SITE CHARACTERIZATION REPORT – HYDROLOGIC CHARACTERIZATION

HYDE PARK LANDFILL SITE
TOWN OF NIAGARA, NEW YORK

APPENDIX C – RESPONSES TO AGENCY COMMENTS

Prepared For:
Miller Springs Remediation Management, Inc.

Prepared By:
S.S. Papadopulos & Associates, Inc.
Services Environmental, Inc.
Conestoga-Rovers & Associates

GENERAL COMMENTS

General Comment 1

It does not appear that the newly developed monitoring network demonstrates that the performance monitoring requirements are being met. In the Geologic/Hydrogeologic Characterization Report, MSRM/GSH asserted that the effectiveness of the NAPL Containment System could not be properly evaluated with the previously existing Hydraulic Monitoring Network because monitoring wells showed composite hydraulic heads resulting from wells being open to multiple fracture zones. However, water levels of upper flow zones suggest that, under current pumping conditions, groundwater flow in areas in and adjacent to the landfill, containment is not achieved. Groundwater in flow zones 02,04, 05, and 11 can move over a portion of the landfill area and laterally away without being contained. Groundwater movement in flow zones 07 and 09 are in hydraulic communication with Forebay/conduit water and can be affected by water level fluctuations (see comment 8).

Response

Discussion of containment is premature and is not related to the contents of the SCR-H. The intent of the SCR-H was not to determine capture. Where a significant containment condition was observed, it was noted in the SCR-H. However, nowhere in the document did we suggest that the groundwater in FZ-01, FZ-02, FZ-04, or FZ-05 was contained by the operation of the pumping system. In fact, the SCR-H concludes that the operation of the groundwater extraction system has no observable influence on the water levels in these flow zones. We are currently evaluating the containment and will submit a *Remedial Characterization Report* (RCR) on May 31, 2003. The RCR will evaluate containment on the basis of observed water levels and groundwater quality data.

General Comment 2

If containment is not achieved with the current purging-well system, then it will be necessary to evaluate possible modifications to the purge-well network that could be made to achieve containment in terms of adding and/or subtracting wells, or eliminating and/or isolating select flow zones in existing purge wells. This newest conceptual model of groundwater flow at Hyde Park, that flow occurs in discrete horizontal zones characterized by various transmissivities between and within zones, indicates that purge wells screen over several flow zones will preferentially stress the most transmissive zones. These flow zones would dominate and produce highest yields, inadvertently interfering with stress on the lesser transmissive zones. Additional pump testing should be considered to determine whether different rates would now be appropriate or whether select flow zones should be blocked in existing wells.

Response

We acknowledge that it is MRSM's responsibility to achieve containment of the bedrock NAPL plume. If the evaluations of the RCR indicate that containment is not being achieved currently, recommendations for modifications to the current system will be provided in the RCR.

General Comment 3

It will be necessary to obtain a new set of water-quality data based on the network of newly installed and retrofitted wells in order to update Site water quality and characterize the distribution of APL/NAPL relative to the newly defined flow zones. The selection of appropriate wells needs to be further discussed.

Response

Agreed. The need for water quality monitoring was discussed with the Agencies at the March 10, 2003 technical update meeting. The flow-zone specific water quality monitoring was also presented in the Work Plan for Site Characterization Groundwater Sampling dated April 8, 2003. The proposed Tier 1 sampling was completed in March 2003 and preliminary data were submitted to the Agencies on April 23, 2003. The results from the Tier 2 sampling will be available in June 2003.

General Comment 4

The report does not address the issue of how seasonal fluctuations in water levels affect containment. The natural variations, those which occur from high in late winter-early spring to lows in late summer-early autumn, and artificially induced variations, those which occur in response to seasonal manipulation of Forebay Canal water levels will need to be evaluated to determine if seasonal variation in water levels can significantly affect groundwater movement and containment in flow zones (see comment 8).

Response

Agreed. The SCR-H was based on two months of continuous data, and as such, it was not possible to investigate seasonal water level fluctuations. The issues of seasonal fluctuations and artificially induced variations can only be properly addressed with long-term monitoring.

General Comment 5

It will be necessary to determine how contaminated groundwater in the upper flow zones migrates to lower zones and can possibly mitigate the effects of capture in lower flow zones. Some suggestion of downward movement of groundwater is shown in figures 3-26, 27, and 28 of flow zones 02, 04, and 05. Assuming that these map interpretations are representative, the figures show areas of groundwater mounds, indicating that groundwater may be seeping down from upper zones.

Response

The significance of vertical flow between flow zones will be evaluated at two levels. First, the data collected in the SCR-H will be synthesized in a numerical model that can simulate vertical flow. Second, groundwater sampling data will be used to map the distribution of landfill-related parameters. The groundwater quality will likely be critical in demonstrating containment performance.

General Comment 6

EPA recommends that the effort to address the containment problem at the Site not be contingent on the completion of a fully developed groundwater-flow model. Rather, the effort should be based on direct evaluation of hydrologic and framework data as well on hydraulic response and water-quality data. EPA is concerned that the development of a model, one that is truly representative of the system and one that will require full calibration and verification, can become a major time sink and distraction to the tasks at hand. The major concerns are:

- *A model that is representative of a flow system characterized by multiple discrete flow zones that are interconnected in unknown ways would be difficult to develop in a relatively short timeframe.*
- *The modeling effort would be complicated by the need to simulate unsaturated flow that occurs near well bores, within portions of some of the lower flow zones (as shown in figures 3-29, 3-31) and possibly within flow zones adjacent to cultural features.*
- *The preponderance of hydrologic data now available (hydrographs) and that will become available will need to be used to verify that the model can simulate hydraulic-head changes over time in response to pumping variations in most of the flow zones and for most of the monitoring/purge well locations. It would, most probably, require many iterative runs to develop a model that can match these field data.*
- *It is anticipated that the simulation of vertical flow in the system will be problematic. In the report, it is purported that vertical flow from upper to lower flow zones is significant. Yet, the amount of vertical flow is presently unknown. Simulated values would not be verifiable. It would also be important for the purpose of demonstrating capture, to know the actual vertical migration pathways. Currently, it is not clear how and to what extent well bores, systems of discrete fractures that are oriented obliquely to flow zones, and leakage through aquitards control vertical movement of groundwater. While vertical conductivities in the model can be manipulated to simulate vertical flow, there appear to be no target data to use to verify results.*

A groundwater-flow model of the system can provide useful information as to process and optimal containment strategies. Hence, while the model development effort should continue, the time constraints dictate that it should only play a supplemental role in developing a solution to containment.

Response

MSRM has not suggested that the analysis of containment is contingent on numerical flow modeling. We acknowledge that the modeling is a significant and challenging task. However, we consider modeling a critical step in the re-characterization of the Site. A draft version of the report, *Site Characterization Report – Groundwater Modeling* was submitted to the Agencies on April 30, 2003. The final version of the report will be submitted on May 30, 2003. Model results will be presented in the RCR as support for the interpretation of containment based on interpretation of water levels and water quality data. The model has provided quantitative insights to the vertical flow in wells interconnecting multiple flow zones. This quantitative analysis is not possible to develop without mathematical modeling. In the long term, the role of the model will be evaluated based on its predictive performance. It is anticipated that the model will be refined and its predictive performance will be improved with time. We believe that is premature to relegate the model to a supplemental role.

General Comment 7

The Cooper-Bredehoeft-Papadopulos and Theis methods, which were used to derive transmissivity values for flow zones, may not be the most suitable analysis because they do not account for horizontal anisotropy that is often present in fracture zones. Drawdown patterns shown on maps of head isopleths appear to show preferred directions of flow in the plane of flow zones 09 and 11 (figures 3-32, 3-33). These preferred directions of transmissivity would affect the shape of capture areas when pumped. To determine anisotropy on a horizontal plane, it would be necessary to analyze concurrent groundwater response from several piezometers that are aligned along rays from the pumping well. An analysis, such as the method of Hantush (1966), can be used to determine the principle directions of anisotropy.

Response

The head isopleths, responses to pumping and shutdown, and the hydraulic testing indicate heterogeneous rather than anisotropic conditions. Heterogeneity is a significantly different physical property from anisotropy.

The transmissivity estimates reported in SCR-H were derived from single-well tests. The single-well tests performed and analyzed by the 'Cooper-Bredehoeft-Papadopulos' and 'Theis' methods provide an indication of conditions in the vicinity of the test interval and are therefore the appropriate tests to characterize heterogeneity. The method of Hantush (1966) [based on the solution of Papadopulos, 1965] that is suggested is not applicable for the interpretation of single well tests. As recognized by the Agencies, Hantush's method requires observation of water levels in multiple wells during a constant-rate pumping test of a single well. Such a test was not performed. Hantush's method could not have been used to assess anisotropy in either the slug tests, packer tests, single-well pumping tests, or from the data collected during the system shutdown that were performed during the SCR-H field investigations.

It should also be recognized that the 'Cooper-Bredehoeft-Papadopulos', 'Theis' and 'Hantush' methods are all mathematical models based on highly idealized conditions. These methods share the common assumption that the formation tested is a homogeneous porous medium of infinite areal extent. Although we have applied these methods to estimate the hydraulic properties of the bedrock aquifer, we recognize that the flow zones in the Lockport Group do not conform to the assumptions of the basic models and the analyses are semi-quantitative at best. The best estimates of the large-scale hydraulic properties will be determined from the groundwater flow modeling.

General Comment 8

In the conclusions and recommendations section of the report, the following is stated, "...demonstrate large areas of hydraulic containment in flow zones FZ-06, FZ-07 and FZ-09 and FZ-11". However, the containment in the northeast/eastern area of flow zones 07 and 09 is questionable. The report indicates that flow zones 07 and 09 are in hydraulic communication with Forebay Canal and the Conduit to the northeast and east of the Site. This, coupled with the finding that these zones are highly transmissive in the area between the Forebay and Landfill have significant implications regarding the maintenance of hydraulic control near the Landfill and potential pathways of contaminated groundwater.

The water-level configuration suggested by figure 3-31 is that water levels in the Forebay are greater than elevations where flow zone 07 intersects the Forebay. Under these conditions, Forebay water would recharge flow zones 07 and 09 and potentially undermine drawdown. This would suggest that a purge-well strategy be designed to control recharge from northeast of the landfill area. However, the effects of low water levels in the Forebay also need to be considered. The report does not discuss how seasonal water level fluctuations affect flow in zones 07 and 09. A question that needs to be considered is, if water levels in the Forebay fall below flow zone 07, would groundwater flow gradients in zones 07 reverse toward the northeast? If so, what would be the hydrologic implications with respect to maintaining capture, and with respect to migration pathways toward the Forebay Canal and Conduits? Low-end water levels will be needed to make that determination.

If the lowest groundwater levels and Forebay Canal water levels are used, then the potential for reversal in hydraulic gradients may occur. It appears that the potential for gradient reversal is greater in FZ-07 than in FZ-09. The analytical data from the second quarter of 2002 of well J2M (zones 6 through 09) gives credence to this hydraulic gradient reversal. Based on the evaluations of the hydrographs, the lower the Forebay water level drops, the higher potential for hydraulic gradient reversal. The flow of water from the landfill to the Forebay, and back again takes on the action of a "waterbed effect".

In order determine if contaminants are reaching the Forebay, we recommend several potential sampling methods/procedures: 1) sample AGW-1M-07 and J6-07 for NAPL System Effectiveness Parameters (Section 9.2 of the RRT); 2) retrofit J2M into discrete flow zones and resample; 3) drill vertical monitoring wells located adjacent to the Forebay, and sample for NAPL System Effectiveness Parameters; and 4) drill horizontal wells (2 to 3 feet into the side of the Forebay wall into the flow zone fracture - if visible), and install passive diffusion bags (if applicable).

Response

The influence of the Forebay will be evaluated with ongoing continuous water level monitoring and water quality sampling. A sampling program for the new piezometers was submitted to the Agencies on April 9, 2003. The influence of the Forebay will also be evaluated with the groundwater flow model in the future. The additional study suggested by the agency is premature. The collection and evaluation of water level and water quality data will provide a basis to determine the scope of additional investigation. The MSRM technical team is not familiar with the "waterbed effect" and would appreciate a reference.

General Comment 9

The report discusses the occurrence of 'dry areas' in flow zones 06 and 07 (Figures 3-29, 3-31), a term used to describe areas where water level in piezometers are at or below the elevation of the flow zones. In effect, the flow zones are not fully saturated within these areas. Although the meaning of the term is adequately explained, the term can be misleading, implying that the zone can become desiccated or that any water entering can creep along dip. We would recommend that the area be described simply as an unsaturated area.

Response

In the future, we will refer to areas that are drained by the bedrock purge wells as "dewatered." We believe that this is a more accurate description than either "dry" or "unsaturated".

General Comment 10

In discussing the cultural features embedded in the bedrock of the Site, the tunnels, railroad bed, and vertical shafts, the report only acknowledges that such excavations into the bedrock can affect flow. In effect, the plan views of sewers and shafts were only superimposed on Site maps; but no explicit hydrologic data was presented that actually demonstrates what their effect is on groundwater in the flow zones. To support the contention that these features affect flow and containment, it would be necessary to show that water levels in piezometers located next to tunnel cuts (that are screened in flow zones intersected by tunnels) indicate locally unsaturated conditions. Also, the water quality of water that seeps into tunnels/shafts may need to be sampled.

Response

If the Agency means numerous water level monitoring points in the vicinity of a cultural feature as "explicit hydrologic data", then the Agency is correct. Based on professional judgment, the influence of the cultural features was apparent in preparing the groundwater potentiometric surface maps. Vertical shafts that drain into the gorge tunnel will have an identical influence as a pumping well that is pumped dry in the same location. However, we do not have detailed data to accurately assess the influence of these features. The influence of these cultural features is being assessed using the groundwater flow model. The preliminary model results indicate that the water levels observed in FZ-01 to FZ-06 are not possible without some of these features.

Ultimately, understanding the influence of the cultural features is critical only as it relates to hydraulic containment at the NAPL plume boundaries. Based on the observations of containment developed in the RCR, further study of the influence of these cultural features on groundwater flow is unnecessary.

We agree that water quality sampling may be necessary.

General Comment 11

Groundwater contour maps (i.e., Figures 3-25 through 3-37), as well as maps showing the locations of wells and piezometers (i.e., Figures 2-2 through 2-9), should present the NAPL plumes. In order to assist in the evaluation of hydraulic containment at the Hyde Park Landfill Site, DNAPL plumes should be provided for each flow zone. We are aware that GSHI is currently reevaluating the DNAPL plumes for each flow zone; however, this information needs to be included for further containment evaluation. In addition to submitting the reevaluated DNAPL plume boundaries, please submit the data as well as the plume rationale in the next version of this report.

Response

Representatives of the Agencies met with the MSRM Technical Team on April 28 and 29, 2003 to re-define the NAPL plumes. The re-defined NAPL plumes will be presented in the RCR at the end of May 2003.

General Comment 12

Several figures and tables do not present accurate data, and will require a more accurate quality control/quality assurance check. For example, in Figure 3-12, every transmissivity value that is presented is incorrect. All presented data and values need to be reviewed prior to the next submission.

Response

The problem with Figure 3-12 was identified in our review of the final document. We apologize for the errors. All tables and figures have been checked. In some cases, the values indicated on the figures have been modified slightly to be absolutely consistent with the values provided in the tables. We are submitting a revised set of transmissivity maps, Figures 3-13 to 3-21, with these responses.

General Comment 13

Based on the data presented on Figure 3-33 (FZ 11), groundwater from the landfill area will flow towards I1-11, located to the east (towards the NYPA conduits). GSHI recognizes that the I1-11 may not be screened over the proper fracture. We strongly recommend that a new well be installed and screened across the flow zone 11 bedding plane fracture. We also recommend that well AGW-3L be retrofitted (well located between the eastern edge of the landfill and I1. Additionally, groundwater elevation data from G1L-11 to H5-11 supports the evidence that groundwater flow is towards I1. (Note: The hydrographs for the above noted wells indicate that the wells may still be recovering).

Response

Piezometer I1-11 is constructed and screened properly; FZ-11 is very low transmissivity in this area. As the Agencies have observed, the water level in the piezometer is recovering. At the end of the SCR-H monitoring period, February 10, 2003, the water level was at about 527 ft MSL. Ongoing continuous water level monitoring has shown that the water level in I1-11 had recovered a further 10 feet by the beginning of May 2003. The water level will likely continue to rise to the average level of the Forebay.

General Comment 14

Prior to any analytical sampling (to assist in the determination of hydraulic containment), a work plan should be submitted to the government agencies for review. Additionally, any grouting plans or any other field events pertaining to hydraulic containment should be submitted and approved by the government agencies prior to the commencement of the activity.

Response

Agreed. The Work Plan for Site Characterization Groundwater Sampling was submitted to the Agencies on April 9, 2003.

General Comment 15

The groundwater model is to be used as a tool to assist in the determination of Site containment. The groundwater model may not be used to determine if hydraulic containment is being achieved. For example, the groundwater movement with flow zones 01-05 must be determined by the analysis of field data (i.e., collection of groundwater measurements from electronic water levels indicators and data loggers). Analytical data may be used in some areas where hydraulic containment may be questionable to determine if Hyde Park contaminants are present in these areas.

Response

Containment will be evaluated in the RCR following multiple lines of evidence. The data being considered in the evaluation of containment include groundwater levels and groundwater quality. Modeling results are presented as support for containment, not as a sole basis for demonstrating containment.

General Comment 16

We understand that the GSHI team has had only a few months to evaluate the hydraulic characteristics of the Site based on the flow zones concept. Based on the current data, we recommend that the GSHI team continue to add additional data that supports areas of hydraulic containment, and addresses areas of concern where containment may be questionable.

Response

Agreed. Water level data continue to be collected at the Site. Continuous, long-term water level records are being collected in 88 piezometers, with an additional transducer monitoring barometric pressure. Transducers have been retained at critical locations; in particular, piezometers have been retained where transmissivities are significant. The Telog dataloggers are downloaded approximately bi-weekly. In addition, water levels in all piezometers are measured manually approximately every two weeks.

General Comment 17

GSHI has indicated that the sewers and other man made features, and other utility features intercept groundwater flow. Based on our evaluation, some features may potentially intercept the groundwater flow. However, GSHI provides no evidence that demonstrates this may occur. Will sampling of the utilities (i.e., pipe bedding) be performed? What other chemical or physical evidence will GSHI collect to support the assumptions that the utilities affect the groundwater flow?

Response

Additional study is required to evaluate the effects of the utilities on groundwater flow. Any studies proposed will be developed based on a scientific process of developing and testing hypotheses. No samples from the sewers have been analyzed for parameters related to the Hyde Park Landfill. There are no current plans for sampling these utilities.

General Comment 18

Several of the flow zones have a limited number of retrofitted piezometers to determine groundwater flow conditions. Several existing wells will need to be retrofitted to further define questionable areas. For example, FZ 01 has only four piezometers to monitor groundwater flow conditions. We understand the GSHI team thinks that the major component of FZ-01 is downward. However, monitoring this zone with only four retrofitted wells will be difficult to prove vertical flow. Additionally, the DNAPL plume of the upper zone, in conjunction with the FZ-01 groundwater contour maps, show the potential for contaminants to migrate off site to the northeast and east (assuming some horizontal component to the flow zone). This is also apparent for FZ-02, FZ-04 and potentially to FZ-05.

Response

We believe that groundwater flow is predominantly vertically downwards over a significant area of the Site. However, it is extremely difficult to quantify vertical flow whether there are 4 piezometers or 50. To assess the horizontal migration in FZ-01, FZ-02, FZ-04, and FZ-05, we have completed a Tier 1 groundwater-sampling program, in accordance with the April 8, 2003 Work Plan. As indicated in General Comment 14, these data will be used to evaluate containment.

