



**ENVIRONMENTAL/NATURAL RESOURCES
TECHNOLOGIES**

State Competency Profile

**Tech Prep Curriculum Services
In conjunction with**

**The Ohio Department of Education
And
The Ohio Board of Regents**

ENVIRONMENTAL OCCUPATIONAL AREA DEFINITIONS

Pollution Prevention and Control - Individuals employed in pollution control ensure the prevention of pollution and safe and effective collection, treatment, disposal and documentation of agricultural and industrial by-products, air emissions, waste, hazardous waste, water treatment and waste water products in compliance with local, state and federal regulations. Skill areas should include, but are not limited to:

compliance with laws, regulations, policies and contracts
safe working conditions
data recording and analysis
preparation of summaries and charts for review
creative solutions for preventing pollution and reducing the use of toxic materials
extent, sources, and clean-up of pollution
certification for various positions
quality control practices
operation, calibration, and maintenance of equipment and pollution control devices
data and sample collection
operation and calibration of field and laboratory instruments
watershed pollution prevention and control

Environmental Sampling and Analysis - Individuals employed in environmental instrumentation and monitoring determine presence, sources, intensity and constituents or components in air, water, soil and waste through field and laboratory techniques utilizing principles of agriculture, chemistry, meteorology, engineering and applied technologies in accordance with government regulations and methodologies. Skill areas should include, but are not limited to:

safe working conditions
installation, operation and calibration of field and laboratory equipment and instruments
data recording and analysis
basic chemical, physical, and biological analyses
hazards recognition
flow monitoring
bio-monitoring
process monitoring
sampling and tracking

Health and Safety - Individuals employed in health and safety evaluate and minimize the risk to human health in relationship to the industrial/commercial/municipal workplace, hazardous and infectious waste sites, air pollution, water supply, and sanitation processes. Skill areas should include, but are not limited to:

safety training programs

job hazard analyses

workplace hazards

Materials Safety Data Sheets (MSDS)

corrective action plans

cost and cost benefit statements for specific corrective actions

accident incidence statistics/accident investigation

certification for various positions

OSHA Workplace Standards 29CFR 1910.120

Environmental Compliance Assurance - Individuals employed in environmental compliance assurance ensure that environmental permits are complied with or assistance is provided to ensure compliance. They may also assist in developing standard operating procedures. Skill areas should include, but are not limited to:

safe working conditions

complaint response

stress response

violations identification and reporting

citations and warnings

compliance inspections

risk assessments

application, modification, or termination of permits

implications of the regulatory development process

certification for various positions

training program assistance

Hazardous Materials Handling - Individuals employed in hazardous materials handle, process, sample and store hazardous materials and respond to hazardous materials situations in accordance with regulatory requirements. Skill areas should include, but are not limited to (*Under Revision*):

collection, preparation, documentation, and shipping of samples for analysis
sample data analysis
equipment related to hazardous materials operations
hazardous materials identification and labeling
calibration, operation, and maintenance of required instrumentation
documentation of hazardous materials management activities
hazardous materials handling, transporting, and storing in accordance with regulations
hazardous materials treatment and disposal systems
toxic effects of hazardous materials on people
certification for various positions (e.g., HAZWOPER)
construction techniques and equipment
mechanical skills

Water Environment Management - Individuals employed in water resource management help solve fresh water resource related problems via conservation agencies and environmental businesses and industries. Skill areas should include, but are not limited to:

water resource utilization
water pollution control and design
water conservation
wetlands management
watershed protection and planning
data collection and analysis
compliance with laws, regulations, policies and contracts
extent, sources and clean-up of water pollution
point and non-point source pollutants
contamination pathways
water ecology
basic toxicology
biological/chemical and ecological effects
test result analysis
drinking water treatment control and design
drinking water treatment equipment
wastewater treatment equipment
basic economics and finance
human health issues

Fishery and Wildlife Habitat Management - Individuals employed in fishery and wildlife habitat management maintain or manage natural resources, including soil, water, plants, animals and fish for recreational purposes and the best interests of the environment. Skill areas should include, but are not limited to:

hatchery fish propagation

fish and wildlife disease control

data compilation

wildlife conservation

wildlife habitats

migratory and native species of birds, mammals, fish, endangered species, and other wildlife

federal, state, and local regulations

wetlands management

animal damage control

human-animal conflicts

bio-monitoring

stream, lake, and pond management

Geographic Information Management Systems - Individuals employed in cartography/Geographic Information Systems (GIS) compile, refine, and map data on selected environmental, economic, natural, infrastructure, and cultural resources for a variety of uses such as habitat rehabilitation, wildlife tracking, resource management, floodplain management, phase mapping, trending analysis, benchmarking, and water quality. Skill areas should include, but are not limited to:

computer skills

digital maps

data collection

database management

database and Geographic Information Systems integration

GIS analysis including GPS/remote sensing concepts, map projections, scale, resolution, accuracy and precision

statistical theory/analysis

resource management principles

surveying

Possible GIS Specialty Areas

Waste Management
Fishery and Wildlife Management
Watershed Management
Soil Science
Forest Science

Environmental Recreational Planning
City and Community Planning
Ecosystem Management
Marine/Oceanography Studies

KEY TO PROFILE CODES

GRADE LEVEL

12 = by the end of grade 12

AD = by the end of the Associate Degree

DEPTH

I = *Introduce* (applies to 25% of the competency builders. In competencies with 3 or less builders, all builders should be introduced before this code can be used.)

R = **Reinforce** or add depth (after introducing or proficiency)

P = **Proficient** (achievement of the competency **without** supervision)

OTHER (Determined by Business, Industry and Labor Panel)

Essential Competency: Competency is needed to ensure **minimal** level of employability. Entry level employees should be able to perform this competency without supervision at the end of the associate degree. Competencies required for certification, licensure, and/or national skills standards should be tagged as essential.

Recommended Competency: Competency should be included but is not essential for minimal level of employability.

Delete: Competency should not be included.

Example:

BIL: Essential – PC, ECA, HS
Recommended - FWM

EDU:	12	AD
PC	P	I
ESA		
HS		P
ECA	P	R
HM		
WEM		
FWM	I	P
GIS		

Competency1.1: Analyze

Competency Builders:

Explain

Identify . . .

ENVIRONMENTAL/NATURAL RESOURCES TECHNOLOGIES

TECH PREP COMPETENCY PROFILE

Matrix

PC =	Pollution Prevention and Control								
ESA =	Environmental Sampling and Analysis								
HS =	Health and Safety								
ECA =	Environmental Compliance Assurance								
HM =	Hazardous Materials Handling								
WEM =	Water Environment Management								
FWM =	Fishery and Wildlife Habitat Management								
GIS =	Geographic Information Management System								
Page #	Unit #	Unit	PC	ESA	HS	ECA	HM	WEM	FWM
1	1	Technical Documentation	E	E	E	E	E	E	E
5	2	Statistical Analysis	E	E	E	E	E		
15	3	Management & Supervision	E	E	E	E	E	E	E
31	4	Psychology of Stress	R	R	E	R			
35	5	Emergency Response	R		E	E	E		
37	6	Environmental Safety	E	E	E	E	E	E	
49	7	Environmental Laws and Regulations	E	E	E	E	E	E	
61	8	Environmental Science	E	E	E	E	E	E	E
77	9	Energy Sources	R			R		R	
79	10	Environmental Assessment	E	E	E	R	E	E	R
89	11	Plant Science		E		R		E	E
105	12	Soil Science	E	E		E	E	E	E
119	13	Hydrology	E	E		R	E	E	R
125	14	Pollution Control I	E	E	R	E		R	R
129	15	Pollution Control II	E	E	E	E	E	E	
139	16	Chemical Technology	E	E	E	E	E	E	R
153	17	Environmental Instrumentation	E	E	E	E	E	E	
173	18	Process Technology	E	R	R	R		R	
181	19	Electrical Basics	E	E	R	R			
185	20	Equipment Operation & Maintenance	R	E	R	E	E	E	E
191	21	Hydraulics & Pneumatics	R		R	E		E	R
201	22	Surveying & Mapping	E	E		E	E	R	E
211	23	Drafting Technology	E		R	R		R	R
217	24	CADD Fundamentals	E			R			R
225	25	Waste Management	E	E	R	R	E	R	
245	26	Drinking Water Treatment Operations	E	E	E	E		E	
265	27	Wastewater Treatment Operations	E	E	R	E	R	E	
283	28	Hazardous Materials Management	E	E	E	E	E	R	
309	29	Wetlands Management	R	E	R	R		E	E
319	30	Watershed Management	E	E	E	R		E	E
325	31	Wildlife Ecology		E		R			E
329	32	Wildlife Management				R			E
347	33	Fisheries Management		E		R		E	E
355	34	Programming Theory		R		R			
359	35	Database Management System Basics	R	E		E	R		
365	36	Database Administration	R	R	R	R	R		R
375	37	Geographic Information Systems (GIS)	E	E		R	R	E	E
393	38	Communication	E	E	E	E	E	E	E

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ESA =	Environmental Sampling and Analysis								
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Page #	Unit #	Unit	PC	ESA	HS	ECA	HM	WEM	FWM
399	39	Basic Microbiology	R	E	E	R		E	E

Unit 1: Technical Documentation

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM	I	P
GIS	I	P

Competency 1.1: Record technical information

Competency Builders:

- Describe various documentation procedures
- Read documentation procedures
- Follow documentation procedures
- Observe process
- Ask open-ended questions
- Record process (e.g., flowchart, step-by-step)
- Compile relevant data
- Identify parameters
- Recognize patterns in data
- Record accurate, truthful data
- Compile cumulative reference notebook/record
- Maintain logs, notes, and records
- Measure appropriate parameters
- Document violation and enforcement notices
- Document test results

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	P	R
ESA	I	P
HS	P	R
ECA	P	R
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

Competency 1.2: **Compose technical reports**

Competency Builders:

Compose technical memoranda

Complete forms and checklists

Identify format or report form

Generate charts and graphs

Generate maps

Analyze data

Draw conclusions

Explain analytical methods used

Outline reports and procedures

Write executive summaries

Present reports and procedures

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

Competency 1.3: Communicate documentation to others

Competency Builders:

- Describe operation(s) to others
- Participate in meetings
- Interact with customers
- Consult with colleagues
- Resolve complaints
- Refer questions and issues to appropriate authority [E-BIL]
- Interact with public on safety environmental, and health issues
- Interact with personnel on safety, environmental, and health issues
- Compose clear instructions
- Interpret prints, diagrams, specifications, and drawings
- Interpret charts and graphs
- Interpret maps
- Draft preventive maintenance and calibration procedures

Identify strategies for communicating with mass media

- Describe strategies for communicating with mass media

Unit 2: Statistical Analysis

BIL: Essential – PC, ESA, HS, ECA, HM, GIS

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS	P	R

Competency 2.1: Apply basic statistics concepts [E-GIS]

Competency Builders:

Describe data collection methods

Collect data

Organize data by flow chart

Interpret data by cause and effect diagrams

Explain nominal, ordinal, interval, and ratio data

Explain mean, median, and mode

Explain significance of standard deviation and correlation coefficient

Explain normal distribution

Differentiate between prevention and detection

Explain statistical score (e.g., t, z)

BIL: Essential – PC, ESA, HS, ECA, HM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	P	R
WEM		
FWM		
GIS	I	P

Competency 2.2: Interpret scattergrams

Competency Builders:

Develop scatter grams

Interpret for positive, negative, or no correlation between X and Y variables

Test for significance

Explain regression analysis

BIL: Essential – PC, ESA, HS, HM, GIS
Recommended – ECA

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS	I	P

Competency 2.3: Analyze probability theories

Competency Builders:

Explain classical probability

Explain empirical probability

Calculate probability for outcomes

BIL: Essential – PC, ESA, HS
Recommended – ECA, HM

EDU:	12	AD
PC	I	P
ESA		P
HS	I	P
ECA	I	R
HM		I
WEM		
FWM		
GIS		

Competency 2.4: Determine control limits

Competency Builders:

Explain uses of precontrol

Calculate precontrol limits

Explain significance of the limits

Plot values on a precontrol chart

Explain "out-of-control" situation

Make decisions on green (good control range), yellow (reaching control limits) and red conditions (out of control)

BIL: Essential - PC
 Recommended – ESA, HS, ECA, HM, GIS

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		I
WEM		
FWM		
GIS		I

Competency 2.5: Determine process capability

Competency Builders:

Measure X, R, USL, and LSL (upper and lower specification limits)

Calculate estimated process standard deviation

Plot right hand and left hand tail of process variation

Compute Z value for percent of probable defect for process

Calculate C_{PK} values that describe process capability

Describe skewed distributions

List probable causes of skewed distribution

BIL: Essential - PC
Recommended – ESA, HS, ECA, HM, GIS

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		I
WEM		
FWM		
GIS		I

Competency 2.6: Prepare control charts

Competency Builders:

- Identify types of control charts
- Interpret attribute data
- Interpret histogram
- Interpret scatter grams
- Interpret NP chart
- Interpret P chart
- Interpret flowchart
- Interpret cause-and-effect diagram
- Construct P (percentage defective) chart for attributes
- Plot control limits of P chart and data points
- Check chart for out-of-control conditions
- Construct an NP (number defective) chart with control limits and data
- Construct C (count of defects) and U (number of defects per unit) charts
- Check data on C and U charts
- Construct flowchart
- Construct cause-and-effect chart

BIL: Essential - ECA
Recommended – PC, HS, HM

EDU:	12	AD
PC	I	R
ESA		
HS	I	R
ECA	I	P
HM		I
WEM		
FWM		
GIS		

Competency 2.7: Construct X and R charts

Competency Builders:

Arrange data into statistical sub-groups

Explain importance of random sampling

Compute \bar{X} (i.e., average of values) and R (i.e., range of values in subgroup) within sample

Plot \bar{X} and R on chart

Construct control chart with \bar{X} (grand average) and R (average range) calculated

Calculate upper and lower control limits for X-chart

Calculate upper and lower control limits for R-chart

BIL: Essential – PC, ECA
Recommended – HS, HM

EDU:	12	AD
PC	I	P
ESA		
HS	I	R
ECA	I	P
HM		I
WEM		
FWM		
GIS		

Competency 2.8: Evaluate X and R charts

Competency Builders:

Plot percentages for normal distribution

Test distribution for normality

Explain difference between common cause and special cause

Explain "in-control" process

Explain significance of an out-of-control point on X or R chart

Identify patterns and trends on control chart

Identify run up and run down

Test for middle third on control chart

Explain significance of middle third on control chart

Explain Rule of Sevens

BIL: Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 2.9: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})

Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)

Identify major steps in conducting a study

Integrate results into the total system

Unit 3: Management & Supervision

BIL: Recommended – PC, ESA, HS, ECS, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA		I
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS		I

Competency 3.1: Assess progress in assigned areas of responsibility/accountability

Competency Builders:

Set short- and long-term goals for assigned areas of responsibility/accountability

Demonstrate commitment to established goals and vision

Obtain support for goals

Provide support for goals

Monitor goal achievement

Adjust goals

Communicate goal achievement

Recognize goal achievement

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		I
GIS		I

Competency 3.2: Hire staff

Competency Builders:

- Develop plans and procedures for identifying staffing needs
- Identify staffing needs in accordance with plans
- Develop job descriptions
- Develop hiring and promotion policies and procedures in compliance with state and federal employment laws
- Establish guidelines for selecting the most qualified person for a specific position
- Identify state and federal employment laws and company hiring policies and procedures
- Identify resources for locating candidates
- Recruit candidates
- Identify most appropriate candidates for position in accordance with established guidelines
- Interview candidates for position
- Follow up on information provided on job applications
- Recommend or select applicants for employment
- Orient new employees
- Maintain personnel records
- Explain unconventional work schedules (e.g., flextime, shared positions)
- Identify additional or alternative employee benefits that the company might consider furnishing to employees

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM		I
WEM		I
FWM		I
GIS		I

Competency 3.3: Supervise employee performance

Competency Builders:

- Apply management/leadership style appropriate for situation
- Clarify roles and relationships using organizational charts
- Communicate performance expectations
- Clarify company policies and procedures
- Create and maintain an environment supportive of productivity
- Establish office procedures
- Maintain office procedure manual(s)
- Monitor employee performance
- Maintain performance records
- Document personnel issues
- Evaluate employee performance
- Provide employees with constructive criticism and feedback
- Explain union role and responsibility
- Counsel employees
- Discipline employees
- Make recommendations based on employee performance (e.g., transfer, promotion, or dismissal)
- Manage the change process (e.g., for right-sizing, technological updating, globalization, retraining)
- Identify company policies and federal laws governing discrimination and harassment
- Demonstrate sensitivity to diversity, including differences in gender, culture, race, language, physical and mental challenges, and family structures
- Explain motivational theory in selecting management techniques

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		
FWM		
GIS		

Competency 3.4: Design employee development activities

Competency Builders:

- Analyze employee development needs (e.g., retraining, updating, stress management)
- Select development strategies designed to meet individual and group needs
- Identify the benefits of employee development activities offered outside the organization
- Secure personnel resources, materials, and equipment needed for employee development activities
- Monitor employee development activities
- Keep employees informed about development opportunities
- Encourage employee participation in development activities
- Evaluate employee progress
- Provide feedback to employees concerning their progress
- Provide formal and informal recognition for employee development

EDU:	12	AD
PC	I	R
ESA	I	R
HS		I
ECA		
HM		
WEM		I
FWM		
GIS	I	R

Competency 3.5: Manage work flow and operations

Competency Builders:

Plan physical layout and work flow

Develop business or job procedures/operations flowcharts

Prioritize work

Establish and maintain operating policies and procedures

Establish and maintain production standards

Establish and maintain linkages with other departments

Systematize work

Delegate work

Communicate operating policies and procedures, priorities, linkages, and standards to others

Assign work

Monitor progress

Solve work flow/operations problems

Prepare productivity reports

Communicate contents of productivity reports to others

BIL: Essential – ECA, WEM, FWM
Recommended – PC, ESA, HS, HM, GIS

EDU:	12	AD
PC		I
ESA	I	R
HS		I
ECA	I	P
HM	I	R
WEM	P	R
FWM	P	R
GIS	I	R

Competency 3.6: Plan meetings

Competency Builders:

Set agenda

Schedule meeting

Reserve meeting room

Invite appropriate personnel

Identify need for outside speakers

Assign someone to take minutes

BIL: Essential - ECA
Recommended – PC, ESA, HS, HM, WEM, FWM, GIS

EDU:	12	AD
PC		I
ESA	I	R
HS		I
ECA	I	P
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

Competency 3.7: Conduct meetings

Competency Builders:

Make introductions

Invite questions, comments, and group participation

Record appropriate action, time frame, and person accountable for identified tasks

Monitor time

Publish minutes in timely manner

BIL: Essential – FWM
Recommended – PC, ESA, HS, ECA, WEM, GIS

EDU:	12	AD
PC		

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, GIS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

Competency 3.9: Manage budgets

Competency Builders:

- Identify the costs of operation
- Perform cost surveys
- Develop a plan for efficient operations
- Explain system-efficiency balance

Identify budget activities and categories of expense accounts

- Identify techniques of budget control
- Identify statements about budget related activities
- Identify factors that are needed to maintain adequate control over supplies on hand and on order
- Develop productivity goals
- Implement productivity goals
- Develop attainable tasks/time estimates

BIL: Essential - HS
Recommended – PC, ESA, ECA, HM, WEM, GIS

EDU:	12	AD
PC	I	R
ESA		I
HS	I	P
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

Competency 3.10: Develop standard operating procedures (SOPS)

Competency Builders:

Plan and implement an in-house training program that includes safety measures and hazardous or toxic materials in the work place (e.g., HAZ, Com, CHP)

Plan and implement a cross-training program in facility operations

Plan and implement a SOP for a job-related task

BIL: Recommended – PC, ESA, HS, WEM, GIS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		
GIS		I

Competency 3.11: Develop facility process optimization and management plans

Competency Builders:

Develop a plan for inventory control

Develop a plan for an analysis of operation and maintenance logs and for the optimum operation of equipment

Develop a plan for facility automation

Develop a plan to achieve efficient, energy-saving, cost-effective operations

Develop a plan for testing and analyzing treatment operations

Develop a plan for the systematic troubleshooting of operations problems

Develop a plan for documenting operations that anticipates and avoids potential problems

Identify facility equipment

Develop a facility staffing plan

Develop a procedure for quality assurance/quality control in a facility

Develop a procedure for obtaining certification for a facility

Develop a sampling/analysis schedule based on sampling requirements

BIL: Essential – ESA, FWM
Recommended – ECA, HM, WEM

EDU:	12	AD
PC		
ESA	I	P
HS		
ECA		I
HM		I
WEM	I	R
FWM	I	P
GIS		

Competency 3.12: Explain federal, state, and local rules

Competency Builders:

Explain operational rules

Apply facility management rules

Apply samples and analyses rules

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		I
HM		I
WEM		I
FWM		I
GIS		I

Competency 3.13: Correct facility operational problems

Competency Builders:

Troubleshoot operational problems

Check the accuracy of observed operational problems

Identify appropriate corrective actions for operational problems

Monitor results of corrective actions taken

Identify actions that should be taken to prevent recurrence of identified operational problems

BIL: Essential – PC
Recommended – ESA, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA		I
HM		I
WEM		I
FWM		I
GIS	I	R

Competency 3.14: Manage environmental operations

Competency Builders:

- Balance environmental costs and benefits
- Explain scope of environmental projects
- Investigate complaint
- Implement corrective action
- Resolve issue with concerned party
- Document investigation and rules

BIL: Essential – PC, HS
Recommended – ESA, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	R
WEM		I
FWM		I
GIS	I	P

Competency 3.15: Develop contingency plans

Competency Builders:

Analyze potential emergency situations that can occur in a facility

Develop a plan for handling problems caused by emergency situations, including what equipment would be used and what sampling would be needed

Develop a procedure to ensure employee safety

Develop procedures to ensure continuous operations (e.g., preventive maintenance)

Practice deployment plan

Unit 4: Psychology of Stress

BIL: Recommended – PC, ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 4.1: Analyze factors that influence response to stress

Competency Builders:

- Describe stress
- Differentiate between stress and stressors
- Analyze how an individual's perception of stress influences response to stressors
- Analyze how internal and external mitigating factors influence one's response to stress
- Analyze coping mechanisms used to decrease stress

BIL: Essential - HS
Recommended – PC, ESA, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	P
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 4.2: Analyze physiological response to stress

Competency Builders:

Describe the stress response on the body systems (e.g., autonomic, nervous, endocrine)

Analyze how mitigating factors relate to the physiological stress response

Differentiate between immune system response to stressors in children and adults

Describe how stress relates to activation of the disease process

Identify biological adaptive responses to stress

BIL: Recommended – PC, ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 4.3: Analyze psychological response to stress

Competency Builders:

- Identify psychological stressors
- Identify causes and characteristics of post catastrophic stress
- Analyze the relationship between personality types and the stress response
- Analyze types of coping strategies
- Identify selected defense mechanisms
- Analyze ineffective coping behaviors
- Explain the psychobiologic response of anxiety as it relates to stress
- Describe the disequilibrium associated with response to stressors
- Describe stress as it relates to teams organizations and groups
- Analyze how individual perception of stress influences relationships

Unit 5: Emergency Response

BIL: Essential – HS, ECA, HM
 Recommended - PC

EDU:	12	AD
PC	I	R
ESA		
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 5.1: Identify various emergency response plan requirements for a facility

Competency Builders:

- Evaluate hazards
- Evaluate and implement evolving contingency plans such as SPCC
- Develop site command/operating procedures
- Identify mitigation techniques
- Participate in field exercises (e.g., drum handling, instrumentation surveying, decontamination procedures, personal protective equipment, medical evaluations)
- Identify training needs for emergency responders
- Document training
- Comply with federal, state, and local regulations

BIL: Essential – HS
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		
HS	I	P
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 5.2: **Develop an emergency response plan for natural disasters**

Competency Builders:

- Assess seriousness of incident
- Identify information to be released to public and media
- Coordinate efforts with other response agencies
- Demonstrate clean-up activities
- Identify mitigation techniques
- Provide first response training
- Document training

Unit 6: Environmental Safety

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 6.1: Identify general workplace safety hazards [E-HS]

Competency Builders:

Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards, non-ionizing radiation, lasers, microwaves, electro magnetic fields)

Identify safety materials/equipment and transportation (e.g., absorbent socks, oil dry)

Explain purpose(s) of OSHA, NIOSH, NFPA and DOT

Identify purpose of emergency evacuation routes, master switch, lockout locations, and safety color coding systems

Identify methods of site protection

Describe methods of evaluating potential hazards (e.g., visual analysis)

Describe methods of correcting potential hazards

Describe corrective procedures for unsafe conditions

Explain precautions required when using toxic or flammable materials

Describe various types of toxicity (e.g., chronic, immediate)

Explain confined space and related requirements

EDU:	12	AD
PC	I	P
ESA	I	P
HS	P	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 6.2: Apply general workplace safety precautions/procedures [E-HS]

Competency Builders:

- Identify local, state, and federal rules and regulations
- Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
- Identify personal protective wear and equipment
- Identify level of personal protective wear required
- Identify visual controls (e.g., monitors, read outs)
- Identify auditory controls
- Interpret hazardous materials notices on containers
- Wear personal protective clothing and equipment
- Apply workplace safety rules and procedures
- Apply personal safety rules and procedures
- Apply workplace organization (e.g., housekeeping)
- Apply applicable electrical, mechanical, steam, hydraulic and pneumatic safety rules and procedures
- Apply fire safety rules and procedures
- Interpret material safety data sheets (MSDS)
- Perform lockout and tagout
- Complete preventive maintenance checklists
- Complete confined space entry check sheets
- Obtain training for confined space entry
- Explain OSHA 1910 requirements

BIL: Essential – ECA, HM, WEM
Recommended – PC, ESA, HS

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 6.3: Acquire and maintain first aid certification

Competency Builders:

- Assist patient with wounds or fractures
- Administer first aid to control bleeding
- Administer first aid for shock
- Administer first aid for burn patient
- Assist with first aid for poisoned patient
- Assist choking patient
- Assist patient having a seizure
- Assist patient having a diabetic reaction
- Assist syncopal patient
- Identify protection from blood-born pathogens

BIL: Essential – ECA, HM, WEM
Recommended – PC, ESA, HS

EDU:	12	AD
PC	I	R
ESA		P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 6.4: Acquire and maintain cardiopulmonary resuscitation (CPR) certification

Competency Builders:

Administer CPR to adults

Administer care for obstructed airways for adults

BIL: Essential - ESA, GIS
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS	I	P

Competency 6.5: Respond to medical emergencies

Competency Builders:

- Perform head to toe assessment
- Describe signs and symptoms of emergency situations
- Identify basic emergency procedures and equipment
- Contact local emergency assistance
- Demonstrate first responder procedures
- Identify evacuation techniques

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 6.6: Explain purpose of pollution control systems

Competency Builders:

- Describe types of air, water, solid waste, and noise pollution
- Explain purpose of air pollution control systems
- Explain purpose of water pollution control systems
- Explain purpose of solid waste pollution control systems
- Explain purpose of noise pollution control systems
- Explain basic philosophy of "Right to Know" legislation
- Explain purpose(s) of regulatory agencies (e.g., EPA, ODH, ODNR, Army Corp.)
- Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
- Describe ethics of environmental issues

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 6.7: Describe procedures to comply with environmental regulations

Competency Builders:

List characteristics of an effective monitoring program

Differentiate among environmental laws (i.e., CAA, CWA, RCRA, CERCLA, SARA, PPA, TSCA)

BIL: Essential – PC, ESA, HS, ECA, HM
Recommended - WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	R
FWM		
GIS		

Competency 6.8: **Maintain environmental health and safety facilities** [E-HS]

Competency Builders:

