLIFE TECHNOLOGY

AUTHOR: VALERIE WALKER

DATE: JANUARY 1994 PREVIOUS OUTLINE DATED: JANUARY 1993

APPROVED: _____ Nov 19/93
DEAN DATE

ENVIRONMENTAL ANALYSIS — FOR364-6

COURSE NAME — COURSE NUMBER

I. PHILOSOPHY/GOALS:

This lab-based course provides the measurement and analysis of various parameters within the environment as well as a discussion of their significance. Topics include instrument operation, calibration and standardization and proper laboratory techniques. Labs will examine primary production, oxygen consumption in aquatic systems, response of organisms to a toxicant (bioassay) and the buffering capacity of lakes as related to acid precipitation. Outdoor Labs will examine temperature and oxygen stratification of lakes in winter, the effect of ice on lake productivity and snow density and snow type and its impact on wildlife . In addition, organic molecules of importance as related to the nutritional requirements of wildlife, will be studied with a practical application to bomb calorimetry.

II. STUDENT PERFORMANCE OBJECTIVES:

Upon successful completion of this course the student will be able to:

1. Discuss the physical, biological and ecological relationships in lentic versus lotic environments.
2. Describe those factors affecting oxygen consumption and production in aquatic systems.
3. Define pollution and discuss the categories of contamination.
4. Outline the procedure for setting up a bioassay and discuss the determination of LC50's, ET50's and toxicity curves.
5. Demonstrate the use and standardization of pH and oxygen meters.
6. Conduct an accurate titration for total inflection point alkalinity and dissolved oxygen.
7. Demonstrate the use of a snow gauge and correct documentation of results.
8. Discuss the physics of snow and its impact on wildlife.
9. List and discuss the essential nutrients required in wildlife nutrition and determine the caloric value of food items through bomb calorimetry.

1-3 Unit I: Freshwater Systems

- lotic and lentic environments
- food chains and food transfer effects
- recycling
- seasonal production cycles
- factors affecting primary productivity
- stability of ecosystems

2 **Lab 2 Temperature and Oxygen Consumption in Aquatic Animals**

4 Unit II: Oxygen Consumption in Aquatic Animals

- factors affecting oxygen consumption
- oxygen as a limiting factor

4 **Lab 3 Total Inflection Point Alkalinity**

5 **TERM TEST #1**

5,6,7 Unit III: Winter Surveys

- inverse stratification of lakes
- ice formation and its effect on light, production, oxygen
- snow compaction, chillometer
- physics of snow

8 **Lab 4 Winter Survey/Snow Study**

ENVIRONMENTAL ANALYSIS — FOR364-6
COURSE NAME — COURSE NUMBER

III. TOPICS TO BE COVERED: CONTINUED

9,10 Unit IV: Aquatic Pollutants

- definition of pollution
- categories of contamination
- acidification (SPEAKER)
- toxicity terminology
- environmental factors affecting toxicity
- biomagnification
- bioassays
- (Videos - H_2 Overview, Early Warning)

11 **Lab 5 Bioassay**

11 - (Speaker: Sea Lamprey)

12 Unit V: Organic Molecules in Wildlife Nutrition

- required nutrients:
  - water
  - protein
  - carbohydrates
  - lipids
- energy metabolism
- macrominerals
- micro (trace) minerals

12 **Lab 6 (a) Bomb Calorimetry - Sample Preparation**

13 **LAB 6 (b) Bomb Calorimetry - Bombing**

14 **TERM TEST #2**

N.B. SCHEDULE SUBJECT TO CHANGE

ENVIRONMENTAL ANALYSIS	FOR364-6
COURSE NAME	COURSE NUMBER

IV. EVALUATION METHOD:

A - 80%
B - 70%
C - 60%
R - less than 60%

Lab Reports	- 50%
Term Tests (2)	- 50%
	100%

Due to the practical nature of this course and the emphasis on laboratory technique and data interpretation, there will be no opportunity for a "rewrite".

Students with a final grade of less than 60% will receive an "R" grade. All labs must be submitted for a passing grade.

Lab attendance is **compulsory**. Students missing labs without documented reason run the risk of repeating the course.

V. REQUIRED STUDENT RESOURCES:

TEXTBOOK(S):

No textbook required for purchase. Lab manual is available at Campus Bookstore.

EQUIPMENT:

- lab coat
- safety glasses

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

VI. ADDITIONAL RESOURCE MATERIAL AVAILABLE IN THE COLLEGE LIBRARY:

Adams, S. Marshall (ed.) 1990. Biological Indicators of Stress in Fish. American Fisheries Society Symposium 8. AFS. Bethesda, Maryland QL 639.1B55 1990

Alabaster, J.S. and R. Lloyd. 1982 Water Criteria for Freshwater Fish (2nd Edition). Butterworth's Inc., Yarmouth MA.

*American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1975, Standard Methods for the Examination of Water and Wastewater. 14th ed. Am. Publ. Health Assoc., Washington, D.C.

*American Society for Testing and Materials. 1977. Bacterial Indicators - Health Hazards Associated with Water. ASTM, Phil.

*American Society for Testing and Material. 1977. Aquatic Toxicology and Hazard Evaluation. ASTM, Philadelphia.

*Andrews, W. A. 1972. A Guide to the Study of Environmental Pollution. Prentice-Hall, Inc. Scarborough, Ontario.

Ashworth, W. 1989. The Late, Great Lakes: An Environmental History. Collins Publ., Stockton, California. QH 545.A1 A57 1989

Black, John A. 1977. Water Pollution Technology. Reston Publishing Company, Inc. Virginia.

Brewer, Richard. 1979. Principles of Ecology. Saunders, Philadelphia

Brown, Lester Russell. 1988. State of the Word: A Worldwatch Institution Report on Progress Toward a Sustainable Society. W. W. Norton, New York

Burns, Noel M. 1985. Erie: The Lake that Survived. Rowman & Allanheld Pub., Totowa, N.J.

*Cairns, John Jr. 1982. Biological Monitoring in Water Pollution. Pergamon.