The conditions necessary for vertical flow are hydraulic gradients and sufficient hydraulic conductivity in the vertical direction. The vertical hydraulic gradients between FZ-01 and FZ-02 are tabulated below.

Well	Vertical gradient, Jan. 06/07, 2003	Vertical gradient, Jan. 23/24, 2003
G1	0.47	0.42
H2	0.89	0.79
H5	0.76	0.73
I1	0.97	0.94

The vertical gradients in the preceding table were calculated by dividing the water level differences by the distance between the mid-point of the piezometer screens:

$$Vertical\ gradient = \frac{h_{FZ-01} - h_{FZ-02}}{z_{FZ-01} - z_{FZ-02}}$$

where *h* designates the average water level in the flow zone piezometer, and *z* designates the midpoint of the piezometer screen. The calculated vertical gradients demonstrate that the vertical gradient between the uppermost flow zones at the Site is close to one. A vertical hydraulic gradient of one represents a physical upper limit for groundwater flow under saturated conditions. The significant vertical hydraulic gradients suggest that the principal source of water to the uppermost bedrock flow zones is infiltrating precipitation.

With respect to the lateral migration of Landfill-related parameters within the flow zones, this is addressed in the RCR.

General Comment 19

The following comment pertains to the retrofitting, sampling and groundwater conditions presented in the SRC-H document for the monitoring well cluster AFW-1.

The AFW wells were designed and installed to monitor the potential contaminant flux to the Niagara gorge, and to fulfill the requirements of the Stipulation on Requisite Remedial Technology. Two APW pumping wells were also installed within the APL plume at the gorge face. Composite sampling of the APWs, and designated AFW wells (with predetermined composite percentages) of AFW-1, 2 and 3 commenced in the 1990s. Both PCBs and 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8 TCDD) were detected in the composite samples in the 1990s. The levels were above the detection limits, but were below the "flux action level".

The detections of both 2,3,7,8 TCDD and PCBs at the gorge face, were indications that containment was not being achieved at the Hyde Park Landfill Site (along with other vector and hydraulic information). In order to more accurately determine the contaminate migration pathway to the gorge, via the bedrock fractures, EPA requested discrete sampling of designated wells along the gorge face. Discrete samples were obtained from wells AFW-1U and AFW-1M. We will use the data from AFW-1M as the example.

The AFW/APW flux composite sample historically consisted of 13% being obtained from well AFW-1M. When this well was sampled (discrete samples) in August 2000, PCBs (0.12 ppb) and 2,3,7,8-Tetrachlorodibenzo-p-dioxin (593 pg/L) were detected.

The original AFW-1M well had an open hole that spanned flow zones 07, 08, and 09. When the well was retrofitted, piezometers were only installed for flow zones 07 and 09. Observations made from the retrofitted wells revealed that both flow-zone piezometers, 07 and 09, are dry during pumping conditions.

The new work plan for the APW/AFW Composite Sampling (for the new retrofitted wells), presented zero percent withdrawal from wells AFW-1-07, and AFW-1-09 (based on hydraulic conductivity testing).

It is obvious that the retrofitting of this well sealed off any potential bedrock fracture (i.e., possibly FZ-08) that may yield groundwater and potential contaminants. We strongly recommend that the retrofitted wells be pulled from this well (as well as AFW-1U), developed, and AFW/APW sampling resumed for long term monitoring. We also recommend that a new cluster be drilled to monitor the discrete zones for the AFW-1U (FZ-06) and AFW-1M (FZ-07 and FZ-09) wells.

Response

As agreed at the April 9, 2003 meeting, the Agencies recommendations for AFW-1 are not critical to demonstration of containment and will be tabled for future discussion.

We feel that the record should show that we do not concur with the Agencies' recommendations and underlying rationale for abandoning retrofit wells or additional drilling. We have three principal objections to the contents of this comment.

- The detection of PCBs and 2,3,7,8-TCDD at the gorge face does not indicate that hydraulic containment of the NAPL plume was not being achieved. These compounds could have been beyond the NAPL plume prior to startup of the NAPL Plume Containment System;
- The percentage of the composite sample collected from AFW-1M, 13%, was developed based on the length of the open interval. It did not take into consideration the transmissivity of the interval nor the hydraulic gradient. Both of these factors are critical to flux calculations.
- We do not believe that the retrofitting sealed off any fractures with significant transmissivity in AFW-1M. A complete set of data for the AFW-1 cluster is attached to these responses. The geophysical logs indicated a potentially transmissive fracture below the predicted elevation of FZ-09. However, the transmissivity estimated from the AFW-1M-09 piezometer is within an order of magnitude of the transmissivities estimated from the 1991 packer testing for the Middle interval and the slug test from AFW-1M. This suggests that neither FZ-08 nor the zone below FZ-09 has significant transmissivity at AFW-1.

SPECIFIC COMMENTS

Introduction

1. Page 1, second paragraph. *Please provide definitions for terms (i.e., aquifer, aquitard, etc.) used in the SCR-H document for the Hyde Park Landfill Site.*

Response

These terms are generally qualitative and may be defined as:

Aquifer:	A formation that can sustain some useful flow of groundwater;
Aquitard:	A formation that separates aquifers (or flow zones) but does not prevent the transmission of water from one aquifer to the other; and
Aquiclude:	A formation that separates aquifers (or flow zones) and prevents the transmission of water from one aquifer to the other.

These are relatively generic terms and are used for a qualitative description of a groundwater flow system. To highlight the general nature of these terms, it should be noted that Johnston (1964) did not identify any aquifers in the Niagara Region. Although he observed active groundwater flow in the Lockport Group, in general the yields of wells are not sufficient that groundwater resources could be developed in it.

2.1 Installation of Piezometers

2. Section 2.1.2 Design of the Piezometers, page 4, second paragraph, third sentence. *The sentence states that the screen was placed in the center of the flow zone. Please briefly explain how the flow zone was determined (i.e., based on videolog, geophysics, core, etc.).*

Response

The determination of the flow zones was based on an inspection of the videologs, geophysical logs, borehole flowmeter profiles, cores, predicted elevations, and packer testing results. Steve Sayko determined the final selection of monitoring intervals, based on his professional judgment. There were no formulae or set criteria, and the decisions on a per-piezometer basis were not documented.

Packer testing was conducted to support the selection of the flow-zone monitoring intervals in the last four new boreholes (E6, F6, H5, and I1). By the time these boreholes were drilled, it had been confirmed that the packer testing provided a reliable basis for determining the detailed transmissivity profile in a borehole and confirming the elevations of flow zones.

3. Section 2.1.3.2 Picking Flow-Zone Monitoring Intervals, second paragraph, third sentence. *The sentence states that videologging was useful for identifying approximately half of the flow zones. As noted in specific comment 2, please explain how the flow zones were identified at each location.*

Response

See the response to Specific Comment 2.

4. Section 2.1.3.2 Picking Flow-Zone Monitoring Intervals, page 5, third paragraph. *Please explain the rationale for not testing the new boreholes J6 and C3. Also, please present the values in which were considered "high transmissivity intervals".*

Response

At the time of the installation of J6 and C3, the packer testing program as described in the Hydrologic Characterization Work Plan was already complete. The key element of the field program was the piezometer retrofitting, and the packer testing was deliberately limited so as not to impede the progress of the retrofitting. Packer testing to support the installation of the piezometers at the locations of the new multiple completion wells was not yet considered.

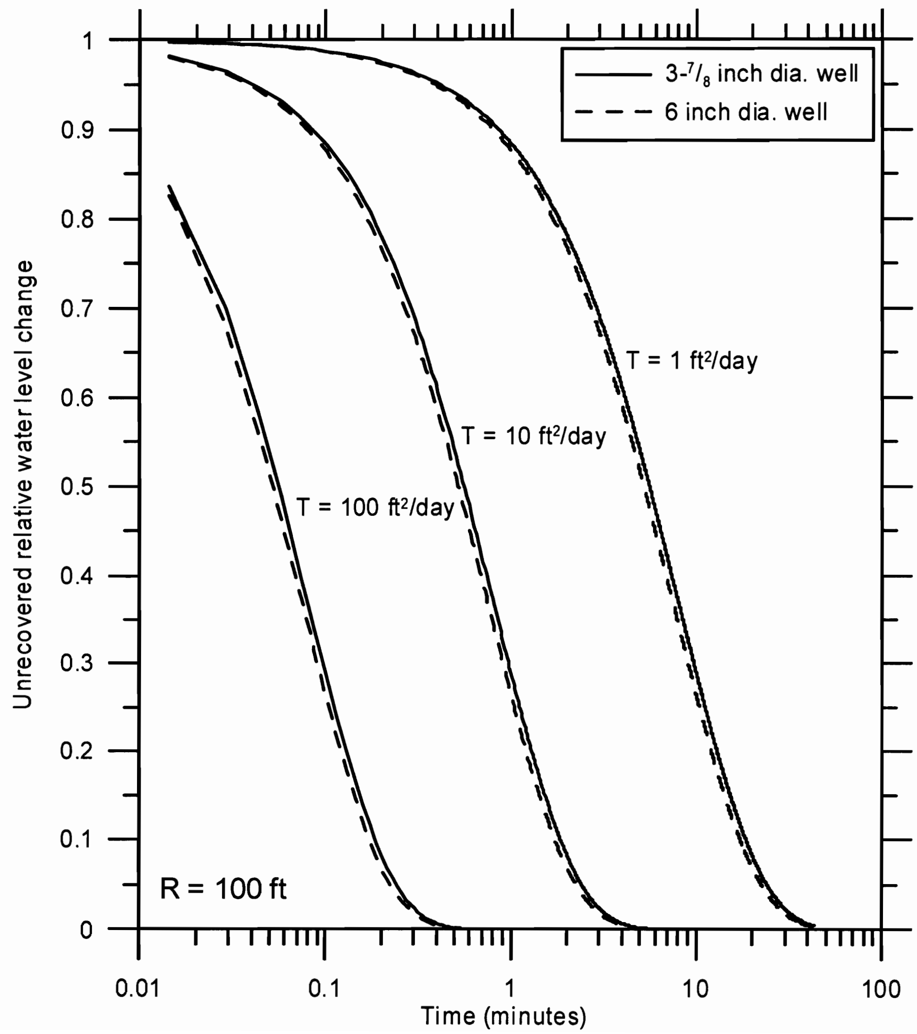
The packer testing was conceived originally as a modest program to confirm the characterization of discrete flow zones developed in SCR-G. The limits of the program were identified clearly in the Hydrologic Characterization Work Plan. The packer testing was very successful and as a result, its final scope was expanded well beyond the original Work Plan. There was an extensive time period between the installation of C3 and J6 and the other new multiple completion wells (E6, F6, I1, H5); during which we waited for approval from the City of Niagara Falls to install the well. This delay afforded us the opportunity to plan and execute complete packer-test profiling of the new boreholes.

At E6, F6, H5, and I1, the flow zones were assumed to correspond to the high transmissivity intervals at or near the predicted elevations of the flow-zones. The transmissivity profiles presented in Appendix A3 of the SCR-H report may be inspected to obtain both visual and quantitative comparisons between the results of the packer testing and the completion details of the wells. The transmissivity profiles presented in the SCR-H show that in general the most significant transmissivities at an individual location are those closest to the predicted elevations of the flow zones.

5. Section 2.1.4 Piezometer Construction, page 5, first paragraph. *During the analysis of data, specifically the hydrographs, was there any difference in response in the piezometers set in the 3.9-inch diameter core holes versus the 6-inch diameter core holes (i.e., difference sand pack volume)?*

Response

We did not observe any difference in response in the piezometers set in the 3.9-inch diameter core holes versus the 6-inch diameter core holes. This is consistent with our expectations regarding the time lag of the two piezometer designs. The figure below shows plots of calculated equilibration times in 1-inch piezometers installed in 3.9-inch and 6-inch diameter core holes. These results were calculated using the time lag theory of Hvorslev (1951). The results of the analysis show that the time lags are nearly identical over a wide range of transmissivities. The results shown on the figure were evaluated assuming a radius of influence of 100 feet. We have conducted additional analyses and the results are relatively insensitive to this assumed radius of influence.



6. Section 2.1.4 Piezometer Construction, page 5, field procedures. *EPA representatives did not observe the drilling of the bottom portion of the well/boring or the re-development of the borehole (existing locations) prior to retrofitting. Please provide a summary of locations in which this activity was completed.*

Response

All wells were flushed with water prior to retrofitting, to improve the water clarity for video-logging and in some cases, to clear any debris at the bottom of a borehole. None of the existing wells were re-drilled during the retrofitting. The only time that a roller bit was placed in an existing well was to either clear an obstruction of flush debris from the bottom.

7. Section 2.1.4 Piezometer Construction, page 6, field procedure 10. *Please provide information on developments at each piezometer (i.e., method of development, volume removed, purge water conditions before and after development).*

Response

The piezometers were developed by removing water using a bailer. The development was assessed by visually examining the turbidity of the purge water after each gallon of water was removed. A table summarizing observations made during development of the piezometers is attached to these responses as Table 1.

8. Section 2.1.5 Survey, page 6, second paragraph. *This paragraph states that minor changes were made to the elevations of some monitoring wells to conform to the new survey. Please state (plus or minus) how many inches were the elevations varied. Was this taken into consideration when selecting the flow zones?*

Response

A listing of changes made in well reference point elevations is provided on the accompanying Table 2. The new survey data were considered when selecting flow zones.

2.3 Monitoring Program

9. Section 2.3. The first sentence states the following, "Upon completion of the 113 piezometers..." Please revise the sentence to state the following, "Upon completion of the well development of the 113 piezometers..."

Response

The sentence is revised to read, "Upon completion and development of the 113 piezometers, and electronic water-level recorder was installed in each piezometer."

10. Section 2.3.1 Water-Level Monitoring/Shutdown Test, page 8, first bullet. *Water-level monitoring at the Site continues to date, please state that data continues to be collected and further analysis will be completed.*

Response

Manual water levels continue to be collected in all 113 piezometers. Continuous water levels continue to be recorded in 88 piezometers. Data continue to be compiled and evaluated by inspection of hydrographs and contouring. Continuous records to the last week of April 2003 will be presented in the *Remedial Characterization Report,* to be submitted in June 2003.

11. Section 2.3.1. General. *Figures 2-2 through 2-9 are not discussed in this section of the report.*

Response

Figures 2-2 through 2-9 are referred to in Section 2.1.3.2. No other references are required.

12. Section 2.5. *The text indicates that the cultural features (i.e., tunnels, etc.) have a significant influence in the groundwater flow. The term "significant" should be removed, as the amount of potential influence to the groundwater regime has not been determined at this time.*

Response

The term "significant" is a professional judgment made by the authors of the SCR-H and as used is considered appropriate.

3.1 Hydrostratigraphy

13. Section 3.1.2 Bedrock, page 10, first paragraph. *Please provide a definition of aquiclude (see comment S-1) as used at the Hyde Park Landfill Site.*

Response

See response to Specific Comment 1.

14. Section 3.1.2. Bedrock, page 10, second paragraph. *Figure 3-1 presents a cross section of the fracture zones, with "A" daylighting at the gorge face. EPA recommends including a photograph of gorge face where A-A' meets the gorge. The fracture zones that daylight at the gorge should also be presented.*

Response

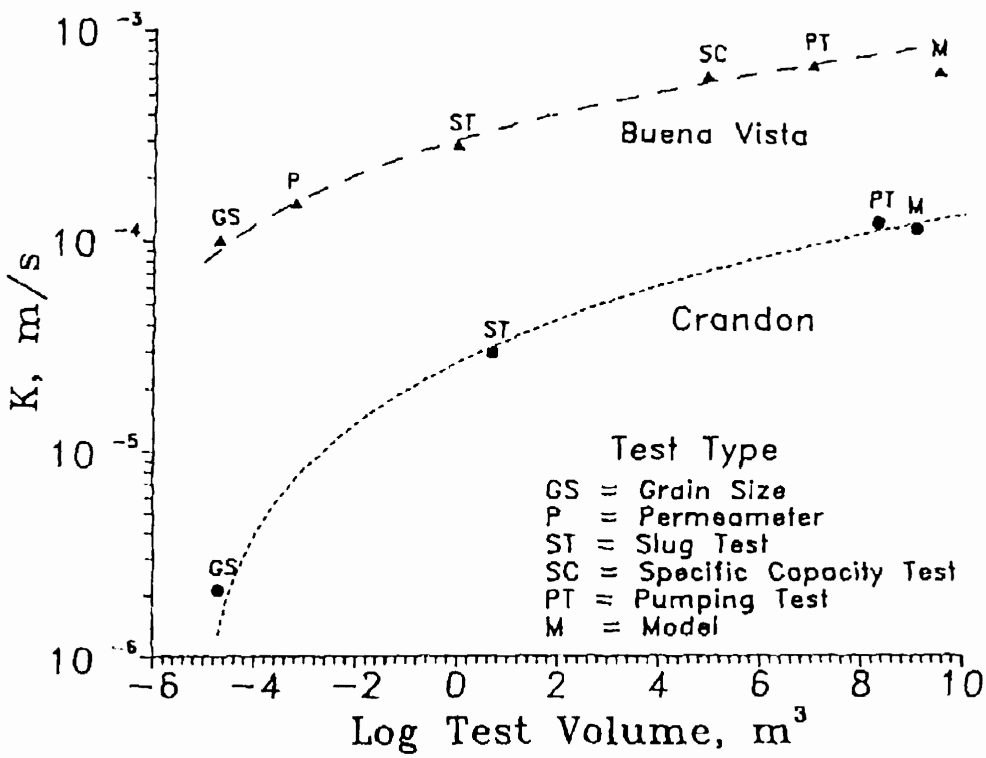
The SCR-G includes a photograph, Figure 4.5, on which the position of "A" can be located.

3.2 Hydraulic Testing

15. Section 3.2.1 Overburden Hydraulic Conductivity, page 12, second paragraph. *Please explain why the laboratory results are lower than field tests (i.e., orientation of clays during testing?).*

Response

Our observation regarding the relative magnitudes of hydraulic conductivity estimates derived from lab-permeameter and slug tests is consistent with findings at other sites. Rovey and Cherkauer (1995) [*Ground Water*, vol. 33, no. 5, p. 769] go so far as to indicate that although the evidence is primarily anecdotal, it amounts to common knowledge that "lab tests consistently give hydraulic conductivities less than field tests." Bradbury and Muldoon (1990) [*ASTM STP 1053*] have compiled the most complete report on the scale dependency of hydraulic conductivity measurements. A plot of the results of their tests on glacial and fluvial materials in Wisconsin is reproduced below.



We can conceive of several factors that would account for underestimation of hydraulic conductivity of unconsolidated materials with permeameter tests. The first factor is sample disturbance. This is particularly an issue in fine-grained materials, and has long been recognized by geotechnical engineers. Even if great care is taken in collecting a sample, some disturbance and remolding of the sample is inevitable. This disturbance tends to alter the fabric of fine-grained material, thereby reducing its permeability. Materials that are unsaturated in the field will tend to have small-scale fractures that are closed during saturated permeameter testing.

An additional factor accounting for the difference between permeameter and slug test hydraulic conductivity estimates is sample orientation. The samples for permeameter testing collected for the study were obtained from vertical boreholes, and the samples were tested in the vertical direction. In contrast, slug tests reflect the in-situ horizontal hydraulic conductivity. It has been established on both experimental and theoretical grounds that the effective hydraulic conductivity in the vertical direction is the harmonic mean *K*, while the effective hydraulic conductivity in the horizontal direction is the arithmetic mean *K*. The harmonic mean is dominated by the permeability of the least permeable material and the arithmetic mean is dominated by the permeability of the most permeable material. For heterogeneous materials such as the silty clays and till at the Hyde Park Site, the geometric mean *K* is generally significantly lower than the arithmetic mean *K*.