- Perform safety inspections
- Participate in safety audits
- Participate in safety, health, radioactive and environmental training
- Participate in safety demonstrations, drills, and meetings
- Identify safety monitoring equipment
- Describe unsafe or potentially unsafe conditions, and acts
- Respond to emergencies, alarms, and any abnormal situations
- Describe potential health or industrial hygiene problem reporting procedures
- Implement federal, state, and local legislation pertaining to environmental, health, and safety regulations
- Identify evacuation procedures, emergency numbers, rules, and practices
- Identify procedural problems in the workplace
- Describe the purpose of various safety related permits
- Identify correct material handling procedures

BIL: Essential – PC, ESA, HS, ECA, HM
Recommended - WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	R
FWM		
GIS		

Competency 6.9: Handle chemicals and safety equipment appropriately

Competency Builders:

List proper safety equipment (e.g., proper hoods, shields)

Identify appropriate protective equipment (e.g., eye wear, special clothing)

Identify specific categories of hazardous chemicals

Identify hazards associated with collecting samples

Refer to chemical reference handbooks

Label all chemicals, materials, tools, and equipment with appropriate safety, health, and environmental details

Explain importance of appropriate display of warning labels

Demonstrate safe handling of materials under pressure

Explain the hazard symbols and toxicology sections of MSDS

Demonstrate safe handling procedures (e.g., handling cylinders, moving heavy items)

Classify chemicals according to reactivity

Identify incompatible combinations of chemicals that could result in potentially dangerous situations

Organize and store chemicals and equipment properly

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA		I
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM		
GIS		

Competency 6.10: Explain ergonomic procedures [R-HS]

Competency Builders:

Explain risk factor

Explain maximum permissible limit (MPL) and action limit (AL) for lifting (i.e., NIOSH Guide for Lifting)

Identify cumulative trauma disorder (CTD)

Identify susceptibility factors for CTD

Identify ways to minimize extreme joint movement

Identify ways to minimize use of excessive muscle force

Identify ways to minimize repetitive tasks

Comply with repetitive strain standard (OSHA)

Identify ways to minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)

Identify ways to minimize awkward body positions

Explain importance of rest pauses

Explain importance of mats and footrest for standing jobs

Explain importance of appropriate working heights of chairs, stools, workbenches, equipment

Explain importance of adequate lighting

Explain importance of anthropocentric design principles (i.e., centering one's view of everything around man)

BIL: Essential – ESA, HS, ECA
Recommended – PC, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	R
WEM	I	R
FWM		
GIS		

Competency 6.11: Assess workplace safety

Competency Builders:

- Describe a work place inspection applying Occupational Safety and Health Administration (OSHA) standards
- Cite specific regulations and standards for items not in compliance
- Develop a written plan of alternative solutions or corrective actions
- Prepare cost and cost benefit statements for specific corrective actions
- Analyze accident incidence statistics
- Explain the purpose and function of a safety committee
- Explain how unions and employee organizations impact on safety procedures
- Develop a site safety plan

BIL: Essential – ESA, HS, ECA
Recommended – PC, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	R
WEM	I	R
FWM		
GIS		

Competency 6.12: Assess a safety-training plan

Competency Builders:

Identify job skills or tasks required of different occupations or positions in a work place

Identify OSHA Regulations requiring safety training programs

Develop an outline to train workers to work safely and efficiently

Develop training activities for identified skills that will reduce or eliminate injuries

Develop a job related pre-test and post-test to document competency

Explain the purpose of a job safety analysis (JSA)

Construct a JSA of the activities of a specific worker in a specific industry

Complete an incident report

Develop an incentive program

Unit 7: Environmental Laws and Regulations

BIL: Essential – PC, ESA, ECA, HM
 Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		I
ECA	I	R
HM	I	P
WEM	I	R
FWM		
GIS		

Competency 7.1: Identify key components of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Competency Builders:

- List sections of CERCLA
- List key parts of CERCLA site evaluation and remedy selection
- List the scores involved with the hazard ranking system and their characteristics
- Explain national priority site identification (NPL)
- List key elements of toxic substance control act (TSCA) relative to CERCLA

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		I
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 7.2: Identify requirements of Superfund Amendment Reauthorization Act (SARA)

Competency Builders:

List sections of SARA

List key parts of SARA

Explain Toxic Release Inventory (TRI)

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	I	R
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 7.3: Identify roles and functions of government

Competency Builders:

Identify the roles and responsibilities of federal, state, and local government

Identify the difference between enabling legislation and implementing regulations

Explain the role of public involvement and participation (public notice, public hearing, public comment)

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 7.4: Identify requirements of waste and material transportation

Competency Builders:

Identify generator requirements to transfer hazardous materials and waste to treatment, storage, and disposal facilities

List key elements of C.F.R. 49

BIL: Essential – PC, ESA, HS, ECA, HM
Recommended - WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 7.5: Describe job-related activities subject to the Occupational Safety and Health Administration (OSHA)

Competency Builders:

Describe OSHA rules and regulations

Describe commercial diving operations involving the environmental field (IAW OSHA 29 CFR 1910.424)

Describe OSHA 29 CFR 1910.1000 Z Tables

Describe OSHA requirements applicable to blood borne pathogens (IAW OSHA 29 CFR 1910.1250)

Describe requirements set forth under Hazard Communication Laws and Regulations (IAW OSHA 29 CFR 1910.1200)

Describe noise exposure limits (IAW OSHA 29 CFR 1910.95)

Describe use and function of portable fire extinguisher (IAW OSHA 29 CFR 1910.157)

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		I
FWM		
GIS		

Competency 7.6: Describe requirements of Resource Conservation and Recovery Act (RCRA)

Competency Builders:

List sections of RCRA

List key components of RCRA

Identify categories of hazardous waste

Describe "cradle to grave" concept

Identify secondary containment requirements for above and below ground storage

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 7.7: Explain requirements of Clean Water Act

Competency Builders:

List sections of Clean Water Act

List key components of CWA

Identify key components of National Pollutant Discharge Elimination System

Identify key components of 503 Sludge Regulations

Explain pre treatment program

Describe the Great Lakes Initiative (GLI)

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 7.8: Explain requirements of Safe Drinking Water Act (SDWA)

Competency Builders:

List sections of SDWA

List key components of SDWA

Explain purpose of Wellhead Protection Program

Describe Sole Source Aquifer Designation

BIL: Essential – PC, ESA, ECA, HM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

Competency 7.9: Explain requirements of Clean Air Act

Competency Builders:

List sections of CAA

List key components of CAA, Chrome Reporting, and MACT's

Explain Title V Air Emissions Inventory and Permitting

Explain hazardous air pollutants (HAPs)

BIL: Recommended – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		I
HM	I	R
WEM		
FWM		
GIS		

Competency 7.10: Identify requirements of the Nuclear Waste Policy Act

Competency Builders:

List key provisions of Nuclear Waste Policy Act

List key agencies involved in high-level radioactive waste management program

List defining characteristics of four categories of nuclear waste

List method of disposal for each category of nuclear waste

Identify locations of storage for each type of nuclear waste

BIL: Essential – PC
Recommended – HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA		
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

Competency 7.11: Identify key components of ISO 14000

Competency Builders:

- List standards of ISO 14000
- Explain purpose of ISO 14000
- Explain impact of ISO 14000

Unit 8: Environmental Science

BIL: Essential – PC, ESA, HM, WEM, FWM
Recommended – HS, ECA, GIS

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	IR	R

Competency 8.1: Identify the components of the earth's atmosphere

Competency Builders:

Describe the composition of the atmosphere

List the most abundant gases by percent volume which make up the composition of clean, dry air

Explain how water vapor varies within the atmosphere

List the major cycles of atmospheric gases

Explain the relationships that exist within the cycles of atmospheric gases

Describe the dependence of organisms on the atmosphere

Explain the importance and impact of water vapor in air

BIL: Essential – PC, ESA, HM, GIS
 Recommended – ECA, WEM, FWM

EDU:	12	AD
PC	I	P
ESA	P	R
HS		
ECA	P	R
HM	P	R
WEM	I	R
FWM	I	R
GIS	P	R

Competency 8.2: Explain meteorology

Competency Builders:

- Explain how the atmosphere is composed of layers of air of varying temperatures
- Differentiate among conduction, convection, and radiation
- Differentiate between convection movement and general air circulation
- List reasons for unequal heating of the earth's surface (land and water)
- Explain how latitude affects the amount of energy received from the sun
- Differentiate between weather and climate
- Explain how mountain ranges affect climate
- Differentiate between continental and marine climates
- Identify the processes in the water cycle
- Explain how humidity relates to the amount of water vapor in the air
- Describe how air masses form
- Explain the relationship of fronts to air masses
- Differentiate fronts, temperature, and pressure on a weather map legend
- Identify weather instruments (e.g., barometer, thermometer, anemometer) and atmospheric conditions that they measure
- Identify the major kinds of clouds (e.g., cirrus, cumulus, stratus, and nimbus)
- Identify causes of hurricanes, tornadoes, and thunderstorms
- Describe the characteristics of hurricanes, tornadoes, and thunderstorms
- Describe the function of the ozone layer
- Describe the impact of technology on the ozone
- Interpret a weather map
- Record measurements of local rainfall, temperature, air pressure, relative humidity, cloud cover and type, and wind speed
- Explain the Greenhouse Effect

BIL: Essential – PC, ESA, HM, WEM, FWM
Recommended – HS, ECA, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	R

Competency 8.3: Determine the quality and quantity of water resources

Competency Builders:

- Identify present and potential sources of water pollution (e.g., point and non-point sources)
- Identify present and potential sources of water pollution in local area
- Evaluate quality of given sample of water
- Calculate the volume and surface area of ponds, lakes, and streams

Plan improvements of waterways, ponds, stream banks, and shorelines

- Determine stream flow
- Collect water samples from a representative test site
- Label water samples from a representative test site
- Store water samples from a representative test site
- Determine the quality of water samples by measuring for pH, turbidity, dissolved solids and dissolved oxygen, visual observation
- Investigate watershed boundaries and drainage patterns
- Monitor water levels of rivers, streams, ponds and lakes
- Monitor erosion hazards and environmental quality
- Determine quality of water samples by examination of particles

BIL: Essential – PC, ESA, HM, WEM, FWM, GIS
Recommended – HS, ECA

EDU:	12	AD
PC	P	R
ESA	P	R
HS	I	R
ECA	I	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.4: Outline the movement and distribution of water in the environment

Competency Builders:

List the areas of distribution of the earth's water

List the properties of water

Differentiate between suspensions and solutions

Illustrate the polar covalent bond between the hydrogen and oxygen atoms in a water molecule

Describe the three physical states of water

Explain evaporation, humidity, and condensation

Illustrate the hydrological cycle and its processes

Identify the functions and uses of water in the environment

BIL: Essential – ESA, HM, WEM, FWM, GIS
Recommended – PC, HS, ECA

EDU:	12	AD
PC	I	R
ESA	P	R
HS	I	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.5: Analyze the relationships between plants and animals within ecosystems

Competency Builders:

Illustrate the major categories of organisms

Differentiate among biomes

Differentiate among types of ecosystems

Explain the dynamic nature of ecosystems

Identify the functions of producers and consumers

Explain how biotic and abiotic factors affect producers and consumers

Compare the growth and development of various types of plant forms

Categorize the various forms of animal life

Describe the interactions between producers, consumers, decomposers, and antagonists

Illustrate a food chain and food web

BIL: Essential – PC, ESA, WEM, FWM, GIS
Recommended – HS, ECA

EDU:	12	AD
PC	P	R
ESA	P	
HS	I	R
ECA	I	R
HM		
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.6: Analyze the character and value of natural resources

Competency Builders:

Describe the value of natural resources

Describe the major categories of natural resources

Describe the types and distributions of natural resources

Contrast the origins of natural resources

Differentiate between renewable and non-renewable natural resources

BIL: Essential – ESA, WEM, FWM, GIS
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	P	
HS	I	R
ECA	I	R
HM	I	P
WEM	P	R
FWM	P	R
GIS	P	

Competency 8.7: **Distinguish between renewable and non-renewable natural resources**

Competency Builders:

Explain renewable natural resources

Explain the major categories of renewable natural resources

Identify the origins of renewable natural resources

Describe the value of renewable natural resources

Explain non-renewable natural resources

Explain the major categories of non-renewable natural resources

Identify the origins of categories of non-renewable natural resources

Describe the value of non-renewable natural resources

BIL: Essential – ESA, WEM, FWM, GIS
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	P	R
HS	I	R
ECA	I	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.8: Evaluate the exploitation of natural resources

Competency Builders:

Evaluate natural events that alter the environment

Evaluate various methods used to obtain natural resources

Evaluate the effects of obtaining natural resources on the environment

Identify the primary factor for the exploitation of natural resources

Identify the technological advances contributing to the exploitation of natural resources by industry

Identify the technological advances contributing to the exploitation of natural resources by agriculture

Identify the transportation advances contributing to the exploitation of natural resources

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	P	R
WEM	I	R
FWM		
GIS	I	R

Competency 8.9: Describe how alternative energy sources can reduce fossil fuel consumption

Competency Builders:

Describe the operation of a solar water distiller

Describe the operation of a solar oven

Describe the operation of a wind generated water pump

Describe the operation of a sundial

Describe the mechanical operation of a solar hot water heater

Describe advanced solar technology

Describe alternative energy sources and technology

BIL: Essential – PC, ESA, GIS
Recommended – HS, ECA, HM, WEM, FWM

EDU:	12	AD
PC	P	R
ESA	P	R
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	P	R

Competency 8.10: Evaluate the impact of an increasing human population on the environment and humans

Competency Builders:

Explain how the history and growth of the human population during the past four thousand years has affected the environment

Explain doubling time, natural increase, natural decrease, rate of population change, and zero population growth

Interpret a population profile

Compare the population profile of a developing country to one of a developed country

Analyze the relationship between a country's economic status and its population

Identify the results of increases in the population on the environment

BIL: Essential – PC, ESA, HS, ECA, WEM, FWM, GIS
 Recommended – HM

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	I	R
HM	I	R
WEM	P	R
FWM	I	R
GIS	P	R

Competency 8.11: Evaluate the consequences of resource use and abuse on the environment

Competency Builders:

Identify the results of overuse that occurred from exploitation

Trace the effects of pollution through a food chain

Differentiate between biodegradable and non-biodegradable products

Differentiate between organic farming and farming practices that incorporate the use of biocides and inorganic fertilizers and their comparative effects on the environment

Describe solid waste disposal methods and groundwater contamination

Explain how fossil fuels contribute to acid rain and petrochemical pollution

Evaluate pro and con attributes of nuclear energy

Describe impact of resource use and abuse on air quality

Describe impact of resource use and abuse on water quality

Describe impact of resource use and abuse on soil productivity

Identify several causes for the reduction of habitat

Differentiate among the various types of habitat

Analyze why preservation of habitat is essential

List examples of threatened, endangered, introduced, extinct and extirpated plant and animal species

Evaluate causes for the decrease of both plant and animal species

Explain factors contributing to accidental resource abuse

Explain factors contributing to incidental resource abuse

Explain factors contributing to deliberate resource abuse

BIL: Essential – PC, ECA
Recommended – HS, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA		
HS	I	R
ECA	I	P
HM	I	R
WEM	I	R
FWM	I	R
GIS	IR	P

Competency 8.12: Identify the impact of individuals/organizations on the development of environmental policies and issues

Competency Builders:

- List prominent individuals/organizations involved with environmental issues
- Explain current trends in property rights and compensation
- Identify the major issues addressed by environmental organizations
- Identify major incidents that have resulted in legislation
- Evaluate results of environmental restoration and conservation efforts
- Identify pros and cons of environmental organizations

BIL: Essential – PC
 Recommended – ESA, HS, ECA, WEM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS	I	R

Competency 8.13: Evaluate the effects of research and education on environmental issues

Competency Builders:

Identify the methods of research used by both public and private agencies in restoration and conservation efforts

Identify the process used in restoration and conservation research

Explain the interrelationship between research and education

Evaluate the outcome of environmental research projects

BIL: Essential – PC
Recommended – ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	R
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

Competency 8.14: Evaluate government's role in environmental restoration and conservation

Competency Builders:

Evaluate the effects legislation has had on the environment

Identify federal and state agencies and their roles in restoration and conservation

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

Competency 8.15: Evaluate the impact and implications of environmental restoration, preservation and resource conservation

Competency Builders:

Evaluate the importance of environmental restoration, preservation and conservation

Cite examples of various levels of environmental restoration, preservation and conservation

Evaluate the results of environmental restoration, preservation and conservation

Identify economic issues of environmental restoration, preservation and conservation projects

Identify non-economic benefits of environmental restoration, preservation and conservation activities

BIL: Essential – PC, ESA, HS, ECA, GIS
Recommended – HM, WEM, FWM

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	I	P
HM	I	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.16: Evaluate the role of responsible stewardship in maintaining a healthy environment

Competency Builders:

Describe responsible stewardship

Evaluate the need for responsible stewardship and environmental accountability

Identify types of environmental accountability and cite examples of each

Cite results stemming from responsible stewardship

Unit 9: Energy Sources

BIL: Recommended – PC, ECA, WEM

EDU:	12	AD
PC	I	R
ESA		
HS		
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

Competency 9.1: Identify conventional energy sources and their environmental impact

Competency Builders:

Identify natural gas resources and their environmental impact

Identify coal resources and their environmental impact

Identify petroleum resources and their environmental impact

Identify nuclear resources and their environmental impact

Identify hydroelectric resources and their environmental impact

BIL: Recommended - PC, ECA, WEM

EDU:	12	AD
PC	I	R
ESA		
HS		
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

Competency 9.2: Identify alternate energy sources and their environmental impact

Competency Builders:

Identify geothermal resources and their environmental impact

Identify wind resources and their environmental impact

Identify solar energy resources and their environmental impact

Unit 10: Environmental Assessment

BIL: Essential - ESA
 Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 10.1: Gather data for assessment (Phase I)

Competency Builders:

- Identify key elements in Phase I, II, and III assessments
- Describe the importance of a title search
- Gather drainage area data
- Complete field data sheet
- Record physical and topographical data
- Interpret basic soil differences
- Measure ground water level
- Identify flood plain areas
- Measure stream flow
- Complete a title search
- Calculate water run off

BIL: Recommended – PC, ESA, ECA, HM

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA		I
HM	I	R
WEM		
FWM		
GIS		

Competency 10.2: Identify past practices (Phase I)

Competency Builders:

Locate regulatory reference materials

Collect background information

Verify accuracy of information

Investigate background of complaint

Interact with various regulatory agencies

Refer to regulatory reference materials

BIL: Essential – PC, ESA, HS, HM, WEM, GIS
 Recommended – ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM	I	P
FWM		I
GIS	I	P

Competency 10.3: Collect physical data: composite; grab; continuous; remote sensing; grid; background; core; auto; biological; air and opacity (Phase II)

Competency Builders:

- Monitor protocol and procedures
- Select appropriate equipment
- Identify safety hazards of materials
- Demonstrate procedures for safe sampling collection and handling
- Develop “Chain of Custody” procedures
- Develop a sampling plan
- Describe federal and state sampling regulations
- Follow appropriate preparation procedures
- Follow appropriate marking procedures

BIL: Essential – ESA, WEM
 Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 10.4: Conduct lab/field analysis: biochemical oxygen demand (BOD); chemical oxygen demand (COD); pH; specific conductivity; dissolved oxygen; suspended solids; nitrates and nitrites; air particulate; percolation.

Competency Builders:

- Measure water temperature
- Measure water hardness
- Measure water level and flow
- Measure turbidity
- Measure oxygen level (HS)
- Measure Lower Explosive Levels (LEL) [R-HS]
- Measure air flow rate and temperature [R-HS]
- Describe procedures for measuring toxic gasses, organic vapors, and radiation [R-HS]
- Measure toxic gases [R-HS]
- Measure organic vapors [R-HS]
- Measure basic field levels of contamination [R-HS]
- Measure radiation [R-HS]
- Sample for radon [R-HS]
- Measure flashpoint [R-HS]
- Measure free liquids
- Measure moisture content/dry content (DC)
- Measure density

Sample for chlorinated compounds

Identify background analytical data to establish norm for site

BIL: Essential – PC, ESA, HS, HM, WEM, GIS
Recommended – ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM	I	P
FWM		I
GIS	I	P

Competency 10.5: Analyze data

Competency Builders:

- Draw conclusions from data
- Write technical reports
- Explain appropriate QA/QC procedures
- Identify provisions of SW846

BIL: Essential – PC, ESA, HS, ECA, WEM, FWM, GIS
Recommended – HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

Competency 10.6: Demonstrate the use of fundamental of statistics in sampling practices

Competency Builders:

Distinguish a population

Demonstrate the steps of statistical analysis

Identify a random sample from a population

Explain the use a random numbers table

BIL: Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA		
HS	I	R
ECA		I
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 10.7: Identify procedures for site remediation

Competency Builders:

Interpret Data

Identify options

Resolve issue with concerned party(s)

Assess options for corrective action

Implement selected option for correction

Document investigation with summary reports

Identify health and safety activities

BIL: Recommended – PC, ESA, ECA, HM, WEM

EDU:	12	AD
PC		I
ESA		I
HS		
ECA	I	R
HM		I
WEM	I	R
FWM		
GIS		

Competency 10.8: Assess water systems

Competency Builders:

- Complete a water quality assessment on a local surface water body
- Complete a ground water quality assessment within a well head protection area
- Develop a NPDES Plan for a construction site
- Complete a surface water assessment within a watershed
- Develop a primary and secondary containment system
- Evaluate the efficiency of a treatment facility
- Conduct a sediment study to determine best management practice

BIL: Essential – ESA
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 10.9: Assess air systems

Competency Builders:

Conduct air emission inventory

Monitor indoor air quality

Assess pollution control system

Monitor auto emissions

Monitor volatile organic compounds (VOC)

BIL: Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		
HS		I
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 10.10: Manage solid waste systems

Competency Builders:

Select a municipal solid waste site (MSW)

Audit a MSW

Identify resources available through recycled solid waste

Draft a proposal to improve the control of solid waste management

Develop and maintain satellite accumulation area (SAA)

Draft/revise a chemical hygiene plan (OSHA 29 CFR 1910.1450) [R-HS]

Unit 11: Plant Science

BIL: Essential – ESA, WEM, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	P	R
HM		
WEM	P	R
FWM	P	R
GIS		

Competency 11.1: Explain plant structure and uses

Competency Builders:

List the parts of the plant and their functions including: seed (embryo, cotyledon, groat), root (tuber, rhizome, stolon, corm, bulb), stem (xylem, phloem, pith), leaf (blade, lobe, cotyledon, auricle, ligule), meristem (apical, dominant, terminal, auxiliary bud), and flowers (anther, stamen, style, ovary)

Contrast dicots and monocots based upon meristematic locations and reproductive structures

Describe the uses of plants (e.g., food, feed, fiber, soil, wood, recreation, erosion control, nutrient recycling, medicinal, industrial-dyes, chemicals)

Differentiate among perennials, biennials and annuals

Differentiate between seed crops and vegetative crops

Describe the life cycle of a crop plant (i.e., from seed to vegetative stage to reproductive stage to seed)

Identify the characteristics used in plant identification (e.g., leaf type and arrangement, type of fruiting structures, type of root system, stem characteristics)

BIL: Essential – ESA, FWM
Recommended – ECA, WEM

EDU:	12	AD
PC		
ESA	P	
HS		
ECA	I	R
HM		
WEM	I	R
FWM	I	P
GIS		

Competency 11.2: Describe the physiology of plants

Competency Builders:

Identify the parts of a plant cell and the function of each part

Describe the process of photosynthesis

Describe the function of the chlorophyll molecule

Describe the process of respiration

Write a simplified word and symbol formula of photosynthesis and respiration

List conditions that affect photosynthesis

Compare the processes of photosynthesis and respiration

Explain the process of osmosis

Describe the basic make-up and function of carbohydrates (sugars and starches), lipids (fats and oils) and proteins (structural and enzymatic)

BIL: Essential – FWM
 Recommended – ESA, WEM

EDU:	12	AD
PC		
ESA	I	R
HS		
ECA		
HM		
WEM	I	R
FWM	I	P
GIS		

Competency 11.3: Explain plant nutrition

Competency Builders:

Explain how available nutrients, leaching, element, organic fertilizer, and inorganic fertilizer impact plant nutrition [R-WEM]

Identify the primary elements and their functions in plant growth

Explain green manure crop

Explain the relationship of adequate fertilization to yields

Explain the relationship of tillering in grain crops

Explain the relationship of return on investment in crop production

Describe purpose of inoculation of legume seeds with nitrogen fixing organisms

Explain minimum, optimum, and luxury consumption of soil nutrients by the plant [R-WEM]

Compare nutrients in the soil versus what plants get from air and water

BIL: Recommended – ESA, FWM

EDU:	12	AD
PC		
ESA	I	R
HS		
ECA		
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WEM		
FWM		I
GIS		

Competency 11.4: Evaluate plant fertilization techniques

Competency Builders:

Identify the micro-nutrients needed in plants and their chemical symbols

Identify deficiencies caused by minor element deficiency

Differentiate between organic and inorganic fertilizers

Identify global uses of inorganic and organic fertilizers

Describe the pollution hazards associated with over fertilization

Evaluate the latest techniques used to dispense only required amounts of fertilizer for crops

BIL: Recommended – ESA, ECA, FWM

EDU:	12	AD
PC		
ESA	I	R
HS		
ECA	I	R
HM		
WEM		
FWM		I
GIS		

Competency 11.5: Identify environmental factors affecting plants

Competency Builders:

Identify external influences on plant growth

Explain photoperiodism and dormancy in plants

Evaluate the effects of plant hormones (e.g., auxins, gibberellins, and cytokinins) on plant growth

Evaluate the commercial uses of auxins

Describe the various tropic responses

Explain the cause of gnostic movement

List some warm and cool season crops

List optimum growth conditions for different types of plants

Explain how crops may be managed to maximize environmental resources (e.g., establishing crop canopies to intercept 100% of light energy prior to fruiting, planting at a date that ensures sufficient biomass to attain maximum yield)

Describe the influence of day length on plant growth

Explain how the cycle of the seasons influences plant growth

Identify how planting date, row spacing, and plant population affect crop yield and quality

BIL: Essential – WEM, FWM
Recommended – ESA, GIS

EDU:	12	AD
PC		
ESA	I	R
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ECA		
HM		
WEM		P
FWM	I	P
GIS		I

Competency 11.6: Conduct vegetation analysis

Competency Builders:

- Demonstrate the proper use of field instruments
- Conduct a quadrant analysis
- Conduct a line transect analysis
- Conduct a belt transect analysis
- Conduct a random pairs analysis
- Perform a comprehensive ecological study of a forest

EDU:	12	AD
PC		
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ECA		
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WEM		
FWM		I
GIS		

Competency 11.7: Explain methods to improve plant seed quality

Competency Builders:

- Explain how heredity, genetics, inbreeding, crossing, progeny, self-fertilization, cross-fertilization, mutation, hybrid, systemic pesticide, toxic, and vigor impact seed quality
- Explain seed development, morphology and composition
- List the characteristics of good seeds
- Describe the factors that create poor seed quality
- Describe the history of crop improvement
- List major aims of plant breeders
- Describe three methods of crop improvement
- Identify state agency responsible for seed certification
- Describe major points and economic aspects to consider when identifying varieties for planting
- Explain the danger of monogenetic type crops (e.g., southern corn blight)
- Evaluate the possible impact of genetic engineering
- Describe breeding for pest resistance (insects, nematodes, and diseases)
- Describe the classes of seed (e.g., breeders, registered, certified)
- Differentiate between hybrid seed and seed from open pollinated or self-fed plants
- Explain how a "hard seed coat" can be used to maintain high quality seed
- Explain why plant breeding takes several years
- Explain why breeders have to constantly be developing improved varieties

BIL: Recommended – ESA, FWM

EDU:	12	AD
PC		
ESA	I	R
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ECA		
HM		
WEM		
FWM	I	R
GIS		

