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From:
Robert Porsche/Doug Smolensky

Date:
4 December 2002

ARCADIS Project No.:
NY001321.0006.00003

Subject:
GM38 Area Remedial Design Modeling Results, Northrop Grumman Regional Groundwater Model, Northrop Grumman Corporation.

Purpose of GM38 Area Remedial Design Modeling

The purpose of this memo is to document the work performed and results of groundwater modeling conducted in support of the GM38 Area Remedial System Design. The so-called GM38 Area is an area of elevated volatile organic compound (VOC) concentrations in groundwater in the vicinity of Monitoring Well cluster GM38. Monitoring Well cluster GM38 is located southeast of the Northrop Grumman facility in Bethpage, New York, between Bethpage Water District (BWD) Plant 4 (supply wells 6915 and 6916), and BWD Plant 5 (supply well 8004), as shown on Figure 1.

GM38 Area Remedial System Goal

The goals of the GM38 Area Remedial System (the System) are to provide capture, contaminent mass removal, and treatment of VOCs in groundwater from the area of elevated concentrations in the vicinity of GM38. Specifically, this modeling effort focused on the capture and removal of groundwater with total VOC (TVOC) concentrations in excess of 1,000 micrograms per liter (μg/L), as is required under the Record of Decision (ROD). During this modeling effort, it was determined that the System could capture and remove groundwater with TVOCs down to the 500 μg/L level if the operational timeframe of the System was minimally extended. Therefore, the System described herein can focus on either the 1,000 μg/L or 500 μg/L TVOC level with a slightly longer period of operation required to remove TVOCs at and above 500 μg/L. The groundwater modeling effort documented in this memo was conducted to develop

the remedial details (number of wells, their locations, depths, and pumping rates) necessary to achieve the System goals of capture and mass removal.

The updated Northrop Grumman groundwater model (documented in the ARCADIS October 30, 2002 letter report) was used in this evaluation to help develop the remedial design in the context of the aforementioned goals.

Design of System

The design of the proposed remedial system summarized in this memo was based on the results of both groundwater flow, and solute transport modeling. Previously conducted solute transport modeling had predicted that without any remedial effort in the GM38 Area, supply wells of the BWD to the northeast and south would extract groundwater with VOC concentrations of up to 250 µg/L. The model also predicted that the area of elevated VOC concentrations was likely to disperse and impact several downgradient supply wells in the future. Based on this information, the following modeling effort was undertaken to develop a remedial system. The following sections describe the methods used to conduct the modeling and how the results of flow and transport modeling were evaluated. The results of the groundwater modeling summarized below are based on the assumption that the groundwater system stresses (i.e., public supply well pumpage) that produce the steady state conditions simulated in the model remain constant through time. Therefore, if significant changes to pumping rates are made in the supply wells in the vicinity of the GM38 Area, the effectiveness of the proposed remedial system design should be reevaluated.

Groundwater Flow Modeling

As previously stated, the model related goals of the proposed remedial system are to provide capture and mass removal of VOC-impacted groundwater, at concentrations in excess of 1,000/500 µg/L TVOC, from the aquifer. Various configurations of pumping well locations, depths, and pumping rates were simulated to optimize the proposed system, as discussed in the following sections.

Remedial Well Locations and Pumping Rates

The groundwater flow model was used to track particles representing the leading edge of the 1,000 µg/L portion of the TVOC plume in model layers 5, 6, and 7 (the model layers that correspond to the depths where elevated concentrations have been locally observed) under steady state conditions. The particles were tracked (forward tracking) until they were either intercepted by nearby supply wells or remedial wells, or reached the end of the model domain. Simulated remedial well pumping rates and screen zone locations were optimized to capture (prevent downgradient migration) the TVOC plume at and above 1,000 µg/L.

Capture Zone Assessment

Reverse particle tracking of particles started in the proposed remedial well screen zones were as used to assess the capture zone resulting from the pumping of the simulated remedial wells. An evaluation of the particle paths indicate the source area of water to the proposed remedial wells under the simulated conditions. Additionally, the evaluation provides verification that the proposed well screen locations are appropriate to capture the 1,000/500 μg/L portion of the plume (based on the current pumping by nearby supply wells, and our understanding of contaminant distribution in the aquifer).

Modeling Results

The following sections summarize model results following a series of particle tracking and solute transport simulations. The particle tracking and solute transport modeling was conducted in an iterative manner, ultimately leading to the proposed design described below. Although several proposed remedial well designs were simulated, they did not achieve the previously stated goals of plume containment and removal and are therefore not discussed here.

Particle tracking model results

Based on the forward and reverse particle tracking described above, a 2-well remedial system was developed. The locations of the proposed remedial wells are shown on Figure 2 as RW-1 and RW-2. The proposed screen zones and pumping rates for the remedial wells are summarized below:

Well ID	Model Layer Screened	Pumping Rate (Gallons per minute)
RW-1	6	800
RW-2	7	300

Under steady state conditions, particle-tracking results indicate that the proposed remedial system will prevent the downgradient migration of groundwater containing TVOC concentrations in excess of 1,000/500 μg/L (see Figures 3, 4, and 5).

It is significant to note that the particle tracking evaluation only indicates the potential for groundwater at the plumes leading edge to reach a downgradient receptor, and does not quantify the concentration of TVOCs in the groundwater predicted to impact the well. Solute transport modeling is used to quantify the remedial systems effectiveness with regard to the removal of contaminants from the aquifer, and potential impacts of the VOC plume on nearby supply wells. The proposed systems effectiveness with regard to contaminant extraction was evaluated through a series of solute transport simulations as discussed below.

Solute transport model results

The proposed system is anticipated to operate for a limited time, as it is designed for the removal of the elevated contaminant mass resident in the aquifer near GM38, and not full plume remediation. As such, three thirty-year simulations were conducted to evaluate remedial well pumping periods of 5, 15, and 30 years. Two part simulations were used to evaluate the 5 and 15-year pumping periods; that is, the remedial wells were simulated to operate only during the first 5 or 15 years of the 30-year simulation. After the appropriate pumping period, the remedial wells were turned off, and the contaminant mass remaining in the aquifer was tracked for the remainder of the 30-year simulation.

