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Alexander B. Grannis
Commissioner

May 11, 2010

Mr. Michael Liskowitz
ARS Technologies, Inc.
114 North Ward St
New Brunswick, NJ 08901

Re: Farrand Controls Site, 360046
Town of Mt. Pleasant, Westchester County
Phase II FEROX Injection Pilot Study

Dear Mr. Liskowitz:

The New York State Department of Environmental Conservation (Department), in conjunction with its consulting engineer, Dvirka and Bartilucci, has completed review of the December 2009 Revised Report of Results, Phase II FEROX Injection Pilot Study (Report) for the Farrand Controls site. The Report is hereby accepted. The final invoice for the outstanding portion of the mobilization cost may now be submitted to Precision Environmental Services, 831 Route 67, Lot 28, Ballston Spa, New York, 12020 for review for payment.

Please be advised that the Department has significant reservations about the conclusions drawn by ARS for the Pilot Study. Dvirka and Bartilucci has provided the Department with the attached comments on the Report, with which the Department is in agreement. Based on post-injection groundwater analyses, the iron injections simply did not provide sufficient contaminant degradation required to demonstrate technology effectiveness.

If you have any questions, you may contact me at (518) 402-9662.

Sincerely yours,

Karen Maiurano

Karen Maiurano
Project Manager
Division of Environmental Remediation

Enclosure

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Division of Environmental Remediation

April 14, 2010

Ms. Karen Maiurano
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233

RE: Farrand Controls Site
Zero-Valent Iron Pilot Study
Work Assignment D004446-19
D&B No. 2587-02

Dear Ms. Maiurano:

As discussed, we have reviewed the *Revised Report of Results, Phase II FEROX Injection Pilot Study* dated December 11, 2009 prepared by ARS Technologies, Inc. The report was revised based on comments provided to ARS Technologies, Inc. on the draft report dated March 2009. In general, the comments provided in our letter to ARS Technologies, Inc. dated May 8, 2009 were incorporated into the report; however, we have some final general comments with regard to ARS Technologies' conclusions presented in the final report.

The presentation of the Chlorinated Volatile Organic Compound (CVOC) Treatment Effectiveness in Section 9.0 of the report utilizes averaged concentrations to evaluate treatment effectiveness across the Ferox treatment cell. The average concentrations of individual VOCs from an upgradient well cluster were compared to the average concentrations of individual VOCs from a downgradient well cluster to determine percent reduction. This data is presented on Tables 3 and 4 of the report.

The use of averaged concentrations to evaluate percent reduction is a misrepresentation of the data. The contaminants of concern in the downgradient well cluster (MW-26S and MW-26D) were consistently low prior to and after injection. The contaminants of concern in the upgradient well cluster (MW-22S and MW-22R) were consistently high prior to and after injection. Therefore, the calculation of a percent reduction as presented in the report by ARS is biased high. For example, concentrations of Freon 113 in MW-22S ranged from 2,300 ug/l to 7,600 ug/l over the 9-month monitoring period. The four sampling events were averaged to obtain

4,000 ug/l as the "average" influent concentration of the Ferox treatment cell. The concentrations of Freon 113 in MW-26S ranged from 4.4 ug/l to 38 ug/l over the 9-month monitoring period. The four events were averaged to obtain 14.3 ug/l as the "average" effluent concentration of the Ferox treatment cell. Utilizing these "average" influent and effluent concentrations, ARS concluded that there was a 99% reduction in Freon 113 as it flowed through the treatment cell. This is simply not an accurate measurement of the effectiveness of the pilot study.

We understand that the concentrations of contaminants flowing into the system are constantly changing and therefore interpretation of the percent reduction of contaminants may be difficult to demonstrate. However, the implementation of this technology was intended to act as a treatment cell or wall that would be able to reduce influent concentrations of contaminants. The intent of the pilot study was to determine if the desired reduction could be achieved. Averaging contaminant concentrations in the wells over time does not allow for an appropriate evaluation of the data collected.

With regard to the conclusions presented in Section 10, Performance Evaluation, the report indicates that the actual treatment performance has been negatively impacted by the high pressure pneumatic fracturing of the soils in the treatment cell which created contaminant migration pathways. However, in Section 9.0, the report indicates an 80 to 95% averaged contaminant reduction. The report provides another contradictory statement in Section 10 when it states that the site geology and high groundwater table limited the full utilization of the fracturing. ARS proposed use of the fracturing to appropriately distribute the iron within the subsurface.

In addition, although the groundwater monitoring was performed by D&B, the data was provided to ARS Technologies, Inc. for their use and interpretation. D&B's data tables were not presented in the report and, therefore, the reader does not have the ability to evaluate the raw data and come to their own conclusions independently.

If you have any comments or questions, please do not hesitate to contact me at (516) 364-9890, Ext. 3060.

Very truly yours,

Maria Wright

Maria D. Wright
Project Manager

MDWt/j
cc: R. Walka (D&B)
♦2587\MDW10LTR.DOC-03(R01)

Report of Results
Phase II FEROX^{sm} Injection
Pilot Study

FARRAND CONTROLS SITE
VAHALLA, NEW YORK

Prepared for:

Dvirka and Bartilucci
330 Crossways Park Drive
Woodbury, New York
11797-2015

Prepared by:

ARS Technologies, Inc.
98 North Ward Street
New Brunswick, New Jersey 08901

March 16, 2009

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GLOSSARY

BGS	Below Ground Surface
cis-1,2-DCE	*cis*-1,2-Dichloroethene
COC	Contaminant of Concern
CVOC	Chlorinated Volatile Organic Compound
DO	Dissolved Oxygen
GPM	Gallons per Minute
ISCR	*In-Situ* Chemical Reduction
MCL	Minimum Concentration Limit
ND	Not detectable
ORP	Oxygen Reduction Potential
PCE	Tetrachloroethene
PF/LAI	Pneumatic Fracturing and Liquid Atomized Injection
PSI	Pounds Per Square Inch
ROI	Radius of Influence
TCE	Trichloroethene
VC	Vinyl Chloride

1.0 INTRODUCTION AND OVERVEIW

This report summarizes the results of a Ferox^{sm} Pilot Study implemented by ARS Technologies, Inc. (ARS) for Dvirka and Bartilucci Consulting Engineers, Inc. at the Farrand Controls Site (The Site) located in Vahalla, New York. The study was initiated to assess the effectiveness of Pneumatic Fracturing/Liquid Atomized Injection (PF/LAI) and In-Situ Chemical Reduction (ISCR) using ARS' patented Ferox^{sm} Zero Valent Iron (ZVI) Technology for the treatment of groundwater impacted with elevated concentrations of Chlorinated Volatile Organic Compounds (CVOCs). Results generated from the study will be used to determine the effectiveness and appropriate design parameters for procurement of a full-scale Ferox^{sm} injection system to intercept and treat dissolved phase CVOCs migrating offsite.

The Pilot Study test area comprised of a 60 long by 40-foot wide treatment grid located down-gradient of a suspected source area and centered on monitoring well cluster MW-28S and MW-28D. A total of twelve (12) Ferox^{sm} injection borings were proposed to be centered around the two aforementioned monitoring wells to emplace and adequately distribute 45,000 pounds of a propriety blend of HCA High Purity Cast and High Carbon Atomized ZVI material (HC-15.) This amount of iron roughly represents 0.91% of the geological material mass within the treatment zone and approximately 6,100 times the mass of existing total CVOC mass.

Ferox^{sm} field injection operations at the Site were performed from November 24 through and December 15, 2008. Ferox^{sm} injection depths varied based upon where bedrock was encountered. A detailed summary of the injection depths and corresponding intervals are provided in later sections of this report.

A ZVI dosage of 0.91% relative to soil mass was targeted to meet the treatment objective goals for the Pilot Test. This dosage was based on the following factors; 1) Treatability Study and initial Pilot Study data, 2) Targeted VOC mass within the treatment cell, 3) Groundwater geochemical parameters specific to the wells within and around the treatment cell and 4) hydraulic conductivity values and groundwater velocity within the treatment cell.

All aspects of the Pilot Study were conducted in accordance with Dvirka and Bartilucci's Scope of Work, dated May 15, 2008.

2.0 SITE AND PILOT STUDY BACKGROUND

The Site is currently owned and operated by Farrand Controls, Inc and is an active electronic component manufacturing facility. The site is approximately 6 acres in size. Site investigations have revealed the site groundwater to be impacted with elevated levels of (VOCs), including trichlorothene (TCE), cis-1, 2-dichloroethene (cis-DCE), trans-1, 2-dichloroethene (trans-DCE), vinyl chloride (VC) and 1,1,2-trichloro-1, 2,2-trifluoroethane (Freon-113).

Most of the Farrand Controls Site is underlain by unconsolidated composites consisting of fine to medium-grained sands containing some gravel and silt. Groundwater has been reported at a depth of 5 feet bgs.

3.0 TECHNOLOGY BACKGROUND

The PF/LAI process has been demonstrated to be an effective method for injecting liquids and/or slurries uniformly within all types of geology. The Ferox^{sm} process is a proprietary process developed by ARS involving the use of highly reactive Zero Valent Iron (ZVI) to chemically reduce contaminants in-situ. Use of ZVI has become accepted as an effective means of environmental remediation. It is inexpensive, easy to handle and effective in treating a wide range of chlorinated compounds or heavy metals. It has been widely applied in-situ or as part of a controlled treatment process in wastewater and/or drinking water applications.

A critical component of ARS' injection process is ensuring that the reactive media is distributed effectively within the subsurface to facilitate the desired chemical reactions. To accomplish this distribution, ARS incorporates its gas-based PF/LAI technologies for the emplacement of reactive media. LAI relies upon the theory that it is more effective to inject gases or "aerosols" into the subsurface than it is to inject an incompressible liquid into the subsurface. Depending upon the permeability or heterogeneities within the targeted geologic zone, PF may be integrated as a precursor to LAI of a reactive media.

3.1 Pneumatic Fracturing

PF is a patented process in which a gas is injected into the subsurface at pressures that exceed the combined overburden pressure and cohesive soil strength of the geologic matrix, and at flow rates that exceed the effective permeability of the undisturbed soil. The result is the propagation of fractures outward from the injection well to various distances depending upon the geology. Fracture propagation distances of 30 - 60 feet are common in rock formations. Unconsolidated materials such as silts and clays typically exhibit fracture propagation distances of 20 - 40 feet. PF can serve as a critical component for many *in-situ* treatment processes since it allows for an effective permeability enhancement of the geologic matrix while reducing geologic heterogeneities within the subsurface.

3.2 Ferox^{sm} Treatment Technology

The Ferox^{sm} process involves the controlled injection and dispersion of specific quantities of highly reactive ZVI into saturated or unsaturated contaminant zones within individual soil borings. This patented technology represents a significant advancement from the conventional Permeable Reaction Barrier technology since the Ferox^{sm} process relies on a passive, non-disruptive, innovative injection methodology (PF/LAI) in combination with a proprietary ZVI powder product emplaced within the subsurface. Numerous field applications of the technology have been shown to effectively treat halogenated organic compounds, and/or leachable heavy metals in a wide range of geologic formations at any depth.

ARS' ZVI is a proprietary highly reactivity powder exclusively manufactured for ARS. Directly reduced from iron ores, it contains no trace elements at toxic levels that may be found in waste iron stocks from which conventional iron filings used in PRBs originate. As a result of its production process, ARS' ZVI contains internal porosities, which greatly enhance its surface area and, therefore, reactivity. Carbon molecules and other inclusions found within its structural matrix (not as a separate phase), have been theorized to further enhance its reactivity exceeding that of similar sized cast iron powder.

Physical characteristics of a soil will typically govern the emplacement mechanism of the ZVI powder. These mechanisms, which are presented in Figure 1, can be characterized into three categories; dispersion, fluidization, or fracture filling. In porous materials such as gravel, the injection of iron powder will result in the dispersion around soil or rock particles, and will travel as far as the gas carrying the particle maintains enough energy to keep it from settling. In loose sand deposits, the injection of high volumes of gas and slurry will result in local fluidization of the formation causing iron particles to get "mixed" within the soil matrix. In more cohesive soils such as clays and silts, the high volume/pressure injections will result in PF of the formation. The emplacement of iron will be governed by the flow of gas in the fractures and the iron particles will settle as the kinetic energy decreases. In field applications of the injection process, iron powder emplacement within a geologic formation will typically exhibit more than one of these mechanisms.

4.0 INJECTION WELL INSTALLATION AND LAYOUT

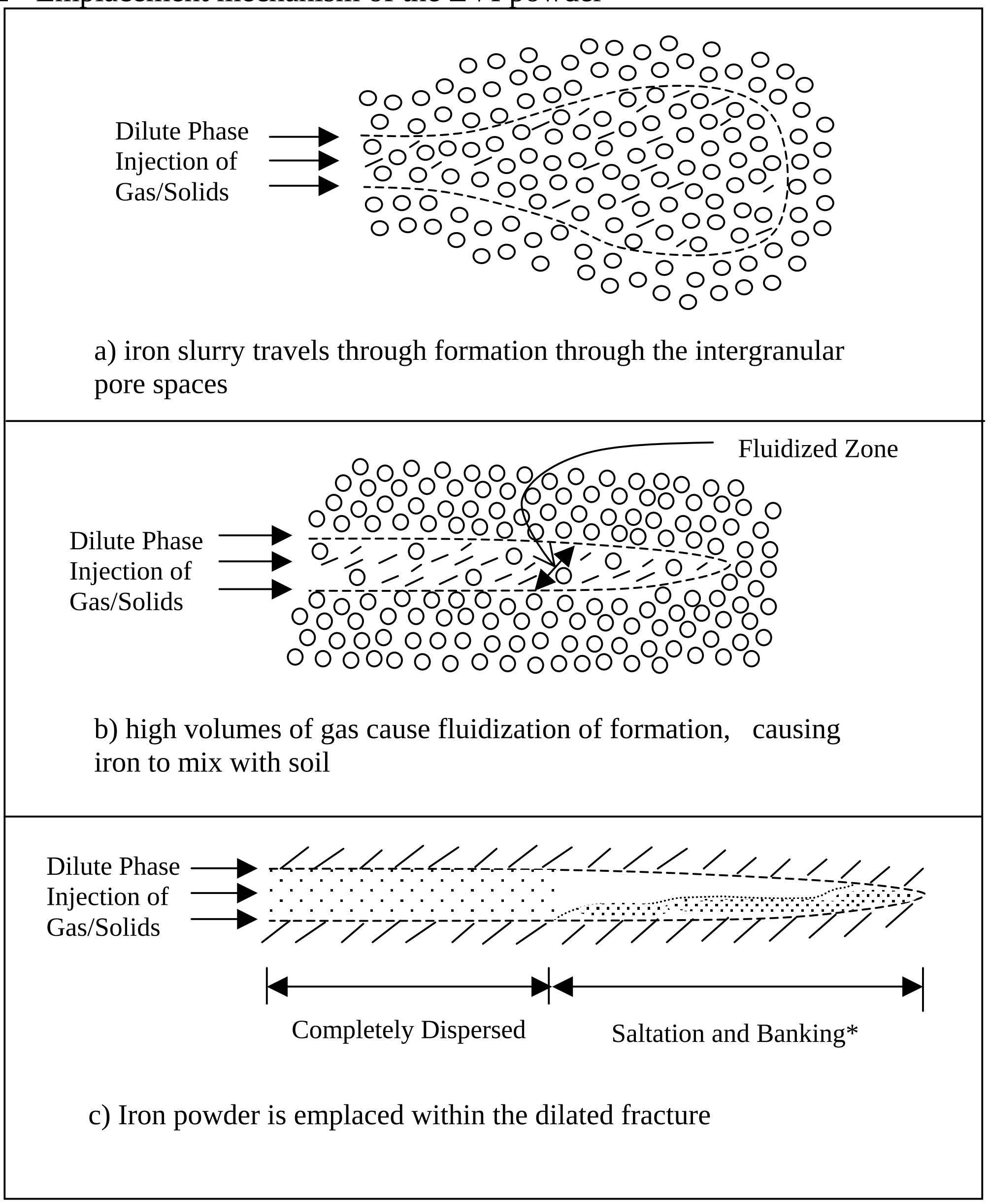
Emplacement of the ZVI in the designated treatment grid was accomplished through the installation of twelve (12) temporary Injection Points (IP) and two (2) offset locations utilizing direct push drilling technology. ARS performed all drilling related activities at the site under its current New York State Drilling license. The target treatment depths were accessed through the advancement a 4.5-inch drill casing. With the exception of 1 location (IW-7) the target depths were achieved to the bedrock interface. Under circumstances whereby the target injection depths could not be attained due to the likely presence of cobbbles, an offset drilling point was selected and subsequently drilled with minimal difficulty. Figure 1 shows the locations of the borings and associated offsets.

5.0 INJECTION PROCEDURES AND PARAMETERS

This section summarizes the procedures and parameters monitored during the injection operations. The parameters discussed below can be used as a confirmatory measure on whether fractures and/or ZVI was successfully propagated within the targeted intervals and whether regions of the site have been favorably impacted by the Ferox^{sm} injections.

In general, the equipment used for the PF process consists of a skid mounted fracture module complete with an injection control manifold and a digital data logger used to monitor various operational parameters. Due to the large quantity of compressed gas needed for fracturing and liquid injections, ARS used pressurized nitrogen as the fracturing fluid. A bulk nitrogen "tube" trailer was mobilized to the site for this operation.

Figure 1 - Emplacement mechanism of the ZVI powder



- Saltation – the leaping or erratic movement of particles as they are transported in a fluid through a pore throat and/or fracture.
- Banking – The temporary deposition and gradual migration of particles as they are transported in a fluid through a pore throat and/or fracture.

5.1 Pneumatic Fracturing Operations

Where appropriate and applicable, PF serves as a precursor to the Ferox^{sm} injections. Fracturing consisted of applying pressurized nitrogen for approximately 10 to 15 seconds within the designated 36-inch injection interval. Selection of the 36-inch injection interval was specifically based on the down-hole assembly configuration and the vertical dispersion patterns of the nozzles utilized for the Pilot Study. Upon completion of the PF injection, the Ferox^{sm} injections are initiated. This approach was then repeated for each subsequent injection interval prior to the Ferox^{sm} injections. The compressed nitrogen was routed through the fracture modules' control manifold, which was connected by a high-pressure hose to a proprietary injector.

During each injection, data parameters including pneumatic pressure influence at surrounding monitoring points, ground surface heave measurements and visual field observations are recorded. Additionally, the pressure in the injection interval is logged electronically using a pressure transducer and data logger system for later analysis and evaluation. The following section describes in detail the data parameters that were collected during the PF process at the Site.

5.1.1 Injection Initiation and Maintenance Pressures

For each injection, the pressure in the fracture interval is recorded by a pressure transducer located in-line within the conduit leading to the injection nozzle. These pressures are recorded by a data logging system located on the injection module and accessed using a lap top computer. By comparing the magnitude and shape of the pressure-history curve to previously collected curves in similar geology, an assessment of fracture propagation is made. This information allows one to evaluate if fracturing resulted and two critical measurements; the fracture initiation pressure and the fracture maintenance pressure. The recorded fracture maintenance pressure is an average over the propagation time.

5.1.2 Pressure Influence at Adjacent Wells

Evaluation of pressure influence data collected during PF operations can provide a reasonable assessment on the extent of fracture propagation. During the injections, pressure influence was measured at target wells using calibrated pressure (psi) gauges and pressure transducers. Each pressure gauge is outfitted with a drag arm indicator that records the maximum pressure detected at the monitoring point during the injection. The pressure transducers were setup up to monitor specific wells within the pilot test area and consisted of Hermit data logger fitted with in-line pressure transducers manufactured by In Situ Inc. Model Number PXD-261.

The analysis of pressure response at various locations around an injection point can provide supplemental real-time evidence that fracture and/or material propagation occurred. This data also assists in determining which directions fractures and the subsequent reagent may have propagated. In addition, the degree of pressure response can often help determine whether a monitoring point has been directly influenced (i.e. fractures propagate outward and intersect wells or boreholes), or indirectly influenced (i.e. existing pathways such as naturally occurring or induced fractures are dilated). Minimal pressure response in monitoring wells located close to the injection point may indicate that fluidization and significant gas dispersion is occurring.

A total of five wells were monitored for pressure influence during the fracturing and Ferox^{sm} injections. The wells selected for monitoring facilitated the evaluation of pressure influence with respect to lateral and vertical propagation. Through the duration of the pilot study, care was taken to ensure that the deep and shallow wells were monitored accordingly correlating the injection intervals with the appropriate monitoring well screen depth.

The pressure influence data is provided and in graphical format in Appendix B. For clarification, it should be noted that the data presented pressure at the surrounding monitoring points over the duration of the injection.

5.1.3 Ground Surface Heave

Ground surface heave monitoring was conducted during the initial pneumatic fracturing injections using surveying transits in conjunction with a heave rod. The heave rod was placed within 5 feet of the injection point. During each injection event, the rod is observed for the maximum amount of upward motion (surface heave). Where no other means of propagation monitoring, such as an established monitoring well network, ground surface heave monitoring can provide additional information that can be used to assess the distances and orientation of injection fluid propagation.

5.2 Ferox^{sm} Injection Operations

When applicable, the Ferox^{sm} powder is injected into the subsurface utilizing a nitrogen gas stream integrated with a high-pressure, high-flow injection manifold. The manifold system provides accurate injection pressures, which enables ARS to achieve the optimal dispersion of iron powder. The ZVI slurry was fed into the gas stream from a proprietary mixing trailer that keeps the iron in suspension by continual circulation of the slurry. The ZVI slurry was delivered into the nitrogen stream through a series of high-pressure diaphragm pumps. Once sufficiently mixed, the ZVI/nitrogen blend is routed through a proprietary injector. Injections were performed in approximately 36-inch intervals.

5.3 Injection Monitoring

During the injection process, the quantity of material was recorded after each injection. For the Ferox^{sm} slurry injections, each batch was specifically mixed within the holding tank and subsequently injected, ensuring accurate mass loading rates.

As with PF, data parameters including the injection pressure and pressure at adjacent wells were recorded. These parameters are discussed in the previous section.

6.0 SUMMARY OF FIELD IMPLEMENTATION

Ferox^{sm} field injections were initiated on November 25, 2008 and were completed on December 15, 2008. The target vertical treatment intervals varied from north to south within the treatment grid due to the presence of a steeply sloping bedrock gradient. Due to the inherent variability in bedrock depth, ZVI dosages were adjusted accordingly to account for larger vertical treatment intervals. As a result, Ferox^{sm} ZVI dosages varied on a per borehole basis.

Where deemed applicable, PF was applied prior to the Ferox^{sm} injections. This approach was implemented in an attempt to increase the bulk permeability of the weathered rock and/or fine-grained site soils through the creation of a fracture network within the targeted treatment zones. The sequence of injection borings and successfully completed treatment depths were as follows:

IW-2 (9.5 – 38 ft bgs)
IW-4 (13.5 – 35 ft bgs)
IW-12 (6.5 – 26.0 ft bgs)
IW-1 (18.0 – 33.0 ft bgs)
IW-10 (6.5 – 17.5 ft bgs)
IW-8 (14.5 – 31.5 ft bgs)
IW-6 (9.0 – 35.0.0 ft bgs)
IW-11 (9.0 – 17.0 ft bgs)
IW-5 (10.5 – 30.5 ft bgs)
IW-7 (11.5 – 31.5 ft bgs)
IW-9 (8.0 – 20.0 ft bgs)
IW-3 (11.5 – 34.5 ft bgs)
IW-4 offset (9.0 – 15.0 ft bgs)
IW-1 offset (9.0 – 18.0 ft bgs)

In some instances, the targeted treatment intervals for specific wells could not be addressed due to significant daylighting of gas and formation water in and around existing monitoring wells and/or abandoned borings. In general, minimal daylighting was observed within the deeper injection intervals suggesting the additional stresses imposed by the overburden weight and geologic makeup of the strata favored lateral propagation of the reactive ZVI slurry.

At the Farrand Controls Site, injection pressures of 10 to 185 psi were required to initiate gas flow and distribute ZVI within the subsurface. In general, once the initial flow of gas into the formation was achieved, gas maintenance pressures matched the initial injection pressure.

The injections were performed in discrete 36-inch intervals. Table 1 summarizes the injection parameters recorded during the injections operations. These parameters represent the actual field measurements recorded by ARS during the injection operations. The relevance of the data presented in Table 1 is discussed in later sections of this report.

Data parameters presented in Table 1 included the 1) Discrete injection interval, 2) Start time 3) Nitrogen gas injection pressures 4) Surface Heave 5) Slurry Injection pressure 6) Mass of iron injected 7) Water volume mixed and 8) Total volume of slurry injected.
The pressure-history curves for each injection are presented in Appendix A of this report. A more detailed description of the pressure-history specific to each boring and corresponding injection intervals is presented in the sections below.

6.1 Injection Point IP-2 Summary

Injection Point IP-2 was situated along the southern down-gradient row of the Ferox^{sm} treatment cell and was the first boring to be addressed. The bedrock interface at this location was encountered at a depth of 38 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Only the deepest interval (36.5-38.0 feet bgs) was pneumatically fractured due to the continual presence of heaving sands encountered within the remaining nine intervals. This was confirmed through the occurrence and removal of sand from injection nozzle as subsequent intervals were addressed. For the first five (5) intervals, gas was slowly introduced into the formation until flow of gas was established within the targeted interval. Under circumstances whereby daylighting became significant (intervals 6 – 10), minimal gas was used and distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical treatment interval of 28.5 feet was treated (9.5 – 38 feet) resulting in the emplacement of 4,050 lbs of ZVI and corresponding iron to soil treatment ratio of 0.65%. A total of 1500 ft^3 of nitrogen was consumed during the injections at IW-2. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. During the gas injection, nitrogen flowrates averaged 800 Standard Cubic Feet per Minute (SCFM). Under circumstances where daylighting around abandoned borings and/or monitoring points was significant, minimal amounts of gas were applied and the ZVI was hydraulically delivered using a series of high-pressure pumps.
During the injections at IW-2 daylighting was encountered during the fifth interval (24.5 – 27.5 ft bgs) consisting of groundwater and ZVI slurry approximately 15 feet away to the east of IW-2. The daylighting persisted for the remaining five (5) intervals.

<u>Injection Initiation and Maintenance Pressures</u>:

The Pressure-History Curves representing Intervals 1 through 5 are presented in Appendix A. These graphs represent the real time logging of the nitrogen gas injection pressure coupled with the ZVI slurry injections overtime. The pressure curves for Interval 6 – 10 were not collected since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. The overall extent of daylighting within intervals 6 – 10 inhibited the use of gas as a delivery mechanism.

Figure FC2-1F in Appendix represents a moderate pneumatic fracturing response with discernable initial rounded peak or initiation pressure (185 psi) followed by a drop in pressure or maintenance pressure (125 psi) representing the pressure at which gas is flowing into the formation. Pressure-History curves of this nature suggest the presence of clayey sand with moderate cohesive stresses.

The remaining graphs represent pulsed atomized injections with general flat-lined pressure response typically indicative of a soil fluidization having no discernable characteristics of a fracture event. This is substantiated through the lack of a distinct pressure peak during early times of the injection events. No discernible pressure peak serves as a direct indicator that fractures were not generated and pore space dilation served as the primary delivery mechanism as illustrated in Figure 1. Typically, pressure responses of this nature suggest the presence of sands or non-cohesive materials permeable enough to readily accept the influx of gas.

The rapid spikes depicted on the curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. It is important to note that these pressure spikes during the ZVI injection are not related to the pressure peaks associated with fracture event. Pneumatic fracturing and the subsequent injection of a reagent (ZVI) are two independent events. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox injections at IW-2. For the first seven (7) injection intervals (18.5 – 38 feet), deep wells MW23D, MW24D, MW-25D, MW26D and MW28D were monitored for pressure influence. During the remaining 3 injection intervals (9.5 – 18.5 feet), shallow wells MW23S, MW24S, MW25S, MW26S and MW28S were monitored.

Pressure response depicted for Interval 1 represents the surrounding monitoring wells response to a pneumatic fracturing event. An immediate and almost instantaneous response is observed at wells MW26D and MW28D, which served as the closest wells within the vicinity of injection boring IW-2. The rapid pressure decline identified on the figure represents gas dissipation following the 10-second fracture event. More notably, both pressure responses at wells MW-26D and MW28D were nearly identical in magnitude (6 psi) confirming uniform pressure propagation, at a minimum, in a north-south direction.

During the Ferox^{sm} injection operations at Interval 1 (Graph FC1-1I), pressure influence correlated with both monitored wells directly influenced by the fracture event. More notably, Figure MW2-1I identified direct responses to the pulsed injections showing incremental pressure increase in response to the LAI. A consistently higher pressure response at up-gradient well MW28D located towards the center of the Ferox^{sm} treatment grid seems to indicate preferential influence and/or propagation up the bedrock interface where reduced overburden stress due to depth are present.

In general, pressure influence was limited to wells MW23D, MW25D, MW26D and MW28D. Measurable pressure influence was not observed at the remaining wells, which were situated outside the targeted 10 foot Radius of Influence (ROI). Shallow monitoring wells monitored during shallow injections (9.5 – 18.5 foot interval) showed minimal pressure influence in response to hydraulic injections. The lack of pressure response at the closest wells (MW-26S and MW-28S) could likely be attributed to preferential influence towards the daylighting location located 15 feet to the east of IW-2.

Surface Heave:

Initial surface heave measurements were recorded during the first five injection intervals. A heave of 0.5 inches was observed adjacent to the wellhead. As the field operations progressed and the injection intervals became more shallower visual heave exceeding 1 inch was observed.

6.2 Injection Point IP-4 Summary

Injection Point (IP- 4) was located within the southern down-gradient row of the Ferox^{sm} treatment cell and was the second boring to be addressed. The bedrock interface at this location was encountered at a depth of 35 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Only the deepest interval (33.5 – 35 ft bgs) was pneumatically fractured due to potential daylighting concerns.

LAI was applied within the deepest two intervals. For the second interval, gas was slowly introduced into the formation until flow of gas was established within the targeted interval. Under circumstances whereby dalylighting became significant, minimal gas was used and distribution of the ZVI slurry was accomplished via hydraulic injection. For the remaining six (6) intervals LAI was not applied due to dalylighting concerns.

A total vertical interval of 21.5 feet was treated (13.5 – 35 feet) resulting in the emplacement of 3,879 lbs of ZVI and corresponding iron to soil dosage ratio of 0.83%. Flowing sands within the deepest interval (33.5 – 35 feet bgs) prevented the target dosage from being achieved resulting in emplacement of 50% of the ZVI dosage. As a result, the remaining ZVI dosage of was injected into Interval 2.

A total of 1000 ft^3 of nitrogen was consumed during the injections at IW-4. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where gas was applied for PF/LAI, nitrogen gas flowrates averaged 700 SCFM. Under circumstances where daylighting around abandoned borings and/or monitoring points was significant, minimal amounts of gas were applied and the ZVI was hydraulically delivered using a series of high-pressure pumps.

During the injections at IW-4 occurrence of daylighting was sporadic around the well annulus of MW26D and MW26S during the third interval and eighth interval where significant daylighting occurred warranting the termination of the injection at this location.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Intervals 1 through 2 are presented in Appendix A. These graphs represent the real time logging of the nitrogen gas injection pressure coupled with the ZVI slurry injections overtime. The pressure curve for interval 3 was not collected since due to field computer malfunction. Pressure data was not collected for the remaining 7 intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. The overall extent of daylighting within intervals 4 – 10 inhibited the use of gas as a delivery mechanism.

Figure FC4-1F in Appendix A represents a flatline pressure response with no discernable peak or initiation pressure. This flat-lined pressure response is typically indicative of a soil fluidization having no discernable characteristics of a fracture event. This is substantiated through the lack of a distinct pressure peak during early times of the injection events. No discernible pressure peak serves as a direct indicator that fractures were not generated and pore space dilation served as the primary delivery mechanism as illustrated in Figure 1. Typically, pressure responses of this nature suggest the presence of sands or non-cohesive materials permeable enough to readily accept the influx of gas.

The rapid spikes depicted on the ZVI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. It is important to note that these pressure spikes during the ZVI injection are not related to the pressure peaks associated with fracture event. Pneumatic fracturing and the subsequent injection of a reagent (ZVI) are two independent events. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox^{sm} injections at IW-4. For the first seven (7) injection intervals (16.5 – 35 feet), deep wells MW23D, MW26SD, MW-26D, MW27 and MW28D were monitored for pressure influence. During the remaining 1 injection interval (13.5 – 16.5 feet), wells MW23S, MW26S, MW26D, MW27 and MW28S were monitored.

Pressure response depicted for Figure MW4-1F (Interval 1) represents the surrounding monitoring wells response to a pneumatic fracturing event. An immediate pressure response is observed at the wells MW26D and MW27D, which served as the closest wells within the vicinity of injection boring IW-4. A slight pressure response was also observed at well MW28D. The rapid pressure decline identified on the figure represents gas dissipation following the fracture event.

During ZVI injection operations (Interval 2–4), pressure influence correlated with the monitored wells directly influenced by the fracture event. During injections at interval 2 (Graph 3), a rapid pressure drop within Well MW26S is observed towards the end of the injection correlating with the annulus daylighting observed during subsequent intervals. As a result of the well seal being breached, pressure influence at Well MW26D was not observed for the remaining injections.

In general, pressure influence was observed in wells MW26D, MW27 and MW28D. Shallow monitoring wells (MW26S) monitored during shallow injections (13.5 – 16.5 foot interval) showed a pressure response to the injections. Minimal influence was observed at wells MW23S and MW28S in response to hydraulic injections. The lack of significant pressure response at the closest wells could likely be attributed to preferential influence towards the daylighting location around well MW26S.

Surface Heave:

Initial surface heave measurements were recorded for the first fracturing event. No heave was observed. Additional heave measurements were not collected since no additional fracturing was attempted.

6.3 Injection Point IP-12 Summary

Injection Point IP-12 was located within the northern up-gradient row of the Ferox^{sm} treatment cell and was the third boring to be addressed. The bedrock interface at this location was encountered at a depth of 26 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Only the deepest interval (24.5 – 26 ft bgs) was pneumatically fractured due to potential daylighting concerns. Pulsed nitrogen injections were applied in the deepest interval only to minimize the potential for daylighting. Within the remaining intervals distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 19.5 feet was treated (6.5 – 26 feet) resulting in the emplacement of 3,955 lbs of ZVI corresponding iron to soil dosage ratio of 0.93%.

A total of 750 ft^3 of nitrogen was consumed during the injections at IP-12. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 700 SCFM.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Fracture Interval 1 are presented in Appendix A. Pressure data was not collected for the remaining six (6) intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. No daylighting was encountered.

Figure FC12-1F represents a moderate pneumatic fracturing response with discernable initial peak or initiation pressure (105 psi) followed by a drop in pressure or maintenance pressure (30 psi) representing the pressure at which gas is flowing into the formation. Pressure-History curves of this nature suggest the presence of weathered rock and/or more competent fine-grained deposits.

The rapid spikes depicted on the ZVI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation. LAI pressures during the pulsing were relatively consistent ranging between 65 and 75 psi. Between pulses, when gas was not applied, hydraulic injection pressures ranged between 18 and 25 psi.

<u>Pressure Influence at Adjacent Monitoring Wells:</u>

A total of five (5) wells were monitored during the Ferox^{sm} injections at IW-12. For the first seven (7) injection intervals (16.5 – 35 feet), deep wells MW23S, MW23D, MW26D, MW27 and MW28D were monitored for pressure influence. During the eight interval (13.5 – 16.5 ft bgs), wells MW23S, MW26S, MW26D, MW27 and MW28S were monitored.

Significant pressure influence of 9.0 psi was observed at monitoring well MW23D which was situated closest to IW-12. During the Ferox^{sm} injections at intervals 1 through 6, MW23D showed a consistent but diminishing pressure response as shallower intervals were addressed. More notably, pressure influence at well MW23D (Interval 1) mirrored the LAI pulsing at IW-12 suggesting propagation of the gas and ZVI via an induced fracture network intersecting well MW23D. This type of response has been observed at sites whereby induced fracture networks could be established facilitating distribution of the reagent within the fracture network. Decreasing pressure responses with shallower injection depths can likely be attributed to the presence of more permeable sand deposits with tend to dissipate the gas/ZVI slurry rendering pressure influence as more of a mounding response (Interval 2 through 6).

In general, minimal pressure influence was observed at the remaining wells monitored, which all were outside the target ROI.

<u>Surface Heave:</u>

Initial surface heave measurements were recorded for the first fracturing event. No heave was observed. Additional heave measurements were not collected since no additional fracturing was attempted.

6.4 Injection Point IP-1 Summary

Injection boring 1 was located within the southern down-gradient row of the Ferox^{sm} treatment cell and was the fourth boring to be addressed. The location was offset approximately 5 feet to the north to minimize impacting MW17SD. The bedrock interface at this location was encountered at a depth of 33 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Only the deepest interval (31 – 33 ft bgs) was pneumatically fractured due to potential daylighting concerns. Pulsed nitrogen injections were applied in the two deepest intervals only to minimize the potential for daylighting. Within the remaining intervals distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 15 feet was treated (18 – 33 feet) resulting in the emplacement of 2,425 lbs of ZVI corresponding iron to soil dosage ratio of 0.74%.

A total of 950 ft^3 of nitrogen was consumed during the injections at IW-1. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 800 SCFM.

<u>Injection Initiation and Maintenance Pressures:</u>

The Pressure-History Curves representing Intervals 1 an 2 are presented in Appendix A. Pressure data was not collected for the remaining three (3) intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. Daylighting in the form of groundwater and ZVI slurry around the injection boring annulus was encountered and the borehole had to be abandoned following completion of the fifth interval.

Figure FC1-1F represents a moderate pneumatic fracturing response with discernable initial rounded peak or initiation pressure (130 psi) followed by a drop in pressure or maintenance pressure (40 psi) representing the pressure at which gas is flowing into the formation. Pressure-History curves of this nature suggest the presence of moderately cohesive fine-grained deposits.

The rapid spikes depicted on the ZVI injection curves 1 and 2 represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation. LAI pressures during the pulsing were relatively consistent ranging between 65 and 75 psi. Between pulses, when gas was not applied, hydraulic injection pressures ranged between 18 and 25 psi.

<u>Pressure Influence at Adjacent Monitoring Wells:</u>

A total of five (5) wells were monitored during the Ferox^{sm} injections at IW-1. For the five (5) injection intervals (18 – 33 feet), deep wells MW24S, MW25D, MW26D, MW28S and MW28D were monitored for pressure influence. The data is presented in Appendix B.

All of the monitoring wells gauged for pressure influence were outside the targeted 10 foot ROI and therefore only registered minimal pressure responses (< 1 psi) from the injections at IW-1.

6.5 Injection Point IP-10 Summary

Injection Point IP-10 was located within the northern up-gradient row of the Ferox^{sm} treatment cell and was the fifth boring to be addressed. The bedrock interface at this location was encountered at a depth of 17.5 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Fracturing applied within the deepest interval and was not attempted within any of the remaining intervals due to potential day-lighting concerns.

Pulsed LAI was only applied within the deepest interval (15.5 – 17.5 ft bgs) due to potential daylighting concerns. The remaining intervals distribution of the ZVI slurry was accomplished via hydraulic injection. A total vertical interval of 11 feet was treated (6.5 – 17.5 feet) resulting in the emplacement of 2,260 lbs of ZVI corresponding iron to soil dosage ratio of 0.95%.

A total of 700 ft^3 of nitrogen was consumed during the injections at IP-10. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 800 SCFM.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Interval 1 are presented in Appendix A. Pressure data was not collected for the remaining three (3) intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. Minor groundwater daylighting was encountered at several locations 5 feet from the injection point.

Figure FC10-1F represents a flatline pressure response with no discernable initial peak or initiation pressure. A pressure of 70 psi was required to initiate flow within the formation.

The rapid spikes depicted on the ZVI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation. LAI pressures during the pulsing ranged between 50 and 75 psi. Between pulses, when gas was not applied, hydraulic injection pressures ranged between 20 and 25 psi.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox^{sm} injections at IW-10. For the first three (3) injection intervals (12.5 – 17.5 feet), wells MW23D, MW24D, MW25D, MW28S and MW28D were monitored for pressure influence. During the remaining two intervals (6.5 – 12.5 ft bgs), wells MW23S, MW24S, MW25D, MW28S and MW28D were monitored. The data is presented in Appendix B.

All of the monitoring wells gauged for pressure influence were outside the targeted 7.5 foot ROI and therefore only registered minimal pressure responses (< 1 psi) from the injections at IW-1.

Surface Heave:

Initial surface heave measurements were recorded for the first fracturing event. No heave was observed. Additional heave measurements were not collected since no additional fracturing was attempted.

6.6 Injection Point IP- 8 Summary

Injection Point IP-8 was located within the middle row of the Ferox^{sm} treatment cell and was the sixth boring to be addressed. The bedrock interface at this location was encountered at a depth of 31.5 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Fracturing was performed within the first interval (29.5 – 31.5 ft bgs). Pulsed LAI was applied in the first four intervals corresponding vertical treatment depths of (20.5 – 31.5 ft bgs). Within the remaining intervals, distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 17 feet was treated (14.5 – 31.5 feet) resulting in the emplacement of 3,390 lbs of ZVI corresponding iron to soil dosage ratio of 0.92%.

A total of 1500 ft^3 of nitrogen was consumed during the injections at IP-8. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 850 SCFM.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Interval 1 are presented in Appendix A. Pressure data was not collected for the remaining two (2) intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. Minor groundwater daylighting was encountered around the annulus of the injection boring resulting in borehole abandonment.

Figure FC8-1F in Appendix A represents a flatline pressure response with no discernable initial peak or initiation pressure. An averaged pressure of 65 psi was required to initiate flow within the formation.

The rapid spikes depicted on the ZVI LAI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation. LAI pressures during the pulsing ranged between 70 and 120 psi. Between pulses, when gas was not applied, hydraulic injection pressures ranged between 10 and 25 psi.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox injections at IW-8. For the five (5) intervals completed corresponding to (14.5 – 31.5 feet), wells MW23D, MW26D, MW27, MW28S and MW28D were monitored for pressure influence. The data is presented in Appendix B.