Competency 11.8: Control weeds

Competency Builders:

List ways weeds spread

List reasons weeds are harmful

Explain the following methods of controlling weeds (e.g., mechanical, biological, IPM)

Explain mode of action of common herbicides

Explain weed resistance to herbicides

Evaluate possible applications of genetic engineering and gene splicing to weed control

Explain how a spray system works (pump, pressure regulator)

Explain how herbicides kill weeds

Explain why some herbicides are applied before or after a crop is planted

Explain why weed problems depend on when they occur during growing season of crop

Identify the major weed species and options available for controlling each

Apply herbicide(s)

BIL: Essential – WEM
 Recommended – FWM

EDU:	12	AD
PC		
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HS		
ECA		
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WEM		P
FWM		I
GIS		

Competency 11.9: Explain moisture control

Competency Builders:

Identify the impact of irrigation, mulch, organic matter, runoff, seepage, subsoiling, and tillage on moisture control

List three methods of moisture control

List the cultural practices used in moisture control (annually and at planting)

Describe importance of internal and external drainage in soils for crop production

Describe importance of irrigation to crops

Describe the methods of irrigation (e.g., drip, furrow, sprinkler, flood)

Explain the unique properties of water

Describe the world's water supply by volume and percent usable

Explain how irrigation causes salinity problems

Describe several regions of the world where salinity has stopped entirely or decreased crop production

Explain salt water intrusion in irrigation wells

Describe desalination possibilities for irrigation water

Explain subsidence caused by removal of irrigation water

Describe methods used to reduce irrigation water loss

Explain the use of tensiometers and moisture meters

Describe the idea of permaculture

Explain irrigation scheduling

BIL: Essential – FWM
Recommended – ESA, ECA, WEM

EDU:	12	AD
PC		
ESA	P	
HS		
ECA	I	
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 11.10: Classify plants

Competency Builders:

Describe the classifications system of living things according to the Kingdoms of Monera (Prokaryotic Cells), Protista (Eukaryotic Cells), Animalia, and Plantae

Describe the different levels of classification within the plant kingdom

Explain the differences in the classes Gymnospermae and Angiospermae

Explain Carolus Linnaeus' binomial system of classification for genus and species

Explain the significance of species plant breeding

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA		
HM		
WEM		
FWM		
GIS		

Competency 11.11: Evaluate the role of genetics in environmental systems

Competency Builders:

Describe the role played by chromosome, gene, DNA, RNA, genotypes, phenotypes, heterozygous, homozygous, alleles, hybrid, inbreeding, hybrid vigor, polyploidy, molecular biology, genetic engineering, genes, sexual crossing, genome, vectors, gene transfer, natural identification, artificial identification, heredity, chromosomes, gene-splicing, gene cloning, toxins, pathogens, and biological control in genetics

Describe mitosis

Describe meiosis

Explain incomplete dominance

Explain the cause of mutation

Describe the occurrence of multiple alleles

Explain the importance of mass identification

Describe the contributions of scientists to applied genetics (e.g., Burbank, Mendel)

Explain the "Green Revolution"

Evaluate the possible impact of genetic engineering to plant improvement

Evaluate possible applications of genetic engineering and gene splicing on pest control

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 11.12: Propagate plants

Competency Builders:

Contrast sexual and asexual propagation

Identify factors that affect seed germination

Describe mass propagation through tissue culture

Identify some of the pitfalls to avoid in propagating plants

Describe the soil chemical and physical properties that influence seed germination and emergency

Evaluate anthroculture and gene splicing as methods for genetic improvement

Explain biotechnology as it relates to plant improvement

Compare organic farming to standard production systems

Describe hydroponic crop production

BIL: Essential – FWM
Recommended – ESA

EDU:	12	AD
PC		
ESA		I
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 11.13: Identify plant diseases

Competency Builders:

Identify major causes of plant diseases

Identify the symptoms and effects of major diseases on plants

Identify several methods by which diseases are transmitted in plants

Identify environmental conditions that favor or hinder disease development

BIL: Recommended – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS		

Competency 11.14: Control plant diseases and pests

Competency Builders:

Explain the "disease triangle"

Evaluate cultural practices that may be used to prevent plant diseases

Evaluate the impact of genetic engineering on control of plant disease

Explain how chemicals control diseases

Evaluate how genetic resistance reduces production costs and potential environmental impact from spraying

Evaluate the economic importance of controlling plant diseases

Employ safety precautions in handling pesticides

Control plant diseases through fumigant, fungicide, resistance, sprays, dust, volatile, crop rotation, and sanitation

Identify control methods of plant pests (e.g., insects, slugs, worms, nematodes)

BIL: Essential – ESA, WEM, FWM

EDU:	12	AD
PC		
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 11.15: Explain aquatic biology

Competency Builders:

Identify and classify aquatic plants, including algae, fungi and aquatic insects

Explain eutrophication principles

Describe stream pollution and species diversity

Describe effects of algae on water quality

Unit 12: Soil Science

BIL: Essential – ESA, ECA, HM, WEM, FWM
Recommended – PC

EDU:	12	AD
PC	I	R
ESA	P	R
HS		
ECA	P	R
HM	P	R
WEM	I	P
FWM	I	P
GIS		

Competency 12.1: Describe soil geology

Competency Builders:

Identify the four major layers of the earth

Identify classes of rock (e.g., igneous, sedimentary, metamorphic)

Match rock classes with their mode of origin

Classify common rocks (e.g., sandstone, limestone, shale, slate, marble, quartzite, granite, obsidian)

Identify particles of varying size and density

Explain how materials deposited in the ocean form sedimentary rock

Explain how rocks change from one form to another

Explain the relationship of minerals to granite

Describe soil formation

Differentiate among the major types of parent material

Identify the factors that exert the most influence on soil formation

List the forms of plant life found in poor soil conditions

Explain how different climatic conditions affect soil formation

Differentiate between surface soil and subsoil

Identify the soil horizons in a soil profile

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	P	R
HS		
ECA	I	R
HM	I	R
WEM	I	R
FWM	P	R
GIS		

Competency 12.2: Describe composition of soil

Competency Builders:

List the main components found in a normal soil

Explain the composition of the solid part of the soil

Describe the main sources of organic matter

List the approximate percentage in which each of the soil properties is found in a normal soil

Differentiate between soil low in organic matter and soil high in organic matter

Explain the value of each soil component with regard to proper growth of plants

BIL: Essential – ESA, FWM
 Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	R
FWM	P	R
GIS		

Competency 12.3: Identify physical properties of soil

Competency Builders:

Interpret the organic matter content of the surface soil using soil color

Interpret internal drainage of the subsoil by observing soil color

Differentiate between "light" and "heavy" soils

Determine the texture of a soil sample

Classify soil samples using the textural triangle as a guide

Explain the effects of soil structure on productivity

Explain why dark color is not always due to organic matter content

Explain the effects of organic matter on soil structure

Describe the effects of soil structure on infiltration, percolation, and the potential for ground water contamination

Explain how soil type affects crop identification

Compare root restricting boundaries (plow pan, fragipan, etc.)

Describe factors that contribute to the information of tillage or traffic pans

Describe methods for alleviating traffic pans (e.g., subsoiling, reduced tillage, no-till)

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM	I	P
GIS		

Competency 12.4: Describe the biological properties of soil

Competency Builders:

List the biological properties of soils

Explain how biological properties affect the nature and conditions of soil

Identify the microorganisms

List the soil microorganisms

List the soil microorganisms beneficial to farmers

Describe the role of higher forms of plant and animal life in soil

Explain the nitrogen cycle and phosphorus cycle

Explain where the energy comes from to carry out the nitrogen transformations

Identify common bacteria in the nitrogen cycle

Explain the symbiotic relationship between bacteria and plants

Specify where bacteria are located in the root of the plants

Explain nitrogen fixation

Identify the roles of different types of bacteria in nitrogen fixation

Describe the concept of mineralization and immobilization of plant nutrients by soil microorganisms

Explain the biological effects on soils when amended with fertilizers, pesticides, and recyclable materials such as municipal wastes

Describe the effects of poor drainage or waterlogging on soil properties and plant growth

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM	I	P
GIS		

Competency 12.5: Describe the chemical properties of soil

Competency Builders:

List the chemical properties of soil

Explain how chemical properties affect the biological properties of soil and the nature and conditions of the soil

Explain the chemical effects on soils when amended with fertilizers, pesticides, and recyclable materials such as municipal wastes

Describe the effect of sand, silt, and clay content on water and nutrient holding ability of soils (CEC-cation exchange capacity)

Explain how charges on clay particles affect nutrient retention

Compare different types of clay to soil nutrient availability

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	P	R
FWM	P	R
GIS		

Competency 12.6: Describe soil acidity and alkalinity

Competency Builders:

Create a chart of the pH scale to show degrees of soil acidity and alkalinity

Conduct laboratory tests for acidity of common products (e.g., fresh milk, sour milk, orange juice, and lemon juice)

Explain how calcium affects soil acidity and the availability of other elements

Explain how pH symbols are used in denoting the degree of acidity and alkalinity in soils

Describe the conditions that lead to soil acidity or alkalinity

List the pH ranges of the major crops

Explain how soil acidity or basicity is corrected

Explain how soil pH affects the availability of nutrients

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	P
FWM	P	R
GIS		

Competency 12.7: Test soil samples to determine characteristics

Competency Builders:

- Collect soil samples from test area
- Complete soil data forms
- Determine soil pH
- Conduct soil mineral and elemental analysis
- Record texture, structure, temperature, and color of each soil layer
- Construct a soil micro monolith of a soil profile or soil pit
- Analyze soil data
- Write report

BIL: Essential – ESA, FWM
Recommended – PC, WEM

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA		
HM		
WEM		I
FWM	I	P
GIS		

Competency 12.8: Explain liming to correct soil acidity

Competency Builders:

- List the benefits obtained from liming a soil
- List the steps involved in liming acid soils used for growing plants
- Explain how lime reduces soil acidity
- Explain how to determine the lime requirement for a specific crop
- Identify different kinds of lime materials
- Describe the appearance of plants growing in soils of different pH levels
- List some sources of commercial lime
- Describe different methods of applying lime and the type of equipment used
- Formulate a liming schedule for various crops
- Explain the effect of soil acidity on soil structure, water infiltration and soil aggregation
- List some problems and effects associated with over-liming soil
- Explain how lime particle size affects its ability to reduce soil acidity
- List several materials that can be used to increase soil acidity or lower pH

BIL: Essential – ESA
Recommended – PC, ECA, FWM

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA	I	R
HM		
WEM		
FWM	I	R
GIS		

Competency 12.9: Identify nutrient requirements of plants

Competency Builders:

- Identify groups into which nutrient requirements of plants are divided
- Describe the interactions of nutrient availability levels on nutrient toxicity and deficiency
- Identify toxicity symptoms caused by excessive manganese and aluminum
- Identify major sources of N, P, K, S, Ca, and Mg in soils
- Identify factors that influence the availability of these nutrients in soils
- Explain how soil pH affects nutrient availability
- Explain how different types of root systems affect plant nutrient uptake

BIL: Recommended – PC, ESA, FWM

EDU:	12	AD
PC		I
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM	I	R
GIS		

Competency 12.10: Differentiate between organic and inorganic fertilizers

Competency Builders:

Identify sources of inorganic fertilizers

Identify sources of organic fertilizers

Identify the main plant nutrients supplied by inorganic and organic fertilizers

Identify multinutrient fertilizers

Explain how plants obtain carbon, oxygen, hydrogen, nitrogen, phosphorus, and potassium

Differentiate between a fertilizer grade and a fertilizer analysis

Explain fertilizer ratio

Explain where most of the nitrogen in the soil is derived

Describe the advantages and disadvantages of dry versus liquid fertilizer

Explain the advantages of foliar fertilization

Identify the factors that influence the efficiency of applied fertilizer such as leaching or fixation

BIL: Recommended – PC, ESA, FWM

EDU:	12	AD
PC		I
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM	I	R
GIS		

Competency 12.11: Describe fertilizer application

Competency Builders:

Explain variable rate fertilization using GPS

Explain the economic factors to consider in buying fertilizers

Describe the methods of applying solid and liquid fertilizers

Explain the purpose of the different placements of fertilizer in the soil, and the relation these placements have to the seed and the growing plant

List the ways fertilizer benefits crop production

Explain how fertilizer applications can decrease crop production

Identify possible losses of each major nutrient and their influences on quality of water in lakes and streams, groundwater quality, and atmospheric quality

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	P
HM		I
WEM	I	P
FWM	I	P
GIS		

Competency 12.12: Explain classification of soil water

Competency Builders:

Compare gravitational, capillary, and hygroscopic water

Demonstrate the water-holding capacities of sandy and clayey soils

Determine soil water availability

List ways available water can be lost by soils

Identify factors in determining water movement in the soil

Explain the main purpose of water conservation

Explain how production techniques influence the efficiency with which water is utilized by plants

Explain water holding capacity and how to determine field soil moisture

Explain the impact of texture and structure on field capacity

BIL: Essential – PC, ESA, WEM, FWM
Recommended - GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	P
GIS	I	R

Competency 12.13: Explain the relationship between soil classifications and land use

Competency Builders:

List the physical features of land and soil necessary for classifying land

Explain the characteristics of each of the land classes

Explain how land capability classes are recorded for use

Explain how topography results from rock type and the opposition of internal and external forces acting on the land surface

Construct a simple topographic map from a three-dimensional model

Demonstrate how chemical and physical weathering work together

Explain how soil relates to the weathering process

Differentiate among topsoil, subsoil, and parent (weathered) rock

Explain permeability

Differentiate between permeability and porosity

Identify the equipment needed to classify soils

Identify the management practices followed to obtain maximum yields and proper soil conservation

Differentiate among different soil structures and textures

Differentiate between erosion and weathering

Describe the role of gravity as the force behind erosion

Explain how vegetation and type of rock affect weathering rate

Identify the agents of erosion, their relative effect, and action to gravity

Explain why and how glaciers move

List evidences of glaciation

Explain why water is the principal agent of erosion

Explain how slope and velocity increase the rate of erosion

Identify landforms that will result from stream action, (e.g., deltas, meanders, flood plains, oxbow lake, cut bank, sand bars)

Explain how forces within the earth cause uplift or mountain building

Explain folding

Differentiate among normal, reverse, and horizontal faults

Explain plate tectonics (cause) and continental drift (effect)

Explain convection currents

Explain how the occurrence of faults relates to earthquakes

Explain how seismographs record earthquakes

Differentiate between the focus and the epicenter

Explain tsunami

Describe how use of land is affected by soil depth, texture, permeability, slope, surface drainage, and degree of erosion

Differentiate among types of water erosion

Explain why soil erosion is very important to land evaluation

Describe the major types of erosion

Identify the factors that influence erosion of soil

Evaluate the effectiveness of erosion prevention procedures

Evaluate land use for construction purposes

Unit 13: Hydrology

BIL: Essential – PC, ESA, HM, WEM, GIS
Recommended – ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS	I	P

Competency 13.1: Explain hydrology

Competency Builders:

Describe the hydrologic cycle

Differentiate between the surface hydrologic system and the subsurface hydrologic system

Explain the role of a hydrologist and a hydrogeologist

Identify terminology used in groundwater hydrology

Explain watersheds in relationship to groundwater table

Describe the basic concepts of flow of groundwater in various well models

Identify geologic conditions for determining the potential groundwater supply in various lithologic settings

BIL: Essential – PC, ESA, HM, WEM
Recommended – ECA, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM	I	P
WEM	I	P
FWM	I	R
GIS	I	R

Competency 13.2: Explain geologic and meteorologic principles affecting groundwater supply

Competency Builders:

Explain evaporation, transpiration, and evapotranspiration

Describe the relationship between precipitation and aquifer recharge

Determine basic rock type of drill cuttings and their relative importance to groundwater potential

Determine the porosity of unconsolidated sediment in relation to grain size, grain distribution and composition

Determine relative permeability of unconsolidated sediment

Explain the relationship between specific retention and the specific yield of various rock types and characteristics

Calculate the basic hydraulics involved with groundwater flow including velocity, hydraulic head, and potential flow

Describe the basic concepts of flow of groundwater in various well models

Identify geologic conditions for determining the potential groundwater supply in various lithologic settings

BIL: Essential – ESA, WEM
Recommended – PC, ECA, HM, FWM, GIS

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA		I
HM	I	R
WEM	I	P
FWM		I
GIS		I

Competency 13.3: Conduct channel flow analysis

Competency Builders:

Identify open channel flow equipment

Measure open channel flow

Characterize open channel flow

Calculate open channel flow

BIL: Essential - ESA
Recommended – PC, ECA, HM, WEM, GIS

EDU:	12	AD
PC		I
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

Competency 13.4: Identify basic criteria for water well design

Competency Builders:

Identify various forms of well records

Determine subsurface structure and flow patterns

Describe basic methods of drilling

Differentiate between production, injection, and monitoring wells

Describe a basic water well system for production, injection, and monitoring

Identify applicable regulations/permit procedures

Identify well development requirements

Identify problems that may develop over the lifetime of a well

Identify well performance characteristics (e.g., flow rate, draw down)

Identify aquifer characteristics that may affect performance

BIL: Essential – PC, ESA, WEM
Recommended – ECA, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		I

Competency 13.5: Identify differences in groundwater potential

Competency Builders:

Identify various geologic regions in the state

Describe the occurrences of groundwater in these geologic settings

Identify important aquifers in these geologic settings

Identify groundwater regions of the United States

Identify important aquifers in the United States

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended – FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	P
HM	I	P
WEM	I	P
FWM		I
GIS		I

Competency 13.6: Identify environmental hazards associated with groundwater supplies

Competency Builders:

Describe standard water quality tests

Identify various sources of contamination

Identify methods of restoration of groundwater supplies

Explain water law

Explain the environmental policies regarding groundwater supplies

Identify elements necessary for developing a study of potential groundwater contamination

Unit 14: Pollution Control I

BIL: Essential – PC, ESA, ECA
 Recommended – HS, WEM, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM		I
FWM		I
GIS		

Competency 14.1: Identify presence of pollution

Competency Builders:

- Evaluate complaints
- Verify complaints
- Determine extent of hazard
- Prioritize complaints
- Determine jurisdictions
- Monitor instrumentation
- Photograph and/or video site
- Analyze data
- Interpret results
- Report violations

BIL: Essential – PC, ESA, ECA
 Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	E
ECA	I	P
HM		
WEM		I
FWM		
GIS		

Competency 14.2: Perform environmental sampling

Competency Builders:

Make and record observations

Conduct interviews

Identify sampling instruments

Identify appropriate sampling protocols

Calibrate sampling instruments

Take readings

Determine sample types

Identify sampling containers

Take samples

Preserve samples

Analyze samples

Complete chain of custody

BIL: Essential – PC, ESA
Recommended – ECA, WEM

EDU:	12	AD
PC	I	P
ESA		P
HS		
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 14.3: Describe environmental impact from industrial and non-industrial processes

Competency Builders:

Compare input flow vs output and waste stream flows from industrial as well as non-industrial (agricultural) processes

Identify pollution prevention applications

Describe environmental economic impact statements for an industrial process

Unit 15: Pollution Control II

BIL: Essential – PC, ECA, HM
Recommended – ESA, HS, WEM

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		I
GIS		

Competency 15.1: Manage pollution

Competency Builders:

Determine applicable regulations

Control emissions and discharges from sources

Install containment barriers

Reroute source

Implement corrective actions

Implement contingency plan

Monitor levels of pollution

Develop episode control plan

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 15.2: Quantify extent of pollution

Competency Builders:

Conduct field survey

Determine sampling points

Determine threat to public health and safety

Sketch site

Notify appropriate officials/agencies/personnel

Initiate further studies

Develop episode control plan

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 15.3: Locate sources of pollution

Competency Builders:

- Plan search activities
- Examine documentation history
- Conduct search activities
- Take measurements [R-HS]
- Sample for source of pollution
- Conduct mechanical tests
- Correct mechanical defects

BIL: Essential – PC, ESA, ECA, HM
 Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 15.4: Monitor remediation activities

Competency Builders:

Describe procedure for monitoring pollution abatement at the source

Describe methods for monitoring magnitude of pollution [R-HS]

Describe procedure for monitoring clean-up [R-HS]

Assess impact of the event

Monitor the pollution abatement

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	R
HS	I	R
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		

Competency 15.5: Conduct Remediation Activities

Competency Builders:

Initiate pollution abatement at the source

Investigate alternative technologies

Recommend methods of cleanup

Participate in the implementation of the remediation activity

BIL: Essential – PC, ECA, WEM
Recommended – HM

EDU:	12	AD
PC	I	P
ESA		
HS		
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 15.6: Establish pollution management and prevention program [E-PC]

Competency Builders:

- Determine possible sources of pollution
- Assess liability of possible pollution sources
- Establish purchasing policies
- Assess material substitution
- Assess incoming materials
- Develop proper handling procedures
- Communicate importance of RRR (reduce, reuse, and recycle)
- Participate in pollution prevention pledge program
- Recommend/implement process modifications
- Eliminate cross media (pollution) transfer
- Assess research needs and pending legislation

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 15.7: Monitor ground and surface water pollution

Competency Builders:

Describe aquatic biological systems

Identify types and sources of water contamination

Collect water samples for analysis

Measure water samples for pH, chloride, turbidity, dissolved solids, biotoxicity, and dissolved oxygen

Investigate watershed boundaries and drainage patterns

Monitor water levels of rivers, streams, ponds and lakes

Identify non-point source hazards

Identify accepted water quality standards for effluent

Demonstrate the technology applied to non-point source pollution control (e.g., stormwater and agriculture runoff)

Monitor water quality (in/out)

Monitor water use (in/out)

Determine water conservation options

Implement water conservation strategies

Analyze water samples

Assess treatment options

Explain impact of exotic species and other growth organisms

Monitor water temperature

Monitor receiving water impacts

Describe legal aspects and consequences of water pollution

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 15.8: Monitor air pollution

Competency Builders:

List the regulated parameters identified industrial source emissions

Describe air pollution control devices used to control emissions of sulfur oxides, nitrogen oxides, particulates and volatile organic contaminants

Measure the air pollutant of a specific source

Interpret laboratory analyses

Explain exhaust system maintenance

Operate IH monitoring equipment

Explain air make-up system maintenance

Maintain controls to minimize odor

Measure vibration levels

Measure source air emission quality

Calculate dispersion and emission rates

Control fugitive emissions

Assess pollution control system

Advise engineering design of air pollution systems

Identify off-property environmental impact

Interpret meteorological data

BIL: Essential – PC, HS, ECA
Recommended – ESA

EDU:	12	AD
PC	I	P
ESA	I	R
HS	I	P
ECA	I	P
HM		
WEM		
FWM		
GIS		

Competency 15.9: Monitor noise pollution

Competency Builders:

Identify the physical properties of sound

Describe the threshold of hearing, tolerance, and hearing loss

Describe environmental noise

Analyze legal aspects and consequences of noise pollution

List sources of noise pollution

List the control devices for different noise sources

Measure noise levels

BIL: Essential – HS, ECA, HM
Recommended – PC, ESA

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	P
ECA	I	P
HM		P
WEM		
FWM		
GIS		

Competency 15.10: Monitor radioactive contamination

Competency Builders:

- Describe radiation and radioactive decay
- Identify types and sources of radiation, including radon
- Describe radiation exposure and dosimetry experiments
- Describe immediate and long range effects of radiation on plants and animals
- Explain nuclear power hazards and safety features
- Describe legal aspects and consequences of radioactive pollution
- Measure radioactivity
- Use radioactive measurement equipment
- Identify certifications required for handling radioactive materials

Unit 16: Chemical Technology

BIL: Essential – PC, ESA, HS, ECA, HM, WEM
Recommended - FWM

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS		

Competency 16.1: Explain basic chemistry principles

Competency Builders:

Explain and describe the properties of matter

Explain chemical terms (e.g., elements, molecules, chemical reactions, bonding, compounds, mixtures)

Describe the organization of the periodic table

Diagram a model of an atom labeling the protons, neutrons, and electrons and their charges

Explain how atoms combine to form molecules

Differentiate among isotopes

Identify the properties of a mixture

Describe solutions and suspensions

Predict the number of different substances in a mixture

Differentiate among acids, bases, minerals, and salts

Differentiate organic and inorganic material

Identify chemical processes and procedures that are controlled or monitored

Describe chemical equations

Explain basic material balancing including the effects of chemical concentrations and solutions

Calculate the amounts of reactants and products in a process reaction (using stoichiometry)

Explain how process variables and catalysts can affect reaction rates

Explain how process variables affect equilibrium reactions

Differentiate between a physical change and a chemical change

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended – HS, FWM

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS		

Competency 16.2: Apply chemical laboratory skills

Competency Builders:

Identify chemical abbreviations (e.g., English and AIUPAC)

Interpret chemical equations and specifications

Analyze graphs and charts

Describe common chemical laboratory equipment

Identify safety supplies appropriate to task

Operate safety equipment

Handle hazardous reagents, hot materials, sharp objects, and contaminating materials

Wear appropriate safety clothing

Identify appropriate glassware for task

Weigh chemical reagents to prepare solutions or stains

Mix chemicals to prepare reagents, solutions or stains

Store prepared solutions and stains to maintain optimal condition

Measure pH electronically and manually

Employ extraction procedures on organic analytes

Filter substances to obtain residues

Describe typical laboratory procedures (e.g., heating, cooling, filtration, glassware set-up, distillation, weighing, measuring, pipetting, volumetrics)

Calibrate containers, flasks, balances, safety testing equipment

Clean and decontaminate work areas

Respond to a laboratory spill

Practice safe and proper use of equipment

Identify storage containers that are compatible with the materials to be stored

Mix acids and bases with other materials

Clean with solvents, acids, and detergents

Demonstrate proper titration techniques

Care for desiccators and centrifuges

Describe the physical and chemical properties of common materials and implications for storage

Prepare dilutions in (grams, milligrams, molarity, normality, and ratios)

Set up vacuum and pressure transfer system

Transfer liquids, solids, and gases

Prepare solutions

Obtain representative samples

Maintain electrodes

Change pressurized cylinders

Demonstrate the proper use of pressurized cylinders

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 16.3: Calculate and measure in the laboratory

Competency Builders:

Calculate quantities needed to perform a test analysis

Measure volume of a solution to perform a laboratory test

Measure temperatures

Calculate unit conversions

Calculate concentrations

Measure using MKS system

Calculate linear regression curves

Plot calibration curve

BIL: Essential – PC, ESA, ECA, WEM
Recommended – HS, HM

EDU:	12	AD
PC	P	R
ESA	I	P
HS	I	R
ECA	P	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 16.4: Maintain laboratory equipment and supplies

Competency Builders:

Wash laboratory equipment

Sterilize equipment to decontaminate soiled materials

Inventory supplies and equipment

Prepare equipment for tests

Demonstrate procedures to ensure optimal working condition of equipment and devices

Demonstrate procedures to ensure optimal shelf life of chemicals

Demonstrate procedures to ensure safe storage of chemicals

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA		P
HS	I	R
ECA	I	P
HM	I	R
WEM		P
FWM		
GIS		

Competency 16.5: Analyze air, water, and solids in the field

Competency Builders:

Monitor stack and fugitive emissions

Sample gases

Analyze gases

Describe pollution control practices

Describe measurements of flow rates

Operate hand-held gas monitor

Monitor and sample wastewater influent and effluent

Analyze physical properties of solids and liquids

BIL: Essential – ESA
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 16.6: Design experiments

Competency Builders:

Conduct on-line literature search

Identify resources (e.g., people, equipment, chemical, and methods)

Gather chemicals and resources

Create a statistical design for the experiment using a quality model

Design control ranges

Write procedures

Design and run computer simulations

BIL: Essential – ESA
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 16.7: Implement new experiment methods

Competency Builders:

Verify method's compliance with regulations

Initialize automated experiments

Monitor automated experiments

Evaluate results

Present results

Assess and redesign experiments as necessary

Implement results as appropriate

Create and report conclusions or final results

Document all phases of the work

EDU:	12	AD
PC	P	R
ESA	I	P
HS	P	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 16.8: Handle chemical materials in accordance with standard safety practices

Competency Builders:

Prepare materials for testing and analysis

Describe the characteristics of chemical materials that are applicable to storage and handling (e.g., toxicity, health effects, flammability, reactivity, sensitivity, stability, and compatibility with other materials)

Classify organic and inorganic compounds

Write generalized formulas

Write the symbols for the elements

Describe the characteristics of the common groupings of elements

Describe the basic reactions that occur between commonly used chemical compounds

Complete the proper paperwork associated with receiving materials

Transfer materials to storage or processing units

Identify containers

Prepare and store samples and materials

BIL: Essential – PC, ESA, ECA, WEM
 Recommended – HS, HM

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 16.9: Conduct physical tests: temperature, solids to moisture, paint filter, residual solids, layers, color, odor, vapor pressure, viscosity, slump, and flash/flammability tests

Competency Builders:

Obtain representative samples

Prepare samples for tests or analyses

Choose appropriate test equipment to make a required measurement

Check instruments for correct operation

Prepare or acquire calibration standards

Calibrate equipment

Test or analyze control "standard" samples

Calculate results and compare with control values

Analyze samples within statistical range,

Troubleshoot causes of error by repeating calibration and instrument check

Record and Tcer Tcet data

Clean and maintain apparatus

Characterize the physical properties of gases, liquids, and solids and describe their reactions to changes of temperature and pressure

Identify appropriate equipment for measuring major physical properties based on specified accuracy and precision requirements

Apply ASTM and/or other standard procedures for specific chemical and physical tests

Collect samples to represent bulk materials to be characterized by physical tests

Develop control charts and determine lower control limits for each

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 16.10: Perform chemical analysis

Competency Builders:

Obtain representative samples

Record characteristics

Respond to problems by reading test documents or procedures and implementing appropriate information

Identify the appropriate equipment for the analysis to be conducted

Gather and clean the necessary glassware, reagents, and chemicals

Calibrate the electrodes and other equipment required to carry out the specified analysis

Prepare and standardize reagents

Analyze standards or control samples using specified techniques

Analyze sample

Calculate results to appropriate significant figures

Present results for single samples and to display trends

Evaluate analytical results and respond appropriately

Identify conditions that indicate need for an analysis to be repeated

Report data

Modify or develop analytical methods to be appropriate to necessary test methods, required analyses, implementing personnel qualifications, and working environment where methods are to be used

Select the proper procedure to sample a bulk material

Prepare samples for analysis, including digesting, ashing, extracting, dissolving, grinding, and removing impurities as appropriate prior to analysis

Use standard separation techniques such as ion exchange and column chromatography

Describe the principles and applications of volumetric analysis

Balance chemical equations involving acid/base, redox, and other chemical reactions

Describe the use of pH in characterizing chemical systems

Measure pH using both wet and instrumental methods

Calculate normality, gram equivalents, molarity, and molality of solutions

Describe the characteristics of acids and bases and the chemistry

Describe the chemical, thermodynamic, and chemical kinetic characteristics of materials that can undergo oxidation/reduction reactions

Standardize acid and base solutions of different concentrations (e.g., molarity, molality)

Apply chemistry concepts to measurements

Conduct analytical tests using acid/base titrations, filtrations, and oxidation/reduction titrations.

