

APR 14 1994

ORNL/TM-11606

ornl

**OAK RIDGE
NATIONAL
LABORATORY**

MARTIN MARIETTA

Soils of Walker Branch Watershed

Environmental Sciences Division
Publication No. 3535



MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37631; prices available from (615) 5766401, FTS 6266401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5265 Port Royal Rd., Springfield, VA 22161.

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ORNL/TM-11606

ENVIRONMENTAL SCIENCES DIVISION

SOILS OF WALKER BRANCH WATERSHED

D. A. Lietzke¹
Lietzke Soil Services
Route 3, Box 607
Rutledge, Tennessee 37661

¹Subcontractor

Environmental Sciences Division
Publication No. **3535**

Date Published — March 1994

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee **37831-6285**
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. **DE-AC05-84OR21400**



TABLE OF CONTENTS

	<u>Page</u>
LIST OF FIGURES	v
LIST OF TABLES	vii
ABSTRACT	ix
1. INTRODUCTION	1
2 SITE DESCRIPTION: GEOLOGIC AND GEOMORPHIC SETTING	5
21 SURFICIAL GEOLOGY	5
2 2 GEOMORPHOLOGY.....	7
2 2 1 Geomorphic History	10
2 2 2 Modern Age Geomorphic Processes	15
2 2 3 Holocene Geomorphic Processes	19
224 Pleistocene Geomorphic Processes	19
225 Early Pleiocene and Late Tertiary Geomorphic Processes	20
23 KARST GEOMORPHOLOGY	26
3. TECHNICAL APPROACH TO SOIL MAPPING	29
4. WALKER BRANCH WATERSHED SOIL CODING LEGEND	33
4.1 SOIL IDENTIFICATION LEGEND	34
4.2 DESCRIPTIONS OF KNOX GROUP; SOILS AND LANDFORMS.:::	37
4.21 Knox Group Residual Soils	36
4.22 Knox Colluvial soils	43
423 Doline Soils	47
4.3 OLD ALLUVIUM	49
4.4 RECENT ALLUVIUM	51
5. INTERPRETATIONS	55
5.1 DRAINAGE	55
5.2 HYDROLOGY	57
5.21 Surface Water Infiltration and Near-Surface Water Flow	57
52.2 Water-Flow Pathways Deeper in the Soil	60
5.23 Soil Role in Hydrologic Diage and Recharge of Perched and Ground Water Tables	60
5.3 DEPTH TO RESTRICTION	61
5.4 DISTURBED SOIL EROSION POTENTIAL	61
5.5 UNDISTURBED SOIL EROSION POTENTIAL	62
5.6 SUITABILITY FOR PINES	62

TABLE OF CONTENTS (Cont'd)

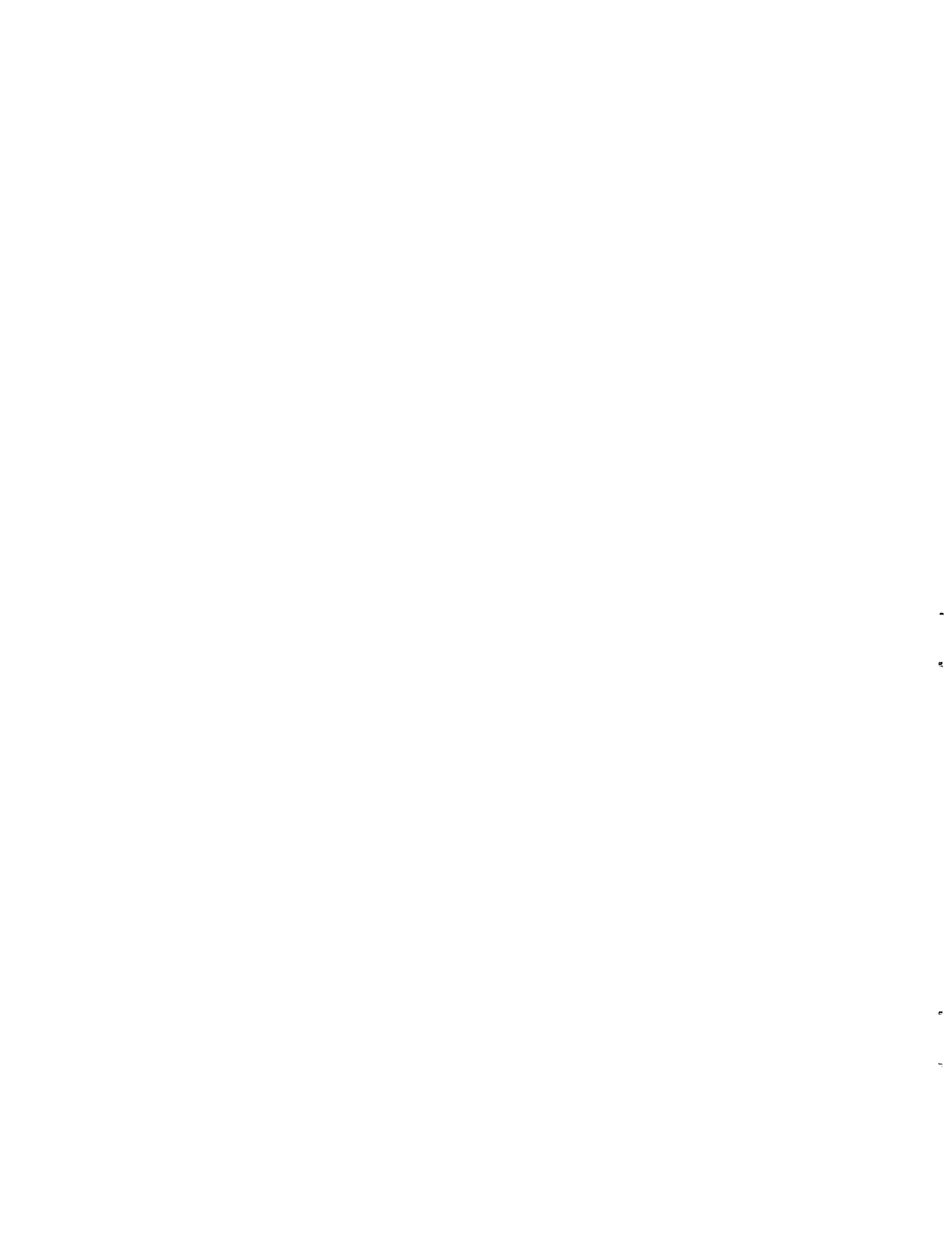
	<u>Page</u>
5.7 RATINGS FOR HARDWOODS	62
5.8 RATINGS FOR PAVED ROADS AND STREETS	62
5.9 UNPAVED ROADS	63
6. CONCLUSIONS	65
7. REFERENCES	67
APPENDIX A	69
A1 SOIL CLASSIFICATION	69
A.2 SOIL DESCRIPTIONS	70
A 3 SOIL CORRELATION FROM TM-2968	94

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Location map of Walker Branch Watershed on the Oak Ridge Reservation	2
2. Soil Conservation' Service soil map of Walker Branch Watershed	3
3. Geologic formations and their extent on Walker Branch Watershed ...	8
4. Geomorphic terms commonly used to describe landforms	9
5. Location of soil coring sites on Walker Branch Watershed	11
6. Soil core number 1	12
7. Soil core number 2	13
8. Soil core number 3	14
9. Pre-AEC takeover land use on Walker Branch Watershed	16
10. Distribution of Pleistocene colluvium on Walker Branch Watershed ...	18
11. Topographic inversion	22
12. Topographic inversion on Chestnut Ridge	23
13. Location of ancient alluvium and ancient colluvium on Walker Branch Watershed	24
14. Residual soils that occur above ancient alluvium and ancient colluvium on Walker Branch Watershed	25
15. Location of dolines on Walker Branch Watershed	27
16. Silt and sand stratigraphy in East Chestnut Ridge Doline C	28
17. Surficial geology and soil map of Walker Branch Watershed	31
18. Soil map of Walker Branch Watershed at a scale of 1:2400 (foldout)	Inside Back Cover
19. Near-surface soil hydrology on Walker Branch Watershed	58

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Soil interpretations	56



ABSTRACT

The soil survey of Walker Branch Watershed (**WBW**) utilized the most up-to-date knowledge of soils, geology, and geohydrology in building the soils data base needed to reinterpret past research and to begin new research in the watershed. The soils of WBW were also compared with soils mapped elsewhere along Chestnut Ridge on the Oak Ridge Reservation to (1) establish whether knowledge obtained elsewhere could be used within the watershed, (2) determine whether there were any soils restricted to the watershed, and (3) evaluate geologic formation lateral variability.

Soils, surficial geology, and geomorphology were mapped at a scale of 1 :1200 using a paper base map having **2-ft** contour intervals. Most of the contours seemed to reasonably represent actual **landform** configurations, except for dense wooded areas. For example, the very large **dolines** or sinkholes were shown on the contour base map, but numerous smaller ones were not. In addition, small drainageways and gullies were often not shown. These often small but important features were located approximately as soil mapping progressed.

WBW is underlain by dolostones of the Knox Group, but only a very small part of the surface area contains outcroppings of rock and most outcrops were located in the lower part. Soil mapping revealed the presence of both ancient alluvium and ancient colluvium deposits, not recognized in previous soil surveys, that have been preserved in high-elevation stable portions of present-day landforms. An erosional geomorphic process of topographic inversion requiring several millions of years within the Pleistocene is necessary to bring about the degree of inversion that is expressed in the watershed. Indeed, some of these ancient alluvial and colluvial remnants may date back into the Tertiary. Also evident in the watershed, and preserved in the broad, nearly level bottoms of **dolines**, are multiple deposits of silty material either devoid or nearly devoid of coarse fragments. Recent research indicates that most of this silty material is the result of slope wash processed during the Holocene Age.

Residual soils of the watershed were related to the underlying geologic formations by their morphology and types of **chert**. Colluvial soils were identified and mapped whenever the colluvium thickness exceeded 20 in. (50 cm). Except for the ancient colluvial soils (colluvium without a present-day source area), colluvial soils were not separated according to their geologic age, but stacked colluvial deposits are located in low footslope landforms. Colluvial soils in the watershed were identified and mapped according to their morphologic properties that would influence the perching and subsurface movement of water. Alluvial soils were restricted to present floodplains, low fan terraces, and low fan deltas. Nearly all alluvial soils contained very young surficial sediments derived from slopewash resulting from land clearing and subsequent agricultural activities.

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

...the ... of ...
...the ... of ...
...the ... of ...
...the ... of ...

1. INTRODUCTION

The soil survey of Walker Branch Watershed (**WBW**) located on Chestnut Ridge (Fig. 1) was conducted to establish a soils base map needed for watershed research activities. The purpose of the soil survey was to determine the location and extent of all important soils on the site, to assist in the analysis of surface and near surface geohydrology, and to interpret significant soil properties that would have an effect on current and future research projects. Soil mapping (Fig. 2) of the Anderson County portion of the Oak Ridge Reservation had been done previously (Moneymaker 1981) at a scale of 1 :**15840**, but the detail of that mapping was insufficient to resolve important landforms and soils that have an effect on geohydrology, especially the location of **dolines**, colluvial soils, and ancient alluvium. The site was previously mapped in 1967, and some characterization data were released in a 1970 publication (Peters et al. 1970). Although the 1967 mapping was made at a scale of **1:3168**, none of the old alluvium was recognized, nor were the **dolines** delineated. However, with correlation of the soils information to current concepts and standards, much of the soils data contained in this report (Peters et al. 1970) is still useful. Earlier work elsewhere on Chestnut Ridge was also utilized in this report (Ketelle and Huff 1984; Lee, Kopp, and Lietzke 1984; Lee, Lietzke, Ketelle, and Ammons 1988).

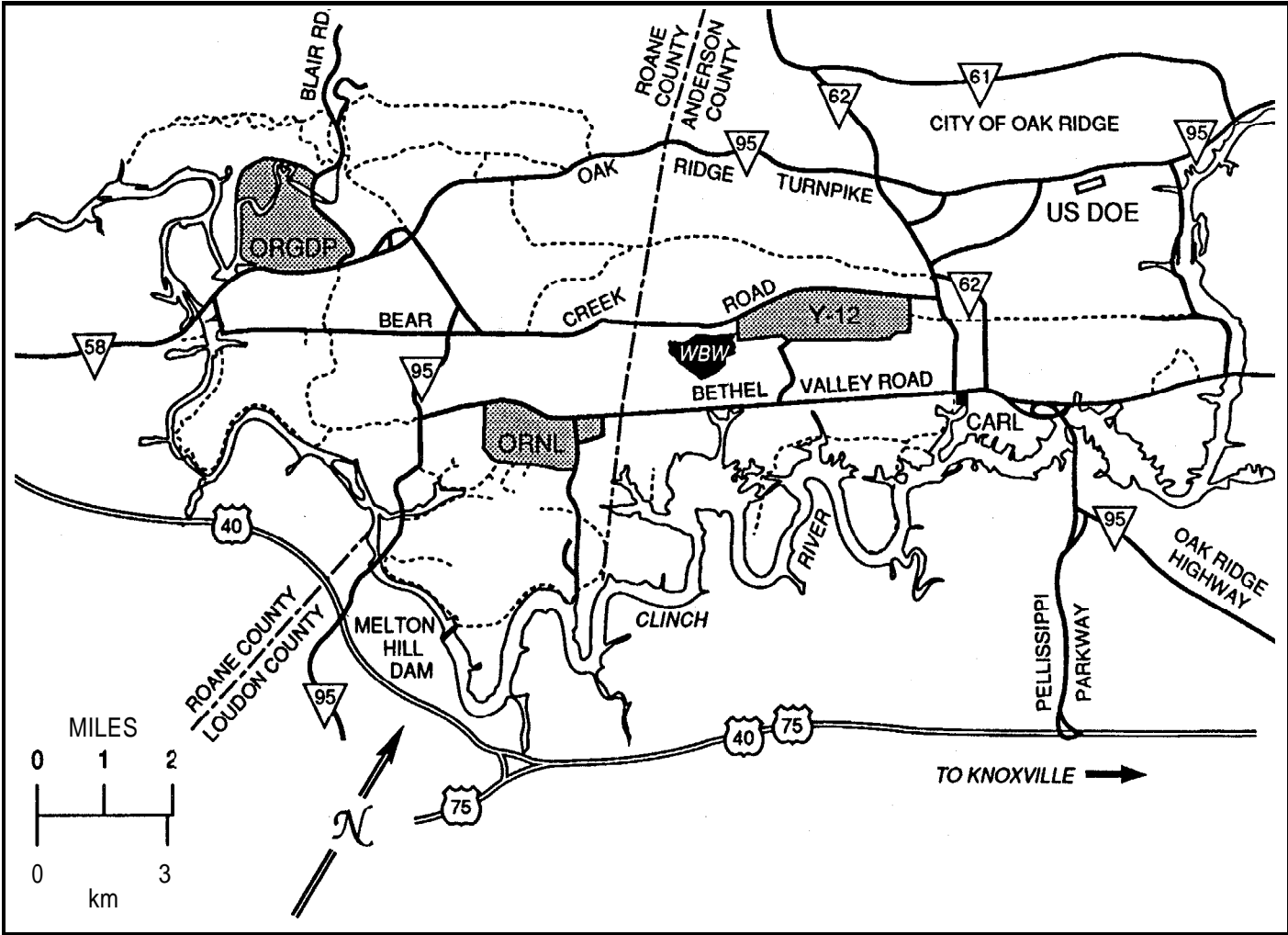


Figure 1. Location map of Walker Branch Watershed on the Oak Ridge Reservation

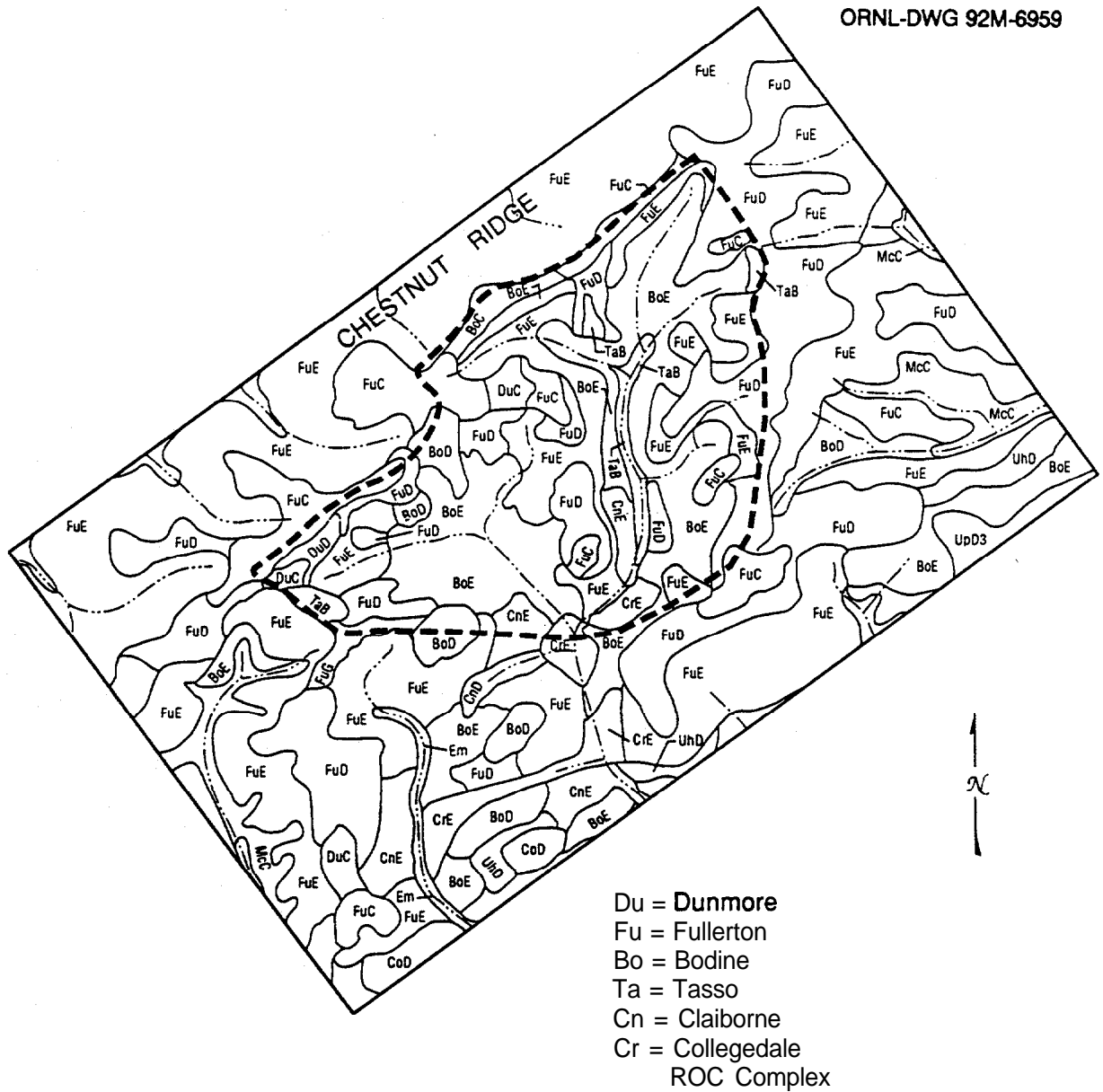


Figure 2. Soil Conservation Service soil map of Walker Branch Watershed



2 SITE DESCRIPTION: GEOLOGIC AND GEOMORPHIC SETTING

WBW occupies a portion of Chestnut Ridge (Fig. 1). The boundary of the watershed generally coincides with the surface drainage divides. However, numerous **dolines** lie along the eastern and northern sides that seem to be outside the boundary but, in fact, may be delivering water to the watershed. The watershed is underlain by the Copper Ridge, Chepultepec, Longview, Kingsport, and Mascot formations of the Knox Group. Chemical weathering processes have transformed hard rock into saprolite, and, near the surface, soil-forming processes have transformed saprolite into distinctive soils having several pedogenic soil horizons. Imposed on the geologic formations and their residual soils are the effects of past geomorphic processes that have given rise to (1) a surficial mantle of ancient alluvium from past stream activity, (2) ancient colluvium, (3) pre-Pleistocene colluvium, and (4) Pleistocene-aged colluvium. Karst geomorphic processes have also been very active in the watershed and have given rise to the many **dolines** (surface depressions or sinkholes) that were identified during the soil mapping activity. Many large **dolines** contain silty materials that have been deposited in them one or more times during the Pleistocene and Holocene and has been preserved in the bottoms of **dolines** with broad shallow basins, an indication that many **dolines** have been stable for several thousands of years. **The** silty material closest to the surface has been dated at early Holocene Age.

21 SURFICIAL GEOLOGY

WBW is underlain on the south by the Mascot formation; in the middle by the Kingsport, Longview, and Chepultepec formations; and on the north, by the Copper Ridge formation. One major objective of the soil survey was to approximately locate the surface boundaries between every formation or member of a group. **McMaster** (1963) mapped the general locations of the major geologic groups of the area, but not the location of each formation within a group. Except for the Mascot formation, there were very few outcrops of hard rock. Only a few areas of ledges and pinnacles are exposed in the upper and lower Knox Group. Other rock outcrops occur in stream channels. Therefore, the characteristics of oxidized and weathered rock leached of calcium carbonate, defined here as isovolumetrically weathered saprolite, and the surficial soil morphology were used to identify the location of boundaries and extent of each major geologic formation. Characteristics of saprolite and saprolitic materials (saprolite that has undergone partial and chaotic collapse) can be drastically different from the unoxidized and **unleached** parent rock. The upper saprolitic materials of the Knox group, for example, consist of an acidic, high-silt and high-clay-content residue into which clay has been either translocated or neo-formed. Iron and manganese oxides are

common but lesser components of saprolites, on which they form a coating on many fragment surfaces. Soil mapping located the boundaries and extent of the residual soils and underlying saprolite from all geologic formations wide enough to be mapped that are exposed at the surface. Substantial areas are covered by alluvium and colluvium of more than one age of deposition.

The Knox Group consists of five recognizable formations that are commonly identified by (1) their location with respect to formations above and below, (2) the type of chert they contain, and (3) their soil morphology. The youngest formation in the Knox is the Mascot. This formation generally contains subrounded jasperoid and chalcedonous chert, which is a **surficial** visual clue used to separate it from the younger Unit A of the Chickamauga, with its tabular chert and the older Kingsport beneath. However, geomorphic processes have scattered chert from both formations downslope across the landscape, so that one must be careful in mapping thicknesses of geologic formations by using surface lag gravel. In addition, the subsoil of the Mascot formation has its own distinctive reddish color and more-plastic rheologic properties that help distinguish Mascot soils from those soils of the Kingsport formation. In addition, the Mascot formation in WBW contains considerable sand matrix chert, giving rise to soils with relatively high sand content. This is especially evident in the southeast section of the watershed. Rocks of the Mascot formation are also commonly exposed above the surface, especially on steeper slopes, in contrast to other Knox Group formations in WBW. The next older formation in the Knox is the Kingsport. This formation contains chert of variable morphology, much of which is **oolitic**. Ledges and pinnacles commonly occur in the uppermost section of the Kingsport formation but also occur to a lesser extent elsewhere in the Kingsport only on very steep slopes. The **Longview** formation, stratigraphically beneath the Kingsport, typically contains dolomoldic chert in both the upper and lower sections; this characteristic is used to distinguish this formation and its approximate surficial thickness. The very high chert content in this formation made augering very difficult. **Longview** soils usually are mottled close to the surface. Partially because of its high chert content, the **Longview** formation tends to be a ridge former. However, because of the thinness of the Longview, it generally cannot be identified on a 1:12,000 scale soil map without considerable distortion but can be resolved on 1:1200 to 1:2400 scale high-resolution soil maps. Because of geomorphic processes of surficial soil transport, dolomoldic chert has been distributed downslope on both sides of **Longview** ridges.

The Chepultepec formation occurs stratigraphically below the **Longview**. It has a lower but variable chert content and contains some very-fine-grained sandstone strata in the lower part, which contributes to a loam rather than silt loam surface texture and a slightly lower upper subsoil clay content. There are only scattered sandstone fragments on the surface in WBW. However, sometimes the presence of loess masks the presence of higher sand content in the surface. Soils that

formed in Chepultepec saprolitic materials have 7.5YR and 5YR hues in the upper mottle-free subsoil, while the Longview and Newala formations above and the Copper Ridge formation below typically have 2.5YR hues in the upper mottle-free subsoil.

The Copper Ridge formation is the lowest and oldest of the Knox Group. This formation also has variable chert content, but most of the chert is massive. Copper Ridge saprolitic materials are characterized by a mostly reddish clay-plugged upper zone that grades irregularly downward into a yellowish high-silt zone with red clay filling voids in old fractures. A thick lag gravel layer, thick E horizons, gradational E/B and B/E horizons and red (2.5YR) upper subsoil horizons with much lower but highly variable chert content are common features of Copper Ridge soils. Figure 3 shows the approximate location and extent of each formation in WBW.

2.2 GEOMORPHOLOGY

Terminology commonly used to describe landforms and geologic materials is shown in Fig. 4. This terminology is used throughout the sections on geomorphology and the descriptions of soil mapping units that follow. Common terms used to describe a hill are summit or crest, shoulder or summit shoulder, sideslope, footslope, and toeslope. Ciests and sideslopes generally have convex shapes and are usually defined as erosion surfaces where soil particles are detached and transported to lower, generally concave, depositional environments. Sideslopes are sometimes referred to as (1) dip slopes, where the rock dip is approximately parallel to the **landform** slope and as (2) obsequent or **scarp** slopes, where the rock dips into the slope. Near-surface hydrology can differ, depending on the permeability of the underlying rock or saprolite, on these two kinds of sideslopes, with subsurface water flow being generally faster on dip slopes. Footslopes are areas where slope shapes change from convex to concave. Footslopes are either erosional or **depositional, depending** on the slope gradient and local convexity or concavity of the landform. Toeslopes have concave slope shapes and are depositional environments in their natural state, where, under the influence of gravity, water-saturated sediments are transported and deposited downslope as colluvium and alluvium. However, past agricultural activities tended to make even these landforms erode. Major Late Pleistocene and Holocene alluvial depositional environments in WBW are terraces, fan deltas, and floodplains that have a thin veneer of Modern-Age or post-European settlement alluvium. In these floodplain environments, sediments transported by running water are deposited as alluvium, which can be identified by its stratification. Local colluvium and alluvium also accumulated in drainage divides or saddles.

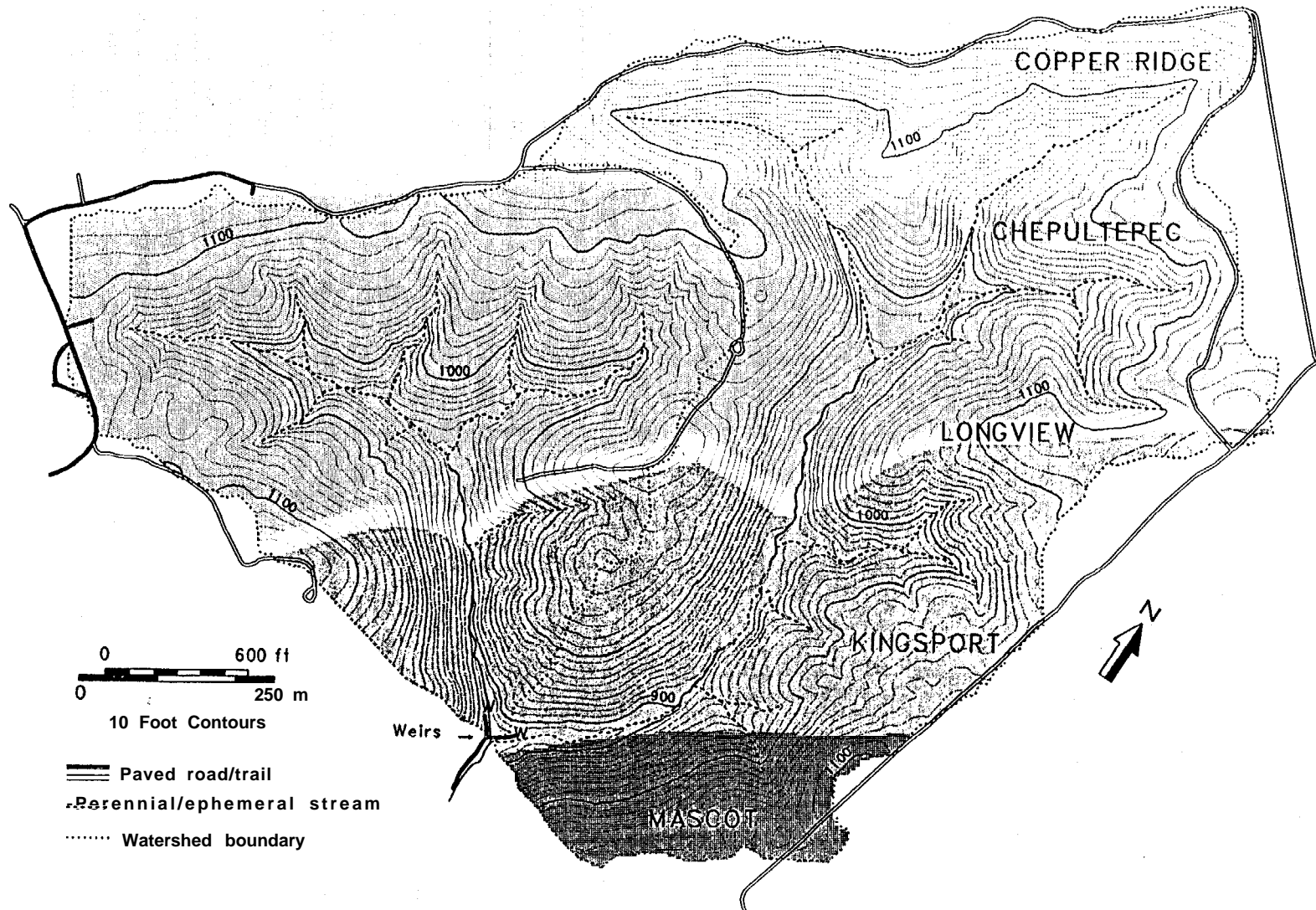


Figure 3. Geologic formations and their extent on Walker Branch Watershed

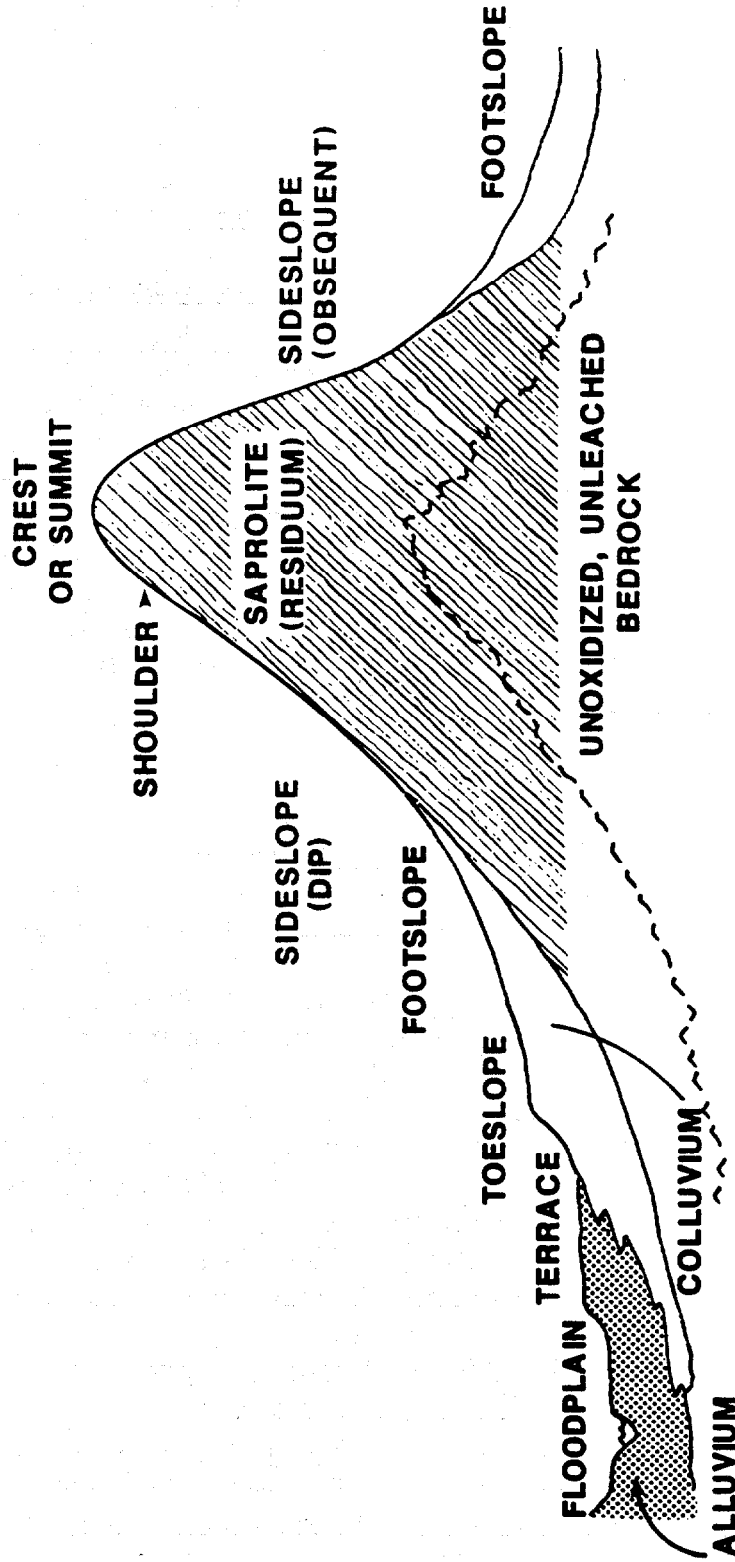


Figure 4. Geomorphic terms commonly used to describe landform

Bedrock (Fig. 4) is defined as unleached and unoxidized rock, and the weathered zones above, which have not been transported, are termed saprolite.