16. *Explain why the word sediment is used instead of soil for the samples collected during the SCR-H field activities? Does the use of the word sediment have an implication to the analysis of Site conditions?*

Response

The terms "soil", "sediment", and "overburden" are used interchangeably in the report to refer to unconsolidated materials overlying the bedrock. The use of the word "sediment" is not intended to have any implications on the analysis of Site conditions.

17. <u>Section 3.2.1 Overburden Hydraulic Conductivity, page 12, third paragraph</u>. *The third sentence states fines ranged from 50% to 98%. Appendix A presents several samples that have less that 50% fines, and are classified as GC-GM and SC-SM. Please revise the sentence to more accurately reflect the data provided in Appendix A.*

Response

The Agencies are correct; the fines content ranged from 43% to 98%. The sentence is revised to read, "The grain size analyses show fines content ranging from 43% to 98%."

18. Section 3.2.1. Overburden Hydraulic Conductivity, page 12, third paragraph. *The last sentence in this paragraph states the following, "the grain size analysis provide a qualitative confirmation of the low hydraulic conductivity of the Overburden at the Site." This statement suggests that the entire Site is underlain by low permeable material (with the exception of the utilities as noted in the fourth paragraph). However, there exits areas at the Site where the "low hydraulic conductivity materials" are missing or disturbed since large amounts of DNAPL have migrated into the bedrock. The last sentence should be rewritten to actually reflect the Site conditions.*

Response

Where the native overburden is present, it exhibits a low hydraulic conductivity. The referenced sentence does not imply that the low permeability sediments are present everywhere. In fact, the paragraph that follows immediately in the report describes where the Overburden permeability is significant. With respect to DNAPL in the bedrock, the landfill was in places excavated to bedrock. DNAPL most likely migrated to the bedrock where the native overburden was not present. However, low permeability sediments/soils do not preclude the migration of DNAPL. There are no inconsistencies between the description presented in this section of the SCR-H and Site conditions.

19. Section 3.2.1, Overburden Hydraulic Conductivity, page 12. *Please include the "hydraulic trench" that was installed north of the NYPA access road in the early 1990's. This trench was designed to permit water to flow from the surface to the bedrock, thereby increasing the hydraulic head within the upper units (and the potential for achieving inward gradients) of the Lockport bedrock.*

Response

The following text is added as Section 3.1.5 Hydraulic Trench:

The Hydraulic Trench was constructed in January 1995. The Hydraulic Trench runs parallel to the northern leg of the OBCS, just north of the cutoff wall, and is approximately 80 feet long, and 5 to 10 feet wide. The Hydraulic Trench is a gravel-backfilled trench constructed through the entire overburden to bedrock. The Hydraulic Trench was constructed to divert flow in the overburden from the OBCS and down into the bedrock. It was postulated that the increased flow in the upper bedrock would enhance the movement of mobile NAPL towards the purge wells or enhance solubilization of non-mobile NAPL coated on the bedrock. Monitoring data collected after the trench was installed demonstrated a close hydraulic connection between the trench and upper bedrock.

20. Section 3.2.2 Lower Bedrock Well Slug Testing, page 13, second paragraph. *Please explain how the transmissivities values were calculated throughout the Site. Slug and packer tests determine the hydraulic conductivity (K) at a given well location. The text does not provide information on how the value "b" (aquifer thickness) was determined. Was the rationale for "b" the same throughout the entire Site? Please provide the calculations on transmissivities in the appendices.*

Response

The slug and packer tests analyses used for the SCR-H calculate transmissivity directly, they do not determine the hydraulic conductivity (K). The appendices submitted with the report included complete analyses of transmissivities, using both transient methods and approximated analyses (specific capacity and Thiem steady-state calculations). The report provides no information on the value of "aquifer thickness" because it did not enter into the analyses.

In our analyses, we assume that during a hydraulic test groundwater flow is horizontal in the immediate vicinity of an interval isolated by packers, or close to a retrofit piezometer screen. This assumption is consistent with the horizontal flow-zone structures observed at the Site. Therefore, the appropriate measure of the relative ease with which water flows through the formation is the transmissivity and not the hydraulic conductivity. The transmissivity is a "direct" parameter in the methods that have been used to analyze the slug and packer tests for this study. In contrast, hydraulic conductivities must be derived by dividing the transmissivity estimates by an assumed thickness. If hydraulic conductivities are calculated by dividing the estimated transmissivity by an assumed aquifer thickness they are not representative of the properties of a rock mass because their values depend on the length of the test interval. A detailed discussion of this issue is presented on page 244 of **Rock Fractures and Fluid Flow**, a review of the state-of-the-art of fractured-rock hydrology, published by the U.S. National Research Council in 1996.

21. Section 3.2.2 Lower Bedrock Well Slug Testing, page 13, third paragraph. *Please provide that value of the total transmissivity of the bedrock above the Rochester Shale and how this number was determined. Additionally, please provide the significance of the 0.1% lower cut-off of 1 ft^2/day.*

Response

The total transmissivity of the bedrock above the Rochester Shale varies spatially at the Site, but is on the order of 1,000 ft^2/day in the area that shows a clear response to the operation of the bedrock purge wells. The transmissivity is significantly higher in the area where water levels in FZ-06, FZ-07, and FZ-09 follow fluctuations in the NYPA Forebay. In this area, the transmissivity may exceed 5,000 ft^2/day.

The rough value for the total transmissivity of 1,000 ft^2/day is based on:

- Results of pumping tests conducted on fully penetrating wells as part of the Requisite Remedial Technology Study (CRA, April 1984);
- Results of the 1991 packer testing;
- Results of the bedrock prototype purge well tests (1993-1994); and
- Slug and packer testing conducted as part of this study.

The rough value for the total transmissivity of >5,000 ft^2/day for the "Forebay responding" area is based on:

- Slug and packer testing conducted as part of this study; and
- Transient analyses of the response to Forebay fluctuations in selected piezometers. These analyses have been conducted after the preparation of this report, to estimate the bulk transmissivity of the flow zones, in the area between the Forebay and the Site.

Total transmissivity values have been presented to provide a conservative gage for assessing the relative significance of transmissivities estimated from individual tests. If 1,000 ft^2/day is used as an approximate measure of the total transmissivity, we see that a transmissivity of 1 ft^2/day represents 1/1000th, or 0.1 percent of the total transmissivity. By invoking this value as a lower cut-off, we maximize the attention directed towards the locations within the flow zones that are hydraulically significant. We recognize that the low transmissivity cutoff is a subjective cutoff. At some point it is truly impractical to pursue an investigation. We continuously make judgment calls on what is or is not important. The values presented were low enough that they were considered, for the current investigation, *de minimus.*

It should be noted that transmissivity values were estimated below 1 ft^2/day. In the subsequent interpretations of water levels, we recognized that water levels may not be reliable at these locations. The time lag for a piezometer depends on the transmissivity, and provides a quantitative measure of the responsiveness of a piezometer, that is, its ability to detect a change of water level in the adjacent formation (M.J. Hvorslev: *Time Lag and Soil Permeability in Ground-Water Observations*, U.S. Army Corps of Engineers, Waterways Experiment Station, Bulletin No. 36, 1951). Piezometers that yielded a transmissivity of less than 1 ft^2/day have time lags of the order of 30 minutes. These piezometers are not sufficiently responsive to track changes in Forebay levels, for example.

22. S-21.Section 3.2.4 Flow-Zone Piezometer Slug Tests, page 15, third paragraph. *Please compare the results of piezometer slug testing to the hydraulic testing (completed prior to retrofitting activities) used in determining which flow zones to monitor.*

Response

As indicated in the Work Plan and in our response to Specific Comment #2, several factors were considered in selecting the flow zones to monitor. These factors included a consideration of the constructability of proper seals between the flow zones, and limitations on the number of piezometers that could be installed in an existing borehole. Consideration was also given to the relative hydraulic significance of the flow zones.

An independent analysis of composite water levels prior to retrofitting was submitted with the Work Plan. This analysis indicated that the flow zones with the highest bulk transmissivities were 01, 02, and 07-08-09 (it was not possible with the existing well constructions to distinguish between these three flow zones). The results of the hydraulic testing conducted for the SCR-H are consistent with the results of the preliminary analysis. The relative transmissivities, expressed as a ranking, are listed below.

Flow zone	Ranked relative transmissivity, Pre-retrofit analysis of water levels	Ranked relative transmissivity, Mean results from SCR-H hydraulic testing
01	2	2
02	3	3
04	4	6
07 - 08 - 09	1	1

FZ-08 was not monitored. In our opinion, little information is lost by not monitoring this flow zone because its water levels are bounded by those in FZ-07 and FZ-09. FZ-10 was also not monitored. The results of the packer testing have confirmed that FZ-10 has relatively low transmissivity. The transmissivity is in general so low that it should probably not be considered as a zone of active groundwater flow.

A comparison of piezometer slug tests with the pre-retrofit hydraulic testing is presented on the figures in Appendix A of the SCR-H.

23. Section 3.2.5 Observations From Hydrographs, page 15, second paragraph. *It is assumed that development was completed prior to slug testing, and slug testing was completed prior to the hydraulic monitoring. If this is not the case please provide a table in which the dates that development and slug testing were completed. This information would aid in the review of the hydrographs, for instance D2M-07 and F4L-11 are said to be recovering from development, albeit, if they were slug tested prior to the hydraulic monitoring would not the addition of 1 liter of water affect the water level as well?*

Additionally, low hydraulic conductivity values may be the result of improper well installation or fracture zones that were not determined. This needs to be further discussed.

Response

All piezometers were developed prior to being slug tested, and prior to continuous water level monitoring. The dates of the installation, development, and slug testing of the piezometers are assembled in Table 3 attached to these responses. As indicated in this table, no wells were slug tested within 1 month of the SCR-H monitoring. Piezometers completed within a month of the SCR-H monitoring were slug tested in early February 2003, about 2 weeks following the restart of the purge wells.

We do not believe that low transmissivity values indicate improper well installation or missed flow zones. The elevations of the piezometer completions were selected following detailed evaluation of all available data. The piezometers were installed carefully, with continuous checking. We find nothing in the data that suggests the low transmissivity observations are unusual. The probability plots of transmissivity presented in the SCR-H show a log-normal distribution of transmissivity data. The low transmissivity results are not "outliers".

24. Section 3.2.6.1 Average Flow-Zone Transmissivities, page 16. *The table presented within this section presents the median and range of transmissivities at the Site. Flow zones 03, 08, and 10 were not screened with retrofitted piezometers. Please provide an explanation of the tests used to determine the median and range at each flow zone. Was there a comparison of data collected prior to retrofitting to the data collected from the retrofit wells, and what was the significance (i.e., generally higher or lower)?*

Response

The values used to prepare the maps of the transmissivity distributions, and to assemble summary statistics for each flow zone were compiled from the results of the packer testing and the slug testing of piezometers. On the maps of the transmissivity distributions, Figures 3-11 through 3-21, the slug test values on the retrofit piezometers are indicated in blue, and the packer test results are indicated in red. At locations within a flow zone where transmissivity estimates were available from both packer and slug testing, the values from both tests are presented. At these locations, only the slug test value was used in the statistical analysis, as it was considered to be more reliable. FZ-03, 08, and 10 were not screened with retrofit piezometers. The transmissivities for these flow zones were estimated solely from the packer testing.

25. Section 3.2.6.2 Distribution of Transmissivity in Each Flow Zone, page 17. *Please provide an explanation of zonation of flow zones based on transmissivity values (i.e., what is the range of transmissivity values for high, moderate, and low zones, respectively).*

Response

No formal quantitative criteria were used to define the transmissivity zones. The zonations were presented simply as relative indicators of the different properties within the individual flow zones. Quantitative interpretations of the transmissivity zones are developed in the numerical groundwater flow model.

26. Section 3.2.6.2 Distribution of Transmissivity in Each Flow Zone, page 18, FZ-05. *Please provide an explanation of the low transmissivity value obtained during the packer testing at D2U-05 (i.e., inadequate development, equipment failure, etc.)*

Response

The transmissivity value obtained from the D2U-05 packer test is not reliable. The low transmissivity value is an artifact of equipment failure. In particular, we suspect that the PTE valve of the packer apparatus malfunctioned. Recent sampling of this piezometer has confirmed that FZ-05 is transmissive at this location.

27. *Section 3.2.6.2 Distribution of Transmissivity in Each Flow Zone, page 19, FZ-09. Please provide the rationale for setting the screen for I1-09 at the installed elevation. Many of the hydrographs from the I1 show that the water level is recovering (flow zones 5, 6, 9, and 11). Could this be evidence that further piezometers at this location are installed at incorrect elevations (i.e., over aquitards)?*

Response

The piezometers at I1 were installed at the correct elevations. The piezometer elevations were selected based on predictions of the elevations of the flow zones, inspection of video logs, and the results of packer testing. The long-term recoveries observed in I1-09 and I1-11 reflect low transmissivities, consistent with results of the packer tests.

28. Section 3.2.6.2 Distribution of Transmissivity in Each Flow Zone, page 20, FZ-11, second paragraph. *The paragraph states that the lower bedrock wells with very low transmissivity were removed from the data set as the water levels are unreliable. Please quantify "very low transmissivity". Also, please explain why all wells during the hydrologic study with Avery low transmissivity" were not excluded in the formation of contour maps because of "unreliable" water levels.*

Response

The designation "very low transmissivity" is subjective. Our interpretation is discussed in detail in the response to Question 21.

29. *Section 3.2.6.2 Distribution of Transmissivity in Each Flow Zone, page 20, FZ-11, last paragraph. Please state if I1-11 is or is not used for flow zone interpretation (similar to I1-09).*

Response

As shown on Figures 3-33 and 3-37, the water levels from F1-11 are colored gray, and as indicated in the figure legend, these data were not used in the contouring.

30. Section 3.2.6.3 Transmissivities of the Aquitards Between the Flow Zones, page 21, first paragraph. *Please provide a reference for the hydraulic conductivity values comparison to transmissivity values, and the rationale for the values. It would be helpful to the reviewer if the comparisons were provided for all transmissivity values presented in this report.*

Response

The equivalent transmissivities of the intact rock samples were calculated by:

1. Converting the laboratory-derived permeabilities to hydraulic conductivities; and
2. Multiplying the hydraulic conductivity by the packer spacing of 5.2 feet.

This comparison was presented for illustrative purposes only. The laboratory samples evaluate permeability only for the small cross section of an intact core sample. Vertical fractures are unlikely to be present in an intact core sample, although they represent a more significant contributor to the average vertical hydraulic conductivity across an aquitard than the matrix hydraulic conductivity. The packer test results are more likely to test a vertical fracture than the laboratory analyses. Thus, the 0.03 ft^2/day median transmissivity from the packer tests is significantly greater than the laboratory "transmissivity" values of 0.000006 to 0.006 ft^2/day.

3.3 Flow-Zone Water Levels Under Pumping Conditions

31. Section 3.4.1 FZ-01, page 24, third paragraph. *GSHI should provide evidence (data) of the downward vertical hydraulic gradient with water levels obtained during the hydrologic investigation to support the 2001 modeling study conclusion.*

Response

See the responses to General Comments 5 and 18.

32. Section 3.4.2 FZ-02, page 24, second paragraph. *Please change Maple Street to Maple Avenue.*

Response

Agreed. A correct reference to Maple Avenue will be included in all future discussions.

33. Section 3.4.2 FZ-02, page 24, second paragraph. *Please provide evidence of the downward vertical hydraulic gradient with water levels obtained during the hydrologic investigation to support the 2001 modeling study conclusion.*

Response

See response to Specific Comment 31.

34. Section 3.4.2 FZ-02, page 24, second paragraph. *Is it thought that the groundwater in flow zone 02 would flow vertically to flow zone 04, in which the water levels are at or near the same that are observed in flow zone 02. Flow zone 05 in the northeast, and Flow zone 06 in the southwest, are the first flow zones in which a significant difference of water levels is observed (i.e., >10 feet).*

Vertical flow between flow zones will be evaluated using water level and groundwater chemistry data. In addition, the groundwater flow model will assess the pathways of water flow to the between flow zones and to the extraction wells. The discussion of vertical flow is best left to the groundwater model report and the containment evaluation report.

35. Section 3.4.2 FZ-04, page 25, second paragraph. *Please provide evidence of the downward vertical hydraulic gradient with water levels obtained during the hydrologic investigation.*

Response

See response to Specific Comment 31.

36. Section 3.4.5 FZ-06, page 27, third paragraph. *In order to confirm the logic presented in this paragraph, will a packer test or videologging be completed at PW-10U prior to changing the pumping rate or sealing off flow zone 06?*

Response

No. FZ-06 in PW-10U was grouted on March 27, 2003. We will evaluate the modification of PW-10U by collecting and interpreting continuous data from PW-10U (pumping rate and waters level), and continuous water levels from the nearby observation wells MW-1-2001 and MW-1-2001. Preliminary data from PW-10U indicate that sealing FZ-06 did not reduce the well yield.

37. Section 3.4.5 FZ-06, page 28, table. *The flow zones intercepted for PW-7U and PW-10U are different than presented on the table in Section 3.4.4. Please clarify.*

Response

We have reviewed the completion details for PW-7U and PW-10U. PW-7U is open across only FZ-06. This is indicated correctly in the table in Section 3.4.5; PW-7U should not be included in the table for FZ-05 in Section 3.4.4. PW-10U is open across FZ-03 to FZ-06. The entry for PW-10U in the table in Section 3.4.5 (FZ-06) is correct. The entry for PW-10U in the table in Section 3.4.5 should be revised to read "03..06".

38. Section 3.4.6 FZ-07, page 28, third paragraph. *The hydrographs of D1M-07 and D2M-07 show that the water is recovering in both of the wells, and that static conditions have not been achieved. Additionally, D2M-07 is reported in the appendices as having the transmissivity of <0.001 ft²/day, which is less than the transmissivity of D1M-07 (0.3 ft²/day), which is opposite of what is stated in this paragraph. The rationale within this paragraph does not seem accurate and should be reevaluated.*

Response

The Agency is correct, the analysis of the D2M-07 slug test indicated a transmissivity lower than the test result for D1M-07. The important point in this paragraph is that in spite of the care that MSRM has taken to construct a pair of identical gradient monitor piezometers, we cannot assume that the measured gradients are reliable reflections of the groundwater flow.

39. Section 3.4.6 FZ-07, page 29, first paragraph. *After review of the hydrographs from flow-zone 07, AFW-1M-07 appears to be dry. Additionally, PWM-1M-07 may potentially be dry (or have very little water) where the flow zone was predicted to be at 525 ft MSL and the water level is around 526, and D2M-07 appears to have been dry until 12/28/02. Please reevaluate and the edit the text and contour map.*

Response

The transmissivity at D1M-07 was relatively low at 0.3 ft²/day. The water level record indicates a gradual recovery in the piezometer, and no apparent response to pumping. The transmissivity at D2M-07 was very low (<0.001 ft²/day). Monitoring performed following the SCR-H, and presented in the RCR, show anomalous water levels in both piezometers. The SCR-H conclusions remain valid: the hydraulic gradient indicated by D1M-07 and D2M-07 does not represent actual conditions; and that natural variability within the bedrock prevents precise monitoring of hydraulic gradients.

40. Section 3.4.7 FZ-09, page 30, first paragraph. *NYPA Forebay also influences wells to the southeast of the landfill (wells H2M and H5). Please edit this paragraph to reflect this information.*

Response

Agreed. The impact of the Forebay on H5-09 is already mentioned in this paragraph. Piezometer H2M-09 was overlooked.

