Chester County Geology

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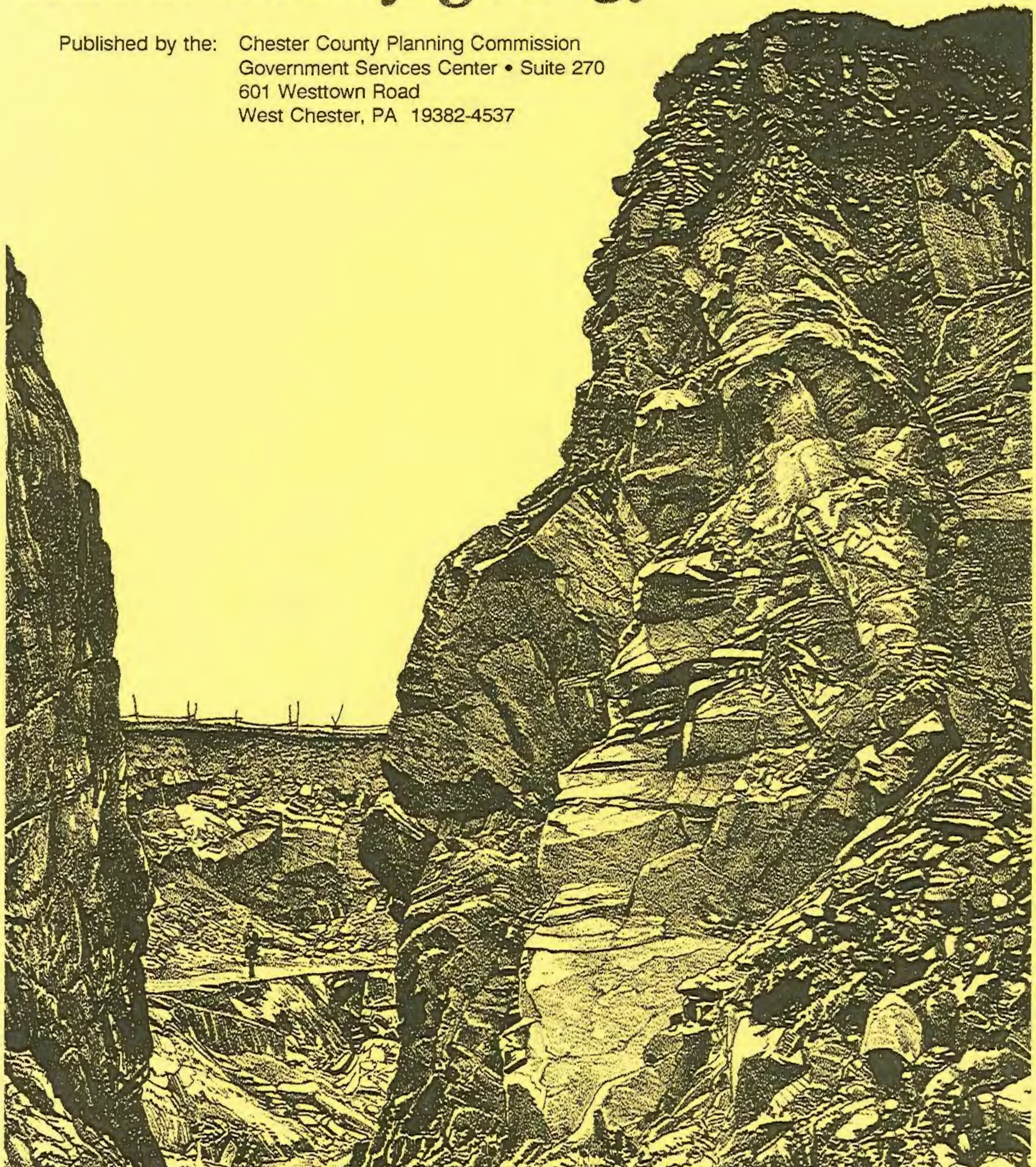

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Chester County Geology

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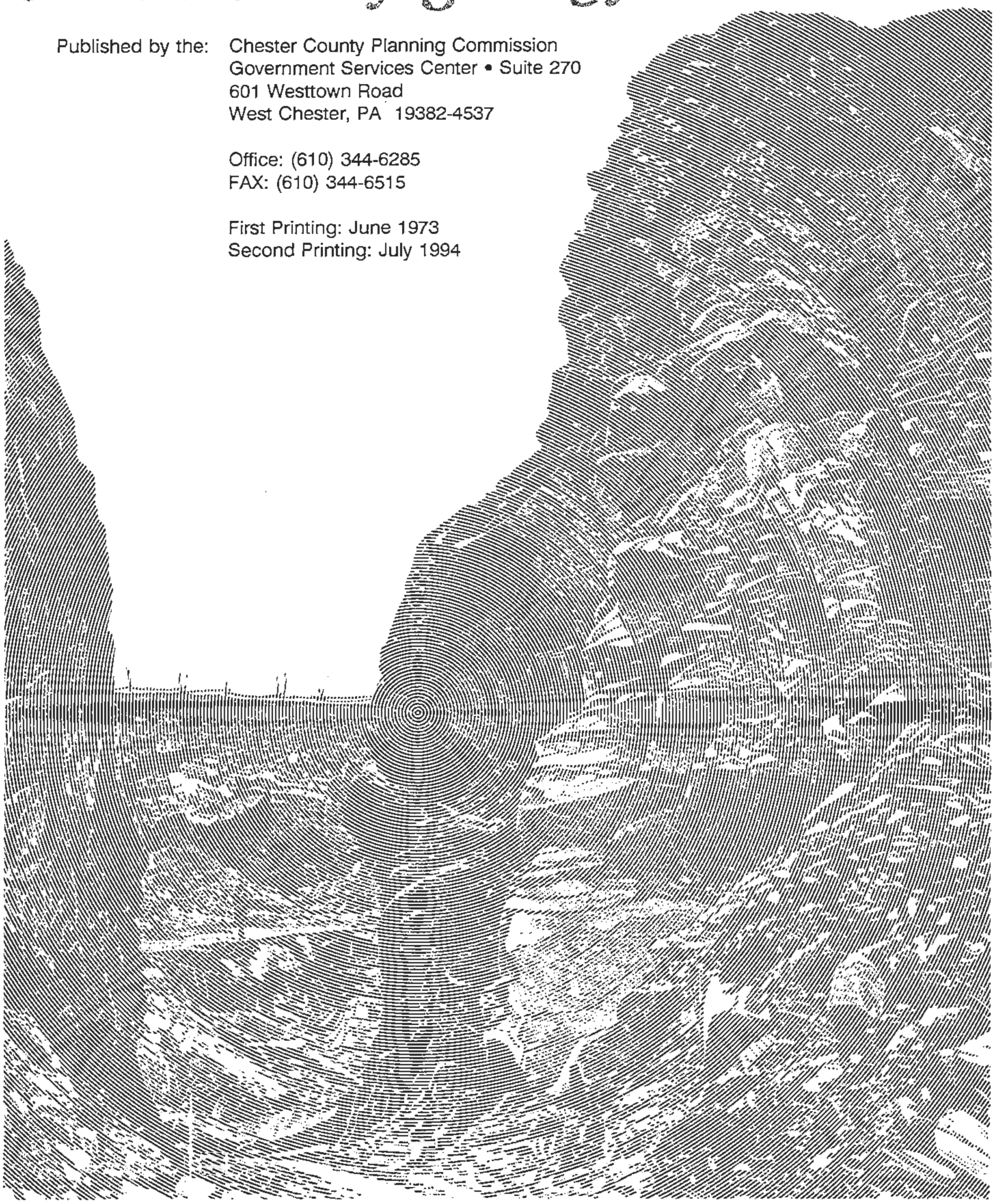


Acknowledgements

The Pennsylvania Geological Survey Is The Chief Source of Technical Help in Geological Matters

This compilation is heavily indebted in nearly every section to the Pennsylvania Topographic and Geological Survey, now part of the Pennsylvania Department of Environmental Resources. This Geological Survey made their open files available to the planning staff for the compilation of the new geology maps. Both the Engineering Geology Reports and the Ground Water reports are reprints of selected portions of the Geological Survey publications relating to Chester County.

The County Planning Commission gratefully acknowledges permission of the Geological Survey to reprint portions of these technical reports.

The new geology maps were complied during 1969 and 1970 primarily by Douglas Y. Helvly, formerly a cartographer and later an assistant planner with the Chester County Planning Commission. He was aided by Al Geyer and Arthur Socolow of the Pennsylvania Geological Survey, and by local geologists, particularly Dr. Seymour Greenberg, Chairman of the Earth Sciences Department, West Chester State College. Dr. Seymour Greenberg also contributed to the "Structural Geology" map.

Introduction

This Report Makes Major Geological Information Conveniently Available Under One Cover

The purpose of this compilation is to present under one cover the new Chester County Planning Commission geological maps, and reprints of selected other major publications having the greatest practical development in the County.

Some of this material, particularly the new geology maps, are not available anywhere else. Other material, particularly the selected sections of other reports, are not always conveniently available.

New County Geology Maps

The underlying geology of Chester County was last mapped in detail during the 1920's and 1930's by Professor Florence Bascom, then at Bryn Mawr College and her many associates. This mapping was done on the old 1900 topographic maps at about one inch to one mile (1:625000). The Bascom mapping is still considered generally accurate by more recent limited field surveys.

These maps have long been out-of-print and obtainable only from rare book dealers or in the reference rooms of large libraries.

In order to make this essential information more widely available, the Chester County Planning Commission compiled a new series of basic geology maps published upon the present series of 1:24000 (1" to 2000 ft.) quadrangle maps.

They are reproduced on the following pages at a reduced size of 1" to one mile (1:63,360). Sheet layout is shown on the index map entitled "Topographic Maps". Paper diazo prints in black and white are also available at the original scale of 1:24,000 (or 1" to 2000 ft.)

The geology maps can be trimmed at the edges and assembled together by tape on the underside to form an overall map of the County or any parts thereof. Sheet arrangement is shown on the index maps.

These maps heavily depend upon the advice and open files of the Pennsylvania Topographic and Geological Survey. The formations and symbols of the maps are in accordance with modern terminology used by the Geological Survey on the most recent state maps.

The Geology Section of the Natural Environment and Planning

In 1964 the Chester County Planning Commission published its initial "Natural Environment and Planning" which dealt in a general way with the effects on practical planning of land forms and topography, geology, soils, climate and woodlands.

The Geology section reprinted here discusses the general nature of the underlying geology, its relation to topography, the historical evolution of the geology, and a number of the practical applications of geology, such as mineral, ground water and engineering properties. This report remains generally valid.

Fortunately, as anticipated at the time the reports were written, additional work has been completed since 1964, that may refine and supersede some of the details then available, particularly as applied to ground water and engineering properties. Extracts of some of these more recent reports are described below.

Engineering Characteristics of the Rocks of Pennsylvania

In 1971 the Pennsylvania Geological Survey published its first engineering geology interpretation, which gives some engineering details to every major rock formation found in Pennsylvania. They have given permission to reproduce those sections of the report related to the major geological formation found in Chester County. This related report stands as the most authoritative general statement so far published, but it is not, of course, ever intended to substitute for detailed engineering evaluation at every construction site.

Hydrology of the Metamorphic and Igneous Rocks of Central Chester County by Charles Poth, et.al.

During the late 1950's and the 1960's, the Pennsylvania Geological Survey in cooperation with the Ground Water Branch of the U.S. Geological Survey conducted some ground water studies in Southeastern Pennsylvania. The series of studies on the Triassic rocks made primarily in Bucks and Montgomery Counties would have some general application to the limited area of Chester County, generally east of the French Creek, that are underlain by Triassic formations.

However, the prime study for Chester County dealt with the metamorphic crystalline rocks that underlie most of Chester County is the report entitled "Ground Water of Central Chester County" by Charles Poth and his associates.

Chester County has long recognized the need for more detailed ground water. Recent studies such as the Poth report suggested that by knowledgeable drilling in fracture zones and other strategic locations greater yield can be obtained than indicated by earlier studies.

At the recommendation of the Chester County Water Resources Study, the County Commissioners recently approved a three year cost sharing agreement with the Ground Water Branch of the U.S. Geological Survey for a much more detailed study of Chester County ground water.

Table of Contents

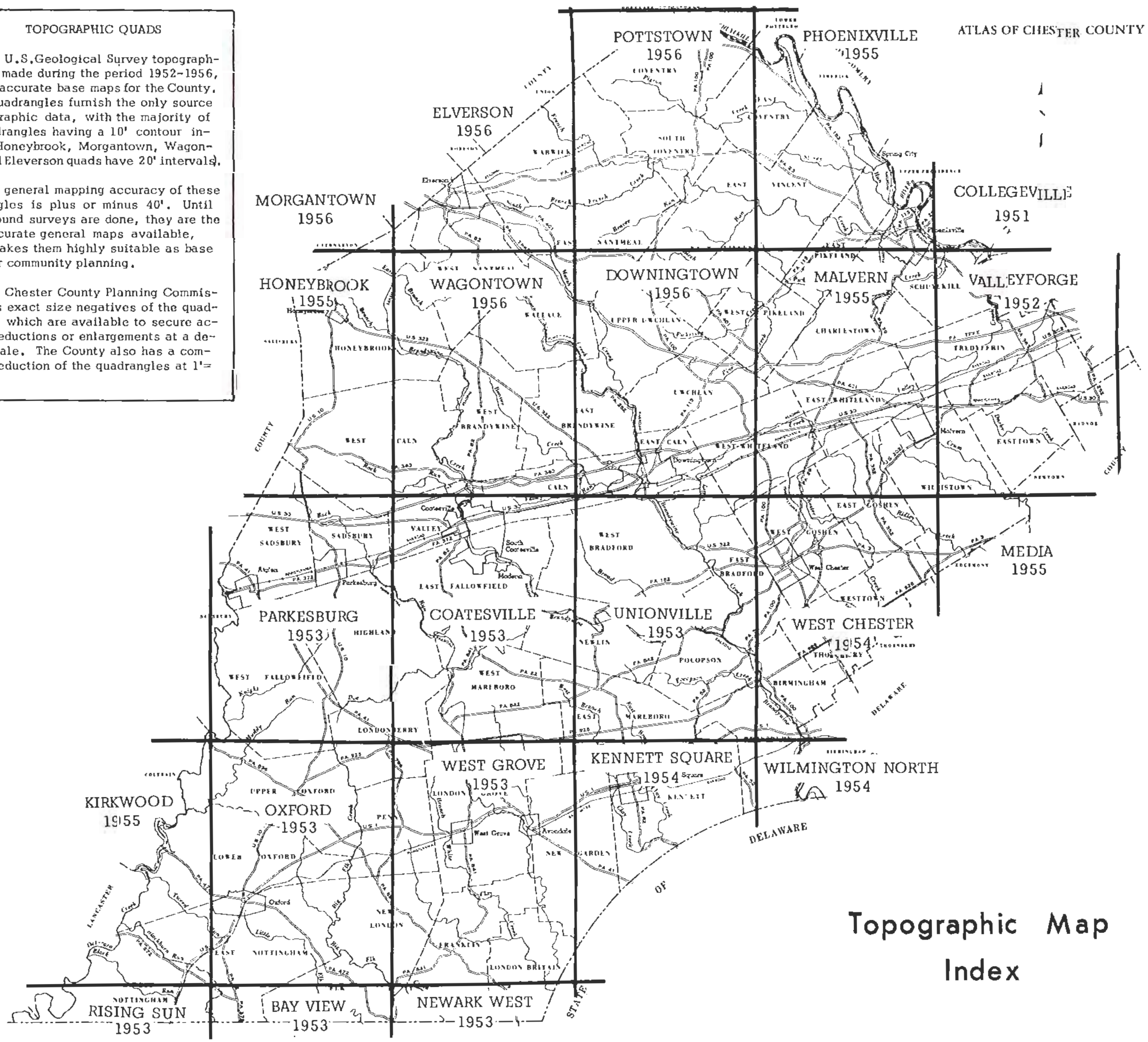
Specialized Geology Maps

TOPOGRAPHIC QUADS

The U.S.Geological Survey topographic maps made during the period 1952-1956, provide accurate base maps for the County. These quadrangles furnish the only source of topographic data, with the majority of the quadrangles having a 10' contour interval (Honeybrook, Morgantown, Wagontown and Eleverson quads have 20' intervals).

The general mapping accuracy of these quadrangles is plus or minus 40'. Until more ground surveys are done, they are the most accurate general maps available, which makes them highly suitable as base maps for community planning.

The Chester County Planning Commission has exact size negatives of the quadrangles, which are available to secure accurate reductions or enlargements at a desired scale. The County also has a composite reduction of the quadrangles at 1"= 1 mile.



Topographic Map Index

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC	IGNEOUS	TRd	Diabase	*Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
TRIASSIC	SEDIMENTARY ROCKS	TRb	Brunswick or Gettysburg Formation	*Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
TRIASSIC	SEDIMENTARY ROCKS	TRqc	Brunswick Formation quartz pebble conglomerate	
TRIASSIC	SEDIMENTARY ROCKS	TRl	Lockatong Formation	*Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
TRIASSIC	SEDIMENTARY ROCKS	TRs	Stockton or New Oxford Formation	*Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*
CAMBRIAN	METAMORPHOSED SED. ROCK	Ꞓl	Ledger Formation	*Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
CAMBRIAN	METAMORPHOSED SED. ROCK	Ꞓk	Kinzers Formation	*Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
CAMBRIAN	METAMORPHOSED SED. ROCK	Ꞓv	Vintage Formation	*Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*
CAMBRIAN	METAMORPHIC ROCKS	Ꞓa	Antietam Formation	*Gray, buff weathering quartzite and quartz schist.*
CAMBRIAN	METAMORPHIC ROCKS	Ꞓh	Harpers Formation	*Dark greenish gray phyllite and schist with thin quartzite layers.*
CAMBRIAN	METAMORPHIC ROCKS	Ꞓch	Chickies Formation	*Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
CAMBRIAN	METAMORPHIC ROCKS	Ꞓhc	Chickies Formation hellam conglomerate	
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xfl	Franklin limestone	*coarse crystalline marble*
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xpg	Pegmatite	
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xc	Serpentinite	*Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	md	Metadiabase	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	qm	Quartz monzonite	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gd	Granodiorite	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gn	Granite gneiss	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	g	Gabbroic gneiss and gabbro	*Includes rocks of probable sedimentary origin*
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	a	Anorthosite	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gg	Graphitic gneiss	*Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

QUATERNARY	SEDIMENTARY ROCKS	Qg	Gravel on Terraces	
TERTIARY	SEDIMENTARY ROCKS	Tbm	Bryn Mawr Formation	*High level terrace deposits; sand and gravel with some silt.*
TRIASSIC	IGNEOUS	TRd	Diabase	*Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
ORDOVICIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ocs	Conestoga Formation	*Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.*
ORDOVICIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ocsu		*upper micaceous limestone*
ORDOVICIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ocsp		*middle phyllite*
ORDOVICIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ocsl		*lower alternating dolomite and limestone*
CAMBRIAN	METAMORPHOSED SED' MENTARY ROCKS	Ꞓe	Elbrook Formation	*Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
CAMBRIAN	METAMORPHOSED SED' MENTARY ROCKS	Ꞓl	Ledger Formation	*Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
CAMBRIAN	METAMORPHOSED SED' MENTARY ROCKS	Ꞓk	Kinzers Formation	*Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
CAMBRIAN	METAMORPHOSED SED' MENTARY ROCKS	Ꞓv	Vintage Formation	*Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*
CAMBRIAN	METAMORPHIC ROCKS	Ꞓah	Antietam-Harpers Formation	
CAMBRIAN	METAMORPHIC ROCKS	Ꞓa	Antietam Formation	*Gray, buff weathering quartzite and quartz schist.*
CAMBRIAN	METAMORPHIC ROCKS	Ꞓh	Harpers Formation	*Dark greenish gray phyllite and schist with thin quartzite layers.*
CAMBRIAN	METAMORPHIC ROCKS	Ꞓch	Chickies Formation	*Chickies-Light gray, hard, massive, sclolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
CAMBRIAN	METAMORPHIC ROCKS	Ꞓhc	Chickies Formation hellam conglomerate	

South of Chester Valley

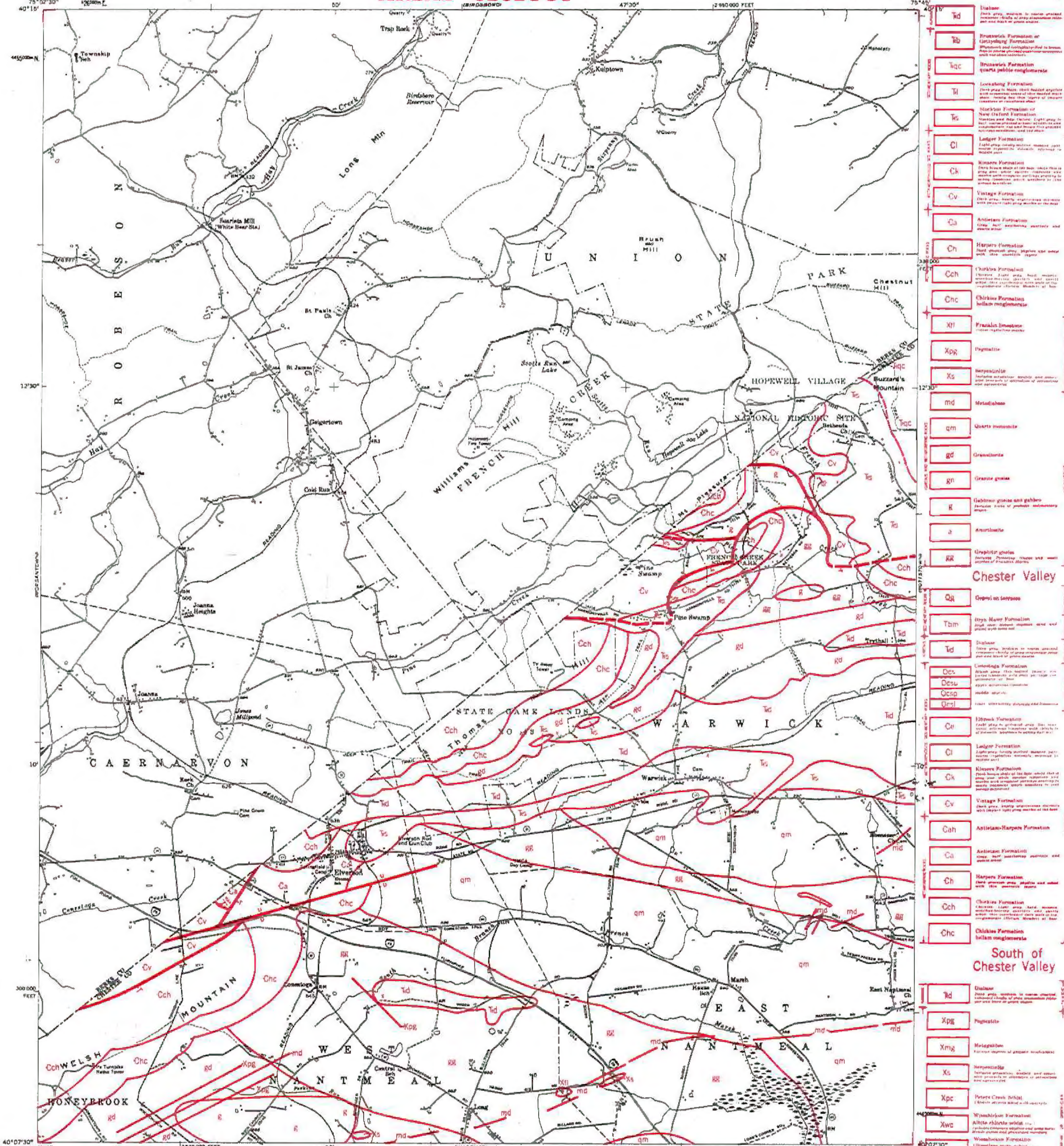
TRIASSIC	IGNEOUS	TRd	Diabase	*Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xpg	Pegmatite	
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xmg	Metaglabbro	*DarVarious degrees of gneissic development.*
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xs	Serpentinite	*Includes serpentine ,steatite and associated products of alteration of peridotites and pyroxenites.*
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xpc	Peter Creek Schist	*Chlorite sericite schist with quartzite.*
PRE-CAMBRIAN OR ORDOVICIAN		Xwc	Wissahickon Formation Albite chlorite schist (Xwc)	*Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
PRE-CAMBRIAN OR ORDOVICIAN		Xw	Wissahickon Formation Oligoclasa mica schist (Xw)	*Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
PRE-CAMBRIAN OR ORDOVICIAN		Xc	Cockeysville Marble	*White to light bluish gray marble.*
PRE-CAMBRIAN OR ORDOVICIAN		Xsq	Setters Formation	*White feldipathic quartzite to gray mica gneiss and schist.*
PRE-CAMBRIAN OR ORDOVICIAN		Xfl	Franklin limestone	*Course crystalline marble.*
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	g	Gabbroic gneiss and gabbro	*Includes rocks of probable sedimentary origin*
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gg	Graphitic gneiss	*Includes Pickering Gneiss and small patches of Franklin Marble*
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gn	Granite gneiss	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	md	Metadiabase	

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION

AREAL GEOLOGY

ELVERSON QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
NE/4 HONEYBROOK 15' QUADRANGLE



40°07'30"
75°52'30"
2 530 000 FEET
50'
(WAGONTOWN)
47'30"

Mapped, edited, and published by the Geological Survey

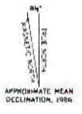
Control by USGS, USC&GS, and USSCS

Topography from aerial photographs by stereoplanigraph. Aerial photographs taken 1951. Field check 1956

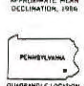
Polyconic projection. 1927 North American datum
10,000-foot grid based on Pennsylvania coordinate system, south zone. 1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue

Unchecked elevations are shown in brown

Fine red dashed lines indicate selected fence and field lines visible on aerial photographs. This information is unchecked



APPROXIMATE MEAN DECLINATION, 1956



QUADRANGLE LOCATION

Updated and Revised by the Chester County, Pa. Planning Commission.

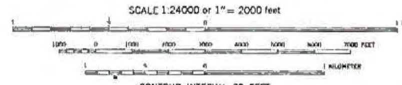
Roads and road names from County tax maps, utility maps, municipal maps, and aerial photographs as of May 1966.

Additions may not necessarily meet original accuracy standards.

Place names from land use surveys and local maps.

Municipal boundaries from County tax maps. Ownership lines from County tax maps as of 1964.

SCALE 1:24000 or 1" = 2000 feet



CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

REVISED AND PROPERTY LINE VERSIONS AVAILABLE ONLY FROM THE CHESTER COUNTY, PA., PLANNING COMMISSION, COURT HOUSE, WEST CHESTER, PA., 19380 (TELEPHONE (215) 696-9100)

ROAD CLASSIFICATION

Heavy-duty		Light-duty	
Medium-duty		Unimproved dirt	
Interstate Route		U. S. Route	State Route

ELVERSON, PA.
NE/4 HONEYBROOK 15' QUADRANGLE
N4007.5—W7545/7.5

1956 Original — 1966 Partial Revision

Geologic contact — dashed where uncertain
Fault line
Geologic dikes
T Overthrust side of lowangle fault
UT Upthrust side of steepangle fault
D Downthrow, normal tension fault
U Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

SEDIMENTARY ROCKS

- **TRb** — Brunswick or Gettysburg Formation. *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
- **TRqc** — Brunswick Formation. quartz pebble conglomerate
- **TRl** — Lockatong Formation. *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
- **TRs** — Stockton or New Oxford Formation. *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*

CAMBRIAN

METAMORPHOSED SED. ROCK

- **Ꞓl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
- **Ꞓh** — Harpers Formation. *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Ꞓch** — Chickies Formation. *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation. hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xfl** — Franklin limestone. *coarse crystalline marble*
- **Xpg** — Pegmatite
- **Xc** — Serpentinite. *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro. *Includes rocks of probable sedimentary origin*
- **a** — Anorthosite
- **gg** — Graphitic gneiss. *Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

QUATERNARY

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces

TERTIARY

- **Tbm** — Bryn Mawr Formation. *High level terrace deposits; sand and gravel with some silt.*

TRIASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS

- **Ocs** — Conestoga Formation. *Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.*
- **Ocsu** — *upper micaceous limestone*
- **Ocsp** — *middle phyllite*
- **Ocsl** — *lower alternating dolomite and limestone*

CAMBRIAN

METAMORPHOSED SED MENTARY ROCKS

- **Ꞓe** — Elbrook Formation. *Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
- **Ꞓl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
- **Ꞓh** — Harpers Formation. *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Ꞓch** — Chickies Formation. *Chickies-Light gray, hard, massive, scolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation. hellam conglomerate

South of Chester Valley

TRIASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

PRE-CAMBRIAN OR ORDOVICIAN

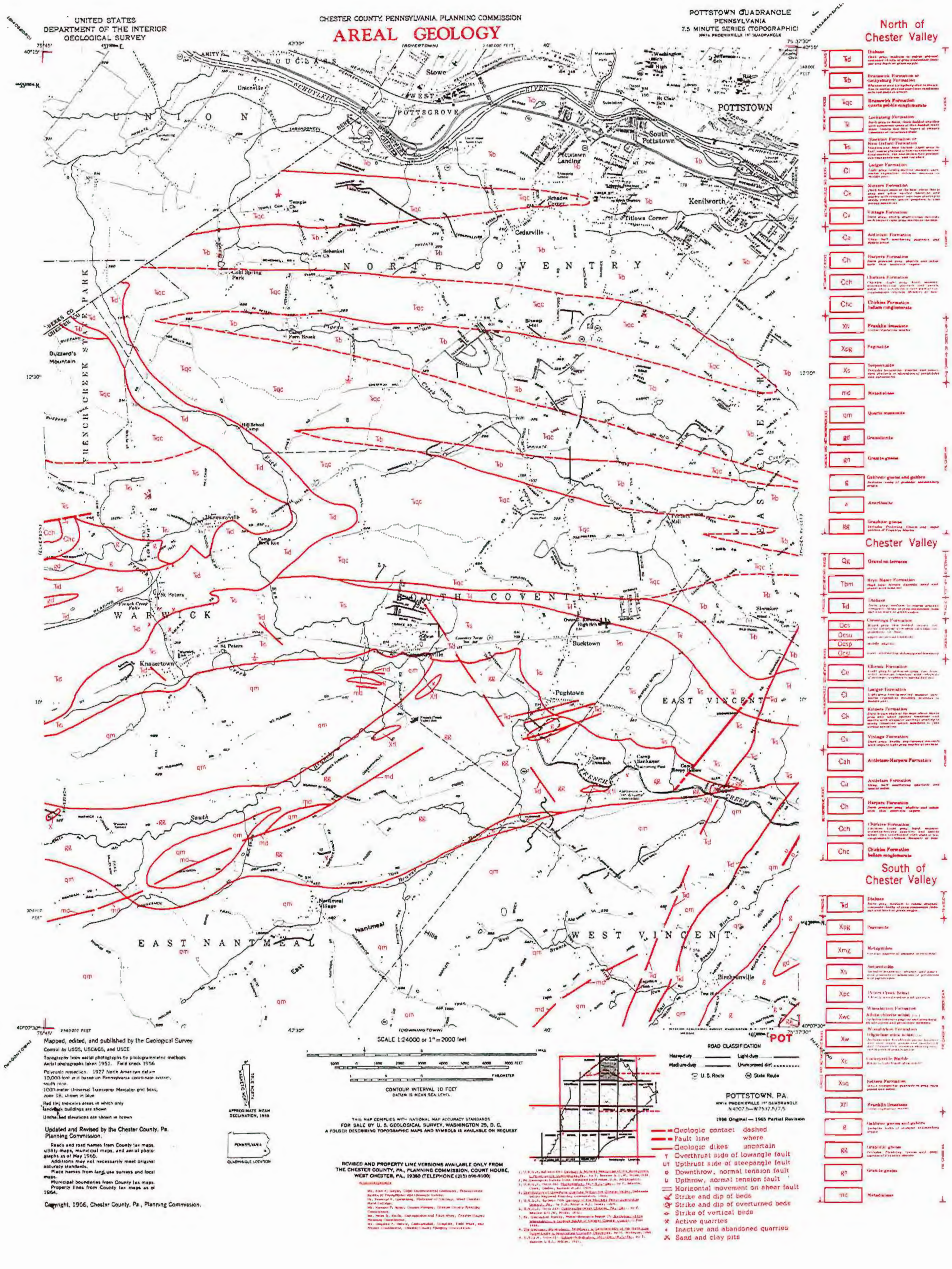
IGNEOUS AND METAMORPHIC ROCKS

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro. *DarVarious degrees of gneissic development.*
- **Xs** — Serpentinite. *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
- **Xpc** — Peter Creek Schist. *Chlorite sericite schist with quartzite.*
- **Xwc** — Wissahickon Formation. Albite chlorite schist (Xwc). *Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
- **Xw** — Wissahickon Formation. Oligoclasa mica schist (Xw). *Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
- **Xc** — Cockeysville Marble. *White to light bluish gray marble.*
- **Xsq** — Setters Formation. *White feldipathic quartzite to gray mica gneiss and schist.*
- **Xfl** — Franklin limestone. *Course crystalline marble.*

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **g** — Gabbroic gneiss and gabbro. *Includes rocks of probable sedimentary origin*
- **gg** — Graphitic gneiss. *Includes Pickering Gneiss and small patches of Franklin Marble*
- **gn** — Granite gneiss
- **md** — Metadiabase


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION
AREAL GEOLOGY
POTTSTOWN QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
North of Chester Valley
Chester Valley
South of Chester Valley
POTTSTOWN
NORTH COVENTRY
SOUTH COVENTRY
EAST VINCENT
WEST VINCENT
EAST NANTMEAL
WARWICK
FRENCH CREEK STATE PARK
Stowe
South Pottstown
Kenilworth
Cedarville
Bucktown
Pughtown
Knauertown
St Peters
Birchrunville
Nantmeal Village
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
Mapped, edited, and published by the Geological Survey
Updated and Revised by the Chester County, Pa. Planning Commission.
Copyright, 1966, Chester County, Pa., Planning Commission.
POTTSTOWN, PA.
1956 Original — 1965 Partial Revision
ROAD CLASSIFICATION
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
REVISED AND PROPERTY LINE VERSIONS AVAILABLE ONLY FROM THE CHESTER COUNTY, PA., PLANNING COMMISSION, COURT HOUSE, WEST CHESTER, PA.
Geologic contact dashed
Fault line where
Geologic dikes uncertain
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits
POT

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

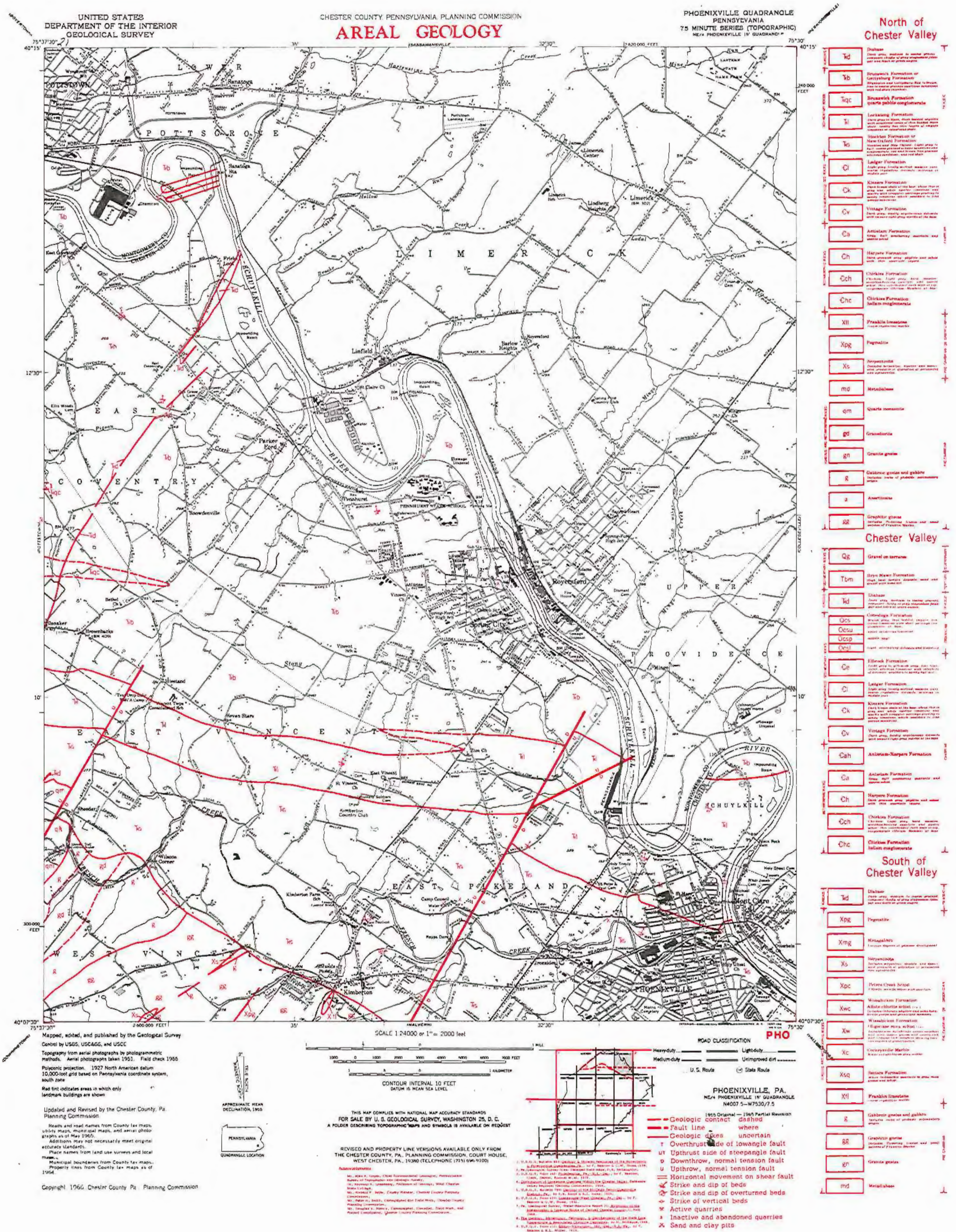
TRIASSIC	IGNEOUS	TRd	Diabase	Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.
TRIASSIC	SEDIMENTARY ROCKS	TRb	Brunswick or Gettysburg Formation	Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.
TRIASSIC	SEDIMENTARY ROCKS	TRqc	Brunswick Formation	quartz pebble conglomerate
TRIASSIC	SEDIMENTARY ROCKS	TRl	Lockatong Formation	Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.
TRIASSIC	SEDIMENTARY ROCKS	TRs	Stockton or New Oxford Formation	Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.
CAMBRIAN	METAMORPHOSED SED. ROCK	Ꞓl	Ledger Formation	Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
CAMBRIAN	METAMORPHOSED SED. ROCK	Ꞓk	Kinzers Formation	Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
CAMBRIAN	METAMORPHOSED SED. ROCK	Ꞓv	Vintage Formation	Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.
CAMBRIAN	METAMORPHIC ROCKS	Ꞓa	Antietam Formation	Gray, buff weathering quartzite and quartz schist.
CAMBRIAN	METAMORPHIC ROCKS	Ꞓh	Harpers Formation	Dark greenish gray phyllite and schist with thin quartzite layers.
CAMBRIAN	METAMORPHIC ROCKS	Ꞓch	Chickies Formation	Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
CAMBRIAN	METAMORPHIC ROCKS	Ꞓhc	Chickies Formation	hellam conglomerate
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xfl	Franklin limestone	coarse crystalline marble
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xpg	Pegmatite	
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xc	Serpentinite	Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	md	Metadiabase	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	qm	Quartz monzonite	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gd	Granodiorite	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gn	Granite gneiss	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	g	Gabbroic gneiss and gabbro	Includes rocks of probable sedimentary origin
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	a	Anorthosite	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gg	Graphitic gneiss	Includes Pickering Gneiss and small patches of Franklin Marble

Chester Valley

QUATERNARY	SEDIMENTARY ROCKS	Qg	Gravel on Terraces	
TERTIARY	SEDIMENTARY ROCKS	Tbm	Bryn Mawr Formation	High level terrace deposits; sand and gravel with some silt.
TRIASSIC	IGNEOUS	TRd	Diabase	Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.
ORDOVICIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ocs	Conestoga Formation	Bluish gray, thin bedded, impure, contorted lime-stone with shale partings, conglomerate at base.
ORDOVICIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ocsu		upper micaceous limestone
ORDOVICIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ocsp		middle phyllite
ORDOVICIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ocsl		lower alternating dolomite and limestone
CAMBRIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ꞓe	Elbrook Formation	Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.
CAMBRIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ꞓl	Ledger Formation	Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
CAMBRIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ꞓk	Kinzers Formation	Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
CAMBRIAN	METAMORPHOSED SEDIMENTARY ROCKS	Ꞓv	Vintage Formation	Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.
CAMBRIAN	METAMORPHIC ROCKS	Ꞓah	Antietam-Harpers Formation	
CAMBRIAN	METAMORPHIC ROCKS	Ꞓa	Antietam Formation	Gray, buff weathering quartzite and quartz schist.
CAMBRIAN	METAMORPHIC ROCKS	Ꞓh	Harpers Formation	Dark greenish gray phyllite and schist with thin quartzite layers.
CAMBRIAN	METAMORPHIC ROCKS	Ꞓch	Chickies Formation	Chickies-Light gray, hard, massive, sciolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
CAMBRIAN	METAMORPHIC ROCKS	Ꞓhc	Chickies Formation	hellam conglomerate

South of Chester Valley

TRIASSIC	IGNEOUS	TRd	Diabase	Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xpg	Pegmatite	
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xmg	Metaglabbro	DarVarious degrees of gneissic development.
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xs	Serpentinite	Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xpc	Peter Creek Schist	Chlorite sericite schist with quartzite.
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xwc	Wissahickon Formation, Albite chlorite schist (Xwc)	Includes Octoraro phyllite and some horn blende gneiss and granitized members.
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xw	Wissahickon Formation, Oligoclasa mica schist (Xw)	Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xc	Cockeysville Marble	White to light bluish gray marble.
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xsq	Setters Formation	White feldipathic quartzite to gray mica gneiss and schist.
PRE-CAMBRIAN OR ORDOVICIAN	IGNEOUS AND METAMORPHIC ROCKS	Xfl	Franklin limestone	Course crystalline marble.
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	g	Gabbroic gneiss and gabbro	Includes rocks of probable sedimentary origin
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gg	Graphitic gneiss	Includes Pickering Gneiss and small patches of Franklin Marble
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	gn	Granite gneiss	
PRE-CAMBRIAN	IGNEOUS AND METAMORPHIC ROCKS	md	Metadiabase	


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CHESTER COUNTY PENNSYLVANIA PLANNING COMMISSION
AREAL GEOLOGY
PHOENIXVILLE QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
North of
Chester Valley
Diabase
Brunswick Formation or
Gettysburg Formation
Brunswick Formation
quartz pebble conglomerate
Lockatong Formation
Stockton Formation or
New Oxford Formation
Ledger Formation
Kinzers Formation
Vintage Formation
Antietam Formation
Harpers Formation
Chickies Formation
Chickies Formation
Hellam conglomerate
Franklin limestone
Pegmatite
Serpentinite
Metadiabase
Quartz monzonite
Granodiorite
Granite gneiss
Gabbroic gneiss and gabbro
Anorthosite
Graphitic gneiss
Chester Valley
Gravel on terraces
Bryn Mawr Formation
Diabase
Conestoga Formation
Elbrook Formation
Ledger Formation
Kinzers Formation
Vintage Formation
Antietam-Harpers Formation
Antietam Formation
Harpers Formation
Chickies Formation
Chickies Formation
Hellam conglomerate
South of
Chester Valley
Diabase
Pegmatite
Metagabbro
Serpentinite
Peters Creek Schist
Wissahickon Formation
Albite-chlorite schist
Wissahickon Formation
Oligoclase mica schist
Cockeysville Marble
Setters Formation
Franklin limestone
Gabbroic gneiss and gabbro
Graphitic gneiss
Granite gneiss
Metadiabase
L O W E R
P O T T S G R O V E
L I M E R I C K
E A S T
C O V E N T R Y
U P P E R
P R O V I D E N C E
E A S T   V I N C E N T
E A S T   P I K E L A N D
W E S T   V I N C E N T
SCHUYLKILL
RIVER
POTTSTOWN
Linfield
Royersford
Spring City
Limerick
Kimberton
PHOENIXVILLE
Mont Clare
Parker Ford
PHO
Mapped, edited, and published by the Geological Survey
Updated and Revised by the Chester County, Pa. Planning Commission
Copyright 1966 Chester County Pa. Planning Commission
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
U. S. Route
State Route
PHOENIXVILLE, PA.
NE/4 PHOENIXVILLE 15' QUADRANGLE
N4007.5—W7530/7.5
1955 Original — 1965 Partial Revision
Geologic contact
Fault line
Geologic dikes
dashed where uncertain
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC

IGNEOUS

- **Ŧd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

SEDIMENTARY ROCKS

- **Ŧb** — Brunswick or Gettysburg Formation
  Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.
- **Ŧqc** — Brunswick Formation
  quartz pebble conglomerate
- **Ŧl** — Lockatong Formation
  Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.
- **Ŧs** — Stockton or New Oxford Formation
  Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.