Saprolite is defined as isovolumetrically chemically weathered bedrock, which is a specific type of residuum. Where saprolite does not form because of a collapse of the weathered soil material, this chemically weathered earthy material is termed either regolith or residuum. The term "saprolitic materials" is commonly used to describe highly weathered carbonate rock in which there may have been partial and chaotic collapse because of insufficient framework strength of the silt and clay particles after removal of the carbonate. Some of the chaotic distribution of chert fragments in formations of the Knox Group is a result of past tectonic activities that deformed parts of the Knox Group. Evidence for this is the presence of **slicken** sides that were observed on large chert fragments, the brecciated appearance of some chert fragments, and the swirled appearance of saprolitic materials in some areas. The topography and depth to bedrock in the survey area is highly irregular because of the joint and fracture network and channelized flow of water at depth. Depth to rock is probably the greatest over the Copper Ridge, Chepultepec, and Longview; intermediate over the Kingsport; and least over the Mascot. Three drill holes (Fig. 5) were drilled to bedrock in March 1990. The coring logs are illustrated in Figs. 6, 7, and 8.

221 Geomorphic History

The geomorphic history of WBW is long and complicated. Only a postulated simplified history, based on observations starting with current or Modern Age conditions and extending back through the Holocene and Pleistocene epochs, is attempted here. The Modern Age of the Holocene epoch is defined, for purposes of this report, as beginning about 300 years ago, when the activities of European settlers resulted in large-scale deforestation, the beginning of slash-and-burn agricultural activities, and the onset of anthropogenic-accelerated erosion. The Holocene epoch covers a time span starting at the end of the Pleistocene, about 12,000 years ago and includes the Modern Age. In the Southeast, the Holocene is often been thought to have been a benign period with little climate fluctuation. However, Holocene climate changes have produced periods of geomorphic instability, the results of which are reflected in the burial of **Paleo-Indian** habitations on low river terraces by fresh sediments. During the Pleistocene epoch, which covers a period of at least 2 million years, several important climate fluctuations occurred in the southeastern United States that affected geomorphic stability. The widespread occurrence of colluvium in WBW is evidence for these geomorphic activities. The ancient high-elevation alluvial and **ridgetop** colluvial soils evidently predate the Pleistocene and are probably remnants of an earlier erosion cycle dating from the Tertiary. Topographic inversion of this magnitude requires considerable geologic time.

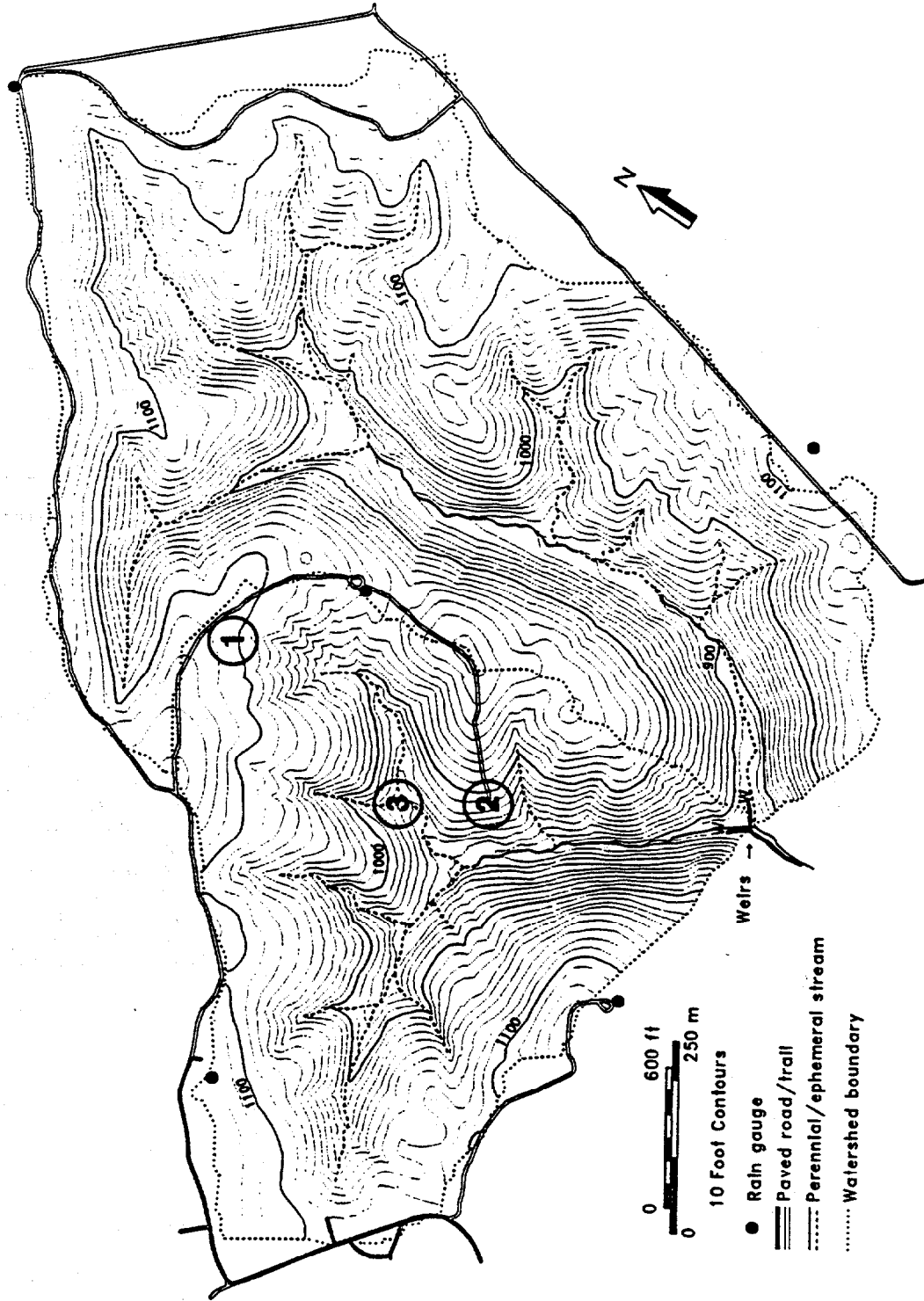


Figure 5. Location of soil coring sites on Walker Branch Watershed

SOIL CORE NO. 1

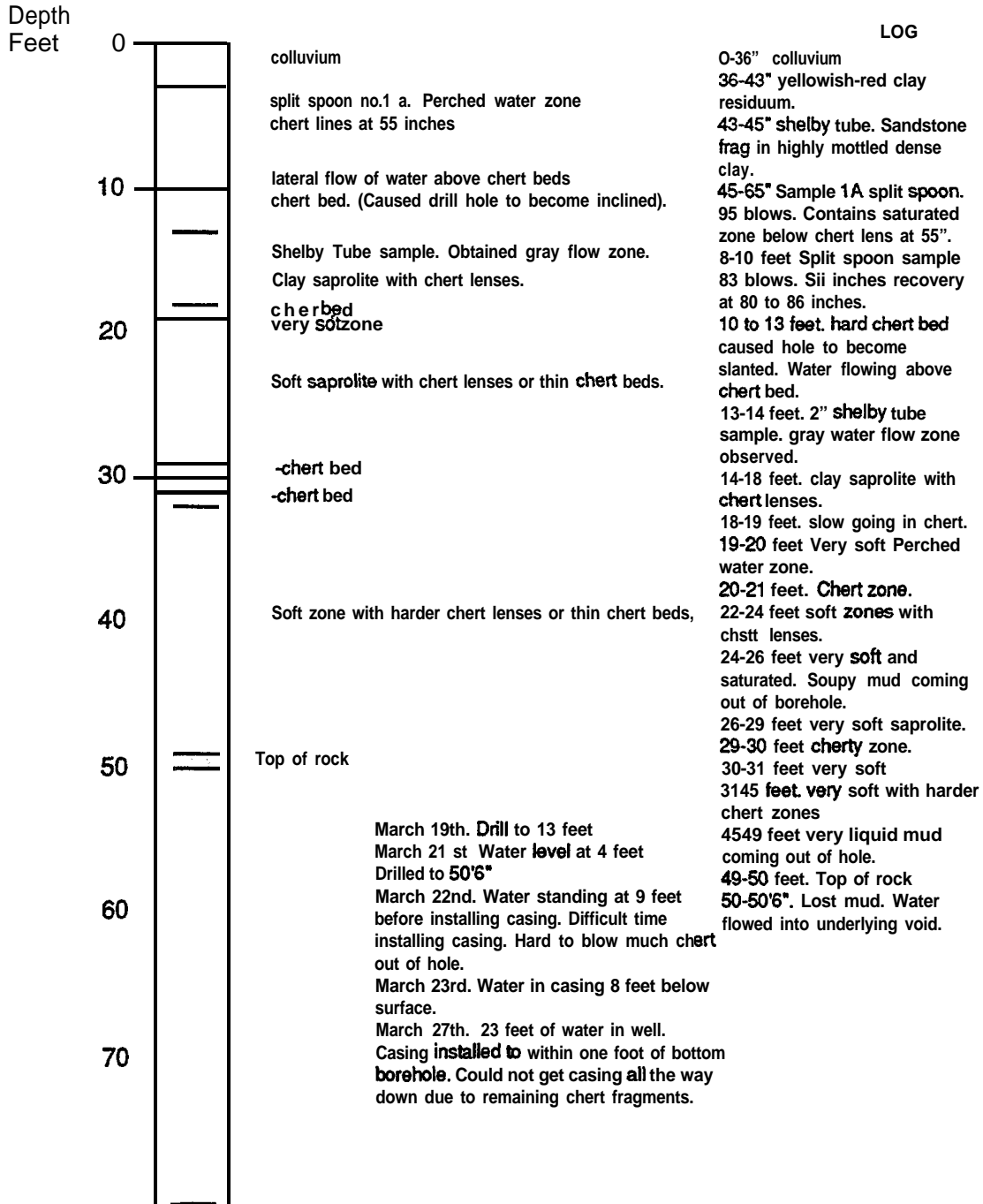


Figure 6. Soil core number 1

SOIL CORE NO. 2

ORNL-DWG 93-13666

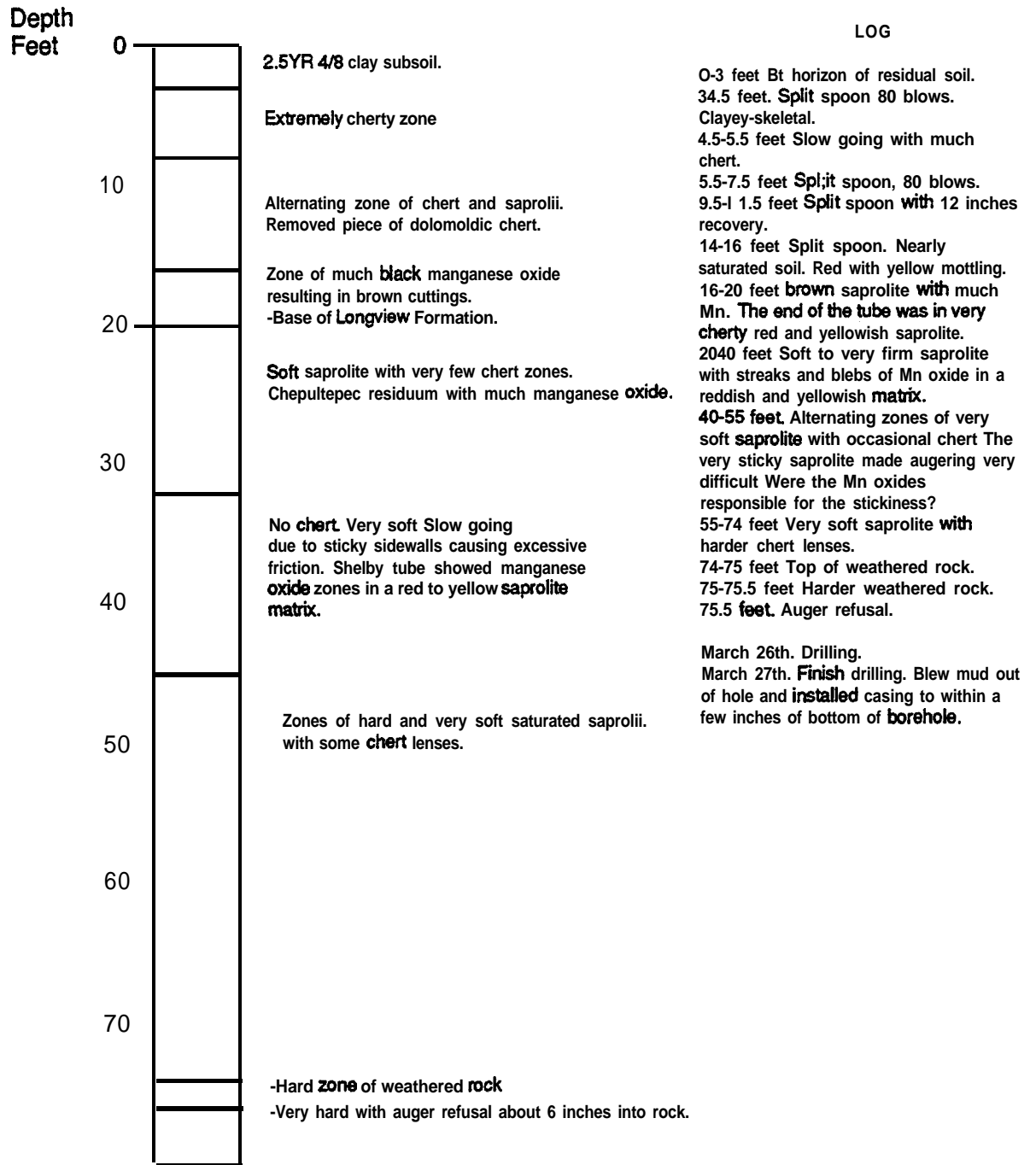


Figure 7. Soil core number 2

SOIL CORE NO. 3

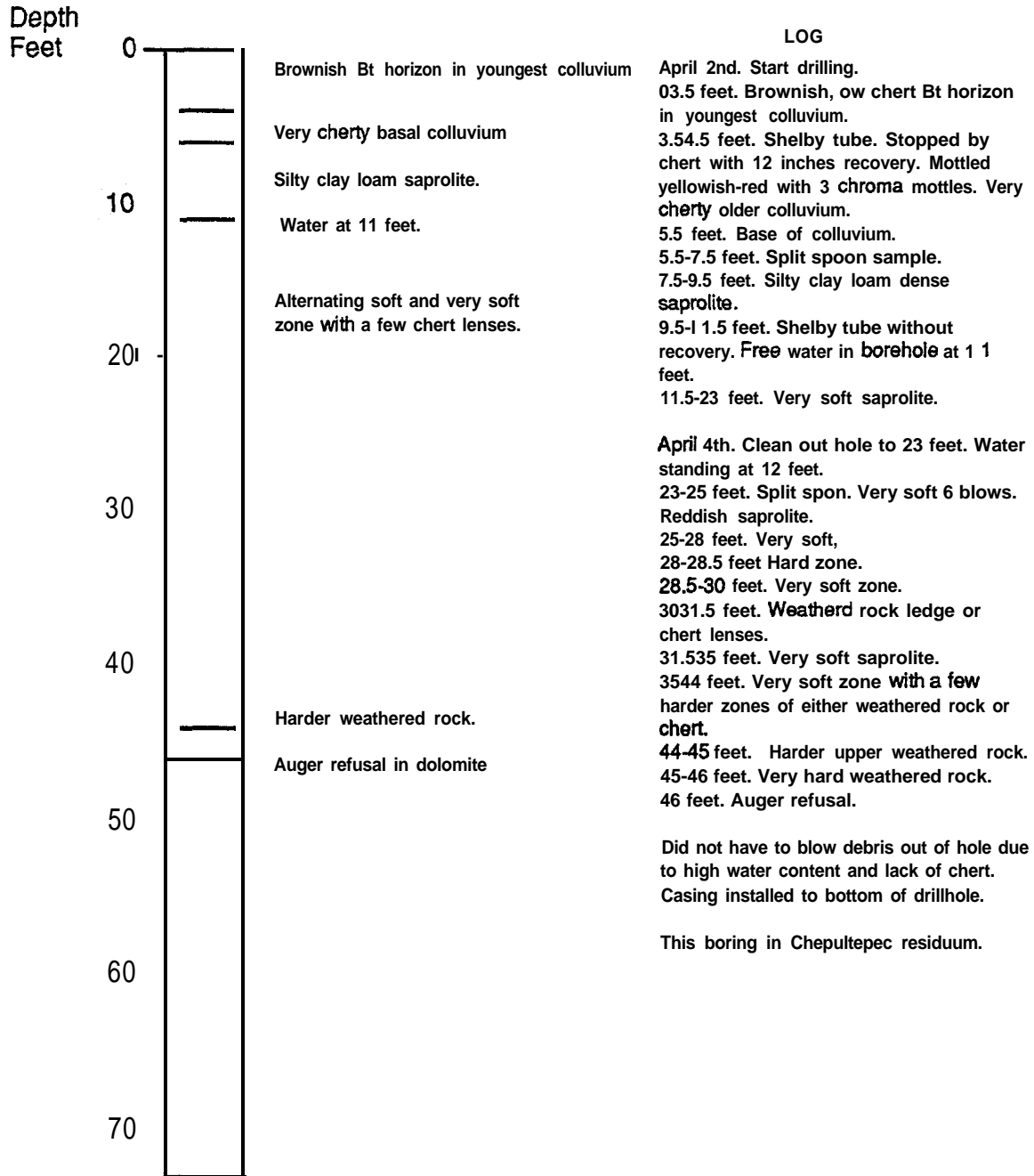


Figure 8. Soil core number 3

2.2.2 Modern Age Geomorphic Processes

The Modern Age is associated with those natural and anthropogenically accelerated geomorphic processes of hillslope erosion, sediment transport, and deposition that have been in operation for about the last 300 years. In humid environments, the dominant geomorphic processes are those of denudation (the wearing away of topographic highs) and either the filling of low areas or the transport of sediment away from the local watershed system. These processes are driven by rainfall and the force of gravity. Soil particles are detached by raindrops or overland flow and then transported downslope to a depositional site or into a stream. This natural transport process will be a slow one whenever a soil vegetative cover and a tree canopy exist above the soil surface. However, ants and other soil fauna can bring fine soil particles above the soil surface or onto or above the leaf litter layer. This fine material may be transported downslope and subsequently accumulate in unbreached **dolines**. Deforestation and primitive agricultural management practices stripped the land of vegetative cover and left bare soil exposed to the full force of raindrop impact and runoff. Agricultural fields were rapidly eroded by sheet and **rill** erosion and related transport processes. Erosion sediments from this activity have also accumulated in some unbreached **dolines** covering the high-silt-content deposits. In areas where flowing water coalesced, gullies formed and started their headwardly cutting activity into steeper landforms.

Within the WBW about half was open land, according to the 1941 U.S. Geological Survey (USGS) Topographic map of the area (Fig. 9):' **However**, there is evidence that some old fields had already reverted back to woods well before 1941. The open land was primarily on the more-gentle slopes and on easterly facing sideslopes that had soils with thick dark surface layers. Evidently, only the very steep slopes and extremely **cherty** areas in the watershed were not cultivated, but many areas were probably pastured and periodically burned. Fences were probably placed around fields to keep animals out, **but** cattle and pigs were allowed to roam at will throughout the woods. Most areas that were in agricultural land uses within the last 60 years can usually be readily identified by (1) the forest vegetation and (2) by the effects of plowing and erosion on soil morphology. Some areas of steeper land, once cultivated or pastured, were allowed to revert back to forest much earlier. Areas of hardwood forest without pines or cedars usually indicate a forest without much past disturbance, except for periodic logging activity. The soils in these areas show little past erosion. A hardwood forest that includes Virginia pines and cedars generally indicates that the land was once logged and cleared or partially cleared, probably pastured, or periodically burned before reverting to forest before takeover by the Atomic Energy Commission (AEC) in 1941-1942. The soils in these areas show some effects of past erosion, but they have been revegetated long enough that the soils are regenerating their natural forest soil morphology, including a surface litter layer and thin organic O

ORNL-DWG 93-13668

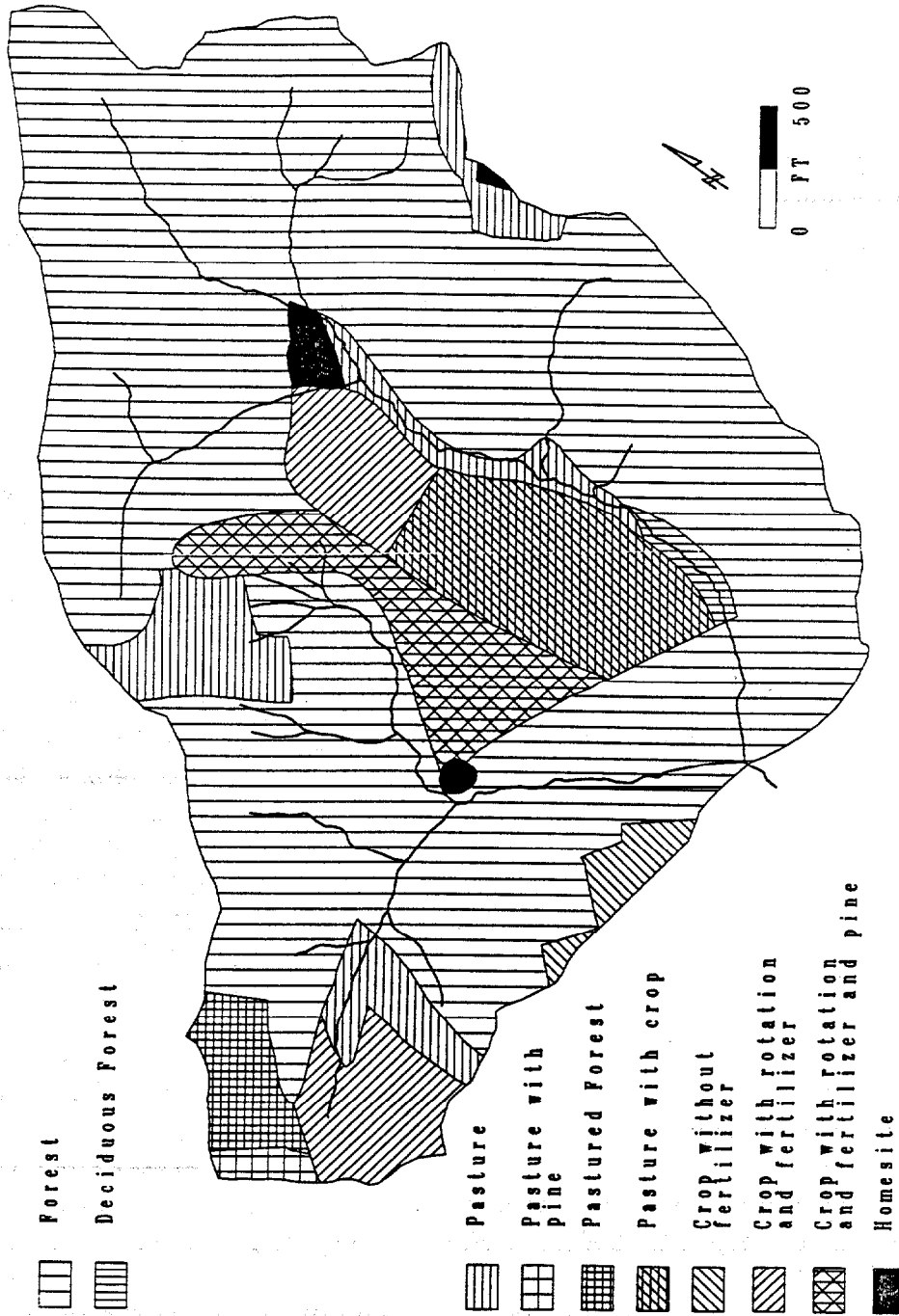


Figure 9. Pre-AEC takeover land use on Walker Branch Watershed

horizons. Indeed, new surface mineral A horizons 8 to 12 cm thick have reformed in many old fields and pastures since 1941.

Fields in the watershed that were still used for growing agricultural crops in 1941 were already or became mostly severely and very severely eroded. Erosion and crop harvests combined to remove most of the natural fertility. The abandonment of open lands after AEC took over evidently produced additional serious erosion and the formation of numerous gullies before old field succession covered the land with grass and weed vegetation and, finally, with trees. Some of these old field areas and eroded woodlands below old fields can be identified by the presence of numerous gullies that are no longer active and a forest of Virginia pine, cedars, tulip poplars, and scrub oaks, depending on remnant fertility. Past soil erosion can significantly change the hydrology of severely eroded areas. Shallow and severely eroded soils produce more overland runoff and less infiltration. **Other** evidence that Modern Age erosion has occurred is revealed in drainageways and floodplains, where 50 to 100 cm or more of Modern Age sediment (mostly topsoil derived from past agriculture and forestry land mismanagement) has covered older soils. Modern anthropogenically accelerated geomorphic processes of erosion and sedimentation have produced significant changes in some of the **surficial** soils of WBW.

The presence of both Modern and older multiaged colluvium on sideslopes and footslopes in the uplands indicates that past cycles of accelerated geologic erosion occurred during the Holocene and Pleistocene. Figure 10 shows the distribution of colluvium in WBW. Colluvium consists of soil particles and rock fragments that have been transported downslope under the influence of gravity, usually as a saturated mass, especially if the materials cover entire toeslopes. **Other** colluvium is a product of soil creep in which moist soil materials slowly move downslope. Colluvium from creep processes usually occurs on steeper slopes with less concavity and more convexity. This colluvium is generally less than 50 cm to about 125 cm thick and is termed hillside colluvium in contrast to the generally thicker colluvial deposits of footslopes. Colluvial deposits are readily identified by the lack of geologic orientation. The rock fragments in colluvium are mostly disoriented from being transported, except that larger and flatter fragments are often oriented parallel or subparallel to the slope. **Colluvium** derived from Knox residual soils has a distinctive appearance, with usually higher rock fragment content and other morphological clues that serve to identify it from either residuum or alluvium. The reworking and sorting of **toeslope** colluvium by lateral stream cutting produces a deposit that has characteristics of both colluvium and alluvium. The age of the youngest colluvium in the watershed is Modern. The largest areas of young colluvium and alluvium are identified as Modern alluvium (map symbols 981 and 982). This soil material, in which genetic soil horizons have not yet formed, covers older soils and occurs as fans at the outlets of gullies and drainageways and at the base of cultivated slopes throughout the area.

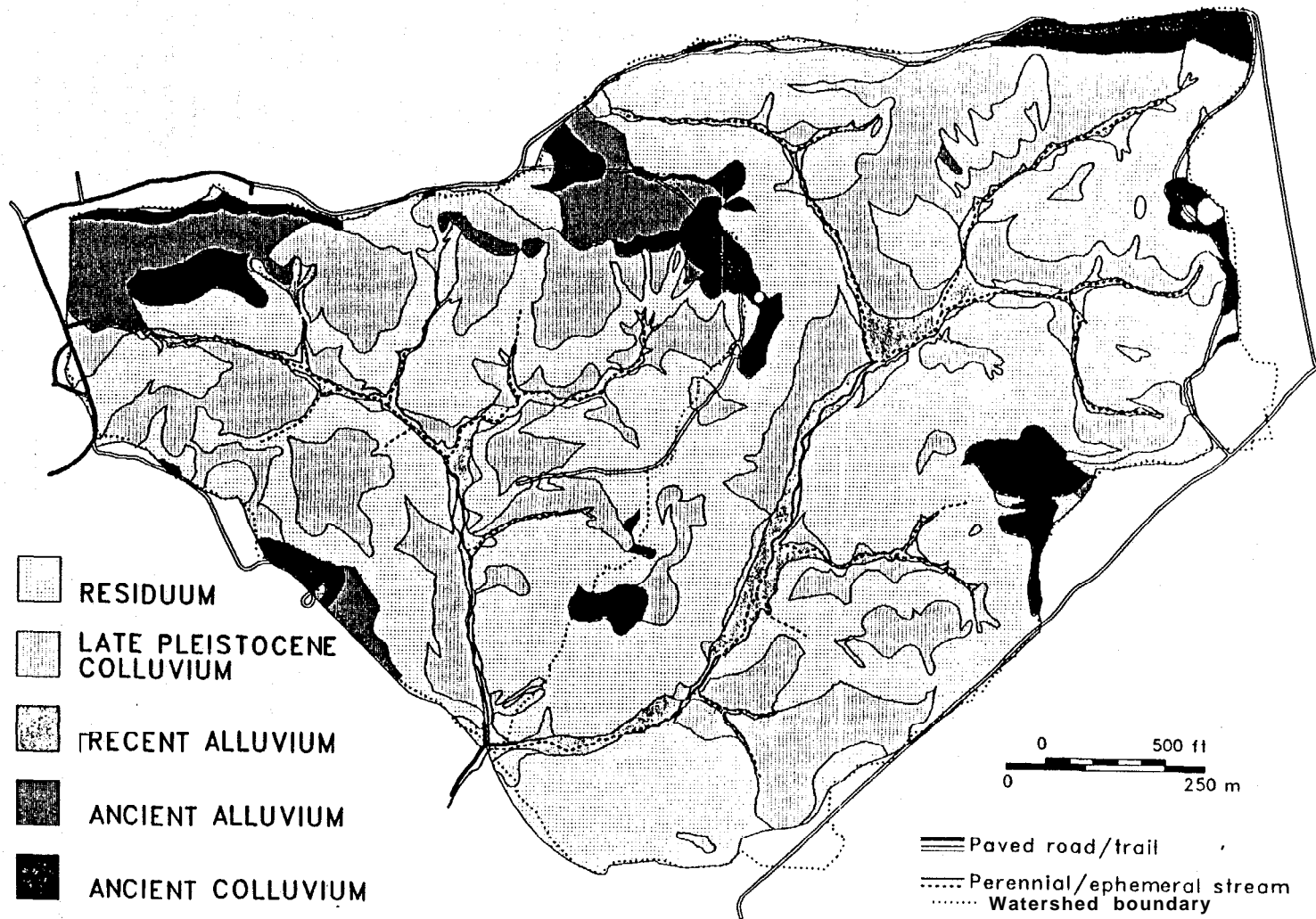


Figure 10. Distribution of Pleistocene colluvium on Walker Branch Watershed

2.2.3 Holocene Geomorphic Processes

The next significant alteration of soils and landforms took place between approximately 4000 and 2800 years ago, a period of time in the Holocene defined in this report as the Neo-glacial. Holocene-aged Neo-glacial colluvium and alluvium have not been positively identified in WBW, probably because the relatively permeable soils were not excessively destabilized by the wetter and colder conditions during this period. However, Holocene-age colluvium occurs elsewhere on the ORR on the Rome and Conasauga formations and on some formations of the Chickamauga (1) in doubly concave **landform** segments that occupy footslope and **toeslope** positions at the base of slopes, (2) as fans at the outlets of headward-eroding drainageways, (3) on sideslopes in doubly concave elongated **landform** segments, and (4) in saddles between subwatersheds. Many colluvial landforms were intensively used for agricultural activities and were severely to extremely eroded with few to many shallow to deep gullies. Holocene colluvium can overlie (1) in-place saprolite, (2) the remnants of a truncated older colluvial soil of early Holocene or Pleistocene age, or (3) the truncated remnants of residual soils.