Cairns, V.W., Hodson, Peter V. and Nriagu, J.O. 1984. Contaminant Effects on Fisheries. John Wiley & Sons, New York.

Chant, D. A. 1970. Pollution Probe. New Press, Toronto.

Colborn, Theodora E. 1990. Great Lakes, Great Legacy? Conservation Foundation and Institute for Research on Public Policy in Canada. Halifax, N.S. TD 181.G73 G73 1990

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

VI. ADDITIONAL RESOURCE MATERIAL - 2

Delwiche, C.C. 1981. Denitrification, Nitrification and Atmospheric Nitrous Oxide. Wiley, New York

Edmondson, W. T. (1969). Eutrophication in North America. In - Eutrophication - Causes, Consequences, Correctives. pp. 124-49. National Academy of Sciences, Washington.

Environment Canada 1986. From Cradle to Grave. A Management Approach to Chemicals. Ministry of Supply & Services Ottawa. TD 196.C45T38 1986

Environmental Protection Agency. 198_. Water Quality Criteria. E.P.A. R3-73-033. Washington, D.C.

*Environmental Studies Board. 1983. Committee on Atmospheric Transport and Chemical Transformation in Acid Precipitation. Acid Deposition: Atmospheric Processes in Eastern North America. National Academy Press, Washington, D.C.

Evans, M. S. (ed). 1988. Toxic Contaminants and Ecosystem Health: A Great Lakes Focus. John Wiley and Sons, N.Y. TD180.A38V.21

Freeman, A.M., Robert Haveman and Allen Kneese. 1984. The Economics of Environmental Policy. R.E. Krieger Publishing Co., Inc., Florida

*Goldman, Charles R. and A. J. Horne. 1983. Limnology. McGraw-Hill, Toronto.

*Gordon, Malcolm S. 1982. Animal Physiology: Principles and Adaptations (4th edition). MacMillan Publishing Co., Inc. New York.

Gore, James A. 1985. The Restoration of Rivers and Streams: Theories and Experience. Butterworth Publishing Co., Boston

Hammer, Mark J., 1986. Water and Wastewater Technology. John Wiley and Son Inc., New York.

Heath, Alan G. 1987. Water Pollution and Fish Physiology. CRC Press Inc., Boca Raton, Florida. SH174.H43 1987

*Hoar, W. S. 1983. General and Comparative Physiology (3rd Edition). Prentice-Hall, Inc., New Jersey.

Hoar, W. S., and D.J. Randall, (eds.). 1979. Fish Physiology. Vol.7: Locomotion Academic Press, Inc., London.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

ADDITIONAL RESOURCE MATERIAL - 3

*Hoar, W.S., D.J. Randall and J.R. Brett (eds). 1979. Fish Physiology. Vol.8: Bioenergetics and Growth. Academic Press, Inc., London.

Hocutt, Charles H. and Jay R. Stauffer Jr. (eds). 1980. Biological Monitoring of Fish. Lexington Books, Lexington, Mass.

Huntley, R.V. and R.Z. Rivers (eds). 1986. Proceedings of the Acid Rain Evaluation Seminar. Dept. of Fisheries and Oceans, Ottawa.

*Hynes, H. B. N. 1970. The Ecology of Running Waters. University Toronto Press, Toronto.

_____. 1974. The Biology of Polluted Waters. University Toronto Press, Toronto.

Isom, Billy G., S.D. Dennis, J.M. Bates. 1986. Impact of Acid Rain and Deposition on Aquatic Biological System. ASTM, Philadelphia.

Johnson, Raymond E. 1982. Acid Rain/Fisheries: Proceedings of an International Symposium on Acidic Precipitation and Fishery Impacts in Northeastern North America, Cornell University, Ithaca, New York, August 2-5, 1981. American Fisheries Assoc., Bethesda, Md.

Kimball, John W. 1978. Biology. 4th Ed. Addison-Wesley, Don Mils, Toronto.

*Krenkel, P.A. and Parker, F.L. 1973. Nation Symposium on Thermal Pollution Proceedings: Biological Aspects of Thermal Pollution.

*Larkin, P.A. 1974. Freshwater Pollution Canadian Style. McGill-Queen's University Press, Montreal.

*Laws, Edward A. 1981. Aquatic Pollution - An Introductory Text. John Wiley and Sons, Toronto.

Mason, C. F. 1981. Biology of Freshwater Pollution. Longman.

McKane, L. and Kandel J., 1985. Micro-Biology Essentials and Applications. McGraw-Hill Book Co., Toronto.

*McNeely, R. N., V. P. Neimanis and L. Dwyer. 1979. Water Quality Sourcebook Guide to Water Quality Parameters. Environment Canada, Inland Waters Directorate, Water Quality Branch, Ottawa.

McPhee, John 1989. The Control of Nature. Strauss, Farrar and Giroux, N.Y.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

ADDITIONAL RESOURCE MATERIAL - 4

Minns, Charles Kenneth 1986. Project Quinte: point-source phosphorus control and ecosystem response in the Bay of Quinte, Lake Ontario. Cdn. Special Publicaiton of Fisheries and Aquatic Sciences. Dept. of Fisheries & Oceans, Ottawa TD227.06 P73

Misener, A. D. and G. Daniel (eds.) 1982. Decisions for the Great Lakes. Great Lakes Tomorrow, Hiram, Ohio.

Morgan, James and Werner Stum. 1981. Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibrium in Natural Waters. Wiley, New York

Murty, A.S. 1986. Toxicity of Pesticides to Fish. CRC Press. Bocaratoni, FLA.

*National Research Council of Canada. 1985. TFM and Bayer 73: Lampricides in the Equatic Environment. Pub. No. NRCC 22488, Ottawa.

Owen, O.S. 1985. Natural Resources Conservation - An Ecological Approach. MacMillan, New York

Palmer, C. Mervin. 1980. Algae and Water Pollution. Castle House Publications, Ltd., England.

Pavoni, J.L., 1977. Handbook of Water Quality Management Planning. Van Nostrand Reinhold Co., Litton Educaitonal Publishing Inc., New York.