CAMBRIAN

METAMORPHOSED SED. ROCK

- **Ꞓl** — Ledger Formation
  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
- **Ꞓk** — Kinzers Formation
  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
- **Ꞓh** — Harpers Formation
  Dark greenish gray phyllite and schist with thin quartzite layers.
- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xfl** — Franklin limestone
  coarse crystalline marble
- **Xpg** — Pegmatite
- **Xc** — Serpentinite
  Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
- **a** — Anorthosite
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble

Chester Valley

QUATERNARY

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces

TERTIARY

- **Tbm** — Bryn Mawr Formation
  High level terrace deposits; sand and gravel with some silt.

TRASSIC

IGNEOUS

- **Ŧd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS

- **Ocs** — Conestoga Formation
  Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.
- **Ocsu** — *upper micaceous limestone*
- **Ocsp** — *middle phyllite*
- **Ocsl** — *lower alternating dolomite and limestone*

CAMBRIAN

METAMORPHOSED SEDIMENTARY ROCKS

- **Ꞓe** — Elbrook Formation
  Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.
- **Ꞓl** — Ledger Formation
  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
- **Ꞓk** — Kinzers Formation
  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
- **Ꞓh** — Harpers Formation
  Dark greenish gray phyllite and schist with thin quartzite layers.
- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

South of Chester Valley

TRASSIC

IGNEOUS

- **Ŧd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro
  DarVarious degrees of gneissic development.
- **Xs** — Serpentinite
  Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.
- **Xpc** — Peter Creek Schist
  Chlorite sericite schist with quartzite.

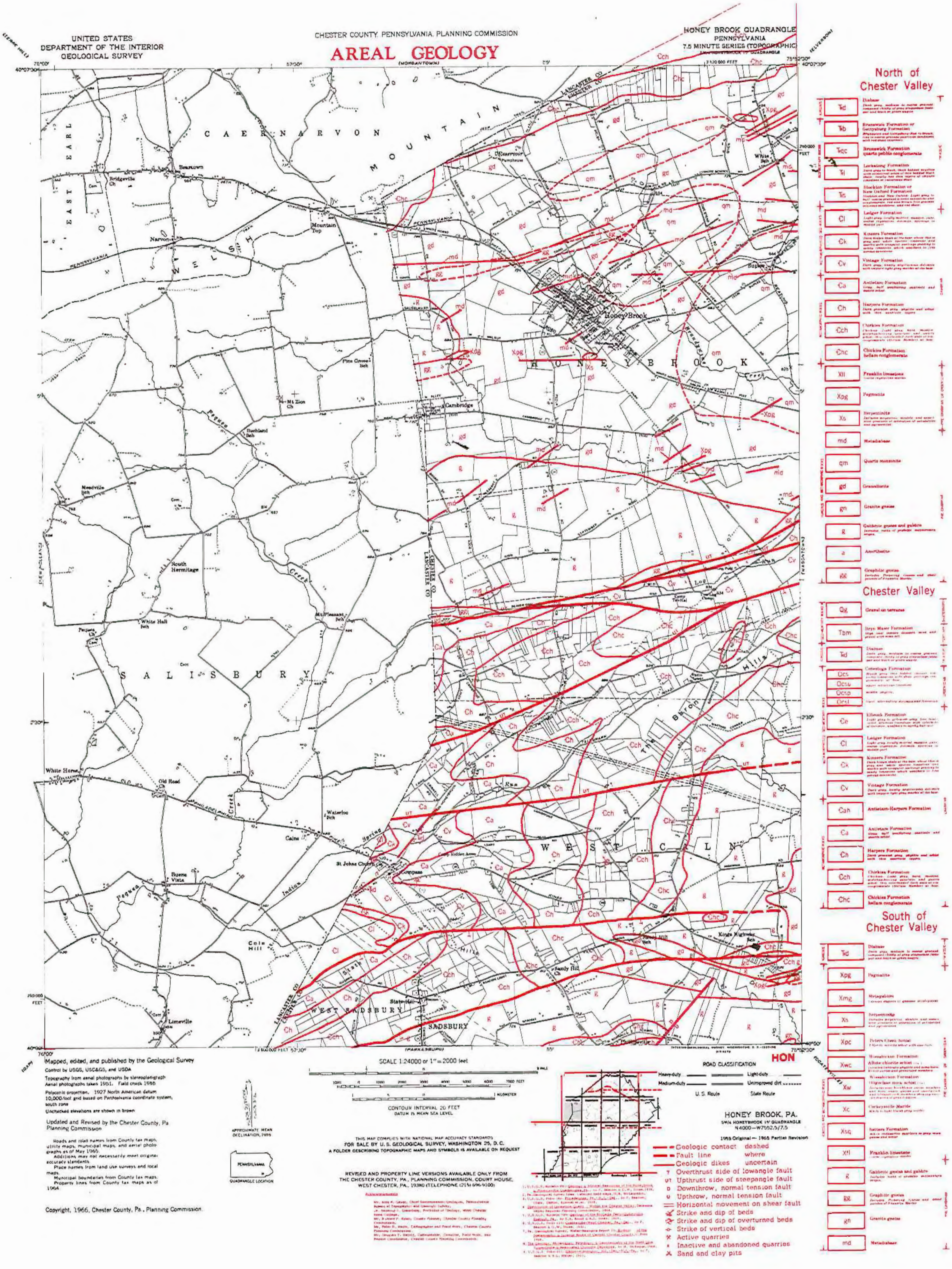
PRE-CAMBRIAN OR ORDOVICIAN

- **Xwc** — Wissahickon Formation
  Albite chlorite schist (Xwc)
  Includes Octoraro phyllite and some horn blende gneiss and granitized members.
- **Xw** — Wissahickon Formation
  Oligoclasa mica schist (Xw)
  Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.
- **Xc** — Cockeysville Marble
  White to light bluish gray marble.
- **Xsq** — Setters Formation
  White feldipathic quartzite to gray mica gneiss and schist.
- **Xfl** — Franklin limestone
  Course crystalline marble.

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble
- **gn** — Granite gneiss
- **md** — Metadiabase


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION
AREAL GEOLOGY
HONEY BROOK QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
North of Chester Valley
Chester Valley
South of Chester Valley
CAERNARVON
MOUNTAIN
EAST EARL
WELSH
HONEY BROOK
Honey Brook
SALISBURY
WEST CALN
WEST SADSBURY
SADSBURY
Cambridge
Narvon
Bridgeville
Mountain Top
South Hermitage
White Horse
Buena Vista
Cole Hill
Limeville
St Johns Church
Pequea
Pegmatite
Metadiabase
Metagabbro
Serpentinite
Peters Creek Schist
Wissahickon Formation
Albite-chlorite schist
Oligoclase mica schist
Cockeysville Marble
Setters Formation
Franklin limestone
Gabbroic gneiss and gabbro
Graphitic gneiss
Granite gneiss
Mapped, edited, and published by the Geological Survey
Control by USGS, USC&GS, and USDA
Topography from aerial photographs by stereoplanigraph
Aerial photographs taken 1951. Field check 1955
Polyconic projection. 1927 North American datum
10,000-foot grid based on Pennsylvania coordinate system, south zone
Unchecked elevations are shown in brown
Updated and Revised by the Chester County, Pa Planning Commission
Roads and road names from County tax maps, utility maps, municipal maps, and aerial photographs as of May 1965.
Additions may not necessarily meet original accuracy standards.
Place names from land use surveys and local maps.
Municipal boundaries from County tax maps.
Property lines from County tax maps as of 1964.
Copyright, 1966, Chester County, Pa., Planning Commission.
APPROXIMATE MEAN DECLINATION, 1955
PENNSYLVANIA
QUADRANGLE LOCATION
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
REVISED AND PROPERTY LINE VERSIONS AVAILABLE ONLY FROM
THE CHESTER COUNTY, PA., PLANNING COMMISSION, COURT HOUSE,
WEST CHESTER, PA., 19380 (TELEPHONE (215) 696-9100)
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
U. S. Route
State Route
HON
HONEY BROOK, PA.
SW/4 HONEYBROOK 15' QUADRANGLE
N4000—W7552.5/7.5
1955 Original — 1965 Partial Revision
Geologic contact
Fault line
Geologic dikes
dashed where uncertain
T Overthrust side of lowangle fault
UT Upthrust side of steepangle fault
D Downthrow, normal tension fault
U Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

IGNEOUS

Ŧd Diabase
Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

SEDIMENTARY ROCKS

Ŧb Brunswick or Gettysburg Formation
Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.

Ŧqc Brunswick Formation
quartz pebble conglomerate

Ŧl Lockatong Formation
Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.

Ŧs Stockton or New Oxford Formation
Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.

TRIASSIC

METAMORPHOSED SED. ROCK

Ꞓl Ledger Formation
Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.

Ꞓk Kinzers Formation
Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone

Ꞓv Vintage Formation
Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

Ꞓa Antietam Formation
Gray, buff weathering quartzite and quartz schist.

Ꞓh Harpers Formation
Dark greenish gray phyllite and schist with thin quartzite layers.

Ꞓch Chickies Formation
Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.

Ꞓhc Chickies Formation
hellam conglomerate

CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

Xfl Franklin limestone
coarse crystalline marble

Xpg Pegmatite

Xc Serpentinite
Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

md Metadiabase

qm Quartz monzonite

gd Granodiorite

gn Granite gneiss

g Gabbroic gneiss and gabbro
Includes rocks of probable sedimentary origin

a Anorthosite

gg Graphitic gneiss
Includes Pickering Gneiss and small patches of Franklin Marble

PRE-CAMBRIAN

Chester Valley

SEDIMENTARY ROCKS

Qg Gravel on Terraces

QUATERNARY

Tbm Bryn Mawr Formation
High level terrace deposits; sand and gravel with some silt.

TERTIARY

IGNEOUS

Ŧd Diabase
Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

TRIASSIC

METAMORPHOSED SEDIMENTARY ROCKS

Ocs Conestoga Formation
Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.

Ocsu *upper micaceous limestone*

Ocsp *middle phyllite*

Ocsl *lower alternating dolomite and limestone*

ORDOVICIAN

METAMORPHOSED SED MENTARY ROCKS

Ꞓe Elbrook Formation
Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.

Ꞓl Ledger Formation
Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.

Ꞓk Kinzers Formation
Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone

Ꞓv Vintage Formation
Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

Ꞓah Antietam-Harpers Formation

Ꞓa Antietam Formation
Gray, buff weathering quartzite and quartz schist.

Ꞓh Harpers Formation
Dark greenish gray phyllite and schist with thin quartzite layers.

Ꞓch Chickies Formation
Chickies-Light gray, hard, massive, scolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.

Ꞓhc Chickies Formation
hellam conglomerate

CAMBRIAN

South of Chester Valley

IGNEOUS

Ŧd Diabase
Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

TRIASSIC

IGNEOUS AND METAMORPHIC ROCKS

Xpg Pegmatite

Xmg Metaglabbro
DarVarious degrees of gneissic development.

Xs Serpentinite
Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.

Xpc Peter Creek Schist
Chlorite sericite schist with quartzite.

PRE-CAMBRIAN OR ORDOVICIAN

Xwc Wissahickon Formation
Albite chlorite schist (Xwc)
Includes Octoraro phyllite and some horn blende gneiss and granitized members.

Xw Wissahickon Formation
Oligoclasa mica schist (Xw)
Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.

Xc Cockeysville Marble
White to light bluish gray marble.

Xsq Setters Formation
White feldipathic quartzite to gray mica gneiss and schist.

Xfl Franklin limestone
Course crystalline marble.

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

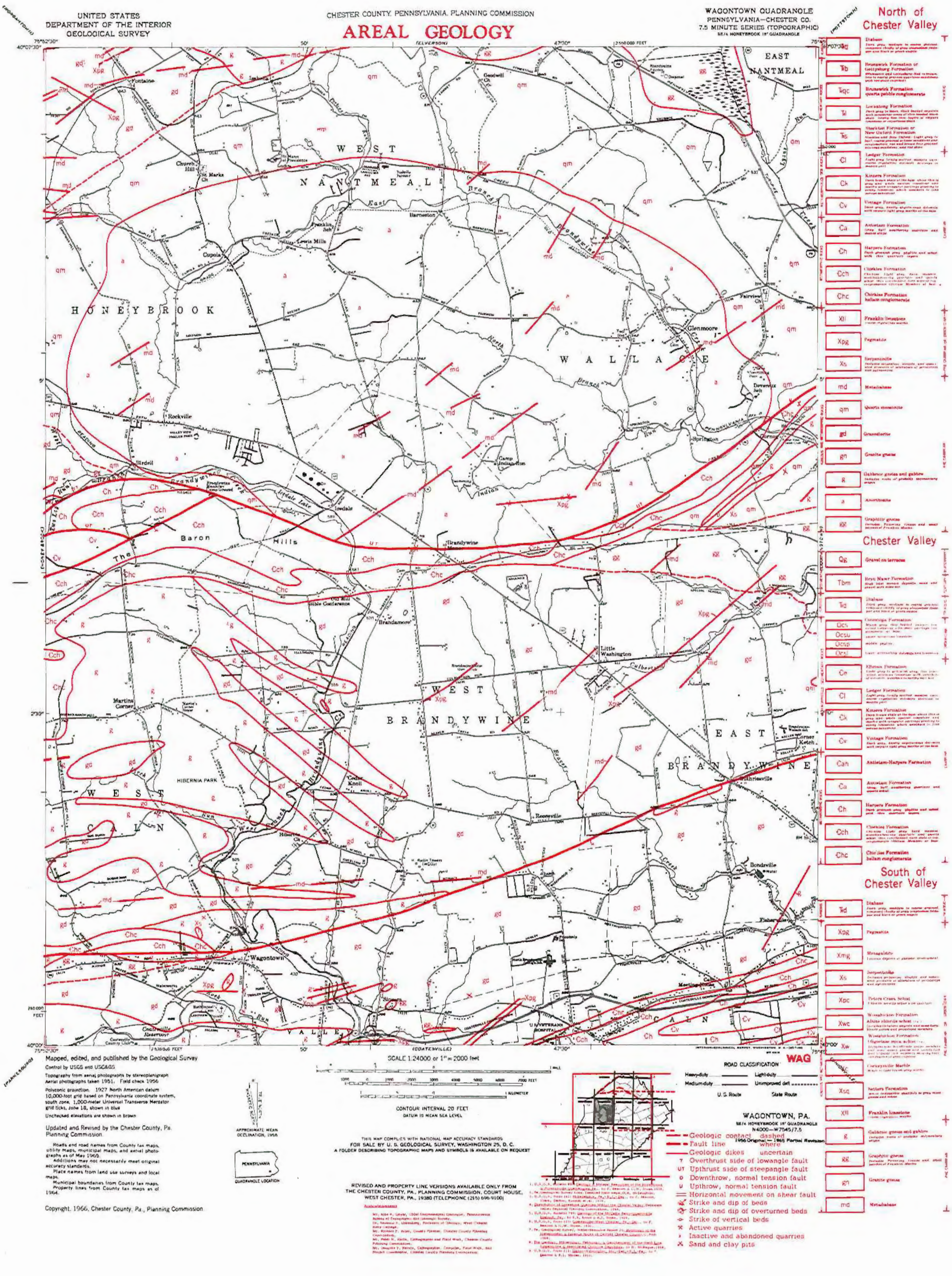
g Gabbroic gneiss and gabbro
Includes rocks of probable sedimentary origin

gg Graphitic gneiss
Includes Pickering Gneiss and small potches of Franklin Marble

gn Granite gneiss

md Metadiabase

PRE-CAMBRIAN



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION
AREAL GEOLOGY
WAGONTOWN QUADRANGLE
PENNSYLVANIA—CHESTER CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
North of Chester Valley
Chester Valley
South of Chester Valley
WEST NANTMEAL
EAST NANTMEAL
HONEYBROOK
WALLACE
WEST BRANDYWINE
EAST BRANDYWINE
WEST CALN
CALN
The Baron Hills
Wagontown
Rockville
Glenmoore
Springton
Little Washington
Brandamore
Bondsville
Martins Corner
HIBERNIA PARK
Mapped, edited, and published by the Geological Survey
Updated and Revised by the Chester County, Pa. Planning Commission.
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
WAG
WAGONTOWN, PA.
Geologic contact dashed where uncertain
Fault line
Geologic dikes
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits
Copyright, 1966, Chester County, Pa., Planning Commission

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC

IGNEOUS

- **TRd** — Diabase — *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

SEDIMENTARY ROCKS

- **TRb** — Brunswick or Gettysburg Formation — *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
- **TRqc** — Brunswick Formation — quartz pebble conglomerate
- **TRl** — Lockatong Formation — *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
- **TRs** — Stockton or New Oxford Formation — *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*

CAMBRIAN

METAMORPHOSED SED. ROCK

- **Ꞓl** — Ledger Formation — *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation — *Dark brown shale at the base; above this is gray and white spatted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation — *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓa** — Antietam Formation — *Gray, buff weathering quartzite and quartz schist.*
- **Ꞓh** — Harpers Formation — *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Ꞓch** — Chickies Formation — *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation — hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xfl** — Franklin limestone — *coarse crystalline marble*
- **Xpg** — Pegmatite
- **Xc** — Serpentinite — *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro — *Includes rocks of probable sedimentary origin*
- **a** — Anorthosite
- **gg** — Graphitic gneiss — *Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

QUATERNARY

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces

TERTIARY

- **Tbm** — Bryn Mawr Formation — *High level terrace deposits; sand and gravel with some silt.*

TRIASSIC

IGNEOUS

- **TRd** — Diabase — *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS

- Conestoga Formation — *Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.*
  - **Ocs**
  - **Ocsu** — *upper micaceous limestone*
  - **Ocsp** — *middle phyllite*
  - **Ocsl** — *lower alternating dolomite and limestone*

CAMBRIAN

METAMORPHOSED SED. MENTARY ROCKS

- **Ꞓe** — Elbrook Formation — *Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
- **Ꞓl** — Ledger Formation — *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation — *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation — *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation — *Gray, buff weathering quartzite and quartz schist.*
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- **Ꞓhc** — Chickies Formation — hellam conglomerate

South of Chester Valley

TRIASSIC

IGNEOUS

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PRE-CAMBRIAN OR ORDOVICIAN

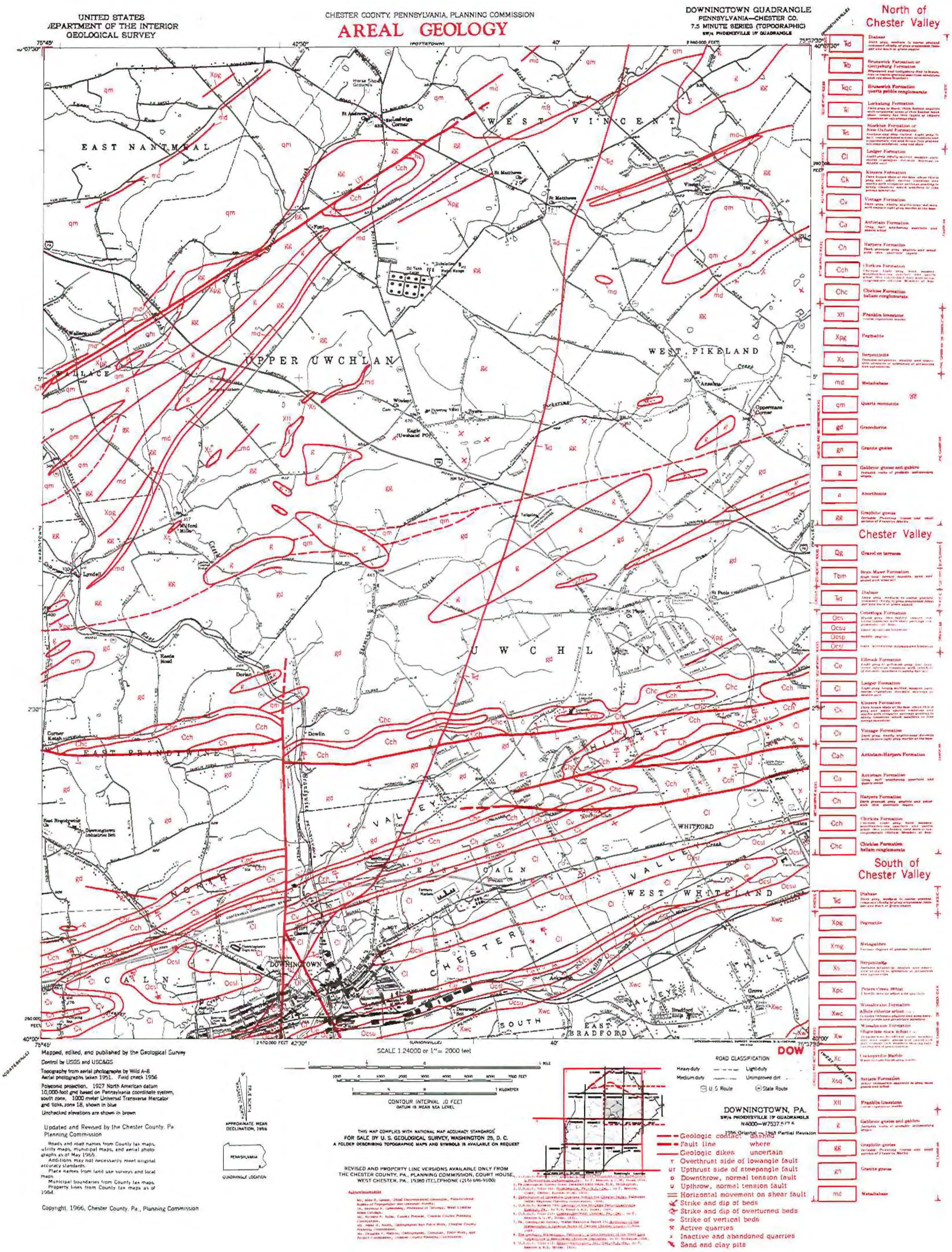
IGNEOUS AND METAMORPHIC ROCKS

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro — *DarVarious degrees of gneissic development.*
- **Xs** — Serpentinite — *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
- **Xpc** — Peter Creek Schist — *Chlorite sericite schist with quartzite.*
- **Xwc** — Wissahickon Formation — Albite chlorite schist (Xwc) — *Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
- **Xw** — Wissahickon Formation — Oligoclasa mica schist (Xw) — *Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
- **Xc** — Cockeysville Marble — *White to light bluish gray marble.*
- **Xsq** — Setters Formation — *White feldipathic quartzite to gray mica gneiss and schist.*
- **Xfl** — Franklin limestone — *Course crystalline marble.*

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **g** — Gabbroic gneiss and gabbro — *Includes rocks of probable sedimentary origin*
- **gg** — Graphitic gneiss — *Includes Pickering Gneiss and small patches of Franklin Marble*
- **gn** — Granite gneiss
- **md** — Metadiabase


UNITED STATES
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CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION
AREAL GEOLOGY
DOWNINGTOWN QUADRANGLE
PENNSYLVANIA—CHESTER CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SW/4 PHOENIXVILLE 15' QUADRANGLE
North of Chester Valley
Chester Valley
South of Chester Valley
EAST NANTMEAL
WEST VINCENT
UPPER UWCHLAN
WEST PIKELAND
UWCHLAN
EAST BRANDYWINE
CHESTER VALLEY
NORTH
EAST CALN
WEST WHITELAND
CALN
DOWNINGTOWN
SOUTH
EAST BRADFORD
Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography from aerial photographs by Wild A-8
Aerial photographs taken 1951. Field check 1956
Polyconic projection. 1927 North American datum
10,000-foot grid based on Pennsylvania coordinate system, south zone. 1000 meter Universal Transverse Mercator grid ticks, zone 18, shown in blue
Unchecked elevations are shown in brown
Updated and Revised by the Chester County, Pa Planning Commission
Roads and road names from County tax maps, utility maps, municipal maps, and aerial photographs as of May 1965.
Additions may not necessarily meet original accuracy standards.
Place names from land use surveys and local maps.
Municipal boundaries from County tax maps.
Property lines from County tax maps as of 1964.
Copyright, 1966, Chester County, Pa., Planning Commission
APPROXIMATE MEAN DECLINATION, 1956
QUADRANGLE LOCATION
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
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REVISED AND PROPERTY LINE VERSIONS AVAILABLE ONLY FROM THE CHESTER COUNTY, PA., PLANNING COMMISSION, COURT HOUSE, WEST CHESTER, PA., 19380 (TELEPHONE (215) 696-9100)
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
U.S. Route
State Route
DOWNINGTOWN, PA.
SW/4 PHOENIXVILLE 15' QUADRANGLE
Geologic contact
Fault line
Geologic dikes
dashed where uncertain
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits
DOW

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

IGNEOUS

- **Ŧd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

SEDIMENTARY ROCKS (TRIASSIC)

- **Ŧb** — Brunswick or Gettysburg Formation
  Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.
- **Ŧqc** — Brunswick Formation
  quartz pebble conglomerate
- **Ŧl** — Lockatong Formation
  Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.
- **Ŧs** — Stockton or New Oxford Formation
  Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.

METAMORPHOSED SED. ROCK (CAMBRIAN)

- **Ꞓl** — Ledger Formation
  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
- **Ꞓk** — Kinzers Formation
  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

METAMORPHIC ROCKS (CAMBRIAN)

- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
- **Ꞓh** — Harpers Formation
  Dark greenish gray phyllite and schist with thin quartzite layers.
- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

IGNEOUS AND METAMORPHIC ROCKS (PRE-CAMBRIAN OR ORDOVICIAN)

- **Xfl** — Franklin limestone
  coarse crystalline marble
- **Xpg** — Pegmatite
- **Xc** — Serpentinite
  Includes serpentine ,steatite and associated products of alteration of peridotites and pyroxenites.

IGNEOUS AND METAMORPHIC ROCKS (PRE-CAMBRIAN)

- **md** — Metadiabase
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  Includes rocks of probable sedimentary origin
- **a** — Anorthosite
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble

Chester Valley

SEDIMENTARY ROCKS (QUATERNARY / TERTIARY)

- **Qg** — Gravel on Terraces
- **Tbm** — Bryn Mawr Formation
  High level terrace deposits; sand and gravel with some silt.

IGNEOUS (TRASSIC)

- **Ŧd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

METAMORPHOSED SEDIMENTARY ROCKS (ORDOVICIAN)

- Conestoga Formation
  Bluish gray, thin bedded, impure, contorted lime-stone with shale partings, conglomerate at base.
  - **Ocs**
  - **Ocsu** — *upper micaceous limestone*
  - **Ocsp** — *middle phyllite*
  - **Ocsl** — *lower alternating dolomite and limestone*

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- **Ꞓhc** — Chickies Formation
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South of Chester Valley

IGNEOUS (TRASSIC)

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IGNEOUS AND METAMORPHIC ROCKS (PRE-CAMBRIAN OR ORDOVICIAN)

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- **Xc** — Cockeysville Marble
  White to light bluish gray marble.
- **Xsq** — Setters Formation
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  Course crystalline marble.

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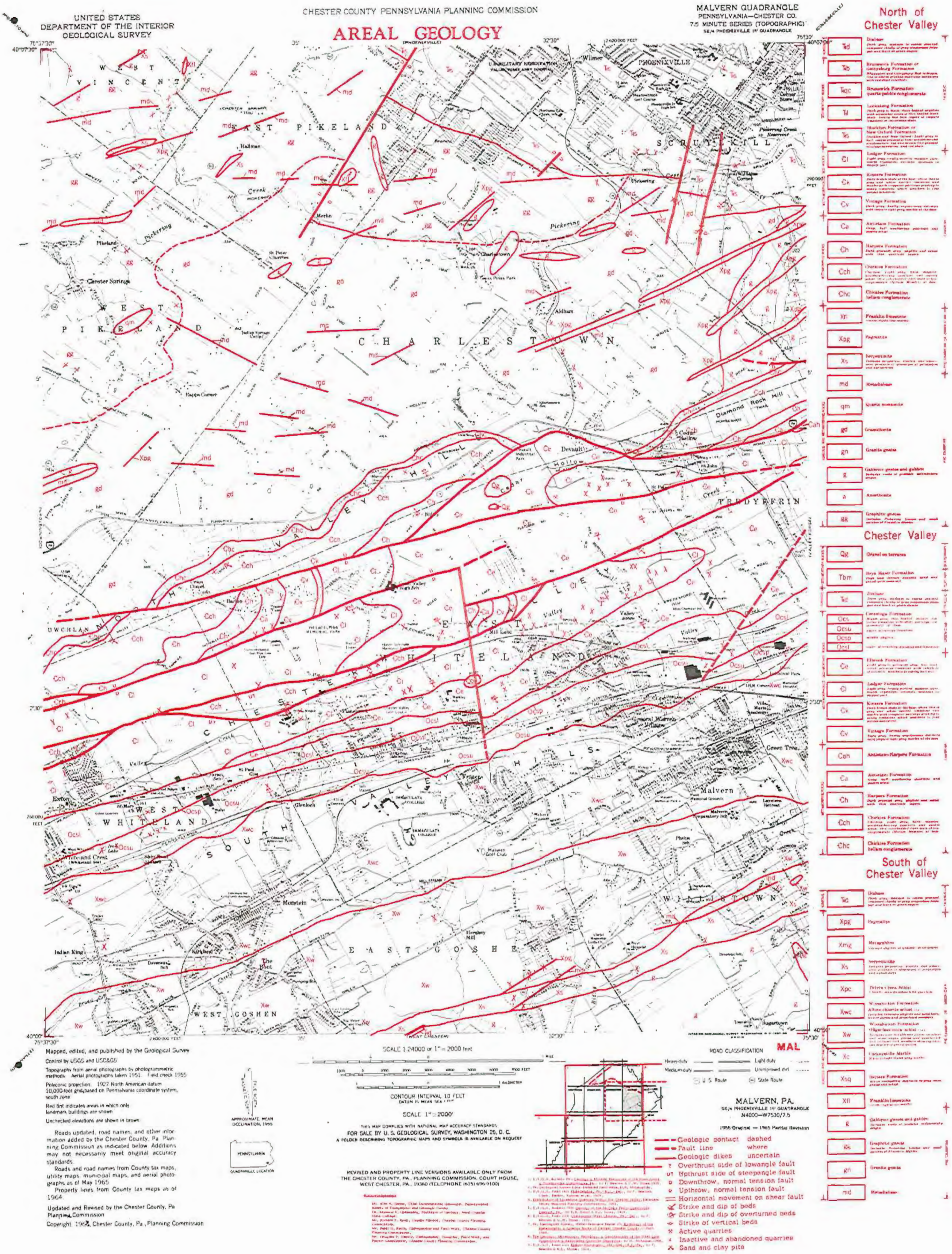
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SCHUYLKILL
TREDYFFRIN
EAST WHITELAND
WEST WHITELAND
WILLISTOWN
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WEST GOSHEN
Malvern
Diamond Rock Hill
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Topography from aerial photographs by photogrammetric methods. Aerial photographs taken 1951. Field check 1955
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10,000-foot grid based on Pennsylvania coordinate system, south zone
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Medium-duty
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N4000—W7530/7.5
1955 Original — 1965 Partial Revision
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North of Chester Valley

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CAMBRIAN

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CAMBRIAN

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PRE-CAMBRIAN OR ORDOVICIAN

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Chester Valley

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South of Chester Valley

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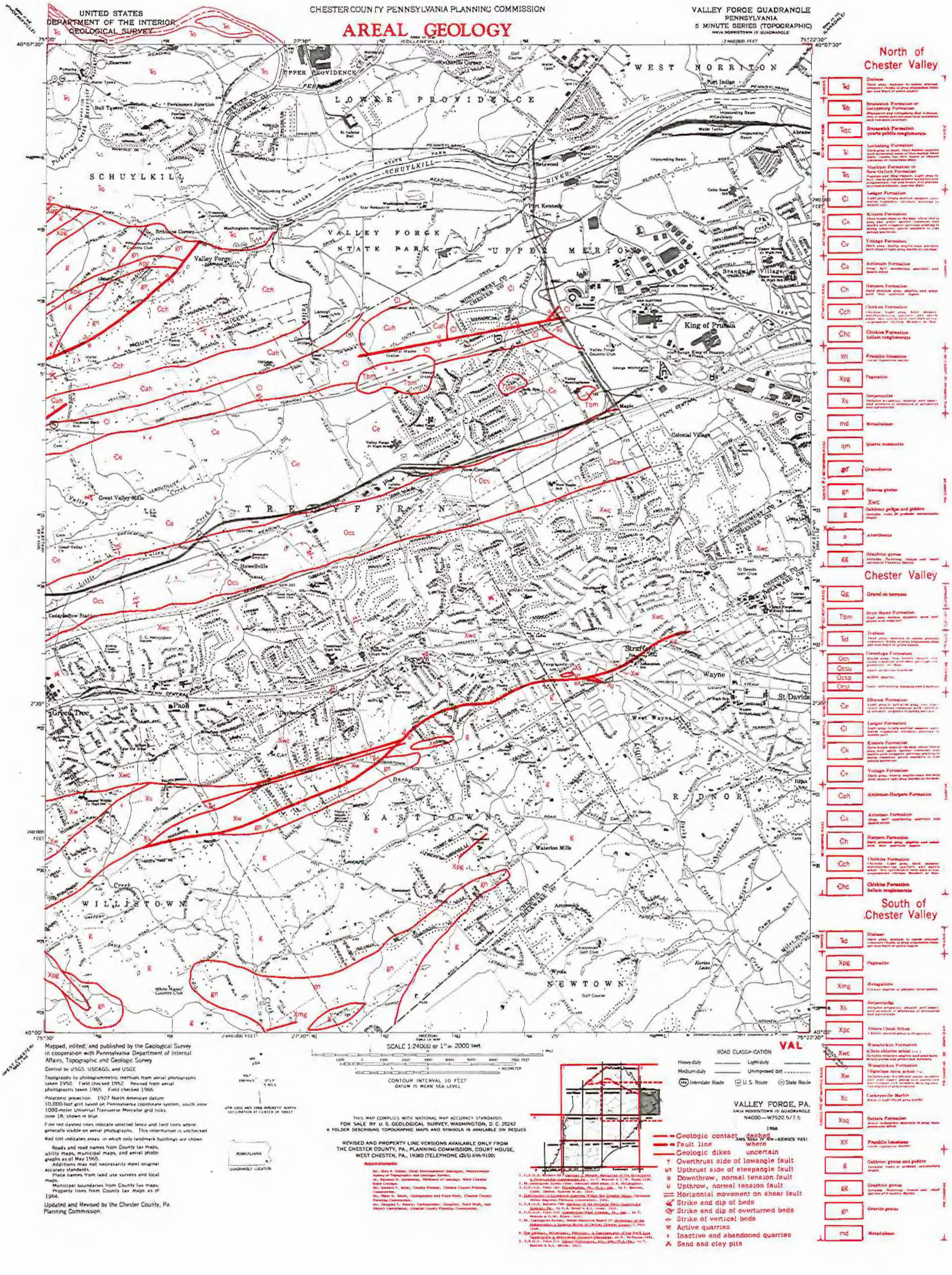

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CHESTER COUNTY PENNSYLVANIA PLANNING COMMISSION
AREAL GEOLOGY
VALLEY FORGE QUADRANGLE
PENNSYLVANIA
5 MINUTE SERIES (TOPOGRAPHIC)
North of Chester Valley
Chester Valley
South of Chester Valley
SCHUYLKILL
LOWER PROVIDENCE
WEST NORRITON
VALLEY FORGE STATE PARK
UPPER MERION
TREDYFFRIN
EASTTOWN
RADNOR
WILLISTOWN
NEWTOWN
King of Prussia
Valley Forge
Berwyn
Devon
Strafford
Wayne
St Davids
Paoli
Green Tree
Daylesford
Waterloo Mills
Colonial Village
Howellville
Great Valley Mills
Mapped, edited, and published by the Geological Survey in cooperation with Pennsylvania Department of Internal Affairs, Topographic and Geologic Survey
Control by USGS, USC&GS, and USCE
Topography by photogrammetric methods from aerial photographs taken 1950. Field checked 1952. Revised from aerial photographs taken 1965. Field checked 1966.
Polyconic projection. 1927 North American datum
10,000-foot grid based on Pennsylvania coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue
Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked
Red tint indicates areas in which only landmark buildings are shown
Roads and road names from County tax maps, utility maps, municipal maps, and aerial photographs as of May 1966.
Additions may not necessarily meet original accuracy standards.
Place names from land use surveys and local maps.
Municipal boundaries from County tax maps.
Property lines from County tax maps as of 1964.
Updated and Revised by the Chester County, Pa. Planning Commission.
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
REVISED AND PROPERTY LINE VERSIONS AVAILABLE ONLY FROM
THE CHESTER COUNTY, PA., PLANNING COMMISSION, COURT HOUSE,
WEST CHESTER, PA., 19380 (TELEPHONE (215) 696-9100)
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
Interstate Route
U.S. Route
State Route
VAL
VALLEY FORGE, PA.
NW/4 NORRISTOWN 15' QUADRANGLE
N4000—W7522.5/7.5
Geologic contact dashed where uncertain
Fault line
Geologic dikes
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

IGNEOUS

- **Ŧd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

SEDIMENTARY ROCKS (TRIASSIC)

- **Ŧb** — Brunswick or Gettysburg Formation. *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
- **Ŧqc** — Brunswick Formation, quartz pebble conglomerate
- **Ŧl** — Lockatong Formation. *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
- **Ŧs** — Stockton or New Oxford Formation. *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*

METAMORPHOSED SED. ROCK (CAMBRIAN)

- **Ꞓl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

METAMORPHIC ROCKS (CAMBRIAN)

- **Ꞓa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
- **Ꞓh** — Harpers Formation. *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Ꞓch** — Chickies Formation. *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation, hellam conglomerate

IGNEOUS AND METAMORPHIC ROCKS (PRE-CAMBRIAN OR ORDOVICIAN)

- **Xfl** — Franklin limestone. *coarse crystalline marble*
- **Xpg** — Pegmatite
- **Xc** — Serpentinite. *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*

IGNEOUS AND METAMORPHIC ROCKS (PRE-CAMBRIAN)

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro. *Includes rocks of probable sedimentary origin*
- **a** — Anorthosite
- **gg** — Graphitic gneiss. *Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces (QUATERNARY)
- **Tbm** — Bryn Mawr Formation. *High level terrace deposits; sand and gravel with some silt.* (TERTIARY)

IGNEOUS (TRIASSIC)

- **Ŧd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

METAMORPHOSED SEDIMENTARY ROCKS (ORDOVICIAN)

- Conestoga Formation. *Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.*
  - **Ocs**
  - **Ocsu** — *upper micaceous limestone*
  - **Ocsp** — *middle phyllite*
  - **Ocsl** — *lower alternating dolomite and limestone*

METAMORPHOSED SEDIMENTARY ROCKS (CAMBRIAN)

- **Ꞓe** — Elbrook Formation. *Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
- **Ꞓl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

METAMORPHIC ROCKS (CAMBRIAN)

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
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- **Ꞓch** — Chickies Formation. *Chickies-Light gray, hard, massive, scolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation, hellam conglomerate

South of Chester Valley

IGNEOUS (TRIASSIC)

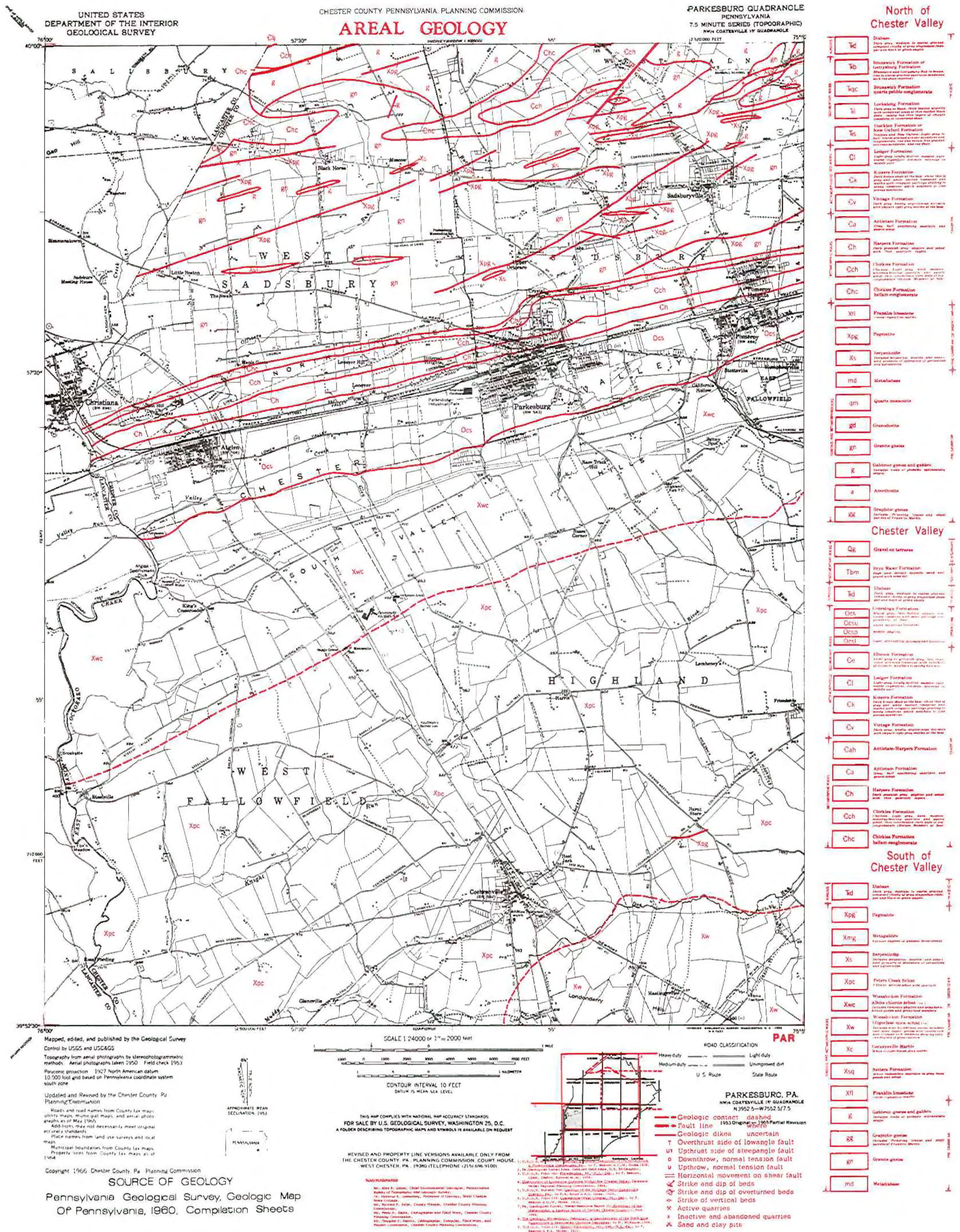
- **Ŧd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

IGNEOUS AND METAMORPHIC ROCKS (PRE-CAMBRIAN OR ORDOVICIAN)

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro. *DarVarious degrees of gneissic development.*
- **Xs** — Serpentinite. *Includes serpentine ,steatite and associated products of alteration of peridotiites and pyroxenites.*
- **Xpc** — Peter Creek Schist. *Chlorite sericite schist with quartzite.*
- **Xwc** — Wissahickon Formation, Albite chlorite schist (Xwc). *Includes Octoraro phyllite and some horn blende gneiss and granilized members.*
- **Xw** — Wissahickon Formation, Oligoclasa mica schist (Xw). *Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
- **Xc** — Cockeysville Marble. *White to light bluish gray marble.*
- **Xsq** — Setters Formation. *White feldipathic quartzite to gray mica gneiss and schist.*
- **Xfl** — Franklin limestone. *Course crystalline marble.*

IGNEOUS AND METAMORPHIC ROCKS (PRE-CAMBRIAN)

- **g** — Gabbroic gneiss and gabbro. *Includes rocks of probable sedimentary origin*
- **gg** — Graphitic gneiss. *Includes Pickering Gneiss and small patches of Franklin Marble*
- **gn** — Granite gneiss
- **md** — Metadiabase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CHESTER COUNTY PENNSYLVANIA PLANNING COMMISSION
AREAL GEOLOGY
PARKESBURG QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
North of Chester Valley
Chester Valley
South of Chester Valley
WEST SADSBURY
SADSBURY
NORTH VALLEY
CHESTER VALLEY
SOUTH VALLEY
HIGHLAND
WEST FALLOWFIELD
Christiana
Atglen
Parkesburg
Sadsburyville
Pomeroy
Cochranville
Londonderry
Mapped, edited, and published by the Geological Survey
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 10 FEET
PARKESBURG, PA.
N3952.5—W7552.5/7.5
Geologic contact
Fault line
Geologic dikes
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits
Copyright 1966 Chester County, Pa. Planning Commission
SOURCE OF GEOLOGY
Pennsylvania Geological Survey, Geologic Map Of Pennsylvania, 1960, Compilation Sheets

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC

IGNEOUS

- **TRd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

SEDIMENTARY ROCKS

- **TRb** — Brunswick or Gettysburg Formation
  Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.
- **TRqc** — Brunswick Formation
  quartz pebble conglomerate
- **TRl** — Lockatong Formation
  Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.
- **TRs** — Stockton or New Oxford Formation
  Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.

