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7. Abstract

This report outlines the types of geologic data available for the Hanford Site north of the Gable Mountain anticline and where this data can be obtained. This report also includes a discussion of the regional geology putting the study area in its geologic context.

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CONTENTS

FIGURES

1.0 INTRODUCTION

1.1 GEOGRAPHIC LOCATION AND SIGNIFICANCE OF AREA

Aquifer geology has a large impact on groundwater movement and contaminant transport. A geologic model for the Hanford Site north of the Gable Mountain anticline currently is lacking and without such a model the hydrogeology of this area can not be clearly understood. The 100 Aggregate Areas are located within this part of the Hanford Site.

The 100 Areas are divided into four groupings for this report: (1) BC and K, (2) N and D, (3) H, and (4) F. These areas are discussed separately because of the differences in geology between each. However, the geologic relationships between each of the localities will be discussed.

1.2 PURPOSE

This report outlines the types of geologic data for the Hanford Site north of the Gable Mountain anticline and where this data can be obtained. Based on the available data, preliminary geologic interpretations will be presented. These interpretations will be divided into four site specific sections: (1) 100-BC and 100-K, (2) 100-N and 100-D, (2) 100-H, and (4) 100-F. This report includes a brief discussion of regional geology in order to put the study area in its geologic context.

2.0 DATA SOURCES

A variety of data is available for many of the boreholes in the 100 Areas. These data include borehole logs, sediment samples, and grain size distributions. The data available for each well are compiled in Peterson (1991).

2.1 BOREHOLE LOGS

Geologic and drillers borehole logs can be acquired from several sources. Logs for boreholes drilled in the 600 Area prior to 1982 are reproduced nearly verbatim in (Fecht and Lillie, 1982). Material prepared by Ledgerwood (1991) provide another source of information on borehole geology and well construction.

A file containing copies of most, if not all, borehole logs is maintained by the Environmental Data Management Center and Environmental Field Services Group. This file contains geologic summaries as well as copies of original borehole geologic logs. Copies of borehole logs can be found in reports on the 100-N (Hartman 1991b), 100-D (Hartman 1991a), and 100-H (Liikala et al. 1988) areas.

2.2 HANFORD GEOTECHNICAL SAMPLE LIBRARY

Drill cuttings from boreholes drilled at the Hanford Site are kept in the Hanford Geotechnical Sample Library in the 2101-M Building in the 200 East Area. Most of these samples are kept in 1-pint glass jars. Some split tube samples also are kept in the sample library. All of these samples are available for examination and analysis with permission from the Geoscience Group Manager.

Intact drill core is kept in a warehouse at Big Pasco Industrial Park in east Pasco. Most of this core is 2.5-in. diameter and the majority is from the Columbia River Basalt Group. No core from the suprabasalt sediments in the 100 Areas is available. The core stored at this facility were drilled by the Basalt Waste Isolation Project (BWIP), Golder Associates for the Puget Sound Power and Light Project (PSPL), and by several dam construction projects on the Columbia River. These cores are available for examination and analysis with permission from the Geoscience Group Manager.

2.3 ROCSAN DATABASE

The ROCSAN database is a computer database on the Hanford Local Area Network. ROCSAN contains grain-size distribution data acquired through sieve analysis of a drill cuttings, intact core, and split-tube samples. This database should be used with some caution because it not always clear how representative of true geologic conditions the samples submitted for sieving are.

2.4 OTHER DATA SOURCES

There are a several other databases and data sources available for characterization of Hanford Site geology. One of these is the Hanford Environmental Information Database (HEIS). HEIS is a newly created computer database that will contain summaries of geologic logs and other borehole information for boreholes across the Hanford Site. This database is not yet fully operational.

The Washington Public Power Supply System (WPPSS) drilled a number of boreholes, including several cored holes, on and near the Hanford Site. Three of the cored holes are in the vicinity of the 100-N Area. Information on some WPPSS boreholes are available in Fecht and Lillie (1982). Some of the core and drill cuttings from WPPSS projects is stored at WPPSS facilities on the Hanford Site.

Copies of borehole logs from holes drilled across the state are kept by the Washington State Department of Ecology (Ecology). Most of these logs are driller's logs of water wells and contain limited geologic information. Ecology's borehole log files are maintained at offices in Spokane, Washington, Yakima, Washington, and Olympia, Washington.

A final source of information is the report by Newcomb et al. (1972). This report contains a limited number of borehole geologic logs from the Hanford Site and surrounding area.

3.0 REGIONAL GEOLOGIC SETTING

The Hanford Site lies in the Pasco Basin, a structural depression, near the eastern limit of the Yakima Fold Belt (Figures 1 and 2). The Hanford Site is underlain by Miocene-aged basalts of the Columbia River Basalt Group and late Miocene to Pleistocene suprabasalt sediments (Figure 3) that thicken into the Pasco Basin. Older Cenozoic sedimentary and volcaniclastic rocks underlying the basalts are not exposed at the surface near the Hanford Site.

3.1 COLUMBIA RIVER BASALT GROUP

The Columbia River Basalt Group comprises an assemblage of tholeiitic, continental flood basalts of Miocene age. These flows cover an area of more than 63,000 mi^2 (163,157 km^2) in Washington, Oregon, and Idaho and have an estimated volume of about 40,800 mi^3 (174,356 km^3) (Tolan et al. 1989). Isotopic age determinations indicate that basalt flows were erupted approximately 17 to 6 Ma (million years before present), with more than 98% by volume being erupted in a 2.5 million year period (17 to 14.5 Ma) (Reidel et al. 1989).

Columbia River basalt flows were erupted from north to northwest-trending linear vent systems in north-central and northeastern Oregon, eastern Washington, and western Idaho (Swanson et al. 1979). The Columbia River Basalt Group is formally divided into five formations (from oldest to youngest): Imnaha Basalt, Picture Gorge Basalt, Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Of these, only the Picture Gorge Basalt is not known to be present in the Pasco Basin. The Saddle Mountains Basalt, divided into the Ice Harbor, Elephant Mountain, Pomona, Esquatzel, Asotin, Wilbur Creek, and Umatilla Members (Figure 3), forms the uppermost basalt unit throughout most of the Pasco Basin. The Elephant Mountain Member is the uppermost unit beneath most of the Hanford Site except near the 300 Area where the Ice Harbor Member is found and north of the 200 Areas where the Saddle Mountains Basalt has eroded down to the Umatilla Member locally. On anticlinal ridges bounding the Pasco Basin, erosion has removed the Saddle Mountains Basalt, exposing the Wanapum and Grande Ronde Basalts.

3.2 ELLENSBURG FORMATION

The Ellensburg Formation consists of all sedimentary units that occur between the basalt flows of the Columbia River Basalt Group in the central Columbia Basin. The Ellensburg Formation generally displays two main sediment types, volcaniclastics and siliciclastics. The volcaniclastics consist mainly of primary pyroclastic air fall deposits and reworked epiclastics derived from volcanic terrains west of the Columbia Plateau. Siliciclastic strata in the Ellensburg Formation consist of reworked clastic, plutonic, and metamorphic detritus derived from the Rocky Mountain terrain. A detailed discussion of the Ellensburg Formation on the Hanford Site area is given by Reidel and Fecht (1981). Smith et al. (1989) provide a discussion of age equivalent units adjacent to the Columbia Plateau.