Pickering, A.D. 1981. Stress and Fish. Academic Press, San Diego, California. QL639.1 S74 1981

Rand, Gary M and Sam, R. 1985. Fundaments of Aquatic Toxicology; Methods and Applications. Hemisphere Publications, Washington.

*Reid, George K. 1961. Ecology of Inland Waters and Estuaries. Van Nostrand Reinhold Co., Toronto.

*Ruttner, F. 1963. Fundamentals of Limnology. University of Toronto Press, Toronto.

Salle, A.J., 1967, Fundamental Principles of Bacteriology. 6th edition, McGraw-Hill Book Co., Toronto.

Schmidtke, N. W. 1986. Toxic Contamination in Large Lakes. World Conference on Large Lakes. Lewis Publishers QH545.W3 W67 1986

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

ADDITIONAL RESOURCE MATERIAL - 5

Shubert, Elliot L. 1984. Algae as Ecological Indicators. Academic Press, San Diego, California. QK 565.A46 1984

*Smith, R. L. 1974. Ecology and Field Biology. Harper and Row Publishers, New York.

*Sprague, J. B. 1973. The ABC's of pollution bioassay using fish. Biological Methods for the Assessment of Water Quality, ASTM STP 528, American Society for Testing and Materials, 1973, pp. 6-30. (Reprint available)

Suffet, Irwin H. 1977. Fate of Pollutants in the Air and Water Environments. Wiley, New York.

Tinsley, Ian J. 1979. Chemical Concepts in Pollution Behaviour. Wiley Interscience, New York.

Tourbier, J. and R. W. Pierson, Jr. (eds.). 1976. Biological Control of Water Pollution. University of Pennsylvania Press, Inc., PA.

Tu, Anthony T. (ed). 1982. Survey of Comtemporary Toxicology, Vol. 2. Wiley, New York.

Vallentyne, J. R. 1974. The Algae Bowl. Lakes and Man. Canada Department of the Environment, Fish and Marine Service, Misc. Spec. Pub. No. 22: 186 pp.

Viessman, W.Jr. and M.J. Hammer. 1985 Water Supply and Pollution Control. Harper and Row, Publishers, New York.

Wagner R. H., 1971. Environment and Man. Norton, New York.

Warren, C. E. 1971. Biology and Water Pollution Control. Saunders, Philadelphia.

Wetzel, Robert G. 1983. Limnology (2nd Edition). Saunders. College Publishing, Toronto.

Wetzel, R. G., and G. E. Likens, 1979. Limnological Analyses. Saunders, Philadelphia.

*Wilber, Charles G. 1969. The Biological Aspects of Water Pollution. Charles C. Thomas. Illinois.

*Worf, D. L. 1980. Biological Monitoring for Environmental Effects. Lexington Books, San Diego, CA

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

Wildlife Aging References

Bagenal, T.B. (ed). 1974. The Aging of Fish. Proceedings of an International Symposium (University of Reading, England, 1973), Unwin Brothers Ltd., Surrey, England

Nielsen, Larry A. and David L. Johnson (eds). 1983. Fisheries Techniques. American Fisheries Society. Southern Printing Co., Inc., Blacksburg, Virginia

Summerfelt, Robert C. and Gordon E. Hall (eds). 1987. Age and Growth of Fish. Iowa State University Press. Ames, Iowa

Weatherley, A. H. and H. S. Gill. 1987. The Biology of Fish Growth. Academic Press. Toronto, Ontario

*ON RESERVE AT THE COLLEGE LIBRARY

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

ACRONYMS

ADI	Acceptable Daily Intake: The dose that is anticipated to be without risk to humans when taken daily. It is not assumed that this dose guarantees absolute safety. The determination of the ADI is often based on the application of laboratory animal toxicity data concerning chronic (long-term) doses to the environmental doses to which humans are exposed.
AOC(s)	Areas of Concern: Geographic locations recognized by the International Joint Commission where water, sediment or fish quality are degraded, and the objectives of the Great Lakes Water Quality Agreement of local environmental standards are not being achieved.
BaP	Benzo-a-pyrene
BAT	Best Available Technology/Treatment
BATEA	Best Available Technology/Treatment Economically Achievable
BCF	Bioconcentration Factor; the ratio of the concentration of a particular substance in an organism to concentration in water.
BCT	Best Conventional Technology/Treatment
BEJ	Best Engineering Judgement
BHC	Benzene Hexachloride or Hexachlorocyclohexane. There are three isomers; alpha, beta, and gamma. Gamma-BHC is the insecticide lindane.
BOD	Biochemical Oxygen Demand: The amount of dissolved oxygen consumed during the decomposition of organic nutrients in water during a controlled period and temperature.
BMP	Best Management Practices
BPAC	Binational Public Advisory Committee
BPJ	Best Professional Judgement
BPT	Best Practical Treatment

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

CANUSLAK	(related to joint spill agreement)
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COA	Canada-Ontario Agreement Respecting Water Quality in the Great Lakes
COD	Chemical Oxygen Demand: The amount of oxygen required to oxidize completely by chemical reagents the oxidizable compounds in an environmental sample.
CofA	Certificate of Approval
CMR	Critical Materials Register
CSO	Combined Sewer Overflow; combined storm and sanitary sewer systems.
CWA	Clean Water Act
DCB	Dichlorobenzene
DDD	A natural breakdown product of DDT.
DDE	Dichlorodiphenyldichloroethylene. A natural breakdown product DDT.
DDT	Dichlorodiphenyltrichloroethane: A widely used, very persistent chlorinated pesticide (now banned from production and use in many countries).
DFO	Department of Fisheries and Oceans (Canada)
DMR	Discharge Monitoring Report
DOA	Department of Agriculture (Canada)
DOE/EC	Department of Environment/Environment Canada

