ENSOL
ENGINEERING SOLUTIONS

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October 12, 2004

0068(B09)

Ms. Jaclynne Drummond
Solid Waste Section
Division of Waste Management
North Carolina Department of Environment and Natural Resources
Mail Service Center 1646
Raleigh, NC 27699-1646

RE: WORK PLAN FOR A PROPOSED PUMP TEST
DUNN-ERWIN MUNICIPAL SOLID WASTE LANDFILL, PERMIT 43-02
HARNETT COUNTY, NORTH CAROLINA

Dear Ms. Drummond:

On behalf of Harnett County and C.T. Clayton, Sr., PE, ENSOL, Inc. (ENSOL) is pleased to herewith submit a work plan for a pump test to be performed in the contamination plume area downgradient of the landfill following the next sampling event scheduled for October 2004. The pump test is another important step in the evaluation of feasible corrective measures to be considered at this site in accordance with North Carolina Solid Waste Management Rule *15A N.C.A.C. 13 B, .1634*, in conjunction with an evaluation of possible permitting options for an extended C&D landfill permit in the downgradient area of the present landfill.

This work plan includes an introduction, drawdown parametric evaluation, pump test methodology, conclusions, and the respective figures. Should you have any questions or comments, please contact me at our address shown above or by e-mail at ***cporan@ensol.us***.

If we do not hear from you by October 29, 2004, we will assume that you have no comments on the work plan and we will proceed to perform the pump test in general accordance with this work plan.

Sincerely,

ENSOL, Inc.

Chaim J. Poran, PhD, PE

cc. Jerry Blanchard (Harnett County)
C.T. Clayton, Sr., PE
Tyrus Clayton, PE (Draper Aden Associates)

/attachment

1. INTRODUCTION

On August 25, 2003, Harnett County submitted to the SWS a report entitled "Assessment of Groundwater Contamination Plume, Dunn-Erwin Municipal Solid Waste Landfill, Permit 43-02". The layout of the downgradient area of the landfill, shown in Figure 1, is taken from that report. Since then, correspondence with the SWS and ground water assessment has continued along with the County's semi-annual groundwater sampling and analyses, in accordance with North Carolina Solid Waste Management Rules *15A N.C.A.C. 13 B, .1633* and *.1634*. Evaluation of feasible corrective action options have also continued in conjunction with possible permitting options for an extended C&D landfill permit in the downgradient area of the present landfill.

However, before further evaluation of feasible corrective action options it appears that a pump test may be needed to provide better understanding of the following main issues:

- Representative composite permeability in the uppermost aquifer within and near the estimated boundaries of the contaminant plume area
- Representative radii of influence and drawdown for pumping in the uppermost aquifer within and near the estimated boundaries of the contaminant plume area

2. DRAWDOWN PARAMETRIC EVALUATION

2.1 Drawdown Effect Radius

Drawdown effect radius was estimated based on Figure 2 which shows a typical drawdown condition in an unconfined surficial aquifer overlying a confining layer. These conditions may be representative of the uppermost aquifer in the downgradient area of the landfill. The equation that may be representative of drawdown conditions in steady state flow is as follows:

$$h = \sqrt{\left(\frac{Q_w}{\pi k} \log_e \frac{r}{r_w} - H_w{}^2 \right)}$$

Where: h = drawn-down water level at radius *r* from the pump
Q_w = steady-state pumping rate
k = representative composite permeability of the aquifer
r = distance from pump location
r_w = radius of well being pumped
H_w = steady-state drawn-down water level in the well being pumped

This well-known simplified equation considers a uniform radial (phreatic) groundwater level prior to pumping. While this situation does not occur at the site, apparent uppermost groundwater gradients in the contaminant plume area are only a few percent. Therefore, for this equation is adequate for a general drawdown evaluation.

The following table shows possible monitoring locations for the pump test, and their respective distances relative to the two possible pumping locations.