A comparison of model predicted TVOC concentrations in remedial wells RW-1 and RW-2 under the 5, 15, and 30-year pumping periods are shown on Figures 6 and 7, respectively. Each line shows the model predicted TVOC concentration in the remedial well with time. In RW-1 (Figure 6) the model predicted TVOC concentrations in years 0-5 are identical under the 5, 15, and 30-year pumping simulations; the same is true for well RW-2 (Figure 7). As such, only the line showing TVOC concentrations in groundwater for the 30-year pumping period is visible. However, if after 5 years the remedial system is turned off, the model predicts a spike in concentration to approximately 140 µg/L in remedial well RW-1, after which concentrations are predicted to decline with time. Likewise, the model predicted TVOC concentrations in years 0-15 is identical under the 15 and 30-year pumping simulations. If, after 15 years the remedial system is turned off, the model predicts a slight increase in TVOC concentrations in RW-1, after which concentrations are predicted to decline. Model predicted changes in concentration with pumping period are similar for RW-2.

At both RW-1 and RW-2, the model predicts that TVOC concentrations will fall below 100 µg/L after approximately 5 years of remedial system operation. However, following the cessation of pumping, concentrations are predicted to rebound to approximately 140 µg/L and 200µg/L at RW-1 and 2, respectively. Approximately 9 years later the model predicts that TVOC concentrations will fall below 100 µg/L in RW-1; at RW-2, TVOC concentrations fall below 100 µg/L in less than 3.5 years after the system is turned off.

Assessment of system loading rates.

In support of remedial system design efforts, peak TVOC influent concentrations were determined. Modeling results indicate that TVOC concentrations in groundwater will peak at system startup, with concentrations at RW-1 and 2 of approximately 950 and 1,000 µg/L, respectively. The model predicts influent concentrations will steadily decline, as shown on Figures 6 and 7.

Impact to nearby supply wells.

At Bethpage Water District (BWD) Wells 4-1 and 4-2 (NYSDEC Well ID No. 6915 and 6916, respectively), the model predicts peak TVOC concentrations to occur within a half-year of the start of the simulations, as shown on Figures 8 and 9. As previously described, model predicted TVOC concentrations are identical (the lines are coincident) for the periods simulating remedial system

operation, with only the line representing the 30-year pumping period visible. At BWD 4-1, the model predicts a peak TVOC concentration of 97 μg/L, with concentrations subsequently declining and then remaining below 20 μg/L after approximately 2.5 years of remedial system operation. At BWD 4-2, the model predicted peak concentration was 182 μg/L, with concentrations then declining and remaining below 65 μg/L after 5 years of remedial system operation.

At BWD Plant 5 (NYSDEC Well No. 8004), model predicted TVOC concentrations remain below 3 μg/L throughout the 30 years simulated regardless of the remedial system pumping period.

Effect of recharge

Although the effect of recharge on the performance of the currently proposed remedial system has not been evaluated, it was assumed that the recharge (to recharge basins or sumps) of treated groundwater would not adversely affect the performance of the proposed remedial system (as long as the recharge occurred at an appropriate distance from the remedial wells). This assumption is supported by previously conducted modeling, in which groundwater from the GM38 area was pumped, treated, and discharged (as recharge) to New York State Department of Transportation Basin No. 109, located adjacent to Route 135, approximately 2,700 ft south of the remedial system. In comparing the proposed system (as simulated and presented in this memo) and this earlier model simulation, no difference in capture zone, peak influent concentration, or rate of mass removal was noted at either of the remedial wells; impacts to downgradient receptors also did not vary with the addition of recharge. The model simulation described in this memo did not include the direct recharge of treated groundwater, but rather, assumed that treated water recharge would occur at an appreciable distance from the remedial wells such that it had no impact on the performance of the remedial wells.

Recommended System Design

The following section describes the recommended locations for extraction and recharge of groundwater, appropriate screen zones, and extraction and recharge rates.