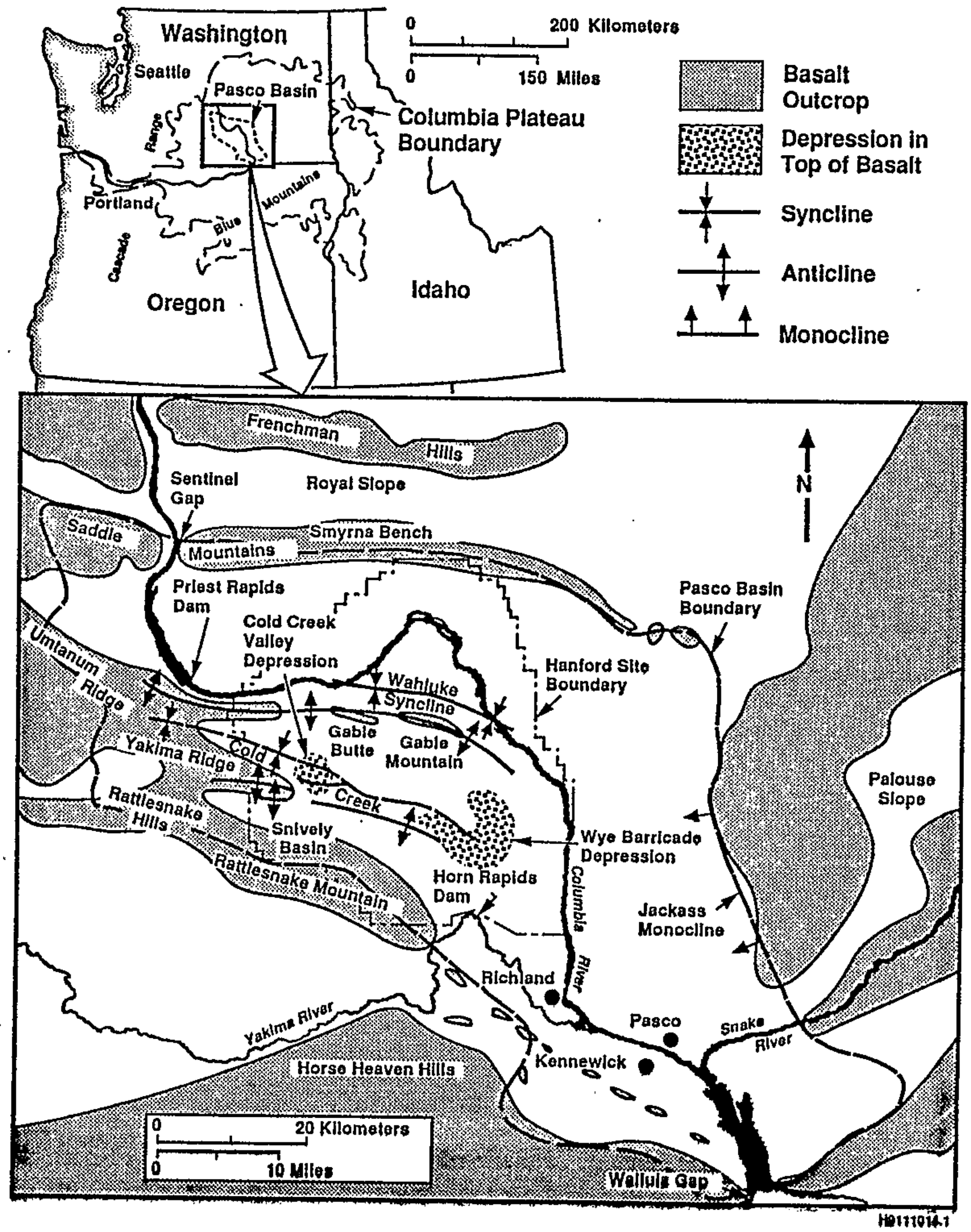


Figure 1. Geographic Setting and Generalized Structural Geology of the Pasco Basin and Hanford Site.

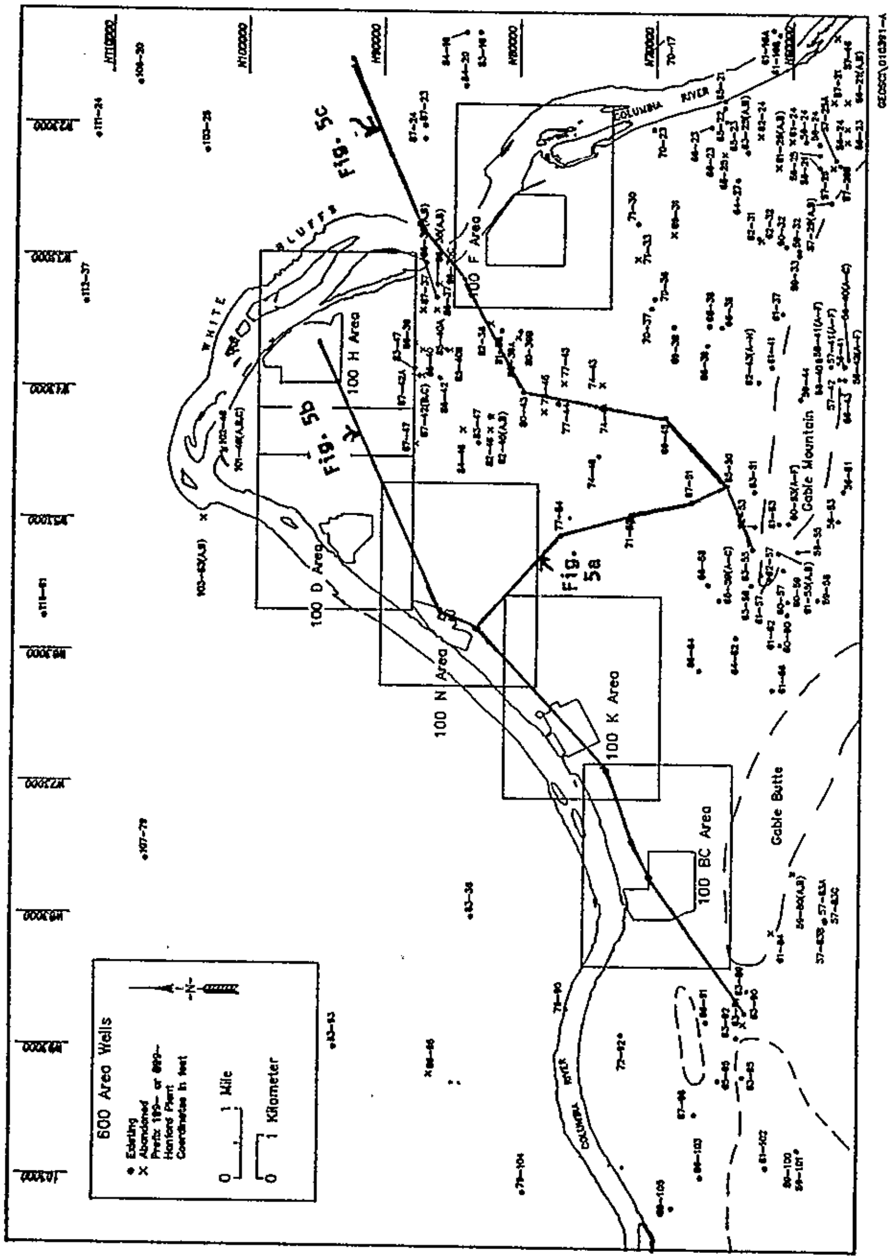


Figure 2. Location Map, Northern Hanford Site.
(Figure shows locations of cross-section illustrated in Figures 5a, 5b, and 5c)

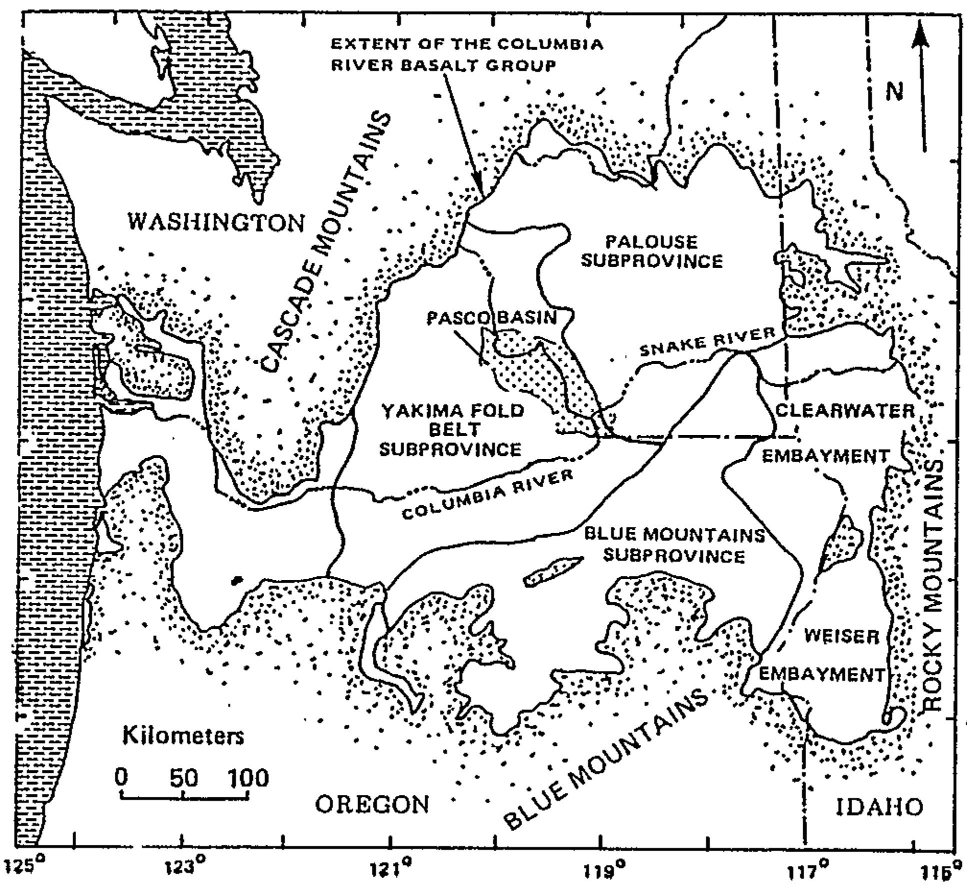


Figure 3. Geologic Provinces in the Columbia Basin.

9 2 1 2 5 2 1 5 1 6

The uppermost unit of the Ellensburg Formation in the Pasco Basin is the tuffaceous sandstone and siltstone of the Levey interbed. The Levey occurs between the Ice Harbor and Elephant Mountain Members of the Saddle Mountains Basalt and it is confined to the vicinity of the 300 Area. The Rattlesnake Ridge interbed is the uppermost unit in the Ellensburg Formation throughout the rest of the Hanford Site (including the 100 Areas). It is bounded on the top by the Elephant Mountain Member and on the bottom by the Pomona Member. The interbed is up to 108 ft (33 m) thick and dominated by three facies at the Hanford Site: (1) a lower clay or tuffaceous sandstone; (2) a middle, micaceous-arkosic and/or tuffaceous sandstone; and (3) an upper, tuffaceous siltstone-to-sandstone.