In general, pressure responses were observed at all wells monitored. The most significant influence was observed at up-gradient well MW-23D, which showed pulses in pressure in direct response to the LAI pulsing at IW-8.

Surface Heave:

Initial surface heave measurements were recorded for the first fracturing event. No heave was observed. Additional heave measurements were not collected since no additional fracturing was attempted.

6.7 Injection Point IP- 6 Summary

Injection Point IP-6 was located within the middle row of the Ferox treatment cell and was the seventh boring to be addressed. The bedrock interface at this location was encountered at a depth of 35 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Fracturing was not performed within the first interval due to potential daylighting concerns. Rather, gas was gradually introduced into the treatment intervals to ascertain whether sands were present and whether the formation was immediately receptive to the influx of gas. LAI was applied in the first three intervals corresponding vertical treatment depths of (27 – 35 ft bgs). Within the remaining intervals, distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 26 feet was treated (9 - 35 feet) resulting in the emplacement of 5,085 lbs of ZVI corresponding iron to soil dosage ratio of 0.90%.

A total of 600 ft^3 of nitrogen was consumed during the injections at IW-10. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 800 SCFM.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Interval 1 are presented in Appendix A. Pressure data was not collected for the remaining six (6) intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. Moderate daylighting was observed 25 feet in the form of gas (25 feet away) and around the annulus o f well MW28S.

The graphs (FC6-1I – FC6-3I) presented in Appendix A represents a flatline pressure response with no discernable initial peak or initiation pressure. An averaged pressure of 120 psi was required to initiate flow within the formation.

The rapid spikes depicted on the ZVI LAI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation. LAI pressures during the pulsing averaged 80 psi. Between pulses, when gas was not applied, hydraulic injection pressures ranged between 10 and 30 psi.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox injections at IW-6. For the deep injection intervals corresponding to intervals 1 thru 7, wells MW23D, MW25D, MW26D, MW28S and MW28D were monitored for pressure influence. The data is presented in Appendix B.

Significant pressure influence was observed at wells MW23D, MW28D, MW28S, in response to the pulsed LAI. As shallow intervals were addressed, pressure influence was essentially limited to MW28S.

Surface Heave:

Initial surface heave measurements were not recorded since fracturing was not conducted.

6.8 Injection Point IP-11 Summary

Injection Point IP-11 was located within the northern row of the Ferox treatment cell and was the eighth boring to be addressed. The bedrock interface at this location was encountered at a depth of 17 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Fracturing was not performed within the first interval due to potential daylighting concerns. Rather, gas was gradually introduced into the treatment intervals to ascertain whether sands were present to ascertain formations receptivity to the influx of gas. LAI was applied in the first interval corresponding vertical treatment depths of (15 – 17 ft bgs). Within the remaining intervals, distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 8 feet was treated (9 - 17 feet) resulting in the emplacement of 1,695 lbs of ZVI corresponding iron to soil dosage ratio of 0.97%.

A total of 600 ft^3 of nitrogen was consumed during the injections at IP-11. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 750 SCFM.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Interval 1 are presented in Appendix A. Pressure data was not collected for the remaining two (2) intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. Moderate daylighting was observed 1 foot and 7 feet away in the form of groundwater.

The graph presented in Appendix A (Figure FC11-1I) represents a flatline pressure response with no discernable initial peak or initiation pressure. An averaged pressure of 85 psi was required to initiate flow within the formation.

The rapid spikes depicted on the ZVI LAI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation. LAI pressures during the pulsing averaged 85 psi. Between pulses, when gas was not applied, hydraulic injection pressures ranged between 10 and 15 psi.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox injections at IP-11. For all three (3) intervals wells MW23S, MW23D, MW24D, MW28S and MW28D were monitored for pressure influence. The data is presented in Appendix B.

Significant pressure influence was consistently observed at well cluster MW23. Minimal but measurable influence was observed at the remaining wells during the shallowest injection.

Surface Heave:

Initial surface heave measurements were not recorded since fracturing was not conducted.

6.9 Injection Point IP-5 Summary

Injection Point IP-5 was located within the middle row of the Ferox treatment cell and was the ninth boring to be addressed. The bedrock interface at this location was encountered at a depth of 30.5 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Fracturing was not performed within the first interval due to potential daylighting concerns. Rather, gas was gradually introduced into the treatment intervals to ascertain whether permeable sands were present to ascertain formation receptivity to the influx of gas. LAI was applied within the first four intervals corresponding vertical treatment depths of (19.5 – 30.5 ft bgs). Within the remaining intervals, distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 20 feet was treated (10.5 – 30.5 feet) resulting in the emplacement of 3,955 lbs of ZVI corresponding iron to soil dosage ratio of 0.91%.
A total of 1000 ft^3 of nitrogen was consumed during the injections at IP-5. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 700 SCFM.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Interval 1 are presented in Appendix A. Pressure data was not collected for the remaining three (3) intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. No daylighting was observed during the injections.

The graphs presented in Appendix A represents a flatline pressure response with no discernable initial peak or initiation pressure. LAI pulsing pressures ranging between 60 and 120 psi was required to initiate nitrogen and slurry flow within the formation.

The rapid spikes depicted on the ZVI LAI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation. Between pulses, when gas was not applied, hydraulic injection pressures ranged between 20 and 30 psi.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox injections at IW-5. For all injection intervals wells MW24D, MW25S, MW25D, MW28S and MW28D were monitored for pressure influence. The data is presented in Appendix B.

For the deepest two (2) injections, significant pressure influence was consistently observed at wells MW24D and MW25D with moderate responses at well cluster MW28. During the remaining injection pressure influence was consistently present at well MW24D with intermittent influence at the other monitored locations.

Surface Heave:

Initial surface heave measurements were not recorded since fracturing was not conducted.

6.10 Injection Point IP-7 Summary

Injection Point IP-7 was located within the middle row of the Ferox treatment cell and was the tenth boring to be addressed. The bedrock interface at this location was encountered at a depth of 31.5 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Fracturing was not performed within the first interval due to potential daylighting concerns. Rather, gas was gradually introduced into the treatment intervals to ascertain whether permeable sands were present to ascertain formation receptivity to the influx of gas. Pulsed LAI was applied within the first three intervals corresponding vertical treatment depths of (23.5 – 31.5 ft bgs). Within the remaining intervals, distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 20 feet was treated (11.5 – 31.5 feet) resulting in the emplacement of 13.955 lbs of ZVI corresponding iron to soil dosage ratio of 0.91%.

A total of 900 ft^3 of nitrogen was consumed during the injections at IP-7. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 850 SCFM.

<u>Injection Initiation and Maintenance Pressures:</u>

The Pressure-History Curves representing Intervals 1 – 3 are presented in Appendix A. Pressure data was not collected for the remaining four (4) intervals since nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. Minimal daylighting was observed during near the injection point.

The graphs presented in Appendix A represents a flatline pressure response with no discernable initial peak or initiation pressure. LAI pulsing pressures ranging between 70 and 140 psi was required to initiate nitrogen and slurry flow within the formation.

The rapid spikes depicted on the ZVI LAI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation. Between pulses, when gas was not applied, hydraulic injection pressures ranged between 10 and 80 psi.

<u>Pressure Influence at Adjacent Monitoring Wells:</u>

A total of five (5) wells were monitored during the Ferox injections at IP-7. For all injection intervals wells MW23D, MW26D, MW27, MW28S and MW28D were monitored for pressure influence. The data is presented in Appendix B.

During the injections a nearly constant pressure response was observed at well MW23D. Direct connectivity with the monitored wells occurred during the two deepest injections corresponding to wells MW23D and MW28D indicated 360 lateral propagation of the gas and atomized ZVI slurry. As the injections proceeded into shallower interval, pressure influence at MW28S became more prevalent.

Surface Heave:

Initial surface heave measurements were not recorded since fracturing was not conducted.

6.11 Injection Point IP-9 Summary

Injection Point IP-9 was located within the upper row of the Ferox treatment cell and was the eleventh boring to be addressed. The bedrock interface at this location was encountered at a depth of 20 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Fracturing was not performed within the first interval due to potential daylighting concerns. Rather, gas was gradually introduced into the treatment intervals to ascertain whether permeable sands were present to ascertain formation receptivity to the influx of gas. Pulsed LAI was applied within the first three intervals corresponding vertical treatment depths of (11 – 20 ft bgs). Within the remaining intervals, distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 12 feet was treated (8 – 20 feet) resulting in the emplacement of 2,260 lbs of ZVI corresponding iron to soil dosage ratio of 0.87%.

A total of 900 ft^3 of nitrogen was consumed during the injections at IP-9. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 850 SCFM.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Intervals 1 and 3 are presented in Appendix A. Pressure data was not collected for interval 2 due to computer problems. During the interval, nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. Minimal daylighting was observed during near the injection point.

The graphs presented in Appendix A represents a flatline pressure response with no discernable initial peak or initiation pressure. LAI pulsing pressures ranging between 50 and 80 psi were required to initiate nitrogen and slurry flow within the formation.

The rapid spikes depicted on the ZVI LAI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox injections at IP-9. For all injection intervals wells MW24S, MW24D, MW25D, MW28S and MW28D were monitored for pressure influence. The data is presented in Appendix B.

During injections within the first three intervals, significant pressure influence was observed at wells MW24S and MW24D in response to the pulsed LAI. As the injections were performed at subsequent shallower intervals, pressure responses were observed to tail off at MW24D but maintained at MW24S.

Surface Heave:

Initial surface heave measurements were not recorded since fracturing was not conducted.

6.12 Injection Point IP- 3 Summary

Injection Point IP-3 was located within the southern row of the Ferox treatment cell and was the twelfth boring to be addressed. The bedrock interface at this location was encountered at a depth of 34.5 feet bgs. Relevant injection data parameters are presented in Table 1 and Appendices A and B. Fracturing was not performed within the first interval due to potential daylighting concerns. Rather, gas was gradually introduced into the treatment intervals to ascertain whether permeable sands were present to ascertain formation receptivity to the influx of gas. Pulsed LAI was applied within the first three intervals corresponding vertical treatment depths of (26.5 – 34.5 ft bgs). Within the remaining intervals, distribution of the ZVI slurry was accomplished via hydraulic injection.

A total vertical interval of 23 feet was treated (11.5 – 34.5 feet) resulting in the emplacement of 24,520 lbs of ZVI corresponding iron to soil dosage ratio of 0.97%.

A total of 1000 ft^3 of nitrogen was consumed during the injections at IW-7. The nitrogen quantities used were minimal based on the relatively low injection pressures and the pulsed injection technique employed during the Pilot Test. Where PF/LAI was applied nitrogen flowrates averaged 800 SCFM.

Injection Initiation and Maintenance Pressures:

The Pressure-History Curves representing Intervals 1 – 3 are presented in Appendix A. During the remaining intervals, nitrogen gas was not used to emplace the ZVI; therefore no pressure data existed to record. Daylighting was observed during the last interval 5 feet from the injection point.

The graphs presented in Appendix A represents a flatline pressure response with no discernable initial peak or initiation pressure. LAI pulsing pressures ranging between 20 and 170 psi were required to initiate nitrogen and slurry flow within the formation.

The rapid spikes depicted on the ZVI LAI injection curves represent the instantaneous pressuring and pulsing action of the gas as the slurry is dispersed into the target intervals. The pressure spikes observed during the injection of ZVI represent the pulsing pressure of the gas combined with the slurry as both are being injected into the formation.

Pressure Influence at Adjacent Monitoring Wells:

A total of five (5) wells were monitored during the Ferox injections at IW-3. For all injection intervals wells MW23D, MW26D, MW27, MW28S and MW28D were monitored for pressure influence. The data is presented in Appendix B.

During injections within the deepest interval, significant pressure influence was observed at wells MW26D with moderate influence at wells MW27 and MW28D. As the injections were performed at subsequent shallower intervals, pressure responses were observed to generally diminish with minimal pressure influence observed for the last interval.

Surface Heave:

Initial surface heave measurements were not recorded since fracturing was not conducted.

6.13 Offset Injection Points – IP-4(O) and IP-1(O)

A total of two (2) offset injection borings were required to adequately address the shallow intervals associated with original injection points IP-4 and IP-1. Data parameters specific to each offset location are provided in Table 1.

A total of two intervals corresponding to 9-12 and 12 – 15 feet bgs were completed at IP-4(O) while a total of three intervals corresponding to 9 – 12, 12 – 15 and 15 – 18 feet bgs were completed at IP-1(O). Due to the shallow nature of the injections, LAI was utilized in the 15 – 18 foot interval at IP-1(O) and the graph is presented in Appendix A. In general, the graph depicts flatlined pressure response indicative of permeable soils.

Pressure responses at the surrounding well were generally minimal due to the shallow injections. The pressure influence results are presented in Appendix B.

7.0 MONITORING WELL GEOCHEMICAL PARAMETERS

Groundwater geochemical parameters were measured prior to the implementation of the Ferox injections (Baseline), two times during the Pilot Test and after completion of the Pilot Test. These parameters included dissolved oxygen (mg/L), oxidation/reduction potential (mV), temperature (°C), pH, conductance (ms/cm) and groundwater elevation (ft. bgs.). Measurements were obtained using a multi-parameter meter at frequencies in accordance with the RFP. Groundwater elevation was measured using a level probe.

Groundwater results pertaining to the geochemical measurements are presented in Table 2. The data presented is specific to monitoring wells located within the general vicinity of the Pilot Test Area at locations up-gradient, down gradient, within and side-gradient to the Ferox treatment cell. Interim and subsequent post-injection measurements within the four (4) key wells (MW-26S, MW-26D, MW-28S and MW28D) that represent geochemical conditions within and down-gradient of the treatment cell showed significant and favorable responses relative to the Baseline (November 24, 2008) sampling round. More specifically, evidence of the presence and/or corrosion of the ZVI within the Pilot Test Area were confirmed through significant drops in the Oxidation Reduction Potential (ORP) coupled with corresponding increases in pH relative to the pre-injection baseline values for the four-targeted wells. The ORP of groundwater is a measure of electron activity and is an indicator of the relative tendency of a solution to accept or transfer electrons resulting from the corrosion of ZVI with water. An increase in pH results from the initial stages of the iron corrosion in the presence of D.O and water to form hydroxyl ions. These favorable and anticipated changes in groundwater geochemistry provide direct evidence that the ZVI reactions are proceeding accordingly and degradation of the CVOCs is occurring in response to the presence of the ZVI. Changes in geochemical parameters were also observed in the surrounding monitoring well locations indicating ZVI propagation occurred outside the designated treatment zone.

8.0 POST-INJECTION CONFIRMATION SOIL CORING AND ANALYSIS

To ascertain distribution of ZVI within the treatment cell, ARS collected a total of nine (9) soil cores and subsequently conducted an evaluation of the 3 random soil core grab samples all collected approximately 7 feet from the injection borings. More specifically, the samples collected for evaluation were obtained from core samples that showed no visual evidence of ZVI powder. However, during preliminary field magnetic screening a significant amount of magnetic material was extracted from the samples resembling ZVI powder. Based on this observation, further analysis was conducted at ARS' offices in New Brunswick, NJ. The results of the soil sampling and soil magnetic evaluation are presented in Appendices XXX and XXX of this report. In summary, the ZVI dosage identified in grab samples 1, 2 and 3 corresponded to a 0.35% 0.28% and 0.44% ZVI:soil mass dosage or ratio, respectively. From this, it appears that the finer-grained HC-15 ZVI (≈ avg. particle size - 45 microns), which represented 16% of the ZVI injected (7000 lbs HC-15 and 38,000 HCA), propagated a minimum distance of 7 feet. From this, it is apparent that a percentage or finer grained portion of the HCA ZVI (≈ 90 microns avg. particle size) contributed to this soil dosage since the distribution of the 7,000 lbs HC-15 injected during the Pilot Test would equate to an in situ soil ZVI dosage of 0.15% representing only 41% of the averaged dosage identified in the cores.

9.0 CVOC TREATMENT EFFECTIVENESS

The data presented in Tables 3, 4, 5 and 6 below show significant contaminant degradation is occurring across the width of the Ferox treatment cell. This is substantiated through significant reductions in concentrations of the target CVOCs within 1) the center of the Ferox treatment cell

(Wells 28S and 28D) and 2) down-gradient (Wells 26S and 26D) of the treatment cell. It is difficult to make a direct comparison with the original baseline concentrations (1/31/2008) since they were collected a year prior to the initiation of the study. The Tables presented below identify reductions relative to the up-gradient contaminant concentrations entering the treatment cell.

Table 3 – Deep CVOC Degradation Within Midpoint of Treatment Cell

Target Compounds	% Reduction in MW-28D Relative to Influent Concentrations from MW-24D
Dichlorodifluoromethane	108% increase – Dechlorination byproduct of Freon 113
Vinyl Chloride	ND
1,1-Dichloroethene	33% Reduction
1,1,2-Trichloro-1,2,2-trifluoroethane	70% Reduction
Trans-1,2-Dichloroethene	ND
1,1-Dichloroethane	39% Increase - Dechlorination byproduct of 1,1,1-Trichloroethane
cis-1,2-Dichloroethene	0% - low ppb levels below MCL
1,1,1-Trichloroethane	78% Reduction
Trichloroethene	51 % Reduction
1,1,2-Trichloroethane	ND

ND – Non Detect
MCL – Maximum Contaminant Level

Table 4 – Deep CVOC Degradation Down-Gradient of Treatment Cell

Target Compounds	% Reduction in MW-26D Relative to Influent Concentrations from MW-24D
Dichlorodifluoromethane	89% Reduction
Vinyl Chloride	Increase from ND to 3.4 ppb
1,1-Dichloroethene	58% Reduction
1,1,2-Trichloro-1,2,2-trifluoroethane	83% Reduction
Trans-1,2-Dichloroethene	ND
1,1-Dichloroethane	82% Reduction
cis-1,2-Dichloroethene	Increase from 4.7 ppb to 48 ppb
1,1,1-Trichloroethane	86% Reduction
Trichloroethene	51 % Reduction
1,1,2-Trichloroethane	ND

ND – Non Detect
MCL – Maximum Contaminant Level

Table 5 – Shallow CVOC Degradation Within Mid-Point of Treatment Cell

Target Compounds	% Reduction in MW-28S Relative to Influent Concentrations from MW-24S
Dichlorodifluoromethane	Increase from 76 ppb to 120
Vinyl Chloride	Increase from ND to 5.9 ppb
1,1-Dichloroethene	19% Reduction
1,1,2-Trichloro-1,2,2-trifluoroethane	Increase from 400 ppb to 590 ppb
Trans-1,2-Dichloroethene	ND
1,1-Dichloroethane	Increase from 46 ppb to 55 ppb
cis-1,2-Dichloroethene	Increase from 11 ppb to 21 ppb
1,1,1-Trichloroethane	31% Reduction
Trichloroethene	11 % Reduction
1,1,2-Trichloroethane	ND

Table 6 – Shallow CVOC Degradation Down-Gradient of Treatment Cell

Target Compounds	% Reduction in MW-26S Relative to Influent Concentrations from MW-24S
Dichlorodifluoromethane	ND
Vinyl Chloride	Concentration below Remedial Goal
1,1-Dichloroethene	100% Reduction
1,1,2-Trichloro-1,2,2-trifluoroethane	Concentration below Remedial Goal
Trans-1,2-Dichloroethene	ND
1,1-Dichloroethane	85% Reduction. Very close to Remedial Goal
cis-1,2-Dichloroethene	Concentration below Remedial Goal
1,1,1-Trichloroethane	100% Reduction
Trichloroethene	95% Reduction. Very close to Remedial Goal
1,1,2-Trichloroethane	ND

These reductions coupled with the favorable changes in geochemistry and generation of ethane (86 ppb within well 28D) provides direct evidence of CVOC degradation and treatment effectiveness confirming that the permeable in situ Ferox reactive zone has been successfully installed along the down-gradient edge of the CVOC plume.

Fluctuations and/or variations in contaminant concentrations at surrounding monitoring well points around the treatment cell can be expected due to temporary changes in groundwater gradients resulting from the Ferox injections. ARS anticipates these concentrations will eventually stabilize with on-going reduction across the Ferox PRB.

Increases in dissolved iron concentrations were reported in the two post-injection sampling events indicating the presence of ferrous iron (Fe^{+2}) resulting from corrosion of the ZVI in situ. Ferrous iron can act a s a reductant and has the ability to provide additional treatment of the CVOCs.

10.0 PERFORMANCE EVALUATION

A Phase II Pilot Study was implemented during November/December 2008 at the Farrand Controls Site to assess the effectiveness of PF/LAI and ISCR utilizing ARS' patented Ferox^{sm} technology to treat subsurface CVOC plume down-gradient of a source area.

The Ferox^{sm} treatment application resulted in the injection of approximately 45,000 pounds of a proprietary blend of ZVI into the targeted treatment zones. Subsurface distribution of ZVI was substantiated through 1) pressure influence in response to injections at surrounding monitoring wells, 2) visual daylighting of ZVI slurry up to 15 feet from the injection boring 3) favorable changes in geochemical parameters at surrounding key monitoring wells located within and immediately dowgradient of the treatment cell 4) visual confirmation of ZVI within cores and 5) Nearly complete degradation of the target CVOCs within down-gradient monitoring wells at or below the Remedial Goals stipulated in D&B's May 15, 2008 RFP. A detailed summary of the sample coring and key observations are provided below and in Appendices C and D of this report.

Site geology and a high groundwater table limited the full utilization of nitrogen gas and hence prevented PF and LAI from being fully implemented at the site. In most instances, PF and pulsed LAI were applied at the deepest intervals to address low permeable weathered rock and fine-grained deposits reported to be present along the bedrock interface.

An evaluation of PF parameters, which was applied prior to the Ferox injections, showed that fracture generation and propagation did occur along the bedrock interface. Above this, pore space dilation and soil fluidization served as the primary delivery mechanism when the gas could be applied suggesting the presence of non-cohesive permeable deposits consisting of sand. For the majority of the injections with the general exception of the deepest 2 intervals, the target Ferox dosages were accomplished by hydraulic injection with minimal use of gas.

In conclusion, the ability to safely implement Ferox injections for the treatment of target CVOCs was proven to applicable at the Farrand Controls Site with minimal disturbances to facility operations. Implementation of the Pilot Study revealed that the target ZVI dosage could be achieved at or below a treatment depth of 6.5 ft bgs.

Implementation of the pilot study identified several site-specific improvements or modifications, which would facilitate and streamline full-scale implementation of the PF/LAI and Ferox^{sm} processes. These are discussed below.

11.0 FULL SCALE IMPLEMENTATION AND RECOMMENDATIONS

Injection Boring Design, Spacing and Injection Approach

The full-scale implementation should incorporate the identical grid layout and injection spacing employed for the pilot study with the points spaced 14 feet on-center. An assumed 7.5-foot ROI should be adequate to address the majority of the vertical treatment intervals and provide a sufficient degree of overlap for the deeper injections where a ROI beyond 7.5 feet is expected. Under this conceptual approach, the Ferox PRB will consist of 3 injection rows with 40 injection points per row. The injection grid will create a 40 foot wide by 600 foot long treatment barrier in the overburden to treat the CVOCs migrating offsite.

The results of the soil boring and magnetic extraction analysis indicate that a finer grained ZVI similar in size to the HC-15 (< 45 microns) used in the Pilot Study, should be utilized for the full-scale treatment. Due to the limitations associated with the use of nitrogen at the site, it is apparent that distribution of the target Ferox ZVI dosages would be accomplished through hydraulic delivery. Use of a more fine-grained ZVI will facilitate distribution into the soil matrix as was confirmed in the soil magnetic extraction test.

<u>Injection Productivity</u>

Estimates regarding full-scale injection production rates would equate to 24 feet of vertical treatment per ten-hour workday. The deeper injections that will be required towards the midpoint and leading edge of the plume may reduce the production rates due longer injection times and increased drilling time.

<u>Nitrogen Gas Usage</u>

Intermittent daylighting issues resulted in low nitrogen consumption corresponding to 11,400 ft^3 of gas for the entire Pilot Study. For the full-scale application, pulsing of the gas within the deeper intervals over the duration of the injection should provide sufficient atomization of the ZVI without compromising the targeted interval. full scale FEROX implementation cost estimate

Approximate cost estimates have been prepared for the installation of a Ferox Permeable Reactive Barrier (PRB) to intercept and treat CVOC migrating off-site along the southern edge of the property. Implementation of the technology will be applied as part of a turn-key phased remedial approach.

Remedial operations will involve the installation of a reactive ZVI treatment zone down gradient of the source area (See Figure 3) to intercept and treat contaminants currently migrating offsite.

12.1 Cost Estimate

The estimated costs associated with the implementation of proposed remediation activities have been based on several key assumptions identified below:

- Treatment Area 600 feet long by maximum 40 deep by 40 feet wide (ROI of 7.5 ft).

- Maximum Treatment Interval: 30 feet bgs, consisting of fine to medium grained sands.
- Porosity of overburden: 0.3 (fine/medium sands).
- Bulk density of overburden: 100 pounds/cubic foot.
- Maximum total CVOC groundwater concentrations in overburden: 29 mg/L (MW-22R).
- Radius of Influence (ROI) of 7.5 feet.

Since the ZVI injections during the Phase II operations will be applied at deeper depths, a ROI of 7.5 ft was selected to serve as a conservative estimate that will provide a sufficient level of overlap between injection borings and ensure lateral continuity of the treatment cell. Table 7 provides the estimated ZVI required for treatment of the overburden within the plume.

Table 7: Estimated ZVI for PRB Overburden Treatment

Parameter	Value	Comment
Treatment Interval	10-40 feet bgs	Overburden (sands)
Area	21,195 ft^2	Plume Zone
Iron Required	404,000 pounds	At 0.96% soil weight
Total Cost of Iron	$585,500	Cost at $1.45 per pound
Gallons Injected	137,800 gallons	3.0 pounds/gallon

Similar to the injection depths associated with the Phase II Pilot Study, the inherent variability of depth to bedrock along the southern property will require that each of the 3 injections row intervals will increase in depth from north to south. As a result of the expanding vertical treatment zone (10 – 40 ft bgs), larger ZVI quantities will be required to treat the larger vertical intervals. A dosage of 0.95 percent iron in soil ratio correlates to approximately 558 lbs of ZVI per interval. As indicated in earlier sections of this report, daylighting may become problematic at the shallower intervals rendering it unlikely that within all the boreholes the entire treatment interval can be completed within one boring; likely requiring offset locations. It is important to note that the 0.96 dosage serves as an estimate on the achievable dosage based on what was achieved during the Phase II Pilot Study and can be increased if higher dosages are warranted. Based upon a 0.96 percent iron in soil ratio for the overburden, approximately 404,000 pounds of iron will be required to treat the target VOCs migrating from the source area.

Based upon a 7.5 foot radius of influence, 3-rows of 40 injection wells per well will be required to treat the overburden from an approximate depth of 10– 40 feet bgs. The width of the treatment zone (40 ft) will provide adequate residence time to treat all COCs migrating through the treatment zone. An estimated production rate of 24 vertical feet per day can be anticipated requiring 95 days (1 field crew, 89 injection days plus 6 days setup/breakdown) to complete the remediation effort. Based on the above assumptions and parameters, the cost to implement full-scale remediation using the Ferox^{sm} Technology is estimated to be **$1,700,000**. Please note that this estimate assumes a maximum treatment depth of 40 ft bgs within the plume and the cost to implement the technology will increase proportionally with depth if injection locations are shifted further southwest to intercept the leading edge of the plume.

Table 1
FEROX Pilot Test Injection Summary Table
Farrand Controls Site, Valhalla, New York

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-2	11/25/2008	36.5 - 38	10:40	FC2-1F/I	185	125	.00 / .00	75 / 10	320	85	170	170	405	Target achieved, no daylighting.
		33.5 - 36.5	11:29	FC2-2I	Due to the presence of flowing sand, initial fracture events were not attempted at these intervals. Pulses of nitrogen gas were applied during slurry injection events at the first five intervals. Due to daylighting issues, the remainder of the borehole was completed hydraulically.			90 / 25	320	85	150	150	405	Standard nozzle clogged after first interval. Pulled out tooling and re-advanced with sand nozzle. Target achieved.
		30.5 - 33.5	15:21	FC2-3I				90 / 35	320	85	150	150	405	Target achieved, no daylighting.
	11/26/2008	27.5 - 30.5	8:54	FC2-4I				40 / 85	320	85	150	150	405	Target achieved, no daylighting.
		24.5 - 27.5	9:50	FC2-5I				110 / 40	320	85	150	150	405	Moderate daylighting of groundwater and ZVI slurry approximately 15 feet away to the East. Target achieved.
		21.5 - 24.5	10:25	ND				25	320	85	150	150	405	Increased daylighting of groundwater and ZVI slurry at same location as previous interval. Target achieved.
	12/1/2008	18.5 - 21.5	11:05	ND				10	320	85	150	150	405	Daylighting at multiple locations within 15 feet. Target achieved.
		15.5 - 18.5	12:48	ND				10	320	85	150	150	405	Same daylighting as previous interval. Target achieved.
		12.5 - 15.5	13:30	ND				10	320	85	150	150	405	Attempted using one pump to lower flowrate in an attempt to limit daylighting. Unsuccessfull, daylighting continued at multiple locations. Target achieved.
		9.5 - 12.5	14:16	ND				10	320	85	150	150	405	Same daylighting as previous interval. Target achieved.
								Totals:	3200	850	1520	1520	4050	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-4	12/2/2008	33.5 - 35	9:48	FC4-1F	25	22	.00 / .00	80 / 50	400	85	150	75	242	Injection nozzle clogged during injection and could not be cleared. Tooling was removed and cleaned but could not re-advance down to target depth.
		31.5 - 33	12:49	FC4-2IA/B	Fracture events were not attempted at these intervals due to daylighting concerns. Pulses of gas were applied during slurry injection at the first tw intervals.			70 / 50	600	127	225	225	727	Remainder of previous batch injected in this interval along with normal dosage. Target achieved. No daylighting.
		28.5 - 31.5	13:50	ND				40	400	85	200	200	485	Dosage delivered in two batches. Daylighting around annulus of MW26D and MW26S. Target Achieved.
		25.5 - 28.5	15:16	ND				45	400	85	150	150	485	Target achieved. No daylighting.
		22.5 - 25.5	15:46	ND				35	400	85	150	150	485	Slurry injection plugged twice before target was achieved on the third attempt. Daylighting from MW26D annulus.
	12/3/2008	19.5 - 22.5	10:20	ND				60	400	85	150	150	485	Target achieved. No daylighting.
		16.5 - 19.5	11:08	ND				50	400	85	150	150	485	Injection completed with one pump. Target achieved. No daylighting.
		13.5 - 16.5	12:06	ND				10	400	85	150	150	485	Continuous daylighting from around MW26D during injection. Target achieved. Due to the daylighting, the borehole was abandoned.
								Totals:	3400	722	1325	1250	3879	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-12	12/3/2008	24.5 - 26	15:52	FC12-1F/I	105	40	.00 / .00	75 / 50	480	85	175	175	565	Target achieved. No daylighting.
	12/4/2008	21.5 - 24.5	9:32	ND	Fracture events were not attempted at these intervals due to daylighting concerns. Pulses of gas were applied during slurry injection at the first interval.			50	480	85	175	175	565	Target achieved. No daylighting.
		18.5 - 21.5	10:18	ND				50	480	85	175	175	565	Target achieved. No daylighting.
		15.5 - 18.5	10:50	ND				20	480	85	175	175	565	Injection completed with one pump. Target achieved. No daylighting.
		12.5 - 15.5	11:33	ND				35	480	85	175	175	565	Injection completed with one pump. Target achieved. No daylighting.
		9.5 - 12.5	12:09	ND				35	480	85	175	175	565	Injection completed with one pump. Target achieved. No daylighting.
		6.5 - 9.5	12:48	ND				50	480	85	175	175	565	Nozzle plugged twice during injection. Activated second pump and completed injection on thrid attempt. Target achieved. No daylighting.
								Totals:	3360	595	1225	1225	3955	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-1	12/5/2008	31 - 33	10:47	FC1-1F/I	135	40	.00 / .00	75 / 45	400	85	150	150	485	Target achieved. No daylighting.
		28 - 31	11:28	FC1-2I	Fracture events were not attempted at these intervals due to daylighting concerns. Pulses of gas were applied during slurry injection at the first tw intervals.			75 / 20	400	85	150	150	485	Minor daylighting of gas around outer casing at injection point during slurry injection. Target achieved.
		25 - 28	12:15	ND				30	400	85	150	150	485	Slurry injection plugged twice . Target achieved on third attempt. Increased daylighting around outer casing.
		22 - 25	13:56	ND				65	400	85	150	150	485	Slurry injection plugged twice . Target achieved on third attempt. Increased daylighting around outer casing.
		18 - 21	15:13	ND				20	400	85	150	150	485	Batch completed with significant daylighting around outer casing. Borehole abandoned.
								Totals:	2000	425	750	750	2425	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-10	12/6/2008	15.5 - 17.5	10:24	FC10-1F/I	70	50	.00 / .00	75 / 30	480	85	175	175	565	Target achieved. No daylighting.
		12.5 - 15.5	11:08	ND	Fracture events were not attempted at these intervals due to daylighting concerns. Pulses of gas were applied during slurry injection at the first interval.			35	480	85	175	175	565	Target achieved. No daylighting.
		9.5 - 12.5	11:48	ND				30	480	85	175	175	565	Target achieved. No daylighting.
		6.5 - 9.5	12:30	ND				25	480	85	175	175	565	Minor daylighting and mounding of the ground at multiple points within 5 feet of injection location. Target achieved.
								Totals:	1920	340	700	700	2260	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Table 1 continued
FEROX Pilot Test Injection Summary Table
Farrand Controls Site, Valhalla, New York

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-8	12/6/2008	29.5 - 31.5	15:03	FC8-1F/I	75	40	.00 / .00	75 / 25	480	85	175	175	565	Target achieved. No daylighting.
		26.5 - 29.5	15:45	FC8-2I	Fracture events were not attempted at these intervals due to daylighting concerns. Pulses of gas were applied during slurry injection in the first four intervals.			80 / 30	480	85	175	175	565	Target achieved. No daylighting.
	12/8/2008	23.5 - 26.5	14:09	FC8-3I				75 / 35	480	85	175	175	565	Slurry injection plugged three times. Target achieved on fourth attempt. No daylighting.
		20.5 - 23.5	10:15	FC8-4I				75 / 40	480	85	175	175	565	Injection nozzle jammed and unable to clear. Removed and readvanced tooling to depth. Target achieved. Slight buckling of surface during gas pulse.
	12/9/2008	17.5 - 20.5	11:13	\				25	480	85	175	175	565	First attempt at slurry injection plugged. Target achieved on second attempt. Minor daylighting of gas around outer casing during gas pulse.
		14.5 - 17.5	11:37	\				35	480	85	175	175	565	Target achieved. Significant daylighting around outer casing. Borehole abandoned.
								Totals:	2880	510	1050	1050	3390	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-6	12/9/2008	33 - 35	15:01	FC6-1I	Fracture events were not attempted at these intervals due to daylighting concerns. Brief pulses of gas were applied immediately prior to commencement of ZVI injections to ascertain whether the formation was receptive. Pulses of gas were used during slurry injections at the first three intervals.			75 / 30	480	85	175	175	565	Target achieved. No daylighting.
		30 - 33	15:27	FC6-2I				80 / 20	480	85	175	175	565	Target achieved. No daylighting.
		27 - 30	15:50	FC6-3I				80 / 15	480	85	175	175	565	Target achieved. Visual buckling of surface and daylighting of gas 25 feet away during fracture event.
	12/10/2008	24 - 27	8:36	ND				35	480	85	175	175	565	Target achieved. No daylighting.
		21 - 24	9:00	ND				30	480	85	175	175	565	Target achieved. No daylighting.
		18 - 21	9:29	ND				35	480	85	175	175	565	Target achieved. Daylighting from around annulus of MW28S.
		15 - 18	9:47	ND				15	480	85	175	175	565	Target achieved. Daylighting from around annulus of MW28S. Visual mounding of ground at two locations within 5 feet of injection point.
		12 - 15	10:34	ND				15	480	85	175	175	565	Target achieved. Daylighting around annulus of MW28S and MW28D. Visual mounding of ground at two locations within 5 feet of injection point.
		9 - 12	11:07	ND				10	480	85	175	175	565	Target achieved. Daylighting around annulus of MW28S and MW28D. Visual mounding of ground at two locations within 5 feet of injection point.
								Totals:	4320	765	1575	1575	5085	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-11	12/10/2008	15 - 17	13:36	FC11-1I	Fracture events were not attempted at these intervals due to daylighting concerns. Pulses of gas were used at the first interval. A brief pulse of gas was used to confirm formation receptivity.			85 / 15	480	85	175	175	565	Target achieved. No daylighting.
		12 - 15	13:58	ND				25	480	85	175	175	565	Target achieved. No daylighting.
		9 - 12	14:20	ND				10	480	85	175	175	565	Target achieved. Daylighting of slurry 1 foot away and visual buckling of ground and daylighting 7 feet away from injection point.
								Totals:	1440	255	525	525	1695	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-5	12/11/2008	28.5 - 30.5	9:04	FC5-1I	Fracture events were not attempted at these intervals due to daylighting concerns. Brief pulses of gas were applied immediately prior to commencement of ZVI injections to ascertain whether the formation was receptive. Pulses of gas were used during slurry injection at the first four intervals.			85 / 30	480	85	175	175	565	Target achieved. No daylighting. MW24S left open and vented groundwater during gas pulses.
		25.5 - 28.5	9:31	FC5-2I				80 / 30	480	85	175	175	565	Target achieved. No daylighting.
		22.5 - 25.5	9:54	FC5-3I				70 / 20	480	85	175	175	565	Target achieved. No daylighting.
		19.5 - 22.5	10:35	FC5-4I				75 / 20	480	85	175	175	565	Slurry injection plugged during first attempt. Target achieved on second attempt. No daylighting.
		16.5 - 19.5	12:11	ND				25	480	85	175	175	565	Slurry injection plugged during first attempt. Target achieved on second attempt. No daylighting.
		13.5 - 16.5	13:57	ND				20	480	85	175	175	565	Target achieved. No daylighting.
		10.5 - 13.5	14:27	ND				15	480	85	175	175	565	Slurry injection plugged twice. Target achieved on third attempt. No daylighting.
								Totals:	3360	595	1225	1225	3955	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-7	12/12/2008	29.5 - 31.5	10:29	FC7-1I	Fracture events were not attempted at these intervals due to daylighting concerns. Brief pulses of gas were applied immediately prior to commencement of ZVI injections to ascertain whether the formation was receptive. Pulses of gas were used during slurry injection at the first five intervals.			110 / 25	480	85	175	175	565	Target achieved. Daylighting of groundwater from within MW23S.
		26.5 - 29.5	11:08	FC7-2I				75 / 25	480	85	175	175	565	Target achieved. No daylighting.
		23.5 - 26.5	11:34	FC7-3				65 / 25	480	85	175	175	565	Target achieved. No daylighting.
		20.5 - 23.5	11:58	ND				40	480	85	175	175	565	Target achieved. No daylighting.
		17.5 - 20.5	12:40	ND				35	480	85	175	175	565	Target achieved. Minimal daylighting near injection point.
		14.5 - 17.5	13:17	ND				30	480	85	175	175	565	Target achieved. Minimal daylighting.
		11.5 - 14.5	14:32	ND				20	480	85	175	175	565	Target achieved. Increased daylighting.
								Totals:	3360	595	1225	1225	3955	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-9	12/12/2008	17 - 20	16:16	FC9-1I	Fracture events were not attempted. Brief pulses of gas were applied immediately prior to commencement of ZVI injections to ascertain whether the formation was receptive. Pulses of gas were used during slurry injection at all but the shallowest interval.			80 / 30	480	85	175	175	565	Target achieved. No daylighting.
	12/13/2008	14 - 17	9:10	ND				ND / 45	480	85	175	175	565	Target achieved. No daylighting.
		11 - 14	9:50	FC9-3I				75 / 20	480	85	175	175	565	Target achieved. No daylighting.
		8 - 11	ND	ND				ND	480	85	175	175	565	Target achieved. Minimal daylighting.
								Totals:	1920	340	700	700	2260	

ND - indicates "No Data Recorded"
F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Table 1 continued
FEROX Pilot Test Injection Summary Table
Farrand Controls Site, Valhalla, New York

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure History Curves F/I	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-3	12/13/2008	32.5 - 34.5	13:05	FC3-1I	Fracture events were not attempted at these intervals due to daylighting concerns. Brief pulses of gas were applied immediately prior to commencement of ZVI injections to ascertain whether the formation was receptive. Pulses of gas were used during slurry injection at the first three intervals.			110 / 25	480	85	175	175	565	Target achieved. No daylighting.
		29.5 - 32.5	13:31	FC3-2I				85 / 30	480	85	175	175	565	Target achieved. No daylighting.
		26.5 - 29.5	13:56	FC3-3I				75 / 25	480	85	175	175	565	Target achieved. No daylighting.
		23.5 - 26.5	14:29	ND				20	480	85	175	175	565	Target achieved. No daylighting.
		20.5 - 23.5	14:55	ND				25	480	85	175	175	565	Target achieved. No daylighting.
		17.5 - 20.5	15:22	ND				25	480	85	175	175	565	Target achieved. Minor daylighting at end of slurry injection.
		14.5 - 17.5	15:59	ND				25	480	85	175	175	565	Target achieved. No daylighting.
	12/14/2008	11.5 - 14.5	10:16	ND				20	480	85	175	175	565	Target achieved. Significant daylighting.
								Totals:	3840	680	1400	1400	4520	

ND - indicates "No Data Recorded"

F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure Graph	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-4A	12/14/2008	12 - 15	11:45	ND	Fracture events were not attempted. Pulses of gas were not used.			20	600	85	175	175	685	Target achieved. Daylighting around outer casing.
		9 - 12	12:20	ND				20	600	85	175	175	685	Target achieved. Daylighting around outer casing.
								Totals:	1200	170	350	350	1370	

ND - indicates "No Data Recorded"