2.2.4 Pleistocene Geomorphic Processes

The largest acreage of colluvium exposed at the surface of WBW is of late Pleistocene age (Fig. 10). Because erosional geomorphic processes were dominant on many surrounding landforms, the extent of older early Holocene and late Pleistocene colluvium (and its associated older upland residual soils) is sporadic except on the Knox Group. Otherwise, no attempt was made to identify and separate young from older Pleistocene colluvium in the watershed, primarily because of the difficulty of exposing the soil stratigraphy. Knox colluvium can be identified by (1) its lower subsoil clay content, (2) the subsoil color, which is at least one hue less red than the adjacent residual soils, and (3) the lack of a distinct genetic E horizon. **Chert** content of Knox colluvial soils is variable, ranging from about 15% to more than 35%. Colluvium was mapped on the Knox Group whenever it was more than 50 cm thick, a depth where it can be easily recognized and where it seems to have an effect on near-surface hydrology. **More** colluvium occurs on south- and west-facing slopes than on north- and east-facing slopes. Because of the more favorable physical properties of colluvium compared with residual soils, even though it usually has a higher **chert** content, colluvium was sought after and intensively cultivated. **Often**, in mapping Knox colluvium, the presence of certain tree species, characteristic of old field succession on Chestnut Ridge, was a key indicator of its presence and extent.

The climate shifts of the Pleistocene produced significant changes not only in the types of geomorphic processes that were active in the area, but in the rates and intensity of these processes. Most upland soils in the watershed underwent

several cycles of denudation during the Pleistocene epoch, generally corresponding to periods of maximum glaciation. Some areas of more geomorphically sensitive soils, especially those on steeper slopes, were periodically stripped down to hard rock or to hard saprolite, whereas other less sensitive areas were hardly affected. Some geomorphically sensitive soils are those high in silt and clay that become easily saturated with water, whereas nonsensitive soils are more permeable and do not easily become saturated. Soils on steeper slopes are also more geomorphically sensitive than soils on flatter slopes. The latest major episode of denudation occurred during the Wisconsinan, a time period of several thousand years that ended about 12,000 years ago. The longest period of unstable soil conditions occurred between 18,000 and 25,000 years ago when Wisconsinan glaciers extended to their maximum. Numerous freeze-thaw cycles, along with periods of deep winter freezing and downward melting of the surface in the spring, produced saturated conditions that destabilized many upland soils. Large volumes of soil flowed downslope as mud and debris flows, filling in topographic lows and choking stream valleys and river channels. Figure 10 shows the rather large extent of Pleistocene colluvium in WBW. Scattered remnants of older alluvium from still earlier events in the Pleistocene are preserved in stable permeable landforms at higher elevations in WBW and elsewhere on Chestnut Ridge.

Dust blowing around during phases of the Pleistocene has apparently accumulated in certain locations on Chestnut Ridge. Here, in shallow depressions, loess or silty low-chert-content hillslope sediments accumulated, burying the very **cherty** lag gravel surfaces of colluvial soils. The chert-free or nearly chert-free loess or silty sediment has, in turn, often been buried by younger Holocene- or Modern-Age silty slope wash that contains a moderate content of **chert** fragments. In one wet depression on Chestnut Ridge close to the northern WBW boundary, at least two episodes of loess deposition seem to have been preserved. Other areas where loess has been preserved occur in WBW where yellow-brown silty deposits overlay ancient alluvium.

At the cessation of Wisconsinan glaciation, climate moderation produced' upland soil stability, allowing streams to down-cut, channelize, form meanders, and to gradually remove accumulated sediments and for drainageways to renew their **headward** cutting and widening activities.

2.2.5 Early Pleistocene and Late Tertiary Geomorphic Processes

The geomorphic events and processes that took place during the Wisconsinan were simply repetitions of similar events that took place during the Illinoian and Nebraskan glacial periods of mid and early Pleistocene. Remnants of old terraces from these earlier, more extensive Pleistocene events are preserved mostly on the Chestnut Ridge and WBW in areas underlain by permeable Knox soils. Permeable

substrates and surface armouring by coarse fragments are two important requirements for the preservation of paleosols and also for topographic inversion. Figure 11 illustrates the general process of topographic inversion, and Fig. 12 shows a hypothesized topographic inversion on Chestnut Ridge. The areas of ancient alluvium and **toeslope** colluvium must represent ancient landforms that were at the low places in an **older** landscape. There are four elevations on Chestnut Ridge where ancient alluvial and colluvial soils, either buried, exhumed, or never buried, have been preserved. At elevations of 1050 to 1060 ft and extending to about 1100 ft in places on Chestnut Ridge, ancient **toeslope** colluvial and alluvial soils have been preserved on northeast and east aspects, and ancient **footslope-toeslope** colluvium has been preserved on what are now broad ridgetops. Also on Chestnut Ridge, old Pleistocene alluvial soils occur at elevations of 875 to 900 ft. The age of deposition of most of the ancient colluvial and alluvial soils is assumed to be late Tertiary to early Pleistocene. The extent of both ancient alluvium and ancient colluvium (colluvium without a present-day source) in WBW is shown in Fig. 13. The No. 991 soils are interpreted to be ancient local alluvium in that the alluvial materials contain chert fragments and abundant **mag-hemite** nodules. Of interest is the presence of a young surficial silty covering that has a yellowish brown or strong brown subsoil and a relatively high content of soil vermiculite (personal communication to D. A. Lietzke, 1990, from P. **Jardine**, ORNL, ESD). Soil vermiculite, being highly reactive, tends to indicate a relatively young deposit. Only one small area of main-channel ancient alluvium, identified by its dark red color, high clay content, and lack of chert fragments, was mapped in the watershed (map symbol No. 990). The very **cherty** remains of a **doline** having undergone topographic inversion have also been preserved in the watershed, providing additional evidence for topographic inversion. Only small areas of residual soils in the watershed (Fig. 14) were above the elevation of the ancient alluvium and colluvium, ranging from about 1140 ft at the east end of the watershed to about 1120 ft at the west side. The elevation of residuum that still occurs above this ancient alluvium drops to about 1080 ft on the West Chestnut Ridge part of the Reservation, a potential indication of the river gradient during the late Tertiary erosion cycle. Further indication that there were higher topographic areas in the vicinity when this ancient alluvium and colluvium was deposited is the lack of Knox chert to the north on the Conasauga and to the south on the Chickamauga. Pleistocene erosion processes lowered both the Conasauga and the Chickamauga relative to the Knox. Only Knox chert derived from mid- and late-Pleistocene **headward** cutting of drainageways into Chestnut Ridge, occurs in drainageways and fan terraces underlain by the **Conasauga** and Chickamauga.

TOPOGRAPHIC INVERSION

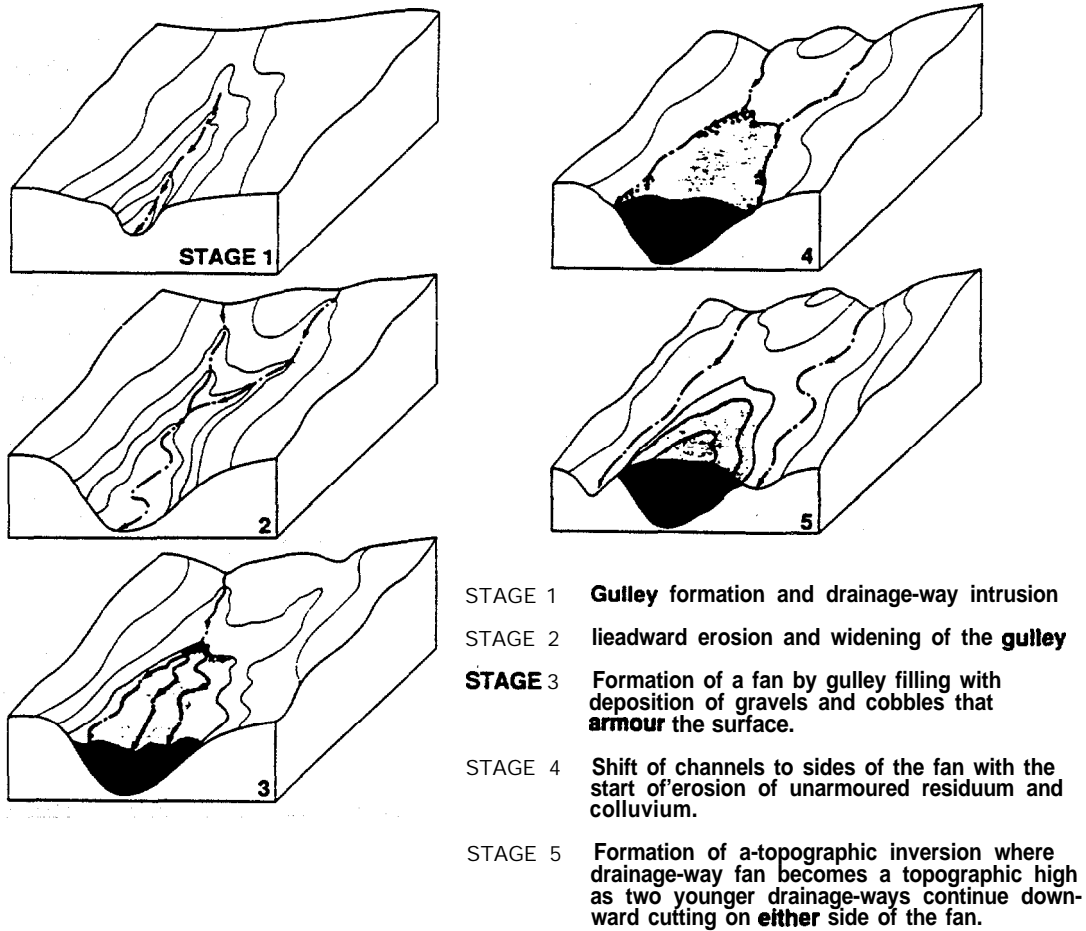


Figure 11. Topographic inversion

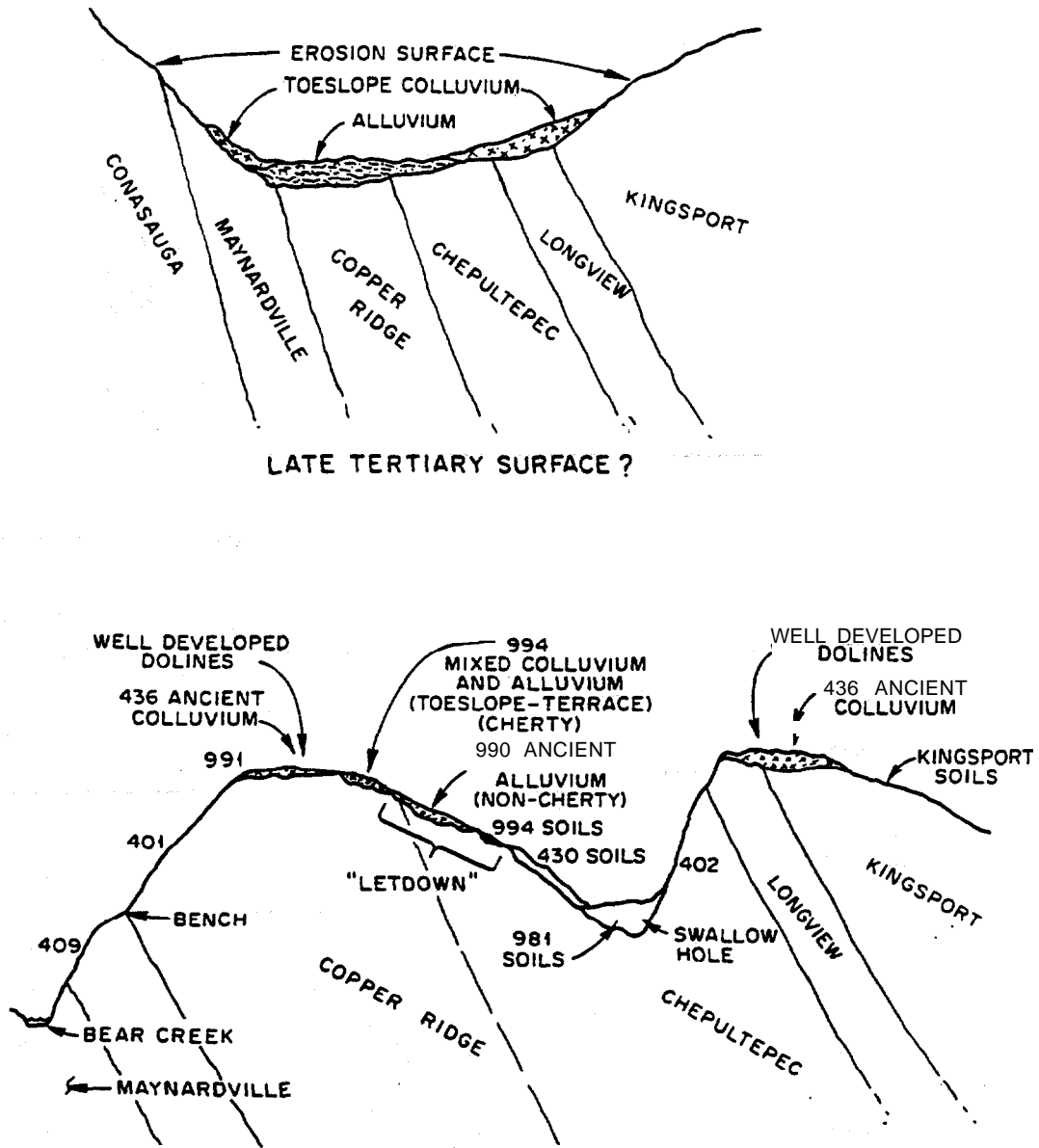


Figure 12. Topographic inversion on Chestnut Ridge

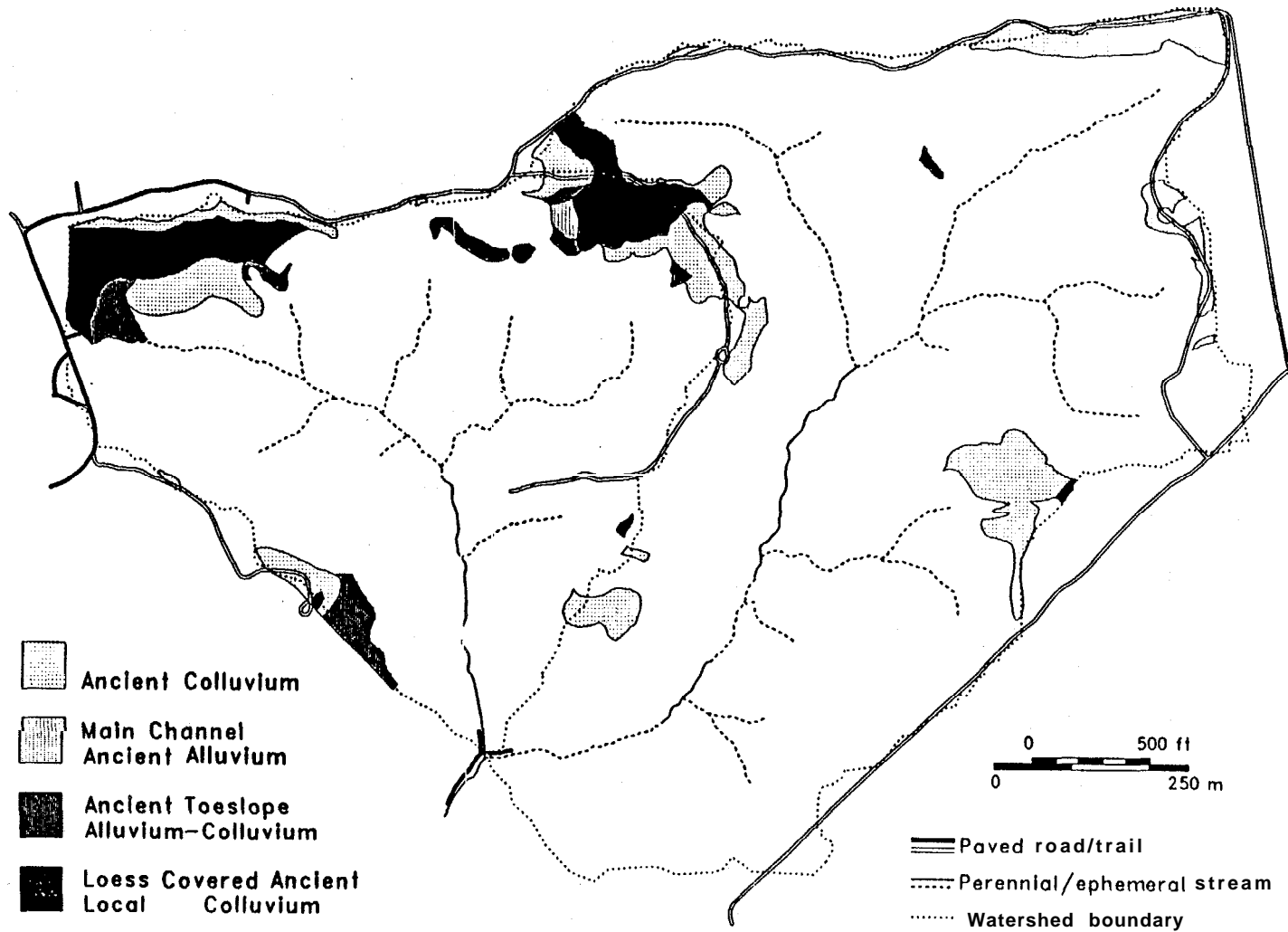


Figure 13. Location of ancient alluvium and ancient colluvium on Walker Branch Watershed

ORNL-DWG 93-13671

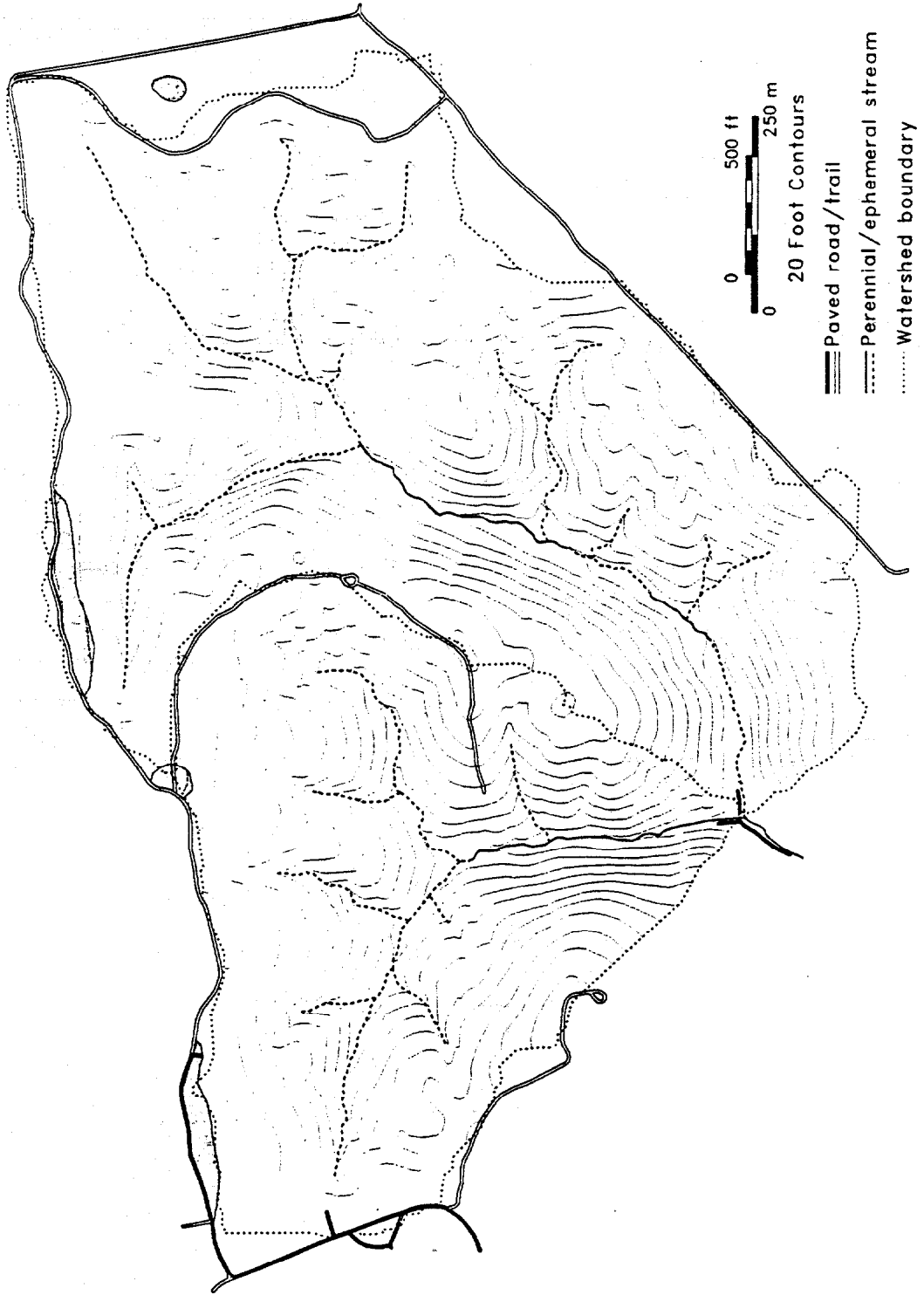


Figure 14. Residual soils that occur above ancient alluvium and ancient colluvium on Walker Branch Watershed

23 KARST GEOMORPHOLOGY

Karst geomorphic processes in WBW are dominated by the infiltration of rainfall and its generally downward movement. Overland runoff in this forested watershed tends to be a rare event and usually occurs only during catastrophic rainstorms. Water moving down through the soil becomes acidified and, as it moves into the rock beneath, dissolves calcium carbonate. Chemical weathering processes transform the rock into saprolite if there is enough structural integrity; otherwise the siliceous residue collapses. Water percolating down through soil moves in defined pathways, and when it reaches rock is further confined to cracks and joints. Water **flowing through** rock enlarges cracks into solution channels and eventually into larger caves. Only one cave opening has been observed within the watershed. The soil mantle may bridge these voids for a time, but eventually the soil collapses into the underlying void forming a distinctive surface feature often called a sinkhole; the term "**doline**" is used in this report. A **doline** is a collapse structure without an open swallow hole. Some **dolines** also form when a cave roof collapses, whereas others form gradually as a solution pipe is enlarged and soil gradually sloughs into the opening. Only a very few **dolines** observed on Chestnut Ridge have extensive rock outcrops on their steep sideslopes. Most **doline** sidewalls are mantled with a layer of colluvium, with variable thickness. Figure 15 shows the location of all **dolines**, breached or unbreached, in WBW. Particle size data from an unbreached **doline** located in the East Chestnut Ridge waste disposal site is shown in Fig. 16, illustrating the considerable variability in particle size distribution. Horizontal lines on the left side of the figure indicate observable discontinuities. Samples were collected from the sidewall representing varying thickness that were identified visually.

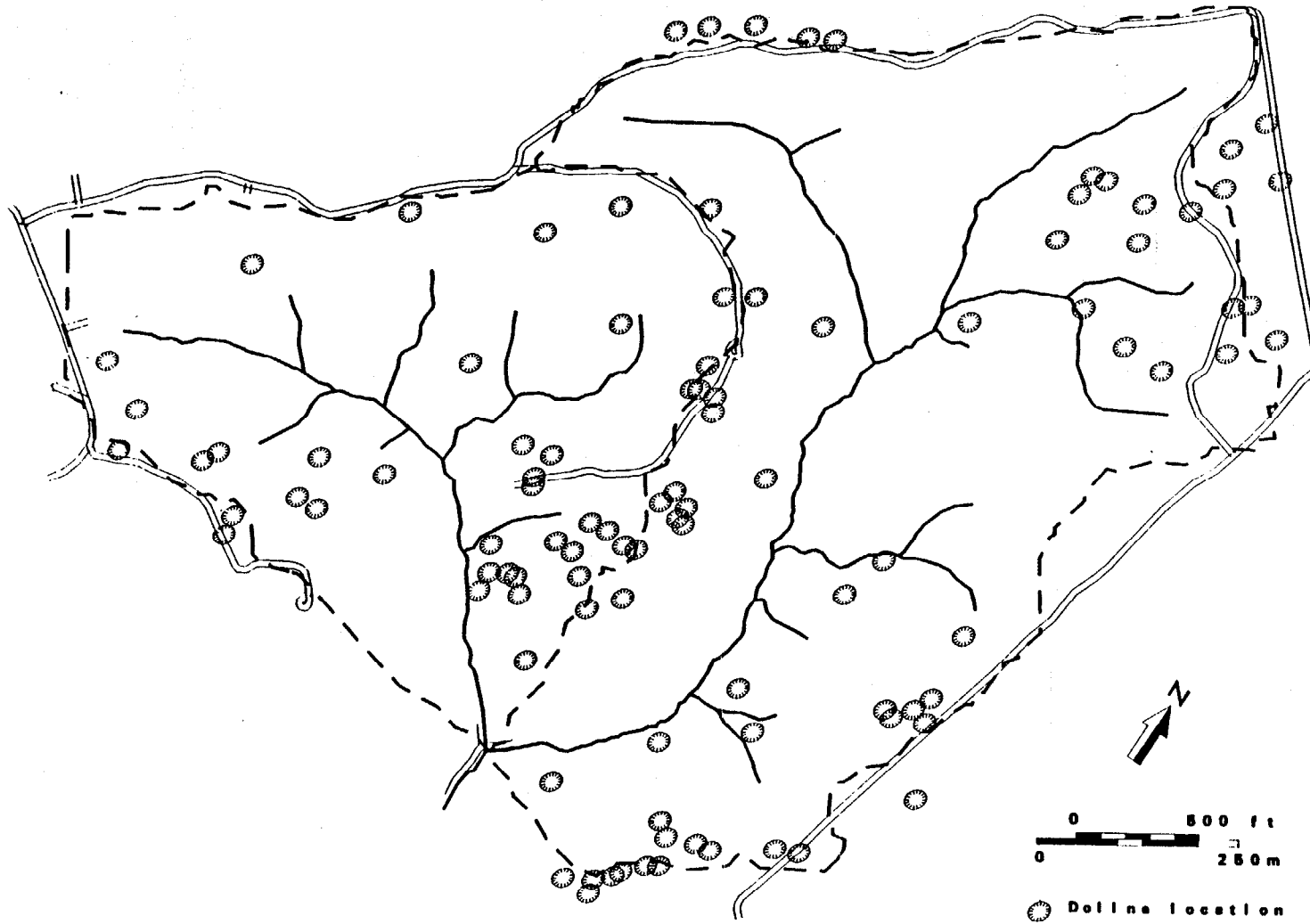


Figure 15. Location of **dolines** on Walker Branch Watershed

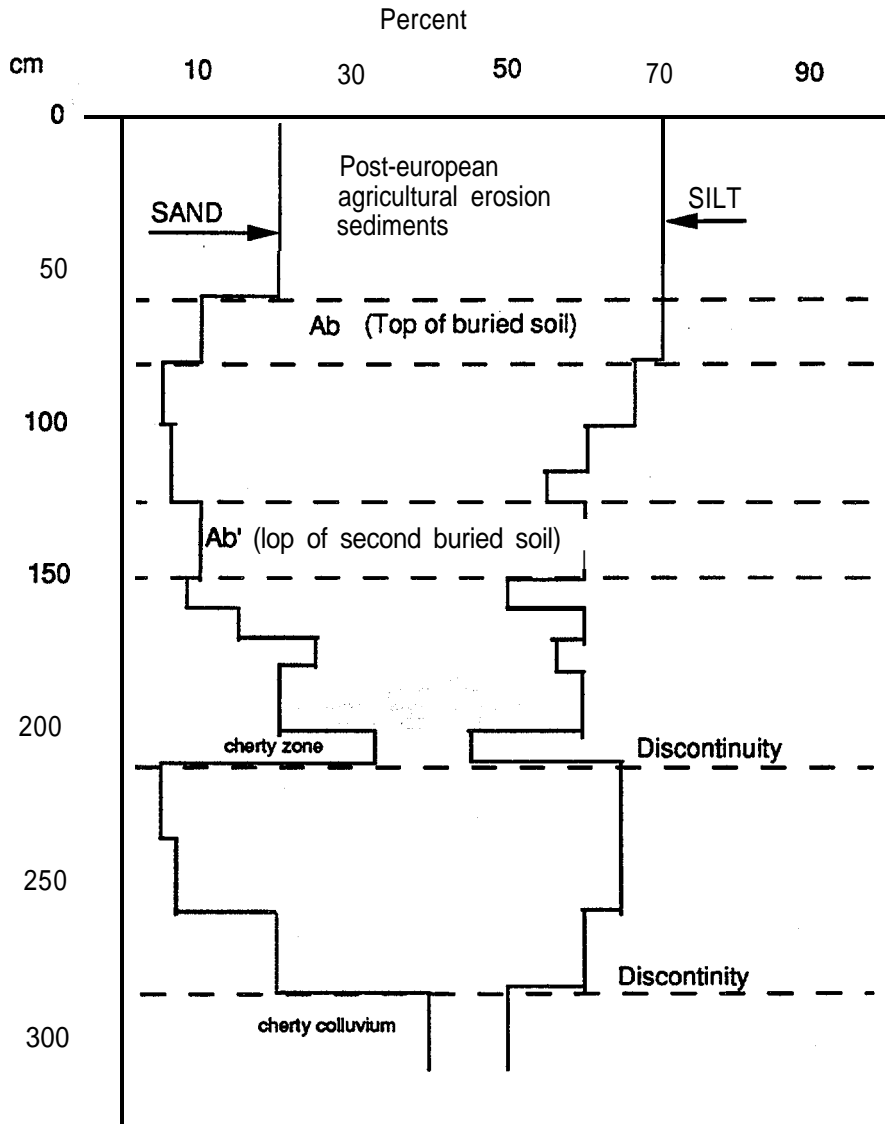


Figure 16. Silt and Sand Stratigraphy in East Chestnut Ridge Doline C.
 Data by Stan Crossover, University of Florida

3. TECHNICAL APPROACH TO SOIL MAPPING

Based on previous geologic and soil mapping in the watershed, the approximate locations of the geologic formations were known. Also, based on past mapping elsewhere on Chestnut Ridge, many morphologic characteristics of residual, colluvial, and ancient alluvial soils were also known. A basic premise in this soil mapping project was that residual soils and landforms were closely associated (Arnold 1993, Huggett 1975). Geomorphic erosional processes that shaped landforms to their current state have also affected the soil system and the basic soil-forming processes of (1) additions to the system, (2) losses from the system, (3) translocations within the system, and (4) transformations within the system (Jenny 1941, **Simonson** 1959, **Smeck** et al. 1983).