CAMBRIAN

METAMORPHOSED SED. ROCK

- **Ꞓl** — Ledger Formation
  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
- **Ꞓk** — Kinzers Formation
  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
- **Ꞓh** — Harpers Formation
  Dark greenish gray phyllite and schist with thin quartzite layers.
- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xfl** — Franklin limestone
  coarse crystalline marble
- **Xpg** — Pegmatite
- **Xc** — Serpentinite
  Includes serpentine ,steatite and associatea products of alteration of peridotities and pyroxenites.

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
- **a** — Anorthosite
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble

Chester Valley

QUATERNARY / TERTIARY

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces
- **Tbm** — Bryn Mawr Formation
  High level terrace deposits; sand and gravel with some silt.

TRASSIC

IGNEOUS

- **TRd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS

- **Ocs** — Conestoga Formation
  Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.
- **Ocsu** — *upper micaceous limestone*
- **Ocsp** — *middle phyllite*
- **Ocsl** — *lower alternating dolomite and limestone*

CAMBRIAN

METAMORPHOSED SEDIMENTARY ROCKS

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CAMBRIAN

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South of Chester Valley

TRIASSIC

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PRE-CAMBRIAN OR ORDOVICIAN

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  Chlorite sericite schist with quartzite.

PRE-CAMBRIAN OR ORDOVICIAN

- **Xwc** — Wissahickon Formation
  Albite chlorite schist (Xwc)
  Includes Octoraro phyllite and some horn blende gneiss and granitized members.
- **Xw** — Wissahickon Formation
  Oligoclasa mica schist (Xw)
  Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.
- **Xc** — Cockeysville Marble
  White to light bluish gray marble.
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  White feldipathic quartzite to gray mica gneiss and schist.
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PRE-CAMBRIAN

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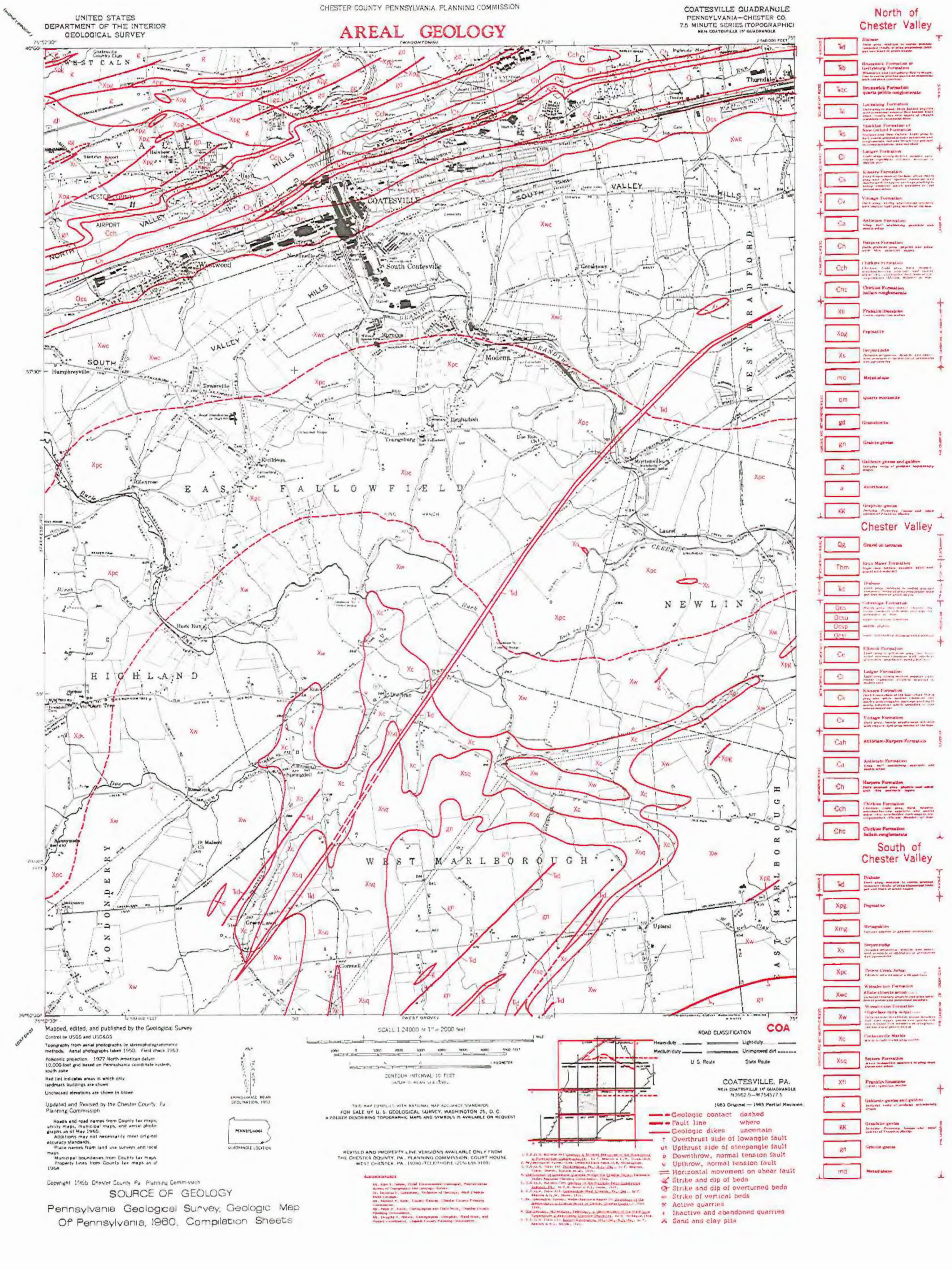

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Chester Valley
South of Chester Valley
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VALLEY
HILLS
COATESVILLE
SOUTH VALLEY HILLS
NORTH VALLEY
South Coatesville
Westwood
EAST FALLOWFIELD
HIGHLAND
NEWLIN
WEST MARLBOROUGH
LONDONDERRY
WEST BRADFORD
EAST MARLBOROUGH
Modena
Mortonville
Youngsburg
Humphreysville
Ercildoun
Buck Run
Springdell
Upland
Laurel
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North of Chester Valley

IGNEOUS — TRIASSIC

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SEDIMENTARY ROCKS — TRIASSIC

- **TRb** — Brunswick or Gettysburg Formation. *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
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METAMORPHOSED SED. ROCK — CAMBRIAN

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METAMORPHIC ROCKS — CAMBRIAN

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IGNEOUS AND METAMORPHIC ROCKS — PRE-CAMBRIAN OR ORDOVICIAN

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Chester Valley

SEDIMENTARY ROCKS — QUATERNARY / TERTIARY

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IGNEOUS — TRIASSIC

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METAMORPHOSED SEDIMENTARY ROCKS — ORDOVICIAN

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South of Chester Valley

IGNEOUS — TRIASSIC

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IGNEOUS AND METAMORPHIC ROCKS — PRE-CAMBRIAN OR ORDOVICIAN

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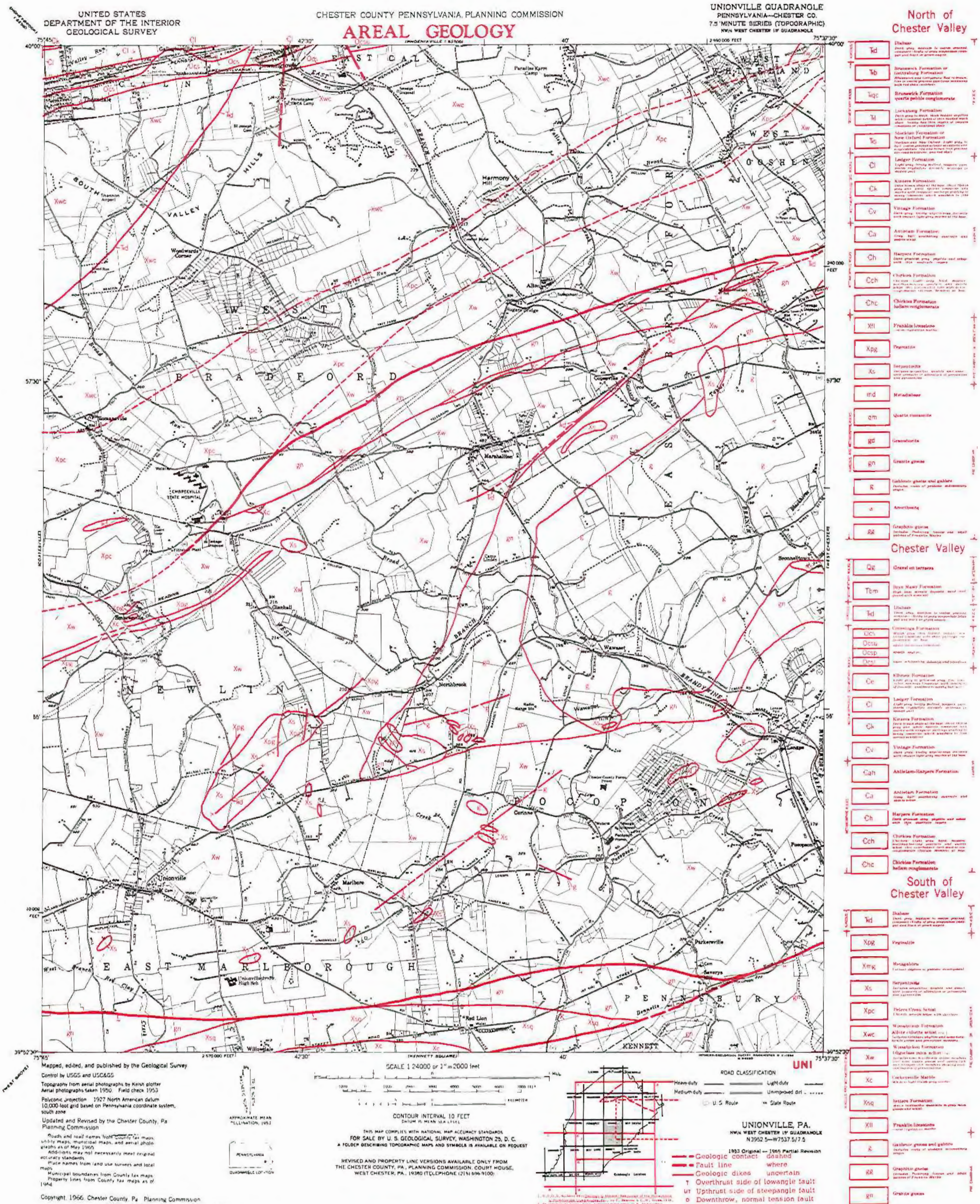

SOURCE OF GEOLOGY

Pennsylvania Geological Survey, Geologic Map Of Pennsylvania, 1960, Compilation Sheets

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC

IGNEOUS

- **R̄d** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

SEDIMENTARY ROCKS

- **R̄b** — Brunswick or Gettysburg Formation
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CAMBRIAN

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  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓa** — Antietam Formation
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- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xfl** — Franklin limestone
  coarse crystalline marble
- **Xpg** — Pegmatite
- **Xc** — Serpentinite
  Includes serpentine, steatite and associated products of alteration of peridoitites and pyroxenites.

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
- **a** — Anorthosite
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble

Chester Valley

QUATERNARY

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces

TERTIARY

- **Tbm** — Bryn Mawr Formation
  High level terrace deposits; sand and gravel with some silt.

TRIASSIC

IGNEOUS

- **R̄d** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS

- Conestoga Formation
  Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.
  - **Ocs**
  - **Ocsu** — *upper micaceous limestone*
  - **Ocsp** — *middle phyllite*
  - **Ocsl** — *lower alternating dolomite and limestone*

CAMBRIAN

METAMORPHOSED SED. MENTARY ROCKS

- **Ꞓe** — Elbrook Formation
  Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.
- **Ꞓl** — Ledger Formation
  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
- **Ꞓk** — Kinzers Formation
  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
- **Ꞓh** — Harpers Formation
  Dark greenish gray phyllite and schist with thin quartzite layers.
- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

South of Chester Valley

TRIASSIC

IGNEOUS

- **R̄d** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro
  DarVarious degrees of gneissic development.
- **Xs** — Serpentinite
  Includes serpentine, steatite and associated products of alteration of peridotities and pyroxenites.
- **Xpc** — Peter Creek Schist
  Chlorite sericite schist with quartzite.

PRE-CAMBRIAN OR ORDOVICIAN

- **Xwc** — Wissahickon Formation
  Albite chlorite schist (Xwc)
  Includes Octoraro phyllite and some horn blende gneiss and granitized members.
- **Xw** — Wissahickon Formation
  Oligoclasa mica schist (Xw)
  Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.
- **Xc** — Cockeysville Marble
  White to light bluish gray marble.
- **Xsq** — Setters Formation
  White feldipathic quartzite to gray mica gneiss and schist.
- **Xfl** — Franklin limestone
  Course crystalline marble.

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

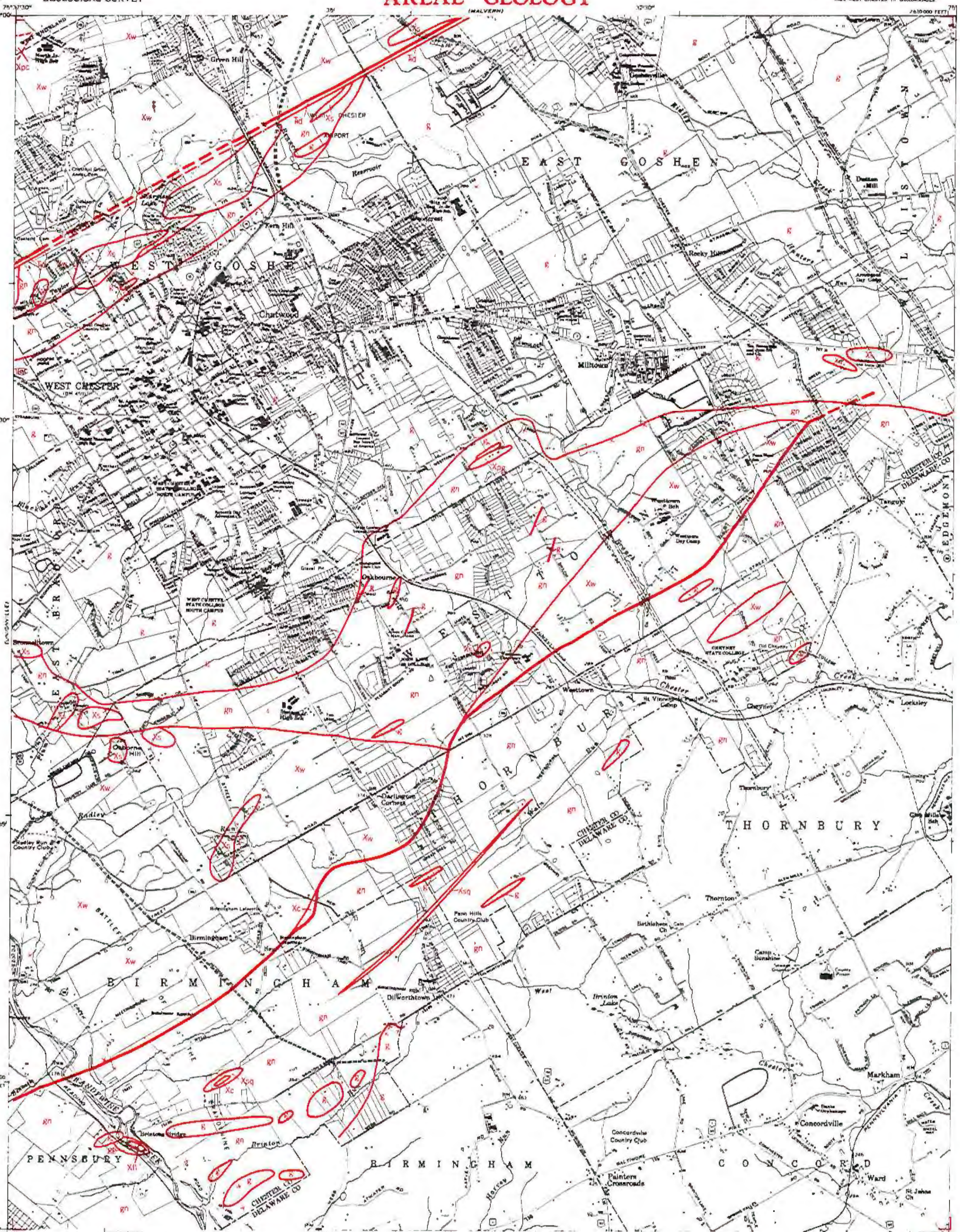
- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble
- **gn** — Granite gneiss
- **md** — Metadiabase

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CHESTER COUNTY PENNSYLVANIA PLANNING COMMISSION

AREAL GEOLOGY

WEST CHESTER QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)



North of Chester Valley

- Td — Diabase
- Tb — Brunswick Formation or Gettysburg Formation
- Trqc — Brunswick Formation quartz pebble conglomerate
- Tl — Lockatong Formation
- Ts — Stockton Formation or New Oxford Formation
- Cl — Ledger Formation
- Ck — Kinzers Formation
- Cv — Vintage Formation
- Ca — Antietam Formation
- Ch — Harpers Formation
- Cch — Chickies Formation
- Chc — Chickies Formation hellam conglomerate
- Xfl — Franklin limestone
- Xpg — Pegmatite
- Xs — Serpentinite
- md — Metadiabase
- qm — Quartz monzonite
- gd — Granodiorite
- gn — Granite gneiss
- g — Gabbroic gneiss and gabbro
- a — Anorthosite
- gg — Graphitic gneiss

Chester Valley

- Qg — Gravel on terraces
- Tbm — Bryn Mawr Formation
- Td — Diabase
- Ocs, Ocsu, Ocsp, Ocsl — Conestoga Formation
- Ce — Elbrook Formation
- Cl — Ledger Formation
- Ck — Kinzers Formation
- Cv — Vintage Formation
- Cah — Antietam-Harpers Formation
- Ca — Antietam Formation
- Ch — Harpers Formation
- Cch — Chickies Formation
- Chc — Chickies Formation hellam conglomerate

South of Chester Valley

- Td — Diabase
- Xpg — Pegmatite
- Xmg — Metagabbro
- Xs — Serpentinite
- Xpc — Peters Creek Schist
- Xwc — Wissahickon Formation
- Xw — Wissahickon Formation
- Xc — Cockeysville Marble
- Xsq — Setters Formation
- Xfl — Franklin limestone
- g — Gabbroic gneiss and gabbro
- gg — Graphitic gneiss
- gn — Granite gneiss
- md — Metadiabase

Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS, and Pennsylvania Dept. of Highways

Topography from aerial photographs by photogrammetric methods. Aerial photographs taken 1950. Field check 1954

Polyconic projection. 1927 North American datum
10,000 foot grid based on Pennsylvania coordinate system, south zone

Red tint indicates area in which only landmark buildings are shown

Unchecked elevations are shown in brown

Updated and Revised by the Chester County, Pa. Planning Commission

Roads and road names from County tax maps, utility maps, municipal maps, and aerial photographs as of May 1965.
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Municipal boundaries from County tax maps.
Property lines from County tax maps as of 1964.

SOURCE OF GEOLOGY

Pennsylvania Geological Survey, Geologic Map Of Pennsylvania, 1960, Compilation Sheets

APPROXIMATE MEAN DECLINATION, 1954

PENNSYLVANIA
QUADRANGLE LOCATION

SCALE 1:24000 or 1" = 2000 feet

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

REVISED AND PROPERTY LINE VERSIONS AVAILABLE ONLY FROM THE CHESTER COUNTY, PA., PLANNING COMMISSION, COURT HOUSE, WEST CHESTER, PA., 19380 (TELEPHONE (215) 696-9100)

ROAD CLASSIFICATION

Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
U. S. Route — State Route

WEST CHESTER, PA.
NE/4 WEST CHESTER 15' QUADRANGLE
N3952.5—W7530/7.5

1954 Original — 1965 Partial Revision

- Geologic contact — dashed where uncertain
- Fault line
- Geologic dikes
- T Overthrust side of lowangle fault
- UT Upthrust side of steepangle fault
- D Downthrow, normal tension fault
- U Upthrow, normal tension fault
- Horizontal movement on shear fault
- Strike and dip of beds
- Strike and dip of overturned beds
- Strike of vertical beds
- Active quarries
- Inactive and abandoned quarries
- Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC

IGNEOUS

- **TRd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

SEDIMENTARY ROCKS

- **TRb** — Brunswick or Gettysburg Formation
  Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.
- **TRqc** — Brunswick Formation
  quartz pebble conglomerate
- **TRl** — Lockatong Formation
  Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.
- **TRs** — Stockton or New Oxford Formation
  Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.

CAMBRIAN

METAMORPHOSED SED. ROCK

- **Ꞓl** — Ledger Formation
  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
- **Ꞓk** — Kinzers Formation
  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
- **Ꞓh** — Harpers Formation
  Dark greenish gray phyllite and schist with thin quartzite layers.
- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xfl** — Franklin limestone
  coarse crystalline marble
- **Xpg** — Pegmatite
- **Xc** — Serpentinite
  Includes serpentine, steatite and associated products of alteration of peridotities and pyroxenites.

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
- **a** — Anorthosite
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble

Chester Valley

QUATERNARY

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces

TERTIARY

- **Tbm** — Bryn Mawr Formation
  High level terrace deposits; sand and gravel with some silt.

TRIASSIC

IGNEOUS

- **TRd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS

- **Ocs** — Conestoga Formation
  Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.
- **Ocsu** — *upper micaceous limestone*
- **Ocsp** — *middle phyllite*
- **Ocsl** — *lower alternating dolomite and limestone*

CAMBRIAN

METAMORPHOSED SED MENTARY ROCKS

- **Ꞓe** — Elbrook Formation
  Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.
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  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
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  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
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- **Ꞓhc** — Chickies Formation
  hellam conglomerate

South of Chester Valley

TRIASSIC

IGNEOUS

- **TRd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro
  DarVarious degrees of gneissic development.
- **Xs** — Serpentinite
  Includes serpentine, steatite and associated products of alteration of peridotites and pyroxenites.
- **Xpc** — Peter Creek Schist
  Chlorite sericite schist with quartzite.

PRE-CAMBRIAN OR ORDOVICIAN

- **Xwc** — Wissahickon Formation
  Albite chlorite schist (Xwc)
  Includes Octoraro phyllite and some horn blende gneiss and granitized members.
- **Xw** — Wissahickon Formation
  Oligoclasa mica schist (Xw)
  Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.
- **Xc** — Cockeysville Marble
  White to light bluish gray marble.
- **Xsq** — Setters Formation
  White feldipathic quartzite to gray mica gneiss and schist.
- **Xfl** — Franklin limestone
  Course crystalline marble.

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
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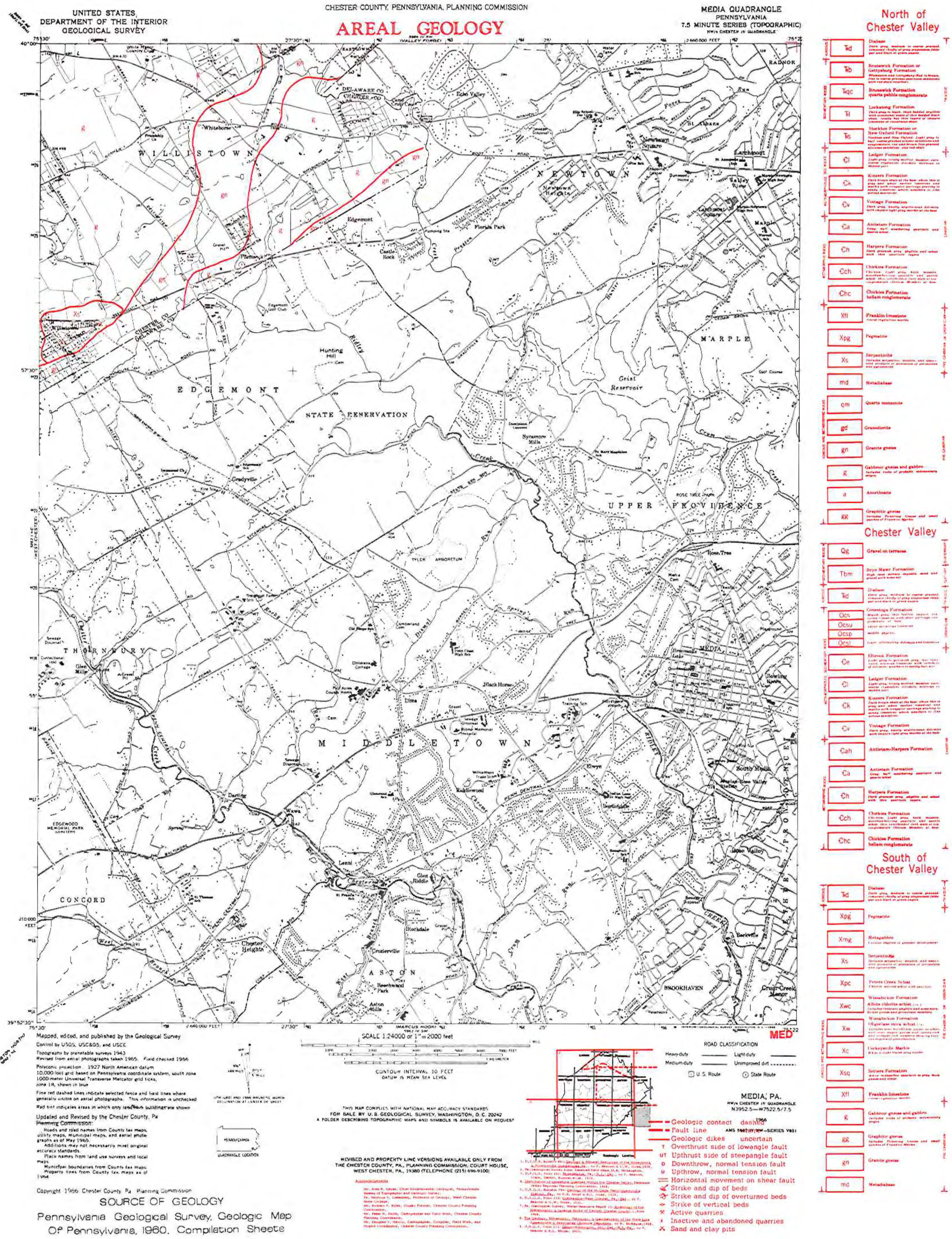
- **md** — Metadiabase


CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
AREAL GEOLOGY
MEDIA QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
WILLISTOWN
NEWTOWN
EDGEMONT
STATE RESERVATION
MARPLE
UPPER PROVIDENCE
THORNBURY
MIDDLETOWN
CONCORD
ASTON
MEDIA
BROOKHAVEN
North of Chester Valley
Chester Valley
South of Chester Valley
Mapped, edited, and published by the Geological Survey
Control by USGS, USC&GS, and USCE
Topography by planetable surveys 1943
Revised from aerial photographs taken 1965. Field checked 1966
Polyconic projection. 1927 North American datum
10,000-foot grid based on Pennsylvania coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue
Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked
Red tint indicates areas in which only landmark buildings are shown
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Heavy-duty
Light-duty
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Unimproved dirt
U. S. Route
State Route
MEDIA, PA.
NW/4 CHESTER 15' QUADRANGLE
N3952.5—W7522.5/7.5
1966
MED
Geologic contact dashed
Fault line
Geologic dikes uncertain
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC — IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

TRIASSIC — SEDIMENTARY ROCKS

- **TRb** — Brunswick or Gettysburg Formation. *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
- **TRqc** — Brunswick Formation. quartz pebble conglomerate
- **TRl** — Lockatong Formation. *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
- **TRs** — Stockton or New Oxford Formation. *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*

CAMBRIAN — METAMORPHOSED SED. ROCK

- **Єl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Єk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Єv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN — METAMORPHIC ROCKS

- **Єa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
- **Єh** — Harpers Formation. *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Єch** — Chickies Formation. *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top; conglomerate (Hellam Member) at base.*
- **Єhc** — Chickies Formation. hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN — IGNEOUS AND METAMORPHIC ROCKS

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Chester Valley

QUATERNARY — SEDIMENTARY ROCKS

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CAMBRIAN — METAMORPHIC ROCKS

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- **Єa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
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South of Chester Valley

TRIASSIC — IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

PRE-CAMBRIAN OR ORDOVICIAN — IGNEOUS AND METAMORPHIC ROCKS

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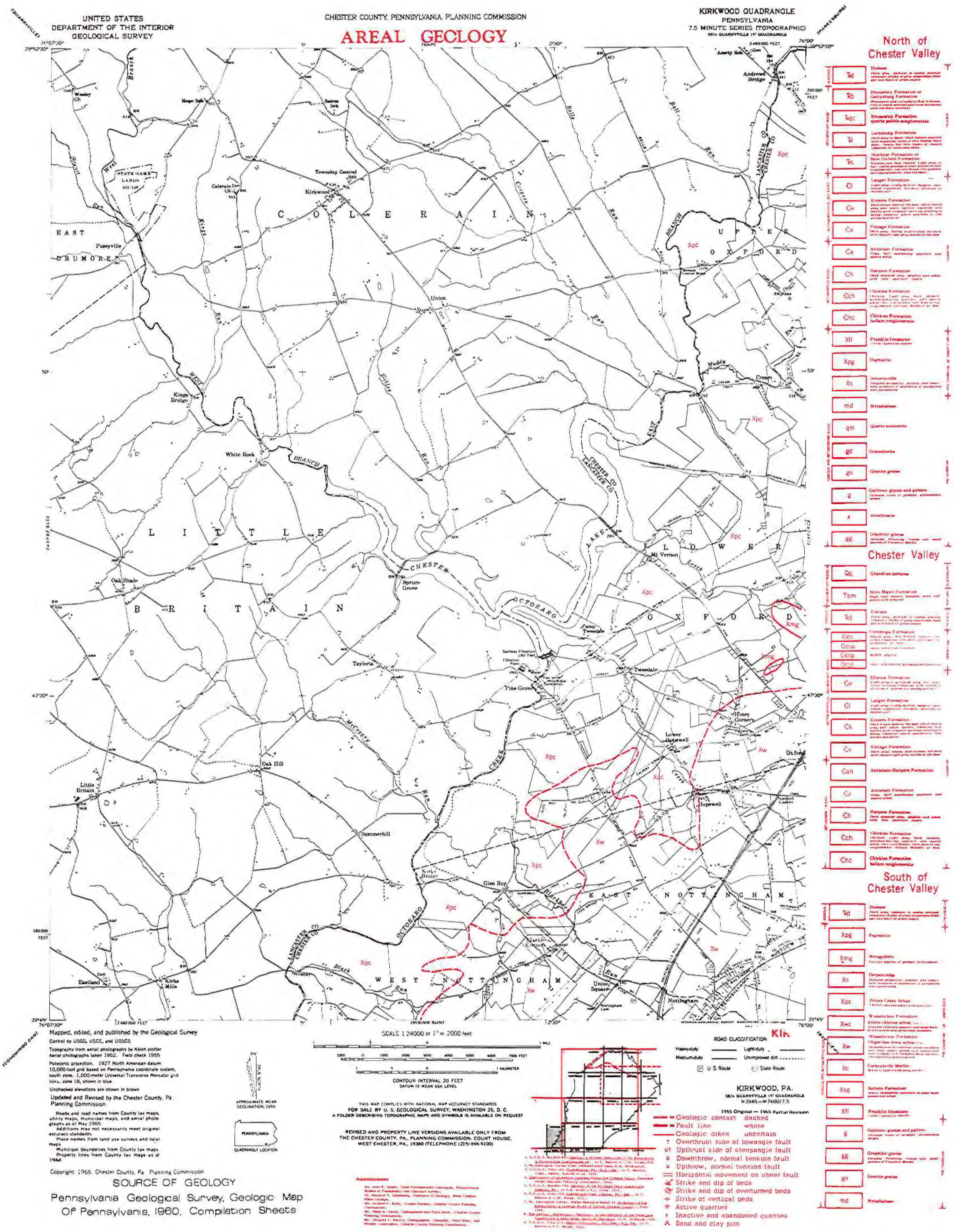

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KIRKWOOD QUADRANGLE
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7.5 MINUTE SERIES (TOPOGRAPHIC)
North of Chester Valley
Chester Valley
South of Chester Valley
C O L E R A I N
U P P E R O X F O R D
L O W E R O X F O R D
E A S T N O T T I N G H A M
W E S T N O T T I N G H A M
L I T T L E B R I T A I N
EAST DRUMORE
Kirkwood
Union
Kings Bridge
White Rock
Oak Shade
Tayloria
Pine Grove
Oak Hill
Little Britain
Summerhill
Glen Roy
Eastland
Kirks Mills
Hopewell
Nottingham
Xpc
Xw
Xmg
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Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
U.S. Route
State Route
KIRKWOOD, PA.
SE/4 QUARRYVILLE 15' QUADRANGLE
N3945—W7600/7.5
1955 Original — 1965 Partial Revision
Geologic contact
Fault line
Geologic dikes
dashed where uncertain
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

SEDIMENTARY ROCKS

- **TRb** — Brunswick or Gettysburg Formation. *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
- **TRqc** — Brunswick Formation, quartz pebble conglomerate
- **TRl** — Lockatong Formation. *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
- **TRs** — Stockton or New Oxford Formation. *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*

CAMBRIAN

METAMORPHOSED SED. ROCK

- **Ꞓl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
- **Ꞓh** — Harpers Formation. *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Ꞓch** — Chickies Formation. *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation, hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xfl** — Franklin limestone. *coarse crystalline marble*
- **Xpg** — Pegmatite
- **Xc** — Serpentinite. *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro. *Includes rocks of probable sedimentary origin*
- **a** — Anorthosite
- **gg** — Graphitic gneiss. *Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

QUATERNARY / TERTIARY

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces
- **Tbm** — Bryn Mawr Formation. *High level terrace deposits; sand and gravel with some silt.*

TRIASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS

- Conestoga Formation. *Bluish gray, thin bedded, impure, contorted lime-stone with shale partings, conglomerate at base.*
  - **Ocs**
  - **Ocsu** — *upper micaceous limestone*
  - **Ocsp** — *middle phyllite*
  - **Ocsl** — *lower alternating dolomite and limestone*

CAMBRIAN

METAMORPHOSED SEDIMENTARY ROCKS

- **Ꞓe** — Elbrook Formation. *Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
- **Ꞓl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
- **Ꞓh** — Harpers Formation. *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Ꞓch** — Chickies Formation. *Chickies-Light gray, hard, massive, sciolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation, hellam conglomerate

South of Chester Valley

TRIASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

PRE-CAMBRIAN OR ORDOVICIAN

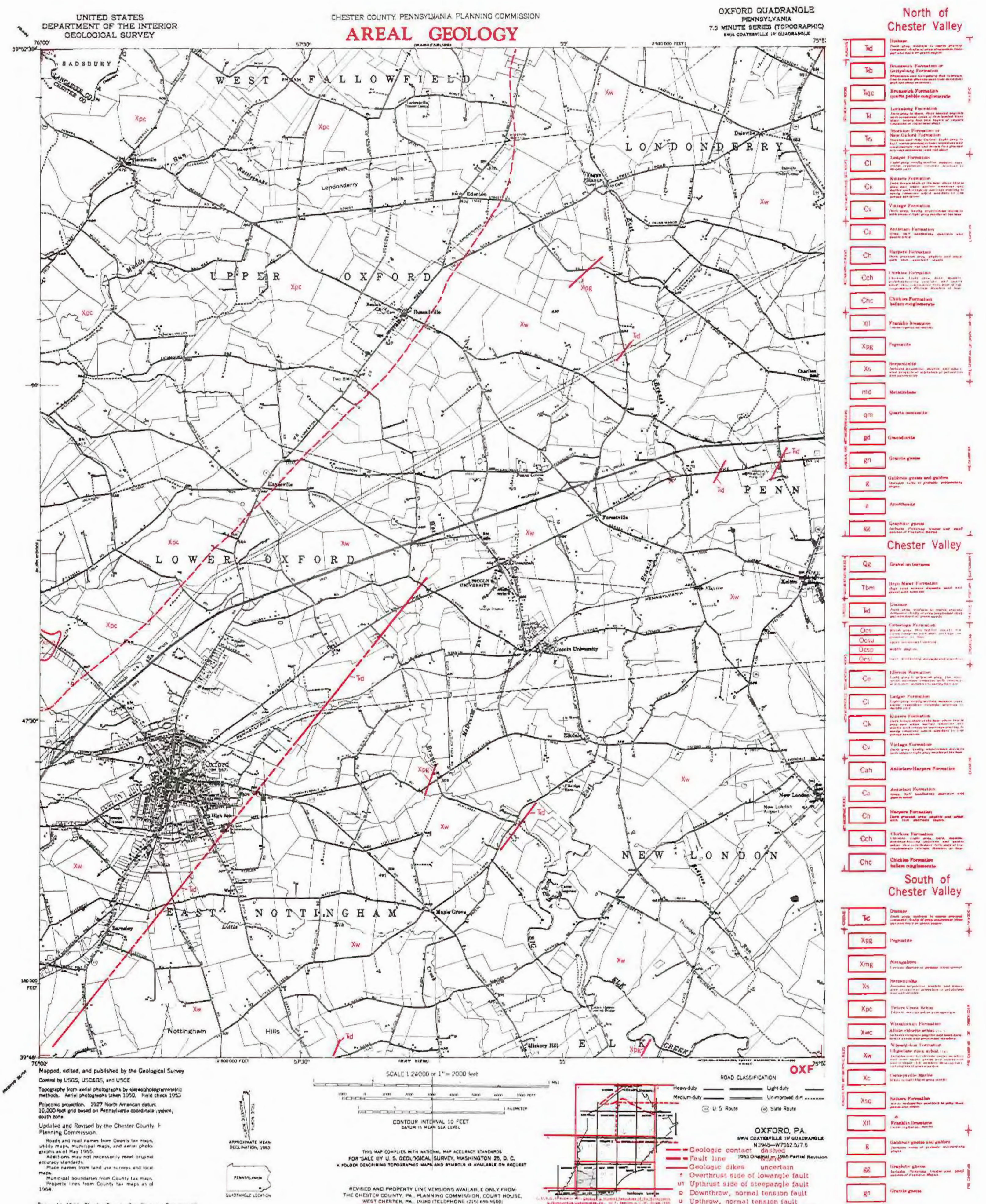
IGNEOUS AND METAMORPHIC ROCKS

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro. *DarVarious degrees of gneissic development.*
- **Xs** — Serpentinite. *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
- **Xpc** — Peter Creek Schist. *Chlorite sericite schist with quartzite.*
- **Xwc** — Wissahickon Formation, Albite chlorite schist (Xwc). *Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
- **Xw** — Wissahickon Formation, Oligoclasa mica schist (Xw). *Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
- **Xc** — Cockeysville Marble. *White to light bluish gray marble.*
- **Xsq** — Setters Formation. *White feldipathic quartzite to gray mica gneiss and schist.*
- **Xfl** — Franklin limestone. *Course crystalline marble.*