F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

Event Data					Fracture Data			Iron Injection Data						
Injection Boring	Date	Interval (ft. bgs.)	Start Time	Pressure Graph	Initiation Pressure (PSI)	Maintainance Pressure (PSI)	Surface Heave Max/Residual (inches)	Slurry Injection Pressure Pulsed/Hydraulic (PSI)	HCA Iron Mixed (lbs)	HC15 Iron Mixed (lbs)	Water Mixed (gals)	Slurry Injected (gals)	Total Iron Injected (lbs)	Comments
FC-1A	12/14/2008	15 - 18	13:27	FC1A-1I	Fracture events were not attempted. Brief pulses of gas were applied prior to ZVI injections to ascertain if the formation was receptive. Pulses of gas were used during injections at first interval.			95 / 30	600	40	160	160	640	Target achieved. No daylighting.
		12 - 15	13:50	ND				30	600	40	160	160	640	Target achieved. No daylighting.
		9 - 12	14:14	ND				25	600	40	160	160	640	Target achieved. No daylighting.
								Totals:	1800	120	480	480	1920	

ND - indicates "No Data Recorded"

F/I - Designates graphs for Fracture Events (F), and/or Pulsed Injections (I)

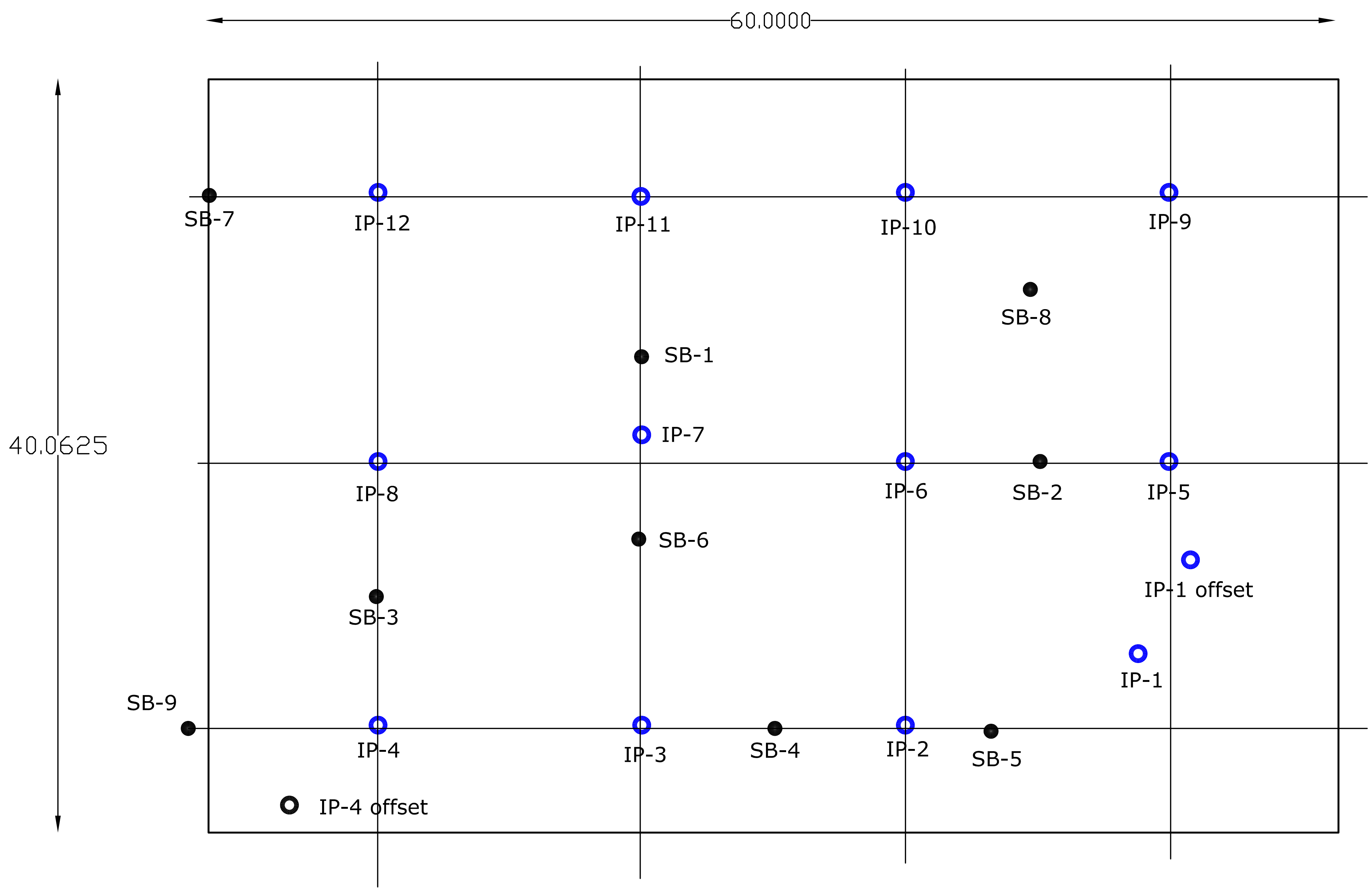
Farrand Control Site -- Zero-Valent Iron Injection Pilot Test

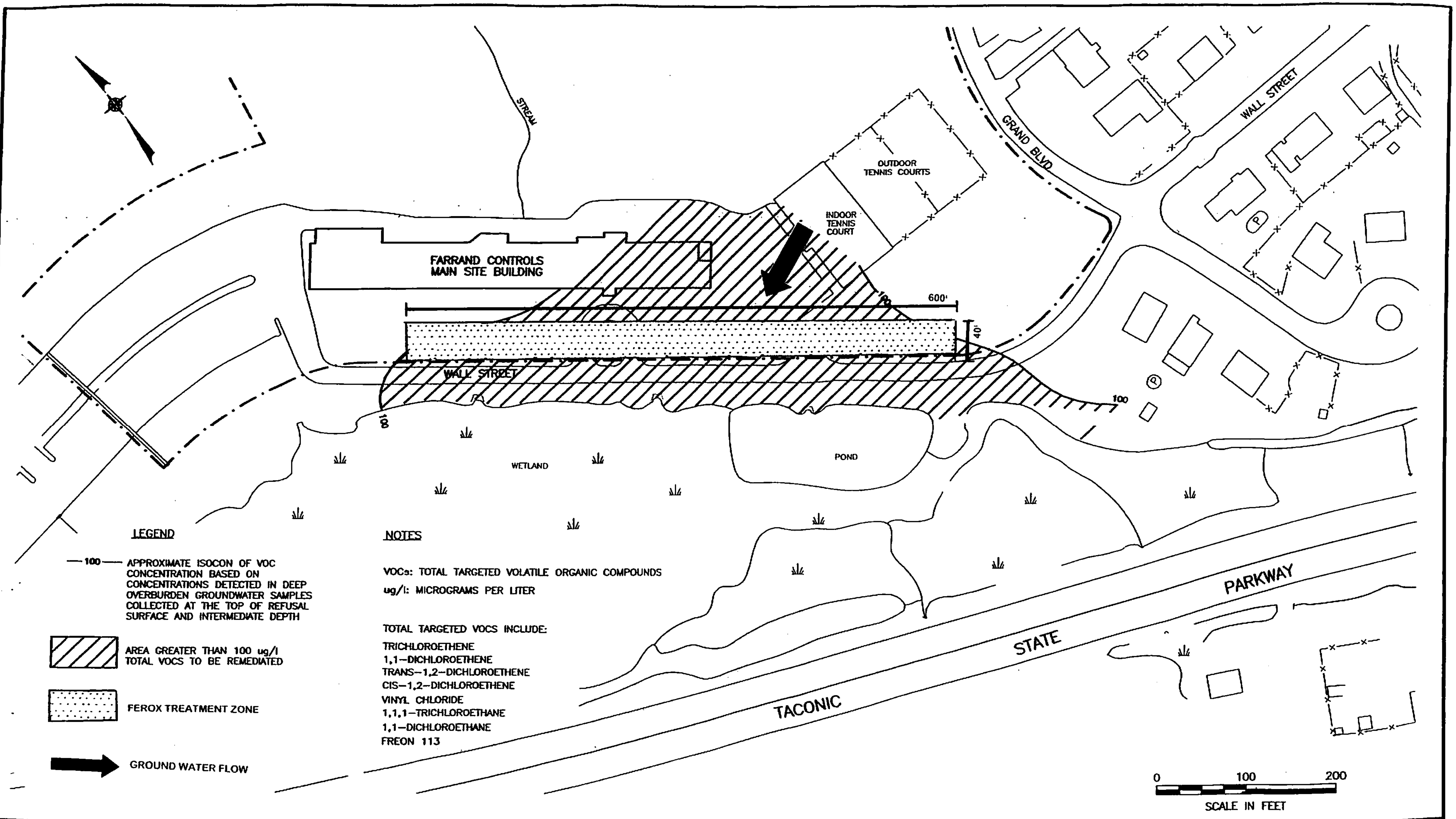
Summary of Groundwater Sampling Parameter Measurements

Monitoring Well	Date (2008)	Screened (ft bgs)	DTGW (ft)	pH	Redox (mV)	Conductance (MS/CM)	Temp (ºC)	D.O. (mg/l)	Comments
24S	24-Nov	3 to 13	5.20	6.24	102	0.577	15.46	0	Baseline
	6-Dec		NA	NA	NA	NA	NA	NA	packer stuck in well
	11-Dec		NA	NA	NA	NA	NA	NA	
	15-Dec		5.10	7.06	-114	0.996	13.44	0	Post Injection
	22-Dec		NA	6.98	-50	0.508	11.33	0	Samples collected by D&B
24D	24-Nov	15.5 to 20.5	5.71	5.98	137	0.356	14.72	0	Baseline
	6-Dec		5.50	6.33	61	0.352	14.57	0	Interim measurements
	11-Dec		5.65	6.90	-42	0.343	15.23	0	Interim measurements
	15-Dec		5.20	7.29	-201	0.327	19.63	0	Post Injection
	22-Dec		NA	6.30	-337	0.250	13.07	0	Samples collected by D&B
23S	24-Nov	3 to 10	4.68	6.42	-59	0.367	14.65	0	Baseline
	6-Dec		5.54	6.23	2	0.329	13.32	0	Interim measurements
	11-Dec		4.60	7.00	-114	0.370	12.98	0	Interim measurements
	15-Dec		4.40	7.06	-124	0.451	12.78	0	Post Injection
	22-Dec		4.80	6.31	-43	0.257	7.77	0	Samples collected by D&B
23D	24-Nov	10 to 20	4.60	6.32	15	0.334	14.02	0	Baseline
	6-Dec		5.45	6.27	42	0.340	13.99	0	Interim measurements
	11-Dec		5.54	6.70	-68	0.350	13.76	0	Interim measurements
	15-Dec		5.23	6.77	-84	0.347	13.89	0	Post Injection
	22-Dec		5.44	6.25	162	0.239	10.58	0.04	Samples collected by D&B
25S	24-Nov	NA	4.26	6.31	75	0.652	14.99	0	Baseline
	6-Dec		4.14	6.28	3	0.685	13.83	0	Interim measurements
	11-Dec		4.32	6.88	-20	0.639	13.54	0	Interim measurements
	15-Dec		4.50	7.11	-79	0.626	13.16	0	Post Injection
	22-Dec		NA	6.41	64	0.472	10.29	0	Samples collected by D&B
25D	24-Nov	15 to 24	4.50	6.28	110	0.338	14.50	0	Baseline
	6-Dec		4.39	6.44	11	0.335	14.45	0	Interim measurements
	11-Dec		4.21	6.70	5	0.300	14.20	0	Interim measurements
	15-Dec		4.34	6.78	-30	0.320	14.27	0.13	Post Injection
	22-Dec		NA	6.10	202	0.239	13.03	0	Samples collected by D&B
26S	24-Nov	2 to 12	3.74	6.32	-54	0.806	14.48	0	Baseline
	6-Dec		3.66	6.86	-124	0.390	13.11	0	Interim measurements
	11-Dec		3.20	8.35	-238	0.376	13.43	0	Interim measurements
	15-Dec		3.34	8.10	-289	0.393	17.05	0	Post Injection
	22-Dec		3.43	6.62	-220	0.415	11.15	0	Samples collected by D&B
26D	24-Nov	29 to 39	3.75	6.37	-4	0.324	12.69	0	Baseline
	6-Dec		3.61	9.27	-320	0.179	13.24	0	Interim measurements
	11-Dec		3.30	9.10	-312	0.187	13.10	0	Interim measurements
	15-Dec		3.54	9.00	-331	0.386	13.00	0	Post Injection
	22-Dec		3.10	6.68	-300	0.448	9.20	0	Samples collected by D&B
27	24-Nov	36 to 36	4.82	6.63	7	0.759	12.83	0	Baseline
	6-Dec		4.70	6.53	22	0.743	12.83	0	Interim measurements
	11-Dec		4.30	7.00	-48	0.698	12.30	0	Interim measurements
	15-Dec		4.80	6.73	-107	0.700	17.88	0	Post Injection
	22-Dec		4.10	6.90	124	0.322	8.81	0	Samples collected by D&B
28S	24-Nov	2 to 12	4.68	6.32	-83	1.010	14.66	0	Baseline
	6-Dec		4.57	6.66	-102	0.980	13.48	0	Interim measurements
	11-Dec		3.80	7.88	-300	0.850	13.54	0	Interim measurements
	15-Dec		3.54	7.20	-246	0.800	13.20	0	Post Injection
	22-Dec		3.60	6.91	-146	0.533	11.07	0	Samples collected by D&B
28D	24-Nov	19.5 to 29.5	4.94	6.39	-2	0.342	13.18	0	Baseline
	6-Dec		4.83	7.51	-73	0.352	13.23	0	Interim measurements
	11-Dec		4.60	6.40	6	0.360	13.50	0	Interim measurements
	15-Dec		4.78	7.30	-256	0.225	13.31	0	Post Injection
	22-Dec		4.20	6.50	-429	0.281	11.73	0	Samples collected by D&B

ºC = Degrees Celsius
MS/CM = Millisiemens/Centimeter
mg/l = Milligrams/liter
mV = Millivolt

Ferox Injection and Soil Boring Locations



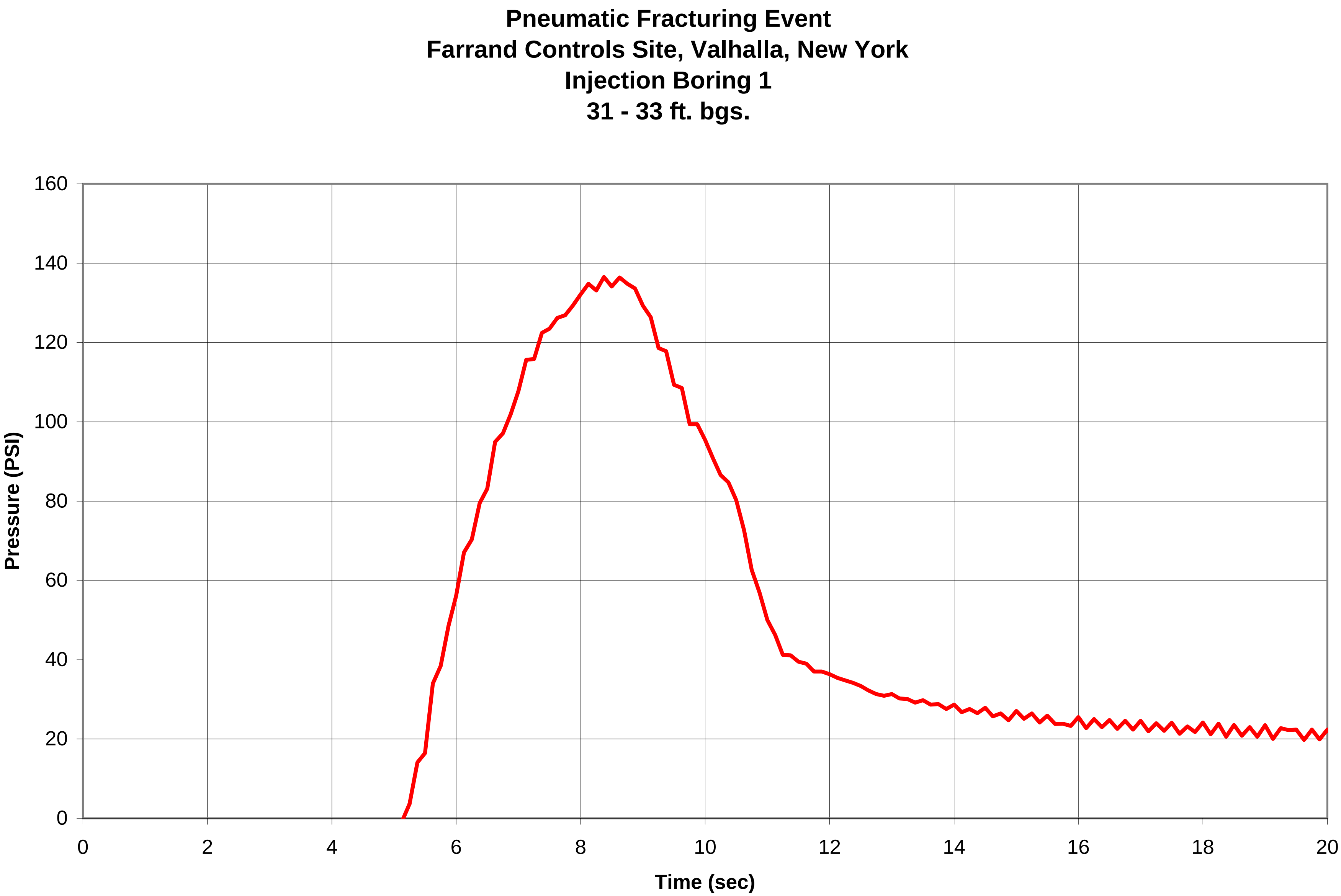


FARRAND CONTROLS SITE
VALHALLA, NEW YORK

ARS TECHNOLOGIES, INC.
FRACTURING, INJECTION & DRILLING SERVICES

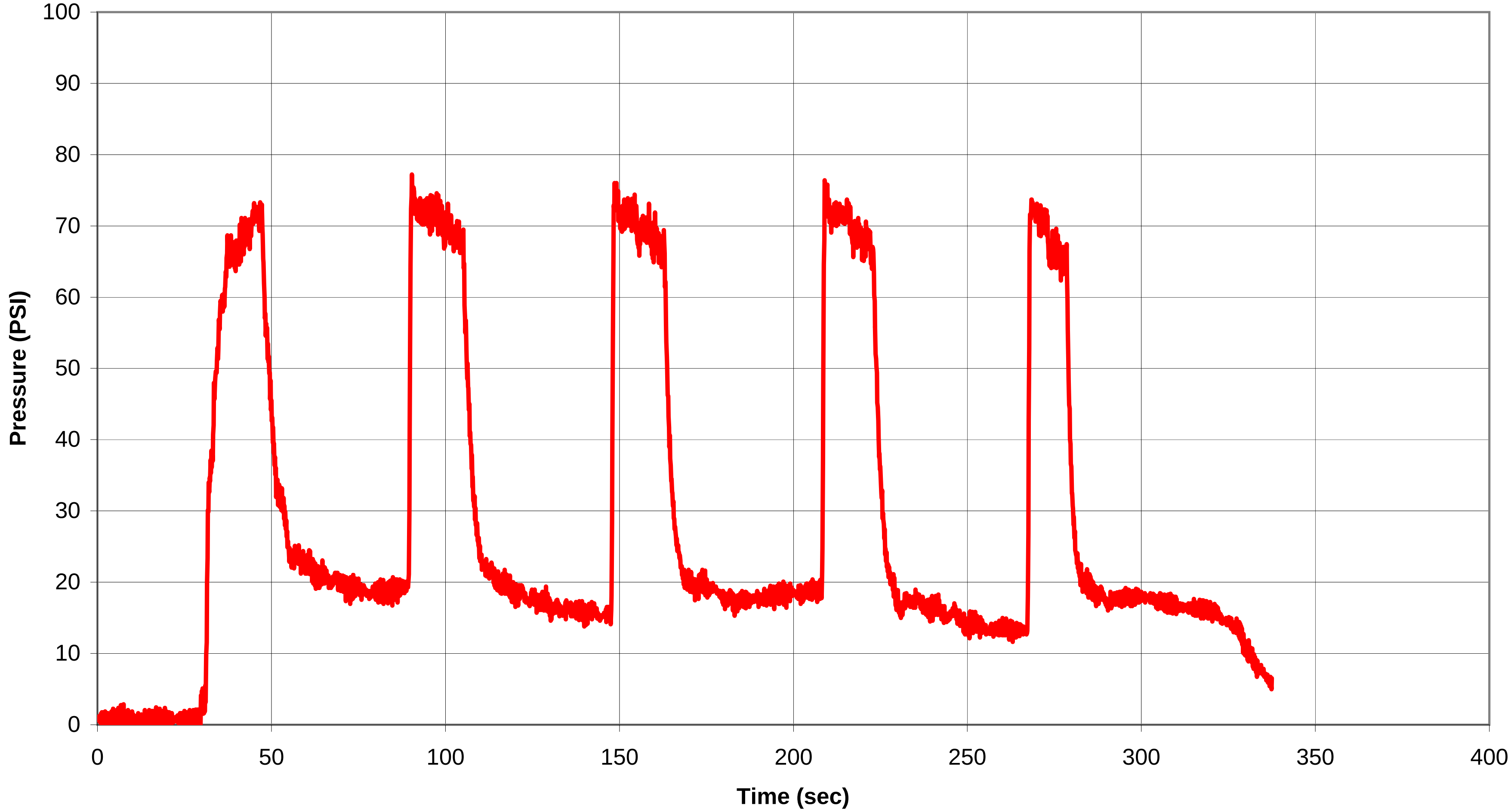
PROPOSED FULL - SCALE FEROX TREATMENT ZONE

FIGURE 3

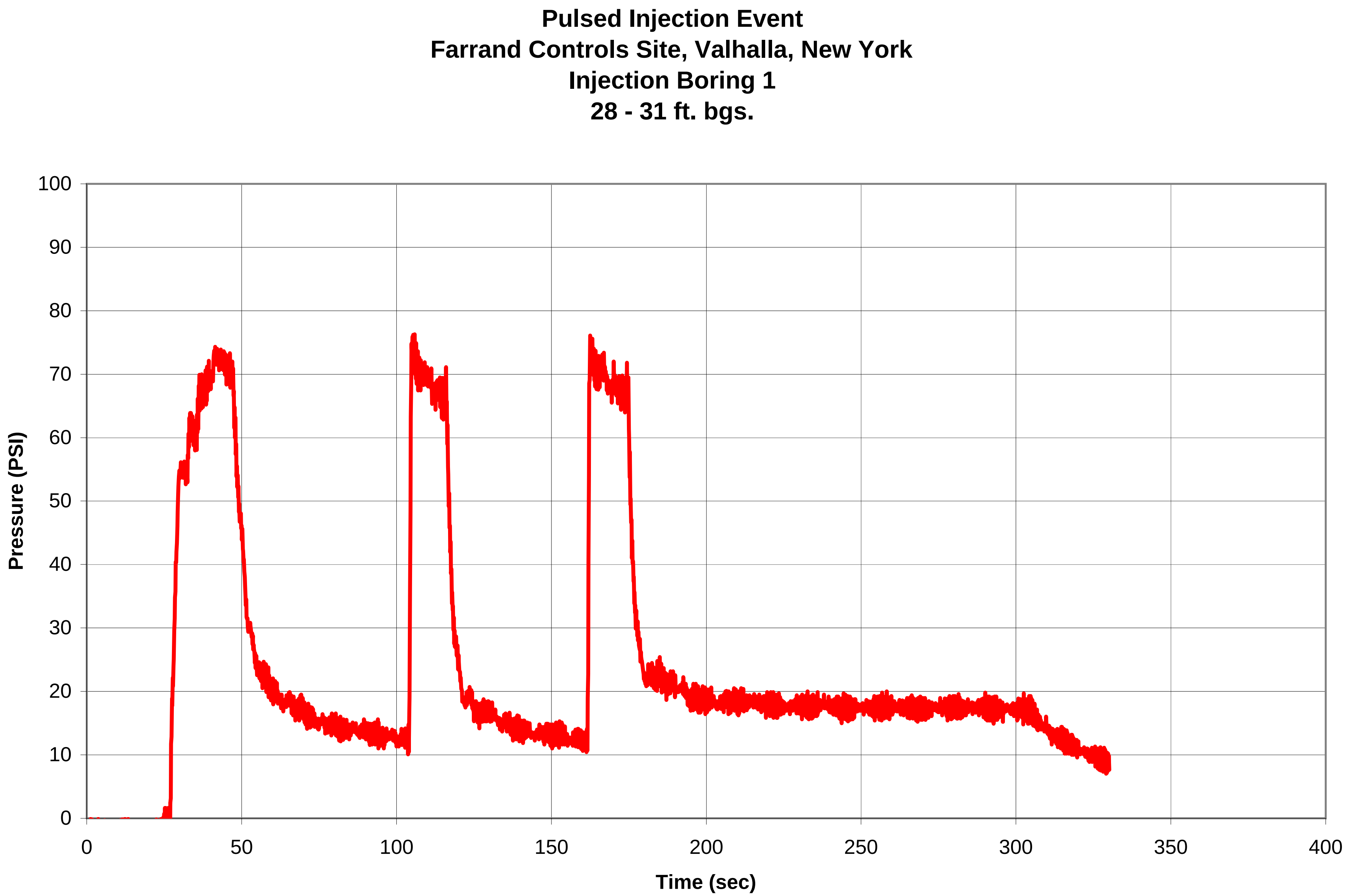

Pneumatic Fracturing Event
Farrand Controls Site, Valhalla, New York
Injection Boring 1
31 - 33 ft. bgs.
Pressure (PSI)
160
140
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18
20
Time (sec)

FC1-1F

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 1
31 - 33 ft. bgs.

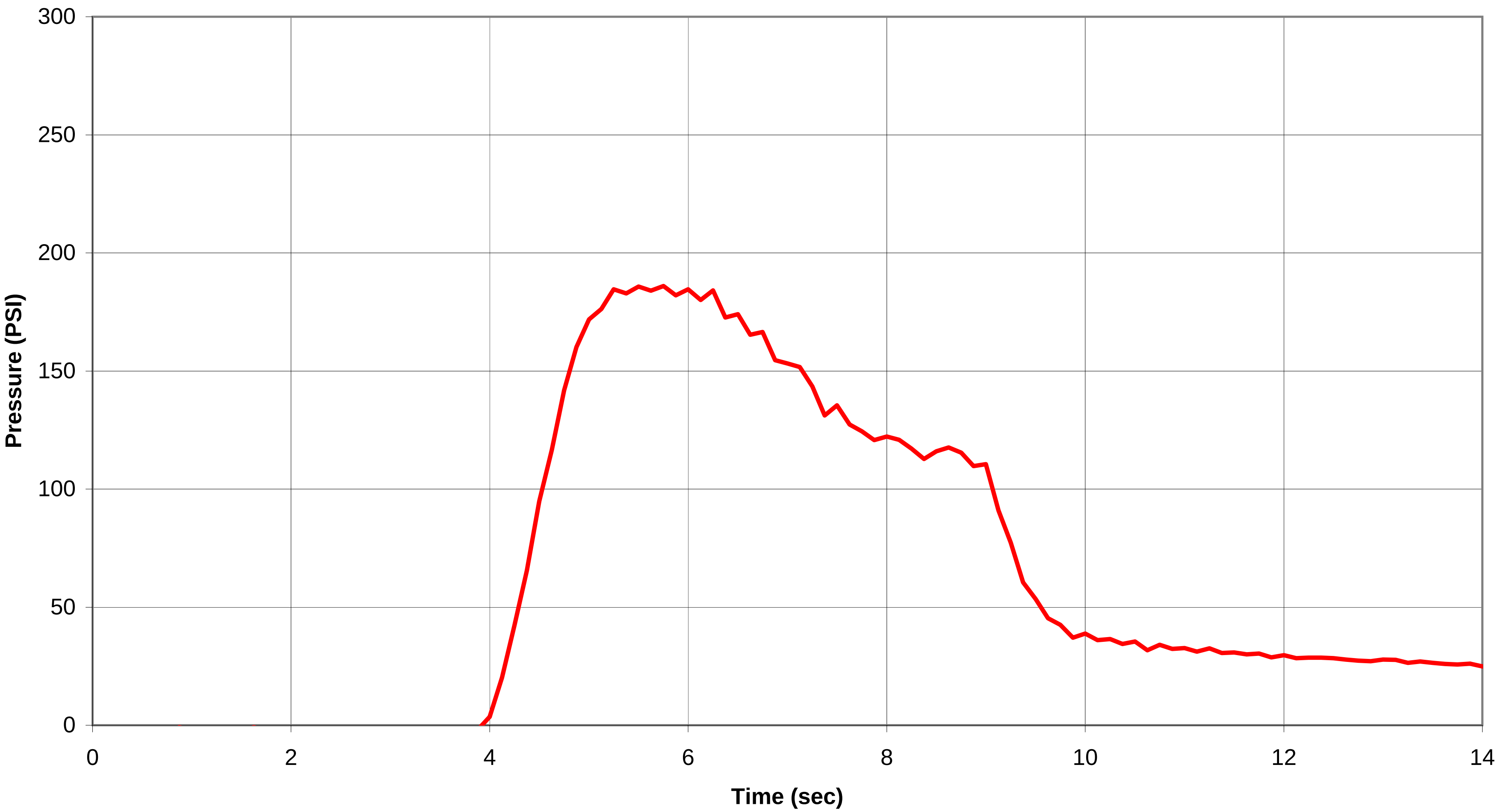


FC1-1I


Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 1
28 - 31 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
Time (sec)

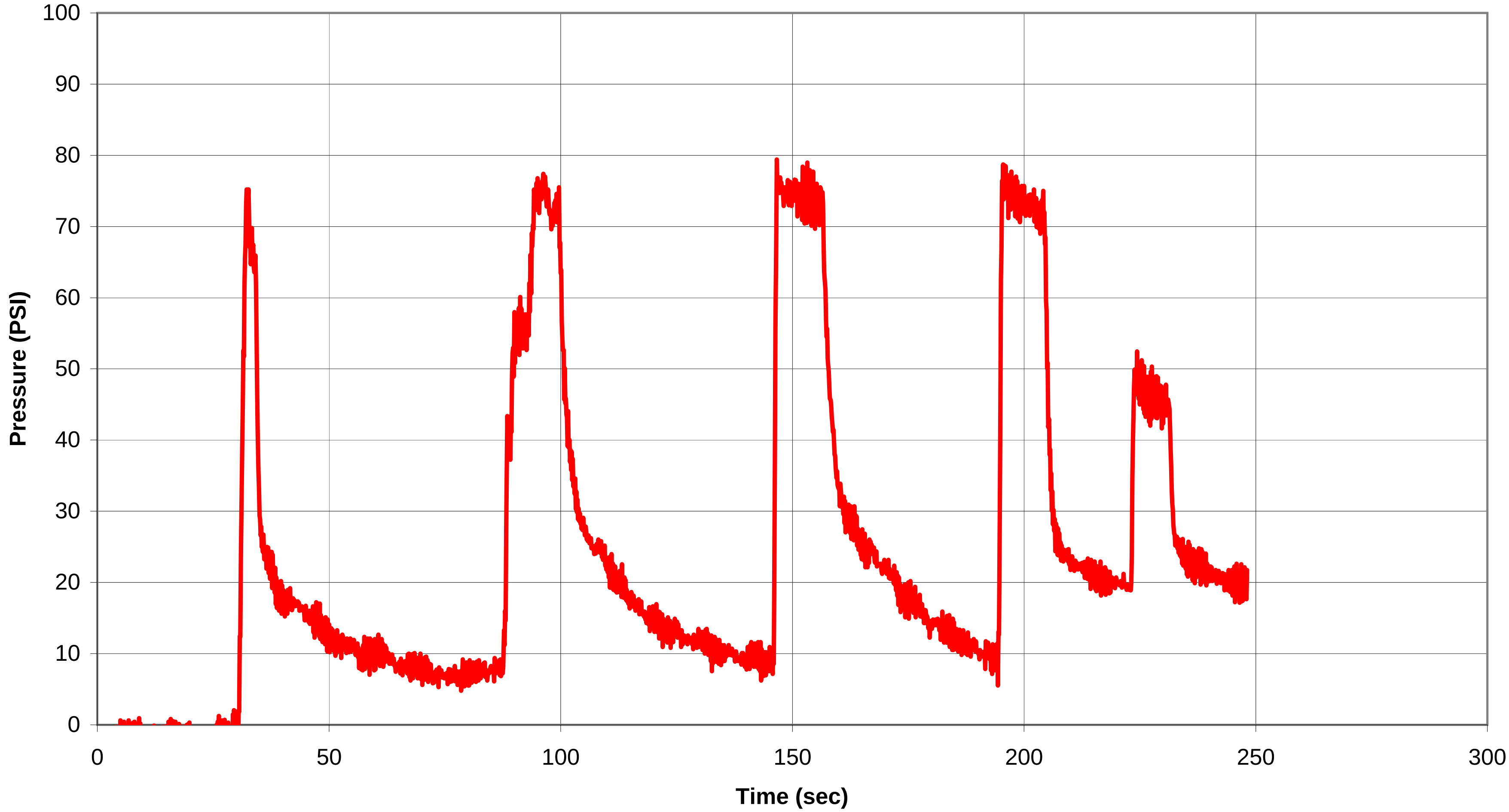
FC1-2I

Pneumatic Fracturing Event
Farrand Controls Site, Valhalla, New York
Injection Boring 2
36.5 - 38 ft. bgs.



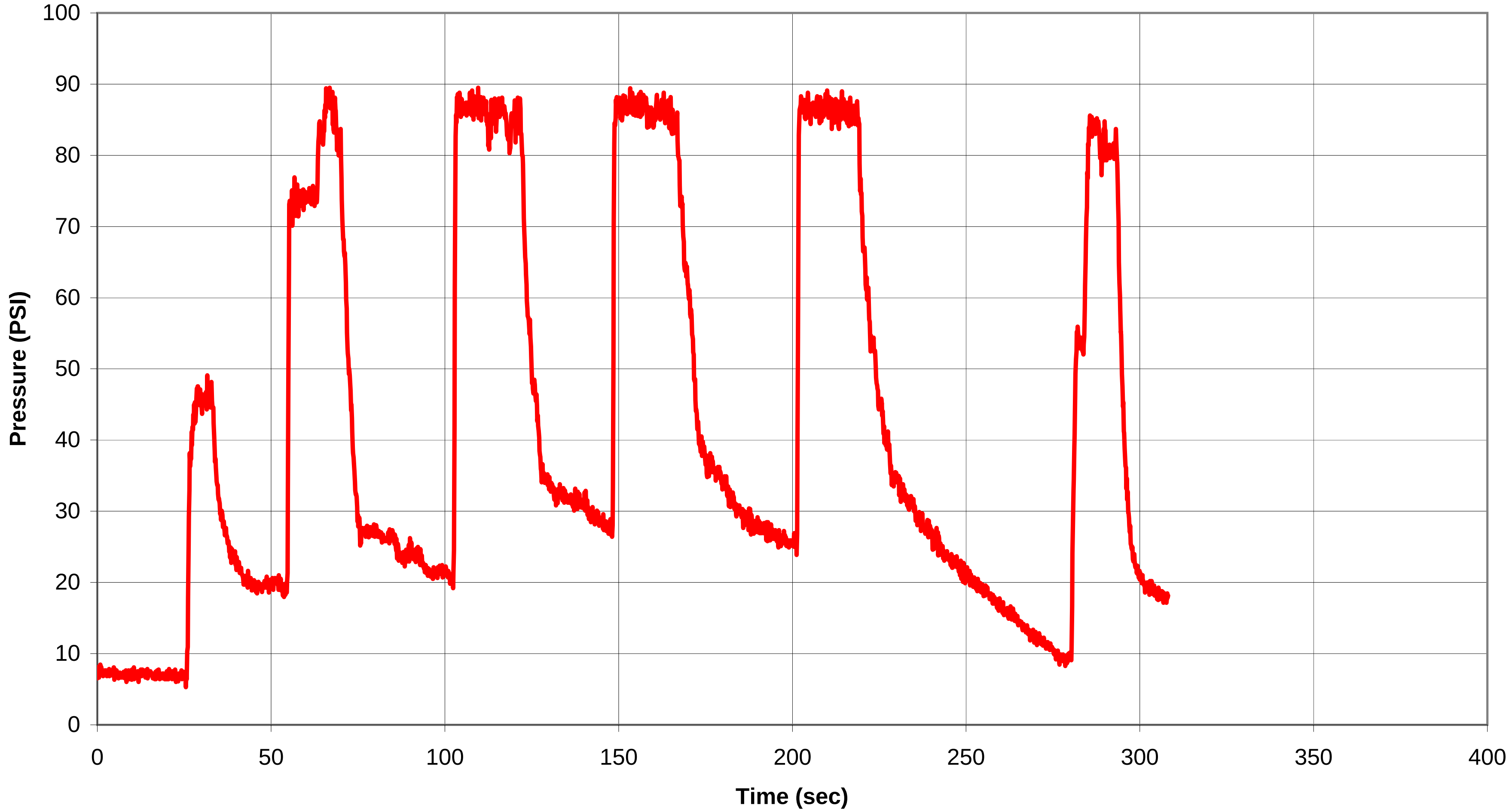
FC2-1F

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 2
36.5 - 38 ft. bgs.

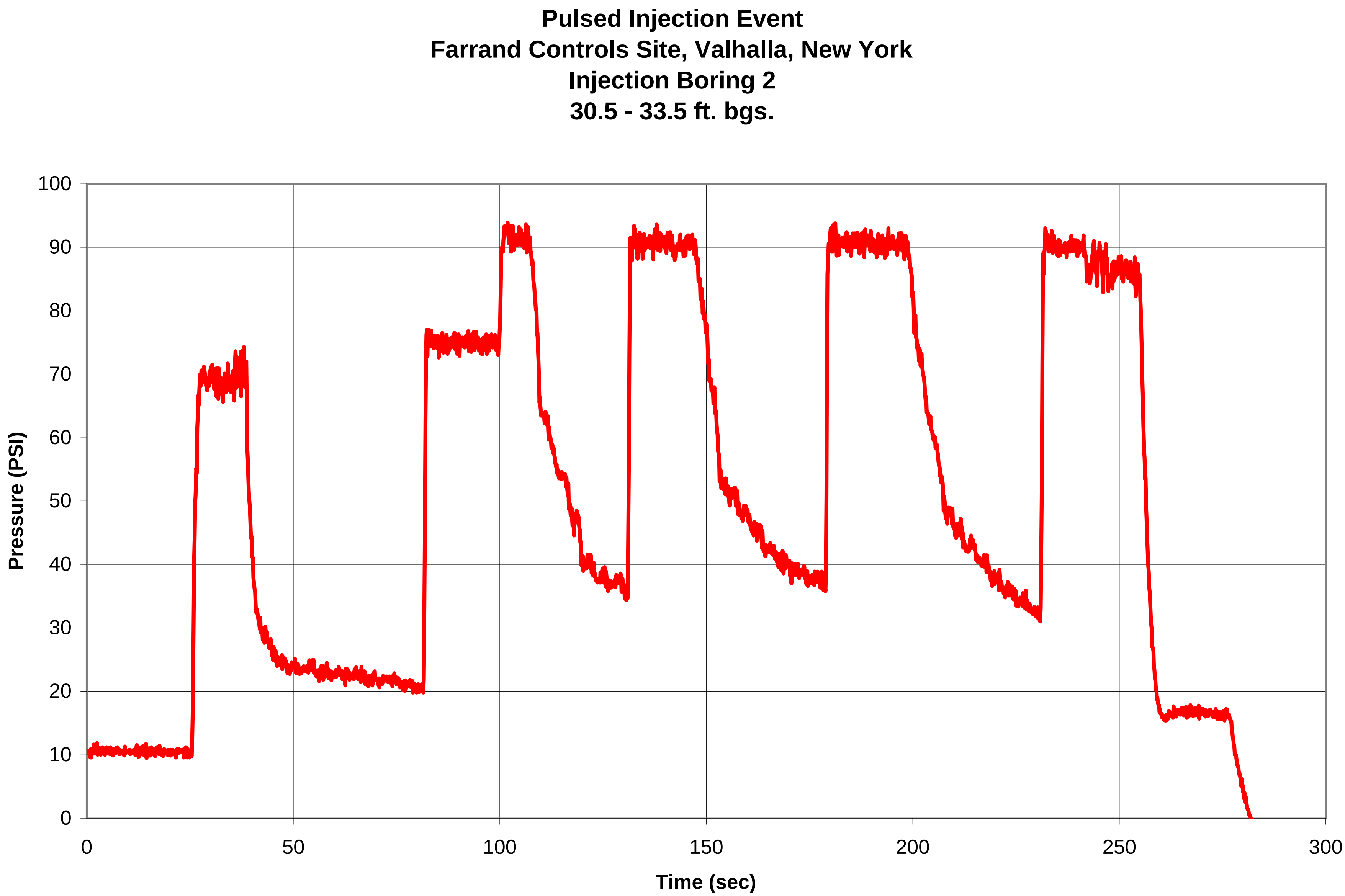


FC2-1I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 2
33.5 - 36.5 ft. bgs.

