

**MASTER**

**MASTER**

# **Preliminary Geologic Map of the Late Cenozoic Sediments of the Western Half of the Pasco Basin**

**J. T. Lillie  
A. M. Tallman  
J. A. Caggiano**

**September 1978**

**Prepared for the United States  
Department of Energy  
Under Contract EY-77-C-06-1030**

**DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED**



**Rockwell International**

**Rockwell Hanford Operations  
Energy Systems Group  
Richland, WA 99352**

## **DISCLAIMER**

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



## **DISCLAIMER**

**Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.**



## **Rockwell International**

**Rockwell Hanford Operations  
Energy Systems Group  
Richland, WA 99352**

PREPARED FOR THE UNITED STATES DEPARTMENT OF ENERGY  
UNDER CONTRACT EY-77-C-06-1030

### **PRELIMINARY REPORT**

This Report contains information of a preliminary nature. It is subject to revision or correction and therefore does not represent a final Report. It was prepared primarily for internal use within The Rockwell Hanford Operations. Any expressed views and opinions are those of the Author and not necessarily of the Company.

### **NOTICE**

This Report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their Employees, nor any of their Contractors, Subcontractors, or their Employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

## Informal Report

PRELIMINARY GEOLOGIC MAP  
OF THE LATE CENOZOIC SEDIMENTS  
OF THE WESTERN HALF OF THE PASCO BASIN

J. T. Lillie

A. M. Tallman

J. A. Caggiano

Earth Sciences Group  
Research Department

NOTICE  
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

for  
Basalt Waste Isolation Program

September 1978

Rockwell International  
Rockwell Hanford Operations  
Energy Systems Group  
Richland, Washington 99352

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

## A B S T R A C T

*The U. S. Department of Energy, through the Basalt Waste Isolation Program within the Rockwell Hanford Operations, is investigating the feasibility of terminal storage of radioactive waste in deep caverns constructed in Columbia River Basalt. This report represents a portion of the geological work conducted during fiscal year 1978 to assess the geological conditions in the Pasco Basin.*

*The surficial geology of the western half of the Pasco Basin was studied and mapped in a reconnaissance fashion at a scale of 1:62,500. The map was produced through a compilation of existing geologic mapping publications and additional field data collected during the spring of 1978. The map was produced primarily to: (1) complement other mapping work currently being conducted in the Pasco Basin and in the region by Rockwell Hanford Operations and its subcontractors; and, (2) to provide a framework for more detailed late Cenozoic studies within the Pasco Basin. A description of procedures used to produce the surficial geologic map and geologic map units is summarized in this report.*

## TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	5
PROCEDURES	5
REGIONAL GEOLOGIC SETTING	7
SURFICIAL GEOLOGY OF THE WESTERN PASCO BASIN	8
DESCRIPTION OF MAP UNITS	8
RINGOLD FORMATION	10
COLLUVIUM	10
HANFORD FORMATION	10
TOUCHET MEMBER	10
PASCO MEMBER	11
TALUS	11
LOESS	11
LANDSLIDES	12
ALLUVIUM AND ALLVIAL FANS	12
EOLIAN DEPOSITS	13
SAND DUNES	13
PATTERNED GROUND	13
BIBLIOGRAPHY	13
DISTRIBUTION	14

## LIST OF FIGURES

FIGURE 1	LOCATION MAP OF THE PASCO BASIN	6
FIGURE 2	THE PEND OREILLE LOBE LOCATION MAP	9

## LIST OF PLATES

PRELIMINARY GEOLOGIC MAPS OF THE LATE CENOZOIC  
SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN

PLATE 1	BEVERLY, WASHINGTON	In Pocket
PLATE 2	SMYRNA, WASHINGTON	In Pocket
PLATE 3	CORFU, WASHINGTON	In Pocket
PLATE 4	PRIEST RAPIDS, WASHINGTON	In Pocket

## Table of Contents (continued)

		<u>Page</u>
PLATE 5	COYOTE RAPIDS, WASHINGTON	In Pocket
PLATE 6	HANFORD, WASHINGTON	In Pocket
PLATE 7	GRANDVIEW, WASHINGTON	In Pocket
PLATE 8	CORRAL CANYON, WASHINGTON	In Pocket
PLATE 9	RICHLAND, WASHINGTON	In Pocket
PLATE 10	PROSSER, WASHINGTON	In Pocket
PLATE 11	WHITSTRAN, WASHINGTON	In Pocket
PLATE 12	RANGER MOUNTAIN, WASHINGTON	In Pocket
PLATE 13	PASCO, WASHINGTON	In Pocket



## INTRODUCTION

The U. S. Department of Energy, through the Basalt Waste Isolation Program within Rockwell Hanford Operations, is investigating the feasibility of terminal storage of radioactive waste in deep caverns constructed in Columbia River Basalt. This report represents a portion of the geological work conducted during fiscal year 1978 to assess the geological conditions in the Pasco Basin.

The surficial geology of the western half of the Pasco Basin (Figure 1) was studied and mapped in a reconnaissance fashion at a scale of 1:62,500. The map was produced through a compilation of existing geologic mapping publications and additional field data collected during the spring of 1978. The preliminary map was produced primarily to: (1) compliment other mapping work currently being conducted in the Pasco Basin and in the region by Rockwell Hanford Operations and its subcontractors; and, (2) to provide a framework for more detailed late Cenozoic studies within the Pasco Basin. A description of procedures used to produce the surficial geologic map and geologic map units is summarized in this report.

## PROCEDURES

The existing surficial maps of the Pasco Basin and adjacent areas (Hajek, 1966; Newcomb, et al., 1972; and Grolier and Bingham 1971) were reviewed to determine the extent of mapping and to determine their utility to the current study. The geohydrologic map of Newcomb, et al., (1972) was found to be most applicable. Only minor changes, which include contact modification and the addition of more detail, were made on this map during field checking. Stereo air photographs at scales of 1:62,500, 1:24,000, and 1:6,000 were used to aid in field location and to map areas of geomorphic features, such as patterned ground, giant ripple marks, sand dunes (active and stable), and landslides. Due to the lack of adequate base map coverage at a scale of 1:24,000, the map was compiled at a scale of 1:62,500.

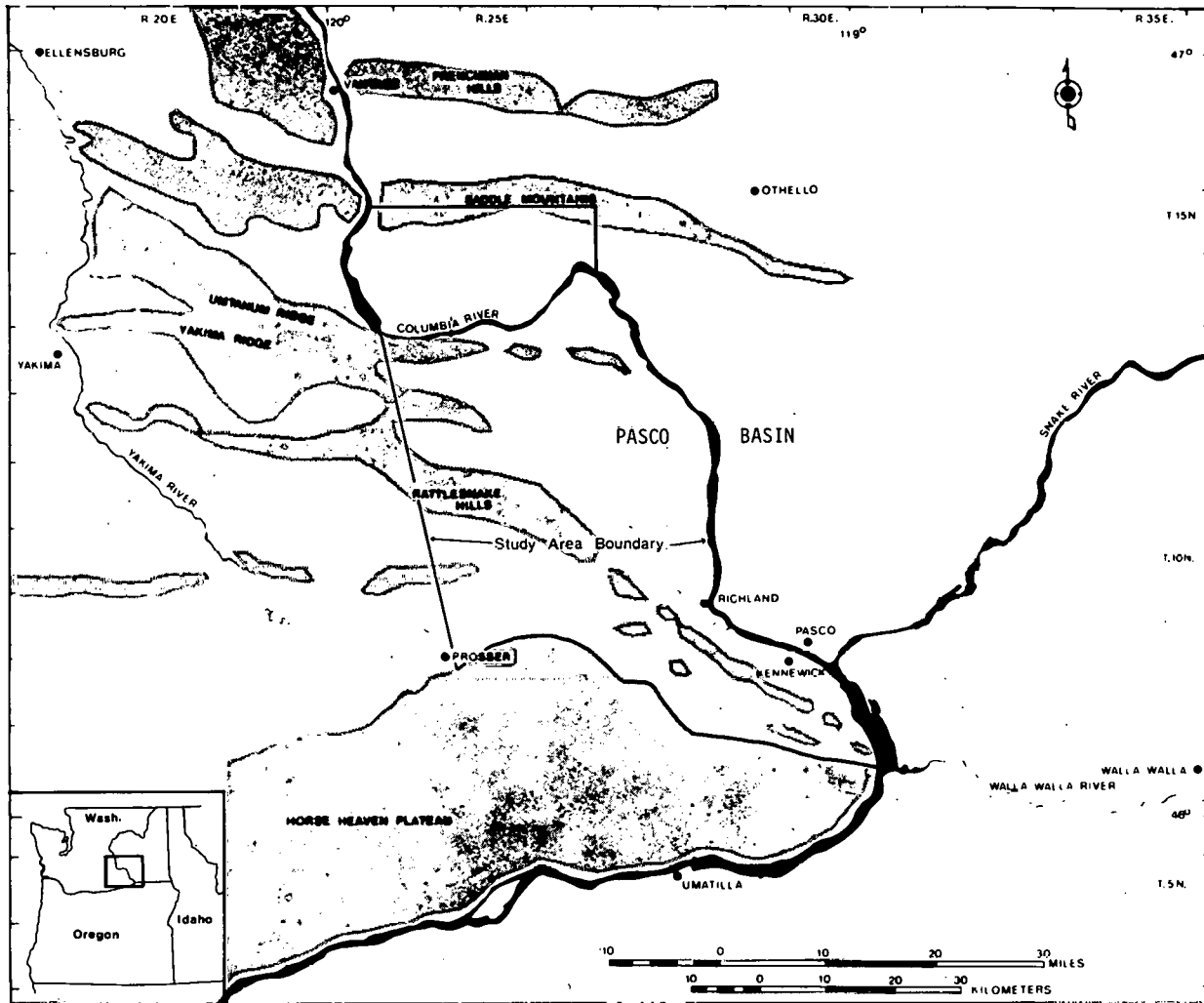


FIGURE 1

LOCATION MAP OF THE PASCO BASIN

Upon completion of photograph interpretation/mapping, stratigraphic units of known geology were studied for identifiable field criteria. Once field criteria were identified, the units were mapped. The map units are only preliminary due to the reconnaissance nature of the study. Additional work is required to integrate the Pasco Basin study with surficial geologic mapping currently being carried out in the surrounding region.

