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Preliminary Report on the Ancestral Potomac River Deposits in Fairfax County, Virginia, and Their Potential Hydrogeologic Significance

by

A.J. Froelich
R.H. Johnston
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1978

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The Potomac Estuary south of Washington, D.C. forms the eastern boundary of Fairfax County, Virginia (Plate 1). Broad swampy lowlands flanking the estuary, such as Hybla Valley and lower Mason Neck, mark part of the abandoned course of a meandering ancestral Potomac River in Fairfax County. The lowlands, now occupied by underfit tributary streams, occur at an average altitude of 40 feet (12 m) and are bordered by gravel-capped highlands of Cretaceous sand and clay rising to about 200 feet (60 m). Although other segments of the sinuous ancestral Potomac River occupy counterpart valleys on the opposite shores in Prince Georges County, Maryland, most of the related deposits underlie the present Potomac Estuary.

Hack (1957) has demonstrated that Chesapeake Bay and its main trunk tributaries occupy Pleistocene (Ice age) river valleys. The valleys are incised in Cretaceous and Tertiary sediments to a depth from 50 to more than 200 feet (15 to 60 m) below sea level and are now filled with soft sediments. Mixon and others (1972) mapped unconsolidated sands, silts, clay and gravels adjacent to the Potomac Estuary in the Quantico quadrangle as Potomac River Terrace Deposits, whose upper surface lies at an elevation of about 50 feet (15 m) and whose base is below sea level. Force (1975) mapped similar deposits in eastern Fairfax County as estuarine(?) deposits, considering them to be of Pleistocene age and of partly marine, partly non-marine origin.

An auger test hole program to evaluate these deposits at 5 localities in eastern Fairfax County was carried out by the U.S. Geological Survey in early 1978 (Plate 1). Preliminary graphic logs of the 18 auger holes through

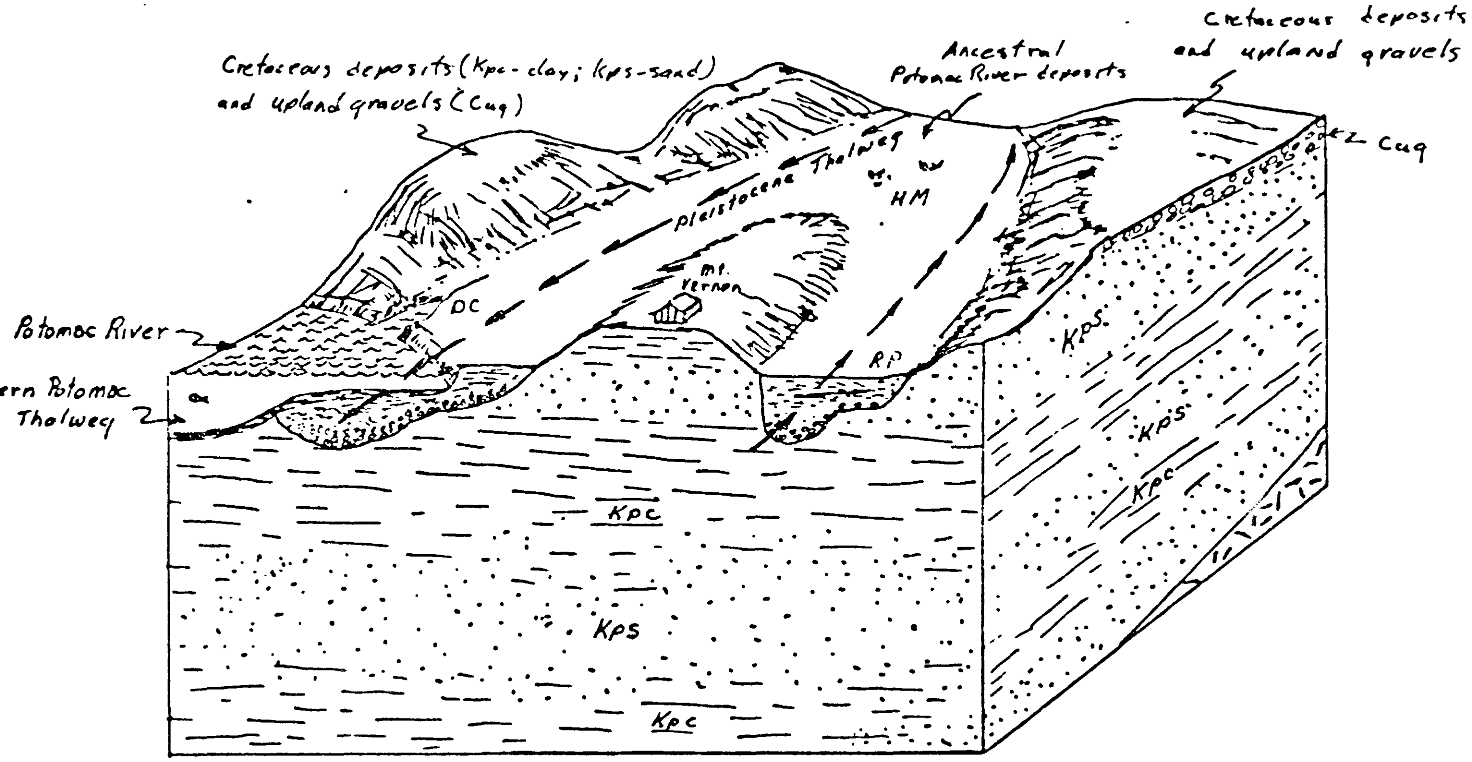


Figure 1 Perspective diagram of Hybla Valley viewed from the southeast. RP - Riverside Park area; DC - Dogue Creek area; HM - Huntley Meadows area.

the unconsolidated Pleistocene deposits are included in the Appendix of this report. The Appendix also contains several interpretive cross-sections (located on Plate 1) and a brief explanatory text for each area explored.

Data from six auger holes and a review of water well data indicate that the base of the Pleistocene deposits occupying central Hybla Valley lies at 18 to 90 feet (5.5 to 27 m) or more below sea level (fig. 1, and appendix). The lithologies consist of a basal 5 to 50 feet (1.7 to 15 m) of coarse gravel and sand (Unit A of Hack), overlain by 15 to 45 feet (4.7 to 14 m) of silty carbonaceous sand (Unit B of Hack), succeeded by as much as 100 feet (30 m) of soft silty and sandy clay with peat layers (Unit C of Hack).

The cross-section of Hybla Valley (fig. 2), based on data from closely-spaced auger holes at Huntley Meadows (Plate 1), shows an asymmetric valley floor with relatively thick fluvial (riverine) sands and gravels occupying the deepest part of the channel (thalweg). These are overlain and flanked by fine-grained carbonaceous sands and silts of probable point-bar or natural levee origin, overlain by fine silt and clay deposits of floodplain and overbank origin. The middle and upper parts of this fining-upward sequence contain several peat layers that are intercalated within the silty clay beds, probably reflecting a gradually rising sea level and upstream encroachment of estuarine conditions.

Preliminary evaluation suggests that the lower sand and gravel units (Units A & B) constitute an aquifer, whereas the overlying peat-bearing clays and silts are probably leaky confining beds. The physical setting at Belle Haven, Riverside Park, Dogue Creek and possibly Mason Neck suggests the possibility that thick gravel and sand deposits may be hydraulically connected to the Potomac Estuary by means of gravel and sand deposits beneath the estuary (see Appendix).

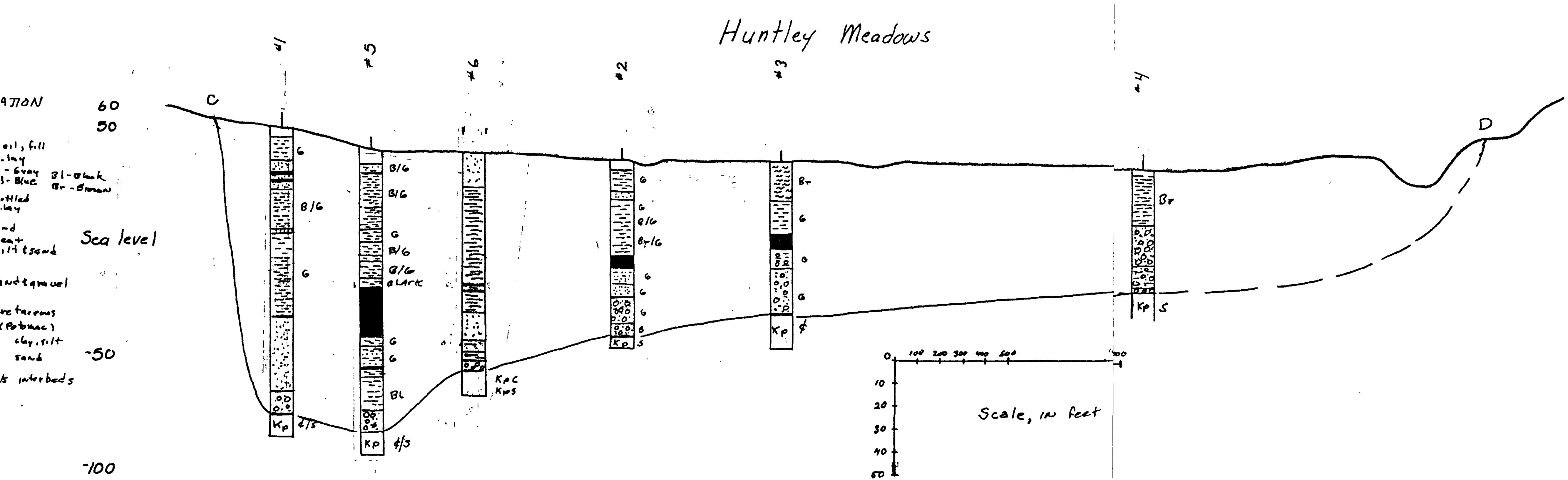
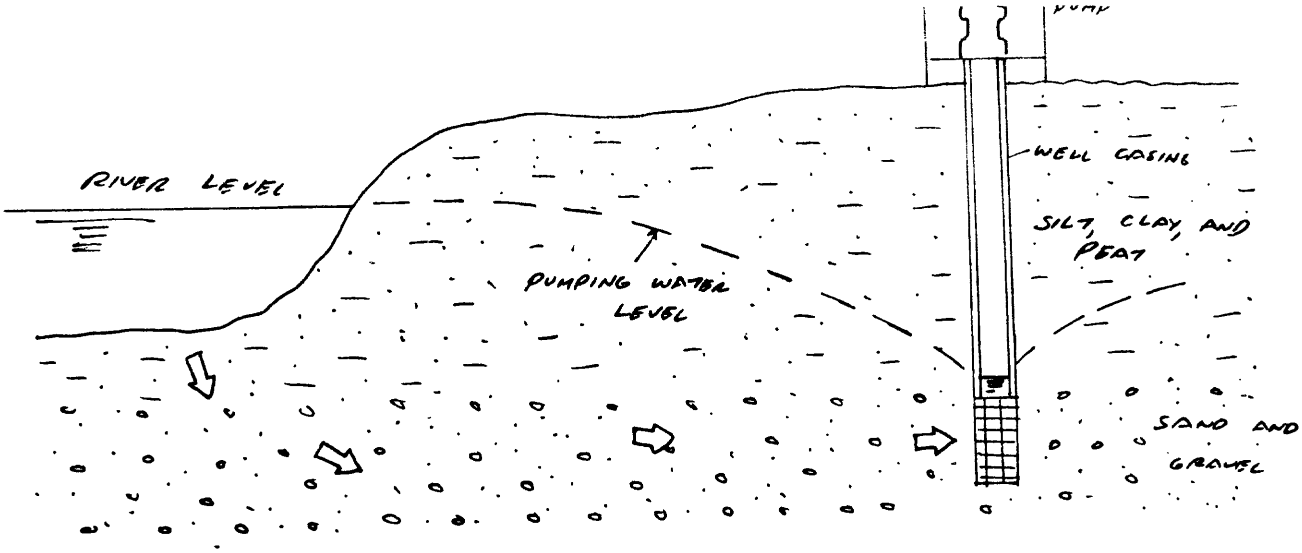