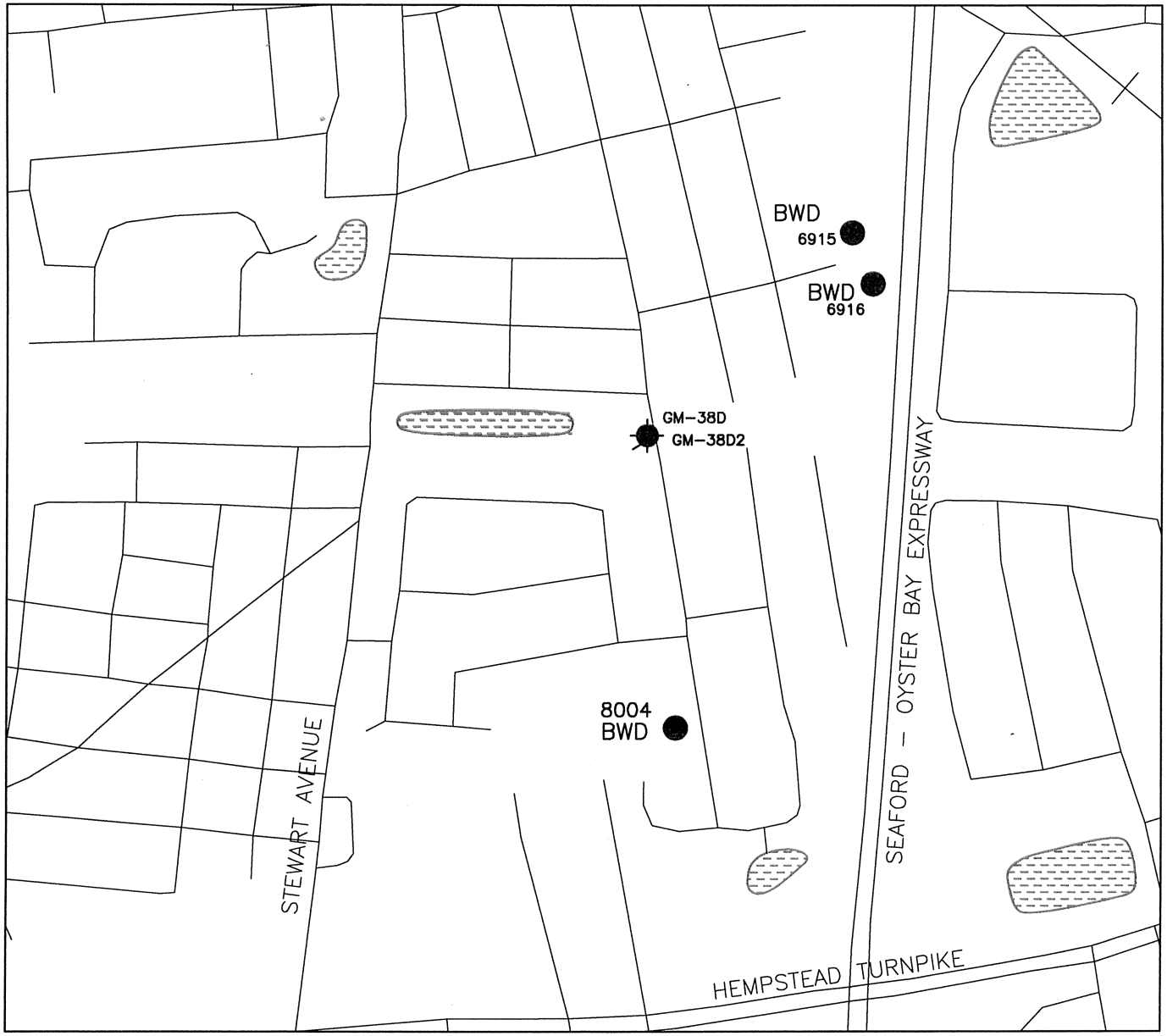
Well locations, screen zones, and pumping rates

Based on the results of the solute transport and particle tracking simulations described above, ARCADIS recommends that remedial well RW-1 be drilled approximately 100 ft east and 200 ft south of the northern end of South Hermann Avenue and RW-2 be drilled at the southern end of North Windhorst Avenue, as shown on Figure 2. While the modeling simulations indicated that screen zones for RW-1 and RW-2 of -260 to -330 ft msl (feet relative to mean sea level), and -350 to -430 ft msl, respectively (approximately 313-388 and 400-480 ft below land surface) were appropriate, ARCADIS recommends that vertical profiling of groundwater quality be conducted while drilling the proposed remedial wells, and the results be used in conjunction with the model results to select screen zones. The rates of groundwater extraction specified in this memo assume that the regional groundwater flow direction, as modified by local pumping

stresses, will remain constant through time. A pumping test following installation and development of the remedial wells will be conducted to quantify specific capacity and well performance.

Conclusion and Recommendation

The proposed remedial system described above achieves the goals of capture and removal of groundwater with TVOC concentrations in excess of 1,000 µg/L or 500 µg/L. However, additional design simulations should be conducted to assess what impact (if any) the local recharge of treated groundwater at select locations may have on the systems capture zone.



LEGEND

- BASINS
- PUBLIC SUPPLY WELL
- OBSERVATION, MONITORING WELL

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DRAWN	DATE	PROJECT MANAGER	DEPARTMENT MANAGER
LMC	11/26/02	R. PORSCHE	N. VALKENBURG
SUPPLY WELLS IN THE VICINITY OF THE GM38 AREA NORTHROP GRUMMAN CORPORATION		LEAD DESIGN PROF.	CHECKED R. PORSCHE
		PROJECT NUMBER NY001321.0006.00003	DRAWING NUMBER 1

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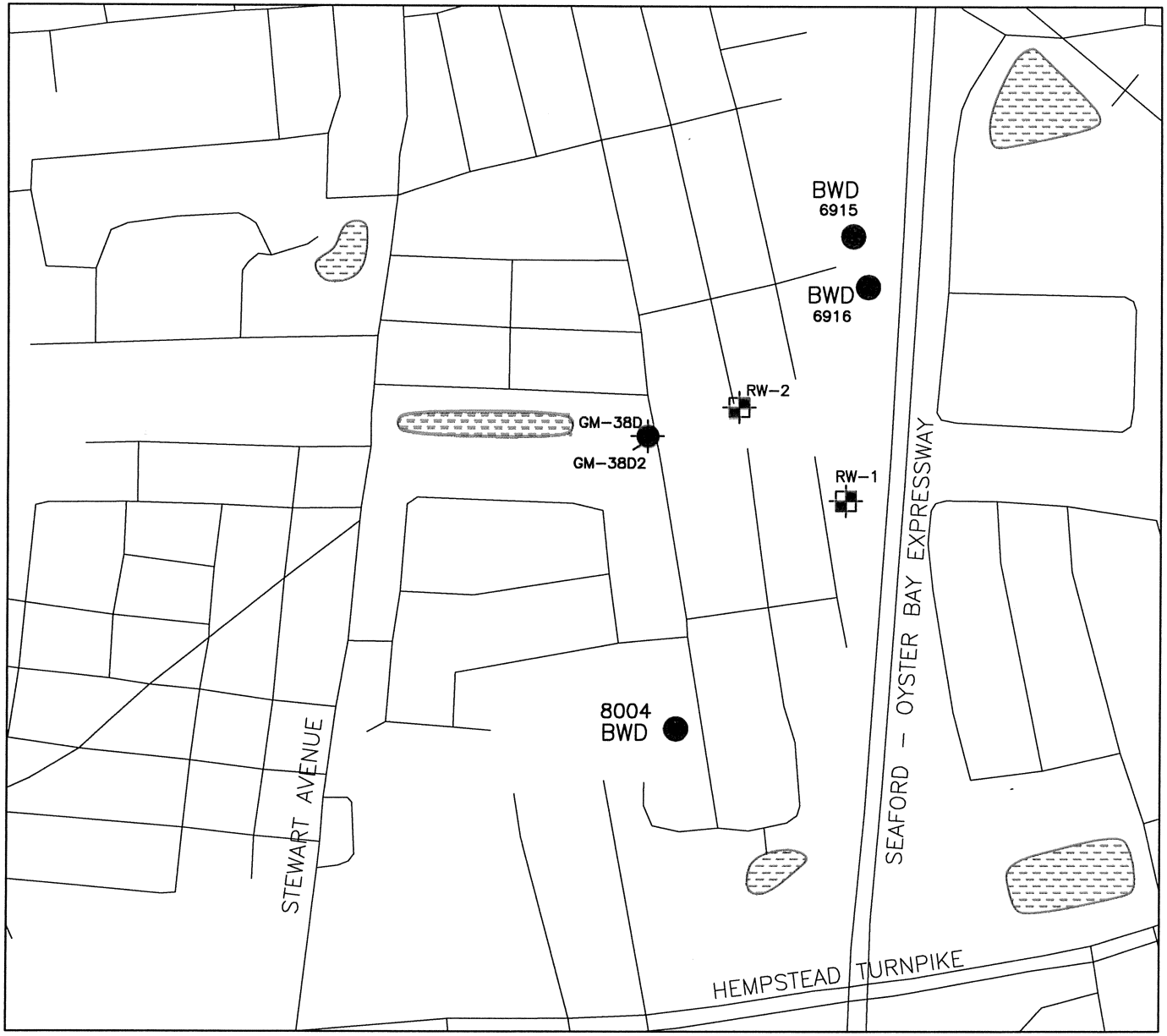

