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Woodward-Clyde Consultants

June 8, 1989
88C2075B-5

E. I. duPont de Nemours & Co., Inc.
26th Street and Buffalo Avenue
Niagara Falls, New York 14302

Attention: Mr. Richard J. Gentilucci, Manager
Utilities and Remedial Alternatives

Re: Overburden Remediation System
Projected Time to Reach
Steady-State Conditions

Gentlemen:

In response to your request, Woodward-Clyde Consultants (WCC) is pleased to present this evaluation of the time required for the proposed Overburden Remediation System to reach a near steady-state condition. The analysis detailed herein is based on the groundwater modeling effort contained in Woodward-Clyde Consultants' report dated August 24, 1988, entitled, "Evaluation of Overburden Remediation System, DuPont Niagara Plant."

WCC was requested to use the existing groundwater flow model of the Niagara Falls Plant to predict how long it would take the hydrogeologic conditions beneath the site to reach equilibrium subject to the proposed Overburden Remediation System. The issue of regulatory significance is when "hydraulic control" would begin. Although the results of the groundwater model should be considered as order-of-magnitude, the groundwater model represents the most logical predictive tool to apply to the problem.

NUMERICAL SCENARIO

Currently, the base representation of the hydrogeological conditions for the overburden and top-of-bedrock zones beneath the Niagara Plant is Simulation 3, outlined in detail in the aforementioned August 1988 report. The hydrogeologic parameters, summarized in Table 1, were derived from an attempt to reproduce the observed hydraulic impact as a result of the April 1988 pump test performed by WCC. The results of Simulation 3 have previously been presented in the form of steady-state hydraulic head distributions for the overburden and top-of-rock (Figures 4-2 and 4-3 of the August 1988 report). In this study, a transient analysis was performed to predict the temporal changes between the nonstressed initial condition and the steady-state condition. The transient analysis consisted of two new simulations designated as Simulation 1 and Simulation 2, which are different from the simulations of like name in the August 1988 report.

The only additional hydrogeologic parameters required for the transient analysis, beyond those outlined for Simulation 3 in the August 1988 report, are the storage coefficients for each of the two model layers. These storage coefficients, which numerically represent the aquifer's ability to release groundwater contained within interstitial pores and/or fractures, were derived from the pump test simulations which attempted to reproduce observed transient responses to the pump tests performed at the site. In the two-layer model, three storage coefficients are required. The first storage coefficient is the specific yield of the unconfined overburden layer termed the Primary Storage Coefficient of model layer 1. The second storage coefficient is the specific storage of the confined top-of-rock layer termed the Primary Storage Coefficient of model layer 2. The final storage coefficient is the specific yield of the top-of-rock layer used in areas where this layer becomes locally unconfined; this storage coefficient is termed the Secondary Storage Coefficient of model layer 2. Since any estimation of these coefficients is order-of-magnitude, a sensitivity simulation was also performed in which the primary storage coefficients were increased by an order-of-magnitude to predict the impact of variations in these parameters.

In the August 1988 computer model simulations of the pump test, analytical solutions were used to estimate the specific storage for the top-of-rock zone based upon the April 1988 pump test. The Jacob Method results (Table 3.6 of the August 1988 report) indicated that storage coefficients were generally between the two values used in these transient simulations. A second analytical solution, the Theis Method, indicated higher storage coefficients for the top-of-rock zone, between 3 x 10^{-3} and 2 x 10^{-2}. The specific yield of the overburden and top-of-rock were estimated from existing field data of the overburden porosity and top-of-rock fracture density, respectively. The calculated and estimated values were then adjusted during the numerical simulations in the August 1988 study.

RESULTS

The new transient simulations were analyzed based on comparing the maximum head deviation between the transient heads and the previously simulated steady-state heads. The head distribution in the entire modeled area was considered at each time step. The plots of maximum head deviations from steady-state water levels in the model (Figures 1 and 2 for Simulations 1 and 2, respectively) indicate that the overburden approaches steady state more slowly than does the top-of-rock. Also, the higher storage values characteristic of Simulation 2 extend the time required to reach steady-state. The most likely scenario, Simulation 1, indicates that the water levels will be within 1/2 of 1 foot of the steady-state values between 6 and 12 months. The overburden response lags slightly behind the top-of-rock response. If the actual storage coefficients are similar to those assumed in Simulation 2, the overburden and top-of-rock zone will take about 26 and 16 months to reach within 1/2 of 1 foot of the steady state water levels, respectively.