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **g** — Gabbroic gneiss and gabbro. *Includes rocks of probable sedimentary origin*
- **gg** — Graphitic gneiss. *Includes Pickering Gneiss and small patches of Franklin Marble*
- **gn** — Granite gneiss
- **md** — Metadiabase



SOURCE OF GEOLOGY

Pennsylvania Geological Survey, Geologic Map Of Pennsylvania, 1960, Compilation Sheets

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRIASSIC — IGNEOUS

Ŧd	**Diabase** *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

TRIASSIC — SEDIMENTARY ROCKS

Ŧb	**Brunswick or Gettysburg Formation** *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
Ŧqc	**Brunswick Formation** quartz pebble conglomerate
Ŧl	**Lockatong Formation** *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
Ŧs	**Stockton or New Oxford Formation** *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*

CAMBRIAN — METAMORPHOSED SED. ROCK

Ꞓl	**Ledger Formation** *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
Ꞓk	**Kinzers Formation** *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
Ꞓv	**Vintage Formation** *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN — METAMORPHIC ROCKS

Ꞓa	**Antietam Formation** *Gray, buff weathering quartzite and quartz schist.*
Ꞓh	**Harpers Formation** *Dark greenish gray phyllite and schist with thin quartzite layers.*
Ꞓch	**Chickies Formation** *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
Ꞓhc	**Chickies Formation** hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN — IGNEOUS AND METAMORPHIC ROCKS

Xfl	**Franklin limestone** *coarse crystalline marble*
Xpg	**Pegmatite**
Xc	**Serpentinite** *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*

PRE-CAMBRIAN — IGNEOUS AND METAMORPHIC ROCKS

md	**Metadiabase**
qm	**Quartz monzonite**
gd	**Granodiorite**
gn	**Granite gneiss**
g	**Gabbroic gneiss and gabbro** *Includes rocks of probable sedimentary origin*
a	**Anorthosite**
gg	**Graphitic gneiss** *Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

QUATERNARY / TERTIARY — SEDIMENTARY ROCKS

Qg	**Gravel on Terraces**
Tbm	**Bryn Mawr Formation** *High level terrace deposits; sand and gravel with some silt.*

TRIASSIC — IGNEOUS

Ŧd	**Diabase** *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

ORDOVICIAN — METAMORPHOSED SEDIMENTARY ROCKS

Ocs	**Conestoga Formation** *Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.*
Ocsu	*upper micaceous limestone*
Ocsp	*middle phyllite*
Ocsl	*lower alternating dolomite and limestone*

CAMBRIAN — METAMORPHOSED SEDIMENTARY ROCKS

Ꞓe	**Elbrook Formation** *Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
Ꞓl	**Ledger Formation** *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
Ꞓk	**Kinzers Formation** *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
Ꞓv	**Vintage Formation** *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN — METAMORPHIC ROCKS

Ꞓah	**Antietam-Harpers Formation**
Ꞓa	**Antietam Formation** *Gray, buff weathering quartzite and quartz schist.*
Ꞓh	**Harpers Formation** *Dark greenish gray phyllite and schist with thin quartzite layers.*
Ꞓch	**Chickies Formation** *Chickies-Light gray, hard, massive, sciolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
Ꞓhc	**Chickies Formation** hellam conglomerate

South of Chester Valley

TRIASSIC — IGNEOUS

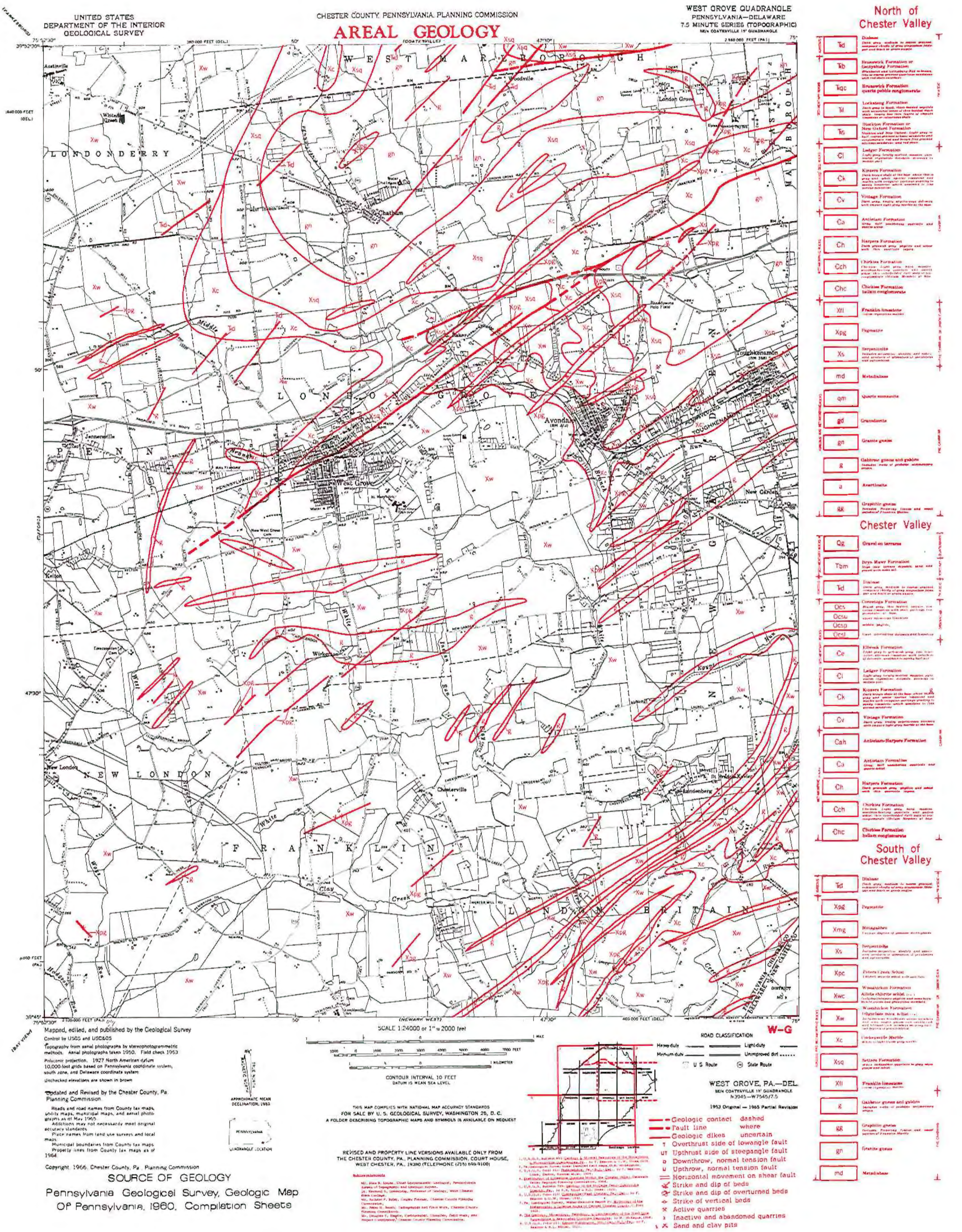
Ŧd	**Diabase** *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

PRE-CAMBRIAN OR ORDOVICIAN — IGNEOUS AND METAMORPHIC ROCKS

Xpg	**Pegmatite**
Xmg	**Metaglabbro** *DarVarious degrees of gneissic development.*
Xs	**Serpentinite** *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
Xpc	**Peter Creek Schist** *Chlorite sericite schist with quartzite.*
Xwc	**Wissahickon Formation** Albite chlorite schist (Xwc) *Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
Xw	**Wissahickon Formation** Oligoclasa mica schist (Xw) *Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
Xc	**Cockeysville Marble** *White to light bluish gray marble.*
Xsq	**Setters Formation** *White feldipathic quartzite to gray mica gneiss and schist.*
Xfl	**Franklin limestone** *Course crystalline marble.*

PRE-CAMBRIAN — IGNEOUS AND METAMORPHIC ROCKS

g	**Gabbroic gneiss and gabbro** *Includes rocks of probable sedimentary origin*
gg	**Graphitic gneiss** *Includes Pickering Gneiss and small patches of Franklin Marble*
gn	**Granite gneiss**
md	**Metadiabase**


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION
AREAL GEOLOGY
WEST GROVE QUADRANGLE
PENNSYLVANIA—DELAWARE
7.5 MINUTE SERIES (TOPOGRAPHIC)
WEST MARLBOROUGH
LONDONDERRY
LONDON GROVE
PENN
NEW LONDON
FRANKLIN
LONDON BRITAIN
West Grove
Avondale
Chatham
Toughkenamon
Chesterville
Landenberg
Jennersville
New London
North of Chester Valley
Chester Valley
South of Chester Valley
Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography from aerial photographs by stereophotogrammetric methods. Aerial photographs taken 1950. Field check 1953
Polyconic projection. 1927 North American datum
10,000-foot grids based on Pennsylvania coordinate system, south zone, and Delaware coordinate system
Unchecked elevations are shown in brown
Updated and Revised by the Chester County, Pa. Planning Commission
Roads and road names from County tax maps, utility maps, municipal maps, and aerial photographs as of May 1965.
Additions may not necessarily meet original accuracy standards.
Place names from land use surveys and local maps.
Municipal boundaries from County tax maps.
Property lines from County tax maps as of 1964.
Copyright 1966, Chester County, Pa., Planning Commission
SOURCE OF GEOLOGY
Pennsylvania Geological Survey, Geologic Map Of Pennsylvania, 1960, Compilation Sheets
SCALE 1:24000
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
APPROXIMATE MEAN DECLINATION, 1953
QUADRANGLE LOCATION
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
U S Route
State Route
W–G
WEST GROVE, PA.—DEL.
SE/4 COATESVILLE 15' QUADRANGLE
N3945—W7545/7.5
1953 Original — 1965 Partial Revision
Geologic contact
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Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

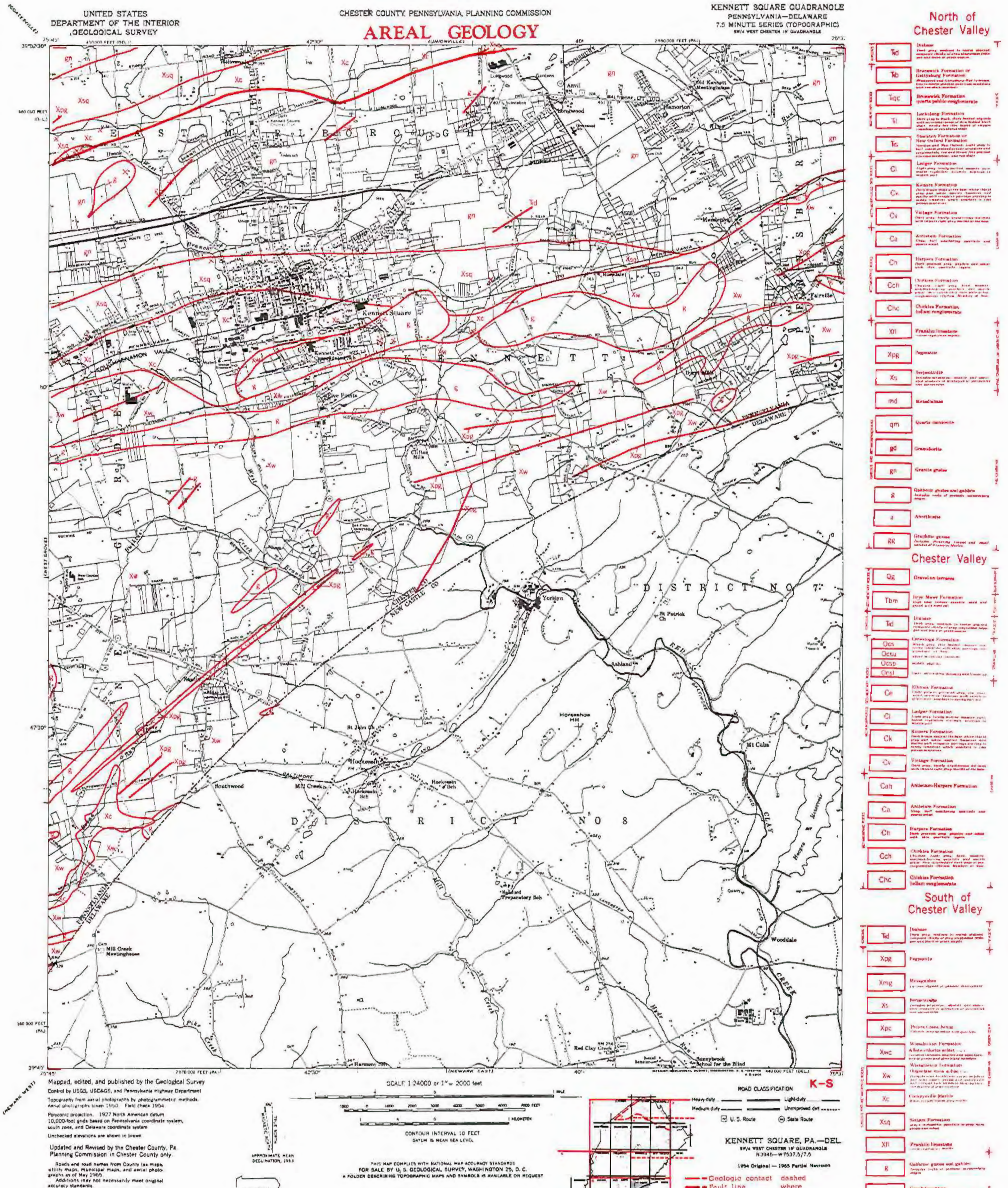
IGNEOUS	TRIASSIC	Ŧd	Diabase	*Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
SEDIMENTARY ROCKS	TRIASSIC	Ŧb	Brunswick or Gettysburg Formation	*Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
SEDIMENTARY ROCKS	TRIASSIC	Ŧqc	Brunswick Formation	quartz pebble conglomerate
SEDIMENTARY ROCKS	TRIASSIC	Ŧl	Lockatong Formation	*Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
SEDIMENTARY ROCKS	TRIASSIC	Ŧs	Stockton or New Oxford Formation	*Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*
METAMORPHOSED SED. ROCK	CAMBRIAN	Єl	Ledger Formation	*Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
METAMORPHOSED SED. ROCK	CAMBRIAN	Єk	Kinzers Formation	*Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
METAMORPHOSED SED. ROCK	CAMBRIAN	Єv	Vintage Formation	*Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*
METAMORPHIC ROCKS	CAMBRIAN	Єa	Antietam Formation	*Gray, buff weathering quartzite and quartz schist.*
METAMORPHIC ROCKS	CAMBRIAN	Єh	Harpers Formation	*Dark greenish gray phyllite and schist with thin quartzite layers.*
METAMORPHIC ROCKS	CAMBRIAN	Єch	Chickies Formation	*Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
METAMORPHIC ROCKS	CAMBRIAN	Єhc	Chickies Formation	hellam conglomerate
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xfl	Franklin limestone	*coarse crystalline marble*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xpg	Pegmatite	
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xc	Serpentinite	*Includes serpentine ,steatite and associatea products of alteration of peridotities and pyroxenites.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	md	Metadiabase	
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	qm	Quartz monzonite	
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gd	Granodiorite	
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gn	Granite gneiss	
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	g	Gabbroic gneiss and gabbro	*Includes rocks of probable sedimentary origin*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	a	Anorthosite	
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gg	Graphitic gneiss	*Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

SEDIMENTARY ROCKS	QUATERNARY	Qg	Gravel on Terraces	
SEDIMENTARY ROCKS	TERTIARY	Tbm	Bryn Mawr Formation	*High level terrace deposits; sand and gravel with some silt.*
IGNEOUS	TRIASSIC	Ŧd	Diabase	*Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
METAMORPHOSED SEDIMENTARY ROCKS	ORDOVICIAN	Ocs	Conestoga Formation	*Bluish gray, thin bedded, impure, contorted lime-stone with shale partings, conglomerate at base.*
METAMORPHOSED SEDIMENTARY ROCKS	ORDOVICIAN	Ocsu		*upper micaceous limestone*
METAMORPHOSED SEDIMENTARY ROCKS	ORDOVICIAN	Ocsp		*middle phyllite*
METAMORPHOSED SEDIMENTARY ROCKS	ORDOVICIAN	Ocsl		*lower alternating dolomite and limestone*
METAMORPHOSED SEDIMENTARY ROCKS	CAMBRIAN	Єe	Elbrook Formation	*Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
METAMORPHOSED SEDIMENTARY ROCKS	CAMBRIAN	Єl	Ledger Formation	*Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
METAMORPHOSED SEDIMENTARY ROCKS	CAMBRIAN	Єk	Kinzers Formation	*Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
METAMORPHOSED SEDIMENTARY ROCKS	CAMBRIAN	Єv	Vintage Formation	*Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*
METAMORPHIC ROCKS	CAMBRIAN	Єah	Antietam-Harpers Formation	
METAMORPHIC ROCKS	CAMBRIAN	Єa	Antietam Formation	*Gray, buff weathering quartzite and quartz schist.*
METAMORPHIC ROCKS	CAMBRIAN	Єh	Harpers Formation	*Dark greenish gray phyllite and schist with thin quartzite layers.*
METAMORPHIC ROCKS	CAMBRIAN	Єch	Chickies Formation	*Chickies-Light gray, hard, massive, sclolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
METAMORPHIC ROCKS	CAMBRIAN	Єhc	Chickies Formation	hellam conglomerate

South of Chester Valley

IGNEOUS	TRIASSIC	Ŧd	Diabase	*Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xpg	Pegmatite	
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xmg	Metaglabbro	*DarVarious degrees of gneissic development.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xs	Serpentinite	*Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xpc	Peter Creek Schist	*Chlorite sericite schist with quartzite.*
	PRE-CAMBRIAN OR ORDOVICIAN	Xwc	Wissahickon Formation Albite chlorite schist (Xwc)	*Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
	PRE-CAMBRIAN OR ORDOVICIAN	Xw	Wissahickon Formation Oligoclasa mica schist (Xw)	*Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
	PRE-CAMBRIAN OR ORDOVICIAN	Xc	Cockeysville Marble	*White to light bluish gray marble.*
	PRE-CAMBRIAN OR ORDOVICIAN	Xsq	Setters Formation	*White feldipathic quartzite to gray mica gneiss and schist.*
	PRE-CAMBRIAN OR ORDOVICIAN	Xfl	Franklin limestone	*Course crystalline marble.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	g	Gabbroic gneiss and gabbro	*Includes rocks of probable sedimentary origin*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gg	Graphitic gneiss	*Includes Pickering Gneiss and small patches of Franklin Marble*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gn	Granite gneiss	
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	md	Metadiabase	


UNITED STATES
DEPARTMENT OF THE INTERIOR
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CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION
AREAL GEOLOGY
KENNETT SQUARE QUADRANGLE
PENNSYLVANIA—DELAWARE
7.5 MINUTE SERIES (TOPOGRAPHIC)
North of Chester Valley
Chester Valley
South of Chester Valley
Kennett Square
Yorklyn
Hockessin
Mt Cuba
Wooddale
Fairville
DISTRICT NO 7
DISTRICT NO 8
Mapped, edited, and published by the Geological Survey
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
KENNETT SQUARE, PA.—DEL.
K-S
Copyright 1966, Chester County, Pa. Planning Commission
SOURCE OF GEOLOGY
Pennsylvania Geological Survey, Geologic Map Of Pennsylvania, 1960, Compilation Sheets
Geologic contact
Fault line
Geologic dikes
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

IGNEOUS — **TRIASSIC**

- **Ћd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

SEDIMENTARY ROCKS — **TRIASSIC**

- **Ћb** — Brunswick or Gettysburg Formation
  Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.
- **Ћqc** — Brunswick Formation
  quartz pebble conglomerate
- **Ћl** — Lockatong Formation
  Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.
- **Ћs** — Stockton or New Oxford Formation
  Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.

METAMORPHOSED SED. ROCK — **CAMBRIAN**

- **Ꞓl** — Ledger Formation
  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.
- **Ꞓk** — Kinzers Formation
  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

METAMORPHIC ROCKS — **CAMBRIAN**

- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
- **Ꞓh** — Harpers Formation
  Dark greenish gray phyllite and schist with thin quartzite layers.
- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

IGNEOUS AND METAMORPHIC ROCKS — **PRE-CAMBRIAN OR ORDOVICIAN**

- **Xfl** — Franklin limestone
  coarse crystalline marble
- **Xpg** — Pegmatite
- **Xc** — Serpentinite
  Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.

IGNEOUS AND METAMORPHIC ROCKS — **PRE-CAMBRIAN**

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
- **a** — Anorthosite
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble

Chester Valley

SEDIMENTARY ROCKS — **QUATERNARY**

- **Qg** — Gravel on Terraces

SEDIMENTARY ROCKS — **TERTIARY**

- **Tbm** — Bryn Mawr Formation
  High level terrace deposits; sand and gravel with some silt.

IGNEOUS — **TRIASSIC**

- **Ћd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

METAMORPHOSED SEDIMENTARY ROCKS — **ORDOVICIAN**

- Conestoga Formation
  Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.
  - **Ocs**
  - **Ocsu** — *upper micaceous limestone*
  - **Ocsp** — *middle phyllite*
  - **Ocsl** — *lower alternating dolomite and limestone*

METAMORPHOSED SED MENTARY ROCKS — **CAMBRIAN**

- **Ꞓe** — Elbrook Formation
  Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.
- **Ꞓl** — Ledger Formation
  Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle port.
- **Ꞓk** — Kinzers Formation
  Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone
- **Ꞓv** — Vintage Formation
  Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.

METAMORPHIC ROCKS — **CAMBRIAN**

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation
  Gray, buff weathering quartzite and quartz schist.
- **Ꞓh** — Harpers Formation
  Dark greenish gray phyllite and schist with thin quartzite layers.
- **Ꞓch** — Chickies Formation
  Chickies-Light gray, hard, massive, scolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.
- **Ꞓhc** — Chickies Formation
  hellam conglomerate

South of Chester Valley

IGNEOUS — **TRIASSIC**

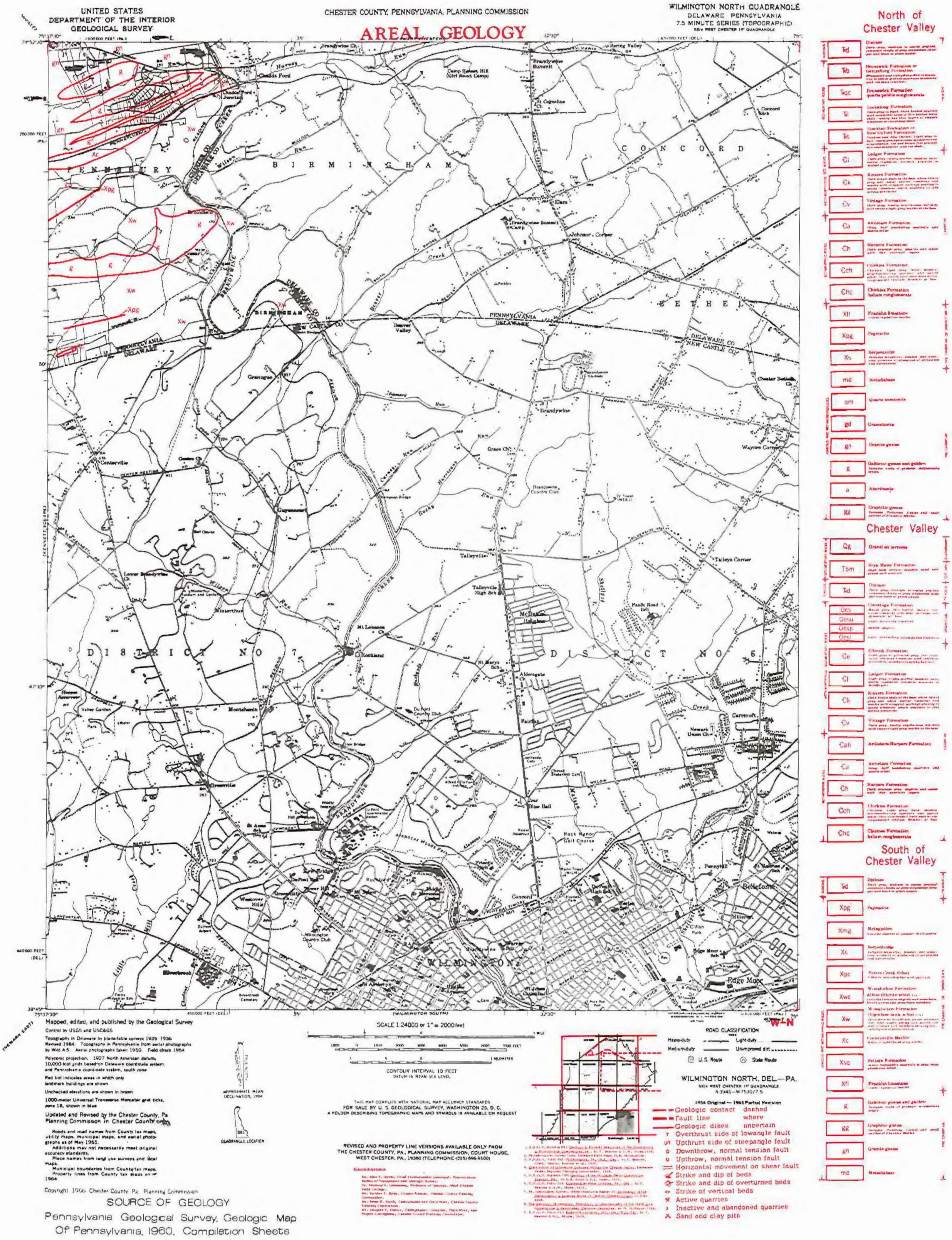
- **Ћd** — Diabase
  Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.

IGNEOUS AND METAMORPHIC ROCKS — **PRE-CAMBRIAN OR ORDOVICIAN**

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro
  DarVarious degrees of gneissic development.
- **Xs** — Serpentinite
  Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.
- **Xpc** — Peter Creek Schist
  Chlorite sericite schist with quartzite.
- **Xwc** — Wissahickon Formation
  Albite chlorite schist (Xwc)
  Includes Octoraro phyllite and some horn blende gneiss and granitized members.
- **Xw** — Wissahickon Formation
  Oligoclasa mica schist (Xw)
  Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.
- **Xc** — Cockeysville Marble
  White to light bluish gray marble.
- **Xsq** — Setters Formation
  White feldipathic quartzite to gray mica gneiss and schist.
- **Xfl** — Franklin limestone
  Course crystalline marble.

IGNEOUS AND METAMORPHIC ROCKS — **PRE-CAMBRIAN**

- **g** — Gabbroic gneiss and gabbro
  Includes rocks of probable sedimentary origin
- **gg** — Graphitic gneiss
  Includes Pickering Gneiss and small patches of Franklin Marble
- **gn** — Granite gneiss
- **md** — Metadiabase



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CHESTER COUNTY, PENNSYLVANIA, PLANNING COMMISSION
AREAL GEOLOGY
WILMINGTON NORTH QUADRANGLE
DELAWARE PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
North of Chester Valley
Td
Diabase
Tb
Brunswick Formation or Gettysburg Formation
Tqc
Brunswick Formation quartz pebble conglomerate
Tl
Lockatong Formation
Ts
Stockton Formation or New Oxford Formation
Cl
Ledger Formation
Ck
Kinzers Formation
Cv
Vintage Formation
Ca
Antietam Formation
Ch
Harpers Formation
Cch
Chickies Formation
Chc
Chickies Formation hellam conglomerate
Xfl
Franklin limestone
Xpg
Pegmatite
Xs
Serpentinite
md
Metadiabase
qm
Quartz monzonite
gd
Granodiorite
gn
Granite gneiss
a
Anorthosite
Chester Valley
Qg
Gravel on terraces
Tbm
Bryn Mawr Formation
Td
Diabase
Ocs
Ocsu
Ocsp
Ocsl
Conestoga Formation
Ce
Elbrook Formation
Cl
Ledger Formation
Ck
Kinzers Formation
Cv
Vintage Formation
Cah
Antietam-Harpers Formation
Ca
Antietam Formation
Ch
Harpers Formation
Cch
Chickies Formation
Chc
Chickies Formation hellam conglomerate
South of Chester Valley
Td
Diabase
Xpg
Pegmatite
Xmg
Xs
Xpc
Xwc
Wissahickon Formation
Xw
Wissahickon Formation
Xc
Cockeysville Marble
Xsq
Setters Formation
Xfl
Franklin limestone
gn
Granite gneiss
md
Metadiabase
BIRMINGHAM
CONCORD
PENNSBURY
BETHEL
DISTRICT NO 7
DISTRICT NO 6
WILMINGTON
Chadds Ford
Centerville
Rockland
Talleyville
Greenville
Winterthur
Montchanin
Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography in Delaware by plane-table surveys 1935-1936
Revised 1954. Topography in Pennsylvania from aerial photographs by Wild A.5. Aerial photographs taken 1950. Field check 1954
Polyconic projection. 1927 North American datum.
10,000-foot grids based on Delaware coordinate system and Pennsylvania coordinate system, south zone
Red tint indicates areas in which only landmark buildings are shown
Unchecked elevations are shown in brown
1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue
Updated and Revised by the Chester County, Pa Planning Commission in Chester County only
Roads and road names from County tax maps, utility maps, municipal maps, and aerial photographs as of May 1965.
Additions may not necessarily meet original accuracy standards.
Place names from land use surveys and local maps.
Municipal boundaries from County tax maps.
Property lines from County tax maps as of 1964
Copyright 1966 Chester County Pa Planning Commission
SOURCE OF GEOLOGY
Pennsylvania Geological Survey, Geologic Map Of Pennsylvania, 1960, Compilation Sheets
APPROXIMATE MEAN DECLINATION, 1954
QUADRANGLE LOCATION
SCALE 1:24000 or 1" = 2000 feet
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
REVISED AND PROPERTY LINE VERSIONS AVAILABLE ONLY FROM THE CHESTER COUNTY, PA., PLANNING COMMISSION, COURT HOUSE, WEST CHESTER, PA., 19380 (TELEPHONE (215) 696-9100)
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
U. S. Route
State Route
WILMINGTON NORTH, DEL.—PA.
N3945—W7530/7.5
1954 Original — 1965 Partial Revision
Geologic contact
Fault line
Geologic dikes
dashed where uncertain
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits
W-N

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

TRASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

SEDIMENTARY ROCKS

- **TRb** — Brunswick or Gettysburg Formation. *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
- **TRqc** — Brunswick Formation. quartz pebble conglomerate
- **TRl** — Lockatong Formation. *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
- **TRs** — Stockton or New Oxford Formation. *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*

CAMBRIAN

METAMORPHOSED SED. ROCK

- **Ꞓl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
- **Ꞓh** — Harpers Formation. *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Ꞓch** — Chickies Formation. *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation. hellam conglomerate

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xfl** — Franklin limestone. *coarse crystalline marble*
- **Xpg** — Pegmatite
- **Xc** — Serpentinite. *Includes serpentine, steatite and associated products of alteration of peridotities and pyroxenites.*

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

- **md** — Metadiabase
- **qm** — Quartz monzonite
- **gd** — Granodiorite
- **gn** — Granite gneiss
- **g** — Gabbroic gneiss and gabbro. *Includes rocks of probable sedimentary origin*
- **a** — Anorthosite
- **gg** — Graphitic gneiss. *Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

QUATERNARY

SEDIMENTARY ROCKS

- **Qg** — Gravel on Terraces

TERTIARY

- **Tbm** — Bryn Mawr Formation. *High level terrace deposits; sand and gravel with some silt.*

TRASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS

- **Ocs** — Conestoga Formation. *Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.*
- **Ocsu** — *upper micaceous limestone*
- **Ocsp** — *middle phyllite*
- **Ocsl** — *lower alternating dolomite and limestone*

CAMBRIAN

METAMORPHOSED SED MENTARY ROCKS

- **Ꞓe** — Elbrook Formation. *Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
- **Ꞓl** — Ledger Formation. *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
- **Ꞓk** — Kinzers Formation. *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
- **Ꞓv** — Vintage Formation. *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS

- **Ꞓah** — Antietam-Harpers Formation
- **Ꞓa** — Antietam Formation. *Gray, buff weathering quartzite and quartz schist.*
- **Ꞓh** — Harpers Formation. *Dark greenish gray phyllite and schist with thin quartzite layers.*
- **Ꞓch** — Chickies Formation. *Chickies-Light gray, hard, massive, scolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
- **Ꞓhc** — Chickies Formation. hellam conglomerate

South of Chester Valley

TRASSIC

IGNEOUS

- **TRd** — Diabase. *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS

- **Xpg** — Pegmatite
- **Xmg** — Metaglabbro. *DarVarious degrees of gneissic development.*
- **Xs** — Serpentinite. *Includes serpentine, steatite and associated products of alteration of peridotities and pyroxenites.*
- **Xpc** — Peter Creek Schist. *Chlorite sericite schist with quartzite.*
- **Xwc** — Wissahickon Formation. Albite chlorite schist (Xwc). *Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
- **Xw** — Wissahickon Formation. Oligoclasa mica schist (Xw). *Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
- **Xc** — Cockeysville Marble. *White to light bluish gray marble.*
- **Xsq** — Setters Formation. *White feldipathic quartzite to gray mica gneiss and schist.*
- **Xfl** — Franklin limestone. *Course crystalline marble.*

PRE-CAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS

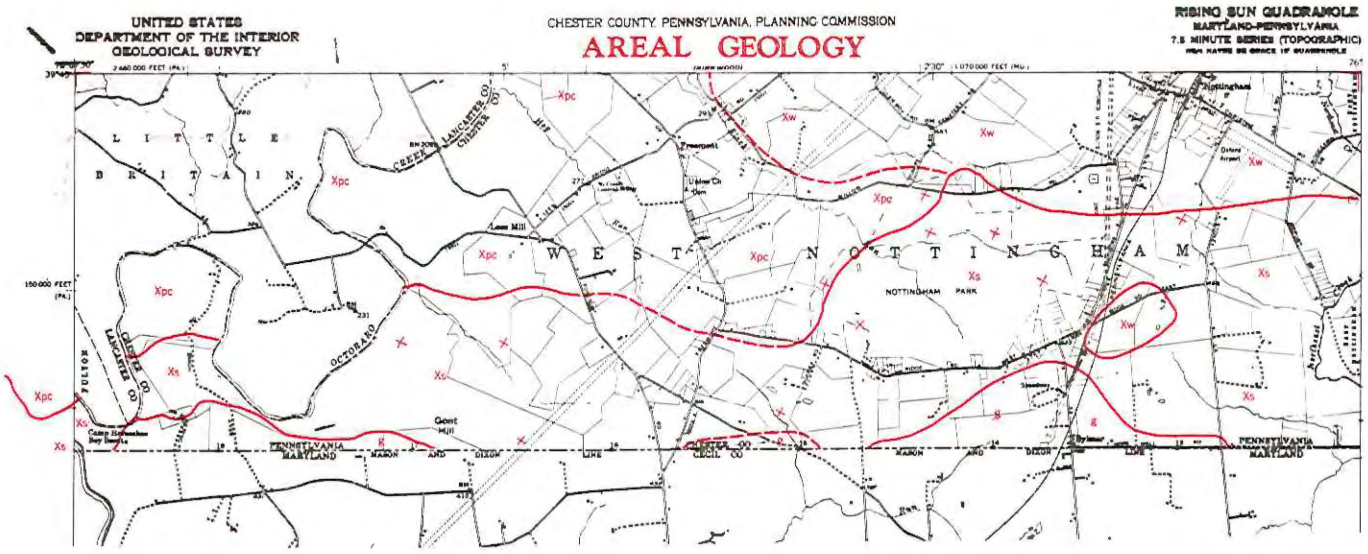
- **g** — Gabbroic gneiss and gabbro. *Includes rocks of probable sedimentary origin*
- **gg** — Graphitic gneiss. *Includes Pickering Gneiss and small patches of Franklin Marble*
- **gn** — Granite gneiss
- **md** — Metadiabase

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CHESTER COUNTY PENNSYLVANIA PLANNING COMMISSION

AREAL GEOLOGY

RISING SUN QUADRANGLE
MARYLAND-PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)



North of Chester Valley

- Td — Diabase
- Tb — Brunswick Formation or Gettysburg Formation
- Tqc — Brunswick Formation quartz pebble conglomerate
- Tl — Lockatong Formation
- Ts — Stockton Formation or New Oxford Formation
- Cl — Ledger Formation
- Ck — Kinzers Formation
- Cv — Vintage Formation
- Ca — Antietam Formation
- Ch — Harpers Formation
- Cch — Chickies Formation
- Chc — Chickies Formation hellam conglomerate
- Xfl — Franklin limestone
- Xpg — Pegmatite
- Xs — Serpentinite
- md — Metadiabase
- qm — Quartz monzonite
- gd — Granodiorite
- gn — Granite gneiss
- g — Gabbroic gneiss and gabbro
- a — Anorthosite
- gg — Graphitic gneiss

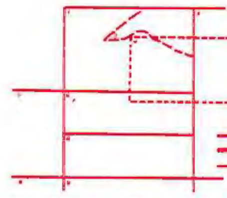
Chester Valley

- Qg — Gravel on terraces
- Tbm — Bryn Mawr Formation
- Td — Diabase
- Ocs, Ocsu, Ocsp, Ocsl — Conestoga Formation
- Ce — Elbrook Formation
- Cl — Ledger Formation
- Ck — Kinzers Formation
- Cv — Vintage Formation
- Cah — Antietam-Harpers Formation
- Ca — Antietam Formation
- Ch — Harpers Formation
- Cch — Chickies Formation
- Chc — Chickies Formation hellam conglomerate

South of Chester Valley

- Td — Diabase
- Xpg — Pegmatite
- Xmg — Metagabbro
- Xs — Serpentinite
- Xpc — Peters Creek Schist
- Xwc — Wissahickon Formation, Albite chlorite schist
- Xw — Wissahickon Formation, Oligoclase mica schist
- Xc — Cockeysville Marble
- Xsq — Setters Formation
- Xfl — Franklin limestone
- g — Gabbroic gneiss and gabbro
- gg — Graphitic gneiss
- gn — Granite gneiss
- md — Metadiabase

R-S.