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

EC-50	Effective concentration of a substance producing a defined response in 50% of a test population. The higher the EC-50, the less effective the substance is because it requires more material to elicit the desired response.
EMS	Enforcement Management System
EP	Extraction Procedure
EP/OR	Environmental Protection, Ontario Region, Environment Canada
EPA	United States Environmental Protection Agency
FDA	Food and Drug Administration
GLISP	Great Lakes International Surveillance Plan. It provides monitoring and surveillance guidance to U.S. and Canadian agencies responsible for implementing the provisions of the GlWQA that include general surveillance and research needs as well as monitoring for results of remedial actions.
GLWQA	Great Lakes Water Quality Agreement
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
HCE	Hexachloroethane
HWC	Health and Welfare Canada
IJC	International Joint Commission: A binational organization established in 1909 by the Boundary Waters Treaty. Through the IJC, Canada and the United States cooperatively resolve problems along their common border, including water and air pollution, lake levels, power generation and other issues of mutual concern.
IPP	Industrial Pretreatment Program

LAMP	Lakewide Management Plan
LC_{50}	Lethal concentration (by volume) of a toxicant or effluent which is lethal to 50% of the test organism over a specified time period. The higher the LC_{50}, the less toxic it is because it takes more toxicant to elicit the same response.
LD_{50}	Lethal dose which is lethal to 50% of the test organism over a specified time period. The higher the LD_{50}, the less toxic it is because it takes more toxicant to elicit the same response.
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDNR	Michigan Department of Natural Resources
MDPH	Michigan Department of Public Health
MERA	Michigan Environmental Response Act
MISA	Municipal-Industrial Strategy for Abatement: The principal goal of this program is the virtual elimination of toxics discharged from point sources to surface waters in Ontario.
MGD	Million Gallons Per Day
MSP	Michigan State Police
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System; a permit system limiting municipal and industrial discharges, administered by U.S.EPA and the states.
NPDWR	National Primary Drinking Water Regulation
NPS	Nonpoint Source
NSPS	New Source Performance Standards
NTU	Nephelometric Turbidity Unit

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

OCS	Octachlorostyrene
OMNR	Ontario Ministry of Natural Resources
OMOE	Ontario Ministry of the Environment/Environment Ontario
PAH	Polynuclear Aromatic Hydrocarbons, also known as Polycyclic Aromatic Hydrocarbons or Polyaromatic Hydrocarbons. Aromatic Hydrocarbons composed of at least 2 fused benzene rings, many of which are potential or suspected carcinogens.
PBB	Polybromated biphenyl; used primarily as a fire retardant.
PCB	Polychlorinated biphenyls; a class of persistent organic chemicals with a potential to bioaccumulate and suspected carcinogens; a family of chemically inert compounds, having the properties of low flammability and volatility and high electric insulation quality. Past applications include use as hydraulic fluids, heat exchange and dielectric fluids; plasticizers for plastics.
PEAS	Pollution Emergency Alert System
pH	The negative power to the base 10 of the hydrogen ion concentration. A measure of acidity or alkalinity of water on a scale from 0 to 14; 7 is neutral; low numbers indicate acidic conditions, high numbers, alkaline.
PL	Public Law
POTW	Publicly Owned Treatment Works
PTS	Persistent Toxic Substance: Any toxic substance with a half-life in water of greater than eight weeks.
PWQO	Provincial Water Quality Objectives
QCB	Pentachlorobenzene
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

SDWA	Safe Drinking Water Act
SPCC	Spill Prevention and Control Countermeasure
SPDES	State Pollutant Discharge Elimination System; a state administered permit limiting municipal and industrial dischargers.
STP	Sewage Treatment Plant
TCB	Trichlorobenzene
TCDD	Tetrachlorodiebenzo-p-dioxins
TCDF	Tetrachlorodibenzofurans
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TOTAL DDT	Sum of DDT isomers and metabolites
TTBEL	Treatment Technology-Based Effluent Limitation
UGLCCS	Upper Great Lakes Connecting Channels Study
U.S.EPA	United States Environmental Protection Agency
WHO	World Health Organization
WPCP	Water Pollution Control Plant
WQBEL	Water Quality Based Effluent limits
WQS	Water Quality Standards
WRC	Water Resources Commission
WTP	Water Treatment Plant (for drinking water)
WWTP	Waste Water Treatment Plan

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

TERMINOLOGY

ABSORPTION	Penetration of one substance into the body of another.
ACCLIMATION	Physiological and behavioural adjustments of an organism in response to a change in environment. See also Adaptation.
ACCIMATIZATION	Acclimation of a particular species over several generation in response to marked environmental changes.
ACCUMULATION	Storage and concentration of a chemical in tissue to an amount higher than intake of the chemical. May also apply to the storage and concentration of a chemical in aquatic sediments to levels above those that are present in the water column.
ACUTE	Involving a stimulus severe enough to rapidly induce a response; in bioassay tests, a response observed within 96 hours is typically considered an acute one.
ACUTE TOXICITY	Mortality that is produced within a short period of time, usually 24 to 96 hours.
ADAPTATION	Change in the structure forms or habits of an organism to better fit changed or existing environmental conditions. See also Acclimation.
ADSORPTION	The taking up of one substance at the surface of another.
AEROBIC	The condition associated with the presence of free oxygen in the environment.
ALGA(E)	Simple one celled or many celled micro-organisms, usually free floating, capable of carrying on photosynthesis in aquatic ecosystems.
ALGICIDE	A specific chemical highly toxic to algae. Algicides are often applied to water to control nuisance algal blooms.
ALKALINITY	A measurement of acid neutralization or buffering capability of a solution (See pH).
AMBIENT	Pertaining to the existing/surrounding environment and its components.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