Cross-sections of water levels perpendicular to the remediation system through pumping well P-12 for the overburden and top-of-rock zones are shown in Figures 3 and 4 for Simulation 1 and Figures 5 and 6 for Simulation 2. The uppermost curve is the simulated water levels prior to pumping; the lowermost curve shows the water levels at steady-state. For Simulation 1, a significant portion of the drawdown occurs in the first month, as shown by the large distance between the initial conditions (top curve) and the one-month conditions (next lower curve). Simulation 2 indicates that the water level declines in the overburden (Figure ~~6~~ 5) are much slower than the top-of-rock (Figure ~~7~~ 6). The overall interpretation of the results is that, although the entire modeled area would not achieve steady-steate for two to three years, the portion of the site that will be monitored to evaluate pumping system performance would achieve a near steady-state condition between 12 to 18 months after the pumping system is fully operational. It should be emphasized that the results of this modeling effort should be considered to be order-of-magnitude estimates based on the accuracy with which key hydrogeologic parameters can be measured.

We appreciate the opportunity to work with DuPont on this project. If you should have any questions, please do not hesitate to call.

Very truly yours,

WOODWARD-CLYDE CONSULTANTS

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cc: Frank S. Waller, WCC

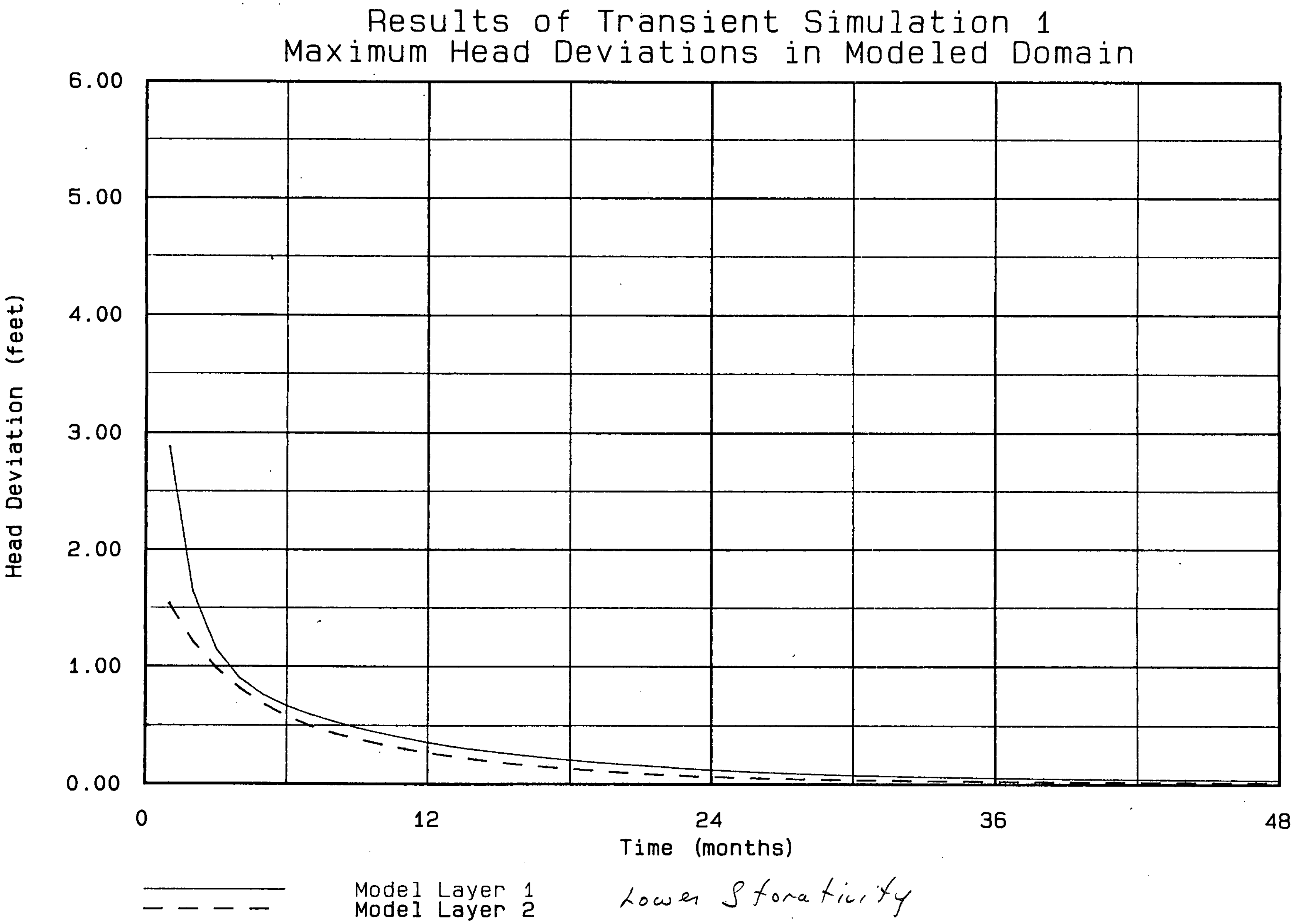
Tables

TABLE 1

KEY HYDROGEOLOGIC PARAMETERS

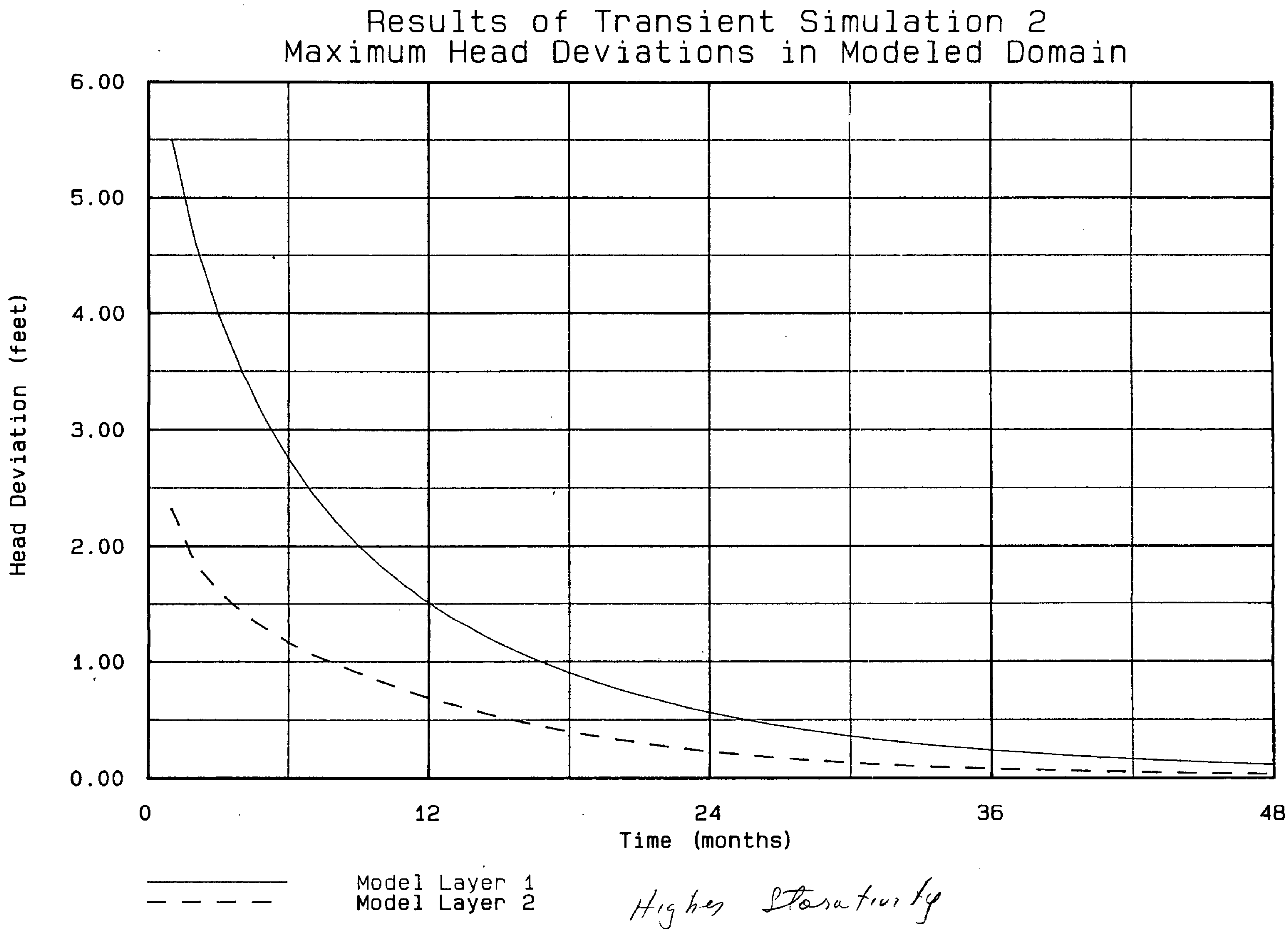
		Layer 1 OB	Layer 2 TOR
Lateral Anistropy		1.0	.167
Hydraulic Conductivity (ft/sec)	($4.57\ 10^{-4}\ \frac{cm}{sec}$)	1.5×10^{-5}	4.0×10^{-4} $1.22 \times 10^{-2}\ \frac{cm}{sec}$
Vertical Conductance (ft/sec/ft)		2.0×10^{-9}	NA
Primary Storage Coefficient	Unconf. OB	$2.0 \times 10^{-3} = S_y$	1.0×10^{-4} confined TOR
Secondary Storage Coefficient		NA	5.0×10^{-2} unconfined TOR $= S_y$