- Geologic contact — dashed where uncertain
- Fault line — dashed where uncertain
- Geologic dikes — dashed where uncertain
- T Overthrust side of lowangle fault
- UT Upthrust side of steepangle fault
- D Downthrow, normal tension fault
- U Upthrow, normal tension fault
- Horizontal movement on shear fault
- Strike and dip of beds
- Strike and dip of overturned beds
- Strike of vertical beds
- Active quarries
- Inactive and abandoned quarries
- Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

IGNEOUS	Ŧd	Diabase *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
SEDIMENTARY ROCKS	Ŧb	Brunswick or Gettysburg Formation *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
SEDIMENTARY ROCKS	Ŧqc	Brunswick Formation quartz pebble conglomerate
SEDIMENTARY ROCKS	Ŧl	Lockatong Formation *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
SEDIMENTARY ROCKS	Ŧs	Stockton or New Oxford Formation *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*
METAMORPHOSED SED. ROCK	Ꞓl	Ledger Formation *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
METAMORPHOSED SED. ROCK	Ꞓk	Kinzers Formation *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
METAMORPHOSED SED. ROCK	Ꞓv	Vintage Formation *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

TRIASSIC; CAMBRIAN

METAMORPHIC ROCKS	Ꞓa	Antietam Formation *Gray, buff weathering quartzite and quartz schist.*
METAMORPHIC ROCKS	Ꞓh	Harpers Formation *Dark greenish gray phyllite and schist with thin quartzite layers.*
METAMORPHIC ROCKS	Ꞓch	Chickies Formation *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top; conglomerate (Hellam Member) at base.*
METAMORPHIC ROCKS	Ꞓhc	Chickies Formation hellam conglomerate
IGNEOUS AND METAMORPHIC ROCKS	Xfl	Franklin limestone *coarse crystalline marble*
IGNEOUS AND METAMORPHIC ROCKS	Xpg	Pegmatite
IGNEOUS AND METAMORPHIC ROCKS	Xc	Serpentinite *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*

CAMBRIAN; PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS	md	Metadiabase
IGNEOUS AND METAMORPHIC ROCKS	qm	Quartz monzonite
IGNEOUS AND METAMORPHIC ROCKS	gd	Granodiorite
IGNEOUS AND METAMORPHIC ROCKS	gn	Granite gneiss
IGNEOUS AND METAMORPHIC ROCKS	g	Gabbroic gneiss and gabbro *Includes rocks of probable sedimentary origin*
IGNEOUS AND METAMORPHIC ROCKS	a	Anorthosite
IGNEOUS AND METAMORPHIC ROCKS	gg	Graphitic gneiss *Includes Pickering Gneiss and small patches of Franklin Marble*

PRE-CAMBRIAN

Chester Valley

SEDIMENTARY ROCKS	Qg	Gravel on Terraces
SEDIMENTARY ROCKS	Tbm	Bryn Mawr Formation *High level terrace deposits; sand and gravel with some silt.*
IGNEOUS	Ŧd	Diabase *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
METAMORPHOSED SEDIMENTARY ROCKS	Ocs	Conestoga Formation *Bluish gray, thin bedded, impure, contorted lime-stone with shale partings, conglomerate at base.*
METAMORPHOSED SEDIMENTARY ROCKS	Ocsu	*upper micaceous limestone*
METAMORPHOSED SEDIMENTARY ROCKS	Ocsp	*middle phyllite*
METAMORPHOSED SEDIMENTARY ROCKS	Ocsl	*lower alternating dolomite and limestone*

QUATERNARY; TERTIARY; TRIASSIC; ORDOVICIAN

METAMORPHOSED SEDIMENTARY ROCKS	Ꞓe	Elbrook Formation *Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
METAMORPHOSED SEDIMENTARY ROCKS	Ꞓl	Ledger Formation *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
METAMORPHOSED SEDIMENTARY ROCKS	Ꞓk	Kinzers Formation *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
METAMORPHOSED SEDIMENTARY ROCKS	Ꞓv	Vintage Formation *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*

CAMBRIAN

METAMORPHIC ROCKS	Ꞓah	Antietam-Harpers Formation
METAMORPHIC ROCKS	Ꞓa	Antietam Formation *Gray, buff weathering quartzite and quartz schist.*
METAMORPHIC ROCKS	Ꞓh	Harpers Formation *Dark greenish gray phyllite and schist with thin quartzite layers.*
METAMORPHIC ROCKS	Ꞓch	Chickies Formation *Chickies-Light gray, hard, massive, sclolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
METAMORPHIC ROCKS	Ꞓhc	Chickies Formation hellam conglomerate

CAMBRIAN

South of Chester Valley

IGNEOUS	Ŧd	Diabase *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
IGNEOUS AND METAMORPHIC ROCKS	Xpg	Pegmatite
IGNEOUS AND METAMORPHIC ROCKS	Xmg	Metaglabbro *DarVarious degrees of gneissic development.*
IGNEOUS AND METAMORPHIC ROCKS	Xs	Serpentinite *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
IGNEOUS AND METAMORPHIC ROCKS	Xpc	Peter Creek Schist *Chlorite sericite schist with quartzite.*

TRIASSIC; PRE-CAMBRIAN OR ORDOVICIAN

	Xwc	Wissahickon Formation Albite chlorite schist (Xwc) *Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
	Xw	Wissahickon Formation Oligoclasa mica schist (Xw) *Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
	Xc	Cockeysville Marble *White to light bluish gray marble.*
	Xsq	Setters Formation *White feldipathic quartzite to gray mica gneiss and schist.*
	Xfl	Franklin limestone *Course crystalline marble.*

PRE-CAMBRIAN OR ORDOVICIAN

IGNEOUS AND METAMORPHIC ROCKS	g	Gabbroic gneiss and gabbro *Includes rocks of probable sedimentary origin*
IGNEOUS AND METAMORPHIC ROCKS	gg	Graphitic gneiss *Includes Pickering Gneiss and small patches of Franklin Marble*
IGNEOUS AND METAMORPHIC ROCKS	gn	Granite gneiss
IGNEOUS AND METAMORPHIC ROCKS	md	Metadiabase

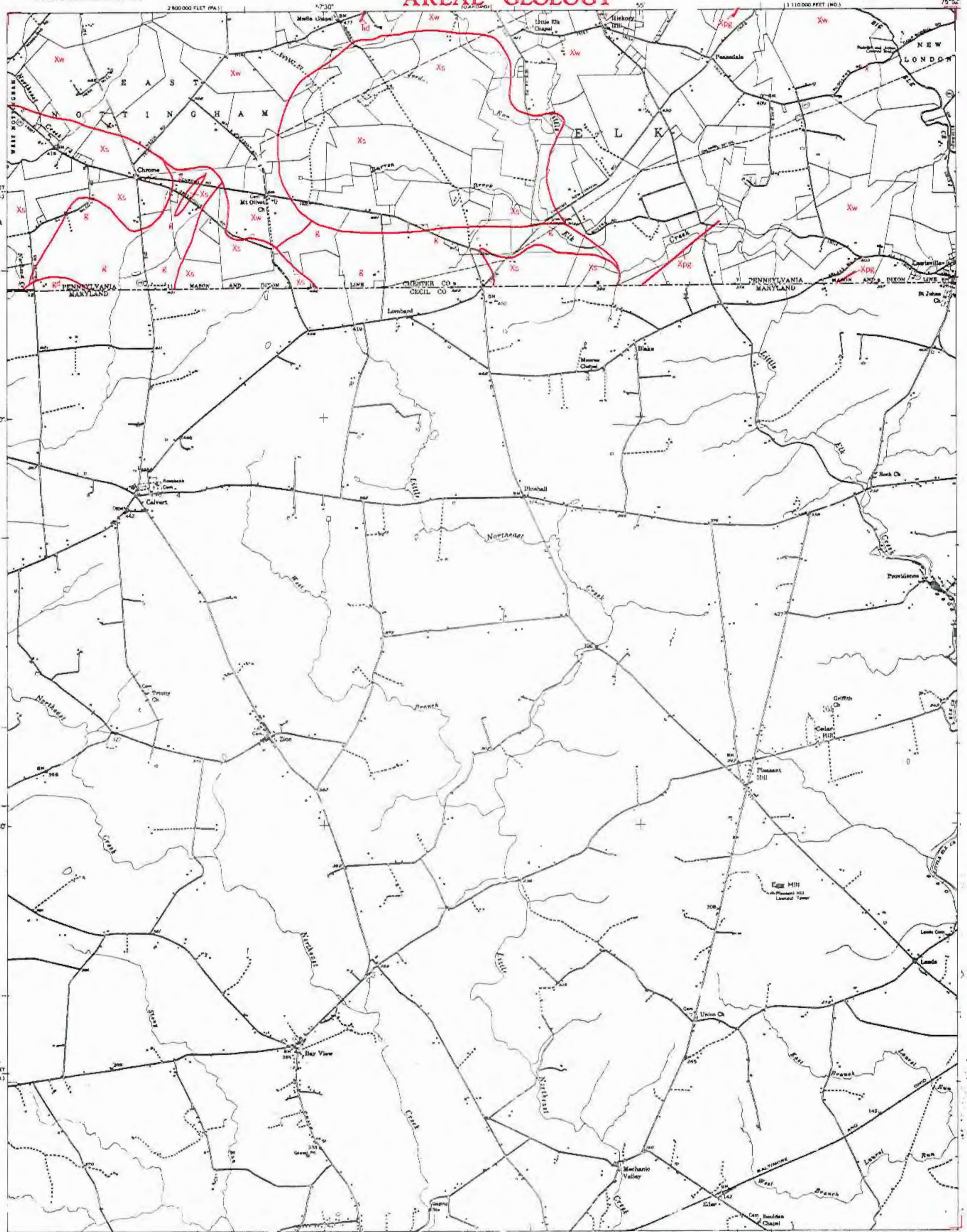
PRE-CAMBRIAN

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CHESTER COUNTY PENNSYLVANIA PLANNING COMMISSION

AREAL GEOLOGY

BAY VIEW QUADRANGLE
MARYLAND—PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 ELKTON 15' QUADRANGLE



North of Chester Valley

- Td — Diabase
- Tb — Brunswick Formation or Gettysburg Formation
- Tbc — Brunswick Formation quartz pebble conglomerate
- Tl — Lockatong Formation
- Ts — Stockton Formation or New Oxford Formation
- Cl — Ledger Formation
- Ck — Kinzers Formation
- Cv — Vintage Formation
- Ca — Antietam Formation
- Ch — Harpers Formation
- Cch — Chickies Formation
- Chc — Chickies Formation hellam conglomerate
- Xfl — Franklin limestone
- Xpg — Pegmatite
- Xs — Serpentinite
- md — Metadiabase
- qm — Quartz monzonite
- gd — Granodiorite
- gn — Granite gneiss
- g — Gabbroic gneiss and gabbro
- a — Anorthosite
- gg — Graphitic gneiss

Chester Valley

- Qg — Gravel on terraces
- Tbm — Bryn Mawr Formation
- Td — Diabase
- Ocs, Ocsu, Ocsp, Ocsl — Conestoga Formation
- Ce — Elbrook Formation
- Cl — Ledger Formation
- Ck — Kinzers Formation
- Cv — Vintage Formation
- Cah — Antietam-Harpers Formation
- Ca — Antietam Formation
- Ch — Harpers Formation
- Cch — Chickies Formation
- Chc — Chickies Formation hellam conglomerate

South of Chester Valley

- Td — Diabase
- Xpg — Pegmatite
- Xmg — Metagabbro
- Xs — Serpentinite
- Xpc — Peters Creek Schist
- Xwc — Wissahickon Formation albite chlorite schist
- Xw — Wissahickon Formation oligoclase mica schist
- Xc — Cockeysville Marble
- Xsq — Setters Formation
- Xfl — Franklin limestone
- g — Gabbroic gneiss and gabbro
- gg — Graphitic gneiss
- gn — Granite gneiss
- md — Metadiabase

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Culture and drainage in part compiled from aerial photographs taken 1952. Topography by plane-table surveys 1939 and 1940. Revised 1953

Polyconic projection. 1927 North American datum. 10,000-foot grids based on Maryland coordinate system, and Pennsylvania coordinate system, south zone

Updated and Revised by the Chester County, Pa. Planning Commission in Chester County only

Roads and road names from County tax maps, utility maps, municipal maps, and aerial photographs as of May 1965.
Additions may not necessarily meet original accuracy standards.
Place names from land use surveys and local maps.
Municipal boundaries from County tax maps.
Property lines from County tax maps as of 1964

APPROXIMATE MEAN DECLINATION, 1953

QUADRANGLE LOCATION

SCALE 1:24000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

REVISED AND PROPERTY LINE VERSIONS AVAILABLE ONLY FROM THE CHESTER COUNTY, PA., PLANNING COMMISSION, COURT HOUSE, WEST CHESTER, PA.

SOURCE OF GEOLOGY

Pennsylvania Geological Survey, Geologic Map Of Pennsylvania, 1960, Compilation Sheets

B-V

ROAD CLASSIFICATION

Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
U. S. Route — State Route

BAY VIEW, MD.—PA.
NW/4 ELKTON 15' QUADRANGLE
N3937.5—W7552.5/7.5

1953 Original — 1965 Partial Revision

- Geologic contact — dashed where uncertain
- Fault line
- Geologic dikes
- T Overthrust side of lowangle fault
- UT Upthrust side of steepangle fault
- D Downthrow, normal tension fault
- U Upthrow, normal tension fault
- Horizontal movement on shear fault
- Strike and dip of beds
- Strike and dip of overturned beds
- Strike of vertical beds
- Active quarries
- Inactive and abandoned quarries
- Sand and clay pits

Chester County Areal Geology Legend: Map Scale; 1 inch = 1 mile

North of Chester Valley

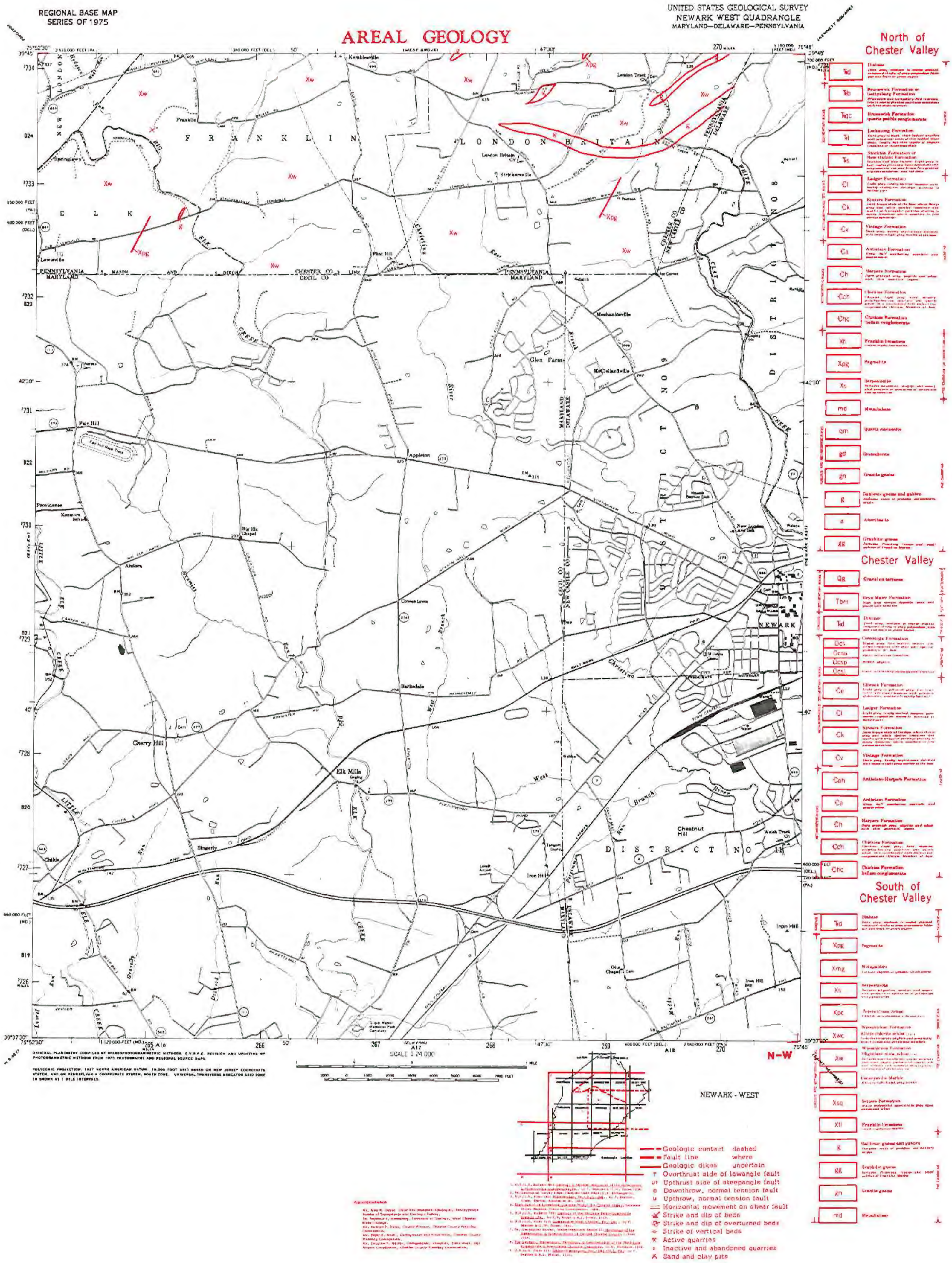
IGNEOUS	TRIASSIC	TRd	Diabase *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
SEDIMENTARY ROCKS	TRIASSIC	TRb	Brunswick or Gettysburg Formation *Brunswick and Gettysburg-Red to brown, fine to coarse grained quartzose sandstone with red shale interbeds.*
SEDIMENTARY ROCKS	TRIASSIC	TRqc	Brunswick Formation quartz pebble conglomerate
SEDIMENTARY ROCKS	TRIASSIC	TRl	Lockatong Formation *Dark gray to black, thick bedded argillite with occassional zones of thin bedded black shale; locally has thin layers of impure limestone or calcareous shale.*
SEDIMENTARY ROCKS	TRIASSIC	TRs	Stockton or New Oxford Formation *Stockton and New Oxford-Light gray buff, coarse grained arkosic sandstone and conglomerate; red and brown fine grained siliceous sandstone, and red shale.*
METAMORPHOSED SED. ROCK	CAMBRIAN	Ꞓl	Ledger Formation *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
METAMORPHOSED SED. ROCK	CAMBRIAN	Ꞓk	Kinzers Formation *Dark brown shale at the base; above this is gray and white spatted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
METAMORPHOSED SED. ROCK	CAMBRIAN	Ꞓv	Vintage Formation *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*
METAMORPHIC ROCKS	CAMBRIAN	Ꞓa	Antietam Formation *Gray, buff weathering quartzite and quartz schist.*
METAMORPHIC ROCKS	CAMBRIAN	Ꞓh	Harpers Formation *Dark greenish gray phyllite and schist with thin quartzite layers.*
METAMORPHIC ROCKS	CAMBRIAN	Ꞓch	Chickies Formation *Chickies-Light gray, hard, massive, scholithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
METAMORPHIC ROCKS	CAMBRIAN	Ꞓhc	Chickies Formation hellam conglomerate
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xfl	Franklin limestone *coarse crystalline marble*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xpg	Pegmatite
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xc	Serpentinite *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	md	Metadiabase
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	qm	Quartz monzonite
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gd	Granodiorite
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gn	Granite gneiss
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	g	Gabbroic gneiss and gabbro *Includes rocks of probable sedimentary origin*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	a	Anorthosite
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gg	Graphitic gneiss *Includes Pickering Gneiss and small patches of Franklin Marble*

Chester Valley

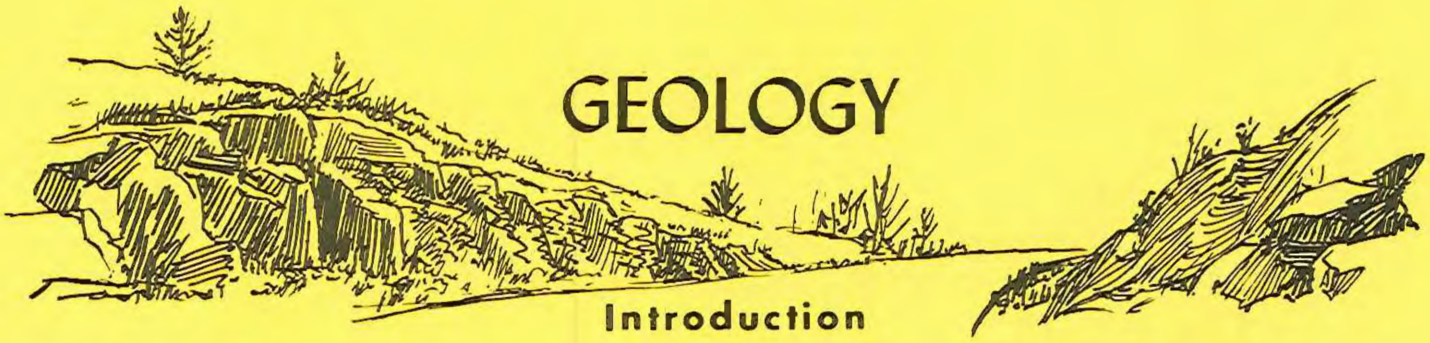
SEDIMENTARY ROCKS	QUATERNARY	Qg	Gravel on Terraces
SEDIMENTARY ROCKS	TERTIARY	Tbm	Bryn Mawr Formation *High level terrace deposits; sand and gravel with some silt.*
IGNEOUS	TRIASSIC	TRd	Diabase *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
METAMORPHOSED SEDIMENTARY ROCKS	ORDOVICIAN	Ocs	Conestoga Formation *Bluish gray, thin bedded, impure, contorted limestone with shale partings, conglomerate at base.*
METAMORPHOSED SEDIMENTARY ROCKS	ORDOVICIAN	Ocsu	*upper micaceous limestone*
METAMORPHOSED SEDIMENTARY ROCKS	ORDOVICIAN	Ocsp	*middle phyllite*
METAMORPHOSED SEDIMENTARY ROCKS	ORDOVICIAN	Ocsl	*lower alternating dolomite and limestone*
METAMORPHOSED SED MENTARY ROCKS	CAMBRIAN	Ꞓe	Elbrook Formation *Light gray to yellowish gray, fine laminated, siliceous limestone with interbeds of dolomite; weathers to earthy buff soil.*
METAMORPHOSED SED MENTARY ROCKS	CAMBRIAN	Ꞓl	Ledger Formation *Light gray, locally mottled, massive, pure coarse crystalline dolomite, siliceous in middle part.*
METAMORPHOSED SED MENTARY ROCKS	CAMBRIAN	Ꞓk	Kinzers Formation *Dark brown shale at the base; above this is gray and white spotted limestone and marble with irregular partings grading to sandy limestone which weathers to fine pourous sandstone*
METAMORPHOSED SED MENTARY ROCKS	CAMBRIAN	Ꞓv	Vintage Formation *Dark gray, knotty argillaceous dolomite with impure light gray marble at the base.*
METAMORPHIC ROCKS	CAMBRIAN	Ꞓah	Antietam-Harpers Formation
METAMORPHIC ROCKS	CAMBRIAN	Ꞓa	Antietam Formation *Gray, buff weathering quartzite and quartz schist.*
METAMORPHIC ROCKS	CAMBRIAN	Ꞓh	Harpers Formation *Dark greenish gray phyllite and schist with thin quartzite layers.*
METAMORPHIC ROCKS	CAMBRIAN	Ꞓch	Chickies Formation *Chickies-Light gray, hard, massive, sciolithus-bearing quartzite and quartz schist; thin interbedded dark slate at top: conglomerate (Hellam Member) at base.*
METAMORPHIC ROCKS	CAMBRIAN	Ꞓhc	Chickies Formation hellam conglomerate

South of Chester Valley

IGNEOUS	TRIASSIC	TRd	Diabase *Dark gray, medium to coarse grained; composed chiefly of gray plagioclase feldspar and black or green augite.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xpg	Pegmatite
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xmg	Metaglabbro *DarVarious degrees of gneissic development.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xs	Serpentinite *Includes serpentine ,steatite and associated products of alteration of peridotities and pyroxenites.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xpc	Peter Creek Schist *Chlorite sericite schist with quartzite.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xwc	Wissahickon Formation Albite chlorite schist (Xwc) *Includes Octoraro phyllite and some horn blende gneiss and granitized members.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xw	Wissahickon Formation Oligoclasa mica schist (Xw) *Includes some hornblende gneiss members and some augen gneiss and quartz-rich and feldspar-rich members showing various degrees of granitization.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xc	Cockeysville Marble *White to light bluish gray marble.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xsq	Setters Formation *White feldipathic quartzite to gray mica gneiss and schist.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN OR ORDOVICIAN	Xfl	Franklin limestone *Course crystalline marble.*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	g	Gabbroic gneiss and gabbro *Includes rocks of probable sedimentary origin*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gg	Graphitic gneiss *Includes Pickering Gneiss and small patches of Franklin Marble*
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	gn	Granite gneiss
IGNEOUS AND METAMORPHIC ROCKS	PRE-CAMBRIAN	md	Metadiabase



REGIONAL BASE MAP
SERIES OF 1975
UNITED STATES GEOLOGICAL SURVEY
NEWARK WEST QUADRANGLE
MARYLAND—DELAWARE—PENNSYLVANIA
AREAL GEOLOGY
North of Chester Valley
Chester Valley
South of Chester Valley
FRANKLIN
LONDON BRITAIN
ELK
NEWARK
DISTRICT NO
PENNSYLVANIA
MARYLAND
DELAWARE
Fair Hill
Appleton
Glen Farms
McClellandville
Mechanicsville
Strickersville
Kemblesville
Cowentown
Andora
Cherry Hill
Elk Mills
Iron Hill
Chestnut Hill
Barksdale
SCALE 1:24 000
NEWARK - WEST
N-W
Geologic contact dashed where uncertain
Fault line
Geologic dikes
Overthrust side of lowangle fault
Upthrust side of steepangle fault
Downthrow, normal tension fault
Upthrow, normal tension fault
Horizontal movement on shear fault
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Active quarries
Inactive and abandoned quarries
Sand and clay pits



GEOLOGY

Introduction

Underlying Geology is of Major Practical Importance.

The type and structure of the rocks underlying Chester County are of major direct and indirect practical concern to the planner in determining the uses that could or should be made of the overlying land surface. They have been a major factor in determining the landforms and slopes described in the Landforms Section; and thus, directly and indirectly influence such aspects as transportation routes and the pattern of settlement. Rock properties are the major determinant of the quantity, quality, and contamination potential of ground water; the ease of difficulty of excavation; the soundness of foundations for buildings, highways, bridges, and dams; the possible hazards of earthquake, abnormal settling of foundations, rockslides and background radiations; the capacity to absorb or transmit explosion shocks; the nature and property of building stones and other earth products, and, in part, the type of soil found.

This Report is a Limited, Non-Technical, Generalized Report of a Few Geologic Factors Important to Planning Preliminary to More Detailed Studies.

Time and resources available for this report permited only basic generalizations in non-technical language of a few of the aspects of Chester County's underlying rocks and their structures that are important to an understanding of the existing land use patterns and of factors important in future land use planning.

Its emphasis is on practical applications — how the underlying rocks affect the uses that can and should be made of the land surface. Excellent technical analyses are available in the published reports listed in the bibliography; although some of these do not discuss the practical application to planning or necessarily reflect the latest knowledge. Most of these reports are out of print; but copies can usually be found in the larger reference libraries, and some are on file at the Chester County Planning Commission office. Many of the State Geological Survey Bulletins, such as M-15 on "Building Stones of Pa." (1930), and M-20 "Limestones of Pa." (1935) and Water Supply Report W-4 "Ground Water in Southeastern Pennsylvania" (1934), are still useful.

While, for the most part, generalizations pertaining to such factors as ground water yield, rock competency, mineral content, soil derivations, etc. are based upon competent sources, it must be understood that the indefinite nature of geology as a science introduces many exceptions and variations. Natural properties of rocks can and do vary greatly from formation to formation and from place to place within a formation. As a result, detailed studies of any specific site problem require the service of a competent geologist.

Fortunately, Chester County's geology has been closely studied and mapped by geologists in the past in greater detail than is true for most other areas. Additional studies in the nature of ground water analysis, of the crystalline rocks and airborne magnetometer mapping are still taking place. Much remains to be done, in more detailed surface mapping, as well as in detailed quantitative studies of mineral and ground water resources.

It is hoped that the services of a geologist can be obtained later to undertake a more detailed and technical approach to practical and applied aspects of geology in planning than is presently possible. One need is to be able to more definitely relate urban lot sizes and population densities to the underlying rocks and soils.

Areal Geology

The County Geology was Well Mapped During the 1920's and 1930's.

Geologically, Chester County is comprised of a highly complex area of folded and altered rocks of many ages where interpretation is difficult. Rocks of all three origins occur: igneous, metamorphic, and sedimentary, with most major rock types of each being present.

The basic areal geology of the County was relatively well mapped during the 1920's and 1930's by the pioneer geologist of the Philadelphia region, Professor Florence Bascom, then Chairman of the Geology Department of Bryn Mawr College, and her many associates. The Coatesville — West Chester 15' quadrangle was published in 1932 as U. S. Geological Survey Folio No. 223, and the Phoenixville — Honeybrook quadrangles in 1937 in U. S. Geological Survey Bulletin No. 891. These two publications are the basic specific technical reference sources for Chester County and include the most detailed geologic maps at a scale of 1:62,500 or about 1" = 1 mile. The maps are printed on the old 15 minute geological survey quadrangles published around the turn of the century and were then — and until the mid 1950's (when the present 7-1/2 minute topographic quadrangles were published) — the most accurate base maps available. Parts of the eastern end of the County are covered in the old Philadelphia Folio No. 162 (1909); and a piece of the extreme southwestern area is in the McCalls Ferry-Quarryville quadrangle published in 1929 as U. S. Geological Survey Bulletin No. 799. Chester County, of course, is also included in less detail in the new Geologic Map of Pennsylvania published in 1960 at a scale of 1:250,000 approximately four miles to the inch. This map also contains changes in terminology, and some previously unpublished changes in areal mapping.

These maps present the most recent information available. Owing to the soil covering, few rock outcrops are visible and contacts are often indefinite, and there is much intergrading of rock types. It is therefore usually impossible to indicate exact formation boundaries. Although there have been some changes in terminology and classification, these can be adjusted without remapping.

Since the detailed maps are out of print, it is anticipated that the Chester County Planning Commission will later reprint a large scale revised version showing all features and resources. Meanwhile, a small fold-out map entitled, "Geology", shows major rock type relationships used in this report in a generalized way. A larger scale version of the same map showing the details of the originally mapped rock types is available from the Planning Commission upon special request.

Rock Types Have Been Grouped for Simplicity and Practical Analysis.

Rock types are classified basically by origin, by rock type, and by age of formation. Of these, the rock type is the most important for this report. Technical differences in mineral or chemical composition, texture or structure, and age, not having major effects on practical applications are not treated in this report. These technical matters are described in the reports listed in the geology bibliography.

The basic rock types of most of Chester County are crystalline meta-igneous and metamorphic rocks. Sedimentary rocks of Triassic age are found in the Schuylkill Valley Lowlands generally east of French Creek; and meta-sedimentary limestones and dolomites of Cambrian and Ordovician age underly the Chester Valley.

The principal rock types, location, and their practical properties are described in the paragraphs that follow, and are shown on the small fold-out map entitled, "Geology".

Crystalline Igneous and Metamorphic Rocks Underly Most of the County.

Most of Chester County, except most of the Schuylkill Valley Lowlands, are underlain by metamorphic rocks. These are rocks that have been recrystallized and in many cases hardened by intense heat and pressure when they were far below the surface during one or more periods of great geologic disturbance. Original metamorphism took place in early geologic times with folding and faulting during the Appalachian Revolution.

The degree of metamorphism depends upon the original rock type before recrystallization and the relative intensity of heat and/or pressure. These are difficult technical considerations, far beyond the scope of this report other than to say that the original shales were foliated and hardened to schists and phyllites, sandstone to quartzites, limestone to marble, and granites to gneisses. There are many degrees of metamorphism found in the rocks.

All generally are fairly resistant to erosion and tend to form rolling uplands. As a group, metamorphic rocks are hard and dense, and thus have little ground water storage capacity, except in the fractures and fissures. They generally make excellent foundations, provided solid bedrock below the weathered area is reached. There is often, particularly overlying schists, a deeply layered zone of soft, strongly weathered "rotten rock" known as "saprolite". Where solid unweathered bedrock is involved excavation is difficult. Many types of metamorphic rocks have value as dimension stone and a few as crushed stone.

The overlying soils tend to be silty or clayey loams in the Glenelg Manor or Glenelg — Neshaminy Association. These soils are relatively susceptible to frost action and are not the best for engineering construction.

The major crystalline rocks, according to Dr. E. H. Watson, Charman of Geology of Bryn Mawr College, are:

Hybrid Granitic Gneisses — Most of the County between the North Valley Hills and the Triassic Lowlands and a large portion of the eastern part of the County are underlain with metamorphic rocks that were originally both sedimentary and igneous rocks. These rocks were originally mapped by Professor Bascom as gabbro (amphibolites), granodiorite, Baltimore gneiss and quartz-monzonite, but because of similar properties and much intergrading, the granoriorite, quartz-monzonite and Baltimore gneiss are lumped as granitic gneiss. They are light colored "felsic" rocks. The "gabbro" is really an amphibolite, is dark colored, and was originally probably gabbro or basalt.

They are hard rocks that have strong though varying resistance to erosion and in parts of the region form rolling uplands. The amount of relief present varies in different localities and depends upon the relative position of the uplands above local base level as well as local differences in rock hardness. In the northern part of the County, elevations are higher and stream gradients steeper; hence stream erosion has cut more deeply into the uplands with the result that they are more strongly dissected and include a number of moderately deep narrow valleys. At the head of the streams in the West Chester — Paoli areas, stream gradients are not as steep and downward erosion is not as rapid and thus a relatively level and undissected upland is present.

These rocks weather to a moderate depth. The gabbros (which technically are now recognized as amphibolites) and Baltimore gneisses weather rather evenly to an average depth of about eight feet, with the gabbros tending to form boulders. The granodiorites and quartz-monzonites, mostly occuring to the north of the Chester Valley, tend to weather more deeply to about 10 to 15 feet, and weather more irregularly. This uneven weathering makes test drilling necessary prior to construction of foundations and roads.

All of the above rock types are overlain by either the Glenelg-Manor or the Glenelg-Neshaminy Soil Association with some tendency for the Glenelg-Neshaminy Association to be more common over the rocks originally mapped as gabbro or Baltimore gneiss. This may be related to the greater uncertainty of proper functioning of septic tanks in the Glenelg and Neshaminy soils formed from this parent material than those formed from mica schists, as discussed in the soils section. The Baltimore gneisses tend to be clayey.

Because the amphibolites are harder, denser, and less weathered, the fractures are fewer, and these types, along with the even denser diabases, are the poorest water sources in the County. Water yields range from 2 — 10 gallons per minute. The other gneisses, granodiorite, and quartz monzonite, particularly the latter two, tend to be more deeply weathered and may yield between 0 — 60 gpm with an average of between 5 and 10 gpm.

Some of the gabbro and amphibolite have value as crushed stone because of its hardness and toughness. The other granitic gneisses also have some possible use as crushed stone, but are not widely used because better sources are available. The Baltimore gneisses have had some use as a building stone, but more so from quarries in neighboring counties than from those in Chester County. The Cornog quarry near Glenmoore, producing crushed stone, mines granitic gneiss.

All these rocks are excellent for foundation support — generally being the strongest available — for heavy construction such as building and dams — provided sound unweathered rock is reached. All granitic gneiss may be subject to a slight amount of rock creep or downward slippage of massive jointed blocks; but this characteristic is measurable only over a period of many generations.

Pickering Gneiss — Pickering gneiss has properties similar to those of the hybrid granite gneisses. The chief difference is due to the possible presence of graphite and to a slightly larger supply of ground water. This rock is shown separately on the accompanying geology map; and is found primarily in the vicinity of Pickering Creek and in the area directly east of Elverson. It has not been used as a crushed or building stone.

Anorthosite — Anorthosite is found in an oval shaped area about six miles long and 3-1/2 miles wide in Honeybrook, West Nantmeal and Wallace Townships, as shown on the fold-out Geology map. It is an unaltered igneous intrusion with different mineral and chemical composition from granitic gneiss in that it contains much more plagioclase feldspar. This is an unusual rock type for this area. It is hard and similar to gabbro in that it weathers rather slowly to an average depth of five to eight feet. Neshaminy — Glenelg soils overly, has little space for ground water storage and has a yield range comparable to gabbro of 0 — 10 gpm with an average of 5 gpm. This rock may have value as a crushed or dimension stone, but is not now so used. Because it contains 25 — 30% alumina, the rock might have a long range future possibility as aluminum ore, when cheaper electric power is available and better sources elsewhere are exhausted.

Pegmatite — Pegmatite dikes are limited in extent in the County and have not been shown on the Geology map because of their small size. Pegmatite is found in granitic material in Schuylkill Township, in Valley Township, in the middle of Willistown Township, and in New Garden and Kennett Townships. Weathering is somewhat irregular, this being a very coarse granitic rock. This formation is found in a rolling topography and because of irregular weathering soils will frequently be thin to nonexistent on hilltops and as deep as 20 feet in valleys. The pegmatites will generally yield small quantities of water with a recovery ranging from 0 — 10 gpm with an average of between 5 and 8 gpm and have proved more reliable as a source than the rock diabase. Pegmatite contains feldspar and quartz and was quarried in the past for feldspar. Just over the State Line in Delaware, this formation is being quarried for kaolin. While pegmatite is a relatively hard rock, foundations will be reasonable to excavate.

Schists — The most abundant rock underlying most of Chester County south of the Chester Valley (except in the eastern portion) are schists, which are a result of the metamorphism of soft clay shales originally present. They are moderately hard and tend to weather somewhat deeper than genisses or other hard rocks. Consequently, the landscape in the mica schist area tends to be less rolling than the granitic gneisses north of the Chester Valley, except where Clay Creek and Elk River steeply down-cut in their course to the Fall Line Zone and the Coastal Plain.

The deep weathering of this rock, occasionally as much as 100', tends to improve the percolation characteristic of the soil; but frequently presents foundation problems. The rock material in the deeply weathered zone is known as "saprolite" or "rotten rock". Foundation conditions for heavy buildings should be carefully checked in areas underlain by schist. Deep weathering is particularly a problem in some of the southern areas and in the South Valley Hills.

Because of the greater weathering, schists yield more ground water, the amounts ranging between 10 and 30 gpm to a maximum of 70 — 100 gpm. Some of the smaller boroughs, such as Oxford in southern Chester County, manage to obtain a precarious municipal water supply from wells, but are now facing shortages. The ground water from schists is of high quality of purity and softness.

The schists can be divided into two phases: the northern and the southern. Both form rolling uplands generally more gentle than the gneisses. The two are separated by a line on the small fold-out Geology map.

The northern phase is comprised of two formations: the Wissahickon albite chlorite schist and the Peters Creek schist. The albite chlorite schist underlies and forms the South Valley Hills while the adjoining Peters Creek schist forms the uplands to the south. Weathering of these rocks is deep, particularly in certain areas of the South Valley Hills. Foundation problems may occur because of the great depth of weathered rock. The rock itself has no significant commercial value. It is less metamorphosed than the southern phase.

The southern phase is comprised of Wissahickon oligoclase mica schists, which also form rolling uplands. It, too, is deeply weathered, with the weathered zone averaging 30 to 50 ft. to bedrock with occasional thicknesses as great as 100 ft. before fresh bedrock is reached. Precaution in detail foundation testing for heavy building is needed. Water yields are slightly better than the northern phase, with fewer dry wells. There is some possibility with drilled wells of mica flakes clogging the screen.

The mica schist has been extensively quarried for building stone in the Philadelphia region; however, there are few quarried in the Chester County area, perhaps because of excessive distance from building sites. The weathered upper portion of the mica schist has some possible value as a future source of low grade mica for insulation products; although in competition with the preferred white mica, it suffers the handicap of a yellow color (due to iron content).

Diabase and Quartzite are the Most Resistant Rocks and Thus are the Principal Ridge Makers.

Several of the hard rock types, primarily the diabases and quartzites, are particularly resistant to erosion and consequently form the major ridges in the County. The degree of relief depends in a large part upon the resistance of the surrounding rocks. Thus, where the hard, highly resistant Chickeis quartzites lie adjacent to the softer, more easily eroded limestones of the Chester Valley, very prominent ridges are present. Similar ridges occur in the vicinity of the contact of the diabase and the shales underlying the Triassic lowland.

The principal ridge makers are the diabase and the quartzite, with serpentine and related rocks, also forming uplands. All of these rock types are shown separately on the Geology Map.

Diabase — Diabase is a hard, tough, igneous, intrusive rock, the hardest and toughest in the County with the possible exception of localized areas of quartzite. Most of the diabase in the County is in the high ridge of the upper region of French Creek in Warwick Township. There are some areas of older pre-Cambrian diabase dikes scattered throughout Baltimore gneisses, but these are too small in areal extent to be shown on the Geology map.

Because of its hardness, compactness and resistance to fracturing and fissuring, diabase has a very low porosity and few voids. Consequently, there is little contained water, with wells yielding very low volumes that range from 0 — 5 gpm. As a rock type, it is the poorest source of ground water in the County and dry holes are frequent.

The rock is very resistant to weathering and tends to form into massive boulders with minimum amounts of fine material suitable for soil. Soils are thin (3 — 5 feet) or non-existent. Owing to its hardness, areas underlain by diabase are generally unsuitable for urbanization because excavations for foundations and rock cuts are extremely difficult and costly. Such areas should best remain in woodland.

The rock has some value as trap rock for non-abrasive crushed stone and paving stone and is the source of the famous "Belgium block" that paved and curbed the City of Philadelphia. Because it takes a high polish and is durable, its chief value is for monument stone and a building trim known as "black granite". Haulage over long distances to specialty market is feasible because of this special value. Diabase is generally not used for dimension stone, except locally, because of its somber black color.

Quartzite — Quartzite is a strongly metamorphosed sandstone that occurs as a hard, smooth rock. Its hardness, second only to diabase, resists erosion and weathers slowly. As a consequence it may, and frequently does, form high sharp ridges.

Most of these ridges, including part of the North Valley Hills, Welsh Mountains, Baron Hill, Thomas Hills, and State Hills, are Chickies quartzite areas north of the Chester Valley. The only quartzite areas south of the Valley are the Settler's quartzite which forms lower ridges over the Toughkenamon Valley and the central ridge in Kennett Square.

Like other hard rocks, water yields are low, although slightly better than from diabase or gabbro. Average ranges are between 5 and 15 gpm.

Quartzite, particularly the Setter's quartzite, quarried near Avondale, is a valuable and beautiful stone. The Chickies quartzite elsewhere has been used as a blast furnace factory lining. Quartzite sometimes has been used as a crushed stone; but is not as desirable as other competing rock types because of its lack of cementing properties, a tencency to brittleness, and to undue wear of crushers due to its hardness.

Serpentine — Serpentine and related rock types are moderately hard ultra-basic metamorphic rocks formed from original igneous intrusions. It is found primarily in the area south of Oxford near the Maryland border. Small out-crops are also found in the West Chester and Willistown areas. It tends to weather slowly, but not as slowly as diabase. A thin, poor "Chrome soil", with little agricultural value, overlies it.

Depending upon the surrounding rock, serpentine tends to form low, flat uplands. Because of the poor quality of the soil and the difficulty of excavation, the area is known as the "Barrens". The Pennsylvania Department of Highways has reported that the soils formed from serpentine are the most difficult in the State for highway construction.

The rock tends to fracture more easily than does diabase and quartzite and thus ground water yield may average between 10 — 30 gpm which is sufficient for domestic use. It contains more dissolved salts than other rocks.

Serpentine stone, with its distinctive green color, was once widely used for building purposes. Many of the buildings at West Chester State College and the University of Pennsylvania are of serpentine. The stone lost favor when acid content in the air in urban areas caused deterioration. Serpentine was also the source of the chromite ore mined about a hundred years ago. It also contains small deposits of asbestos of no commercial value.

The best use for areas underlain by serpentine is woodland, parks, or very low density residential development. Most of the recently acquired Chester County Park at Nottingham is underlain with serpentine.

Sedimentary Sandstones and Shales Underly the *Schuylkill* Valley Lowlands.

In the general area east and north of French Creek and in the Phoenixville vicinity, as shown on the Geology map, other different rock types occur. These are sedimentary rocks — conglomerates, shales, argillites and sandstones formed much later in geologic time during the late Triassic era (the early part of the Age of Reptiles). They are comprised of sands and muds washed down from the highlands and deposited either in alluvial or lake environment that then covered much of the County. The deposits subsequently were cemented and hardened into rock.

These sedimentary rocks are a stratified series with bedding planes essentially parallel owing to initial depository of eroded material under water. Their thickness varies from a few to several hundreds of feet whereas the crystalline rocks are massive with thicknesses in the thousands. The sedimentary rock overly the deeper crystalline. They are generally much softer than the igneous and metamorphic rocks and their porosities are nearly always considerably greater.

The attitudes or position of the Triassic sedimentary series, present within the County, is essentially flat lying with a gentle northerly dip. However, uplift and compression of the beds, since deposition, has resulted in a series of relatively gentle folds striking east-northeast and forming a general landscape of elongated ridges and valleys parallel to and coincident with the folds.

The sedimentaries, being softer, are generally easier to excavate than are the crystalline rocks found in the remainder of the County. Foundation bearing strengths of the rock formations themselves, although generally weaker, are normally adequate for ordinary structures. Having greater porosities, they consequently have significantly greater yields of ground water in those instances where permeabilities are sufficiently high as in the sands and conglomerates. Water yields in rocks of this nature depend largely on porosities rather than on joints and fractures and that as a result the probabilities of drilling large numbers of dry holes are considerably less than in the crystalline areas. In respect to both metallic and non-metallic minerals, the sedimentary sandstones and shales occuring within Chester County usually are barren.

There are three formations of Triassic sedimentary rocks identified on the detailed state geologic map, which are not shown separately on the small fold-out map. They are, beginning with the oldest, the Stockton, Lockatong and the Brunswick formations. These are identified as formations since they are composed of successive layers of different types of rocks, mostly shale, arkosic, sandstone, argillite and conglomerates.

The Stockton Sandstone — The Stockton Formation is comprised of layers of arkosic sandstone, siltstones and conglomerate irregularly interbedded with layers of red shale as well as fine grained silicous sandstones. It is located in a narrow belt along French Creek and through much of Phoenixville and Schuylkill Townships. Because of its ease of erosion, the Stockton forms gently rolling or relatively flat lowlands.

