

Course of Study

Heavy Equipment and Site Construction

Warren County Career Center

**3525 North State Route 48
Lebanon, Ohio 45036**

Adopted July 17, 2008

*This document is for the use of the staff at Warren County Career Center.
Credit is given the designer of the template, Upper Valley JVS, Piqua, Ohio.*

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Acknowledgements

Heavy Equipment and Site Construction Warren County Career Center

We would like to take this opportunity to express our gratitude to the following people for their guidance and support in the preparation of this course of study:

Warren County Career Center Administrative Team
Warren County Educational Service Center
Mr. Jerry Broshear
Mr. Darin Dodge
Mr. SkipHamilton
Mr. Andy Heitzman
Mr. Jim Jurgensen
Mr. Todd Kelchner
Mr. Paul Lorenz
Mr. Eddie Mullins
Mr. Michael Wolf

***Warren County Career Center
Resolution Of School Board Approval***

WHEREAS, representatives of the Heavy Equipment and Site Construction Advisory Committee of the Warren County Career Center have reviewed the Heavy Equipment and Site Construction Course of Study; and

WHEREAS, this Course of Study is based upon Integrating Technical and Academic Competencies adopted by the State of Ohio for the Heavy Equipment and Site Construction program; and

WHEREAS, the Heavy Equipment and Site Construction faculty and the Career-Technical Advisory Committee have reviewed and added competencies as needed to address local labor market needs and trends in the industry;

NOW, THEREFORE, BE IT RESOLVED, in accordance with the Superintendent's recommendation, that the Warren County Career Center adopt the Heavy Equipment and Site Construction Course of Study.

District Superintendent

Date

President, Board of Education

Date

Statement of Recommendation

The Heavy Equipment and Site Construction Advisory Committee at Warren County Career Center has reviewed this course of study and recommends it for use as the foundation for instruction in the Heavy Equipment and Site Construction class.

The developers of this course of study have considered local labor market needs and the school's ability to offer specialized programs. The competencies have been reviewed and accepted as being congruent with our school's vision, mission, and strategic goals. When appropriate, additional competencies related to the program area have been incorporated into this course of study.

Achievement of technical competencies, utilizing proper attitudes, and demonstrating appropriate values are critical for successful employment and for furthering educational opportunities within a student's chosen field. We believe that this course of study adequately and correctly focuses upon student development.

This course of study is recommended on: July 17, 2008

Warren County Career Center Vision Statement

WCCC is the valued partner of choice within the educational and economic systems of our communities, by providing quality academic and career technical education.

We pave the way for a future of opportunities unique to each of our learners.

Warren County Career Center Mission Statement

To prepare youths and adults to make informed career choices and to successfully enter, compete, and advance in a changing work world.

Warren County Career Values

- Treating each other with respect, dignity, trust and mutual value
- Communicating openly and honestly
- Taking ownership of personal actions and being held accountable for results
- Upholding and demonstrating high ethical, educational and fiscal standards
- Exhibiting high levels of professionalism
- Providing high quality instruction and highly qualified staff to ensure success for all learners
- Making quality customer service a high priority
- Promoting partnerships and a team environment
- Celebrating team and individual achievements
- Using data to drive planning, decision making and actions
- Embracing educational opportunities for change and diversity

Course Design

Courses are designed to reflect career-focused education, which combines high-level academics with real-life technical skills. The intent is to maximize a student's present and future academic and career success.

Career-focused education enhances the integration of academic and technical skills, designs programs that prepare students with transferable skills and promotes each student's career opportunities.

Course Philosophy

We believe that the **Heavy Equipment and Site Construction** instructional program is designed to meet the needs and career choice of high school youth so that they will be able to find a position in society where they can realize a sense of accomplishment in a career. Through the accomplishment of acquiring technical knowledge and work skills, the person will become employable in the construction industry.

Through orientation and preparation, the attainment of proper work habits, and attitudes, appreciation and a sense of responsibility will contribute to the development of the individual who is socially, emotionally and physically competent.

The course of study in the **Heavy Equipment and Site Construction** trades is arranged to meet the needs of the student who desires to seek gainful employment in the equipment operators industry.

The student must develop a competency in hand and eye coordination, efficiency, neatness, pride in workmanship, skill in the use of tools and other equipment related to the **Heavy Equipment and Site Construction** industry. The student must develop an awareness that in the **Heavy Equipment and Site Construction** industry one must work cooperatively with others, with safety in mind for himself and his fellow workers.

Besides being familiar with various materials, tools, and practices of the trade, the equipment operator must acquire knowledge of current safety rules and federal and state guidelines regulating the trade. A basic knowledge of mathematical functions, scientific concepts, and interpretation of building plans is essential. The equipment operator should be in good physical condition and possess a sense of balance and coordination.

Course Goals

The course goals for Heavy Equipment and Site Construction are to:

1. To introduce students to the various options and post-secondary training in the construction field.
2. To prepare students for gainful employment in an industry-related occupational field
3. To prepare students to be productive members of society
4. To foster meaningful learning through an authentic, real-life context utilizing the following National Center for Construction Education and Research profile:
 - N.C.C.E.R. Core Curriculum
 - Heavy Equipment and Site Construction Operations Level One
 - Heavy Equipment and Site Construction Operations Level Two
 - Heavy Equipment and Site Construction Operations Level Three
5. To Develop Proficiency In the Following Heavy Equipment and Site Construction Occupational Competency Areas:
 - General Safety Precautions
 - Orientation to the Trade
 - Identification of Heavy Equipment and Site Construction
 - Equipment Preventative Maintenance
 - Dump Trucks, Tractors, Backhoes, Excavators, Bulldozers, and Loaders
 - Job Site Preparation
 - Blueprint Reading, Record Keeping and Estimating Backhoes
 - Soils and Grades
 - Soils & Soil Compaction
 - Grade checking equipment set up and use

Course Description

The Heavy Equipment and Site Construction and Site Construction Technology program will include classroom and hands on learning experiences that will prepare the student for the construction industry. The student will be able to read and understand blueprints (plans) and have the capability to properly layout the project to correct line and grade. The student will learn how to safely operate and perform preventative maintenance on six different pieces of heavy equipment. Using the skills learned they will be able to effectively and productively construct the projects utilizing the lines and grading information they established. Leadership as well as team player skills will be required of each student as their teams prepare and complete each phase of the projects.

Academic and Technical Integration

Expectations of curriculum must be aligned with what is written, taught, assessed, and reported. Student expectations focus on active, project-centered learning—an approach to learning that emphasizes a connection between ideas in a discipline and the outside world. Educational programming and course content will clearly connect career and post-secondary opportunities. At the Warren County Career Center, the main goal is to design courses and projects that use strategies for authentic instruction. These characteristics of instruction focus on deep understanding, established opportunities for concept connections, provide anticipatory and abstract thinking, and emphasize genuine application.