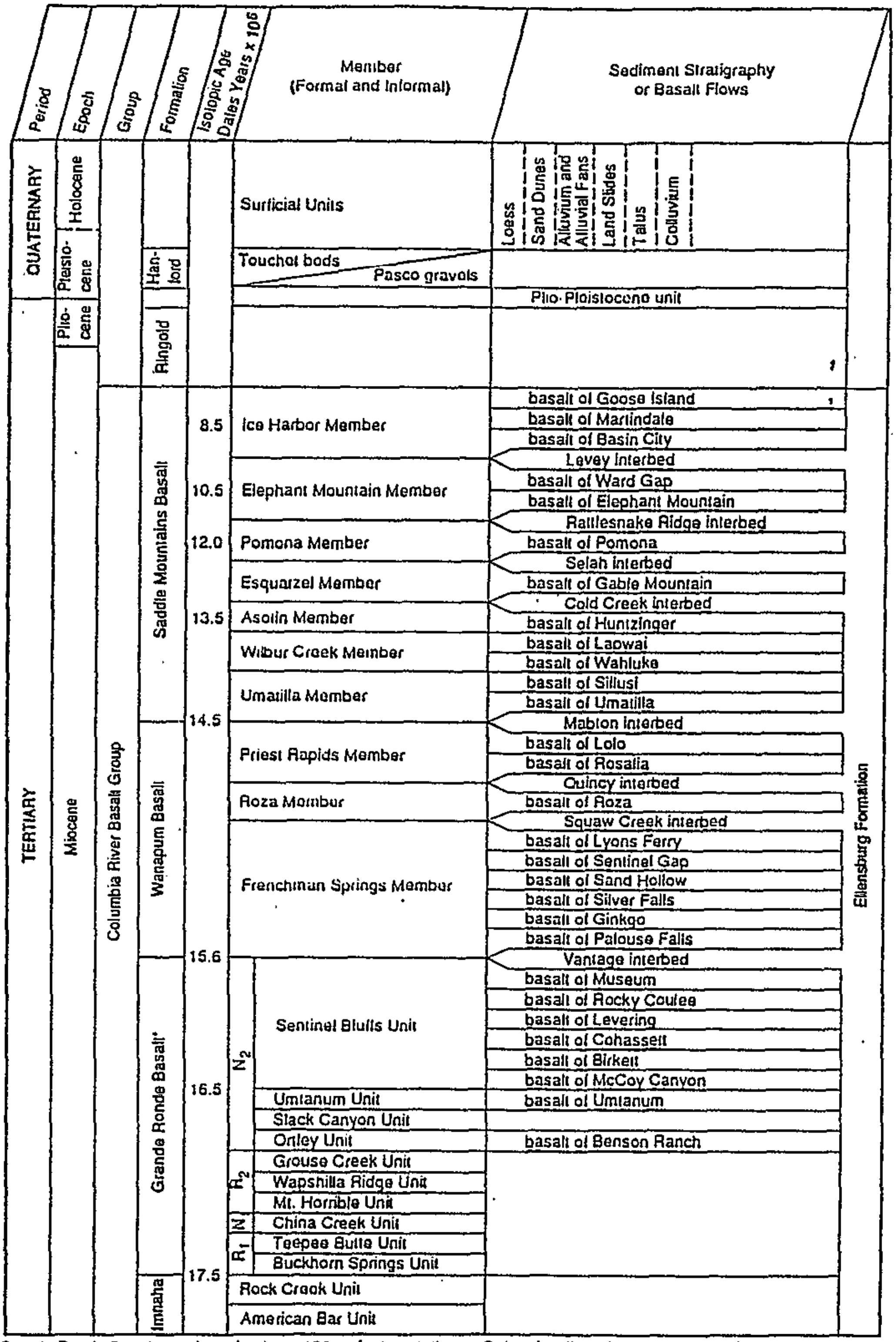
3.3 SUPRABASALT SEDIMENTS

The suprabasalt sedimentary sequence at the Hanford Site is up to approximately 750 ft (230 m) thick in the west central Cold Creek syncline, while it pinches out against the Saddle Mountains anticline, Gable Mountain/Umtanum Ridge anticline, Yakima Ridge anticline, and Rattlesnake Hills anticline. The suprabasalt sediments are dominated by laterally extensive deposits assigned to the late Miocene to Pliocene-aged Ringold Formation and the Pleistocene-aged Hanford formation (Figure 4). The informally defined Plio-Pleistocene unit, early "Palouse" soil, and pre-Missoula gravels separate the Ringold Formation and Hanford formation locally.

3.3.1 Ringold Formation

Recent studies of the Ringold Formation in the Pasco Basin and Hanford Site indicate it contains significant, previously undocumented stratigraphic variation (Lindsey and Gaylord 1989; Lindsey 1991). The Ringold Formation is up to 600 ft (185 m) thick in the deepest part of the Cold Creek syncline south of the 200 West Area and 560 ft (170 m) thick in the western Wahluke syncline near the 100-B Area. The Ringold Formation pinches out against the Gable Mountain, Yakima Ridge, Saddle Mountains, and Rattlesnake Mountain anticlines. It is largely absent in the northern and northeastern parts of the 200 East Area and adjacent areas to the north in the vicinity of West Pond.

The Ringold Formation consists of semi-indurated clay, silt, pedified mud, fine- to coarse-grained sand, and granule to cobble gravel. These strata have commonly been divided into the (1) gravel, sand, and paleosols of the basal unit; (2) clay and silt of the lower unit; (3) gravel of the middle unit; (4) mud and lesser sand of the upper unit; and (5) basaltic detritus of the fanglomerate unit (Newcomb 1958; Newcomb et al. 1972; Myers et al. 1979; Bjornstad 1984; DOE 1988). Ringold strata also have been divided on the basis of facies types (Tallman et al. 1981) and fining upwards sequences (PSPL 1982). All of these stratigraphic divisions are of limited use because they are too generalized to account for marked local stratigraphic variation or they were defined in detail for relatively small areas (Lindsey and Gaylord 1989). The Ringold Formation is assigned a late Miocene to Pliocene age (Fecht et al. 1987; DOE 1988).



*The Grande Ronde Basalt consists of at least 120 major basalt flows. Only a few flows have been named. N_2, R_2, N_1 and R_1 are magnetostratigraphic units.

H9102029.6

Figure 4. Generalized Stratigraphy of the Pasco Basin.

9 2 1 2 5 6 2 5 1 9

Recent studies of the Ringold Formation (Lindsey and Gaylord 1989; Lindsey 1991) indicate that it is best described and divided on the basis of sediment facies associations and their distribution. Facies associations in the Ringold Formation, defined on the basis of lithology, petrology, stratification, and pedogenic alteration, include fluvial gravel, fluvial sand, overbank deposits, lacustrine deposits, and alluvial fan. These facies associations [described in Lindsey (1991)] are summarized as follows:

1. Fluvial gravel - Strata consisting dominantly of clast-supported granule to cobble gravel with a sandy matrix form this association. Low angle to planar stratification, massive bedding, channels, and large-scale cross-bedding are found in outcrops. The association was deposited in a gravelly fluvial system characterized by wide, shallow, shifting channels.

2. Fluvial sand - Quartzo-feldspathic sands displaying cross-bedding and cross-lamination in outcrop dominates this association. The sands commonly form fining upwards sequences less than 1 m to several meters thick that were deposited in wide, shallow channels incised into a muddy floodplain.

3. Overbank - This association consists of laminated to massive silt, silty fine-grained sand, and paleosols containing variable amounts of pedogenic calcium carbonate. These sediments record deposition in a floodplain under proximal levee to more distal floodplain conditions.

4. Lacustrine - Plane laminated to massive clay with thin silt and silty sand interbeds displaying some soft-sediment deformation characterize this association. These sediments were deposited in a lake under standing water to deltaic conditions.

5. Alluvial fan - Massive to crudely stratified, weathered to unweathered basaltic detritus dominates this association. The association was deposited largely by debris flows in alluvial fan settings and in sidestreams.

The lower half of the Ringold Formation contains five separate stratigraphic intervals dominated by fluvial gravels. These gravels, designated units A, B, C, D, and E (Figure 4), are separated by intervals containing deposits typical of the overbank and lacustrine facies associations. The lowest occurrences of these fine-grained strata are designated the lower mud sequence (Figure 4). The uppermost gravel grades upward into interbedded fluvial sand and overbank deposits, which are in turn overlain by lacustrine deposits. A detailed discussion of Ringold strata in the 100 Areas is presented in Section 4.0.

3.3.2 Post-Ringold and Pre-Hanford Units

Three informal units separate the Ringold Formation from the Hanford formation in various parts of the Hanford Site. These units are the: (1) Plio-Pleistocene unit, (2) Pre-Missoula gravels, and (3) Early "Palouse" soil (Figure 4). None of these units are found north of the Gable Mountain anticline.

3.3.3 Hanford Formation

The Hanford formation consists of pebble to boulder gravel, fine- to coarse-grained sand, and silt. These deposits are divided into three facies: (1) gravel-dominated, (2) sand-dominated, and (3) slackwater. These facies are referred to as coarse-grained deposits, plane-laminated sand facies, and rhythmite facies respectively in Bjornstad et al. (1987). The slackwater deposits also are referred to as the "Touchet Beds". The Hanford formation is thickest in the vicinity of 200 West and 200 East Areas where it is up to 65 m thick. The Hanford formation was deposited by cataclysmic flood waters that drained out of glacial lake Missoula (Bjornstad et al. 1987; Fecht et al. 1987; DOE 1988). Hanford formation deposits are absent on ridges above approximately 385 m above sea level, the highest level of cataclysmic flooding in the Pasco Basin (Bjornstad et al. 1987).