It weathers evenly, although fairly slowly, and is overlain with thin soil, mostly of the Penn Lansdale series. Its foundation bearing strength is not as great as most of the crystalline rocks, but adequate for ordinary buildings. It is relatively easy to excavate, and can often be removed with a power shovel. The Stockton has some value for building stone, but is too soft for crushed stone.

The Stockton sandstone is the best source of safe ground water in the County. Yields will range from 100 to 300 gpm, averaging about 130 gpm of moderately soft water.

Recently, detailed research by the Ground Water Branch of the U. S. Geological Survey has shown that for ground water purposes the Stockton should be subdivided into three units. The middle has the best yields of about 130 gpm, the lower arkose unit about 110 gpm, and the upper shale member only 20 gpm. These subdivisions are not shown on the geologic map, but in most of Chester County, the Stockton formation produces from the high yielding middle and lower units.

The Lockatong Argillite Formation — The Lockatong formation is comprised of dark gray to black, thick bedded argillite with occasional zones of thin bedded black shale. Locally there are thin layers of limestone and calcorgous shales and rare sandstones. The formation is partially metamorphized.

Because this formation is relatively harder than the surrounding sandstones and shales, it tends to form ridges trending in an east-northeast to west-southwest direction. The Lockatong is limited in Chester County to a narrow ridge more or less along Route 23, west of Phoenixville. It, however, is a principal ridge maker in Montgomery and Bucks Counties.

Because of the hard, impervious shale, with fractures, ground water yields are poor, averaging only 10 gpm, but along fault zones yields are occasionally as high as 100 gpm. The water is moderately hard. The formation is somewhat harder to excavate or to drill than are most ordinary shales and sandstones. It is used locally as crushed stone in Montgomery and Bucks Counties.

The Brunswick Formation — The Brunswick is a formation comprised largely of soft red shales with interbedded red to brown, fine to coarse grained quartzose sandstones. In places it carries minor interbedded shale and limestone conglomerates as well as major interbedded units or quartz pebble conglomerates.

The formation occupies the largest areal extent of the Schuylkill Valley Triassic lowlands generally from Spring City to Pottstown. The Brunswick red sandstone and shale phase is a fairly soft material and thus readily weathers to a low level plain.

Although it is relatively weak, it does have sufficient strength to support all but the heaviest buildings without special underpinning. Excavation is a comparatively simple matter with a power shovel although occasionally blasting may be necessary.

This rock has no value as crushed stone or building stone. It is a source of a moderate supply of ground water ranging from 20 — 40 gpm, depending upon variations of porosity and permeability.

The quartz pebble conglomerate phase is more prominent near the western edge of the Brunswick formation in Chester County. It is in this area that the generally recognized red sandstones and shales grade into and are interbedded with a poorly sorted series of quartz pebble conglomerate beds. These conglomerate beds are generally well cemented and hence resistant to erosion with a resultant formation of more extensive uplands than are present to the east.

The Limestones of the Chester Valley Define the County's Most Valuable Land, Soil and Minerals; But Have Special Problems.

The Chester Valley is the County's most distinctive topographic feature and contains its most valuable land. It bisects the County, running on a generally east-northeast west-southwest line from Tredyffrin Township to Atglen where it leaves the County. It is widest to the east, particularly in East and West Whiteland Townships and progressively narrows to less than one half mile at Atglen.

The Valley was formed not by a major stream, but by a sequence of limestones and dolomites down-dropped by a combination of folding and faulting to form a relatively narrow band of sediments lying between the igneous and metamorphic rocks on either side. Subsequent physical and chemical weathering, the latter at the surface as well as at the depth, has further reduced the general level to below that of the quartzites of the North Valley Hills and of the Wissahickon albite-chlorite schist of the South Valley Hills. The Valley is therefore defined by the limestone area.

The Hagerstown and Conestoga soils formed from limestone are deep and well drained; and they are the most valuable agricultural soils in the East.

The limestone — dolomite rocks are sedimentary in origin, having resulted from the deposition of countless billions of shells constructed by the microscopic animals which existed in the waters of the seas covering the area during the Cambrian and Ordovician times. Within the Valley, the beds are sharply contorted into a series of long parallel anticlines and synclines often overturned to the North-Northwest with both limbs frequently compressed together, and dipping steeply to the South-Southeast. Their trend is parallel to that of the Valley.

The most distinctive characteristic of these limestones is that the chemical interaction of air and water tends to form a weak carbonic acid solution which in conjunction with humic acid formed from the decay of vegetation, slowly dissolves the limestones and forms underground solution channels which frequently extend over long distances. These solution channels are significant for urban planning. They present the danger of sink holes and foundation collapse as well as the hazard of ground water pollution. Fortunately, some of the limestones of the Chester Valley appear to be more resistant to solution than others and none seem to have sinks or caves to any great extent. However, this condition does exist, predominantly in the Conestoga limestone.

There are two types of carbonate rock present in the Chester Valley: limestone, which is calcium carbonate and dolomite, which is magnesium carbonate. Many gradational phases between the two are present. All are metamorphosed to some degree. These types are not shown on the small scale Geology map, but are indicated on official geologic maps of the area. The limestones and dolomites are of varying degrees of purity, containing varying percentages of sand, shale and certain alteration products.

The five distinct carbonate formations present within the Valley occur in the Cambrian and Ordovician systems of rocks. Those formations which are Cambrian in age include, from oldest to youngest, the Vintage dolomite, the Kinzers limestone and marble, the Ledger dolomite and the Elbrook limestone. The formation occuring in rocks of Ordovician age is the Conestoga limestone.

The Vintage Dolomite — This formation is a dark gray, shaly dolomite with impure, light gray marble occuring at the base. It is a thin, thinly bedded formation overlying the Cambrian Harpers phyllite and is present on the north side of the Valley along with slopes of the North Valley Hills. The Vintage is exposed along the outcrop from Whitford P. O., just east of Downington, to southwest of Coatesville. Small exposures are found in the vicinity of Bacton and Mill Lane. The Vintage has little economic value, owing to its impurity and its small exposure over a limited area.

The Kinzers Limestone — This formation has a thin dark brown shale at its base overlain by a gray and white spotted limestone and marble with irregular bedding. It grades upward to a sandy limestone which weathers into a fine porous sandstone. The outcrops of Kinzers are thin and are found essentially in the same areas as those of the Vintage dolomite. It has no significant commercial value.

The Ledger Dolomite — Overlying the Kinzers formation is the Ledger Dolomite. This formation is comprised of a light gray, locally mottled, massively bedded, coarsely crystalline dolomite often silicous in the middle part. It is a thick formation, although in places the thickness is partially due to repitition of beds due to both folding and faulting. Areally it extends from the County Line near Valley Forge southwest to the vicinity of Coatesville where it is overlapped by the Conestoga. Its maximum extent is present in both East and West Whiteland Townships and in the vicinity of Downington in East Caln Township. Soil cover over the beds varies from practically nothing to thicknesses over 100 feet and the rock surface, due to irregular weathering, presents a sawtooth like configuration.

The Ledger dolomites are economically the most valuable deposits in the Valley. Extensive quarrying operations are progressing at numerous locations in both Chester and Montgomery Counties. Outstanding in size of quarries and annual tonnages quarried are those located at Bradford Hills in E. Caln, Cedar Hollow in Whiteland Township, and Valley Forge Stone Co. near Malvern. The material quarried finds a ready market for metallurgical refractory linings, crushed stone, fluxing agents, soil conditioners, source of lime for plasters, and various chemical uses.

The value of these dolomites is such that considerable areas underlain by the Ledger formation should be held in reserve for future quarrying operations. Although land development has already removed extensive acreage, sufficient open land yet exists over Ledger deposits to justify efforts to prevent further urban encroachment.

The Elbrook Limestone — This formation is a light to yellowish grey impure, silicous, often shaly limestone. It is a finely laminated rock often interbedded with dolomite that weathers to an earthy buff soil. In extent, it covers much of the eastern part of the Valley in Tredyffrin Township and thin zones are present in the Downingtown area. It has no particular economic use.

The Conestoga Limestone — This formation, of Ordovician age, is a bluish gray, thin bedded, impure limestone with shale partings. In the Chester Valley it can be divided into two parts separated by a middle phyllite. The Upper Conestoga is relatively homogeneous and is micaceous in character, while the Lower Conestoga consists of alternating limestones and dolomites. The entire formation is moderately to extensively crumpled and contorted. The latter factor may help to explain the greater tendency of the Conestoga limestone to underground solution and consequent settling and sinking of localized surface areas.

The areal extent of the Conestoga is widespread. It extends the entire length of the Chester Valley from Abington in Montgomery County to beyond the Susquehanna River in Lancaster County. It lies along the south side of the valley against the South Valley Hills in a band varying in width from one-half to three quarters of a mile. West of Coatesville, it occupies all of the Valley.

Potentially the Upper Conestoga has use as a source of limestone for cement, and is similar in composition to the Lower Jacksonburg formation, the famed Lehigh Valley cement rock. Quarrying and milling of cement is proceeding at West Conshohocken. The Lower Conestoga is less useful although the rock is used as a "cement sweetener". An active quarry in the lower Conestoga is located near Howellville and the material is used for crushed stone, etc.

Marble — Marble is metamorphosed limestone and thus is often harder and usually capable of taking a polish. The chief marble in the County is the Cockeysville marble, as shown on the small Geology map. Marble underlies much of the Toughkenamon Valley, and reaches its greatest extent in the Avondale area. It also crops out in the Doe Run area. The Cockeysville marble has been widely used in the past for buildings and monuments; but most of the quarries have now been flooded.

The Franklin limestone (marble) is an ancient pre-Cambrian formation, probably the oldest rock in Chester County. It crops out in only a few places, and is of little economic or practical importance.

Water properties are similar to limestones.

Applications

The comparative applications of the geologic considerations important to planning are outlined and discussed below. These are general comparisons and considerations that can not replace detailed investigations at any given site.

Chester County is Mostly a Hard Rock Area with Small Ground Water Storage.

The quantity, quality, and reliability of supply of ground water available depends upon rainfall, vegetation, slope, and particularly upon the porosity and permeability of underlying soil and rock. All ground water in Chester County, with minor variations in the limestone areas, comes from rain or snow falling on the surface immediately above. It does not come from the Delaware River, Pocono Mountains, or other distant source.

Despite the relative abundance and even distribution of rainfall, Chester County has, for the most part, limited ground water resources owing to the low porosity and permeability of most of the underlying rocks, which thus cannot store and transmit large amounts of water. The quantity and quality of ground water available at specific locations depends upon which of the three basic rock provinces is involved: the crystalline rocks underlying most of the County, the Triassic sediments lying east of French Creek, and the limestones of Chester Valley.

Crystalline Rocks — Most of the crystalline granitic gneisses, schists, gabbros, amphibolites and anorthosites have low porosities and permeabilities and hence retard the storage and flow of ground water. In these rocks, ground water is found only in fractures, fissures and weathered zones within the rock mass. Rarely is any ground water found deeper than 300 feet and most is found above 100 feet. Confined (artesian) yields are small. The gabbros, diabases, granitic gneisses, quartzites and pegmatite dikes produce the poorest yielders of all the average predictable ranges between 0 — 10 gpm. Many wells are dry; but occasional wells, particularly when near streams may yield somewhat greater amounts. Location drilled on a basis of detailed geological study plus a little trial and error have occasionally found wells yielding up to 100 gpm, particularly near streams, but this is not an average expectation. Drilling is difficult and expensive in these hard rocks.

The Wissahickon schist underlying much of the southern part of the County, because it is more deeply weathered, tends to have slightly higher ground water yields ranging between 10 and 20 gpm, with occasional yields to greater than 100 gpm where a system of horizontal or master joints are tapped. The Setter's quartzite formation and the serpentine areas produce lower yields. These yields are generally adequate for domestic supplies at low residential densities. These yields, like most wells, do not supply volumes and pressures adequate for fire fighting.

Ground water obtained from the crystalline rocks is very soft, with some of the best quality to be found anywhere. Hardness of water may be higher where Pickering gneiss is associated with limestone lenses. Because of the lack of permeability, ground water pollution is relatively localized. Supplies within the yield limits generally are reliable throughout the year, unless extreme drought conditions prevail.

Triassic Sediments — The County's best ground water yields are in the Stockton Formation found in the vicinity of Phoenixville. Here, yields will average over 100 — 150 gpm. Smaller, although relatively substantial yields of 20-60 gpm, with an average of 40 — 50 gpm, may be obtained from the interbedded sandstones of the Brunswick Formation, in the region generally east of French Creek in the northern part of the County. Yields are usually larger in the valleys and away from heavily pumped wells. Well drilling is relatively easy.

There is likely to be mutual interference with wells spaced closer than 1000 feet apart. Confined artesian water is present in the Triassic rocks so that it generally pays to drill to depths of from 300 to 600 feet. There is some danger of ground water pollution, particularly in the more permeable sandstones. The chemical quality of the water is moderately hard, but is usually adequate for domestic purposes without treatment.

Limestones — The limestones underlying Chester Valley and the Cockeysville marble underlying the Toughkenamon Valley and the Doe Run area are variable in their ground water yields. In the limestone areas of Chester County, ground water is primarily found in solution channels, surface fractures and fissures.

In these areas, where a large solution channel is tapped, very large supplies may result. Otherwise yields are small. According to reports of a well driller, there are large diameter wells in the limestone in Tredyffrin Township yielding as high as 1400 gpm that could be pumped to 2000 gpm, and at Frazer yielding over 900 gpm. Often these large supplies present in the solution channels can be traced by following and connecting the sink collapses. The Philadelphia Suburban Water Company has employed consulting geologists to help locate large supplies.

Limestone water, because of the generally high content of dissolved minerals such as calcium and magnesium carbonates is often very hard, and should have softening treatment for many types of usage.

The ground water contamination hazard is great, because contaminants can get into the underlying water channels easily; can often be carried long distances in unpredictable ways; and because underground water is not easily self purifying due to a lack of air, sunshine and filtering material. At present, it is not believed there is serious contamination of the limestone ground waters. However, increasing urbanization with its attendant problems of disposal of ever increasing amounts of industrial and domestic wastes does make it a serious potential problem for the future.

Because of the ground water contamination danger, the Pennsylvania Dept. of Health has recommended strongly that septic tanks, and particularly, cess pools and seepage pits be prohibited in limestone areas; and that public water and sewerage systems be available for all urban development.

The small fold-out "Ground Water Resources" map shows general ranges of yield expectancies in overall terms, but it cannot predict accurate yields for individual wells. More detailed study with results appearing on a larger scale map is needed for more accurate predictions. Fortunately, during the summer of 1963, the Ground Water Branch of the U. S. Geological Survey, in cooperation with the Pennsylvania Geological Survey, Dept. of Internal Affairs, began a three year study that will attempt to obtain detailed data on yields, mutual interference of wells, and on other features pertinent to an understanding of the ground water resources of the area. A report by the same agencies on the Stockton Formation was recently published, and one is anticipated for the Brunswick Formation in 1964.

The Rock Structure is Generally Good for Foundations with Caution Needed in Limestone Areas or Where Rock is Deeply Weathered.

The underlying bedrock of Chester County is hard and generally introduces no major problems in regard to foundation suitability for support of buildings, hazard of rock slides and similar problems.

However, there are two areas where care must be taken and detailed studies based on core borings must be made before heavy construction is undertaken. One of these is the area underlain by limestone of the Chester Valley which may contain sink holes and other solution channels. The other is the hard, crystalline rock areas which are basically excellent for foundations. However, because of deep weathering in some of these rocks there is apt to be significant thicknesses of badly weathered material overlying sound bed rock. This condition is particularly likely in the deeply weathered mica schists which underly much of the area of the County south of Chester Valley, and in some parts of the South Valley Hills.

The suitability of any location where dams are to be constructed depends in part upon the ability of the rock to support the load of the dam and in part upon impermeability of the rock formations underlying the dam and the reservoir. Rocks heavily fractured and fissured, badly weathered, or of such type as to permit large amounts of seepage through pore spaces or channels are highly unsuitable. However, for the most part, all areas of Chester County are generally well suited for dam construction, provided that excavations are carried below the weathered zone. Exceptions to this are the limestone areas of the Chester Valley and the Triassic sandstone and shale areas of the north and northeast portions of the County. Because of the possibility of many hidden unknowns such as faults and uneven weathering, very detailed site exploration with core borings is recommended before any dam sites are finally located.

The cost and difficulty of excavation for building foundations, water and sewer lines and for grading depends upon the depth of soils, the degree of weathering of the rocks, and the hardness of the rock itself. Table S-1 in the Soils Section gives average range of depth to bedrock. In many places in the mica schists areas, the weathered upper layers are soft and can be removed with a power shovel without the costly use of explosives. Generally, most of the serpentines, gneisses, amphibolites, quartzites, and gabbros are hard and difficult to excavate once unweathered material has been removed. In general the relative depth of weathering of the crystalline rocks is in the following order of magnitude: diabase (least) (0-5 ft); quartzite (1-20 ft); amphibolite, granitic gneiss; and schist (greatest) (1 to 50 ft).

The County is not in a seismic belt and, as a result, the possible occurrance of earthquakes is so infrequent that no special care need be taken as a safeguard in building practices. Ordinary sound construction will provide feasible protection.

The ability of a rock to either transmit or absorb explosion shock wave seems to be related to the amount and percentage of water it contains. Thus, most of the hard crystalline rocks containing little water should be ready to absorb explosion shock within a short distance. Presumably the sandstones and the limestones are more susceptible to explosion shock.

There is always a very small amount of radioactivity from rocks. Whether or not this background radioactivity has any relation to human health or longevity is not known. The hybrid gneisses and amphibolites are believed to have the highest radiation, the schists and quartzites intermediate, and the sedimentary limestones, sandstones and shales the lowest. But in this area, the natural background radiation is lower than in many other places, particularly places with higher elevations.

The County is Well Favored with Building Stone.

One of the chief contributors to the past beauty of the Chester County countryside was the availability for barns and houses of attractive building stone, a resource that most Mid-West cities lack. Most of the County's granitic gneisses, schists, gabbros, limestones, sandstones and quartzites provide satisfactory and available sources of building stone. Of these, the Chickies and Setter's quartzites are considered to be the most attractive. The Wissahickon schists were also extensively used as building stone in the Philadelphia area, but often much of the weathered material must be removed before fresh, solid rock can be quarried.

The serpentine "greenstone" was formerly used in building the West Chester State College, University of Pennsylvania, and many local churches and stores. However, serpentine deteriorates rapidly owing to reactions of some of its contained minerals with the impurities usually present in the air of industrialized cities, and hence has lost favor as a building stone.

Useful marble has been quarried both in the Chester Valley and from the Cockeysville marble quarries near Kennett Square.

The famous "Black Granite" or trap rock from the diabase dike near French Creek not only makes an excellent and durable monument stone but also is desirable for trim uses. However, it is usually too dark and somber in color for general building purposes. It appears to be the toughest, hardest rock available and thus is excellent for paving blocks and pier foundations.

Good Crushed Stone is Abundant.

Chester County can partially make up for its lack of good construction sand and gravel through the substitution of crushed stone aggregates of which ample supplies are available.

The best road metal and crushed stones are the limestones, the diabases and some gabbros. Schists and shales are not usually suitable for crushed stone. Quartzite is marginally suitable; although hard, it does have good cementing properties.

At present, the limestone quarries at Bradford Hills and Howellville are those approved by the Pennsylvania Dept. of Highways as a source of crushed rock.

Minerals Aided in the Early Economic Development of the County; But Only Limestone Deposits are Now of Principal Importance.

The early deposits of iron, chrome, and to a lesser extent lead, zinc, and graphite, were of importance to the early economic development of Chester County, but today only the limestones are of major importance.

The iron ore in the diabase ridges was the source of iron from which cannon balls were made and supplied to the Continental Army at Valley Forge. It provided the start of a steel industry at Coatesville and Phoenixville. By thus bringing primary employment, the minerals indirectly helped stimulate land clearance, industry, commerce, and transportation.

The general location of these mineral workings are shown on the small fold-out map, entitled "Mineral Resources". This map shows past workings, not necessarily the areal extent of the mineral resource.

Iron — The only iron deposits in Chester County are in the French Creek area in the northern part of the County. These deposits were created by contact metamorphism from the intrusion of igneous rocks. They were worked intermittently from 1717 to 1874 with occasional revival thereafter. The mines are now flooded and caved in.

There still are iron deposits in the northern Chester County Hills, but they presently have no commercial importance owing to the existence of better ores elsewhere and the small size of the deposits. They lie many hundreds of feet below the surface and cannot become profitable until either higher grade deposits are exhausted, or an economic method of recovery is discovered.

Chrome — The first chrome mines in the United States were found and operated in the serpentine intrusive areas near the Maryland-Pennsylvania state line. Mining commenced about 1810, reached its peak in the 1840's, and dwindled off after the Civil War as better ores elsewhere were discovered.

Because of the high quality of the early Maryland-Pennsylvania chrome deposits, the area was seriously prospected during and after World War II when chrome became scarce with the interruption of foreign supplies. However, as no new mining areas resulted, it is considered improbable that further workable chromite deposits exist, although this has not been conclusively proved.

Lead and Zinc — Lead and zinc deposits were discovered in the Pickering Creek area south of Phoenixville and near Audubon in Montgomery County around 1808. Production reached a peak around 1855 and the mines generally were worked out around 1877. There was some attempt to revive production after World War I, but this was soon abandoned. There seems to be no feasibility of further profitable lead or zinc mining.

Graphite — The Pickering Graphite gneiss located south of Phoenixville has produced graphite intermittently since about 1870. One mine operated until recently was that of the Graphite Corporation of America at Chester Springs. These deposits are small and are not of major economic importance.

Brick and Clay Products — The only geological formation in Chester County suitable for brick manufacture is the shales of the Triassic lowland area. The McAvoy Brick Co., east of Phoenixville, is the chief brick producer within the County. It is not believed that local clays will produce a higher grade of clay product than brick. Some clays have come from feldspar in pegastite and other hard rocks.

Limestones and Dolomites — Limestone and dolomite plus crushed stone from Chester County's great limestone valley are now the County's principal mineral products. Their economic importance to the County now and in the future is great.

Limestone and dolomite are quarried at the Cedar Hollow Plant of the Warner Company at Devault for agricultural lime, blast furnace flux, manufacturing refractories, and lime hydrates for building purposes. The Cedar Hollow Plant, the Warner Johnston Plant near Howellville, and the Brandford Hills Quarry in East Caln are large producers of limestone aggregates for crushed stone and for road metal. There is also potential in the lower Conestoga formation for cement rock of a type comparable to the famous Lower Jacksonberg cement rock of the Lehigh Valley. The County presently has and in the future will have need for these earth products, particularly so, since haulage distances are reasonable.

Quarry Operations Require Much Planning, Large Land Reservations, and Reuse Considerations.

Limestone quarrying is necessarily a nuisance industry. It is space consuming, involves considerable truck traffic, and occasional blasting with the accompanying unpleasant dust and shock, and leaves a large hole. As a result it is not compatible with nearby residential uses and therefore careful planning is necessary for its integration into the community.

It is recommended that some of the limestone and Ledger dolomite reserves be preserved by appropriate exclusive industrial zoning, as well as by extensive ownership of large adjacent tracts by the industries involved, so that ample space to be used as buffer zones with appropriate plantings can be provided.

Sooner or later, the mineral resources of a quarry will become worked-out or flooded and will have to be abandoned. What use can be made of this big hole?

Reclamation of quarries has not been extensively practiced in Chester County or in Southeastern Pennsylvania; but several possibilities have been suggested:

Recreation — Several quarries, particularly the old Howellville Quarries, have been used by skin and scuba diving groups training in the area. Such quarries could be stocked for fishing, and perhaps used for limited boating or swimming under supervision. In most cases the precipitous drop makes general swimming and recreation dangerous without supervision; however, there may be a few areas with a more gradual approach to deep water.

Disposal of Refuse — Perhaps the best use of a quarry is for the disposal of refuse, particularly noncombustibles or incinerator ash. Quarries could also be used for general refuse disposal, with some problems of securing adequate covering material.

Bulk Storage — Quarries might be useful for the storage of bulk commodities not susceptible to weathering, or even as low cost space that could house enclosures. In a few instances quarries have been used for storage of petroleum; however, this would not appear feasible in Chester County due to the great costs of making quarries leak proof, and in providing a roof to prevent evaporation.

Underground Oil and Gas Storage May be Possible Only in the Stockton Sandstones; But Does Not Appear Feasible in Chester County.

The increasing use of gas for winter heating has produced the need for storage capacity to meet peak demands on cold days. One of the possibilites is to store this gas, often in compressed form, in the voids of porous rocks.

The possibility of underground storage of oil and gas within Chester County appears to be very unlikely. The crystalline areas offer no possibility, because of the absence of the voids necessary for storage. The Chester Valley limestones appear to be little better due to the fact that these rocks also are generally compact and relatively impermeable. In addition, the folding and faulting that is present has probably fractured the beds to such an extent that leakage could not be controlled.

The only area that appears to offer any possibility is that of the Triassic sedimentaries. Storage is theoretically possible provided that the conditions of structure, suitable porosities and premeabilities of the storage beds themselves, and impermeable cover rock are present. In addition, an absence of significant fracturing and faulting is paramount. Attainment of this data is dependent on thorough study of the subsurface beds in question. It is doubtful whether sufficient subsurface information is available to determine the underground conditions and the presence of suitable storage reservoirs.

In the unlikely event all these natural requirements are met, such storage would probably be incompatible with the other more valuable urban uses of the land. For one thing, ground water would probably be contaminated. Therefore, such storage does not seem feasible.

More Scientific Study is Needed of Mineral Resources, Ground Water, and Practical Application to Planning.

Despite the complexity of Chester County's geology, and the absence of outcrops, thanks to the pioneering geologists, the County is relatively well-mapped geologically. However, considerable further study is needed if answers to important problems are to be obtained. High priority for additional study should be assigned as follows.

1. Ground Water Considerations — Much more needs to be known about the predictable yields of ground water, well spacing, areas of greatest yield, yield per acres and other quantitiative factors. It is expected that some answers to many of these considerations will be available upon completion of several studies by the Ground Water Branch of the U. S. G. S., mentioned previously. These reports should be of great value in preparing a comprehensive water supply plan for Chester County.

2. More Practical Studies on Geology in Planning and Engineering — Until comparatively recently, most of the effort in geology has been orientated to the study of chemical and mineralogical properties, historical geology and economic mineral surveys instead of toward planning and engineering considerations. As a result, there has been relatively little effort to apply geologic methods and principles to planning and engineering needs. This report is a first attempt at emphasizing the lack of such considerations and in calling attention to their increasing importance in planning in the future.

3. More Exact Scientific Studies of Future Mineral Resources — Another technical need is an exact scientific quantitive study of potential mineral resources of the County. This should include chemical analysis, estimates of depth of overburden, volumes of ore, strike and dip of mineral bearing rocks, and other data needed to provide a more accurate estimate of future possibilities. The recent airborne magnetometer survey of iron ore deposits is a beginning and a good example of scope and methods that should be used. It is likely that the steel companies and quarry interests in the area have made such studies, but these are not available to the public.

4. More Detailed Areal Mapping — The larger scale and more accurate topographic maps completed during the 1950's should make it possible to remap the general areal geology in a somewhat more detailed manner.

5. Need for Public Well Log Records — Since the underlying rocks are covered with overburden (except at a few surface outcrops, in stream valleys, in quarries, and road/railroad cuts) the main source of basic knowledge is from borings, of which the most common are wells.

Well log records, if accurately kept, not only provide essential information on rock composition, but also give vital data on water yields.

It is unfortunate that Pennsylvania, unlike most of its neighboring states, does not have a law requiring public filing of this most valuable data.

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CHESTER COUNTY HAS MANY MINERAL RESOURCES;BUT ONLY LIMESTONES ARE NOW OF REAL ECONOMIC VALUE

This map designates the major mineral resources that were of economic importance in the past. It does not necessarily indicate, as explained in the text, that they will be important in the future, or that the resources will be only in the locations indicated.

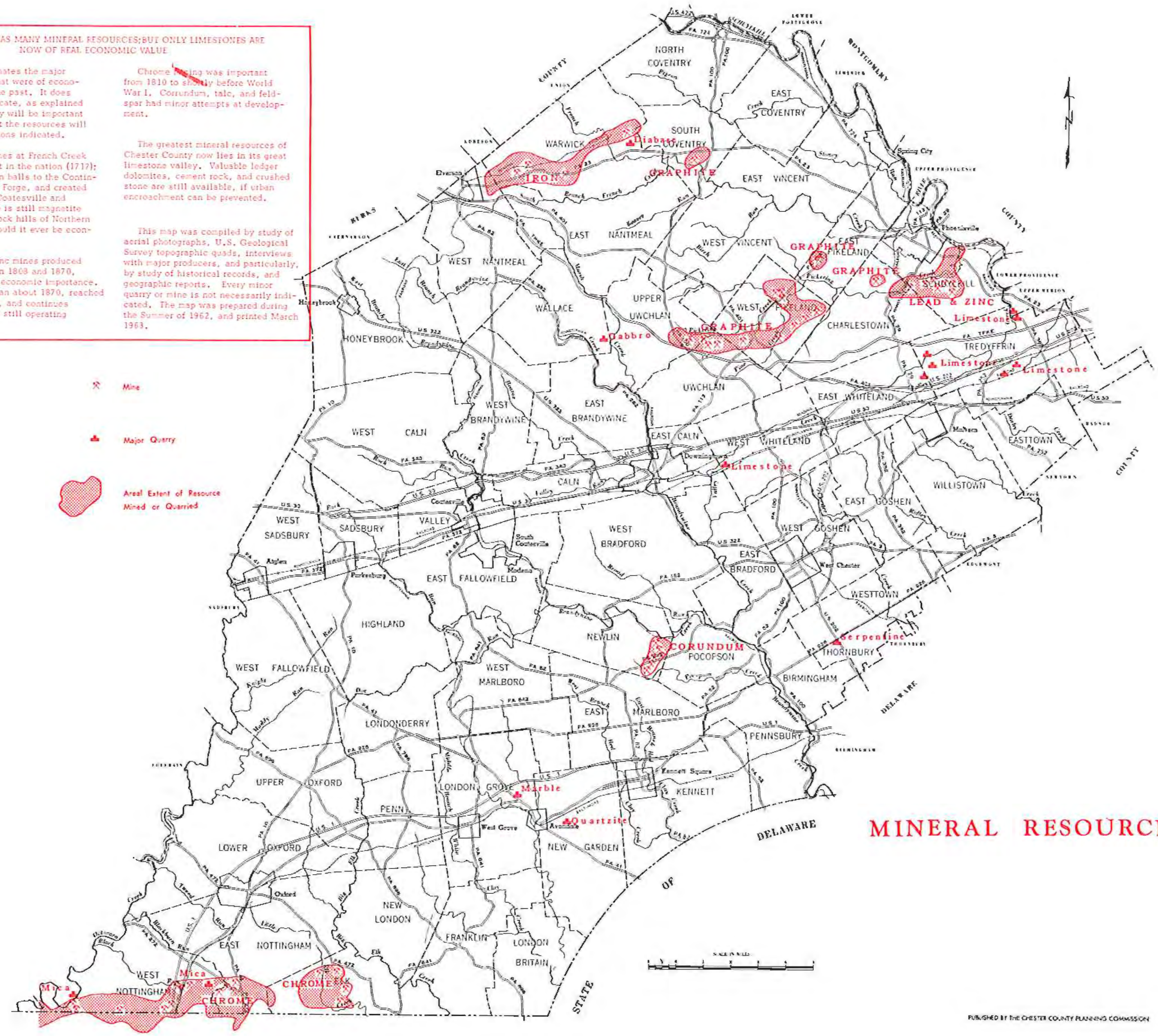
The iron ore mines at French Creek are among the oldest in the nation (1717); they supplied cannon balls to the Continental Army at Valley Forge, and created a steel industry at Coatesville and Phoenixville. There is still magnetite ore under the hard rock hills of Northern Chester County, should it ever be economical to mine.

The lead and zinc mines produced sporadically between 1808 and 1870, but are no longer of economic importance. Graphite mining began about 1870, reached its peak about 1900, and continues with one small mine still operating today.

Chrome mining was important from 1810 to shortly before World War I. Corrundum, talc, and feldspar had minor attempts at development.

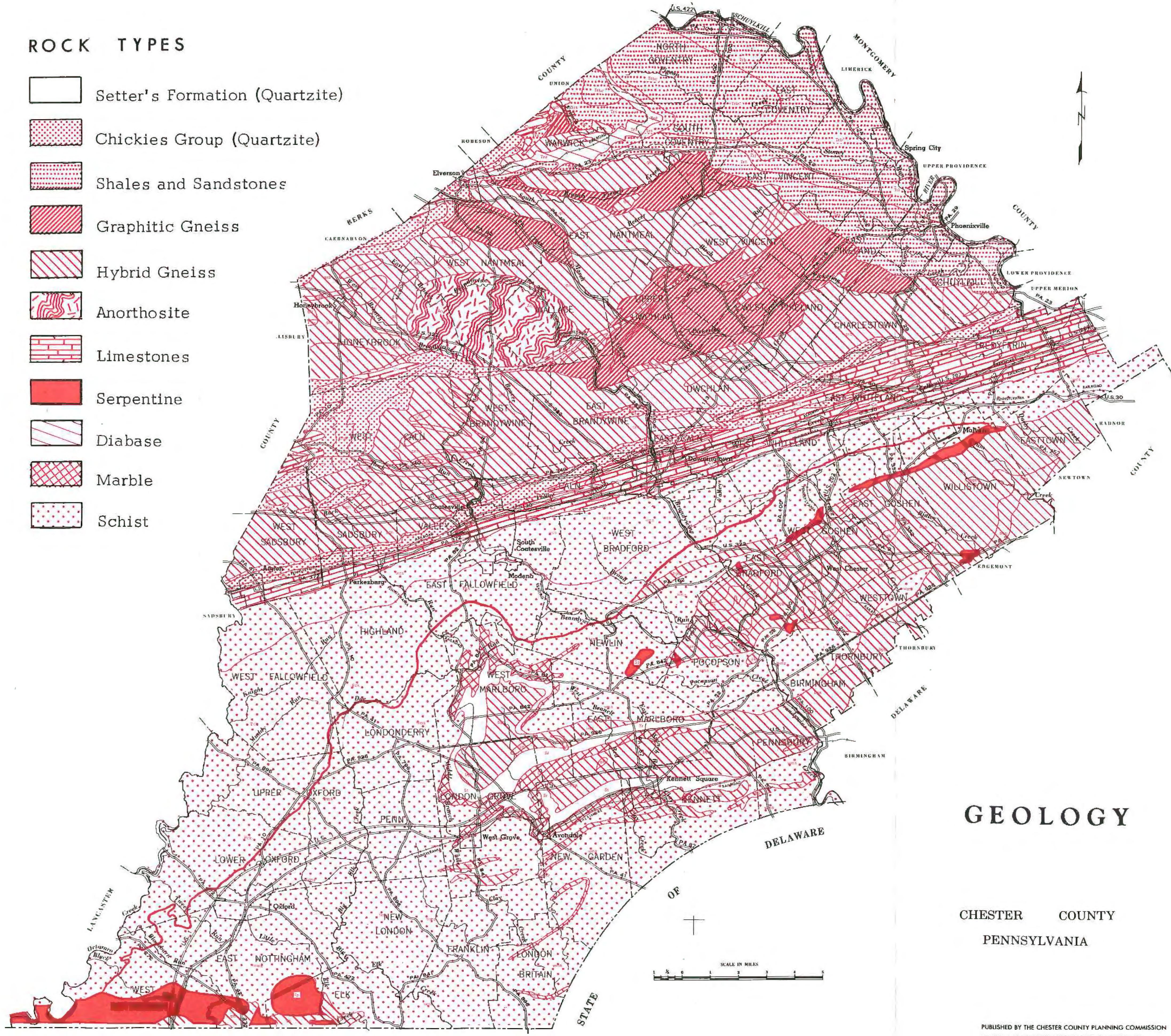
The greatest mineral resources of Chester County now lies in its great limestone valley. Valuable ledger dolomites, cement rock, and crushed stone are still available, if urban encroachment can be prevented.

This map was compiled by study of aerial photographs, U.S. Geological Survey topographic quads, interviews with major producers, and particularly, by study of historical records, and geographic reports. Every minor quarry or mine is not necessarily indicated. The map was prepared during the Summer of 1962, and printed March 1963.



MINERAL RESOURCES

PUBLISHED BY THE CHESTER COUNTY PLANNING COMMISSION



GEOLOGY

CHESTER COUNTY
PENNSYLVANIA

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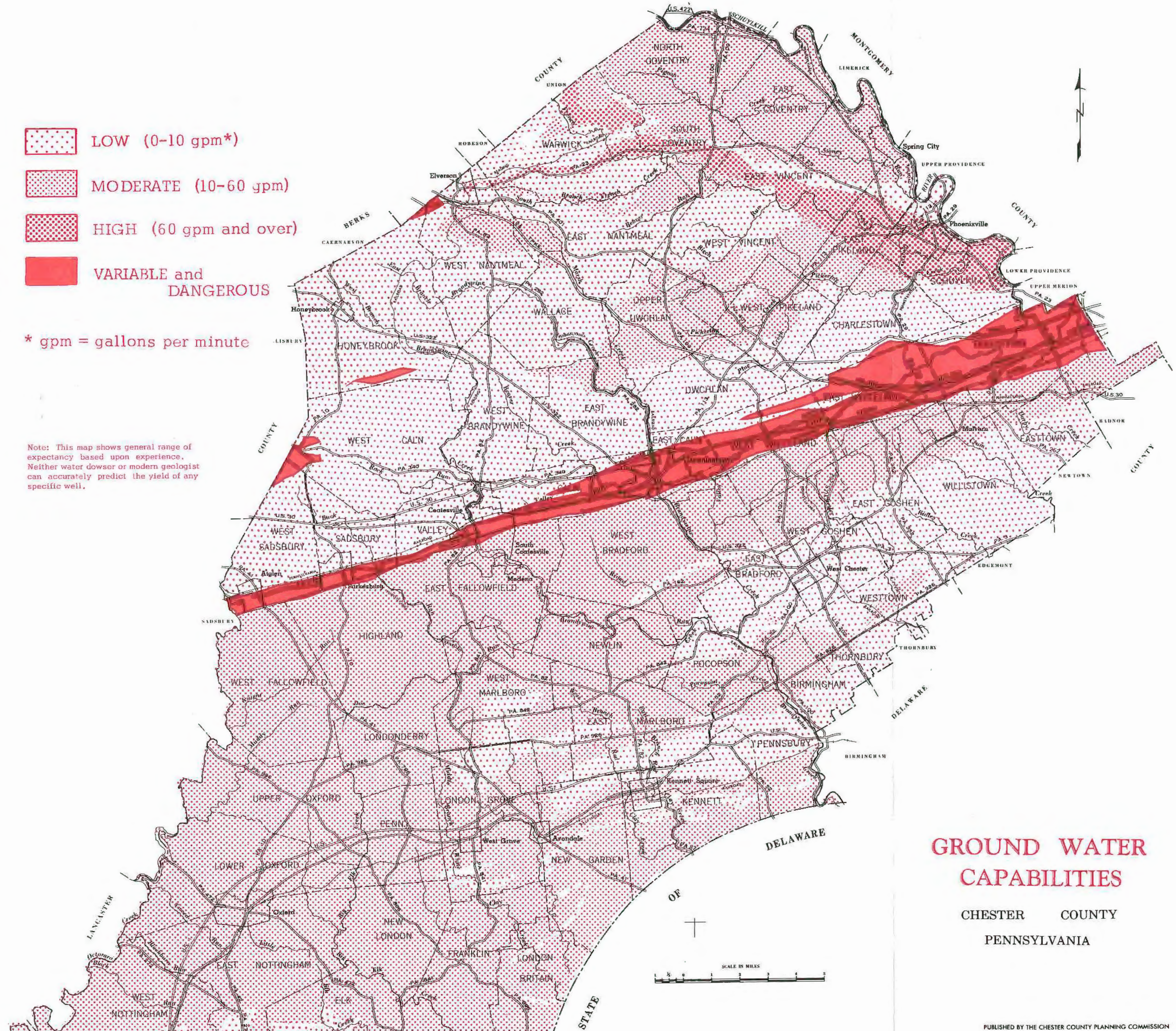
COURT HOUSE ANNEX WEST CHESTER, PENNSYLVANIA



Note: This map shows general range of expectancy based upon experience. Neither water dowser or modern geologist can accurately predict the yield of any specific well.

GROUND WATER CAPABILITIES

CHESTER COUNTY

PENNSYLVANIA

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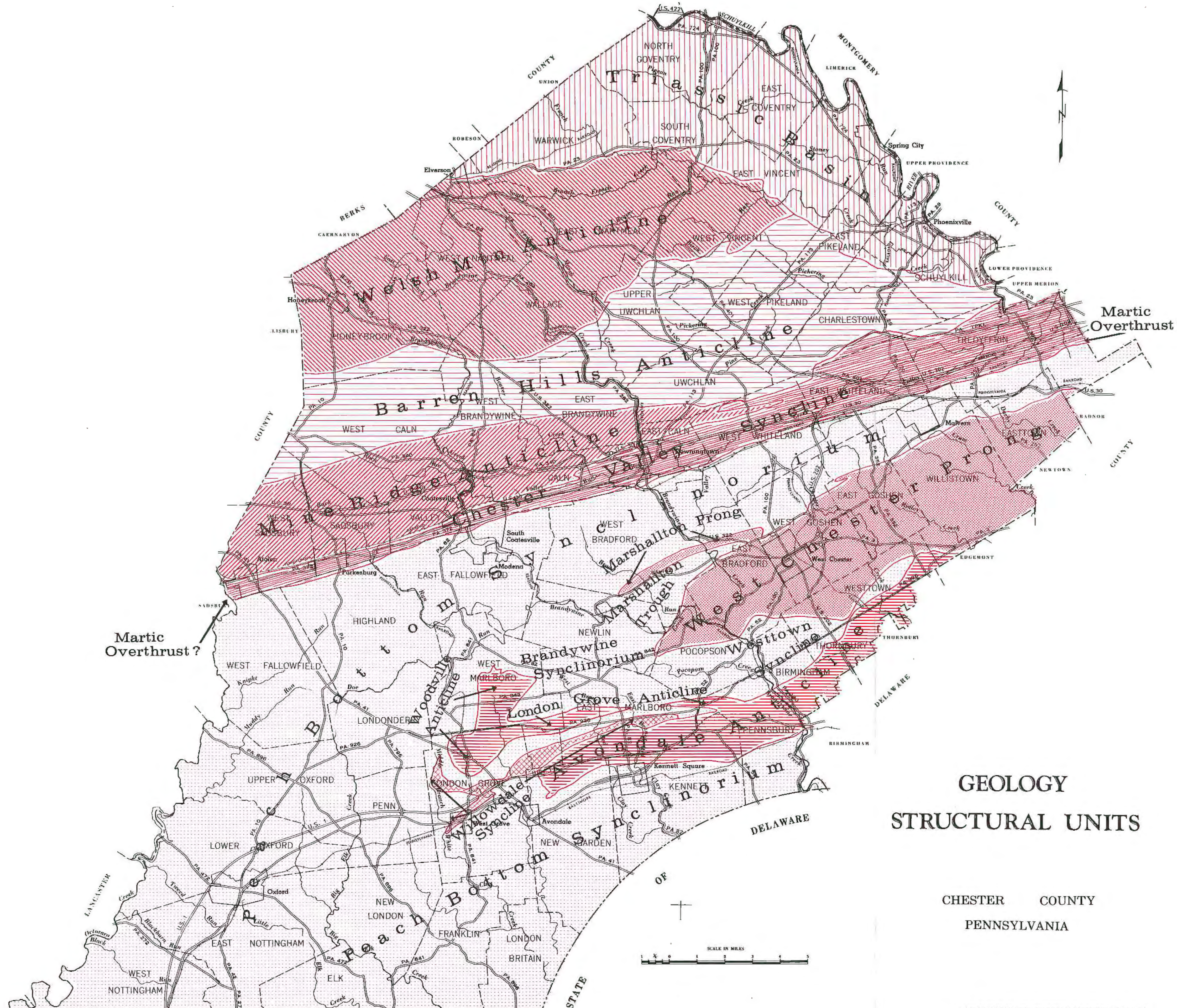


GEOLOGY STRUCTURAL UNITS

CHESTER COUNTY

PENNSYLVANIA

PUBLISHED BY THE CHESTER COUNTY PLANNING COMMISSION
COURT HOUSE ANNEX WEST CHESTER, PENNSYLVANIA

ENGINEERING CHARACTERISTICS

OF THE

ROCKS OF PENNSYLVANIA

Environmental Geology Supplement to the State Geologic Map

by William G. McGlade
Alan R. Geyer
John P. Wilshusen

PENNSYLVANIA GEOLOGICAL SURVEY FOURTH SERIES

HARRISBURG

1972

ANORTHOSITE (a)

DESCRIPTION

An igneous rock, medium-gray, containing primarily the feldspar laboradorite.