The academic courses at the WCCC follow the state model curricula. They are designed to meet both associate school and state requirements. These standards respond to the need to improve student achievement, quality of curriculum and instruction, and strengthen school and community relationships.

Technology

The Warren County Career Center board and staff believe that technology skills are essential for all students to achieve in the 21st century. It is the goal of this district to infuse technology into all facets of education:

- Instruction
- Assessment
- Administration
- Career planning
- Course design
- Professional development

Strategies to incorporate technology into all facets of education are a priority of the district and there is commitment to a continual process to provide updated hardware, software, and professional development for staff members for the purpose of providing a high quality education, with the integration of technology, for all students.

Job Shadowing/Internships/Career Placement

The Warren County Career Center Internship/Placement/Job Shadowing Program involves placing students in meaningful career-based learning experiences to complement their classroom learning. The experiences relate to student interests within their chosen career-technical program and may include job shadowing, group and individual internships, or career placement. This process is coordinated by the Educational Services/Career Pathways Department and supervised by the career-technical instructor.

Job Shadowing is designed to give the student a short-term overview of the many opportunities within a career field. Career-technical instructors confer with students to determine appropriate experiences.

Internships and Job Placement vary somewhat, but during each experience students should accomplish the following goals:

1. Work with mentors, supervisors, co-workers, and others to accomplish assigned tasks that contribute to the long- and short-term goals of the student. All aspects of the internship/placement (including dates, times, responsibilities, evaluations, etc.) will be outlined in an approved *Internship Learning Plan* that is coordinated by the career-technical instructor.
2. Apply basic skills and knowledge to “real world” business settings and learn new skills that are relevant to the career path.
3. Demonstrate a solid understanding of the basic skills outlined in the *Internship Learning Plan*.
4. Reflect upon the internship/placement/job shadowing in terms of post-secondary education/career options.

The criterion for participation in career-based learning experiences is included in the approved packet for each activity and may be obtained **by the instructor** from the Career Pathways office.

The specifics of how these opportunities are offered in this career-technical program or statement of academic support are:

Students that meet the requirements set forth by the Early Placement Committee are eligible to work with local Contractors during the second semester of their senior year. This allows the student to work during designated lab time with the approval of the Heavy Equipment and Site Construction Instructor. The Heavy Equipment and Site Construction Instructor will monitor academic eligibility along with the status of their field progress using contractor evaluations. In addition, parent approval and a written contract with the student for certain goals to be achieved will be required.

Students Served

The population served by this program is juniors and seniors.

Scope and Sequence

Heavy Equipment

Site Development

ESTABLISH AND MAINTAIN LINE AND GRADE

- a. Describe the worker's role in maintaining and establishing the design location and elevation
- b. Describe the steps used in identifying the actual location and elevation
- c. Describe the steps used to deduce the variance from the design location and elevation
- d. Identify the best possible method to communicate the relation between the design and the actual location and elevation to other workers
- e. Use lasers, levels and transits to check alignment and elevations
- f. Describe the appropriate use of soil types

MANAGE AN EXCAVATION TO MEET SPECIFICATIONS

- a. Discuss different types of excavation situations
- b. Explain excavation specifications on prints and in building codes
- c. Maintain a project's performance within allowable industry tolerances
- d. Monitor the progress of excavation activities
- e. Use hand signals appropriate to various excavation activities
- f. Identify specific safety hazards and maintain awareness throughout the excavation

DETECT WORK SITE SAFETY AND ENVIRONMENTAL HAZARDS

- a. Explain the various hazards associated with site development
- b. Identify safety procedures available to the worker
- c. Identify early warning signs associated with various hazards
- d. Review legal issues with those in the field

BLUE PRINT READING

2. Goals of this section;
 - a. Be able to identify what they are looking at
 - b. Be able to find desired information from the set of blueprints.
 - c. Be able to develop a mental image of the project.
3. Parts of a blue print;
 - a. Title sheet
 - i. What it contains.
 - b. Plan and profile sheet.
 - i. Information they contain.
 - ii. How are they different
 - c. Grading plans.
 - i. How to read them.
 - ii. How to locate limits of construction from them.

- iii. Determine areas of either cut or fill.
- iv. Limits of erosion control.
- v. Demolition requirements for this project.
- d. Detail sheets.
 - i. Specific details about various phases of the project.
 - ii. Specific details about various structures on the project.
- e. Offsite plans.
 - i. Specifications, elevations and information about any areas offsite where sewer, water or other items connect or tie into this project.
- f. City, county or state approved systems or structures related to the project.
 - i. Items or particular interest containing details required by each individual engineering department.
 - ii. All information and particulars to erosion control and materials needed for this function.

STAKES AND GRADING

1. Goals of this section;
 - a. Learn the types of stakes.
 - b. Learn what each type represents and what information is on each type.
 - c. Learn how to read cut and fill information.
 - d. Learn how to use the civil system of numbering and what each one means. Hundredths, tenths, and feet.
 - e. Learn how to read and engineers rule and a grade rod.
 - f. Basic of surveying.
 - g. Be able to put in stakes and place them properly.
 - h. Learn what a benchmark is and how it applies to civil projects.
 - i. Be able to place the correct elevation on stakes using the benchmark elevation.
 - j. Be able to locate various elements of the project from the centerline information provided on the blueprints.

SOILS AND COMPACTION

1. Goals of this section;
 - a. Be able to identify the various soil types.
 - b. Learn what effect weather has on each soil type.
 - c. Learn which soils will hold up under various construction conditions and applications.
 - d. What are proctors and how are they procured and how are they used in construction.
 - e. What effect does moisture have on compaction and soils?
 - f. What equipment will work best and in what type of soils?
 - g. Compaction testing and soils personnel.
 - h. Compaction problems and how they are handled.
 - i. Verification, recording and signed documentation of each different scenario.
 - j. Best repair for each scenario.
 - k. What constitutes an undercut?

1. People involved in any area to be undercut.
 - i. All must agree on what is to be done and amounts involved.

GRADE CHECKING EQUIPMENT

1. Goals of this section:
 - a. Introduction of each type of equipment.
 - i. Locke Level
 - ii. Engineers Rule
 - iii. Tri-pod
 - iv. Contractors Level
 - v. Transit
 - vi. Rotating Laser Level
 - vii. Receiver for Laser
 - viii. Alignment Laser for sewer systems.
 - ix. GPS (global positioning system)
 - b. Learn the function of each piece of equipment.
 - c. Learn the similarities of each piece of equipment.
 - d. Learn the basic differences of each piece of equipment.
 - e. Basic use of each piece of equipment.
 - f. Know the specific details of how each piece of equipment works.
 - g. Know which piece of equipment is needed for which application.
 - h. Know how to properly set up and use each piece of equipment.
 - i. Do basic alignment and elevation work using all the types of grade checking equipment.