AMBIENT WATER	The water column or surface water as opposed to groundwater or sediments.
AMPULES	A sealed glass container of known concentration of a substance.
ANADROMOUS	Species which migrate from salt water to fresh water to breed.
ANAEROBE	An organism for whose life processes a complete or nearly complete absence of oxygen is essential.
ANOXIA	The absence of oxygen necessary for sustaining most life. In aquatic ecosystems this refers to the absence of dissolved oxygen in water.
ANTAGONISM	Reduction of the effect of one substance because of the introduction or presence of another substance; e.g. one substance may hinder, or counteract, the toxic influence of another. See also Synergism.
APPLICATION FACTOR	A factor applied to a short-term or acute toxicity test to estimate a concentration of waste that would be safe in a receiving water.
AQUATIC	Living in water.
ASSIMILATION	The absorption, transfer and incorporation of substances (e.g. nutrients by and organism or ecosystem)
ASSIMILATIVE CAPACITY	The ability of a waterbody to transform and/or incorporate substance (e.g. nutrients) by the ecosystem, such that the water quality does not degrade below a predetermined level.
BENTHIC	Of or living on or in the bottom of a water body; benthic region, benthos.
BENTHOS	Bottom dwelling organisms, the benthos comprise: 1) sessile animals such as sponges, some the of the worms and many attached algae; 2) creeping forms such as snails and flatworms, and 3) burrowing forms which include most clams and worms, mayflies and midges.
BIOACCUMULATION	Uptake and retention of environmental substances by an organism from both its environment (i.e. directly from the water) and its food.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

BIOASSAY	A determination of the concentration or dose of a given material necessary to affect a test organism under stated conditions.
BIOCONCENTRATION	The ability of an organism to concentrate substances within its body at concentrations greater than in its surrounding environment or food.
BIOCONCENTRATION FACTOR	The ratio of the measured residue within an organism compared to the residue of the substance in the ambient air, water or soil environment of the organism.
BIOLOGICAL MAGNIFICATION	The concentration of a chemical up the food chain.
BIOMASS	Total dry weight of all organisms in a given area or volume.
BIOMONITORING	The use of organisms to test the toxic effects of substances in effluent discharges as well as the chronic toxicity of low level pollutants in the ambient aquatic environment.
BIOTA	Species of all the plants and animals occurring within a certain area or region.
CARCINOGEN	Cancer causing chemicals or substances.
CHIRONOMID	Any of a family of midges that lack piercing mouth parts.
CHRONIC	Involving a stimulus that lingers or continues for a long period of time, often one/tenth of the life span or more.
CHRONIC TOXICITY	Toxicity marked by a long duration, that produces an adverse effect on organisms. The end result of chronic toxicity can be death although the usual effects are sublethal; e.g. inhibits reproduction or growth. These effects are reflected by changes in the productivity and population structure of the community. See also Acute Toxicity.
COMMUNITY	Group of populations of plants and animals in a given place; ecological unit used in a broad sense to include groups of various sizes and degrees of integration.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

CONGENER	A member of the same taxonomic genus as another plant or animal: Also a different configuration or mixture of a specific chemical usually having radical groups attached in numerous potential locations.
CONTAMINANT	A substance foreign to a natural system or present at unnatural concentrations.
CONTAMINATION	The introduction of pathogenic or undesirable micro-organisms, toxic and other deleterious substances which renders potable water, air, soils, or biota unfit for use.
CONTROL ORDER/ REQUIREMENT AND DIRECTION ORDER	Enforceable orders in Ontario.
CONVENTIONAL POLLUTANT	A term which includes nutrients, substances which pollutant consume oxygen upon decomposition, materials which produce an oily sludge deposit, and bacteria. Conventional pollutants include phosphorous, nitrogen, chemical oxygen demand, biochemical oxygen demand, oil and grease, volatile solids, and total and fecal coliform, chlorides, etc.
CRITERIA	Numerical limits of pollutants established to protect specific water uses.
CRITERION, WATER QUALITY	A designated concentration of a constituent based on scientific judgments, that, when not exceeded will protect an organism, a community or organisms, or a prescribed water use with an adequate degree of safety.
CRITICAL LEVEL	See Threshold.
CRITICAL RANGE	In bioassays the range of magnitude of any factor between the maximum level of concentration at which no organisms responds (frequently mortality) to the minimum level or concentration at which all organisms respond under a given set of conditions.
CUMULATIVE	Brought about or increased in strength by successive additions.
CUMULATIVE ACTION	Increasingly severe effects due to either storage or concentration of a substance within the organism.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

DENSITY	Number of individuals in relation to the space.
DETRITUS	A product of disintegration, defecation, destruction, or wearing away.
DIATOM	Any of a class of minute planktonic unicellular or colonial algae with silicified skeletons.
DIOXIN	A group of approximately 75 chemicals of the chlorinated dibenzodioxin family, including 2, 3, 7, 8 - tetrachlorodibenzo-para-dioxin (2, 3, 7, 8 - TCDD) which is generally considered the most toxic form.
DISSOLVED OXYGEN	The amount of oxygen dissolved in water.
DRAINAGE BASIN	A waterway and the land area drained by it.
DREDGE SPOILS	The material removed from the river, lake, or harbor bottom during dredging operations.
DREDGING GUIDELINES	Procedural directions designed to minimize the adverse effects of shoreline and underwater excavation with primary emphasis on the concentrations of toxic materials within the dredge spoils.
ECOSYSTEM	The interacting complex of living organisms and their non-living environment; the biotic community and its abiotic environment.
EFFLUENT	Contaminated waters discharged from facilities to either wastewater sewers or to surface waters.
ENVIRONMENT	All the biotic and abiotic factors that actually affect an individual organism at any point in its life cycle.
EPHEMERAL	A plant that grows, flowers, and dies in a few days.
EPHEMERA	Invertebrates (mayflies) that live as adults only a very short time.
EPILIMNION	The warm, upper layer of water in a lake that occurs during summer stratification.

ENVIRONMENTAL ANALYSIS — FOR364-6

COURSE NAME — COURSE NUMBER

EROSION — The wearing away and transportation of soils, rocks and dissolved minerals from the land surface, shorelines, or river bottom by rainfall, running water, wave and current action.

EUTROPHICATION — The process of nutrient enrichment that causes high productivity and biomass in an aquatic ecosystem. Eutrophication can be a natural process so it can be a cultural process accelerated by an increase of nutrient loading to a waterbody by human activity.

