STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
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Suitability for Solid-Waste Disposal in the Lorain 30 X 60-Minute Quadrangle, Ohio

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DRAFT

Map SG-2b LOR
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INTRODUCTION AND PURPOSE

The Ohio Department of Natural Resources (ODNR), Division of Geological Survey has completed a reconnaissance map showing areas suitable for solid waste disposal in the Lorain, Ohio, 30 x 60-minute (1:100,000-scale) quadrangle. The main purpose of this map is to provide a reconnaissance level map that shows the relative suitability of various surficial materials for the disposal or containment of solid waste in this quadrangle. Our goal was to create this map from existing ODNR Division of Geological Survey maps and GIS datasets as much as possible. Consequently, the Lorain map is a derivative map based directly from the ODNR Division of Geological Survey SG-2 Series map, *Surficial Geology of the Lorain and Put-in-Bay 30 x 60 Minute Quadrangles* (Pavey and others, 2005). The SG-2 series features maps based upon polygons that represent a "stack" of mapped unit lithologies and thicknesses. These maps show surficial materials in increments of 10 feet within each polygon across the study area. A set of queries were run in ESRI ArcGIS to determine the range of thickness and nature of the sediments.

The main premise of this map is to specify areas of thick, fine-grained glacial till and glaciolacustrine silt and clay deposits for solid-waste disposal and containment. A minimum of 30 feet of fine-grained material was deemed necessary for waste disposal for areas where the drift overlies shale; siltstone; or interbedded, shaley limestone. If the fine-grained material was directly overlying an aquifer, the minimum required thickness was increased to 50 feet. Aquifers included sand and gravel, sandstone, limestone, and dolomite. Areas with over 20 feet of sand and gravel or sand at the surface (e.g., kames, beach ridges) were excluded as were areas with alluvium (active streams) and organic deposits at the land surface. The main factor in the decision-making process was to have adequate fine-grained materials overlying the aquifers.

A secondary goal is to use the SG-2 Series surficial geology "stack maps" as the basis for creating a number of *easy-to-construct*, reconnaissance-scale derivative maps that allow the user to *quickly* determine the thickness and nature of the drift and the underlying bedrock for a variety of uses including the potential for mineable bedrock, sand-and-gravel aggregate resources, and suitability for solid-waste disposal sites. Provided here is a description of the mapping conventions for the surficial mapping units followed by a description of the bedrock units and a brief discussion of the potential suitability for waste disposal and containments. A more-detailed discussion of the data sources and techniques used for creating the original SG-2 Series map, *Surficial Geology of the Lorain and Put-in-Bay 30 x 60 Minute Quadrangles*, can be found in Pavey and others (2005). We determined that the geology in the Put-in-Bay quadrangle was not conducive for solid waste disposal, hence the derivative map did not include the areas within the Put-in-Bay 1:100,000-scale quadrangle.

Besides the main "stack map"-based derivative map, this publication also includes three useful smaller-scale "inset" maps. The first inset map (fig. 1) provides descriptions of the Quaternary units for the Lorain 30 x 60-minute quadrangle, essentially making it a map of geomorphic units depicting glacially derived landforms. This inset map is derived from the map *Quaternary Geology of Ohio* (Pavey and others, 1999). The second inset map (fig. 2) shows the bedrock geology of the Lorain 30 x 60-minute quadrangle derived from the *Bedrock Geologic Map of Ohio* (Slucher and others, 2006). Map unit symbols used for this inset map appear in bold in the bedrock unit descriptions below. The third inset map (fig. 3) depicts the drift thickness map of the Lorain 30 x 60-minute quadrangle based upon the *Shaded Drift-Thickness Map of Ohio* (Powers and Swinford, 2006)

MAPPING CONVENTIONS

This map provides a three-dimensional framework of the area's surficial geology and depicts four important aspects of surficial geology:

1. Geologic deposits, indicated by letters that represent the major lithologies.
2. Thicknesses of the individual deposits, indicated by numbers and modifiers.
3. Lateral extent of the deposits, indicated by map-unit area boundaries.
4. Vertical sequence of deposits, shown by the stack of symbols within each map-unit area.

Figure 4 illustrates mapping conventions. Letters, numbers, and modifiers are arranged in stacks that depict the vertical sequence of lithologic units for a given map-unit area. A single stack of symbols occurs in each map-unit area and applies only to the volume of sediments within that particular map-unit area.