### REGIONAL GEOLOGIC SETTING

The Pasco Basin is a structural and topographic low in south-central Washington underlain by at least three major stratigraphic units. These stratigraphic units in ascending order are: (1) the Columbia River Basalt Group; (2) the Ringold Formation; and, (3) the Hanford Formation. Outcrops of all three are found within the Pasco Basin. During the Tertiary, the basalts flowed intermittently into the basin. Between eruptions of the younger flows, streams from surrounding highlands flowed into the ancestral Pasco Basin depositing sediments which were covered by later basalt flows. The youngest basalt flow in the Pasco Basin is about 8 million years old and is overlain by fluvial detrital sediments.

Continued deformation of the basalt flows produced isolated, small topographic basins, such as the Pasco Basin, in which Pliocene and Quaternary sediments were deposited. Ancestral rivers which flowed into the Pasco Basin deposited a sequence of terrigenous sediments during Pliocene time known as the Ringold Formation.

The Ringold Formation consists of a number of textural facies and has been divided into the lower, middle, and upper Ringold. Lower Ringold, recognized from well data, is largely bluish-green clayey silt and contains some sand and gravel. The middle Ringold facies are composed predominantly of well-rounded pebbles and cobbles with interstitial sand and silt. Upper Ringold sediments are composed of nearly horizontal beds of sand and silt with some relatively minor fine gravel lenses. Mammalian fauna from the upper Ringold have been identified as Blancan (late Pliocene) by Gustafson (1978). The age of the oldest Ringold sediments is not known.

After deposition of the Ringold sediments, the surface was subjected to subaerial erosion. An eloian silt overlying the Ringold Formation in the central part of the basin has been identified from wells (Brown 1960).

The Pasco and Touchet members of the Hanford Formation were deposited by Pleistocene flood waters when ice dams broke and glacial lakes were discharged catastrophically across the Columbia Plateau.

The Pend Oreille Lobe (Figure 2) of the Cordilleran ice sheet blocked the Clark Fork Valley in northwestern Montana forming glacial Lake Missoula (Bretz, 1969). Failure of this ice dam resulted in the catastrophic discharge of up to 21.3 million cubic meters per second (20 cubic miles per hour) across the Columbia Plateau (Baker, 1973) eroding the coulees of the channeled scablands and depositing clastic sediments. Sand and gravel of the Pasco Member were deposited in main flood channels and as bars on the lee of bedrock obstructions and channel restrictions (Baker, 1973).

Flood waters were hydraulically impounded in the Pasco Basin behind the narrow outlet at Wallula Gap. Low-energy environments resulting from this impoundment were the site of deposition of silt and fine sand of the Touchet Member. The last major flood in the Pasco Basin occurred about 13,000 years before present (Mullineaux, et al., 1977). The number of floods in the Pasco Basin is not known.

Giant ripple marks, large fluvial bars, flood channels, and bergmounds are geomorphic expressions of catastrophic flooding found in the Pasco Basin.

Late Quaternary and Holocene dune sand, loess, alluvium, and colluvium overlie the basalt, the Ringold Formation, and Hanford Formation in parts of the Pasco Basin.

Clastic dikes are also present in the Hanford and Ringold formations and produce surficial polygonally patterned ground in some areas.

## SURFICIAL GEOLOGY OF THE WESTERN PASCO BASIN

### DESCRIPTION OF MAP UNITS

The following description of map units is based on the late Cenozoic geologic map of the western portion of the Pasco Basin (Plates 1 through 13). This interpretation is preliminary and is only a progress report of

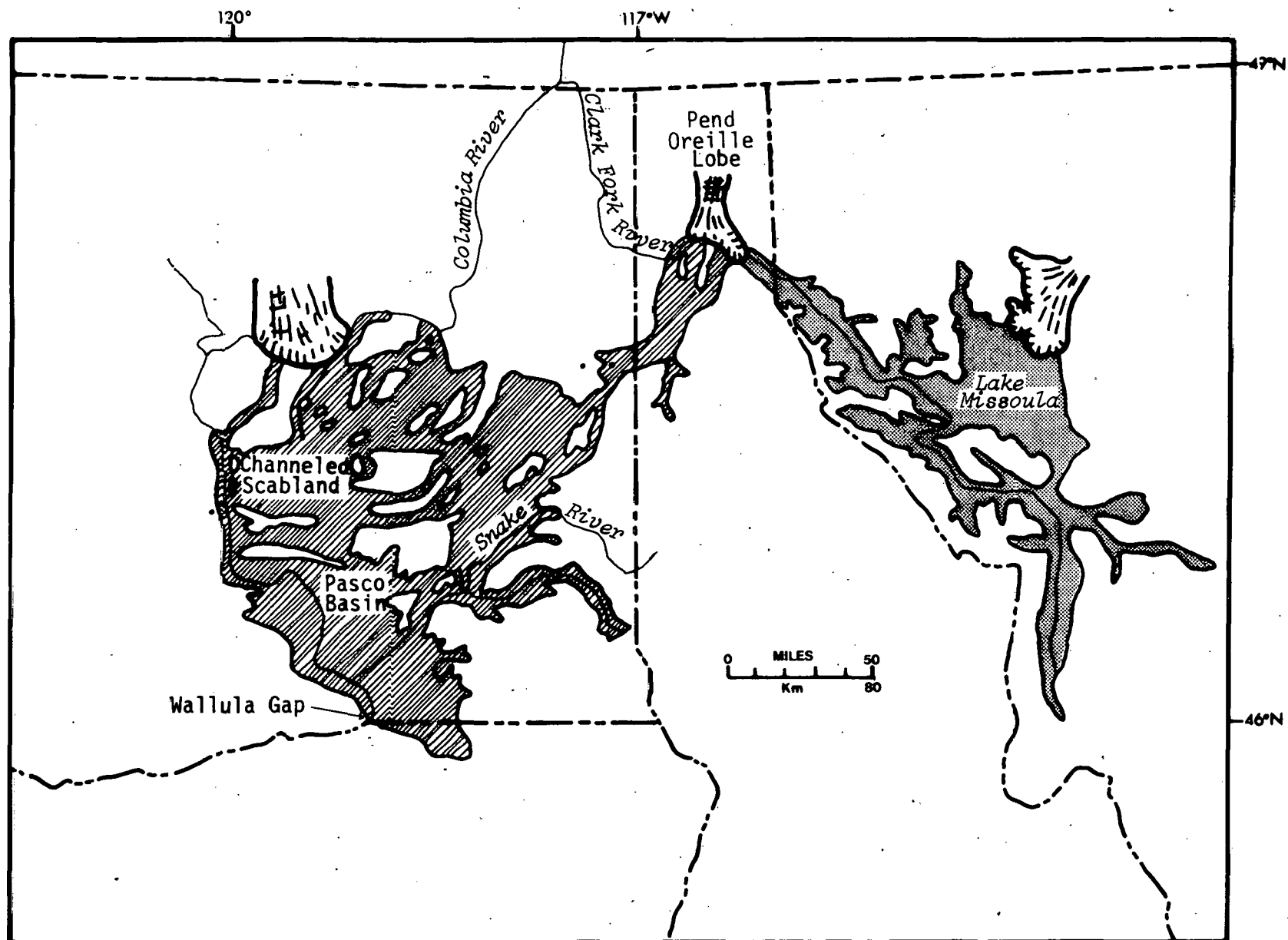


FIGURE 2

THE PEND OREILLE LOBE LOCATION MAP

ongoing investigations. Further work must be completed before any final interpretations can be made. All locations discussed in this section may be located on Plates 1 through 13.

#### Ringold Formation (TQrc) (TQr1)

Two outcrops of the Ringold Formation were found in the mapped area. One outcrop occurs at Coyote Rapids on the Columbia River and is the conglomeratic facies. The other outcrop occurs along the northern extension of the White Bluffs onto Wahluke Slope and is the fine-grained facies of the Upper Ringold.

#### Colluvium (Qco)

The mapping unit Qco may be a misnomer for this unit; these units may be conglomerates of pre-flood(s) age. Preliminary mapping uncovered deposits of what appeared to be talus and slope wash of indeterminate age on the flanks of some ridges. These deposits are composed entirely of angular basalt clasts and are capped by an approximately 0.3-meter (1-foot) thick petrocalcic horizon.

#### HANFORD FORMATION

##### Touchet Member (Qht)

The second-most widespread sediment in the Pasco Basin and surrounding areas is the sand and silt facies known as the Touchet Member of the Hanford Formation. The major occurrences of this unit that have been mapped are in Cold Creek, Dry Creek, and the Yakima River valleys. They occur on the basin margins discontinuously to an altitude of at least 345 meters (1,150 feet) above mean sea level. The primary criterion for field identification, where stratification is not apparent, is the occurrence of ice-rafted glacial erratics. The Touchet is very easily reworked by eolian processes, which causes stripping of this deposit from higher elevations. For this reason, and the random occurrences of erratics, it is difficult to accurately map the upper limit of these sediments. Thus, the upper map limit has been tentatively dashed in on the map. Further field mapping will be required to



accurately map this contact, which is of significance as the upper limit of the Touchet in the basin is believed to closely correspond to the upper limit for the ponding of flood waters in the basin.

#### Pasco Member (Qhp)

The major surficial sediment unit within the Pasco Basin is the sand and gravel facies of the catastrophic flood deposits of the Pasco Member of the Hanford Formation. At least 777 square kilometers (300 square miles) are covered by these deposits. In places, these gravels exceed 200 meters (600 feet) in thickness, and unconformably overlie the Ringold Formation or basalt. They are overlain in places by active and stabilized dune fields, loess, and Touchet sediments. In areas near channel bottom irregularities (i.e., ridges which were under water during flooding), the tops of the bars are covered with giant current ripples (see Plate 5). The sand and gravel facies of the Pasco Member grade both laterally and vertically into the sand and silt facies of the Touchet Member.