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- BASINS
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- PROPOSED REMEDIAL WELL

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		PROJECT NUMBER	DRAWING NUMBER

LOCATIONS OF
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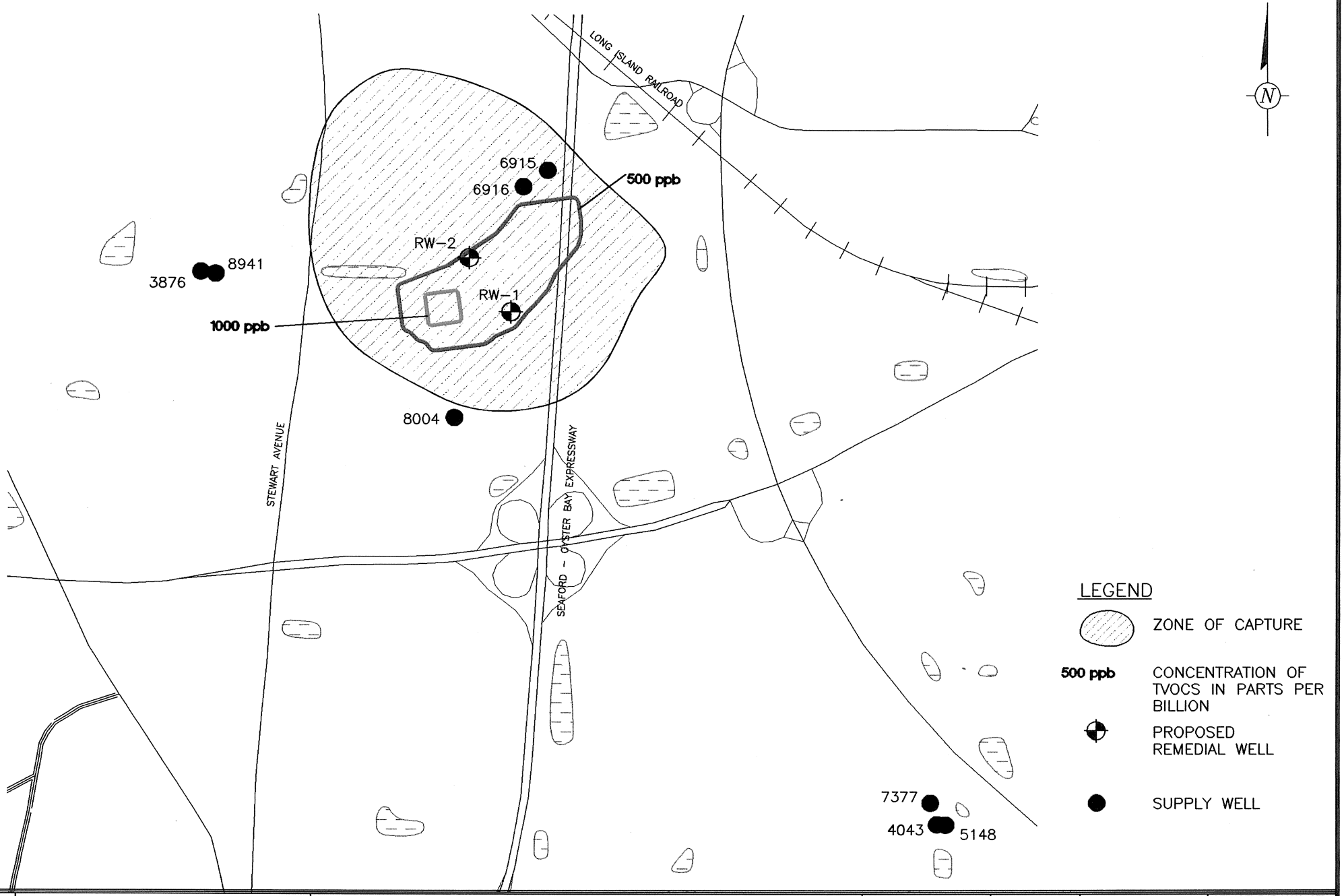
GM38 AREA
NORTHROP GRUMMAN CORPORATION