FIGURE 2 Cross section of Hybla Valley.

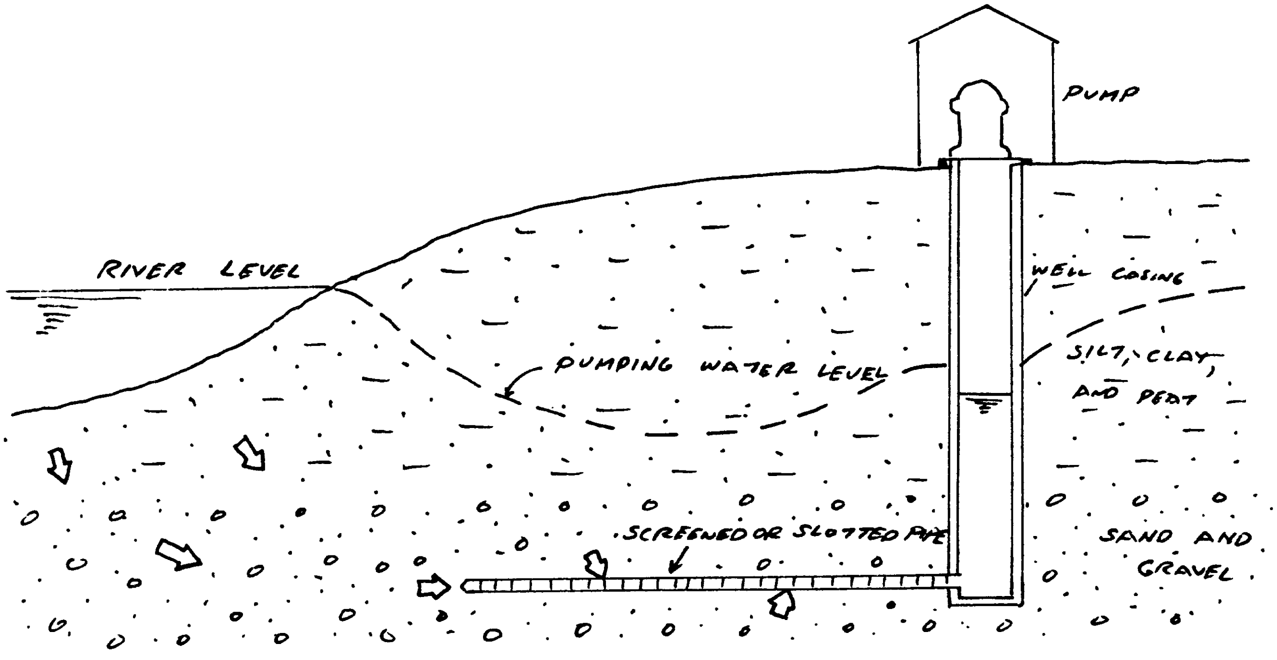
If subsequent tests establish that there is hydraulic connection with the river, water wells tapping the lower sand and gravel unit (and the Cretaceous sands that immediately underlie it) may obtain water supplies by induced infiltration of water from the estuary (figure 3). Winslow and others (1965) described the principles of induced river infiltration. They stated (p. 49) "When a well is pumped the water is withdrawn from storage in the immediate vicinity of the well, and the water level in the aquifer around the well declines. The resulting difference in water levels between the pumped well and the surrounding area provides the hydraulic gradient necessary for water to move through the aquifer to the well. The depression of water level in the aquifer around the well is called the cone of depression, and it expands until enough recharge (from precipitation or other sources) is intercepted to equal the amount of water pumped from the well. If a well is located adjacent to a lake or a stream so that the cone of depression intersects the stream, part of the water pumped will be infiltrated from the stream. The amount of water than can be infiltrated from the stream depends on the transmissivity of the streambed and of the aquifer, and the hydraulic gradient between the stream and the well."

Full evaluation of the potential for water supply utilizing river-infiltration wells would require a program of exploratory drilling and aquifer testing in the deposits flanking the Potomac Estuary. The drilling should be planned to delineate and evaluate promising shallow sand and gravel aquifers. Locating areas of thin silt cover in the river bottom might best be done using bottom sampling, coring or geophysical techniques. Aquifer tests, preferably involving several observation wells at a site, would be needed to determine the transmissivity of the aquifer, evaluate recharge boundaries, and estimate long-term well yields.



A. CONVENTIONAL WATER WELL SUPPLIED BY RIVER INFILTRATION

GENERALIZED DIRECTION ⇨ OF GROUND-WATER FLOW



B. COLLECTOR WELL WITH HORIZONTAL PIPES BELOW RIVER

FIGURE 3. WATER WELLS SUPPLIED BY INDUCED INFILTRATION OF SURFACE WATER

Downstream from the vicinity of Hunter Point the effluent discharge from sewage-treatment plants imposes constraints on site selection and also on seasonal operating schedules for well fields that would depend upon river infiltration. Although the intermediate and higher flows of the Potomac River provide ample dilution for mitigating the pollution residuals of effluent discharge from the present sewage treatment plants, this would not be the case in extended periods of very low flow. However, as communities in the metropolitan area continue to upgrade their sewage-treatment facilities, the improved quality of effluent discharge to the Potomac Estuary will increase the potential for development of river-infiltration supplies and permit operation at lower flows and over extended periods.

Wells supplied by induced river infiltration along the Potomac offer several advantages, as follows:

(1) An extremely large source of recharge is available -- the estuary

(2) Suspended sediment and bacteria are removed by filtration through the silt, sand, and gravel deposits in the transit from the river bed to the wells.

(3) Fresh water in the Potomac Estuary is presently (1978) unused.

(4) Salty water does not extend as far up the estuary as Mount Vernon in Fairfax County -- even during very dry summers.

(5) The range in temperature of water withdrawn from wells supplied by river infiltration is narrower than the temperature range of the river. This characteristic is highly desirable for many uses such as heat exchange systems.

River infiltration supplies are used in many parts of the United States, particularly along principal rivers of the East and Midwest. The hydrologic controls on developing such water supplies are discussed in detail by Rorabaugh (1963).

In conclusion, the advantages of induced riverbed infiltration demonstrated in other areas, plus these preliminary findings, suggest that investigation of the sand and gravel deposits along the Potomac Estuary should prove beneficial to local communities that need additional water supplies.

References

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Winslow, J.D., Stewart, H.G., Jr., Johnston, R.H., and Crain, L.J., 1965, Ground-water resources of eastern Schenectady County, New York - with emphasis on infiltration from the Mohawk River: New York State Water Resources Comm., Bulletin 57, 148 p.

Appendix - Graphic logs, cross-sections and brief texts

A. Belle Haven Area
B. Huntley Meadows Area
C. Riverside Park Area } Hybla Valley
D. Dogue Creek Area
E. Mason Neck Area

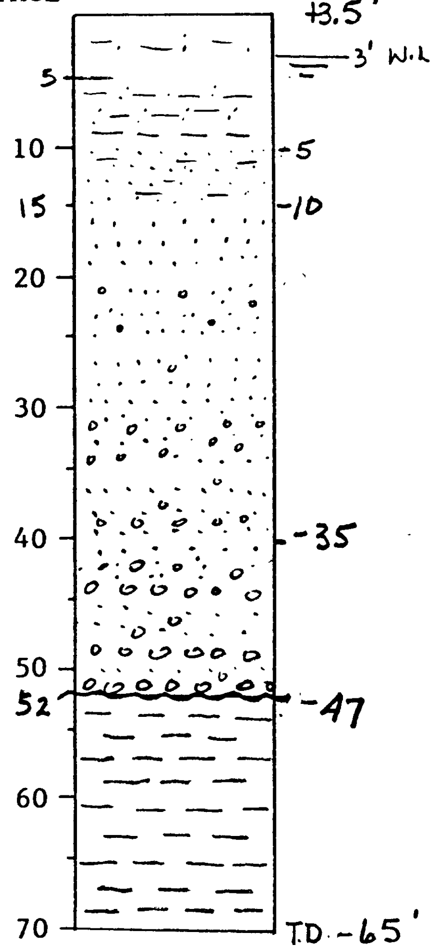
Belle Haven Area (A.J. Froelich)

The shallow subsurface deposits at Belle Haven Park adjacent to George Washington Memorial Parkway consist of 35 to 40 feet (10-12 m) of friable sands and gravels that unconformably overlie tight Cretaceous clays at depths of 30 to 50 feet (9-15 m) or more below sea level. The sand and gravel is overlain by 15 to 22 feet (4.7-7 m) of clay, silt, and very fine sand (Fig. 4). The loose sand and gravel is an aquifer that may be suited for river infiltration.

The U.S. Army Corps of Engineers and others have drilled and dredged more than 50 holes in the estuary adjoining Belle Haven while evaluating gravel and sand resources. Logs of these holes indicate that the sand and gravel unit is very extensive, and these data help define the subsurface configuration of the potential aquifer beneath the estuary. The geologic setting is shown in cross-section A-A^1 and A-B, the latter of which is extended across the river to Prince Georges County.