EQUIPMENT SAFETY & ON THE JOB SAFETY

1. Goals of this section:
 - a. Introduce each piece of equipment to the student.
 - b. Review Operators Manual for each piece of equipment.
 - i. The machine manufacture supplies the manual with each machine.
 - c. Review safety video's pertaining to each specific machine.
 - d. Go over general safety practices, the do's and the don'ts of each different machine.
 - e. Learn proper preventative maintenance for each piece of equipment.
 - ii. Proper check points for each fluid of the machine.
 - iii. Proper lubrication points for each piece of equipment.
 - iv. Proper start-up procedures for each machine.
 - v. Proper pre-operation functions and what each does.
 - vi. Proper shutdown procedures.
2. Safety on the job site.
 - a. Have tailgate safety talks.
 - b. Make all students aware of PPE. (Personal protective equipment)
 - c. Keep good house keeping on entire job site.

- d. Make sure all equipment & tools are in good operating condition.
 - e. Have all OSHA required materials on the site.
 - i. All cans marked as to contents.
 - ii. All logs sheets required are on site.
 - iii. All supplies tagged for identification.
 - iv. Trenching logs available.
 - v. Go over OSHA requirements as set forth in manuals.
3. Material Safety Data Sheets. (MSDS)
- a. Available for each type of chemical or material on the job site.
 - b. Proper display of these sheets.
 - c. Make each employee aware of the location of the MSDS book.

EQUIPMENT OPERATION

1. Goals of this section:
- a. Introduce each piece of equipment to each student.
 - b. Learn the basic operation of each control and what it does.
 - c. Learn how to combine the control operations to produce the results necessary to achieve the desired results.
 - d. Learn the most productive way to perform each task with each different machine.
 - e. Be able to complete each field exercise with accuracy and productively.
 - f. Each piece of equipment has separate field exercises to complete.

1. CLEARING, GRUBBING & DEMOLITION:

A. Staking and flagging

- 1. Centerline stakes and clearing limits.
- 2. Being able to find clearing limits on set of plans.
- 3. Checking limits to make sure there will be enough cleared.
- 4. How are clearing limits determined?

B. Type of demolition to be performed.

- 1. How must the demolition material be disposed of?
- 2. Are any underground utilities present? (OUPS)
 - a. Ohio Utilities Protection Service must be notified 48 hours in advance of work.
- 3. Are there any hazardous materials in the demolition and how must they be disposed of?

C. How is the clearing and grubbing materials to be disposed of?

- 1. Bury Pit:
 - a. Where should the bury pit be located?
 - b. Excavation of materials and where will the spoil be used?

- c. Is it topsoil?
- d. Is it compactable dirt usable in the building areas?
- e. What you cannot put into a pit.
- f. Size and depth of pit.
- g. What equipment will be needed to excavate the bury pit?
- h. How must the clearing and grubbing materials be placed to productively fill the bury pit?
- i. How to place and compact layers within the bury pit.
- j. How much cover should be over the bury pit?

2. Tub Grinding or chipping:

- a. Proper placement of the tub grinder or chipper, must be able to relocate as necessary.
- b. Proper machine to do clearing in order to maintain the cleanliness necessary for tub grinding.
- c. Proper placement of material to be tub ground.
- d. Provisions for the ground material.
- e. Ground materials to be used on site or removed?
- f. Keep work area around tub grinder clean in order to protect the tub grinder.
- g. Constant preventative maintenance is necessary.

3. Harvest trees/saw timber

- a. Limbs and branches disposed of on site or off site?
- b. Tub grinder or bury?
- c. Must have haul roads for removal of saw timber.
- d. Proper haul road maintenance is mandatory.
- e. Must be kept clean and clear of all debris.

2. TOPSOIL STRIPPING:

- A. Equipment needed to perform this operation productively.
- B. What is the volume of material to be removed? Usually included in bid as a per cubic yard quantity.
- C. Where is the topsoil to be stored or stock piled?
 - 1. Needs to be located conveniently to prevent handling more than once.
 - 2. Needs to be stockpiled in a way that promotes good drainage and prevent lose of material due to weather conditions.
- D. Is the topsoil to be reused on site for final grade?
 - 1. Depth that topsoil is to be spread?
- E. Does grading plan indicate any mounds or berms to be built?
 - 1. Usually discussed with engineer or developer.

3. EXCAVATION:

- A Equipment needed for the excavation.
- B Where do we start?
- C What is the material we are dealing with?
 - 1. Moisture content
 - 2. Type of soil
- D How to build:
 - 1. Slopes
 - 2. Building pads
 - a. Slab type
 - b. Basement
 - 3. Ponds
 - a. Detention
 - b. Retention
 - 4. Roadway
 - a. Temporary turn around
 - b. Private drives
 - c. Islands
- E. Compaction
 - 1. What are proctors?
 - 2. How and when to get proctors?
 - 3. Where do proctor samples come from?
 - 4. Type of soil?
 - 5. Gradation of the soil.
 - 6. Optimum moisture
 - 7. How to tell if material is compacted?
 - a. What does the soil do under load of heavy equipment?
 - b. Use of penetrometer.
 - 8. Testing Equipment
 - 9. Testing Procedures
 - 10. Depth of lifts or layers
 - 11. Type of equipment to be used to achieve compaction
 - a. Flat drum roller
 - b. Flat drum vibratory roller
 - c. Pull type sheep foot roller
 - d. Self-propelled sheep foot roller
 - e. Self-propelled vibratory sheep foot roller
 - f. Pneumatic tired rollers
 - g. Plate tamps
 - h. Jumping jacks (impact compactors)
 - i. Hydraulic actuated compaction equipment attached to stick of track excavator.

F. Bridging

1. What it is
2. What equipment should be used
3. How bridging should be done
 - a. What material should be used?
 1. Soil
 2. Granular
 3. Combination of both soil and granular.
 4. What should be done if excess water is encountered?
 5. Proper compaction of bridging material

G. Undercutting

1. Who/what determines if an undercut needs to be made?
 - a. Soils person, contractor's personnel, developer, soil types, and soil conditions.
2. Equipment needed?
3. Where do we put the undercut material?
 - a. Remove and spread to dry if too wet.
 - b. Remove and replace with good stable material.
 - c. Where do we get this good stable material
 1. Could come from cut area on the project.
 2. Could come from borrow pit area.
 3. Could come from surplus dirt from bury pit.
 4. Could come from trench excavation.
4. Verify size of undercut area, volume of material to be removed and the location of undercut area.
 - a. Performed by the contractors' rep. and soils person.
 1. All parties involved must agree upon size and quantity.
 2. All parties must file a written report.
 - a. Undercut locations will be designated on the plans and the station numbers used to verify the location.
 3. A final report will be sent to all parties involved.
5. Placement and compaction of suitable material.
 - a. A proctor sample of new material must be taken.
 - b. Compaction tests of new material must be performed.