Apply Beer's law for calculating results

Describe techniques and instruments used for colorimetric analysis

Identify the techniques and devices appropriate for specific samples and accuracy requirements

Describe the principles of gravimetric analysis, and the tools used to conduct such analyses

Describe the processes of filtration and the effect of the filtering medium on the results

Describe the use of several electrochemical techniques

Apply specified information in standard procedural manuals and books, including those produced by ASTM, SM, SW846, NIOSH (McCaww

EPA 600), AOAC, 40 CFR Part 60 other groups that produce "standards", and government agencies that issue and/or monitor regulations

Perform extraction techniques including TCLP

BIL: Essential – ESA
Recommended – PC, ECA, HM

EDU:	12	AD
PC		I
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 16.11: Discuss methods to analyze unknown materials

Competency Builders:

Identify interfering materials

Modify analytical procedures

Develop new procedures for chemical analysis

BIL: Essential – ESA, ECA, HM
Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 16.12: Explain basic organic and inorganic chemistry principles

Competency Builders:

Explain molecular structure in terms of chemical bonding

Explain stoichiometric relations to chemical equations

Write formulas of identified compounds from their names and vice versa

Explain the principles of Charles', Boyle's, Graham's and Dalton's laws

Classify compounds into appropriate groups based on their properties

Explain quantitative relationships to express solution concentrations

Identify organic compounds through the interpretation of IR, mass spectroscopy and gas chromatography

Unit 17: Environmental Instrumentation

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	
FWM		
GIS		

Competency 17.1: Operate basic laboratory equipment and environment monitoring instruments (e.g., pH meter/ISE meter, compound microscope/dissecting microscope, sound level measuring devices, turbidimeter, conductivity meter, chlorine meter OVA, HNMU)

Competency Builders:

Prepare sample appropriately (e.g., use oil immersion lens, Bunsen/Fisher burner, balance, centrifuge, timing device autoclaves, hot air oven desiccators)

Select appropriate calibration method

Select appropriate calibration standards

Zero the instrument

Span the instrument

Measure samples

Record and store data

BIL: Essential – ESA, WEM
Recommended – PC, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 17.2: Perform chemical laboratory sample preparation

Competency Builders:

Perform chemical extractions

Perform gravimetric analysis

Perform wet chemical analysis including filtering, distilling, and titrating

Record anomalies

Calculate statistical uncertainties and deviations

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.3: Explain the use of chemical analytic instruments

Competency Builders:

Identify the analytical applications of mass spectrometers, chromatographs, spectrometers

Introduce prepared gas or liquid samples into chromatographs

Obtain quantitative chemical results

EDU:	12	AD
PC		
ESA		P
HS		
ECA		
HM		
WEM		
FWM		
GIS		

Competency 17.4: Perform analytical separation techniques

Competency Builders:

Describe the principles of gas chromatography and typical instrumentation

Separate mixtures of different materials

Describe the principles of liquid chromatography and typical HPLC instrumentation

Calibrate, operate, troubleshoot, and maintain apparatus and instruments

Describe principles of I.C.

BIL: Essential – ESA
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA		I
HM		I
WEM		I
FWM		
GIS		

Competency 17.5: Perform spectroscopic analysis using instruments such as: spectrophotometer/auto spectrophotometer, AA/graphite furnace, ICP, GC/MS, oxygen meter, IC, IR, FTIR X-ray diffraction nitrogen analyzer, mercury analyzer, FID/PID analyzer, and RAD meter

Competency Builders:

Describe the principles of spectroscopy (e.g., AA, IR, MS, UVIS)

Describe the instrumentation for AA, IR, MS, UVIS

Calibrate, operate, troubleshoot, and maintain spectroscopic instruments

Describe similarities and differences among the various instruments

BIL: Essential – ESA
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

Competency 17.6: Operate advanced laboratory and field equipment and instruments (e.g., HPLC, GC, bomb calorimeter, geiger mueller counter, explosimeters specific gas meters, carbon analyzer, microwave)

Competency Builders:

Prepare sample appropriately (e.g., use oil immersion lens, Bunsen/Fisher burner, balance, centrifuge, timing device autoclaves, hot air oven desiccators)

Select appropriate calibration method and standards

Zero and span the instrument

Measure samples

Record and store data

Make back-up copies of data

Demonstrate appropriate shut-down procedures

BIL: Essential – ESA
Recommended – PC, ECA, WEM

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 17.7: Use computers to interface with chemical analytical instruments

Competency Builders:

Explain how instrument output is collected and stored by the computer

Collect and store data

Manipulate and recall stored data from analytical instrument operations

Create graphs and data tables using computer applications prepared for chemical analysis instruments

Operate chromatographs, mass spectrometers, and electron microscopes using a computer interface

Use computers to determine instrument status and to troubleshoot chemical analytical instruments

BIL: Essential – ESA
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.8: Maintain instruments using gas systems

Competency Builders:

Change gas cylinder

Troubleshoot instruments

Start systems after unplanned and planned down time

Discuss use of diagrams to troubleshoot

Bring vacuum systems up and take vacuum systems down

Maintain maintenance and use logs

Maintain gas systems, including plumbing lines, reattaching regulators

Identify regulators and pressures

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.9: Calibrate chemical analytical instruments

Competency Builders:

Adjust filament voltages to tune mass spectrometers

Introduce standard compounds into gas chromatographs and change columns as needed to calibrate chromatograph

Run computer checks, components checks, and system checks

Adjust apertures and beam widths

Identify various deuterated solvents, and their chemical shifts

Recognize "spinning side bands" and ferromagnetic impurities

Run quality control samples

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.10: Operate mass spectrometers

Competency Builders:

Prepare samples for introduction into a mass spectrometer

Introduce samples into a mass spectrometer

Obtain mass spectra of specific compounds using a mass spectrometer as a single instrument or as part of a gas chromatograph, ion trap chromatograph, or inductively coupled argon plasma system

Calibrate mass spectrometers using appropriate calibration standards and by adjusting filament voltage

Clean the ion source

Maintain a mass spectrometer

Troubleshoot a mass spectrometer as a single instrument or as part of a gas chromatograph, ion trap chromatograph, or inductively coupled argon plasma system

Describe the abilities and limitations of chromatographs

Describe the physics of mass spectrometry

Perform spectral interpretation

Describe the relationships between thin layer, column, paper, gas chromatograph, ion chromatograph, supercritical fluid chromatograph

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.11: Operate chromatographs

Competency Builders:

Prepare samples for introduction into a chromatograph

Inject samples into a chromatograph

Calibrate a chromatograph using appropriate calibration standards and by cleaning or changing columns

Maintain a chromatograph, including changing cryogenic gas cylinders

Troubleshoot a chromatograph

Describe the capabilities and limitations of chromatography

Describe the physics of chromatography

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.12: Operate electron microscopes

Competency Builders:

Prepare samples for introduction into an electron microscope

Introduce samples into an electron microscope, including closing and opening the electron gun, emptying and restoring vacuum, and placing the sample

Obtain magnified images of organic and inorganic samples

Obtain elemental analysis of the surface of samples using an energy dispersive system coupled to an electron microscope

Adjust aperture, beam width, voltage, and current to obtain optimum image resolution

Calibrate an electron microscope and energy dispersive system

Maintain an electron microscope and energy dispersive system, including gas fills

Troubleshoot an electron microscope and energy dispersive system

Describe the mechanics of the electron gun, the vacuum system, and the sample stage

Describe the physics of electron microscopy for image magnification and energy dispersion for elemental analysis

Describe the relationships between resolution and aperture, beam width, voltage, magnifications, and current

BIL: Essential – ESA
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 17.13: Interpret quantitative and graphic output from chemical analysis instruments

Competency Builders:

Identify elements and/or chemical compounds present in a sample from graphic output

Identify relative concentrations of chemical elements and/or compounds present in a sample from graphic output

Quantify results of chemical analyses using numerical output

Record deviations and anomalies (interferents)

Write reports

BIL: Essential – ESA
 Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 17.14: Perform instrumental analysis

Competency Builders:

Obtain representative samples

Determine appropriate treatment of the sample prior to conducting an analysis

Prepare a sample for analysis

Identify the analytical instrument to be used as appropriate to the results needed and other constraints

Start up instrument by checking all connections, gas cylinders, and implementing procedures to ensure reliable results

Set all the instrumental parameters properly using manual and/or program microprocessor settings

Calibrate and standardize equipment and materials

Develop necessary calibration charts

Analyze standards and control materials

Evaluate results of testing or analyzing standards and control materials

Readjust operating parameters as necessary

Conduct analyses

Review and interpret results

Record results

Report results as appropriate

Perform routine maintenance

Shut down instrument

Clean up work area

Maintain and/or order spare parts necessary to ensure consistent operation

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 17.15: Operate and maintain flow instrument systems

Competency Builders:

Identify flow measuring sensors

Explain flow measuring principles

Identify instrument calibration standard units

Analyze systems using troubleshooting flow sheet

Identify displacement measurement methods

Identify the properties of fluid flow measurement

Identify primary and secondary measuring devices for fluid flow

Identify applications for variable area instruments

Identify open channel flow devices

Identify applications for positive displacement meters, turbine flow meters, magnetic flow meters, ultrasonic flow meters

Identify solid particle flow metering methods

Install flow instruments

Identify control valves

Identify control element applications

BIL: Essential – ESA
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.16: Operate and maintain pressure test instruments (e.g., manometers, vacuum pumps, pressure and vacuum gages)

Competency Builders:

Identify pressure measuring sensors

Explain pressure measuring principles

Identify instrument calibration standard units

Analyze systems using troubleshooting flow sheet

Identify pressure principles

Install, maintain, and service pressure instruments

Identify force, stress, and strain measurement units

Identify weight and mass measuring instruments

Identify pneumatic and hydraulic actuators

Identify applications of vacuum measuring methods

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 17.17: Service thermal measuring instruments

Competency Builders:

- Identify temperature measuring sensors
- Explain temperature measuring principles
- Determine temperature measuring instrument and sensor failures
- Troubleshoot temperature measuring instruments and sensors
- Remove and replace temperature measuring instrument and sensor components
- Check and make adjustments to temperature measuring instruments and sensors
- Determine calorific value measuring instrument failures
- Troubleshoot calorific value measuring instrument
- Remove and replace calorific value measuring instrument components
- Check and make minor adjustments to calorific value measuring instruments
- Identify and explain bimetallic and fluid-filled temperature measuring instruments
- Identify instruments that use electrical methods of measuring temperature
- Identify pyrometers
- Install temperature measuring instruments

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 17.18: Service physical property (sample control) measuring instruments

Competency Builders:

Identify physical property measuring instruments

Explain the principles of physical property measuring instruments

Identify instrument calibration standard units

Analyze systems using troubleshooting flow sheet

Identify level measurement instruments

Identify electrical methods for level measurement

Maintain and service level measuring instruments

Identify final control elements in process loops

Identify on-site safety standards and maintenance practices

Describe electrical and electronic servicing stations

Describe troubleshooting requirements

Troubleshoot and repair density and specific gravity measuring instruments

Check operating systems

Adjust density and specific gravity measuring instruments

Troubleshoot and repair humidity measuring instruments

Check humidity measuring instruments operating systems

Adjust humidity measuring instruments

Troubleshoot and repair moisture content measuring instruments

Check systems moisture content measuring instruments

Adjust systems moisture content measuring instruments

Troubleshoot and repair viscosity measuring instruments

Check viscosity measuring instruments

Adjust viscosity measuring instruments

BIL: Recommended – PC, ESA, HS, ECA

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 17.19: Service chemical property measuring instruments (e.g., O2 meter, spectrophotometer, atomic absorption spectrophotometer inductively coupled plasma, ion chromatography, infrared)

Competency Builders:

- Troubleshoot and maintain analytical measuring instruments
- Perform operating systems checks and make minor adjustments to analytical measuring instruments
- Troubleshoot and maintain pH measuring instruments
- Check and make minor adjustments to pH measuring instruments
- Troubleshoot and maintain liquid conductivity measuring instruments
- Check and make adjustments to liquid conductivity measuring instruments
- Troubleshoot and maintain chromatograph measuring instruments
- Check and make minor adjustments to chromatograph measuring instruments
- Troubleshoot and maintain mass spectrometer measuring instruments
- Check and make adjustments to mass spectrometer measuring instruments
- Troubleshoot and maintain gas analyzer measuring instruments

Unit 18: Process Technology

BIL: Essential – PC
Recommended – ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 18.1: Operate and control continuous processes

Competency Builders:

Describe the characteristics of a continuous process

Describe the major industrial continuous processes, by (1) describing the characteristics of each, (2) the chemical/physical properties of materials important to the operation, (3) the environmental regulations and safety concerns that are related to each operation, and (4) how the operations usually are interrelated

Interpret process diagrams

Describe the various components and streams of a continuous process

Describe the types and operations of control loops and sample collection devices

Identify typical valves, pumps, and other equipment

Draw a simplified process diagram

Check equipment to ensure safety for electrical loading, physical stressing, and temperature variation

Start up continuous process according to specified procedures

Review checklists associated with a continuous process

Complete required reports to describe process activities, discrepancies, and maintenance

Adjust control equipment as specified by procedures

Set operating parameters

Identify abnormal conditions that require reporting

Record operating parameter information from gauges, instruments, and meters

Adjust operating parameters to optimize conditions

Correct deviations

Respond to alarms

Collect appropriate samples

Conduct on-site inspections

Submit samples for analysis

Record data

Report data

Shut down continuous processes

Shut down continuous processes in emergency situations

Maintain piping networks

Write documentation for an operating procedure

Describe a troubleshooting strategy for a continuous process in upset conditions

Describe the operation, characteristics, and limitations of process measurement equipment (e.g., thermocouples)

Describe process flows (both gas and liquid streams)

Describe the concepts associated with process optimization

Describe when, where, and why samples are taken for analysis and how sampling techniques relate to quality products

BIL: Essential – PC
Recommended – ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 18.2: Operate and control batch processes

Competency Builders:

Describe the characteristics of a batch process

Check equipment safety for electrical loading, physical stressing, and temperature variation

Start up batch processes

Review checklists associated with a batch process

Complete required reports to describe process activities, discrepancies, and maintenance

Adjust control equipment as specified by procedures

Set operating parameters

Identify abnormal conditions that require reporting

Measure raw materials

Explain disposition of “off-spec” batch

Monitor operating parameters by recording information from gauges, instruments, and meters,

Adjust pumps and valves

Adjust operating parameters to optimize conditions

Correct deviations

Respond to alarms

Collect appropriate samples

Conduct on-site inspections

Submit samples for analysis

Record data

Report data

Shut down processes according to procedures

Start up after an emergency shutdown

Describe the major industrial batch processes including common chemical, refinery, water, and waste treatment processes by (1) describing the operation of each; (2) characterizing the chemical/physical properties of materials that are important to the processes; (3) writing the molecular formulas and chemical structures for substances involved in the processes; (4) describing the chemical reactions involved in each process; (5) describing the chemical equilibrium, kinetics, and chemical reactivity relationships that characterize the processes or may impact safety; and (6) identifying relevant environmental regulations and safety concerns

Read process diagrams

Describe the various components and streams of a batch process

Describe the types and operations of control loops and sample collection devices

Identify typical valves, pumps, and other equipment

Draw a simplified process diagram

Write documentation for an operating procedure that meets regulatory requirements

Describe a troubleshooting strategy for a batch process given a variety of upset conditions

Describe the operation, characteristics, and limitations of process measurement equipment (e.g., thermocouples)

Start up and shut down different kinds of electric motors

Describe the concepts associated with process optimization

Demonstrate ability to add solids, liquids, and gases

Describe the relationship of vacuum and pressure upon boiling point

Operate various types of heat exchangers

Perform filtrations, extractions, distillations, drying, blending, milling, and packaging

Retrieve data and information

Provide shift transfer notes

BIL: Essential – PC
Recommended – ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 18.3: Analyze materials

Competency Builders:

Collect appropriate samples for analysis from process streams or products (solids/liquids/gases)

Inspect samples visually to ensure adequate representation of the sampled materials

Determine response is required

Label samples

Deliver samples

Prepare necessary reagents and standards required to conduct tests

Identify quality control standards and appropriate precision levels

Perform appropriate physical and chemical tests

Calculate results

Determine if resampling and reanalyzing are necessary

Maintain analysis area to ensure correct results will be produced repeatedly

Report results to appropriate personnel

Adjust process parameters as necessary

Enter data into appropriate logs

Review trends of process variations and sample analyses

Compare sample analyses with control values

Submit samples to the laboratory

Characterize gases, liquids, and solids

Obtain representative samples of solids

Describe sampling devices for use with gases under pressure

Use typical sampling devices

Sample a flowing liquid stream

Identify proper containers for a variety of solids, liquids, and gases with a wide range of physical properties

Identify common and standard chemical names

Use standard labeling procedures

Calibrate and measure pH

Explain standard measurement and analytical procedures (e.g., ASTM, AOAC)

Calculate normality, molality, and molarity

Prepare standard solutions

Describe physical properties and measurement methods of materials (e.g., specific gravity, density, flash point, and viscosity)

Conduct chemical analyses using volumetric techniques (e.g., acid-base titrations, redox titrations)

Explain the use of instrumental methods such as gas chromatography, infrared, basic spectrophotometry, and colorimetry

Describe pressure and temperature relationships for all states of matter

Balance simple chemical equations

BIL: Essential – PC
Recommended – WEM

EDU:	12	AD
PC		P
ESA		
HS		
ECA		
HM		
WEM		I
FWM		
GIS		

Competency 18.4: Program programmable logic controllers (PLC's)

Competency Builders:

Interpret ladder logic

Identify troubleshooting procedures

Develop process program

Evaluate data generated

Identify trends

Unit 19: Electrical Basics

BIL: Essential – PC
Recommended – ESA, HS

EDU:	12	AD
PC	I	P
ESA	I	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

Competency 19.1: Explain electrical concepts

Competency Builders:

Describe the relationship of basic atomic structure to electricity

Describe the relationship between electrical and magnetic properties

Describe the electrical and magnetic properties of a magnet

Describe the photoelectric effect

Describe the thermocouple effect

Describe the electrical effect of friction

Identify sources of electricity

Explain Ohm's Law

Explain Kirchoff's Laws

Identify power formulas

Describe effects varying degrees of electricity have on the human body

BIL: Essential – PC, ESA
Recommended - HS, ECA

EDU:	12	AD
PC	I	P
ESA		P
HS	I	R
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 19.2: **Maintain basic electrical systems**

Competency Builders:

Replace electrical cords

Replace batteries

Replace fuse(s)

Replace switches and other sensors

Replace plugs

Maintain lockout/tagout

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 19.3: Explain DC circuit principles

Competency Builders:

Identify characteristics common to most conductors

Identify materials that can be used as insulators

Identify conductors of electricity

Explain the purpose of insulating material around electrical wiring

Identify different situations where insulation can be employed other than around electrical wiring

Measure resistance and current of conductors and insulators

Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters

Build series, parallel, and combination circuits

Measure current, voltage, and resistance in DC circuits

Explain DC generator action

Explain DC motor action

Identify classes, voltage ratings and/or polarity of electronic components

Identify use of circuit protective devices (e.g., fuses, breakers)

Apply Ohm's Law

Solve problems in electrical units utilizing metric units

Describe the principles and operation of electrochemical supplies

Apply Kirchoff's law

Measure properties of a circuit using analog and digital meters

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 19.4: Explain AC circuit principles

Competency Builders:

Analyze properties of an AC signal

Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms

Identify AC sources

Describe principles and operation of characteristics of capacitive circuits

Demonstrate the operation of capacitive circuits

Operate capacitive circuits

Describe principles and operation of characteristics of inductive circuits

Demonstrate the operation of inductive circuits

Operate inductive circuits

Describe principles and operation of the principles of transformers

Analyze power in AC circuits

Measure power in AC circuits

Identify use of circuit protective devices (e.g., fuses, breakers)

Describe basic motor theory and operation

Describe basic generator theory and operation

Measure current, voltage, and resistance in AC circuits

Calculate power factor in AC circuits

Unit 20: Equipment Operation & Maintenance

BIL: Essential – WEM, FWM
 Recommended – ESA,HS, GIS

EDU:	12	AD
PC		
ESA		I
HS		I
ECA		
HM		
WEM	I	P
FWM	I	P
GIS		I

Competency 20.1: Operate vehicles (pickup trucks, four-wheel-drive vehicles, tractors, vehicles with attachments, rig-up trucks, graders, backhoe tractors, front-end loaders, excavators, scrappers, cranes, and watercraft)

Competency Builders:

- Explain the safety features of the vehicle
- Perform a safety inspection on the vehicle
- Drive vehicle
- Demonstrate defensive vehicle operation
- Back vehicle with attachments into confined space
- Control vehicle equipment
- Explain procedures for transporting hazardous materials in appropriate vehicles
- Interpret operator’s and manufacturer’s manuals

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA, HM, FWM

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA		I
HM		I
WEM	I	P
FWM		I
GIS		

Competency 20.2: Operate applicable pumps (diesel and gas engines, centrifugal pumps, positive displacement pumps, air and gas compressors)

Competency Builders:

- Follow appropriate safety precautions
- Prime pump when appropriate
- Start the pump
- Adjust the flow rate
- Shut pump down

BIL: Recommended – PC, HS, HM, WEM, FWM

EDU:	12	AD
PC		I
ESA		
HS		I
ECA		
HM		I
WEM		I
FWM		I
GIS		

Competency 20.3: Operate applicable miscellaneous equipment (hoists, winches, pulleys, boilers and associated equipment, drilling equipment)

Competency Builders:

- Identify function of equipment
- Follow appropriate safety precautions
- Set up equipment
- Use equipment for desired purpose
- Shut down equipment

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	R
ECA		I
HM		I
WEM	I	R
FWM	I	R
GIS	I	R

Competency 20.4: Operate applicable electronic equipment (electrical distribution systems, electronic survey equipment, generators)

Competency Builders:

Identify health hazards

Describe safety practices

Identify source of electricity

Set up electrical equipment

Lay electrical cords within safety standards

Conduct survey

Monitor generator

Shut down electronic system

BIL: Essential – ECA
 Recommended – PC, ESA, HS, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA		I
HS	I	R
ECA	I	P
HM		I
WEM	I	R
FWM	I	R
GIS		I

Competency 20.5: Maintain a preventive maintenance schedule

Competency Builders:

- Observe and record any deviations from normal operations
- Initiate work requests
- Implement a preventive maintenance schedule
- Inspect equipment
- Prepare equipment for maintenance
- Set up a maintenance schedule
- Open lines and equipment
- Change seals and valves on on-line equipment
- Change seals and packing on pumps and valves
- Change and replace pipes
- Check fluid levels in process equipment
- Conduct vibrational analysis
- Conduct steam tracing techniques
- Test and replace pressure release valves
- Check standards
- Complete maintenance logbooks
- Complete calibration records/logbooks
- Reference O & M (Operations and Maintenance) manuals

BIL: Essential – ECA, HM, FWM
 Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
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HS	I	R
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HM		P
WEM	I	R
FWM	I	P
GIS		

Competency 20.6: Maintain equipment according to owners' manual specification

Competency Builders:

- Add lubricant and fuel
- Analyze engine performance
- Make necessary adjustments to engine
- Check and adjust tire air pressure
- Inspect and service battery
- Inspect and service/replace spark plugs
- Inspect and service/replace air cleaners
- Check and refer for service thermostats, fans, and radiators
- Inspect and refer for service water pumps, lines, and connections
- Perform seasonal service on cooling systems
- Conduct voltage, current, resistance, charging and load tests
- Clean, repair, and paint

Unit 21: Hydraulics & Pneumatics

BIL: Essential – ECA, WEM
Recommended – PC, HS

EDU:	12	AD
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Competency 21.1: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law

Explain Boyle's Law

Explain Bernoulli's Principle

Describe flow velocity

Explain how heat and pressure relate to power and transmission

Describe physical and chemical properties of a fluid

Describe fluids in motion in closed conductors

Describe continuity of mass flow

Identify types of fluids

Identify properties of fluids

Identify English and metric units of measurement for pressure, density, and viscosity

BIL: Essential – ECA, WEM
Recommended – PC, HS

EDU:	12	AD
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WEM	I	P
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Competency 21.2: Describe energy considerations

Competency Builders:

Differentiate work and power

Differentiate potential and kinetic energy

Explain energy conservation concept

Explain hydraulic horsepower

Explain work of compression in compressible fluids

BIL: Essential – WEM
Recommended – PC, ECA

EDU:	12	AD
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Competency 21.3: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow

