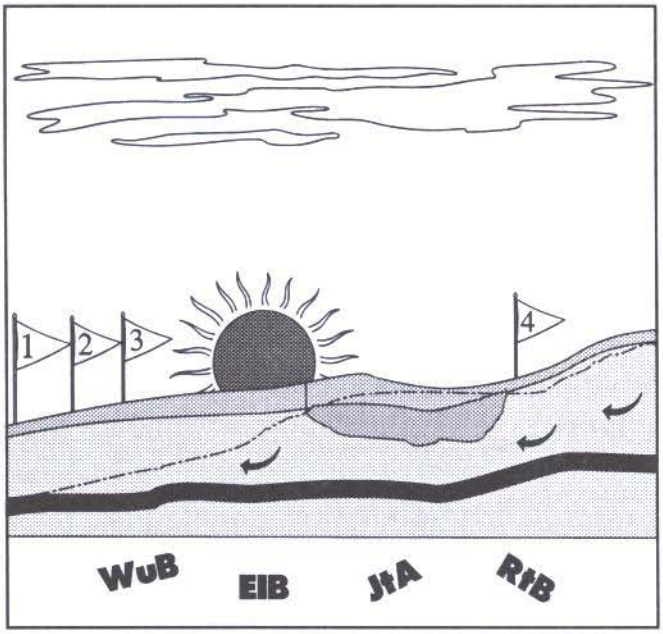
WHERE ON EARTH



ISSUE: SITING A LANDFILL

OBJECTIVES

Students will be able to: *identify* landform features; *interpret* and *analyze* data from charts and geological maps; *rank order* proposed landfill sites; *cooperate in groups* for problem solving; *design* and *construct* a physical model; *interpret* data from community maps and observations to *draw* topographic and cross-section models.

DESCRIPTION

Students evaluate four landfill sites and select the best site by using earth science principles, including soil analysis and use of topographic and cross-section maps. Students draw topographic and cross-section models.

SUBJECTS
EARTH SCIENCE, Geography

SUBJECT CONCEPTS
Geologic stratigraphy, permeability, rock types, slope, soil types, topographic maps

VOCABULARY
Aquifer, bedrock, cross-section, flood plain, ground water, permeability, permit-to-install, sanitary landfill, surface water, water table

GRADE: *8-10*

DURATION: *Two to four class periods*

SETTING: *Classroom and community*

BACKGROUND

Geology and hydrology play important roles in the siting and construction of a landfill, because of concerns about potential surface and ground water contamination whenever waste materials are buried in the ground. Numerous considerations are part of the process of identifying those sites with the best potential for environmental protection. Clay rich materials are required for construction of the base or "liner system" of a landfill, and for daily and final cover material used to prevent seepage of water into and through the landfill. Areas prone to mass (downslope) movement, differential compaction of soils, and subsidence must be carefully evaluated. Evaluating a site typically involves the drilling of numerous test borings from which an accurate, three-dimensional geologic framework of each site can be established. Material samples from the borings are analyzed for grain-size distribution, mineralogy, weathering, fracturing (jointing), porosity, permeability, engineering strength, and various other physical/chemical traits. Ground water wells are installed to identify water-bearing units, the piezometric surface (water table) for water-bearing units, and depth of saturation, as well as to evaluate the interconnections of water-bearing units.

Refer to Section A, pp. A-15 to A-18, handouts in this activity; and the handout, ***EPA Siting Criteria***, in the activity, ***FINDING THE BEST SITE*** .

PREPARATION AND MATERIALS

Rulers, colored pencils or markers, paper, transparencies made from various handouts for teacher use and for student use

Prior understanding of topographic map reading, geologic cross-sections, soil formation, ground water, and rock types will assist students in the completion of this lesson.

HANDOUTS

Hydrogeology and Landfill Sites; Landfill Site Selection Criteria: Degree of Limitation; Soil Properties Chart; Topographic Map; Soils Map; Geologic Cross-sections; Landfill Site Selection Criteria: Evaluation Form; Site Drawings Criteria

PROCEDURES

1. Distribute to students copies of the handouts, ***Hydrogeology and Landfill Sites, Landfill Site Se-***

lection Criteria: Degree of Limitation, Topographic Map, Soils Map, Soil Properties Chart, Geologic Cross-sections.