H. Setting new stakes to assure proper grade in the roadway area.

1. Offset stakes for the roadway.
 - a. Transfer grades from centerline stakes to offset stakes.
2. Offset stakes in parking lot areas for proper grades.
 - a. Learn how to offset from the plans on specific grade lines.

b. How to transfer grades to the new stakes.

I. Rough-cut to sub-grade with either cut or fill operations.

1. Under a cut situation remove excess dirt to proper area either on site or remove from site.
2. With a fill operation place and compact dirt to achieve proper sub-grade elevation.
3. Once compacted sub-grade elevation is established seal the roadway prior to next operation.

4. SANITARY SEWER:

A. Outline and highlight all the sanitary sewer system.

1. Sanitary sewer mains.
2. Sanitary sewer laterals.
3. All general notes pertaining to sanitary sewer.
4. Complete and accurate materials list.
 - a. Manholes
 - b. Sanitary sewer pipe
 - c. Sanitary sewer laterals
 - d. Lubricant for pipe assembly
 - e. All fittings needed for the job.
 - f. Check to make sure all materials are on site

B. Check the staking at new and existing manholes for grades and alignment.

1. Check sanitary sewer mains for grades and alignment.
2. Check sanitary sewer laterals for proper location.
3. Check existing manhole invert grade to assure accuracy of first piece of sewer main to be placed.
 - a. Refigure percent of grade at this time if necessary to adjust grades to match proposed invert grade of first new manhole.

C. Set-up for alignment, flagging and laser placement.

1. Set up transit and laser in manhole.
2. Align transit to center of next upstream manhole.
3. Set flagging for digging operation.
 - a. Flag line is an operator aid.
4. Remove excess dirt to expose opening in existing manhole for new sewer main, install trench box at this time.
5. Using the transit align laser for line and percentage of grade.

D. Installing the sanitary sewer main.

1. Make sure sewer main is on line and grade.
 - a. Properly lubricated and assembled joints are critical.
 - b. Properly glued and assembled joints are critical.

E. Laterals:

1. All laterals must be installed to provide a down stream flow.
2. All laterals must be installed as per plans.
3. The ends of all laterals must be capped and marked as per Plans and specifications.
 - a. Usually this is noted in the general notes.
4. Pumping stations
 - a. Install all pumping stations as per plans and specifications.

F. Inspections:

1. Inspector must be notified prior to installation of any sewer main or laterals.
2. Types of testing to be done?
 - a. Infiltration test, checks for any water leaking in from outside the sewer main.
 1. Leaking water will accumulate in downstream manhole.
 - b. Deflection test, checks for any deforming of the sewer main during construction.
 - c. Vacuum test apply only to the manhole structure, must hold 10 inches of mercury for a period of two minutes.
 - d. Pressure testing applies to the line going from one manhole to the next manhole.
 - e. Visual test, using a special video camera the entire length of sewer main is photographed and examined.

G. Placing manholes on grade.

1. Each manhole structure has an elevation on the set of plans.
 - a. Manhole elevations are measured to the invert or flow line of the structure.
2. Adjust grade in trench to allow for thickness of base below the invert grade of a pre-cast manhole.

H. Assembling the manhole to the proposed height or rim elevation.

1. Components of the manhole assembly.
 - a. Pre-cast manhole base with openings for the sewer mains, channels and branches cast into the bottom, and the bench area also cast into the structure.
 - b. Pre-cast barrel sections to construct the vertical sidewalls of the manhole. Pre-cast barrel sections come in different heights to achieve the finish rim elevation indicated on the set of plans. Pre-cast barrel sections are assembled with rubber lip seals and mastic to prevent any outside water infiltration. The internal step assembly needs to be aligned as the barrel sections are assembled.
 - c. The location of the internal steps should be marked on the outside of the barrel for ease of assembly.
 - d. Lip seals and manhole ribs must be properly lubricated prior to assembly to assure proper sealing and fit.

- e. Barrel sections should be assembled carefully so as not to have manhole lean. After completing assembly, there should be granular back fill placed all the way around the manhole to keep it stable. The remaining backfill and compaction will be done after the laser is removed from the structure.

I. CONE SECTIONS:

1. Cone heights vary, most common are 2', 2 ½', 3'.
2. Similar to the barrel sections, the cones have steps and these should be marked on the outside of the cone to make assembly easier.
3. Safety is the primary reason a manhole section should never be left open when personnel are not present.
4. Manhole ring and cover assembly can be placed at this time or the cone section temporarily covered until ring and cover are placed.
5. Finish grade elevations provided on the plans are used to determine the final positioning of the ring and cover.
 - a. Plastic or concrete risers are available in various heights to achieve final elevation of the ring and cover. These must be secured with mastic to prevent any water leakage.

J. SANITARY SEWER MAIN LINE:

1. Sewer main line to be the correct size and type as indicated on the plans.
2. The fittings for the laterals should be installed at the time of the main line construction.
 - a. Lateral locations are indicated on the plans.
 - b. Laterals are connected to main sewer line utilizing a fitting known as a sanitary Y.
 - c. These Y's are usually plugged and the laterals are placed at a later time during the construction of the sanitary system.
3. Main line construction and laterals construction to continue until next manhole.
4. The upstream manhole is set to line and grade, the grading equipment moved and reset to proper alignment and elevation and the next section of the sanitary main line is started.

K. LATERAL LINE CONSTRUCTION:

1. Staking of lateral location must be offset to avoid damage by installation operation.
2. Spoil piles from trench excavation will have to be relocated in order to install lateral lines.
3. Short laterals do not cross roadway, long laterals cross roadway and may require special back-fill treatment as noted in plans and specifications.
4. Laterals must be placed at the correct percentage of grade as indicated on plans.
5. Plans and specifications may also indicate at what elevations the laterals will terminate.

- a. This may be determined by the type or location of the structure being built.
- 6. The upstream end of the lateral should be plugged and marked for future use.
 - a. Markings are usually a 2x6 placed at the plugged end and extending 4' above the finished ground elevation. The top of the board is usually painted green and marked with a green "S", below the painted top.
- 7. Trench safety devices will be used or slopes must be in compliance with OSHA regulations for the type of material being excavated.

L. BACK FILLING OF TRENCHES:

- 1. Back filling must be done in accordance with plans and specification for the project.
 - a. Main line and lateral trenches must be filled and compacted to prevent any future settlement of materials.
- 2. Numerous ways to properly back fill and compact trenches.
- 3. Back fill should always be placed and compacted in lifts or layers.
 - a. Six to twelve inch layers, thickness to be determined by material type.
- 4. Compaction equipment to use?
 - a. Track Excavator w/ compactor wheel.
 - b. Track Excavator w/ vibratory plate compactor.
 - c. Track Excavator w/ vibratory sheep foot roller.
 - d. Self-propelled compactors, either static or vibratory.
- 5. Always break the vertical seam when backfilling. Failure to do this will result in backfill cracking at the vertical line of the trench.
- 6. Roadway trench backfill using granular material.
 - a. Place back fill in layers and compact as per plans and specification to a height of one foot below sub-grade. Final material to be ODOT 304 to add extra stability and support to roadway.