The gravel-dominated facies generally consists of coarse-grained basaltic sand and granule to boulder gravel. These deposits display massive bedding, plane to low-angle bedding, and large-scale planar cross-bedding in outcrop. These gravels usually are matrix-poor and display an open-framework texture. Lenticular sand and silt beds are intercalated throughout the facies. Gravel clasts in the facies generally are dominated by basalt (50 to 80%). Other clast types include Ringold and Plio-Pleistocene rip-ups, granite, quartzite, and gneiss. The gravel facies dominates the Hanford formation in the 100 Areas north of Gable Mountain, the northern part of the 200 Areas, and the eastern part of the Hanford Site including the 300 Area. The gravel-dominated facies was deposited by high-energy flood waters in or immediately adjacent to the main cataclysmic flood channelways.

The sand-dominated facies consists of fine- to coarse-grained sand and granule gravel displaying plane lamination and bedding and less commonly plane bedding and channel-fill sequences in outcrop. These sands may contain small pebbles and rip-up clasts in addition to pebble-gravel interbeds and silty interbeds less than 1 m thick. The silt content of these sands is variable, but where it is low a well sorted and open framework texture is common. These sands typically are basaltic, commonly being referred to as black, gray, or salt-and-pepper sands. This facies is most common in the central Cold Creek Syncline, in the central to southern parts of the 200 Areas, and in the vicinity of the WPPSS facilities. The laminated sand facies was deposited adjacent to main flood channelways during the waning stages of flooding and as water spilled out of channelways, loosing competence. The facies is transitional between the gravel-dominated facies and the rhythmite facies.

The slackwater facies consists of thinly bedded, plane laminated and ripple cross-laminated silt and fine- to coarse-grained sand that commonly display normally graded rhythmites a few centimeters to several tens of centimeters thick (Myers et al. 1979; Bjornstad et al. 1987; DOE 1988). The facies dominates the Hanford formation along the western, southern, and northern margins of the Pasco Basin. These fine-grained deposits can also be found in the central, southern, and western Cold Creek syncline within and south of the 200 Areas. These sediments were deposited under slackwater conditions and in back flooded areas (DOE 1988).

In addition to the three Hanford formation facies discussed previously, clastic dikes (Black 1979) are commonly found in the Hanford formation. These dikes, while common in the Hanford formation, are found locally in other sedimentary units in the Pasco Basin. Clastic dikes, whether in the Hanford formation or other sedimentary units, are structures that generally cross-cut bedding, although they do locally parallel bedding. The dikes generally consist of alternating vertical to subvertical layers (millimeters to centimeters thick) of silt, sand, and granules. Where the dikes intersect the ground surface a feature known as patterned ground can be observed.

3.3.4 Holocene Surficial Deposits

Holocene surficial deposits consist of silt, sand, and gravel that form a thin [<16 ft (4.9 m)] veneer across much of the Hanford Site. These sediments were deposited by a mix of eolian and alluvial processes.

3.4 STRUCTURAL GEOLOGY

The Columbia Plateau can be divided into three informal structural subprovinces: Blue Mountains, Palouse, and Yakima Fold Belt (Figure 1) (Tolan and Reidel 1989). These structural subprovinces are delineated on the basis of their structural fabric, unlike the physiographic provinces that are defined on the basis of landforms. The Hanford Site is located near the junction of the Yakima Fold Belt and the Palouse subprovinces.

The Yakima Fold Belt consists of a series of segmented, narrow, asymmetric anticlines that have wavelengths between 3 and 19 mi (5 to 32 km) and amplitudes commonly less than 0.6 mi (1 km) (Reidel et al. 1989). The northern limbs of the generally east-west trending asymmetric anticlines of the Yakima Fold Belt dip steeply to the north or are vertical. The south-dipping limbs generally dip at relatively shallow angles. Thrust or high-angle reverse faults with fault planes that strike parallel or subparallel to the anticline axial trends are principally found on the north sides of these anticlines. The amount of vertical stratigraphic offset associated with these faults varies but commonly exceeds hundreds of meters. These anticlinal ridges are separated by broad synclines or basins that, in many cases, contain thick accumulations of Neogene- to Quaternary-age sediments. Deformation of the Yakima folds occurred under north-south compression and was contemporaneous with the eruption of the Columbia River basalts (Reidel 1984; Reidel et al. 1989). The fold belt continued to be active through the Pliocene Epoch, into the Pleistocene Epoch, and perhaps to the present.

The Pasco Basin (where the Hanford Site is situated) is one of the largest structural basins on the Columbia Plateau. The Pasco Basin is bounded on the north by the Saddle Mountains anticline, on the west by the Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills anticlines, and on the south by the Rattlesnake Mountain anticline (Figure 2). The Palouse slope, a west-dipping monocline, bounds the Pasco Basin on the east (Figure 2). The Pasco Basin is divided into the Wahluke and Cold Creek synclines by the Gable Mountain anticline, the easternmost extension of the Umtanum Ridge anticline (Figure 1).

The Wahluke syncline (Figure 1) is the principal structural unit that contains the 100 Areas. The Wahluke syncline is an asymmetric and relatively flat-bottomed structure similar to the Cold Creek syncline. The northern limb dips gently (approximately 5°) to the south. The steepest limb is adjacent to the Umtanum Ridge structure. The Gable Mountain/Gable Butte segment of the Umtanum Ridge structure consists of two topographically isolated, anticlinal ridges that are composed of a series of northwest trending, doubly plunging, en echelon anticlines, synclines, and associated faults (Fecht et al. 1987). Capable faulting has been identified on Gable Mountain (NRC 1982; PSPL 1982).

4.0 GEOLOGY OF THE 100 AREAS

All of the 100 Areas except 100-B/C are situated on the north limb of the Waluke syncline. Consequently, strata beneath these areas tend to dip at shallow angles to the south. The 100-B/C Area lies on and just south of the axis of the syncline. The Elephant Mountain Member of the Saddle Mountains Basalt underlies the entire 100 Areas. Because few holes penetrate to the Elephant Mountain Member, little information about them is available.

The suprabasalt sedimentary section in the 100 Areas consists of the Ringold Formation, Hanford formation, and Holocene surficial deposits. The Ringold Formation shows significant stratigraphic variation across the 100 Areas (Figures 5a, 5b, and 5c). Gravel-dominated intervals generally are more abundant and thicker in the western part of the Wahluke syncline. These gravels pinchout to the north, up dip on the north limb of the syncline. In addition, gravels dominate the uppermost Ringold in the west while in the east the uppermost Ringold deposits are dominated by muds. The muds that separate the gravel sequences generally are thicker than correlative intervals south of the Gable Mountain anticline.

The gravel-dominated facies dominates the Hanford formation throughout the 100 Areas. Horizons consisting of the sand-dominated facies are present locally. The slackwater or graded rhythmite facies has not been identified in the 100 Areas. Where the Hanford formation overlies Ringold gravels, in the western part of the area (Figure 6), the contact between them is usually determined by an increase in cementation or induration in Ringold versus Hanford deposits and/or a change in lithology to more felsic deposits in the Ringold Formation. Where Hanford gravels overlie mud-dominated Ringold deposits, in the easter part of the area (Figure 6), the contact is placed at the bottom of the last gravel.

Holocene deposits in the 100 Areas are dominated by Columbia River deposits and eolian deposits. The river deposits consist of gravels and coarse-grained sands deposited in channels and overbank silts and fine sands. Eolian deposits consist of thin (<1 m) fine silty sands that blanket much of the area to well developed dune sands. Sections 4.1 through 4.4 discuss the geology of each of the 100 Areas in more detail.

Explanation

Grain Size Scale, Indicates Dominant Grain Size in an Interval

C/Z S P C/B

C/Z	Clay and silt
S	Sand
P	Pebble Gravel
C/B	Cobble and boulder gravel

Additional Lithologic Symbols, Includes Subordinate Lithologies

- Pedogenic calcium carbonate
- Paleosols
- Silt–rich strata
- Clay–rich strata
- Clast supported pebble–cobble gravels
- Clast supported, cobbly to bouldery gravels
- ++++ Ash
- Basalt

Other Symbols

- ————?——?—— Formational contact, ? where inferred
- — — — —?—?—?— — Unit or sequence contact, ? where inferred
- - - - - - - - - - - Major facies contact

Stratigraphic Abbreviations

EP – Early "Palouse" soil
PP – Plio–Pleistocene unit
UR – Upper unit, Ringold Formation
E – Gravel unit E, Ringold Formation
D – Gravel unit D, Ringold Formation
C – Gravel unit C, Ringold Formation
B – Gravel unit B, Ringold Formation
LM – Lower mud sequence, Ringold Formation
A – Gravel unit A, Ringold Formation

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Figure 5. Explanation of Symbols used in Ringold Formation Cross-Sections, Figures 5a, 5b, and 5c.