Traverses across landforms were made at closely spaced but irregular intervals, the spacing depending on the suspected or observed spatial variability. Observations of genetic soil horizons were made with a **7-cm-diam** auger. Numerous previously dug pits were also utilized. Some new pits were dug to expose soil horizons in those additional soils that were recognized and mapped. Soil horizons, horizon sequences and thicknesses, colors, soil textures, and other morphologic features were utilized in recognizing distinctive soils. Factual data were organized into conceptual taxonomic entities termed "soil series" in which each soil series was identified by the first three digits of the five-digit symbol shown within each delineation on the soils map. Each residual soil series mapped in the watershed is confined to a particular geologic formation, particular landforms, or parent materials and has a certain sequence of genetic soil horizons, which has a certain narrowly defined range in colors, textures, and other morphological features. Soil series are represented on the ground by specific bodies of soil, termed "**pedons**." A pedon represents a volume of natural or disturbed soil that possesses all of the morphologic properties utilized in defining the taxonomic concept of a soil series.

In the process of mapping, individual soils or polypedons belonging to one soil series are found to have a certain extent on the landform. A line drawn around this soil body becomes a mapping delineation, indicating that the soils within the delineation are more alike than the soils outside the delineation. Slope gradient, slope shape, and past erosion phases of a soil series are used in conceptually defining a map unit. A map unit, then, is a taxonomic concept that relates a particular soil series to particular segments of a landform. The sum total of all the delineations that are identified by a particular soil series identification, particular slope, and erosion phase comprises the physical "on the ground" representation of a particular map unit concept. Each mapping delineation, identified by five symbols, is different in some respects from all other delineations of the map unit.

4. WALKER BRANCH WATERSHED SOIL CODING LEGEND

A five digit number codes all important soil map information for easy computer sorting and manipulation of the Walker Branch Soil Survey. The first digit codes for geologic formations. The second digit codes for geomorphic information including residuum, colluvium, and alluvium by major geologic formations and Pleistocene to Modern alluvium. The third digit codes for each individual soil. The fourth digit codes for slope gradient class. The fifth digit codes for soil erosion class or other soil or **landform** properties considered important for planning or utilization. Bold print indicates which parts of the code are used in WBW.

1st-digit Codes – Geologic formations

- 0 Rome
- 1 Conasauga-Pumpkin Valley/Rutledge
- 2 **Conasauga-Rogersville/Maryville**
- 3 Conasauga-Nolichucky/Maynardville
- 4 **Knox-Copper Ridge, Chepultepec, Longview, Kingsport, Mascot**
- 5 Chickamauga (Lithic within 100 cm)
- 6 Chickamauga (Lithic > 100 cm)
- 7 Silurian/Devonian/Mississippian
- 8 Cut land, fill land, waste burial land
- 9 Alluvium

2nd-digit Codes – Geomorphic codes

- 0 **Residuum**
- 1 Rome colluvium
- 2 Conasauga colluvium
- 3 **Knox colluvium**
- 4 Chickamauga colluvium
- 5 Silurian/Devonian, Mississippian colluvium
- 6 Rome alluvium
- 7 Conasauga alluvium
- 8 **Knox/Chickamaugaalluvium**
- 9 **Pleistocenealluvium**

3rd-digit Codes – Individual soil identification numbers 0 through 9 (Soil series is explained in more detail in Sect. 4.1.)

4th-digit Codes - Slope classes

- 1 0 to 2% slopes
 - 2 2 to 5% slopes
 - 3 5 to 12% slopes
 - 4 12 to 25% slopes
 - 5 25 to 45% slopes
 - 6 >45% slopes
-

5th-digit Codes - Erosion classes from past land use and other codes for disturbed lands

- 1 none to slightly accelerated erosion
 - 2 moderately accelerated erosion
 - 3 severely accelerated erosion
 - 4 very severely erosion with common to many gullies
 - 5 Not assigned in WBW
 - 6 Not assigned in WBW
 - 7 Not assigned in WBW
 - 8 Not assigned in WBW
-

EXAMPLE OF SOIL MAP CODE

- 40043 **4**--- is the geologic formation code
 -**0**--- is the geomorphic code
400-- is the soil series code
 ---**4**- is the slope code
 ---3 is the erosion code
-

4.1 SOIL IDENTIFICATION LEGEND

The soil series in this section are organized with respect to geologic and geomorphic criteria. Each soil series is identified by a three-digit number, which consists of the first three digits of the five-digit mapping unit number. Most soil series identified in the WBW do not have an analog name. However, some soil series identified in WBW are very similar to named Soil Conservation Service soil series; these designations have been included in parenthesis.

KNOX GROUPCopper Ridge Residuum

- 400 Typic Paleudults; clayey, kaolinitic, thermic. (Cherty and noncherty Fullerton with degraded upper Bt.)
- 401 Typic or **Humic** Paleudults; clayey, kaolinitic, thermic. (Occurs only on east and north aspects and has thicker and darker surface layer.)

Chepultepec Residuum

- 402 Typic Paleudults; clayey, kaolinitic, thermic. (Dunmore, **cherty** and noncherty with **7.5YR** or **5YR** upper Bt horizon.)
- 408 Typic Paleudults; loamy-skeletal, siliceous, thermic. (Bodine-like series. Chert beds.)

Lonaview Residuum

- 403 Typic Paleudults; clayey or clayey-skeletal, kaolinitic, thermic. (Clayey-skeletal Fullerton Variant with **2.5YR** upper Bt and highly mottles lower subsoil.)

Kinasoort Residuum

- 406 Typic Paleudults; clayey, kaolinitic, thermic. (Fullerton)
- 407 Hapludults-Hapludalfs-Rock Outcrop Complex; clayey, mixed, thermic.

Mascot Residuum

- 404 Typic Hapludults; clayey, mixed, thermic. (Fullerton)
- 405 Hapludalfs-Hapludults-rock outcrop complex; fine, mixed, thermic.

Knox Group Colluvium

- 430 **Fragic Paleudults**; fine-loamy or loamy-skeletal, siliceous, thermic. (Shack and Tassos series.)
- 431 Fluventic Dystrochrepts; fine-loamy, siliceous, thermic. (Modern slope wash from old agricultural fields and bottoms of some **dolines**. Greendale series.)
- 433 Typic Paleudults (**humic**); fine-loamy or loamy skeletal, siliceous, thermic. (Toeslope colluvium from A and E horizons of **upslope** soils, without a red argillic horizon. Has a brown argillic horizon.) (Pace series)
- 434 Typic Paleudults; fine-loamy. siliceous, thermic. (Minvale series)

ANCIENT COLLUVIUM

436 Typic Paleudults; loamy-skeletal, siliceous, thermic.

Doline Sediments

437 Typic or Glossic Fragiudults; fine-silty/loamy-skeletal, siliceous, thermic. (Loess over old colluvium on uplands or in depressions.) (Tarklin-like.)

438 Typic and Aquic Hapludults; fine-silty; siliceous, thermic. (Silt capping over colluvium in depressions.)

439 Typic and **Aeric** Ochraquults; fine-silty, siliceous, thermic. (Silt capping over **cherty** colluvium in depressions.)

ANCIENT ALLUVIUM

990 Rhodic Paleudults; clayey, oxidic, thermic. (Decatur Soil Series.)

991 Typic Paleudults; fine-silty, siliceous, thermic (Loess over ancient local alluvium over Knox residuum. Has profile with at least two argillic horizons.)

994 Typic Paleudults; fine-loamy, siliceous, thermic. (Ancient alluvium mixed with **chert**. Mapped over Knox Dolostones.) (Waynesboro-like without loess capping.)

HOLOCENE ALLUVIUM

999 Typic Hapludults; fine-loamy, siliceous, thermic. (Sequatchie-Variant.)

MODERN ALLUVIUMKnox Oriain

980 Udifluvents-Hapludults-Fragiudults complex; fine-loamy/loamy-skeletal, siliceous, thermic, acid.

981 Typic and Aquic Udifluvents; loamy-skeletal, siliceous, thermic.

982 Typic and **Aeric** Fluvaquents; loamy-skeletal, siliceous, thermic.

4.2 DESCRIPTIONS OF KNOX GROUP SOILS AND LANDFORMS

Soils that formed in Knox Group residuum and are on slopes up to 25% seem to have thick enough, clay-enriched, subsoil Bt argillic horizons and solum thicknesses to classify as Paleudults. Knox Group residual soils on slopes exceeding 25% are mostly Hapludults, based on observations in trenches, even though laboratory data does not show much decrease in clay content, a consequence of clay translocation into porous saprolite. The presence of saprolite-yellow colors (a different shade of yellow than drainage yellow mottles) and loss of most pedogenic soil structure within a depth of 1.5 m would indicate that the argillic horizon terminates before the depth required for **Paleudults**, even though transitional BC and **CB** horizons **beneath** may be quite thick and extend for many centimeters deeper. The WBW area encompasses all formations of the Knox Group. The **Longview** formation, situated between the **Chepultepec** and **Kingsport** formations, is not very thick; but it contributes large blocks of chert in some areas that mantle the surface. In addition, numerous quantities of **smaller-sized Longview** chert have been let down as "lag" onto the uppermost **Chepultepec** and lowermost **Kingsport**. Often, the **Longview** can be identified by chert ledges, which are most often exposed on the east side of drainageways. Some of the chert from the **Longview** also has a distinctive appearance—the presence of dolomolds. Dolomolds are cavities in the chert that were once occupied by calcite or **dolomite rhombs**. In the current geomorphic erosion cycle, the **Longview** formation occupies **ridgetop** positions. However, where, ridgetops in WBW underlain by the **Copper Ridge, Chepultepec, and Longview** are broad enough, the surface is often mantled with a thin layer of ancient colluvium. This indicates that in a previous erosion cycle, what are now ridgetops were situated in toeslope-drainageway landforms similar to the present-day **toeslope** landforms, where very **cherty** colluvium is now accumulating. Topographic inversion occurred because the very high chert content of both the residuum and overlying colluvium preserved the soils beneath, while the **adjoining less-cherty residual soils**, lacking any armouring, underwent faster rates of denudation..

A combination of morphologic features were utilized in the identification of soils that formed in the **Copper Ridge, Chepultepec, Kingsport, and Mascot** formations in WBW. These features, including the residual chert, are derived from the inert residue that remains after the carbonates have been stripped from the **underlying bedrock**. It must be pointed out that the carbonate, **bedrock** features that geologists use to make **distinctions** between the members of the **Knox Group** are not necessarily the same as the soil and saprolite features that are utilized by pedologists. Indeed, as the carbonate content of a rock increases, the similarity between bedrock and the inert residue decreases. Increasing age and intensive chemical and mineral weathering also tend to result in the formation of similar soils from fairly diverse but related soil parent materials such as the rocks of the **Knox Group**.

Soil map units in this section are described by soil series in increasing numerical order.

4.2.1 Knox Group Residual Soils

40031, 40033, **40041**, 40043, 40044, 40053. These soils formed in residuum of the Copper Ridge formation. The residuum has high silt plus high-clay content and highly variable chert content. Soils of this unit are on doubly convex landforms. The A and E horizons are very cherty to extremely cherty due to lag chert remaining behind as fines are washed downslope by overland flow. The Bt horizons beneath vary in chert content from about 5 to 30%. Some included soils that are more than 35% chert in the subsoil, and others are almost chert-free. The chert is commonly massive, but both **oolitic** and chalky types are present. The upper part of the subsoil has a uniform red (**2.5YR**) color and is free of yellow mottles. In some areas, the lower subsoil becomes increasingly mottled in shades of dull yellow because of decreased permeability. Decreased permeability in the lower subsoil can result in the temporary perching of water, which is accompanied by gray colors in reduced water flow zones. Even in well-drained permeable soils, the lower subsoil and the underlying saprolitic materials will have increasing amounts of yellowish color. This particular yellowish color represents saprolite or saprolitic materials that are oxidized and highly leached. Saprolite colors are dominated by yellows and reds, but the red colors are different from the red colors of the upper subsoil. Translocated or neo-formed yellowish red to red clay coats voids and fracture faces in the upper saprolite. Depth to rock is generally deep, probably more than 50 ft, and is highly variable. Some drill holes on Chestnut Ridge have penetrated more than 100 ft of saprolite before encountering rock. However, because of Karst geomorphic processes in an acidic humid environment and the way carbonate rock weathers, pinnacles and ledges, either attached or detached, are a common feature of the underlying extremely variable rock topography, and their location is not predictable. Surface depressions, called **dolines**, are a common surface expression of underground collapse of caverns and solution channels. Some areas of Chestnut Ridge and WBW have higher concentration of **dolines** than other areas. Most large **dolines** occur on **crestal** landforms or at relatively high elevations with respect to the ridgetop; this is evidence of their relatively great geomorphic age and stability. Most depressions in the higher-elevation uplands appear to be stable and do not exhibit evidence of recent subsidence activity. One or more layers of silt have been deposited in many broad shallow **dolines**. Most **dolines** with active swallow holes and cave entrances seem to be situated on lower sideslopes where water flow is concentrated or close to present drainageways. Only a few cave entrances or swallow holes were noted in WBW, and they were at low elevations in the watershed.

Because of the high chert content in the upper 40 to 80 **cm** of the soil, most areas of these No. 400 soils were not cleared and cultivated. They were apparently

periodically logged, and there was some woodland pasturing. Current forest vegetation ranges from stands dominated by chestnut oak to stands dominated by white and red oak. However, based on observations further east along Chestnut Ridge, better forest stands of white oak, red oak, and tulip poplar tend to be underlain by either pinnacles, ledges, or bedrock that are closer to the surface where long-lived tree roots can encounter them and cycle calcium to the surface. Forest that is dominated by chestnut oak with a vaccinium ground cover is generally over areas of colluvium or residuum much deeper to rock, or in areas where there are few if any pinnacles and tree roots do not encounter rock, or in areas that were badly eroded in the past with loss of most surface soil fertility. Forest stands on Chestnut Ridge are still in the process of adjusting from the demise of chestnut trees, which dominated the canopy at one time. Past land-use practices of partial clearing, pasturing, and burning increased overland **flow** and the removal of nutrient-rich O and A horizons. Based on numerous observations elsewhere on Chestnut Ridge, regrowth of trees on these eroded areas seems to follow different successional pathways than on other areas not as disturbed. Indeed, certain tree species (among other indicators) were used to indicate the presence of old fields in WBW.

Some areas of these soils that were severely to very severely eroded from past agricultural activities are identified by the presence of the digits "3" or "4" in the fifth place of the identification symbol. Eroded areas have lost most of their original A and E horizons, with the newly formed Al and older Ap horizon resting directly on the clayey subsoil beneath. Eroded soils become-saturated in the uppermost horizons very quickly. Consequently, they tend to generate overland flow more quickly than do adjacent uneroded soils. Rainwater infiltrates rapidly and moves downward to the top of the clayey subsoil. Here, water tends to perch and then move either downward under hydraulic head as saturated flow in macropores or laterally downslope in the lower portion of the E horizon. During heavy rains, the E horizons of these soils usually saturate, and during late winter, they are often saturated for extended periods.

The soils in these map units classify as Typic Paleudults; **clayey, kaolinitic**, thermic.

40151. These soils formed in surficial creep materials and the underlying residuum of the Copper Ridge formation. They occur in protected, shaded, and cool northeast and east aspects on the north side of Chestnut Ridge and on steep, shaded slopes of larger drainageways. They have a thicker and darker A horizon and a darker and less distinct E horizon beneath than the **adjacent** No. 400 soils, which occur on southerly and westerly aspects. Most areas of these soils also occur on obsequent **scarp** slopes where the rock dips into the slope, resulting in greater retention of subsurface water flow. Rock outcrops occur with a higher frequency in areas of these soils elsewhere on Chestnut Ridge, but none was observed in the watershed. The higher nutrient content in the thicker and darker A horizons of the No. 401 soils compared with the No. **400** soils is also

reflected in the forest vegetation composition, including canopy trees and the forest floor vegetation. Especially noticeable is the presence of sugar maple saplings on other parts of Chestnut Ridge that are growing thickly in areas that were partially logged about 10 to 15 years ago.

The soils in this map unit classify as Typic or **Humic Paleudults**; clayey, kaolinitic, thermic.

40221, 40222, 40231, 40241, 40242, 40243, 40251, 40253, 40261. The soils of these map units formed in saprolite weathered from dolomite of the **Cheputtepec** formation. These soils are on low, upland summits and convex sideslopes in relationship to the higher Copper Ridge and **Longview** landforms. Depth to hard carbonate rock tends to be deeper beneath these soils than for any of the other formations of the Knox Group. Mapping units differ primarily by slope and past erosion classes. Because some areas of these **soils** had lower surface chert content, they were farmed in the past. The A and E horizons of these soils have higher chert content than subsoil horizons because of the lag gravel effect. Lag gravel consists of inert materials that have been “let-down” on the current land surface by the removal of silt and clay-sized particles, an effect of past geologic erosion.

The uppermost Bt horizon in uneroded soils has a **10YR** or **7.5YR** hue and a clay loam texture, but the lower clayey horizons become redder in **5YR** and **2.5YR** hues, and the amount of bright yellow colors from saprolite increases with depth. Subsoil chert content is highly variable, ranging from less than 5% to more than 35% by volume, and its occurrence is not predictable. Eroded phases have lost most of their original A and E horizons and have an old plow layer (Ap) horizon in which a new Al horizon is forming.

Rainwater infiltrates rapidly and moves downward to the top of the clayey subsoil. Here, water tends to perch and then move either downward under hydraulic head as saturated flow in macropores or laterally downslope in the lower portion of the E horizon. During heavy rains, the E horizons of these soils usually saturate, and during late winter, they are often saturated for extended periods.

The soils in these map units classify as Typic Paleudults; clayey; kaolinitic, thermic.

40321, 40331, 40341, 40351, 40361. The soils in these map units formed in a thin layer of surficial creep or ancient colluvium and the very **cherty** underlying saprolite that weathered from the **Longview** formation. Soils in these units occur only on narrow ridgetops and summit shoulders. The surficial soils of the **Longview** formation occupy a strip 15 m to about 20 m wide. They could not be **mapped at a scale of 1:12,000** without distortion, but they can generally be **mapped at a scale of 1:1200 to 1:2400**. Blocks of dolomoldic chert on the surface

tend to help identify the presence of the **Longview** formation. However, other chert from the Kingsport formation has in places also been let down onto the **Longview** and does not have dolomolds. Dolomoldic chert from the **Longview** has also been let down onto Chepultepec and Kingsport soils downslope. However, dolomoldic chert in substratum saprolite usually confirms that the soil formed in **Longview** residuum. Most areas of these soils were never cleared and farmed because of the high chert content on the surface and within the soil. These soils have a very thick, very cherty to extremely cherty E horizon that extends to a **depth** of 60 to **80** cm. Depth to the red (**2.5YR** hue) clayey Bt horizon is commonly 75 to 90 cm. The colluvium that is derived from the **Longview** soils has a very high chert content throughout, and the footslope colluvial soils below are loamy-skeletal, with more than 35% chert by volume throughout the soil.

These soils have limited extent but their location and extent can be important for some land uses where high surface chert content and subsoil chert content is a limiting consideration. Because of the high chert content, **Longview** soils have low water-storage capacity. Trees tend to be subjected to several drought-stress cycles during the summer. Consequently, only trees and ground cover that tolerate drought stress will grow well on these soils.

The soils in these map units classify as Typic Paleudults; clayey-skeletal, kaolinitic, thermic.

40431, 40432, 40433, 40441, 40442, 40443, 40451, 50453. The soils in these map units formed in residuum weathered from the **Mascot formation**. These soils have a more-intense red upper subsoil than the adjacent No. 406 Kingsport soils. In addition, the subsoil has a much more plastic consistency. The presence of sandstone fragments and chert matrix sandstones on the surface and in the residuum serve as additional indicators. Because of the sandstone fragments, these soils often have a higher sand content in the surface; with **loam or** fine-sandy loam rather than silt loam textures. These soils do not have any exposed rock outcrops, but carbonate rock is evidently close enough to the surface that lime-loving trees such as redbud tend to grow well on these soils. Because these soils evidently had higher natural fertility, they were more intensively farmed during the past, and many areas were severely eroded before abandonment.

Because of the closeness of bedrock to the surface, these soils have slightly higher base cation status and higher cation exchange capacity because the clay minerals are less weathered. Tree roots are apparently able to tap into the weathering front at the rock-saprolite interface and cycle calcium to the surface. As a result, tree growth and species diversity of both the overstory and ground cover appears to be higher in WBW. Depending on depth to rock, the soils in these map units classify as **Typic Hapludalfs, Ultic Hapludalfs** or **Typic Halpudults**; fine, mixed, thermic.

40531, **40541**, **40551**, 40561. Within these map units are few to many areas of ledges and pinnacle outcroppings of rock. The soils in these map units formed in saprolite weathered from the uppermost Mascot formation. They are adjacent to the Unit A soils of the Chickamauga Group, which are close to but not included along the southern side of the watershed. The type of chert in the Mascot (**jasperoid** and chalcedonic) helps to identify these soils and was used to separate them from the **Kingsport** No. 406 soils which contain soft chalky chert to the north and the Unit A Chickamauga soils to the south which contain blocky brick-shaped tabular chert.

The presence of pinnacles and ledges, especially noticeable on steeper slopes, is a common surficial feature of the landscape. Karst depressions are also a common landscape feature. **The** soils have a cherty or very cherty lag gravel surface and upper subsoil and a highly variable chert content in the lower subsoil. Depth to rock is also highly variable.

Because of variable depth to rock and numerous karst features, these soils and their landscapes should be managed for forest and wildlife purposes. They are not suited for other more-intensive uses. The soils in these map units occur as a complex. Some soils classify as Typic Hapludults; clayey, mixed, thermic. Some soils classify as **Ultic** Hapludalfs; fine, mixed thermic, and some are Typic Hapludalfs; fine, mixed, thermic.

40621, 40622, 40631, 40632, 40633, 40641, 40643, 40651, 40653, 40661. These soils formed in saprolite weathered from the Kingsport formation. They have a variable subsoil chert content, which approaches 15% by volume. Subsoil chert in the lower part of the formation is quite soft and chalky, appearing to be highly weathered and serving as an indicator for these soils and their separation from the adjacent **Longview** soils. The Bt horizon is red (**2.5YR** hue) in the upper part and does not exhibit much evidence of pedogenic degradation. Eroded phases of these soils have lost most of their original A and E horizons. These particular eroded soils have an old plow layer in which a new A horizon is forming. In the most eroded areas, clayey subsoil is just below the surface horizon. The lower subsoil stays redder with depth than most other Knox Group soils. Most soils underlain by the Kingsport are deep to rock and have few if any outcrops. Areas with ledges and rock outcrops were mapped as Soil No. 407. The soils in these map units classify as Typic Paleudults; clayey, kaolinitic, thermic.

40751. The soils in this map unit formed in saprolitic residuum of the Kingsport formation. Outcrops of dolomite are a common surface feature. The upper soil horizons have a very high lag chert content. Chert content is also relatively high throughout the lower subsoil. Because the slopes on which these soils are found are quite steep, they have relatively thin **soils**. Clay-plugged saprolitic soil occurs at a depth less than 100 cm. Depth to rock is also highly variable. Because of variable depth to rock and numerous karst features, these

soils and their landscapes should be managed for forest and wildlife purposes. They are not suited for other more intensive uses. In these soils rainfall probably reaches rock quite quickly. One cave opening occurs in this map unit. The soils in these map units occur as complexes. Some soils classify as Typic Hapludults; clayey, mixed, thermic. Some are Ultic Hapludalfs; fine, mixed thermic; and some are Typic Hapludalfs; fine, mixed, thermic.

40851, 40861. The soils in these map units formed in thick residual chert beds of the Chepultepec formation and have been mapped only in' WBW on south-facing dip slopes. The upper soil horizons have a very high chert content. **The** subsoil has a high content of **sharp-edged** chert, 'and 'chert content' increases **with** increasing depth. Chert beds in the Chepultepec formation have a limited distribution and have been mapped only in a small area of WBW. Because of their high chert content and steep slopes, these soils were never farmed, but were probably logged one or more times. Trees growing on these soils are probably tolerant of low fertility and drought conditions. The soils in this map unit classify as Typic Paleudutts; loamy-skeletal, kaolinitic, thermic.

42.2 Knox **Colluvial** Soils

Most Knox colluvium has a rather high chert content, ranging from about 15% to more than 50% by volume. Colluvium is generated by several processes. One process occurs whenever the upper part of upland residual soils becomes saturated with a consequent loss in stability. The saturated mass flows downslope as a mud and covers the slope below. Another process is colluvium generated by bioturbation. Trees are overthrown, and the upturned roots bring soil above the surface. As the roots decay, soil is let-down the slope a few meters. This process produces a particular kind of microrelief that is commonly called "cradle-knoll" or "pit and mound." The colluvium generated by this particular process has a sporadic distribution on the landscape and accounts for the sporadic distribution of colluvial pockets in larger areas of residual upland soils. Another geomorphic process that generates colluvium is creep. Creep is a very slow process in which soil material is very slowly transported downslope under the primary influence of gravity. Creep processes also slowly move windthrow soil mounds downslope. it is difficult to distinguish creep materials from bioturbated materials (soil disturbed by the growth of roots). However, creep processes are more active on steeper slopes and the local colluvium has a more general and more uniform distribution over the hillslope in contrast to colluvium produced by bioturbation.

Knox colluvial soils were identified and separated in mapping according to several criteria including (1) soil morphology and chert content, (2) landscape setting, (3) age, and (4) minimum thickness. Colluvial soils were mapped only when the colluvium was more than 50 cm thick, a thickness that appears to affect near-surface lateral water-flow pathways. Colluvial soils were also separated,

depending on the presence or absence of fragic subsoil properties, often identified by pale brown mottles, brittleness, compactness, and direct evidence of its ability to perch water. Fragipans, or subsoil layers with fragic properties that perch water, occur only in some colluvial soils. Colluvial soils with fragipans occur on low toeslopes in the watershed but have a sporadic distribution that cannot be mapped at a scale of 1:1200 to 1:2400. Colluvial soils on doubly concave landscapes, commonly with fragic properties, were separated from nonfragic colluvial soils that occur mostly on convex landscapes. Knox colluvium spans a wide range in age, from Tertiary to at least Late Pleistocene. Ancient Knox colluvium has undergone topographic inversion and now occupies some of the highest elevations on Chestnut Ridge. Pleistocene colluvium occurs in saddles and other concave footslope and toeslope landforms. Most Knox footslope colluvium has one or more time discontinuities, an indication of more than one major episode of geomorphic instability. The presence of fragic subsoil layers, fragipans, or glossic zones always marks such a discontinuity in these soils.

Loess has also been deposited throughout the Pleistocene, with the latest significant deposition occurring about 12,000 to 25,000 years ago during the melting of the Wisconsinan glaciers. Most of the loess either mixed into the upper soil horizons by biotic activity or was washed downslope into depressions or onto gentle toeslopes and preserved beneath younger cherty slopewash or removed entirely from the area. Only at scales of 1: 1200 to 1:2400 could loess-derived soils (Soil No. 438 and 439) be mapped in dolines.

43021, 43023, 43031, 43033, 43041, 43042, 43043, 43051. The soils in these map units formed in a minimum of 50 cm to several meters of colluvium derived from residual soils of the Knox Group. The No. 430 soils are similar in some respects to the ancient colluvium No. 436 soils, but the No. 436 soils are only mapped in the highest places on hilltops and have no current source area of colluvium. The No. 430 soils generally have more than 15% chert by volume throughout and can range to more than 50% by volume in some areas, depending on the chert content in the residual soils above. These soils occur in saddles and below saddles to the heads of drains but have a colluvial source in residual soils above them. These soils also occur on lower sideslopes and commonly have a doubly concave slope configuration. Most areas of these soils have a restrictive layer that perches water during wet periods. This restrictive layer commonly occurs at a depth of 80 to 125 cm below the surface and is more pronounced where slope forms are doubly concave. The restrictive layer, identified by the presence of **10YR 6/3** mottles, locates a discontinuity and the presence of an older, often truncated paleosol, that formed in either an older colluvium or in residuum beneath. Some areas of these soils have a fragipan, but the fragipan is intermittent. Most of the surficial colluvium is of late Pleistocene age, with the latest period of upland denudation and downslope mass movement occurring during the Wisconsinan stage of glaciation. The No. 430 colluvial soils have not experienced topographic inversion. Where topographic inversion has occurred,

the ancient late Tertiary or early Pleistocene colluvial soils are identified as No. 436 soils on the soil map.

The dominant subsurface water flow in these soils is lateral downslope. Because of the extensive lateral water flow, these soils are highly leached and **extremely** acidic, Forest vegetation does not seem to be as productive on these soils, in contrast to the Knox No. 433 and No. 434 colluvial soils. Thickness of colluvium varies from about 50 cm on upper concave sideslopes to 1 m or more on some low footslopes. These soils have a very high capacity for the lateral downslope transmission of water, with water perching and flowing above the **fragic** layer. During periods of late winter and early spring, the soil above **the fragic** layer is often saturated with shallow pits and drill holes that fill 'rapidly' under these wet conditions. However, during the summer, these soils dry out and become very droughty as plant roots extract the soil water from above the fragic layer. Some roots do penetrate the fragic layer and can extract water from deeper parts of the soil. The high **chert** content of these soils also reduces water-storage capacity. Perching of water can occur at several depths in these soils. On steeper hillsides, where colluvium ranges from 50 cm to about 80 cm thick, perching occurs at the contact with the colluvium and the truncated residual soil beneath. **If** perching lasts long enough to allow biologic activity to reduce the oxygen content of water to very low levels, a process of ferrollysis can begin. Ferrollysis is a process in which iron is differentially reduced in some part of the perched zone, translocated laterally or downwards, and precipitated out as coatings on ped faces or **eventually** forming a nodule. This process produces the typical drainage mottling and, especially, the formation of pale brown **(10YR 6/3)** mottles. Ferrollysis, in addition, also destroys clay minerals with the subsequent release of silica and aluminum plus whatever base cations might be present in the clay mineral. The aluminum is often incorporated into the mineral lattice of vermiculite, transforming this mineral into hydroxy interlayered vermiculite. The silica and aluminum may also recombine in the perched zone as an-amorphous **alumino-silicate**, which acts as a cementing agent in the formation of a genetic fragipan, or the aluminum and silica can recombine lower in the soil to form the clay mineral kaolinite. Iron, released by this process is translocated to lower positions in the soil where drainage mottles are formed. Where these soils occur on more-concave footslope and **toeslope** landforms, the thickness of colluvium increases, and there is usually more than one layer of colluvium. In these low landforms, water can perch at several depths. The soils in these map units classify as **Fragic** Paleudults; loamy-skeletal or fine-loamy, siliceous, thermic.