Belle Haven No. 1
225' W. of Potomac River
adjacent to G.W. Mem. Pkwy

DEPTH BELOW SURFACE | ELEVATION | DESCRIPTION



SOIL, silty & clayey

CLAY red brn, silty to vf sdy

SAND, vfg, silty, minor clay, red brn.

SAND, reddish brn, vcg, porous

SAND, red brn, vcg, scat pbls, 1/4-1/2" diam

SAND, red brn, vcg, clean + porous

SAND, vcg, red brn, abun pbls to 1" diam

SAND, gravelly, v. porous

GRAVEL, bf, pbls to 2" diam, vcg sd. matrix, porous
pbls are: qtz->75%, qtzite, chert, TR? ss, metagwke etc.

CLAY, Kpc, mottled red brn & gy, v. stiff

Cretaceous

CLAY, KPc, mottled, red-brn, gn, gy, v. stiff

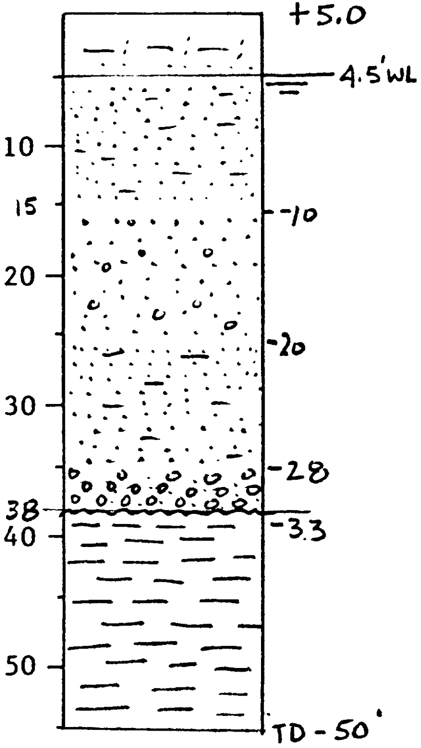
Note: 15-52' (37') good potential aquifer
for river infiltration

Belle Haven No. 2
50' S. of Norsh opp. Jct. of
Tulane Dr. & G.W. Mem. Pkwy

DEPTH BELOW SURFACE

ELEVATION

DESCRIPTION



SOIL, silty and vf sandy

SAND, red brn, f-m. grd, silty

SAND, red brn, m-c grnd, scatt ½" pbls

SAND, red-brn, f-m grnd, silty

GRAVEL, pebbles to 1", silty sand matrix

CLAY, Kpc, grn, silty, stiff

<u>Cretaceous</u>

CLAY, Kpc, grn, mottled brn, hard & stiff

Note: 15-48' (23') fair to poor potential aquifer sand

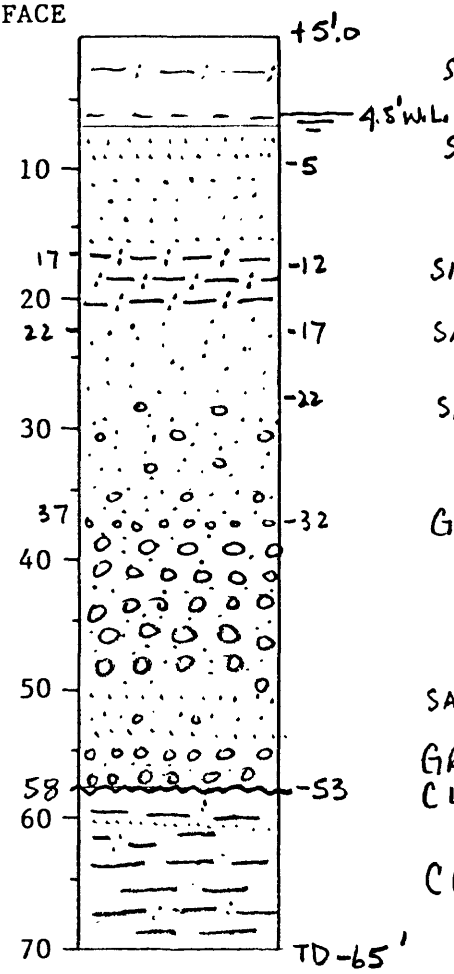
Belle Haven No. 3.

280' W. of Potomac River
adjacent to Belle Haven Marina

DEPTH BELOW SURFACE

ELEVATION

DESCRIPTION



Soil and clay

SAND, f-mg, silty & clayey
rounded & friable

SILT, brn, micromicaceous, sdy

SAND, brn, f-mg, well sorted, rounded gns, dk brn humate and clay coatings @ 26-27'

SAND, tan, m-cg, scatt. pbls to 1/4", well rndd, porous

GRAVEL, tan, VCG sdy matrix, subrdd gns; pbls are: qtz, qtzite, chert, TR. ss, metagwcke. Ave diam 1", porous

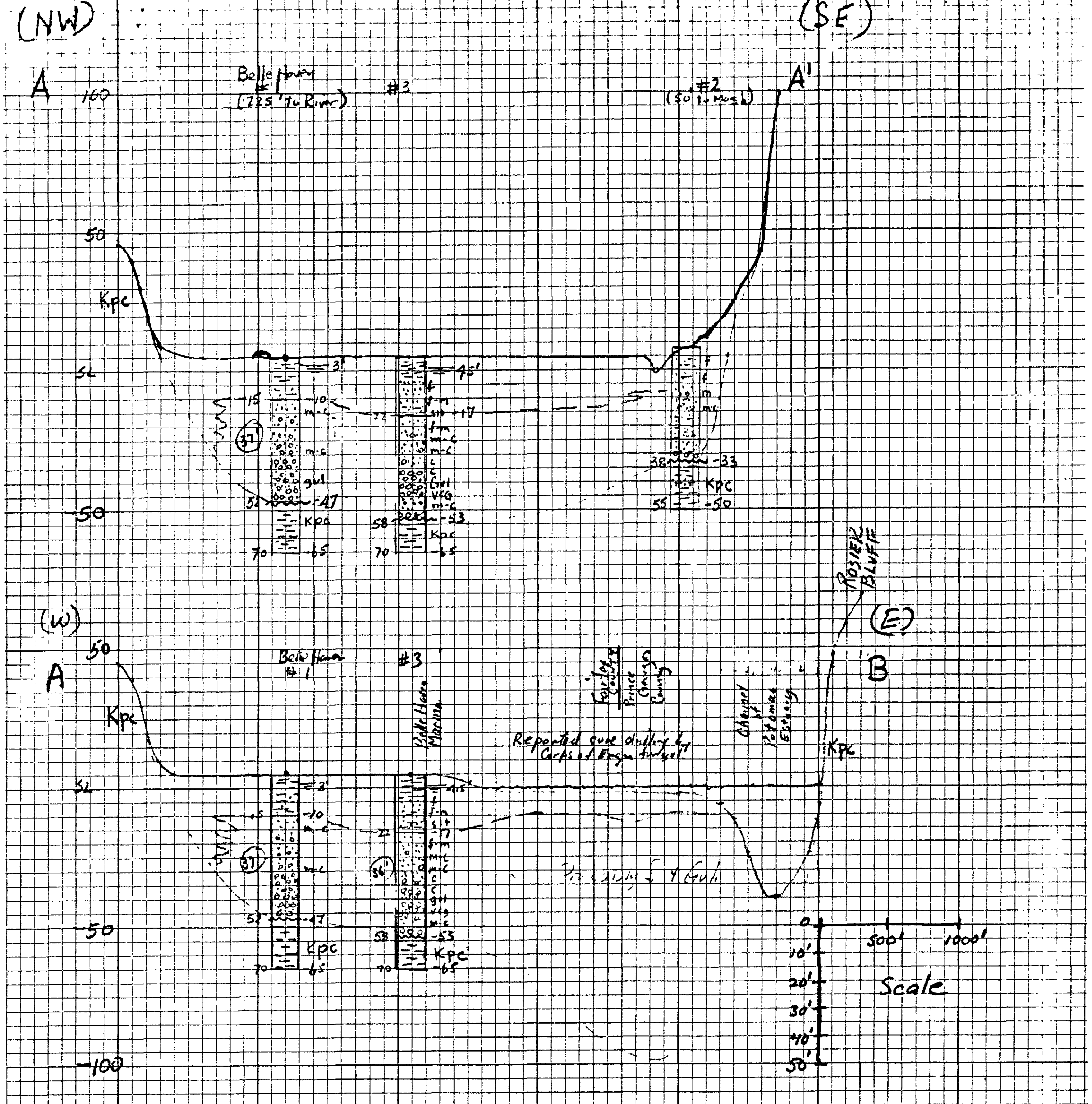
SAND, tan, m-cg w/ scatt pbls to 1/4" diam, abun mica & heavy mins.

GRAVEL, VCG sand matrix, porous

CLAY, Kpc, gn, gy, mottled, silty

CRETACEOUS

Note: 22-58 (36') good potential aquifer



Vertical Exaggeration x 40

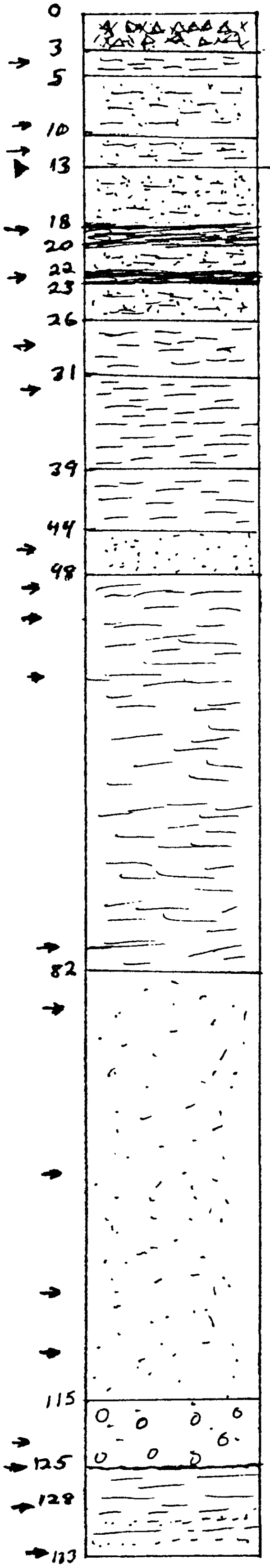
Profiles at Belle Haven, N.E. Fairfax County, Va

B

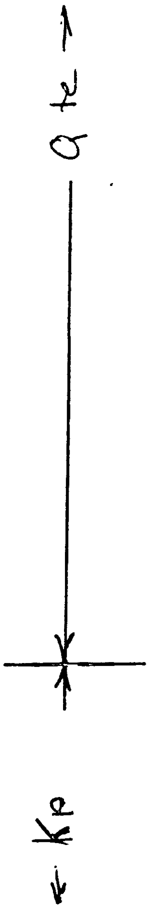
Huntley Meadows (Langer & Froelich)

Description and cross section in text.