#### Talus (Qt)

The only areas of active talus formation today are in areas of high relief where the basalt crops out as cliffs. These areas are the north face of the Saddle Mountains (out of mapping area), the north-northeast faces of Umtanum Ridge (out of mapping area), and minor amounts on the Rattlesnake and the Horse Heaven hills.

#### Loess (Q1) (Q1/Tb)

Loess is present over much of the Pasco Basin and on the ridges bounding the basin. Where present, it is variable in thickness ranging from a very thin veneer on windward ridge slopes to several meters on the leeward sides of valleys. The mapping unit Q1/Tb is used to indicate a thin loessal cover over the Columbia River Basalt. Portions of the Saddle Mountains and the Rattlesnake Hills are covered by loess, which, at this time, have not been differentiated as to age on the map (see Plates 1, 2, 3, 4, 7, 8, 10, and 11). The majority of the loess deposits within the basin are post-last flood. The source material for these

loess deposits most likely is the fine sand and silt facies of the Touchet Member of the Hanford Formation which has been reworked by prevailing west-to-southwest winds. Loess can generally be differentiated from Touchet and the sand and silt facies of the Ringold by its massive, unstructured appearance in outcrop. Loess chronology, if it can be determined in this area, may be a useful tool for determination of the late Cenozoic stratigraphy and should be investigated further.

#### Landslides (Qld)

There are two areas of massive landslides in the western part of the mapping area. A landslide complex covering over 52 square kilometers (20 square miles) occurs in the area where the main structural trend of the Rattlesnake Hills changes from northwest to west-to-east. This slide complex is a series of very large slide blocks. Recent field evidence indicates that not only is this an area of complex sliding, but there are also intact structural blocks in a complex arrangement.

The second area of massive landsliding is along the northwest face of the Horse Heaven Hills from Chandler to Prosser. The area covered by the multiple slide blocks exceeds 65 square kilometers (25 square miles) in a strip 1.6 kilometers (1 mile) wide and 32 kilometers (20 miles) long. Individual slide blocks have not been mapped due to limited time, but should be. There are also several areas of local landslides on the northeast face of the Rattlesnake Hills. In places, these landslide complexes appear to have a thin veneer of flood deposits overlying them.

#### Alluvium and Alluvial Fans (Qa) (QaF)

Aside from the alluvial deposits of the Columbia and Yakima rivers, there is relatively little Holocene alluvium in the area mapped. Some minor run-off occurs on the flanks of the ridges in the spring and fall producing a small amount of very angular basalt cobble alluvium in the run-off gullies. Two of the larger alluvial fans in the basin are associated with the Snively Basin slide complex on the Rattlesnake Hills. There are small areas of alluvium not shown on the map, which will be picked up with additional detailed mapping.

## EOLIAN DEPOSITS

### Sand Dunes (Qda, Qds)

Several areas are covered by active sand dune fields (Qda). The largest of these fields occurs between Townships 12 and 11 North, Range 27 East and the Columbia River south of the town site of Hanford. This field is composed primarily of barchan dunes and covers an area of about 33.7 square kilometers (13 square miles). The other areas of active dunes are relatively small (no greater than 2.5 square kilometers [1 square mile]) and consist of longitudinally modified barchan dune fields. The probable source of sand for these dunes is the Touchet Member of the Hanford Formation.

The area of the basin from Township 13 North, south to the City of Richland, and between Cold Creek Valley-Yakima River Valley and the Columbia River is mantled by stabilized longitudinal dunes (Qds). These dunes generally trend from west to east and are covered with sagebrush and cheatgrass. The intervening blowouts associated with these dunes are covered with a gravel lag. These dunes are probably eolian reworked sand and silt of the Pasco gravels and sands. These dunes have been suggested to be giant ripple marks modified by eolian processes (Bretz, et al, 1956).

### PATTERNED GROUND

Several areas of Cold Creek Valley display a polygonal pattern in which narrow planar zones cut the Touchet sediments and are reminiscent of giant mud cracks. This patterned ground is the surface expression of clastic dikes which cut the Touchet sediments. On the map, these areas are represented by a mud crack-like pattern. This pattern is to show the location of these areas only and does not reflect the spatial distribution of the clastic dikes or the patterned ground.

## BIBLIOGRAPHY

Baker, V. R., 1973, "Paleohydrology and Sedimentology of Lake Missoula Flooding in Eastern Washington," Geological Society of America Special Paper 144, 79 p.

Bretz, J. H., Smith, H. T. U., and Neff, G. E., 1956, "Channeled Scabland of Washington; New Data and Interpretations," Geological Society of America, 67, pp. 957-1049.

Bretz, J. H., 1969, "The Lake Missoula Floods and the Channeled Scablands," Journal of Geology, 77 (5), pp. 505-543.

Brown, D. J., 1960, An Eolian Deposit Beneath 200 West Area, HW-67549, General Electric Hanford Atomic Products Operation, Richland, Washington.

Grolier, M. J., and Bingham, J. W., 1971, "Geologic Map and Sections of Parts of Grant, Adams, and Franklin Counties, Washington," U. S. Geological Survey Miscellaneous Geologic Investigations Map I-589.

Gustafson, E. P., 1978, "The Vertebrate Faunas of the Pliocene Ringold Formation, South-Central Washington," Museum of Natural History Bulletin 23, University of Oregon, Eugene, Oregon, 62 p.

Hajek, B. F., 1966, Soil Survey, Hanford Project in Benton County, Washington, BNWL-243, Battelle, Pacific Northwest Laboratories, Richland, Washington.

Mullineaux, D. R., Wilcox, R. E., Fryxell, R., Ebaugh, W. F., and Rubin, M., 1977, "Age of the Last Major Scabland Flood of Eastern Washington as Inferred from Associated Ash Beds of Mount St. Helens Set S," Geological Society of America Abstracts with Programs, 9 (7), p. 1105

Newcomb, R. C., Strand, J. R., and Frank, F. J., 1972, "Geology and Ground-Water Characteristics of the Hanford Reservation of the U. S. Atomic Energy Commission, Washington," U. S. Geological Survey Professional Paper 717, 78 p.

## DISTRIBUTION

### Number of Copies

1	<u>J. F. T. AGAPITO</u>
1	<u>CENTRAL WASHINGTON UNIVERSITY</u> Department of Geology
1	<u>COLORADO SCHOOL OF MINES</u>
1	<u>J. W. CORWINE</u>
1	<u>GEOSCIENCE RESEARCH CONSULTANTS</u> J. G. Bond
1	<u>IDAHO BUREAU OF MINES AND GEOLOGY</u> M. M. Miller

## Distribution (continued)

Number of  
Copies

1	<u>OREGON STATE DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES</u> J. D. Beaulieu
1	<u>OREGON STATE UNIVERSITY</u> Department of Geology
1	<u>PACIFIC NORTHWEST LABORATORY</u> J. R. Raymond
1	<u>F. L. PARKER</u>
1	<u>I. REMSON</u>
1	<u>R. SCHNEIDER</u>
1	<u>G. SERVOS</u>
1	<u>U. S. BUREAU OF RECLAMATION</u> Columbia Basin Project Geologist
1	<u>U. S. DEPARTMENT OF ENERGY-COLUMBUS PROGRAM OFFICE</u> J. Neff
2	<u>U. S. DEPARTMENT OF ENERGY-HEADQUARTERS</u> M. W. Frei D. L. Vieth
3	<u>U. S. DEPARTMENT OF ENERGY-RICHLAND OPERATIONS OFFICE</u> R. B. Goranson D. J. Squires (2)
1	<u>U. S. GEOLOGICAL SURVEY-WATER RESOURCES DIVISION</u> C. Collier
1	<u>U. S. GEOLOGICAL SURVEY-WESTERN DIVISION</u> D. A. Swanson
1	<u>UNIVERSITY OF IDAHO</u> Department of Geology
1	<u>UNIVERSITY OF WASHINGTON</u> Department of Geology
1	<u>WASHINGTON PUBLIC POWER SUPPLY SYSTEM, INC.</u> D. D. Tillson