Explain Manning's formula for friction

Explain friction factor

Explain pressure losses

Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

BIL: Essential – ECA, WEM
Recommended – PC, HS

EDU:	12	AD
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WEM	I	P
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Competency 21.4: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity

Explain buoyancy

Explain equilibrium

BIL: Essential – WEM
Recommended – PC

EDU:	12	AD
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Competency 21.5: Calculate energy

Competency Builders:

- Explain application of Pascal's Law in energy calculation
- Explain application of Bernoulli's Principle in energy calculation
- Explain application of Boyle's Law in energy calculation
- Calculate work and power
- Calculate potential and kinetic energy
- Calculate hydraulic horsepower
- Calculate flow velocity and pressure
- Calculate pressure losses
- Calculate laminar flow
- Calculate pump capacity
- Calculate system requirements

BIL: Essential – WEM
Recommended – PC, HS, ECA

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Competency 21.6: Describe hydraulic component operation

Competency Builders:

- Identify functions and operation of hydraulic components
- Identify functions and operation of pneumatic components
- Explain application(s) of different materials (e.g., plastic, copper, PVC, CPT)

BIL: Essential – WEM
Recommended – PC, ECA, FWM

EDU:	12	AD
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ECA		I
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WEM		P
FWM		I
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Competency 21.7: Assess pipe flow characteristics

Competency Builders:

- Determine head and pressure and loss
- Determine weir flow
- Determine full flow
- Determine pressure flow
- Determine friction loss
- Determine gravity flow
- Determine cubic feet per second (CFS)
- Determine wing walls
- Determine stability and capacity

BIL: Recommended – PC, ECA, WEM, FWM

EDU:	12	AD
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WEM		I
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Competency 21.8: Maintain piping and accessories for high and low pressure fluid power systems

Competency Builders:

Identify components of a piping system

Explain maintenance features of both metallic and non-metallic piping systems

Explain types of valves and their operation and maintenance

Explain use and maintenance of strainers, filters, and traps in piping systems

Join common fittings

Join pipe

Join copper and steel tubing

Bend copper and steel tubing

Cut copper and steel tubing

Flare tubing

BIL: Recommended- PC, ECA, WEM

EDU:	12	AD
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Competency 21.9: Maintain and repair pump

Competency Builders:

Identify types and operating features of pumps

Identify pump capacity and system requirements

Explain packing and seal requirements

Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)

Disassemble pumps

Reassemble pumps

Perform shaft alignment

Unit 22: Surveying & Mapping

BIL: Essential – PC, FWM, GIS
Recommended – ESA, ECA, HM, WEM

EDU:	12	AD
PC		P
ESA	I	R
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ECA		I
HM	I	R
WEM	I	R
FWM	I	P
GIS	I	P

Competency 22.1: Identify civil drafting symbols and abbreviations

Competency Builders:

Identify standard symbols and abbreviations

- Set up a map legend
- Locate symbols and features on a U.S.G.S. map
- List common types of symbols used in civil drafting
- Identify abbreviations for words commonly used in civil drafting
- Identify factors that determine when an abbreviation should be used
- State purposes of symbols on maps
- Draw examples of north arrow symbols
- Describe general rules for drawing map symbols
- Describe methods used in drawing symbols
- Match color codes with corresponding map symbols
- Identify common material symbols used in structural and architectural drawings
- Identify common welding symbols

BIL: Essential – PC, ESA, ECA, HM, FWM, GIS
Recommended - WEM

EDU:	12	AD
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ESA	I	P
HS		
ECA	I	P
HM	I	P
WEM	I	R
FWM	I	P
GIS	I	P

Competency 22.2: Read maps

Competency Builders:

Identify major classes of maps

Explain terms related to map scales and measurement

Create chart of standard measures and their equivalents

Identify characteristics of map scales

Describe ways map scales are expressed

Identify ranges of map scales and their classifications

Identify factors affecting the selection of a map scale

Match types of maps with their common scales

Identify characteristics of a quadrangle scale

Match quadrangle scales commonly used on U.S.G.S. topographic maps with their one-inch equivalencies

Identify characteristics of graphic scales

Explain published map accuracy standards

Describe types of scales used in civil drafting

Convert a representative fraction to a graphic scale

Read a vernier scale

Measure with a civil engineer's scale

Measure acreage on maps

Differentiate between latitude and longitude

BIL: Essential – FWM, GIS
Recommended – PC, ESA, ECA

EDU:	12	AD
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ECA		I
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WEM		
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GIS		P

Competency 22.3: Utilize surveying skills

Competency Builders:

Describe survey methods used to determine distances and positions of points

Identify types of horizontal and vertical angles

Explain stationing

Explain purpose of field notes

Describe the arrangement of field notes in the field book

Identify types of field notes

Record field notes

Explain traverses

Differentiate between a bearing and an azimuth

Convert azimuths to bearings and bearings to azimuths

Describe common methods for plotting traverses

BIL: Essential – GIS
 Recommended – ESA, ECA, HM, WEM, FWM

EDU:	12	AD
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WEM		I
FWM	I	P
GIS	I	P

Competency 22.4: Perform site measurements

Competency Builders:

Determine location and distance from maps

Identify major parts of a compass

Read a compass

Sight along a given bearing

Describe compass declination and variation

Explain surveying [R-HM]

Differentiate among accidental and systematic errors and mistakes

Explain use of principal surveying equipment

Describe types of surveys and their uses [R-HM]

Measure distance in field [R-HM]

Measure area in field [R-HM]

Measure elevations in field [R-HM]

Reference datum [R-HM]

Pace horizontal distance [R-HM]

Tape horizontal distance [R-HM]

Explain differential leveling [R-HM]

Explain profile leveling

Explain cross-sectional leveling

Measure horizontal angles

Measure vertical angles

Use planimeter [R-HM]

Compare microcomputer surveying and mapping application programs

Apply GPS technology in surveying [R-HM]

BIL: Essential – GIS
 Recommended – PC, ECA, FWM

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Competency 22.5: Draft maps

Competency Builders:

- Explain terms related to map drafting procedures
- Identify characteristics of drafting media
- List types of lettering used in civil drafting
- Identify rules for good lettering
- Differentiate among map registration methods
- Describe reprographic techniques used in civil drafting
- Identify types of pressure-sensitive films
- Describe methods used for coloring maps
- Describe aerial photography
- Interpret aerial photographs and maps
- Record measurements on photos or in records
- Describe the standard sheet format for a set of civil drawings
- Label components of a map layout
- Identify the steps for drafting a map or drawing
- Make rough tracings of maps
- Describe common mistakes made in map drafting
- Differentiate among types of planimeters
- Label the parts of a polar planimeter
- Produce finished map of area
- Identify underground surveying techniques
- Ink a mapped area
- Apply transfer film and press-on letters
- Register a map

BIL: Essential – GIS
 Recommended – FWM

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Competency 22.6: Prepare topographic maps

Competency Builders:

- Explain how elevation is shown on a topographic map
- List uses of topographic maps
- Describe types of surveys used in topographic mapping
- Identify field methods for obtaining topography
- Identify factors affecting the selection of the field method to be used for a topographic survey
- Differentiate between horizontal and vertical controls for topographic surveys
- Lay out a topographic survey
- Determine topography
- Describe methods used to establish contours
- Identify national standards for horizontal and vertical accuracy on topographic maps
- Create a chart of scale ratios used in the USGS topographic series
- Describe the selection of contour intervals
- Identify characteristics of contour lines
- Match contour line features with their correct configurations
- Identify common methods used to calculate area from a topographic map
- Calculate cut and fill using the contour area method
- Plot a profile from profile leveling notes
- Develop a profile from a contour map
- List three methods for plotting contours lines
- Explain how to fix a grade line
- Describe aerial photogrammetry
- Identify advantages and disadvantages of using aerial photography for mapping
- Identify applications of aerial photogrammetry
- Explain aerial photo control
- Interpolate contours from a grid survey
- Prepare profiles from the contour map
- Set up contours in isometric
- Calculate grades in percents

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Competency 22.7: Map transportation system

Competency Builders:

- State the purpose of route surveys
- Describe the fundamentals of a route survey
- Describe superelevated roadways
- Identify elements of a horizontal circular curve
- Explain mathematical formulas used for computing a horizontal curve
- Describe circular curve layout by tangent offsets
- Describe vertical curves
- Describe plan views for route surveys
- Identify characteristics of profiles for a route survey
- Identify characteristics of cross sections for a route survey
- Describe field note reduction for a cross section
- Explain plotting cross sections
- Differentiate among methods used to determine areas of cross sections
- Identify formulas for calculating earth volume
- List drawings included in a set of highway plans
- Identify common horizontal and vertical scales used in transportation mapping
- List items that appear on a typical title sheet for a set of highway plans
- Describe detail sheets
- Draft plan views, profiles, and cross sections
- Layout open traverses
- Layout a survey alignment for a road
- Plot field notes for horizontal control, topography, profile, and cross section for a proposed road

BIL: Essential – GIS
Recommended – HM, WEM

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Competency 22.8: Map municipal infrastructure

Competency Builders:

- Explain terms related to municipal mapping
- Identify types of utilities
- List agencies who develop and maintain municipal maps
- Identify users of municipal maps
- Describe types of drawings used in municipal mapping
- Describe methods of presenting utilities on maps
- Describe the surveying and mapping of municipal maps
- List support information needed to develop utility drawings
- Explain utility easements
- Identify types of valves and valve housings
- Identify types of gas piping and devices
- List information included on utility drawings
- Describe types of sewers and sewer lines
- Research the plats for local utilities

Unit 23: Drafting Technology

BIL: Essential – PC, GIS
Recommended – ECA, WEM, FWM

EDU:	12	AD
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Competency 23.1: Apply basic drafting skills

Competency Builders:

- Identify line styles, weights (alphabet of lines)
- Select proper drawing scale, introduction to different types
- Prepare title blocks and other drafting formats
- Apply freehand and other lettering techniques
- Develop multi-view drawings
- Develop multi-view sketches
- Develop orthographic views
- Develop change control block
- Describe change control block/revision block
- Measure angles
- Draw horizontal, vertical, angular, parallel, and perpendicular lines
- Transfer an angle
- Construct tangent lines (to arcs) and tangent arcs (to arcs)
- Bisect angles and arcs
- Bisect lines
- Divide lines
- Construct three-point circle
- Construct regular hexagon, pentagon, and octagon
- Reproduce a drawing
- Develop single-view drawings
- Develop dimension drawings
- Interpret notes and dimensions to determine part
- Draw arcs, circles, and conics
- Transfer measurements

BIL: Essential – GIS
Recommended – PC, ECA, FWM

EDU:	12	AD
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Competency 23.2: Prepare drawings

Competency Builders:

- Describe types of blueprints and their applications
- Demonstrate isometric, oblique and perspective sketching techniques
- Prepare isometric, oblique and perspective sketches
- Prepare sectional views
- Prepare auxiliary views
- Identify ANSI symbols

Describe systems drafting techniques

- Dimension drawings using ANSI 14.5 standards
- Describe purpose of auxiliary and sectional views
- Prepare pictorial drawings
- Prepare schematics
- Draw conics
- Interpret basic pneumatic/hydraulic standard and symbols

BIL: Essential – GIS
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
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GIS		P

Competency 23.3: Interpret machine, hydraulic and pneumatic, instrument, electrical, process flow, P & ID diagrams, and detail and assembly drawings/prints/schematics

Competency Builders:

Identify the types of information found on floor plans, elevation plans, flow diagrams, piping and instrumentation diagrams, and electrical diagrams

Identify commonly used symbols and abbreviations

Explain how to trace diagrams

Explain how to use diagrams to locate actual components

Visualize object from drawing

Analyze orthographic projections

Analyze isometric views

Analyze sectional views

Explain dimensions

Explain tolerances

Identify GD&T symbols

Identify basic mechanical standards and symbols

BIL: Essential – GIS
Recommended – PC, ECA, FWM

EDU:	12	AD
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Competency 23.4: Analyze structural drawings

Competency Builders:

- Explain structural drawing
- List types of structures
- Identify types of materials used for structures
- Describe types of steel members
- Identify structural steel shapes
- Explain drawing practices for steel members
- Describe the placement of gage lines for steel members
- Describe fastener sizes and spacings
- Explain dimensioning procedures for steel structures
- Label a structural steel callout
- Explain structural steel marking
- Describe anchor bolts
- Differentiate among types of concrete
- Identify types of concrete reinforcement
- Identify standard pre-stressed concrete units
- Describe foundation parts
- Describe types of structural drawings for concrete
- Create chart of symbols and abbreviations for concrete placing drawings
- Identify standard practices for documentation of rebar
- Identify typical details of concrete structures
- Describe wood construction
- Identify types of wood connectors
- Identify types of framing connectors
- Describe components of wood construction
- Explain heavy timber construction
- Prepare detail drawings of structural steel members
- Draw to scale a concrete engineering drawing
- Detail a wood truss

BIL: Recommended – PC, ECA, GIS

EDU:	12	AD
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GIS	I	R

Competency 23.5: Demonstrate dimensioning techniques

Competency Builders:

Convert dimensions and tolerances to and from metric to English units

Construct arrowheads using various styles/disciplines

Apply symbols for surface and texture control

Add labels/notes to drawing

Interpret decimal tolerance dimensions

Prepare dimensional drawing of arcs, angles, curves, rounded-end shapes, spherical objects, cylindrical objects, cones, pyramids, prisms, features on circular center line, theoretical point of intersection, object using rectangular coordinate system, object using polar coordinate system, object using tabular coordinate system, object using ordinate dimensioning system

Unit 24: CADD Fundamentals

BIL: Essential – PC, GIS
Recommended – ECA, FWM

EDU:	12	AD
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Competency 24.1: Identify computer mapping applications

Competency Builders:

- Classify hardware used in a CAD system as input, output, or neither
- Explain data input
- List types of data output
- Differentiate between digital and interactive computer graphics
- Identify types of computer drawings
- List methods of storing graphic information
- List advantages of using computers for mapping applications
- Describe an interactive data management system for mapping

BIL: Essential – PC, GIS
Recommended – ECA, FWM

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Competency 24.2: Operate a CADD system

Competency Builders:

- Boot system/start up procedure
- Log on terminal
- Load start file
- Use keyboard input
- Use screen and tablet menus
- Use other input devices (e.g., scanner, digitizer)
- Create scaled plots
- Operate a pen plotter
- Operate a printer-plotter (i.e., laser plotter)
- Access on-line help for commands
- Convert files
- Transfer data
- Manage files
- Plot out drawings
- Store a file
- Shut down a system
- Log off

BIL: Essential – PC, GIS
Recommended – FWM

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Competency 24.3: Change existing drawings or details

Competency Builders:

- Plan drawing changes
- Find drawing file
- Load drawing file
- Execute changes
- Obtain approvals/check drawing changes
- Plot out drawing
- Update file

BIL: Essential – PC, GIS
Recommended – FWM

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Competency 24.4: **Compose drawings**

Competency Builders:

Plan original drawing

Employ system commands

Manipulate geometry

Select geometry

Add test

Rotate views

Move views

Scale views

Dimension a drawing

Store files

BIL: Essential – GIS
Recommended – PC, FWM

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Competency 24.5: Create 2-D orthographic drawings

Competency Builders:

- Create primitive drawing entities
- Draw utilizing absolute Cartesian coordinates
- Draw utilizing relative Cartesian coordinates
- Draw utilizing polar coordinates
- Draw using construction aides (e.g., snaps, grid, snap)
- Change drawing attributes
- Edit drawing entity properties (e.g., color, layer, thickness, linetype)
- Construct drawing entities (e.g., offset, timer, extend, break, mirror)
- Edit drawing entities
- Set system variables (e.g., units, scale)
- Annotate orthographic drawings
- Create layers
- Identify layers
- Manipulate layers
- Save files
- Create back-ups
- Create hatches, patterns, symbols
- Recall drawing templates/blocks
- Create text styles
- Edit text styles
- Select text styles
- Apply notes
- Create dimensions
- Edit text

Control dimension variables/models

- Apply view control while drawing (e.g., zoom and pan)
- Control view resolution (e.g., viewers)
- Save views
- Display views
- Add or remove entities separately
- Add or remove entities using a window
- Add or remove entities with a crossing-box
- Select entities using a fence

Select entities by other methods (e.g., last, previous, type)

BIL: Essential – PC, GIS
Recommended – ECA, FWM

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GIS	I	P

Competency 24.6: Extract entity and drawing information

Competency Builders:

Measure distances

Measure areas

Identify locations

List entity characteristics (e.g., length, size, location, properties, etc.)

Unit 25: Waste Management

BIL: Essential – PC, ESA, HM
Recommended – HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		I
FWM		
GIS		

Competency 25.1: Collect waste materials

Competency Builders:

- Identify source of waste materials
- Monitor collection of waste materials
- Document collection of waste materials
- Determine sampling method
- Prepare sampling container
- Collect sample
- Prepare chain of custody
- Test waste materials
- Document waste materials testing
- Identify hazardous materials/waste
- Determine compatibility of waste materials
- Separate waste materials
- Identify container type
- Contain waste materials
- Label waste materials
- Review waste material labels
- Document contained-waste collection
- Identify regulations

BIL: Essential – PC, ESA
Recommended – ECA, HM

EDU:	12	AD
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ESA		P
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ECA		I
HM		I
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FWM		
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Competency 25.2: Treat waste materials

Competency Builders:

- Separate waste materials
- Verify operating parameters
- Determine test method
- Add additional chemicals to material
- Monitor efficiency of additions
- Document compliance with treatment standards
- Document raw-materials usage
- Maintain inventory of supplies
- Sort treated materials
- Release treated materials
- Seek markets for recovered materials

Match recovered materials with end users

- Identify regulations

BIL: Essential – PC, ESA, HM
 Recommended – HS, ECA

EDU:	12	AD
PC	I	P
ESA		P
HS	I	R
ECA		IR
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Competency 25.3: Manage waste

Competency Builders:

- Monitor instrumentation
- Determine material needs
- Verify the operation of the equipment
- Reroute source
- Troubleshoot equipment
- Identify source of waste materials
- Document contained-waste collection
- Identify hazardous materials
- Determine compatibility of waste materials
- Separate waste materials
- Contain waste materials
- Label waste materials
- Document contained-waste collection
- Store material containers
- Load/unload storage containers
- Transport waste materials
- Repair leaking containers
- Clean up container leaks
- Verify operating parameters
- Determine test method
- Add additional chemicals to material
- Monitor efficiency of additions
- Document raw-materials usage
- Sort treated materials
- Initiate pollution abatement at the source
- Document non-reusables
- Monitor pollution abatement at the source
- Determine disposal method
- Identify container for non-reusables
- Label non-reusables
- Monitor clean-up

Arrange for transportation of non-reusables

Sample waste before disposal

Transport non-reusable

Monitor disposal by contractor

Dispose of non-reusables

Destroy non-reusables

Perform routine maintenance on implements

Perform routine maintenance on test instruments

Remove trash

BIL: Essential – PC, HM
 Recommended – ESA, ECA, WEM

EDU:	12	AD
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Competency 25.4: Manage waste systems

Competency Builders:

Develop waste system training

- Coordinate mandatory consultation programs
- Manage and implement three R's program (i.e., reduce, recycle, reuse)
- Characterize all waste
- Register subject waste
- Arrange waste collection
- Arrange waste disposal
- Prepare manifest for subject waste
- Conduct waste audits including compliance and pollution prevention components
- Establish waste reduction work plans
- Manage internal waste disposal operations
- Monitor leachate collection systems**
- Process leachate
- Assess leachate treatment options

BIL: Essential – PC, ESA, ECA
Recommended - HM

EDU:	12	AD
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Competency 25.5: Identify characteristics of solid waste treatment

Competency Builders:

Explain solid waste

List sources of solid waste

Identify types of solid waste

Identify physical and chemical compositions of waste

Correlate typical source with locations and type of solid waste

Describe landfill alternatives (reduction, separation, processing, waste of energy and application)

Describe characteristics of a sanitary landfill

List reactions that occur as a landfill matures

BIL: Essential – PC, ESA
Recommended – ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 25.6: Identify the risks associated with solid waste accumulation and disposal

Competency Builders:

Describe the composition, sources, and quantity of solid waste

Describe methods of solid waste disposal

Describe various solutions to solid waste accumulations and disposal

Describe the legal aspects and consequences of solid waste pollution

Describe the construction features of a safe landfill

Describe the possibilities of contaminants (leachates) seeping into the groundwater

Describe the need to have monitoring wells located around a sanitary landfill

Identify those wastes that are permitted by state and federal regulation to be disposed at a landfill site

BIL: Recommended – PC, ESA, ECA, HM

EDU:	12	AD
PC		I
ESA	I	R
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 25.7: Describe methods of site identification and acceptance

Competency Builders:

List typical factors that may restrict or eliminate a potential location from consideration as a future landfill site

Develop a plan to identify and manage the parts of the waste stream

List factors that determine waste acceptability

Identify liquids that may be excluded from landfill

Describe management options for lead acid batteries, used oil, eludes and infectious waste

Identify radioactive waste

Describe operational/equipment limitations that would prevent materials from going into landfills and disposal options

BIL: Essential – PC, ESA
 Recommended – HS, HM

EDU:	12	AD
PC	I	P
ESA	IR	P
HS		I
ECA		
HM	I	R
WEM		
FWM		
GIS		

Competency 25.8: Describe the process of waste decomposition

Competency Builders:

- Categorize waste by method of decomposition and by-products created
- List factors that effect the rate of decomposition
- List events that occur in a landfill as a result of decomposition
- Explain subsidence
- Explain differential settlement
- Describe settlement control
- Identify methods to determine whether settlement is occurring
- Explain landfill gas operation [R-HM]
- Describe composition of landfill gas and gas generation cycle [R-HM]
- Explain landfill gas migration [R-HM]
- List items that intercept migration routes [R-HM]
- Describe techniques for recognition and control of landfill migration [R-HM]
- Explain leachate generation [R-HM]
- Characterize leachate
- Describe leachate impact [R-HM]
- List controlling factors in establishing leachate quality [R-HM]

BIL: Essential – ESA
 Recommended – PC, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 25.9: Describe sanitary landfill procedures

Competency Builders:

Describe aspects of site security

Describe the importance of excluding unacceptable waste from the landfill

Describe the careful execution of a monitoring permit

Identify the size of working at the operations field station

Identify access for vehicles at operations field station

Describe landfill equipment operation

Identify compaction practices at operations field station

Describe scope of work at operations field station

Describe nuisance conditions at operations field station including litter control, odors, and noise

Describe cover at operations field station

Classify field station operation (e.g., daily, intermediate, and final)

Describe drainage control (i.e., run-on, run-off, depressions, erosions) at operations field station

Describe liner integrity at field operations site including vegetation, sand blanket, erosion, waste placement, and traffic

Describe other factors at field operations site including leachate seeps and vegetation screening

List recommended procedures for maintaining monitoring well

Complete chain of custody record for equipment at operations field station

Describe an area of the field operations site that illustrates the best type of soil for different methods of operation

Describe resource recovery and source reduction procedures

BIL: Essential – ESA
Recommended – PC, HS, HM

EDU:	12	AD
PC		I
ESA	IR	P
HS		I
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 25.10: Monitor sanitary landfill procedures

Competency Builders:

Explain safety rules and the importance of each

Identify individual safety items needed for landfill personnel to be appropriately equipped

Identify waste types received at operations field station including liquids, hazardous wastes, special wastes

Obtain samples from monitoring well at field operations site including the purging of a well

Complete laboratory analysis form

List various types of soil and their best use

Operate equipment used in soil sampling

Take a meter reading

BIL: Recommended – PC, ESA, HM

EDU:	12	AD
PC		I
ESA	I	R
HS		
ECA		
HM	I	R
WEM		
FWM		
GIS		

Competency 25.11: Describe methods to operate a composting facility

Competency Builders:

Identify materials acceptable in a compost facility

Describe the steps necessary to construct a facility

Identify procedures used in receiving material

Describe operational procedures

Describe records/management document

BIL: Essential – HM
Recommended – PC, ESA, HS, ECA

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

Competency 25.12: Describe methods to incinerate waste

Competency Builders:

- Identify materials acceptable to be received at facility
- Describe methods employed in incineration of waste
- Describe material flow in incinerators
- Explain methods employed in separating waste
- Identify data management procedures

BIL: Essential – PC, HM
Recommended – ESA, ECA

EDU:	12	AD
PC	I	P
ESA	I	R
HS		
ECA		I
HM	I	P
WEM		
FWM		
GIS		

Competency 25.13: Describe recycling methods

Competency Builders:

Identify materials appropriate to recycle

Describe the economic and physical drivers associated with recycling

Identify methods to receive recycling material

Describe recycling management procedures

Identify markets for recycling material

Identify market factors associated with recycling

BIL: Recommended – PC, ESA, HS, HM, WEM

EDU:	12	AD
PC		I
ESA	I	R
HS		I
ECA		
HM		I
WEM		I
FWM		
GIS		

Competency 25.14: Explain control processes for landfill gas and leachate

Competency Builders:

- List characteristics of decomposition, leachate, and landfill gas
- Describe process for determining the potential for landfill gas
- Describe process for locating test wells
- List types of test wells
- Describe monitoring process used to detect the presence of methane
- Describe control methods for landfill gas
- Describe methods for landfill gas recovery and use
- Describe process which prevents leachate contact with groundwater [R-WEM]
- Describe control process of surface water [R-WEM]
- List characteristics of leachate migration [R-WEM]
- Describe controls for surface discharge of leachate [R-WEM]
- Describe methods for detecting leachate discharge to groundwater [R-WEM]
- List methods for control of leachate migration [R-WEM]
- Describe remedial actions which may be taken where leachate is contaminating groundwater [R-WEM]
- List types of leachate treatment systems [R-WEM]
- Describe methods of leachate recirculation [R-WEM]
- List representative leachate treatment technologies both biological and physical/chemical and give characteristics of each [R-WEM]
- List characteristics of an effective groundwater monitoring program [R-WEM]

BIL: Essential – HM
Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM	I	P
WEM		
FWM		
GIS		

Competency 25.15: Identify design requirements for sanitary landfills

Competency Builders:

Explain how specifications are used in the construction of landfills

Describe the basic types of plans necessary to show how a facility is to be developed

List items essential to following facility plans

Describe methods of measuring horizontal distance determining compliance with a facility plan

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC		I
ESA	I	R
HS		I
ECA		I
HM		I
WEM		I
FWM		
GIS		

Competency 25.16: Describe standard operational techniques for sanitary landfills

Competency Builders:

Identify elements that dictate facility operations

Read sanitary landfill plans

Identify elements of a design plan

Identify elements of an operational plan

Identify items an operator must control for a successful operation

List methods for controlling moisture

List methods for controlling run-off

List methods for controlling waste

Explain confinement methods

Explain compaction methods

Explain ratio of slope to compaction in an ideal landfill situation

Describe the advantages of using proper soil for use as cover

Describe types of cover and their functions

Describe operation of a lined sanitary landfill

Describe what must be accomplished to ensure a lined system will function

Identify operational problems that are exacerbated by weather

Identify strategies to resolve weather related problems

Identify hard-to-handle wastes

Describe operational problems exacerbated by hard to handle wastes

Explain how to handle hard-to-handle wastes

Identify failures of site operation principles that could result in environmental and health problems

Identify potential nuisance and health problems

Identify controls that can be used to reduce nuisance and health problems

BIL: Recommended – PC, ESA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		
HM		
WEM		
FWM		
GIS		

Competency 25.17: Explain sanitary landfill equipment procurement and maintenance

Competency Builders:

- Identify types of equipment and their advantages and disadvantages in the operation of a sanitary landfill
- Describe daily maintenance of equipment program
- Describe shutdown procedures
- Describe a periodic maintenance program
- Describe the role of accurate records of maintenance in the decision to depreciate and replace equipment
- Identify costs that are common to maintain a sanitary landfill
- Explain the bid process
- List methods of equipment financing
- Perform a total cost evaluation (TCE) of equipment considered for purchase or lease-purchase