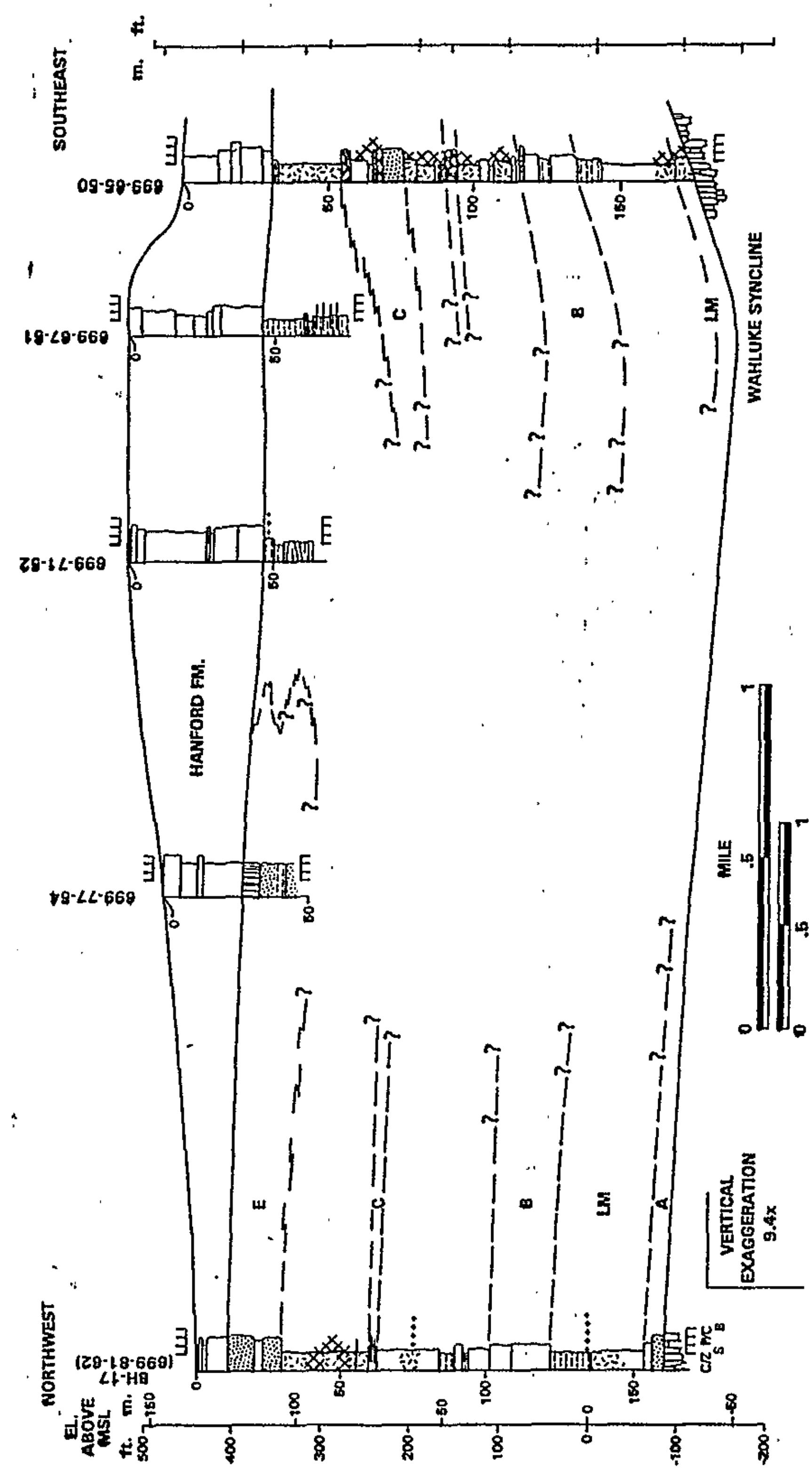

Figure 5a. Northwest to Southeast Oriented Cross-Section in the Ringold Formation Between Boreholes 699-81-62 and 699-65-50.

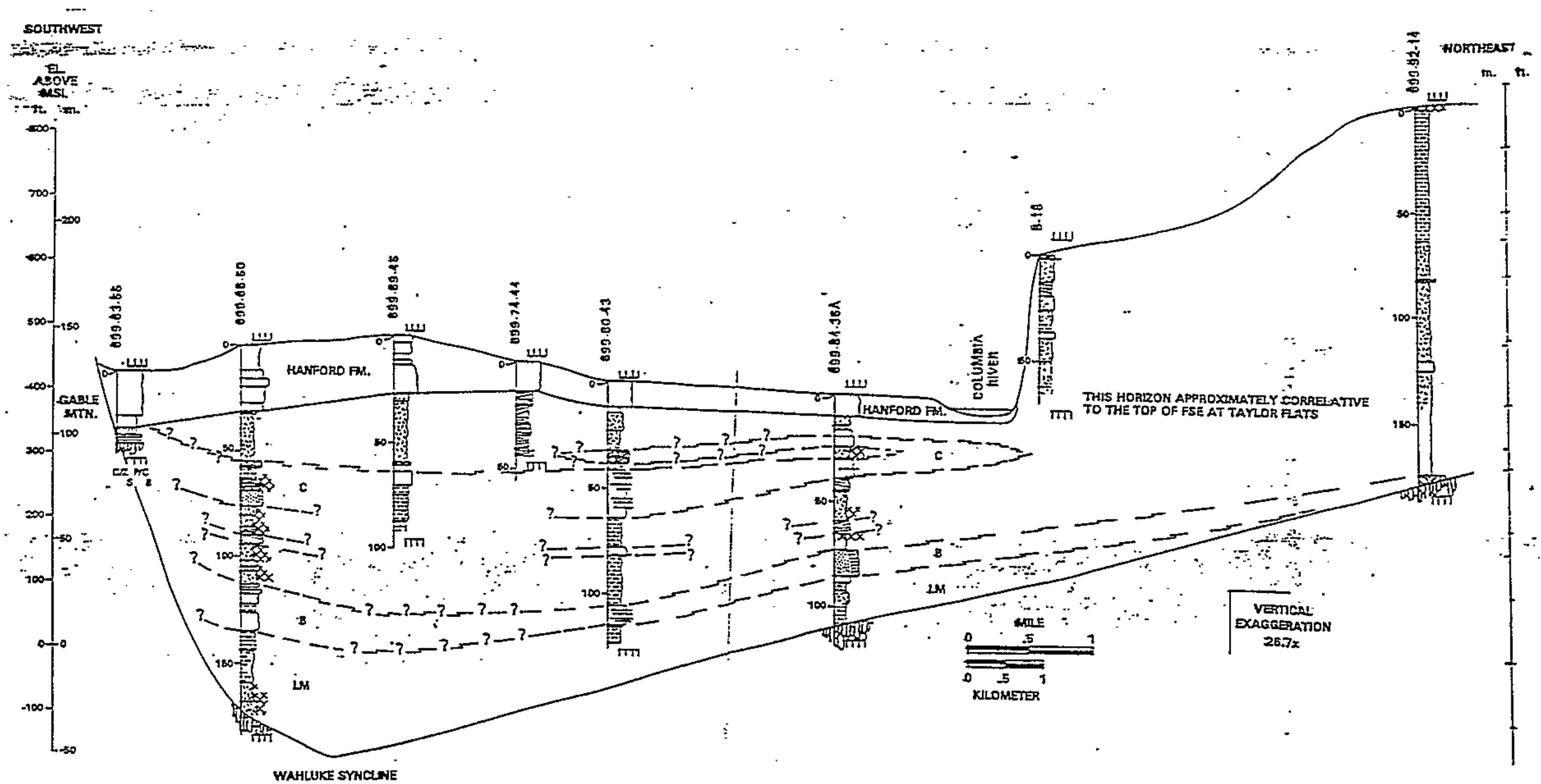

Figure 5c. Southwest to Northeast Oriented Cross-Section in the Ringold Formation Between Boreholes 699-63-55 and 699-92-14.

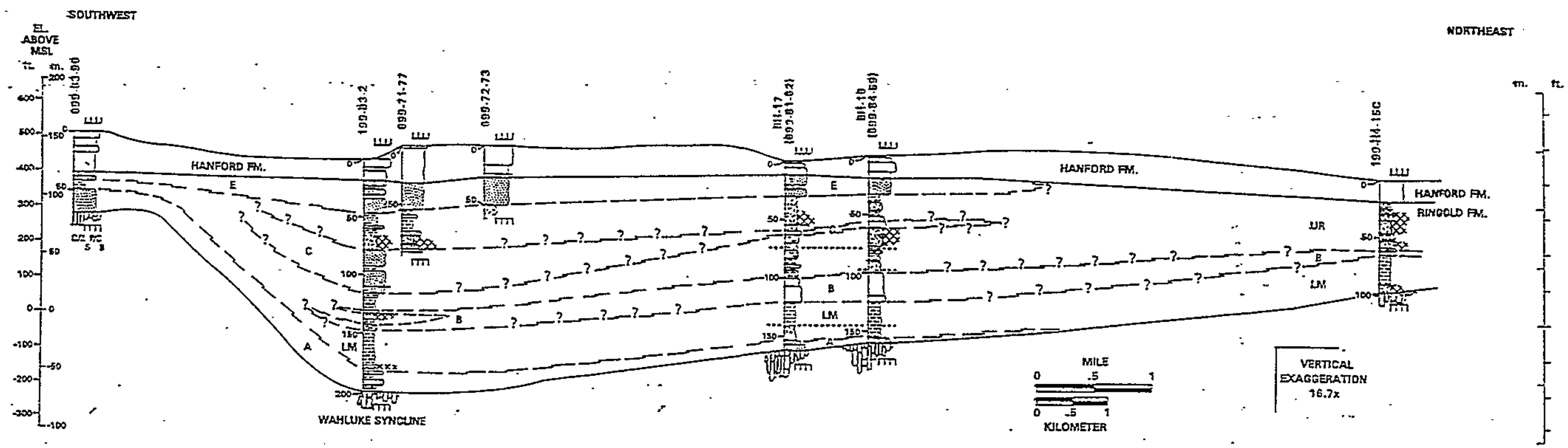

Figure 5b. Southwest to Northeast Oriented Cross-Section in the Ringold Formation Between Boreholes 699-63-90 and 199-H4-15C.