## Distribution (continued)

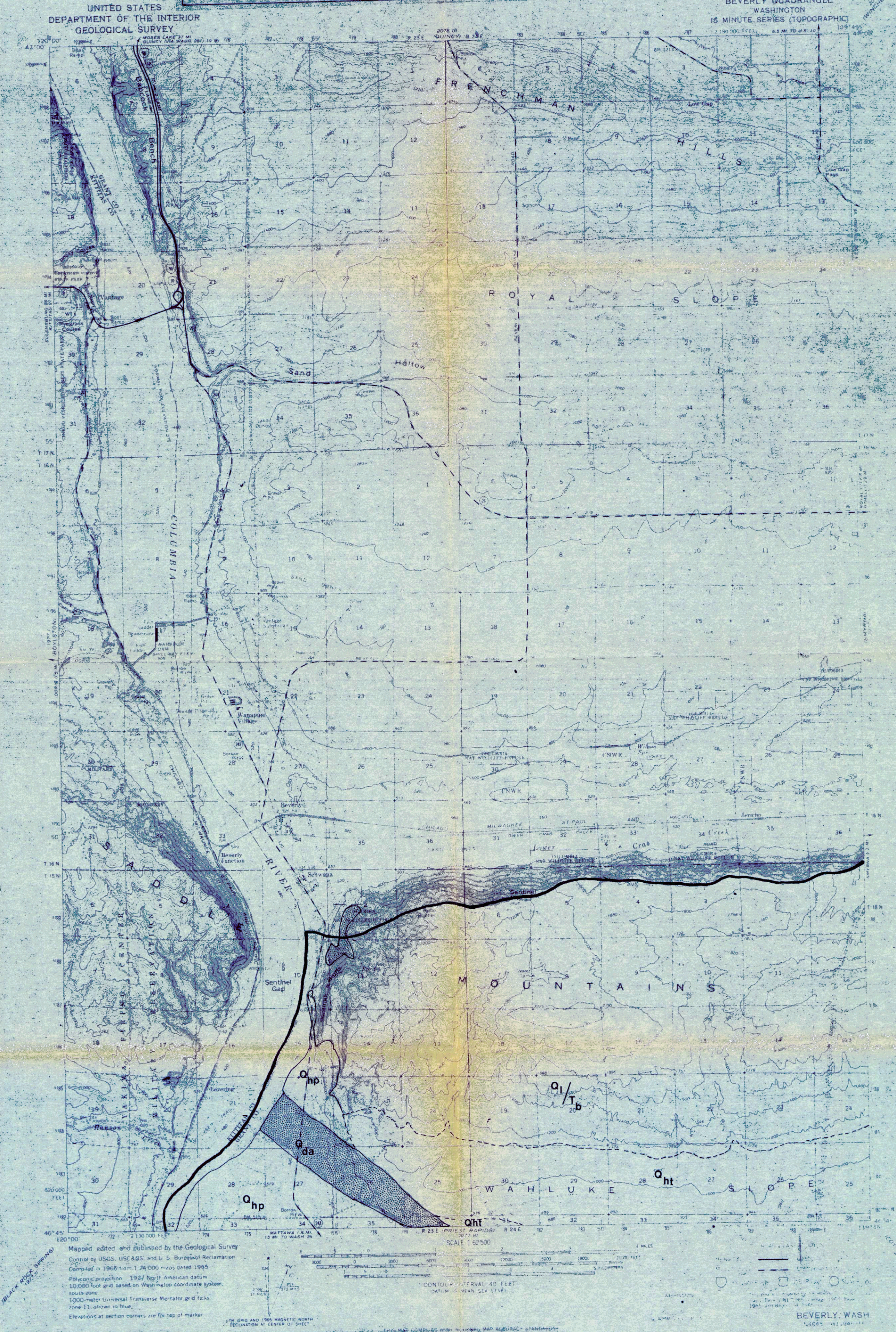
Number of  
Copies

1	<u>WASHINGTON STATE DEPARTMENT OF ECOLOGY</u> P. M. Grimstad
1	<u>WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES</u> V. E. Livingston
1	<u>WASHINGTON STATE UNIVERSITY</u> Department of Geology
1	<u>A. C. WATERS</u>
1	<u>H. C. WEISENECK</u>
1	<u>WESTERN WASHINGTON UNIVERSITY</u> Department of Geology
39	<u>ROCKWELL HANFORD OPERATIONS</u> H. Babad D. J. Brown D. J. Cockeram T. A. Curran (5) R. A. Deju (2) R. C. Edwards R. E. Gephart R. J. Gimera R. E. Isaacson C. W. Myers W. H. Price (5) Basalt Waste Isolation Program Library (15) Document Control (4)

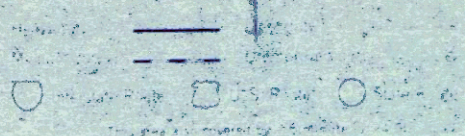


Rockwell	Hanford	Operations	Basalt	Waste	Isolation	Program
PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN			Appd. Program Dir.		Date	Quality Assurance
			Appd. Unit Mgr.		Date	Appd. Project Mgr.
			Drafting Appd.		Date	Responsible Engr.
			Drawn by		Date	Review
			Scale		Drawing No. H-06-4602-1	

BEVERLY QUADRANGLE  
WASHINGTON  
15 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey  
Control by USGS, USC&GS, and U.S. Bureau of Reclamation  
Compiled in 1965 from 1:24,000 maps dated 1965  
Polyconic projection, 1927 North American datum  
10,000-foot grid based on Washington coordinate system,  
south zone  
1900-meter Universal Transverse Mercator grid ticks  
zone 11, shown in blue  
Elevations at section corners are for top of marker



POCKET PART 1 OF 13 RHO-BWI-LD-8  
PLATE 1 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
THE WESTERN HALF OF THE PASCO BASIN

BEVERLY, WASH.  
4602-1 (11/19/65)

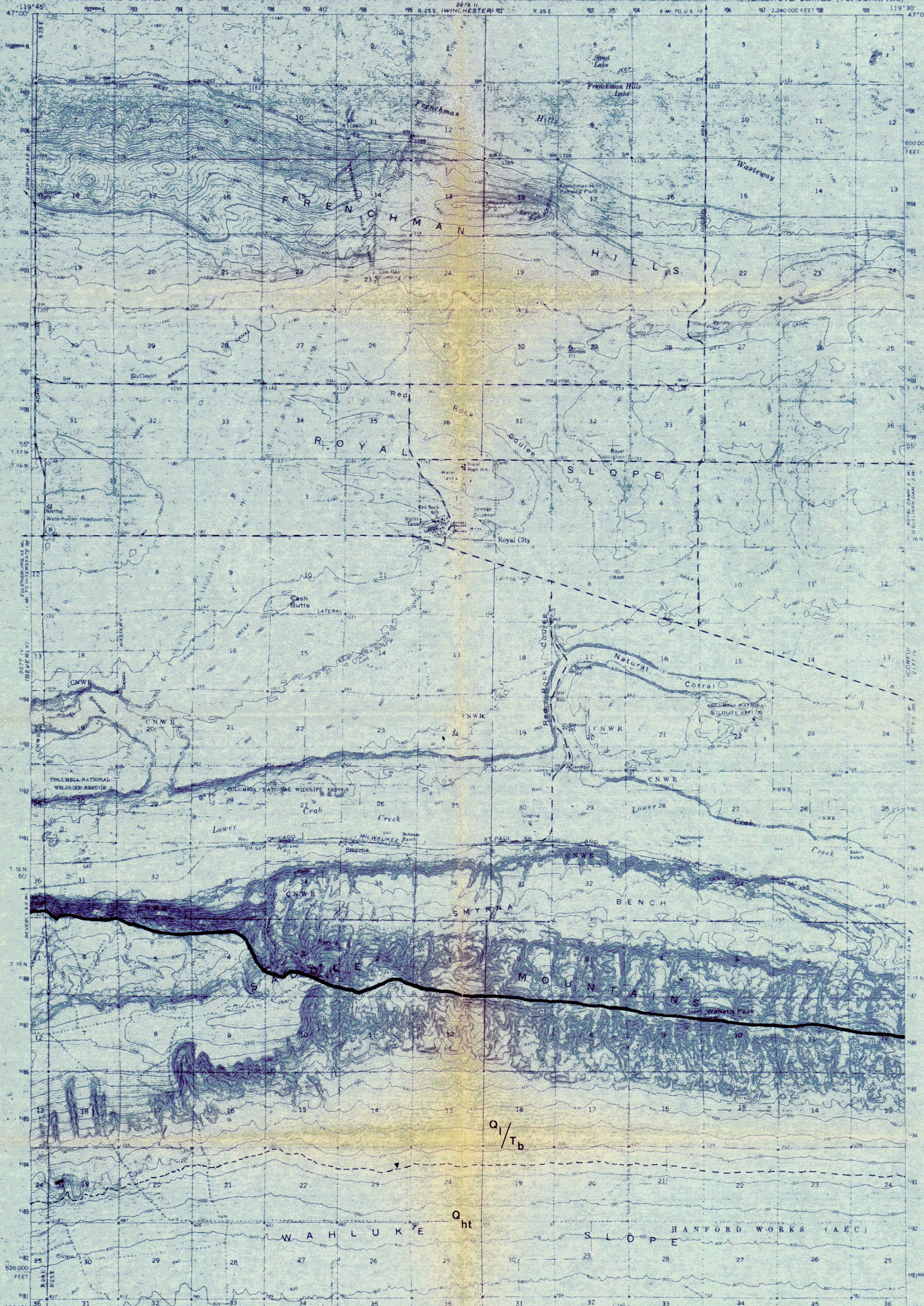


## Basalt Waste Isolation Program

Appd. Program Dir.	Date	Quality Assurance	Date
Appd. Unit Mgr.		Appd. Project Mgr.	
<i>L.A. Curran</i>	<i>7/21/78</i>	<i>C.W. Mayers</i>	<i>7/29/78</i>
Drafting Appd.		Responsible Engr.	
<i>Shirley Pollie</i>	<i>7/29/78</i>	Review	
Scale	Drawing No.		

SMYRNA QUADRANGLE  
WASHINGTON-GRANT CO.  
MINUTE SERIES (TOPOGRAPHIC)

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY



Mapped, edited, and published by the Geological Survey in cooperation with the Army Map Service.  
Control by USGS, USC&GS, and U. S. Bureau of Reclamation.  
Topography by photogrammetric methods from aerial photographs taken 1949 and planetable surveys by USBR 1935-41. Field checked 1950. Revised from aerial photographs taken 1964. Field checked 1965.