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 25.18: Describe site closure methods and post-closure considerations

Competency Builders:

- Describe goals that must be met for successful site closure
- Describe steps in preplanning the closures
- Describe the process that should occur three months prior to closure
- Describe steps that should occur at closure
- Describe things that need to be done three months after closure
- Describe landfill gas control systems and their usefulness in long-term maintenance of a closed landfill
- Explain use of data gathered from landfill gas and leachate monitoring systems
- Explain how surface water and settlement can effect the containment of waste in a closed landfill
- Describe some end uses for closed sites
- Describe buffer layer, gas channel, filter layer, barrier, topsoil, and vegetation
- Identify guidelines for constructing the final cover system
- Identify desirable characteristics for vegetation on final cover
- Explain how to determine soil suitability for planting and plant requirements for nutrients
- Describe method for planting and protecting the seed
- Identify methods for controlling run-on and run-off on a closed site
- List information used by inspectors to determine acceptability of closure
- Describe methods of financing closure and post closure

Unit 26: Drinking Water Treatment Operations

BIL: Essential – PC, ESA, ECA, WEM
 Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM	I	P
FWM		
GIS		

Competency 26.1: Identify characteristics of drinking water treatment

Competency Builders:

- Identify constituents inherent to groundwater and/or surface water
- Describe the pH scale and its importance in the water-treatment process
- Correlate treatment processes to types of facility influent and solids
- Identify commonly measured drinking water items
- Identify factors affecting raw drinking water
- Identify waterborne diseases
- Identify gases found in drinking water

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.2: Sample drinking water

Competency Builders:

Identify the reasons for sampling and the types of samples (e.g., simple, representative, grab, composite)

Describe methods of sample collection and handling

Identify process control samples (biological or chemical)

Identify representative sampling points

Determine the significance of process control sample results (biological or chemical)

Identify the basic procedure for quality control/quality assurance in sampling

Identify the significance of the flow measurement on process control

Identify pathogenic organisms, including bacteria, protozoa, and virus, and describe their disease associations

Identify applicable regulatory sampling guidelines

Test for bacteria

Explain sample chain of custody

Apply correct sample-collection procedures for inorganic and organic analyses

Describe the need for chemical analyses in water treatment

Determine whether the finished water is acceptable or unacceptable

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	P	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.3: Identify constituents of water entering water-treatment facility

Competency Builders:

Differentiate between turbidity and the microbiological quality of raw water

Describe the uses of chemical analysis in water-treatment operations

Identify commonly used units of constituent measurement

Explain the importance of water treatment for the control of coliform bacteria and algae

BIL: Essential – PC, ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM		
WEM		P
FWM		
GIS		

Competency 26.4: Analyze the constituents of drinking water

Competency Builders:

Analyze the specific physical, chemical, and biological characteristics of drinking water

Identify ranges in drinking water treatment and limits on facility discharges

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

Competency 26.5: Explain the aeration process in water treatment

Competency Builders:

Differentiate between aeration and air stripping

Identify types of aeration systems

Explain the benefits of aeration

Describe the components of an air-stripping system

Describe process control methods for aeration systems

BIL: Essential – ESA, WEM
 Recommended – PC, HS, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 26.6: Monitor the mixing, coagulation, and flocculation processes in water treatment

Competency Builders:

Explain turbidity, color, coagulation, and flocculation

Identify the kinds of equipment used in the coagulation process

Identify coagulant chemicals used in water-treatment facilities

Identify the steps of coagulation

Identify specific sampling locations for control in a coagulation process

Identify factors that would contribute to poor floc formation

Compute the feed rate in pounds per day (lbs/d)

Compute the dosage (mg/l) of coagulant

Compute the dosage rate that is needed to treat a different flow (MGD) at the current dosage

BIL: Essential – ESA, WEM
 Recommended – PC, HS, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 26.7: Monitor the filtration and sedimentation process in water treatment process

Competency Builders:

Explain concepts related to filtration including types of filters, filter-system components, and the steps for normal filtration operations

Explain common problems of filtering systems including head loss, mudballs, filter media loss, and blinding

Determine when to backwash a filter

Identify the steps for backwashing a filter

Explain filter backwash rates

Explain concepts of sedimentation, including types of classifiers, sedimentation system components and steps for normal operation

Measure sedimentation rates

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.8: Monitor the water-softening process in water treatment

Competency Builders:

Identify treatment processes used for water softening

Describe types of hardness

Describe alkalinity and its components

Calculate the distribution of bicarbonate, carbonate, and/or hydroxide ions when given the total alkalinity and phenolphthalein alkalinity

Describe carbonate removal

Identify the important zones of an upflow clarifier unit

Identify the appropriate chemical(s) to use in chemical-precipitation softening process

Compute lime demand from raw-water analyses

Describe the reasons for recarbonization

Compute hardness removal when the ion-exchange capacity is known

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 26.9: Monitor the stabilization process in water treatment

Competency Builders:

Identify the chemicals used in stabilization

Identify two stabilization indices

Conduct marble test

Conduct Langelier index

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 26.10: Monitor the corrosion-control process in water treatment

Competency Builders:

Describe problems that can be created by corrosive waters

Describe an electrochemical reaction

Identify the factors that influence corrosion

Explain cathode film formation

Describe the conditions for calcium carbonate film formation

Identify the chemicals used in corrosion control

Describe cathodic protection and its application in water-treatment

Describe the basic concepts of electrolysis

Describe effects of lead and copper rule

BIL: Essential – ESA, WEM
 Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

Competency 26.11: Monitor the disinfection process in water treatment

Competency Builders:

- Identify chemicals used in primary disinfection
- Identify non-chemical methods in primary disinfection
- Identify commonly used chlorinators and hypochlorinators
- Determine the maximum amount of chlorine gas (in pounds) that may be taken from a cylinder in a 24-hour period
- Identify proper maintenance procedures for equipment chlorination
- Identify terminology related to chlorination and disinfection
- Identify common safety problems or emergency situations that might occur during chlorination
- Identify the properties of chlorine and its use in water treatment
- Explain the points at which chlorine is applied most effectively in water treatment
- Compute the feed rate (lbs/d)
- Compute the feed rate (lbs/d) of a hypochlorite compound
- Compute the new rate of flow and the feed rate that will be needed to maintain the current dosage
- Compute the feed rate needed to treat a given amount of water

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

Competency 26.12: Monitor the control and treatment of trihalomethanes in water

Competency Builders:

- Describe the formation of total trihalomethanes (TTHM)
- Collect samples to determine trihalomethane levels
- Compute the quarterly average and the annual TTHM measurements
- Identify processes that remove trihalomethane precursors
- Identify processes that remove trihalomethanes after they are formed
- Identify the benefits of alternate disinfectants
- Describe chloramination as a control of TTHM

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.13: Monitor the iron and manganese removal processes in water treatment

Competency Builders:

Describe the importance of controlling iron and manganese

Explain the occurrence of iron and manganese in source water and in treated water

Perform sample-collection and analysis procedures for iron and manganese

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.14: Describe taste and odor control in water treatment

Competency Builders:

- Identify common types of complaints about water quality
- Identify causes of tastes and odors
- Explain how microbial growths affect tastes and odors
- Explain how eutrophication contributes to surface-water tastes and odors
- Describe a cross-connection
- Identify the chemicals used in the control and treatment of tastes and odors
- Describe the Threshold Odor Number (TON) test
- Determine the TON when dilution volumes and positive samples are given

BIL: Essential – ESA
 Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 26.15: Describe the demineralization processes in water treatment

Competency Builders:

- Explain concepts related to demineralization (e.g., reverse osmosis (RO), flux, feedwater, permeate, salinity)
- Describe the structure, composition, and performance of an RO membrane
- Describe feedwater impurities, physical parameters, and conditions potentially harmful to the RO process
- Identify items included in a typical RO-facility-operation checklist
- Describe the common causes of membrane damage
- Describe the procedure for membrane cleaning
- Compute the percent of recovery
- Compute the percent of mineral rejection
- Describe the basic concepts of electrodialysis (ED), such as the cathode and anode relationship and the removal of typical inorganic salts
- Describe the most common problem of ED operation in a facility
- Explain how the cation membrane and the anion membrane differ
- Describe the multi-compartment unit used in the ED process
- Describe ED operating procedures in detail
- Describe the most common chemical solutions used to flush ED stack membranes

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

Competency 26.16: Monitor the fluoridation process in water treatment

Competency Builders:

Identify the basic concepts of fluoridation and the kinds of chemicals used

Identify the properties of fluoride and its use

Identify the types of equipment used in fluoridation

Describe proper maintenance procedures for fluoridation equipment

Describe potential safety problems or emergency situations in the fluoridation process, and ways to avoid them

Compute the feed rate of chemicals used in the fluoridation process

BIL: Recommended – PC, ESA, HS, WEM

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		
GIS		

Competency 26.17: Correct facility operational problems in water treatment

Competency Builders:

Describe common facility operational problems in the treatment train, effluent disposal, and solids management

Identify appropriate corrective actions for common problems in disposal, and solids management

Troubleshoot coagulation and flocculation

Troubleshoot sedimentation

Troubleshoot disinfection

Troubleshoot filtration

Troubleshoot corrosion control

Troubleshoot taste and odor control

Troubleshoot iron and manganese control

Troubleshoot fluoridation

Troubleshoot softening

Troubleshoot demineralization

Troubleshoot trihalomethanes

BIL: Essential – PC, ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		P
ECA	I	P
HM		
WEM	I	P
FWM		
GIS		

Competency 26.18: Explain state and federal environmental protection agency (EPA) rules for drinking water

Competency Builders:

Describe the operator's duties and responsibilities, certification requirements, testing, renewal, staffing, and facility classification

Complete a EPA monthly operating report (MOR) form

Describe OSHA, EPA, and local health department rules for procedures such as reclaimed water, reuse, and biosolids residuals management

Describe federal rules that apply to the operation of a drinking water-treatment facility

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	R
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 26.19: Analyze environmental microbiological techniques

Competency Builders:

Perform coliform analyses

Perform sterilization techniques

Describe cultivation of microorganisms

Perform a standard plate count

Perform pressure presence/absence in membrane filter colifon analysis

BIL: Essential – PC, ESA
Recommended – HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 26.20: Identify methods for backflow prevention

Competency Builders:

Explain cross-connection

Identify purposes and consequences of backflow prevention

Identify approved backflow prevention devices

Unit 27: Wastewater Treatment Operations

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 27.1: Identify characteristics of wastewater treatment

Competency Builders:

- Identify constituents inherent to groundwater and/or surface water
- Describe the pH scale and its importance in the water-treatment process
- Correlate treatment processes to types of facility influent and solids
- Identify biological organisms used in treatment processes
- Identify commonly measured wastewater items
- Identify factors affecting raw wastewater
- Identify waterborne diseases
- Identify gases found in wastewater

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 27:2 Sample wastewater

Competency Builders:

- Identify the reasons for sampling and the types of samples (e.g., simple, representative, grab, composite)
- Describe methods of sample collection and handling
- Identify process control samples (biological or chemical)
- Identify representative sampling points
- Determine the significance of process control sample results (biological or chemical)
- Identify the basic procedure for quality control/quality assurance in sampling
- Identify the significance of the flow measurement on process control
- Identify laboratory tests required by the NPDES permit
- Identify pathogenic organisms, including bacteria, protozoa, and virus, and describe their disease associations
- Identify regulatory sampling guidelines
- Perform coliform analyses
- Describe cultivation of microorganisms
- Test for bacteria
- Explain sample chain of custody
- Apply sample-collection procedures for inorganic and organic analyses
- Describe the need for chemical analyses in wastewater treatment
- Determine whether the finished water is acceptable or unacceptable

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HS, HM

EDU:	12	AD
PC	I	P
ESA		P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 27.3: Describe wastewater collection systems

Competency Builders:

Identify types of wastewater collection systems

Identify flow variations and conditions that affect plant treatment including infiltration, inflow, and lift stations

Describe methods to detect and correct infiltration and inflow

Identify dissolved gases in wastewater and the effect of their presence/absence on treatment

BIL: Essential – PC, ESA, ECA
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM		
FWM		
GIS		

Competency 27.4: Identify constituents of wastewater entering wastewater treatment facility

Competency Builders:

Describe the uses of chemical analysis in wastewater-treatment operations

Identify commonly used units of constituent measurement

Identify pollutants, chemical, and microbial in raw water

BIL: Essential – PC, ESA, ECA, WEM
Recommended –HS, HM

EDU:	12	AD
PC	I	P
ESA		P
HS		I
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 27.5: Analyze the constituents of wastewater

Competency Builders:

Analyze the specific physical, chemical, and biological characteristics of wastewater

Analyze attached and suspended growth, respiration, gas production, aerobic and anaerobic conditions, differences in effluent disposal, and biosolids management

Identify ranges in wastewater treatment and limits on facility discharges

BIL: Essential – ESA, WEM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM	I	P
FWM		
GIS		

Competency 27.6: Troubleshoot collection system

Competency Builders:

Explain the significance of dissolved gases in the influent and the effects of dissolved gases on treatments

Explain the sources of infiltration and inflow and the effects of infiltration and inflow on treatment processes

Detect infiltration and inflow

Correct infiltration and inflow

Explain the effect of lift-station performance on the overall treatment process

Implement solutions for lift-station problems, such as surging flows, septic conditions, and power outages

BIL: Essential – ESA, WEM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 27.7: Describe the mixing, coagulation, and flocculation processes in wastewater treatment

Competency Builders:

Identify coagulant chemicals used in wastewater-treatment facilities

Identify the steps of coagulation

Identify specific sampling locations for control in a coagulation process

Identify factors that would contribute to poor floc formation

Compute the feed rate in pounds per day (lbs/d)

Compute the dosage (mg/l) of coagulant

Compute the dosage rate that is needed to treat a different flow (MGD) at the current dosage

BIL: Essential – ESA
 Recommended – PC, HS, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS	I	R
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 27.8: Describe the disinfection process in wastewater treatment

Competency Builders:

- Identify chemical disinfection methods
- Identify non-chemical disinfection methods
- Identify commonly used chlorinators and hypochlorinators
- Determine the maximum amount of chlorine gas (in pounds) that may be taken from a cylinder in a 24-hour period [R-HS]
- Identify proper maintenance procedures for equipment chlorination
- Identify terminology related to chlorination and disinfection [R-HS]
- Identify terminology related to ultraviolet disinfection
- Identify common safety problems or emergency situations that might occur during chlorination
- Identify the properties of chlorine and its use in waste water treatment
- Explain the points at which chlorine is applied most effectively in waste water treatment
- Compute the feed rate (lbs/d)
- Compute the feed rate (lbs/d) of a hypochlorite compound
- Compute the new rate of flow and the feed rate that will be needed to maintain the current dosage
- Compute the feed rate needed to treat a given amount of water

BIL: Essential – ESA, WEM
 Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		P
FWM		
GIS		

Competency 27.9: Describe the treatment train, effluent disposal, and solids management in wastewater

Competency Builders:

Describe concepts related to preliminary and primary treatment

Describe the types of preliminary-treatment equipment, the way they function, and the relationship of each to the treatment train

Describe the types of primary-treatment equipment, the way they function, and the relationship of each to the treatment train

Describe concepts related to secondary treatment, including attached growth, aeration, and clarification

Describe process control methods for aeration systems

Describe the types of secondary-treatment equipment, the way they function, and the relationship of each to the treatment train

Describe concepts related to tertiary-treatment processes, including sand filtration, nitrification/denitrification, oxic/anoxic, activated carbon, and artificial wetlands

Describe the types of tertiary-treatment equipment, the way they function, and the relationship of each to the treatment train

Describe concepts related to disinfection and effluent disposal, including surface water, reuse reclamation, deep well, and ocean outfall

Describe the types of disinfection and the types of effluent-disposal equipment, they way they function, and the relationship of each to the system

Describe concepts related to solids management, including thickening, aerobic and anaerobic digestion, stabilization, dewatering, and reuse

Describe the types of solids-management equipment, the way they function, and the relationship of each to the system

BIL: Essential – ESA, WEM
 Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		I
WEM		P
FWM		
GIS		

Competency 27.10: Analyze process optimization for the treatment train, effluent disposal, and biosolids management in waste water treatment

Competency Builders:

- Interpret laboratory data commonly obtained on incoming wastewater to monitor the efficiency of the identified treatment
- Describe possible adjustments to achieve process optimization for handling influent
- Interpret laboratory data commonly obtained on wastewater during primary treatment to monitor the efficiency of the identified treatment
- Describe possible adjustments to achieve process optimization for handling primary treatment
- Interpret laboratory data commonly obtained on wastewater during secondary treatment to monitor the efficiency of the identified treatment
- Describe possible adjustments to achieve process optimization for secondary treatment
- Interpret laboratory data commonly obtained on wastewater during tertiary treatment to monitor the efficiency of the identified treatment
- Describe possible adjustments to achieve process optimization for tertiary treatment
- Interpret laboratory data commonly obtained on reclaimed water during disinfection and disposal to monitor the efficiency of the identified treatment
- Describe possible adjustments to achieve process optimization for disinfection and disposal processes
- Interpret laboratory data commonly obtained during solids management, including solids-content tests, to monitor the efficiency of the identified treatment
- Describe possible adjustments to achieve process optimization in solids management*
- Identify proper disposal of solids based on the analysis of constituents, including accountability records and costs

BIL: Essential – ESA, WEM
 Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		I
WEM		P
FWM		
GIS		

Competency 27.11: Analyze treatment process control for the treatment train, effluent disposal, and biosolids management in wastewater

Competency Builders:

Describe grit-removal process

Describe laboratory tests performed on influent

Describe primary-clarifier removal efficiencies including settleable solids, suspended solids, total solids, BOD, and bacteria

Describe sampling points, frequency of sampling, and the laboratory tests and results that are used for the proper operation of the primary clarifier

Identify and plot on a trend chart the parameters for primary clarification

Describe advanced laboratory tests taken in the primary sedimentation tank

Evaluate the performance of secondary-treatment processes including attached growth, suspended growth, aeration, and clarification

Describe sampling points, the frequency of sampling, and the laboratory tests and results used for proper operation of the secondary-treatment processes

Identify and plot on a trend chart the parameters for secondary clarification

Describe advanced laboratory tests taken in the secondary-treatment processes

Evaluate the performance of tertiary-treatment processes, including sand filtration, phosphorus removal, and nitrogen removal

Describe sampling points, the frequency of sampling, and the laboratory tests and results used for checking the proper operation of tertiary treatment

Identify and plot on a trend chart the parameters for tertiary treatment

Describe advanced laboratory tests taken in advanced or tertiary treatment

Evaluate the performance of effluent-disposal processes, including disinfection and dechlorination

Describe sampling points, the frequency of sampling, and the laboratory tests used for checking the proper operation of effluent disposal

Identify and plot on a trend chart the parameters for effluent disposal

Describe the chemical and physical properties of chlorine

Describe the reactions of chlorine with water, ammonia compounds, and sulfides

Describe the safe storage and handling of chlorine, including the use of testing compounds

Explain the points of application of chlorine in wastewater treatment

Describe methods of dechlorination

Describe methods commonly used to dispose of wastewater effluents, including reuse applications

Describe laboratory tests commonly used on the reuse of effluent

Describe types of sludge and their characteristics

Evaluate the performance of solids management, including sludge thickening, digestion, dewatering, and disposal processes

Describe sampling points, the frequency of sampling, and the laboratory tests and results used for checking the proper operation of solids management

Describe advanced laboratory tests for disinfection, effluent disposal, and solids management

Identify 503 sludge regulations

Identify various recycling methods

BIL: Essential – ESA, WEM
 Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 27.12: **Inspect and maintain equipment for the treatment train, effluent disposal, and biosolids management in wastewater**

Competency Builders:

Identify equipment used in the treatment train, effluent disposal, and solids

Identify the maintenance needs of equipment used in the treatment train, effluent disposal, and solids management

Document the results of inspections

Develop preventive maintenance plans for equipment used in preliminary-, primary-, secondary-, and tertiary-treatment processes, and for equipment used in effluent disposal and solids management

Explain trends analysis used in preventive-maintenance planning for all treatment processes, effluent disposal, and solids management

Describe the monitoring of facility-equipment operation and usage with remote sensing equipment

BIL: Essential – ESA, WEM
 Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 27.13: Describe common facility operational problems

Competency Builders:

Check accuracy of observed operational problems in preliminary, primary, secondary, and tertiary treatment, effluent disposal, and solids management

Identify appropriate corrective actions for common problems in disposal, and solids management

Describe the methods for monitoring results of corrective action taken for common problems in preliminary, primary, secondary, and tertiary treatment, effluent disposal, and solids management

Identify sedimentation problems

Identify disinfection problems

Identify filtration problems

BIL: Essential – PC, ESA, ECA, WEM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA		P
HS		I
ECA		P
HM		
WEM	I	P
FWM		
GIS		

Competency 27.14: Explain state and federal environmental protection agency (EPA) rules for waste water

Competency Builders:

Describe the operator’s duties and responsibilities, certification requirements, testing, renewal, staffing, and facility classification

Explain rules concerning samples and analysis at wastewater-treatment facilities

Complete an EPA monthly operating report (MOR) form

Complete a National Pollution Discharge Elimination System (NPDES) MOR form

Identify OSHA, EPA, and local health department rules for procedures such as reclaimed water, reuse, and biosolids residuals management

Identify federal rules that apply to the operation of a wastewater-treatment facility

BIL: Essential – PC, ESA
Recommended – HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 27.15: Identify methods for cross-connection and backflow prevention

Competency Builders:

Identify purposes and consequences of backflow prevention

Identify approved backflow prevention devices

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		I
ECA	I	R
HM	I	R
WEM		P
FWM		
GIS		

Competency 27.16: Identify industrial pretreatment program

Competency Builders:

Identify categorical industries

Identify non-categorical industrial

Identify purpose of industrial pretreatment

Describe federal and state pretreatment regulations

Unit 28: Hazardous Materials Management

BIL: Essential –ESA, ECA, HM
Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.1: Describe risks related to hazardous materials

Competency Builders:

Define hazardous material

Differentiate hazardous materials incidents from other emergencies (First Responder Awareness-FRA; First Responder Operations Level-FRO; Hazardous Materials Technician-HMT; Hazardous Materials Specialist-HMS)

Differentiate between hazardous materials and waste with non-hazardous materials (FRA, FRO, HMT, HMS)

Differentiate between acute and chronic hazards

Describe the properties /nomenclature of hazardous materials

Describe physical, chemical, biological hazards (including explosion/fire hazards)

Describe the routes of exposure for hazardous materials

Describe the fundamentals of chemical hazards including but not limited to vapor pressure, boiling points, flash points and pH (FRA, FRO, HMT, HMS)

Describe fire and explosion hazards of chemicals including typical ignition sources (FRA, FRO, HMT, HMS)

Describe viral and bacteriological hazards of biological materials

Describe types of radiation and their effects

Identify examples of a confined space

Describe the hazards related to confined space (FRA, FRO, HMT, HMS)

Describe general safety hazards (e.g., electrical hazards, powered equipment hazards motor vehicle hazards, walking-working surface hazards associated with working in hot and cold temperature extremes (FRA, FRO, HMT, HMS)

Identify routes by which hazardous materials enter the human body upon exposure

Describe the basic principles of toxicology

Describe the human signs and symptoms as responses to exposures to chemical, biological and radiological hazards

BIL: Essential – ESA, HS, ECA, HM
 Recommended – PC, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.2: Describe health and safety practices to reduce risks from hazardous materials

Competency Builders:

Describe protocol to control stress from noise

Describe the exposure guidelines for hazardous materials (threshold limit value, permissible exposure limits)

Explain the impact of basic nutrition on the risks from hazardous materials

Describe the elements of a spill control program (FRO, HMT)

Describe examples of engineering controls, equipment and safety technology or safety procedures (FRO, HMT)

Identify typical design and construction of containers, bulk and non-bulk packaging used to store , process, or transport hazardous materials (e.g., bags, bottles, boxes, cans, carboys, drums, fixed tanks, intermodal portable tanks, piping tank cars, tank trucks, and trailers (FRO, HMT)

BIL: Essential – ESA, HS, ECA, HM
 Recommended – PC

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.3: Demonstrate appropriate responses for major types of hazardous materials disasters (e.g., chemical, fire and explosion, general safety hazards) (FRA, FRO, HMT, HMS)

Competency Builders:

Describe the principles and practices of establishing exposure zones, and medical surveillance stations and procedures (HMT, HMS)

Describe how MSDS (material safety data sheet) may be used to obtain hazard and response information

Identify risk assessment considerations of hazardous materials (e.g., size and type of container and quantity involved; nature of the container stress; potential behavior of the container and its contents; level of resources available; exposure potential to people, property, environment, and systems; and weather conditions and terrain) (FRA, FRO, HMT, HMS)

Describe the procedures for implementing continuing response actions consistent with local emergency response plan, the organizations standard operating procedures, and the current edition of Department of Transportations’s ERG including extended emergency notification procedures and follow-up communications (FRA, FRO, HMT, HMS)

Demonstrate decontamination procedures

Describe the advantages and limitations of each of the following methods of decontamination: absorption, adsorption, neutralization, and solidification (HMT, HMS)

Identify the steps in critiquing a hazardous materials incident

BIL: Essential –PC, ESA, HS, ECA, HM
Recommended – WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.4: Describe appropriate use of Personal Protective Equipment (PPE)

Competency Builders:

Describe the following terms as associated with chemical protective clothing: degradation; penetration; and permeation

Identify the physical and psychological stresses that can affect users of specialized protective clothing

Identify various types of protective breathing apparatus and the advantages and limitations of each at a hazardous materials incident (FRO, HMT, HMS)

Interpret chemical compatibility chart for chemical protective clothing (FRO, HMT, HMS)

Explain the four levels of PPE (A, B, C, D) (FRO, HMT, HMS)

Identify the equipment used with each of the four levels of PPE

Identify the conditions under which it is safe to enter a space with each of the four levels of PPE

BIL: Essential – ESA, ECA, HM
 Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.5: Explain hazardous substance regulations

Competency Builders:

Describe the role of federal, state and local agencies in developing and implementing regulation

Describe the core elements of an occupational safety and health program as identified in 29 CFR1910.120 (q) (FRA, FRO, HMT, HMS)

Describe the components of an effective site safety and health plan consistent with the requirements of 29 CFR1910.120 (b)(4)(ii)

Describe what activities are controlled by OSHA 29 CFR1926 regulations

Describe the record keeping requirements for workmen’s compensation, OSHA (100 &200), Department of Transportation, and the Environmental Protection Agency

Explain the rights and responsibilities of employers and employees under applicable OSHA and EPA laws

Describe confined space considerations as outlined in 29 CFR 1910.146 and lock-out tag-out standards

Explain OSHA’s hazard-communication standard (29 CFR 1910.1200)

Explain the impact of the following regulations on hazardous substance:

CERCLA- Comprehensive Environmental Response Liability and Compensation Act (Super Fund)

RCRA- Resource Conservation and Recovery Act

TSCA- Toxic Substance Control Act

SDWA- Safe Drinking Water Act

CWA -The Clean Water Act

CAA- Clean Air Act

HM181- Hazardous Materials Regulations

NFPA-704- National Fire Protection Association No. 704

Code of Federal Regulations

SARA- Super Fund Amendment and Reauthorization Act

Explain the competencies of the First Responder at the Awareness level as covered in the National fire Protection Association Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (FRA)

Explain the competencies of the First Responder at the Operations Level covered in the National Fire Protection Association’s Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (FRO)

Explain the competencies of the Hazardous Materials Technician covered in the National Fire Protection Association’s Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (HMT)

Explain the competencies of the Off-Site

Specialist Employee covered in the National Fire
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BIL: Essential – ESA, ECA, HM
Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.6: Demonstrate an ability to obtain and use information addressing hazardous substance release

Competency Builders:

Identify chemical reference materials (i.e., NIOSH)