Figures



Lower Storativity

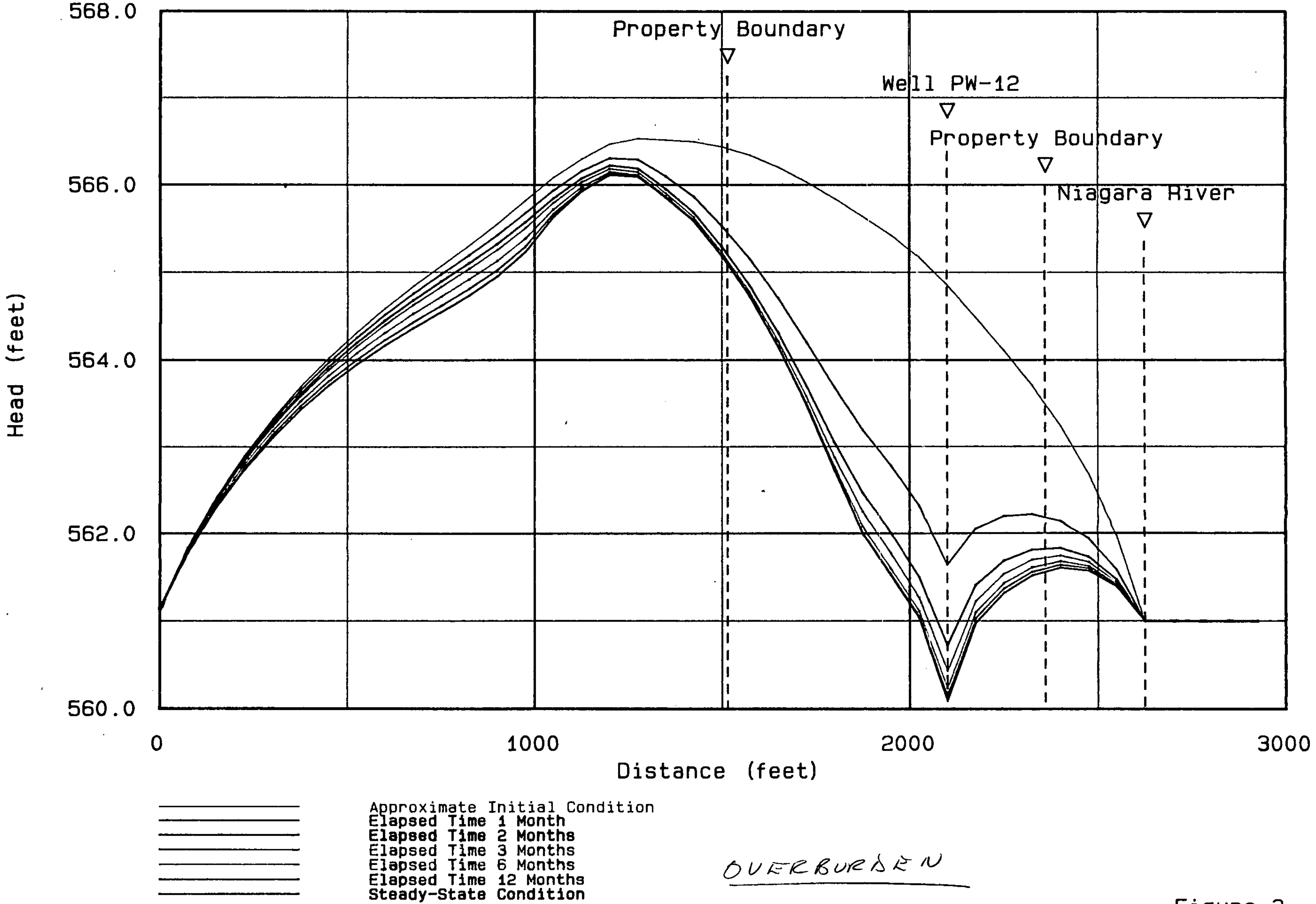
Figure 1



Higher Storativity

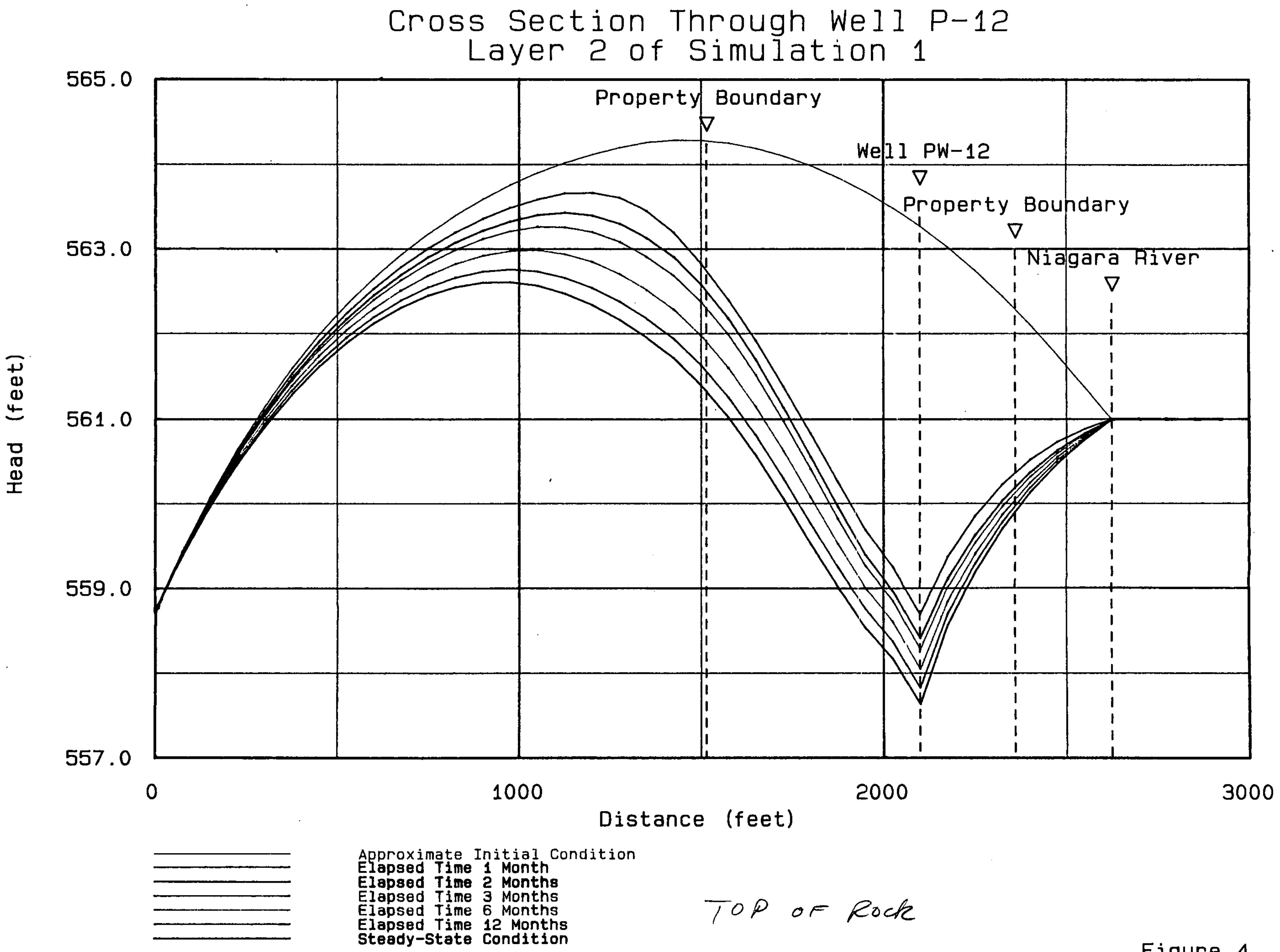