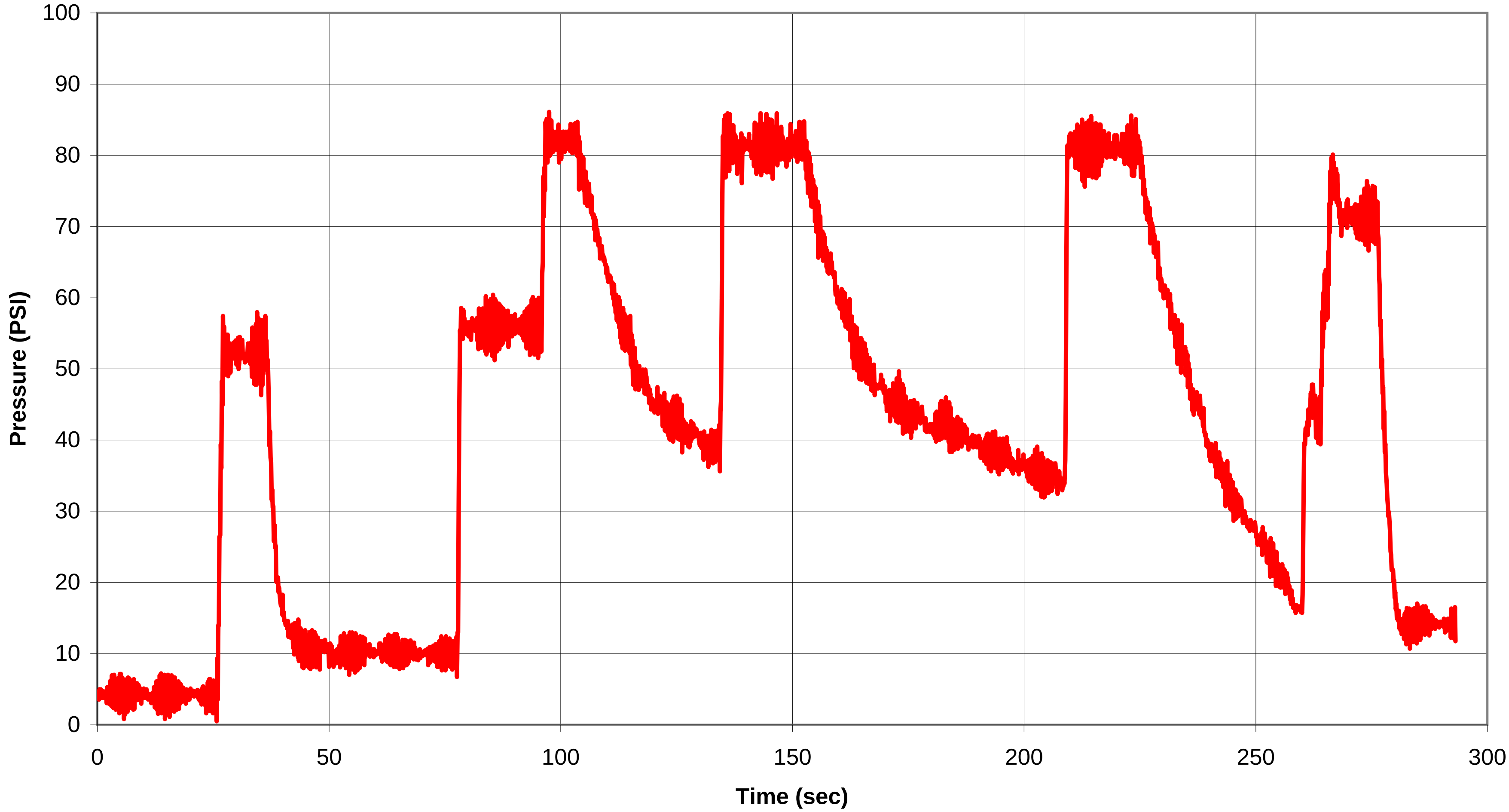


FC2-2I

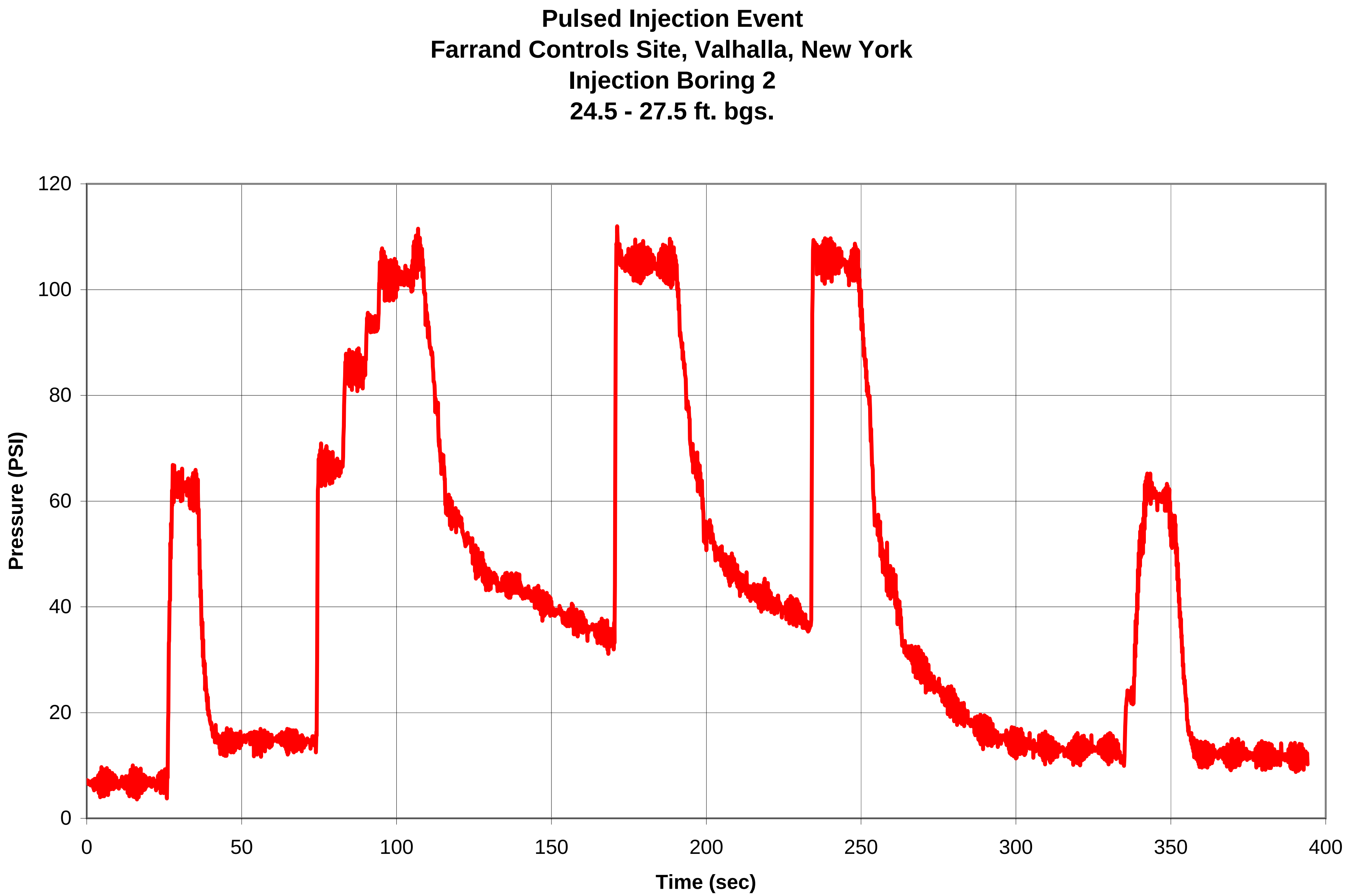

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 2
30.5 - 33.5 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
Time (sec)

FC2-3I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 2
27.5 - 30.5 ft. bgs.

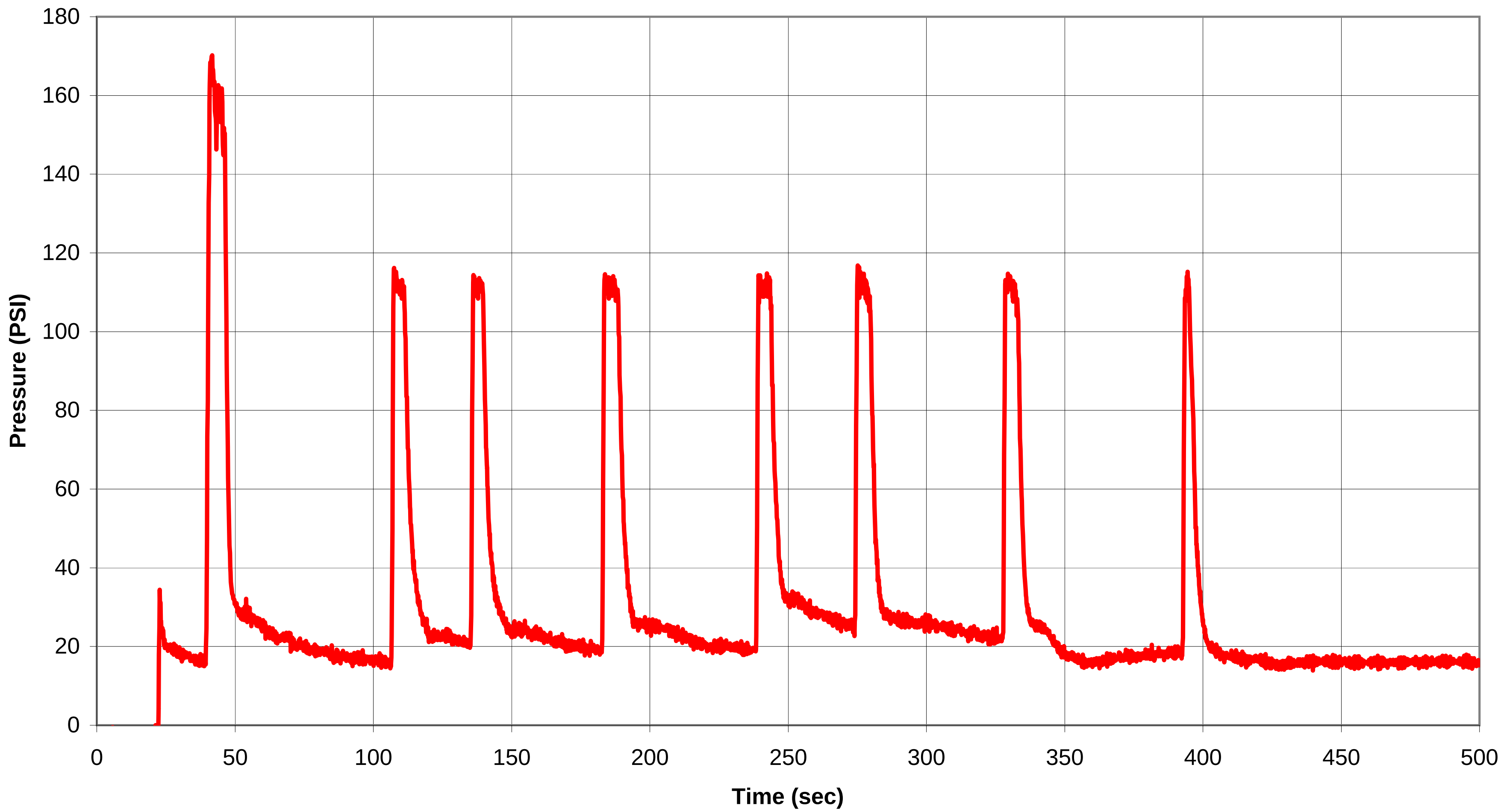


FC2-4I

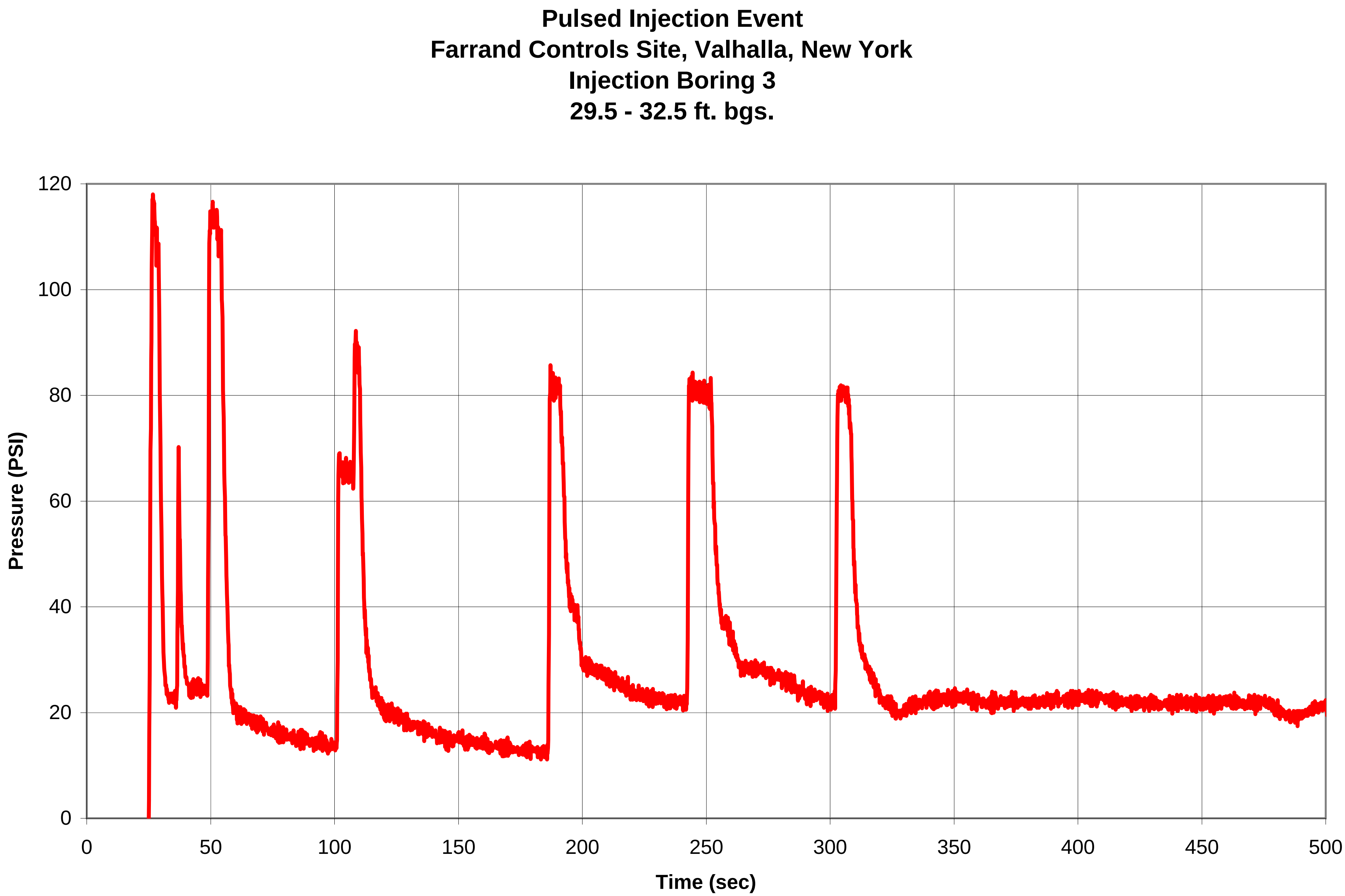

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 2
24.5 - 27.5 ft. bgs.
Pressure (PSI)
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
400
Time (sec)

FC2-5I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 3
32.5 - 34.5 ft. bgs.

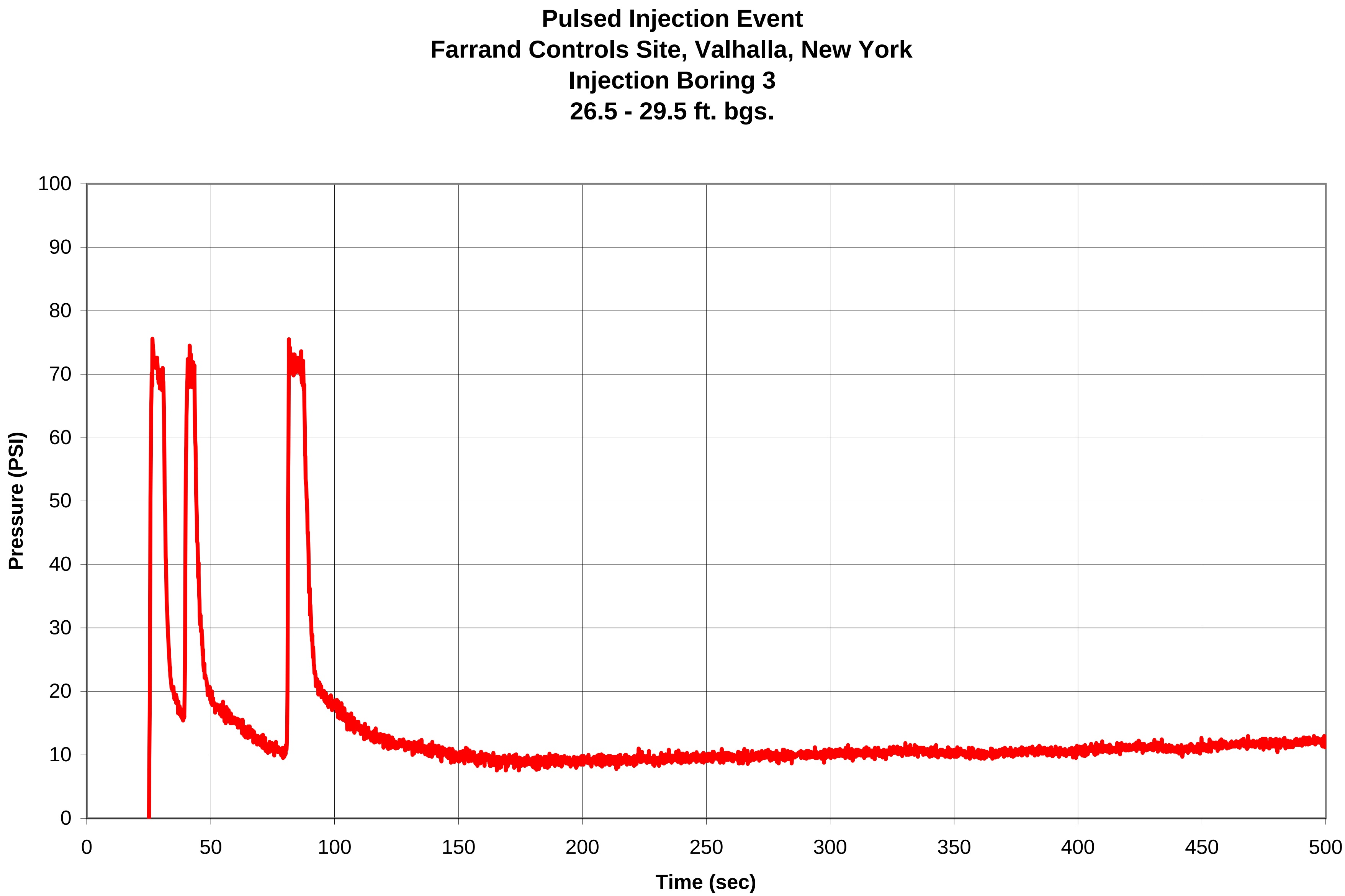


FC3-1I



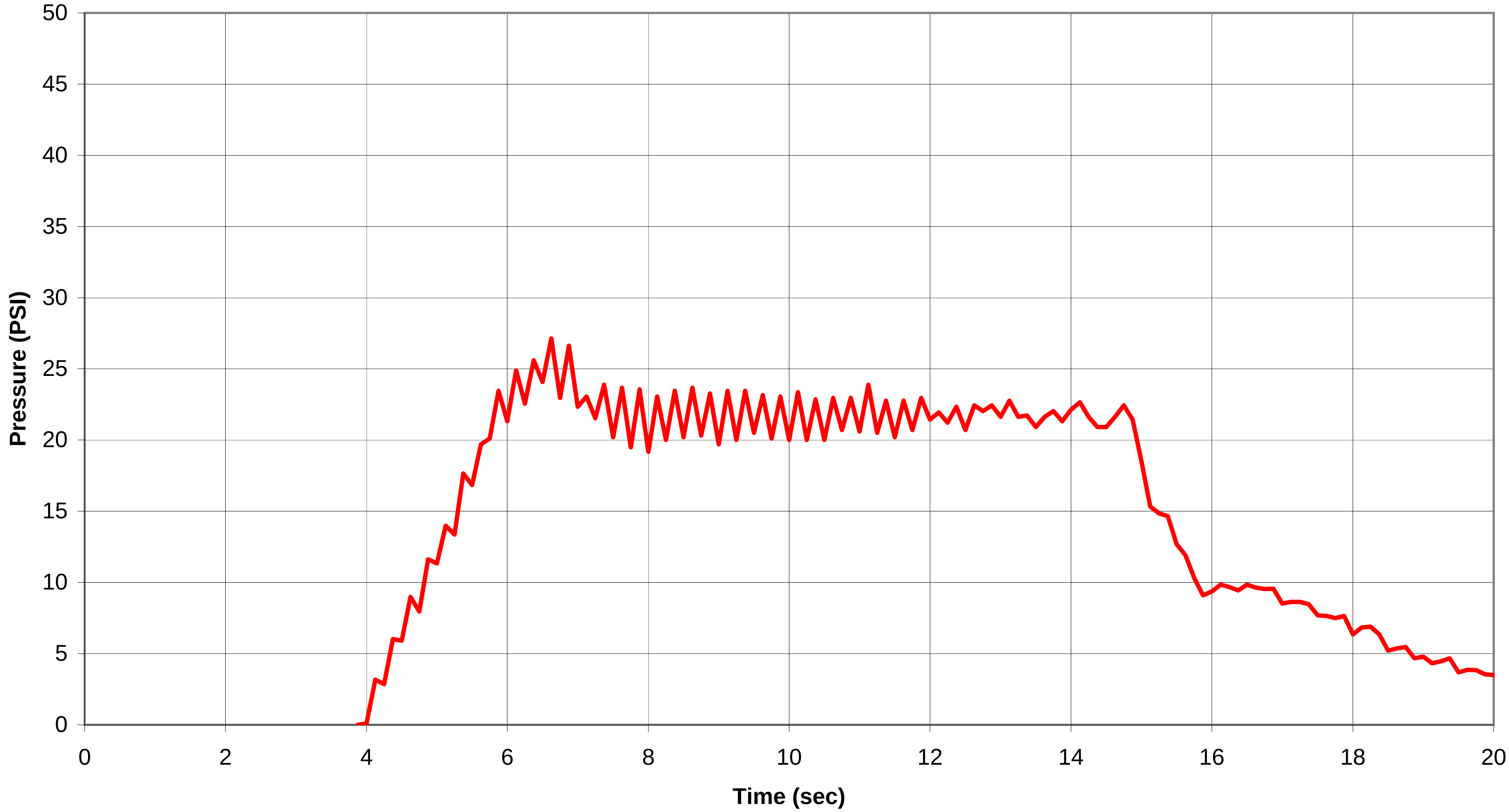
Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 3
29.5 - 32.5 ft. bgs.
Pressure (PSI)
120
100
80
60
40
20
0
0
50
100
150
200
250
300
350
400
450
500
Time (sec)

FC3-2I


Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 3
26.5 - 29.5 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
450
500
Time (sec)

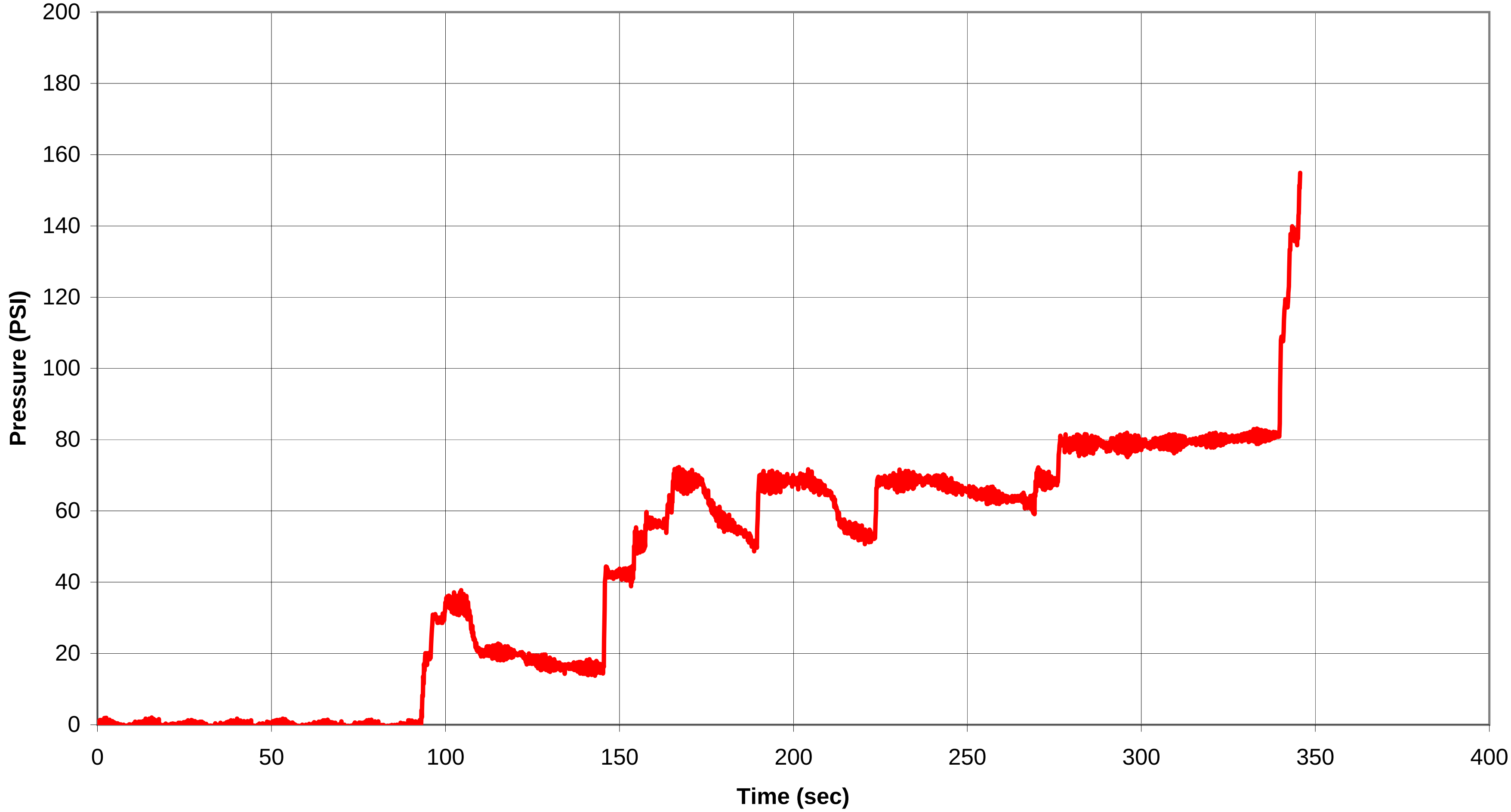
FC3-3I

Pneumatic Fracturing Event
Farrand Controls Site, Valhalla, New York
Injection Boring 4
33.5 - 35 ft. bgs.

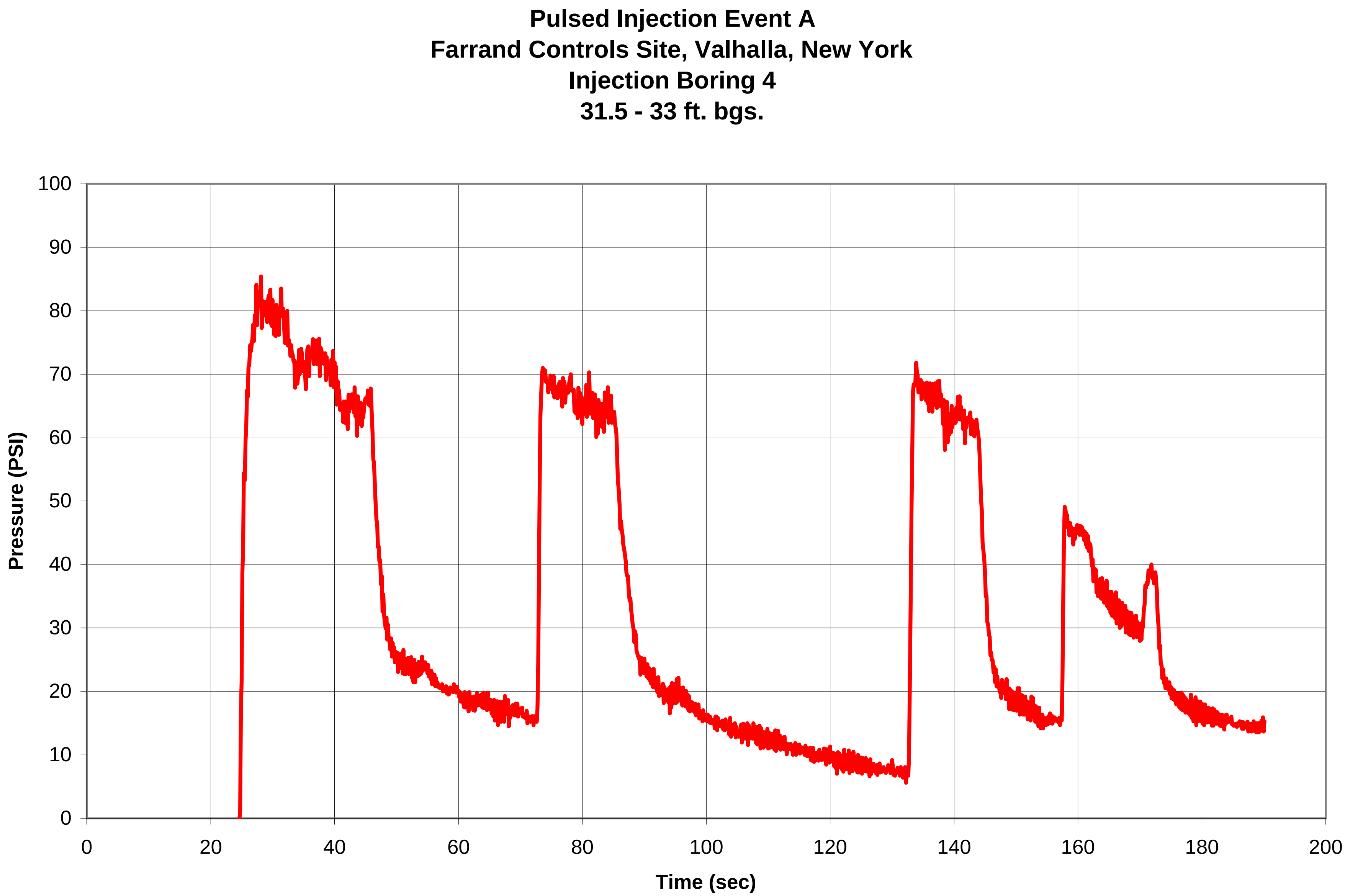


FC4-1F

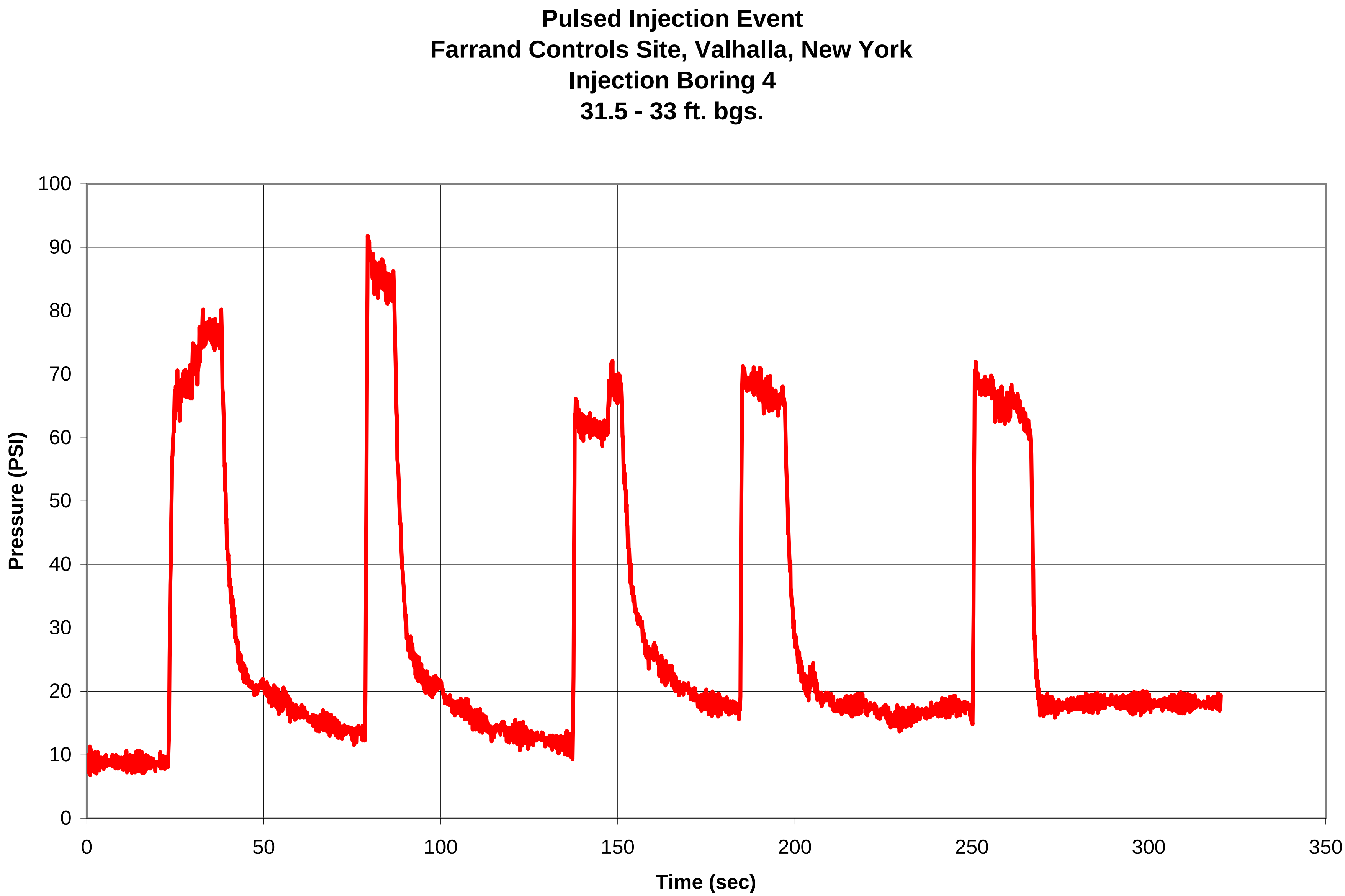
Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 4
33.5 - 35 ft. bgs.



FC4-1I

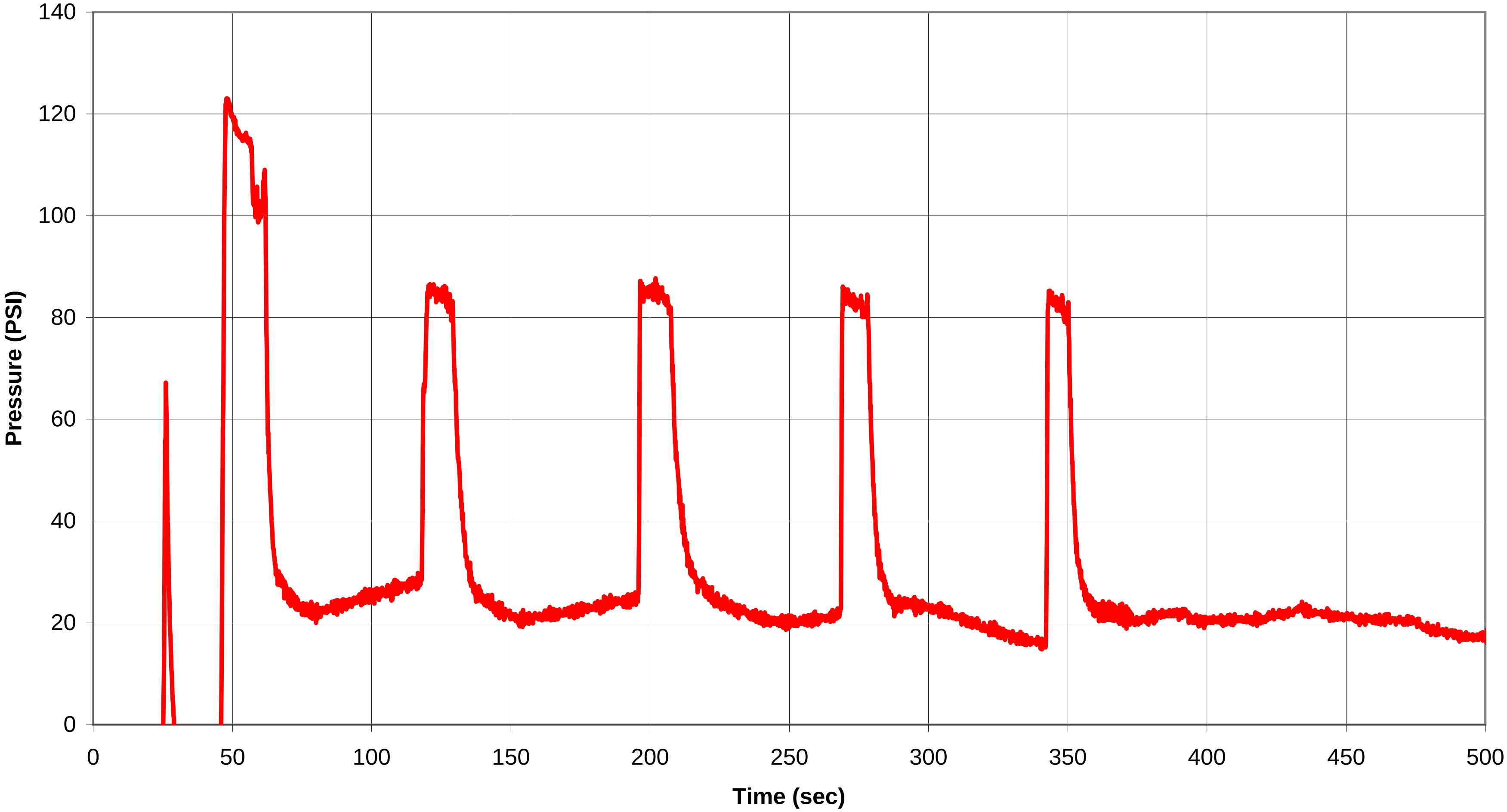

Pulsed Injection Event A
Farrand Controls Site, Valhalla, New York
Injection Boring 4
31.5 - 33 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
180
200
Time (sec)

FC4-2IA

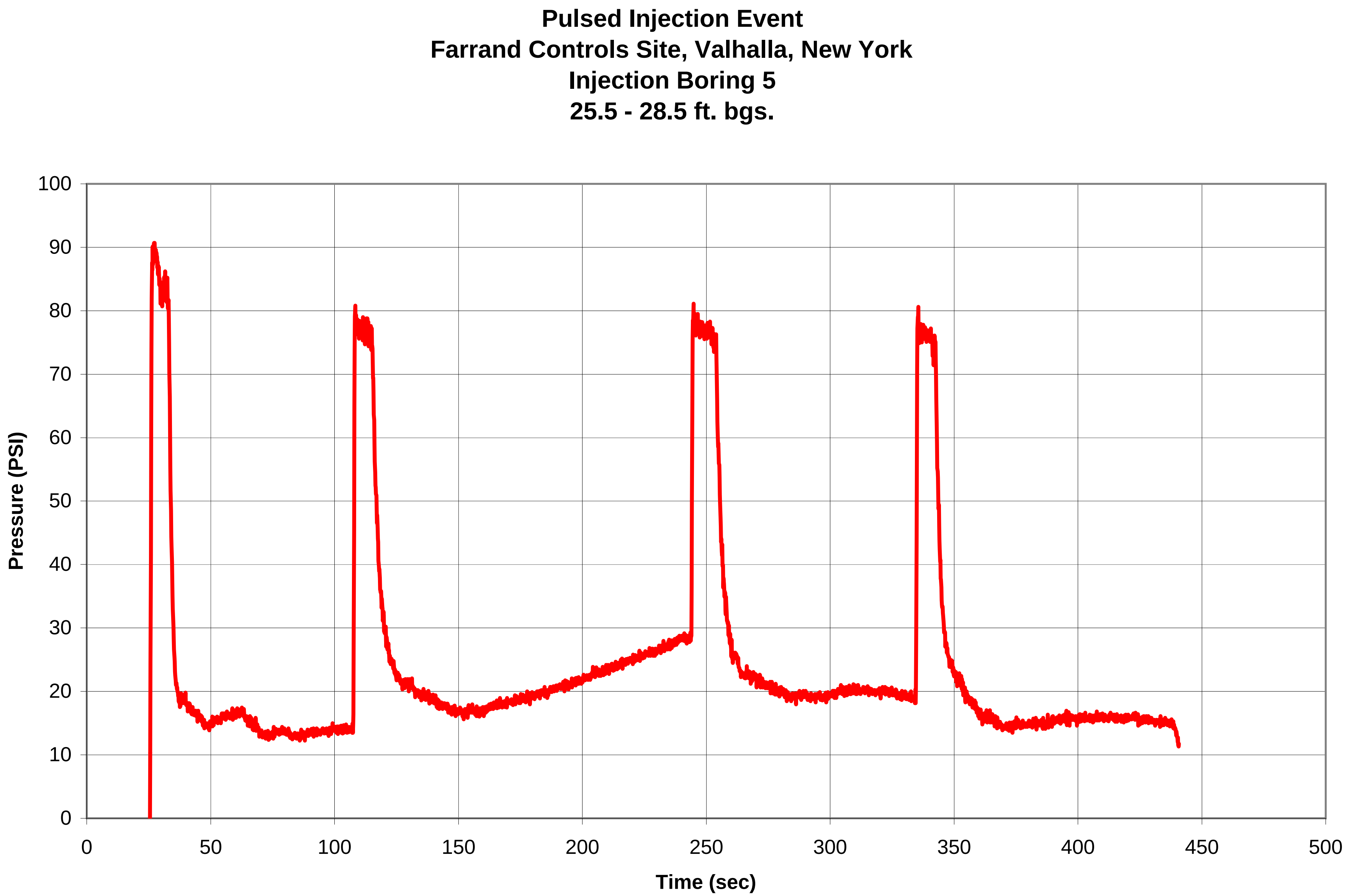

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 4
31.5 - 33 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
Time (sec)

FC4-2IB

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 5
28.5 - 30.5 ft. bgs.