Describe the use of mapping

Identify suppliers and technical resources

Identify responders

Demonstrate competency using the U.S. Department of Transportation’s Emergency Response Guidebook (ERG) (FRA, FRO, HMT)

Demonstrate competence using manufacturer material safety data sheets, CHEMTREC//CANUTEC, shipper or manufacturer contacts, and other sources of information addressing hazardous substance release (FRO, HMT)

Demonstrate competence using hazardous materials computer databases and response models (HMT)

Utilize computer networking

BIL: Essential – PC, ESA, ECA, HM
 Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.7: Conduct environmental sampling

Competency Builders:

Determine reason for sample

Define risks associated with sampling

Identify sampling protocol

Follow chain of custody procedures

Determine frequency of sampling

Identify testing plan

Define QA/QC protocol

Identify potential sample interferences

Demonstrate preventive maintenance and testing procedures, including operational and calibration checks, for sampling and monitoring equipment

Demonstrate appropriate use of equipment (e.g., bailers, hand augers, organic–vapor analyzers, pumps, radioactivity measuring equipment, split spoons, combustible gas detector, oxygen meter, elorimetric tubes, pH papers and strips, CO meter, radiation detection instruments, colorimetric indicator, combustible-gas indicator, organic-vapor analyzer,OVA, HNU, PID and explosimeter)

Demonstrate container sampling and safeguarding procedures (e.g., general drum/container handling procedures, special requirement for laboratory waste packs, shock-sensitive wastes, and radioactive wastes (HMS))

Sample ground water, waste water, sewer line, drum, air, soil, unknown materials, personnel

Perform field tests (i.e., HAZCAT)

Perform OVD test

Identify proper preservation and storage procedures for hazardous materials samples

Demonstrate the appropriate use of the Perform personnel-exposure monitoring

Follow chain-of-custody procedures

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.8: Demonstrate safe handling procedures for hazardous materials and hazardous waste

Competency Builders:

List and describe containers used to store hazardous chemicals and waste (HMS)

Describe safe handling procedures for hazardous materials

Describe different types of hazardous substance transportation vehicles (HMT)

Demonstrate appropriate selection and use of the various types of equipment available for plugging or patching transportation containers, vessels or vehicles (HMS)

Implement safe chemical-handling procedures (e.g., bonding fire control, grounding, storage, vapor control, ventilation)

Demonstrate safe handling procedures for bulk chemical containers, drums, and portable and stationary tanks (HMT)

Prepare to ship sample to laboratory (per Department of Transportation)

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.9: **Demonstrate record keeping**

Competency Builders:

Explain why and how long hazardous materials in

BIL: Essential – ESA, ECA, HM
Recommended – PC, HS

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.10: Evaluate laboratory results

Competency Builders:

List criteria for the selection of the laboratory

Identify laboratory methodology

Identify laboratory instrumentation

Identify laboratory quality control procedures

BIL: Essential – ESA, HS, ECA, HM
Recommended – PC

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.11: Demonstrate health and safety practices to reduce risks from hazardous substances

Competency Builders:

Demonstrate lead and asbestos safety procedures

Demonstrate confined space safety procedures

Demonstrate decontamination procedures

Demonstrate the procedures to carry out a respirator program to comply with 29 CFR 1910.134 (FRO, HMT)

Demonstrate methods of communication including those used while wearing respirator protection

Demonstrate the donning and doffing of protective equipment (FRO, HMT, HMS)

Write a site safety plan

Conduct a site safety meeting

Obtain first aid/CPR certification

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.12: Demonstrate methods for identifying hazardous material

Competency Builders:

- Describe the advantages, disadvantages, and limitations of placards, labels, container markings, and shipping papers used in the transportation of hazardous materials
- Describe the shipping papers found in various modes of transportation, the individual's responsible for the papers, and location where carried and found during an incident
- Explain circumstances for use of the following terms: hazardous substances, hazardous chemicals; extremely hazardous substances; hazardous wastes; hazardous materials; and dangerous goods
- List the advantages and disadvantages of each of the following information sources: MSDS; reference guidebooks; hazardous materials data base; technical information centers such as CHEMTREC; technical information specialist; monitoring equipment; and NIOSH pocket guide to chemical hazards
- Explain labeling of hazardous materials by the chemical and physical properties of color, corrosivity, density, flammability, reactivity, specific gravity, toxicity, and viscosity
- Identify hazardous wastes according acute toxicity, corrosivity, ignitability, reactivity, and toxic characteristic leachate procedure (TCLP)
- Demonstrate proper labeling for hazardous wastes
- Label containers of repackaged materials with appropriate warnings and expiration information

BIL: Essential – ESA, HS, ECA, HM
 Recommended – PC

EDU:	12	AD
PC	I	R
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.13: Detect hazardous materials

Detect toxicity, flammability, reactivity, radioactivity, corrosivity, and oxygen deficiency

Use MSDS in obtaining hazard and response information to determine isolation and evacuation distances

Use air reactivity; catalysts and inhibitors; concentration; corrosivity; critical temperature and pressure; instability; oxidation ability; pH; polymerization; radioactivity; self-accelerating decomposition temperature (SADT); strength; sublimation; surface tension; viscosity; volatility; and water reactivity in the risk assessment process

Explain the use of threshold limit value (TLV-TWA); lethal concentration and dose (LD 50/100); parts per million/billion (ppm/ppb); immediately dangerous to life and health (IDLH); permissible exposure limit (PEL); short-term exposure limit (TLV-STEL); and ceiling level (TLV-C)

Explain the importance of chemical interactions; dose-response relationship; local and systemic effects; acute, subacute, and chronic exposure; and ingestion, absorption, inhalation in the risk assessment process

Explain half-life, time, distance, and shielding in reference to radiation hazards

Demonstrate the analysis procedure for identification of unknown hazardous materials, their physical and chemical properties, and the likely behavior of the hazardous substance and its container, vessel, or vehicle (HMS)

Compare laboratory and field sample analysis against regulatory limits

Identify considerations associated with the placement, location, and set up of a decontamination site

Identify which activities are required in terminating the emergency phase of a hazardous materials incident

Describe the preparation of a required report with supporting documentation

Describe the process for implementing the Incident Command System for hazardous materials emergencies

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.14: Perform site evaluation

Competency Builders:

- Activate site assessment plan
- Notify appropriate authorities
- Check for immediate dangers to life and health
- Determine site topography and accessibility
- Determine wind direction
- Implement appropriate site health and safety plan
- Describe the emergency-response program
- Establish boundaries
- Restrict site access
- Orient zones
- Determine needs for PPE
- Record findings
- Report findings to appropriate authorities
- Control site
- Monitor site and personnel
- Close site

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	R	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.15: Retrieve and evaluate hazardous materials and hazardous waste sample data

Competency Builders:

Interpret prints, charts, curves, graphs, maps, plans, and spreadsheets from plotted and tabulated data

Tabulate data using calculators, computers, databases, graphics, and/or spreadsheets

Perform mathematical calculations

Compare appropriate laboratory and/or field sample analyses against regulatory limits

BIL: Essential – PC, ESA, HS, HM
 Recommended – ECA

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

Competency 28.16: Respond to mock hazardous materials emergency situations

Competency Builders:

Maintain certification in first aid and CPR

Describe the elements of a spill control program

Follow a written contingency plan

Use proper chain of command

Ensure that adequate spill-control equipment and supplies are available

Contact appropriate hazardous materials public and private resources (HMS)

Implement an emergency-response program consistent with local emergency response plan, and the organization’s standard operating procedures (HMS)

Select the appropriate strategy for approaching a release site and continuing or stopping the release (HMS)

Implement an Incident Command System for a hazardous materials emergency

Demonstrate competency in first aid, CPR and emergency response

Identify considerations associated with the placement, location, and set up of a decontamination site

Implement decon

Organize and direct the use of multiple teams of hazardous materials technicians in a Command System (ICS) (HMS)

Identify which activities are required in terminating the emergency phase of a hazardous materials incident

Prepare the required report with supporting documentation for a hazardous waste Emergency

Follow media protocol

BIL: Essential – ESA, HM
 Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	R	P
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.17: Describe use of equipment related to hazardous materials and hazardous-waste operations

Competency Builders:

Explain appropriate equipment-decontamination procedures

Identify appropriate operations and maintenance procedures, plans, and manuals

Identify skill and certification requirements

Describe proper use of drum crushers, hand tools, heavy equipment, monitoring and sampling equipment, instrumentation, motorized lifting devices, power tools, pumps, valves, meters, vehicles

Employ communication systems, eyewashes, safety showers, fire extinguishers, and first aid

EDU:	12	AD
PC	I	P
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.18: Prepare hazardous-materials for transportation and storage in accordance with regulations

Competency Builders:

Prepare documentation related to the shipment of hazardous materials and hazardous wastes

Identify incompatible combinations of chemicals that could result in dangerous situations

Describe safe and healthful procedures for packaging, loading, documenting, and shipping of hazardous materials and hazardous wastes

Inspect hazardous-waste storage areas for compliance with appropriate rules and regulations following a checklist

Segregate and store incompatible hazardous materials and hazardous wastes

Employing a hazard category list

BIL: Essential – HM
 Recommended – PC, ESA, HS, ECA

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

Competency 28.19: **Demonstrate ability to operate treatment and disposal systems for hazardous-materials and hazardous-waste**

Competency Builders:

Record and maintain documentation of operations activities

Contribute to the development and revision of plans and reports

Identify appropriate drums and containers

Document activities of hazardous-waste treatment and disposal contractors

Recommend improvements in the reduction, reuse, recycling, or disposal of waste streams

Describe the collection and disposal of empty hazardous materials containers

Describe the preparation of accumulated hazardous waste for proper disposal

Describe treatment, removal and disposal systems such as: bio-remediation, chemical and physical, deep-well injection, incineration, vitrification, and volatile organic compounds

Describe hazards associated with abatement of materials such as: asbestos, fiberglass, and lead

Describe hazards associated with treatment, removal, and disposal systems and operations

Demonstrate decontamination programs including personnel, equipment and hardware; including level A, B and C ensembles and appropriate decontamination lines

EDU:	12	AD
PC	I	P
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.20: Maintain required documents for hazardous-materials and hazardous-waste management activities

Competency Builders:

Demonstrate manifest procedures

Maintain documentation of chain of custody, equipment calibration and maintenance, exception reports, field notebooks, incident documentation, laboratory data, manifests, MSDS, purchase orders, shipping documents, and vendor invoices

Maintain compliance reports

Ensure current MSDS are available in the workplace

Maintain auditable record-keeping systems

Maintain a hazardous-materials inventory

Maintain a hazardous-waste inventory

Maintain an inventory of empty and full containers

BIL: Essential – ECA, HM
 Recommended – PC, ESA, HS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.21: Audit regulatory compliance

Competency Builders:

Describe Phase I and Phase II audits

- Describe closure reports
- Describe the penalties for noncompliance
- Follow organization’s policies and procedures
- Create master file (e.g., data base for record management)
- Create/follow audit schedule
- Audit records
- Interview personnel
- Inventory materials and equipment
- Assess environmental factors and conditions (e.g., on-site visits)
- Write contamination assessment report
- Propose corrective action
- Verify follow-up activities
- Maintain confidentiality
- Control dissemination of report finds
- Critique the audit process

BIL: Recommended – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

Competency 28.22: Contract for services

Competency Builders:

- Define scope of work/needs
- Write or review specifications
- Consult with legal staff
- Consult with purchasing department
- Provide cost justifications
- Research qualified contractors/vendors for services and products
- Conduct on-site visits
- Select contractor
- Secure and award bid
- Obtain permits
- Train contractors
- Evaluate and verify vendor's performance

BIL: Essential – ECA, HM
Recommended – PC, ESA, HS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		P
HM		P
WEM		
FWM		
GIS		

Competency 28.23: Conduct preplanning activities

Competency Builders:

- Explain need for preplanning
- Identify type of preplanning needed
- Identify agency involvement
- Identify contamination zones
- Preplan for hurricanes, tornadoes, floods, fires, nuclear accidents, and earthquakes,
- Describe preplanned deployment
- Write a contingency plan

Unit 29: Wetlands Management

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

Competency 29.1: Identify properties of wetland

Competency Builders:

Explain differences between uplands, wetlands and open bodies of water

Identify the conditions necessary for wetlands to exist

Identify sources of water in wetlands

Describe wetland formation

Describe key elements used to define wetlands

Describe a wetland

Describe characteristics of hydric soils

Describe physical differences between wetlands and upland soils

Describe characteristics of hydrophytic plants

Describe factors which influence the distribution and extent of wetlands

Differentiate between temporary and permanent wetlands

List factors used by the U. S. Army Corps of Engineers and the Environmental Protection Agency to define an area as a wetland

Compare definition of wetlands used by the U. S. Fish and Wildlife Service and the Natural Resources Conservation Service of the U. S. Department of Agriculture

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

Competency 29.2: Explain wetlands classification

Competency Builders:

List common types of wetlands

Differentiate between coastal and inland wetlands

Describe types of vegetated wetlands

Describe types of non-vegetated wetlands

Explain common characteristics associated with each major type of wetland

Identify qualities that distinguish one type of wetland from another

Distinguish between a wetland type and wetland habitat complex

Explain wetland class, form and type

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 29.3: Explain the function of wetlands

Competency Builders:

Identify reasons wetlands are important

Identify ecological functions of wetlands

Identify the role of wetlands as a pollutant removal mechanism

Describe the use of wetlands as part of a comprehensive waste water treatment program

Describe how wetlands can provide a flood control benefit and help prevent soil erosion

Explain the role of wetlands in preserving water quality

Interpret the role of plants in water purification

Explain the role of wetlands in coastal protection

Describe the function of wetlands in ground water discharge and recharge

Describe the ability of wetland soils to filter pollutants from water

Describe the benefits of wetlands in serving as sediment traps

Explain how wetlands can impact atmospheric equilibrium

Describe the filtering ability of wetland plants

Describe how wetland plants remove pollutants from water

List several factors that contribute to wetlands performance in processing waste

Explain the role of wetlands as habitats for commercially important fish, bird and animal populations

Describe the role of the wetlands in primary biological production

Describe the role of wetlands in agricultural production

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 29.4: Describe the living components of wetland habitats

Competency Builders:

Identify common animals (mammals, reptiles, amphibians, macro-invertebrates) that live and use wetlands

Describe the habitats of these animals

Identify common wetland plants

Describe how plants and animals have adapted to the environmental conditions present in wetlands

Explain morphological, physiological and reproductive adaptations of plants common to wetlands

Identify animals and plants in a wetland food web and describe their role

Describe interrelationships among wetland organisms

Classify selected wetland plants

List some obligate wetland plants

List some facultative wetland plants

Describe the common characteristics of waterfowl family

Explain the role played by wetlands in waterfowl production

Identify fish species of the wetlands

BIL: Essential – ESA, WEM, FWM
 Recommended – PC

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA		
HM		
WEM		P
FWM		P
GIS		

Competency 29.5: Assist in wetland delineation

Competency Builders:

- Explain wetland delineation
- Identify steps used in offsite determination of wetlands
- Determine circumstances where offsite method is most useful
- Explain use of National Wetlands Inventory (NWI) maps in wetland determination
- Explain use of SCS soil survey maps and county hydric soil lists in wetland determination
- Explain aerial photos in offsite determination
- Delineate offsite wetland
- Contrast offsite and onsite methods of wetland delineation
- List equipment and materials needed in routine methods of onsite determination
- Identify dominant vegetation by strata
- Explain measures of plant species dominance
- Determine plant species dominance for a particular stratum
- Explain criteria used to determine presence of hydrophytic vegetation
- Analyze vegetation
- Explain hydrophytes
- Record indications of wetland hydrology
- Record indications of hydric soil

BIL: Essential – ESA, WEM
Recommended – PC, FWM, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	R
GIS		I

Competency 29.6: Explain impact of an increasing human population on wetlands

Competency Builders:

- Explain the historic decline of wetlands
- Explain factors that can cause wetland destruction
- Explain nutrient overloading
- Describe how nitrogen and phosphorus get into a wetland
- Explain the effects of oil spills, acid rain and human wastes on wetlands
- Describe how wetlands can be harmed by pollution
- Explain the use of bio-monitoring to determine pollution
- Describe how an overload of pollutants can affect the filtering ability of plants
- Explain the potential impact of dams and levees on a wetland
- Identify ways land alteration affects wetlands
- Explain effects of alteration on wetland hydrology
- Explain effects of alteration on wetland soils
- Explain effects of alteration on wetland vegetation

BIL: Essential – WEM
 Recommended – PC, ESA, ECA, FWM

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	R
GIS		

Competency 29.7: Explain government’s role in wetland restoration and conservation

Competency Builders:

- Distinguish the role played by federal and state agencies in wetland restoration and conservation
- Explain Section 401 of the Clean Water Act and the agencies responsible for compliance oversight
- Explain Sections 9 and 10 of the Rivers and Harbors Act and the agency responsible for compliance oversight
- Explain Section 404 of the Clean Water Act and oversight agencies involved
- Describe the National Environmental Policy Act (NEPA)
- Explain the Coastal Management Act and identify the oversight agency
- Explain how flood plain management programs have potential impact on wetlands
- Explain the North American Waterfowl Management Plan
- Explain “swampbuster” provisions in Food Security Act
- Identify problems in current wetland regulation
- Compare economic, social and environmental tradeoffs in various wetland conservation
- Explain the “takings” issue
- Describe the pros and cons of a “no net loss” policy in wetlands management

BIL: Essential – WEM, GIS
 Recommended – PC, ESA, ECA, FWM

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		P
FWM		I
GIS		P

Competency 29.8: Identify techniques used in wetland management, enhancement and restoration programs

Competency Builders:

- Identify key elements in a wetlands management program
- Describe steps involved in an impact assessment program
- Explain how Geographic Information Systems (GIS) are used to analyze wetland habitats
- Explain how aerial photography, satellite imagery, wetland, and topographic maps are used in wetland management
- Determine wetland hydrological disturbance
- Determine wetland soil disturbance
- Determine wetland vegetation disturbance
- Explain wetland restoration
- Explain hydroperiod restoration
- Explain proper wetland topography reestablishment
- Describe how changes in watershed may impact restoration
- Describe ways to control invasion of undesirable wetland plants
- Describe ways to control destructive wildlife
- Describe techniques in using wetlands to treat wastewater

BIL: Essential – WEM
 Recommended – PC, ESA, ECA, FWM

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		P
FWM		I
GIS		

Competency 29.9: Identify principles used in wetland mitigation and restoration

Competency Builders:

- Explain wetland mitigation
- Explain wetland mitigation banking
- Explain factors to consider in determining a site for wetland development
- Describe elements used in design of surface-flow wetlands
- Describe elements used in design of subsurface flow wetlands
- Describe factors used to determine appropriate plant selection
- Describe factors used to attract and stock wildlife
- Explain various approaches to wetland design, (e.g., rule of thumb, regression-based empirical and rational approaches)
- Compare properties of created and natural wetlands

Unit 30: Watershed Management

BIL: Essential – PC, ESA, HS, WEM, FWM
Recommended – ECA, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

Competency 30.1: Identify properties of watersheds

Competency Builders:

Explain how watersheds are formed

Identify different types of watersheds and the significant characteristics of each

Explain basic watershed processes and their interrelated nature

Explain how watersheds function

Identify the benefits of a healthy watershed

Explain how change occurs in watersheds

Evaluate the effects of natural and human disturbances on watersheds: landslides, floods, forestry, urbanization, and agriculture

Identify the three zones in a watershed (waterbody, riparian, and upland)

Explain water born pathogen movement in a watershed

BIL: Essential – PC, ESA, WEM
 Recommended – HS, ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 30.2: Explain watershed management

Competency Builders:

- Explain terms associated with watershed ecology
- Explain contemporary issues in watershed ecology
- Identify different types of watershed management
- Identify the principles of long-term watershed management

Identify successful watershed management framework

- Identify watershed management benefits
- Explain the effect of the 1998 Clean Water Initiative on watershed planning
- Identify problems and political aspects of watershed management
- Explain how watershed analysis and planning can mitigate watershed disturbances
- Explain how human activities within a watershed affect it
- Explain the purpose of stream stabilization
- Explain methods of stream stabilization (e.g., stream mechanics, natural channel geometry, bank paving, stone dikes, bendway weirs, longitudinal peaked toe, willow pole curtain)
- Explain stream hydraulics
- Explain sediment transport

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA, FWM, GIS

EDU:	12	AD
PC	I	R
ESA		P
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM		I
GIS		I

Competency 30.3: Delineate watersheds

Competency Builders:

Identify watersheds on topographic maps

Identify watersheds in the field

Determine the true water-parting divide

Explain the consequences of the surface and sub-surface water-parting divides being different

Explain the use of BASINS software to map watersheds

Prepare source maps

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		P
FWM		I
GIS		

Competency 30.4: Assess source water

Competency Builders:

Identify methods to assess watershed conditions

Identify factors that impact quality of water

Apply segmentation and risk hierarchy concepts to water

Conduct contaminant inventories

BIL: Essential – WEM
 Recommended – PC, ESA, HS, ECA, FWM

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM		I
GIS		

Competency 30.5: Identify elements of a watershed management plan

Competency Builders:

- Identify boundaries of the watershed
- Determine topography of the watershed
- Determine soil types within the watershed
- Identify land uses within the watershed boundary
- Determine the natural resources of the watershed
- Identify social trends, particularly economic and employment data, which may affect the watershed
- Determine human activities within the watershed
- Identify animals and vegetation in the watershed
- Assess risks
- Identify stakeholders
- Identify environmental objectives

Prioritize issues

Unit 31: Wildlife Ecology

BIL: Essential – ESA, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	I	R
HM		
WEM		
FWM	I	P
GIS		

Competency 31.1: Identify representative animal species

Competency Builders:

Identify representative mammals and their life histories

Identify representative birds and their life histories

Identify representative reptiles and their life histories

Identify representative amphibians and their life histories

Identify representative invertebrates and their life histories

Identify representative fish and their life histories

BIL: Essential – ESA, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	I	
HM		
WEM		
FWM	I	P
GIS		

Competency 31.2: Identify representative amphibians, reptiles, birds, invertebrates, fish, and mammals typical of Ohio

Competency Builders:

Determine the order, family and other appropriate taxonomic categories

Describe differentiating characteristics of the taxonomic groups

Identify examples of Ohio species in each taxonomic group

Identify animals (field and laboratory)

Identify animals from laboratory specimens and field observations

BIL: Essential – ESA, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	I	
HM		
WEM		
FWM	I	P
GIS		

Competency 31.3: Explain animal biology

Competency Builders:

Describe the basic anatomy of amphibians, reptiles, birds, invertebrates, fish, and mammals

Describe the major systems of amphibians, reptiles, birds, invertebrates, fish, and mammals with major emphasis on the digestive and reproductive systems

Describe the nutritional requirements of amphibians, reptiles, birds, invertebrates, fish, and mammals

Explain the role of genetics in the biology of amphibians, reptiles, birds, invertebrates, fish, and mammals

Unit 32: Wildlife Management

BIL: Essential – FWM

EDU:	12	AD
PC		
ESA		
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ECA		
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WEM		
FWM	I	P
GIS		

Competency 32.1: Identify the major factors that affect the growth and regulation of animal populations

Competency Builders:

Compare ecosystem, population, and biotic community

Explain environmental resistance, environmental support, biotic potential, natality, mortality, immigration, emigration, density dependent, and density independent, etc.

Graph and label growth curves

Diagram and label age structures for populations that are increasing, decreasing, or stable

Diagram three types of survivorship curves

Identify the characteristics of populations with low densities and populations with high densities

List the major types of population regulation mechanisms

Distinguish between R and K selected species

Explain the basic principles of population genetics and natural selection

Explain the Hardy-Weinberg Principle

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	P	R
GIS		

Competency 32.2: Explain interdependency of ecosystem

Competency Builders:

Identify communities

Identify relationship between communities of ecosystem

Identify major plant biomes

Differentiate renewable and nonrenewable resources

EDU:	12	AD
PC		
ESA		
HS		
ECA		
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WEM		
FWM	P	R
GIS		

Competency 32.3: Analyze current trends in the populations of wildlife species in Ohio

Competency Builders:

List the current population trends for various species in Ohio

Explain the reasons for stable, increasing, or decreasing populations

Identify potential problems

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.4: Control pests that affect wildlife

Competency Builders:

Identify the major external parasites that affect birds and mammals

Identify the major internal parasites that affect birds and mammals

Identify the major vertebrate pest species that affect man and wildlife

Identify appropriate control measures for both invertebrate and vertebrate pest species

Distinguish control measures for invertebrate and vertebrate pest species

EDU:	12	AD
PC		
ESA		
HS		
ECA		
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WEM		
FWM	I	P
GIS		

Competency 32.5: Perform population estimates, food habits analyses, aging and sexing, and necropsy exams

Competency Builders:

Identify types of population density surveys

Identify the measurements made on wildlife species that are used to assess the condition of the wildlife population

Calculate sex ratios, average measurement data on antler beam, and number of points

Set up and run NACSM and grid trap lines for mark-recapture and removal studies

Calculate or determine population size estimates using the Lincoln-Peterson Index plus selected modifications and several removal techniques

Perform food habits analyses on both herbivores and carnivores

Identify the dentition of deer

Explain how replacement of deciduous teeth and wear of teeth serve as age indicators

Identify the major external sexing criteria for bird and mammal species

Identify the major internal organs of birds and mammals

Dissect birds and mammals

EDU:	12	AD
PC		
ESA		
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WEM		
FWM	I	P
GIS		

Competency 32.6: Immobilize wildlife

Competency Builders:

Employ safety procedures when handling and firing a cap-chur gun and related equipment

Hit a target when firing a cap-chur gun on the range

List the major drugs used in the immobilization of wildlife

List the integral components of a radiotelemetry system used in wildlife management

Operate a wildlife materials radiotelemetry unit in the tracking and locating of a collared animal

EDU:	12	AD
PC		
ESA		
HS		
ECA		
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WEM		
FWM	I	P
GIS		

Competency 32.7: Trap animals

Competency Builders:

- Identify reasons for trapping
- Identify basic types of traps
- Identify common animals that are trapped
- Identify basic sets of each species trapped
- Identify other equipment needed in trapping
- Maintain trapline
- Maintain records

EDU:	12	AD
PC		
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HS		
ECA		
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WEM		
FWM	I	P
GIS		

Competency 32.8: Apply animal control techniques

Competency Builders:

Operate restraining mechanisms

Tag legs

Identify animal control purposes

Operate small animal carrier, rabbit restrainer, metabolism cage, and shoebox cage

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.9: Control damage from wildlife

Competency Builders:

Identify potential areas of human-animal conflict and methods to minimize their impact

Identify problems caused by wildlife

Select appropriate wildlife control method(s) for the situation

Apply wildlife control method(s)

EDU:	12	AD
PC		
ESA		
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WEM		
FWM	I	P
GIS		

Competency 32.10: Explain ecological principles required for habitat evaluation and manipulation

Competency Builders:

Diagram energy flow through food chains and food webs

List examples of organisms which occupy each trophic level

Distinguish between autotrophic and heterotrophic based food webs

Describe both gaseous and sedimentary biogeochemical cycles

Distinguish between primary and secondary succession

List the various serial stages that occur for typical successional patterns in Ohio

List the ecosystem development characteristics for early, intermediate, and late successional stages

Explain the use of bio-monitoring to evaluate habitats

List the physical, chemical, and biological factors that affect microclimate and how they influence the plant and animal communities

EDU:	12	AD
PC		
ESA		
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WEM		
FWM	I	P
GIS		

Competency 32.11: Evaluate habitats

Competency Builders:

Calculate, and interpret visual obscurity measurements using a vegetation density board

Explain the use of 1/660 aerial photographs in making a cover map

Field verify cover maps

Correct cover maps

Collect quantitative vegetation

Analyze quantitative vegetation data

Interpret quantitative vegetation

Explain the use of plant indicators, plant condition, soil type, soil moisture, and nutrient conditions in habitat evaluation

Explain the role of maps (including glacial, geologic, physiographic, topographic, and vegetation) in habitat evaluation

Compare the different methods used for habitat evaluation

Use GIS in habitat evaluation

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
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ECA	I	R
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WEM		
FWM	P	R
GIS		

Competency 32.12: Identify endangered species in Ohio

Competency Builders:

Explain the Endangered Species Act and its primary objectives

Explain why species are endangered

Explain the efforts to save endangered species in Ohio

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
ESA		
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ECA	I	R
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WEM		
FWM	P	R
GIS		

Competency 32.13: Identify the habitat requirements for Ohio’s major wildlife species and for endangered species

Competency Builders:

List the habitat requirements for species found in early successional stages, such as rabbit, quail, pheasant and dove

List the habitat requirements for species found in intermediate successional stages, such as deer and grouse

List the habitat requirements for species found in late successional stages, such as turkey and squirrel

List the habitat requirements for species found in wetland types of habitat, such as waterfowl

Identify factors which limit selected endangered species

EDU:	12	AD
PC		
ESA		
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WEM		
FWM	I	P
GIS		

Competency 32.14: Develop a wildlife management plan

Competency Builders:

Identify reasons for wildlife management

Explain wildlife management practices for forest game, farm game, furbearers, waterfowl, nongame species, and endangered species

Identify animals associated with forest game, farm game, furbearers, waterfowl, and nongame species

Identify types of equipment used in wildlife management

Explain advantages and disadvantages of introduction of wildlife species to new habitats

Explain the importance of healthy wildlife population to local economy

Determine what species of wildlife are to be managed

Establish management practices

Identify management strategies possible in the regulation of ecological succession

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
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ECA	I	R
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FWM	P	R
GIS		

Competency 32.15: Analyze the role the Ohio Division of Wildlife plays in the total management program of Ohio

Competency Builders:

List the major research units of the ODNR Division of Wildlife

Explain the roles of the major research units of the ODNR Division of Wildlife

Distinguish between the roles of the major research units and the roles played by the various wildlife area crews in Ohio

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
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Competency 32.16: Identify wildlife laws used in the regulation of species populations

Competency Builders:

List the types of wildlife laws

Explain how wildlife laws help in the harvesting of animals needed to maintain a viable sustained yield

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
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Competency 32.17: Explain regulations

Competency Builders:

Explain boating regulations

Explain fishing regulations

Explain littering regulations

Explain swimming regulations

Explain park regulations

Explain game laws

Explain stream, lake, pond, and groundwater laws

Explain outdoor burning regulations

Unit 33: Fisheries Management

BIL: Essential – ESA, FWM
Recommended – ECA, WEM

EDU:	12	AD
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Competency 33.1: Describe the anatomy and taxonomy of fish species

Competency Builders:

- Identify the major parts of the external anatomy of fish species, including all fins and other structures used in taxonomic keys
- Identify the family level fish species common to Ohio
- Identify the species level selected game fish
- Identify the major structures in the internal anatomy of fish useful in species identification, reproductive condition, food habits studies, etc.