Letters represent geologic deposits (lithologic units) and are described in detail below. Lithologic units may be a single lithology, such as sand (S) or clay (C), or a combination of related lithologies that are found in specific depositional environments, such as sand and gravel (SG) or ice-contact deposits (IC). The bottom symbol in each stack indicates the bedrock lithologies that underlie the surficial deposits. The detailed lithologic unit descriptions below summarize:

1. Geologic characteristics, such as range of textures, bedding, and age.
2. Engineering properties or concerns attributed to the unit.
3. Depositional environment.
4. Geomorphology or geomorphic location.
5. Geographic location within the map area, if pertinent.

Numbers (without modifiers) that follow the lithology designator represent the average thickness of a lithologic unit in tens of feet (for example, *3* represents 30 ft). If no number is present, the average thickness is implied as *1* (10 ft). These unmodified numbers correspond to a thickness range centered on the specified value but may vary up to 50 percent. For example, *74* indicates the average thickness of till in a map-unit area is 40 ft, but thickness may vary from 20 to 60 ft.

Modifiers provide additional thickness and distribution information:

1. Parentheses indicate that a unit has a patchy or discontinuous distribution and is missing in portions of that map-unit area. For example, *(T2)* indicates that till with an average thickness of 20 ft is present in only part of that map-unit area.

2. A minus sign following a number indicates the maximum thickness for that unit in areas such as a buried valley or ridge. Thickness decreases from the specified value, commonly near the center of the map-unit area, to the thickness of the same lithologic unit and vertical position specified in an adjacent map-unit area. For example, a *SG9* map-unit area adjacent to a *SG3* area indicates a sand-and-gravel unit having a maximum thickness of 90 ft that thins to an average of 30 ft at the edge of the map-unit area. If the material is not present in an adjacent area, it decreases to zero at that boundary.

The small scale of this reconnaissance map generalizes the great local variability within surficial deposits. That variability is explained in the lithologic unit descriptions and by the use of thickness ranges. Some areas and lithologies are too small to delineate at 1:100,000 scale and have been included in adjacent areas. This map should serve only as a regional predictive guide to the area's surficial geology and not as a replacement for subsurface borings and geophysical studies required for site-specific characterizations.

SURFICIAL UNITS

w — **Water.** Lakes generally larger than 20 acres and not appearing on basemap.

m — **Made land.** Large areas of cut and fill, such as dams, landfills, and urban areas; may include reclaimed strip-mined areas. Underlain by bedrock or other lithologic units.

a — **Alluvium (Holocene).** Includes a wide variety of textures from silt and clay to boulders; commonly includes organic material; generally not compact; rarely greater than 20 ft thick. Present in floodplains of modern streams throughout entire map area. Mapped only where areal extent and thickness are significant.

o — **Organic deposits (Holocene).** Muck and peat, may contain clay at depth; generally less than 20 ft thick. Formed in undrained depressions. Organic deposits too small to map at 1:100,000 scale indicated by an asterisk [(*)] and underlain by material shown in surrounding map-unit area. Present also on outwash trains, ice-contact areas, and hummocky moraines throughout the map area.

om — **Organic and marl deposits (Holocene).** Found only in the area north and west of Castalia, where groundwater rich in calcium carbonate discharges from springs at the base of the Columbus Limestone escarpment. Precipitation of carbonate [marl] around plants on poorly-drained Lake Plain sediments has constructed these "upland bogs."

Af — **Alluvial terraces (Wisconsinan).** Old floodplain remnants along streams that flowed into high, proglacial lake predecessors of Lake Erie. Highly variable textures; commonly found tens of feet above modern floodplains.

Ac — **Alluvium and alluvial terraces, combined.** Shown in areas where space is insufficient to delineate separate units.

C — **Clay (Wisconsinan).** Massive to laminated; may contain interbedded silt and fine sand; clay content can exceed 80 percent. Laminated clay commonly contains thin silt or sand partings. Carbonate-cemented concretions occur in some areas. Commonly contains fractures 6 to 12 inches apart. Distributed throughout map area as lowland surface deposits, terraces, and as deep-water deposits of proglacial lakes.

L — **Silt (Wisconsinan).** Massive or laminated, commonly contains thin sand partings. Carbonate-cemented concretions occur in some areas. May contain localized clay, sand, or gravel layers. Clay content commonly increases with depth. Present throughout the map area as lowland surface deposits; terraces; and thick, deltaic deposits of proglacial lakes.