Huntley Meadows #1

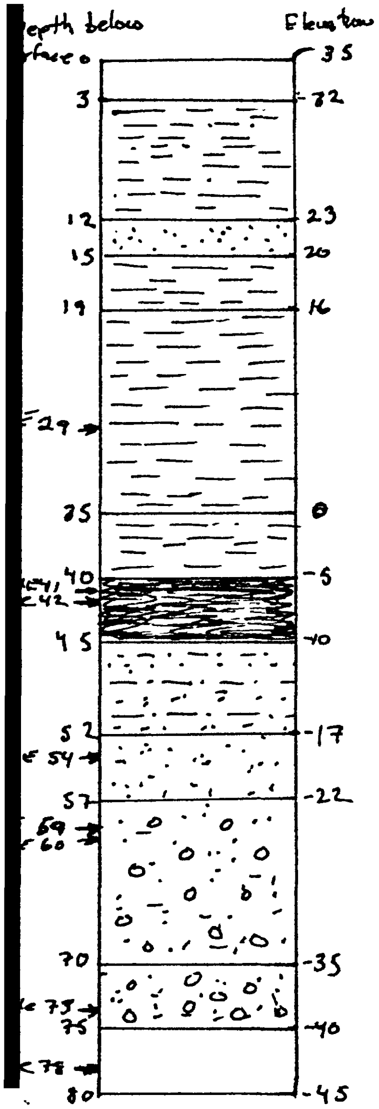


Depth below Surface.	Elevation	Description
0	50'	Fill
3	47'	Silty CLAY
5	45'	Sandy CLAY, med gray
10	40'	Silty, sandy CLAY, light gray
13	37'	clayey SAND, light gray
18	32'	Peat
20	30'	SAND and SILT, gray
22		PEAT
23	28'	SAND And SILT, light gray
26	24'	CLAY, blue gray
31	19'	CLAY, dark gray
39	11'	CLAY, blue
44	6'	SAND, blue
48	2'	CLAY with [illegible] sand, blue organics dispersed throughout
	Sea level	
82	-32'	Sand, medium., silty ~~CLAY~~, gray
115	-65	Sand, gravel, clay Fragments of Kpd
125	-75'	Kpd
128		Kpd/Kps interbedds
133	-83'	



LSD-35±

Huntley Meadows No. 2



Description

Soil

Gray silty CLAY, very soft

Brown silty med SAND

Gray silty CLAY, soft. Trace of fine sand

Blue-gray CLAY, trace silt, soft

Brown-gray CLAY, soft.

PEAT

Gray clayey SILT & SAND

Gray clayey silty SAND

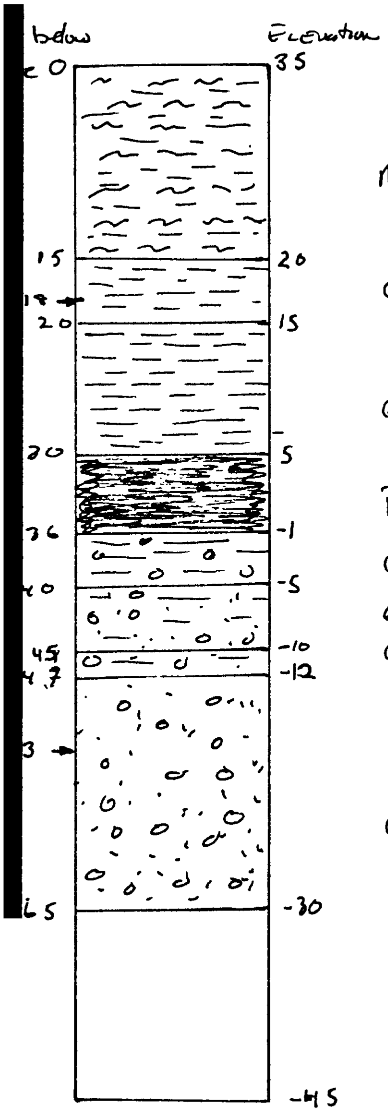
Gray silty SAND & GRAVEL

Blue re-worked Kp SAND & GRAVEL

Kps - blue silty

End of hole

Huntley Meadows No. 3



Description

Mottled red-brown (oxidized) CLAY

Gray ~~CLAY~~, soft

Gray silty CLAY, soft

PEAT & Black clay

Gray CLAY with gravel

Gray sandy CLAY with GRAVEL

Clayey SILT, SAND & GRAVEL

Gray coarse SAND & GRAVEL

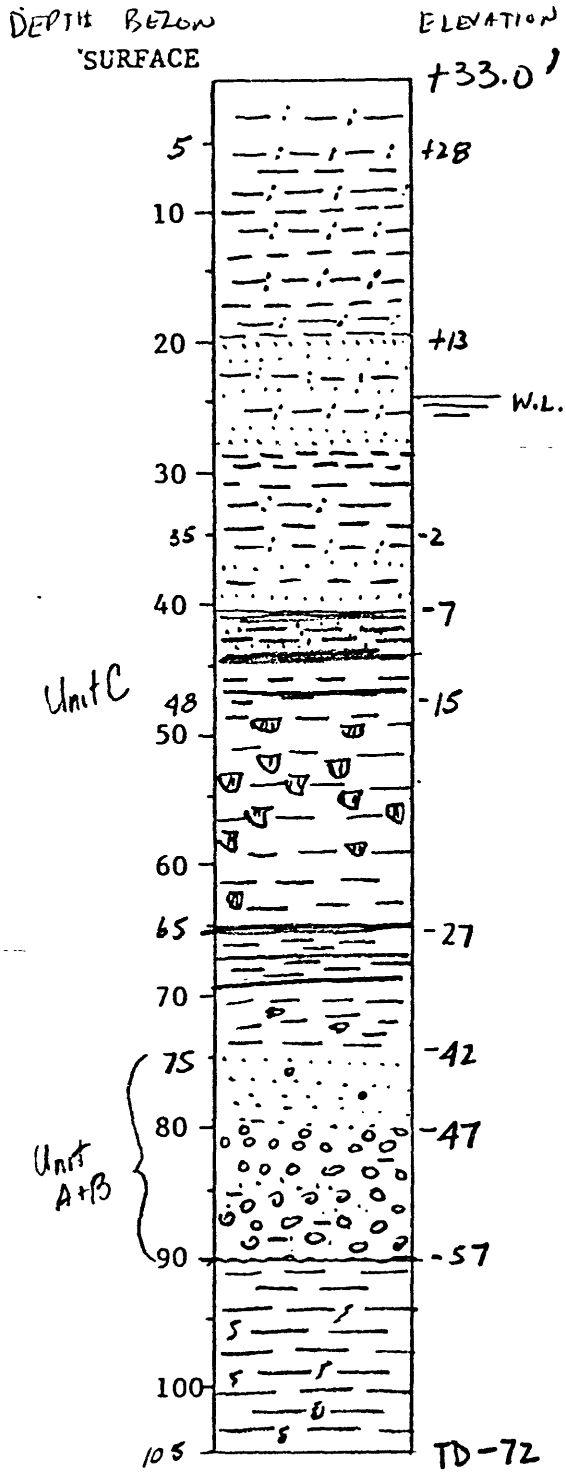
Kpℓ, STIFF

End of hole

Riverside Park Area (A.J. Froelich)

The shallow subsurface materials at Riverside Park adjacent to George Washington Memorial Parkway and the Potomac Estuary east of Mt. Vernon consist of 15 to more than 25 feet (4.7 to 7.5 m) of unconsolidated sand and gravel that overlie Cretaceous clays and sands (Fig. 5). The sand and gravels are overlain by 25 to more than 75 feet (7.5 to 23 m) of clay, part of which is fossiliferous, silt, and very fine silty sand. Part of the unconsolidated sand and gravel deposit may be an aquifer that is potentially suited for river infiltration. As shown in cross-section G-G^1 and G-H^1, the geologic setting is such that the deep Potomac Channel (-53') probably cuts sand and gravel beds hydraulically connected to auger hole R.P. No. 3 at the southeast corner of Fort Hunt Park.

RIVERSIDE PARK NO. 1
50'W of Potomac River



DESCRIPTION

Soil, brn, silty & clayey

SILT & CLAY, red brn, mottled gy, dry.

SILT & SAND, mottled gy & red brn

CLAY, dk gy, carb, silty

CLAY & SAND, inbd, gy, carb

PEAT, WOOD & SAND, vfg, gy

CLAY, dk gy, abun calc fossil frags (pelecypods, gastropods, charophytes) fossils v. abundant 52-58; sps 58-65 w/ scatt wood frags at base.

CLAY, dk gy, peaty, abun plant frags

CLAY, med gy, silty, scatt wood frags + v. hd concretionary clay clasts (phosphatic?)

SAND, m-dk gy, vf-f gnd., silty, scatt ½-1" pbls.