5. STORM SEWER SYSTEM:

- A. Storm sewer systems always start from the lowest elevation, progressing to the highest elevation.
 - 1. Storm sewer systems will never be tied onto sanitary sewer.
 - 2. Storm sewer systems are installed to a positive % of grade to insure proper drainage.
 - 3. Storm sewer systems are always installed in a straight line; any turns in the system will be done utilizing a control structure.
 - 4. During the installation of storm sewer systems the upstream opening of any pipes or structures are sealed at the end of the shift to prevent any silt infiltration into the system.
 - a. Silt barriers or hay bales are the most common method of preventing silt intrusion into the system.

- b. Opening in control structures are also sealed in a like manner.
- 5. Prior to construction of storm sewer system all stakes should be checked to assure that all the information is located on them and it is correct.
 - a. Correct location of the catch basin or control structure as indicated by the station number.
 - b. Correct invert grade for the pipe being installed.
 - c. Correct location of the upstream catch basin or control structure.
 - d. Catch basin offsets indicate back of curb alignment.
 - e. Flag line is established to aid operator with proper alignment.
 - f. The laser guidance system is properly aimed and the correct % of grade is programmed into the laser.
 - 1. Transit alignment is critical for both flagging and laser alignment.
 - g. Properly position stockpiles of back fill material prior to starting trenching operation.
 - h. Prior to trenching all the materials needed for this operation should be located adjacent to the trench line.
 - 1. Proper size and style of pipe.
 - 2. Banding for pipe if necessary
 - 3. Lubricant for pipe joints or adhesive as needed.
 - 4. Correct control structure for this portion of the system.
 - a. Structure could be a catch basin, manhole, headwall or cut-off wall.
- 5. Correct hardware for this structure.
- 6. Are the control structures pre-cast or built in place?
 - a. Built in place structures need to have all materials needed for the construction of the structure placed at the location of the structure. These need to include; sand, mortar, concrete bricks and 4"x8"x16' conc. slabs.
 - b. If utilizing a "built in place" structure, several areas need to be prepared prior to ordering the concrete for the bases to eliminate an additional charge for small loads of ready mix concrete.
- 7. Storm sewer piping will be installed to line and grade prior to the placement of either pre-cast or built in place structures.
- 8. Excavations for the control structure should be large enough to accommodate personnel working around structure and make back filling and compaction easier.
- 9. Pre-cast units will need to have the pipe openings removed prior to placement in the trench area.

- a. Pre-cast structures should have the sub-grade undercut and then brought back to correct elevation with #57 to achieve a stable workable footing for the pre-cast unit.
 - 10. Pre-cast or built in place structures need to have the pipe grouted to the structure to prevent any infiltration of water and the invert channel of the structure should be placed and properly shaped.
 - a. Invert channels are usually constructed with a concrete mix.
 - b. Built in place structures need to have the inside of the structure grouted to seal it and provide a neat, smooth appearance.
 - 11. Finish elevations need to be checked and double checked for accuracy prior to proceeding upstream with the storm sewer system.
 - 12. Some control structures require modification to allow for additional piping to enter the structure, these would be classified as a Modified catch basin or structure.
 - 13. Headwalls, saddles, cut-off walls sizes are determined by the diameter of the pipe flowing into or resting on them.
 - 14. Structures for lakes, retention ponds, and detention ponds are usually pre-cast units.
 - a. As with other pre-cast structures these will also be undercut and backfilled with #57's to achieve a stable base to finish sub-grade under the structure.
6. Outfall from structures.
- a. Outfall piping is installed from the lowest elevation to the highest as with any other storm system.
 - b. External collars at structures and the interior benches with channels must be poured and shaped using concrete.
 - c. The concrete anti-seep collars must totally encase the pipe and be poured to create a bond around the pipe preventing any seepage along the length of the pipe.
The anti-seep collar trenches should be dug neatly and the concrete has to be poured from wall to wall in the trench.
 - 1. Seeping will saturate the fill material
 - 2. Seeping can causes washout of fill material
 - d. Placing storm sewer systems or structures in a filled area.
 - 1. Filled area should be brought to a grade of at least three feet above the invert grade of the proposed pipe or structure and compacted to specifications prior to the excavation of the trench for the piping or the area for the structure.

- e. The use of granular material to backfill around storm pipe going through a dam or dyke should never be done, the granular will allow for water flow around the piping and leakage could occur.
- f. All backfill material in the trench area and around any structures should be compacted to 100% of the proctor minimizing the possibility for any leaks.
- g. Once the trench and structure backfill has been compacted and reaches a designated elevation the remainder of the fill material can be placed and compacted to final desired elevation.
- h. Two factors enter into determining the thickness of layers or lifts of fill material.
 - 1. The size of compaction equipment.
 - 2. The type of material used in the fill.
- i. Headwall size for any outfall structure will be determined by the pipe size as set forth in specifications of the city, county or state.

6. WATER MAIN INSTALLATION

- A. Prior to any water main installation the inspector for the city, county or state should be notified and will be on site.
- B. Staking for water main usually serves two purposes.
 - 1. Center line and grades for the roadway
 - 2. Offsets and grades to determine the depth and location of the water main.
- C. Stakes should also be set for.
 - 1. Open cuts or borings where the water main crosses an existing roadway.
 - 2. Locations for fire hydrants, water main valves, bends, Y's, Tee's, and any water taps.
 - 3. Note all locations where water main has to be lowered to clear any storm drainage system pipe or structure.
- D. All materials for water main installation should be checked prior to any installation.
 - 1. The pipe size and type according to specifications.
 - a. Make sure the certification papers from the manufacture are available for the inspector.
 - 2. All pipe sizes for the job are on site and ready for installation.
 - 3. All fire hydrant assemblies are on site.
 - a. Hydrant
 - b. Reducer Tee or Y's
 - c. Hydrant valves
 - d. Valve boxes
 - e. All bolts All gaskets
 - f. All material for restraint joints
 - 4. Chlorine tablets and adhesive to place tablets inside the pipe.
 - a. Allows for cleaning of the pipe when it is filled with water the first time and brought to test pressure.