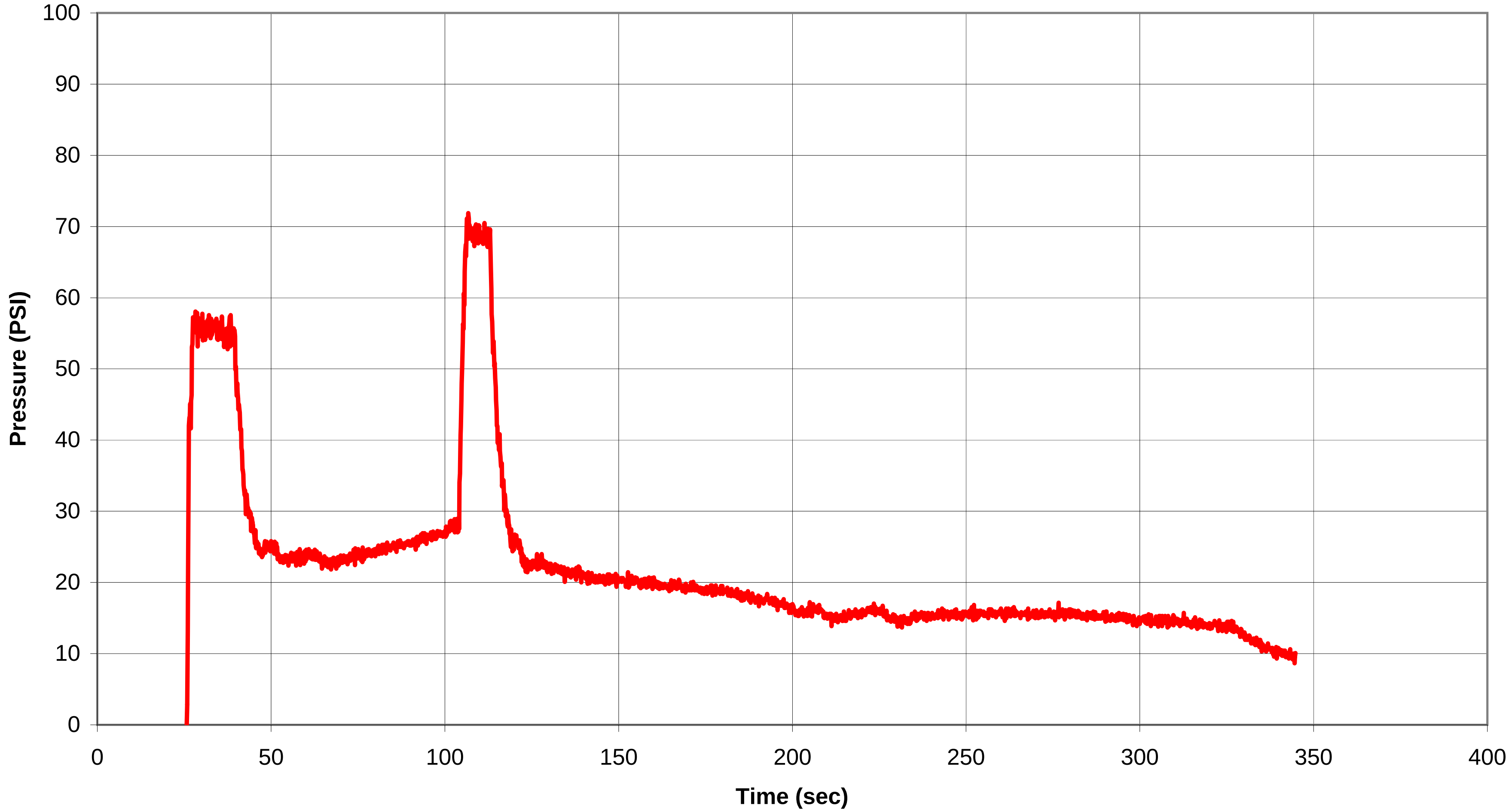
FC5-1I



Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 5
25.5 - 28.5 ft. bgs.
100
90
80
70
60
50
40
30
20
10
0
Pressure (PSI)
0
50
100
150
200
250
300
350
400
450
500
Time (sec)

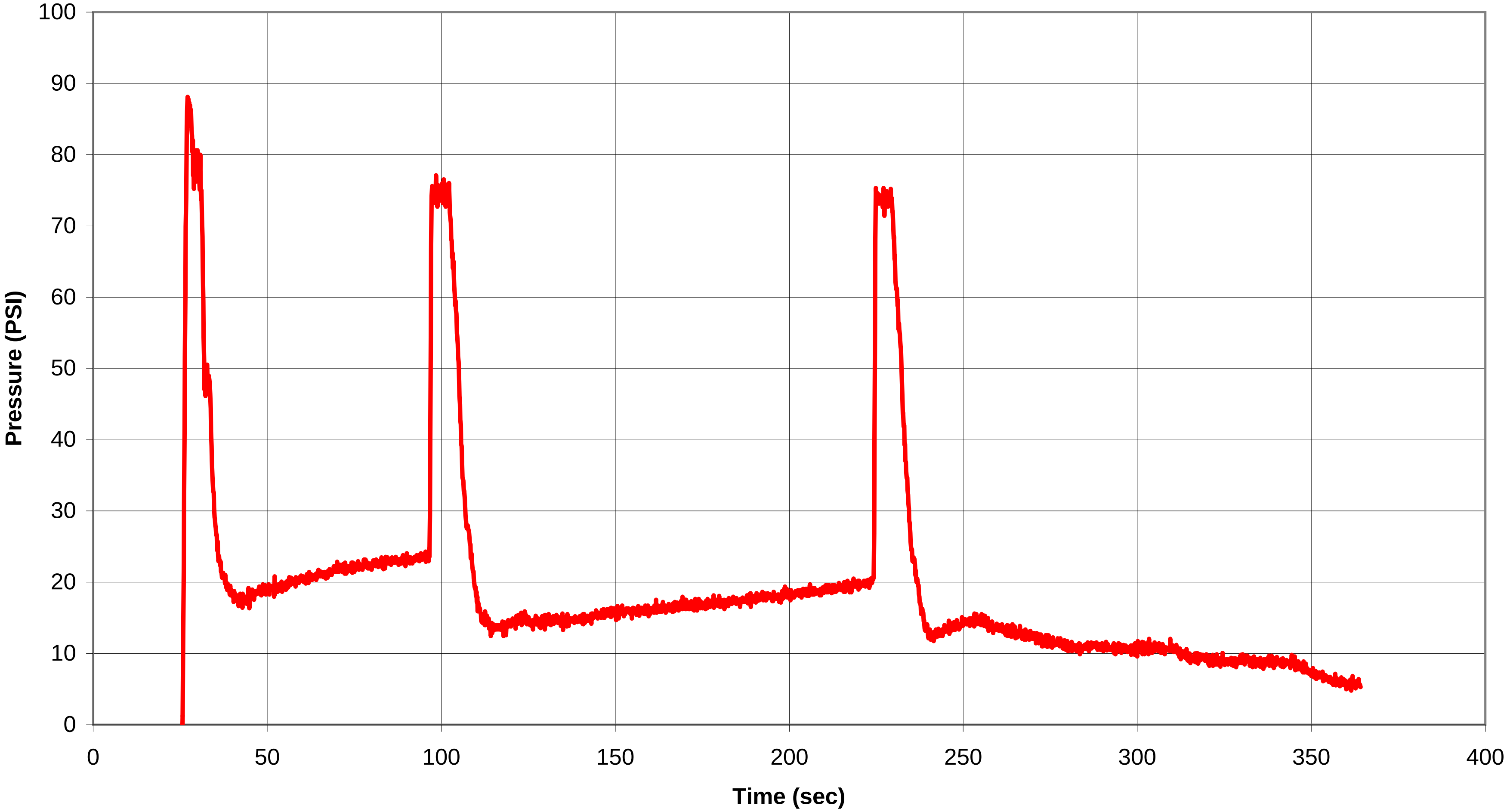
FC5-2I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 5
22.5 - 28.5 ft. bgs.

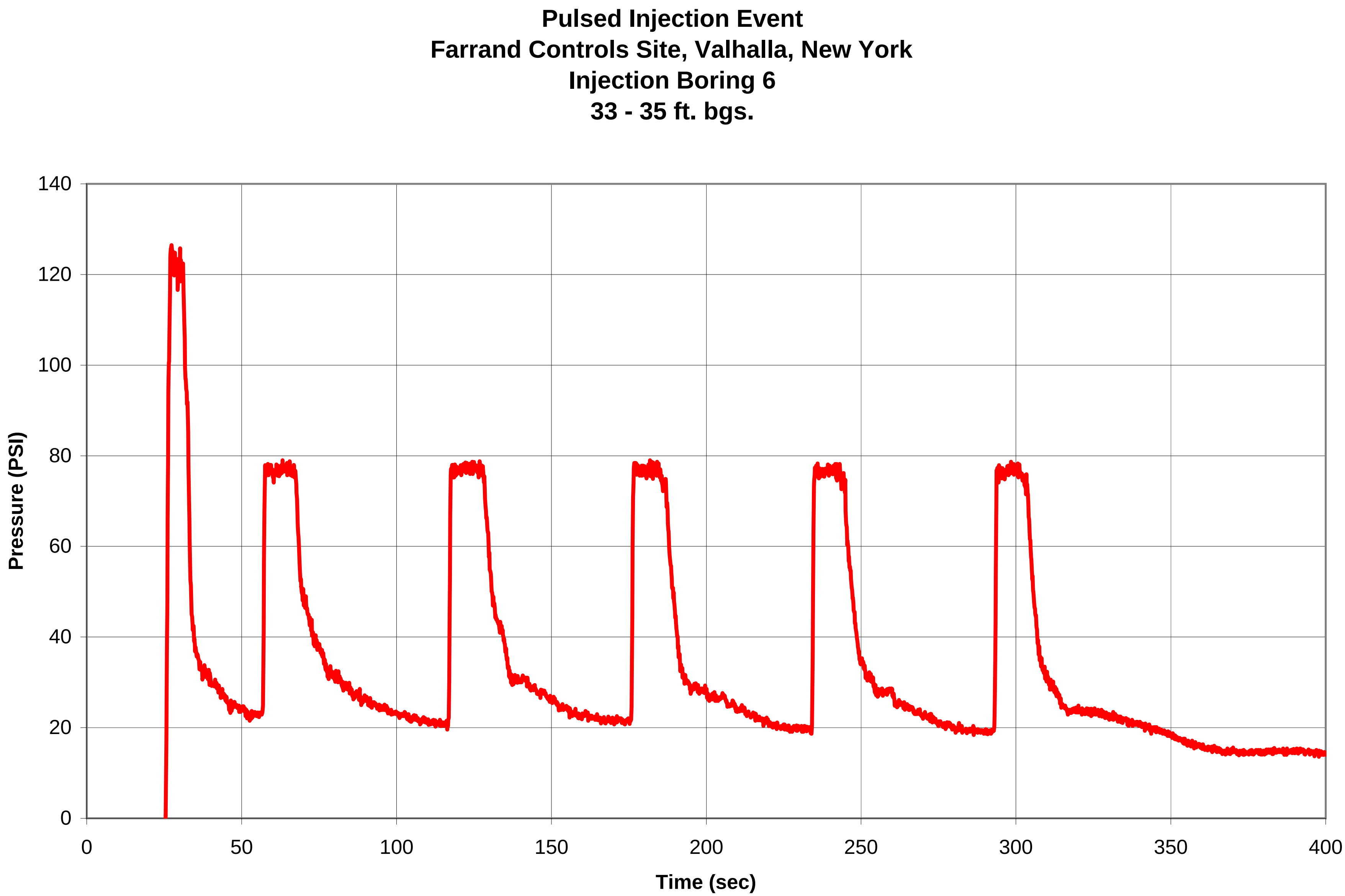


FC5-3I

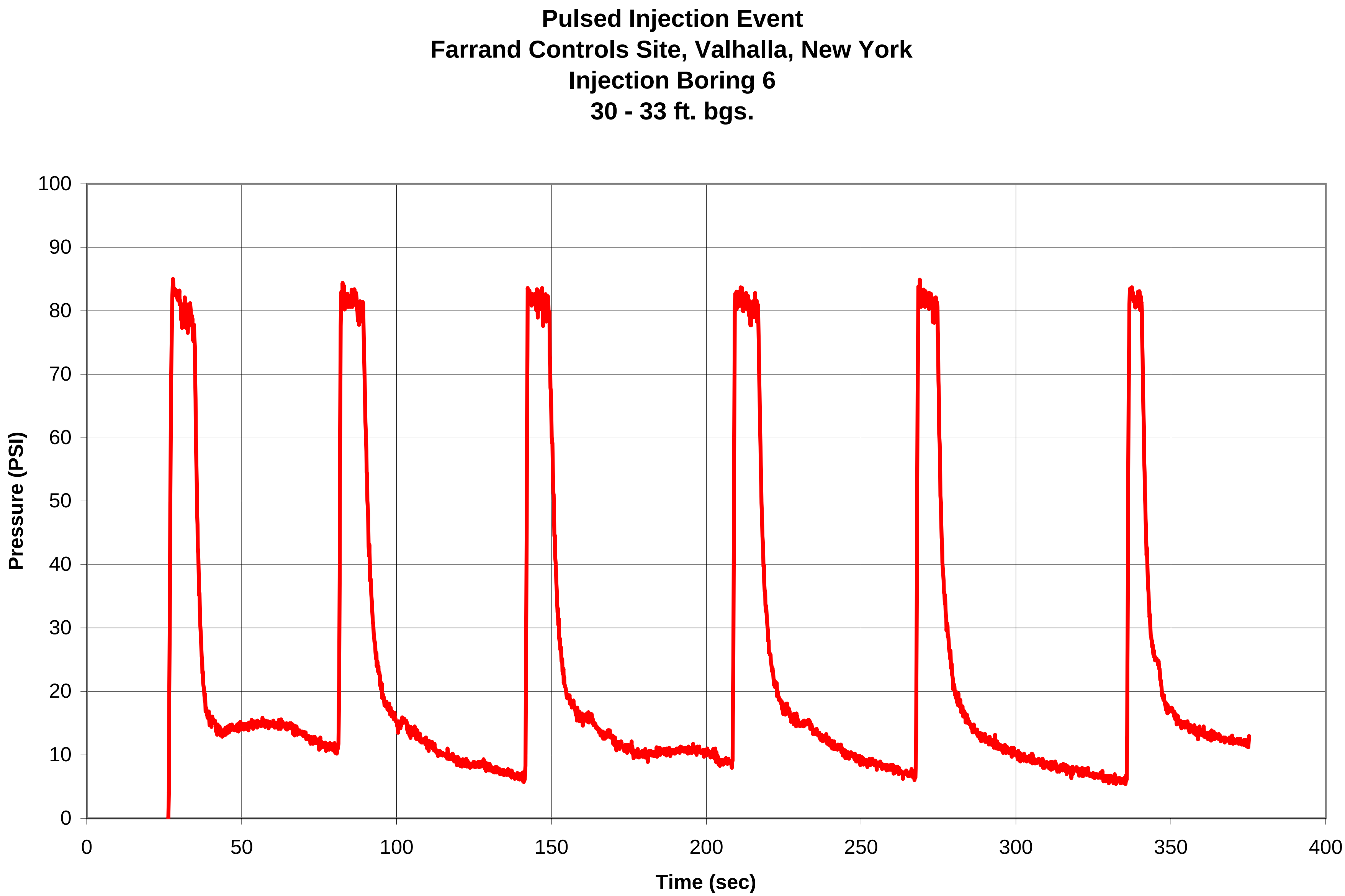
Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 5
19.5 - 22.5 ft. bgs.



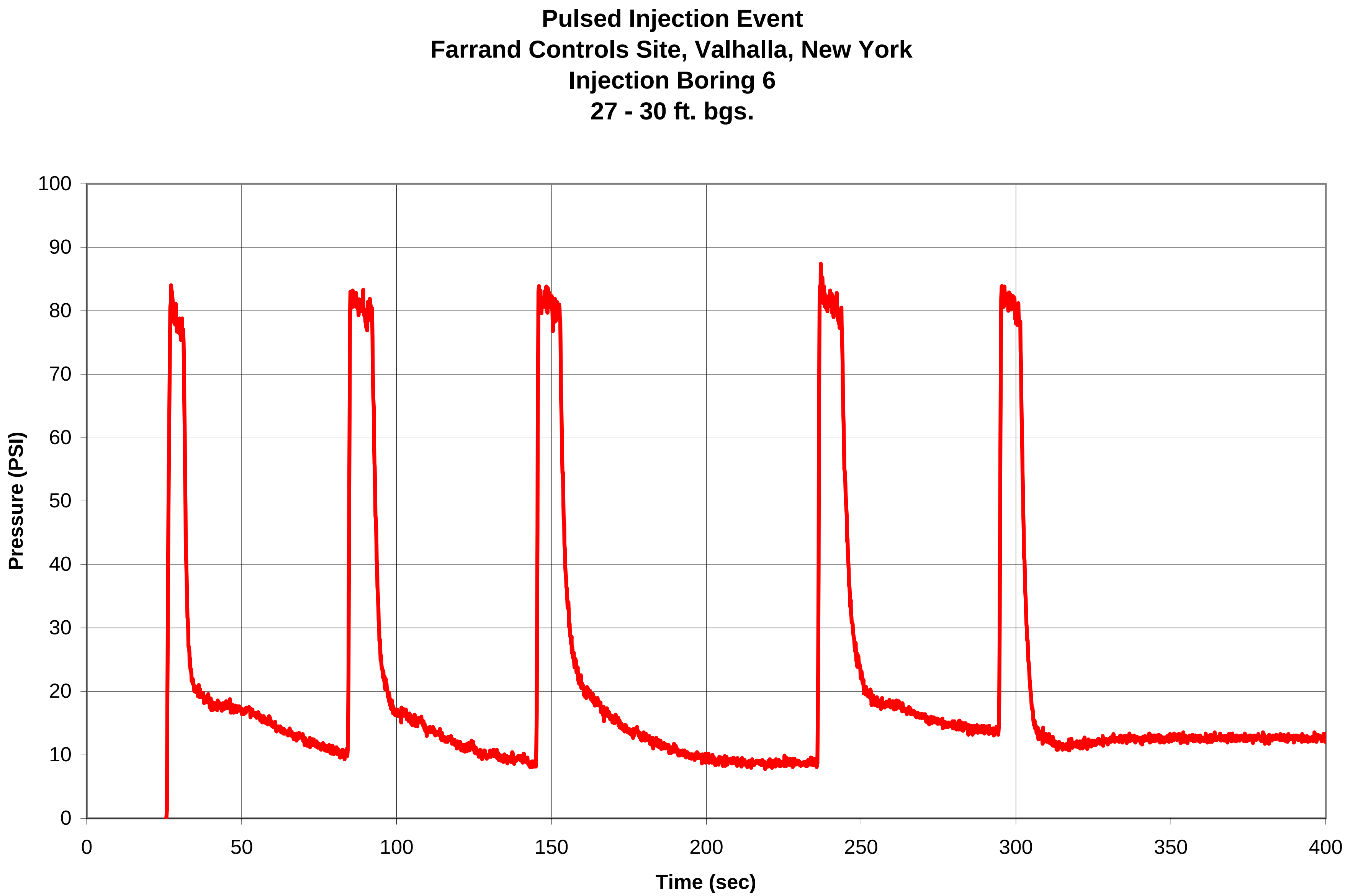
FC5-4I


Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 6
33 - 35 ft. bgs.
Pressure (PSI)
Time (sec)
0
20
40
60
80
100
120
140
0
50
100
150
200
250
300
350
400

FC6-1I


Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 6
30 - 33 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
Time (sec)

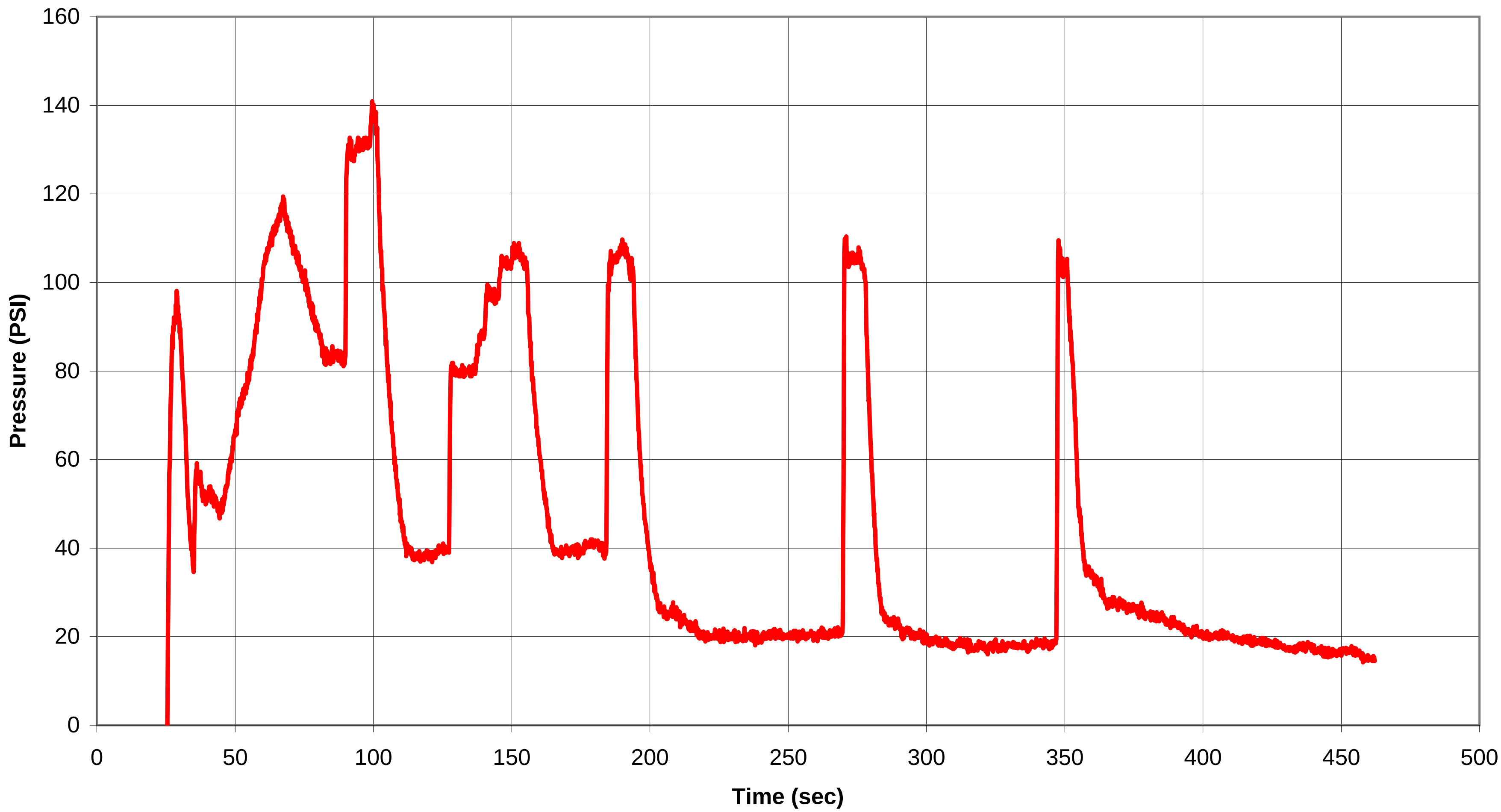
FC6-2I



Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 6
27 - 30 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
Time (sec)

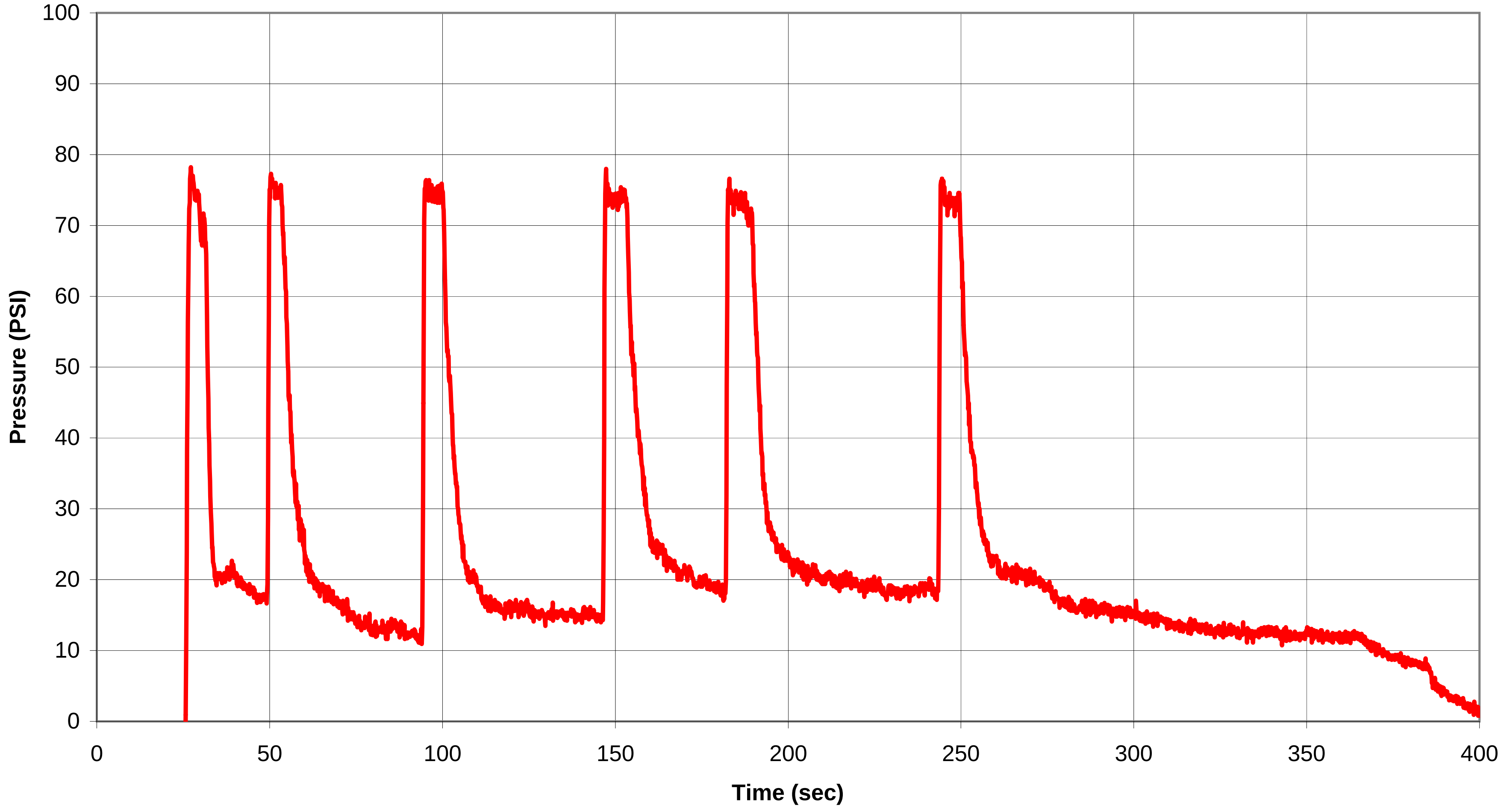
FC6-3I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 7
29.5 - 31.5 ft. bgs.



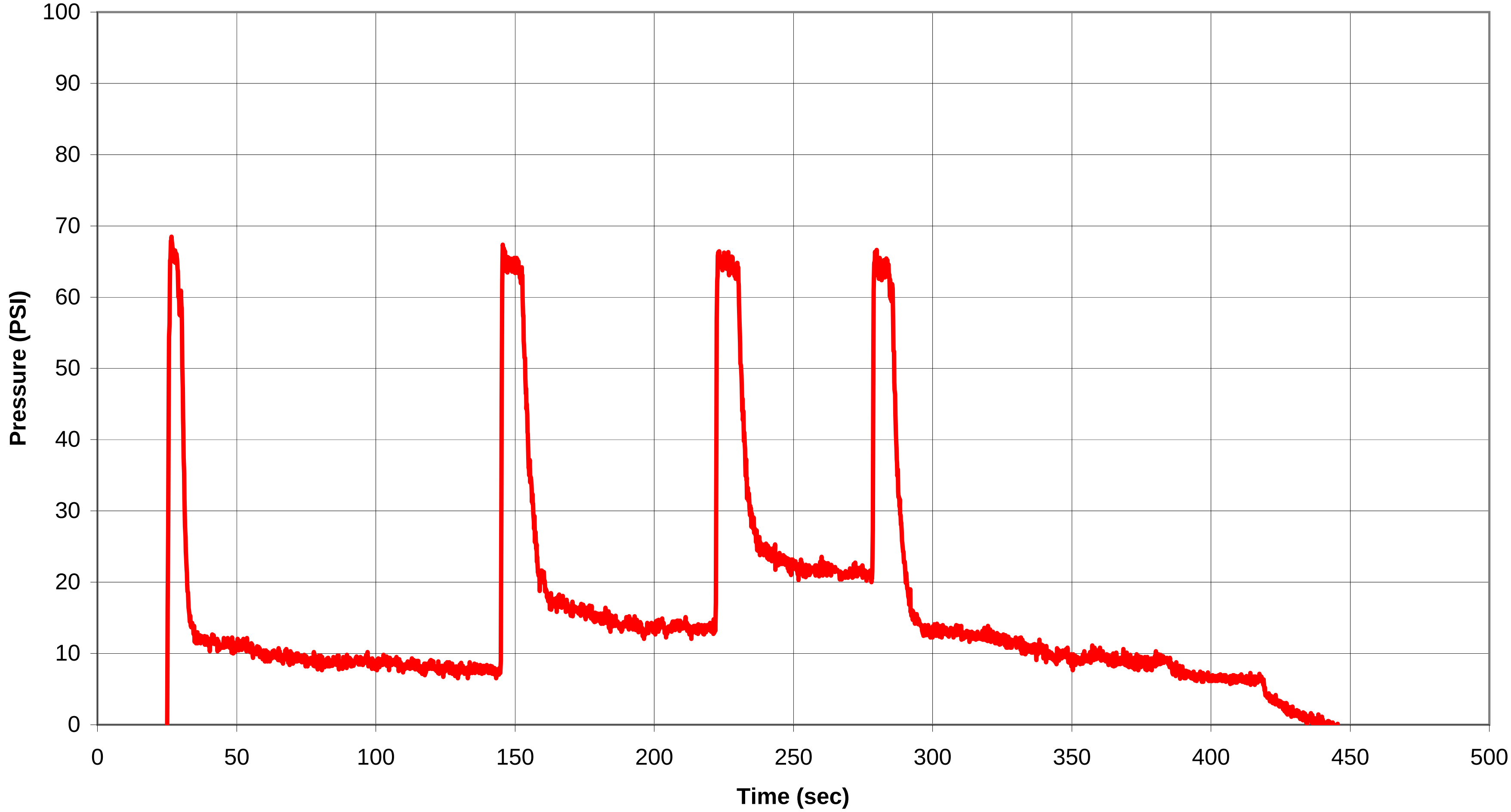
FC7-1I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 7
26.5 - 29.5 ft. bgs.



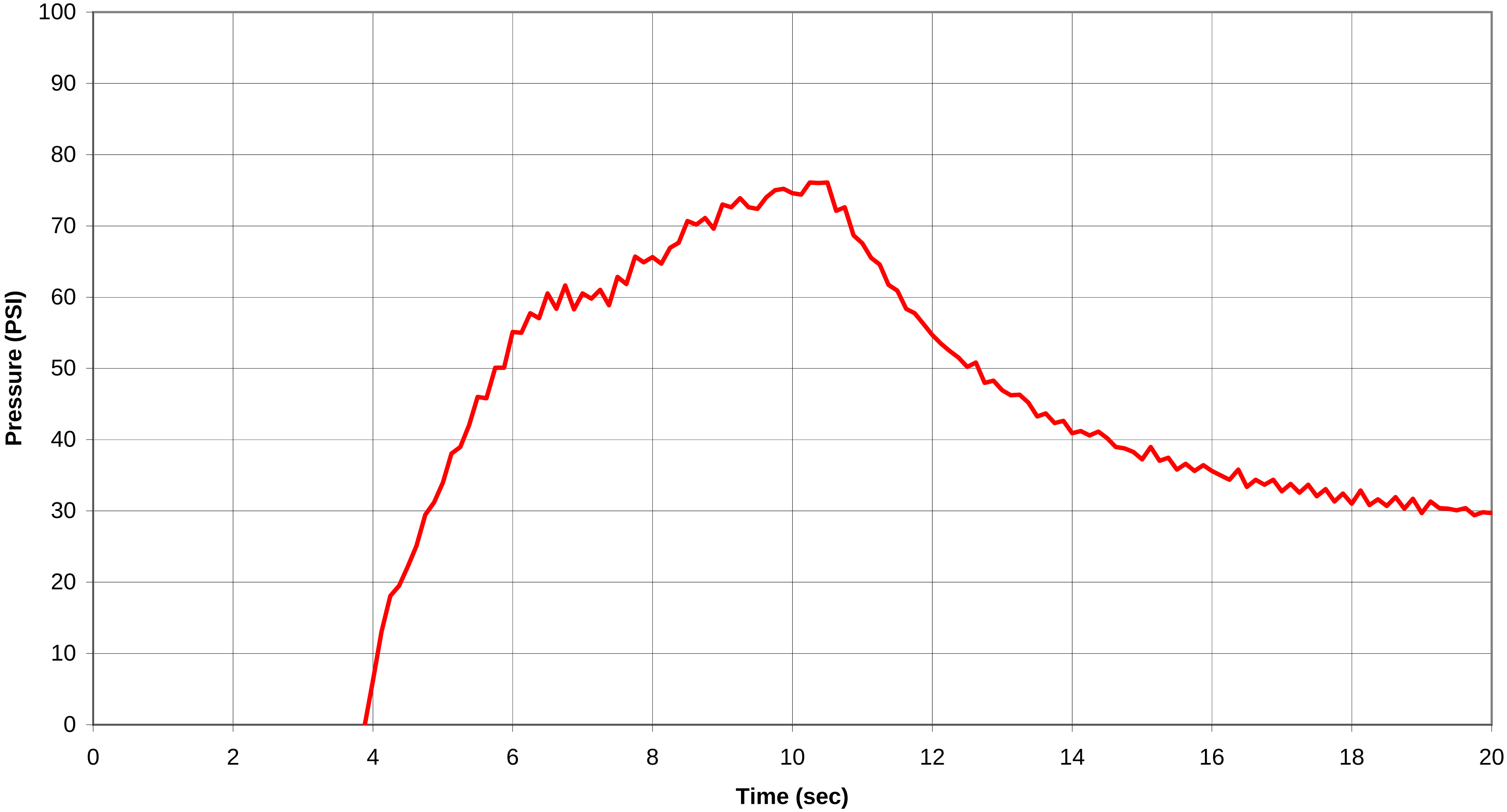
FC7-2I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 7
23.5 - 26.5 ft. bgs.



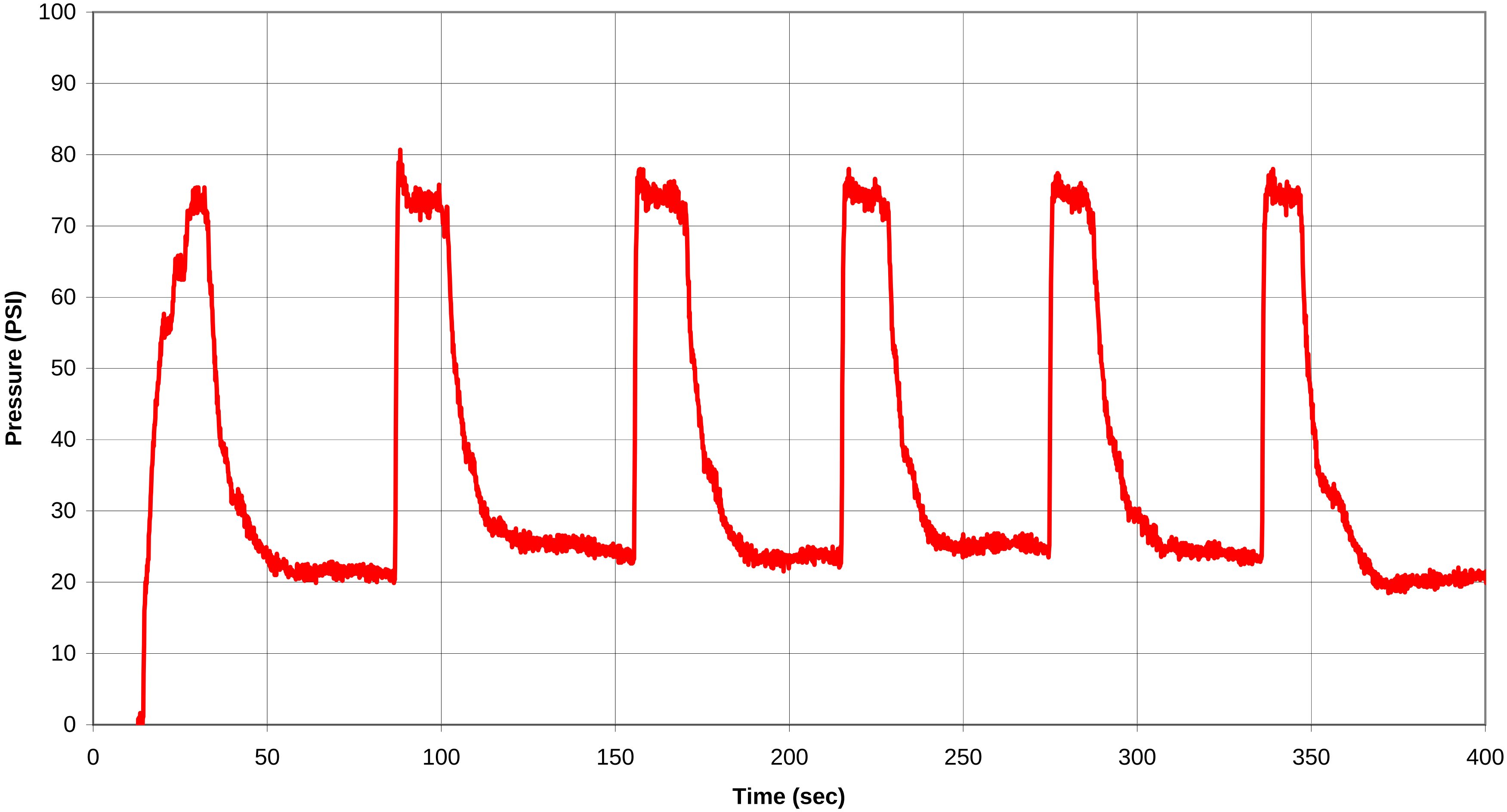
FC7-3I

Pneumatic Fracturing Event
Farrand Controls Site, Valhalla, New York
Injection Boring 8
29.5 - 31.5 ft. bgs.



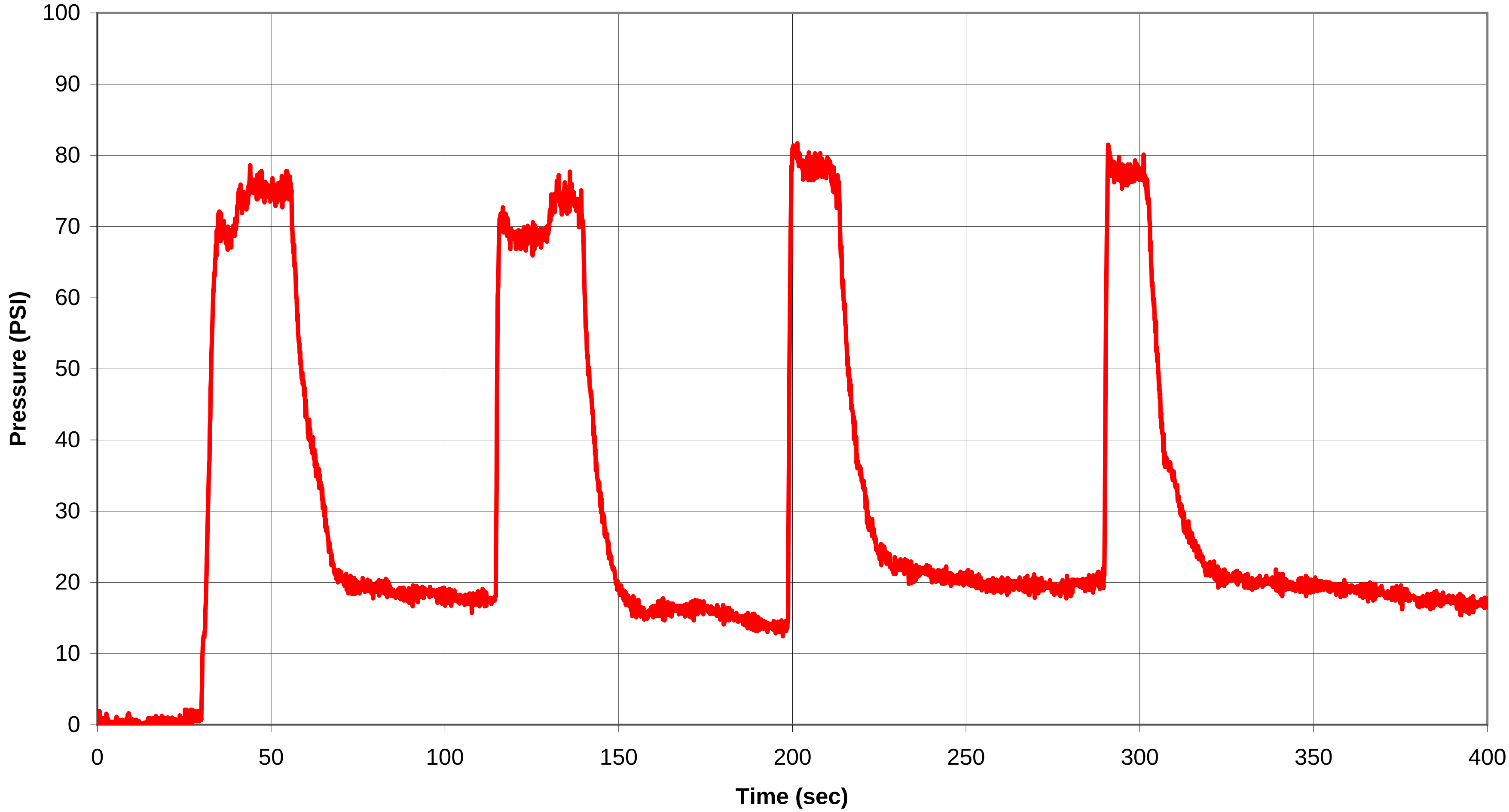
FC8-1F

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 8
29.5 - 31.5 ft. bgs.