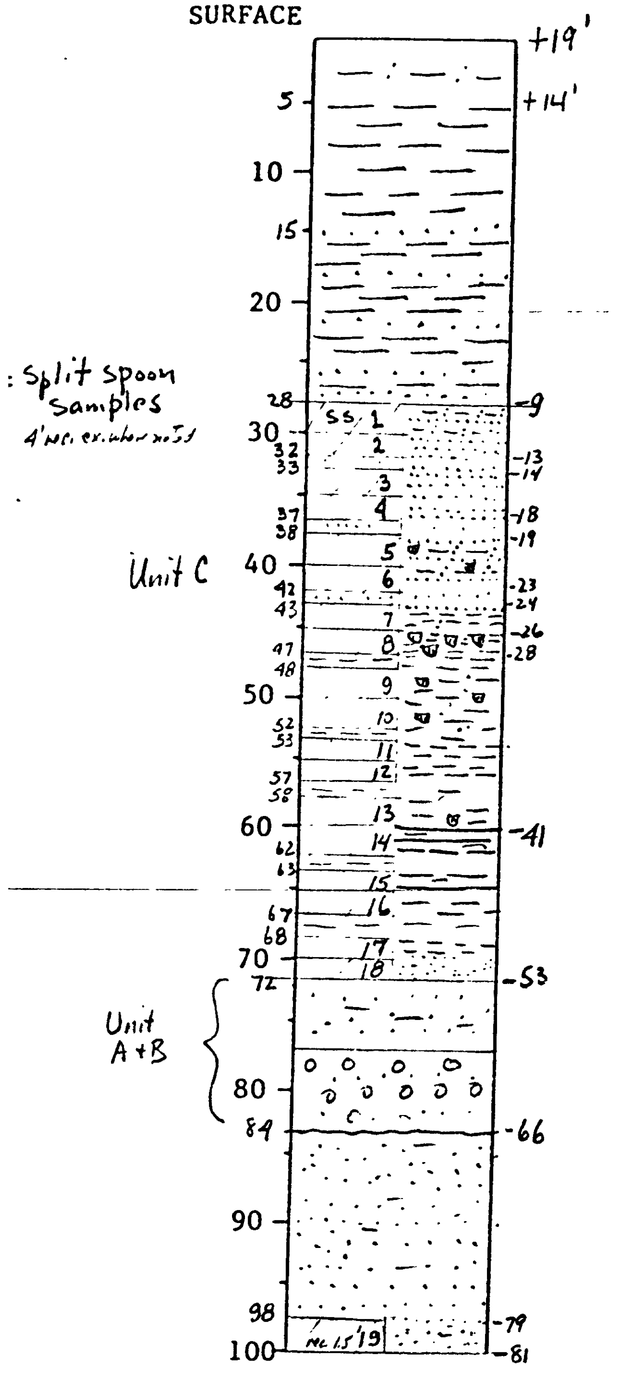
GRAVEL, sdy + clay-rich matrix, scattered clay clasts

CLAY, KPc, gy, red, brn, pink, v. stiff, blotchy + mottled. Looks disturbed like fossil slide debris(?!)

Note! Not much potential aquifer (75-90')

RIVERSIDE PARK No. 2
W. side of Little Hunting Ck., S. side of G.W. Pkwy, 1/2 mi E of Mt. Vernon

DEPTH BELOW SURFACE ELEVATION DESCRIPTION



SOIL, brn, silty, clay rich
CLAY, brn, silty

CLAY & SAND, Brn, intbd, sd is vfg.

SILT & SAND, lt gy, arg, scatt carb.
SAND, med gy, vfg, wet, abun mafic heavy mins, carb specs

SAND & SILT, Inbd, med gy, mic, carb, spars. white shell frags.

CLAY, med gy, silty, mic, scatt shell frags, carb specks
shells abundant @ 45-47 (Split spoon # 8)
spars plant frags @ 52' (" " #10)
red brn spores? 53-57 (" " # 11, 12)

CLAY, med gy, w/ lenticular f.g. sd & bf. nodular hard clay, spars shell frags?

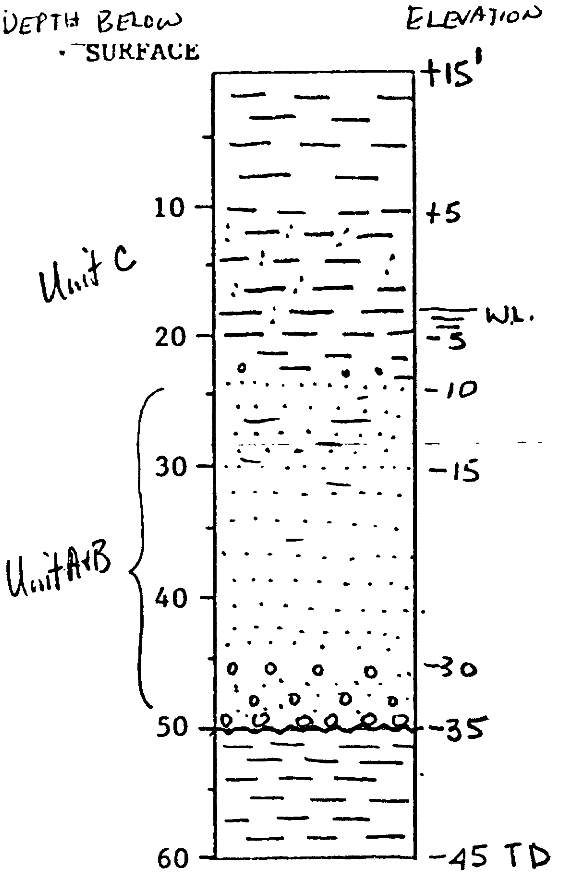
CLAY, med gy-brn, peaty & woody layers, abun plant debris

SAND, silty, f-mg

GRAVEL, f-cg sd matrix

SAND, gn, Kps, f-mg., well sorted
Cretaceous
Note : 72-84 poor potential aquifer; 84-100'+ Kp sand, in part porous & weathered, may contribute water.

Riverside Park No.



Descriptor

CLAY, orange brn, sticky

CLAY, brn, silty, tight

CLAY, brn, silty, inbdw/ minor vfg sd + fine grvl

SAND, brn, silty, f-m grnd

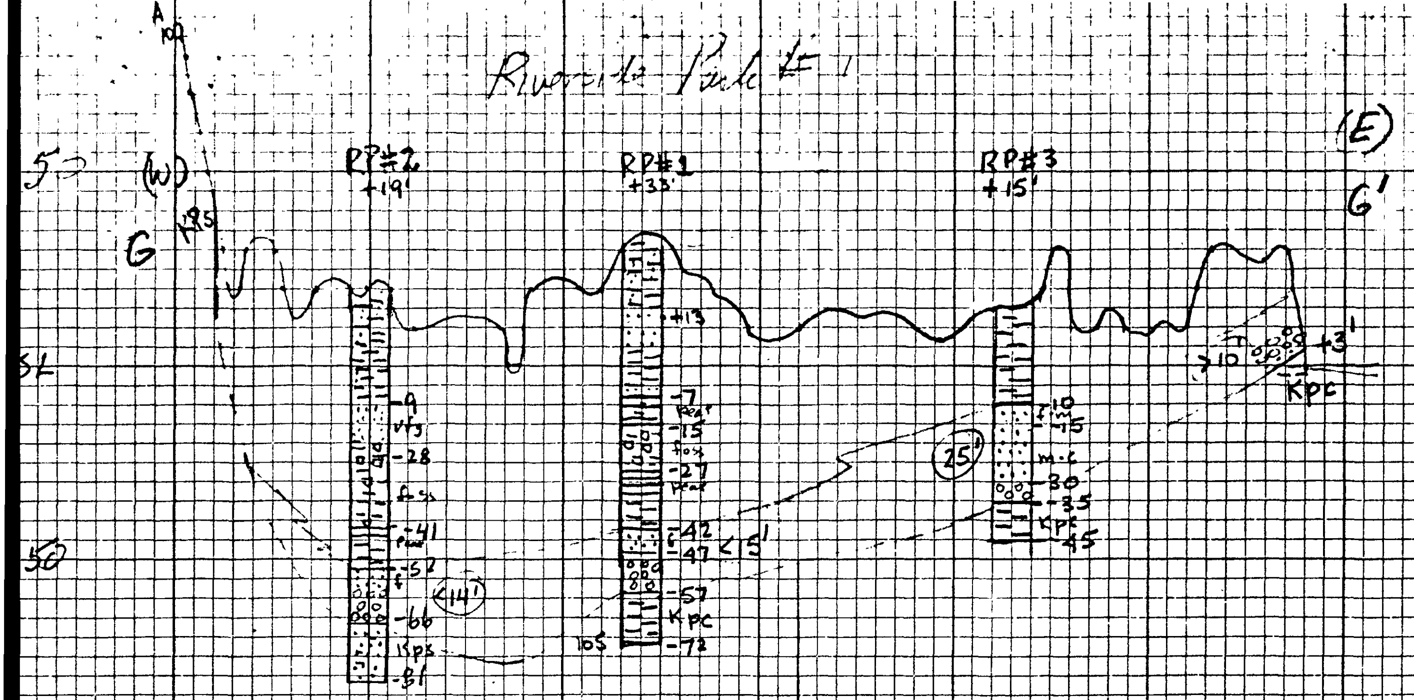
SAND, med-crs, silty, porous

GRAVEL, crs sd matrix, some Kpc clasts.

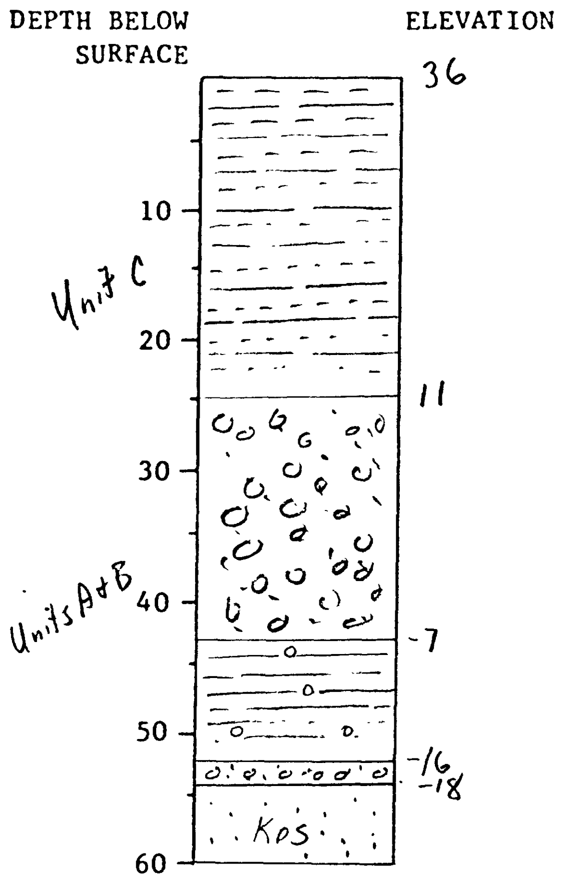
CLAY, Kpc, mottled gy, bl, red brn at top,
being bl-gy at bottom.