CONTOUR INTERVAL 20 FEET  
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION

Medium-duty ☒ Light-duty ☐  
Unimproved dirt ☐ State Route ☐

SMYRNA, WASH.  
N4645—W11930/15

1965  
AMS 2077 | -SERIES V79|

POCKET PART 2 OF 13 RHO-BWI-LD-8  
PLATE 2 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS  
OF THE WESTERN HALF OF THE PASCO BASIN

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS  
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D.C. 20242  
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST







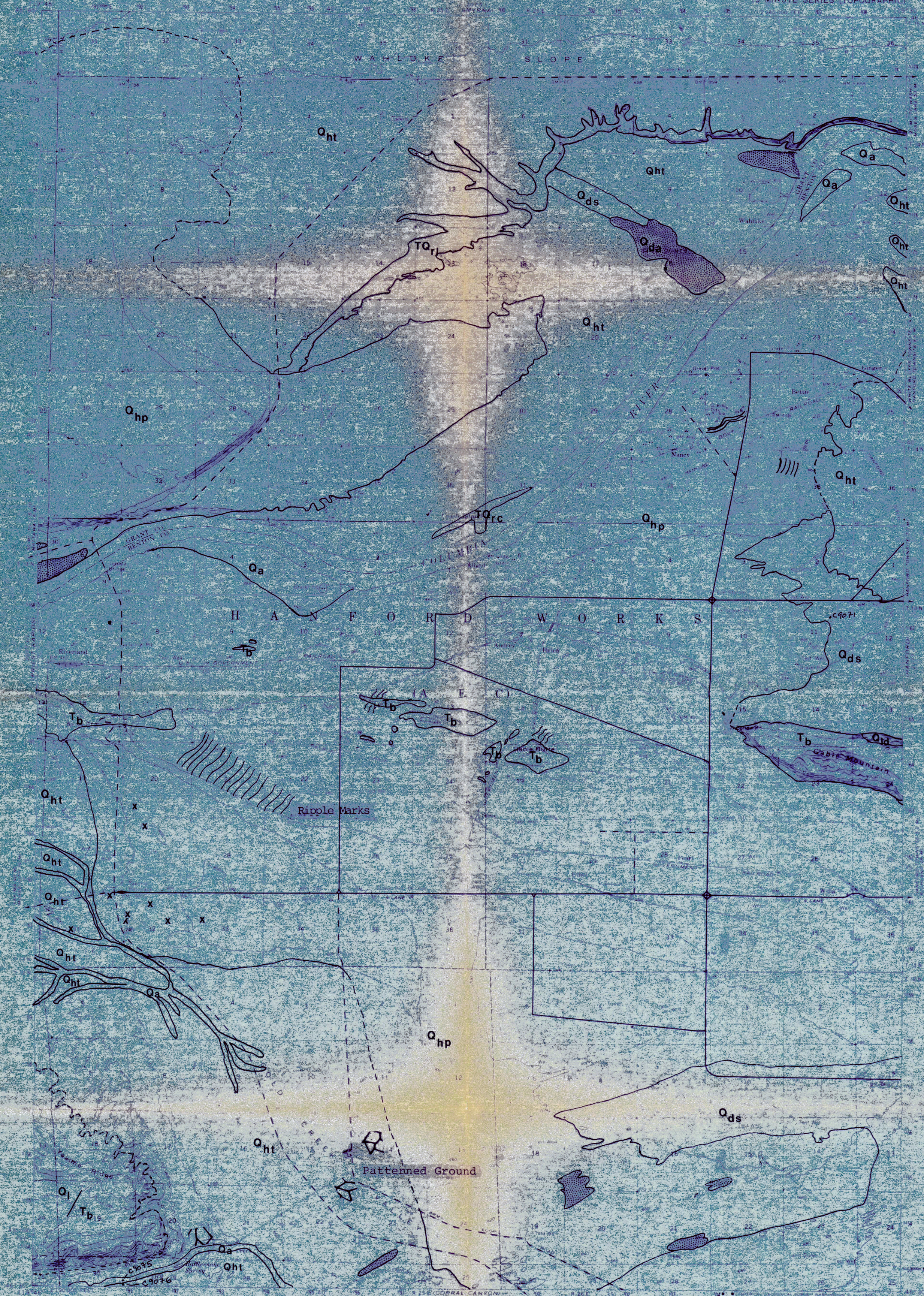




Rockwell	Hanford	Operations	Basalt	Waste	Isolation	Program
PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN			Appd. Program Dir.	Date	Quality Assurance	Date
			Appd. Unit Mngr.		Appd. Project Mngr.	
			Drafting Appd.		Responsible Engr.	
			Drawn		Review	
			Scale		Drawing No.	

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

COYOTE RAPIDS QUADRANGLE  
WASHINGTON  
15 MINUTE SERIES (TOPOGRAPHIC)



Map was edited and published by the Geological Survey  
in cooperation with the Army Map Service  
under the terms of a contract dated 1965  
and revised 1966  
The map was prepared from aerial  
photographs taken in 1965 and 1966  
and from ground truthing data  
collected in 1965 and 1966  
The map was prepared from aerial  
photographs taken in 1965 and 1966  
and from ground truthing data  
collected in 1965 and 1966  
The map was prepared from aerial  
photographs taken in 1965 and 1966  
and from ground truthing data  
collected in 1965 and 1966

POCKET PART 5 OF 13 RHO-BWI-LD-8  
PLATE 5 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
THE WESTERN HALF OF THE PASCO BASIN

FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242  
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

COYOTE RAPIDS, WASH.  
14630-W11930715  
1965  
AMS 2077 (I) SERIES VII



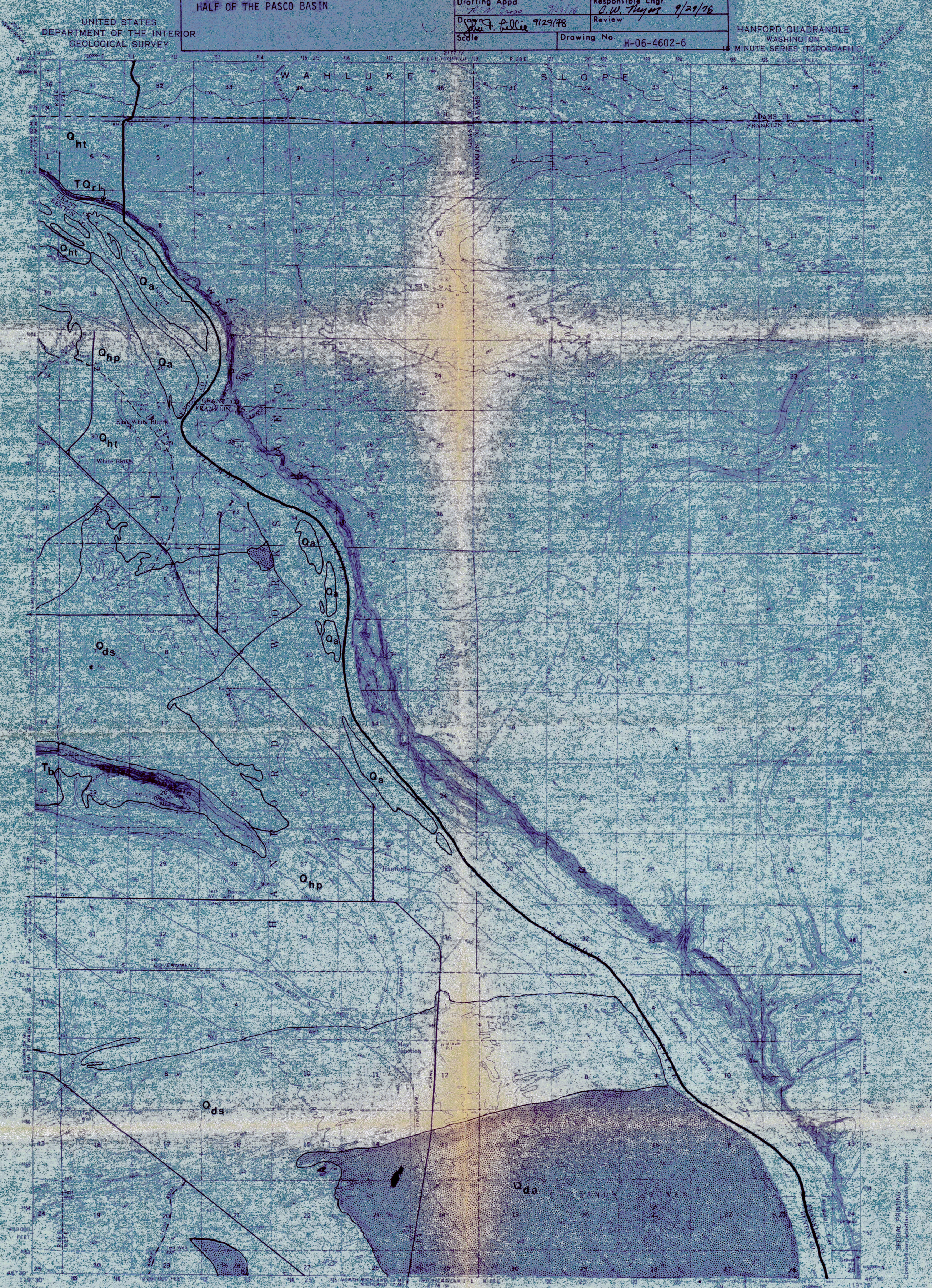
Rockwell Hanford Operations

Basalt Waste Isolation Program

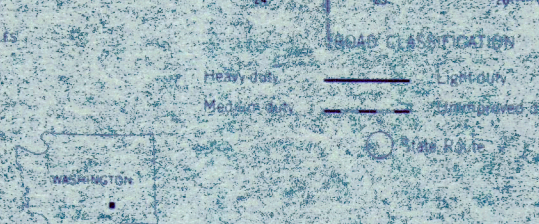
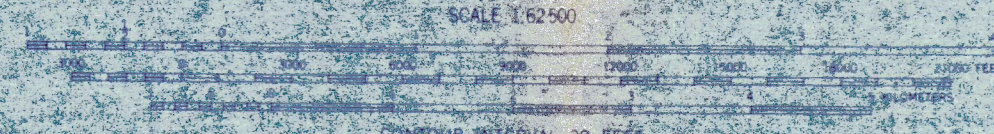
PRELIMINARY GEOLOGIC MAP OF THE LATE  
CENOZOIC SEDIMENTS OF THE WESTERN  
HALF OF THE PASCO BASIN

Appd. Program Dir.	Date	Quality Assurance	Date
Appd. Unit Mngr.		Appd. Project Mngr.	
Drafting Appd.		Responsible Engr.	
Drawn		Review	
Scale		Drawing No.	H-06-4602-6

HANFORD QUADRANGLE  
WASHINGTON  
MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey  
in cooperation with the Army Map Service  
Controlled by USGS and USCGS  
Topography by photogrammetric methods from aerial  
photographs taken 1948 and planimetric surveys 1951  
Revised from aerial photographs taken 1964  
Map checked 1965  
Polyconic projection - 1927 North American datum  
15,000 foot grid based on Washington coordinate system  
Scale 1:62,500  
UTM GRID AND ZEISS MAGNETIC NORTH  
INDICATION AT CENTER OF SHEET  
Contours shown in blue