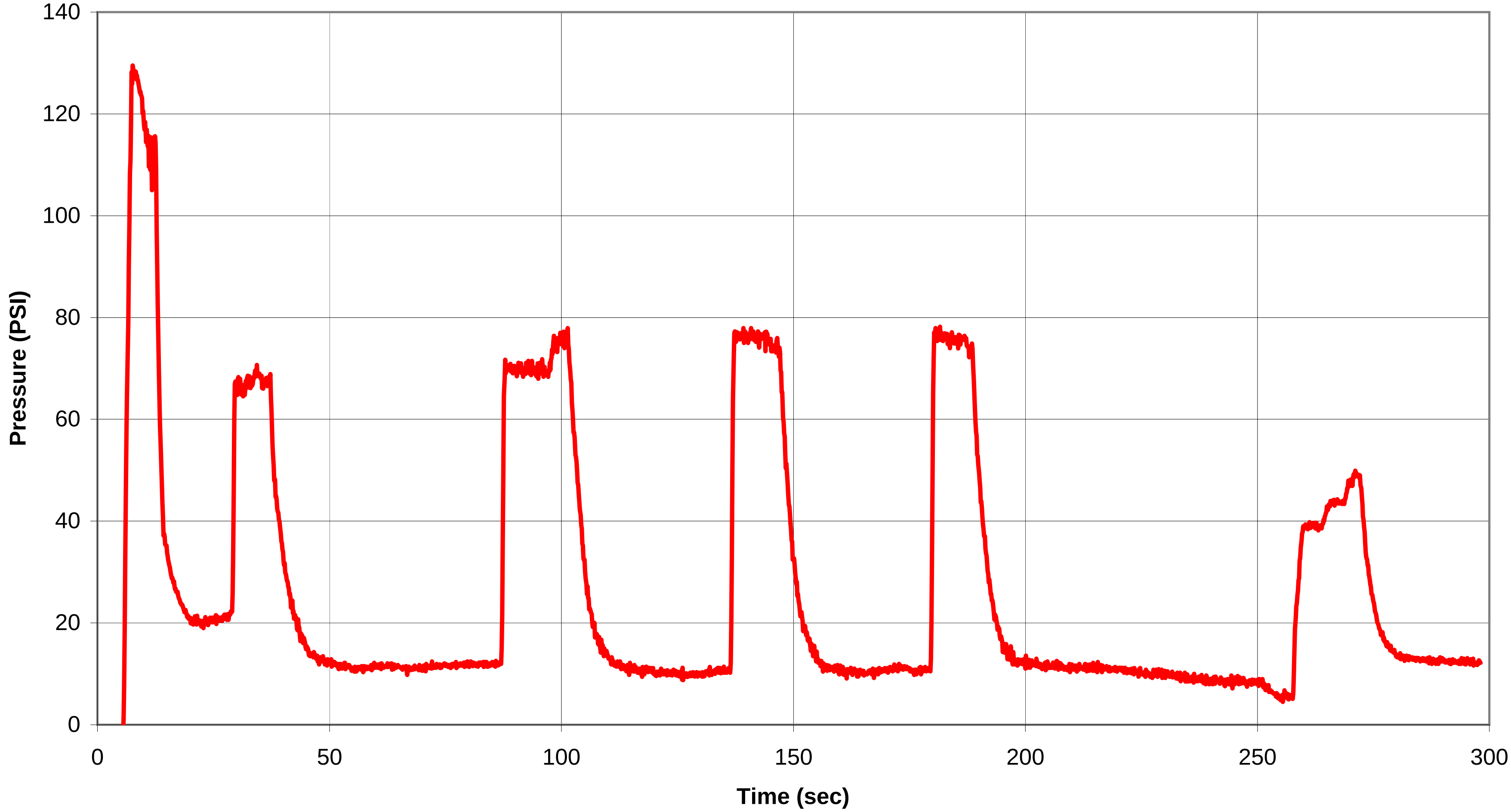
FC8-1I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 8
26.5 - 29.5 ft. bgs.

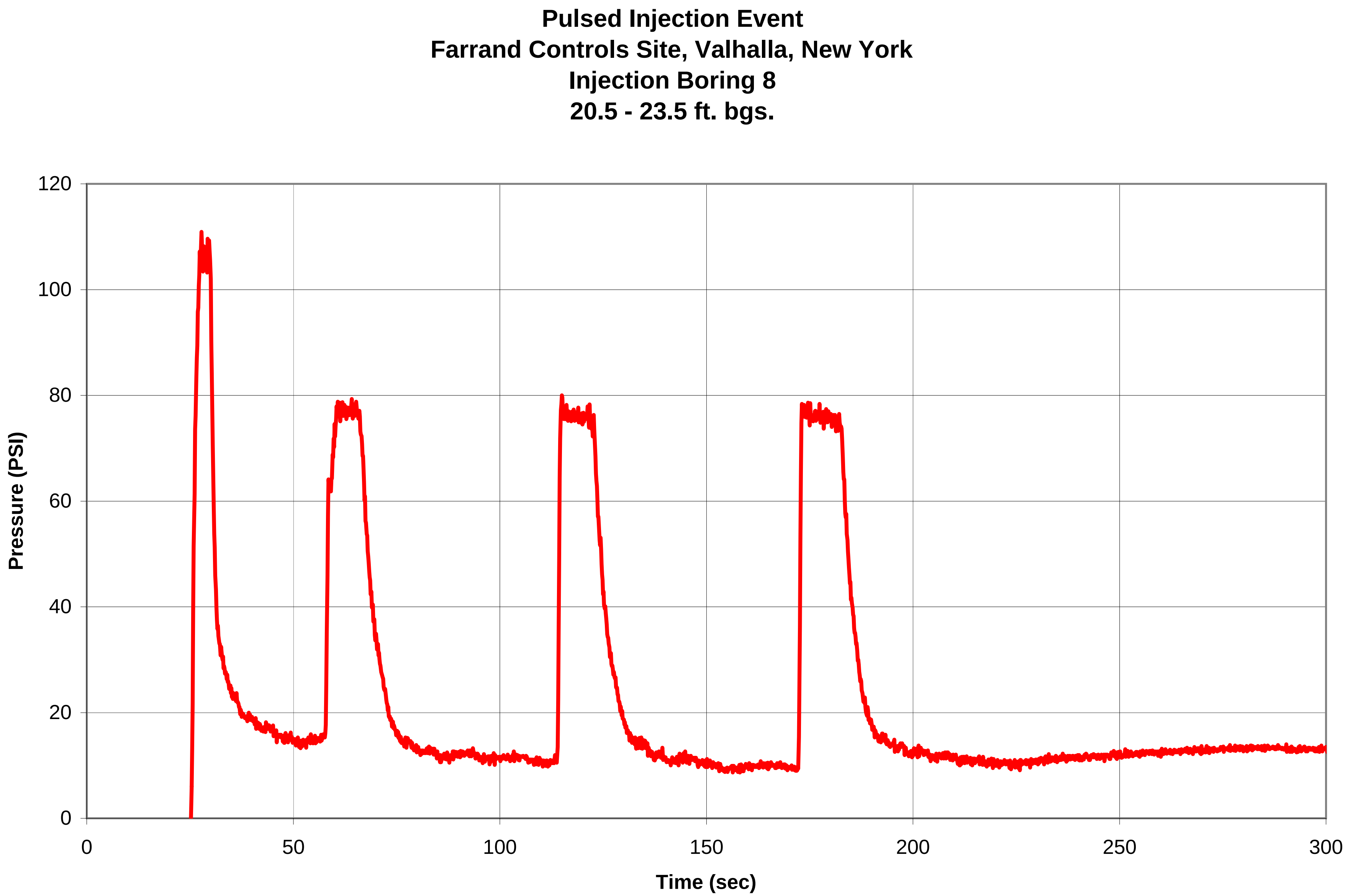


FC8-2I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 8
23.5 - 26.5 ft. bgs.

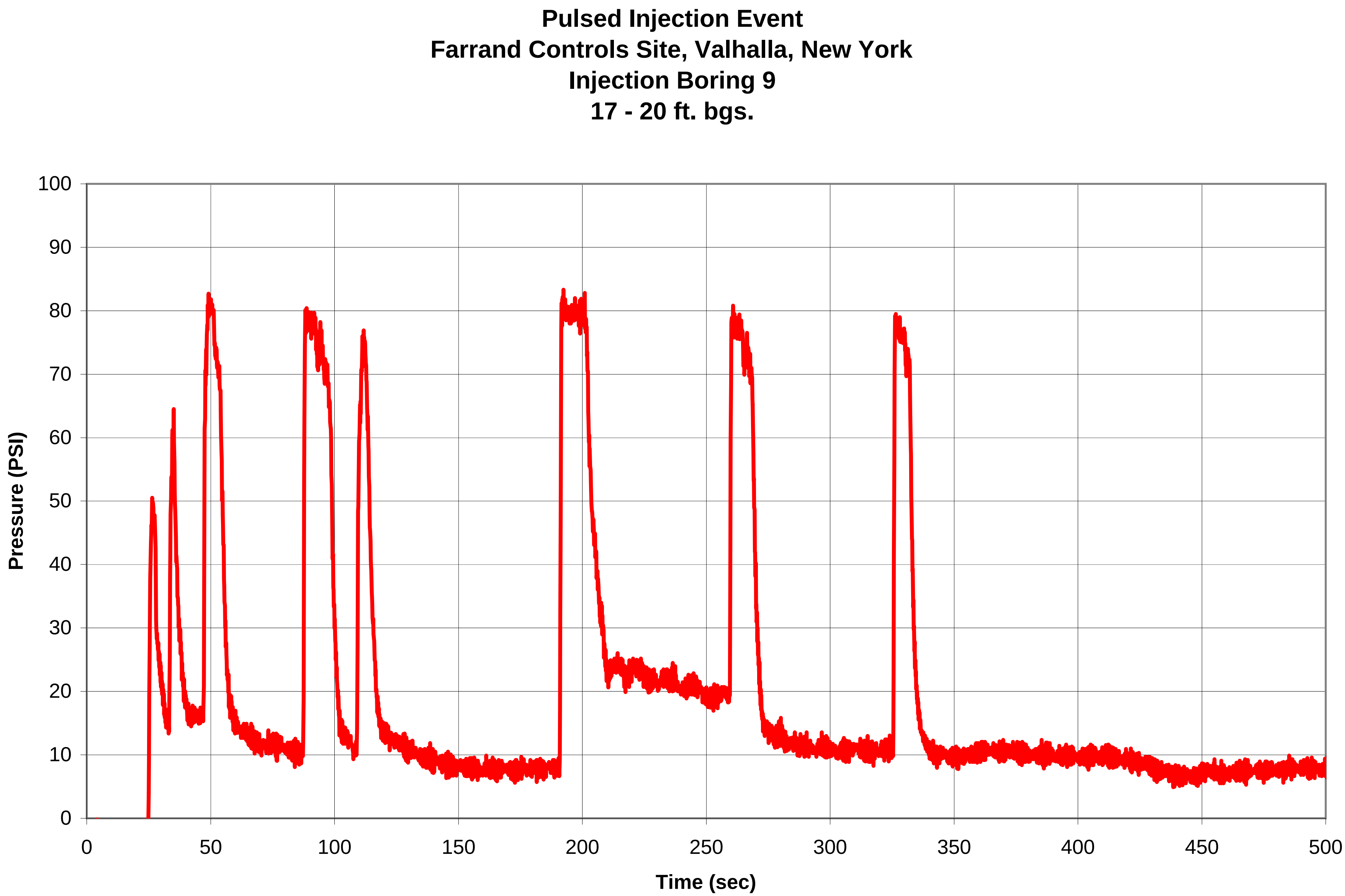


FC8-3I



Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 8
20.5 - 23.5 ft. bgs.
120
100
80
60
40
20
0
Pressure (PSI)
0
50
100
150
200
250
300
Time (sec)

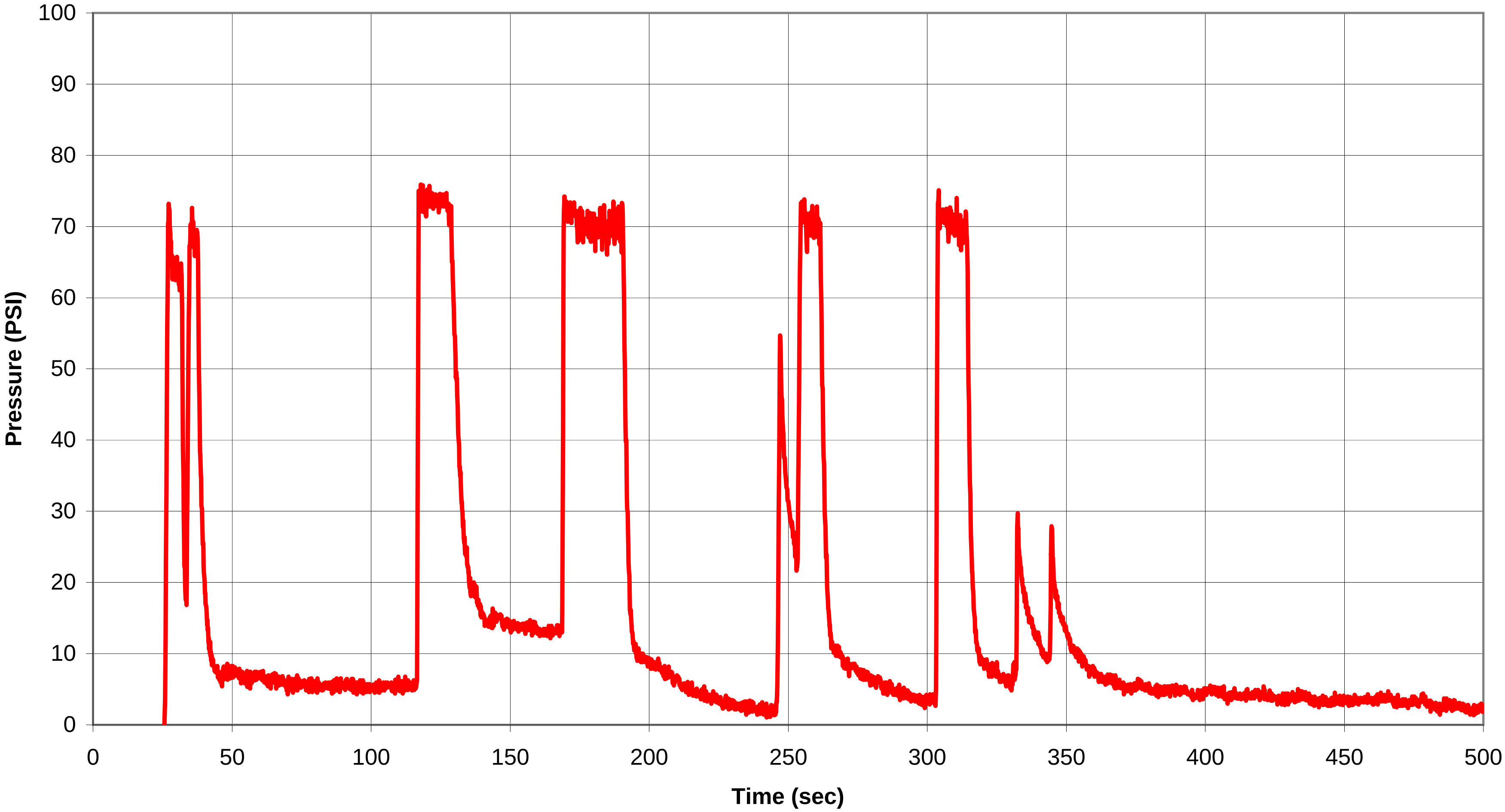
FC8-4I



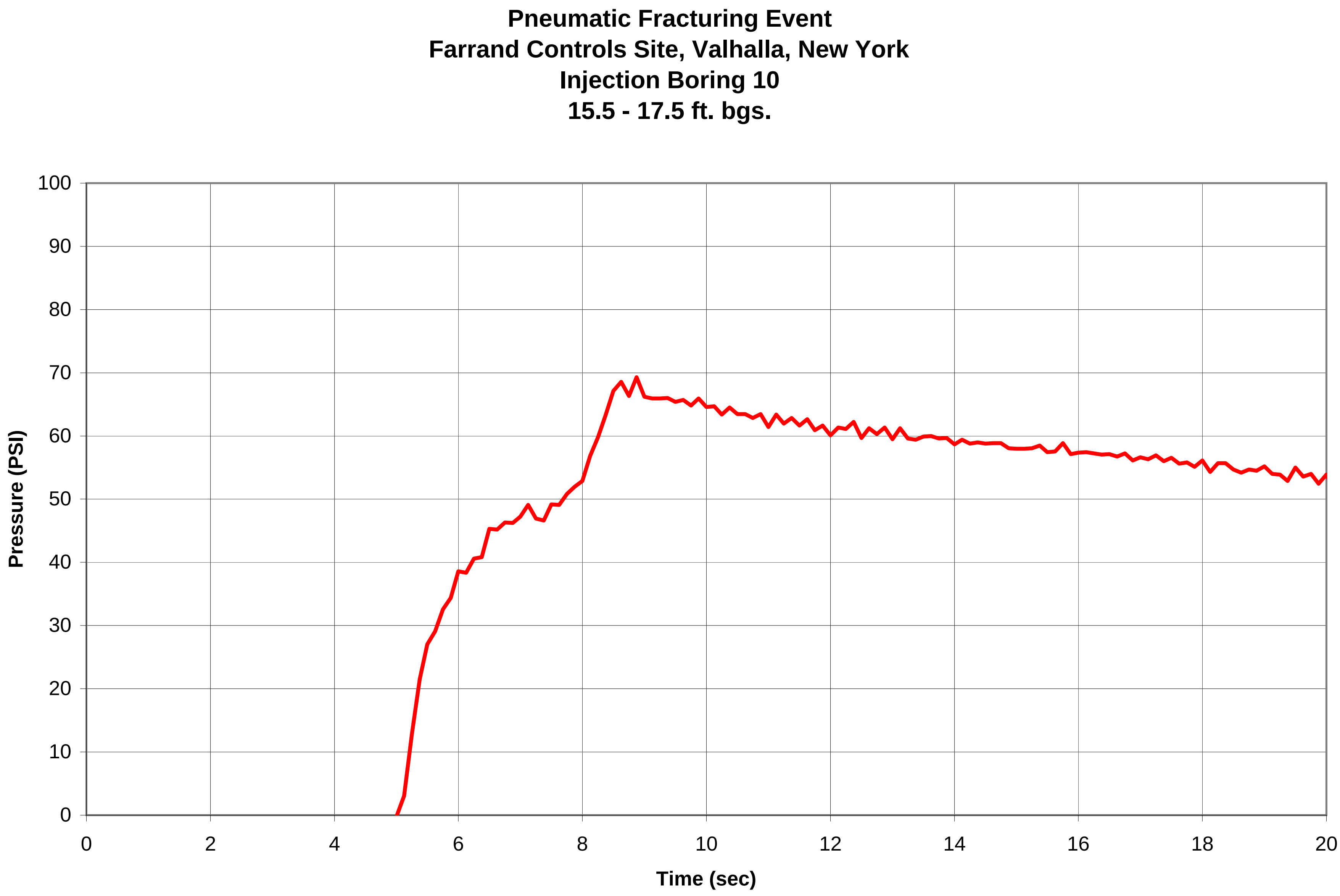
Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 9
17 - 20 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
450
500
Time (sec)

FC9-1I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 9
11 - 14 ft. bgs.



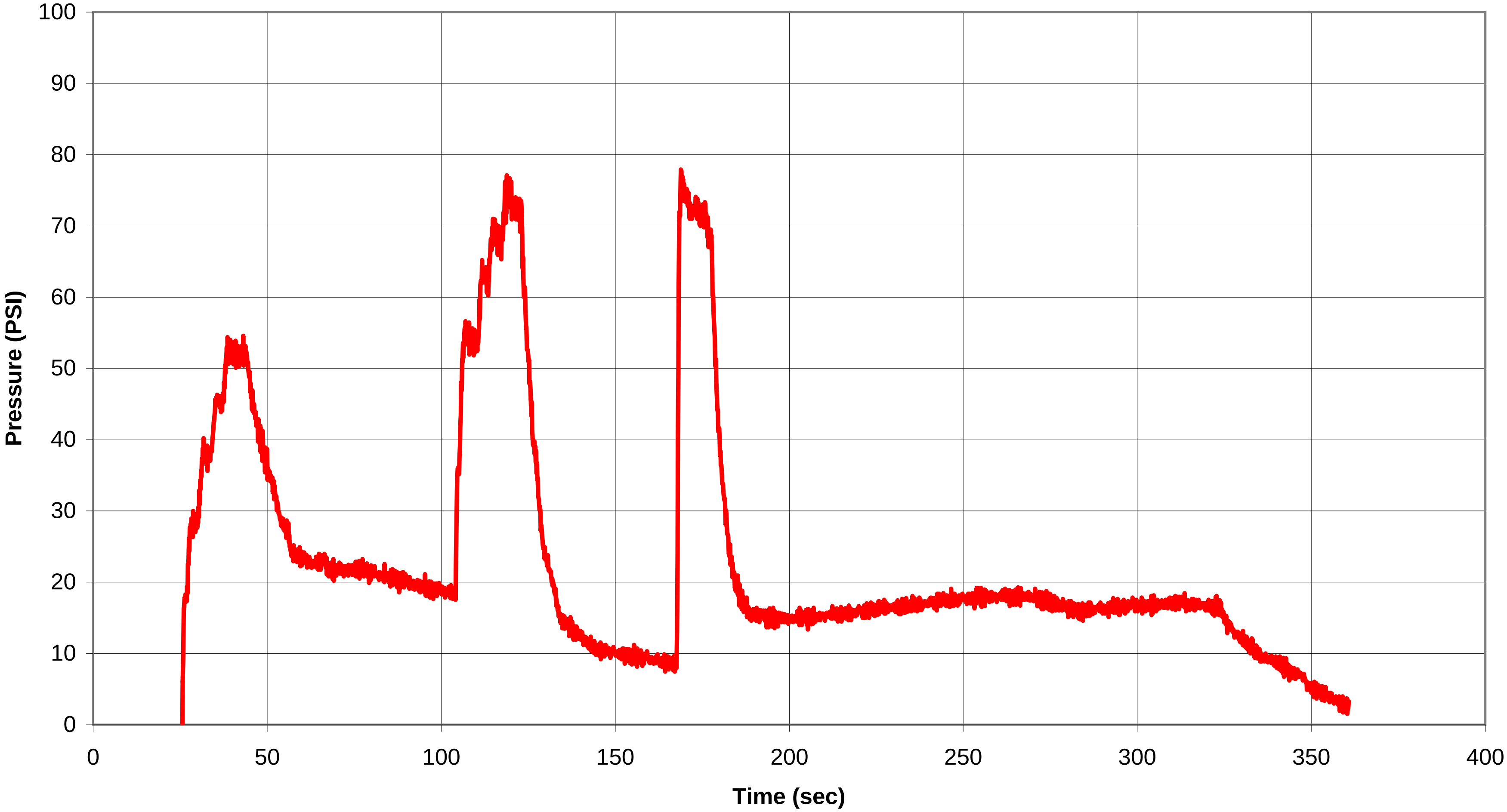
FC9-3I



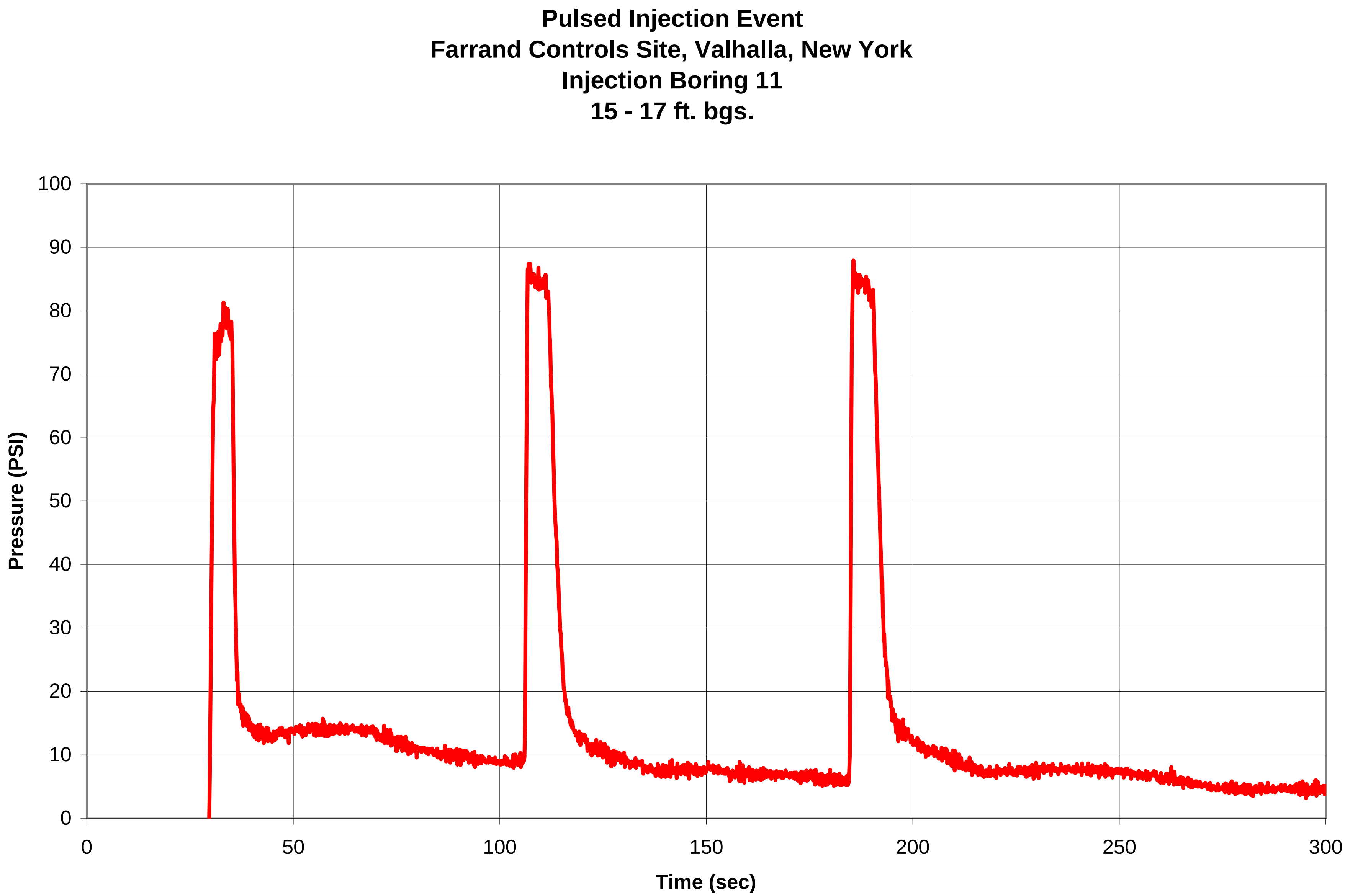
Pneumatic Fracturing Event
Farrand Controls Site, Valhalla, New York
Injection Boring 10
15.5 - 17.5 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Time (sec)

FC10-1F

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 10
15.5 - 17.5 ft. bgs.

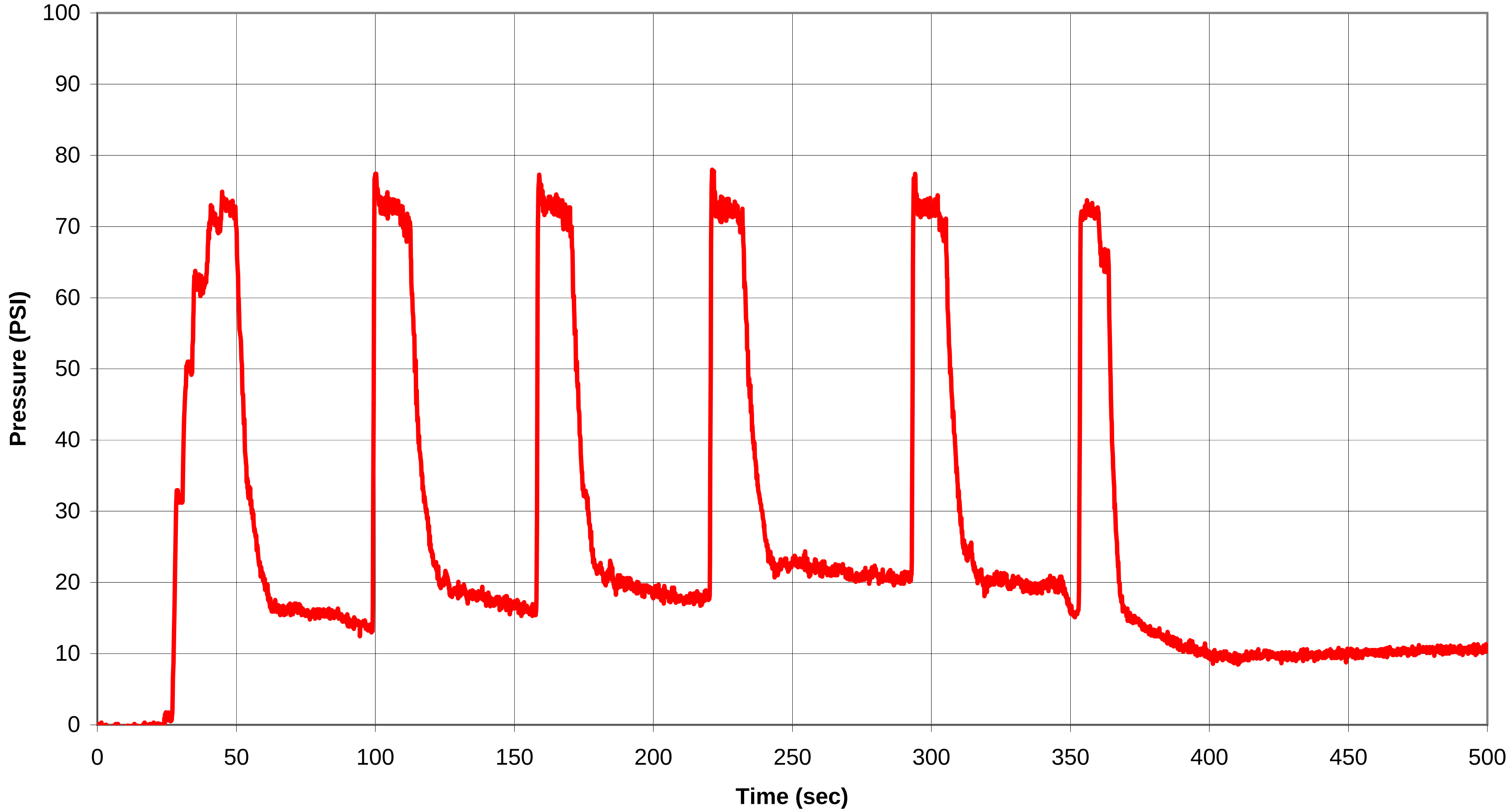


FC10-1I


Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 11
15 - 17 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
Time (sec)

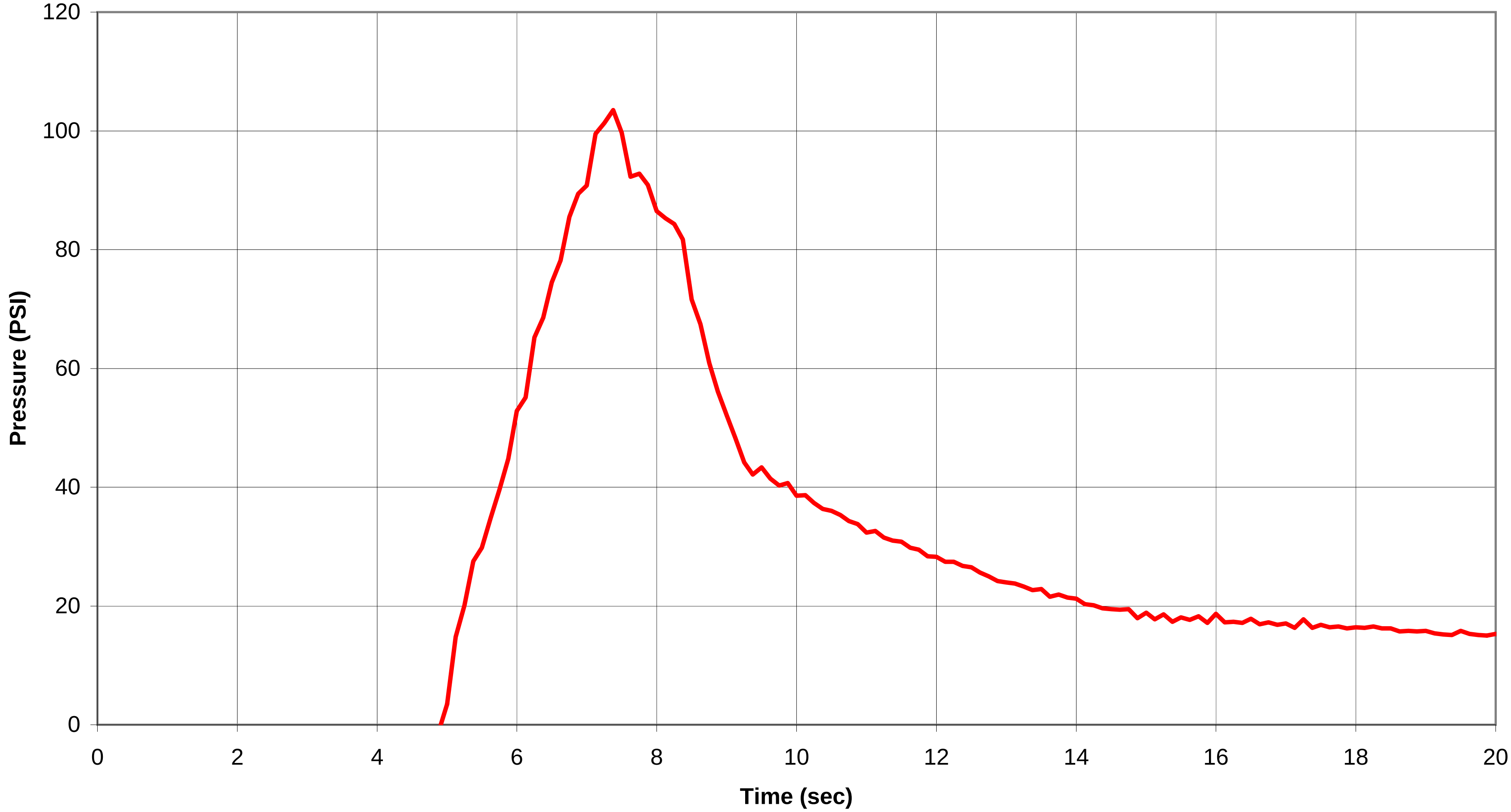
FC11-1I

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 12
24.5 - 26 ft. bgs.

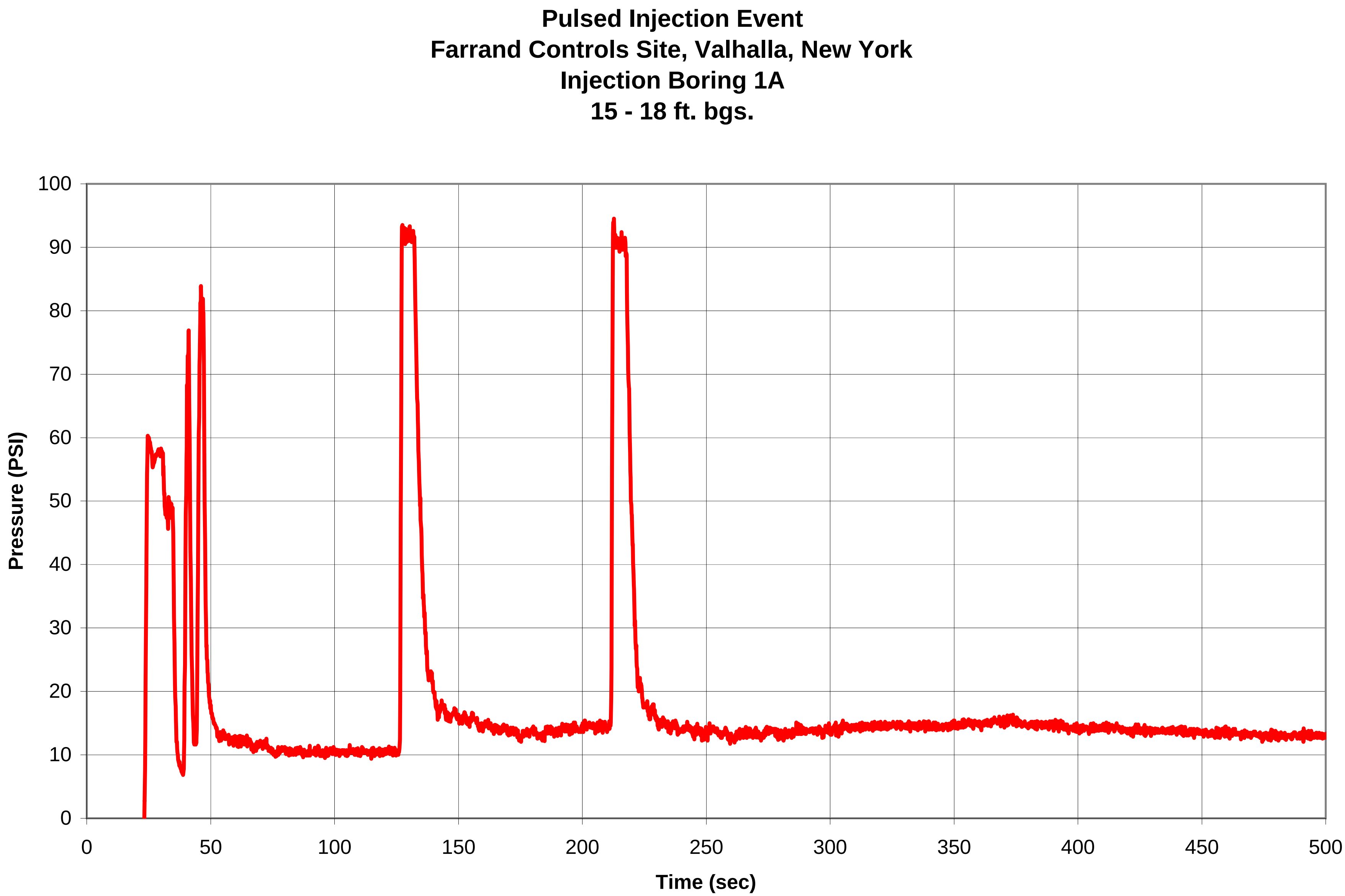


FC12-1I

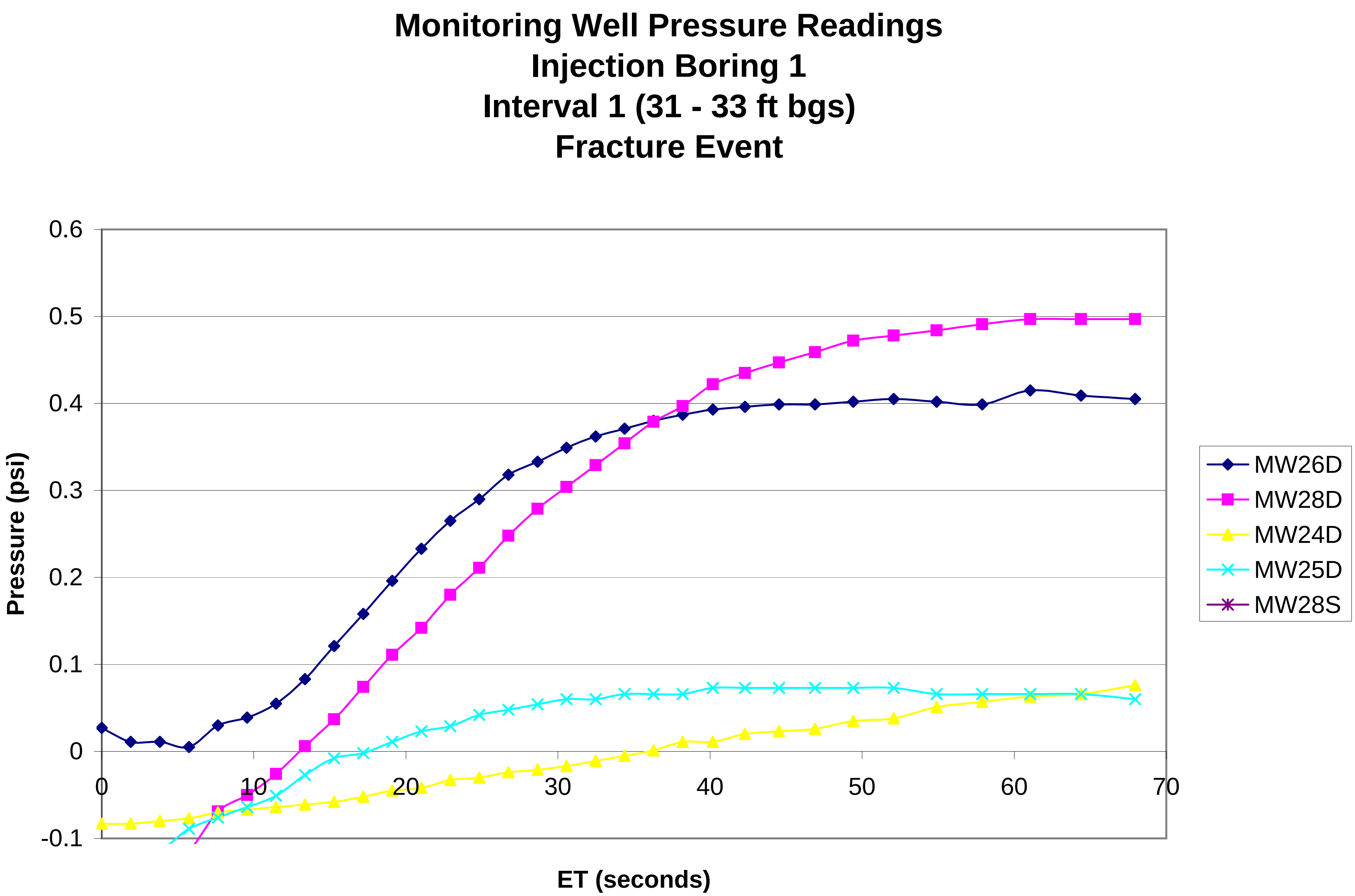
Pneumatic Fracturing Event
Farrand Controls Site, Valhalla, New York
Injection Boring 12
24.5 - 26 ft. bgs.