Note: 25-50 (25') fair to good ~~potential aquifer sand~~

Riverside Park #1



Huntley Meadows No



DESCRIPTION

CLAY & SILT, brown - soft

SAND & GRAVEL

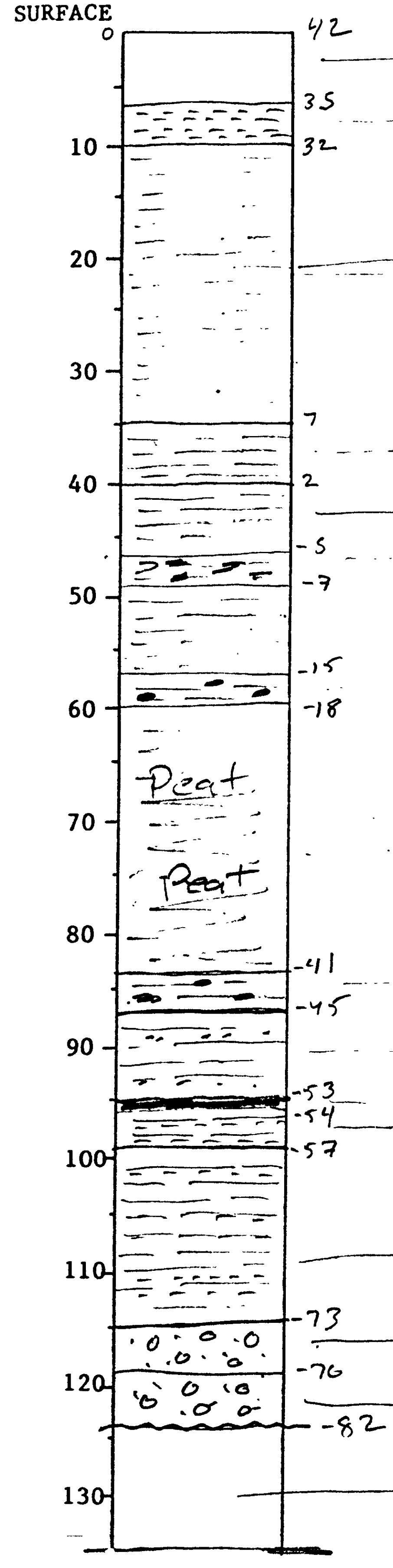
Silty sandy CLAY, w/pebbles, gray

SAND & GRAVEL w/ Kps fragments

Sand, gn gy, weathered - Cretaceous

Huntley Meadow No. 5

DEPTH BELOW SURFACE | ELEVATION | DESCRIPTION



Fill

Blue/gray silt, sandy silt, soft

Blue/gray clay, soft

gray clay, soft

Blue/gray clay, med consistency

organics in gray clay, soft

Blue/gray clay

Black clay/organics

Peat/clayey

gray clay/organics

gray clay w/sand layers

Peat

silty clay

Black silty clay w/organics
sand interbeds

sand & gravel

sand & gravel Kpc clasts

Kpt & Kps interbeds

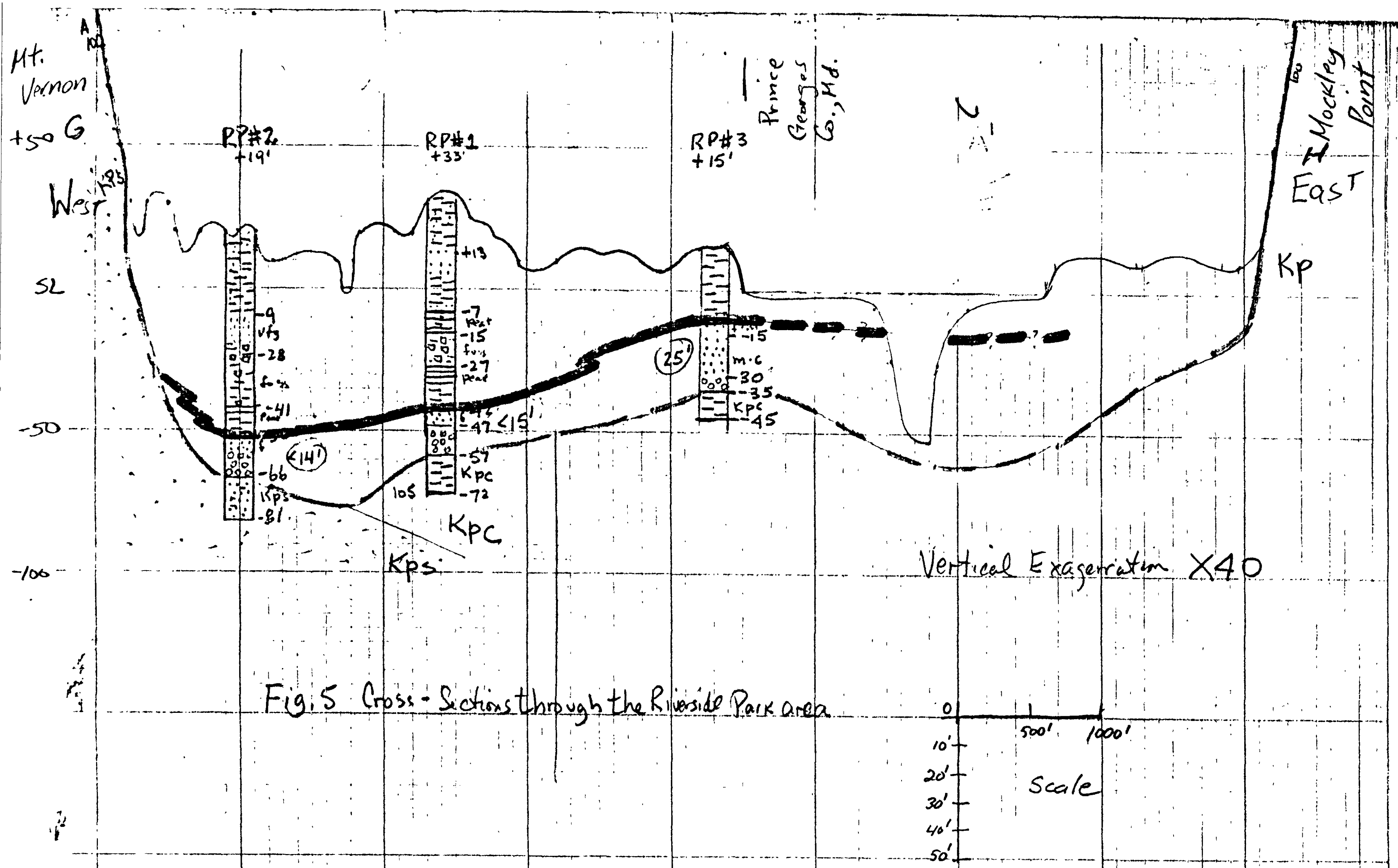


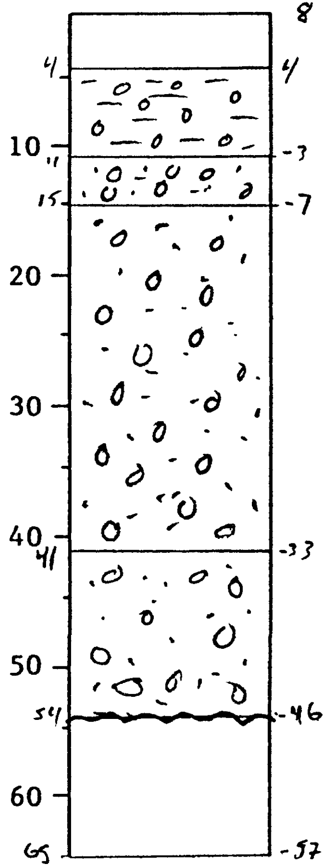
Fig. 5 Cross-Sections through the Riverside Park area

Dogue Creek Area (W.H. Langer)

The subsurface Pleistocene deposits at Dogue Creek consist of 35 to 50 feet (10.5 to 15 m) of friable sand and gravel unconformably overlying Cretaceous clay and sand. The section is overlain by approximately 30 feet (9 m) of clay and silt at Dogue Creek #2. Section line E-F (Fig. 6) appears to be located at the edge of the Pleistocene channel with the thalweg probably being located within 1000-1500 feet (300-450 m) of the section line.

Dogue Creek #1

DEPTH BELOW SURFACE
ELEVATION
DESCRIPTION



Fill

silty CLAY & gravel, soft, gray

silty SAND & gravel, gray / Iron stained

Med. SAND & GRAVEL; Red/Brown
change to gray w/depth

Med to coarse SAND & GRAVEL,
w/clay, gray.

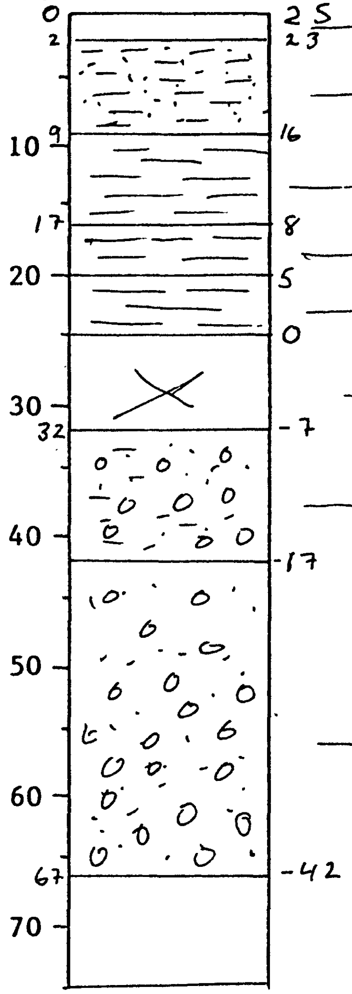
Kpd

Dogue Creek #2

DEPTH BELOW SURFACE

ELEVATION

DESCRIPTION



FILL

SILT & V.F. SAND, reddish/brown

Red/brown silty CLAY, soft

gray/brown silty CLAY, med soft

Red/brown silty CLAY, med

Sample missing Same as above?