Table 1. Pump test Drawdown Evaluation

Pumping Location	Drawdown Monitoring Locations, Distance and Characteristics											
MW-10	Monitoring Location	MW-			PZ-			GP-(number below)-W				
		6	7B	9	41S	46S	46D	27	30	33	34	36
	App. *r* (ft)	270	240	205	210	340	340	360	170	340	80	190
	Notes	IN	IN UG	IN	IN DG	IN	DA	OUT DG	OUT DG	OUT DG	IN DG	IN DG
MW-9	Monitoring Location	MW-		PZ-			GP-(number below)-W					
		7B	10	41S	46S	46D	24	28	30	31	34	36
	App. *r* (ft)	205	205	400	130	130	470	470	350	455	220	260
	Notes	IN	IN	IN DG	IN	DA	IN DG	IN DG	OUT DG	IN DG	IN DG	IN DG

<u>Notes to Table 1</u>:

IN = Inside estimated contamination plume boundaries
OUT = Outside estimated contamination plume boundaries
DG = Downgradient from pumping location
UG = Upgradient from pumping location
DA = Deeper aquifer
Uppermost aquifer monitoring points that do not show an indication of UG or DG are estimated to have roughly similar static water level

It should be noted that other monitoring points could be added during the test in more remote downgradient locations, based on actual drawdown measurements. For example, when the pumping is performed in MW-9, in case that a measurable drawdown is recorded in GP-31-W and GP-36-W, we will also attempt to measure drawdown at GP-35-W and GP-33-W, respectively, and possibly even further downgradient, as appropriate.

2.2 Composite Permeability

The parametric evaluation was performed assuming two values for ***k*** to represent the possible range of composite permeability in the contaminant plume, as follow:

- <u>Average Permeability (AP) of 5×10^{-5} cm/s</u>: This is similar to the semi-pervious (SEP) permeability used in the August 25, 2003 contamination plume assessment report. This value also corresponds to the average slug test results performed at MW-9 and MW-10 following their installations in March 2001.

- <u>Higher Permeability (HP) of 5×10^{-4} cm/s</u>: This ***k*** value is an order of magnitude higher than the AP value to represent the potential of more conductive sandy deposits in the uppermost aquifer.

2.3 Parametric Evaluation Results

Results from the parametric drawdown evaluation are shown in Figures 3 and 4, for AP and HP permeability values aforementioned in Section 2.2, respectively. Also, in addition to the aforementioned abbreviations in Sections 2.1 and 2.2, the figures also include several parameters shown in abbreviated notations as follows:

H	= static (phreatic) groundwater level before pumping
h	= water level during drawdown test at radius *r* from the pump
D_h	= water level drawdown at radius *r* from the pump (H - h)
D_H	= water level drawdown in the well being pumped (H - H_w)
GPH	= Q_w expressed in gallons-per-hour

In the figures, conditions in Groups A and B correspond to pre-pumping static (phreatic) heads of 5 and 10 feet relative to the confining layer, respectively.

The following evaluation results are noted:

2.3.1 The water level drawdown diminishes as the radial distance from the pumping point increases.

2.3.2 Generally, the radius R represents the distance from the pumping point where the drawdown effect stops, and the static (phreatic) head returns to the undisturbed, pre-pumping level. The results show that R values vary from 300 to more than 600 feet depending of the parameter set. The higher R values generally correspond to Group B.

2.3.3 Within each group (A or B), drawdown is greater at a given monitoring distance from the pumping point (***r***) when H_w (steady-state drawn-down water level in the well being pumped) is higher, all other parameters equal. While these results may appear counterintuitive it is consistent with the equations that govern pumping drawdown in an unconfined aquifer.

2.3.4 Within each group (A or B), drawdown is greater at a given monitoring distance from the pumping point (***r***) when Q_w (steady-state pumping flow rate) is lower, all other parameters equal. While these results, just as in 2.3.3 above, may appear counterintuitive it is consistent with the equations that govern pumping drawdown in an unconfined aquifer.

2.3.5 In case that AP permeability is more representative of actual site conditions, it is expected that Q_w rates could be in the low range of one (1) or two (2) GPH to enable significant drawdown measurements in monitoring points as far as 300 to 400 feet away from the pumping location.