S — **Sand (Wisconsinan).** Contains minor amounts of disseminated gravel or thin lenses of silt or gravel; grains well to moderately sorted, moderately to well rounded; finely stratified to massive, may be cross bedded; locally may contain organics. In deep buried valleys, may be older than Wisconsinan age. Present in terraces and buried valleys throughout the map area, and in association with deltaic deposits or outwash.

SG — **Sand and gravel (generally Wisconsinan).** Intermixed and interbedded sand and gravel commonly containing thin, discontinuous layers of silt, clay, and till. Grains well to moderately sorted, moderately to well rounded; finely stratified to massive, may be cross bedded; locally may contain organics. In deep buried valleys, may be older than Wisconsinan age. Present as terraces along valley walls and in buried valleys throughout the map area.

G — **Gravel (Wisconsinan).** Contains intergranular sand, some sand and silt beds and lenses; unit well to moderately sorted, subangular to well rounded; may be massive, crossbedded, or horizontally bedded. Clasts very in lithology and are commonly derived from bedrock in immediate area. In deep buried valleys, may be older than Wisconsinan age.

IC — **Ice-contact deposits (Illinoian).** Highly variable deposits of poorly sorted gravel and sand with common inclusions of silt, clay, and till lenses. Deposited directly from stagnant ice as kame or esker landforms. Found in southeastern part of the map area.

GA — **Basal gravel.** Highly variable, poorly sorted gravel and sand with significant amounts silt and clay. Found in the southwest part of map area; deposited at or near front of the ice sheet directly on bedrock. Presumably of Wisconsinan age but may be older.

CG — **Complexly interbedded deposits of clay, silt, sand, gravel, and till in deeper parts of buried valleys (unspecified).** Found in southeast part of map area. Up to 275 feet thick; insufficient data are available for more detailed differentiation.

T — **Unsorted mix of silt, clay, sand, gravel, and boulders (Wisconsinan).** Variable carbonate content, fractures common. May contain silt, sand, and gravel lenses. Deposited directly from several separate ice advances. Undifferentiated and nonspecified age in buried valleys or where separated by intervening nontill units from an overlying, designated till. Surface may be wave planed or modified by lacustrine erosion and deposition.

BEDROCK UNITS

SSh — **Sandstone and shale (Mississippian and Devonian).** Cuyahoga Formation, Sunbury Shale, Berea Sandstone, and Bedford Shale. Cuyahoga Formation, the uppermost unit, is present in southeast portion of map area. Shale and siltstone dominate and rapidly change vertically and horizontally. Sunbury Shale, present in south central portion of the map, is black to brown, fissile-parted, silty, carbonaceous shale. Berea Sandstone, a resistant unit that forms hills and cliffs at or near northern edge of study area, is light gray, medium to fine grained, and thin to massive bedded. Unit is generally 40 to 60 feet thick but can vary from 0 to 230 feet in thickness because of an erosional surface at base of unit. Berea is thicker in central Lorain and western Medina Counties. Bedford Shale, exposed in the northern portion of the study area, is predominantly soft, red, clay shale that grades downward into a gray shale. Thick siltstone lentils are present. Bedford Shale ranges from 50 to 150 feet in thickness.

Sh — **Shale (Devonian).** Ohio Shale, present along a 12 mile-wide, north–south oriented belt in western Huron and central Erie Counties and along Lake Erie shoreline in Lorain County. Unit is black to brown, silty, carboniferous, fissile-parted shale that contains gray to greenish-gray, soft, clay shale beds. Ohio Shale thickens from 350 to 500 feet from west to east.

S-L — **Shale with minor limestone (Devonian).** Prout Limestone and Plum Brook Shale and their southern equivalent, Olentangy Shale, present in a one-to-three mile-wide, north–south oriented belt in western Huron County and central Erie County. Plum Brook Shale is gray to greenish-grey, soft, fossiliferous, calcareous, clay shale 50 to 80 feet thick. The unit is capped by Prout Limestone, a hard, siliceous, gray to brown limestone bed 3 to 10 feet thick. Prout Limestone pinches out in the southern part of the study area. Olentangy shale is greenish-grey, calcareous, sparsely fossiliferous clay shale.