E. Lubricant for assembling the water main

F. Fittings and all related hardware

1. Backfill material or material specified on the plans located along proposed water main route.
2. Water main piping and all related hardware should be spotted along the designated water main route prior to construction.
3. Material for temporary blocking should be available on site.
 - a. Solid concrete blocking
 - b. Thick oak blocking
 - c. 4"x8"x16" slabs
4. Pre-cast concrete pads for installation under fire hydrant assemblies
 - a. Allows for stability of the assemblies and prevents any settling that might apply forces to the water main.
5. Valve stems, valve risers, and valve boxes for the project should be available on site.
6. Corporation stops, curb stops, water service piping should be on site.
7. Water tap machine should be available.
8. Pressure pump for testing.
9. Blow off/vent pipe for the installed water main will be located at the end of a water main where no other openings or outlets are available.

G. Excavation for the water main

1. Depth of the excavation to be determined from the offset hub elevation and the requirements set forth on the plans and specifications.
2. Placement of granular material as bedding under water main is determined by the city, county or state specifications used on the job.
3. The amount of cover over the water main is determined by the city, county or state regulations specified.
4. Water main location as set forth in typical cross section are usually indicated as offset from centerline.
5. Water main will always be on the opposite side of the road from the sewer main line.
6. Water main cannot be tied into existing active main until the new water main is completed and tested.
7. During the installation of the water main the installing crew must be careful not to roll or pinch the packing gland at the joints assuring a good leak proof fit.
8. Where the water main is to receive thrust blocks the blocks must be to original ground.
9. Fire hydrant assemblies are put together and then installed on the water main.
 - a. Pipe fill and pre-cast conc. pads are usually placed under fire hydrants for support.

- b. Fire hydrants need additional support during backfill to prevent any mis-alignment during this phase of construction.
 - c. Fire hydrants need to be aligned in such a manner as the 4-inch pumper nozzle is facing the roadway.
- 10. Restraint joints should meet all city, county or state codes for the area where you are working
- 11. Water main piping has two indicator lines on the spigot end of the pipe. These lines are for assembly guides.
 - a. For straight line the bell must be pushed to the second line on the spigot end of the pipe.
 - b. For curved line around the slight bend in a roadway the bell end of the pipe must go only to the first line allowing for lateral movement of the line to achieve the desired radius.
- 12. On all mechanical joints with packing glands the bolts must be torqued evenly to prevent any binding that will result in a leak at that joint.
- 13. When using any mechanical joint the preformed bell end of the pipe must be removed, this must be done in a manner leaving a clean smooth straight cut.
 - a. All mechanical cuts will be ground to remove any sharp edges that might cut or damage the packing gland of the mechanical joint.
- 14. When a water main goes around a radius the water main at the start of the radius and at the end of the radius must be at the proper offset dimension.
- 15. When a water main and a storm sewer cross at approximately the same elevation the water main must be lowered to give adequate clearance to the storm sewer line.
 - a. This measurement is usually specified in the general notes or specification of the plans.
 - b. Locations should be carefully noted and extreme caution is needed not to dislodge or disturb the existing storm sewer pipe while digging under the pipe. Additional bracing and very careful backfill is needed to prevent settlement during this undercutting operation.
- 16. Most new water mains will terminate with a fire hydrant; this allows the line to be periodically flushed to prevent any stagnation and bacterial growth.
- 17. The amount of cover over a water main is such that in most cases a trench box is not required for having personnel in the trench; however sloping the sides is a good preventive measure.
- 18. To assure safety of the trench personnel always check the condition of any and all lifting slings or hardware when lifting or placing pipe in a trench.
- 19. This sling or lifting hardware may also be used to properly seat the new pipe into the already placed piece of pipe in the trench.
 - a. A spud bar is another common tool used in the proper placement of the pipe as it is laid in the trench.

- b. Proper lubrication of the joints at the bell and spigot area aid in proper alignment and seating of each joint.
- 20. Backfilling of a water main should be done in a manner that provides the best possible compaction of the material and insures that the water main is not dislodged or moves during the backfill or during the pressure testing of the line.
 - a. Bleeder valves need to be placed at the end of water main to assure all air is removed from line and a proper location is made for the pressure build up of the line required for testing.
- 21. Water main crossing existing roadways sometimes requires special treatment.
 - a. Open cutting of the roadway
 - b. Sleeve or boring under roadway.
 - c. Requires a pit on both sides of roadway.
 - d. A live tap will be made when connecting to an existing water main.
 - e. When a pipe is placed in a sleeve the preassembled unit is placed in sleeve with the required number of supports as determined by the city, county or state agency involved.
 - f. Water main will be concrete encased only if specified by the city, county or state agency involved.
- 22. Water taps are preformed after the water main is fully charged.
 - a. Wet taps are preferred because they tend to flush any contaminates out of the system with the tap.
 - b. Corporation stops are placed at the water main and all water service lines are either trenched to the property being serviced or a boring method is used.
 - c. Curb stops and a pigtail is placed at the end of the service line as per plans and marked with a 2x4 painted blue to indicate the end of the water service. This painted board should extend above the finished ground approximately four feet.
- 23. When all taps are in place the line is again checked for complete charge and then brought to full test pressure as per city, county or state specifications.
- 24. All air must be removed for the water main at fire hydrants to prevent bleed down during pressure testing.
 - a. Pressure tests are usually about 1 ½ to 2 times the normal operating pressure of the lines.
 - b. Pressure will not be allowed to drop more than 5 pounds per square inch during a fifteen-minute test period.
 - c. A large pressure drop indicates a leak that must be found and corrected immediately.
- 25. Bacteria testing of the new water main are performed by the city, county or state as per plans or specifications.

- a. Usually consists of two tests over a two or three day period, if any one fails then the system must be completely flushed, brought to proper ph and retested.
 - b. Caution must be taken that the collection sites for the tests are free from any contamination that would influence the tests.
26. Once all tests are completed and passed the final connection can be made to the existing water main system.
27. Final backfill of the trenches can now be completed, compacted, tested and ready for rough grading to elevations on the plans.

7. CURB AND ELECTRIC CROSS OVERS

- A. The engineer or surveyor will set curb and electric cross over stakes.
 - 1. Curb stakes will be set on 25-foot intervals and the elevation provided will reflect the top of curb grade at the back of curb.
 - 2. Electric crossover stakes will be set from property line to property line and should extend into the utility easement.
- B. Once the hubs and curb stakes are properly located and the desired elevations are known, the sub-grade crew can proceed with cutting the sub-grade to the desired elevation.
 - 1. The sub-grade crew must know all the information about the curb being placed.
 - a. How thick is the curb from top to bottom, how wide is the curb from face to back.
 - b. Is this a hand formed curb?
 - c. Is this a machine formed curb and does the machine have the desired shaped molds.
- C. Once all this information is known the operator and the grade checker can begin preparing the sub-grade for the proposed curb.
- D. The grade checker is responsible for giving the operator correct and well-understood information.
 - 1. The sub-grade crew is a team that should know what needs to be done at all times.
- E. Any surplus material from the sub-grade operation should not be allowed to accumulate interfering with productive operation.
 - 1. This removal can be accomplished with a small self-loading scraper with a flat cutting edge or a loader and the material placed behind the stakes out of the way.
 - 2. Operators must be extremely cautious as not to disturb or knock out any grade stakes.
- F. To improve production more than one crew can be working in an area at once.
 - 1. Another crew can be installing the electric crossover as per plans and specifications.
 - 2. Electric crossovers are usually installed using a small backhoe for the excavation.
- G. The location for each electric crossover is indicated on the plans.