2.3.6 However, in case that HP permeability is more representative of actual site conditions, it is expected that Q_w rates could be in the range of three (3) to 20 GPH to enable significant drawdown measurements in monitoring points as far as 400 or 500 feet away from the pumping location.

3. PUMP TEST METHODOLOGY

The pump test will be performed just after completion of the next semi-annual sampling scheduled for late October 2004. That way the pump test would not affect turbidity or contaminant concentrations in compliance wells to be sampled. The layout of the downgradient area including estimated contaminant plume extent and locations of monitoring wells and piezometers is shown in Figure 1, last updated on August 25, 2003. The following general procedure will be used for the pump test:

a. Just before the test, static groundwater levels will be measured in potentially affected and nearby compliance wells (MWs), piezometers (PZs), and observation wells (GP-xx-Ws, where "xx" is their respective number),

according to their locations shown in Figure 1, including the following:
MWs: 6, 7B, 8, 9, and 10
PZs: 41S, 46S and 46D
GP-xx-Ws: 24, 25, 27, 28, 30, 31, 33, 34, 35, 36, 38

b. The pump test will be attempted first by pumping from monitoring well MW-10 then from MW-9. Once a steady-state flow can be established, groundwater levels will be measured in affected monitoring wells, piezometers, and observation wells, to evaluate drawdown effects. These two possible pumping locations are well within the estimated boundaries of the contaminant plume. Therefore, there is no risk of inducing contaminant advection to the outside (downgradient) directions of the estimated boundaries of the plum. Additionally, these wells are also sufficiently remote from the landfill waste boundary (about 250 feet) to minimize concerns of increase groundwater contaminant advection from the landfill due to the downgradient pump test.

c. At first the pump will be set at MW-10. After completion of associated drawdown measurements or in case that steady-state flow cannot be established with measurable flow rate, the pumping from MW-10 will be stopped and groundwater allowed to recover to static levels before moving the pump to the next pumping point at MW-9.

d. Table 1 above shows potentially affected locations for drawdown evaluations based on the pumping point, and their respective distances.

e. All pumps and groundwater level probes will be thoroughly decontaminated between application in different monitoring wells, piezometers, or observation wells.

f. Pumped effluent from the pump test will be collected into a truck mounted plastic tank and then discharged into the leachate collection/wash down water tanks of the onsite MSW transfer station. These tanks are periodically emptied on an as-needed basis by Harnett County and their contents are pumped and hauled to the Harnett County owned waste water treatment plant in Buies Creek, NC. Figures 3 and 4 show that even if composite permeability at a pumping location is on the high side, pump flow rates are not expected to exceed 15 gallons per hour. Thus, even at the highest pumping rate the pumped volume is likely to be less than 180 gallons for a 12 hour pumping interval.

4. CONCLUSIONS

4.1 If successful, the proposed pump test will provide valuable data to be used in the evaluation of:

i. Representative composite permeability in the uppermost aquifer within and near the estimated boundaries of the contaminant plume area;

and,

ii. Representative drawdown and radii of influence for pumping in the uppermost aquifer within and near the estimated boundaries of the contaminant plume area.

4.2 By the selection of pumping points at MW-10 and MW-9, the pump test plan is intended to eliminate risk of adverse contaminant advection outside the estimated contaminant plume boundaries, and to greatly minimize risk of increased contaminant advection from the waste boundaries into the contaminant plume area.

4.3 The pump test plan and procedures will eliminate the risk of cross contamination among measurement and pumping locations, and the pumped out effluent will be properly discharged into the leachate collection tanks of the on-site transfer station.