Figure 2

Cross Section Through Well P-12
Layer 1 of Simulation 1



OVERBURDEN

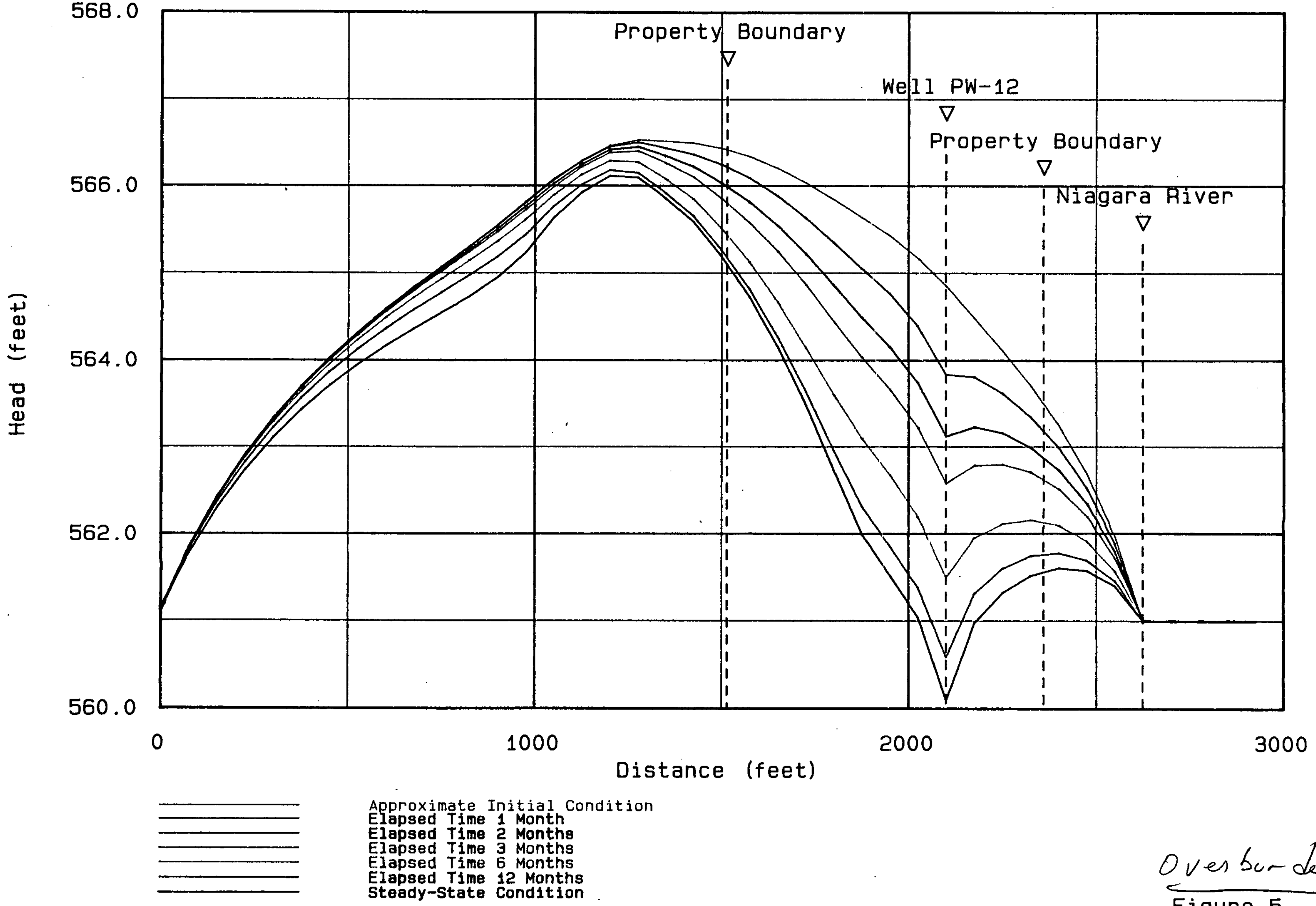