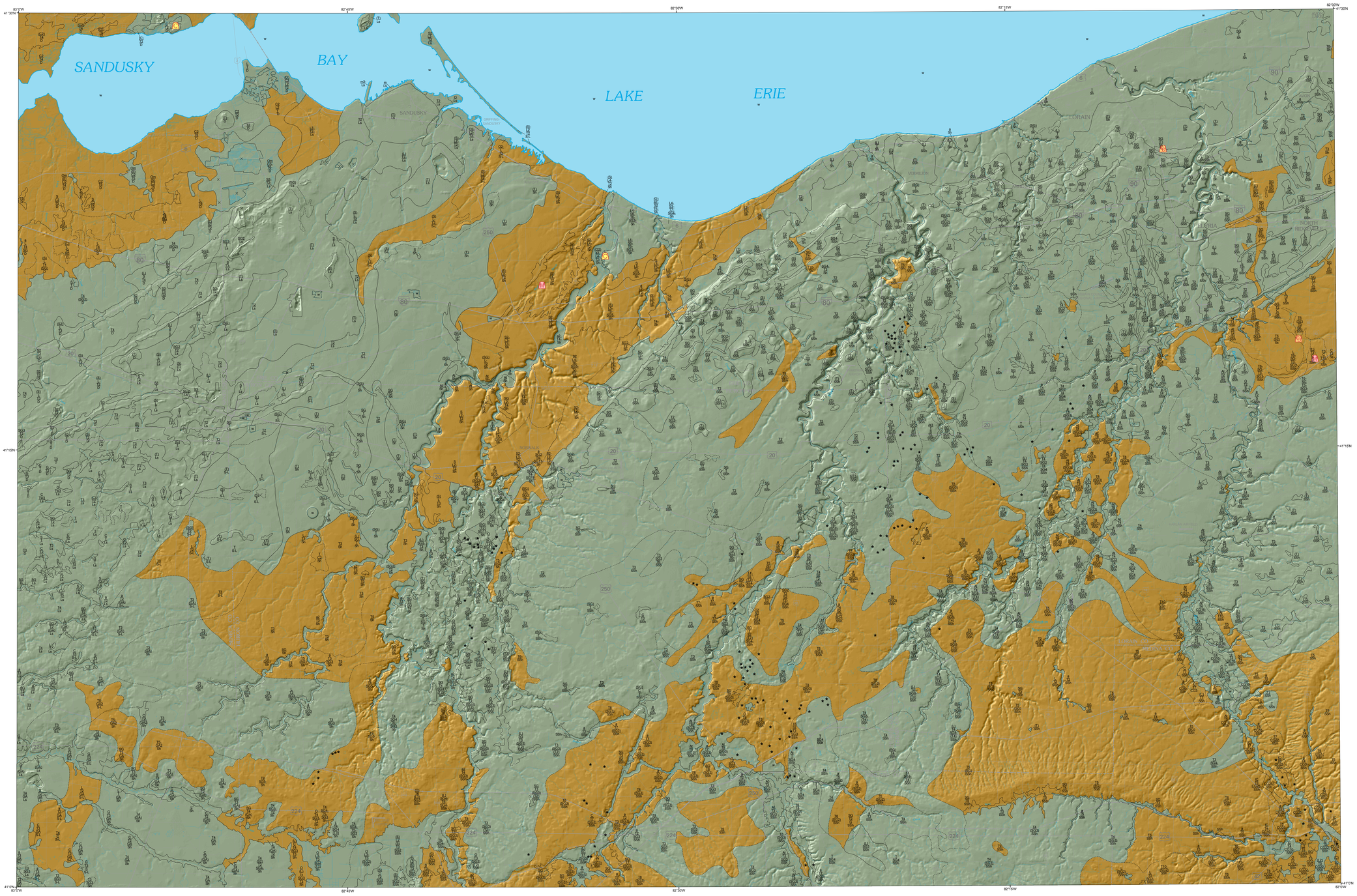
Ls — **Limestone (Devonian).** Delaware and Columbus Limestones, present in a 10-mile-wide belt in eastern Seneca, Sandusky, and Ottawa Counties; western Erie County; and Kelleys Island. Delaware Limestone is medium brown, fine to medium crystalline, fossiliferous, and cherty containing shale laminae. Columbus Limestone is light to medium gray to brown, fine to coarse crystalline, fossiliferous, and cherty in the upper portion. The lower portion is light brown to gray, fine to medium crystalline, dolomitic, massive bedded, and contains quartz grains in the basal ten feet. The combined Columbus and Delaware units are 200 feet thick. This unit is susceptible to dissolution and contains significant areas of well-developed karst topography.