EXOTIC SPECIES — Species that are not native to the Great Lakes and have been intentionally or inadvertently introduced into the system.

FACULTATIVE — Exhibiting a broad life-style which allows it to survive under a broad range of environmental conditions.

FOODCHAIN — The process by which organisms in higher trophic levels gain energy by consuming organisms at lower trophic levels; the dependence for food of organisms upon others in a series, beginning with plants and ending with the largest carnivores.

GOAL — An aim or objective towards which to strive; it may represent an ideal condition that is difficult, if not impossible to attain economically.

GREAT LAKES BASIN ECOSYSTEM — The interacting components of air, land, water and living organisms, including man, within the drainage basin of the St. Lawrence River at or upstream from the point at which this river becomes the international boundary between Canada and the United States (from article 1 of the 1978 GLWQ Agreement).

GREAT LAKES WATER QUALITY AGREEMENT (GLWQA) — A joint agreement between Canada and the United States which commits the two countries to develop and implement a plan to restore and maintain the many desirable uses of the waters in the Great Lakes Basin. Originally signed in 1978, the Agreement was amended in 1987.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

GROUNDWATER — Water entrained and flowing below the surface which may supply water to wells and springs.

GUIDELINES — Any suggestion or rule that guides or directs; i.e. suggested criteria for programs or effluent limitations.

HALF-LIFE — The period of time in which a substance loses half of its active characteristics (used specifically in radiological work); the amount of time required for the concentration of a pollutant to decrease to half of the original value through natural decay or decomposition.

HAZARDOUS SUBSTANCES — Chemicals considered to be a threat to man in the environment, including substances which (individually) or in combination with other substances) can cause death, disease (including cancer), behavioural abnormalities, genetic mutations, physiological malfunctions or physical deformities.

HYDROLOGIC CYCLE — The natural cycle of water on earth, including precipitation as rain and snow, runoff form land, storage in groundwaters, lakes, streams, and oceans, and evaporation and transpiration (from plants) into the atmosphere to complete the cycle.

HYPOLIMNION — The cold, dense, lower layer of water in a lake that occurs during summer stratification.

ICHTHYOLOGY — A branch of zoology that deals with fishes.

INCIPIENT LC_{50} — The level of the toxicant which is lethal for 50% of individuals exposed for periods sufficiently long that acute lethal action has ceased. Synonymous with lethal threshold concentration.

INCIPIENT LETHAL LEVEL — That concentration of a contaminant beyond which an organism could no longer survive for an indefinite period of time.

INSECTICIDE — Substances or a mixture of substances intended to prevent, destroy or repel insects.

LACUSTRINE — Formed in, or growing in lakes.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

LEACHATE	Materials dissolved or suspended in water that percolate through solids such as soils, solid wastes and rock layers.
LETHAL	Involving a stimulus or effect directly causing death.
LIPOPHILIC	Having an affinity for fats or other lipids.
LITTORAL	Productive shallow water zone of lakes, rivers or the seas, with light penetration to the bottom; often occupied by rooted aquatic plants.
LOADINGS	Total mass of pollutant to a water body over a specified time; e.g. tones per year of phosphorus.
MACROPHYTE	A member of the macroscopic plant life (i.e. larger than algae) especially of a body of water.
MACROZOOBENTHOS	The distribution of macrozoobenthos in an aquatic ecosystem is often used as an index of the impacts of contamination on the system.
MALIGNANT	Resistent to treatment, occurring in severe form and frequently fatal.
MASS BALANCE	An approach to evaluating the sources, transport and fate of contaminants entering a water system, as well as their effects on water quality. In a mass balance budget, the amounts of a contaminant entering the system less the amount leaving the system. If inputs exceed outputs, pollutants are accumulating and contaminant levels are rising. Once a mass balance budget has been established for a pollutant of concern, the long-term effects on water quality can be simulated by mathematical modelling and priorities can be set for research and remedial action.
MUTAGEN	Any substance or effect which alters genetic characteristics or produces an inheritable change in the genetic material.
MUTAGENICITY	The ability of a substance to induce a detectable change in genetic material which can be transmitted to progeny, or from one cell generation to another within an individual.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

NONPOINT SOURCE	Source of pollution in which pollutants are discharged over a widespread area or from a number of small inputs rather than from distinct, identifiable sources.
NUTRIENT	A chemical that is an essential raw material for the growth and development of organisms.
ORGANOCHLORINE	Chlorinated hydrocarbon pesticides.
PATHOGEN	A disease causing agent such as bacteria, viruses, and parasites.
PERIPHYTON	Organisms that live attached to underwater surfaces.
PERSISTENT TOXIC SUBSTANCES	Any toxic substance with a half-life in water and greater than eight weeks.
PESTICIDE	Any substance used to kill plants, insects, algae, fungi or other organisms; includes herbicides, insecticides, algicides, fungicides.
PHENOLICS	Any of a number of compounds with the basic structure of phenol but with substitutions made onto this structure. Phenolics are produced during the coking of coal, the distillation of wood, the operation of gas works and oil refineries, from human and animal wastes, and the microbiological decomposition of organic matter.
PHOTOSYNTHESIS	A process occurring in the cells of green plants and some micro-organisms in which solar energy is transformed into stored chemical energy.
PHYTOPHAGOUS	Feeding on plants.
PHYTOPLANKTON	Minute, microscopic aquatic vegetative life; plant portion of the plankton; the plant community in marine and freshwater situations which floats free in the water and contains many species of algae and diatoms.
POINT SOURCE	A source of pollution that is distinct and identifiable, such as an outfall pipe from an industrial plant.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