41. Section 3.4.7 FZ-09, page 30, table. *Purge well PW-1L is presented as intercepting flow zones 06-09, although on the figures and in the tables it is presented as intersecting flow-zones 08 - 11. Please edit the table accordingly.*

Response

The Agencies are correct, PW-1L is open across FZ-08 to FZ-11. This will be corrected on future tables.

42. Section 3.4.8 FZ-11, page 31, third paragraph. *The hydrograph from piezometer I1-11 shows that this well is recovering. The conclusions drawn in this paragraph may be premature due to the low transmissivity and the fact that the well is recovering.*

Response

Agreed. Water levels will continue to be monitored and evaluated at I1-11.

43. Section 3.4.8 FZ-11, page 31, table. *Please edit the table to reflect that purge well PW-1L intercepts flow zones 08 - 11.*

Response

The Agencies are correct, PW-1L is open across FZ-08 to FZ-11. This will be corrected on future tables.

3.5 Response to Shutdown and Recovered Conditions

44. Section 3.5 Response to Shutdown and Recovered Conditions, page 32, first paragraph. *Please explain what the expected water levels are and how these expected levels were determined (i.e., how was the expected downward gradient determined).*

The expected water levels were levels observed following the May/June 2001 shutdown of the bedrock purge wells. Hydrographs from the May/June 2001 shutdown were included in Appendix B6.

45. Section 3.5 Response to Shutdown and Recovered Conditions, page 32, fourth paragraph, last sentence. *Please elaborate on how the sewer cuts and shafts (i.e., tunnels) that interconnect flow zones may affect the containment criteria at the Site, if at all.*

Response

As stated previously, the purpose of the SCR-H was not to evaluate containment. The impact of the sewers, etc. will be discussed in the modeling report and as necessary in the RCR.

3.6 Hydraulic Testing at PW-2M

46. Section 3.6 Hydraulic Testing at PW-2M, page 35, second paragraph. *Upon review of the hydrographs, it was noted that piezometers B2M-09 and C3-09 appear to show effects of pumping at PW-2M (in addition to the piezometers listed). Please review and clarify.*

Response

The Agencies are correct, B2M-09 and C3-09 also responded to the pumping of PW-2M. The last sentence of the paragraph is revised to read, "The effect of pumping was observed in FZ-09 at seven piezometers (B2M-09, C3-09, D1M-09, D2M-09, F2M-09, F4M-09, and PMW-1M-09)."

47. Section 3.6 Hydraulic Testing at PW-2M, page 35, third paragraph. *Upon review of the hydrographs, it was noted that piezometers B2L-11, D1L-11, J5M-06, E6-06, D1U-06, G1M-06 and F6-06 appear to show effects (same "blip" in hydrograph around 01/15-16/03) of pumping at PW-2M. Please edit the paragraph to reflect this data.*

Response

The effect of pumping at PW-2M was also observed in the FZ-11 piezometers B2L-11 and D1L-11. Pumping from PW-2M may also have caused very subtle water level changes at the FZ-06 piezometers E6-06, F5-06, and G1M-06.

5.0 References

48. *Please include the SCR-G document as a reference.*

Response

Agreed. The reference to the SCR-G is:

Conestoga-Rovers & Associates, Sayko Environmental Data Analysis, and S.S. Papadopulos & Associates, Inc., 2002: Site Characterization Report - Revised Geologic and Hydrogeologic Characterization [SCR-G], prepared for Miller Springs Remediation Management, Inc., and Glenn Springs Holdings, Inc., February 2002.

COMMENTS ON FIGURES

49. Figure 2-3. *J3U is depicted as intersecting flow zones 2 through 5 but is outside of the flow zone subcrop. Please edit subcrop as needed.*

Response

Noted. The figure will be modified in future reports.

50. Contour figures - *General Comment - Please provided rationale for not utilizing a groundwater elevation at certain piezometers in a note within each figure (i.e., well recovering, inaccurate due to low transmissivity, etc.).*

Response

A table is presented in the RCR defining several classifications for piezometers. For example, some piezometers (e.g. I1-11) continue to follow a recovery curve months after the piezometer was completed. Many of the hydrographs presented in the SCR-H show response to a slug test where water was added to raise the water level. In most piezometers the water level recovered in a relatively short time frame (less than a week). However, the water level in some piezometer has not recovered in months. It is our opinion that a piezometer that does not recover from a slug test cannot be relied upon for a water level.

51. Figure 3-12. *Incorrect values for FZ-02 are presented in this figure. Please edit and re-submit.*

Response

We apologize for the mistakes on this figure. A complete set of transmissivity maps is attached with these responses. Numerous small changes to the figures have been made to ensure that the values shown in the figures are completely consistent with results presented elsewhere in the report.

52. Figures 3-11 through 3-21. *General comment: various transmissivity values are incorrect in comparison with the values presented in Appendix A. Please check values and edit.*

Response

See the response to Comment S1.

COMMENTS ON APPENDICES

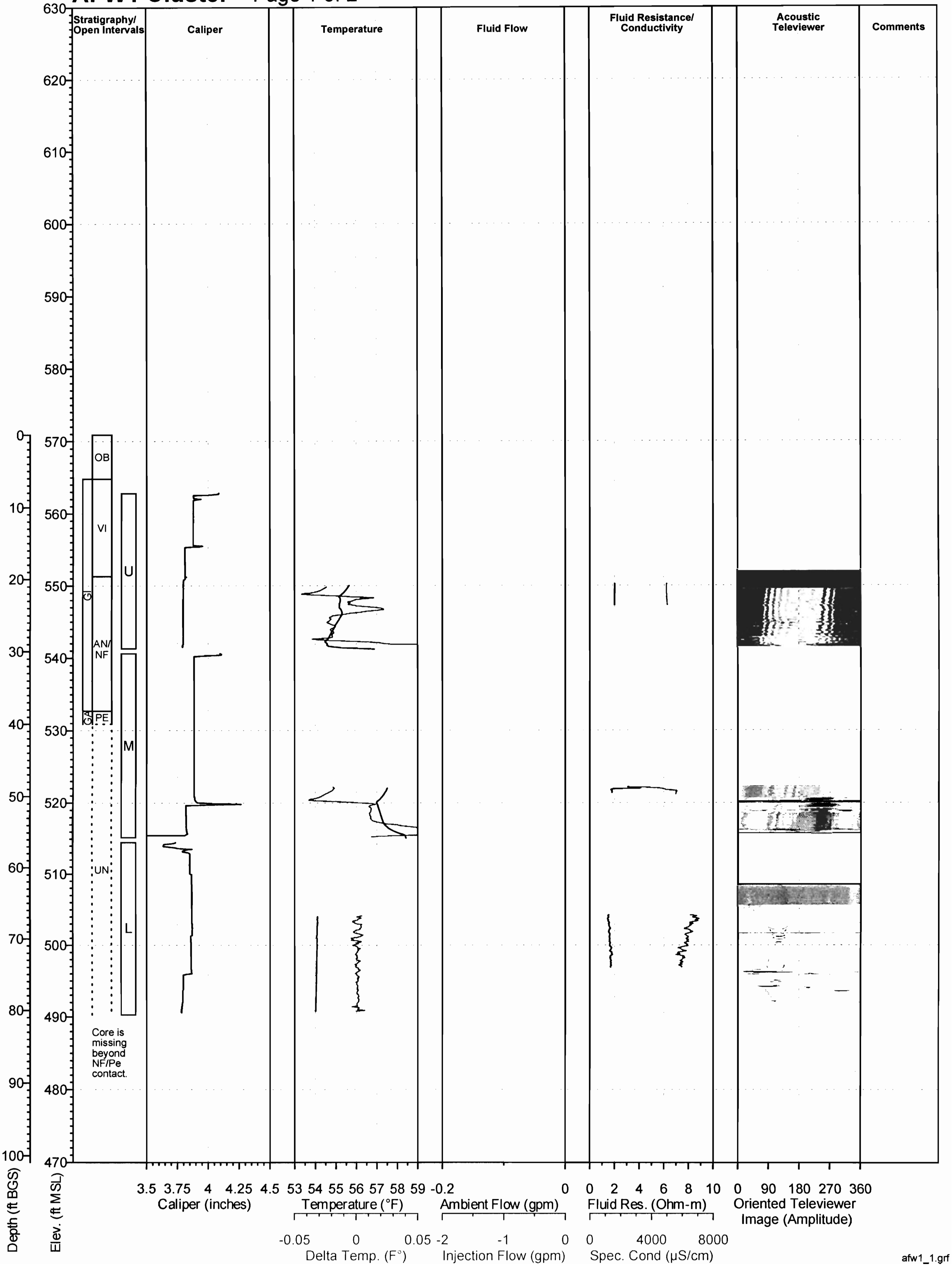
53. Appendix B1. Hydrographs for Individual Piezometers - *please provide a note indicating why certain hydrographs end on January 30, 2003 or prior, why certain hydrographs have large jumps (i.e., D2U-05, D2M-07, F6-07, etc.), and explanations for other odd trends in the hydrographs (i.e., H2U-01).*

Response

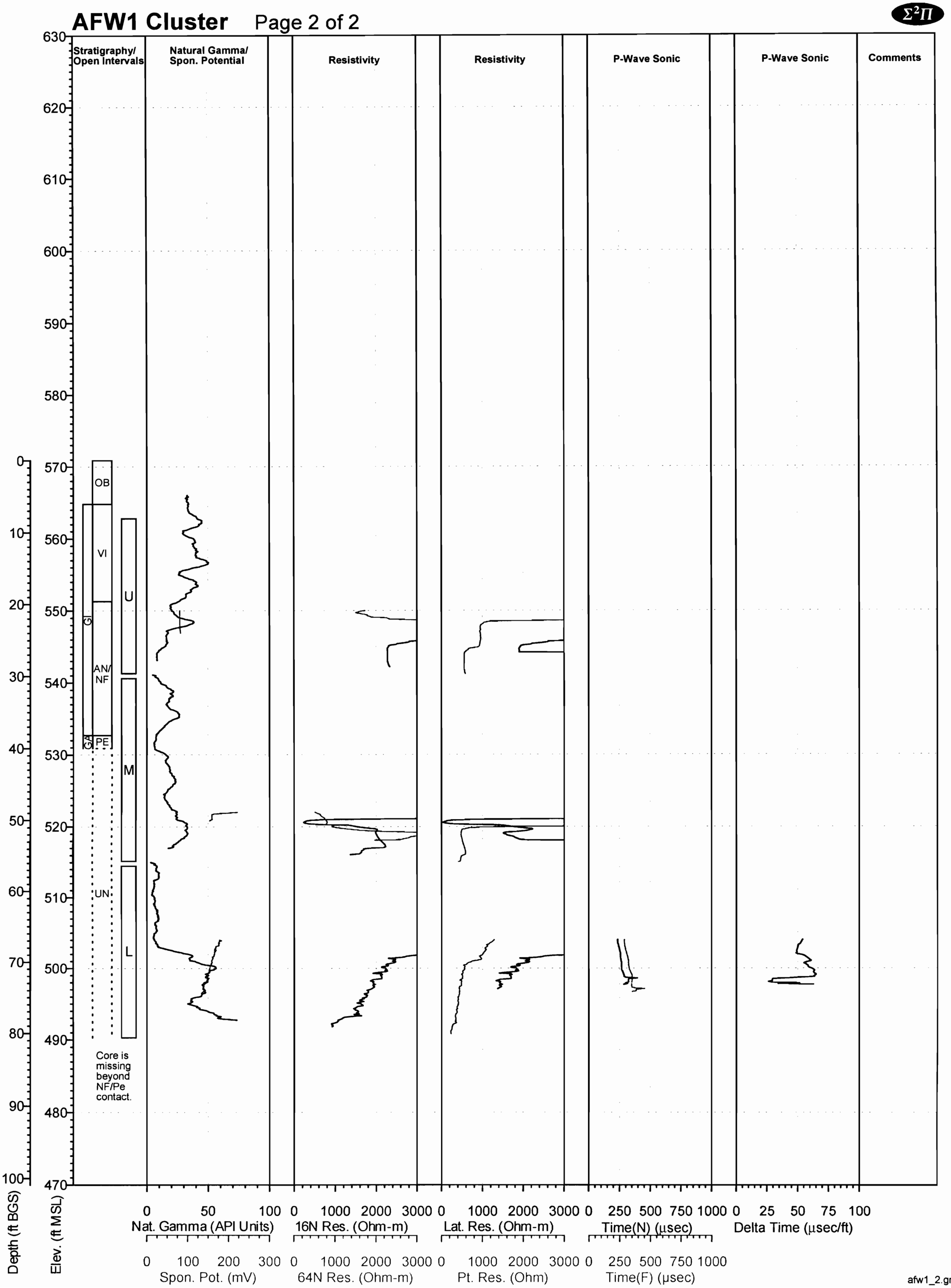
The request that explanations be provided for all "odd" trends in the hydrographs is not compatible with the reporting schedule that was established by the Agencies. We could discuss the unique features of every hydraulic test, every hydrograph, and every water level contour map. However, we do not believe that this would enhance significantly our understanding of overall conditions at the Site. More importantly, we believe that it would distract us from our final objective of demonstrating hydraulic containment at the Site.

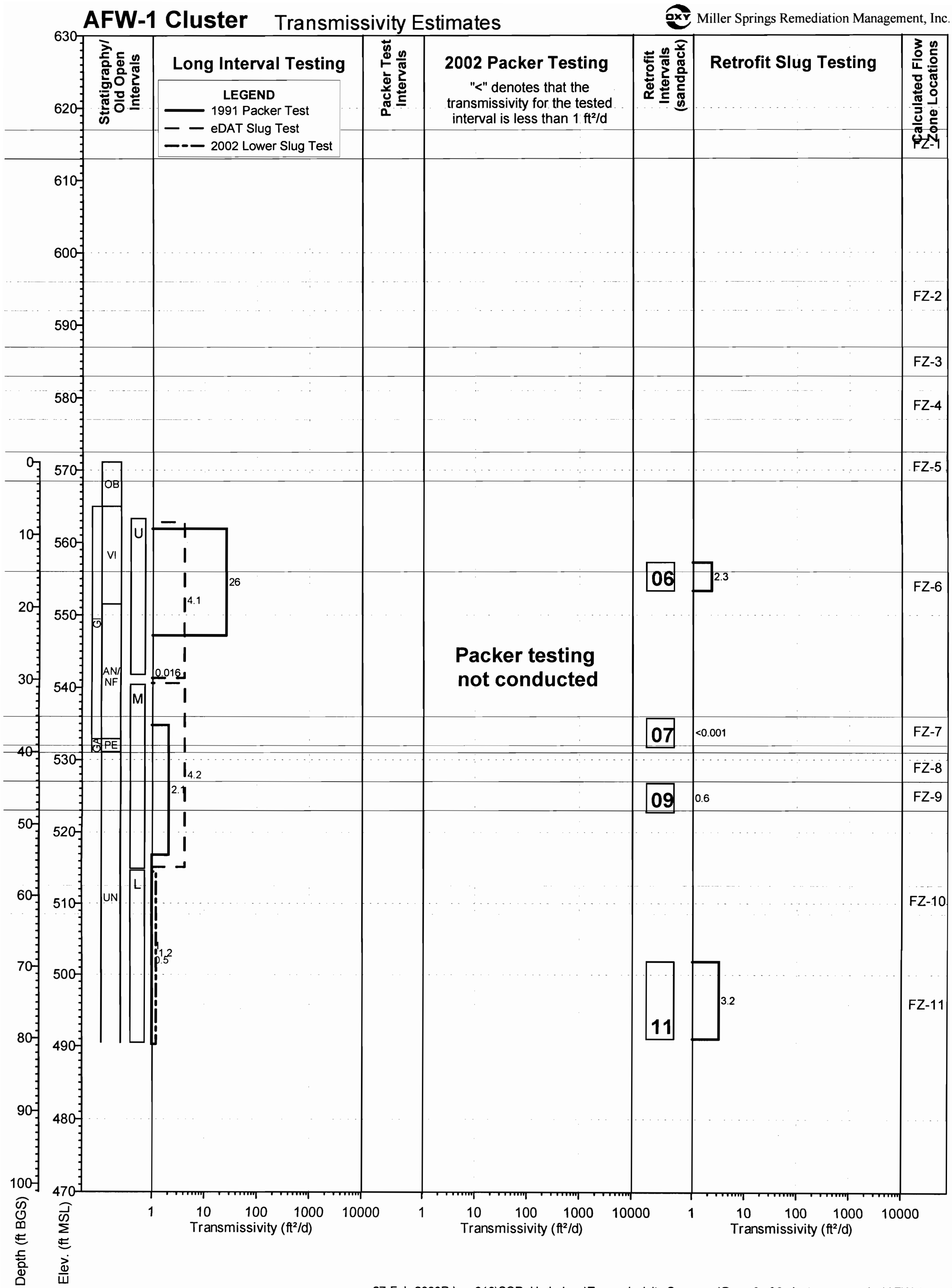
The sudden rises in water levels in some piezometers observed during the first week of February 2003 are due to slug testing. As indicated previously, the completion of the piezometer slug testing was delayed until the end of the SCR-H monitoring period. At D2M-07 and several other low transmissivity wells, the transducer recording at 10-minute intervals was left in the well to monitor slug test recovery. At higher transmissivity locations, e.g., H5-07, the transducer was removed to insert a water level recorder sampling at a 1-second interval. H5-07 shows a spike down in water level. This is due to removing the transducer and is not real. This false spike will be deleted from the database and future hydrographs. The dates of the slug tests are presented on Table 3 attached to these response, and have been checked against the data plots presented on the CD-ROM in Appendix A of the SCR-H.