43121, 43131, 43141. The soils in these map units formed in **Recent and** Modern **deposits** of **slopewash** where surface soil washed from higher slopes has accumulated to a depth of more than 50 cm. A buried soil always occurs in these soils within a depth of 100 cm. These soils have very limited extent in the watershed and are mostly situated in **dolines** and drainageways along the eastern

WBW boundary in old agricultural fields The soils on these mapping units classify as Fluventic Dystrachrepts; fine-loamy, siliceous, thermic.

43351, 43353, **43361**. These soils formed in soil creep **materials** of varying thicknesses and in the underlying Knox Group residuum. They occur only on shaded east and northeast aspects. The surface layer is dark from the high organic matter content and 18 cm to more than 25 cm thick. The clay enriched subsoil has a yellowish-brown color. Windthrow cradle-knoll microrelief is a common surface feature of these soils, Included in mapping are small areas of soils with higher base saturation caused by the proximity to rock pinnacles or ledges to the surface. One area of these soils in WBW was farmed, became severely eroded, and is identified by the No. 43353. Numerous shallow gullies formed either before abandonment or after the area was abandoned and before the land surface was stabilized by forest vegetation. The soils in these map units are classified as **Humic** Hapludults and Typic Paleudults; fine-loamy and loamy-skeletal, siliceous, thermic.

43421, **43431**, 43432, 43433, 43441, 43433, 43451. These soils formed in **colluvium** between 50 and 125 cm thick and in the underlying Knox Group clayey residuum. These soils occur on landforms that are mostly convex in contrast to the No. 430 soils, which occur on landforms that are more concave. The No. **434** soils have subsoil colors that are brighter and less yellow than the No. 430 soils, and they have no evident subsoil layer that perches water. Included in mapping are areas where depth of colluvium is less than 50 cm, and small concave portions of the **landform** where colluvial soils with subsoil **fragic** layers occur. Because of the rapid infiltration of rainwater and the rapid subsurface lateral flow in these soils, they are rarely saturated. The soils in these map units classify as Typic Paleudults; fine-loamy, siliceous, thermic.

43621, 43631, 43641. The soils in these map units formed in ancient **toeslope colluvium and ancient local alluvium** that through topographic inversion now occupies upland summit landscapes. Soils in these map units are mapped only on broad, stable high-elevation upland summits on Chestnut Ridge and are generally underlain by the **Longview** formation and parts of the Chepultepec and Kingsport formations on either side. **In** WBW some areas of No. 436 soils are underlain by Copper Ridge residuum. The No. 436 soils have a thicker and more strongly expressed E horizon than the younger No. 430 and No. 434 soils that occur on recognizable colluvial landforms. A paleosol that formed in very **cherty** residuum commonly occurs beneath the colluvium. The **chert** fragments in this old paleosol are highly weathered, most are soft and easily broken by augering, indicating a long age of weathering. Chert fragments in the ancient colluvium are also highly weathered and commonly impregnated with iron oxides. Downslope from delineations of these No. 436 soils, it is common to find adjacent areas of the No. 990, No. 991, and No. 994 soils that formed in ancient alluvium. Both these No. 436 soils and the related No. 990, No. 991, and No. 994 soils have a probable

mid to late Tertiary age considering the time required for topographic inversion and reddening of the No. 990 alluvium.

Some areas of these soils were cultivated in the past and were moderately eroded. The thickness of ancient colluvium that remains is highly variable, ranging from less than 50 cm to more than 150 cm. The soils in these map units classify as Typic Paleudults; loamy-skeletal, siliceous, thermic.

4.2.3 Doline Soils

Most **Dolines** in WBW of larger diameter are associated with topographically inverted, former footslope, toeslope, and terrace landscapes and are of considerable age. **Dolines** with broad, nearly level bottoms contain distinctive soils. Soil materials have been periodically added to the surfaces of preexisting **doline** soils and then preserved, unless the **doline** sidewall has been breached. The lowermost paleosol of large **dolines** typically has a very high chert content, and appears to have a colluvial origin. **Its** major source was from the sidewalls as the **doline** increased in diameter, although some increase in content was a result of clay washing from the residuum that slumped into the bottom. In larger and broader **dolines**, a layer of compacted silt loam occurs immediately above this very cherty layer. This stratum contains from none to a few pea-sized, soft, chert fragments. This particular stratum was evidently deposited in standing water. A cherty stratum mantles this lowermost, mostly **chert-free** silt layer and probably represents a time when slope erosion processes were more active. Above this cherty stratum, another layer of high-silt-content materials was deposited, again in a very wet environment. Within this stratum a complete paleosol has often been preserved. Above this particular stratum, there is another thin layer of larger chert fragments. Above this paleosol, another layer of high silt content soil material, presumed to have a mostly loessal origin, has been deposited. It has very few pea-sized chert fragments. A soil horizon sequence has formed in this stratum. This stratum occurs at the surface in **dolines** that are forested. However, where **dolines** occur in cultivated areas, this high-silt-content stratum has been buried by Modern Age cherty slope sediments that are 25 cm to more than 100 cm thick. Colluvium, of presumed Wisconsinan age, has covered the uppermost silty layer around **doline** margins. The history of most **dolines** in WBW is one of formation, infilling, and enlargement; a wet period or periods when **ponded** water occurred; and the more recent infilling and drying during the Holocene. Periods of 'infilling or of subsidence activity are probably associated with Pleistocene climate changes producing increased rainfall. The youngest surficial materials in many **dolines** is derived from soil eroded from hillsides after clearing. Charcoal fragments are abundant in this most recently buried surface. A discussion of **dolines** and their stratigraphy is contained in TM-1 1364 (Lietzke, Kettle, and Lee 1989).

43721, 43731, 43741. The soils in these map units formed in a layer of loess, high-silt-content slope wash, and the underlying very cherty to extremely cherty

colluvium. These soils occur in some **dolines** that have broad shallow bottoms and on broad gently sloping hilltops underlain by ancient colluvium. A well-developed but highly degraded fragipan occurs at the contact of the loess and the cherty colluvial soil materials beneath. These soils have very limited extent. The soils in these mapping units classify as Typic or Glossic Fragiudults; fine-silty over loamy-skeletal, siliceous, thermic.

43821, 43831. The soils in these map units formed in loess or high-silt-content slopewash materials that are 50 cm to more than 100 cm thick and occur only in the broad bottoms of well-drained and moderately well-drained **dolines**. These soils are very similar to the No. 439 soils but are better drained. The **high-silt-content** material is commonly capped with a thin layer of Modern Age slopewash, having a few to many chert fragments. The paleosol beneath generally has a completely preserved genetic soil horizon sequence, but the buried A horizon has lost its organic component and now has a grayish bleached-out appearance. At some depth below the loess, another paleosol occurs in cherty or very cherty colluvium. In some broad and stable **doline** bottoms, there are two layers of loess, commonly separated by a thin layer of silty slopewash that contains some chert fragments. Not all **dolines** that are shown on the surficial geology map have loess deposits in them. **Dolines** with a funnel-shaped bottom generally have only very cherty slopewash in their lowermost portions. **Dolines** with breached sidewalls commonly have lost their silty strata and contain only very cherty sediments. These **doline** soils have very limited extent and can be mapped only at scales of **1:2400** or **1:1200**. The preservation of strata in **dolines** is important in that a history of some past geomorphic events has been preserved. On smaller-scale soil maps, **dolines** are shown by spot symbols, and the soils in their bottoms cannot be mapped. The soils in these mapping units classify as Typic and Aquic Hapludults; fine-silty, siliceous, thermic.

43911, 43921. The soils in these map units formed in one or more layers of loess and the underlying cherty colluvium. (Two distinct layers of loess have been identified thus far.) Surficial loess thickness is 50 cm to more than 100 cm. These soils become increasingly gray with depth, although there are some places where surficial water is perched by **palic** fragipans that formed in the underlying colluvial paleosol before it was buried by the loess. These soils have very limited extent and can be mapped only at scales of **1:2400** or larger. The soils are important in acquiring an understanding of the past geomorphic processes and events that have shaped the surrounding landforms. Very small **dolines** are shown on the soil map with a spot symbol. The soils in these map units are classified as **Aeric** and Typic Ochraqults; fine-silty, siliceous, thermic.

4.3 OLD ALLUVIUM

Geomorphic process of the past are preserved in scattered locations in WBW. Ancient streams deposited sediments in floodplains and on terraces. Subsequent processes of erosion and topographic inversion have resulted in these alluvial deposits being located on some of the higher elevations of Chestnut Ridge. Old alluvium on the site has both local (contains local chert) and distant sources (**meta** quartzites from the Unaka mountains). Main-channel ancient alluvium has a **dark-red** clayey subsoil and few, if any, chert fragments, whereas ancient alluvium of a more local source area has a higher content of highly weathered and iron impregnated chert fragments. Most of the ancient alluvium on the site occurs on the upper Copper Ridge formation, where it blankets southeast-facing slopes. Subsequent erosion processes and the **headward** migration of drainageways have removed some of this ancient alluvium. The thickness of ancient alluvium on Chestnut Ridge ranges from 'less than 1 m to about 6 m, as revealed in one drill hole located in the East **Chestnut Ridge** area' and several boreholes located in the West Chestnut Ridge area of the Reservation.

99031, 99042, 99043, 99053. The soils in these map units formed in alluvium of probable late Tertiary or early Pleistocene. Today, these soils occupy some of the higher elevations on Chestnut Ridge. Most areas of these soils were preserved on southeast and south slopes, which tend to be more geomorphically stable, and are mostly underlain by residuum of the upper Copper Ridge formation and the lower Chepultepec formation. The No. 990 soils have not been mapped over the Kingspott, Mascot, or Chickamauga Unit A formations on Chestnut Ridge or in WBW.

The No. 990 soils have a thick, dark surface layer and dark-red clayey subsoil horizons. Most areas of these soils have very few coarse' fragments, and only fragments resistant to weathering remain. These **are** chert of **local origin** and metaquartzites from the Unaka Mountains of Upper East Tennessee or perhaps Chilhowee Mountain that have been impregnated with maghemite and iron oxides. Another key indicator of these soils is the presence of numerous small, **1- to 2-mm-diam** hard iron-manganese nodules throughout the soil, nodules that do not occur in adjacent residual or colluvial soils.

Because of their generally favorable physical properties, nearly all areas of these soils were in agriculture when the Reservation area was taken over by the AEC. Because the soils are relatively permeable, they were not all severely eroded, although there are some severely eroded areas. The soils are sticky when wet because of the high iron oxide content, but they dry rapidly and become very friable and have a strong granular or blocky soil structure. These soils are the alluvial remnants preserved from an earlier erosion cycle. Several questions remain about how these soils became dark red, including What is 'the "source of all the iron oxide? Was the iron oxide translocated from higher landforms when

these soils were in floodplain and terrace landforms? Today, except for the occasional rounded river slick gravel, it is difficult to imagine that these soils were once in low-lying but well-drained floodplain landscapes with hills rising from their edge. The current distribution of iron oxides and their color suggest that these soils were not subjected to a long period of fluctuating water tables. **If** they had been, then the iron would have been organized into hard nodules, with a pale soil matrix between nodules. Typically, these soils are identified by the numerous iron nodules that are about 1 to 2 mm in diameter. This soil feature would suggest that these soils were once in a fluctuating water table zone, a condition required for the migration of these oxides into hard nodules. However, as rivers shifted course and continued to **downcut**, the soil would have become better drained. It would seem that further additions of iron would be necessary to form the dark-red colors observed today. There are at least two possible sources of additional iron that are now disseminated throughout these dark-red soils. One source is deposition from the air, the other iron sources are weatherable biotite and chlorite minerals carried from the Unakas by an ancestral Tennessee River. The soils in these map units classify as Rhodic Paleudults; clayey, oxidic, thermic.

99121, 99131. The soils in these map units formed in a thin layer of Late Pleistocene loess 50 cm to about 100 cm thick, with the underlying old local alluvium and residuum beneath. These soils typically have two or more clay-enriched subsoil horizons. The upper subsoil formed in loessal materials. It is yellowish-brown and has a silt loam-silty clay loam texture. The lower **clay**-enriched subsoil formed in the underlying old alluvium. This particular subsoil layer has a redder but often mottled color, caused by perching of water, and a clay loam or silty clay loam texture. Maghemite nodules, 2 to 3 cm in diameter, and iron-impregnated **chert** fragments are a common feature of the old alluvium and help to identify its presence. The underlying soil materials are highly weathered **cherty** residuum. These soils occur on dissected terrace landforms close to the crest of the residual soil hills. They have undergone topographic inversion, an indication that their absolute age is quite old. The greater permeability of the alluvium compared with the surrounding clayey residual soils allowed for greater geomorphic stability, thus preserving these ancient soils. The permeability of the alluvium also allowed for the preservation of loess. The surficial loess is presumed to be of Wisconsinan age, or about 19,000 to 23,000 years ago. Older loess would have been mostly washed off. However, some soil borings revealed the presence of an older loess with a yellowish-red color and a silty clay loam texture beneath the younger yellowish-brown uppermost loess. The soils in these map units classify as Typic Paleudults; fine-silty, siliceous, thermic.

99421, 99431, 99433, 99441, 99443. These soils are on broad upland summit landscapes. They formed in a mixture of ancient local **cherty** colluvium and alluvium and the underlying Knox clayey residuum and were mapped whenever the surficial materials were more than 50 cm thick. These soils originally occupied low toeslope-terrace landforms where alluvium and colluvium accumulated.

Subsequent topographic inversion has transformed these once low-elevation landforms. The soils in these map units have subsoils that contain less clay than nearby residual soils. Subsoil colors also tend to be redder than the adjacent residual soils but less **red and** with **lower** clay content than the **adjacent No. 990** ancient alluvial soils. They are also very similar to the No. 991 soils but lack the loess capping. A more important indicator of these soils is the highly weathered and iron-impregnated nature of the chert fragments. Maghemite is a common feature of these soils, and its presence helps in their identification. Many chert fragments are quite soft and have **partially converted** to kaolinite. Other chert fragments have a red rind. These soils usually occupy a transition zone between the No. 436 soils, which were stripped free of iron and manganese oxides, and the No. 990 soils, which have red and dark red subsoils and abundant iron-manganese nodules. Where these soils occur near the No. 436 soils, they have a higher chert content and a less-red-color, whereas areas near No. 990 soils have redder colors, higher clay content, and less chert. As mapped on Chestnut Ridge and in WBW, the No. 994 soils represent at least two erosion cycles. **Ridgetop** areas of No. 994 soils represent the remnants of the oldest cycle. Other areas of No. 994 soils are mapped at a lower elevation elsewhere on Chestnut Ridge on old fan-terrace landscapes but are still high above present areas of **toeslope** and fan-terrace colluvium-alluvium deposition. The extent of the No. 994 soils is not large, but the age and geomorphic history of these soils and the associated No. 436 and No. 990 soils is important in determining both the ages of **landform** surfaces and the development of karst geomorphic features. The soils in these map units classify as Typic Paleudults; fine-loamy, siliceous, thermic.

99922 The soils in this map unit classify as Typic Hapludults; fine-loamy, mixed, thermic. (Sequatchie-like.) These soils occur in one area in WBW. They are located in the East Fork area, at the confluence of two tributaries. An old home site is located on this fan terrace landform. These soils are considered to have a late Pleistocene or early Holocene age. They have a high content of very fine sand and silt throughout the upper profile and a yellowish brown Bt horizon with a silt loam or light clay loam" texture. The **soils are underlain** by extremely **cherty** alluvium. They have segregated iron-manganese zones in the subsoil but no hard nodules, an indication that sediment deposition ceased in the **late** Pleistocene to Early Holocene, or about 20,000 to 18,000 years ago.

These soils are classified as Typic Hapludults; fine-loamy over loamy-skeletal, siliceous, thermic.

4.4 RECENT ALLUVIUM

98031, 98041. The landforms and soils in these units occur as a complex that comprise the coves and narrow drainageways and coves of Chestnut Ridge and WBW. The Udifluent **soils** occur in **floodplains and** narrow bottoms. They are

stratified and show minimal evidence of soil genesis, Textures are cherty to extremely cherty silt loams and loams. The Fragiudult and Paleudult colluvial soils occur in narrow strips on toeslopes that are usually too small to delineate but are important in hydrology and land use. Also included in the colluvial parts of the landscape are small alluvial fans from recently cut gullies, the results of past land mismanagement from both farming and forestry. Old farm or logging access roads are a common feature in areas of these soils, especially in wider drainageways. Most of the soils in these mapping units are well-drained but some areas, where small seeps and springs occur, are wet. **Knick** points, entrenched channels, and overwashed zones occur throughout the Udifluent soil areas, giving rise to a complicated sequence and pattern of soils. Fragipans commonly occur in low colluvial soil areas. In addition there are areas without fragipans and areas that have **fragic** subsoil properties. Some **toeslope** areas have been covered by modern slopewash from agricultural fields on the slopes above. Most vegetation on these soils is forest, ranging from tulip poplar to red maple, and Paw Paws are common in some moist drainageways. Some areas of these soils have abundant cobble-sized and boulder-sized **chert** on the surface and in the soil. Most rainfall and run-on water from higher slopes infiltrates and flows downward and laterally in these soils. Consequently, these soils have a tendency to become filled with water during wet periods. Water also perches at discontinuities, but these soils tend to drain freely because of the low clay content, slope, and the pipes that have formed from bioactivity. The soils in these map unit complexes classify as Udifluents, Fragiudults, and Paleudults; loamy-skeletal, siliceous, thermic.

98121, **98131**. These well- and moderately well-drained soils formed in alluvium washed from residual upland and colluvial soils of the Knox Group. The upper part of these soils is derived from Modern Age sediments washed down into drainageways by land clearing and subsequent agricultural activities of European settlers. The thickness of this Modern Age sediment ranges from about 50 cm to more than 100 cm. The Modern sediments commonly contain one or more buried surface layers, the results of catastrophic local intense storms on bare soils. Buried soils beneath this Modern Age alluvium have a variety of morphologic expression ranging from weak **cambic** horizons to clay-enriched argillic horizons. The largest area of these soils occurs along the east fork of Walker Branch Creek. However, most areas of these soils occur in narrow drainageways, are mapped as a complex with low **toeslope** colluvial soils, and are identified by the No. 980 symbol.

The soils in these map units classify as Typic and Aquic Udifluents; fine-loamy or loamy-skeletal, siliceous, thermic.

98211. The soils in this map unit are located on wet floodplains but are undifferentiated with respect to their morphology and classification. They are somewhat poorly to very poorly drained. Most of the delineations in this unit generally contain springs and seeps that keep the soils wet and saturated most

of the time. In other areas that are wet, stream channels tend to be poorly defined or else they are very shallow. Only vegetation tolerant of wet conditions grows well on these soils. Small areas of these soils occur as inclusions in larger areas of No. 980 soils. These soils **should** be kept in a natural condition. They are important in maintaining stream water quality regardless of upper-watershed land use. The soils in this undifferentiated map unit classify as **Fluvaquents** and **Ochraqualfs**; loamy-skeletal, siliceous, thermic.

5. INTERPRETATIONS

The ability to predict the response of a particular type of soil to a change in land use needs to be known. Many predictions of soil behavior or potential forest productivity are based on (1) past observations, (2) research on the same or similar soils, (3) external and internal forces and processes that influenced rock weathering and soil formation, and (4) the physical, chemical, mineralogical, and hydrologic properties of the soil. Many of the interpretations of Table 1 were developed according to the criteria in the *National Soils Handbook* (Soil Survey Staff 1983). The rating criteria in the Handbook allow soil scientists to make reasonable estimates of inferred soil properties based on observable soil characteristics. The depth of soil observation for predicting soil behavior in the *National Soils Handbook* is confined to a depth of about 2 m or to hard rock or dense weathered bedrock (saprolite) if it occurs at a shallower depth. Table 1 lists interpretive ratings for each soil series. Where there is a range in "the ratings, the range is usually related to the slope gradient and its effects on that particular interpretation.

5.1 DRAINAGE

Drainage classes are based in the frequency and duration of periods when the soil is saturated. Water may be either perched by some restrictive layer in the soil during wet periods or saturated by the groundwater table. Perched water or groundwater in the soil can be identified by soil color patterns. Soil colors are of two general kinds: colors inherited from the parent materials (saprolite, colluvium, or alluvium) and colors that are the result of soil formation (oxidation and reduction). Most color in the soil is caused by (1) iron oxides, (2) organic carbon (surface horizon), (3) manganese, and (4) colors that result when water saturates the soil.

When water perches in a soil, the soil is usually not uniformly saturated, but there are areas with high biologic **activity where** the **bacteria** remove oxygen from the soil, resulting in anoxic conditions. - **In these** anoxic areas, manganese and iron are reduced, becoming much more mobile. These mobile forms **migrate** laterally and downward to areas that are oxidized, where they precipitate out forming either coatings or nodules that have their own **shades** of reds and yellows, whereas the reduced zones acquire a pale brown to grayish-brown color. Perched zones usually have a highly mottled color pattern, whereas the more-oxidized-unsaturated zone beneath does not. In those areas where the groundwater table intersects the surface, the upper soil can have a mottled color pattern, but the color becomes increasingly gray with increasing depth. There are only a few areas on the Reservation where the groundwater table comes to the surface. These areas are found below springs and seeps and in drainageways that flow year round.

Table 1. Soil Interpretations

Map Symbol	Drainage	Hydrology	Depth to restrict	Eros Dist	ErosUndist	pin	hardwoods	streets and roads	Unpaved Roads
Sec. 4.	Sec. 5.1	Sec. 5.2	Sec. 5.3	Sec. 5.4	Sec. 5.5	S. 5.6	Sec. 5.7	Sec. 5.8	Sec. 5.9
400	2	R karst	>200 cm 3	M	L	G	G	F-G	F unstable base, too clayey
401	2	R Karst	>200 cm 3	M-L	L	G	G	F-G	F unstable base, too clayey
402	2	R karst	>200 3	M	L	G	G	G	F unstable base, high silt
403	2	R karst	>200 cm 3	M	L	G	G	G	F unstable base
404	2	R karst	150-200 cm 4	M	L	G	G	G	F high chert
405	2	R karst	25->200 cm 4	M	L	G	G	P-F rock	P depth to rock, high clay
406	2	R karst	>200 cm 3	M	L	G	G	G	P high clay and silt
408	2	R karst	100-200cm 3	L	VL	G	G	G	G
430	2-3	R-D colluvium	75-125 cm 2, 3	M	L	G	G	G	F perched water
431	2-3	R-D colluvium	50-150 cm 3	L	L	G	G	P	P unstable base
433	2	R-D colluvium	50-150 cm 3	M	L	G	G	F-G	P steep slopes, unstable base
434	2	R-D colluvium	50-150 cm 3	M	L	G	G	F-G	F - G high silt
436	2	R-D colluvium	50-150 cm 3	M	L	G	G	G	G
437	2-3	R-D colluvium	50-125 cm 2,3	L	L	G	G	P too silty	P unstable base, high silt
438	2-3	R dolines	50-150 cm 3	L	L	G	G	P too silty	V P very high silt
439	4-5	R dolines	50-150 cm 3	L	L	G	G	P too silty	V P very high silt
980	2-3	D	50-150 cm 3	M-H	L	F-G	G	F-G	P - F wetness
981	2-3	D	100-150 cm 3	M	L	F-G	G	F	F - G wetness, floods
982	4-5	D	100-150 cm 3	L	L	P-F	G	P	P very freq. flooding
990	2	R	>200 cm	M-H	L	G	G	F-G	G
991	2	R-D	50-100 cm 3	H-VH	L	G	G	F	P unstable base, high silt
994	2	R	>200 cm	M-H	L	G	G	F-G	F - G
LEGEND									
DRAINAGE	1 excess	2 well	3 mod. well	4 swpd	5 poor				
EROSION POT.	L = low	M = moderate	H = high	VH= v. high					
HYDROLOGY	D = discharge	R = recharge							
RATINGS	G Good	F Fair	P Poor	VP V. Poor					
RESTRICTIONS	1 paralithic	2 fragipan	3 change in perm.	4 rock					

Drainage conditions in soils have traditionally been interpreted for growing agronomic plants during the growing season. Drainage conditions are divided into five classes, ranging from excessively well-drained to very poorly drained. Definitions of these classes are in the *Revised Soil Survey Manual* (Soil Survey Staff 1964) and are used in this report because other definitions of drainage wetness classes for deeper soil zones do not exist.

5.2 HYDROLOGY

Soils and their associated landforms are rated for their capability to allow the downward movement of water to recharge the groundwater or for their discharge potential. Once rainfall has infiltrated the soil surface, it tends to move downward rather uniformly through the surface layer and upper subsoil. However, with increasing depth in the subsoil, water tends to move in preferred pathways, many of which were formed by biologic activity including deep rooting by trees and burrowing by soil fauna, or flow becomes confined to fractures and joints that are preserved in the underlying saprolite. Figure 19 illustrates schematically some pathways of water flow in the soil.

5.21 Surface Water **Infiltration** and Near-Surface Water Flow

Direct infiltration of rainfall, tree drip, or **stemflow** into the soil is a dynamic process controlled by several factors including: (1) slope gradient; (2) slope shape; (3) presence or absence of surficial organic layers and their hydrophobicity; (4) surface layer soil texture, soil structure and aggregate stability, and macropores; (5) subsoil hydraulic conductivity, including pore size distribution and continuity; and (6) the layer in the soil that has limiting hydraulic conductivity. Rainfall initially infiltrates at its highest rate in either dry or moist bare soil. The ability of a soil to sustain its high rate of infiltration depends on the ability of the soil to transmit this water downward. Whenever the rate of rainfall exceeds the rate of infiltration, overland flow starts. As water moves downward, the rate at which it does so decreases. Once a limiting hydraulic layer is encountered, water will tend to pile up and to saturate flow pathways in the soil. Eventually, the 'surface layer can become saturated. Once this happens, overland runoff can start, even under conditions of less-intense rainfall. Saturated soil layers also tend to lose much of their stability and move downslope if not anchored by roots.

Surface litter can greatly affect the pathways by which- rainfall "eventually gets into the mineral soil. Leaves and needles with high surface wax content and most dry organic matter tend to be hydrophobic. Water beads up on leaf surfaces and tends to puddle. Where the ground surface is covered with a thick layer of waxy leaves, intense rainfall can puddle on the surface and flow off the site without much infiltration. The overlapping leaves act somewhat like a shingle roof. Often, rainfall that beads up on leaves will break through in random places and flow downward

ORNL-DWG93-13675

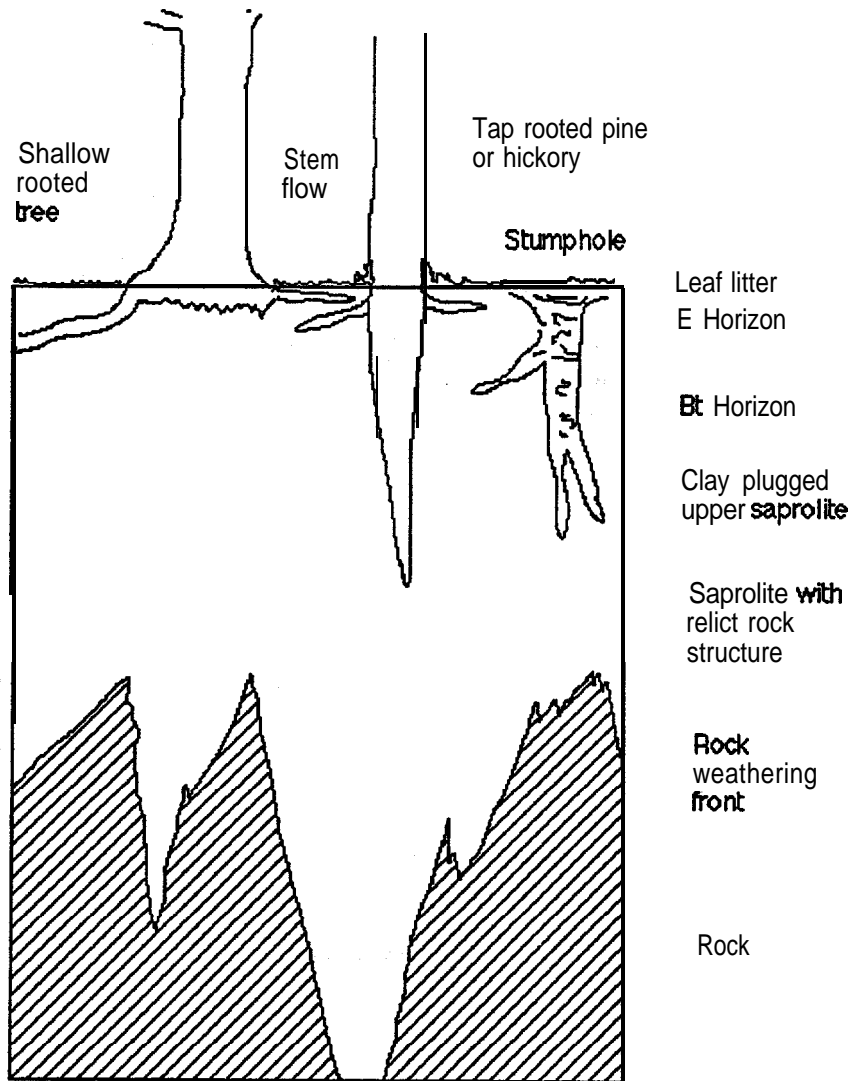


Figure 19. Near-surface soil hydrology on Walker Branch Watershed

as saturated flow, while in other places the mineral soil does not become wetted. Tree stemflow, once it starts, results in considerable delivery of water into the soil. **Stemflow** water can evidently penetrate quickly to considerable depth via saturated flow, down existing root channels. Rainfall that initially ponds and flows on the surface litter can also impinge on old stump holes that are filled with leaves. The loose soil and leaves in the stump hole become saturated, as noted in numerous observations. Water **leaving** old stump holes can also move rapidly downward as saturated flow. This water, because it passes through a thick layer of decayed and decaying leaves, can be enriched with dissolved organic carbon.

Water can perch in a soil whenever the saturated hydraulic conductivity of the soil layer beneath is exceeded. Perched water has a tendency to flow laterally along a hydraulic gradient. In residual soils, water commonly perches during and after heavy rains within the E horizon because the Bt horizon beneath has much slower conductivity. Perched E horizon water also moves readily laterally downslope. Water that perches in the E horizon is responsible for both its pedogenic formation and its thickening over time. Specific kinds of chemical processes take place within an E horizon that is underlain by a Bt horizon. Water infiltrating through the organic surface layers and the carbon enriched A horizon carry dissolved organics into the E horizon. The presence of these organics plus anaerobic respiration result in the reduction of iron, destruction of clay minerals, and subsequent organic chelation of iron and aluminum. Iron and aluminum are carried downward into the Bt horizon. Here, aluminum can recombine with silica, forming kaolinitic clay, and iron can precipitate as oxides or hydroxides. In addition, downward streaming of water through the E horizon can also transport particulate clay particles into the Bt horizon. Here, translocated clay, neo-formed clay, and clay-oxide complexes coat ped surfaces and pores.

The upper part of the clay-enriched Bt horizon has higher conductivity than does the lower part. Water that gets into the Bt horizon tends to become confined to particular flow pathways in the lower part. Here, water tends to perch again whenever the conductivity of the more-limiting layer beneath is exceeded. Once water has moved through the lower subsoil, it tends to move rapidly via saturated flow in defined pathways and also much more slowly by unsaturated flow away from these saturated zones. Patterns of soil colors in the lower subsoil and saprolite visually define these pathways of saturated water flow. Water usually perches at two or more depths in many residual soils in WBW. Water commonly perches at the base of the E horizon at a depth between about 25 cm to nearly 80 cm, the depth depending the thickness of the E horizon. **Water also** commonly perches in the lower Bt horizon between depths of about **100** to 125 cm, especially in soils with high-clay-content subsoils. Water can also perch in the upper **Cr** horizon boundary zone and also on top of hard rock.