POLLUTION (WATER)	Anything causing or inducing objectional conditions in any watercourse and affecting adversely the environment and use or uses to which the water thereof may be put.
POTABLE WATER	Water suitable, on the basis of both health and aesthetic considerations, for drinking or cooking purposes.
PRECAMBRIAN	The earliest era of geological history.
PRIMARY TREATMENT	Mechanical removal of floating or settable solids from wastewater.
PUBLIC	Any person, group, or organization.
RADIONUCLIDE	A radioactive material.
RAPTORS	Birds of prey.
RAW WATER	Surface or groundwater that is available as a source of drinking water, but has not received any treatment.
RESUSPENSION	(of sediment) The remixing of sediment particles and pollutants back into the water by storms, currents, organisms and human activities such as dredging.
RIPARIAN	Living or located on the bank of a natural watercourse.
SCAUP	A diving duck.
SECONDARY TREATMENT	Primary treatment plus bacterial action to remove organic parts of the waste.
SEDIMENT	The fines or soils on the bottom of the rive or lake.
SEICHE	An oscillation in water level form one end of a lake to another due to wind or atmospheric pressure. Most dramatic after an intense but local weather disturbance passes over one end of a large lake.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

SELENIUM	A nonmetallic element that chemically resembles sulfur and is obtained chiefly as a by-product in copper refining, and occurs in allotropic forms of which a gray stable form varies in electrical conductivity with the intensity of its illumination and is used in electronic devices.
SESSILE	An animal that is attached to an object or is fixed in place (e.g. barnacles).
SIGMOID CURVE	S-shaped curve (e.g. the logistic curve)
SLUDGE	The solids removed from waste treatment facilities.
SOLUBILITY	Capability of being dissolved.
STABILITY	Absence of fluctuations in population; ability to withstand perturbations without large changes in composition.
STRATIFICATION	(or layering) The tendency in deep lakes for distinct layers of water to form as a result of vertical change in temperature and therefore, in the density of water.
SUBACUTE	Involving a stimulus below the level that causes death.
SUBCHRONIC	Effects from short-term multiple dosage or exposure; usually means exposure for less than three months.
SUB-LETHAL	Involving a stimulus below the level that causes death.
SUSPENDED SEDIMENTS	Particulate matter suspended in water.
SYNERGISM	The joint action of two or more substances is greater than the sum of the action of each of the individual substances. The improvement in performance is achieved because two agents are working together. See also Antagonism.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

SYNERGISTIC	Interactions of two or more substances or organisms producing a result such that the total effect is greater than the sum of the individual effects.
SYNTHESIS	The production of a substance by the union of elements or simpler compounds.
TAXA	A group of similar organisms.
TAXONOMICALLY	To identify an organism by its structure.
TERATOGEN	A substance that increases the incidence of birth defects.
TERATOGENICITY	The ability of a substance to produce irreversible birth defects, or anatomical or functional disorders as a result of an effect on the developing embryo.
THERMOCLINE	A layer of water in lakes separating cool hypolimnion (lower layer) from the warm epilimnion (surface layer).
THRESHHOLD	The chemical concentration or dose that must be reached before a given reaction occurs.
TOXIC SUBSTANCE	As defined in the Great Lakes Agreement, any substance that adversely affects the health or well being of any living organism.
TOXICITY	Quality, state or degree of the harmful effect resulting from alteration of an environmental factor.
TRANSLOCATION	Movement of chemicals within a plant or animal; usually refers to systemic herbicides and insecticides that are moved from the point of contact on the plant to other regions of the plant.
TROPHIC ACCUMULATION	Passing of a substance through a food chain such that each organism retains all or a portion of the amount in its food and eventually acquires a higher concentration in its flesh than in its food. See also Biological Magnification.
TROPHIC LEVEL	Functional classification of organisms in a community according to feeding relationships; the first trophic level includes green plants, the second level includes herbivores; etc.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

TROPHIC STATUS	A measure of the biological productivity in a body of water. Aquatic ecosystems are characterized as oligotrophic (low productivity), mesotrophic (medium productivity) or eutrophic (high productivity).
TUBIFICID	Of aquatic oligochaete or sludge worms which is tolerant to organically enriched waters.
TURBIDITY	Deficient in clarity of water.
WATER QUALITY OBJECTIVES	Under the Great Lakes Water Quality Agreement, goals set by the Governments of the United States Agreement, goals set by the Governments of the United States and Canada for protection of the uses of the Great Lakes.
WATER QUALITY STANDARD	A criterion or objective for a specific water use standard that is incorporated into enforceable regulations.
WIND SET-UP	A local rise in water levels caused by winds pushing water to one side of a lake. (See Seiche)

ppm? ppb? ppt?

"Parts per million", "parts per billion", and even "parts per trillion" have gradually worked their way into commonly accepted usage as expressions of air and water pollutant measurements. But who, other than the experts, really knows what these terms mean? What are the terms of reference? How small is small?

Research chemists recently undertook the challenge of delineating some readily understandable terms of reference. The assignment clearly sparked the group's collective imagination, as the list of comparisons they produced shows.

One part per million:

= one inch in 16 miles;
= one minute in two years;
= one ounce in 31 tons of potato chips;
= one bad apple in 2,000 barrels.

One part per billion:

= one inch in 16,000 miles;
= one second in 32 years;
= a pinch of salt in 10 tons of potato chips;
= one bad apple in 2 million barrels.

One part per trillion:

= one hairsbreadth (blond specified) in a trip around the world;
= one second in 320 centuries;
= one pinch of salt in 10,000 tons of potato chips;
= a drop of vermouth in 250,000 hogsheads of gin; or, getting even more specific;
= one flea in 360 million elephants.

At what point are chemicals perceived? Table salt in water becomes somewhat unpalatable at one part per thousand; swimmers can detect chlorine in a pool at one part per million; and sensitive noses can detect the odour of fuel oil at one part per billion. One part per trillion of anything is not detectable without the use of advanced and costly analytical equipment.