2. Prepare transparencies of each of the handouts and discuss them with the students. Begin with the handout, ***Hydrogeology and Landfill Sites***, to explain the importance of geological factors in the siting of a landfill. Introduce new vocabulary as needed and discuss the relationships between the maps and charts. (To engage students in a hands-on activity to explain soil permeability, see the activity, ***FINDING THE BEST SITE***, Step 5 of "PROCEDURES.")

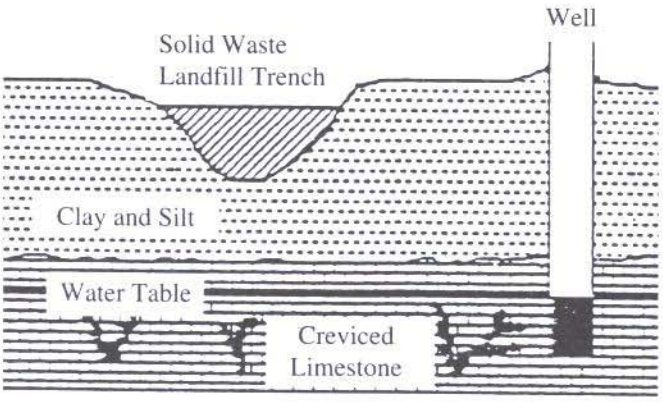
3. Depending on student background it may be necessary to teach one or more lessons on the earth science principles contained in the handouts. The success of this lesson depends on the ability of students to use these maps and charts correctly. If students have difficulty understanding topographical map concepts two exercises could be used: (a) using water soluble markers, have each student draw a topographical map on the back of her/his hand, making use of knuckles, ridges at finger joints, etc. (b) work with students to construct a topographical map of a local area to enhance understanding of the correlation between an actual land area and a topographical map.

4. In a brain-storming session with students, prepare a list of landfill site requirements. Be sure to include information about location, topography and surface slope, soil composition, bedrock characteristics, and water table position.

5. As a homework assignment ask the students to study the maps and charts and evaluate each landfill site, listing both its positive characteristics and its limitations. Students can be given the handout, ***Landfill Site Selection Criteria: Evaluation Form***, to summarize the data.

6. Organize students into groups and have each group evaluate the four landfill sites based on the homework analysis of each individual in the group. Each group should prepare a ranked list of the sites and each student should write a report on this ranked list including reasons given for the rankings and how a landfill site should be chosen.

7. As part of each group's report, cross-section diagrams could be drawn indicating the excavation limits of the proposed landfill in relation to the geologic stratigraphy, including aquifer systems at each site as depicted on the handout, ***Geologic Cross-sections***. This can be done by assuming the landfill trench will be 10 feet deep at each location. Below is a sample cross-section diagram.



8. Discuss student group choices and reasons for the choices.

EVALUATION

Group presentations and individual homework assignments.

EXTENSION

As a class project an actual physical model of Buckeye County could be constructed. Or, have students identify potential landfill sites in their own community and draw up permit-to-install plans for specific locations based on the handout, ***Site Drawings Criteria***.

HYDROGEOLOGY AND LANDFILL SITES

Protection of ground water is an important consideration when siting and constructing a landfill. Various factors related to the hydrogeology of the landfill site must be described prior to acquiring a permit-to-install. According to the Ohio Administration Code (OAC 3745-27-06, 07), the following information must be included in a permit-to-install application.

CROSS-SECTION DRAWINGS MUST SHOW:

* geologic stratigraphy and significant zones of saturation corresponding to site-boring information;

* the uppermost aquifer and all saturated strata above the uppermost aquifer;

* all well logs of the borings intercepted by the cross-section;

* ground water flow patterns for the uppermost aquifer and all significant zones of saturation above the uppermost aquifer;

* limits of excavation of the landfill; and

* any permanent ground water control structures.

A NARRATIVE EXPLANATION MUST INCLUDE:

* the identification of the regional aquifer(s);

* a description of the geomorphology at the proposed sanitary landfill facility;

* a description of the structural geology under the proposed sanitary landfill facility;

* a description of the uppermost aquifer system and all significant zones of saturation above the uppermost aquifer system. This description shall include the depth to, and lateral and vertical extent of, the uppermost aquifer system, and all significant zones of saturation above the uppermost aquifer system; and

* identification and characterization of recharge and discharge areas within the boundaries of the proposed sanitary landfill facility. This shall include any relationships of ground water with seeps, springs, streams, and other surface water features.