The colluvial soils in the soil survey area have slightly different hydraulic conductivity properties than do the residual soils. First, the **colluvial** soil material

was once saturated and flowed downslope as a saturated mass to a lower concave slope position, where it achieved some degree of geomorphic stability. This colluvial material underwent a partial sorting as it moved downslope. The clay content was reduced, and considerable iron was removed. Colluvium tends to have a higher hydraulic conductivity, and water tends to readily infiltrate and move downward. However, the contact with the more-permeable colluvium and the **less**-permeable paleosol beneath constitutes a limiting layer. Here, water perches and then readily flows laterally downslope. If conditions are right, a fragipan having very limited conductivity forms at this discontinuity. Fragipans are not a common feature of most Reservation and WBW colluvial soils because of the relatively good permeability of the underlying paleosol, but some lower colluvial subsoil layers have some properties of fragipans or show visual morphologic evidence of present or past perching of water. Water usually perches in colluvial soils at the uppermost discontinuity that commonly occurs at a depth of about 80 cm to more than 125 cm.

Most young alluvial soils, because of their stratified nature, tend to transmit water laterally very easily because the fine strata act as water barriers for downward movement.

5.22 Water-Flow Pathways Deeper in the Soil

Most saturated water movement in deeper soil layers and in saprolite is strongly confined along cracks, fractures, and bedding planes. Color patterns, including distributions of iron and manganese coatings in saprolite, can be used to show where water is moving via saturated and unsaturated flow. Water flows away from saturated zones via unsaturated flow mechanisms. Manganese **is** commonly reduced and mobilized in saturated zones but is then transported laterally away via unsaturated flow. Some but not all **chert** beds in residual soils derived from the Knox Group tend to be zones in which water moves downward quite rapidly. These water-flow zones have bright-red iron oxide coatings. Manganese, if present, occurs as a crystalline mineral that has been occluded from the system by a thick iron oxide-clay coating. Water, once it reaches a limestone pinnacle, can move downward very rapidly in the thin but very permeable weathering zone between hard rock and the clayey residuum. Lee and Ketelle (1987) discuss pathways of deep groundwater flow on West Chestnut Ridge in greater detail.

5.23 Soil Role in Hydrologic Discharge and Recharge of Perched and Ground Water Tables

Rainfall that infiltrates the soil can either move downward to recharge either ephemeral perched water tables or the groundwater table or can move laterally at shallow depths in permeable zones, where it either surfaces as a wet weather spring or seep or eventually moves downward to the water table. Most landforms underlain by residual soils tend to be recharge areas to the groundwater, but

some upland residual soils have much higher **capacity to recharge groundwater** than other soils. For example, residual soils that formed over feldspathic sandstones and siltstones of the uppermost Rome formation have a very high capacity to transmit water very quickly to the groundwater. Many of the Knox Group residual soils also can transmit water quickly downward compared with residual soils underlain by shale; although clay-plugged lower subsoil and upper clay-plugged saprolite slows down the rate. Knox Group soils also have the capability to transmit water laterally in E horizons to lower landforms, a discharge of the ephemeral uppermost perched water table.

Colluvial soils also have the capability to both recharge and discharge water. Laterally transmitted water from colluvial soils is discharged by upwelling in ephemeral "**wet weather**" seeps or is discharged **in seepy** wet areas at the bases of hills. Both colluvium and alluvium have a high capacity to move water laterally downslope. Groundwater recharge occurs readily in areas of karst, allowing for rapid movement of rainfall, **overland** flow; or near-surface lateral flow directly to the watertable through **dolines**, pipes, or open swallow holes.

The only areas where groundwater is discharged is at permanent springs. The soils downslope from these springs have the gray soil colors typical of soil that is constantly saturated. Stream reaches that flow only during periods of rainfall in which overland flow is generated tend to be areas of groundwater recharge. Stream reaches having permanent flow are areas of discharge.

5.3 DEPTH TO RESTRICTION

Depth to a restriction refers to the location in the soil where there is a significant change in porosity or where a lithologic or time discontinuity results in a change in porosity. The potential for perched water conditions, the depth at which perching will occur, and its subsequent lateral downslope movement beneath the soil surface are often controlled by pore-size continuity or discontinuity. Restrictions to water flow are (1) depth to weathered bedrock, (2) subsoil **fragipan** or **fragic** properties, (3) pore size discontinuity, and (4) hard rock.

5.4 DISTURBED SOIL EROSION POTENTIAL

Soils are rated for erosion of disturbed soils without surface vegetation cover or mulch. Erosion potential is rated from **low** to very high. Erosion is caused by raindrop splash, which detaches soil particles and overland flow. [See Soil Survey Staff (1983) for rating criteria and classes.]

5.5 UNDISTURBED SOIL EROSION POTENTIAL

Soils are rated for erosion of undisturbed soils that are covered by grass or covered by a forest litter layer. Erosion potential is rated from low to medium in WBW. Soil surface layers that have a high silt and clay content generally have a medium erosion potential, or less than 1-2 tons of soil per acre per year. In a forested area, soil particles are brought to the surface above the litter layer by ant and other soil fauna activity and then subjected to downslope transport by overland flow. Increasing slope gradients also affect undisturbed soil erosion potentials.

5.6 SUITABILITY FOR PINES

Soils are rated for their suitability for growing tap-rooted pines. Soil depth for rooting activity is an important rating criterion. Subjective ratings range from poor to good for short-rotation management of pines.

5.7 RATINGS FOR HARDWOODS

Soils are rated for long-term management of hardwoods for saw logs. Different species of hardwoods have varying site requirements, including the ability of the soil to supply water and nutrients and potential rooting depth over the life span of the tree. Some hardwoods have the potential to extend their root systems downward deeply into saprolite and to hard rock, where chemical weathering processes release quantities of calcium, potassium, and other elements that trees need for sustained growth. Soils are subjectively rated from poor to good.

5.8 RATINGS FOR PAVED ROADS AND STREET'S

Paved roads and streets are covered with an impermeable layer of asphalt or concrete, which covers a prepared subbase of natural soil materials that are modified by the additions of gravel to support a design load. Soils are rated for their suitability as a source of on-site subbase materials and for the ability of the natural undisturbed soil beneath the subbase to support the road and its designed dynamic load.

Ratings range from very poor, for soils with very high silt content or are saturated close to the surface, to good, for soils that have good physical properties and are well drained. Rating criteria are defined in Soil Survey Staff (1988) and were used for generating these interpretive classes.

5.9 UNPAVED ROADS

Unpaved roads are those that rely on the properties of the natural soil for strength. Unpaved roads may be covered with gravel or cinders. Often in construction, the surface organic enriched material is stripped off and the subsoil material from the ditches on either side is put onto the road bed, shaped to crown it, compacted to some extent, and covered with gravel. Therefore, on-site soils are rated for their suitability to support loads. Ditch and **roadbank** erosion potential is also considered in rating soils for this use. Ratings range from very poor to good.

6. CONCLUSIONS

The soils of WBW were mapped using the most up-to-date knowledge of soil genesis, geologic information, and geomorphic processes that shaped present-day landforms. The extent and distribution of residual soils were used to map the surficial geology and to evaluate **spacial** lateral geologic variability, primarily distribution of **chert** throughout all formations of the underlying Knox dolostones, and sandstone in the Mascot formation. Evidence of past geomorphic processes were preserved throughout the watershed by the presence of (1) ancient dark-red clayey alluvium, (2) ancient loamy local alluvium, (3) ancient colluvium (i.e., colluvium without a present-day source), and (4) extensive hillside colluvium of presumed Pleistocene age. Karst Geomorphic processes have also had significant effects on **landform** evolution in the watershed. Large **dolines**, surface depressions without open shallowholes, are located at high elevations around the perimeter of the watershed and show minimal evidence of recent subsidence or other activity. The presence of high-silt-content strata separated by **cherty** slopewash indicates (1) the preservation of dust deposition from the air and (2) slopewash which transported hillside cherty sediments into large, flat-bottomed **dolines**. Large **flat-bottomed dolines** have also preserved evidence that they contained water for periods of time, possibly during glacial stages of the Pleistocene. The remains of one topographically inverted **doline** are preserved in the watershed. The only **dolines** that exhibit effects of present or very-recent-past subsidence are located within present-day drainageways. These particular **dolines** have the more typical funnel-shaped appearance and do not have flat bottoms.

7. REFERENCES

- Arnold, R. W. 1983. Concepts of soils and pedology. IN Wilding, Smeck, and Hall (eds.), Pedogenesis and Soil Taxonomy 1. 'Concepts and interactions. Developments in Soil Science 11A. Elsevier, Amsterdam.
- Huggett, R. J. 1975. Soil landscape systems: A model of soil genesis. *Geoderma* 13: 1-22.
- Jenny, H. 1941. Factors of Soil Formation. McGraw-Hill, New York. 281 pp.
- Ketelle, R. H., and D. D. Huff. 1984. Site characterization of the West Chestnut Ridge Site. **ORNL/TM-9229**.
- Lee, S. Y., O. C. Kopp, and D. A. Lietzke. 1984. Mineralogical characterization of West Chestnut Ridge soils. **ORNL/TM-9361**.
- Lee, S. Y., D. A. Lietzke, R. H. Ketelle, and J. T. Ammons. 1988. Soil and surficial geology guidebook to the Oak Ridge Reservation, Oak Ridge, Tennessee. **ORNL/TM-10803**.
- Lietzke, D. A., R. H. Ketelle, and R. R. Lee. 1989. Soils and geomorphology of the East Chestnut Ridge Site. **ORNL/TM-11364**.
- McMaster**, W. C. 1963. Geologic map of the Oak Ridge Reservation, Tennessee. **ORNL/TM-713**.
- Moneymaker, R. 1981. Soil Survey of Anderson County, Tennessee. U.S. Government Printing Office, Washington, DC.
- Peters, L. N., D. F. Grigal, J. W. **Curlin**, and W. J. Selvidge. 1970. Walker Branch Watershed Project: Chemical, physical, and morphological properties of the soils of Walker Branch Watershed. **ORNL/TM-2968**.
- Simonson, R. W. 1959. Outline of a generalized theory of soil genesis. *Soil Sci. Soc. Am. Proc.* 23: 152-156.
- Smeck, Neil E., E. C. A. Runge, and E. E. Macintosh. 1983. Dynamics and genetic modelling of soil systems. IN Wilding, **Smeck**, and Hall (eds.), Pedogenesis and **Soil Taxonomy** 1. Concepts and Interactions. Developments in Soil Science 11 A. Elsevier, Amsterdam.

Smith, G. D. 1983. Historical development of soil taxonomy. IN Wilding, Smeck, and Hall (eds.), *Pedogenesis and Soil Taxonomy 1. Concepts and Interactions. Developments in Soil Science 1 IA*. Elsevier, Amsterdam.

Soil Survey Staff. 1975. *Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys.* Agriculture Handbook No. 436. U.S. Department of Agriculture, U.S. Government Printing Office, Washington, D.C.

Soil Survey Staff. 1983. *National soils handbook.* USDA-SCS Agriculture Handbook No. **430-VI-NSH**. U.S. Government Printing Office, Washington, D.C.

Soil Survey Staff. 1984. *Soil survey manual, rev.* USDA-SCS Agriculture Handbook **430-V-SSM**. U.S. Government Printing Office, Washington, D.C.

APPENDIX A

AI SOIL CLASSIFICATION

Each soil has distinctive subset of morphologic properties that can include color, horizonation, soil structure, and soil texture. Some related properties are measured in the laboratory. Important diagnostic properties that soils have in common and that were produced by a soil-forming process (i.e., soil genesis) are used to define conceptual classes for purposes of classifying soils (Smith 1983). In the United States, a hierarchical system of soil classification evolved to its current state with the development of the handbook *Soil Taxonomy* (Soil Survey Staff 1975), along with more recent amendments that are a reflection of advancing knowledge of soil science and soil genesis. *Soil Taxonomy* is based primarily on the properties of soil near the surface (i.e., properties that are the most direct result of a soil-forming process), but some deeper soil properties (at or near a depth of 2.0 m) are used to define one or more high-level categories of the classification system. The highest category of *Soil Taxonomy* is the "order." There are currently eleven orders. The WBW area has soils in four of the ten orders. These orders are:

1. **Entisols.** Entisols in WBW are very young, well to poorly drained soils of floodplains that have a thin A horizon over stratified alluvium.
2. **Inceptisols.** Soils with weakly developed genetic soil horizons are classified into this order. Most of these soils are on low terraces or on floodplains where there is little if any deposition.
3. **Alfisols.** Soils in this order have a clay enriched subsoil Bt horizon (argillic horizon) and more than 35% base saturation at a depth of 1.8 to 2.0 meters.
4. **Ultisols.** Soils in this order have a clay enriched subsoil Bt horizon (argillic horizon) but are highly weathered and very acidic with less than 35% base saturation at a depth of 1.8 to 2.0 meters below the surface.

All of the soils in an order must have at least one or more common properties that are the result of a common genetic pathway of soil formation.

Each order has one or more suborders. Suborder soils have 'more **properties** in common. In the order Entisols, there are **two suborders** present in WBW. These are (1) Fluvents, well- and moderately well-drained soils of **floodplains** that have fine stratification throughout the upper soil and (2) Aquents, wet soils of floodplains and seepage areas. There is one suborder to **Ochrepts** in the Inceptisol order. Ochrepts have a thin, light-colored surface horizon and a subsoil **cambic** horizon with minimal soil formation (i.e., a horizon where geologic rock structure has been

destroyed by the formation of stable soil structure). Within the watershed, there is one suborder of Udalfs in the order of Alfisols. Udalfs are freely drained and well-oxidized soils. Within the watershed there are two suborders of Ultisols. The suborder of Aquults includes wet soils that have a light-colored surface layer (ochric epipedon) and a clay-enriched subsoil horizon (argillic horizon). The suborder of Udults, includes well-drained soils that have both an ochric epipedon and an oxidized subsoil argillic horizon. Udults comprise the soils of greatest extent in WBW.

Each suborder has one or more "great groups," with the soils in each great group having still more commonality of properties. Each great group has one or more "subgroups," and each subgroup has one or more "families." Every category above the family is conceptual. The family category is represented by real physical, chemical, and mineralogical properties derived from a prescribed depth and thickness of soil. In the WBW area, mineralogy classes are similar for most soils (either kaolinitic, mixed or siliceous), whereas particle-size classes range from loamy-skeletal to fine-loamy to fine-silty to clayey to clay-skeletal. The "soil series" is the lowest conceptual category. Each soil series is mostly defined by observable soil features. Some of the soils in the WBW area would fit into existing soil series, provided only the upper soil, above a depth of 2 m (or to rock if shallower), were classified. Appendix A-3 lists soil series names from the 1967 WBW soil survey with a comparison with soil series from this soil survey.

A.2 SOIL DESCRIPTIONS

The following soil profile descriptions were described from pits or trenches. Each profile description represents a fairly typical example of a pedon.

KNOX SOILS

Soil Series No. 400

Location:	East Chestnut Ridge, Doline A sideslope trench in upper northeast corner of site. E60950, N27650
Classification:	Typic Paleudults (Hapludults); clayey, kaolinitic, thermic.
Geomorphic Position:	Doline sideslope
Slope and Aspect:	25 to 30% SW
Parent Material(s):	Copper Ridge residuum
Vegetation:	Pines, hardwoods, and cedars of old field succession
Described By:	Lietzke
Date:	May 30, 1989

Soil Description

- O** 3 to 0 cm; leaf litter and twigs.
- A** 0 to 7 cm; dark brown (1 OYR 3/3) extremely cherty silt loam; strong fine granular structure; very friable; many fine and common medium roots; 50 to 60% chert fragments; clear wavy boundary.
- Ap** 7 to 25 cm; dark yellowish brown (10YR 4/4) extremely cherty silt loam; moderate fine granular structure; very friable; common fine and medium roots; 50 to 60% chert fragments; gradual wavy boundary. (Base of surficial creep materials.)
- E/B** 25 to 40 cm: yellowish brown (10YR 5/4) E part and strong brown (7.5YR 5/6) B part; extremely cherty silt loam; weak fine subangular blocky structure; very friable; few fine and medium roots; 60 to 70% fragments; gradual irregular boundary.
- B/E** 40 to 64 cm: yellowish red (5YR 5/6) B part and strong brown (7.5YR 5/6) E part; extremely cherty silty clay loam; weak medium subangular blocky structure; very friable; few fine roots; 50 to 60% fragments; gradual irregular boundary.
- Bt1** 64 to 86 cm: red (2.5YR 4/8) cherty clay; moderate medium subangular blocky structure; firm; yellowish red (5YR 5/6) clay on ped surfaces; yellowish and reddish saprolite colors within ped interiors in lower part; few fine roots; 15 to 25% fragments; gradual wavy boundary.
- Bt2** 86 to ,130 cm; highly mottled red (2.5YR 4/8), yellowish red (5YR 5/6) brownish yellow (10YR 6/8) cherty clay; weak medium subangular blocky structure; firm; yellowish red (5YR 5/6) clay on ped surfaces; few fine roots; 20 to 30% fragments; gradual wavy boundary.
- BC** 130 to 150 cm; yellowish red (5YR 5/6) and brownish yellow (10YR 6/8) saprolitic material that easily crushes to cherty clay; weak coarse subangular blocky structure, but ped interiors are saprolite; very firm; thick red (2.5YR 4/6) clay of surfaces; few fine roots; 15 to 20% chert fragments.

NOTES: The Copper Ridge residual soils in this trench, about 30 m long, and on slopes of 25 to 30% are borderline Hapludults-Paleudults based on soil morphology.

Soil Series No. 401

Location: ORR. Chestnut Ridge area of Roane County, and about 200 feet north of boundary of borrow area and southwest of depression. E33500, N28100

Classification: Typic Paleudults; clayey, mixed, thermic

Geomorphic Position: Upper sideslope

Slope and Aspect: 25 to 28% north-northwest

Parent Material(s): Copper Ridge residuum
 Vegetation: Hardwoods of old field succession
 Described By: Lietzke
 Date: May 18, 1988

Soil Description

- Oi 4 to 0 cm; leaf litter.
- A 0 to 12 cm; dark brown (1 OYR **3/3**) cherty silt loam; moderate fine granular structure; very friable; many fine and medium roots; many pores; 15 to 20% chert fragments; clear wavy boundary.
- E 12 to 33 cm; yellowish brown (1 OYR **5/4**) cherty silt loam; weak fine granular structure; very friable; common fine and medium roots; many pores; 25 to 35% chert fragments; clear wavy boundary.
- E/B** 33 to 53 cm; dark yellowish brown (1 OYR **4/6**) cherty silt loam E part and strong brown (**7.5YR 5/6**) cherty silty clay loam B part; weak medium subangular blocky structure; very friable; few fine and medium roots; many pores; 20 to 35% chert fragments; gradual wavy boundary.
- B/E** 53 to 75 cm; yellowish red (**5YR 5/6**) B part and strong brown (**7.5YR 5/6**) E part; cherty silty clay loam; moderate medium subangular blocky structure; friable; few fine and medium roots; many pores; 30 to 35% chert fragments; gradual wavy boundary.
- Btl 75 to 100 cm; red (**2.5YR 4/8**) cherty clay; moderate medium subangular blocky structure; firm; ped faces are yellowish red (**5YR 5/6**) with no evidence of clay flows; few fine and medium roots; 20 to 25% chert fragments; gradual wavy boundary.
- Bt2 100 to 116 cm; red (**2.5YR 4/8**) cherty clay; moderate medium subangular blocky structure; very firm; yellow (**2.6Y 7/8**) saprolite colors; thick yellowish red (**5YR 5/6**) clay flows on ped faces; few medium and fine roots; many pores.

NOTES: Large chert fragments prevented further auger penetration. Pit dug to 75 cm depth. This is an included soil in No. 400 map unit delineations. It occurs on steep north and east facing slopes.

Soil Series No. 402

Location: ORR. Telephone ROW transect across Chestnut Ridge. Second pit north of **gasline** road and telephone line intersection. E29900, N26300

Classification: Typic Hapludults; clayey, mixed, thermic

Physiography: Upland

Geomorphic Position: Mid sideslope

Slope and Aspect: 25 to 45% WNW
 Parent Material(s): Chepultepec residuum
 Vegetation: Chestnut oak, red oak, and white oak
 Described By: Lietzke
 Sampled By: Lietzke, Ammons, and Timpson
 Date: March 23, 1988

Soil Description

- Oi** 5 to 0 cm; leaf litter and root mat.
- E1** 0 to 17 cm; pale olive (5Y 6/3) cherty loam: weak fine granular structure; very friable; many fine and medium roots; many pores; 15 to 25% chert fragments; gradual wavy boundary.
- E/B** 17 to 40 cm; olive yellow (2.5Y 6/6) E part and yellowish brown (10YR 5/6) B part; cherty loam; weak fine granular structure; very friable; many fine and medium roots; many pores; 15 to 25% chert fragments; gradual wavy boundary. (Lower boundary contains B/E horizon.)
- Bt1** 40 to 69 cm; yellowish red (5YR 5/8) clay or clay loam; moderate fine subangular blocky structure; friable; common medium and fine roots; many pores; 5 to 10% chert fragments; gradual wavy boundary.
- Bt2** 69 to 99 cm; yellowish red (5YR 5/8) with red (2.5YR 4/8) and yellowish brown (1 OYR 5/6) saprolite colors; clay or clay loam; moderate fine subangular blocky structure; firm; yellowish red (5YR 5/8) clay films on all ped faces; common medium and fine roots; many pores; 5 to 10% chert fragments; gradual wavy boundary.
- BC** 99 to 139 cm; brownish yellow (10YR 6/6) and red (2.5YR 4/8) saprolite colors; clay or clay loam: weak coarse subangular and angular blocky structure; very firm: red (2.5YR 4/8) clay films on many ped faces and coating large pores; few fine roots; many pores; 5 to 10% chert fragments; gradual wavy boundary.
- CB** 139 to 187 cm; yellowish brown (10YR 5/8) saprolite that easily crushes to silty clay loam; angular blocks from fractured saprolite; very firm; strong brown (7.5YR 5/6) clay flows on most faces: water flow zones with light gray (1 OYR 7/1) interiors and olive yellow (2.5Y 6/8) exteriors; few fine roots; many pores; clear wavy boundary.
- CI** 187 to 231 cm; strong brown (7.5YR 5/6) and brownish yellow (10YR 6/8) saprolite that easily crushes to silty clay loam; angular blocks from fractured saprolite; very firm; yellowish red (5YR 5/8) clay flows on some faces; red (2.5YR 4/8) iron plasma in pores and coating some faces; few fine roots; many pores; less than 5% chert fragments; clear wavy boundary. (Manganese concentrate zone marks base of horizon.)

- C2 231 to 276 cm; yellowish red (5YR 5/6) and brownish yellow (10YR 6/8) multi-colored saprolite with thin strata of disoriented highly weathered grayish and reddish very fine grained sandstone that crushes to silty clay loam; very firm; water flow zones have light gray (10YR 7/2) interiors and yellowish iron depleted exteriors: few fine roots; common to many manganese concentrate bodies; less than 5% chert fragments.

Soil Series No. 403

Location: East Chestnut Ridge site in long trench that crosses the Chepultepec-Longview and Longview-Kingsport boundaries. E61050, N26450
 Classification: Typic Hapludults; clayey-skeletal, kaolinitic, thermic
 Geomorphic Position: Summit shoulder and upper sideslope
 Slope and Aspect: 15 to 18% SE
 Parent Material(s): Longview residuum, uppermost part of the section
 Vegetation: Hardwoods
 Described By: Lietzke
 Date: May 30, 1989

Soil Description

- O** 3 to 0 cm; leaf litter and root mat.
- A** 0 to 10 cm; very dark grayish brown (1 OYR 3/2) very cherty silt loam; strong fine granular structure; very friable; many fine and common medium roots; 45 to 50% chert fragments; clear wavy boundary.
- E** 10 to 27 cm; light yellowish brown (10YR 6/4) very cherty silt loam: weak fine granular structure; very friable; many fine and common medium roots; 45 to 50% chert fragments; clear wavy boundary.
- B/E** 27 to 37 cm; strong brown (7.5YR 5/6) B part, and yellowish brown (10YR 5/6) E part; very cherty silty clay loam; weak fine subangular blocky structure: very friable; few fine and medium roots; 35 to 40% fragments; clear wavy boundary.
- Bt1** 37 to 56 cm; red (2.5YR 4/8) cherty to very cherty clay; moderate medium subangular blocky structure; friable; few fine and medium roots; 30 to 40% fragments; gradual wavy boundary.
- Bt2** 56 to 77 cm; mottled red (2.5YR 4/8) and yellowish red (5YR 5/6) very cherty clay; moderate medium subangular blocky structure; firm; some yellowish brown (10YR 5/6) saprolite bodies in ped interiors; strong brown (7.5YR 5/6) clay on ped surfaces; few fine roots; 30 to 40% fragments; gradual wavy boundary.

- Bt3** 77 to 110 cm; distinctly mottled yellowish brown (**10YR 5/6**) and yellowish red (**5YR 5/6**) very cherty clay with some red (**2.5YR 4/8**) streaks; moderate fine subangular blocky structure; firm; strong brown (**7.5YR 5/6**) clay on ped surfaces; 35 to 45% chert fragments; gradual wavy boundary.
- BC** 110 to 135 cm; prominently mottled red (**2.5YR 4/8**), brownish yellow (1 OYR **6/6**), and olive yellow (**2.5Y 6/6**) very cherty clay; weak fine subangular blocky structure; firm; yellowish red (**5YR 5/6**) clay on ped surfaces; no roots; 35 to 45% fragments. (Upper clay-plugged saprolite.)

Soil Series No. 404

Location: East Chestnut Ridge. Trench in open field. E58500, N25550
 Classification: Typic Hapludults; clayey, mixed, thermic
 Geomorphic Position: Broad ridgetop bench
 Slope and Aspect: 4 to 5% SE
 Parent Material(s): Lowermost Mascot residuum
 Vegetation: Grass and weeds
 Described By: Lietzke
 Date: May 23, 1989

Soil Description

- Ap** 0 to 20 cm; dark brown (**10YR 3/3**) cherty loam; moderate fine granular structure; friable; many fine roots; 20 to 25% chert fragments; abrupt wavy boundary.
- Bt1** 20 to 36 cm; strong brown (**7.5YR 4/6**) cherty clay loam; weak fine subangular blocky structure; friable; common fine roots; 15 to 20% chert fragments; clear wavy boundary.
- Bt2** 36 to 68 cm; red (**2.5YR 4/8**) clay; moderate fine and medium subangular blocky structure; firm; red (**2.5YR 4/6**) clay films on ped faces; 10 to 15% chert fragments; gradual wavy boundary.
- Bt3** 68 to 117 cm; mottled red (**2.5YR 4/8**) and yellowish red (**5YR 5/6**) clay; moderate fine angular blocky structure; very firm; yellowish red (**5YR 4/6**) clay films on ped faces; some saprolite remnants in ped interiors; few fine roots; 5 to 10% chert fragments; gradual wavy boundary.
- BC** 117 to 145 cm; prominently mottled red (**2.5YR 4/8**), brownish yellow (1 OYR **6/8**) and yellowish red (**5YR 5/6**) clay; moderate fine angular blocky structure; very firm; clay plugged; few fine roots; 5 to 10% chert fragments; gradual irregular boundary.
- CB** 145 to 185 cm; swirled brown (1 OYR **4/3**), yellowish red (**5YR 4/6**), strong brown (**7.5YR 5/6**) and brownish yellow (1 OYR **6/8**) saprolitic material that easily crushes to clay; very firm (augered).

- C 185 to 263 cm; multi-colored saprolite that is dominated by reds in the upper part and yellows in the lower part; black manganese coatings on some cracks. (Hit chert fragment at 263 cm.)

NOTES: Enough chert matrix sandstone occurs so that the surface of these soils commonly has a loam and sometimes a fine sandy loam texture.

Soil Series No. 405

Location: Southeast corner of Walker Branch Watershed above weirs. Approx. 75' N of grid point 7582, 5546
 Classification: Typic Hapludalfs; fine, mixed, thermic
 Geomorphic Position: Uppermost bench of bench **landform** segments on steep sideslope
 Slope and Aspect: 35 to 40% NW
 Parent Material(s): Mascot residuum
 Vegetation: Hardwoods
 Described By: **Lietzke**
 Date: May 22, 1989

Soil Description

- O 3 to 0 cm; leaf litter.
- A 0 to 11 cm; very dark grayish brown (1 OYR **3/2**) extremely cherty silt loam; moderate fine granular structure; very friable; many fine and few medium roots; 75 to 85% chert lag from slopes above; clear wavy boundary.
- E 11 to 20 cm; yellowish brown (1 OYR **5/4**) very cherty silt loam; weak fine granular structure; very friable; common fine and few medium roots; 50 to 75% lag chert; clear wavy boundary.
- Bt1 20 to **45** cm; red (**2.5YR 4/8**) clay; moderate medium and coarse subangular blocky structure; firm; continuous yellowish red (**5YR 4/6**) clay flows on ped surfaces; common fine and medium roots; 10 to 15% fragments; gradual wavy boundary.
- Bt2 45 to 75 cm; red (**2.5YR 4/6**) clay; moderate medium and coarse subangular and angular blocky structure; very firm; continuous red (**2.5YR 4/8**) clay flows on ped surfaces; few fine and medium roots; **10** to 15% fragments; clear irregular boundary.
- BC 75 to 86 cm; light yellowish brown (**10YR 6/4**) chert seam and sandstone that crushes to sandy loam; massive; sand strata saturated; few fine and medium roots; abrupt wavy boundary.

- CB** 86 to 140 cm; red (**2.5YR 4/6**) clay; fine angular blocks brachiated?; friable; thin dark reddish brown (**2.5YR 3/4**) strata: some thin strata fragments are coated with iron-manganese oxides; few fine roots; 1 to 5% fragments; clear irregular boundary.
- C** 140 to 148 cm: pinkish gray (**7.5YR 7/2**) and red (**2.5YR 4/8**) soft saprolite; massive.
- R** 148 cm; carbonate rock contact.

NOTES: Removed large chert fragment with slickensides on surface, which indicates that the rock may have been brachiated. Removed small unattached dolomite ledge from right side of pit at a depth of 50 cm. Depth to rock on other side of pit was 150 cm.

Soil Series No. 406

Location:	East Chestnut Ridge. E58730, N26050
Classification:	Typic Hapludults; clayey, kaolinitic , thermic
Geomorphic Position:	Ridgetop bench landform
Slope and Aspect:	3-4% SE
Parent Material(s):	Kingsport residuum
Vegetation:	Hardwoods
Described By:	Lietzke in lineament trench
Date:	May 23, 1989

Soil Description

- O** 2 to 0 cm; leaf litter and some grass.
- A** 0 to 4 cm; very dark grayish brown (**10YR 3/2**) cherty silt loam; strong fine granular structure; very friable: many fine roots; 15 to 20% chert fragments; abrupt wavy boundary.
- E** 4 to 16 cm; pale olive (**5Y 6/4**) cherty silt loam; moderate fine granular structure; very friable; many fine roots; 15 to 20% chert fragments: clear wavy boundary.
- EB** 16 to 28 cm; strong brown (**7.5YR 5/8**) **cherty** silty clay loam; weak fine subangular blocky structure; very friable; common fine roots; 15 to 20% chert fragments: clear wavy boundary.
- Btl** 28 to 48 cm; yellowish red (**5YR 5/18**) clay; moderate fine subangular blocky structure; **friable**; strong brown (**7.5YR 5/6**) clay films on most ped faces; common fine roots; 5 to 10% chert fragments; gradual wavy boundary.