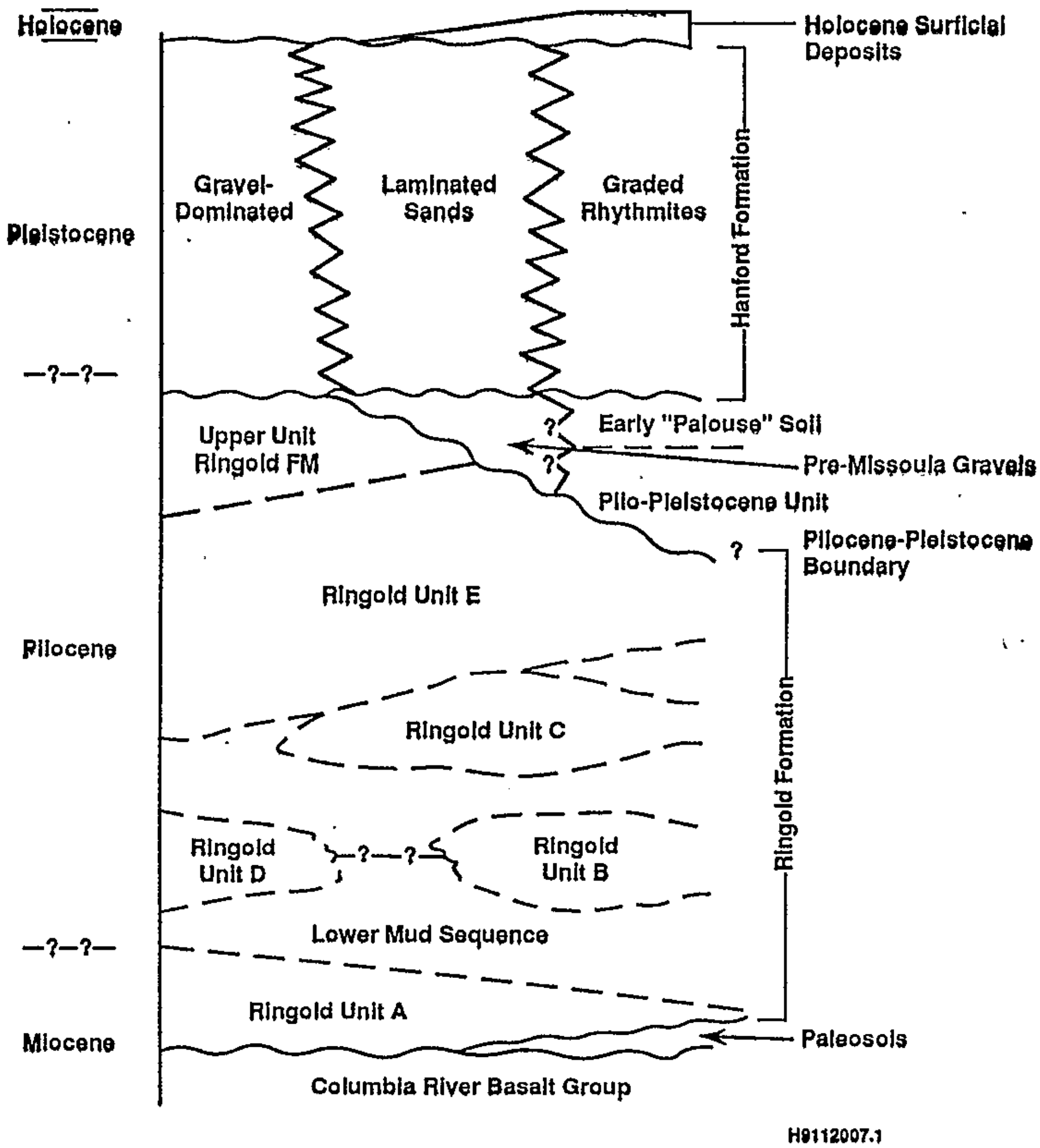

Figure 6. Generalized stratigraphy of the Suprabasalt Sediments in the Pasco Basin.

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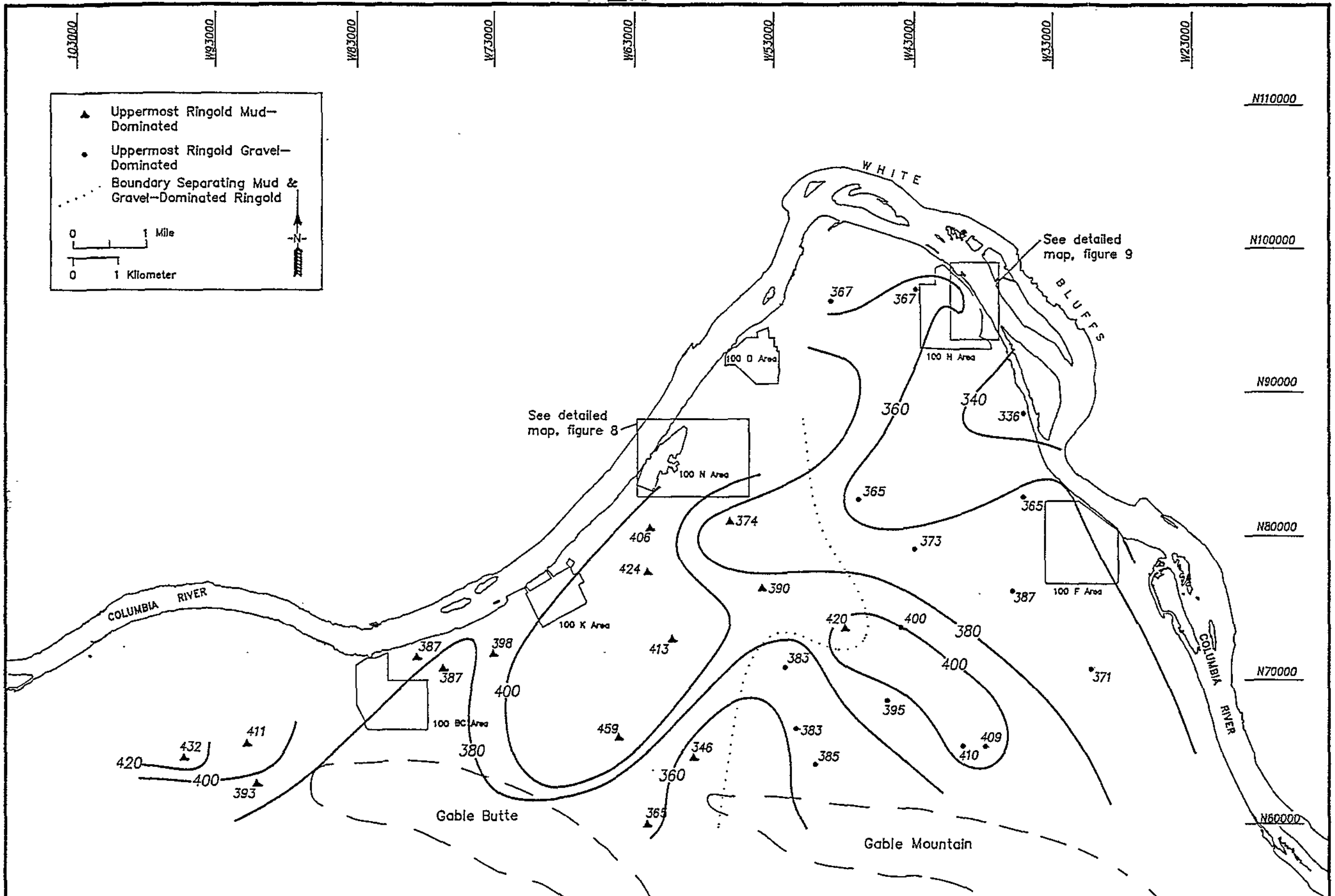
Figure 7. Structure Contour Map of the Hanford/Ringold Contact in the 100 Areas. Map also shows the geology of the uppermost Ringold Formation in the area.



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The stratigraphic unit in which the water table occurs is variable across the 100 Areas (Figure 8). Throughout most of the 100 Areas the water table is situated within the lower part of the Hanford formation, in strata composed mostly of the gravel-dominated facies (Figure 8). At 100-K, 100-N, and southwest of 100-F the water table lies below the base of the Hanford formation. In the areas of 100-K and 100-N the water table is found within fluvial gravels of the Ringold Formation (Figure 8). The water table is situated in the overbank dominated strata that is typical of the Ringold Formation in that area (Figure 8).