/Attached: Figures 1 - 4

FIGURES

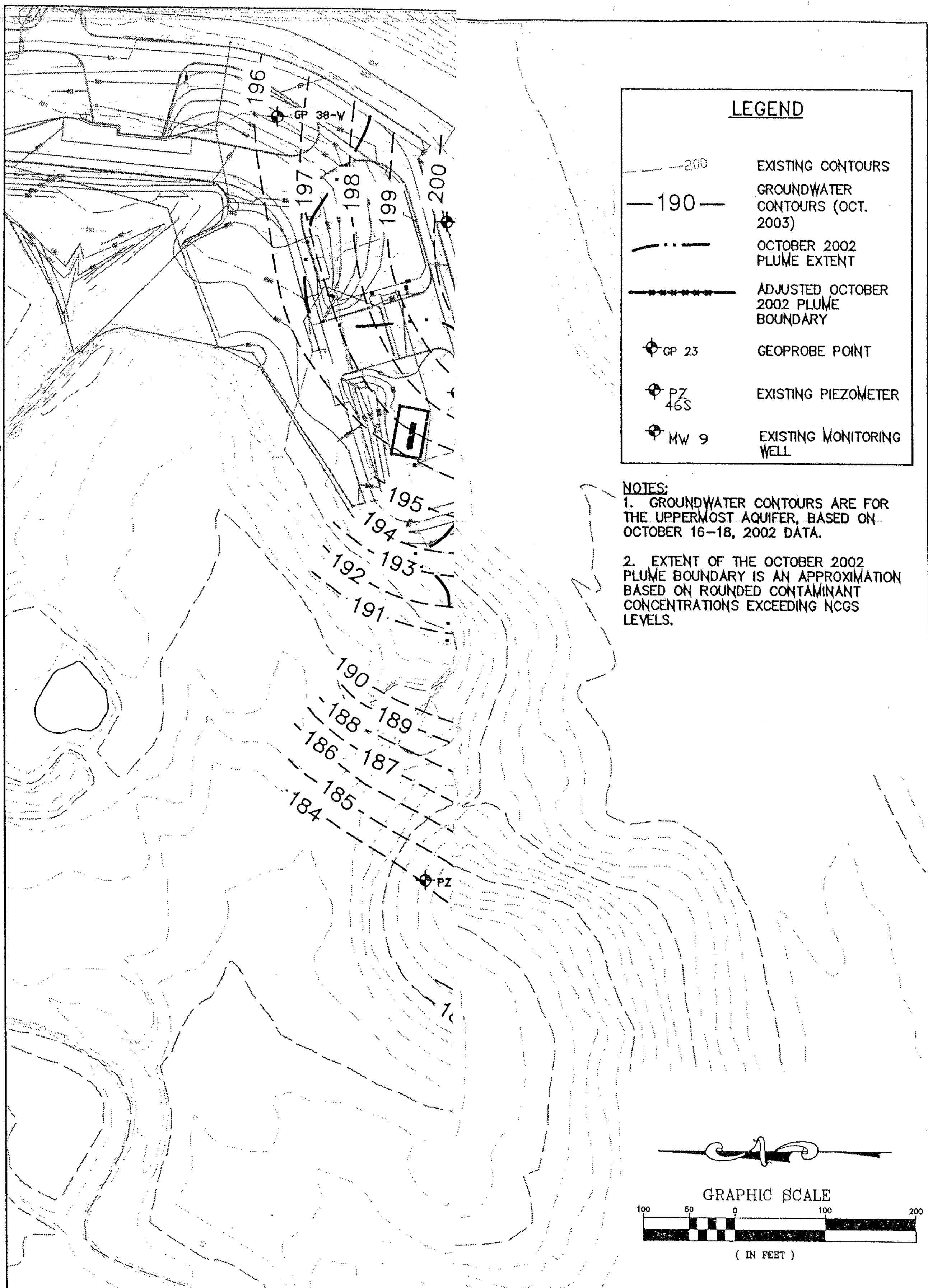

FIGURE 1

CONTAMINANT PLUME ASSESSMENT

at

DUNN/ERWIN LANDFILL

NTY NORTH CAROLINA

PROJECT # : 0003002
PROJ. ENG. : CTC
DRAWN BY : CTC Jr.
CHECKED BY : CJP
CAD FILE : DELF Plume 2003.dwg
SCALE : SEE GRAPHICAL SCALE
DATE : AUGUST 28, 2003
SHEET # : 1 OF 1
Email: ctc@cox.net