AFW1 Cluster   Page 1 of 2



AFW1 Cluster Page 2 of 2

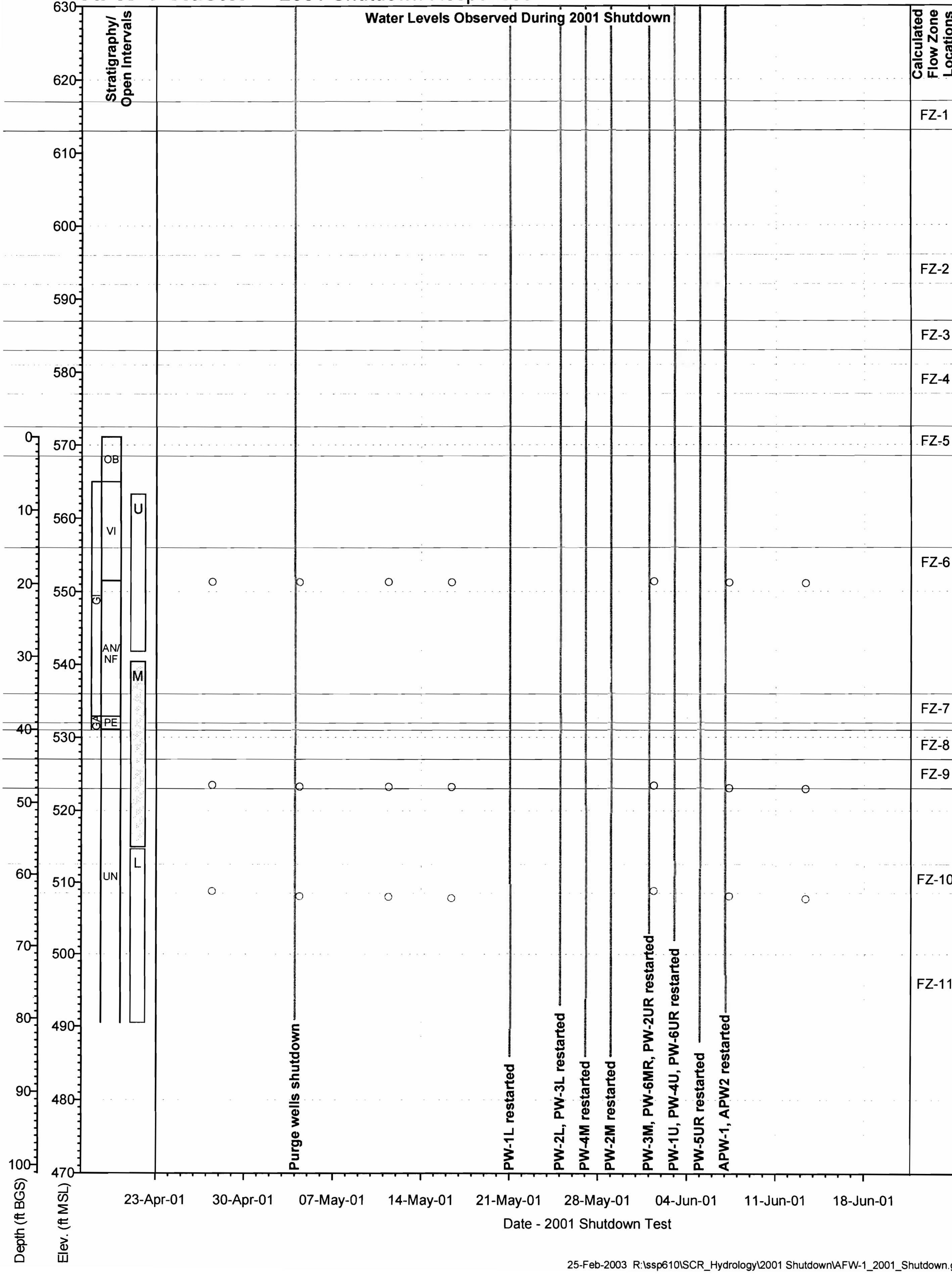




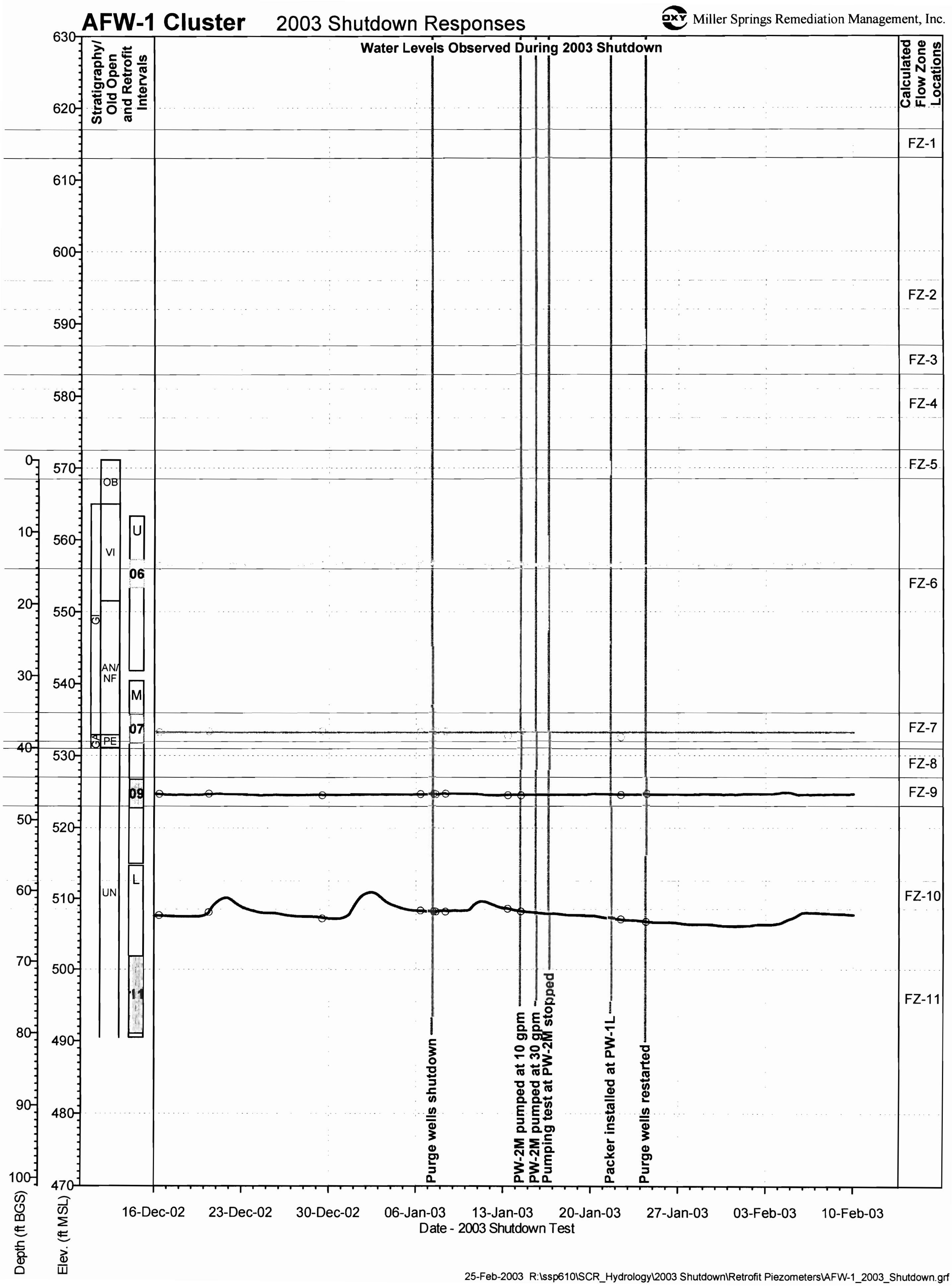
AFW-1 Cluster Transmissivity Estimates
Miller Springs Remediation Management, Inc.
Stratigraphy/ Old Open Intervals
Long Interval Testing
LEGEND
1991 Packer Test
eDAT Slug Test
2002 Lower Slug Test
Packer Test Intervals
2002 Packer Testing
"<" denotes that the transmissivity for the tested interval is less than 1 ft²/d
Retrofit Intervals (sandpack)
Retrofit Slug Testing
Calculated Flow Zone Locations
FZ-1
FZ-2
FZ-3
FZ-4
FZ-5
FZ-6
FZ-7
FZ-8
FZ-9
FZ-10
FZ-11
OB
VI
AN/ NF
PE
UN
U
M
L
26
4.1
0.016
4.2
2.1
1.2
0.5
Packer testing not conducted
06
07
09
11
2.3
<0.001
0.6
3.2
Depth (ft BGS)
Elev. (ft MSL)
Transmissivity (ft²/d)

AFW-1 Cluster 2001 Shutdown Responses

Miller Springs Remediation Management, Inc.



25-Feb-2003 R:\ssp610\SCR_Hydrology\2001 Shutdown\AFW-1_2001_Shutdown.grf



AFW-1 Cluster
2003 Shutdown Responses
Miller Springs Remediation Management, Inc.
Water Levels Observed During 2003 Shutdown
Stratigraphy/ Old Open and Retrofit Intervals
Calculated Flow Zone Locations
FZ-1
FZ-2
FZ-3
FZ-4
FZ-5
FZ-6
FZ-7
FZ-8
FZ-9
FZ-10
FZ-11
OB
VI
GI
AN/NF
GA
PE
UN
U
06
M
07
09
L
11
Purge wells shutdown
PW-2M pumped at 10 gpm
PW-2M pumped at 30 gpm
Pumping test at PW-2M stopped
Packer installed at PW-1L
Purge wells restarted
16-Dec-02
23-Dec-02
30-Dec-02
06-Jan-03
13-Jan-03
20-Jan-03
27-Jan-03
03-Feb-03
10-Feb-03
Date - 2003 Shutdown Test
Depth (ft BGS)
Elev. (ft MSL)
25-Feb-2003 R:\ssp610\SCR_Hydrology\2003 Shutdown\Retrofit Piezometers\AFW-1_2003_Shutdown.grf

Table 1
Observations Made During Development of the SCR-H Piezometers

Well Name	Reference Elevation (ft MSL)	Water Level (ft BTOC)	Water Level (ft MSL)	Notes
ABP-1-07	576.98	26.38	550.60	Purged 3 gallons intermittently over several days.
ABP-1-09	576.73	41.96	534.77	Purged 5 gallons continuously.
ABP-7-06	575.78			
ABP-7-07	575.73	40.75	534.98	No recovery, added 3 gallons of water and then purged.
ABP-7-09	575.67	44.30	531.37	Purged 3 gallons continuously.
AFW-1L-11	572.10			
AFW-1M-07	571.41			
AFW-1M-09	571.12			
AFW-1U-06	571.83			Purged 3 gallons intermittently during 1 day
AFW-2L-11	593.43			Purged 15 gallons intermittently over a several day period.
AFW-2M-07	593.44	54.05	539.39	Purged 3 gallons intermittently during 1 day
AFW-2M-09	593.32	44.30	549.02	Purged 3 gallons intermittently during 1 day
AFW-2U-04	593.48	17.28	576.20	Purged 15 gallons continuously.
AFW-2U-05	593.33	17.32	576.01	Purged 15 gallons continuously.
AFW-2U-06	593.22			Purged 3 gallons intermittently during 1 day
AGW-1L-11	592.71	3.00	589.71	Purged 8.5 gallons to dry.
AGW-1M-07	592.91	36.13	556.78	Purged 3 gallons continuously.
AGW-1M-09	592.75	35.06	557.69	Purged 5 gallons continuously.
AGW-1U-05	591.80	6.17	585.63	Unable to purge water.
AGW-1U-06	591.66	38.34	553.32	No recovery, added 3 gallons of water and then purged.
B2L-11	589.65	71.86	517.79	Purged 3 volumes (4.8 gallons), continuous.
B2M-07	589.52	70.38	519.14	No recovery, added 3 gallons of water and then purged.
B2M-09	589.34	44.08	545.26	Watterra will not pick up water, slug test indicated very fast recovery.
B2U-06	589.29	34.58	554.71	No recovery, added 3 gallons of water and then purged.
C3-06	585.78	36.80	548.98	Purged 0.1 gallons to dry.
C3-07	585.62	54.72	530.90	Purged 15 gallons continuously.
C3-09	585.54	54.96	530.58	Purged 20 gallons continuously.
D1L-11	593.80	83.24	510.56	Purged 30 gallons continuously.
D1M-07	594.15			Dry.
D1M-09	594.02	76.21	517.81	Purged 20 gallons continuously.
D1U-04	593.77	18.20	575.57	Purged 20 gallons continuously.
D1U-05	593.51	14.07	579.44	Purged 20 gallons continuously.
D1U-06	593.25			Dry.
D2L-11	590.21	57.90	532.31	Purged 20 gallons continuously.
D2M-07	590.77			Dry.
D2M-09	590.66	73.10	517.56	Purged 20 gallons continuously.
D2U-04	590.65	14.15	576.50	Purged 20 gallons continuously.
D2U-05	590.56	15.95	574.61	Purged 20 gallons continuously.
D2U-06	590.38	44.53	545.85	
E6-04	578.23	11.90	566.33	
E6-05	578.04	11.43	566.61	
E6-06	577.99	15.90	562.09	Purged 15 gallons continuously.
E6-07	577.91	18.66	559.25	Purged 1 gallon to dry.
E6-09	577.82	20.80	557.02	Purged 20 gallons continuously.
E6-11	577.72	42.67	535.05	Purged 20 gallons continuously.
F2L-11	598.94	52.32	546.62	Purged 15 gallons intermittently over a 2 day period.
F2M-06	599.06	7.33	591.73	Purged 2 gallons then dry, added 3 gallons of water then purged.
F2M-07	598.91	56.25	542.66	Purged 3 gallons intermittently over a 2 day period.
F2M-09	598.71	77.90	520.81	Purged 15 gallons continuously.
F2U-02	599.89	22.60	577.29	Purged 15 gallons continuously.
F2U-04	599.76	21.45	578.31	Purged 10 gallons continuously.
F2U-05	599.64	19.51	580.13	Purged 3 gallons intermittently over a 3 day period.
F4L-11	602.22	40.88	561.34	Purged 4 gallons to dry.
F4M-06	602.05	22.90	579.15	Purged 3 gallons to dry.
F4M-07	601.91	62.75	539.16	Purged dry 3 consecutive days.
F4M-09	601.79	78.15	523.64	Purged 12 gallons continuously.
F4U-02	602.32	13.81	588.51	Purged 10 gallons continuously.
F4U-04	602.19	12.52	589.67	Purged 2 gallons to dry.
F4U-05	602.06	15.09	586.97	Purged 2 gallons to dry.
F6-04	588.06	19.10	568.96	Purged intermittently over 2 days.

Table 1
Observations Made During Development of the SCR-H Piezometers

Well Name	Reference Elevation (ft MSL)	Water Level (ft BTOC)	Water Level (ft MSL)	Notes
F6-05	587.85	18.51	569.34	Purged 20 gallons continuously.
F6-06	587.84	26.89	560.95	Purged 20 gallons continuously.
F6-07	587.68	23.13	564.55	Purged 3.5 gallons to dry.
F6-09	587.53	23.50	564.03	Purged 3.5 gallons to dry.
F6-11	587.40	49.21	538.19	Purged 20 gallons continuously.
G1-02	616.86	24.56	592.30	Purged 6 gallons intermittently during 1 day.
G1L-11	616.84	35.50	581.34	Purged 6 gallons continuously.
G1M-06	616.75	49.42	567.33	Purged 8 gallons continuously.
G1M-07	616.68	59.18	557.50	Purged 5.5 gallons intermittently over a 2 day period.
G1M-09	616.58	56.35	560.23	Purged 3 gallons intermittently over a 2 day period.
G1U-01	617.08	12.20	604.88	Purged 13 gallons continuously.
G1U-04	616.96	24.37	592.59	Purged 5 gallons continuously.
H2L-11	620.73	78.11	542.62	Purged 5 gallons to dry.
H2M-05	621.59	32.95	588.64	Purged 4 gallons intermittently during 1 day.
H2M-06	621.42	33.06	588.36	Purged 15 gallons continuously.
H2M-09	621.32	68.50	552.82	Purged 15 gallons continuously.
H2U-01	620.92	8.76	612.16	Purged 15 gallons continuously.
H2U-02	620.88	8.14	612.74	Purged 15 gallons continuously.
H5-01	617.61	11.43	606.18	
H5-02	617.47	15.22	602.25	Purged 20 gallons continuously.
H5-04	617.40	19.59	597.81	Purged 20 gallons continuously.
H5-05	617.31	29.86	587.45	Purged 20 gallons continuously.
H5-06	617.17	12.89	604.28	Purged 10 gallons intermittently, dry after 5 gallons.
H5-07	617.05	67.79	549.26	Purged 20 gallons continuously.
H5-09	616.93	67.66	549.27	Purged 15 gallons continuously.
H5-11	616.81	54.39	562.42	Purged 20 gallons continuously.
I1-01	621.55	14.45	607.10	Purged 20 gallons continuously.
I1-02	621.42	20.83	600.59	Purged continuously.
I1-04	621.31	30.14	591.17	Purged 20 gallons intermittently.
I1-05	621.21	37.19	584.02	Purged 2 gallons to dry.
I1-06	621.08	38.29	582.79	Purged 3 gallons to dry. 1 additional gallon purged after 20 min.
I1-07	620.97	69.97	551.00	Purged 20 gallons continuously.
I1-09	620.86	65.98	554.88	Purged 3.5 gallons to dry.
I1-11	620.71	62.03	558.68	Purged 4 gallons to dry.
J5L-11	607.20	53.04	554.16	Purged 15 gallons over a 2 day period.
J5M-06	606.22	48.30	557.92	Purged 4 gallons continuously.
J5M-07	606.07	50.73	555.34	Purged 15 gallons continuously.
J5M-09	605.82	49.79	556.03	Purged 15 gallons continuously.
J5U-02	606.21	13.45	592.76	Purged 15 gallons continuously.
J5U-04	606.05	24.36	581.69	Purged 4 gallons over a 2 day period, dry after each 1 gallon.
J5U-05	605.87	37.48	568.39	Purged 15 gallons intermittently over a 2 day period.
J6-02	609.23			
J6-04	609.12	32.79	576.33	Purged 20 gallons continuously.
J6-05	609.02	33.94	575.08	Purged 20 gallons continuously.
J6-06	608.93			Purged 2 gallons intermittently.
J6-07	608.85			Purged 20 gallons continuously.
J6-09	608.76			Purged 1 gallon intermittently, slow recharge.
J6-11	608.68	40.00	568.68	Purged 20 gallons continuously.
PMW-1L-11	598.84			Purged 0.5 gallons to dry.
PMW-1M-07	598.50			Purged 5 gallons intermittently over a 2 day period.
PMW-1M-09	598.34			Purged 15 gallons over a 2 day period.
PMW-1U-05	598.00			Purged 10 gallons over a 2 day period.
PMW-1U-06	597.92			Purged 3 gallons intermittently over a 2 day period.