LANDFILL SITE SELECTION CRITERIA DEGREE OF LIMITATION*

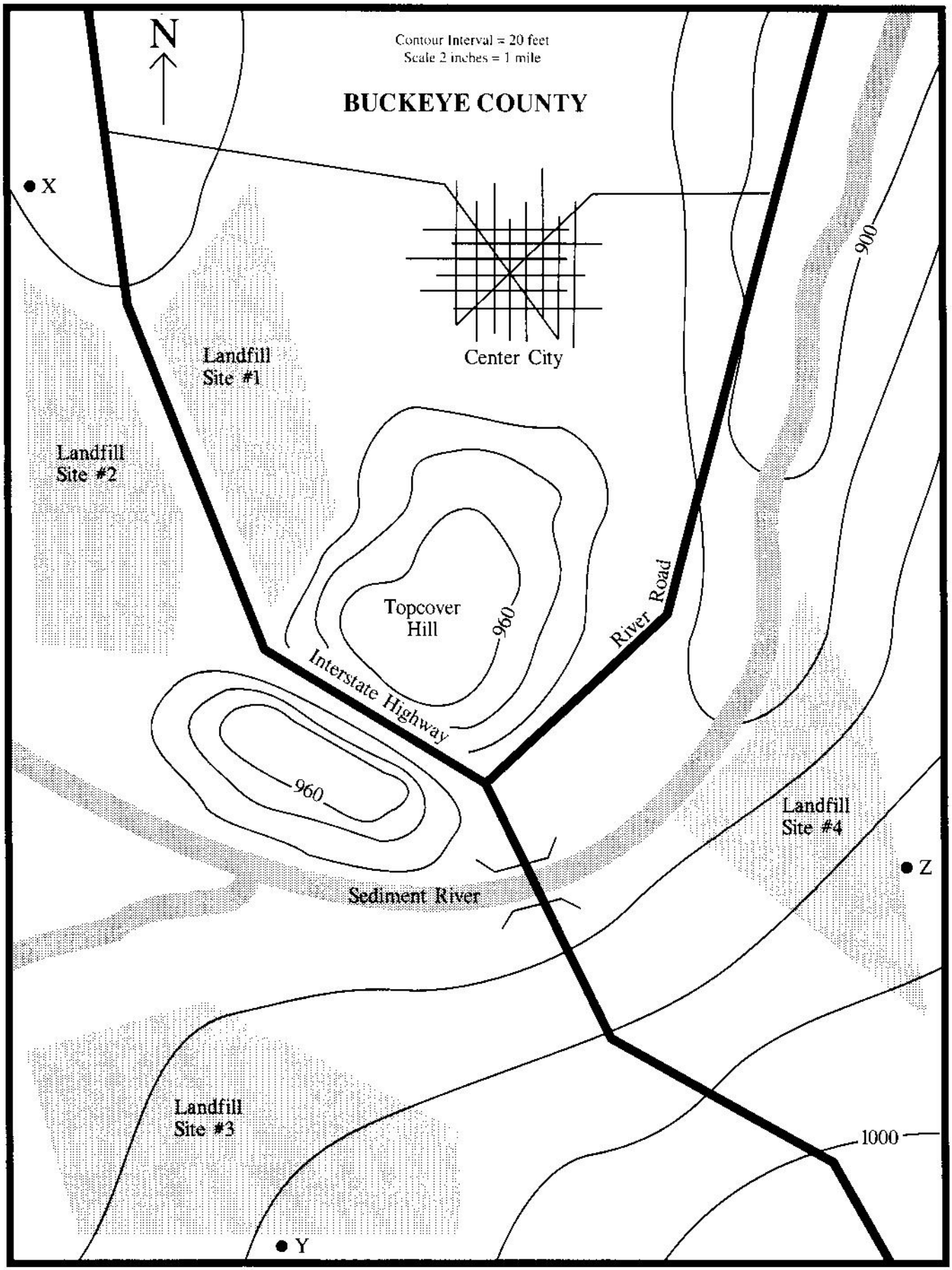
Limiting Factor	Severe Limitations	Moderate Limitations	None or Slight Limitations
Land, slopes	>15%	3-15%	less than 3%
Character of surface deposits	clean sand/ gravel: heavy organic clay	sand/gravel mixed: with silt 50 ft. thick	glacial till
Depth to bedrock	<10 ft.	10-50 ft.	>50 ft.
Bedrock type	Fractured dolomite	sandstone	unpermeable shale
Depth to ground water	<10 ft.	10-25 ft.	>25 ft.
Distance to:			
Water supply	within area	N/A	>1000 ft.
Floodplains	<300 ft.	300-1000 ft.	>1000 ft.
Streams	<300 ft.	300-1000 ft.	>1000 ft.
Lakes	<1000 ft.	N/A	>1000 ft.
Parks/highways	<200 ft.	200-1000 ft.	>1000 ft.
Wetlands	within wetland	N/A	>1000 ft.