BIL: Essential – ESA, WEM, FWM
Recommended – ECA

EDU:	12	AD
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WEM	I	P
FWM	I	P
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Competency 33.2: Identify the major physical, chemical, and biological features of standing water (lentic) and running water (lotic) habitats that affect fish and their distribution

Competency Builders:

Distinguish between lentic and lotic aquatic habitats

Identify the physical factors, such as flow rates, depth, bottom substrate, temperature, etc. affecting the distribution of fish and other aquatic organisms

Identify the chemical factors, such as dissolved oxygen, pH, hardness, alkalinity, etc. in the distribution, reproduction, and growth of fish

Identify the natural assemblages of aquatic organisms that would normally be found in: pools vs. riffles; lentic vs. lotic habitats; polluted vs. clean water habitats; cold vs. warm water habitats; etc.

Describe changes in the physical, chemical, and biological components of aquatic habitats on a seasonal basis, which will affect fish and their distribution

BIL: Essential – ESA, FWM
Recommended – ECA, WEM

EDU:	12	AD
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FWM	I	P
GIS		

Competency 33.3: Conduct fish population surveys

Competency Builders:

Distinguish among the different types of nets used to sample fish populations including seines, trammel nets, gill nets, trap (fyke) nets, and hoop nets

Identify the major components of electrofishing gear used for small stream surveys and in boat shocking systems

Conduct seining and electrofishing surveys on river/stream and lake/pond habitats

Survey shoreline

Interpret data obtained from a 24-hour shoreline survey

BIL: Essential – ESA, WEM, FWM
Recommended – ECA

EDU:	12	AD
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ESA	I	P
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WEM	I	P
FWM	I	P
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Competency 33.4: Analyze water quality

Competency Builders:

Obtain water samples from lakes and rivers

Explain use of portable field kit procedures for analyzing dissolved oxygen, pH, hardness, alkalinity, phosphate, conductivity, and temperature

List procedure manuals and books that contain the wet chemistry methods for in-lab analyses

Run pH and dissolved oxygen tests on water samples

Run a static bioassay test using selected aquatic organisms

BIL: Essential – ESA, WEM, FWM
Recommended – ECA

EDU:	12	AD
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FWM	I	P
GIS		

Competency 33.5: Conduct studies on fish populations and their habitats

Competency Builders:

Explain the basic parameters of fish population dynamics in terms of rate functions and limiting factors

Explain the use of bio-monitoring to evaluate habitats

Sample aquatic organisms used as forage species for fish and/or as pollution indicators

Identify aquatic organisms used as forage species for fish and/or as pollution indicators

Distinguish among the several types of scales

Determine the age of fish

Explain the major techniques used to tag or mark fish

Identify the types of data obtained from mark/recapture studies

Conduct a fish population estimate

Explain the Lincoln/Peterson Mark-Recapture procedure

Set up a water quality study on a river and lake system

Calculate species diversity index values for fish community data

Run an index of biotic integrity on fish community data

Write a life history report for a major fish species

BIL: Recommended – ECA, WEM, FWM

EDU:	12	AD
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Competency 33.6: Manage aquatic vegetation

Competency Builders:

- Identify owner or agency objectives of water area
- Explain physical, chemical, cultural, and biological vegetative control methods
- Evaluate advantages and disadvantages of aquatic vegetation related to recreation
- Analyze water quality parameters
- Determine surface area to be treated
- Determine volume to be treated

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
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Competency 33.7: Manage fisheries

Competency Builders:

Identify the components and reasons for making a creel survey

List the types of data obtained in a creel survey

List the major reasons for seasons, bag limits, and restrictions for methods of capture of fish in Ohio

List the reasons for stocking or not stocking fish in aquatic systems

Identify fish stocking guidelines

Identify the types of fish hatcheries and the specific warm and cold water species they produce

List the major manipulation techniques that will improve the quality of aquatic habitats for fish

Describe the procedures for culturing fish

Explain the principles of fisheries management as applied to recreational and commercial fisheries

Interpret fisheries management data

Determine appropriate techniques to reach management objectives

Unit 34: Programming Theory

BIL: Recommended – ESA, ECA, GIS

EDU:	12	AD
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ESA		I
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Competency 34.1: Explain programming language concepts

Competency Builders:

Explain the concept of physical representation of digitized information (e.g., data, text, image, voice)

Describe the hardware-software connection

Explain the concepts of data and procedural representation

Explain the function and operation of compilers and interpreters

Explain the basic principles for analyzing a programming language

Explain the basics of structured, object-oriented, and event-driven programming

Explain how a programming language can support multitasking and exception-handling

Identify current key programming languages and the environment they are used in (e.g., C, C++, Visual Basic, Java, RPG, COBOL, Assembler)

EDU:	12	AD
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Competency 34.2: Describe the stages of program development

Competency Builders:

Identify the use of program design tools

Explain structured/modular programming

Explain the information system (IS) life cycle

Describe the characteristics and uses of batch processing

Describe the characteristics and uses of interactive processing

Describe the characteristics and uses of event-driven, object-oriented processing

EDU:	12	AD
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Competency 34.3: Compile technical documentation associated with software development

Competency Builders:

Secure needed information

Analyze specifications

Identify constraints

Identify input and output (I/O) requirements

Prepare logic using a program flowchart

Unit 35: Database Management System Basics

BIL: Essential – ESA, GIS
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
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ECA	I	R
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GIS	I	P

Competency 35.1: Describe Database Management System (DBMS) basics

Competency Builders:

- Interpret terminology associated with relational databases
- Identify the features, functions, and architecture of a DBMS
- Identify the uses of a DBMS in business organizations
- Explain the concepts necessary to access organizational databases
- Analyze the organization of data in a DBMS

BIL: Essential – ESA, ECA, GIS
Recommended – PC, HM

EDU:	12	AD
PC	I	R
ESA	I	P
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GIS	I	P

Competency 35.2: Develop a report from a database

Competency Builders:

Produce formatted reports

Produce single- and multiple-level control break reports and subtotal and final totals

Query a relational database

EDU:	12	AD
PC		I
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Competency 35.3: Develop database programs

Competency Builders:

Write programs that allow the user to make a menu choice to carry out an appropriate action

Write programs that require statements to be executed multiple times by using structured programming

Write programs that access multiple files

Design an information system within a database environment

Develop a data model for computation

EDU:	12	AD
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Competency 35.4: Build DBMS applications

Competency Builders:

Analyze and model organizations using Entity-Relationship and Object technologies

Remove data anomalies through the process of normalization

Create and update a relational database

Query data from an organizational repository

Perform database administration tasks

EDU:	12	AD
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Competency 35.5: Monitor a DBMS

Competency Builders:

Coordinate security requirements

Identify desired levels of access and security

Select monitoring tools and procedures

Identify monitoring methodologies

Identify problems

Document problems

Propose solutions that are congruent with application requirements

Implement solutions to problems

Calibrate DBMS configuration parameters for optimum performance

EDU:	12	AD
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Competency 35.6: Explain computational and logical operations in software

Competency Builders:

Identify programs that use arithmetic operations

Identify programs that use relational operators and compound conditions

Identify programs that use control breaks

Identify programs that use subtotals and final totals

Unit 36: Database Administration

BIL: Recommended – PC, ESA, HS, ECA, HM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA		I
HS	I	R
ECA	I	R
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Competency 36.1: Apply databases to actual situations and business problems

Competency Builders:

- Derive database design from a workflow drawing or other requirement documents
- Design a database for a Geographic Information System (GIS)
- Identify the relationship between database components
- Sort data on multiple fields
- Add and remove filters
- Create queries with multiple criteria
- Create and apply different types of queries
- Join tables in a query
- Enhance the design of a form
- Create needed subforms
- Group data in reports
- Make a calculation on a report
- Imbed data and graphics
- Import data and graphics
- Link data and graphics

BIL: Recommended – ECA, HM

EDU:	12	AD
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Competency 36.2: Apply data modeling techniques

Competency Builders:

Interpret terminology associated with data models

Compare/contrast various data models

Analyze data models

Develop a data model to describe an application's data

EDU:	12	AD
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Competency 36.3: Create conceptual data models

Competency Builders:

Analyze model requirements

Identify business entities and the relationships between them

Identify data in an integrated data dictionary

Facilitate user access

EDU:	12	AD
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GIS		

Competency 36.4: Validate conceptual data models

Competency Builders:

- Present conceptual data model to client
- Resolve issues with client
- Secure client approval for model
- Revise model based on client recommendations
- Document validation process

EDU:	12	AD
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Competency 36.5: Integrate conceptual data models with enterprise models

Competency Builders:

Modify conceptual data model to ensure consistency with enterprise model (e.g., entity names, relationships, and definitions)

Develop conceptual schema

Secure client approval for modifications in enterprise models

EDU:	12	AD
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Competency 36.6: Reconcile conceptual models with appropriate-level process models

Competency Builders:

Verify consistencies between models

Identify areas of overlap

Verify that data entities in process model have a corresponding entity data model

Document changes or modifications in either model

EDU:	12	AD
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Competency 36.7: Create logical data models

Competency Builders:

Map data model to a relational model

Identify attributes of model entities and relationships between them

Verify that logical model is consistent with conceptual model

Specify integrity constraints

EDU:	12	AD
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Competency 36.8: Evaluate environment/platform for physical data models

Competency Builders:

Research potential computer environments/platforms

Identify platform capabilities and limitations

Select environment/platform based on technical, business, and skill information gathered

Secure approval of target environment/platform

EDU:	12	AD
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Competency 36.9: Identify backup and recovery requirements for physical models

Competency Builders:

Establish backup requirements consistent with corporate policy and business needs

Document established backup procedures

Control access to database to maintain security

EDU:	12	AD
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Competency 36.10: Identify physical database characteristics

Competency Builders:

Identify name, type, and length of attributes

Employ table and file names that conform to naming conventions

Group/assign tables to disk files

Index files for performance and integrity

Verify that data types are consistent between attributes

Employ normalization and modeling as cross-checking techniques

Unit 37: Geographic Information Systems (GIS)

BIL: Essential – PC, ESA, WEM, FWM, GIS
Recommended – ECA, HM

EDU:	12	AD
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ECA	I	R
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WEM	I	P
FWM	I	P
GIS	P	R

Competency 37.1: Explain GIS Basics

Competency Builders:

Explain what a Geographic Information Systems (GIS) is
Identify basic terms associated with geographic information

Identify the advantages of digital maps over paper maps

Explain why geographic information systems are important
Identify some primary uses of GIS
Identify the steps of a GIS project
Explain how GIS helps define and solve geographic questions
Describe primary environmental applications

BIL: Essential – GIS
Recommended - ECA

EDU:	12	AD
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GIS	I	P

Competency 37.2: Explain the basic principles of remote sensing

Competency Builders:

Explain remote sensing

Explain electromagnetic energy

List measurements of electromagnetic waves

Explain how frequency and wavelength are related

Explain why the relationship between photon energy levels and wave energy levels is important to remote sensing

Explain Planck's Law and its manipulation

Explain the various types of scattering which occur when electromagnetic energy passes through the atmosphere

Explain absorption

BIL: Essential – GIS
Recommended – ECA, HM

EDU:	12	AD
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GIS	I	P

Competency 37.3: Explain the basic principles of aerial photography

Competency Builders:

- Identify various camera types
- Identify various film types
- Explain basic photographic terms

Explain photographic resolution

- Explain forward motion compensation
- Identify characteristics of CIR film
- Explain the use of filters
- Explain photographic scale
- Explain the geometry of aerial photography
- Explain parallax displacement
- Explain stereoscopic photography

BIL: Essential – GIS
Recommended – ECA, HM, WEM, FWM

EDU:	12	AD
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WEM		I
FWM		I
GIS	I	P

Competency 37.4: Interpret aerial photographs

Competency Builders:

Explain the role of a photo interpreter

Explain how aerial photographs differ from regular photographs

Identify the image elements used in interpretation

Identify the steps in interpretation

Explain interpretation strategies

Explain photogrammetry

Explain relief displacement

Arrange photos for stereo viewing

Determine non-distorted coordinates, horizontal ground distance and angles from measurements on a single vertical photo

Calculate object height from relief displacement

Calculate heights from image parallax measurements

Explain interpretive software

BIL: Recommended – GIS

EDU:	12	AD
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Competency 37.5: Plan the collection of new photos

Competency Builders:

Identify the initial considerations

Write a specification sheet

Provide a flight map

EDU:	12	AD
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GIS	I	P

Competency 37.6: Evaluate accuracy of aerial photographs

Competency Builders:

Explain accuracy, precision, thematic accuracy, cartographic accuracy, and ground truth

Identify general sources of errors

Identify sources of classification errors and factors affecting the errors

BIL: Essential - GIS
Recommended – ECA, WEM, FWM

EDU:	12	AD
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GIS	P	R

Competency 37.7: Explain map projections

Competency Builders:

Explain map projection

List the three general classifications of map projections

Explain the properties of an ideal map (i.e., conformality, equivalence, equidistance, and true direction)

Describe the construction, major property and primary use of various map projections

Explain datum as related to map projections

EDU:	12	AD
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Competency 37.8: Describe data structures

Competency Builders:

Describe the three file types (i.e., simple list, sequential, indexed)

Describe the three types of database file structures (i.e., hierarchical, network, relational)

Compare vector and raster data structures

Describe methods of storing raster data

Describe methods of storing vector data

Describe polygon data structures

Describe a polygon network structure

BIL: Essential – GIS
Recommended – HM

EDU:	12	AD
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GIS		P

Competency 37.9: Explain digital elevation methods (DEM)

Competency Builders:

Explain DEMs

List the important uses of DEMs

List methods of representing DEMs

Explain interpolation techniques

Describe products derived from DEMs

EDU:	12	AD
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GIS		I

Competency 37.10: Explain spatial interpolation

Competency Builders:

Explain spatial interpolation

Explain tessellation

Explain planar ordinary Voronoi diagram

Explain ordinary Voronoi polygons

Explain Delaunay triangulation

Explain polygonal methods of interpolation

Explain triangular methods of interpolation

Explain contour generation and 3-D surface plotting

Explain landscape metrics

EDU:	12	AD
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GIS		I

Competency 37.11: Explain two-dimensional functional spatial analyses

Competency Builders:

Explain area/perimeter/distance calculations

Explain vector-to-raster conversion

Explain raster-to-vector conversion

Explain overlays

Explain Thiessen polygons

Explain querying/theming

Explain corridor analysis

Explain proximity analysis

Explain network analysis

Explain planning rings

BIL: Recommended – GIS

EDU:	12	AD
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ECA		
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GIS		I

Competency 37.12: Explain three-dimensional functional spatial analyses

Competency Builders:

Explain contour lines

Explain how a DEM is created

Explain slope and aspect derivations

Explain orthographic/perspective views

Explain draping

Explain threshold tables

Explain surface filtering

Explain interviewability

Explain surface modeling

EDU:	12	AD
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WEM		
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GIS	I	P

Competency 37.13: Explain ranging methods

Competency Builders:

Explain standard deviation

Explain equal interval

Explain natural breaks

BIL: Essential – ESA, GIS
Recommended – ECA, HM, WEM

EDU:	12	AD
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ESA	I	P
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ECA	I	R
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WEM		I
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GIS	I	P

Competency 37.14: Identify sources of possible error in GIS

Competency Builders:

Explain accuracy, precision, data quality, and error

Explain the importance of error, accuracy and precision

Identify obvious sources of error (e.g., age of data, areal coverage, map scale, density of observations, relevance, format, accessibility, cost of new vs old data)

Identify errors due to natural variation or from original measurements (e.g., positional accuracy, accuracy of content, sources of variation in data)

Identify errors arising through processing (e.g., numerical errors, errors in topological analysis, classification and generalization problems, digitizing and geocoding)

Explain error propagation

Explain cascading of error

Explain the dangers of undocumented data

Explain how to determine data quality

BIL: Essential – ESA, GIS
Recommended – HM, WEM, FWM

EDU:	12	AD
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FWM		R
GIS	I	P

Competency 37.15: Determine position on the earth

Competency Builders:

List the major global georeferencing systems

Explain why different coordinate systems have been developed to record location

Explain how the shape of the earth is related to geographic position and to the measurement of distance

Explain how geographic coordinates can be assigned to street address and postal codes using discrete georeferencing

Identify the difficulties and errors that arise in discrete geocoding

Explain what a GPS is

List the major GPS segments as defined by the Department of Defense

Explain how a GPS receiver computes position and time from GPS signals

Explain major sources of GPS errors

Explain the methodological differences between single-user and differential GPS

Explain the practical differences between using GPS for low-precision and high-precision positioning

Determine location and calculate distances using global coordinate systems (latitude-longitude and UTM)

BIL: Recommended – ECA, GIS

EDU:	12	AD
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GIS		I

Competency 37.16: Identify legal issues relating to GIS

Competency Builders:

Explain how public access rules affect GIS

Identify liability issues related to accuracy and reliability of GIS information

Identify privacy issues related to GIS data

Explain the use of GIS data as evidence in court cases

BIL: Essential – GIS
Recommended – FWM

EDU:	12	AD
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WEM		I
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GIS	I	P

Competency 37.17: Develop a GIS plan

Competency:

- Conduct a needs assessment
- Develop a database model
- Determine available data
- Evaluate GIS hardware and software
- Evaluate potential data sources
- Develop a detailed database design
- Perform pilot study and benchmark tests
- Construct the database
- Integrate the various components of the GIS
- Develop GIS database applications
- Maintain the GIS

BIL: Essential – GIS
 Recommended – ECA, HM, WEM, FWM

EDU:	12	AD
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FWM		I
GIS		P

Competency 37.18: Analyze GIS tools

Competency Builders:

- Identify the hardware required for an operational GIS
- Describe various GIS software packages and their characteristics
- Explain the importance of a DBMS to a GIS
- Explain layers and coverages
- Explain items to consider when acquiring digital map data
- Identify sources of digital map data
- Explain media conversion
- Explain geographic data conversion
- Explain coordinate transformation
- Explain tiling and edgematching
- Describe the digitizing issues to be considered
- Automate map features and attribute data associated with map features
- Link map features to a database
- Design data tables and layers
- Determine answers to spatial questions related to the planning objectives of the GIS application
- Organize the output of information based on the analyses
- Develop a custom user interface for a GIS application that will simplify and increase user productivity*

Unit 38: Communication

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.1: Apply communication skills

Competency Builders:

Guide communication activities using established rules for grammar, spelling, and sentence construction

Follow written and/or oral instructions

Apply creativity in oral and written communications

Proofread documents

Interpret oral, written, and nonverbal communications

Evaluate audience (e.g., specific interests, level of technical knowledge)

Adjust communication style to fit audience (e.g., use of jargon, level of technical details)

Determine means of communications appropriate for given situations (e.g., telephone, meeting, electronic mail, and written communication)

Reinforce intended message using nonverbal communication

Influence listeners' perceptions through precision questioning

Practice active listening skills (e.g., paraphrasing)

Obtain needed information using questioning techniques

Adjust message and/or its delivery based on feedback from listeners (verbal and nonverbal)

Participate in group discussions and meetings

Assess and refine communication skills

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.2: Compose documents

Competency Builders:

Identify the characteristics of different approaches to writing R(ET121.08 638.7 0.72 0.780.02121.08 638.7

EDU:	12	AD
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ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.3: Demonstrate sensitivity in communicating with a diverse workforce

Competency Builders:

Identify factors (e.g., culture, ethnicity, equity, special/exceptional needs) that impact communication

Identify strategies for successful communication with a diverse workforce

Determine communication style appropriate for listener(s)

Bridge communication styles

Establish guidelines for dealing with conflict

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.4: Deliver oral presentations

Competency Builders:

Prepare presentation and supporting materials (e.g., handouts, transparencies, electronic slide shows)

Practice presentation

Deliver presentation

Obtain feedback

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.5: Build interpersonal skills with individuals and other team members

Competency Builders:

- Analyze the interdependence of empathetic listening, synergy, and consensus building
- Define roles within the group decision-making process
- Explain group dynamics
- Promote teamwork, leadership, and empowerment
- Identify strategies for fostering creativity
- Analyze the effect of influence, power, and politics on communication
- Establish negotiation guidelines

Unit 39: Basic Microbiology

BIL: Essential – ESA, HS, WEM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 39.1: Apply microbiological principles and procedures

Competency Builders:

Explain microbial taxonomy and classification

Explain bacterial metabolism, reproduction, cell structures, and their functions

Disinfect and sterilize

Explain classification, composition, and preparation of culture media

Collect, handle and culture specimen

Identify bacteriologic culture techniques necessary for isolation and identification of organisms

Test for antibiotic susceptibility

Identify commonly encountered aerobic bacteria through morphological, physical, and biochemical properties

Prepare Gram stains

Explain collection and handling of specimens for fungal, mycobacterial, and viral specimens

Prepare specimens

Examine specimens

Identify difference between autotrophic and heterotrophic microbes

BIL: Recommended – PC, ESA, HS

EDU:	12	AD
PC		I
ESA		I
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

Competency 39.2: Explain immunological procedures

Competency Builders:

Explain immune system and normal immune response

Explain physical and chemical properties of immunoglobulins and complement and their reaction in vitro

Explain principles of basic agglutination, flocculation, and precipitation procedures

Perform basic agglutination, flocculation, and precipitation procedures

Explain principles of complement fixation, immunoelectrophoresis and enzyme immunoassay

Explain clinical significance of commonly performed serological tests

BIL: Essential – ESA, HS, WEM
Recommended – PC, ECA, FWM

EDU:	12	AD
PC		I
ESA	I	P
HS	I	P
ECA		I
HM		
WEM		I
FWM		I
GIS		

Competency 39.3: Describe roles of microorganisms in the environment

Competency Builders:

Categorize common microorganisms (e.g., viruses, bacteria, protozoans, etc.)

Categorize common pathogenic organisms and common microorganisms found in the environment

Describe how microorganisms impact nutrient cycles

Explain microbial decomposition and use of microbes in degrading pollutants

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 39.4: Perform common microbiology procedures

Competency Builders:

Operate microscope, compound microscope, incubator, colony counter, and other basic microbiology and analytical equipment

Identify microorganisms and cells

Quantify microorganisms and cells

Isolate pure cultures

Maintain pure cultures

Analyze fermentation materials

Harvest cells

Transform hosts

Stain cells and/or bacteria

Prepare media

Identify sterile techniques used during handling, sampling, and analytical procedures

Explain Koch's Postulates and their use in determining primary and secondary pathogens

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC		I
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 39.5: Conduct bioassay tests

Competency Builders:

Explain bioassay [R-WEM]

Identify the purposes of bioassay testing [R-WEM]

Conduct acute/chronic, freshwater/marines NPDES Permit Bioassays for 1, 2, or 3 species

Conduct sediment bioassays

Conduct LC50 and percent survival bioassays

Conduct hazardous waste bioassays

Conduct terrestrial bioassays

Conduct bioaccumulation studies

Conduct biodegradation testing

Conduct whole effluent toxicity testing

Conduct Toxicity Identification Evaluations/Toxicity Reduction Evaluations (TIE/TRE)

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM, FWM

EDU:	12	AD
PC	I	R
ESA	P	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		I
GIS		

Competency 39.6: Contrast prokaryotic and eukaryotic cells

Competency Builders:

List parts of prokaryotic and eukaryotic cells

State function of each cell structure

Distinguish between those parts that are common to both and those that are not always present

Identify the giant polymeric molecule constituting the cell wall

Explain endospore

Identify conditions that favor the formation of endospores

Explain plasmid

Describe nutritional patterns of fungi

Describe fungal identification and cultivation

BIL: Essential – ESA
Recommended – PC, HS, WEM, FWM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA		
HM		
WEM		I
FWM		I
GIS		

Competency 39.7: Identify groups of microorganisms

Competency Builders:

- Identify various bacterial organisms by shape
- Identify various cell arrangements or groupings
- Identify organisms by cell wall types
- Identify groups of fungi
- Identify groups of algae
- Describe types of parasite life cycle

BIL: Essential – ESA
Recommended – PC, HS

EDU:	12	AD
PC	I	R
ESA	P	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

Competency 39.8: Analyze factors affecting microbial growth

Competency Builders:

Correlate how sources of nutrients overlap

Explain microbial nutrition type (carbon)

Compare inorganic and organic nutrients

BIL: Essential – ESA
Recommended – PC, HS

EDU:	12	AD
PC	I	R
ESA	P	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

Competency 39.9: Describe influence of environmental factors on microbes

Competency Builders:

- Explain various temperature requirements
- Describe various gas requirements
- Describe major types of microbial interaction

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM, FWM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	
HM		
WEM		I
FWM		I
GIS		

Competency 39.10: Explain microbial growth

Competency Builders:

Correlate bacterial binary fission with generation time

Describe normal bacteria population growth curve

Indicate methods of enumerating bacteria and measuring bacterial growth

Explain closed bacterial culture

Identify phases of bacterial growth curve