NY001321.0006.00003

2



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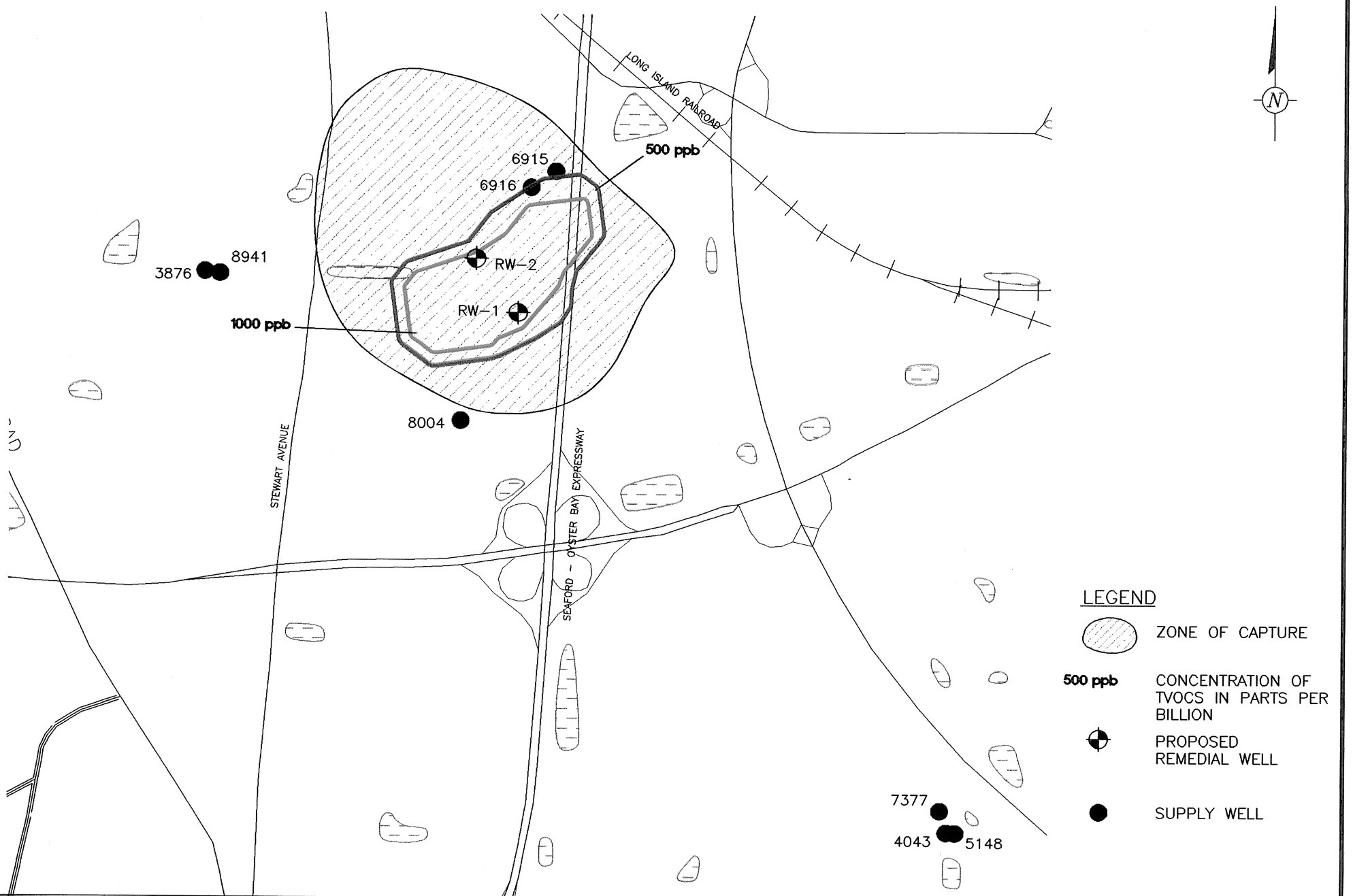

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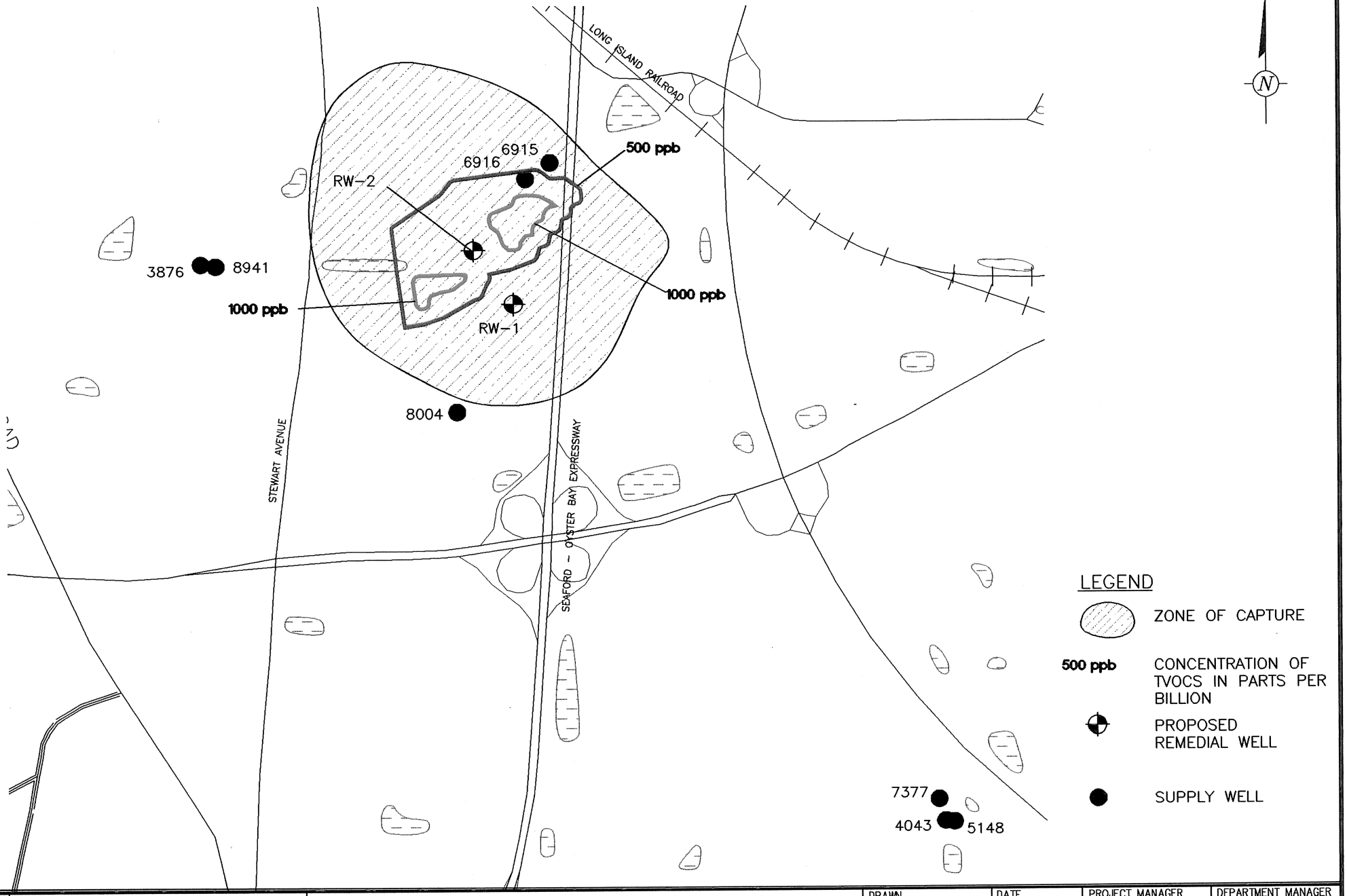