*A. Zaparozec and F.D. Hale, *Geoforum*, 1975

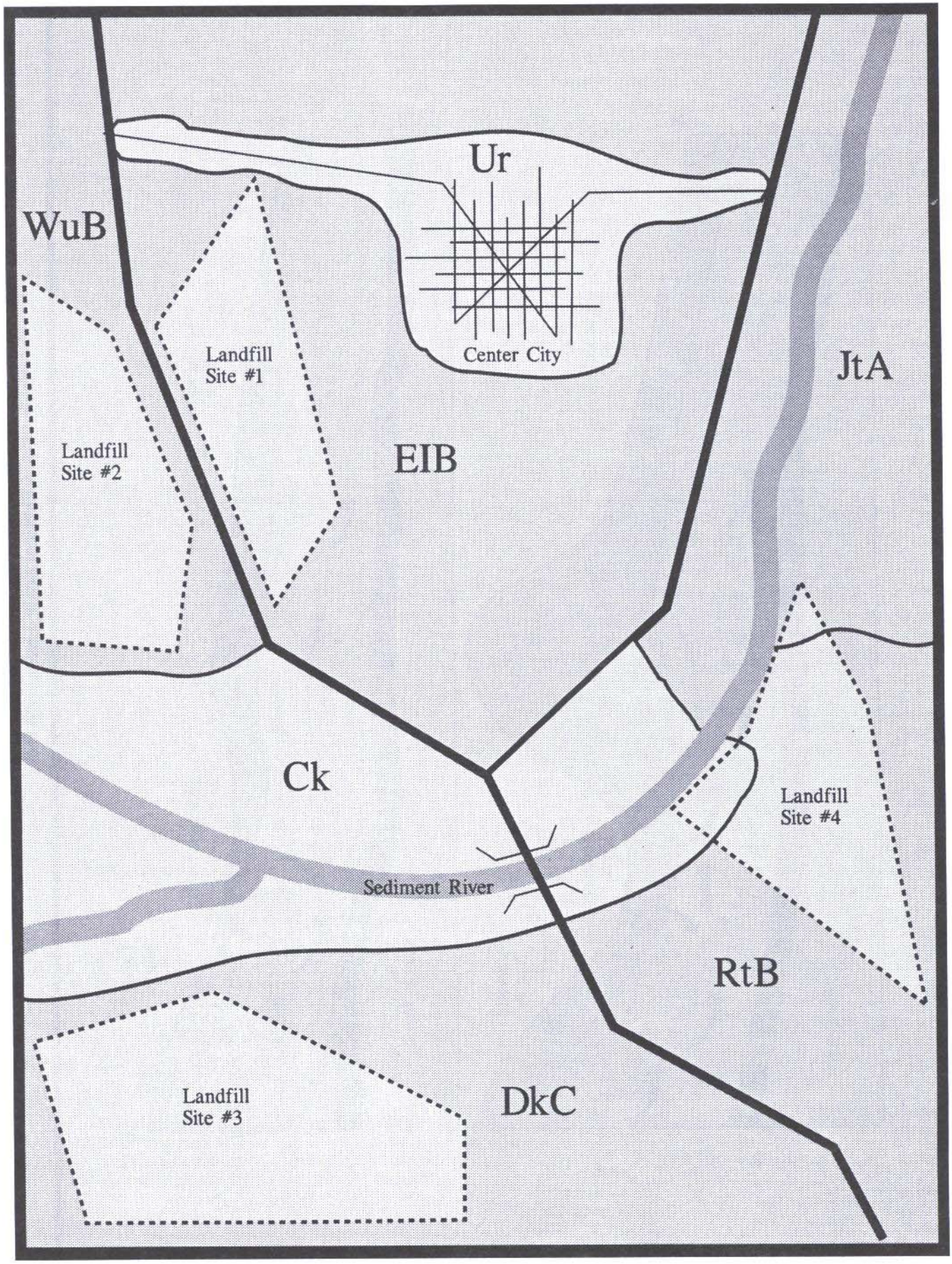
SOIL PROPERTIES CHART

SOIL TYPE	SYMBOL	COMPOSITION			DEPTH TO BEDROCK	PERMEA-BILITY (inches/hour)	FEATURES
		SAND	SILT	CLAY			
Chagrin	Ck	20%	65%	15%	>6 ft.	0.63-6.3	deep, nearly level, silt loam, well-drained, subject to flooding
Dekalb	DkC	45%	45%	10%	1.5-3.5 ft.	6.3-12.0	moderately deep, 2-6% slope, sandy loam, well drained, sandstone bedrock
Ellsworth	ElB	25%	65%	10%	>6 ft.	0.06-2.0	deep, 2-6% slope, silt loam, moderately well-drained, seasonally high water table
Jimtown	JtA	40%	45%	15%	>6 ft.	0.63-12.0	deep, 0-2% slope, loam poorly drained, seasonally high water table, pervious material
Rittman	RtB	30%	60%	10%	>6 ft.	0.06-2.0	deep with shallow clay layer, 6-12% slope, silt loam, moderately well-drained, seasonally high water table
Urban	Ur						0-25% slope, building or paved surfaces
Wooster	WuB	15%	60%	25%	>5 ft.	0.63-2.0	deep with deep clay layer, 2-6% slope, silt loam, well-drained