ENVIRONMENTAL ANALYSIS — FOR364-6

COURSE NAME — COURSE NUMBER

COMMONLY USED TERMINOLOGY

Measurements & Units

mg/l	=	milligram per litre	= part per million (ppm)
ug/l	=	microgram per litre	= part per billion (ppb)
ng/l	=	nanogram per litre	= part per trillion (ppt)
pg/l	=	picograms per litre	= part per quadrillion (ppq)
mg/kg	=	milligram per kilogram	= part per million (ppm)
ug/kg	=	microgram per kilogram	= part per billion (ppb)
ng/kg	=	nanogram per kilogram	= part per trillion (ppt)
L/d	=	litre per day	
m^3/d	=	cubic metres per day	
kg/ann (kg/yr)	=	kilograms per year	
t/ann (kg/yr)	=	tonnes per year	
uS/cm	=	microsiemens per centimetre (conductivity)	
mgd	=	millions of gallons per day	
cfs	=	cubic feet per second	

ENVIRONMENTAL ANALYSIS — FOR364-6

COURSE NAME — COURSE NUMBER

REPORT WRITING

All lab reports should include the following components:

1. Purpose/Objective - a brief statement outlining the intent of the exercise. Objectives may be itemized, i.e.,

   a) to determine LC_{50} for zinc using rainbow trout
   b) to investigate the relationship between water temperature, pH, alkalinity and the toxicity of zinc to rainbow trout

2. Method/Procedure - a brief outline of how the exercise was conducted. In many instances "Refer to manual" will suffice.

3. Results - a presentation of results, and only results, in an organized format, i.e., TABLE FORMAT. There should be no sentences, no paragraphs--table and figures (graphs) only. Be sure all table and figures are entitled and numbered.

Table 1 - Physical Characteristics of the Great Lakes

Lake	Area (km2)	Area of Drainage Basin (km2)	Average Depth (m)	Volume (ckm)	Retention time (yr)
Superior	82,100	127,700	147	12,100	191
Michigan	57,800	118,000	85	4,920	99
Huron	59,600	134,000	59	3,540	22
Erie	25,700	78,000	19	484	2.6
Ontario	18,960	64,030	86	1,640	6

4. Calculations - one example of each different calculation used in presenting the results should appear in this section. Subsequent work using the same calculations should appear in the Appendix. Hence, with the exception of one example calculation, all calculations use to generate data in tables must be shown in the Appendix.

ENVIRONMENTAL ANALYSIS — FOR364-6

COURSE NAME — COURSE NUMBER

5. Discussion of Results and Conclusions - results are interpreted and discussed. Carefully observe data to determine trends and relationships among all parameters measured.

Are apparent relationships consistent with established relationships present in literature? In this section, you are responsible for conducting a literature search to compare your findings with that of established authors.

Be sure to refer to your data using table and figure numbers - e.g., a direct linear relationship between white sucker weight and fork length is apparent in Figure 2. This relationship agrees well with that established for white sucker by J. A. Smith (1982), W. T. Jones (1974) and B. R. Brown (1971).

If your findings are not consistent with other studies or theories, offer some explanation for the deviation.

e.g., According to Saunders (1972), the principle component of lake trout stomach samples (n=785) in Round Lake prior to 1965 was lake herring (Coregonus artedii) at 72% by volume. Data from this study, however, indicates rainbow smelt (Osmerus mordax) as the dominant food item in 525 lake trout sampled, averaging 97% of stomach contents by volume (Figures 1 and 2). This change in forage species preference is attributed to the introduction of rainbow smelt in 1969 (Wilson, 1971).

All questions posed at the end of a lab exercise should be answered in this section.

N.B. There are several acceptable methods of citing references and referring to your data within the text of your report. Footnotes are not acceptable. Quotes are not acceptable.

N.B. Scientific names of species should appear in brackets only once after the first time the common name appears in the text.

In addition to interpreting and discussing, conclusions should be clearly stated, often itemized, at the end of this section.

6. Sources of Error - itemize all conceivable sources of error.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

7. Appendix

- present calculations for all values appearing in tables.

8. Reference Cited

- presented on a separate page at end of report,

- all citations in text of report must be listed alphabetically in this section and conversely all references listed in this section must be cited in the text of the report.

i.e.:

1) For paper presented in a journal:

Mason, C. F. and R. J. Bryant. 1974. The structure and diversity of the animal communities in a broad land reed-swamp, J. Zool., 172, 289-309.

issue no. page reference

2) For book references:

Hynes, H. B. N., 1970. The Ecology of Running Waters, Liverpool University Press, Liverpool.

3) For paper/chapter presented in publication:

Chapman, D.W. 1978. Production fish populations. In Ecology of Freshwater Fish Production (S. D. Gerking, ed.). Blackwell. Oxford.

ENVIRONMENTAL ANALYSIS	FOR364-6
COURSE NAME	COURSE NUMBER

MAJOR DO'S AND DON'TS

1. Don't use first person in report text, i.e., I, we, our.

2. Do refer to tables and figures by number. Be sure all tables and figures in Results are numbered and entitled.

3. Use correct citation of references.

4. Do not use quotes.

5. Scientific names of species need only appear once in text of report. They are placed in brackets and underlined after the common name of the species appears for the first time.

ENVIRONMENTAL ANALYSIS — COURSE NAME

FOR364-6 — COURSE NUMBER

REPORT MARKING - ONE REPORT SUBMITTED PER STUDENT

	SECTION	MARK	MARKING BASED ON
1.	Purpose	1	Conciseness; completeness
2.	Method	1 (if applicable)	Conciseness; completeness
3.	Results	2	Organization; labels, numbers on tables, figures; neatness; correctness
4.	Calculations	1	Correctness, completeness
5.	Discussion	4 or 5 if method not applicable	Conciseness; organization; reference material used and cited; completeness
6.	Errors	1	Completeness
		TOTAL 10	
7.	Appendix	minus 1 mark if absent or incorrect	
8.	Reference	minus 1 mark if absent or incorrect	

N.B. Ten percent (10%) deducted per day for late reports.

ENVIRONMENTAL ANALYSIS	FOR364-6
COURSE NAME	COURSE NUMBER

GLASSWARE PREPARATION

For accuracy, glassware must be properly cleaned fo all impurities prior to conducting lab exercises.

1. Wash all glassware needed in warm soapy water. Use brushes if necessary.
2. Rinse glasware 3 times under tap water.
3. Rinse glassware well with distilled water 3 times.
4. Place glassware upside down on paper towel to drain.