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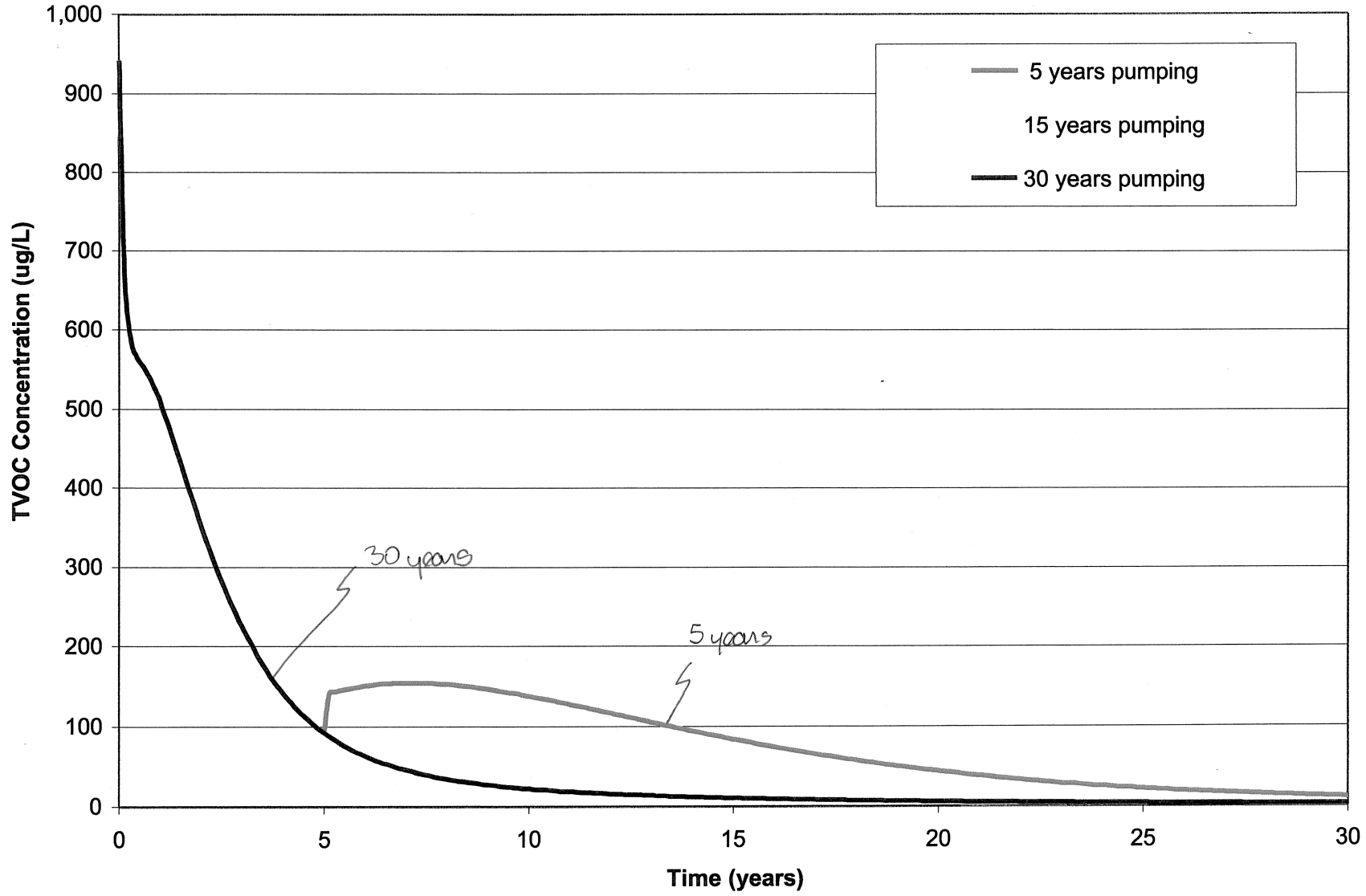