TOPOGRAPHIC MAP

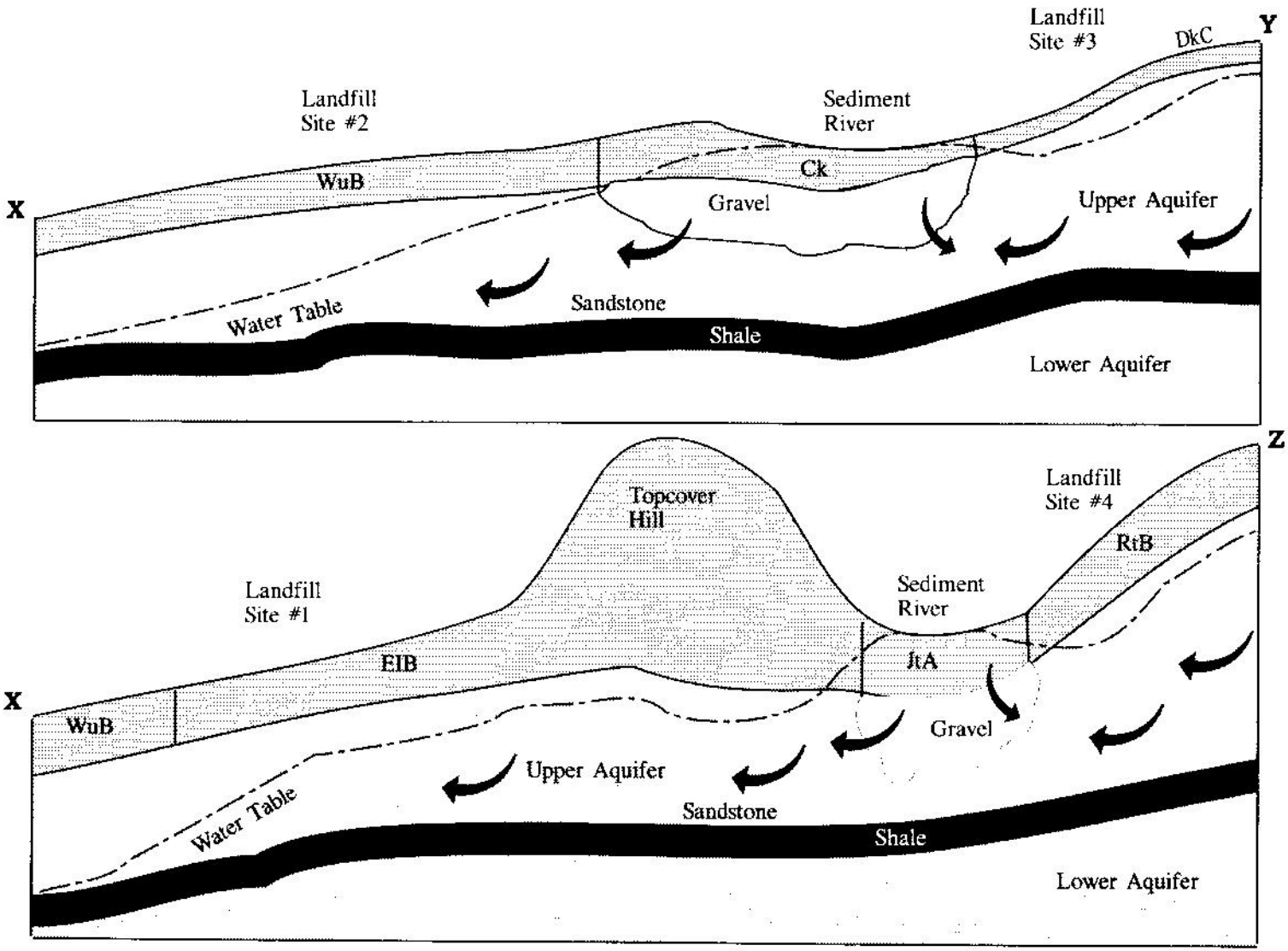


SOILS MAP


Ur
WuB
Landfill
Site #1
Center City
JtA
Landfill
Site #2
EIB
Ck
Landfill
Site #4
Sediment River
RtB
Landfill
Site #3
DkC

GEOLOGIC CROSS-SECTIONS

Vertical Scale 1 inch = 40 feet



LANDFILL SITE SELECTION CRITERIA EVALUATION FORM

Evaluate each site using the Degree of Limitation criteria. Mark the actual value; whether the limitation is severe, moderate, or slight; and rank the sites from 1 to 4 for each limiting factor.

LIMITING FACTOR	SITE 1	SITE 2	SITE 3	SITE 4
Land, Slopes				
Character of surface deposits				
Depth to bedrock				
Bedrock type				
Depth to ground water				
Distance to:				
Water supply				
Floodplains				
Streams				
Lakes				
Parks/highways				
Wetlands				

SITE DRAWINGS CRITERIA

The following is a list of items which must be included in drawings submitted to the Ohio EPA as part of the permit-to-install application (OAC 3745-27-06). A scale of 1 inch equals no greater than 200 feet should be used.

ON A TOPOGRAPHIC DRAWING SHOW THE FOLLOWING:

1. The property lines of the land owned or leased for construction of the landfill
2. The north arrow
3. The limits of solid waste placement within the landfill
4. Direction of prevailing winds during each season
5. Traffic patterns

Within 1,000 feet of the limits of solid waste placement

6. Existing topography showing vegetation, streams, swamps, lakes, springs, and other surface waters, with a contour interval no greater than 5 feet
7. All public roads, railroads, and occupied structures
8. All existing land uses including potential explosive gas migration pathways (sewers, waterlines, electric cables, pipe lines, oil wells, and gas wells), parks and nature preserves
9. Zoning classifications, political subdivisions, and communities

Within 2,000 feet of the limits of solid waste placement

10. All public and private water supply wells
11. Faults that have displacement in Holocene time
12. All surface and underground mining of coal and noncoal minerals
13. All airport runways within 10,000 feet; or within 5,000 feet if runway is used only by propeller driven craft

IN A CROS-SECTION DRAWING SHOW THE FOLLOWING:

(At an interval no greater than every 300 hundred feet of length and width and clearly showing the horizontal and vertical scale used)

1. Existing topography
2. Limits of excavation for solid waste placement
3. Final grade, including cap system
4. Geologic stratigraphy showing the uppermost aquifer and all saturated strata above the uppermost aquifer, including ground water flow patterns
5. Any human made or natural potential explosive gas migration pathways