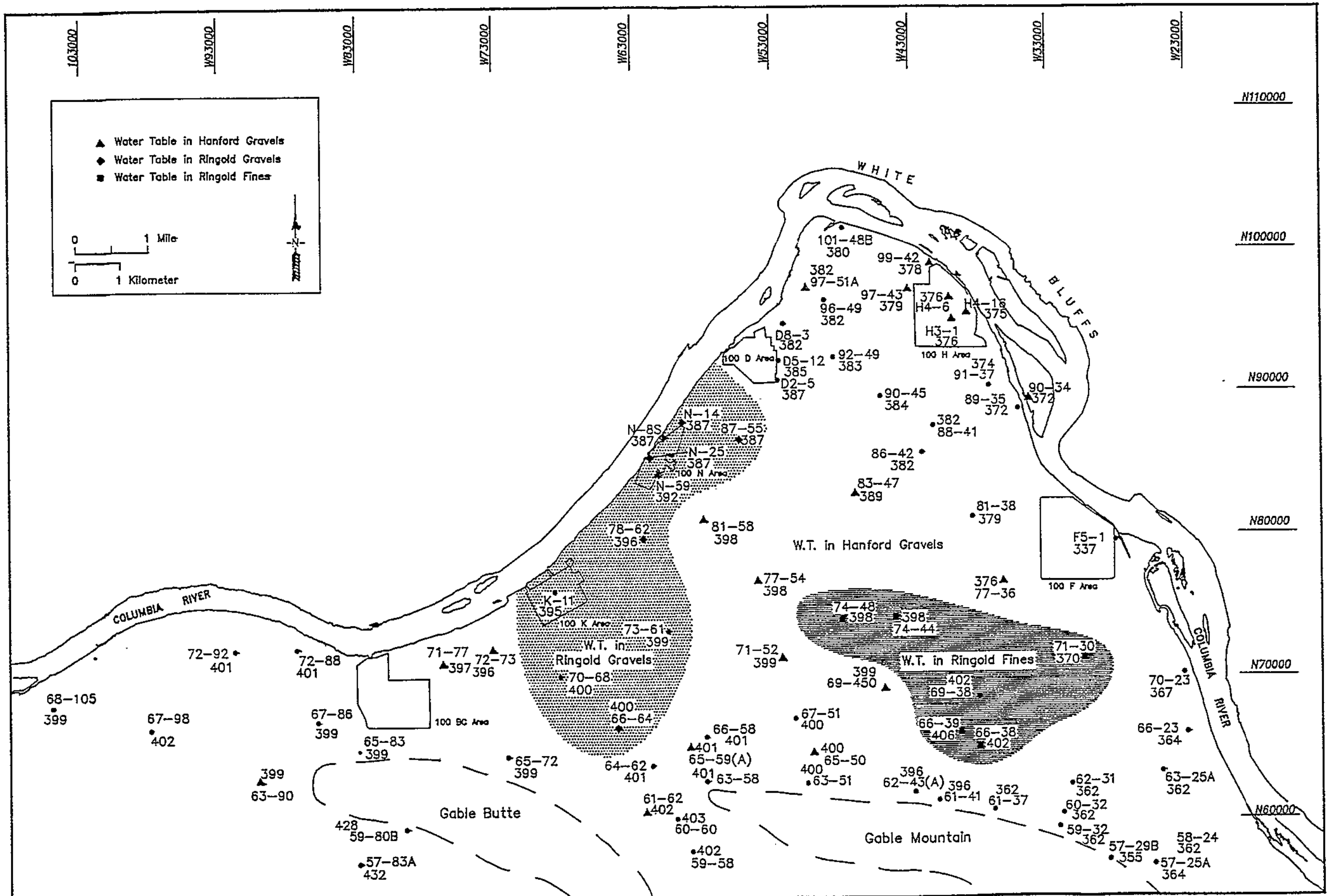
4.1 100-B/C AND 100-K AREAS

Most of the major Ringold units, in addition to coarse-grained Hanford deposits, underlie the 100-B/C and 100-K areas. The Ringold Formation in this area is up to 180 m thick and more closely resembles the Ringold Formation found south of the Gable Mountain anticline than any other 100 Areas location. The three northwest to southeast trending Ringold gravel sequences, units A, C, and E, go through this area before continuing to the southeast through the Gable Butte/Gable Gap area. Strata correlative to gravel unit B also is present in the area. However, these strata are thin, the entire interval is less than 20 m thick and sand-dominated. This interval thickens and coarsens to the east of the area. The lacustrine dominated lower mud sequence separates unit A from unit B while paleosol/overbank strata lie between the other gravel units.

The Hanford formation in the 100-B/C and 100-K areas is 20 to 35 m thick and generally coarser grained than other 100 Area localities. In this area, at least the upper 5 m of the Hanford formation can consist of open framework boulder-cobble gravels. The maximum observed clast size in these gravels is up to 2 m. Clasts generally average 25 cm to 0.5 m in most of these boulder-rich deposits. Where boulder-rich strata are absent or less abundant, north and east of 100-K, Hanford gravels are dominated by the open-framework pebble to cobble gravels more commonly encountered throughout the basin.

Holocene surficial deposits in the area are limited to river gravels and overbank silty sands. The river deposits only are found in and immediately adjacent to the modern Columbia River while the overbank deposits are found in small topographic depressions adjacent to the river. Eolian deposits are limited to a thin veneer of sediment on the surface.

Figure 8. Geology of the Water Table Across the 100 Areas.



4.2 100-N AND 100-D AREAS

The same Ringold units found beneath the 100-B/C and 100-K areas are found beneath 100-N and 100-D. However, the Ringold Formation is thinner (140 to 150 m), Ringold gravel units generally are finer grained and thinner, and mud-dominated intervals are thicker. Ringold units A and C each are less than 10 m thick at 100-N and thinner or even absent at 100-D. Unit E at 100-N is approximately the same thickness at B/C and 100-K. At 100-D unit E appears to be present in some boreholes and absent from others. The only gravel unit that thickens from 100-B/C and 100-K to 100-N and 100-D is unit B. Beneath 100-N and 100-D unit B is up to 25 m thick and dominated by sands with minor gravels. The fine-grained Ringold intervals, the lower mud and the paleosols separating the different fluvial gravels, thicken from 100-B/C and 100-K towards 100-N and 100-D.

The Hanford formation in the 100-N and 100-D areas is between 10 and 20 m thick and dominated by open framework granule to cobble gravel. Boulders also are present, but not as abundant as in the 100-B/C and 100-K areas. Lenticular silty interbeds also are present. The contact between the Hanford formation and underlying Ringold Formation in this area is fairly irregular (Figure 9).

North of 100-D (downstream) Holocene river deposits are common. These deposits are concentrated between the river and the 400-ft contour and found in a series of abandoned and seasonally active channels. Pockets of overbank deposits may be found within this channel system as well as above it. Eolian deposits form a thin discontinuous layer across much of the area.

4.3 100-H AREA

The Ringold Formation thins to approximately 80 m in the vicinity of the 100-H Area. In addition, Ringold gravels do not extend this far to the east and north. Three main stratigraphic intervals comprise the Ringold at 100-H. In ascending order these intervals are: (1) the lacustrine-dominated lower mud sequence, (2) a thin (<5 m) sequence of sand correlative to gravel unit B, and (3) a sequence of paleosol-dominated strata laterally equivalent to Ringold gravel units C and E and the intervening paleosols. This upper sequence is contiguous with strata exposed across the Columbia River along the White Bluffs.

The Hanford formation again displays the characteristics that are typical of it across the northern Hanford Site. The Hanford formation is approximately 20 m thick in the vicinity of 100-H and consists dominantly of open framework granule to cobble gravel. The Hanford-Ringold contact is placed at a sharp break between Hanford gravels and Ringold overbank deposits. The elevation of the contact is mapped on Figure 10.

The distribution of Holocene surficial deposits in the 100-H Area resembles that seen in the 100-D and 100-N areas upstream and the 100-F Area downstream. River and overbank deposits are found in and adjacent to abandoned and seasonally active channels. Eolian deposits form a thin, discontinuous blanket across much of the area.