HANFORD, WASH.  
N4630-W1915/15  
1965  
AMS 2177 III-SERIES V791

POCKET PART 6 OF 13 RHO-BWI-LD-8  
PLATE 6 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
THE WESTERN HALF OF THE PASCO BASIN

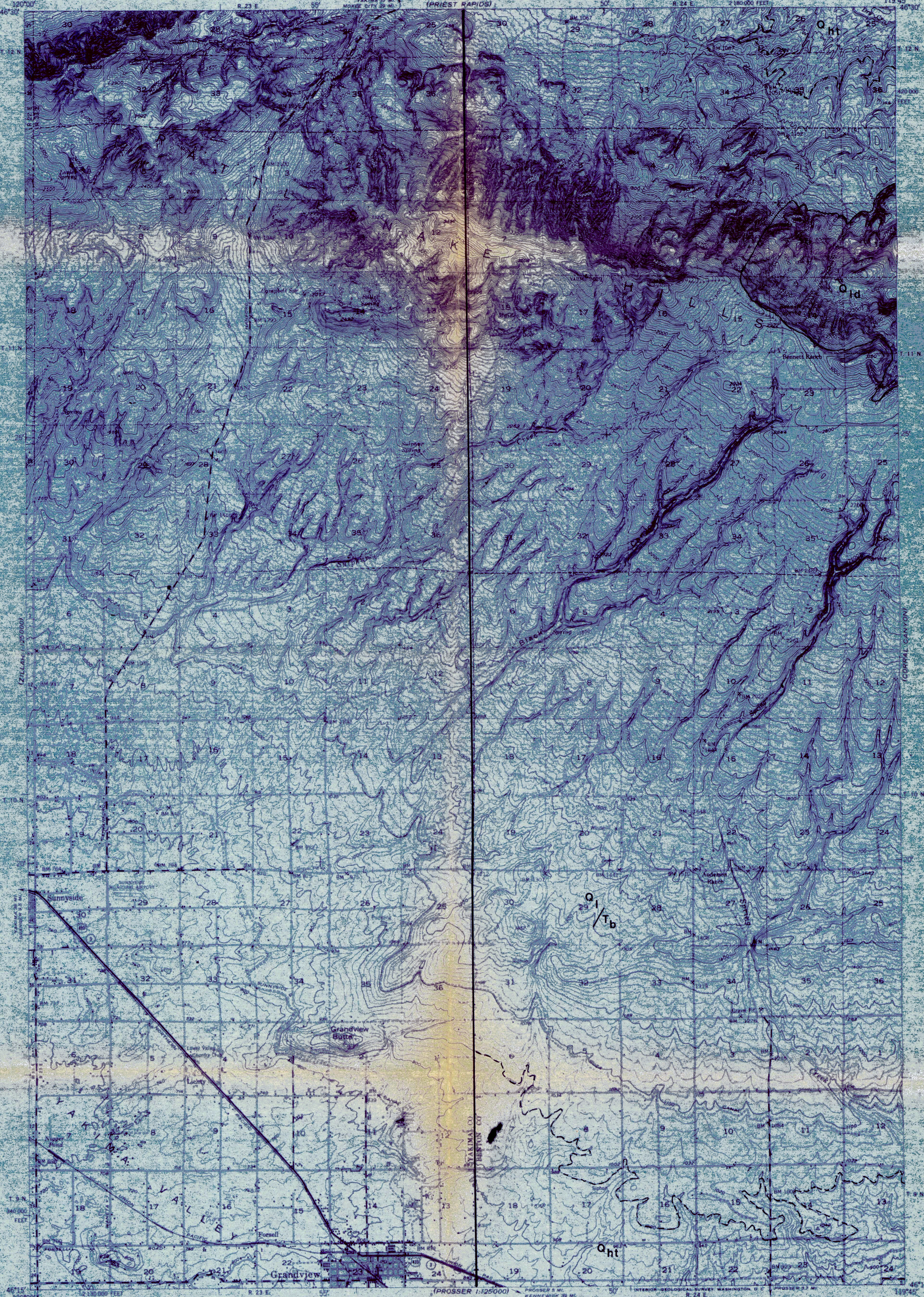


Rockwell	Hanford	Operations	Basalt	Waste	Isolation	Program
PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN			Appd. Program Dir.	Date	Quality Assurance	Date
			Appd. Unit Mngr.	9/29/78	Appd. Project Mngr.	11/6/79
			Drafting Appd.	9/29/79	Responsible Engr.	9/29/78
			Drawn	9/29/78	Review	
			Scale	Drawing No H-06-4602-7		

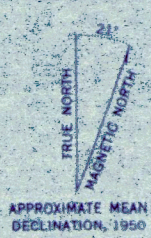
UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

UNITED STATES  
DEPARTMENT OF THE ARMY  
CORPS OF ENGINEERS  
(PRIEST RAPIDS)

GRANDVIEW QUADRANGLE  
WASHINGTON  
15 MINUTE SERIES (TOPOGRAPHIC)



Maped by the Geological Survey and Bureau of Reclamation.  
Edited and published by the Geological Survey  
Control by USGS and USO&GS  
Topography from plane-table surveys by USBR 1935-1941  
and by USGS from aerial photographs by multiplex methods  
Aerial photographs taken 1948. Field check 1950  
Polyconic projection, 1927 North American datum  
50,000-foot grid based on Washington coordinate system;  
south zone  
Red-dot indicates area in which only  
landmark buildings are shown  
Dashed land lines indicate approximate location  
Dotted land lines were established by USBR



CONTOUR INTERVAL 20 FEET  
DATUM IS MEAN SEA LEVEL

SCALE 1:62,500

ROAD CLASSIFICATION  
Heavy-duty ——— Lane 10 Lane Light-duty  
Medium-duty ——— Lane 10 Lane Unimproved dirt  
U.S. Route State Route

GRANDVIEW, WASH.  
N4615-W11945/15  
EDITION OF 1951

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

POCKET PART 7 OF 13 RHO-BWI-LD-8  
PLATE 7 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
THE WESTERN HALF OF THE PASCO BASIN







Rockwell	Hanford	Operations	Basalt	Waste	Isolation	Program
PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN			Appd. Program Dir.	date	Quality Assurance	Date
			Appd. Unit Mngr.		Appd. Project Mngr.	
			Drafting Appd.		Responsible Engr.	
			Drawn		Review	
			Scale		Drawing No.	

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION

RICHLAND QUADRANGLE  
WASHINGTON  
SIMULTANEOUS GEOGRAPHIC



Maped by the Geological Survey for the Army Map Service  
 Edited and published by the Geological Survey  
 Control by USGS and USACE  
 Topography from aerial photographs by multiple methods  
 and by planimetric methods  
 Aerial photographs taken 1943; field check 1951  
 Polyconic projection; 1927 North American datum  
 100,000-foot grid based on Washington coordinate system  
 south zone  
 Red-dot indicates areas in which only  
 landmark buildings are shown  
 1000-meter Universal Transverse Mercator grid ticks  
 zone 11, shown in blue  
 CONTOUR INTERVAL 20 FEET  
 DATUM: MEAN SEA LEVEL  
 FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D.C. 20242  
 A COLOR-DESIGNED PHOTOGRAPHIC MAP AND SYMBOLS IS AVAILABLE ON REQUEST  
 RICHLAND WASH.  
 1951  
 AMS 2175 IV, SERIES V701

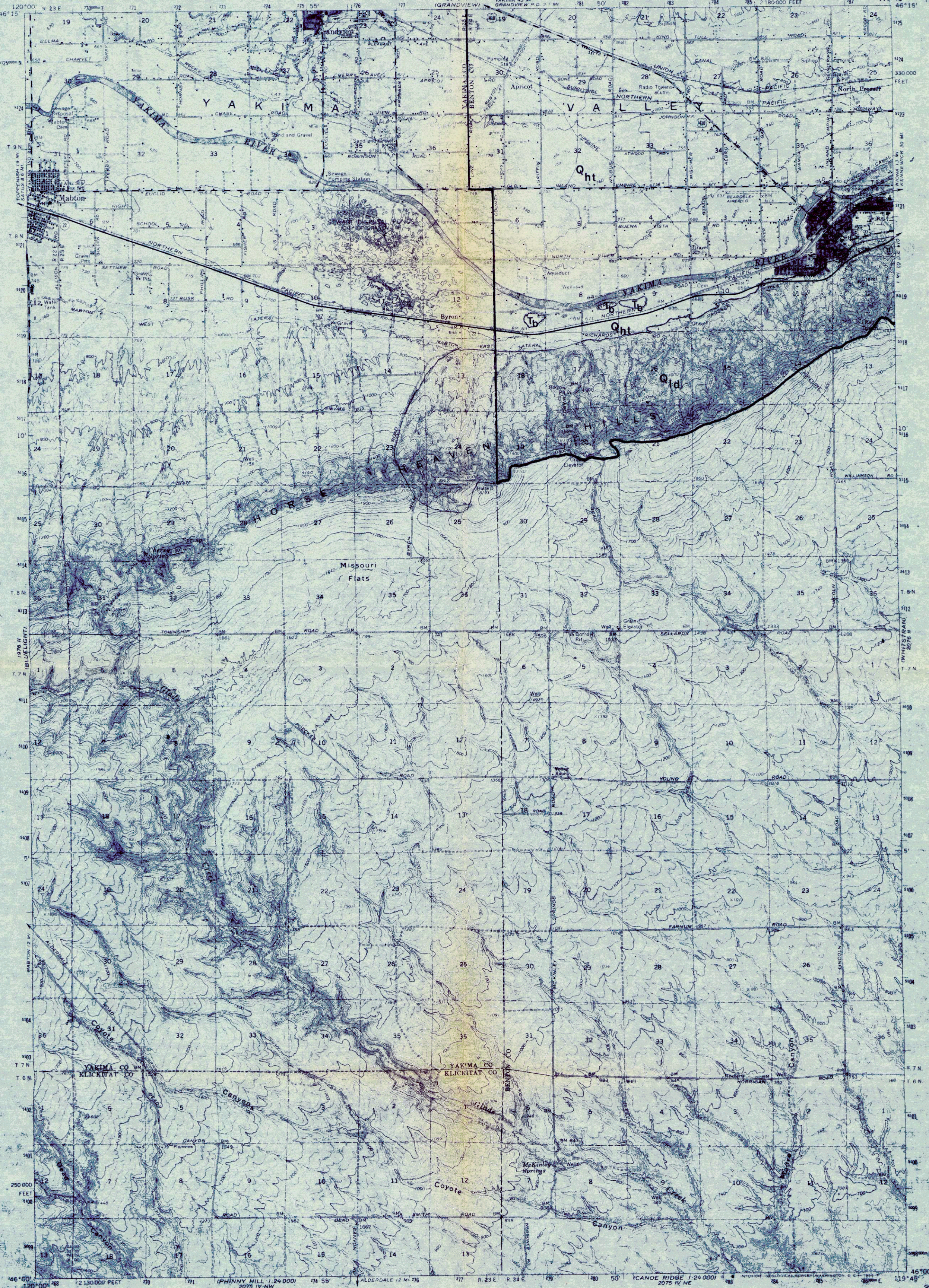
POCKET PART 9 OF 13 RHO-BW-LD-8  
 PLATE 9 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
 THE WESTERN HALF OF THE UNITED STATES