Table 2
Changes in Well Reference Point Elevation Based on SCR-H Survey

Location	Northing	Easting	Original Elevation NGVD 29	2002 Survey Elevation NGVD 29	Elevation Difference (ft)
ABP-1	1142988.25	1026063.67	571.68		
ABP-1-07				576.98	
ABP-1-09				576.73	
ABP-1 (GROUND)			571.90	575.50	3.60
ABP-7	1142135.06	1025288.99	575.61		
ABP-7-06				575.78	
ABP-7-07				575.73	
ABP-7-09				575.67	
ABP-7 (GROUND)			574.40	574.10	-0.30
AFW-1L	1141670.69	1024294.33	570.61		
AFW-1L-11				572.10	
AFW-1L (GROUND)			570.90	571.10	0.20
AFW-1M	1141693.47	1024338.38	570.33		
AFW-1M-07				571.41	
AFW-1M-09				571.12	
AFW-1M (GROUND)			570.60	570.40	-0.20
AFW-1U	1141681.52	1024316.71	569.84		
AFW-1U-06				571.83	
AFW-1U (GROUND)			570.30	570.80	0.50
AFW-2L	1140410.76	1023231.11	591.83		
AFW-2L-11				593.43	
AFW-2L (GROUND)			592.20	592.50	0.30
AFW-2M	1140453.94	1023257.65	591.73		
AFW-2M-07				593.44	
AFW-2M-09				593.32	
AFW-2M (GROUND)			592.20	592.60	0.40
AFW-2U	1140433.29	1023243.38	591.99		
AFW-2U-04				593.48	
AFW-2U-05				593.33	
AFW-2U-06				593.22	
AFW-2U (GROUND)			592.40	592.30	-0.10
AGW-1L	1142414.99	1027330.66	592.94		
AGW-1L-11				592.71	
AGW-1L (GROUND)			591.40	591.30	-0.10
AGW-1M	1142417.84	1027306.72	593.56		
AGW-1M-07				592.91	
AGW-1M-09				592.75	
AGW-1M (GROUND)			591.40	591.50	0.10
AGW-1U	1142415.25	1027269.82	593.52		
AGW-1U-05				591.80	
AGW-1U-06				591.66	
AGW-1U(GROUND)			590.20	590.50	0.30
B2L	1142012.81	1026288.57	590.08		
B2L-11				589.65	
B2L (GROUND)			588.00	587.90	-0.10
B2M	1142058.01	1026305.80	589.96		
B2M-09				589.34	
B2M-07				589.52	
B2M (GROUND)			587.90	588.00	0.10
B2U	1142037.99	1026298.88	590.17		
B2U-06				589.29	
B2U (GROUND)			587.90	587.90	0.00
C3 (CONCRETE PAD)	1141621.20	1025154.55		584.72	
C3 (TOP OF CASING)				585.28	

Table 2
Changes in Well Reference Point Elevation Based on SCR-H Survey

Location	Northing	Easting	Original Elevation NGVD 29	2002 Survey Elevation NGVD 29	Elevation Difference (ft)
C3-09				585.54	
C3-07				585.62	
C3-06				585.78	
D1L	1140904.57	1026247.23	592.37	592.81	0.44
D1L-11				593.80	
D1L (GROUND)			592.70	593.10	0.40
D1M	1140905.82	1026222.60	592.53	592.45	-0.08
D1M-07				594.15	
D1M-09				594.02	
D1M (GROUND)			592.90	592.80	-0.10
D1U	1140905.70	1026196.45	592.89	592.33	-0.56
D1U-04				593.77	
D1U-05				593.51	
D1U-06				593.25	
D1U (GROUND)			593.20	592.40	-0.80
D2L	1140911.00	1025944.77	589.92	589.04	-0.88
D2L-11				590.21	
D2L (GROUND)			589.40	589.30	-0.10
D2M	1140910.60	1025972.27	589.40	589.28	-0.12
D2M-07				590.77	
D2M-09				590.66	
D2M (GROUND)			589.60	589.50	-0.10
D2U	1140909.68	1025997.82	589.51	589.42	-0.09
D2U-04				590.65	
D2U-05				590.56	
D2U-06				590.38	
D2U (GROUND)			589.80	589.70	-0.10
E6	1139161.38	1024985.96		577.47	
E6-04				578.23	
E6-05				578.04	
E6-06				577.99	
E6-07				577.91	
E6-09				577.82	
E6-11				577.72	
F2L	1139449.10	1026302.13	597.63		
F2L-11				598.94	
F2L (GROUND)			597.60	597.70	0.10
F2M	1139423.00	1026286.57	597.32		
F2M-06				599.06	
F2M-07				598.91	
F2M-09				598.71	
F2M (GROUND)			597.60	597.60	0.00
F2U	1139419.99	1026316.54	598.27		
F2U-02				599.89	
F2U-04				599.76	
F2U-05				599.64	
F2U (GROUND)			598.40	598.60	0.20
F4L	1140148.17	1026969.95	600.30		
F4L-11				602.22	
F4L (GROUND)			601.00	600.90	-0.10
F4M	1140148.05	1026944.83	600.41		
F4M-06				602.05	
F4M-07				601.91	
F4M-09				601.79	

Table 2
Changes in Well Reference Point Elevation Based on SCR-H Survey

Location	Northing	Easting	Original Elevation NGVD 29	2002 Survey Elevation NGVD 29	Elevation Difference (ft)
F4M (GROUND)			600.90	600.80	-0.10
F4U	1140148.33	1026919.87	600.65		
F4U-02				602.32	
F4U-04				602.19	
F4U-05				602.06	
F4U (GROUND)			601.10	601.00	-0.10
F6	1138052.69	1024524.93		586.90	
F6-04				588.06	
F6-05				587.85	
F6-06				587.84	
F6-07				587.68	
F6-09				587.53	
F6-11				587.40	
G1-02	1139317.71	1027687.69			
G1-02				616.86	
G1-02 (GROUND)				615.90	
G1L	1139319.83	1027674.60	617.53		
G1L-11				616.84	
G1L (GROUND)			615.60	615.60	0.00
G1M	1139321.00	1027647.58	617.78		
G1M-06				616.75	
G1M-07				616.68	
G1M-09				616.58	
G1M (GROUND)			615.30	614.70	-0.60
G1U	1139319.47	1027697.97	618.33		
G1U-01				617.08	
G1U-04				616.96	
G1U (GROUND)			615.80	615.60	-0.20
H2L	1140504.78	1028659.38	621.57		
H2L-11				620.73	
H2L (GROUND)			619.30	619.40	0.10
H2M	1140529.58	1028660.76	621.77		
H2M-05				621.59	
H2M-06				621.42	
H2M-09				621.32	
H2M (GROUND)			619.80	619.80	0.00
H2U	1140555.04	1028662.20	621.70		
H2U-01				620.92	
H2U-02				620.88	
H2U (GROUND)			619.60	619.70	0.10
H5	1139825.73	1029365.84		616.45	
H5-01				617.61	
H5-02				617.47	
H5-04				617.40	
H5-05				617.31	
H5-06				617.17	
H5-07				617.05	
H5-09				616.93	
H5-11				616.81	
H5 (GROUND)				615.75	
I1	1140860.27	1030472.05		620.39	
I1-01				621.55	
I1-02				621.42	
I1-04				621.31	

Table 2
Changes in Well Reference Point Elevation Based on SCR-H Survey

Location	Northing	Easting	Original Elevation NGVD 29	2002 Survey Elevation NGVD 29	Elevation Difference (ft)
I1-05				621.21	
I1-06				621.08	
I1-07				620.97	
I1-09				620.86	
I1-11				620.71	
I1 (GROUND)				619.62	
J5L	1141433.56	1028101.66	607.79		
J5L-11				607.20	
J5L (GROUND)			606.10	605.80	-0.30
J5M	1141456.73	1028105.38	606.37		
J5M-06				606.22	
J5M-07				606.07	
J5M-09				605.82	
J5M (GROUND)			604.60	604.80	0.20
J5U	1141480.56	1028104.03	606.10		
J5U-02				606.21	
J5U-04				606.05	
J5U-05				605.87	
J5U (GROUND)			604.50	604.40	-0.10
J6	1142729.99	1028891.50		608.45	
J6-02				609.23	
J6-04				609.12	
J6-05				609.02	
J6-06				608.93	
J6-07				608.85	
J6-09				608.76	
J6-11				608.68	
J6 (GROUND)				607.64	
PMW-1L	1141357.99	1026652.78	597.37		
PMW-1L-11				598.84	
PMW-1L (GROUND)			597.40	597.60	0.20
PMW-1M	1141358.98	1026618.04	597.21		
PMW-1M-7				598.50	
PMW-1M-9				598.34	
PMW-1M (GROUND)			597.70	597.30	-0.40
PMW-1U	1141360.13	1026581.93	596.66		
PMW-1U-5				598.00	
PMW-1U-6				597.92	
PMW-1U (GROUND)			596.90	596.80	-0.10

Table 3
Dates of SCR-H Piezometer Activities

Piezometer ID	Piezometer completion	Piezometer development	Slug test
ABP-1-07	2002/May/21	2002/May/31	2002/Sep/24
ABP-1-09	2002/May/21	2002/May/31	2002/Sep/24
ABP-7-06	2002/May/17	2002/May/28	2002/Aug/26
ABP-7-07	2002/May/17	2002/May/31	2002/Aug/26
ABP-7-09	2002/May/17	2002/May/31	2002/Aug/22
AFW-1U-06	2002/Jun/18	2002/Jul/02	2002/Jul/16
AFW-1M-07	2002/Jun/18		2002/Jul/16
AFW-1M-09	2002/Jun/18		2002/Jul/16
AFW-1L-11	2002/Jun/18	2002/Jul/02	2002/Jul/16
AFW-2U-04	2002/Jun/19	2002/Jul/02	2002/Aug/26
AFW-2U-05	2002/Jun/19	2002/Jul/02	2002/Aug/26
AFW-2U-06	2002/Jun/19		2002/Aug/26
AFW-2M-07	2002/Jun/19	2002/Jul/02	2002/Jul/17
AFW-2M-09	2002/Jun/19	2002/Jul/02	2002/Jul/17
AFW-2L-11	2002/Jun/19	2002/Jul/03	2002/Jul/17
AGW-1U-05	2002/May/14	2002/May/31	2002/Sep/23
AGW-1U-06	2002/May/14	2002/May/31	2002/Sep/23
AGW-1M-07	2002/May/13	2002/May/31	2002/Sep/23
AGW-1M-09	2002/May/13	2002/May/31	2002/Sep/23
AGW-1L-11	2002/May/13	2002/May/31	2002/Sep/23
B2U-06	2002/May/10	2002/May/27	2002/Sep/23
B2M-07	2002/May/10	2002/May/24	2002/Sep/23
B2M-09	2002/May/09	2002/May/27	2002/Sep/23
B2L-11	2002/May/09	2002/May/31	2002/Sep/24
C3-06	2002/Aug/06	2002/Aug/16	2002/Aug/22
C3-07	2002/Aug/06	2002/Aug/16-2002/Aug/19	2002/Aug/22
C3-09	2002/Aug/06	2002/Aug/16-2002/Aug/19	2002/Aug/22
D1U-04	2002/Nov/08	2002/Nov/14	2003/Feb/06
D1U-05	2002/Nov/08	2002/Nov/14	2003/Feb/06
D1U-06	2002/Nov/08	2002/Nov/14	2003/Feb/06
D1M-07	2002/Nov/08	2002/Nov/14	2003/Feb/06
D1M-09	2002/Nov/08	2002/Nov/14	2003/Feb/06
D1L-11	2002/Nov/15	2002/Nov/19	2003/Feb/06
D2U-04	2002/Nov/07	2002/Nov/14	2003/Feb/06
D2U-05	2002/Nov/07	2002/Nov/14	2003/Feb/06
D2U-06	2002/Nov/07	2002/Nov/14	2003/Feb/06
D2M-07	2002/Nov/07	2002/Nov/14	2003/Feb/03
D2M-09	2002/Nov/07	2002/Nov/14	2003/Feb/06
D2L-11	2002/Nov/15	2002/Nov/18	2003/Feb/06
E6-04	2002/Nov/20	2002/Nov/21	2003/Feb/06
E6-05	2002/Nov/20	2002/Nov/21	2003/Feb/06
E6-06	2002/Nov/20	2002/Nov/21	2003/Feb/06
E6-07	2002/Nov/20	2002/Nov/21	2003/Feb/06
E6-09	2002/Nov/20	2002/Nov/21	2003/Feb/06
E6-11	2002/Nov/20	2002/Nov/21	2003/Feb/06
F2U-02	2002/May/16	2002/Jun/28	2002/Aug/26
F2U-04	2002/May/16	2002/Jun/27	2002/Aug/26
F2U-05	2002/May/16	2002/Jun/27	2002/Aug/26
F2M-06	2002/May/16	2002/Jun/13-2002/Jul/02	2002/Jul/19
F2M-07	2002/May/16	2002/Jun/13-2002/Jul/01	2002/Jul/19
F2M-09	2002/May/16	2002/Jun/12	2002/Aug/26
F2L-11	2002/May/15	2002/Jun/28	2002/Jul/17
F4U-02	2002/Jun/04	2002/Jun/12	2002/Jul/18

Table 3
Dates of SCR-H Piezometer Activities

Piezometer ID	Piezometer completion	Piezometer development	Slug test
F4U-04	2002/Jun/04	2002/Jun/12-2002/Jul/09	2002/Jul/18
F4U-05	2002/Jun/04	2002/Jun/12-2002/Jul/09	2002/Jul/18
F4M-06	2002/Jun/05	2002/Jun/12-2002/Jul/09	2002/Sep/05
F4M-07	2002/Jun/05	2002/Jun/12-2002/Jul/09	2002/Jul/18
F4M-09	2002/Jun/05	2002/Jun/12-2002/Jun/13	2002/Jul/18
F4L-11	2002/Jun/04	2002/Jun/12-2002/Jun/26	2002/Jul/18
F6-04	2002/Nov/19	2002/Nov/21	2003/Feb/06
F6-05	2002/Nov/19	2002/Nov/20	2003/Feb/06
F6-06	2002/Nov/19	2002/Nov/20	2003/Feb/06
F6-07	2002/Nov/19	2002/Nov/20	2003/Feb/03
F6-09	2002/Nov/19	2002/Nov/20	2003/Feb/06
F6-11	2002/Nov/19	2002/Nov/20	2003/Feb/06
G1U-01	2002/May/07-2002/May/08	2002/Jun/10	2002/Sep/25
G1-02	2002/May/31	2002/Jun/11-2002/Jul/08	2002/Jul/17
G1U-04	2002/May/07	2002/Jun/11-2002/Jul/08	2002/Sep/25
G1M-06	2002/May/24	2002/Jun/10	2002/Sep/25
G1M-07	2002/May/08-2002/May/09	2002/Jun/11-2002/Jul/08	2002/Sep/25
G1M-09	2002/May/08-2002/May/09	2002/Jun/11-2002/Jul/08	2002/Sep/25
G1L-11	2002/May/08-2002/May/09	2002/Jun/10	2002/Jul/17
H2U-01	2002/May/24	2002/Jun/27	2002/Sep/05
H2U-02	2002/May/24	2002/Jun/27	2002/Jul/18
H2M-05	2002/May/23	2002/Jun/27-2002/Jul/08	2002/Jul/18
H2M-06	2002/May/23	2002/Jun/27	2002/Sep/05
H2M-09	2002/May/23	2002/Jun/27	2002/Jul/19
H2L-11	2002/May/21	2002/Jun/27-2002/Jul/08	2002/Jul/19
H5-01	2002/Nov/13	2002/Nov/15	2003/Feb/11
H5-02	2002/Nov/13	2002/Nov/15	2003/Feb/04
H5-04	2002/Nov/12	2002/Nov/15	2003/Feb/06
H5-05	2002/Nov/12	2002/Nov/15	2003/Feb/04
H5-06	2002/Nov/12	2002/Nov/15-2002/Nov/18	2003/Feb/04
H5-07	2002/Nov/11	2002/Nov/15	2003/Feb/04
H5-09	2002/Nov/11	2002/Nov/15-2002/Nov/18	2003/Feb/04
H5-11	2002/Nov/11	2002/Nov/18	2003/Feb/04
I1-01	2002/Nov/14	2002/Nov/20	2003/Feb/11
I1-02	2002/Nov/14	2002/Nov/19	2003/Feb/06
I1-04	2002/Nov/14	2002/Nov/19	2003/Feb/06
I1-05	2002/Nov/14	2002/Nov/19	2003/Feb/06
I1-06	2002/Nov/14	2002/Nov/19	2003/Feb/06
I1-07	2002/Nov/13	2002/Nov/19	2003/Feb/06
I1-09	2002/Nov/13	2002/Nov/19	2003/Feb/06
I1-11	2002/Nov/13	2002/Nov/19-2002/Nov/20	2003/Feb/03
J5U-02	2002/May/22	2002/Jul/09	2002/Aug/22
J5U-04	2002/May/22	2002/Jul/09-2002/Jul/10	2002/Jul/15
J5U-05	2002/May/22	2002/Jul/09-2002/Jul/10	2002/Jul/16
J5M-06	2002/May/21	2002/Jul/09-2002/Jul/10	2002/Jul/15
J5M-07	2002/May/21	2002/Jul/09	2002/Aug/22
J5M-09	2002/May/21	2002/Jul/09	2002/Aug/22
J5L-11	2002/May/21	2002/Jul/09-2002/Jul/10	2002/Jul/16
J6-02	2002/Nov/11		2003/Feb/04
J6-04	2002/Sep/19	2002/Nov/08	2003/Feb/04
J6-05	2002/Sep/19		2003/Feb/04
J6-06	2002/Sep/19	2002/Oct/31	2003/Feb/03
J6-07	2002/Sep/18	2002/Oct/31	2003/Feb/04

Table 3
Dates of SCR-H Piezometer Activities

Piezometer ID	Piezometer completion	Piezometer development	Slug test
J6-09	2002/Sep/18	2002/Oct/31-2002/Nov/13	2003/Feb/03
J6-11	2002/Sep/17	2002/Oct/14	2003/Feb/04
PMW-1U-05	2002/Jun/21	2002/Jul/15-2002/Jul/16	2003/Feb/07
PMW-1U-06	2002/Jun/21	2002/Jul/11-2002/Jul/15	2003/Feb/03
PMW-1M-07	2002/Jun/20	2002/Jul/15-2002/Jul/16	2003/Feb/03
PMW-1M-09	2002/Jun/20	2002/Jul/11-2002/Jul/12	2003/Feb/07
PMW-1L-11	2002/Jun/20	2002/Jul/15-2002/Jul/16	2003/Feb/07

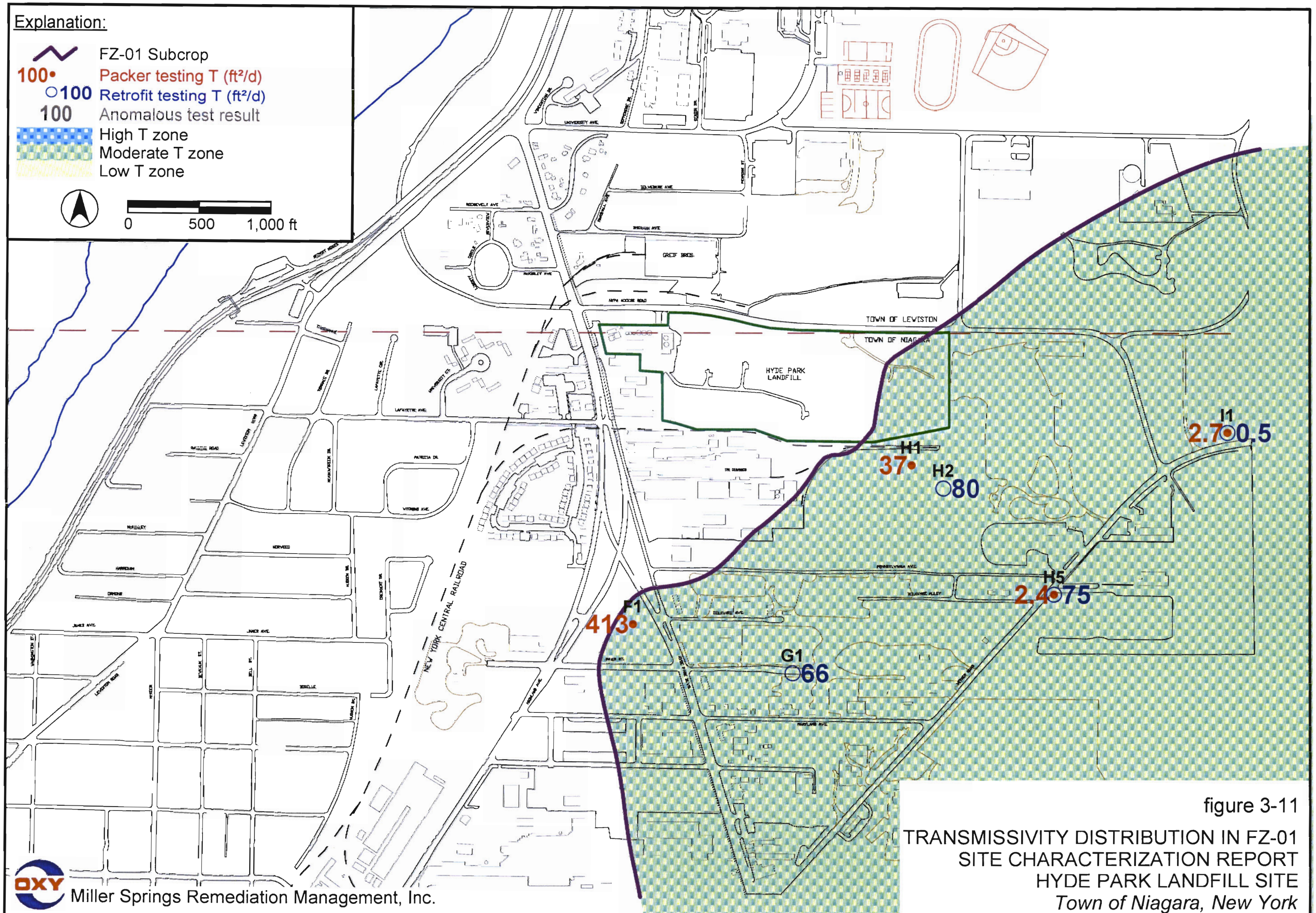


figure 3-11

TRANSMISSIVITY DISTRIBUTION IN FZ-01
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