Silty sandy GRAVEL, brown

GRAVEL & C-M SAND, silty,

KPS

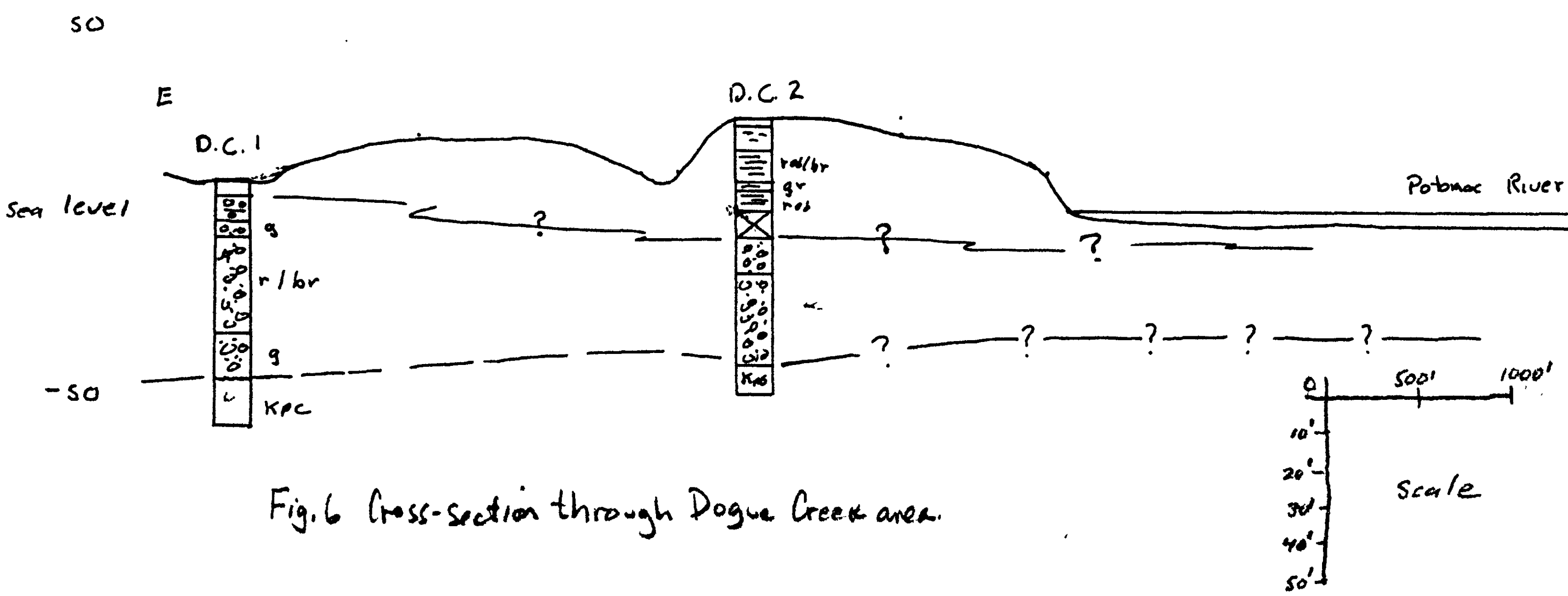


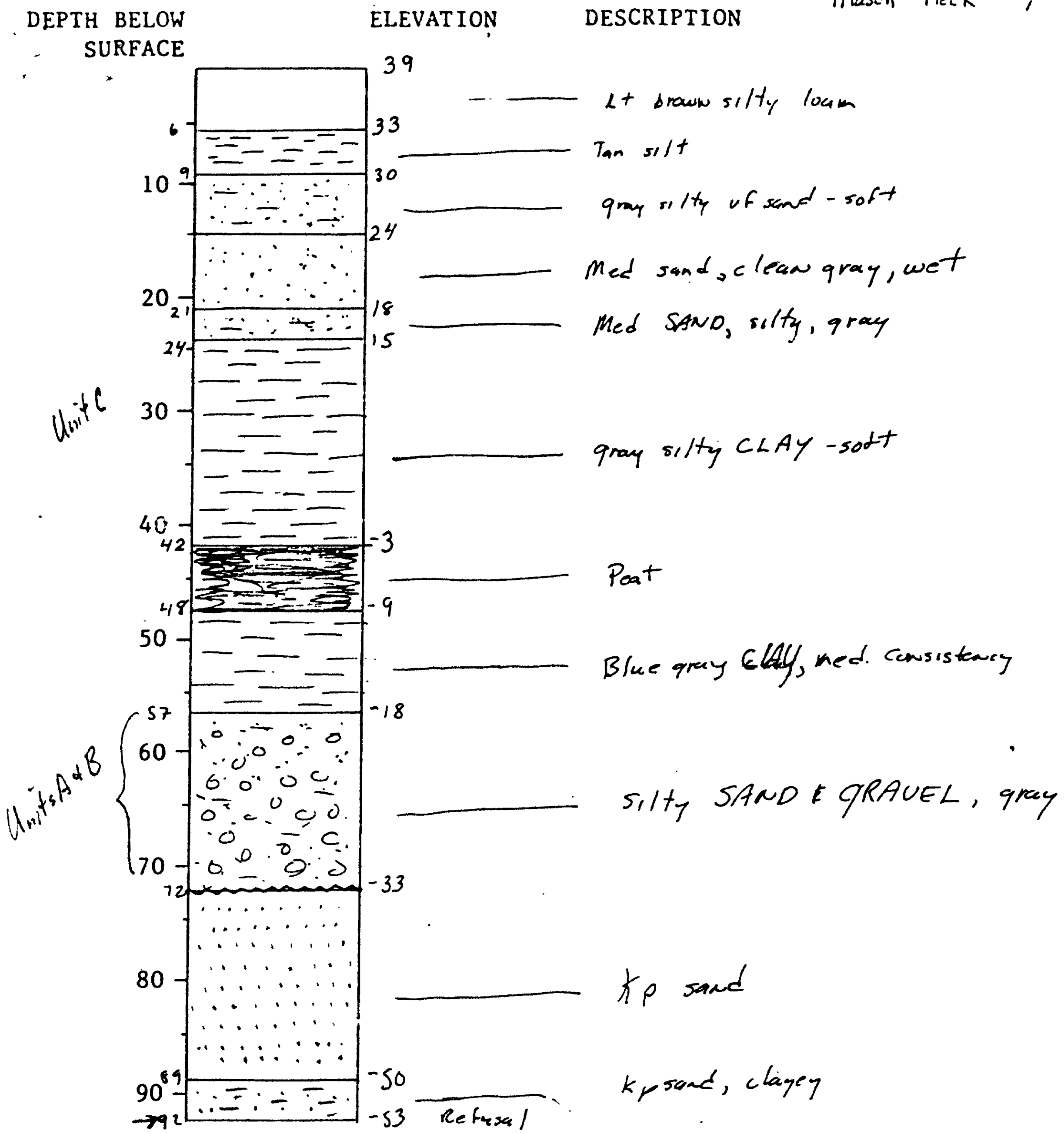
Fig. 6 Cross-section through Dogue Creek area.

Mason Neck Area (W.H. Langer)

The subsurface Pleistocene deposits at Mason Neck adjacent to Gunston Road consist of 50 to 75 feet (15-22 m) of silt and clay interbedded with a few discontinuous lenses of sand and gravel. A peat bed is fairly continuous 40 feet (12 m) below present land surface. The Pleistocene deposits unconformably overlie Cretaceous sands and clays. The section J-K (Fig. 7) appears to be east of, and parallel to the Pleistocene thalweg.

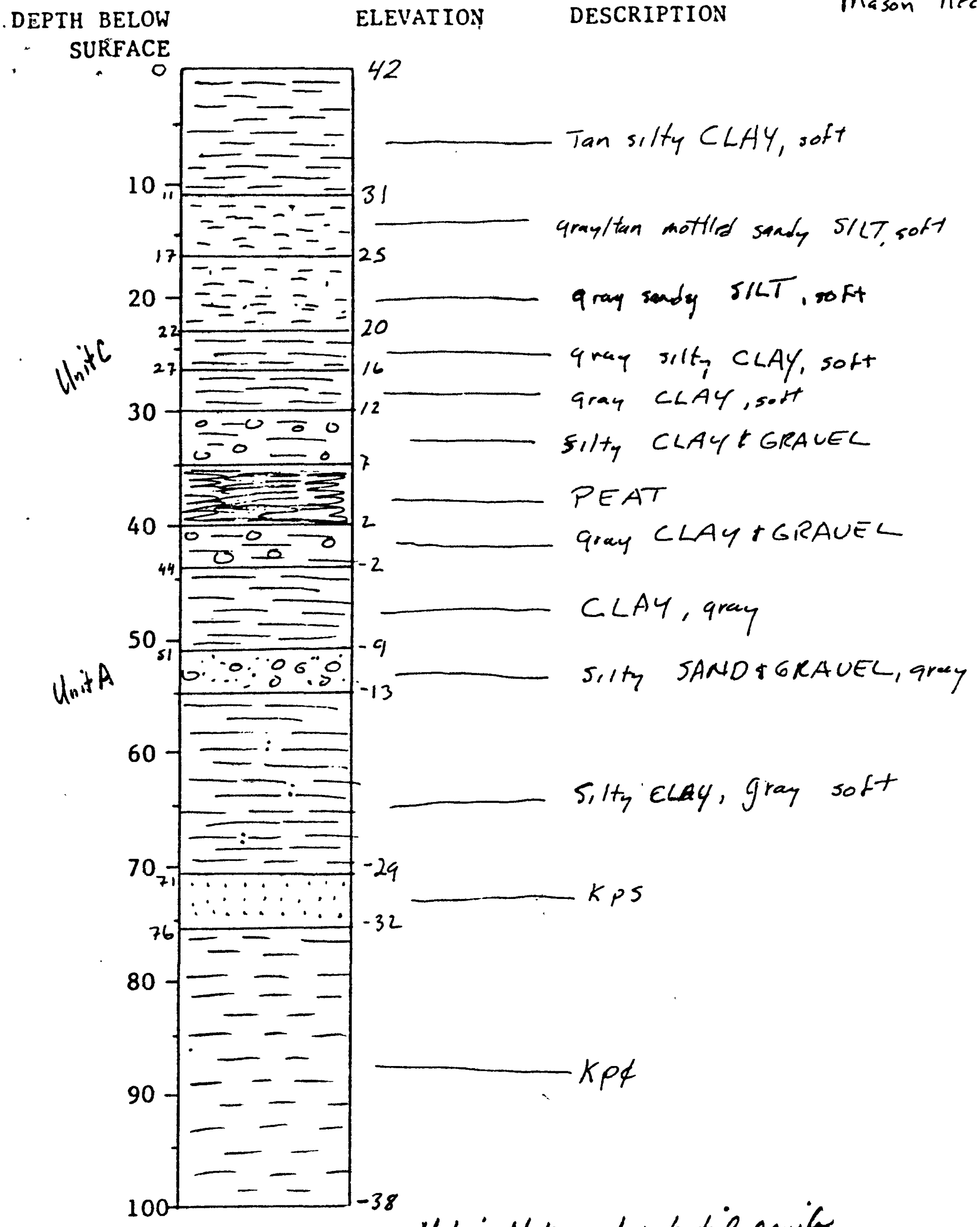
The subsurface material at Mason Neck locality number 4 consists of 109 feet (33 m) of Pleistocene deposits unconformably overlying Cretaceous clay. The lower 8 feet (2.3 m) of the section is a basal gravel with the upper 100 feet (30 m) being predominantly silts and clays with two interbeds of sand. This deposit is on the flank of, and probably 1500 to 2000 feet (450-600 m) from the thalweg of the Pleistocene channel. Further drilling is necessary to determine in which direction the main channel is located.