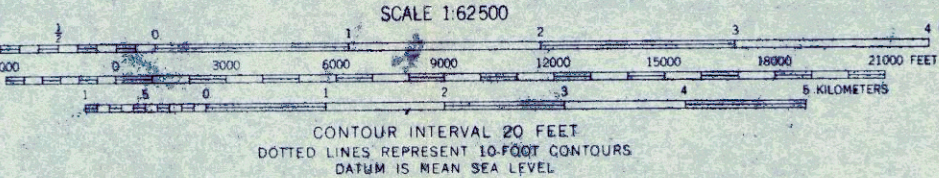
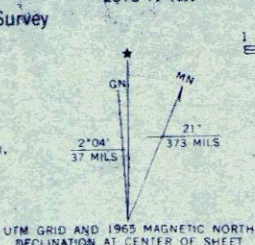
Rockwell	Hanford	Operations	Basalt	Waste	Isolation	Program
Appd. Program Dir.			Date		Quality Assurance	
Appd. Unit Mgr.			Date		Appd. Project Mgr.	
T. A. Curran (C.W.M.) 9/29/78			9/29/78		C.W. Myers 9/29/78	
Drafting Appd.			Date		Responsible Engr.	
9/29/78			9/29/78		C.W. Myers 9/29/78	
Drawn			Date		Review	
John F. Pillie 9/29/78			9/29/78		Review	
Scale			Drawing No. H-06-4602-10			

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

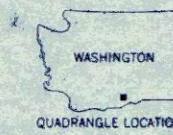
PROSSER QUADRANGLE  
WASHINGTON  
15 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey  
Control by USGS and USC&GS  
Topography by photogrammetric methods from aerial  
photographs taken 1963. Field checked 1965  
Polyconic projection. 1927 North American datum  
10,000-foot grid based on Washington coordinate system.  
South zone  
1000-meter Universal Transverse Mercator grid ticks,  
zone 11, shown in blue  
Red tint indicates areas in which only landmark  
buildings are shown  
Certain land lines are omitted because of insufficient data



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



THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS  
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242  
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

PROSSER, WASH.  
N4600-W11945/15  
1965  
AMS 2075 III SERIES V791

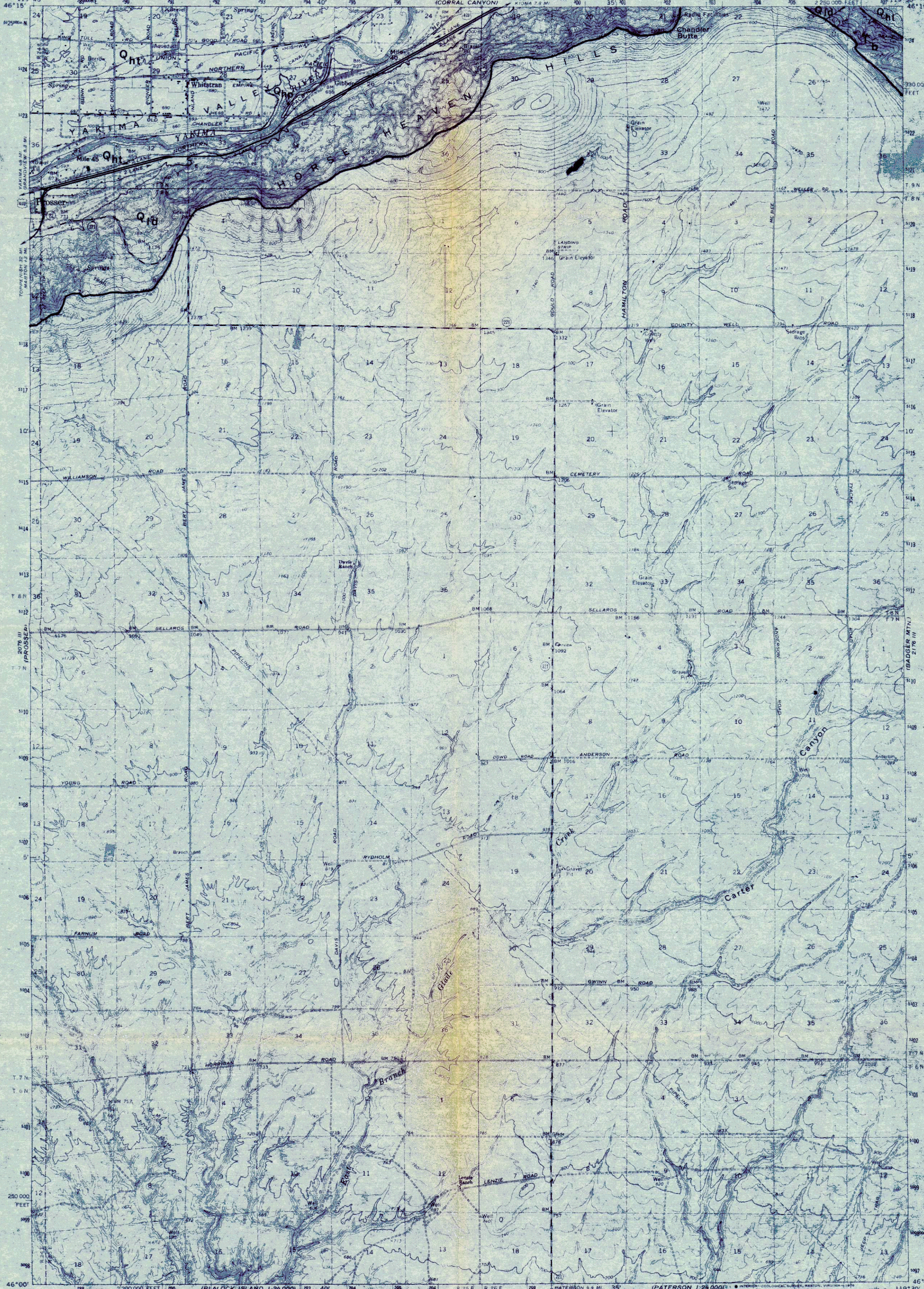
POCKET PART 10 OF 13. RHO-BWI-LD-8  
PLATE 10 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
THE WESTERN HALF OF THE PASCO BASIN



Rockwell Hanford Operations		Basalt Waste Isolation Program	
PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN		Appd. Program Dir. Date	Quality Assurance Date
		Appd. Unit Mngr. T.A. Curran (CWM) 9/29/78	Appd. Project Mngr. 9/29/78
		Drafting Appd.	Responsible Engr. C.W. Myers 9/29/78
		Drawn by J.W. Fuller 9/29/78	Review
		Scale	Drawing No. H-06-4602-11

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

WHITSTRAN QUADRANGLE  
WASHINGTON-BENTON CO.  
15 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey  
Control by USGS and USC&GS  
Topography by photogrammetric methods from aerial  
photographs taken 1963. Field checked 1965  
Polyconic projection. 1927 North American datum  
10,000-foot grid based on Washington coordinate system,  
south zone  
1000-metre Universal Transverse Mercator grid ticks,  
zone 11, shown in blue  
Red tint indicates area in which only  
landmark buildings are shown.

SCALE 1:62,500

CONTOUR INTERVAL 20 FEET  
DOTTED LINES REPRESENT 10-FOOT CONTOURS  
NATIONAL GEODETIC VERTICAL DATUM OF 1929

ROAD CLASSIFICATION

Heavy duty    Light duty  
Medium duty    Unimproved dirt

U.S. Route    State Route

POCKET PART 11 OF 13 RHO-BW-LD-8  
Plate 11 PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
THE WESTERN HALF OF THE PASCO BASIN

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS  
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092  
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