BEDDING

None.

FRACTURING

Joints; blocky pattern; moderately developed; moderately abundant; irregular; widely spaced; open and moderately dipping.

WEATHERING

Highly resistant; slight weathering to shallow depth; results in smooth, rounded, large boulders. The overlying mantle is thin.

TOPOGRAPHY

Hills; medium relief; natural slopes are fairly steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joint fractures produce a secondary porosity of low magnitude.

GROUND WATER

Detailed ground-water studies not complete. The median yield expected might be 10 gallons per minute; yield of 25 gallons per minute or more might be obtained from wells properly situated and developed. Wells should be located in valleys and should be drilled 200 feet deep for maximum yield.

EASE OF EXCAVATION

Blasting required; large surface and near surface boulders hamper excavation; slow drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Good cut-slope stability; able to stand in fairly steep cuts.

FOUNDATION STABILITY

Good quality foundation, for heavy structures. Should be excavated to sound material.

CONSTRUCTION MATERIALS

Good source of road material, riprap, building stone, embankment facing and fill.

ANTIETAM FORMATION (Єa)

DESCRIPTION

Gray, buff-weathering quartzite and quartz schist.

BEDDING

Moderately well bedded to well bedded; thick.

FRACTURING

Joint and cleavage planes display a blocky pattern; moderately well developed; moderately abundant; widely spaced and fairly regular; steeply dipping and open.

WEATHERING

Highly resistant to weathering; usually slightly to moderately weathered to a shallow depth; hackly, large, irregularly shaped fragments result from weathering; overlying mantle is thin.

TOPOGRAPHY

Rough mountains of medium to high relief; natural slopes are steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joint and cleavage planes provide a secondary porosity of very low magnitude.

EASE OF EXCAVATION

Seventy-five percent of wells studied yielded 20 gpm or more; for maximum yields, well sites must be carefully chosen; valleys, fault zones, and other fracture zones are most favorable sites.

GROUND WATER

Requires blasting; slow drilling rates with rotary equipment; in part, due to many quartz veins that exceed 12 inches in width; large boulders may be a special problem; locally, highly fractured and highly weathered and moderately easy to excavate with light power equipment.

CUT-SLOPE STABILITY

Good stability in very steep cuts; locally, where highly fractured, cut-slope stability is only fair and moderate cuts necessary.

FOUNDATION STABILITY

Good to excellent quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Good source for road material, riprap, building stone and embankment facing; in some localities, refractory brick, and where intensely fractured and weathered, sand is available.

BRUNSWICK FORMATION (Trb)

DESCRIPTION

Typically reddish-brown shale, mudstone, and siltstone; beds of green shale and brown shale occur; very fine-grained; near base, rock is tough, red argillite interbedded sometimes with dark-gray argillite.

BEDDING

Moderately well bedded; thin to flaggy.

FRACTURING

Joints have blocky pattern; moderately developed; moderately abundant; uneven regularity; closely spaced; steeply dipping; open and filled with quartz and calcite.

WEATHERING

Moderately resistant; moderately weathered to a moderate depth; weathered fragments range in size from elongated and pencil-like to medium-sized, irregularly-shaped blocks; smaller fragments result from rapid hydration of minerals in exposed outcrop; overlying mantle is moderately thick.

TOPOGRAPHY

Undulating hills of low relief; natural slopes are moderately steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joint and bedding planes provide secondary porosity of medium magnitude.

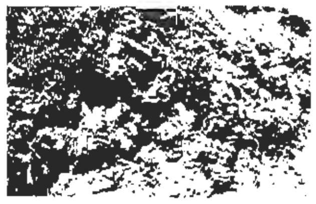
GROUND WATER

Highest yields obtained from wells ranging in depth from 200 to 550 feet; wells less than 2000 feet apart have generally shown some interference.

EASE OF EXCAVATION

Weathered zone may be excavated moderately easy with heavy power equipment; unweathered rock requires blasting; moderate to fast drilling rate expected with rotary equipment, except adjacent to diabase where rock is harder and drilling rate slow.

CUT-SLOPE STABILITY



Gentle slope cuts necessary; fair to poor cut-slope stability; landslides occur where cut slopes are steep and rocks dip toward cut.

FOUNDATION STABILITY

Good quality foundation for heavy structures; should be excavated to sound material; good drainage necessary.

CONSTRUCTION MATERIALS

Should prove good to fair source for road material and fill; part of formation should prove excellent as source of lightweight aggregate and material for common brick.

ROCK TEST DATA

Water of Plasticity = 18 to 19%
Drying shrinkage = 1 to 5%

REMARKS

Test data from USBM.

CHICKIES FORMATION (€ch)

DESCRIPTION

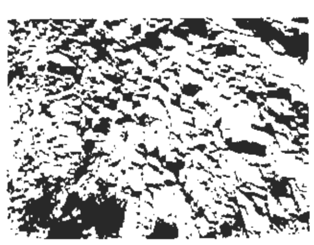
Light-gray, hard quartzite and quartz schist; thin, interbedded, dark slate at top, conglomerate at base.

BEDDING

Moderately well bedded to well bedded; thick.

FRACTURING

Joint and cleavage planes display a blocky pattern; moderately well developed; moderately abundant; widely spaced and fairly regular; steeply dipping and open.



WEATHERING

Highly resistant to weathering; usually slightly to moderately weathered to a shallow depth; hackly, large, irregularly shaped fragments result from weathering; overlying mantle is thin.

TOPOGRAPHY

Rough mountains of medium to high relief; natural slopes are steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joint and cleavage planes provide a secondary porosity of very low magnitude.

GROUND WATER

Seventy-five percent of wells studied yielded 20 gpm or more; for maximum yields, well sites must be carefully chosen. Valleys, fault zones, and other fracture zones are most favorable sites.

EASE OF EXCAVATION

Requires blasting; slow drilling rates with rotary equipment, in part, due to many quartz veins that exceed 12 inches in width; large boulders may be a special problem; locally highly fractured and highly weathered and moderately easy to excavate with light power equipment.

CUT-SLOPE STABILITY

Good stability in very steep cuts; locally where highly fractured, cut-slope stability is only fair and moderate cuts necessary.

FOUNDATION STABILITY

Good to excellent quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Good source for road ma[illegible] building stone, and embankment facing; in some localities, refractory brick and where intensely fractured and weathered, sand is available.

COCKEYSVILLE MARBLE (cv)

DESCRIPTION

Typically a medium to coarse-grained, white to light blue-gray colored marble, often banded with flakes of golden brown phlogopite.

BEDDING

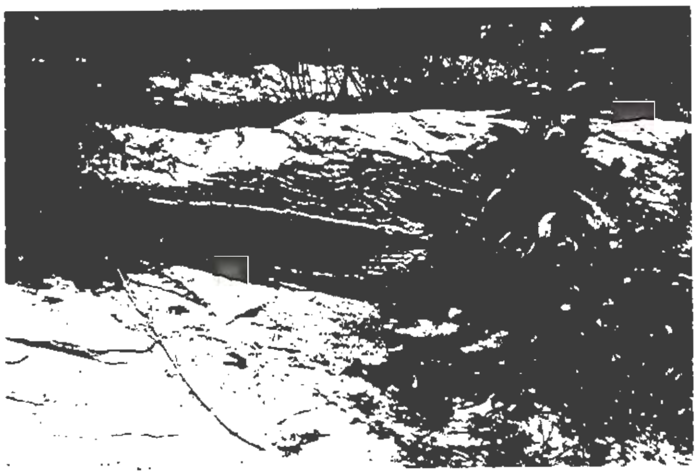
Well bedded in thick beds.

FRACTURING

Joints have a blocky pattern; well developed; moderately abundant; regular; moderately spaced; open and usually vertical.

WEATHERING

Moderately resistant; slightly weathered surface; shallow in depth; smooth, sandy-textured, large blocks result from long, continued weathering; overlying mantle is variable in thickness.



TOPOGRAPHY

Low, rolling valleys; natural slopes are gentle and stable.

DRAINAGE

Good surface and subsurface drainage.

POROSITY

Joints and solution channels produce a secondary porosity of medium to high magnitude.

GROUND WATER

Yields of up to 1000 gallons per minute or more are obtainable.

EASE OF EXCAVATION

Blasting required; bedrock pinnacles may be encountered; moderate drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Good cut-slope stability; able to stand in near-vertical cuts.

FOUNDATION STABILITY

Good quality foundation for heavy structures; thorough sinkhole and bedrock pinnacle investigations should be made.

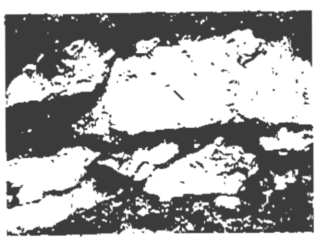
CONSTRUCTION MATERIALS

Good source for road material, riprap, building stone, embankment facing and fill.

CONESTOGA FORMATION (Ocs)

DESCRIPTION

Medium-gray, impure limestone with shale partings; conglomeratic at base; in Chester Valley includes micaceous limestone, phyllite and alternating dolomite and limestone.



BEDDING

Crudely bedded to poorly bedded; thin.

FRACTURING

Joints have an irregular pattern; poorly formed; moderately abundant; widely spaced and have an uneven regularity; many open but some filled with quartz and calcite.

WEATHERING

Moderately resistant; slightly weathered to a shallow depth; variably weathered (impure layers weather to a higher relief); large, irregularly shaped fragments result; mantle thickness is highly variable and may be extremely thick; interface between bedrock and mantle is usually pinnacle.

TOPOGRAPHY

Rolling valleys and hills of low relief; natural slopes are gentle and stable.

DRAINAGE

Good surface drainage with minor subsurface drainage; few sinkholes.

POROSITY

Joint and some solution channel openings provide a secondary porosity of low magnitude.

GROUND WATER

Fair for public supplies and industrial use; very good for small public supply; excellent for domestic use.

EASE OF EXCAVATION

Requires blasting; bedrock pinnacles and numerous quartz veins are special problems; slow drilling rates with rotary equipment; quartz veins slow drilling rate.

CUT-SLOPE STABILITY

Stable in very steep cuts.

FOUNDATION STABILITY

Good quality foundation for heavy structures; thorough investigation for possible sink areas should be undertaken.

CONSTRUCTION MATERIALS

Good for road material, riprap, building stones, and fill.

ROCK TEST DATA

Specific Gravity = 2.70-2.71
Absorption = 0.12 to 0.40%
Compressive Strength = 182 to 600 tons per sq. ft. (decomposed micaceous limestone, broken limestone, and solid micaceous limestone)

REMARKS

Compressive strength tests from Conwell & Co.; other test data from PDT.

DIABASE (Trd)

DESCRIPTION

Diabase occurs in Pennsylvania primarily as dikes and sheets; the dikes being generally 5 to 100 feet thick and the sheets much thicker; rock is usually black, dense, very fine-grained, and consists of 90 to 95 percent labradorite and augite.

BEDDING

None.

FRACTURING

Joints have a blocky pattern; well developed; moderately abundant; regularly spaced with a moderate distance between fractures; open and steeply dipping.

WEATHERING

Highly resistant; slightly weathered to a shallow depth; weathering produces large, rounded boulders mixed with a thin mantle.

TOPOGRAPHY

Undulating hills of medium relief; natural slopes are moderately steep and stable.

DRAINAGE

Fair surface drainage.

POROSITY

Joint openings provide a very low, secondary porosity.

GROUND WATER

Small yields (10 gpm or less) are common from wells drilled to 150 feet in depth; fractured zones, sometimes represented by stream valleys or gulleys, are best well sites.

EASE OF EXCAVATION

Requires considerable blasting; large boulders are a special problem; very slow drilling rate with rotary equipment.

CUT-SLOPE STABILITY

Steep cut-slopes possible; good, cut-slope stability adversely influenced by local, intense fracturing and depth of cut.

FOUNDATION STABILITY

Good to excellent foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

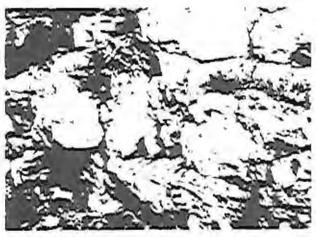
Excellent source for road material, riprap, embankment facing, fill, and building stone.

ELBROOK FORMATION (Ꞓe)

DESCRIPTION

Light-gray to yellowish-gray, finely laminated, siliceous limestone with interbeds of dolomite.

FRACTURING



Joint pattern is irregular and moderately developed; joints moderately abundant, irregularly spaced with wide to moderate distance between fractures; most open but some filled with quartz and calcite; steeply dipping.

BEDDING

Well bedded; usually thick but does occur flaggy and massive.

DRAINAGE

Good subsurface drainage; little surface drainage.

WEATHERING

Moderately resistant; moderate weathering to a shallow depth; small, flat fragments ranging to large boulders result; the overlying mantle is thin to moderately deep; bedrock-mantle interface is characterized by pinnacles.

TOPOGRAPHY

Rolling valley of low relief; natural slopes are gentle and stable.

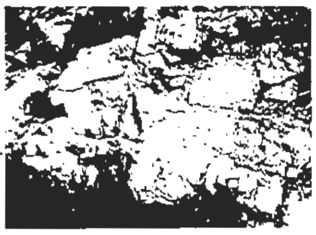
GROUND WATER

Moderately permeable aquifer; median specific capacity of wells is 4.9 gallons per minute per foot of drawdown.

EASE OF EXCAVATION

Requires blasting; bedrock pinnacles a special problem; moderate drilling rates with rotary equipment; locally, sandstone beds slow drilling rate.

CUT-SLOPE STABILITY



Good cut-slope stability; stable in near-vertical cuts.

POROSITY

Solution channels provide a secondary porosity of medium magnitude.

FOUNDATION STABILITY

Good quality foundation for medium structures; thorough investigation for sinkholes and bedrock surface should be undertaken.

CONSTRUCTION MATERIALS

Good for road material, riprap and fill.

ROCK TEST DATA

Specific Gravity = 2.61 to 2.76
Absorption = 0.26 to 0.80%

REMARKS

Test data from PDT.

GABBRO (g)

DESCRIPTION

Dark color; medium to coarse-grained; fresh rock consists of calcic plagioclase, hypersthene or augite, and up to 30% quartz.

BEDDING

Banding is poorly developed; bands are massive in thickness.

FRACTURING

Joints have an irregular pattern; moderately to poorly formed; moderate in abundance, widely to moderately spaced; irregular, steeply dipping to vertical and open.

WEATHERING

Highly resistant to weathering; most exposures show slight weathering, shallow depth; loose material consists of large, rectangular blocks; overlying mantle is thin.

TOPOGRAPHY

Hills of medium relief and undulating surface; natural slopes are fairly steep to steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Extremely low primary porosity; joints provide a very low secondary porosity.

GROUND WATER

Median yield is about 15 gpm; median depth is 84 to 94 feet; yields of 35 gpm or more should be obtainable from wells properly situated and developed; wells should be in draws; should be at least 100 feet deep, but probably not over 200 feet for maximum yield.

EASE OF EXCAVATION

Blasting required; slow drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Fairly steep cuts are possible. Good cut-slope stability has been observed.

FOUNDATION STABILITY

Fair quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Excellent for road material, riprap, building stone, embankment facing, and fill.

GABBROIC GNEISS (g)

DESCRIPTION

Dark color, medium to coarse-grained; fresh rock consists of calcic plagioclase, hypersthene or augite, and up to 30% quartz.

BEDDING

Banding is well developed; bands are massive in thickness.

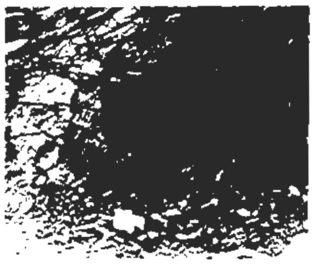
WEATHERING

Highly resistant to weathering; most exposures show slight weathering; shallow depth; loose material consists of large, rectangular blocks; overlying mantle is thin.

TOPOGRAPHY

Hills of medium relief and undulating surface; natural slopes are fairly steep to steep and stable.

FRACTURING



Joints have an irregular pattern; moderately to poorly formed; moderate in abundance; widely to moderately spaced; irregular, steeply dipping to vertical and open.

DRAINAGE

Good surface drainage.

POROSITY

Extremely low primary porosity; joints provide a very low secondary porosity.

GROUND WATER

Median yield is about 15 gpm; median depth is 84 to 94 feet; yields of 35 gpm or more should be obtainable from wells properly situated and developed; wells should be in draws; should be at least 100 feet deep, but probably not over 200 feet for maximum yield.

GRANITE GNEISS (gn)

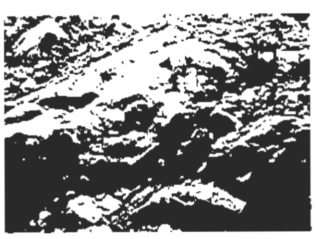
DESCRIPTION

Light buff to light pink color; fine to medium grained texture; most mineral grains about one millimeter in diameter; essential minerals are quartz, microline, hornblende (5 to 10%), and occasional biotite; rocks are extremely resistant to abrasion and rupture.

BEDDING

Banding is poorly developed; bands are massive in thickness.

FRACTURING



Joints have an irregular pattern; moderately to poorly formed; moderate in abundance; widely to moderately spaced; irregular, steeply dipping to vertical and open.

WEATHERING

Highly resistant to weathering; most exposures show slight weathering, shallow depth; loose material consists of large, rectangular blocks; overlying mantle is thin.

TOPOGRAPHY

Rough hills of medium to high relief; natural slopes are fairly steep to steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Extremely low primary porosity; joints provide a very low secondary porosity.

GROUND WATER

Median yield is about 17 gpm; median depth is 84 to 94 feet; yields of 35 gpm or more should be obtainable from wells properly situated and developed; wells should be in draws; should be at least 100 feet deep, but probably not over 200 feet for maximum yield.

EASE OF EXCAVATION

Blasting required; slow drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Fairly steep cuts are possible. Good cut-slope stability.

FOUNDATION STABILITY

Fair quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Excellent for road material, riprap, building stone, embankment facing, and fill.

ROCK TEST DATA

Unconfined Compressive Strength = 6,340 to 7,250 psi (dry, unweathered gneiss)

REMARKS

Test data from VU.

GRANODIORITE (gd)

DESCRIPTION

A light-colored, igneous rock rich in quartz with orthoclase, plagioclase, various accessory minerals, biotite and hornblende.

FRACTURING

Joints; blocky pattern; moderately developed; moderately abundant; irregular; widely spaced; open and moderately dipping.

WEATHERING

Highly resistant; slight weathering to shallow depth; results in smooth, rounded, large boulders. The overlying mantle is thin.

TOPOGRAPHY

Hills; medium relief; natural slopes are fairly steep and stable.

BEDDING

None.

GROUND WATER

Detailed ground water studies not complete; the median yield expected might be 10 gallons per minute; yield of 25 gallons per minute or more might be obtained from wells properly situated and developed; wells should be located in valleys and should be drilled 200 feet deep for maximum yield.

EASE OF EXCAVATION

Blasting required; large surface and near surface boulders hamper excavation; slow drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Good cut-slope stability; able to stand in fairly steep cuts.

DRAINAGE

Good surface drainage.

POROSITY

Joint fractures produce a secondary porosity of low magnitude.

FOUNDATION STABILITY

Good quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Good source of road material, riprap, building stone, embankment facing, and fill.

HARPERS FORMATION (Ꞓh)

DESCRIPTION

Dark greenish-gray phyllite and schist with quartzite layers.

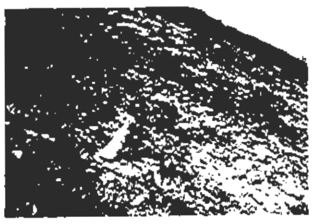
BEDDING

Moderately well bedded; fissile.

FRACTURING

Joint and cleavage planes display a seamy pattern; moderately developed; highly abundant; irregularly distributed and very closely spaced; open and steeply dipping to moderately dipping.

WEATHERING



Moderately resistant; highly and deeply weathered; complete break-up of rock occurs frequently with medium- to small-sized fragments resulting; the overlying mantle is thin.

TOPOGRAPHY

Undulating hills of low relief; natural slopes are moderately steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joints and cleavage planes provide a secondary porosity of very low magnitude.

GROUND WATER

Median reported yield is 14 gpm; specific aquifer potential unknown.

EASE OF EXCAVATION

Moderately easy with heavy power equipment; unweathered rock requires blasting; quartz boulders a special problem; moderate drilling rates with rotary equipment; some quartz veins slow drilling rate.

CUT-SLOPE STABILITY

Poor to fair cut-slope stability; rapid disintegration when exposed to moisture for a relatively short time; gentle to moderate slope cuts are necessary.

FOUNDATION STABILITY

Good quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Good for road material and fill.

ROCK TEST DATA

Permeability = 0 to 6 ft/day

REMARKS

Test data from SCS.

KINZERS FORMATION (Ꞓk)

DESCRIPTION

Dark-brown shale is considered here.

FRACTURING

Joint and cleavage planes display a seamy pattern; moderately developed; highly abundant; irregularly distributed and very closely spaced; open and steeply dipping to moderately dipping.

BEDDING

Moderately well bedded; fissile.

WEATHERING

Moderately resistant; highly and deeply weathered; complete break-up of rock occurs frequently with medium to small sized fragments resulting; the overlying mantle is thin.

TOPOGRAPHY

Undulating hills of low relief; natural slopes are moderately steep and stable.

CUT-SLOPE STABILITY

Poor to fair cut-slope stability; rapid disintegration when exposed to moisture for a relatively short time; gentle to moderate slope cuts are necessary.

FOUNDATION STABILITY

Good quality foundation for heavy structures; should be excavated to sound material.

DRAINAGE

Good surface drainage.

POROSITY

Joint and cleavage planes provide a secondary porosity of very low magnitude.

GROUND WATER

Median reported yield is 14 gpm; specific aquifer potential unknown.

EASE OF EXCAVATION

Moderately easy with heavy power equipment; unweathered rock requires blasting; quartz boulders a special problem; moderate drilling rates with rotary equipment; quartz veins slow drilling rate.

CONSTRUCTION MATERIALS

Good for road material and fill.

ROCK TEST DATA

Specific Gravity = 2.66 to 2.81
Absorption = 0.26 to 0.64%

REMARKS

Test data from PDT.

LEDGER FORMATION (€l)

DESCRIPTION

Light-gray, massive, pure, coarsely crystalline dolomite; siliceous in part.

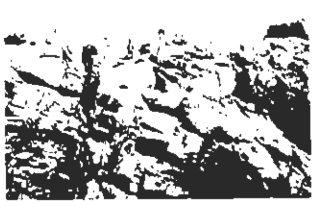
BEDDING

Moderately well bedded; massive.

FRACTURING

Joints have a blocky pattern; moderately to well developed; moderately abundant; irregularly spaced with a wide distance between fractures; open and steeply dipping.

WEATHERING



Moderately resistant; slight to moderate weathering to a shallow depth; break-up of rock results in large blocks; overlying mantle is thin; pinnacles characterize the interface between mantle and bedrock.

TOPOGRAPHY

Undulating valley of low to medium relief; natural slopes are gentle to moderately steep and stable.

DRAINAGE

Good surface drainage; little subsurface drainage.

POROSITY

Joints and solution channels provide a secondary porosity of low magnitude.

GROUND WATER

Only fair water source for public supply and general industrial use; good source for small public supply and limited industrial use; excellent source for domestic supplies.

EASE OF EXCAVATION

Requires blasting; bedrock pinnacles a special problem; moderate drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Good cut-slope stability; stable in fairly steep cuts.

FOUNDATION STABILITY

Good quality foundation for medium-weight structures; sinkholes and bedrock pinnacles should be thoroughly investigated.

CONSTRUCTION MATERIALS

Good for road material, riprap, concrete aggregate, building stone, embankment facing and fill.

ROCK TEST DATA

Specific gravity = 2.72 to 2.82
Absorption = 0.22 to 0.70%

REMARKS

Test data from PDT.

LOCKATONG FORMATION (Trl)

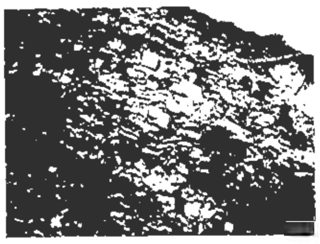
DESCRIPTION

Dark gray to black argillite with occasional zones of black shale; locally, thin layers of impure calcareous shale are found.

BEDDING

Moderately well developed; flaggy to thick.

FRACTURING



Joints have a blocky pattern; moderately developed; closely spaced; steeply dipping, and open.

WEATHERING

Moderately resistant; moderately weathered to a shallow depth; small, elongate and triangular fragments result from rapid hydration of minerals in exposed rock; overlying mantle is moderately thick.

TOPOGRAPHY

Rolling hills of medium relief; natural slopes are moderately steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joint openings provide a secondary porosity; both weathered and unweathered rocks have a low effective porosity.

GROUND WATER

Median yield about 10 gpm; yields greater than for domestic purposes not generally available.

EASE OF EXCAVATION

Upper few feet may be excavated moderately easily but the unweathered bedrock requires blasting; slow to moderate drilling rate expected with rotary equipment.

CUT-SLOPE STABILITY

Fair cut-slope stability; moderate slope cuts advisable.

FOUNDATION STABILITY

Good quality foundation for heavy structures; should be excavated to sound material; may need grouting for extremely heavy loads.

CONSTRUCTION MATERIALS

Possible source of fill.

PETERS CREEK SCHIST (Xpc)

DESCRIPTION

A chlorite-sericite schist with quartzite.

BEDDING

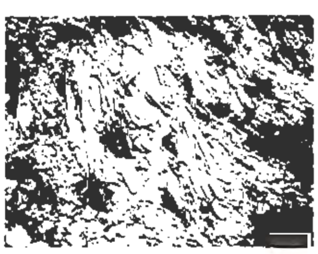
Fissile to thin; usually steeply dipping.

FRACTURING

Cleavage has a platy pattern; well developed; highly abundant; displays an even regularity; very closely spaced; open and steeply dipping. Joints are present; usually irregular, poorly formed, widely spaced, steeply dipping and open.

WEATHERING

Moderately resistant; often highly weathered to a moderate depth, resulting in uneven, hackly, small plate-like rubble at the base of exposures; overlying mantle is thin.



TOPOGRAPHY

Undulating hills of medium relief; natural slopes are moderately steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joints and cleavage provide a low secondary porosity.

GROUND WATER

An average yield of 75 gpm or more should be realized from wells drilled in the chlorite phase on slopes or in draws to about 150 feet deep; in the muscovite phase, wells should be about 300 feet deep for maximum production.

EASE OF EXCAVATION

Moderately easy with heavy power equipment; unweathered rock will require blasting; moderate drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Fair cut-slope stability; in part due to partial disintegration when exposed to moisture for a relatively short time; moderate slope cuts are often necessary; where fairly steep cuts are made, maintenance is required; drainage maintenance may be required.

FOUNDATION STABILITY

Good quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

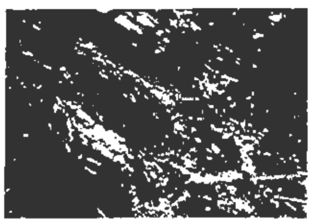
Good source for fill; may be a source of expandable aggregate.

PICKERING GNEISS (gg)

DESCRIPTION

A graphitic gneiss; light to medium-gray in color; includes the minerals quartz, orthoclase, hornblende, biotite, and graphite; graphite occurs as flakes one to two millimeters in diameter, somewhat larger than the usual grain size of the rock, and is disseminated throughout the gneiss; graphite shows a glistening luster which is sometimes a helpful aid in identification of this rock.

BEDDING



Banding is distinct and very common; bands are flaggy in thickness.

FRACTURING

Joints most common fracture, platy pattern, well developed, moderate to highly abundant, regular, moderate to closely spaced, open and steeply dipping to vertical.

WEATHERING

Moderately resistant; deeply weathered; sometimes results in disintegration into very small rectangular fragments; overlying mantle is thin.

TOPOGRAPHY

Hills; low to medium relief; natural slopes gentle to moderate and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joints produce a secondary porosity; weathered portion has a medium porosity.

GROUND WATER

Detailed ground water studies not complete; median yield expected might be 10 gallons per minute; yields of 35 gpm or more might be obtained from wells properly situated and developed; wells should be in valleys and should be 200 feet deep for maximum yield.

EASE OF EXCAVATION

Weathered portion may be excavated moderately easy with heavy power equipment; moderate drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Due to almost complete disintegration when exposed to moisture for a relatively short time, moderate slope-cuts are necessary. Only fair cut-slope stability has been observed.

FOUNDATION STABILITY

Good quality foundation, for medium to heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Fair to good source for fill.

SERPENTINE (s)

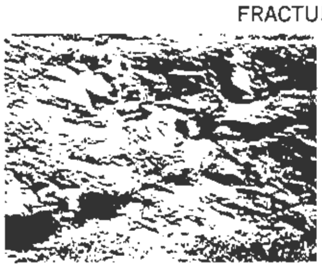
DESCRIPTION

Magnesium-rich rock derived from pyroxenite and peridotite; usually green in color and can be fiberous.

BEDDING

None.

FRACTURING



Joints have a platy to irregular pattern; are moderately developed; highly abundant; closely spaced and irregular; open joints characteristic but some filled with quartz; usually steeply dipping.

WEATHERING

Highly resistant; shows moderate weathering, usually shallow in depth, resulting in irregular, hackly, broken masses of medium-sized fragments; thin overlying mantle.

TOPOGRAPHY

Undulating hills of low relief with gentle, stable slopes.

DRAINAGE

Good surface drainage.

POROSITY

Secondary porosity of very low magnitude.

GROUND WATER

Capable of yielding small to moderate supplies; wells should be drilled 200 feet deep for maximum yield and located in valleys.

EASE OF EXCAVATION

Requires blasting; slow drilling rates with rotary equipment; numerous quartz veins contribute to slow drillability.

CUT-SLOPE STABILITY

Due to fracturing, moderate slope cuts may be necessary; fair to good cut-slope stability.

FOUNDATION STABILITY

Excellent quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Good source of road material, riprap, and fill.

ROCK TEST DATA

Permeability = 1 to 615 ft./day weathered rock;
0 to 0.5 ft./day solid rock

REMARKS

Test data on serpentine from SCS; field determination.

SETTERS QUARTZITE (Xsq)

DESCRIPTION

Light-gray in color; weathered outer portion of rock is light brown to dark brown; coarse-grained; micaceous layers.

BEDDING

Well bedded; flaggy.

FRACTURING

Joints have seamy to platy pattern; well formed; moderately abundant; widely spaced; steeply dipping and open.

WEATHERING

Highly resistant; slightly weathered to a shallow depth; medium-sized flat fragments result from weathering; long, continued weathering may result in complete disintegration to sand size particles; overlying mantle is very thin.

TOPOGRAPHY

Rolling hills of medium relief; natural slopes are moderate and stable.

DRAINAGE

Good surface drainage.

GROUND WATER

Small supplies for domestic purposes; probably should not be drilled deeper than 200 feet for maximum yield.

EASE OF EXCAVATION

Requires blasting except where highly weathered; several feet below the surface may be moderately easy to excavate with power equipment; slow drilling rates with rotary equipment.

POROSITY

Secondary porosity of low magnitude.

CUT-SLOPE STABILITY

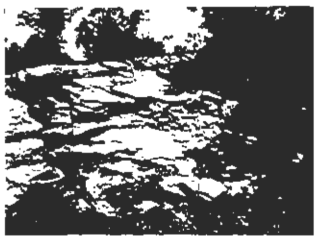
Good cut-slope stability; able to stand in steep cuts; where steeply dipping, rock should not be undercut.

FOUNDATION STABILITY

Excellent quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Good for road material, riprap, embankment facing, fill, and building stone.



STOCKTON FORMATION (Trs)

DESCRIPTION

Light colored sandstone, arkosic sandstone, and conglomeratic sandstone; includes red to purplish-red sandstone, shale, and mudstone; beds of conglomerate are most numerous near the base of the formation; in places, coarse conglomerates, consisting chiefly of quartz cobbles and boulders in a poorly-sorted sand matrix, occur at the base.

BEDDING

Well bedded; thin to flaggy.

FRACTURING

Joints have seamy to platy pattern; moderately developed; highly fractured; very close spacing; vertical and open.

WEATHERING

Only slightly resistant; exposures quickly weather to moderate depth; very small, pencil-like, platy fragments result from rapid disintegration; overlying mantle is thin.

TOPOGRAPHY

Undulating hills of low relief; natural slopes are moderately steep and stable.

GROUND WATER

Yields up to 300 gallons per minute obtained from wells drilled 500 feet deep; valleys drained by perennially flowing streams most favorable sites to drill; ground water is of calcium bicarbonate type; generally good chemical quality.

EASE OF EXCAVATION

May be excavated moderately easy with heavy power equipment; relatively fast drilling rate expected with rotary equipment.

CUT-SLOPE STABILITY

Poor to fair cut-slope stability; due to rapid disintegration when exposed to moisture for relatively short time, gentle slope cuts necessary.

DRAINAGE

Good surface drainage.

POROSITY

Primary porosity occurs in weathered portion; joint and bedding planes provide secondary porosity in unweathered rock; high to medium total effective porosity.

FOUNDATION STABILITY

Good quality foundation for heavy structures; should be excavated to sound material; possibly underdrainage required.

CONSTRUCTION MATERIALS

Only fair for fill; possibly source of brick, floor tile, and sintered aggregate material.

ROCK TEST DATA

Compressive Strength = 108 to 1116 tons per sq. ft.

REMARKS

Test data from USBM.

VINTAGE FORMATION (€v)

DESCRIPTION

Dark gray, knotty, argillaceous dolomite with impure, light-gray marble at the base of the formation.

FRACTURING

Joints have a block pattern; moderately to well developed; moderately abundant; irregularly spaced with a wide distance between fractures; open and steeply dipping.

WEATHERING

Moderately resistant; slight to moderate weathering to a shallow depth; break-up of rock results in large blocks; overlying mantle is thin; pinnacles characterize the interface between mantle and bedrock.

TOPOGRAPHY

Undulating valley of low to medium relief; natural slopes are gentle to moderately steep and stable.

BEDDING

Moderately well bedded; massive.

DRAINAGE

Good surface drainage; little subsurface drainage.

POROSITY

Joints and solution channels provide a secondary porosity of low magnitude.

GROUND WATER

Only fair water source for public supply and general industrial use; good source for small public supply and limited industrial use; excellent source for domestic supplies.

EASE OF EXCAVATION

Requires blasting; bedrock pinnacles a special problem; moderate drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Good cut-slope stability; stable in fairly steep cuts.

FOUNDATION STABILITY

Good quality foundation for medium-weight structures; sinkholes and bedrock pinnacles should be thoroughly investigated.

CONSTRUCTION MATERIALS

Good for road materials; riprap; concrete aggregate; building stone; embankment facing; and fill.

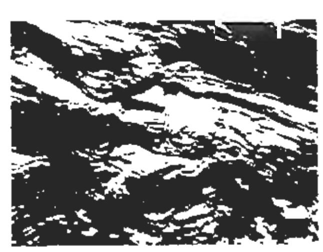
WISSAHICKON FORMATION (Xw)

[The Wissahickon Formation includes the Albite-chlorite schist (Xwc), Marburg schist (Xwn), and Oligoclase-mica schist (Xw).]

DESCRIPTION

Albite-chlorite schist is typically a phyllite; composed chiefly of quartz, feldspar, muscovite, and chlorite; oligoclase-mica schist more coarsely crystalline and excessively micaceous; feldspar more abundant in the oligoclase-mica schist; Marburg schist is gray-green in color and is a mica-chlorite-quartzite schist.

FRACTURING



Cleavage has a platy pattern; well developed; highly abundant; displays an even regularity; very closely spaced; open and steeply dipping. Joints are present; usually irregular, poorly formed, widely spaced, steeply dipping and open.

BEDDING

Fissile to thin; usually steeply dipping.

WEATHERING

Moderately resistant; often highly weathered to a moderate depth; resulting in uneven, hackly, small plate-like rubble at the base of exposure; overlying mantle is thin.

TOPOGRAPHY

Undulating hills of medium relief; natural slopes are moderately steep and stable.

DRAINAGE

Good surface drainage.

POROSITY

Joints and cleavage provide a low secondary porosity.

GROUND WATER

An average yield of 75 gpm or more should be realized from wells drilled in the chlorite phase on slopes or in draws to about 150 feet deep; in the muscovite phase, wells should be about 300 feet deep for maximum production.

EASE OF EXCAVATION

Moderately easy with heavy power equipment; unweathered rock will require blasting; moderate drilling rates with rotary equipment.

CUT-SLOPE STABILITY

Fair cut-slope stability; in part due to partial disintegration when exposed to moisture for a relatively short time; moderate slope cuts are often necessary; where fairly steep cuts are made, maintenance is required; drainage maintenance may be required.

FOUNDATION STABILITY

Good quality foundation for heavy structures; should be excavated to sound material.

CONSTRUCTION MATERIALS

Good source for fill; may be a source of expandable aggregate.

ROCK TEST DATA

Permeability = 0.2 to 3.0 ft/day

Unconfined Compressive Strength (2″ diameter × 2″ height samples) = 334 to 830 psi (dry) (highly decomposed and weathered mica schist)
= 30 to 40 psi (wet) (highly decomposed and weathered mica schist)
= 1,255 to 3,830 psi (dry) (unweathered mica schist)

Failure Load = 59 to 919 tons per sq. ft. (Hard mica schist)
= 15-16 tons per sq. ft. (Soft mica schist)

REMARKS

Permeability data from SCS; compressive strength data from VU; load test data from Conwell & Co.

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APPENDIX

EXPLANATION OF SEMI-QUANTITATIVE TERMS AND MISC. CHARTS

Topography

Steepness of Natural Slopes

gentle	= 1° - 5°
moderate	= 5° - 15°
fairly steep	= 15° - 45°
steep	= 45° - 80°
very steep	= 80° - 89°
vertical	= 90°

Bedding

Thickness

laminated/fissil	= less than .08"
thin/flaggy	= ½" to 2"
medium	= 2" to 2'
thick	= 2' to 4'
massive	= more than 4'

Attitude

horizontal	= 0°
very gently	= 1° - 5°
gently	= 5° - 20°
moderately	= 20° - 45°
steeply	= 45° - 85°
very steeply	= 85° - 90°

Fracturing

Joint Spacing (after Deere, 1963)

very widely spaced	= more than 10'
widely spaced	= 3' to 10'
moderately spaced	= 2' to 3'
closely spaced	= 2" to 1'
very closely spaced	= less than 2"

Inclination

same as bedding attitude

Weathering (Rock)

Depth

deep	= greater than 4'
moderate	= 1' to 4'
shallow	= less than 1'

Mantle Thickness

thick	= greater than 30'
moderate	= 5' to 30'
thin	= 0 to 5'

Cut-Slope Stability

Max. Stable Cut-Slope Observed

gentle	= 0 - 5°
moderate	= 5° - 15°
fairly steep	= 15° - 45°
steep	= 45° - 80°
near vertical	= 80° - 89°
vertical	= 90°

Engineering Classification of Intact Rock
(after Deere and Others, 1967)

	Uniaxial Compressive Strength, psi.
very high strength	= over 32,000
high strength	= 16,000 - 32,000
medium strength	= 8,000 - 16,000
low strength	= 4,000 - 8,000
very low strength	= less than 4,000

	Uniaxial Compressive Strength, psi.
high modulus ratio	= over 500
average (medium) ratio	= 200 - 500
low modulus ratio	= less than 200

Relationship of Modified Core Recovery to Overall Rock Quality

(Modified core recovery is determined by counting only those pieces of core which are 4 inches (10cm) in length or longer and which are hard and sound.)
(After Deere and Others, 1967)

Modified Core Recovery		*Description of Rock Quality*
0 - 25%	—	very poor
25 - 50%	—	poor
50 - 75%	—	fair
75 - 90%	—	good
90 - 100%	—	excellent

Bearing Capacity

	(tons/ft²)
very poor	= less than 1
poor	= 1 - 4
fair	= 4 - 8
good	= 8 - 32
excellent	= greater than 32

GLOSSARY

Albite—a feldspar mineral consisting primarily of sodium-aluminum silicate; common in igenous, metamorphic and some sedimentary rocks.

Aquifer—a rock unit or group of units that is capable of supplying water to wells in usable quantities.

Argillite—a rock derived from siltstone, claystone or shale with a higher degree of induration than is present in those rocks.

Augite—a common igneous rock-forming mineral of the pyroxene group; dark colored and contains considerable calcium-aluminum iron and silicate; a common mineral in diabase.

Bedding—in geology, the physical separation within sedimentary rocks along planes of stratification dividing rocks of similar or different lithologies.