Figure 3



TOP OF Rock

Figure 4

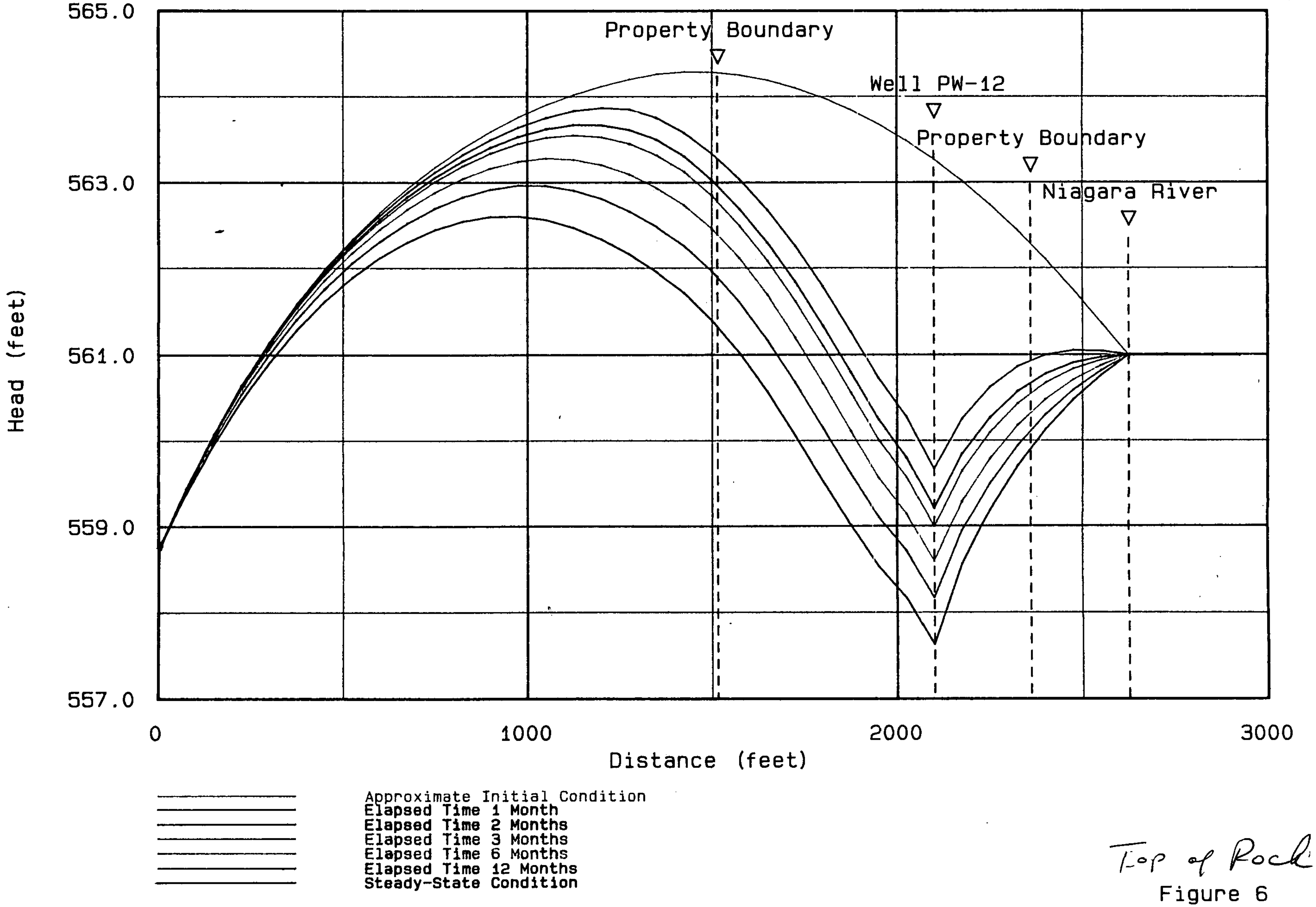
Cross Section Through Well P-12
Layer 1 of Simulation 2



Overburden

Figure 5

Cross Section Through Well P-12
Layer 2 of Simulation 2



Top of Rock

Figure 6