1. Each of these locations also contains information to size of the crossover pipe, the number of pipes, the type of pipe required for this application.
- H. The crossover crew must pay close attention to the alignment of the pipe, the glue joints of each pipe and the temporary plugs used on the ends of the pipes.
1. Glue joints and temporary plugs should provide a watertight seal and not allow for any foreign material to enter the pipe preventing the placement of electric cables in the future.
- I. The ends of the electric crossover should be marked and the ends will extend into the utility easement on each side of the roadway.
1. Depending on the city, county or state requirement they are usually marked with a 2x4 inserted at the end of the pipe, sticking out of the ground about 4 feet and painted red.
- J. The electric crossover crew must pay attention to the elevation of the newly installed crossover so it will not be disturbed or broken by any future sub-grading in the area.
- K. The backfill for the trench containing the crossover piping must be backfilled according to the plans in all areas under the roadway, curb area and 3' behind each curb.
1. This is usually a granular material, preferably 304. The city, county or state writing the specification for the project will determine which material will be used.
 2. Area from 3' behind the curb to the end of the crossovers can be material from the site.
- L. Some cities, counties or state regulations may require the crossovers to be completely encased in concrete from end to end. Care should be taken to properly comply with plans and specifications.
- M. Soft areas encountered during this sub-grade operation will be undercut, properly stabilized, backfilled and compacted prior to placement of curb or electric crossover.
1. Make sure the undercut is verified in writing by soils personnel, the engineer, the contractor, and the developer and all parties are in agreement to the size, location, the volume of material in the undercut area, the method of stabilizing the area, and the volume of material needed for backfill, otherwise payment may not be issued for this work.
- N. The final elevation for the curb sub-grade should be + or - 1/10 of a foot of the desired elevation as per plan.
- O. The final sub-grade should be inspected and tested for compaction to assure it meets or exceeds the specifications of the city, county or state.
1. This assures there is no loose material under the proposed curb line.
- P. Final curb elevations and sub-grade elevations should be checked for proper placement and drainage prior to placement of any curb.
- Q. Upon final acceptance of the prepared sub-grade by an inspector from the city, county or state the curb line can be set up.

8. POURING THE CURB WITH A CURB & GUTTER MACHINE.

- A Alignment pins are placed at each hub with additional pins located between hubs and in radius areas.
- B The alignment pins will be placed using the information on the offset hubs or stakes.
 - 1. In most cases offset stakes or hubs are placed 3' or 4' in back of curb and are marked accordingly.
 - 2. Placement of the pins in a radius area, like a cul-de-sac, will be provided from a central or radius point utilizing a tape measure to locate them.
- C Once these pins are located an attachment known as a finger is placed on the pin.
 - 1. The fingers hold a string that will provide the proper elevation and will guide the curb machine pouring the concrete curb.
 - 2. This string line is usually set at 1' to 2' above and behind the proposed top edge of the back of the curb.
 - 3. This string, anchored at both ends has to be as tight as possible to prevent any sag in the curb elevation or mis-alignment in the location of the curbing.
- D The fingers are checked for proper elevation using the information from the offset stakes utilizing a level and grade rod for this operation; each finger is checked and adjusted to achieve the desired elevation. Alignment is double checked at this time.
 - 1. The elevation is checked with a level, tripod and grade rod to assure that both sides of the road are the same elevation and that the percentage or slope of the curb will provide the drainage called for on the plans.
- E Once everything is ready the curbing machine is positioned and the sensor is placed on the string line and all the adjustments are made to assure correct elevation and alignment.
 - 1. This sensor controls the elevation of the curbing machines' cutters assuring the correct elevation, the placement of the molds and the alignment as the machine follows the string.
- F The curb crew has many tasks to assure the finish curb is exactly as per plan and specification.
 - 1. They must trowel and apply the proper finish to the face and gutter line of the curb.
 - a. Most curbs and gutter get a light broom finish.
 - 2. They must keep the area in front of the molds clean and free of any boil over or concrete build up.
 - 3. Areas at catch basin inlets and around tight radius' at intersections must be hand formed and poured.
 - 4. They must place expansion joints and dowels at points called for on the plans as per city, county or state specifications.
 - 5. They must apply a curing agent to the curb.
 - 6. They must saw dummy joints at intervals as per plans and specifications.
 - 7. Keep a close eye on the curb as it leaves the mold to assure it does not sag.

- a. This is a result of too much water in the mix and this area needs to be boarded up to assure continuity in the curb and the gutter portion works correctly providing proper drainage.
- 8. Position the trucks to dump into the machine, check the slump of the concrete and keep a continuous flow of concrete to the machine.
 - a. Slump is the amount of water in the mix. Too dry and the curb will separate in the mold, too wet and the curb will sag as it leaves the mold.
- 9. Check the grade of the finish curb to assure it is to desired elevation.
- 10. Need to do correct calculations to assure enough concrete on the job site to finish the curb set up and have enough material for any repair or hand pouring at catch basins or hand formed radii.
 - a. This entails figuring how many feet of curbing you get from one cubic yard of concrete and how many feet you have to pour, how much is needed for any handwork. Concrete is an expensive item.
- 11. While the concrete is still soft one man should be marking the curb where all the sewer laterals are, where all the water services are and any electric or telephone crossovers.
- 12. Immediately after the pouring of the curb all machines and tools need to be cleaned while the concrete is still wet.
 - a. Concrete allowed to dry on machines or tools is very hard on both machines and tools.
 - b. As soon as possible the string line, fingers and pins need to be relocated to the next area of the curb to be built and made ready for the next days' activity.
- 13. Cold weather presents a whole new set of problems for the curbing crew.
 - a. Must have anti-freeze in the water to prevent freezing.
 - b. Must cover the fresh poured curb with plastic or straw to hold in heat during the curing period.
 - 1. The chemical reaction in curing concrete generates enough heat to allow for cold weather pouring.
 - c. Must keep an eye on employees for signs of cold weather exposure or frostbite.

9. SUB-GRADE AND BASE MATERIAL.

- A After a short curing period the newly poured curb will be backfilled.
 - 1. This is to prevent any movement of the curb during sub-grade operations and bring the berm area close to final grade.
 - 2. You do not want to bring the behind the curb grade to final elevation at this time because there will probably be some more material to be placed there during the final sub-grade operation.
 - 3. The sub-grade crew will at this time bring the area between the curbs to the final sub-grade elevations.