Biotite—a mica mineral; a hydrated silicate containing aluminum and iron; usually dark colored (brown to black or green) and occurs in flakes.

Breccia—a rock made up of highly angular, coarse fragments; may be indicative of the presence of a fault.

Calcarenite—a limestone or dolomite rock of coral or shell sand.

Chlorite—a mineral which is tabular or in scales like mica; usually green to black, transparent to opaque; common in metamorphic schists; usually not visible in sedimentary rocks.

Claystone—rocks which are largely composed of clay and sometimes bound together by iron carbonate; non-laminated.

Cleavage—in rock, the tendency to split along definite, parallel, closely-spaced planes.

Conglomerate—a cemented clastic rock containing rounded fragments corresponding in their grade sizes to gravel or pebbles.

Dip—the angle at which a rock unit is inclined to the horizontal.

Dolomite—a rock composed chiefly of magnesium carbonate.

Effective Porosity—a qualitative evaluation of the usable pore spaces in a rock for the transmission of ground water.

Epidosite—a pistachio green and white, altered igneous rock usually consisting of the minerals epidote and quartz.

Fault—a physical break within the rocks along which there has been movement of the two sides relative to one another.

Feldspar—a general name for a common group of rock-forming minerals of alkali-aluminum silicate composition.

Ferromagnesian—containing iron and magnesium; usually refers to the silicate minerals in rock.

Fracture—break in rock caused by stresses.

Gneiss—a banded metamorphic rock.

GPM—gallons per minute.

Ground water—water below the water table.

Hornblende—a mineral belonging to the amphibole group; usually black to dark green and commonly prismatic; a metasilicate of calcium, magnesium with iron; most common in igneous rocks and certain gneisses.

Hypersthene—a mineral belonging to the pyroxene group; usually brownish-green, grayish-black to brown, prismatic or tabular; uncommon.

Interstitial—existing in or forming an opening.

Intrusion—a body of igneous rock that invades older rock.

Joint—a fracture in rock along which no movement has occurred.

Labradorite—a mineral belonging to the feldspar group; anorthosite is a rock composed largely of labradorite.

Limestone—a rock composed chiefly of calcium carbonate.

Lithology—a compositional description of rocks.

Mantle—the layer of loose, incoherent rock material, of whatever origin, that nearly everywhere forms the surface of the land and rests on hard bedrock. It comprises rock waste of all sorts, volcanic ash, glacial drift, alluvium, wind-blown deposits, vegetal accumulations, and soils.

Matrix—in rock in which certain grains are much larger than others; the grains of smaller size comprise the matrix.

Micaceous—a term meaning "flaky"; consisting of thin plates like the mica minerals.

Microcline—a member of the feldspar mineral group containing potassium, aluminum and silica; usually white, but may be pink or green.

Muscovite—a member of the mica group of minerals; usually colorless and in flakes.

Oolitic—composed of oolities which are spherical to ellipsoidal bodies.

Oligoclase—a mineral member of the feldspar group that occurs principally in igneous rocks and some gneisses.

Orthoclase—a mineral belonging to the feldspar group with the same composition as that of microline.

Peridotite—an igneous rock consisting largely of olivine; frequently altered to serpentine (a softer mineral); dark colored.

Phenocryst—a porphyritic crystal; one of the relatively large and ordinarily conspicuous crystals of the earliest generation in a prophyritic igneous rock.

Phlogopite—a mineral belonging to the mica group; resembles muscovite in hand specimen; this mineral is most common in metamorphic rocks.

Phyllite—a metamorphic rock rich in mica with less distinct cleavage and often finer-grained than schist.

Plagioclase—a series of sodium, calcium, aluminum, silicate minerals in the feldspar group.

Plane—a flat or level material surface.

Porphyritic—a rock texture containing large mineral grains among the finer grains; applies to igneous rocks.

Pyroxenite—any rock principally composed of pyroxene minerals; dark green to black when fresh.

Rebound—the amount of vertical rebound of a surface that occurs when a load is removed from the surface.

Recharge (intake)—the processes by which water is absorbed into a rock formation either directly or indirectly by way of another formation.

Sandstone—rock composed mainly of aggregates of sand-sized quartz grains.

Schist—a metamorphic rock which has a foliated structure and splits up in thin, irregular plates.

Shale—a laminated sediment, in which the constituent particles are predominantly of the clay grade; fissility that is approximately parallel to bedding.

Specific Capacity—the yield of a well divided by the drawdown necessary to produce this yield; expressed as gallons per minute per foot of drawdown.

Stromatolites—laminated but otherwise structureless calcareous objects, commonly called fossil algae.

Underclay—a non-bedded clay occurring below a coal seam; also called plastic clay or soft clay.

SOURCES OF ROCK TEST DATA

Bureau of Mines (USBM), U. S. Department of Interior
E. L. Conwell & Co., Philadelphia, Pennsylvania
Corps of Engineers, U. S. Army, Pittsburgh District, Philadelphia District and Baltimore District. (USCE)
Pennsylvania Department of Transportation, Bureau of Testing, Materials, & Research and District 8-0 Soils Engineering Office (PDT)
John H. Robinson Engineering, Inc, Erie, Pennsylvania
Soil Conservation Service, U. S. Department of Agriculture, Harrisburg (SCS)
Villanova University, Department of Civil Engineering, Villanova, Pennsylvania (VU)

Summary of Physical Properties of Appalachian Shales (From F. M. Mellinger, 1969)

Material Classification	Unit Dry Weight lbs/ft³	Unconfined Compressive Strength psi	Tensile Strength (1) psi	*Shear Strength* Angle of Internal Friction°	*Shear Strength* Cohesion In psi	No. of Projects Represented
Clay Shale	134-165	30 - 1,000 1,000 - 2,950	250 - 1,480	6-33	95 - 1,500	12
Silty Shale	145-169	370 - 1,000 1,000 - 6,300	720 - 3,200	10-54	200 - 1,970	13
Sandy Shale	154-167	4,850 - 13,580	1,400 - 3,140	29-60	310 - 2,660	7
Indurated Clay	131-170	55 - 1,000 1,000 - 3,520	790 - 1,090	10-60	18 - 600	11
Clay Stone	148-164	420 - 1,000 1,000 - 6,000		24-60	0 - 600	4
Silt Stone	149-166	2,000 - 11,300	1,380 - 3,160	19-48	590 - 2,930	10

BULLETIN W 25

Hydrology of the Metamorphic and Igneous Rocks of Central Chester County, Pennsylvania

Prepared by the United States Geological Survey,
Water Resources Division, in cooperation with the
Pennsylvania Geological Survey

by Charles W. Poth
U. S. Geological Survey

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PREFACE

The information in this report on subsurface water resources of central Chester County will benefit all water consumers in that rapidly developing suburban area of southeastern Pennsylvania. With a population increase in the area of about 23 percent from 1950 to 1960 plus rapid growth of commercial and industrial establishments, the great demand for water has necessitated the development of subsurface water resources. Individual and community water wells, as well as industrial wells, are supplying many of the newer establishments with water.

The water-yielding capacities of the rocks in this area differ widely from place to place; yields of more than 300 gallons per minute were obtained from favorably located and properly constructed wells. The ground water occurs in fractures and minute openings in the various rock types. Based on data collected from about 600 wells, the best yields were obtained from wells in valleys, while the poorest yields came from wells on hills or uplands. The water is soft and generally of good quality, except for a minor number of improperly located wells which show evidence of contamination by cesspool or barnyard wastes.

The information in this report should assist planners and water authorities to coordinate water wells with available water resources. Water well drillers will benefit through guidance toward maximum water well yields; the data in this report will help them to know the most favorable locations to drill, probable depths, probable yields, and the anticipated quality of the water.

ABSTRACT

The area covered by this report is in southeastern Pennsylvania and includes not only central Chester County but a small amount of the adjoining Lancaster and Delaware Counties. The rocks underlying the area were mapped by Bascom and Stose (1932) and are chiefly the Baltimore Gneiss, the Glenarm Series (Setters Formation, Cockeysville Marble, Wissahickon Formation, and Peters Creek Schist), and gabbro. The Chester Valley, which trends northeastward across the northwest part of the area, contains the Chickies Quartzite, Harpers Schist, Antietam Quartzite, Vintage Dolomite, Kinzers Formation, Ledger Dolomite, and Elbrook Limestone of Cambrian age; and the Conestoga Formation of Ordovician age. Small bodies of serpentine and pegmatite are scattered throughout the area, except in the Chester Valley. Several diabase dikes of Triassic age trend generally north or northeastward across the area.

The ground water occurs in and moves through these rocks in fractures. The size, number, and degree of interconnection of the fractures intercepted by a well determine the well's sustained yield. Most of the formations were found to yield water to wells through several zones. The zones were generally less than 200 feet below the surface, but some in the Baltimore Gneiss were encountered at depths exceeding 300 feet.

About 10 percent of the wells on which yield data were obtained yielded more than 50 gpm (gallons per minute), and 5 percent of this group yielded more than 330 gpm. The median depth of the wells yielding over 50 gpm was 160 feet and about two-thirds of these wells were situated in draws and valleys.

Depth of weathering does not exert much control on well yields; however, the weathered zone is important as a storage reservoir where it is not highly clayey.

Topography is probably the greatest single factor affecting the yield and depth of wells. Wells in the lower topographic positions yielded more water and were shallower than those on slopes or upland areas.

Increasing metamorphic rank (from slate to gneiss) in some of the Glenarm formations was associated with a decrease in the yield of the wells. It was also associated with an increase in the depth of weathering of the rocks, as shown by the increase in the amount of casing needed in the wells.

The hydrologic properties of the formations were observed to range widely even within short distances. The range was sufficiently great that the formations could not be separated from one another on the basis of their hydrologic properties.

Most of the water was of the calcium-magnesium bicarbonate type. The dissolved-solids content was generally low, median 146 ppm (parts per million), the water was soft, hardness 3 gpg (grains per gallon); and slightly acidic, median pH 6.6.

A large number of the samples analyzed appeared to be contaminated, as indicated by the abundance of nitrate, sulfate, chloride, and sodium. The sources of contamination are believed to be local.

Large yields were obtained from wells in several of the formations. The maximum yields obtained were 270 gpm from the Baltimore Gneiss, 330 gpm from the Cockeysville Marble, 350 gpm from the Wissahickon Formation, 312 gpm from the Peters Creek Schist, 665 gpm from the Vintage Dolomite, 150 gpm from the Ledger Dolomite and Elbrook Limestone, 175 gpm from the Conestoga Limestone, 125 gpm from the gabbro, and 80 gpm from the serpentine.

INTRODUCTION

PURPOSE AND SCOPE

The investigation on which this report is based was undertaken to study the occurrence of ground water in an area of metamorphic and igneous rocks; accordingly, an area was selected that included a large number of these rock types. Some of the principal objectives were to determine the relation of factors such as well yield, well depth, depth of water-bearing zones, depth of weathering, and chemical quality of the water to rock type and topographic and geographic position of the well.

The study was made in an area undergoing rapid suburban development so as to provide information that will aid in the efficient utilization of the ground-water resources.

LOCATION OF THE AREA

The area is in southeastern Pennsylvania between 39° 52′ 30″ and 40° 00′ N. latitude and 75° 30′ and 76° 00′ W. longitude. The West Chester, Unionville, Coatesville, and Parkesburg 7½-minute topographic quadrangles provide topographic coverage for the area. Most of the area is in central Chester County, but the southeast corner of the West Chester quadrangle lies in Delaware County, and a narrow strip along the western border of the Parkesburg quadrangle is in Lancaster County. (Figure 1.)

METHODS OF STUDY

An inventory was made of approximately 620 domestic, industrial, and municipal wells, and 1-hour pumping tests were made on 94 of these wells. Electric logs were made of five wells and the depth and yield of water-bearing zones were determined by the brine-tracing method on the same wells. Periodic water-level measurements were made on three wells. Approximately 400 samples of ground water were tested in the field for pH, hardness, and specific conductance. More complete chemical analyses of 31 samples were made in the laboratory of the U. S. Geological Survey.

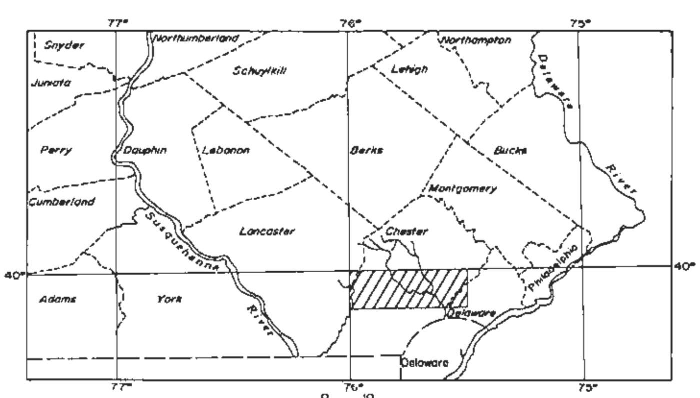

Figure 1. Map of southeastern Pennsylvania showing the location of the area of this investigation.

PREVIOUS INVESTIGATIONS

Southeastern Pennsylvania is one of the classic problem areas of North American geology and has been thought to hold the key to the solution of problems in both the northern and southern Appalachians. As such, it has been the focus of much study, and many reports have been written about the geology of the area. For the purpose of this report, however, it is sufficient to mention only a few.

The geology was mapped by Bascom and Stose (1932) and structural details of part of the area were further delineated by McKinstry (1961). Swartz (1948) offers an excellent summary of work done up to 1948.

The ground-water resources were discussed briefly by Hall (1934) in a report on the ground water in southeastern Pennsylvania. Olmsted and Hely (1962) described ground-water surface-water relationships in the Brandywine basin.

ACKNOWLEDGMENTS

The writer is grateful to the many well owners who allowed their wells to be test pumped or sampled, and to the following drillers who kindly provided information: Artesian Well Drilling Co., Brookover Well Drilling Co., Thomas G. Keyes, Charles Lauman, Clifford Myers, Lee Myers, I. N. Petersheim and Son, R. Walter Slaugh and Sons, and Hope Womble.

W. C. Roth assisted the writer on some of the pumping tests and conducted the geophysical investigations.

WELL-NUMBERING SYSTEM

The well-numbering system used in this report shows the location of wells according to a latitude-longitude grid system. Each number consists of three groups of digits. For example, in the number 959-532-3, which was assigned to a well at Goshenville in the West Chester quadrangle, the first group (959) is composed of the last digit of the degrees (39) and the two digits of the minutes (59) that define the latitude on the south side of a 1-minute quadrangle; the second group (532) consists of the last digit of the degrees (75) and the two digits of the minutes (32) that define the longitude on the east side of a 1-minute quadrangle. The last segment (3) indicates the consecutive number assigned to the well in this 1-minute grid. Plates 1 and 2 show the locations of selected wells in the project area.

GEOGRAPHY

Topography and Drainage

The area of the investigation is in the Piedmont Province and lies mostly in the Piedmont Upland Section, but it includes also the Chester Valley —a narrow, elongate extension of the Conestoga Valley Section—which trends northeastward across the Parkesburg and Coatesville quadrangles and intercepts the northwest corner of the Unionville quadrangle.

The upland is maturely dissected and slopes gently southeastward. The highest hill is in the northwest corner of the Parkesburg quadrangle; it reaches an altitude of 860 feet. The lowest altitude is in the southwest corner of the West Chester quadrangle, where the Brandywine Creek leaves the area at an altitude of about 160 feet.

About two-thirds of the area is drained by the Brandywine Creek, which flows into the Delaware River via Christiana River. The drainage divides of the Brandywine are located approximately by north-south lines through Parkesburg and West Chester. The area west of the Brandywine basin is drained into the Susquehanna River by Octoraro Creek and its tributaries. East of the Brandywine basin the area is drained by Chester and Ridley Creeks, which flow into the Delaware River.

Climate

The climate of southeastern Pennsylvania is characterized by hot, humid summers during which temperatures reach 90° F or above on an average of 25 days each year. Winters are comparatively mild, for temperatures rarely reach 0° F and fall below freezing on an average of less than 100 days each year. Approximately 30 inches of snow falls each year, and the land is snow-covered about one-third of each winter. The frost-free period averages about 180 days.

Climatic data are available from two stations of the U. S. Weather Bureau in the area. One set of data is recorded at the Philadelphia Electric Co., 1 mile southwest of Coatesville; the other is recorded at the Daily Local News, at West Chester. These data (based on a period of record from 1931-1955) show that the area has a mean annual temperature of about 53° F and a mean annual precipitation of about 46 inches. Monthly averages of temperature and precipitation for each station are shown in the following table.

Average monthly temperature and precipitation at U. S. Weather Bureau stations for the period 1931-1955[1]

Month	Temperature (°F) Coatesville	Temperature (°F) West Chester	Precipitation (inches) Coatesville	Precipitation (inches) West Chester
January	30.5	30.8	3.87	3.76
February	30.6	31.4	3.62	3.63
March	39.9	39.4	4.13	3.92
April	50.4	50.0	3.73	3.69
May	61.4	61.0	3.90	4.34
June	70.3	69.7	4.21	4.26
July	75.2	75.5	4.19	4.55
August	72.9	73.3	5.29	5.37
September	65.8	66.9	3.15	3.54
October	54.9	56.5	3.17	3.14
November	43.2	45.1	3.60	3.96
December	33.0	34.8	3.33	3.28

[1] Kaufman, N. M., 1960.

Population and Water Use

The population of the area has increased about 23 percent (to nearly 73,500) between 1950 and 1960; a rate of growth that is nearly three times that of the state as a whole (7.82 percent). Most of the increase has taken place around West Chester, in townships such as Pocopson, Thornbury, West Goshen, Westtown, and Willistown, where the population has more than doubled.

The growth rate of the boroughs has been much less than the townships. The City of Coatesville, for example, lost about 6 percent of its population between 1950 and 1960. The townships adjacent to each of the municipalities show an attendant increase in population that more than balances the latter's growth rate.

The changes in population are producing a change in the pattern of water use. The large municipalities such as West Chester and Coatesville have utilized surface-water supplies and are continuing to do so. However, the increasing demand for water in the townships is being satisfied by ground water. Individual wells are used at isolated houses and in some of the housing developments, but community wells are used for public supply in an increasing number of the new developments.

GEOHYDROLOGY

GEOLOGIC SETTING

The geology of southeastern Pennsylvania is extremely complex and has been the subject of much study. Swartz (1948) offers an excellent summary. More recently McKinstry (1961) has published the results of a detailed study of the structure of the controversial Glenarm Series, which underlies a large part of the area.

Geologic Structures

The rocks in the area covered by this report range in age from Precambrian to Ordovician, and are chiefly metamorphosed sediments, but they include also considerable amounts of igneous rocks. Because of their age and position in the Appalachian geosyncline, the rocks have been intensively folded and faulted. The prominent structures of the area are shown in Figure 2.

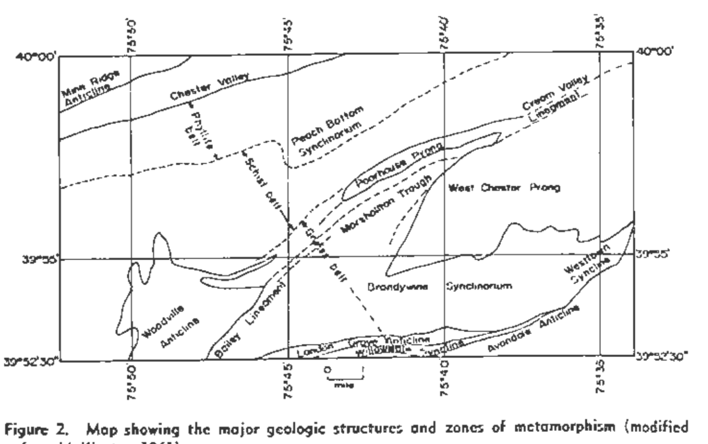

Figure 2. Map showing the major geologic structures and zones of metamorphism (modified from McKinstry, 1961).

The Chester Valley, a narrow, elongate feature on the northwest limb of a syncline in the Peach Bottom synclinorium, trends east-northeast across the western part of the area. The valley is underlain by Cambrian and Ordovician limestone and dolomite and is flanked along the northern side by Cambrian quartzite and schist. The hills north of the valley are on the southeast limb of the Mine Ridge anticline; they are underlain by Precambrian gneiss and gabbro containing small elongate intrusions of serpentine, and by fault-slices of Cambrian quartzite, schist, and carbonates. Dikes and sills of pegmatite strike predominantly east-northeastward across the gneiss, the gabbro, and the quartzite.

South and east of Chester Valley the area is underlain chiefly by gabbro-intruded gneiss and a group of metamorphosed sediments known as the Glenarm Series. Several prominent diabase dikes of Triassic age strike northeastward across the area.

The southwestward-plunging anticlinal West Chester Prong and the Brandywine synclinorium are the dominant structural features in the central part of the area. The northeast end of the Brandywine synclinorium extends along the northwest flank of the West Chester Prong, where it is termed the Marshallton Trough and is, in turn, flanked by the narrow anticlinal Poorhouse Prong. The synclinorium extends along the southeast side of the West Chester Prong also—where its eastern end is called the Westtown syncline.

The recumbent Woodville anticline, which has been overturned to the northwest, lies at the nose of the Brandywine synclinorium. The London Grove anticline, which appears to merge eastward into the northeast-trending Avondale anticline, lies along the south side of the synclinorium.

The synclines are in areas of phyllite or schist. In the anticlines, however, a gneissic core is exposed, and frequently this core has been intruded by gabbro. The flanks of the anticlines may expose schist or marble.

Geologic Formations

The formations, and their thickness and generalized character are summarized in Table 1. More details are given in the section on the stratigraphy and water-bearing properties of the rocks.

GROUND-WATER PRINCIPLES

Source

Ground water is precipitation which has percolated downward through the soil and openings in the rocks to a zone within which all interconnected openings are filled with water under pressure greater than atmospheric. The upper surface of this zone is called the water table. Ground water moves continuously from points of high hydraulic head to points of lower hydraulic head and eventually to points of discharge—perhaps into another formation, to a spring, a stream, or to a well.

Fluctuations of Ground-Water Levels

If water is added to the ground-water reservoir (aquifer) at a faster rate than it can be discharged, the water level will rise in the aquifer. The amount of recharge an aquifer receives depends upon the amount and distribution of precipitation. Most recharge occurs during the winter and spring months.

Despite the fact that approximately 13 percent more precipitation falls between April and September than between October and March, little recharge occurs during the summer and fall months, because higher temperatures plus the growth of plants result in the evapotranspiration or consumption of nearly all precipitation. By the middle of May, generally, water levels begin to decline and may continue to do so past the period of high temperatures and the growing season. Cool and unusually wet summers and falls may allow recharge to occur a few weeks earlier than usual and may hold water levels slightly above their normal annual lows, but generally little recharge occurs during this period and that which does occur produces only a small and temporary reversal of the downward trend of the water level.

The rate at which the water level falls and the size of the annual fluctuation depend chiefly on the permeability of the rocks, the height of the water above points of discharge, and the distance the water must travel to the discharge point.

Plate 3 shows the water-level fluctuations in well 956-555-1 in Chester County.

Occurrence

In unconsolidated rocks such as sands and gravels the water occurs in and moves through the interstices between the grains (called primary openings). In consolidated clastic rocks such as sandstones and shales, and in crystalline rocks such as limestones, gneisses, schists, and gabbros that underlie the area covered by this report, the water is confined mainly to fractures (secondary openings).

Pumping Effects

In a well supplied from primary openings, water generally enters the borehole throughout the entire saturated thickness of the aquifer. In a well supplied by secondary openings, water generally enters the borehole in discrete zones separated from each other by nonproductive zones.

The amount of water a well is capable of yielding depends on the size, number, and degree of interconnection of the water-filled openings intercepted by the well. It depends also on how these features change at different distances from the well. As the well is pumped, the water level is drawn down in the well and in the formation surrounding the well. The zone in which the water level is drawn down is called the cone of depression. As pumping continues, the cone deepens and grows in areal extent as water from an ever greater area is diverted from its natural flow path to replace the water pumped from the well. If the aquifer is

Table 1.—*Generalized geologic section (modified after Bascom and Stose)*

System	Series	Formation	Thickness (feet)	Character
Triassic		Diabase	?	Medium- to fine-grained rocks; composed chiefly of plagioclase and pyroxene. Present as dikes.
Ordovician	Lower Ordovician	Conestoga Limestone	500+	Thin-bedded blue to gray granular limestone; has thin dark shale and impure limestone partings; limestone in part conglomeratic at base.
	Middle Cambrian	Elbrook Limestone	300+	Finely laminated, fine-grained impure marble; weathers shaly.
		Ledger Dolomite	600	Granular, crystalline ligbt-gray to white dolomite.
		Kinzers Formation	150	Micaceous limestone and calcareous mica schist.
Cambrian	Lower Cambrian	Vintage Dolomite	300+	Massive, knotty, granular, glistening, dark-gray dolomite.
		Antietam Quartzite	150	Gray laminated quartzite, rust spotted, and contains fossil molds.
		Harpers Schist	280—1,000+	Gray sandy micaceous schist; has thin quartzite beds.
		Chickies Quartzite and Hellam Conglomerate Member	500	Vitreous to granular quartzite, massive and thin bedded, some quartz schist and mica schist; conglomerate-bearing beds at base.

Table 1.—*Generalized geologic section (modified after Bascom and Stose)—Continued*

System	Series	Formation	Thickness (feet)	Character
Age uncertain—Precambrian to Lower Paleozoic		Gabbro	?	Chiefly calcic plagioclase and hypersthene or augite; may contain quartz. In small masses hornblende replaces pyroxenes.
Age uncertain—Precambrian to Lower Paleozoic		Pegmatite	?	Ranges in composition from that of granite to gabbro. Present as small sill-like bodies.
Age uncertain—Precambrian to Lower Paleozoic		Serpentine	?	Altered peridotite and pyroxenite. Present in small isolated exposures.
		Peters Creek Schist	2,000+	Green fine-grained laminated chlorite mica schist.
Age uncertain—Precambrian to Lower Paleozoic	Glenarm	Wissahickon Formation	5,000—8,000+	Chlorite phyllite and muscovite schist, injected by gabbro.
		Cockeysville Marble	200+	Medium to coarse grained white saccharoidal marble, banded with phlogopite.
		Setters Formation	1,000+	Quartz schist, quartzite, and mica gneiss.
Precambrian		Baltimore Gneiss and Franklin Limestone	?	Contorted, banded gneiss, in part graphitic, injected by gabbro, and serpentine. Franklin Limestone is a banded, white, coarsely crystalline marble containing graphite.

homogeneous and isotropic, the cone will be circular and will expand at a uniform rate; if it is not, and this is common where water occurs in fractures in the rock, the cone will not be circular, and it will expand erratically. The effect can be noted at the well (Figure 3) by observing the rate of drawdown of the water level in the well. If the producing fractures enlarge or intersect larger or more numerous water-yielding fractures near the well, the rate of drawdown of the water level in the well will decrease markedly as the cone reaches outward. If the producing fractures decrease in size or if some of them terminate, the rate of drawndown will increase markedly to reflect the reduction in permeability.

The water level in a well is drawn down rapidly when pumping begins, but the rate of drawdown decreases as pumping continues and the cone expands. The rate at which water is supplied to the well depends on the permeability of the aquifer and the hydraulic gradient in the aquifer. In a well supplied from a single yielding zone, the maximum effective gradient is obtained when the water level stands at the base of the yielding zone. As pumping continues, and water is drawn from more distant parts of the aquifer, the gradient (and hence the yield of the zone) will gradually decline. The water level in the well will decline rapidly as it falls below the base of the zone and water is taken from storage in the borehole.

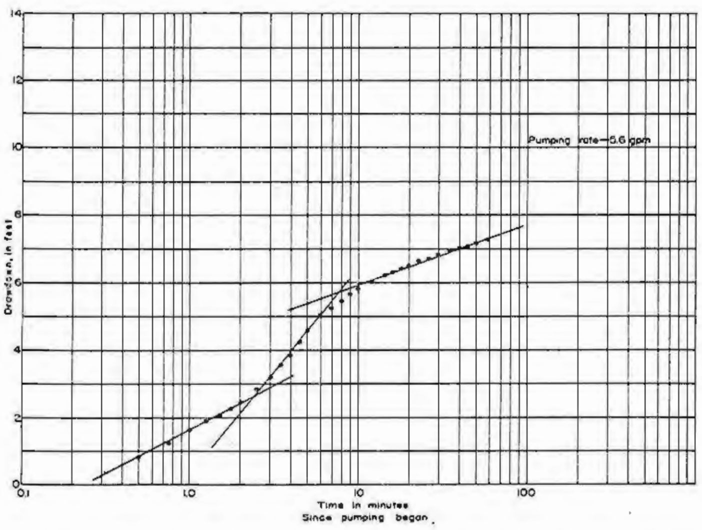

Figure 3. Graph showing drawdown of the water level in well 956-536-2 during pumping.

Well Yields

The capacity of a well is generally reported in either of two ways: (1) as yield, in gallons per minute (gpm) or (2) as specific capacity, in gallons per minute per foot of drawdown (gpm per ft.). The former is commonly obtained at the time the well is drilled by measuring the rate at which water must be removed from the well by bailing (if a churn drill is used) or blowing (if a pneumatic rotary drill is used) to maintain the water level near the bottom of the well. The method is properly applied only to wells whose yields are small enough to allow the water in the borehole to be removed in this way.

Where larger capacities are to be estimated a pump is generally used. In this method, the water level is pumped down nearly to the bottom of the well and the pump is then throttled back to the point at which the water level in the well stabilizes. This discharge is taken as the yield of the well.

The critical part of the yield test is the thoroughness with which the water is removed from the borehole. If the drawdown is less than the maximum, then the reported yield will be some fraction of the well's potential yield.

The specific capacity test requires only that the well be pumped at a constant rate and that accurate measurements be made of the drawdown and discharge. The specific capacity thus obtained may be used to predict the behavior of the well at higher pumping rates as long as the water level in the well is not drawn down below the place at which the water enters the well, as discussed under pumping effects.

The results of neither the yield test nor the specific capacity test in fractured rock can be extrapolated safely to a time greater than the length of the test because of the possibility that the expanding cone of depression will encounter erratic changes in permeability. However there will be a tendency for the yield of the well to decrease slowly during continuous pumping owing to increasing frictional losses in head as water is drawn from greater distances to the well.

In addition to the factors discussed above, the specific capacity may decrease as the discharge increases owing to several factors that may be grouped conveniently as well losses. Because these factors may be minimized by proper well design and construction they are here described individually.

A major part of the well loss is due to friction as the water passes through the well face into the borehole. This friction is caused by imperfect development of the well or by clogging of the well by clays, iron compounds, and other encrustations that reduce the size of the openings through which the water must pass. By surging the well with solutions designed to remove the encrusting materials, the materials may be removed and the well yield improved.

At any given discharge, the velocity at which the water enters the well is inversely proportional to the diameter of the well. High entrance velocities may cause considerable loss in head because of internal friction due to turbulence. Thus, by increasing the diameter of the well, the entrance velocity may be reduced and part of the well losses minimized.

Turbulence may be produced in the well itself if the annular space between the pump and the walls of the well is too small for the velocity at which the water is moving. This, too, may be minimized by enlarging the well.

In this study, specific-capacity tests were standardized at 1 hour's duration, although for many uses a longer test would have been advantageous. However, by standardizing the length of the tests it was possible to compare results of tests in different aquifers and in different environments. Such comparisons permit selection of the most favorable sites for drilling when a ground-water supply is required.

Although inherently less accurate and less flexible than specific capacities, well yields are also used in this report because they do offer some estimate of a well's capacity, are abundant, and furnish information that would not be available otherwise on some aquifers and in some areas. The relationship of yield to specific capacity in the area of the investigation is shown in Figure 4.

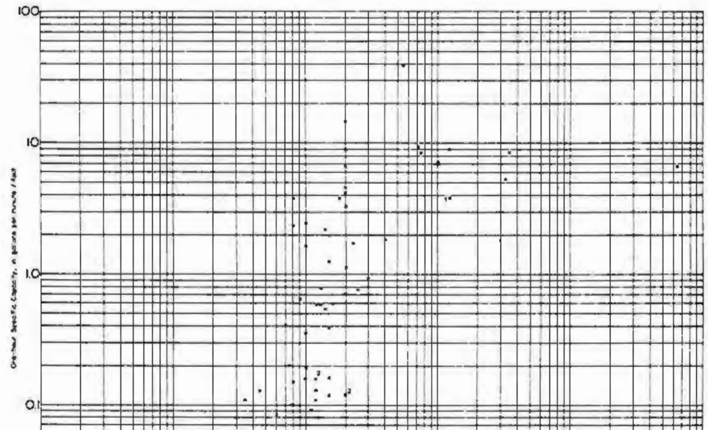

Figure 4. Graph showing the relation of reported well yields in gpm to 1-hour specific-capacity tests. Number next to point indicates the number of sets of data having this value.

Evaluation of Well Data

In most instances well yields are not necessarily representative of the yields that could be obtained because the bulk of the wells have been drilled to supply domestic needs (5-10 gpm). Because of their intended use, they were probably located for convenience rather than at the most favorable site, and were drilled only to a depth sufficient to supply domestic needs. A large-yielding domestic well, then, is one that intercepted a large supply at shallow depths. What the yield would have been had the well been drilled deeper is not known. A deep domestic well, furthermore, is generally one that could not obtain a domestic supply at shallow depth, and is probably in an unfavorable place for a well.

Thirty-six wells, or approximately 10 percent of the wells for which yields were reported or measured, yield over 50 gpm. These include wells drilled for municipal supply, for community supply in housing developments, at industrial plants, at mushroom farms, and at a few private homes. The median yield of the 36 wells was 100 gpm, and the median yield of all reported yields was 15 gpm. Five percent of the high-yielding wells yielded over 330 gpm, whereas only 5 percent of wells inventoried yielded more than 88 gpm.

It is instructive to compare the parameters of the 36 high-yielding wells with those of all the wells inventoried. The median depth of the better wells is 160 feet—or about 60 feet more than that of the group as a whole. About 10 percent of the high-yielding wells exceeded 300 feet in depth, whereas only about 3 percent of all the wells were deeper than 300 feet.

Unfortunately, information on the number and depth of water-bearing zones was not available on many of the wells, especially the high-yielding ones. However, based on the data available, about 10 percent (4 out of 41) of the water-bearing zones of the high-yielding wells were below 170 feet, whereas only about 4.5 percent of the zones of the entire group were deeper than 170 feet.

The most striking difference between the high-yielding wells and the rest of the wells was in their topographic positions. Two-thirds of the high-yielding wells were in draws or valleys, whereas only one-third of all the wells inventoried were in draws or valleys.

Despite the fact that most of the wells were neither deep enough to realize maximum yields nor favorably situated for such yields, an inventory of the wells was necessary because there were not enough municipal or industrial wells to provide an understanding of the factors controlling the occurrence of ground water in the area. If it is assumed that the basis for the location of domestic wells is the same throughout the area, it is possible to use the data from these wells to evaluate the influence of such factors as geologic formation, topographic position, and degree of metamorphism of the rocks.

Aquifer Hydrology

Table 2 summarizes the important parameters of the wells, except those concerned with yielding zones. The Baltimore Gneiss, the gabbro, the Wissahickon Formation, and the Peters Creek Schist (the most extensive rocks in the area) are both the most important and the best understood of the aquifers. A few of the rock units were so small in areal extent that hydrologic data on them were not available; they include the Franklin Limestone, the Antietam Quartzite, and the pegmatite.

The range of the data is given in the table rather than percentiles, because data are abundant enough to merit the use of percentiles in only a few aquifers. Percentiles are presented, however, in the discussion of those few aquifers.

Table 3 summarizes data available on water-bearing zones. The table is in two parts. Table 3-A contains a variety of information.

First, as the denominator of the fraction indicates the number of wells penetrating any particular depth range, the denominator of the shallowest range obviously indicates the total number of wells in that formation for which data on depth to water-bearing zones were obtained. Thus, data were obtained from 40 wells in the muscovite phase of the Wissahickon Formation.

Second, the table indicates the maximum depth range of the wells for which yielding-zone data were obtained. In the "normal" phase of the Baltimore Gneiss, for example, 4 wells exceeded 200 feet in depth and 2 were between 301 and 350 feet deep. No yielding zones were encountered in any of the 4 wells 201 to 300 feet deep, but 2 zones were encountered between depths of 301 and 350 feet.

Third, the relative abundance of zones at different depths is shown by the value of the fraction. In the gabbro, for instance, the relative abundance of zones is seen to decrease as the depth increases. The comparison of abundances, however, does become less sensitive as the depth increases because of the decreasing size of the sample. Thus, the data give some suggestion of the practical depth to which a well should be drilled in a formation in order to obtain maximum production. In the chlorite phase of the Wissahickon, only one zone was found below 150 feet in the 7 wells that exceeded this depth.

Available data do not always fully explore the depth of the yielding zones in some formations (such as the Setters); so, drilling to depths greater than those of existing wells may be recommended.

Table 3-B may be used to estimate the number of yielding zones a well in a particular formation may be expected to intercept and to indicate qualitatively the performance of the well under pumping conditions. As discussed in an earlier section, the specific capacity of a well will decrease as the water level is drawn down below a yielding zone; so, a well that yields principally from a single zone, such as most of the wells in the

TABLE 2.—*Summary of well data*

Formation	Reported yield: Number of Wells	Reported yield: Range (gpm)	Reported yield: Median (gpm)	Specific capacity: Number of Wells	Specific capacity: Range (gpm per ft)	Specific capacity: Median (gpm per ft)	Well depth: Number of Wells	Well depth: Range (feet)	Well depth: Median (feet)	Casing depth: Number of Wells	Casing depth: Range (feet)	Casing depth: Median (feet)
Baltimore Gneiss												
"Normal" phase	64	1-270	17	10	0.2-8.9	0.93	89	31-359	84	56	10-76	33
Gabbro-intruded phase	55	¾-125	11	9	.06-9.0	2.2	69	45-265	102	50	14-69	39
Graphitic phase	3	½-45	15	0	......	..	3	50-154	145	2	28-32	30
Setters Formation	5	12-33	16	3	.2-2.5	.6	8	69-140	106	6	17-100	40
Cockeysville Marble	3	3-330	20	4	.1-78.5	3.15	6	33-170	86	4	20-80	42
Wissahickon Formation												
Chlorite phase	41	0-80	8	18	.04-38.2	2.4	63	35-1,000	125	46	15-200	15
Muscovite phase	77	0-350	10.5	20	.06-8.4	.4	115	48-400	112	67	10-157	40
Peters Creek Schist	35	0-312	11.3	18	.03-11.3	1.0	69	32-426	92	36	6-110	29
Chickies Quartzite	6	2-20	12	2	.2	.2	11	42-222	112	9	13-60	22
Hellam Conglomerate Member	0	......	....	1	......	.05	8	38-170	68	1	......	74
Harpers Schist	6	4-30	14	1	......	1.7	7	28-160	125	5	28-120	36

TABLE 2.—*Summary of well data—Continued*

Formation	Reported yield: Number of Wells	Reported yield: Range (gpm)	Reported yield: Median (gpm)	Specific capacity: Number of Wells	Specific capacity: Range (gpm per ft)	Specific capacity: Median (gpm per ft)	Well depth: Number of Wells	Well depth: Range (feet)	Well depth: Median (feet)	Casing depth: Number of Wells	Casing depth: Range (feet)	Casing depth: Median (feet)
Antietam Quartzite	0	......	....	0	......	..	0	....	....	0	......	..
Vintage Dolomite	2	3-665	334	0	......	..	2	55-300	178	1	......	208
Kinzers Formation	0	......	....	0	......	..	2	65-147	106	1	......	4
Ledger Dolomite	5	7-150	25	0	......	..	7	42-400	118	4	5-100	40
Elbrook Limestone	2	15-150	82	0	......	..	2	85-200	142	2	50-100	75
Conestoga Limestone	9	7-175	20	2	.1- .4	.3	16	42-200	90	8	18-134	49
Gabbro	45	½-125	10	5	.2- 3.9	1.3	52	36-235	94	39	10-87	33
Serpentine	4	4-80	18	1	......	.6	5	40-310	104	2	15-108	62
Pegmatite	0	......	..	0	......	..	1	....	100	0	......	..
Diabase	1	......	½	0	......	..	1	....	255	1	......	23

TABLE 3.—*Summary of data on water-bearing zones*

Table 3-A.—Ratio of number of water-bearing zones of specified depth range to number of wells penetrating this range

Table 3-B.—Percentage distribution of zones in wells.

Formation	3-A Depth range, in feet: 0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	3-B Zones per well: 1	2	3	4	5	6	7
Baltimore Gneiss															
"Normal" phase	38/44	35/41	4/15	5/9	0/4	0/2	2/2		39	36	20	5			
Gabbro-intruded phase	27/33	33/32	2/13	1/5	0/1				43	27	27	3			
Graphitic phase	0/2	1/2	1/2						0	100					
Setters Formation	2/4	3/4	2/4						75	0	0	25			
Cockeysville Marble	0/1	0/1	1/1						100						
Wissahickon Formation															
Chlorite phase	12/20	13/20	8/16	1/7	0/3	0/3	0/2	0/2	55	25	15	5			
Muscovite phase	27/40	36/40	16/25	8/13	3/9	2/3	0/1	0/1	27.5	45	15	5	2.5	2.5	2.5

TABLE 3.—*Summary of data on water-bearing zones—Continued*

Formation	Table 3-A.—Ratio of number of water-bearing zones of specified depth range to number of wells penetrating this range								Table 3-B.—Percentage distribution of zones in wells.						
	Depth range, in feet								Zones per well						
	0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	1	2	3	4	5	6	7
Peters Creek Schist	6/12	10/11	1/6	0/4	2*/2	0/1	0/1		59	33	0	8			
Chickies Quartzite	4/4	1/3	0/1	1/1	1/1				25	75					
Hellam Conglomerate Member	?/0								—						
Harpers Schist	0/3	6/3	2/3						33.3	33.3	33.3				
Antietam Quartzite	?/0								—						
Vintage Dolomite	?/0								—						
Kinzers Formation	1/2	0/2	1/1						100						

TABLE 3.—*Summary of data on water-bearing zones—Continued*

Formation	Table 3-A.—Ratio of number of water-bearing zones of specified depth range to number of wells penetrating this range								Table 3-B.—Percentage distribution of zones in wells.						
	Depth range, in feet								Zones per well						
	0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	1	2	3	4	5	6	7
Ledger Dolomite	2/5	1/5	3/3	0/2	0/2	0/1	0/1	0/1	80	20					
Elbrook Limestone	1/1	1/1							0	100					
Conestoga Limestone	1/3	2/3							100						
Gabbro	35/28	21/27	7/16	3/8	0/5				29	32	21	14	4		
Serpentine	2/2	0/2	1/2	1/1	0/1	0/1	0/1		50	0	50				
Pegmatite	?/0								—						
Diabase	0/1	1/1	0/1	0/1	0/1	0/1			100						