- Bt2 48 to 75 cm; mottled red (2.5YR 4/8) and strong brown (7.5YR 5/6) clay; moderate fine angular blocky structure; firm; red (2.5YR 4/8) clay films on most ped faces; light gray (10YR 7/2) streaks due to perching of water; remnant saprolite colors in some ped interiors in the lower part; few fine roots; 5 to 10% chert fragments; gradual wavy boundary.
- BC 75 to 135 cm; highly mottled saprolitic and drainage colors of reds, yellow browns and light grays; clay; moderate fine angular blocky structure; very firm; brown (7.5YR 5/4) clay films on most ped faces; few fine roots; 5 to 10% chert fragments; most ped interiors are saprolite; gradual irregular boundary.
- CB 135 to 150 cm; multi-hued reddish and yellowish very soft saprolitic material that easily crushes to clay, but there are distinct strata that are silt loam or silty clay loam; friable; massive rock controlled structure.

NOTES: Depth to the CB horizon ranges from 75 to 140 cm in the trench.

Soil Series No. 407

Location: Walker Branch Watershed. About 50' grid south of 6074-6790 grid stake in recent **tipover**

Classification: Typic Hapludults; clayey or clayey-skeletal, kaolinitic, thermic

Geomorphic Position: **Steep sideslope** above main channel of west fork

Slope and Aspect: **40% WSW**

Parent Material(s): **Surficial** creep and residuum of Kingsport, **1-2%** outcrops in delineation

Vegetation: Forest

Described By: **Lietzke**

Date: January 11, 1990

Soil Description

Oi & Oe 4 to 0 cm; oak leaves.

Oa-A 0 to 1 cm; black (10YR 2/1) extremely cherty silt loam; moderate fine granular structure; very friable; more than 70% chert fragments; many fine and few medium roots; abrupt wavy boundary.

E1 1 to 28 cm; light brownish gray (2.5Y 6/2) extremely cherty silt loam; weak fine granular structure; very friable; slightly sticky; **60-70%** chert fragments; many fine and common medium roots; gradual wavy boundary.

E2 28 to 41 cm; light yellowish brown (2.5Y 6/4) extremely cherty silty clay loam; weak fine subangular blocky structure; very friable; sticky; **50-65%** chert fragments; few **fine** roots; few medium roots; few coarse roots; clear irregular boundary.

- E/B** 41 to 56 cm; light yellowish brown (**2.5Y 6/4**) extremely cherty silt loam E part, and strong brown (**7.5YR 5/6**) extremely cherty silty clay loam B part; weak medium subangular blocky structure; very friable; sticky; **45-55%** chert fragments; few fine roots; few medium roots; clear irregular boundary. (Boundary includes thin B/E horizon.) Base of saturated soil.
- Bt** 56 to 79 cm; red (**2.5YR 4/8**) with streaks and ped coatings of yellowish red (**5YR 5/6**) and strong brown (**7.5YR 5/6**) cherty clay; moderate fine and medium subangular blocky structure; friable; 20 to 25% chert fragments; few fine and few medium roots; abrupt irregular boundary. (Chert fragments become oriented with respect to strike and dip at base of horizon.)
- BC** 79 to **120** cm; highly mottled red (**2.5YR 4/8**), yellowish red (**5YR 5/8**), strong brown (**7.5YR 5/6**) and yellowish brown (**10YR 5/8**) clay plugged saprolitic material that very easily crushes to cherty clay; massive; firm; red (**2.5YR 4/6**) clay flows in pores and cracks; black Mn-Fe zones; **15-25%** highly weathered gravel sized chert fragments; few medium roots; diffuse irregular boundary.
- CB** 120 to 170 cm; saprolitic strata of red (**2.5YR 4/8**) clay, brownish yellow (**10YR 6/8**) silty clay loam, and yellow (**10YR 7/6-7/8**) silt loam; massive; clay plugged with red (**2.5YR 4/8**) clay flows; black Mn-Fe coatings; common highly weathered oitic and relatively less weathered chalcedaneous chert fragments.

NOTES: Pit dug to 50 inches, **augered** rest of way to 67 inches and large chert fragment. This delineation has an cave opening.

Soil Series No. 408

Location: Walker Branch Watershed above old road that goes down from subsurface transport research site. Along grid line 7130. East about 100 feet between grid point 7130, 5470, and grid point 7130, 5734, then about 60 feet grid north.

Classification: Typic Hapludults; loamy-skeletal, siliceous, thermic

Geomorphic Position: **Steep dip slope**

Slope and Aspect: **30% SSW**

Parent Material(s): **Chepultepec** chert beds with 30 cm of **surficial** cherty creep

Vegetation: Hardwoods

Described By: **Lietzke**

Date: **May 2, 1989**

Soil Description

- 0 4 to 0 cm; oak leaf litter.
- A1 0 to 5 cm; very dark brown (**10YR 2/2**) cherty silt loam; strong fine granular structure; very friable; many fine roots; 15 to 20% chert fragments; clear wavy boundary.
- A2 5 to 16 cm; dark brown (1 OYR **3/3**) cherty silt loam; strong fine granular structure; very friable; many fine roots; 20 to 50% chert fragments: clear wavy boundary.
- E 16 to 40 cm; yellowish brown (1 OYR **5/4**) extremely cherty silt loam; weak fine granular structure; very friable to loose; organic matter streaming downward; common fine and medium roots: 50 to 70% chert fragments; gradual irregular boundary.
- E/B** 40 to 61 cm; light yellowish brown (**10YR 6/4**) E part, and yellowish brown (**10YR 5/4**) B part, extremely cherty silt loam; weak medium subangular blocky structure; very friable to loose; few brown (**7.5YR 4/4**) clay bridges; few fine and medium roots; 70 to 80% chert fragments; gradual irregular boundary.
- B/E** 61 to 90 cm; yellowish brown (**10YR 5/6**) extremely cherty silty clay loam B part, and pale brown (1 OYR **6/3**) extremely cherty silt loam E part; weak coarse subangular blocky structure; friable to firm; few strong brown (**7.5YR 4/6**) clay bridges and clay coatings on fragments; few fine and medium roots; 70 to 75% chert fragments; gradual irregular boundary.
- Bt 90 to 114 cm; yellowish brown (**10YR 5/6**) and brownish yellow (**10YR 6/6**) extremely cherty silty clay loam; weak coarse subangular blocky structure; very porous; firm to very firm; yellowish red (**5YR 5/6**) clay coats on fragments, as bridges, and as filaments; few fine roots; 60 to 70% fragments; gradual irregular boundary. (Base of chert bed.)
- BC 114 to 150 cm; mottled yellowish brown (1 OYR **5/6**) and brownish yellow (1 OYR **6/6**) very cherty to extremely cherty clay; weak coarse subangular blocky structure tending towards massive; very firm; yellowish red (**5YR 5/6**) clay coats on fragments, as bridges, and as filaments; few fine roots: 50 to 60% fragments; gradual irregular boundary. (Partially transformed saprolite..)
- CB 150 to 176 cm: mottled yellowish brown, brownish yellow, yellowish red and red very cherty clay, with light gray (**10YR 7/1**) in flow zones; some saprolitic areas are light gray (**10YR 7/2**) but cracks are coated with brownish yellow (1 OYR **6/6**) clay.

NOTES: Estimated permeability is rapid to 70 cm, moderate to 130 cm, and slow below.

KNOX COLLUVIUMSoil Series No. 430

Location: Roane County. ORR West Chestnut site. E18900, N25950
 Classification: Fragic Paleudults; fine-loamy or loamy-skeletal, siliceous, thermic
 Physiography: Upland
 Geomorphic Position: Doubly concave lower footslope
 Slope and Aspect: 4% SE
 Parent Material(s): Younger colluvium over older colluvium
 Vegetation: Pines and hardwoods
 Described By: Lietzke
 Date: December 5, 1983

Soil Description

- 0 4 to 0 cm; leaves, needles and twigs.
- E 0 to 15 cm; dark grayish brown (1 OYR 4/2) gravelly loam; moderate fine granular structure; very friable; many fine and medium roots; 15 to 30% chert fragments; clear wavy boundary.
- Bt1 15 to 39 cm; yellowish brown (1 OYR 5/4) gravelly to very gravelly clay loam; moderate fine to medium subangular blocky structure; friable; thin dark yellowish brown (1 OYR 4/4) clay films on ped faces; few medium roots; 25 to 50% chert fragments; gradual wavy boundary.
- Bt2 39 to 60 cm; brown (7.5YR 4/4) gravelly clay loam; moderate medium subangular blocky structure; friable; thin yellowish red (5YR 4/6) clay films on ped faces; some ped faces coated with black manganese materials; few medium roots; 20 to 35% chert fragments; gradual wavy boundary.
- 2Btx/Ex 60 to 115 cm; yellowish red (5YR 4/6) -B part, and light yellowish brown (10YR 6/4) -E part; gravelly clay loam; weak coarse prismatic structure; 30 to 40% brittle zones mostly associated with Ex, remainder is friable to firm; reddish brown (5YR 4/4) coats both primary and secondary ped faces, pores and roots channels; many vesicular pores in brittle parts; few roots on prism faces and in friable material; 25 to 30% chert fragments; gradual irregular boundary.
- 2Bt 115 to 150 cm; strong brown (7.5YR 5/6) gravelly loam; weak coarse subangular blocky structure; friable; thin red (2.5YR 4/6) clay films on ped faces; many light yellowish brown (10YR 6/4) flow zone streaks descending from the E materials in the horizon above; no roots; 10 to 20% chert fragments.

NOTES: Fluctuating water rises to about 90 cm below the surface or less during rainy periods when soil water is moving laterally. Some areas within the mapping delineation are saturated at the surface for several days during late winter.

Soil Series No. 431

Location: East Chestnut Ridge Site, Doline A. E60850, N27850
 Classification: Fluventic Dystrachrepts; fine-loamy, siliceous, thermic
 Geomorphic Position: **Doline** bottom
 Slope and Aspect: **1-2%**
 Parent Material(s): Modern agricultural sediments overlying an older paleosol
 Vegetation: Hardwoods
 Described By: Lietzke
 Date: July 12, 1989

Soil Description

- A 0 to 23 cm: dark brown (**7.5YR 3/2**) very cherty silt loam slope wash; moderate fine granular structure; very friable; common fine and common medium roots; 30 to 40% chert fragments; clear wavy boundary.
- C 23 to 98 cm; dark brown (**7.5YR 3/3**) loam; massive; stratified; friable; thin strata and bits of red silty clay loam scattered throughout; charcoal fragments scattered throughout; few fine and medium roots; 5 to 10% chert fragments; clear wavy boundary.
- Ab 98 to 140 cm; dark brown (**7.5YR 3/2**) silt loam; strong fine granular structure; very friable; few fine roots; less than 10% chert fragments; high amount of charcoal fragments in upper part; gradual wavy boundary.
- Bw 140 to 190 cm: dark brown (**7.5YR 3/4**) silt loam; weak fine subangular blocky structure; friable; few fine roots; less than 10% chert fragments; clear wavy boundary.
- 2Bt 190 to 235 cm; strong brown (**7.5YR 4/6**) heavy silt loam; friable; 10 to 15% chert fragments. (augered)
- 3Bt **235** to 260 cm; yellowish red (**5YR 5/8**) cherty silty clay loam; 15 to 25% chert fragments. (augered)

Soil No. 433

Location: Walker Branch Watershed. Pit No 11 from TM 2968. pages 67 to 71
 Classification: Typic (**Humic**) Paleudults, fine-loamy or loamy-skeletal, siliceous, thermic
 Geomorphic Position: Steep sideslopes with easterly aspects
 Slope and Aspect: 25 to 45% E
 Parent Materials: Colluvium over residuum
 Vegetation: Old field succession hardwoods
 Described By: R. Moneymaker, modified by Lietzke

Soil Description

- 0 2 to 0 cm; hardwood litter, the lower part partially decomposed.
- A1 0 to 5 cm; dark brown (7.5YR 3/2) cherty silt loam; strong medium granular structure; friable; abrupt smooth boundary; 27% sand, 7% clay, 66% silt, 19% frags., 34% base sat.
- A2 5 to 23 cm; dark brown (7.5YR 4/2) cherty silt loam: weak medium granular structure; friable; clear smooth boundary; 26% sand, 7% clay, 67% silt, 20% frags., 55% base sat.
- Bt1 23 to 38 cm; strong brown (7.5YR 5/6) cherty silt loam; weak medium subangular blocky structure: friable; patchy clay films; clear smooth boundary; 22% sand, 12% clay, 66% silt, 17% frags., 29% base sat.
- Bt2 38 to 60 cm; strong brown (7.5YR 5/6) cherty silt loam: moderate fine and medium subangular blocky structure; friable; common clay films; clear smooth boundary; 18% sand, 20% clay, 63% silt, 23% frags., 71% base sat.
- 2Bt3 60 to 80 cm; yellowish red (5YR 4/8) cherty silt loam; moderate medium subangular blocky structure; firm; patchy clay films; gradual smooth boundary. 18% sand, 17% clay, 65% silt, 22% frags., 58% base sat.
- 2Bt4 80 to 110 cm; yellowish red (5YR 4/8) cherty silt loam; strong medium subangular blocky structure; firm; patchy clay films; 19% sand, 20% clay, 61% silt, 34% frags., 27% base sat.

Soil Series No. 434

Location: Walker Branch Watershed. Pit No. 3 from TM-2968, pages 25 to 28

Classification: Typic Paleudults; fine-loamy, siliceous, thermic

Geomorphic Position: Linear to slightly convex sideslopes

Slope and Aspect: 15 to 25% SW

Parent Materials: Colluvium over residuum

Vegetation: Hardwoods

Described By: R. Moneymaker, modified by Lietzke

Soil Description

- 0 3 to 0 cm; hardwood litter, the lower part partially decomposed.
- E1 0 to 5 cm; grayish brown (1 OYR 5/2) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 41% sand, 2% clay, 57% silt, 17% frags., 20% base sat.

- E2 5 to 38 cm; pale brown (10YR 6/3) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 46% sand, 7% clay, 47% silt, 29% frags., 15% base sat.
- EB 38 to 48 cm; light yellowish brown (10YR 6/4) cherty silt loam; weak medium subangular blocky structure; friable; gradual wavy boundary; 32% sand, 4% clay, 64% silt, 29% frags., 23% base sat.
- BE 48 to 55 cm; yellowish red (5YR 5/6) cherty silt loam; weak medium subangular blocky structure; friable; gradual wavy boundary; 33% sand, 7% clay, 50% silt, 27% frags., 9% base sat.
- Btl 55 to 65 cm; yellowish red (5YR 5/6) cherty silt loam; moderate medium subangular blocky structure; friable; few patchy clay films; clear wavy boundary. 33% sand, 9% clay, 58% silt, 32% frags., 11% base sat.
- Bt2 65 to 102 cm; red (2.5YR 4/8) cherty clay loam; strong medium subangular blocky structure; very firm; continuous clay films; clear wavy boundary; 24% sand, 27% clay, 49% silt, 14% frags., 11% base sat.
- 2Bt3 102 cm; red (2.5YR 4/8) clay.

ANCIENT COLLUVIUM

Soil Series No. 436

Location: East Chestnut Ridge 'Site. E58850, N27630
 Classification: Typic Hapludults; loamy-skeletal over clayey; siliceous, thermic
 Geomorphic Position: **Topoinverted toeslope**
 Slope and Aspect: **5-6% SW**
 Parent Material(s): **Ancient colluvium over truncated Chepultepec residuum**
 Vegetation: Hardwoods
 Described By: Lietzke
 Date: July 11, 1989

Soil Description

- Oi 2 to 0 cm; leaf **litter**.
- Oe-Oa 0 to 5 cm; dark reddish brown (5YR 2/2) **hemic** and sapric materials with dense root mat.
- A 5 to 9 cm; dark brown (1 OYR 3/3) extremely cherty silt loam; strong fine granular structure; very friable; common fine roots; 50 to 60% **chert** fragments; clear wavy boundary.

- E** 9 to 27 cm; olive brown (**2.5Y 4/4**) extremely cherty silt loam; weak fine granular structure; very friable; common fine roots; 50 to 60% chert fragments; gradual wavy boundary.
- Bt1** 27 to 50 cm; light yellowish brown (1 **0YR-2.5Y 6/4**) extremely cherty silty clay loam; moderate medium subangular blocky structure: friable; few fine and few medium roots; 60 to 70% chert fragments: abrupt wavy boundary.
- 2Bt2** 50 to 70 cm; yellowish red (**5YR 5/6**) cherty silty clay loam or cherty clay; moderate medium subangular blocky structure; firm; few fine roots; 25 to 35% chert fragments; gradual wavy boundary.
- 2Bt3** 70 to 92 cm; yellowish red (**5YR 5/6**) and red (**2.5YR 4/8**) cherty clay; moderate medium subangular blocky structure; very firm; few yellowish saprolite splotches in lower part; few fine roots; 25 to 35% chert fragments; gradual wavy boundary.
- 2BC** 92 to 135 cm; yellowish red (**5YR 5/6**) and red (**2.5YR 4/6**) cherty silty clay loam; weak medium subangular blocky structure; firm; common yellowish saprolite splotches; few fine roots; 25 to 35% chert fragments.

NOTES: Most of the surficial colluvium is from older and younger materials that have been reworked and spread over a truncated residual surface. The abrupt boundary at 50 cm indicates the presence of a discontinuity. Depth of ancient colluvium in mapping varied from less than 50 cm to more than 100 cm.

DOLINE SOILS

Soil Series No. 437

Location: Highest hill on south side of Walker Branch Watershed. The pit is located just outside the watershed boundary. Approx 200' grid south of grid point 6338, 5734.

Classification: Typic Fragiudults; fine-silty over loamy-skeletal; siliceous, thermic

Geomorphic Position: **Within a very shallow sidehill doline**

Slope and Aspect: **3 to 4% S**

Parent Material(s): Loess over ancient colluvium

Vegetation: **Pine and oaks of old field succession**

Described By: **Lietzke**

Date: April 27, 1989

Soil Description

- O** 3 to 0 cm; oak leaf litter.
- A** 0 to 7 cm; grayish brown (**2.5Y 5/2**) silt loam; moderate fine granular structure; very friable; many fine and common medium roots; 1 to 5% chert fragments; clear wavy boundary.

- E 7 to 21 cm; olive; (5Y 5/3) silt loam; weak fine granular structure; very friable; few fine and common medium roots; 2 to 5% fragments; gradual wavy boundary.
- EB 21 to 36 cm; yellowish brown (1 OYR 5/4) silt loam; weak fine subangular blocky structure; very friable; few fine and common medium roots; 2 to 5% fragments; clear wavy boundary.
- Btl 36 to 50 cm; dark yellowish brown (10YR 4/6) light silty clay loam; moderate fine subangular blocky structure; very friable; few fine and medium roots; 2 to 5% fragments; gradual wavy boundary.
- Bt2 50 to 65 cm; dark yellowish brown (1 OYR 4/6) cherty silty clay loam; weak fine subangular blocky structure; friable; dark yellowish brown (1 OYR 4/4) clay on ped surfaces; few fine roots; 15 to 30% fragments; gradual wavy boundary. (Mixed zone between loess and colluvium.)
- 2Bt3 65 to 87 cm; strong brown (7.5YR 4/6) extremely cherty silty clay loam; weak fine subangular blocky structure; friable; few fine roots; 50 to 70% fragments; abrupt wavy boundary.
- 2Bx 87 to 94 cm; pale brown (1 OYR 6/3) extremely cherty silt loam to silty clay loam, with dark yellowish brown (1 OYR 4/6) clay coatings; massive?; firm and brittle; no roots; 50 to 70% fragments.

NOTES: Depth of pit 94 cm. Could not auger any deeper.

Soil Series No. 438

Location: ORR. Intersection of **Gasline** Road and Telephone line.
First pit south of intersection. E30000, N26000

Classification: Typic Hapludults; fine-silty, mixed or siliceous, thermic

Geomorphic Position: Bottom of partially breached upland karst depression

Slope and Aspect: **2 to 5% S**

Parent Material(s): Loess over ancient cherty fragipan paleosol

Vegetation: Hardwoods

Described By: Lietzke

Date: April 22, 1988

Soil Description

- Oi 5 to 0 cm; leaf litter and root mat.
- C 0 to 10 cm; yellowish red (5YR 4/6) cherty clay loam; moderate fine granular structure; very friable; common fine and medium roots; many pores; 15 to 25% **chert** fragments; abrupt wavy boundary. (Overwash from pipeline construction.)

- A 10 to 20 cm; olive brown (**2.5Y 4/3**) silt loam; weak fine granular structure; very friable; common fine and medium roots; many pores; 5 to 10% chert fragments; clear wavy boundary.
- E 20 to 33 cm; light olive brown (**2.5Y 5/4**) silt loam: weak medium subangular blocky structure; very friable; common fine and medium roots; many pores; less than 5% chert fragments; clear wavy boundary.
- Btl 33 to 67 cm; light olive brown (**2.5Y 5/6**) silt loam-silty clay loam; moderate medium subangular blocky structure: very friable; common fine and medium roots; many pores; less than 5% chert fragments; clear wavy boundary. (Base of loess)
- Bt2 67 to 79 cm; mixed light olive brown (**2.5Y 5/4**) and yellowish brown (1 OYR **5/4**) cherty silty clay loam; weak medium subangular blocky structure; friable; few fine roots; common pores; 15 to 25% chert fragments; gradual wavy boundary. (Mixed zone)
- Agb 79 to 90 cm; light brownish gray (**2.5Y 6/2**) cherty silt loam or cherty silty clay loam; weak medium subangular blocky structure; friable; few fine roots; common pores: 25 to 35% chert fragments; gradual wavy boundary. (Old A horizon)
- Egb 90 to 104 cm; light brownish gray (**2.5Y 6/2**) very cherty silt loam or very cherty silty clay loam; weak medium subangular blocky structure; friable; few light olive brown (**2.5Y 5/6**) drainage mottles; few fine roots; common pores; 30 to 50% chert fragments; gradual wavy boundary.
- Btgb 104 to 115 cm; light brownish gray (**2.5Y 6/2**) extremely cherty silty clay loam; weak medium subangular blocky structure tending towards massive; very firm; cracks, ped faces, and pores coated with yellowish brown (**10YR 5/8**) and strong brown (**7.5YR 4/6**) iron plasma; few fine roots; few pores; greater than 50% chert fragments.

NOTES: - Standing water in pit at 115 cm', probably perched.
 - Parent materials are recent subsoil overwash, thin cherty slope wash (A horizon), over loess over cherty **slope wash**, over ancient cherty paleosol similar to the ancient cherty No. 436 paleosol in the next pit to the south.

Soil Series No. 439

Location: East Chestnut Ridge, small wet **doline** with well No. 571. E58940, N27660

Classification: **Aeric** or Typic Ochraquults; fine-silty, siliceous, thermic

Geomorphic Position: Bottom of clay-plugged **doline**

Slope and Aspect: 2%

Parent Material(s): Slope wash and loess over cherty colluvium

Vegetation: **Hardwoods**

Described By: **Lietzke**

Date: July 11, 1989

Soil Description

- O** 2 to 0 cm; leaf litter.
- A** 0 to 12 cm: black (10YR 2/1) silt loam; strong medium granular structure; very friable; many fine and common medium roots; 5 to 10% chert fragments; clear wavy boundary.
- Bt1** 12 to 35 cm; olive (5Y 5/4) heavy silt loam; moderate medium subangular blocky structure; friable; slightly sticky; many medium and common fine roots; 5 to 10% chert fragments; clear wavy boundary.
- Bt2** 35 to 63 cm; olive (5Y 5/3) silty clay loam; moderate medium subangular blocky structure; firm; slightly sticky; grayish brown (1 OYR 5/2) coatings on ped faces; few medium and common fine roots; 5 to 10% chert fragments; clear wavy boundary.
- Ab** 63 to 82 cm: grayish brown (1 OYR 5/2) very cherty silty clay loam; moderate fine subangular blocky structure; firm; slightly sticky; dark gray (10YR 4/1) ped coatings; 40 to 50% chert fragments; clear wavy boundary.
- Eg** 82 to 103 cm: gray (1 OYR 6/1) very cherty silt loam; weak fine subangular blocky structure; friable with brittle areas; light yellowish brown (2.5Y 6/4) mottles and strong brown (7.5YR 5/6) iron streaks; few fine roots; 30 to 40% chert fragments; clear wavy boundary.
- Btg** 103 to 135 cm; light gray (10YR 7/1) cherty silty clay loam; moderate medium subangular blocky structure; firm; slightly sticky; 20 to 35% chert fragments; clear wavy boundary.
- Bg** 135 to 145 cm: light gray (1 OYR 7/1) extremely cherty silt loam; friable; strong brown (7.5YR 5/6) iron streaks and stains.

NOTES: The well log of well No. 571 indicates the presence of a high silt content soil to a depth of about 5 feet. From 5 to about 20 feet the material is a gray cherty or very cherty clay loam colluvium. From 28 to 40 feet there is cherty or very cherty clay colluvium. From about 40 feet to 50 feet was clayey reddish saprolite, with gray streaks in flow zones. A dolomite fragment was encountered at a depth of 48 to 50 feet. The saprolite was very wet with red and gray colors. Below 52 feet the saprolite was redder and less wet, but had gray water flow streaks. The hole penetrated to 80 feet with auger refusal in oxidized and slightly leached dolomite fragments. The hole collapsed at about the 10 foot depth, the base of the first perched zone.

ANCIENT ALLUVIUM

Soil Series No. 990

Location: Walker Branch Watershed. Upper left part of seven fingered subwatershed in the only delineation of this soil. Approx. 100 feet grid east of grid point 7054, 7658.

Classification: Rhodic Paleudults; clayey; kaolinitic, thermic

Geomorphic Position: Ancient topographically inverted dissected terrace

Slope and Aspect: **10 to 12% SE**

Parent Material(s): Ancient alluvium

Vegetation: Pines and hardwoods of old field succession

Described By: Lietzke

Date: May 22, 1989

Soil Description

- O** 2 to 0 cm; leaf litter.
- A** 0 to 3 cm: dark reddish brown (5YR 3/2) silty clay loam; moderate **fine** granular structure; very friable; few fine and few medium roots; 0 to 2% fragments; abrupt wavy boundary.
- Ap** 3 to 16 cm; dark reddish brown (**2.5YR 3/4**) silty clay loam; weak fine subangular blocky structure; friable; few fine and few medium roots; 0 to 2% fragments; abrupt wavy boundary.
- Bt** 16 to 150 cm; dark red (**2.5YR 3/6**) clay; strong fine subangular blocky structure; friable; no fragments.

Soil Series No. 991

Location: Walker Branch Watershed in seven-fingered subwatershed of West Fork. Approx. **80** feet grid east of grid point 7318, 7658.

Classification: Typic Paleudults; fine-silty, siliceous, thermic

Geomorphic Position: Topographically inverted loess covered terrace

Slope and Aspect: **5% SW**

Parent Material(s): Loess over old local alluvium over Chepultepec residuum

Vegetation: Pines and hardwoods of old field succession

Described By: Lietzke

Date: May 22, 1989

Soil Description

- O** 2 to 0 cm; leaf litter and root mat.
- A** 0 to 4 cm; very dark grayish brown (**10YR 3/2**) silt loam; moderate fine granular structure; very friable; many fine and few medium roots; 2 to 5% chert fragments; clear wavy boundary.
- AP** 4 to 15 cm; dark brown (**10YR 3/3**) silt loam; weak fine granular structure; very friable; common fine and common medium roots; 2 to 5% chert fragments; clear wavy boundary.
- EB** 15 to 33 cm; yellowish brown (**10YR 5/4**) silt loam; weak fine granular structure; very friable; very porous; common fine and common medium roots; 2 to 5% chert fragments; clear wavy boundary.
- Bt1** 33 to 50 cm; dark yellowish brown (1 OYR **4/6**) heavy silt loam; moderate fine subangular blocky structure; very friable; few fine roots; 2 to 5% chert fragments; gradual wavy boundary.
- Bt2** 50 to 69 cm; dark yellowish brown (1 OYR **4/6**) silty clay loam; moderate fine subangular blocky structure; very friable; few fine roots; 2 to 5% chert fragments; gradual wavy boundary.
- 2Bt3** 69 to 86 cm; strong brown (**7.5YR 5/6**) silty clay loam; weak coarse subangular blocky structure; very friable; many soft red and dark red bodies where iron oxide is accumulating; few fine roots; 10 to 15% chert fragments; clear wavy boundary. (Perched water at base of horizon.) (Mixed zone of soil above and that beneath)
- 2Bt4** 86 to 110 cm; yellowish red (**5YR 4/6**) silty clay loam with yellowish brown mottles; 10 to 15% weathered chert. (augered)
- 2Bt5** 110 to 160 cm; red (**2.5YR 4/8**) silty clay loam; 10 to 15% weathered chert. Base of old alluvium and **toeslope** colluvium.
- 3Bt6** 160 to 190 cm; highly mottled red and yellowish brown clay. Chepultepec residuum.

Soil Series No. 994

Location: ORR. Chestnut Ridge area in Roane County. Pit located between ,new borrow area and Reeves Road. E33950, **N28150**

Classification: Typic Paleudults; fine-loamy, siliceous, thermic

Geomorphic Position: Upper colluvial footslope

Slope and Aspect: 35% east

Parent Material(s): Mixture of ancient alluvium and **toeslope** colluvium over Copper Ridge residuum

Vegetation: Tulip poplar, redbud, dogwood, and pines of old field succession
 Described By: Lietzke
 Date: May 18, 1988

Soil Description

- Oi 4 to 0 cm; leaf litter.
- A1 0 to 20 cm; dark brown (**7.5YR 3/2**) silt loam; strong fine granular structure; very friable; many fine and medium roots; many pores; 10 to 15% chert fragments; many hard dark nodules; clear wavy boundary.
- A2 20 to 34cm; dark brown (**7.5YR 3/4**) silt loam; moderate medium granular structure; very friable; many fine and medium roots; many pores; 10 to 15% chert fragments; many hard dark nodules; clear wavy boundary.
- E 34 to 57 cm; strong brown (**7.5YR 4/6**) cherty silt loam; weak fine subangular blocky structure: very friable; common **fine** and medium roots; many pores; 15 to 25% chert fragments; many hard dark nodules; clear wavy boundary.
- BE 57 to 75 cm; brown (**7.5YR 4/4**) cherty silt loam-cherty silty clay loam; moderate fine subangular blocky structure; very friable; few fine roots; many **pores; 25** to 30% chert fragments; many hard dark nodules; clear wavy **boundary**.
- Bt1 75 to 92 cm; yellowish red (**5YR 4/6**) cherty silty clay loam; moderate medium and fine subangular blocky structure; very friable; few fine roots; many pores: 20 to 30% chert fragments: many hard dark nodules; gradual wavy boundary. Base of cherty alluvium and **toeslope** colluvium.
- Bt2 92 to 129 cm; mixed yellowish red (**5YR 4/6**) and red (**2.5YR 4/8**) cherty silty clay loam; moderate medium subangular blocky structure; friable: few fine roots; many pores; 30 to 35% chert fragments; few hard dark nodules; clear irregular boundary. [mixed zone]
- 2Bt3** 129 to 150 cm; red (**2.5YR 4/8**) cherty clay; firm; few fine and medium roots; 20 to 30% chert fragments; no dark nodules. Copper Ridge residuum.

NOTES: **Chert** fragments in the upper 129 cm of the soil are 'soft and highly weathered. This soil, on east aspects, has an umbric epipedon.