20-May-2003 R:\ssp610\SCR_Hydrology\Transmissivity summary\Tests by flow zone\Tests in FZ-01.srf

932021

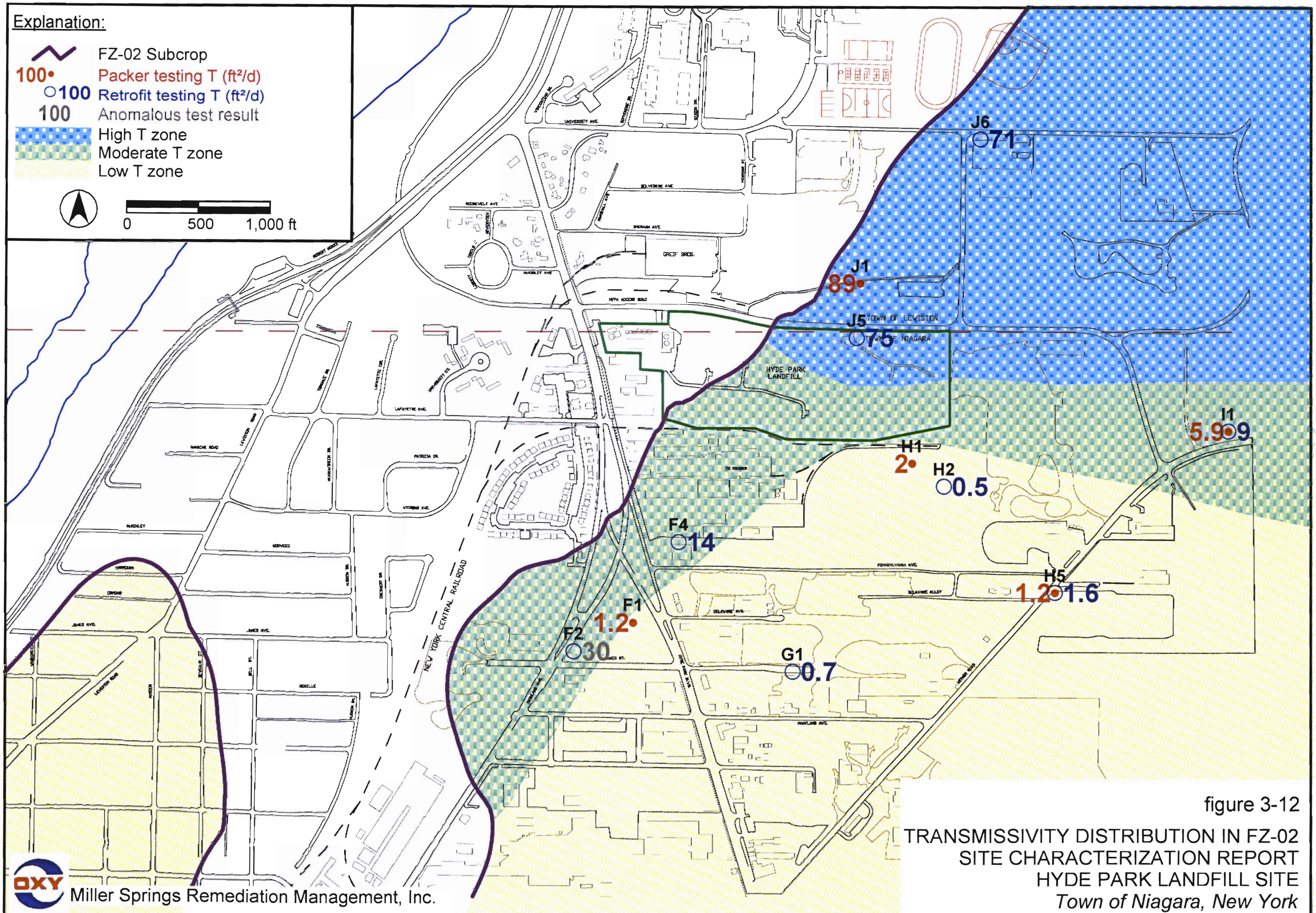


figure 3-12

TRANSMISSIVITY DISTRIBUTION IN FZ-02
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

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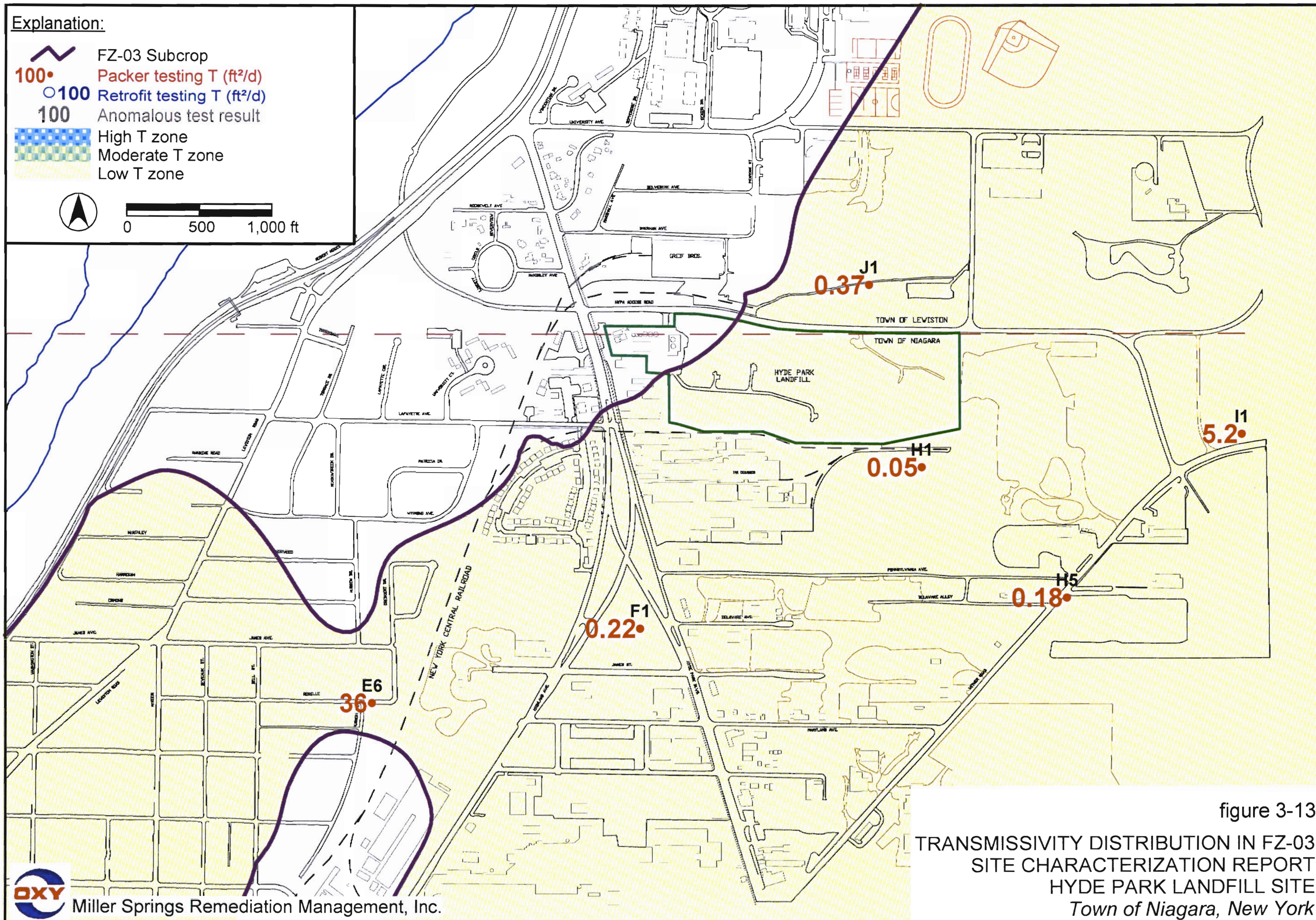

figure 3-13

TRANSMISSIVITY DISTRIBUTION IN FZ-03
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

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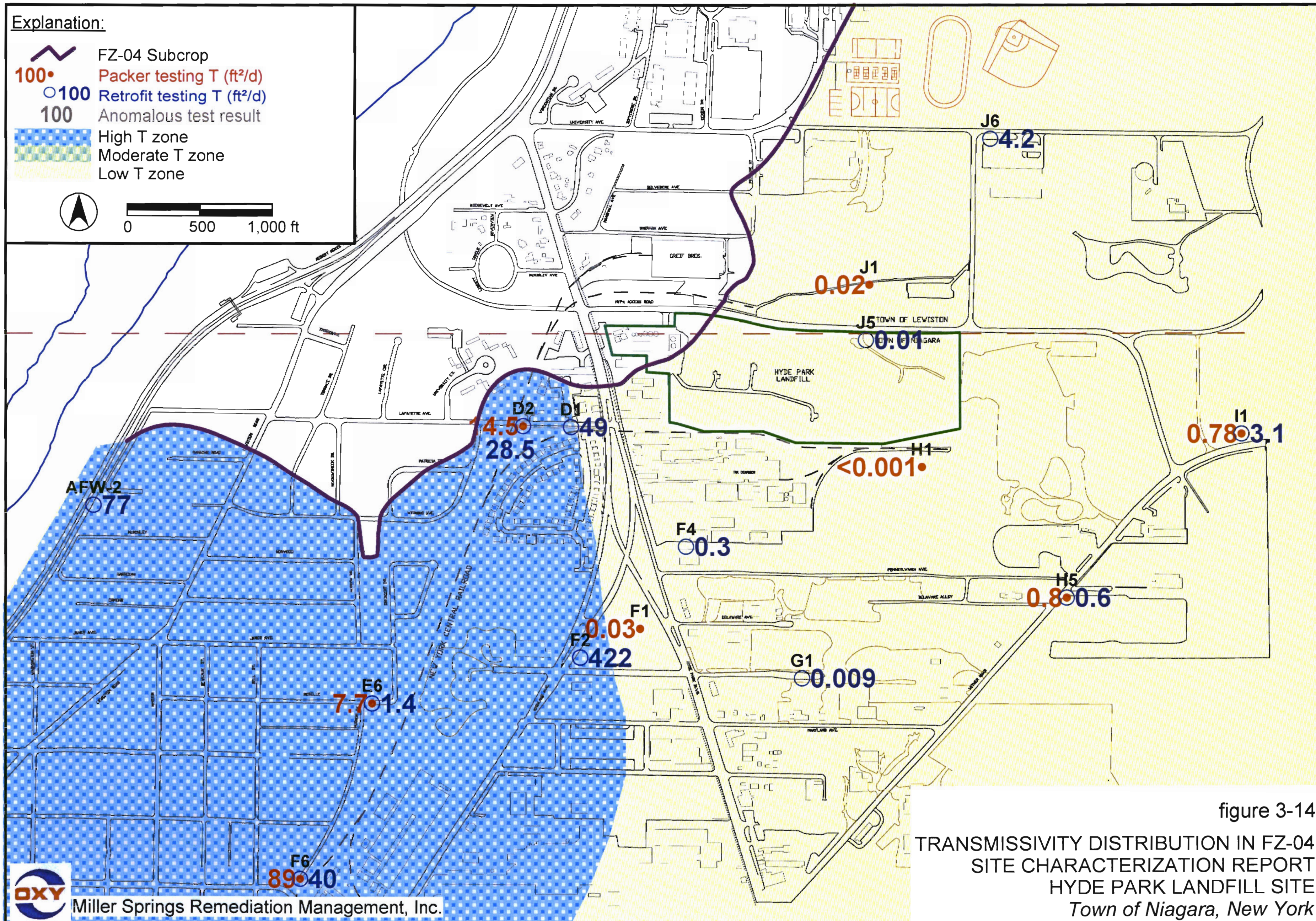

figure 3-14

TRANSMISSIVITY DISTRIBUTION IN FZ-04
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

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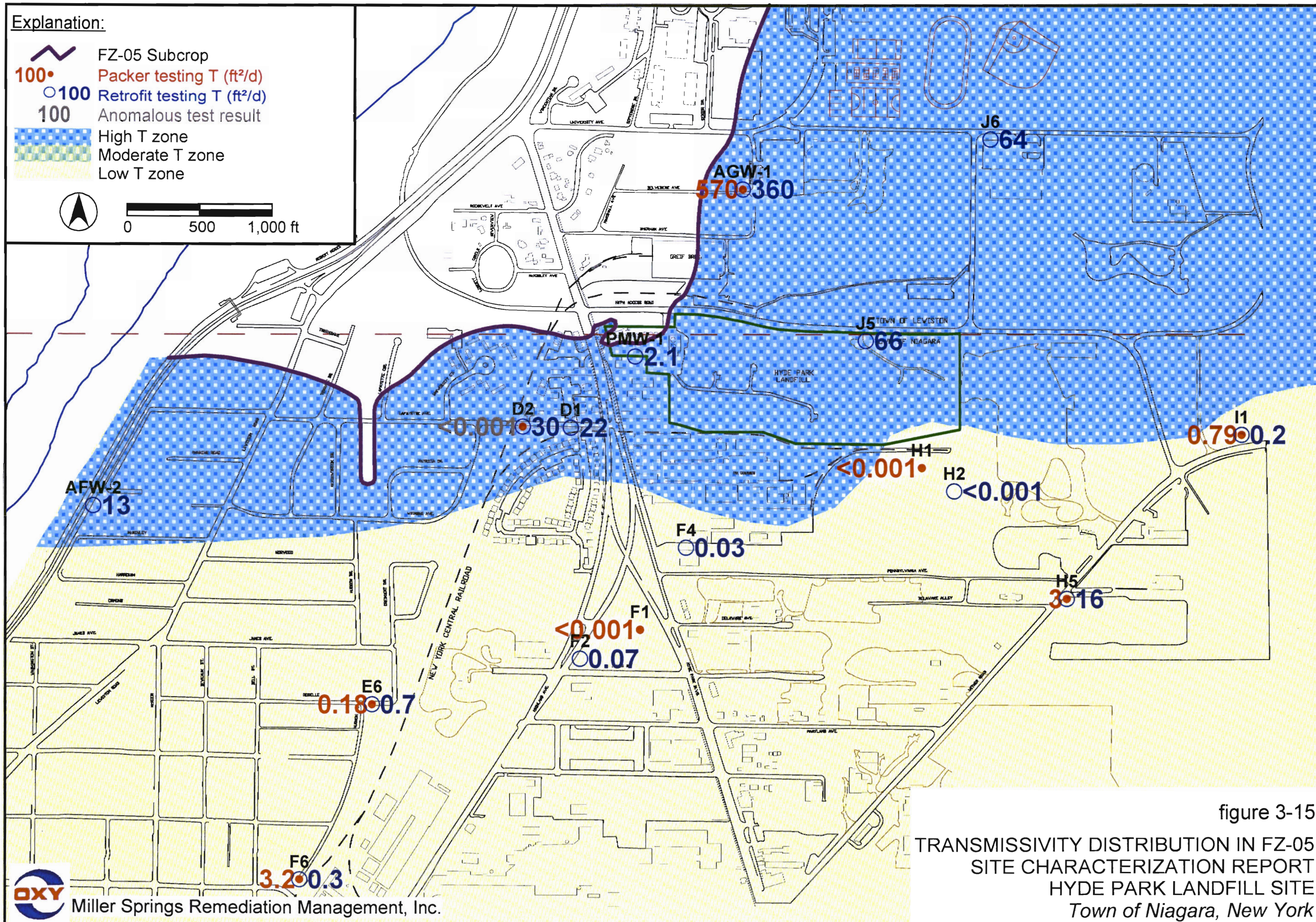

figure 3-15

TRANSMISSIVITY DISTRIBUTION IN FZ-05
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

OXY Miller Springs Remediation Management, Inc.

26-May-2003 R:\ssp610\SCR_Hydrology\Transmissivity summary\Tests by flow zone\Tests in FZ-05.srf

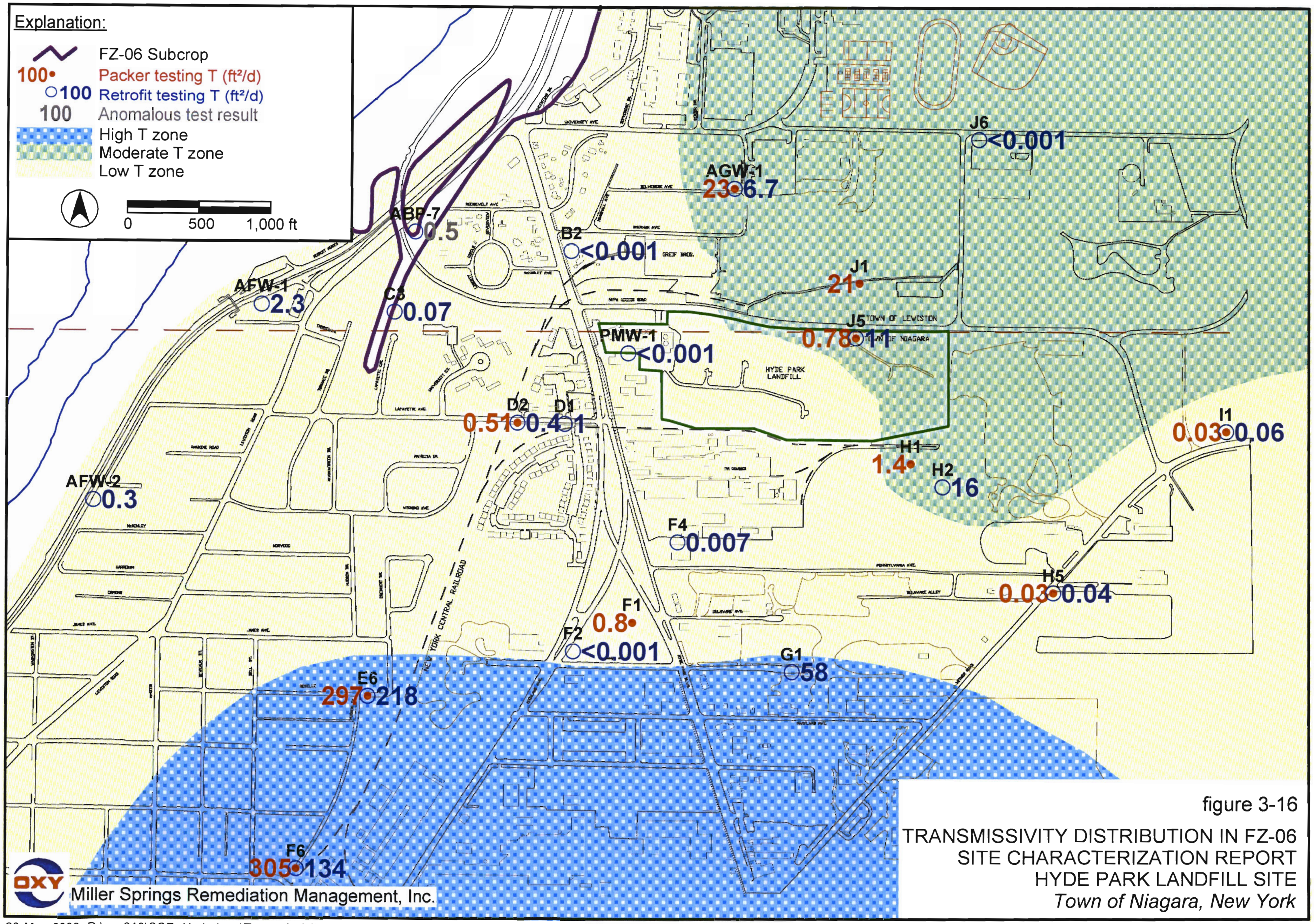

figure 3-16

TRANSMISSIVITY DISTRIBUTION IN FZ-06
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