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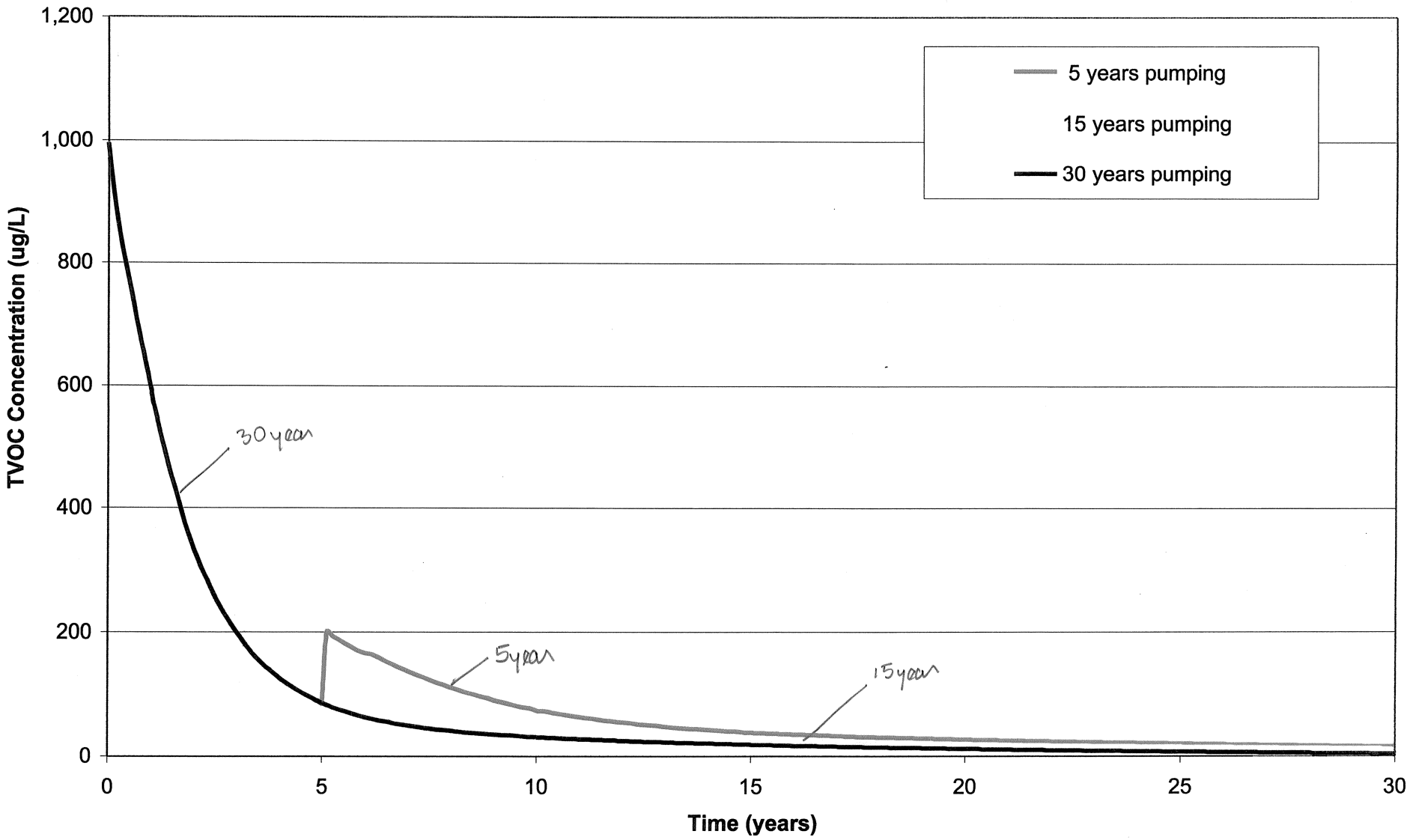

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			R. PORSCHE
		PROJECT NUMBER	DRAWING NUMBER
		NY001321.0006.00003	7

MODEL PREDICTED TVOC CONCENTRATIONS
IN PROPOSED REMEDIAL WELL 2
GM38 AREA
NORTHROP GRUMMAN CORPORATION

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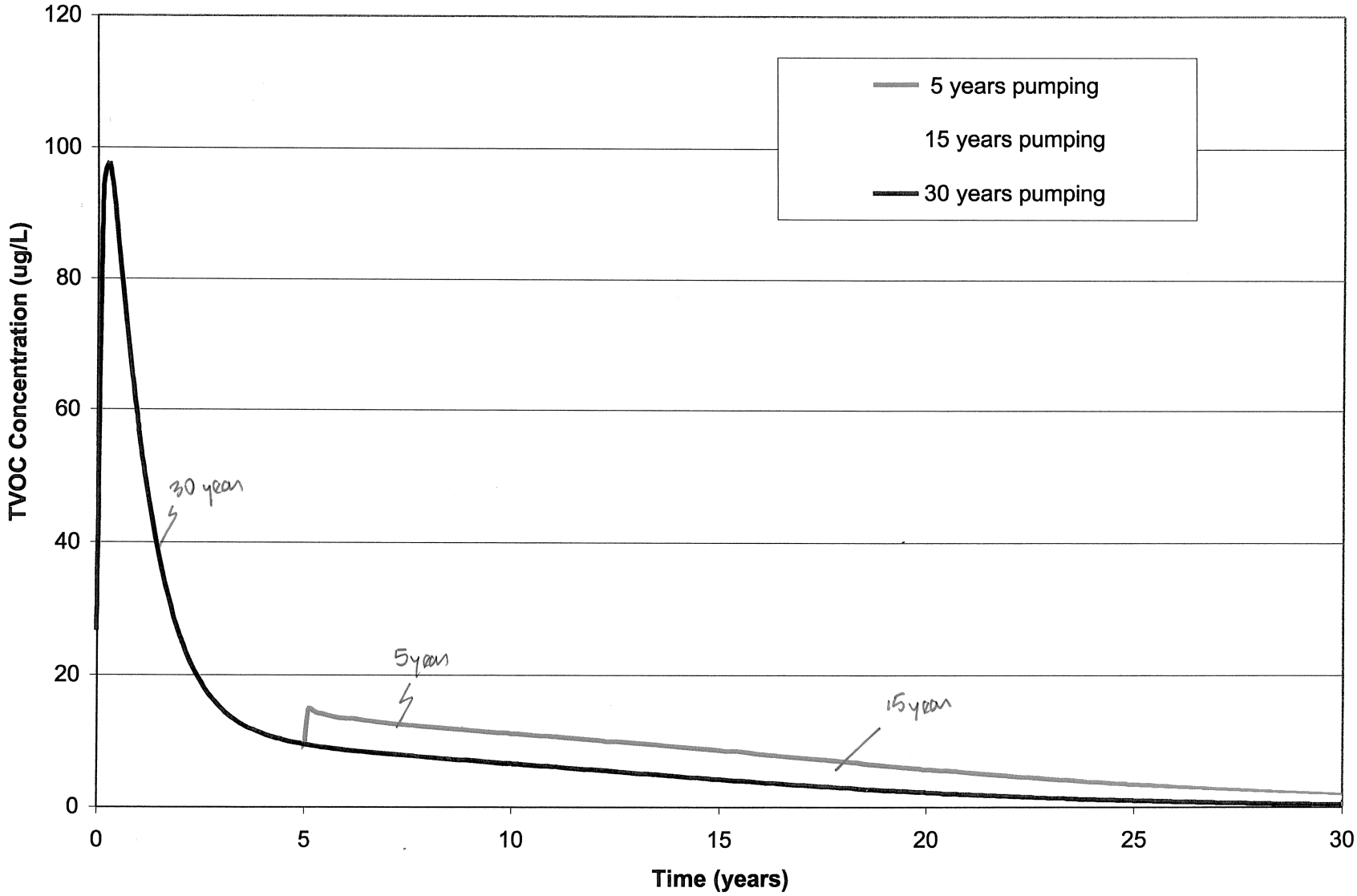