HOLOCENE ALLUVIUM

Soil Series No. 999

Pit No. 13 from TM-2968, Pages 79 to 82

- Al 0 to 5 cm; grayish brown (1 OYR 5/2) silt loam; weak fine granular structure; very friable; abrupt smooth boundary; 24% sand, 7% clay, 69% silt, 11% frags., 43% base sat.
- A2 5 to 23 cm; grayish brown (10YR 5/2) cherty silt loam; weak fine granular structure; friable; abrupt smooth boundary; 25% sand, 4% clay, 71% silt, 17% frags., 57% base sat.
- Bt1 23 to 30 cm; light yellowish brown (10YR 6/4) silt loam; moderate fine subangular blocky structure; friable; gradual wavy boundary; 25% sand, 9% clay, 65% silt, 12% frags., 17% base sat.?
- Bt2 30 to 50 cm; brownish yellow (1 OYR 6/8) silt loam; moderate medium subangular blocky structure; friable to firm; clear smooth boundary; 24% sand, 12% clay, 63% silt, 13% frags., 66% base sat.
- Bt3 50 to 68 cm; brownish yellow (1 OYR 6/8) silt loam: moderate medium subangular blocky structure; friable to firm; mottled, some brittle areas; abrupt smooth boundary; 22% sand, 17% clay, 60% silt, 7% frags., 48% base sat.
- 2c 68 cm; extremely cherty silt loam.

Classification: Typic Hapludults; fine-loamy; siliceous, **thermic**.Soil Series: No. 999

Note: Not a typical example of this soil.

MODERN ALLUVIUMKNOX ALLUVIUMSoil Series No. 981

Location: Walker Branch Watershed approx. 60 feet grid east of grid point 6602, 6526, then about 20 feet grid north.
Close to remains of old cabin

Classification: Fluventic Dystrochrepts; loamy-skeletal, siliceous, thermic

Geomorphic Position: Floodplain

Slope and Aspect: Nearly level

Parent Material(s): Modern alluvium overlying an older truncated very cherty paleosol that either formed in Pleistocene alluvium or colluvium
 Vegetation: Hardwoods
 Described By: Lietzke
 Date: 1986

Soil Description

- A** 0 to 8 cm; very dark grayish brown (1 OYR **3/2**) loam; moderate fine granular structure; very friable; common medium roots; 10% chert fragments; abrupt wavy boundary.
- C** 8 to **15** cm; 60% dark brown (1 OYR **3/3**) and 40% brown (1 OYR **4/3**) sandy loam; massive and stratified; very friable; few fine roots; 10 to 15% chert fragments; abrupt wavy boundary.
- Ab** 15 to 30 cm; dark brown (1 OYR **3/3**) loam; weak fine granular structure; very friable; few fine roots; 5 to 10% chert fragments; clear wavy boundary.
- Bw1** 30 to 65 cm; brown (**10YR 4/3**) cherty loam; weak fine subangular blocky structure; friable; few fine roots; 30 to 35% chert fragments; gradual wavy boundary.
- Bw2** 65 to 93 cm: dark yellowish brown (1 OYR **4/4**) very cherty loam; weak medium subangular blocky structure; friable; no roots; 35 to 40% chert fragments; gradual wavy boundary.
- Bw3** 93 to 118 cm; dark yellowish brown (1 OYR **4/6**) very cherty loam-clay loam; weak medium subangular blocky structure; friable; 35 to 40% chert fragments; some manganese stains and charcoal fragments and a few yellowish red (5YR **5/6**) peds.

Soil Series No. 982 (Site No. 6 W.B.)

Location: Walker Branch Watershed near 320 meter marker above weirs
 Classification: Typic Humaquepts; loamy-skeletal, siliceous, thermic
 Physiography: Recently overwashed gravel bar in floodplain
 Geomorphic Position: **Top of bar**
 Slope and Aspect: **3 to 4%**
 Parent Material(s): **Cherty alluvium** from Knox
 Vegetation: Hardwoods
 Described By: Lietzke
 Date: October 8, 1987

A.3 SOIL CORRELATION FROM TM-2968 (Peters et al. 1970)

<u>Pit no.</u>	<u>New soil no.</u>	<u>Old name</u>	<u>Comments</u>
1	430	Fullerton	Hillside phase with 50 to 80 cm of colluvium over Chepultepec residuum
2	430	Bodine	100 cm to discontinuity. Loamy-skeletal phase
3	434	Fullerton	Greater than 100 cm to discontinuity. Mottled zone but no pale brown mottle and no evident brittleness. Intergrade to No. 430 soils
4	408	Fullerton	Chepultepec soil form in residuum of chert beds. (Inclusion in colluvial delineation.)
5	408	Bodine	Chepultepec soil formed in residuum of chert beds. Upper 60 cm of soil is creep materials
6	434	Bodine	Discontinuity at 130 cm
7	434	Bodine	Discontinuity at 80 cm
8	402	Fullerton	Good example of Chepultepec soil
9	430	Bodine	Hillside phase with 72 cm to discontinuity
10	406	Fullerton	Good example of Kingsport soil
11	433	Claiborne	Typical morphology with thick, dark surface
12	981	Lindside	Typical soil of the floodplain
13	999	Tarklin	Fan terrace phase from local alluvium

Pit No. 1, Page 14, TM-2968

Description has been modified by using current horizon designations, lab data to verify soil textures, and changing depths from inches to centimeters.

- 0 2 to 0 cm; hardwood litter, the lower part partially decomposed.
- E1 0 to 8 cm; grayish brown (**2.5Y 5/2**) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 36% sand, 2% clay, 62% silt, 24% frags., 16% base sat.
- E2 8 to 25 cm; light yellowish brown (1 OYR **6/4**) very cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 25% sand, 9% clay, 66% silt, 39% frags., 9% base sat.

- E3 25 to 45 cm; light yellowish brown (10YR 6/4) very cherty silt loam; weak medium granular structure; friable; the lower part streaked with very pale brown (10YR 8/4); clear irregular boundary; 32% sand, 7% clay, 62% silt, 40% frags., 19% base sat.
- Bt1 45 to 55 cm; reddish yellow (7.5YR 6/6) very cherty silt loam; weak fine subangular blocky structure; firm to friable; few thin patchy clay films; clear irregular boundary; 31% sand, 9% clay, 60% silt, 47% frags., 11% base sat.
- 2Bt2 55 to 65 cm; yellowish red (5YR 5/8) cherty silty clay loam; moderate medium subangular blocky structure; firm; continuous clay films; clear irregular boundary; 31% sand, 33% clay, 50% silt, 17% frags., 10% base sat.
- 2Bt3 65 to 115 cm; red (2.5YR 5/8) clay; strong medium angular blocky structure; very firm; continuous clay films; 12% sand, 39% clay, 49% silt, 2% frags., 6% base sat.

Classification: **Fragic** Paleudults; loamy-skeletal, siliceous, thermic.
Soil Series No. 430, skeletal, hillside phase.

Additional data for this soil is on pages 16, 17, and 18 of TM-2968.

Soil Pit No. 2, Pages 21-24 of TM-2968

- O 1 to 0 cm; hardwood litter, the lower part partially decomposed.
- A 0 to 5 cm; very dark grayish brown (10YR 3/2) cherty silt loam: weak medium granular structure; friable; abrupt smooth boundary: 36% sand, 2% clay, 62% silt, 19% frags., 33% base sat.
- E1 5 to 15 cm: pale brown (1 OYR 6/3) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 24% sand, 14% clay, 61% silt, 27% frags., 10% base sat.
- E2 15 to 50 cm: light yellowish brown (1 OYR 6/4) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 11% sand, 4% clay, 84% silt, 25% frags., 17% base sat.
- Bt1 50 to 68 cm; reddish yellow (7.5YR 6/6) very cherty silt loam; moderate medium subangular blocky structure; friable; few patchy clay films; **gradual smooth** boundary: 37% sand, 7% clay, 56% silt, 51% frags., 15% base sat.
- Bt2 68 to 90 cm: reddish yellow (7.5YR 6/6) very cherty silt loam; moderate medium subangular blocky structure; friable; few thin patchy reddish yellow (5YR 6/8) clay films; gradual wavy boundary; 13% sand, 13% clay, 75% silt, 16% base sat.

NOTE: Additional examination of this pit in 1989 showed a discontinuity at about 100 cm to the clayey Chepultepec residuum beneath.

Pit No. 3 from TM-2968, Pages 25-28

- 0 3 to 0 cm; hardwood litter, the lower part partially decomposed.
- E1 0 to 5 cm; grayish brown (**10YR 5/2**) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 41% sand, 2% clay, 57% silt, 17% frags., 20% base sat.
- E2 5 to 38 cm; pale brown (1 OYR **6/3**) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 46% sand, 7% clay, 47% silt, 29% frags., 15% base sat.
- EB 38 to 48 cm; light yellowish brown (1 OYR **6/4**) cherty silt loam; weak medium subangular blocky structure; friable; gradual wavy boundary; 32% sand, 4% clay, 64% silt, 29% frags., 23% base sat.
- BE 48 to 55 cm; yellowish red (**5YR 5/6**) cherty silt loam; weak medium subangular blocky structure; friable; gradual wavy boundary; 33% sand, 7% clay, 50% silt, 27% frags., 9% base sat.
- Bt1 55 to 65 cm; yellowish red (**5YR 5/6**) cherty silt loam; moderate medium subangular blocky structure; friable; few patchy clay films; clear wavy boundary: 33% sand, 9% clay, 58% silt, 32% frags., 11% base sat.
- Bt2 65 to 102 cm; red (**2.5YR 4/8**) cherty clay loam; strong medium subangular blocky structure; very firm; continuous clay films; clear wavy boundary; 24% sand, 27% clay, 49% silt, 14% frags., 11% base sat.
- 2Bt3** 102 cm; red (**2.5YR 4/8**) clay.

Classification: Typic Paleudults; fine-loamy, siliceous, thermic.
Soil Series: No. 434 (Minvale)

Pi No. 4 from TM-2968, Pages 31 to 35

- 0 2 to 0 cm; hardwood litter, the lower part partially decomposed.
- A 0 to 8 cm; dark grayish brown (1 OYR **4/2**) very cherty silt loam; weak fine granular structure; friable: clear smooth boundary; 47% sand, 4% clay, 49% silt, 44% frags., 40% base sat.
- E1 8 to 33 cm; pale brown (1 OYR **6/3**) very **cherty** silt loam; weak medium granular structure; friable; clear smooth boundary; 34% sand, 12% clay, 54% silt, 44% frags., 6% base sat.

- E2 33 to 43 cm; light yellowish brown (**10YR 6/4**) very cherty silt loam; weak fine granular structure; friable; abrupt smooth boundary: 31% sand, 9% clay, 60% silt, 40% frags., 11% base sat.
- EB 43 to 50 cm; strong brown (**7.5YR 5/6**) extremely cherty silt loam; weak fine subangular blocky structure; friable; clear smooth boundary; 28% sand, 9% clay, 63% silt, 53% frags., 5% base sat.
- Btl 50 to 69 cm; yellowish red (**5YR 5/6**) cherty silty clay; weak medium subangular blocky structure; firm; patchy clay films: gradual smooth boundary; 19% sand, 40% clay, 40% silt, 27% frags., 7% base sat.
- Bt2 69 to 90 cm; red (**2.5YR 5/8**) extremely cherty clay variegated with reddish yellow (**7.5YR 6/8**); strong medium subangular blocky structure; firm; continuous clay films; 19% sand, 49% clay, 33% silt, 65% frags., 8% base sat.

Classification: Typic **Paleudults**; clayey-skeletal, kaolinitic, thermic.
Soil Series: No. 408.

Pit No. 5 from TM-2968, Pages **37 to 40**

- O 3 to 0 cm; hardwood litter, lower part partially decomposed.
- A 0 to 8 cm: dark grayish brown (1 OYR **4/2**) cherty loam; moderate fine granular structure; friable; clear smooth boundary; 47% sand, 4% clay, 49% silt, 27% frags., 34% base sat.
- E1 8 to 20 cm; brown (**10YR 5/3**) **cherty** loam; weak fine and medium granular structure; friable, clear smooth boundary; 47% sand, 12% clay, 41% silt, 34% frags., 16% base sat.
- E2 20 to 60 cm; light yellowish brown (1 OYR **6/4**) very cherty **loam**; weak fine and medium granular structure; friable; clear smooth boundary; 49% sand, 9% clay, 41% silt, 40% frags., 16% base sat.
- BE 60 to 73 cm; reddish yellow (**5YR 6/8**) **extremely cherty** loam; friable; clear wavy boundary; 38% sand, 20% clay, 43% **silt**, 65% frags., 10% base sat.
- Btl 73 to 163 cm: yellowish red (**5YR 5/8**) **very cherty clay** loam; strong medium angular blocky structure; very firm; continuous clay films; 25% sand, 38% clay, 37% silt, 57% frags., 8% base sat.

Classification: Typic **Paleudults**; clayey-skeletal, **kaolinitic**, thermic. (This profile was not described deep enough to get into the clayey **argillic** beneath. The upper 60 cm of the **soil** formed in creep materials.)

Soil Series: No. 408.

Pit No. 6 from TM-2968, Pages 41 to 44

- O 3 to 0 cm; hardwood litter, the lower part partially decomposed.
- A 0 to 8 cm; very dark grayish brown (1 OYR **3/2**) cherty silt loam; weak fine granular structure; friable; abrupt smooth boundary; 20% sand, 2% clay, 78% silt, 33% frags., 19% base sat.
- E 8 to 30 cm; pale brown (**10YR 6/3**) cherty silt loam; weak fine and medium granular structure; friable; clear smooth boundary; 19% sand, 7% clay, 75% silt, 24% frags., 6% base sat.
- EB 30 to 45 cm; light yellowish brown (1 OYR **6/4**) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 19% sand, 7% clay, 75% silt, 29% frags., 15% base sat.
- BE 45 to 65 cm; strong brown (**7.5YR 5/6**) cherty silt loam; weak fine and medium subangular blocky structure; friable; pockets of pale brown (**10YR 6/3**) around fragments and roots; few patchy clay films; clear smooth boundary; 21% sand, 12% clay, 68% silt, 25% frags., 10% base sat.
- Bt1 65 to 85 cm; yellowish red (5YR **5/8**) very cherty silt loam; weak medium subangular blocky structure; firm to friable; common clay films; clear smooth boundary; 16% sand, 17% clay, 66% silt, 41% frags., 7% base sat.
- Bt2 85 to 105 cm; red (**2.5YR 4/8**) very cherty silt loam; strong medium angular blocky structure; firm; continuous clay films; 14% sand, 25% clay, 61% silt, 41% frags., 6% base sat.

NOTE: The discontinuity to clayey residuum occurs at a depth of about 130 cm.

Classification: Typic Paleudults; fine-loamy, siliceous, thermic.

Soil Series: No. 434 (Minvale)

Pi No. 7 from TM-2968, Pages 47 to 50

- O 1 to 0 cm; the surface litter has been burned.
- A 0 to 33 cm; light brownish gray (**10YR 6/2**) very cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 24% sand, 4% clay, 71% silt, 43% frags., 30% base sat.
- Bt 33 to 43 cm; brown (**10YR 5/3**) cherty silt loam, with a few pockets of strong brown (**7.5YR 5/6**) and pale brown (1 OYR **6/3**); weak medium granular structure; friable; clear smooth boundary; 16% sand, 20% clay, 64% silt, 29% frags., 14% base sat.

- 2E1** 43 to 55 cm; yellowish red (5YR 5/6) cherty silt loam; weak medium subangular blocky structure; friable; patchy clay films; clear smooth boundary; 19% sand, 9% clay, 72% silt, 26% frags., 15% base sat.
- 2E2** 55 to 65 cm: yellowish red (5YR 5/8) cherty silt loam; weak medium subangular blocky structure; friable; continuous clay films; clear smooth boundary; 13% sand, 9% clay, 77% silt, 32% frags., 27% base sat.
- 2B't** 65 to 80 cm; red (2.5YR 4/8) cherty silty clay loam: strong medium angular blocky structure; firm; continuous clay films; clear smooth boundary; 13% sand, 35% clay, 51% silt, 23% frags., 27% base sat.
- 3B't** 80 to 123 cm; red (2.5YR 4/8) clay. (This discontinuity to the clayey residuum was noted in 1989.)

Classification: Typic Paleudults; fine-loamy, siliceous, thermic.

Soil Series: No. 434

Pit No. 8 from TM-968, Pages 53 to 56'

- O** 3 to 0 cm; hardwood litter, the lower part partially decomposed.
- E1** 0 to 25 cm; pale yellow (2.5Y 7/4) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 22% sand, 7% clay, 72% silt, 27% frags., 6% base sat.
- EB** 25 to 85 cm; pale yellow (2.5Y 7/4) silt loam; weak fine granular structure; friable; abrupt smooth boundary; 14% sand, 30% clay, 56% silt, 11% frags., 2% base sat.
- BE** 35 to 40 cm; strong brown (7.5YR 5/6) silty clay loam; weak medium subangular blocky structure; friable to firm; few clay films; clear smooth boundary; 15% sand, 28% clay, 58% silt, 8% frags, 4% base sat.
- Btl** 40 to 50 cm: yellowish red (5YR 5/8) clay; moderate medium subangular blocky structure; firm; common clay films; clear smooth boundary; 8% sand, 64% clay, 28% silt, 4% frags., 3% base sat.
- Bt2** 50 to 100 cm; yellowish red (5YR 5/8) clay; strong medium subangular blocky structure; firm to very firm; continuous clay films; 4% sand, 75% clay, 22% silt, 2% frags., 1% base sat.

Classification: Typic Paleudults; clayey, kaolinitic, thermic.

Soil Series: No. 402, Excellent example of a Chepuitepec soil

Pit No. 9 from TM-2968, Pages 57 to 60

- O 3 to 0 cm; hardwood litter, with a very thin partially decomposed layer.
- A 0 to 8 cm; very dark gray (**10YR 3/1**) extremely cherty silt loam. (This layer consists mostly of **chert** fragments.) 35% sand, 4% clay, 61% silt, 84% frags., 4% base sat.
- E 8 to 50 cm; pale yellow (**2.5Y 7/4**) very cherty silt loam; weak medium granular structure; friable; clear smooth boundary; 31% sand, 14% clay, 55% silt, 41% frags., 8% base sat.
- Btl 50 to 73 cm; yellow (1 OYR **7/6**) very cherty silt loam; weak medium to fine subangular blocky structure; friable; few patchy clay films; clear wavy boundary; 25% sand, 17% clay, 58% silt, 51% frags., 3% base sat.
- 2Bt2** 73 to 80 cm; yellowish red (**5YR 5/6**) silty clay; moderate medium subangular blocky structure; firm; continuous clay films; clear smooth boundary; 11% sand, 43% clay, 46% silt, 6% frags., 2% base sat.
- 2Bt3** 80 to 103 cm; yellowish red (**5YR 5/8**) clay; strong medium angular blocky structure; very firm; continuous clay films; 4% sand, 72% clay, 24% silt, 3% frags., 3% base sat.

Classification: **Fragic** Paleudults; fine-loamy, siliceous, thermic.

Soil Series: Soil No. **430.**, hillside phase.

NOTES: A discontinuity to the underlying Chepultepec clayey residuum was noted in 1989 at a depth of 72 cm.

Pit No. 10, from TM-2968, Pages 61 to 64

- O & A 0 to 5 cm; these layers have been almost destroyed by fire; 23% sand, 2% clay, 76% silt, 38% frags., 4% base sat.
- E 5 to 23 cm; light yellowish brown (**10YR 6/4**) cherty silt loam; weak fine granular structure; friable; abrupt smooth boundary; 21% sand, 4% clay, 74% silt, 21% frags., 7% base sat.
- BE 23 to 28 cm; yellowish red (**5YR 5/6**) to strong brown (**7.5YR 5/6**) cherty silt loam: weak medium granular structure; friable; pockets of light yellowish brown (1 OYR **6/4**); clear smooth boundary; 17% sand, 14% clay, 68% silt, 34% frags., 4% base sat.
- Btl 28 to 35 cm; yellowish red (**5YR 5/6**) cherty silty clay; weak medium angular and subangular blocky structure; firm; patchy clay films; clear smooth boundary; 12% sand, 46% clay, 42% silt, 18% frags., 1% base sat.

- Bt2 35 to 50 cm; red (2.5YR 4/8) clay; strong coarse angular blocky structure; firm or very firm; continuous clay films; highly weathered light gray chert; gradual smooth boundary; 8% sand, 55% clay, 37% silt, 10% frags., 2% base sat.
- Bt3 50 to 73 cm; red (2.5YR 4/8) variegated with yellow (10YR 7/8) cherty clay; strong coarse and medium angular blocky structure; very firm; continuous clay films; highly weathered light gray chert; gradual smooth boundary; 5% sand, 67% clay, 29% silt, 3% frags., 2% base sat.
- BC 73 to 105 cm; prominently mottled red (2.5YR 4/8) and yellow (1 OYR 7/8) silty clay; strong coarse and medium angular blocky structure; very firm; continuous clay films; highly weathered light gray chert; 6% sand, 48% clay, 46% silt, 11% frags., 1% base sat.

Classification: Typic Hapludults; clayey, kaolinitic, thermic.

Soil Series: No. 406.

NOTE: Good example of a Kingsport soil.

Pit No. 11 from TM-2968, Pages 67 to 71

- O 2 to 0 cm; hardwood litter, the lower part partially decomposed.
- A1 0 to 5 cm; dark brown (7.5YR 3/2) cherty silt loam; strong medium granular structure; friable; abrupt smooth boundary; 27% sand, 7% clay, 66% silt, 19% frags., 34% base sat.
- A2 5 to 23 cm; dark brown (7.5YR 4/2) cherty silt loam; weak medium granular structure; friable; clear smooth boundary; 26% sand, 7% clay, 67% silt, 20% frags., 55% base sat.
- Bt1 23 to 38 cm; strong brown (7.5YR 5/6) cherty silt loam; weak medium subangular blocky structure; friable; patchy clay films; clear smooth boundary; 22% sand, 12% clay, 66% silt, 17% frags., 29% base sat.
- Bt2 38 to 60 cm; strong brown (7.5YR 5/6) cherty silt loam; moderate fine and medium subangular blocky structure; friable; common clay films; clear smooth boundary; 18% sand, 20% clay, 63% silt, 23% frags., 71% base sat.
- 2Bt3** 60 to 80 cm; yellowish red (5YR 4/8) cherty silt loam; moderate medium subangular blocky structure; firm; patchy clay films; gradual smooth boundary; 18% and 17% clay, 65% silt, 22% frags., 58% base sat.
- 2Bt4** 80 to 110 cm; yellowish red (5YR 4/8) cherty silt loam; strong medium subangular blocky structure; firm; patchy clay films; 19% sand, 20% clay, 61% silt, 34% frags., 27% base sat.

Classification: **Humic** Hapludults; fine-loamy, siliceous, thermic.

Soil Series: No. 433

Pit No. 12 from TM-2968, Pages 73 to 76

- Al 0 to 5 cm; very dark grayish brown (**10YR 3/2**) cherty silt loam; strong medium granular structure; very friable; abrupt smooth boundary; 24% sand, 14% clay, 61% silt, 27% frags., 56% base sat.
- A2 5 to 18 cm; dark brown (**10YR 4/3**) cherty silt loam; weak fine granular structure; friable; clear smooth boundary; 40% sand, 9% clay, 51% silt, 35% frags., 55% base sat.
- AC 18 to 38 cm; dark grayish brown (1 OYR **4/2**) very cherty silt loam; weak fine granular structure; firm to friable; clear smooth boundary; 29% sand, 12% clay, 59% silt, 38% frags., 47% base sat.
- Cl 38 to 55 cm; yellowish brown (1 OYR **5/4**) extremely cherty loam; weak fine granular structure; friable; gradual smooth boundary; 50% sand, 14% clay, 36% silt, 64% frags., 59% base sat.
- c2 55 to 88 cm; yellowish brown (1 OYR **5/8**) extremely cherty sandy loam; weak fine subangular blocky structure; friable; 64% sand, 17% clay, 19% silt, 64% frags., **46%** base sat.

Classification: Typic Udifluvents; loamy-skeletal, siliceous, thermic.

Soil Series: No. 981

Pit No. 13 from TM-2968, Pages 79 to 82

- Al 0 to 5 cm; grayish brown (**10YR 5/2**) silt loam; weak fine granular structure; very friable; abrupt smooth boundary; 24% sand, 7% clay, 69% silt, 11% frags., 43% base sat.
- A2 5 to 23 cm; grayish brown (1 OYR **5/2**) cherty silt loam; weak fine granular structure; friable; abrupt smooth boundary; 25% sand, 4% clay, 71% silt, 17% frags., 57% base sat.
- Bt1 23 to 30 cm; light yellowish brown (1 OYR **6/4**) silt loam; moderate fine subangular blocky structure; friable; gradual wavy boundary; 25% sand, 9% clay, 65% silt, 12% frags., 17% base sat.?
- Bt2** 30 to 50 cm; brownish yellow (1 OYR **6/8**) silt loam; moderate medium subangular blocky structure; friable to firm; clear smooth boundary; 24% sand, 12% clay, 63% silt, 13% frags., 66% base sat.

Bt3 50 to 68 cm; brpwnish yellow (1 OYR 6/8) silt loam; moderate medium subangular blocky structure; friable to firm; mottled, some brittle areas; **abrupt smooth** boundary; 22% sand, 17% clay, 60% silt, 7% frags., 48% **base sat.**

2c 68 cm; extremely **cherty** silt loam.

Classification: Typic Hapludults; fine-loamy; siliceous, thermic.

Soil Series: No. 999

NOTE: Not a typical example of this soil.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

INTERNAL DISTRIBUTION

1. S. I. Auerbach, Building 1505, Mail Stop 6036
2. L. D. Bates, Building K-1 001, Mail Stop 7169
3. H. L. Boston, Building **7078-A**, Mail Stop 6402
4. J. W. Chason, Building 1505, Mail Stop 6036
5. R. B. Clapp, Building 1505, Mail Stop 6036
6. L. W. Cooper, Building 1505, Mail Stop 6036
7. J. H. Cushman, Building 1503, Mail Stop 6352
8. R. Dreier, Building 1503, Mail Stop 6352
9. N. T. Edwards, Building 1506, Mail Stop 6034
10. N. D. **Farrow**, Building 3504, Mail Stop 6317
11. T. A. Fontaine, Building 1505, Mail Stop 6036
12. D. E. Fowler, Building 1505, Mail Stop 6035
13. C. W. Francis, Building 3504, Mail Stop 6317
14. C. T. **Garten**, Building 1505, Mail Stop 6036
15. C. W. Gehrs, Building 1505, Mail Stop 6036
16. P. J. Hanson, Building 1506, Mail Stop 6034
17. R. D. Hatcher, Building 1503, Mail Stop 6352
18. S. G. Hildebrand, Building 1505, Mail Stop 6037
- 19-73. M. A. Huston, Building 1505, Mail Stop 6036
74. P. M. **Jardine**, Building 1505, Mail Stop 6036
75. J. D. **Joslin**, Building 1506, Mail Stop 6034
76. P. Kanciruk, Building 0907, Mail Stop 6490
77. R. H. Ketelle, Building **4500N**, Mail Stop 6165
78. B. L. **Kimmel**, Building **7078-A**, Mail Stop 6402
79. I. L. Larsen, **Building** 1505, Mail Stop 6036
80. P. J. Lemiszki, **Building** **1503**, Mail Stop 6352
- 81-90. D. A. Lietzke, Building 1505, Mail Stop 6036
91. J. M. Loar, Building 1504, Mail Stop 6351
92. R. J. Luxmoore, Building 1505, Mail Stop 6036
93. L. K. Mann, Building 1505, Mail Stop 6036
94. W. M. **McMaster**, Building 1503, Mail Stop 6352
95. P. J. Mulholland, Building 1505, Mail Stop 6036
96. R. J. **Norby**, Building 1506, Mail Stop 6034
97. E. G. **O'Neill**, Building 1506, Mail Stop 6034
98. A. V. Palumbo, Building 1505, Mail Stop 6036
99. P. D. Parr, Building. 1506, Mail Stop 6034
100. B. S. Pedersen, Building 1506, Mail Stop 6034
101. W. M. Post, Building 1000, Mail Stop 6335
102. D. **E. Reichle**, Building **4500N**, Mail Stop 6253
103. F. E. Sharples, Building 1505, Mail Stop 6036
104. D. S. Shriner, Building 1505, Mail Stop 6036
105. D. K. Solomon, Building 1503, Mail Stop 6352
106. S. H. Stow, Building 1505, Mail Stop 6036
107. J. Switek, Building 3504, Mail Stop 6317
108. S. P. Timmins, Building 1505, Mail Stop 6036
109. D. E. Todd, Building 1505, Mail Stop 6036
110. R. R. Turner, Building 1505, Mail Stop 6036

INTERNAL DISTRIBUTION (Continued)

- 111. R. S. Turner, Building 1505, Mail Stop 6638
- 112-113. Central Research Library, Building **4500N**, Mail Stop 6191
- 114-128. ESD Library, Building 1505, Mail Stop 6635
- 129-130. Laboratory Records Department, Building **4500N**, Mail Stop 6285
- 131. Laboratory Records, ORNL-RC, Building **4500N**, Mail Stop 6285
- 132. ORNL Patent Section, Building **4500N**, Mail Stop 6285
- 133. ORNL Y-1 2 Technical Library, Building 971 **1-1**, Mail Stop 8104

EXTERNAL DISTRIBUTION

- 134. J. W. Elwood, Office of Energy Research, ER-74, U.S. Department of Energy, Washington, DC 26845
- 135. R. N. Farvolden, Professor, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario **N2L 3G1**, Canada
- 136. D. W. Freckman, Director, College of Natural Resources, 101 Natural Resources Building, Colorado State University, Fort Collins, CO 86523
- 137. D. Genereux, Department of Civil Engineering, Building 48, Room 419, Massachusetts Institute of Technology, Cambridge, MA 02139
- 138. R. C. Harriss, Institute for the Study of Earth, **Oceans**, and Space, Science and Engineering Research Building, University of New Hampshire, Durham, NH 03824
- 139. D. W. Johnson, Biological Sciences Center, Desert Research Institute, P. O. Box 60220, Reno, NV **89506-0220**
- 140. G. Y. Jordy, Director, Office of Program Analysis, Office of **Energy** Research, ER-30, G-226, U.S. Department of Energy, Washington, DC 20545
- 141. C. D. Jorgensen, Environmental Sciences Division, ER-74, Office of Health and Environmental Research, U.S. Department of Energy, Washington, DC 20585
- 142. J. D. O'Dell, Plant and Soil Science Department, The University of Tennessee, Knoxville, TN **37996-4500**
- 143. R. H. Olsen, Professor, Microbiology and Immunology Department, University of Michigan, Medical **Sciences** II, **#5605**, 1301 East Catherine Street, Ann Arbor, MI **48109-0620**
- 144. A. Patrinos, Director, Environmental Sciences Division, Office of Health and Environmental Research, ER-74, U.S. Department of Energy, Washington, DC 20585
- 145. A. D. Steinman, Science Applications International Corporation, 10260 Campus Point Road, M/S C-2, San Diego, CA 92121-1578
- 146. H. Van Miegroet, Department of Forest Resources, Utah State University, Logan, UT 84322-5215
- 147. F. J. Wobber, Environmental Sciences Division, **Office** of Health and Environmental Research, ER-74, U.S. Department of Energy, Washington, DC 20585
- 148. Office of Assistant Manager for Energy Research and Development, U.S. Department of Energy Oak Ridge Operations, P. O. Box **2001**, Oak Ridge, TN **37831-8600**
- 149-I 50. Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for ensuring transparency and accountability in financial reporting.