FC12-1F

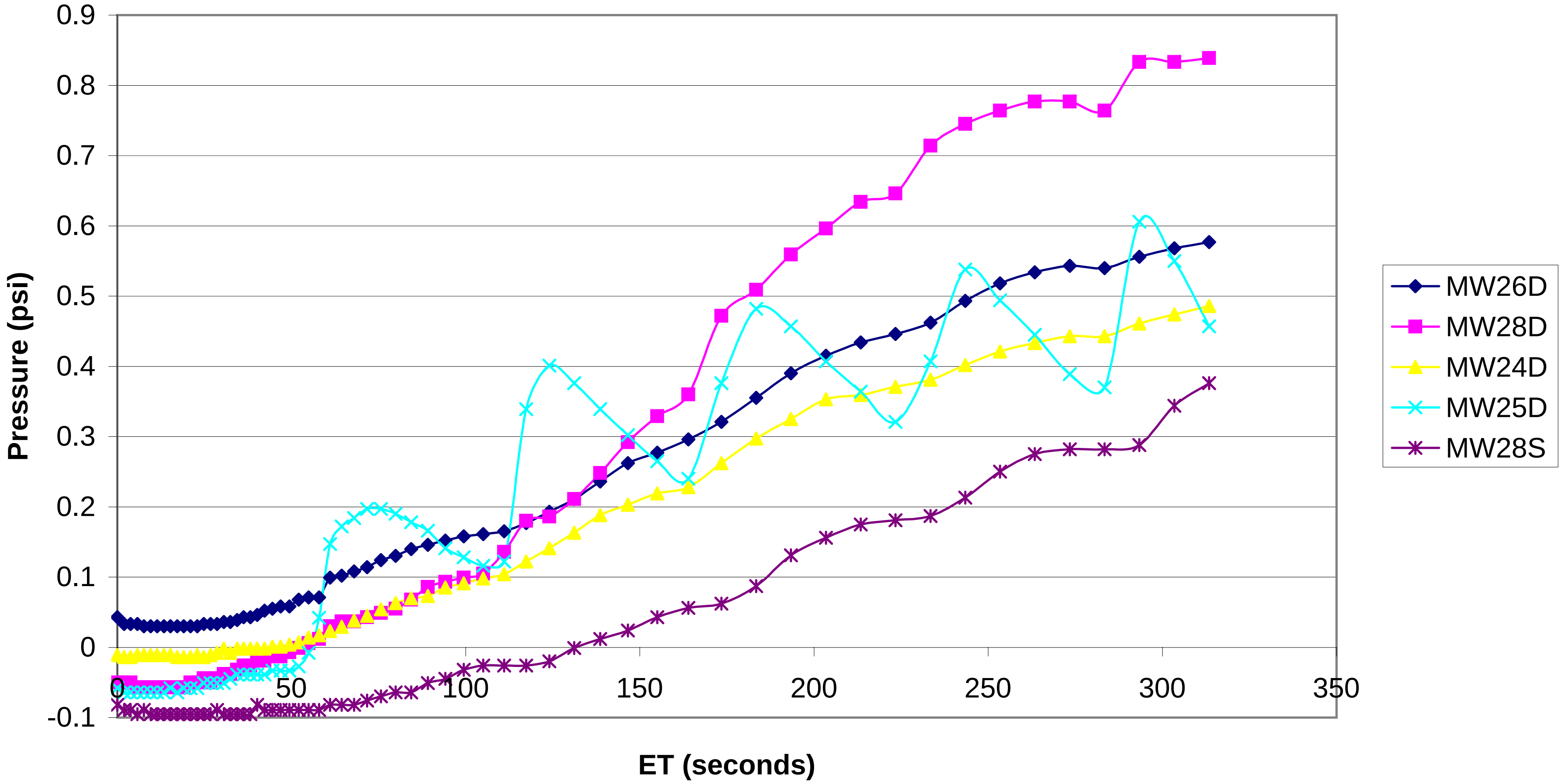

Pulsed Injection Event
Farrand Controls Site, Valhalla, New York
Injection Boring 1A
15 - 18 ft. bgs.
Pressure (PSI)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
450
500
Time (sec)

FC1A-1I

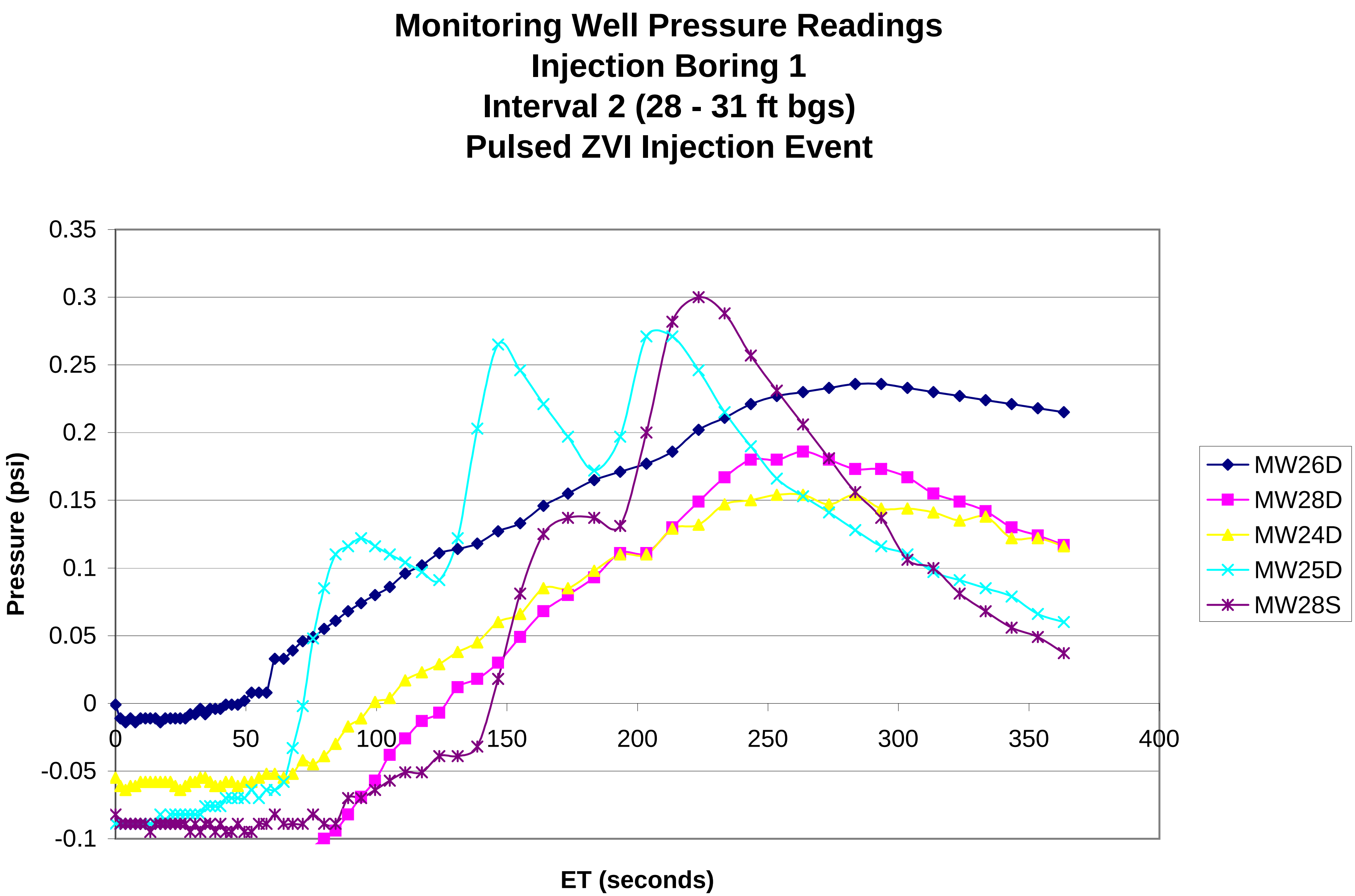

Monitoring Well Pressure Readings
Injection Boring 1
Interval 1 (31 - 33 ft bgs)
Fracture Event
Pressure (psi)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
10
20
30
40
50
60
70
ET (seconds)
MW26D
MW28D
MW24D
MW25D
MW28S

MW1-1F

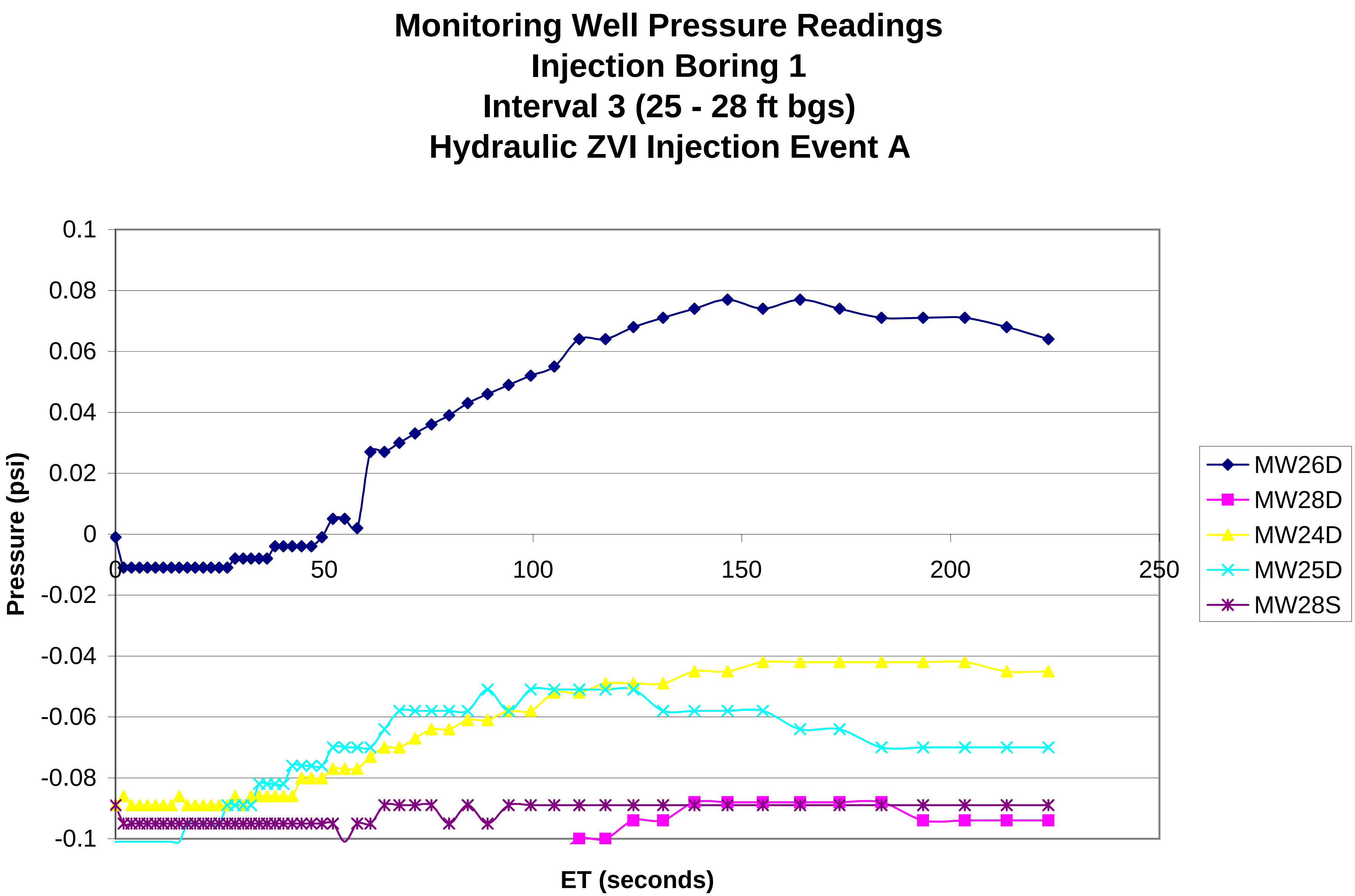
Monitoring Well Pressure Readings
Injection Boring 1
Interval 1 (31 - 33 ft bgs)
Pulsed ZVI Injection Event



MW1-1I

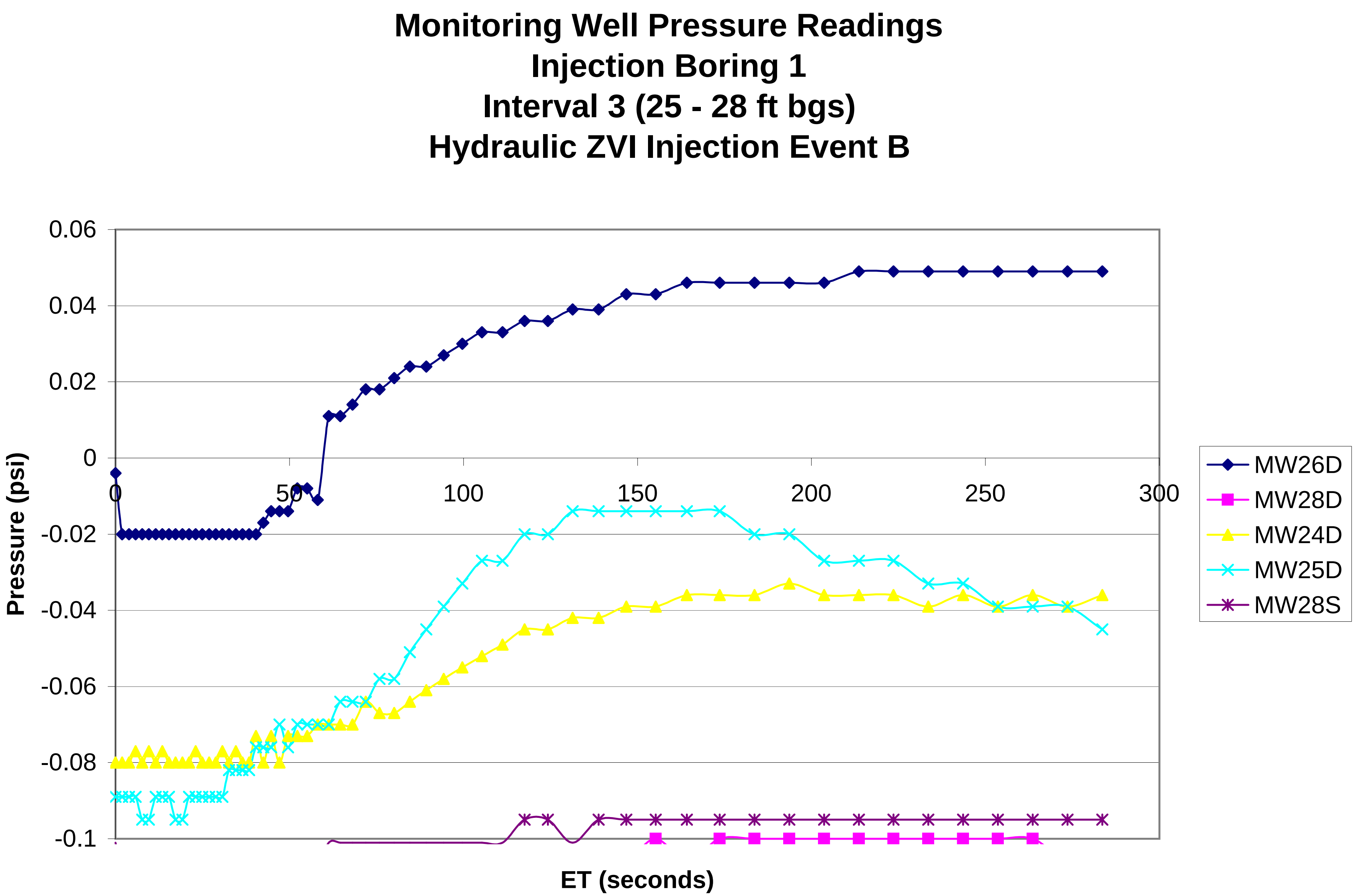

Monitoring Well Pressure Readings
Injection Boring 1
Interval 2 (28 - 31 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
0
50
100
150
200
250
300
350
400
ET (seconds)
MW26D
MW28D
MW24D
MW25D
MW28S

MW1-2I



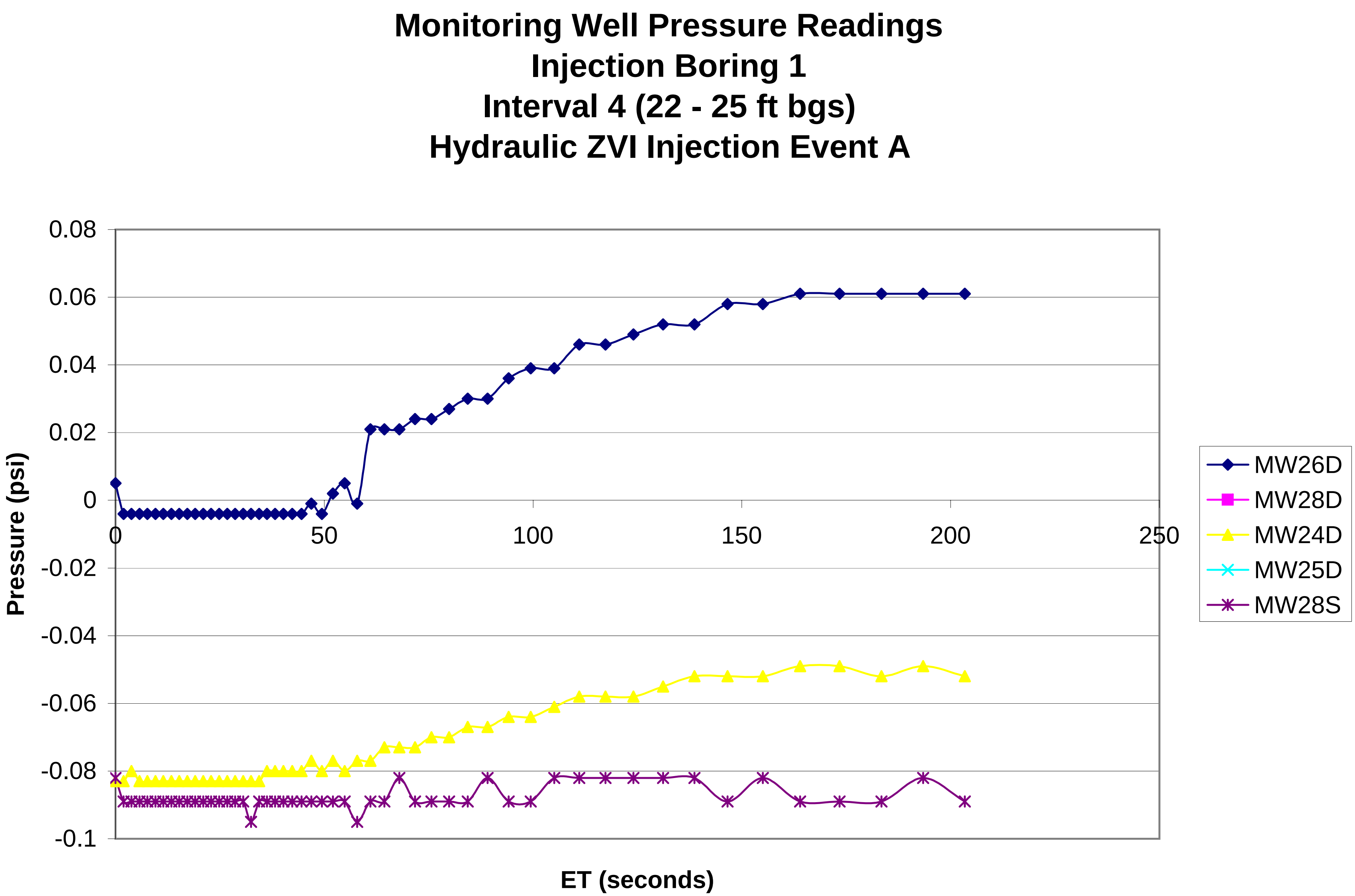
Monitoring Well Pressure Readings
Injection Boring 1
Interval 3 (25 - 28 ft bgs)
Hydraulic ZVI Injection Event A
Pressure (psi)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0
50
100
150
200
250
ET (seconds)
MW26D
MW28D
MW24D
MW25D
MW28S

MW1-3IA

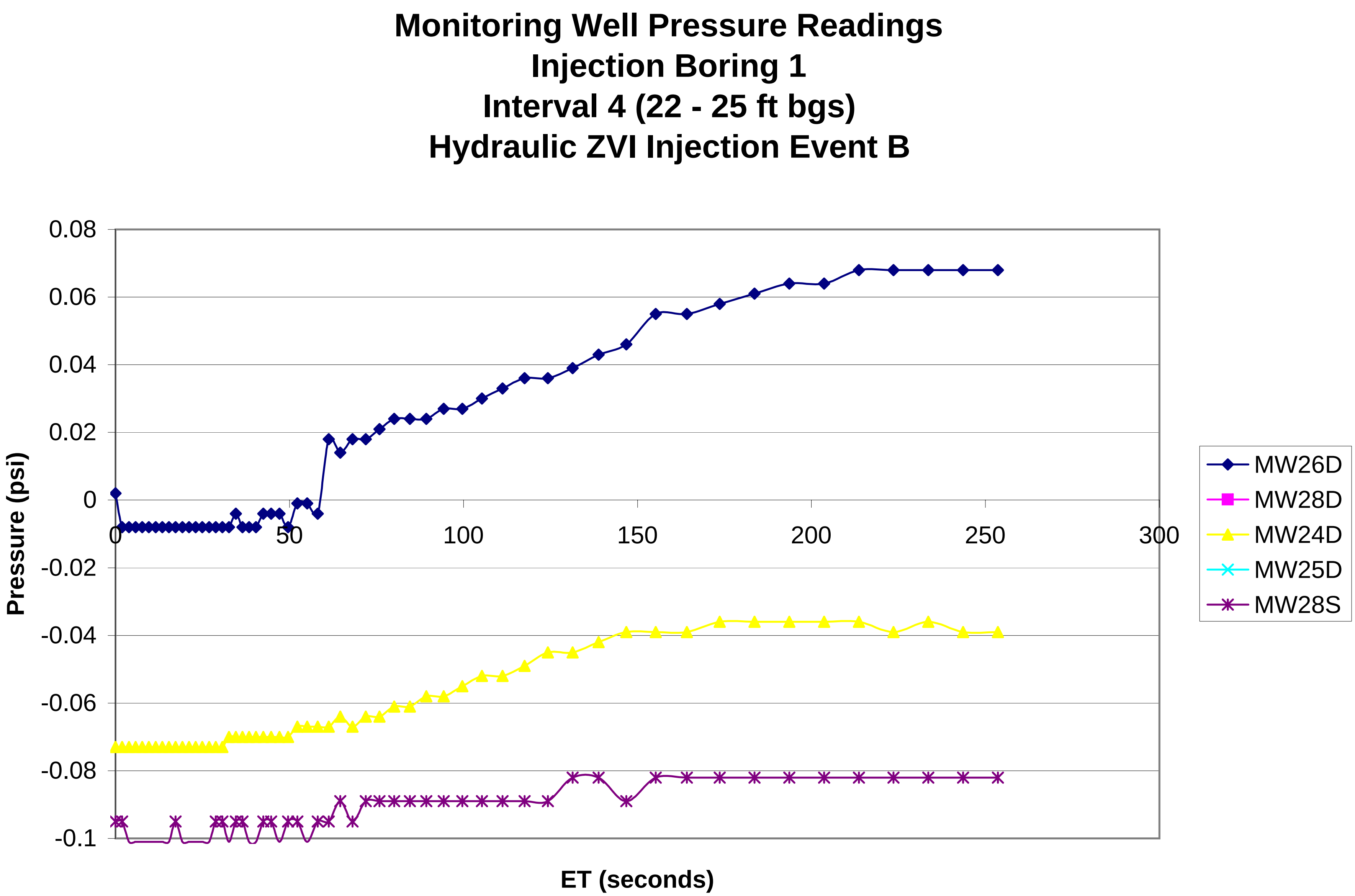


Monitoring Well Pressure Readings
Injection Boring 1
Interval 3 (25 - 28 ft bgs)
Hydraulic ZVI Injection Event B
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0
50
100
150
200
250
300
Pressure (psi)
ET (seconds)
MW26D
MW28D
MW24D
MW25D
MW28S

MW1-3IB

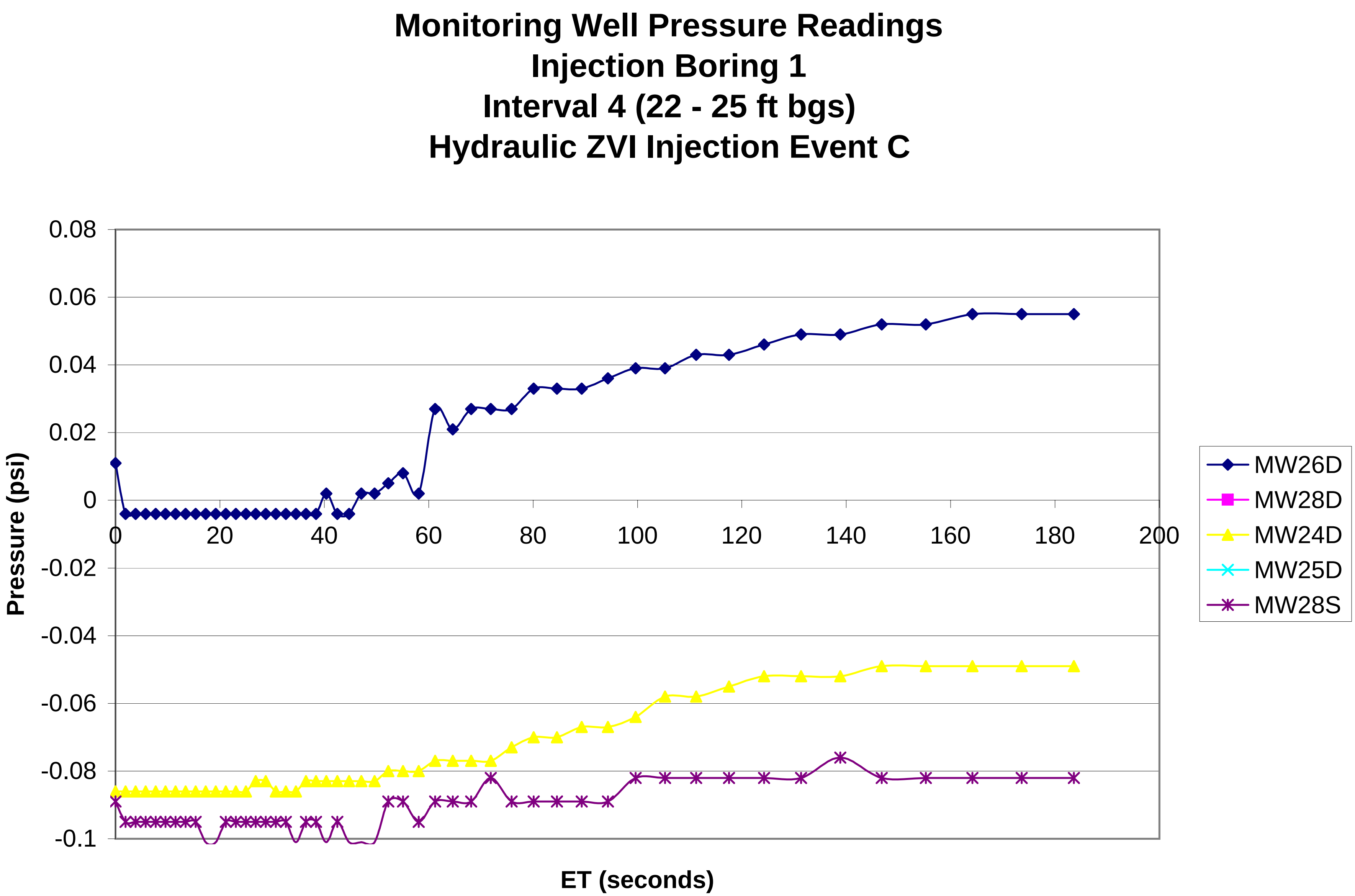

Monitoring Well Pressure Readings
Injection Boring 1
Interval 4 (22 - 25 ft bgs)
Hydraulic ZVI Injection Event A
Pressure (psi)
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0
50
100
150
200
250
ET (seconds)
MW26D
MW28D
MW24D
MW25D
MW28S

MW1-4IA



Monitoring Well Pressure Readings
Injection Boring 1
Interval 4 (22 - 25 ft bgs)
Hydraulic ZVI Injection Event B
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
Pressure (psi)
0
50
100
150
200
250
300
ET (seconds)
MW26D
MW28D
MW24D
MW25D
MW28S

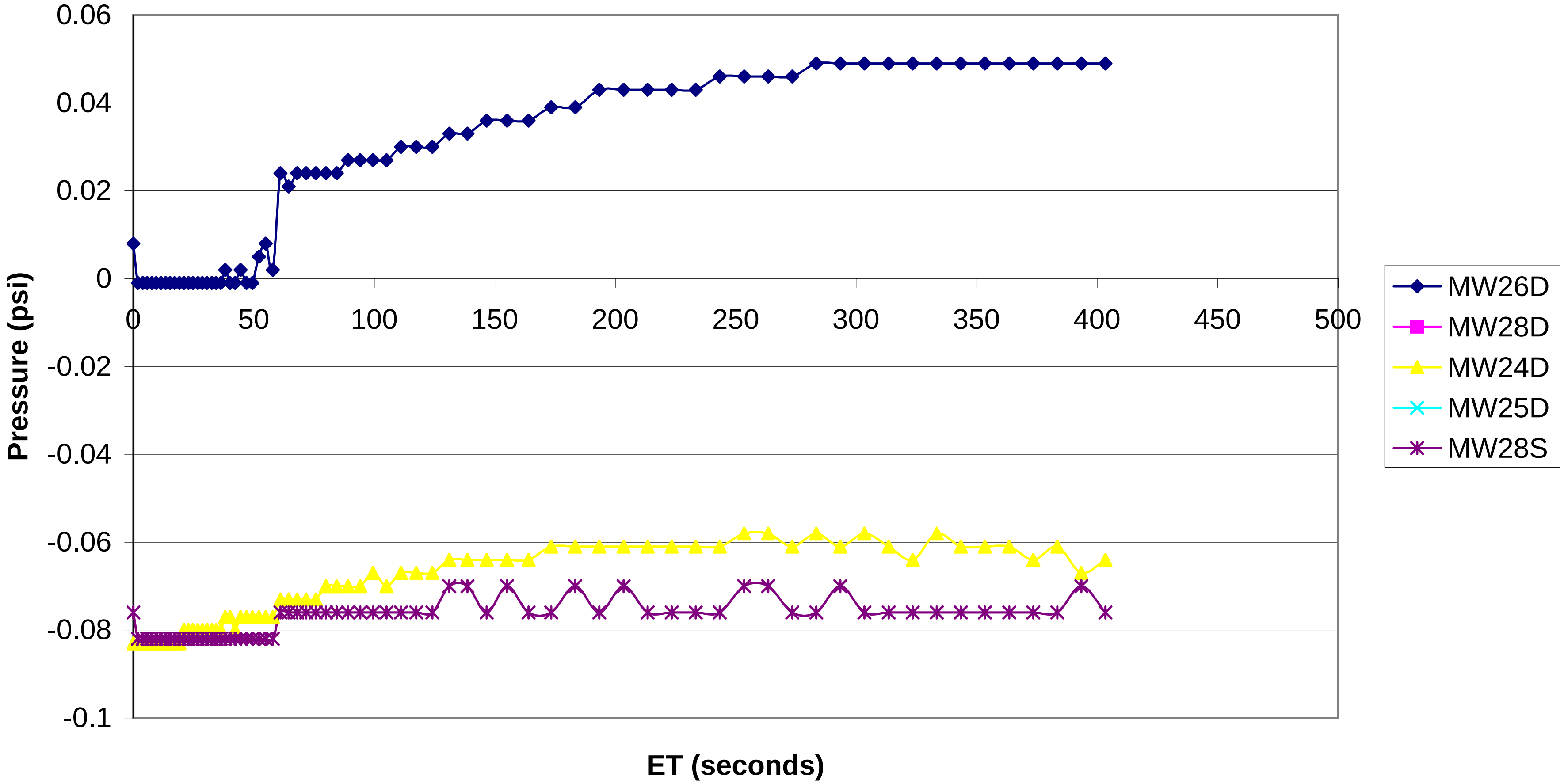
MW1-4IB



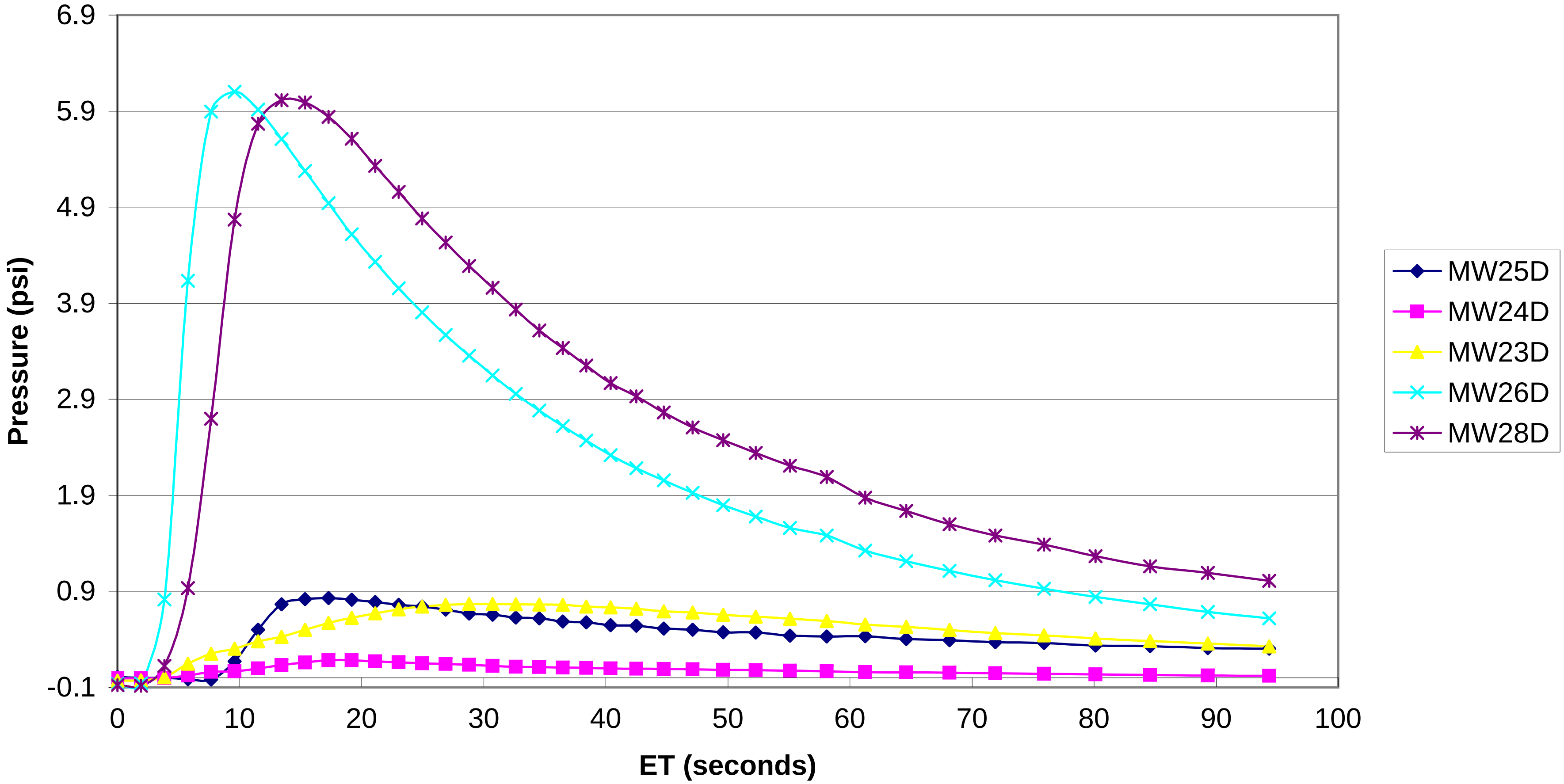
Monitoring Well Pressure Readings
Injection Boring 1
Interval 4 (22 - 25 ft bgs)
Hydraulic ZVI Injection Event C
Pressure (psi)
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0
20
40
60
80
100
120
140
160
180
200
ET (seconds)
MW26D
MW28D
MW24D
MW25D
MW28S

MW1-4IC

Monitoring Well Pressure Readings
Injection Boring 1
Interval 5 (18 - 21 ft bgs)
Hydraulic ZVI Injection Event

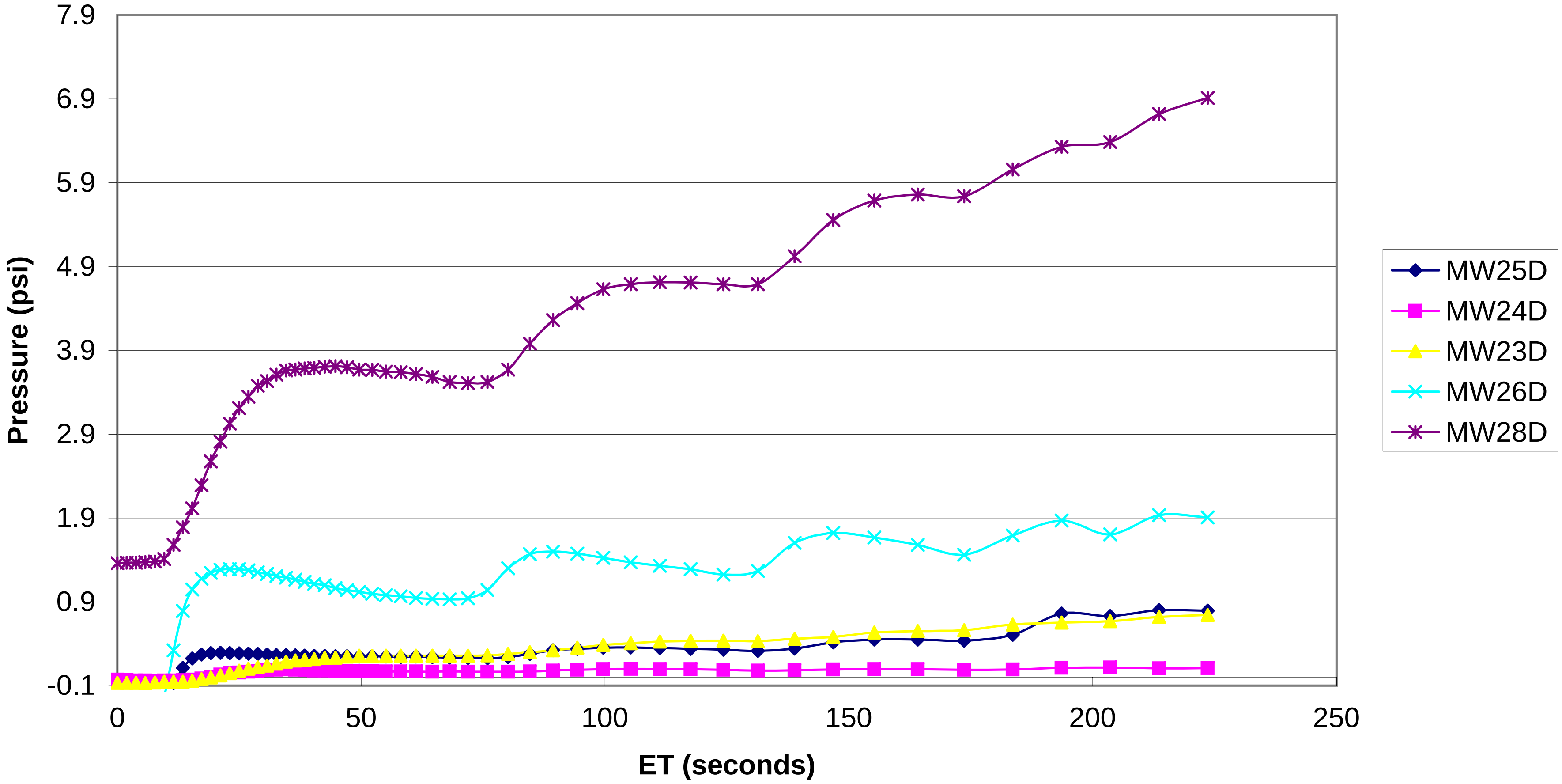


Monitoring Well Pressure Readings
Injection Boring 2
Interval 1 (36.5 - 38 ft bgs)
Fracture Event