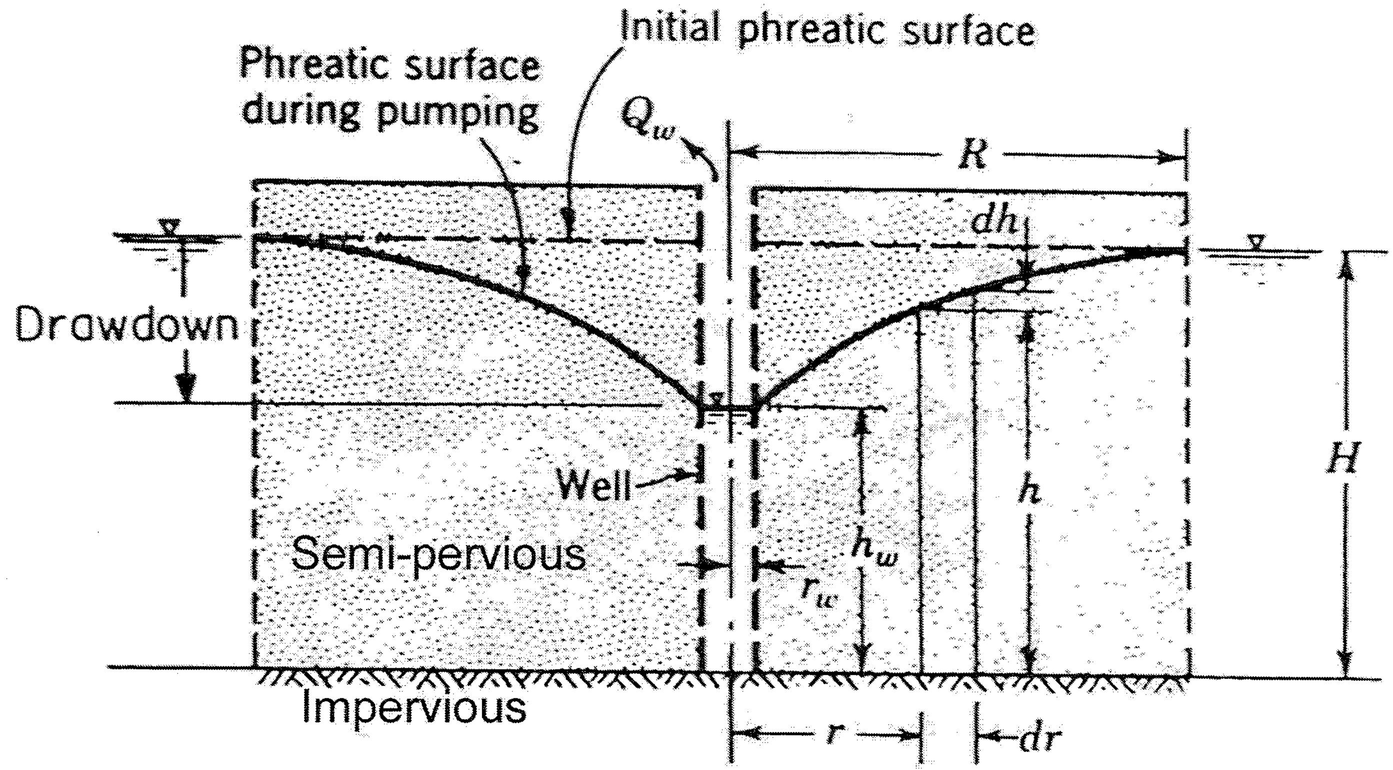

Figure 2. Drawdown Evaluation Parameters
(modified from Hunt, R.E., 1983, *Geotechnical Engineering Investigation Manual*, McGraw Hill, FIG. 8.33, p. 621)

FIGURE 3. PUMP TEST AT DUNN-ERWIN LANDFILL
Estimated Drawdown Vs. Distance from Well Being Pumped