There is little likelihood that either of the areas of Mason Neck that were investigated are hydraulically connected to the Potomac River by permeable Pleistocene deposits; however, the area east of Mason Neck No. 1 may merit further evaluation as the basal gravel deposits are moderately thick, and overlie friable, weathered Potomac Group sands thatmay be a potential aquifer.

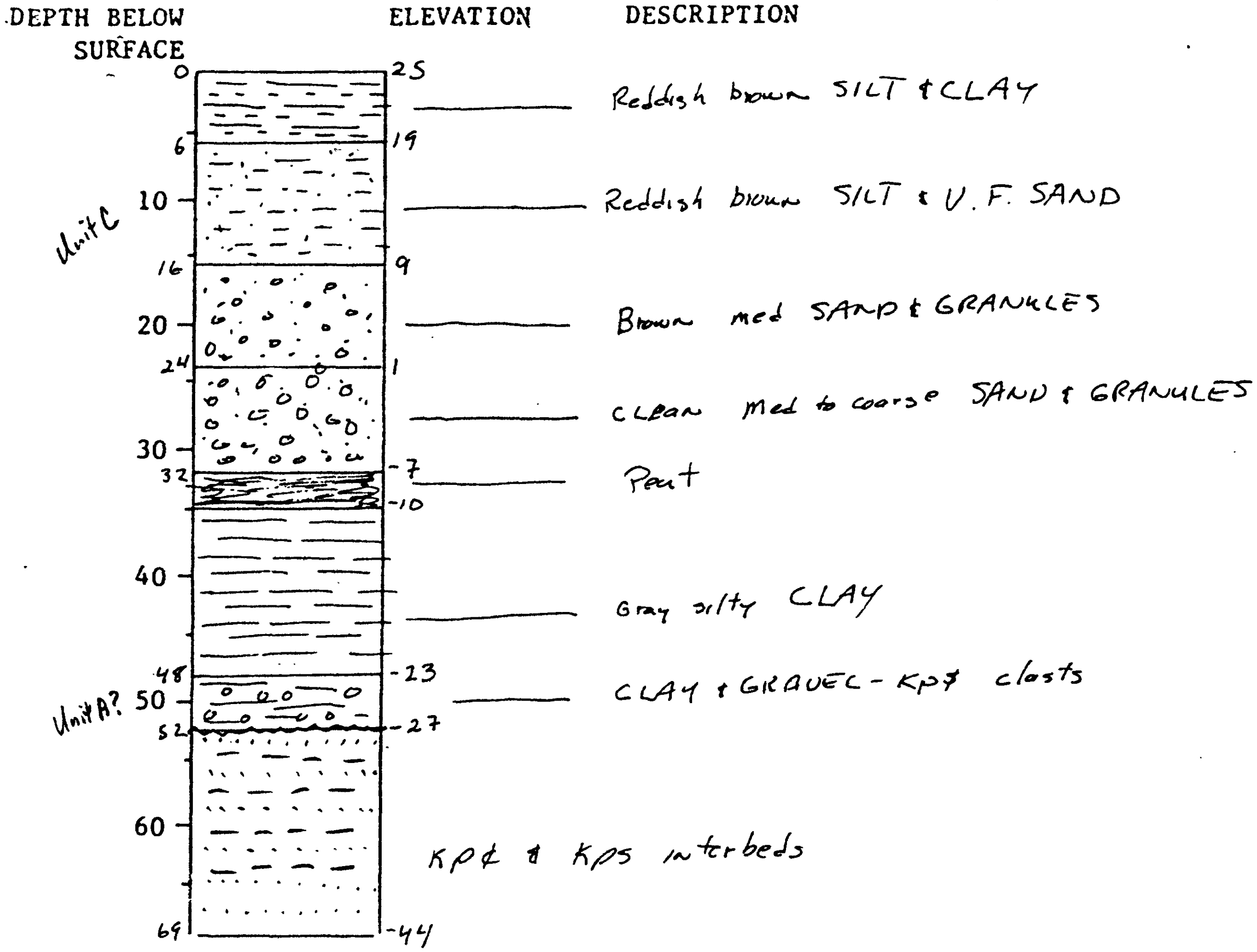


Note: 57-72 (15') Potential aquifer in Qtc
72-89 (17') Potential aquifer in KPS.

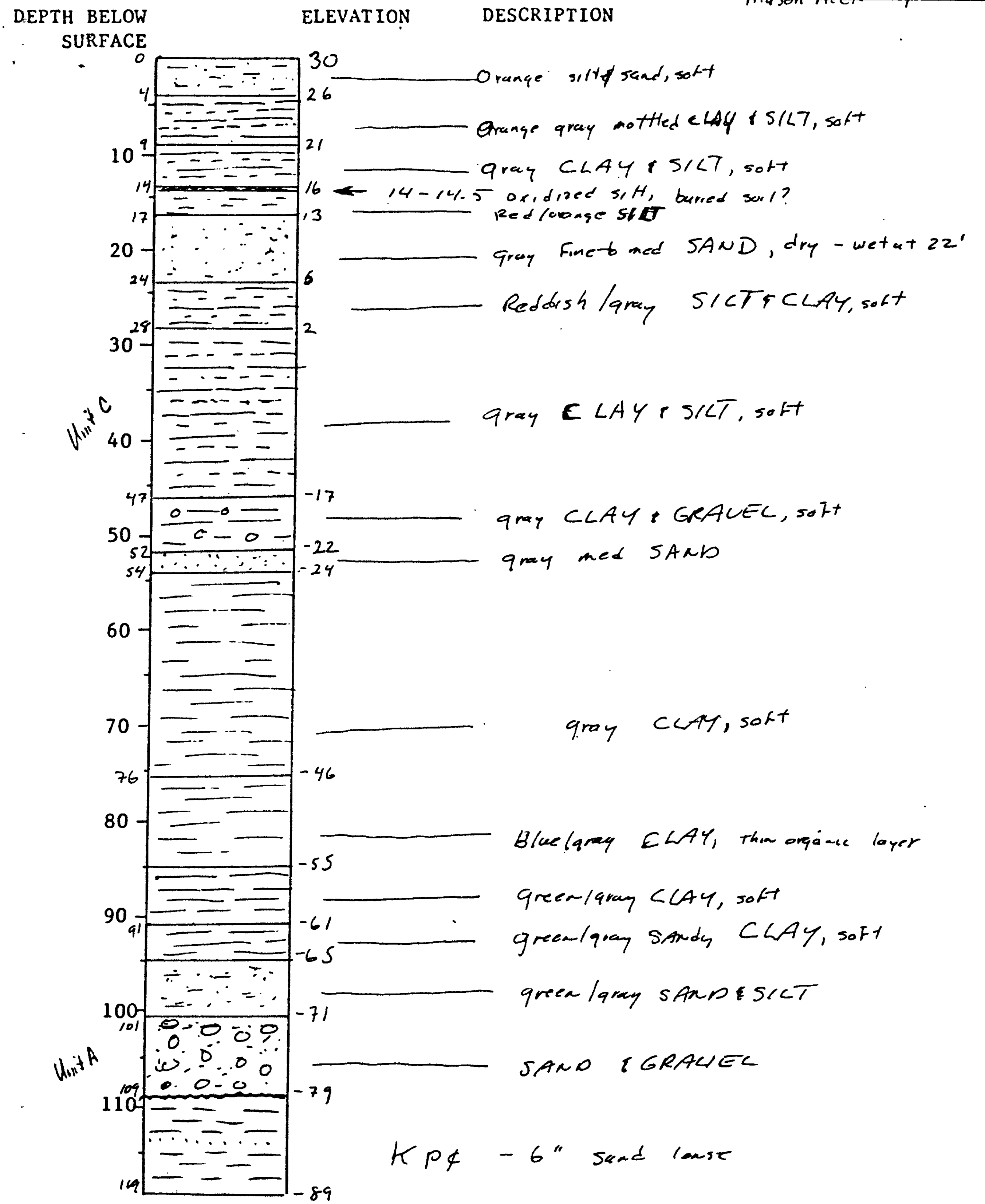
Mason Neck 2



Note: Not much potential aquifer



Note: 16 - 32 (16') potentially fair aquifer sands in Qte.



Note: Not much potential aquifer

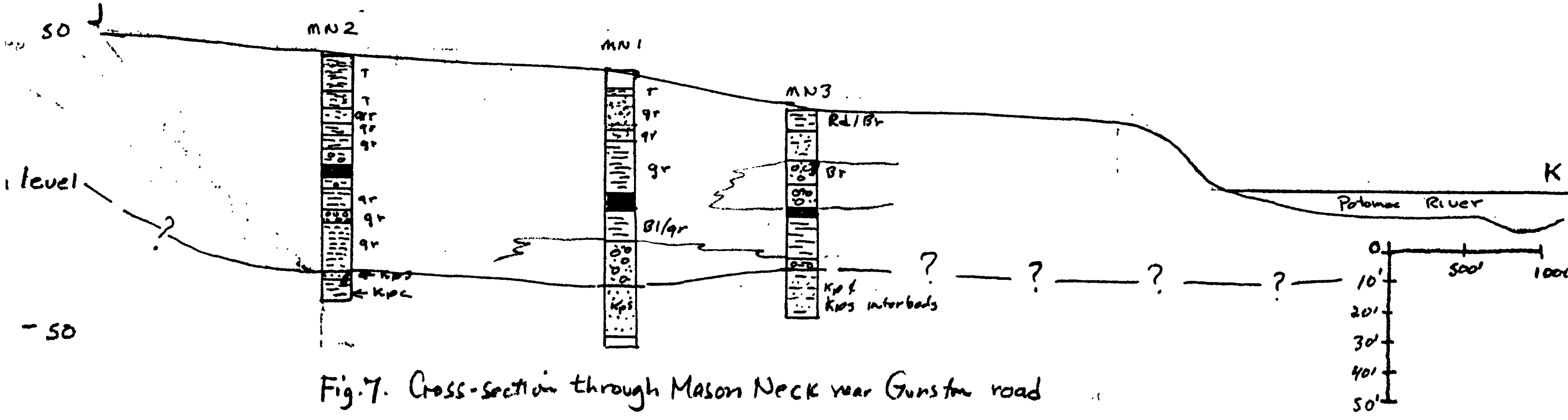


Fig. 7. Cross-section through Mason Neck near Gunston road