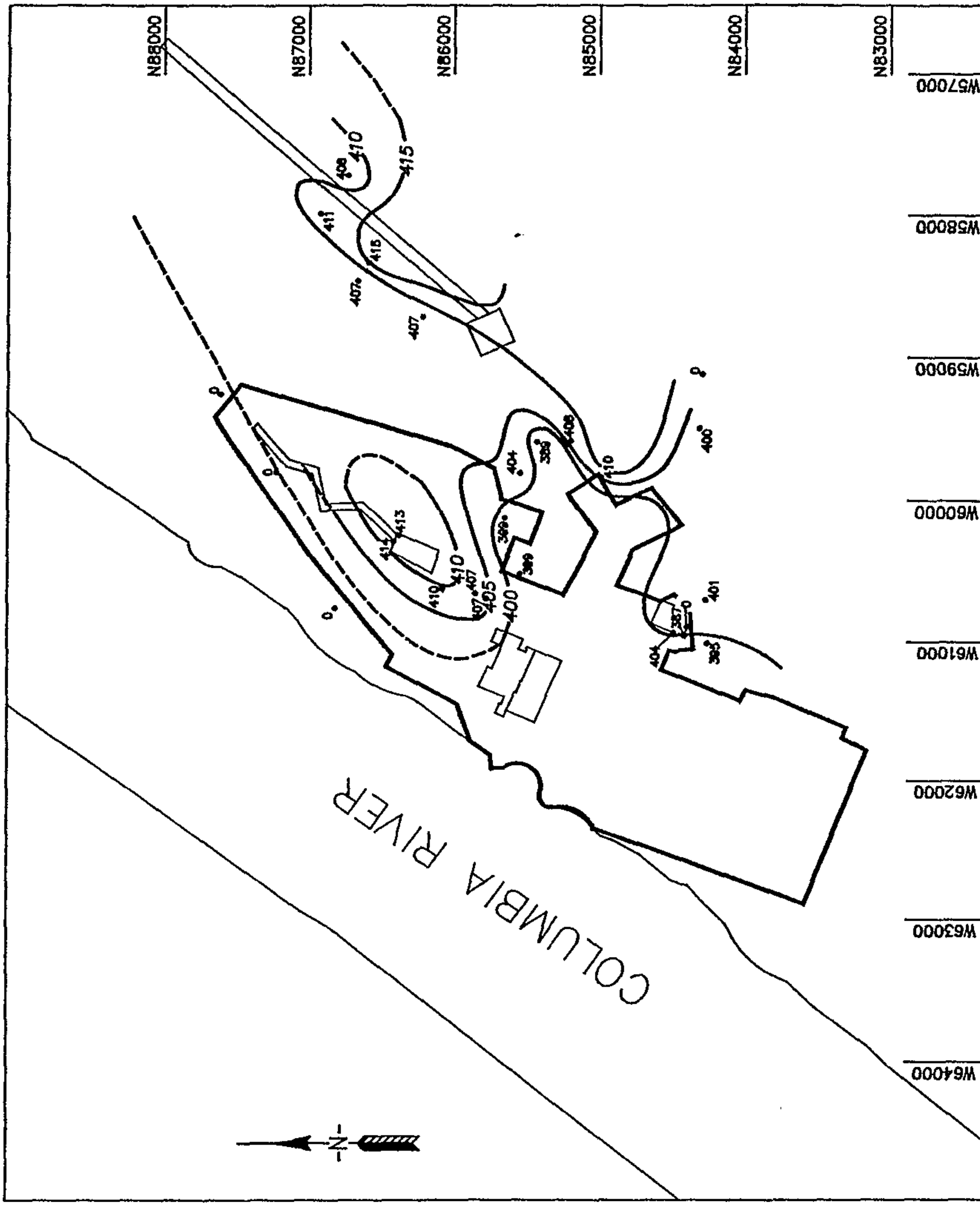


Figure 9. Structure Contour Map of the Hanford/Ringold Contact in the 100-N Area.

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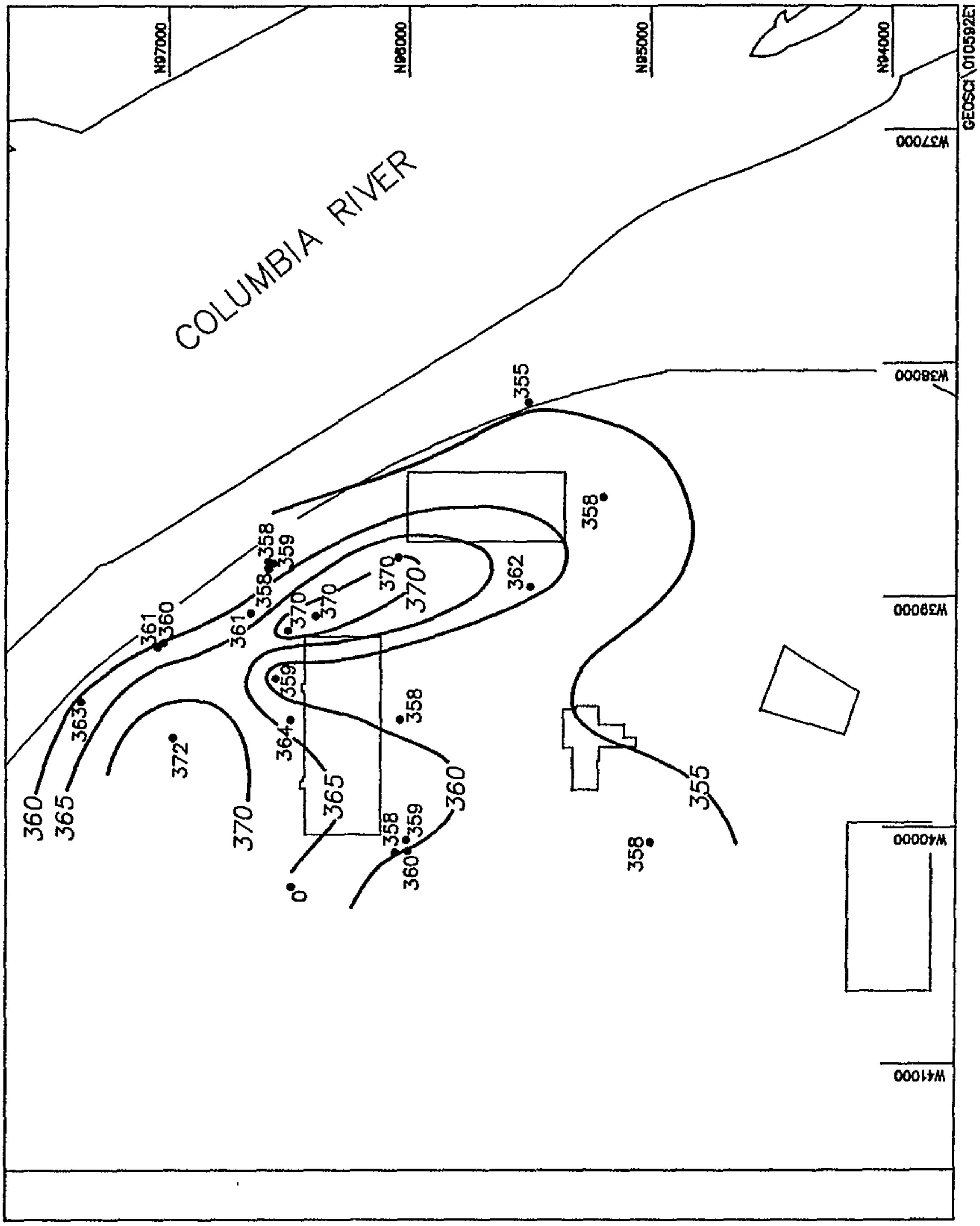

Figure 10. Structure Contour Map of the Hanford/Ringold Contact in the 100-H Area.

4.4 100-F AREA

The gravelly strata so typical of the Ringold Formation throughout most of the Pasco Basin begin to reappear in the vicinity of the 100-F Area. An approximately 20 m thick sequence of gravels correlated to gravel unit B is found in the lower part of the Ringold Formation here. These gravels overlie laminated muds assigned to the lower mud sequence and are overlain by a thick (60 to 70 m) succession of paleosol dominated strata. Sandy intervals located near the top of this paleosol-dominated succession are lateral equivalent to gravel unit C. Gravel units A and E are not found in the vicinity of 100-F. Coarse strata encountered in the 100-F Area are thought to become more abundant towards the center of the Wahluke syncline, to the south, and southwest.

Open framework granule to cobble gravels dominate the Hanford formation in the vicinity of 100-F, just as they do throughout most of the 100 Areas. Lenticular silty interbeds are present locally.

Holocene river deposits are relatively rare except immediately adjacent to the modern Columbia River. Eolian deposits are fairly common in and around the 100-F Area. A small dune field is located just to the south of the area.

5.0 CONCLUSION

Geologic data for the 100 Areas are available from several sources. Grain size data can be found in the ROCSAN database. Sediment samples are kept in the Hanford Geotechnical Sample Library in the 2101-M Building in the 200 East Area. These samples are available for analysis. The WPPSS also has a limited number of core samples in storage at their facilities on the Hanford Site. A few core samples also are in the Core Library maintained by the Westinghouse Hanford Company (Westinghouse Hanford) at the Big Pasco Industrial Park. Borehole logs of most holes drilled at the Hanford Site are kept in files at the location of the Westinghouse Hanford Environmental Field Services Group. Logs, especially of offsite boreholes, are kept on file by Ecology. Additional borehole information can be found in various Westinghouse Hanford and U.S. Geological Survey reports.

The Hanford formation is dominated by open framework granule to cobble gravel throughout most of the 100 Areas. Boulder-rich strata are found throughout the Hanford Site with boulders being most abundant in the areas of 100-B/C and 100-K. In these areas the entire Hanford formation may consist of boulder-dominated deposits with boulders up to 2 m across being common. Lenticular silty interbeds can be encountered throughout most of the 100 Areas.

The Ringold Formation is variable throughout the 100 Areas. Near the 100-B/C, 100-K, and 100-F areas the Ringold Formation consists of interbedded fluvial gravel-dominated intervals and paleosol- and lacustrine-dominated intervals. This stratigraphy resembles what is found in the Cold Creek syncline to the south. The gravel-dominated intervals fine and thin to the north, towards the 100-N, 100-D, and 100-H areas. In these areas, Ringold strata are dominated by lacustrine deposits of the lower mud sequence at the base and paleosols above. No significant gravel-dominated intervals are found in the Ringold Formation in the vicinity of the 100-H Area.

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