PERMEABILITY k=0.00005 cm/s

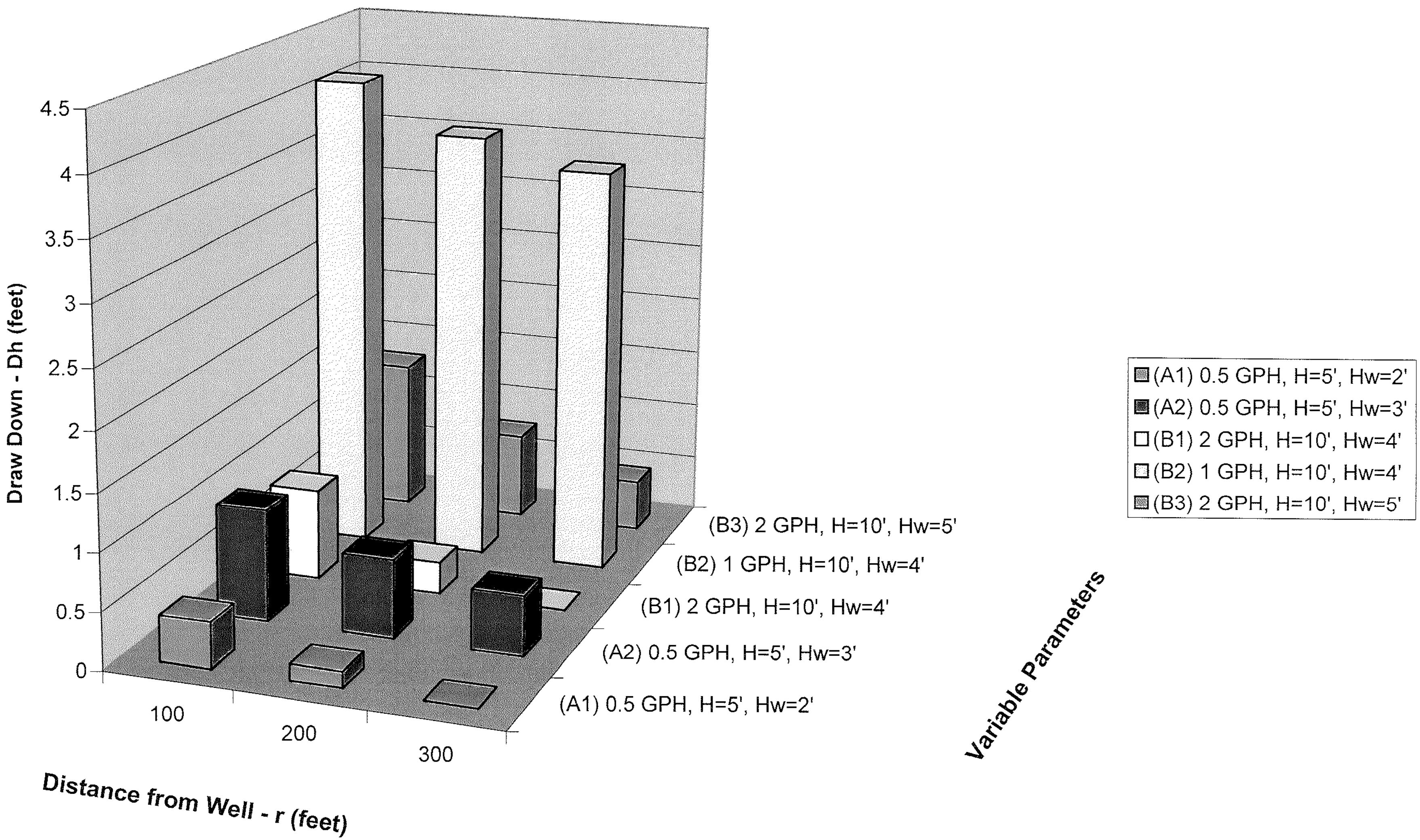

FIGURE 4. PUMP TEST AT DUNN-ERWIN LANDFILL
Estimated Drawdown Vs. Distance from Well Being Pumped

PERMEABILITY k=0.0005 cm/s