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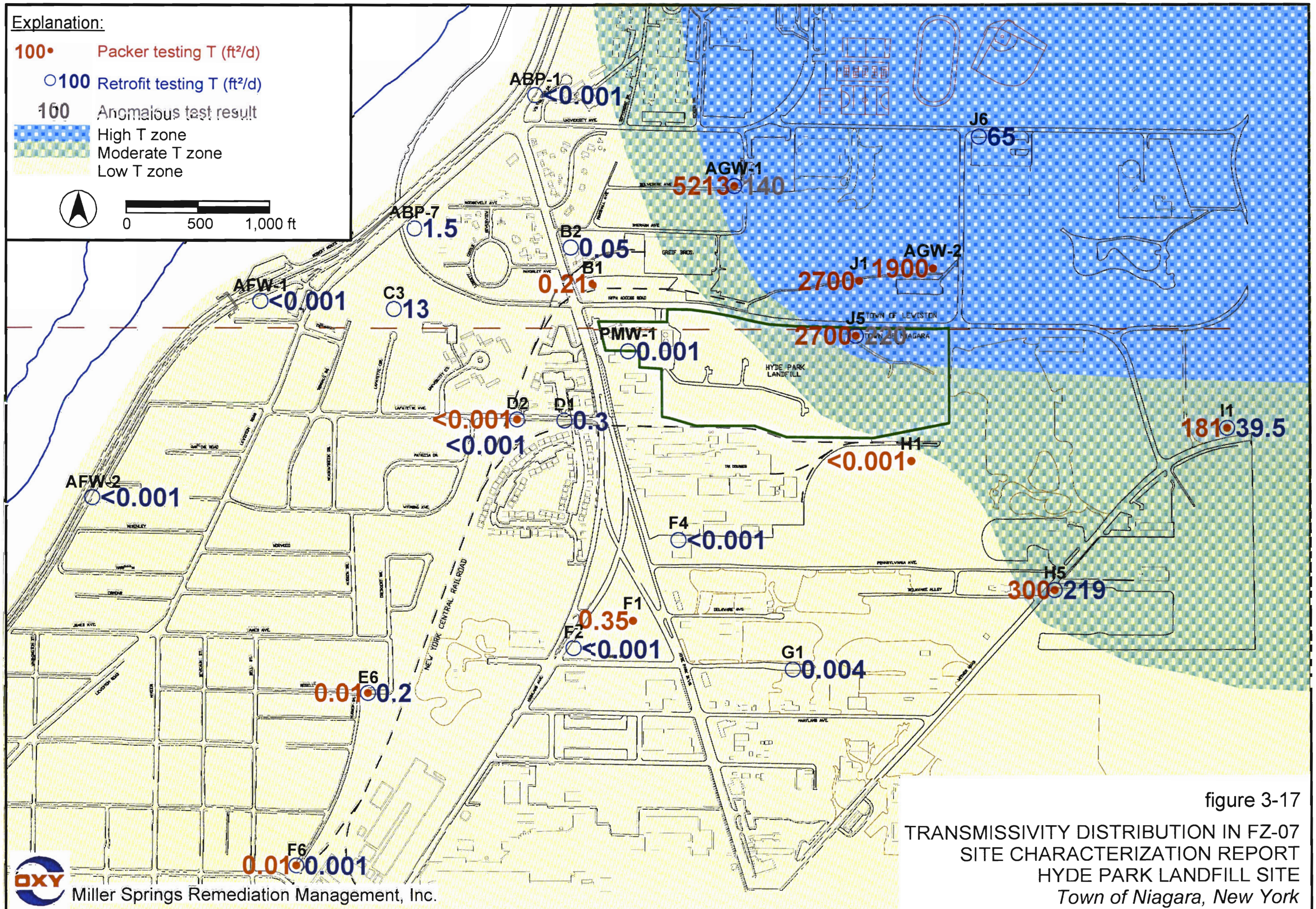

figure 3-17

TRANSMISSIVITY DISTRIBUTION IN FZ-07
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

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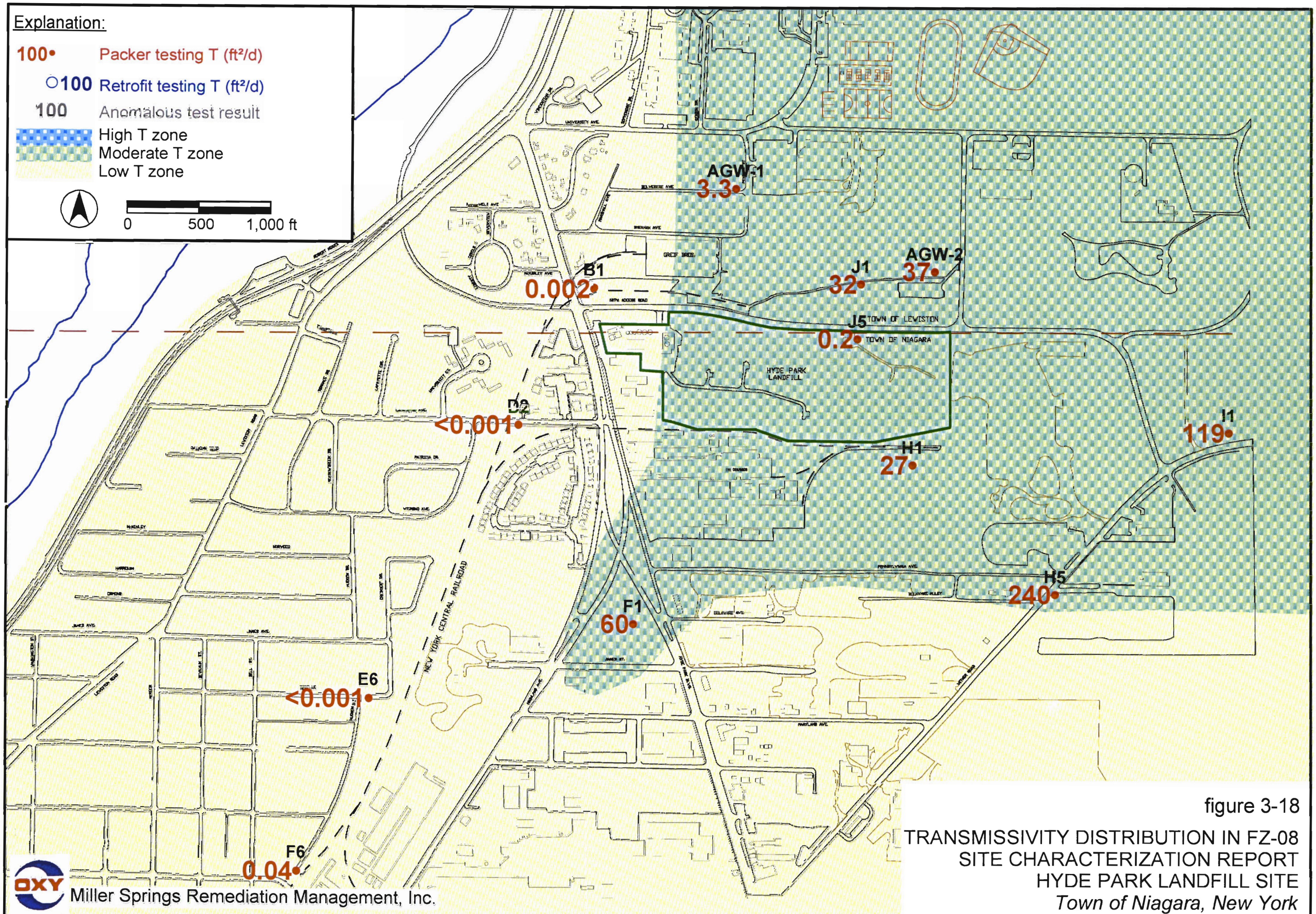

figure 3-18

TRANSMISSIVITY DISTRIBUTION IN FZ-08
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

OXY Miller Springs Remediation Management, Inc.

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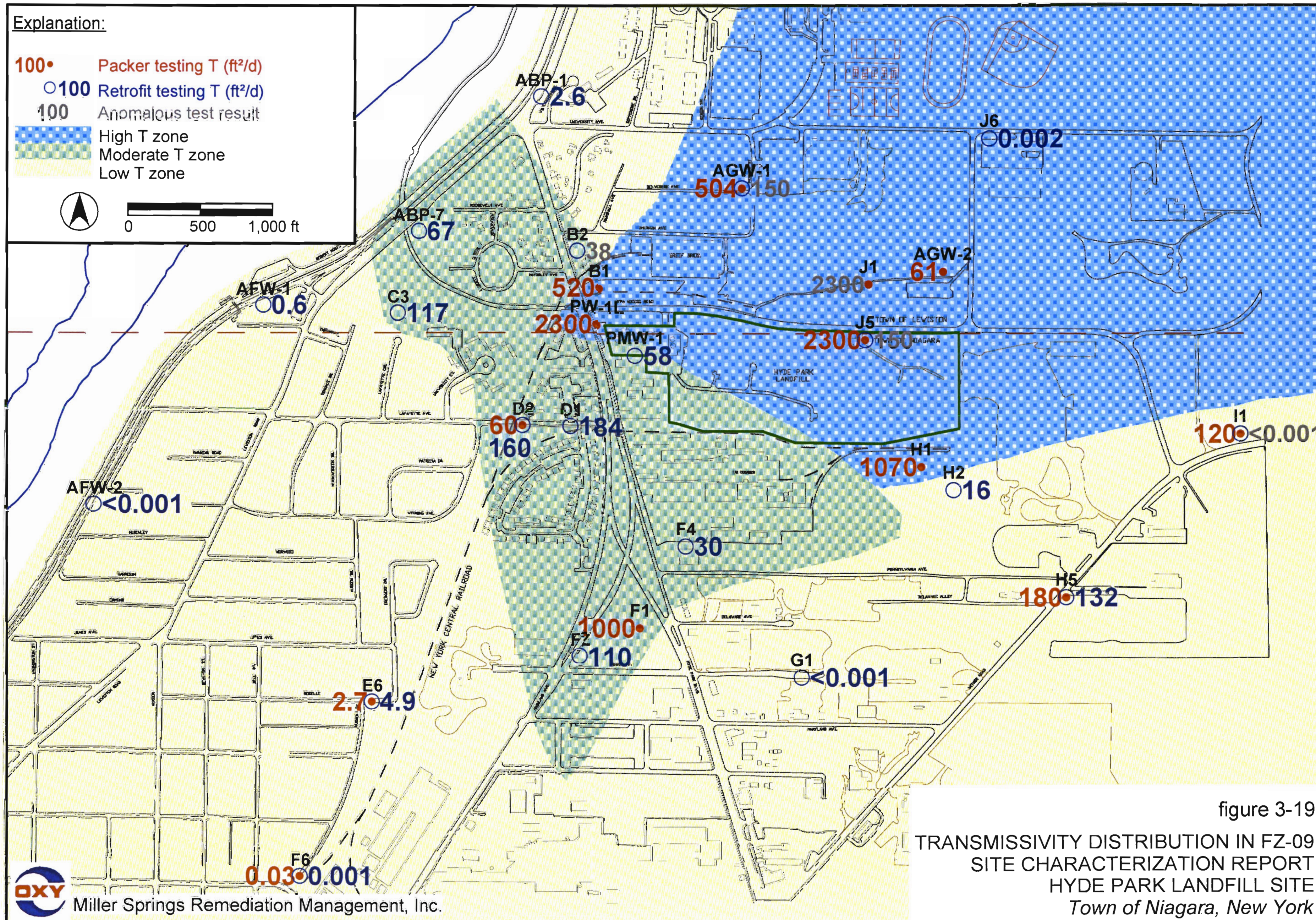

figure 3-19

TRANSMISSIVITY DISTRIBUTION IN FZ-09
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

OXY Miller Springs Remediation Management, Inc.

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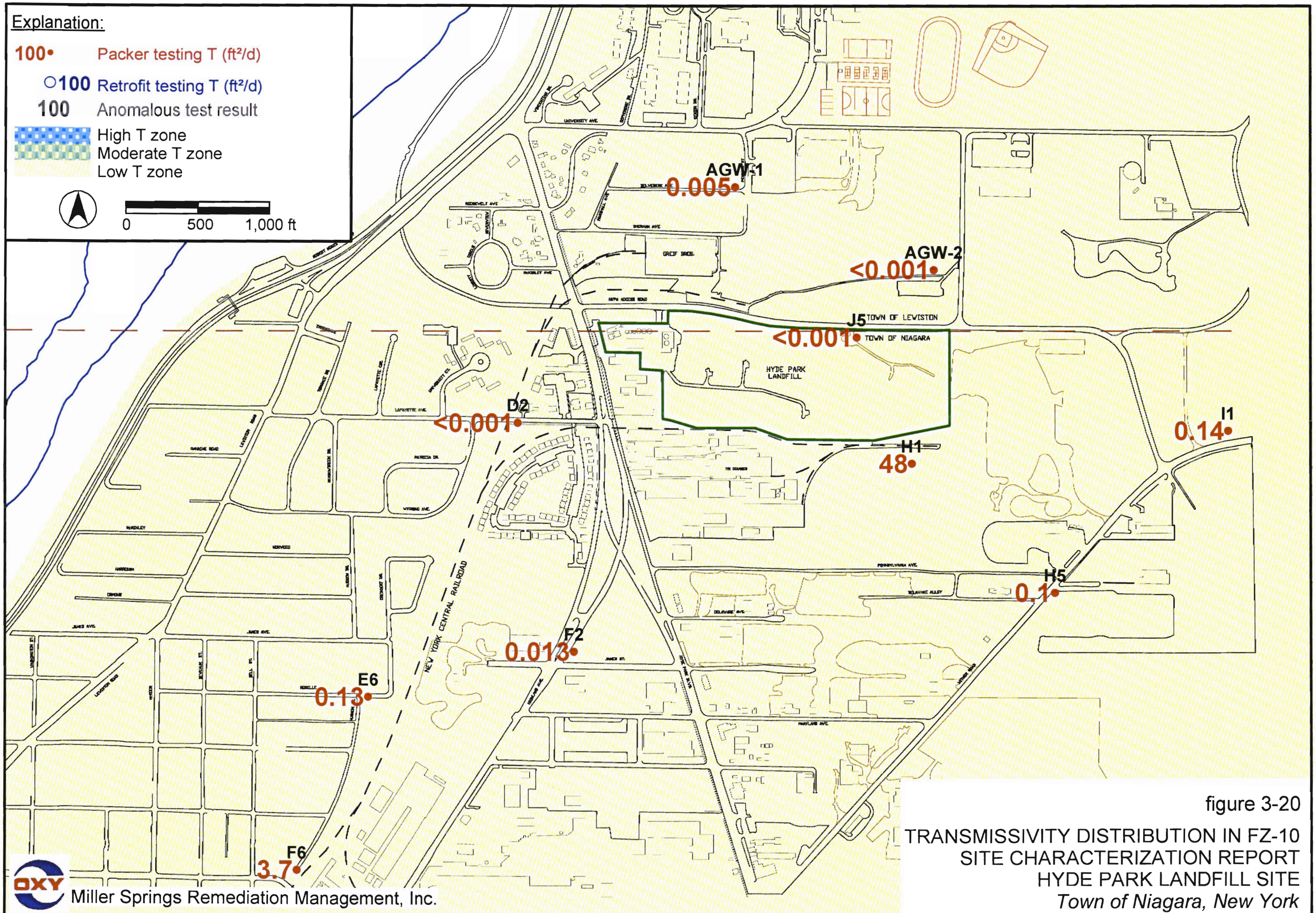

figure 3-20

TRANSMISSIVITY DISTRIBUTION IN FZ-10
SITE CHARACTERIZATION REPORT
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Town of Niagara, New York

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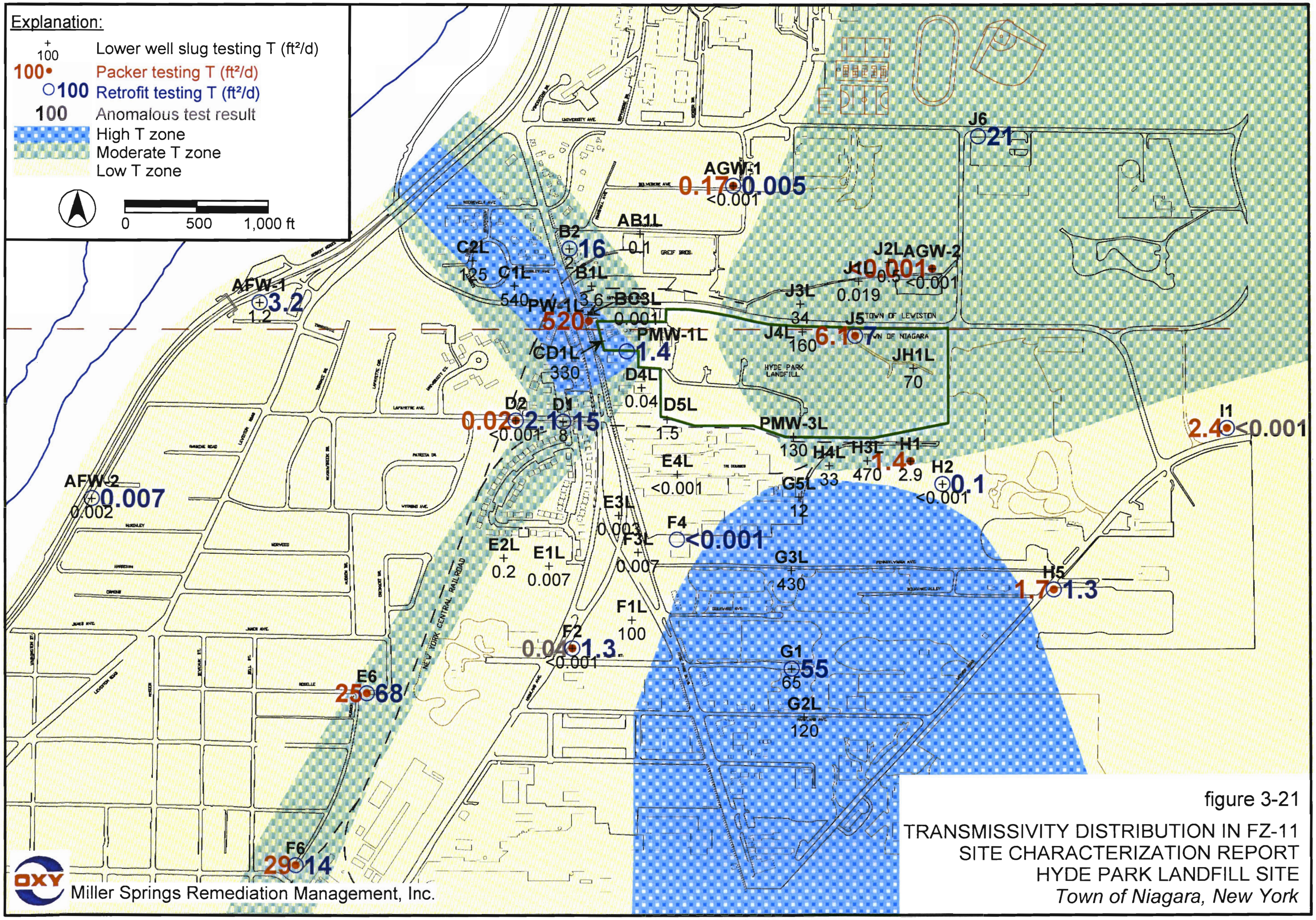

figure 3-21

TRANSMISSIVITY DISTRIBUTION IN FZ-11
SITE CHARACTERIZATION REPORT
HYDE PARK LANDFILL SITE
Town of Niagara, New York

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