D — **Dolomite (Silurian).** Undifferentiated Salina Dolomite, present in a northeast-trending belt in eastern portion of study area in eastern Sandusky County, on Marblehead Peninsula in eastern Ottawa County, and the Bass Islands of Lake Erie. Salina undifferentiated is brown to gray dolomite that is laminated, microcrystalline, argillaceous, and contains beds of gypsum, anhydrite, or anhydritic dolomite. The upper portion can be light gray to medium brown, brecciated, and cherty.

GLACIAL GEOLOGY AND SUITABILITY FOR WASTE DISPOSAL

The uppermost surficial deposits found in the Lorain quadrangle are predominantly Wisconsinan in age (Pavey and others, 1999; Pavey and others, 2005). Holocene-age alluvium and organic estuarine deposits are also found in the quadrangle. Surficial materials include typical glacial sediments, including till and ice-contact deposits, as well as sediments associated with the ancestral lakes, including glaciolacustrine, beach ridge, and deltaic deposits.

The Lorain map is intended as a general guide or "first look" for indentifying the suitability for solid-waste disposal and containment. The map also may be useful for land-use planning and zoning. For the purposes of this map, the term *solid waste* applies to solid-waste municipal landfills, construction/demolition debris landfills, manure piles, silage and feed areas, and sewage and septage spreading. Because the Lorain map is based on reconnaissance-level surficial-geology and bedrock-topography maps, it should not be used in lieu of site-specific studies for siting the above-mentioned land usages. Aquifer maps, ground-water pollution potential (DRASTIC) maps, ground-water potentiometric surface (water table) maps, and ground-water resources maps available from the ODNR Division of Soil & Water Resources are highly recommended for evaluating ground-water conditions for determining site suitability. A more-detailed geologic and engineering investigation utilizing soils maps, additional water-well data, drilling, and laboratory testing of chemical and physical properties of the surficial materials would be necessary to delineate and evaluate the suitability of solid-waste disposal for specific projects.



Suitability for Solid-Waste Disposal in the Lorain 30x60-minute quadrangle

potentially suitable — not suitable

Active Landfill Operations

municipal landfill (OEPA, 2006)

construction and demolition debris landfill (OEPA, 2003)

industrial and residual landfill (OEPA, 2003)

MAP SYMBOLS

★ Small area of organic deposits.

Quarry, mine, or strip mine; floored in bedrock; may contain reclaimed areas.

Sand-and-gravel pit. Pit bottom generally underlain by unconsolidated lithologic units of surrounding polygon(s). May contain reclaimed areas.

Boundary between map-unit areas having different uppermost, continuous lithologies or significant bedrock lithology change; underlying lithologies may or may not differ.

Boundary between map-unit areas having the same uppermost, continuous lithology but different thicknesses or different underlying lithologies.

Miles 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13
Kilometers 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

N

SCALE 1:100 000

5,000 0 5,000 10,000 15,000 20,000 25,000 30,000 35,000 40,000 45,000 50,000 55,000 60,000 65,000 70,000 Feet
1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 11,000 12,000 13,000 14,000 15,000 16,000 17000 18,000 19,000 20,000 Meters

ACKNOWLEDGMENTS

Data were collected from numerous sources (see References). The concentration of data was greatest near the surface and decreased with depth. County soil survey maps, which described the top 5 ft of surficial materials, provided an initial guide to map-unit areas. These areas were modified through interpretation of local geomorphic settings and other data that indicated change of deposits at depth, such as Ohio Department of Natural Resources (ODNR) water-well logs; Ohio Department of Transportation and Ohio EPA test-boring logs; theses; and published or unpublished geologic reports, maps, and field notes. These data also provided the basis for lithologic unit descriptions, which summarize, as accurately as possible, recognized associations of genetically related materials. The total thickness of surficial deposits was calculated from ODNR Division of Geological Survey open-file bedrock-topography maps, which are available for each 7.5-minute quadrangle in the map area. The bedrock units were summarized from ODNR Division of Geological Survey bedrock-geology maps, also available for each 7.5-minute quadrangle. Land-surface topography shown on the basemap was prepared largely from data derived from the U.S. Geological Survey's National Elevation Dataset (30 meter grid spacing).