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MODEL PREDICTED TVOC CONCENTRATION IN BWD WELL 4-1 GM38 AREA NORTHROP GRUMMAN CORPORATION		LEAD DESIGN PROF.	CHECKED R. PORSCHE
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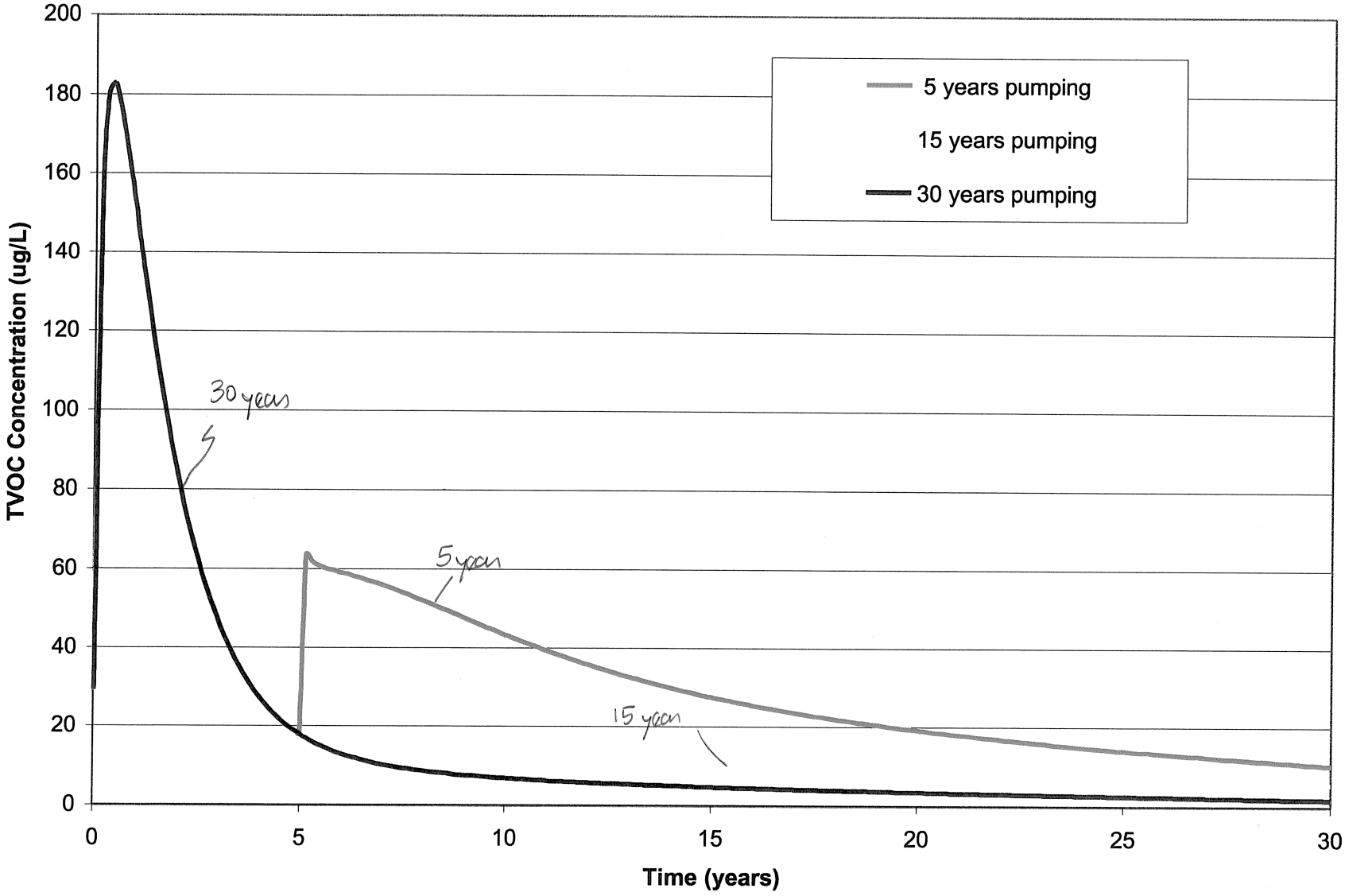

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MODEL PREDICTED TVOC CONCENTRATION IN BWD WELL 4-2 GM38 AREA NORTHROP GRUMMAN CORPORATION		LEAD DESIGN PROF.	CHECKED R. PORSCHE
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