- a. Any undercuts will be made so the sub-grade can be proofed rolled and accepted by the city, county or state inspector.
- b. All excess material will be picked up from the sub-grade and dumped behind the curb to be used to bring this area to final elevation.
- c. When connecting to an existing roadway, the existing pavement must be cut to provide a straight connection.
- d. A ramp providing an easy access to the sub-grade area needs to be placed at the newly sawed edge to prevent any breakage of the existing pavement.
- e. The final elevation of the sub-grade has to be rolled to compact any loose material on the top of the sub-grade.
- f. Once it is compacted, the sub-grade has to be proof rolled for the inspector.
 1. Proof rolling usually consists of a heavy loaded truck traversing the sub-grade without cutting into or marking the finished surface.
 2. Once the sub-grade is accepted the bituminous aggregate base can be placed over the prepared sub-grade.
 3. A smooth drum roller may be required to keep any tire marks removed from the sub-grade surface.
- g. Usually the base course is 301 bituminous aggregate bases and placed to the thickness required in the plan or specification for the city, county or state agency involved in the project.
 1. If the base course is more than 6", it will usually have to be placed in two levels or lifts.
- h. The tack coat is applied over the base course; it not only seals but also acts as an adhesive to bond the layers together.
 1. Tack coats are usually 407 or 408 and are applied at gallons per square yard rate instead of a thickness requirement.
- i. The leveling course is the next to be applied and is usually either #402 or #403.
 1. This course has a smaller aggregate than the final course and tends to level any imperfections in the base course.
- j. The final item is the finish course or wear surface. It is usually #404. This is the surface we are most familiar with as it is always the one we see as we drive over the road.
 1. This final course of pavement is usually applied only after all the other work is done in the project, inspected and accepted by the city, county or state agency involved in the project.

10. FINAL GRADING

- A After the black top is finished there is usually some finish work that has to be completed.
1. This involves all of the disturbed areas on the site.
 2. Everything should be brought to the final elevations denoted on the plans and specifications and made ready for the inspection by the city, county, state or developer in case of a sub-division.
 3. This is the phase of the job where the expertise and skills of the contractor and his personnel really come to the forefront.
 4. Prior to final acceptance of the project the inspector will prepare a punch list of items that need attention. Some areas that might need attention are as follows.
 - a. Fire hydrants turned correctly and on grade.
 - b. Water valve boxes protected by conc. slabs.
 - c. All boards marking sanitary sewer laterals, water services or electric crossovers clearly marked and positioned correctly.
 - d. Any areas to receive riprap erosion protection are in place.
 - e. Make sure all catch basins or storm drain inlets are protected with silt control.
 - f. Check curb for damage, elevation and alignment of dummy joints or expansion joints.
 - g. Proper placement of any signage required by the contract.
 - h. Finish elevations of all sanitary manholes rims.
 - i. Headwalls are properly backfilled and secure.
 - j. That all slopes are to the correct slope ratio and properly finished.
 5. When everything is complete as per plan and specification and the final inspection has been made and the project accepted by the city, county, state or developer, the contractor is now no longer responsible for any recalls or repairs that need to be done after that point in time.
 6. Always remember a job is not completed until the final inspection has been made and all parties have accepted it as being correct and have documented that fact.

Technology Standards

Standard 1: Nature of Technology

Students develop an understanding of technology, its characteristics, scope, core concepts* and relationships between technologies and other fields.

Benchmark A: Synthesize information, evaluate and make decisions about technologies.

Benchmark B: Apply technological knowledge in decision-making.

Benchmark C: Examine the synergy between and among technologies and other fields of study when solving technological problems.

Standard 2: Technology and Society Interaction

Students recognize interactions among society, the environment and technology, and understand technology's relationship with history. Consideration of these concepts forms a foundation for engaging in responsible and ethical use of technology.

Benchmark A: Interpret and practice responsible citizenship relative to technology.

Benchmark B: Demonstrate the relationship among people, technology and the environment.

Benchmark C: Interpret and evaluate the influence of technology throughout history, and predict its impact on the future.

Benchmark D: Analyze ethical and legal technology issues and formulate solutions and strategies that foster responsible technology usage.

Benchmark E: Forecast the impact of technological products and systems.

Standard 3: Technology for Productivity Applications

Students learn the operations of technology through the usage of technology and productivity tools.

Benchmark A: Integrate conceptual knowledge of technology systems in determining practical applications for learning and technical problem-solving.

Benchmark B: Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

Standard 4: Technology and Communication Applications

Students use an array of technologies and apply design concepts to communicate with multiple audiences, acquire and disseminate information and enhance learning.

Benchmark A: Apply appropriate communication design principles in published and presented projects.

Benchmark B: Create, publish and present information, utilizing formats appropriate to the content and audience.

Benchmark C: Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.

Standard 5: Technology and Information Literacy

Students engage in information literacy strategies, use the Internet, technology tools and resources, and apply information-management skills to answer questions and expand knowledge.

Benchmark A: Determine and apply an evaluative process to all information sources chosen for a project.

Benchmark B: Apply a research process model to conduct research and meet information needs.

Benchmark C: Formulate advanced search strategies, demonstrating an understanding of the strengths and limitations of the Internet, and evaluate the quality and appropriate use of Internet resources.

Benchmark D: Evaluate choices of electronic resources and determine their strengths and limitations.

Standard 6: Design

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

Benchmark A: Identify and produce a product or system using a design process, evaluate the final solution and communicate the findings.

Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.

Benchmark C: Understand and apply research, development and experimentation to problem-solving.

Standard 7: Designed World

Students understand how the physical, informational and bio-related technological systems of the designed world are brought about by the design process. Critical to this will be students' understanding of their role in the designed world: its processes, products, standards, services, history, future, issues and career connections.

Benchmark A: Classify, demonstrate, examine, and appraise energy and power technologies.

Benchmark B: Classify, demonstrate, examine and appraise transportation technologies.

Benchmark C: Classify, demonstrate, examine and appraise manufacturing technologies.

Benchmark D: Classify, demonstrate, examine and appraise construction technologies.

Benchmark E: Classify, demonstrate, examine and appraise information and communication technologies

Benchmark F: Classify, demonstrate, examine and appraise medical technologies.

Benchmark G: Classify, demonstrate, examine and appraise agricultural and related biotechnologies.

Performance Measures/Student Assessment/Instructional Strategies

Assessments/Evaluations

- Observations
- Demonstrations
- Portfolios
- Standardized Tests
- Class Assignment
- Quizzes/Tests/Exams

Instructional Strategies

- Teacher-Directed & Student-Centered Activities
- Case Study Problem Solving
- Cooperative Learning
- Project-Based Learning
- Career-Based Learning (Internships/Shadowing/Placement)
- Community-Based Learning (CTSOs and Other)
- Exploratory Learning
- Independent Research
- Team Teaching

Content Specific Strategies