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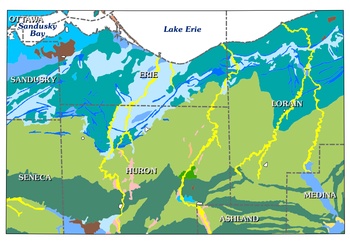


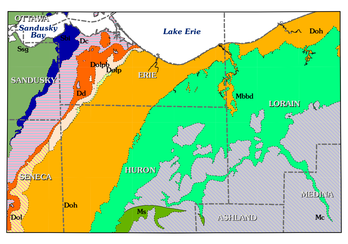
Description of Quaternary Units

HOLOCENE (RECENT) - 10 k.y. to present
- Water
- Alluvium and alluvial terraces
- Beach sand
- Peat

LATE WISCONSINAN - 23 to 13 k.y.; water-deposited units
- Beach ridges
- Lacustrine sand
- Lacustrine silt
- Lacustrine clay
- Outwash, undifferentiated
- Kames and kame terraces
- Eskers

LATE WISCONSINAN - Late Woodfordian-18 to 14 k.y., ice-deposited units: Clayey till (Hiram, Yorkshire, Lake Tills)
- Ground moraine
- Lake-planed moraine
- End moraine
- Hummocky moraine

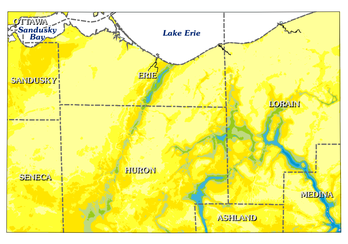
FIGURE 1.—Quaternary geology of the Lorain 30 X 60-minute quadrangle, Ohio.



Bedrock Unit Descriptions

- Dc - Columbus Limestone; fossiliferous limestone and dolomite, Middle and Lower Devonian
- Dd - Delaware Limestone; argillaceous, cherty, carbonaceous limestone
- Doh - Ohio Shale; carbonaceous shale with carbonate/siderite concretions
- Dol - Olentangy Shale; clayey shale with limestone nodules
- Dolp - Olentangy Shale - Prout Limestone Member; limestone, dolomitic in part
- Dolpb - Olentangy Shale - Plumbrook Shale Member; shale and argillaceous limestone
- Mbbd - Berea Sandstone and Bedford Shale undivided; sandstone and minor shale.
- Mc - Cuyahoga Formation; shale and interbedded sandstone and siltstone.
- Ms - Sunbury Shale; carbonaceous shale
- Sbi - Bass Islands Group undivided; dolomite
- Ssg - Salina Group; dolomite

FIGURE 2.—Bedrock geology of the Lorain 30 X 60-minute quadrangle, Ohio.



Thickness in Feet

0–30 — 10–130 — 226–300 — 461–723
31–60 — 131–160 — 301–360
61–100 — 161–225 — 361–460

FIGURE 3.—Drift thickness of the Lorain 30 X 60-minute quadrangle, Ohio.

Location of the Lorain 30 X 60-minute quadrangle

Base map derived from Ohio Department of Transportation data sets. Projection of data is Ohio coordinate system, south zone, North American Datum, 1983.

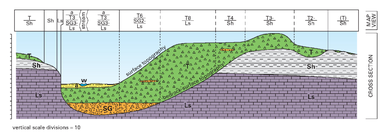


FIGURE 4.—Map view and cross section of a hypothetical stack-unit map. See lithologic-unit descriptions for explanation of symbols. In the map view (top), solid-line boundaries separate map-unit areas having different lithologic units at the surface; underlying lithologic units may or may not differ. Dashed-line boundaries separate map-unit areas having the same surface lithologic unit but different thickness or different underlying lithologic units. The cross section illustrates thickness and mapping conventions. Thickness values are in tens of feet. Values are gross averages that can vary up to 50 percent, except (1) those followed by a minus sign (-), which represent the maximum thickness of a thinning trough- or wedge-shaped sediment body, or (2) units in parentheses ( ), which indicate a discontinuous distribution of that unit. Precise surface topography can be determined from topographic maps that are available from the ODNR Division of Geological Survey at several scales; bedrock-surface topography and bedrock geology are available from the ODNR Division of Geological Survey as 1:24,000 scale quadrangle maps.

Recommended bibliographic citation:

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