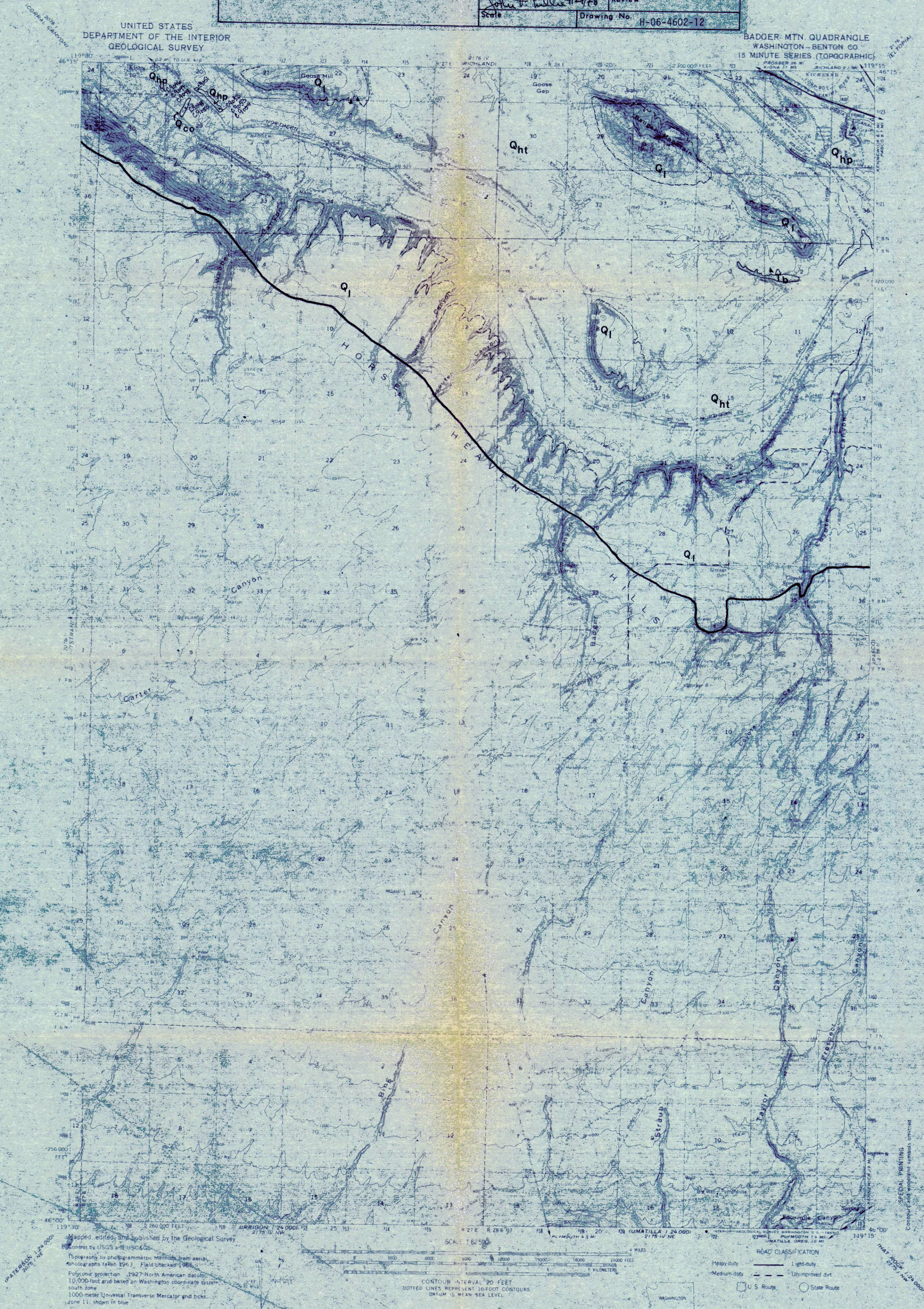
WHITSTRAN, WASH  
N4600-W11930/15  
1966  
AMS 2076 U-SERIES V251



Rockwell		Hanford		Operations		Basalt		Waste		Isolation		Program			
Appd. Program Dir.				Date				Quality Assurance				Date			
Appd. Unit Mngr.				Date				Appd. Project Mngr.				Date			
Drafting Appd.				Date				Responsible Engr.				Date			
Drawn				Date				Review				Date			
Scale				Drawing No.				H-06-4602-12							

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

BADGER MTN. QUADRANGLE  
WASHINGTON-BENTON CO.  
15 MINUTE SERIES (TOPOGRAPHIC)



Maped, edited, and published by the Geological Survey.  
Control by USGS and USCGS.  
Topography by photogrammetric methods from aerial  
photographs taken 1963. Field checked 1965.  
Polyconic projection, 1927 North American datum.  
10,000-foot grid based on Washington coordinate system,  
south zone.  
1000-meter Universal Transverse Mercator grid ticks,  
zone 11, shown in blue.

FOR SALE BY U.S. GEOLOGICAL SURVEY, DEPT. OF THE INTERIOR, WASHINGTON, D.C. 20242  
A FOLDER DESCRIBING TOPOGRAPHIC, MAPS, AND SAMPLES IS AVAILABLE ON REQUEST

POCKET PART 12 OF 13 RHO-BW-LD-8  
PLATE 12 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
THE WESTERN HALF OF THE PASCO BASIN

BADGER MTN., WASH.  
N4600-W11915/15  
1965

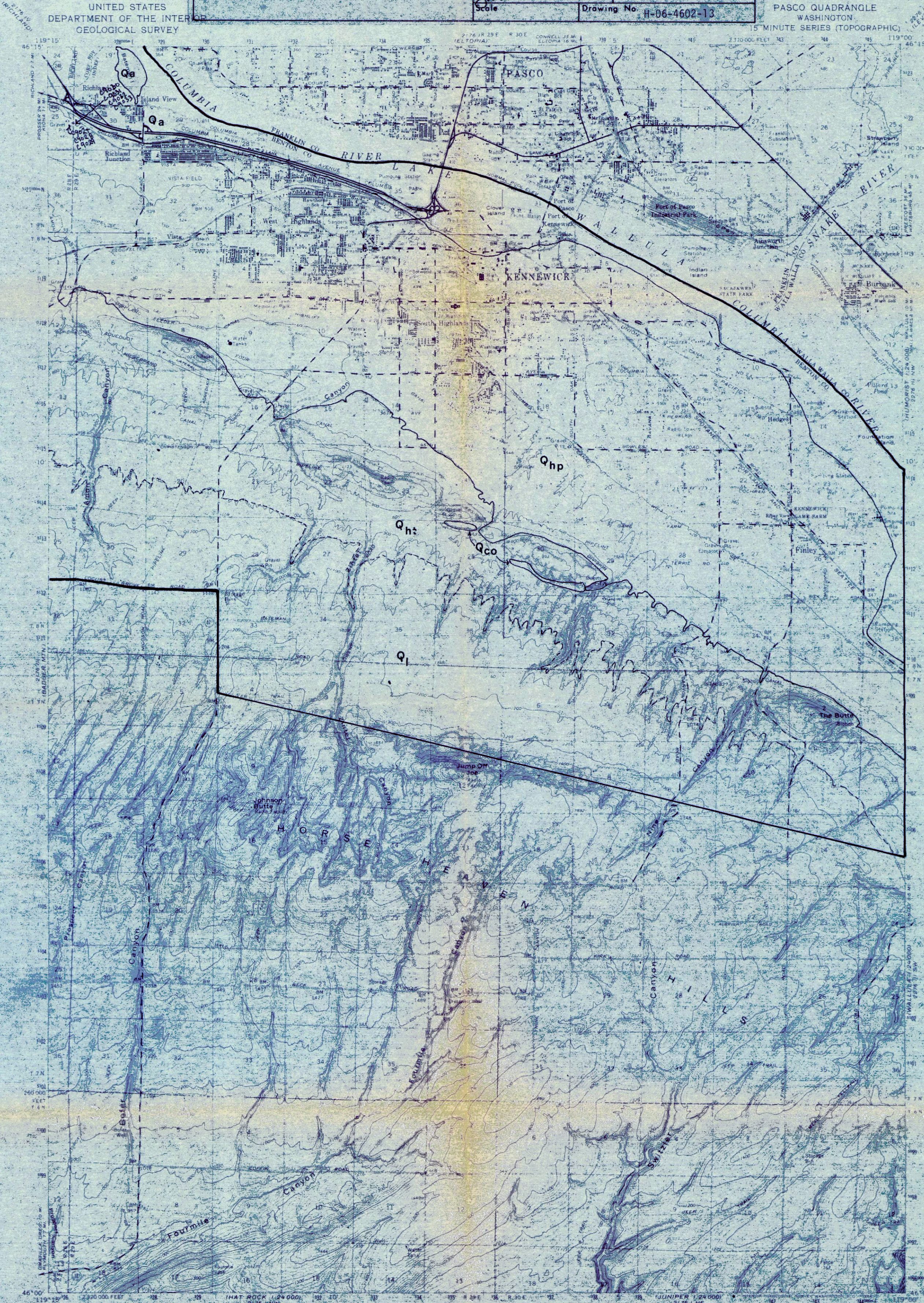
AMS 2176 H-SERIES 779



Rockwell Hanford Operations		Basalt Waste Isolation Program	
Appd. Program Dir.	Date	Appd. Project Mngr.	Date
Appd. Unit Mngr.	9/29/78	Responsible Engr.	9/29/78
Drafting Appd.	7/29/78	Review	
Drawn by	John P. Hillie 7/29/78		
Scale		Drawing No.	H-06-4602-13

PRELIMINARY GEOLOGIC MAP OF THE LATE  
CENOZOIC SEDIMENTS OF THE WESTERN  
HALF OF THE PASCO BASIN

PASCO QUADRANGLE  
WASHINGTON  
15 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey  
Control by USGS and USC&GS  
Topography by photogrammetric methods from aerial  
photographs taken 1959. Field checked 1964  
Underwater contours by USCG  
Selected hydrographic data compiled from  
USCG Charts 6164 (1960) and 682 SG (1963)  
This information is not intended for navigational purposes  
Polyconic projection: 1927 North American datum;  
10,000-foot grid based on Washington coordinate system,  
south zone  
1000-meter Universal Transverse Mercator grid ticks,  
zone 11, shown in blue  
Red tint indicates areas in which only landmark buildings are shown

UTM GRID AND 1964 MAGNETIC NORTH  
DECLINATION AT CENTER OF SHEET

SCALE 1:62,500

CONTOUR INTERVAL 20 FEET  
DOTTED LINES REPRESENT 10-FOOT CONTOURS  
DATUM IS MEAN SEA LEVEL  
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS NORMAL POOL ELEVATION 340 FEET

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

WASHINGTON  
QUADRANGLE LOCATION

PASCO, WASH.  
N4600—W11900/15  
1964  
AMS-2174-T-SERIES 7/79

POCKET PART 13 OF 13 RHO-BWI-LD-8  
PLATE 13 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF  
THE WESTERN HALF OF THE PASCO BASIN