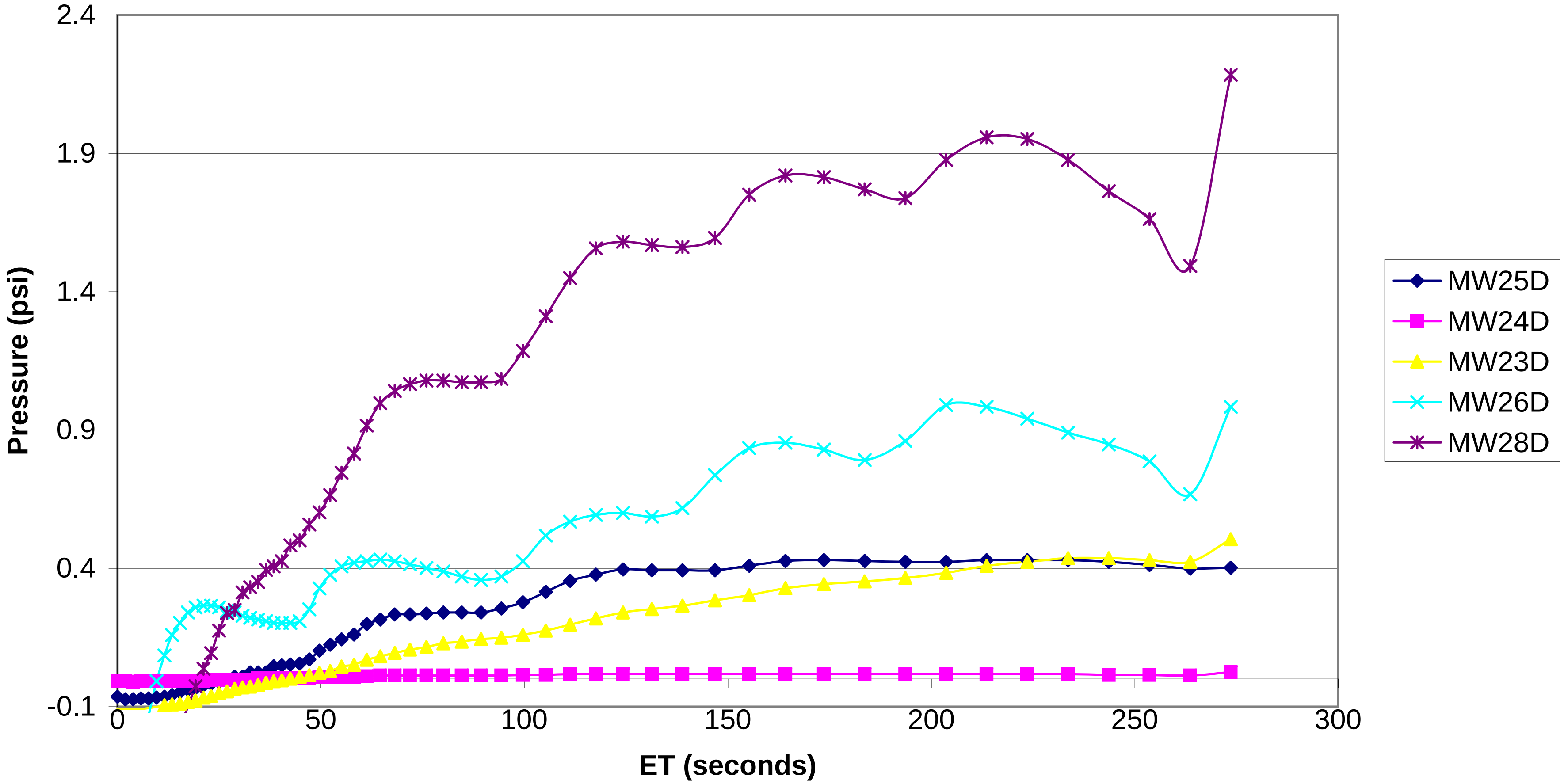
MW2-1F

Monitoring Well Pressure Readings
Injection Boring 2
Interval 1 (36.5 - 38 ft bgs)
Pulsed ZVI Injection Event



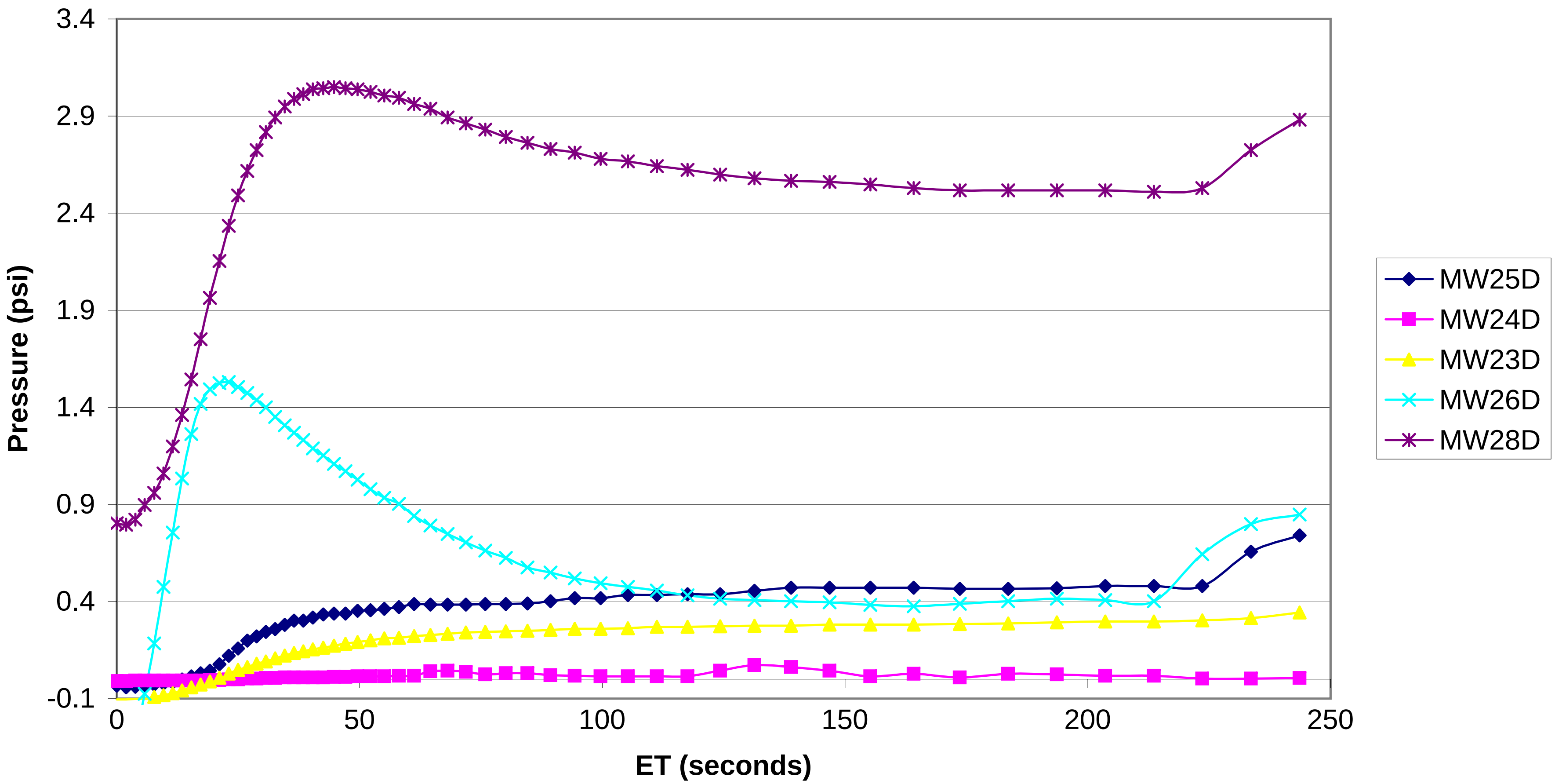
MW2-1I

Monitoring Well Pressure Readings
Injection Boring 2
Interval 2 (33.5 - 36.5 ft bgs)
Pulsed ZVI Injection Event



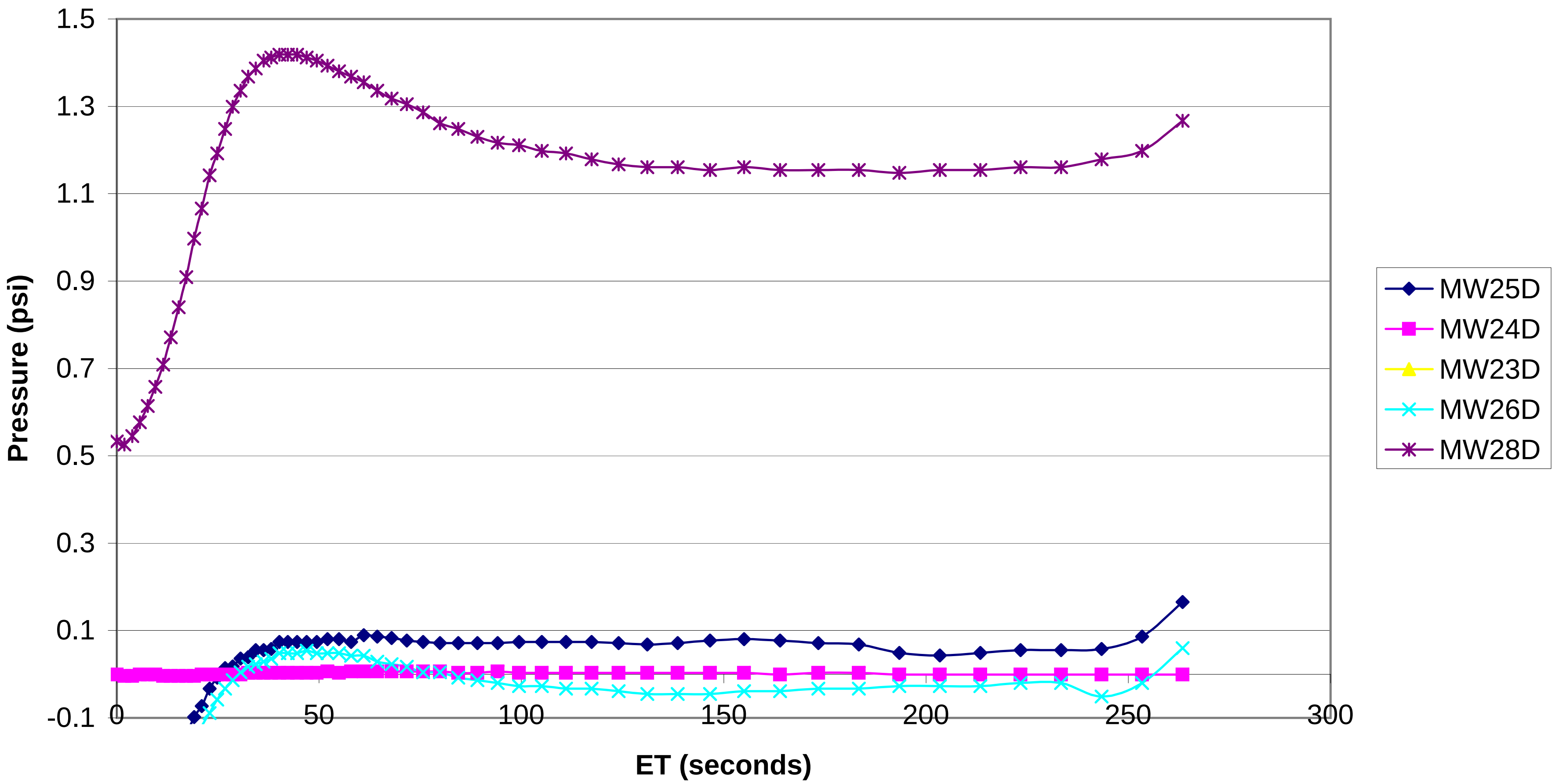
MW2-2I

Monitoring Well Pressure Readings
Injection Boring 2
Interval 3 (30.5 - 33.5 ft bgs)
Pulsed ZVI Injection Event

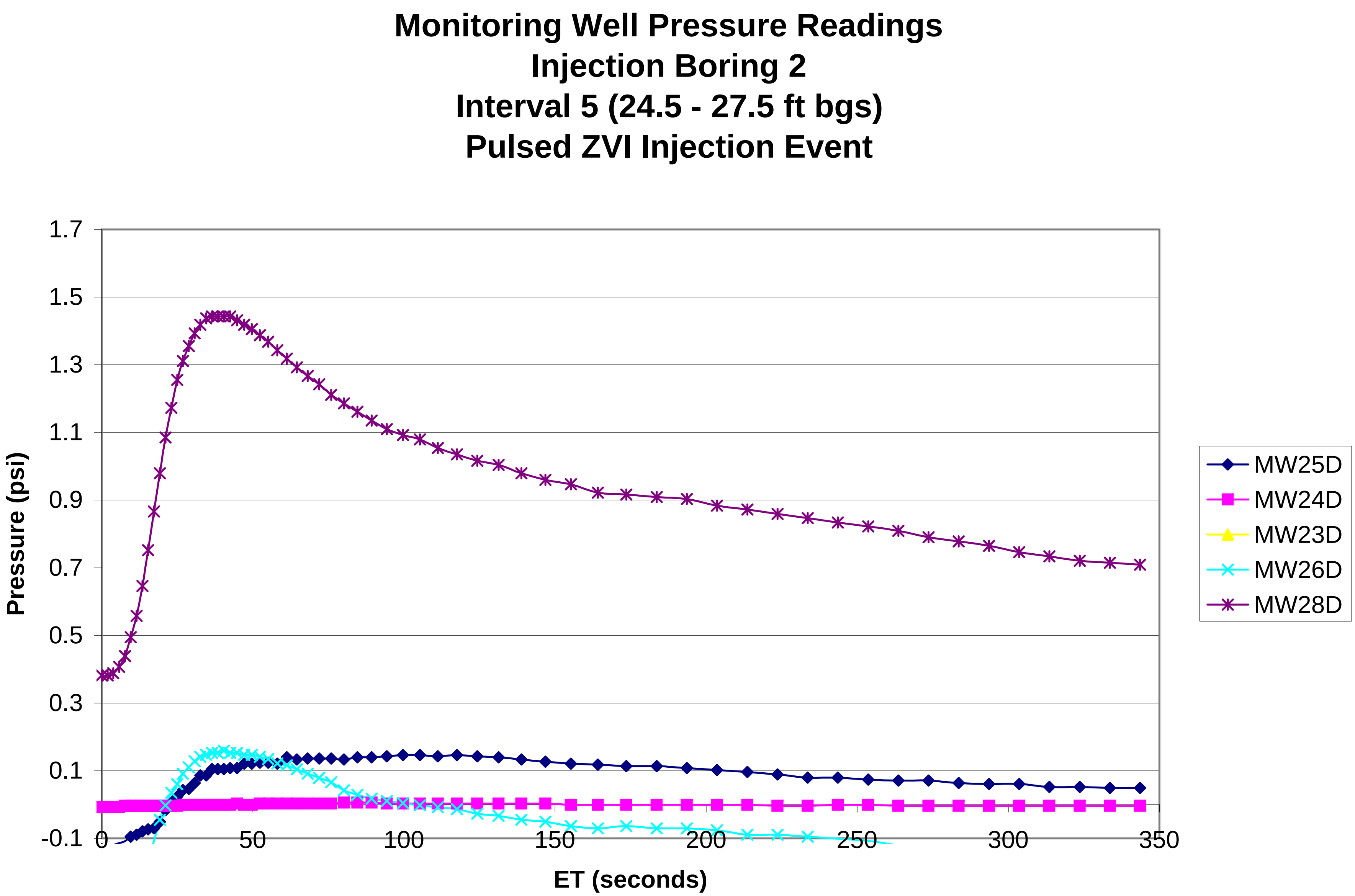


MW2-3I

Monitoring Well Pressure Readings
Injection Boring 2
Interval 4 (27.5 - 30.5 ft bgs)
Pulsed ZVI Injection Event

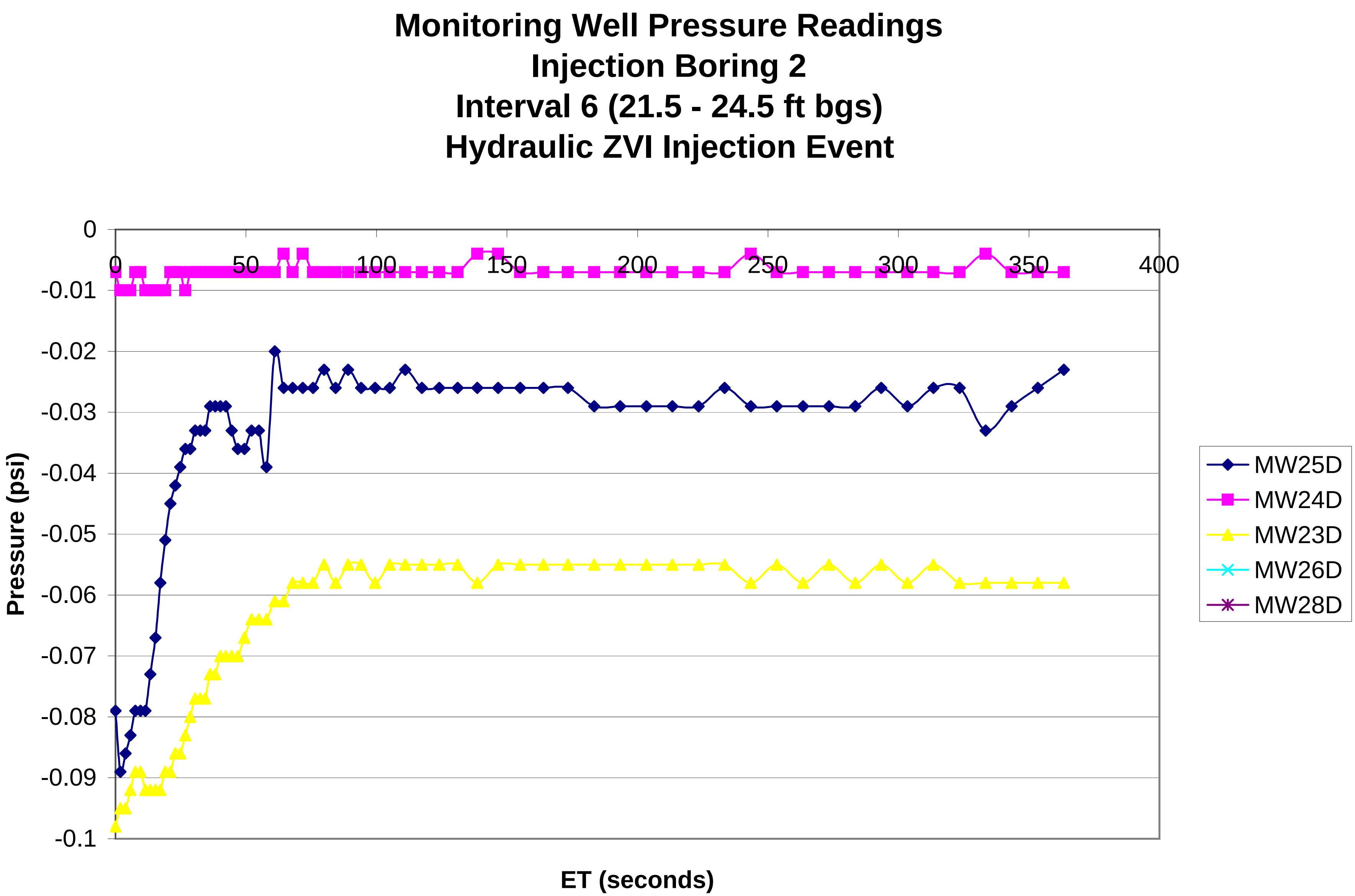


MW2-4I



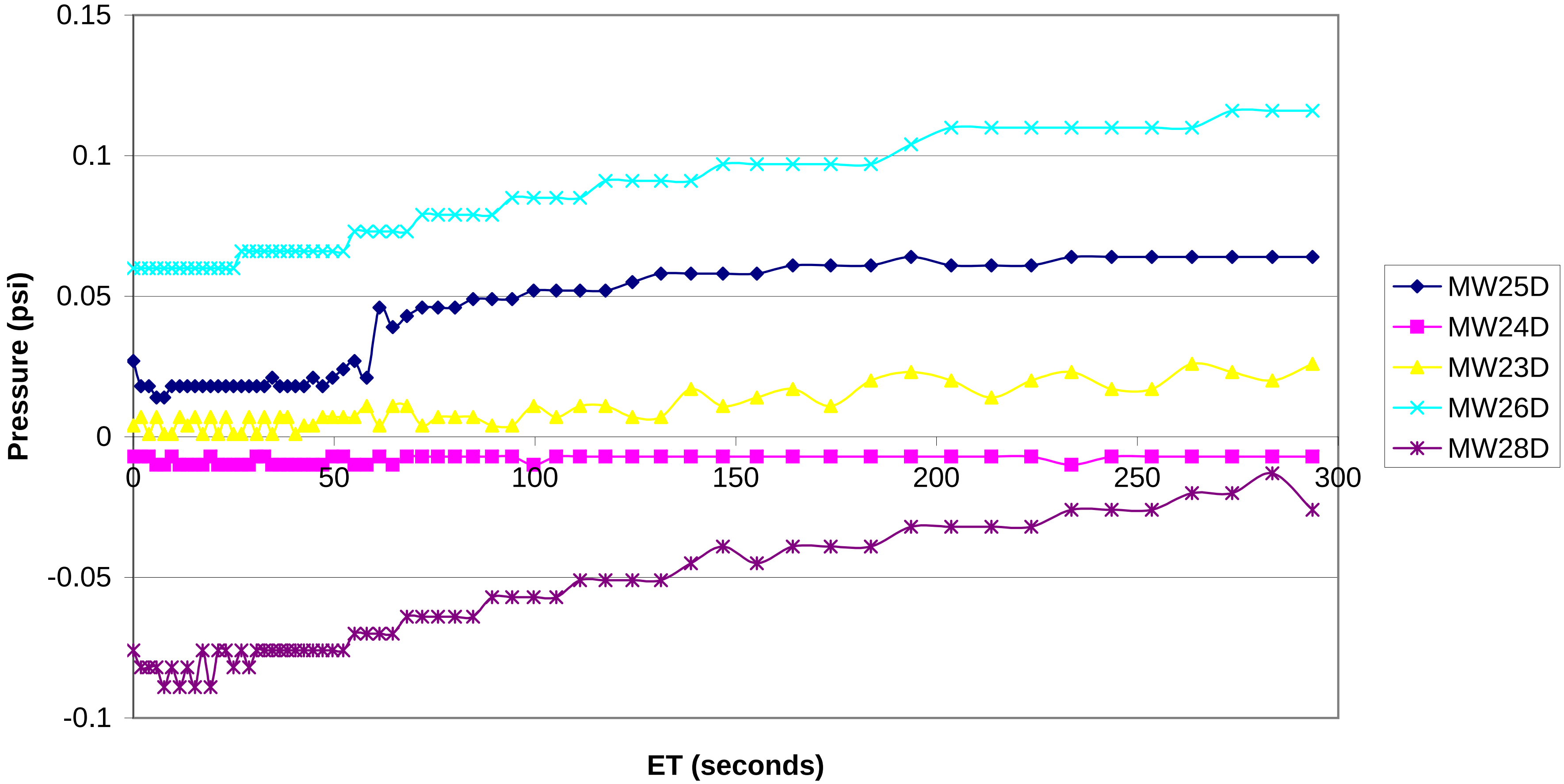
Monitoring Well Pressure Readings
Injection Boring 2
Interval 5 (24.5 - 27.5 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
1.7
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
50
100
150
200
250
300
350
ET (seconds)
MW25D
MW24D
MW23D
MW26D
MW28D

MW2-5I


Monitoring Well Pressure Readings
Injection Boring 2
Interval 6 (21.5 - 24.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.1
0
50
100
150
200
250
300
350
400
ET (seconds)
MW25D
MW24D
MW23D
MW26D
MW28D

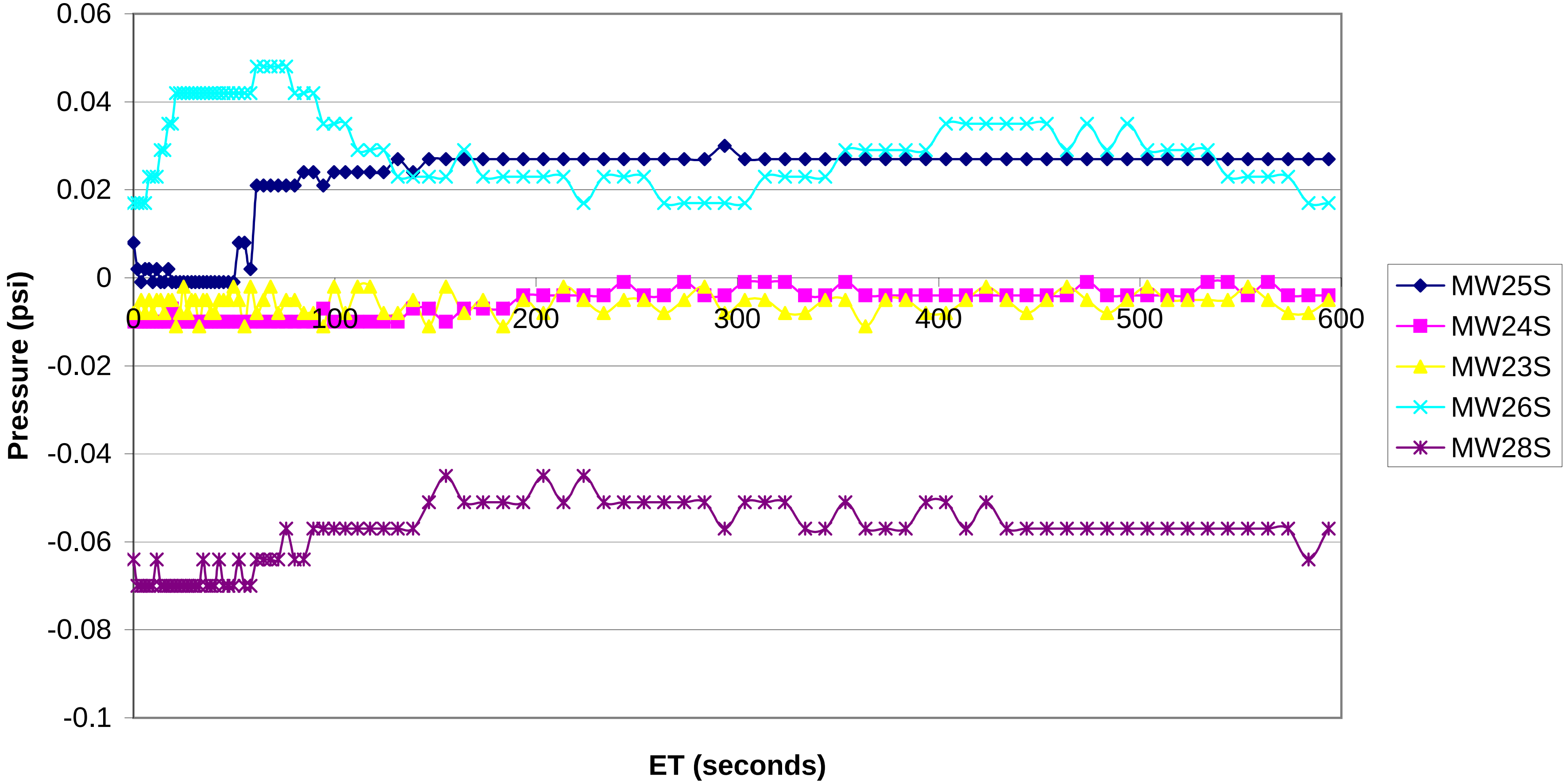
MW2-6I

Monitoring Well Pressure Readings
Injection Boring 2
Interval 7 (18.5 - 21.5 ft bgs)
Hydraulic ZVI Injection Event



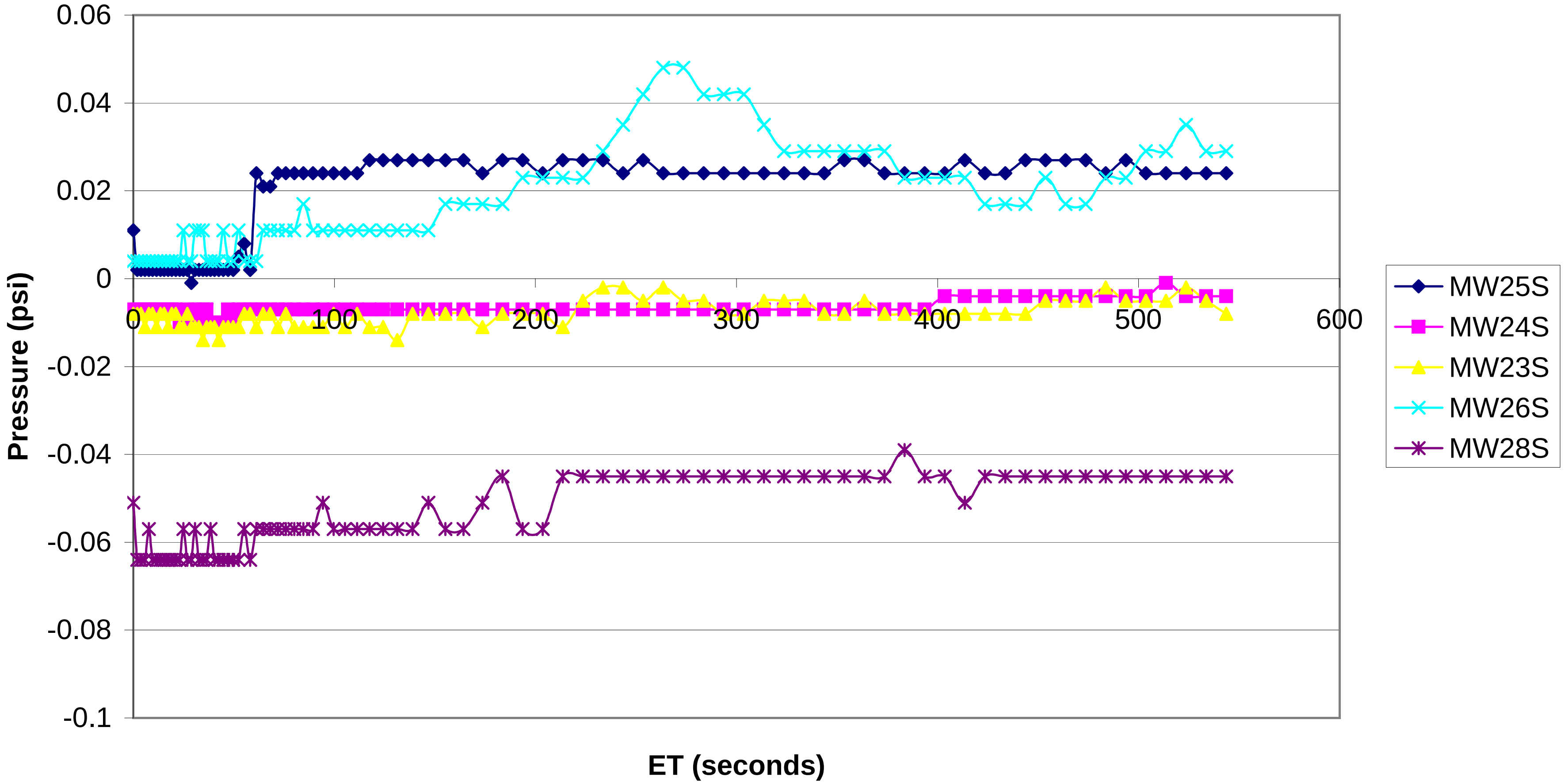
MW2-7I

Monitoring Well Pressure Readings
Injection Boring 2
Interval 8 (15.5 - 18.5 ft bgs)
Hydraulic ZVI Injection Event



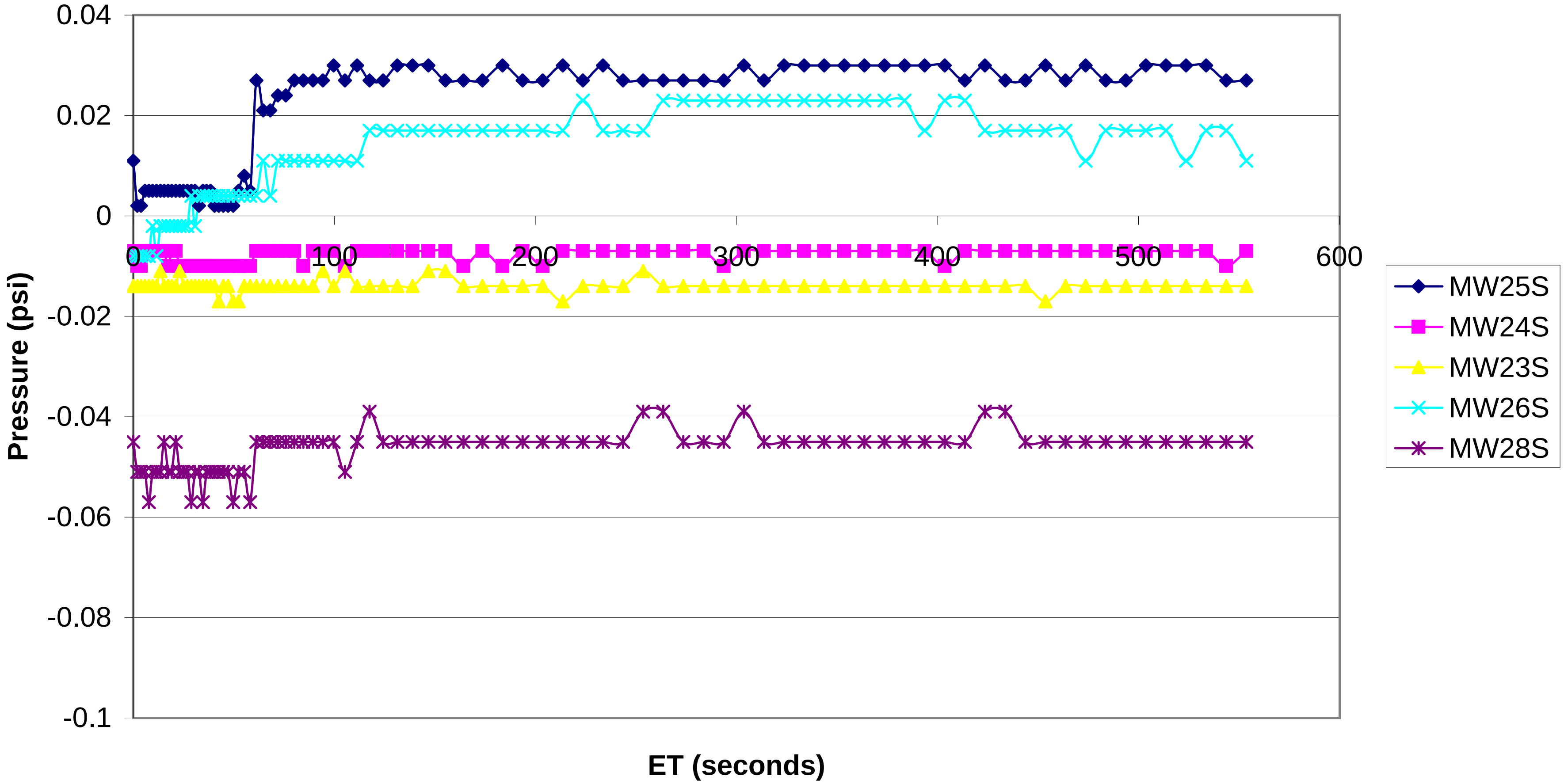
MW2-8I

Monitoring Well Pressure Readings
Injection Boring 2
Interval 9 (12.5 - 15.5 ft bgs)
Hydraulic ZVI Injection Event

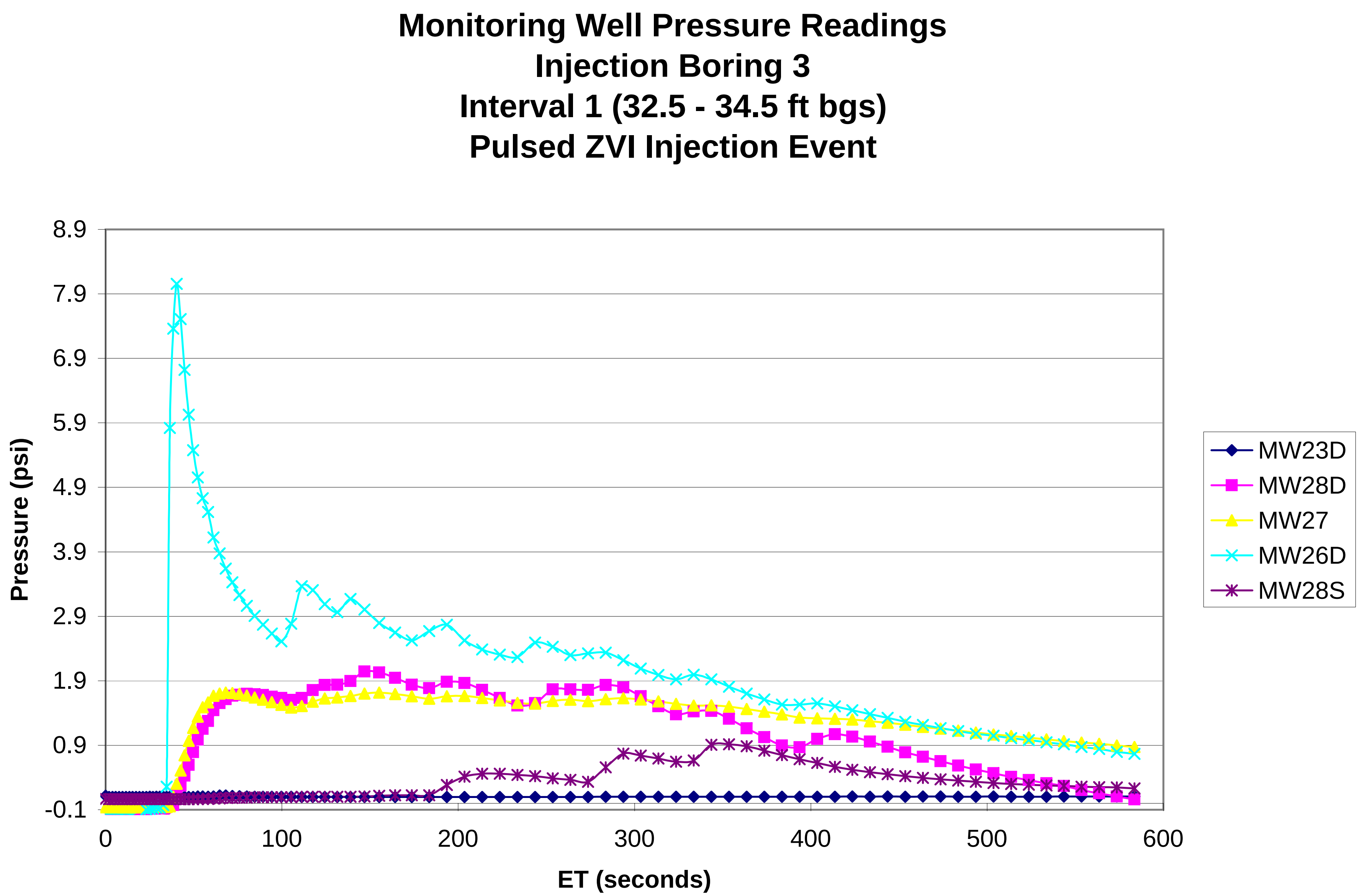


MW2-9I

Monitoring Well Pressure Readings
Injection Boring 2
Interval 10 (9.5 - 12.5 ft bgs)
Hydraulic ZVI Injection Event

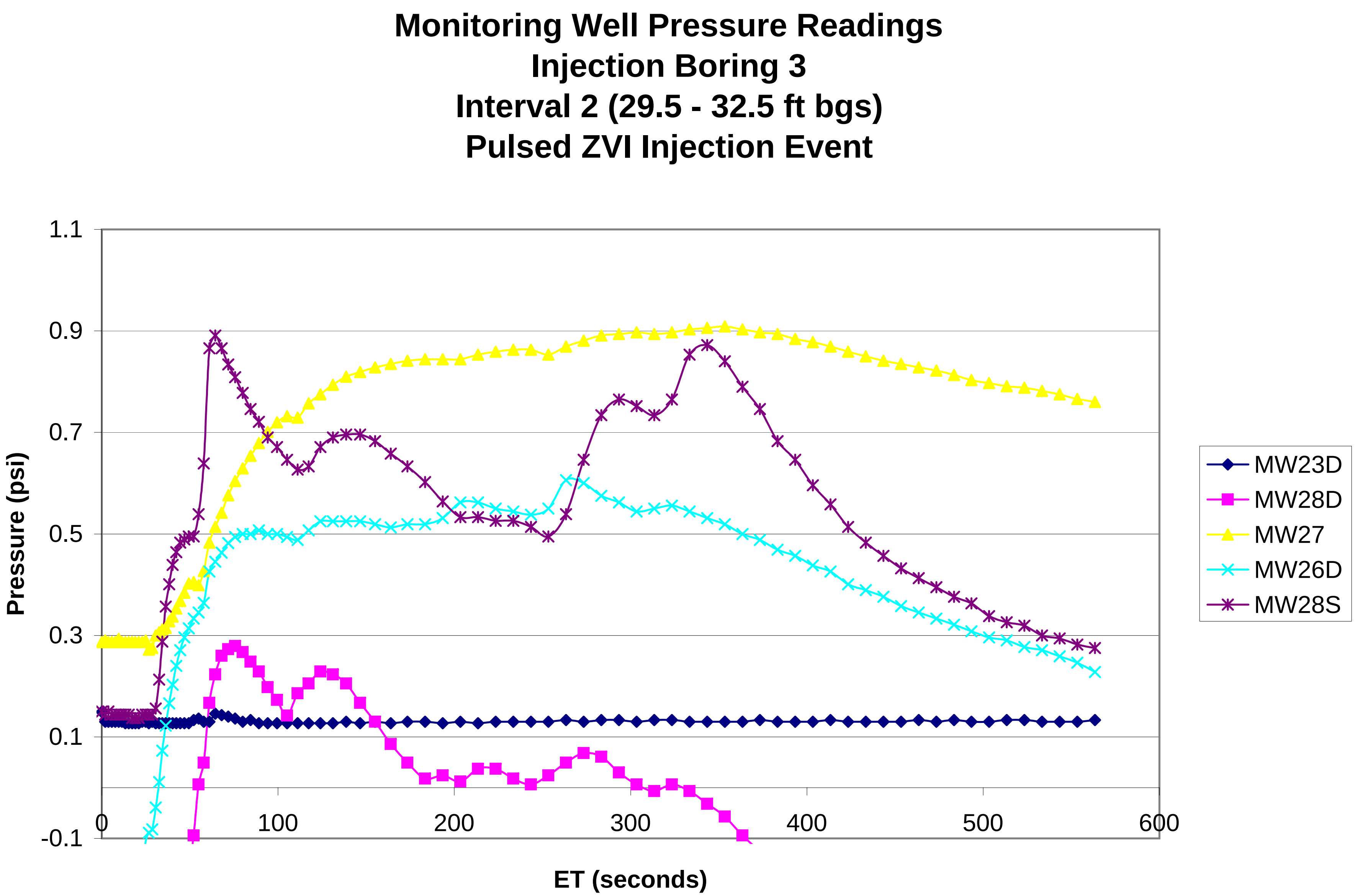


MW2-10I

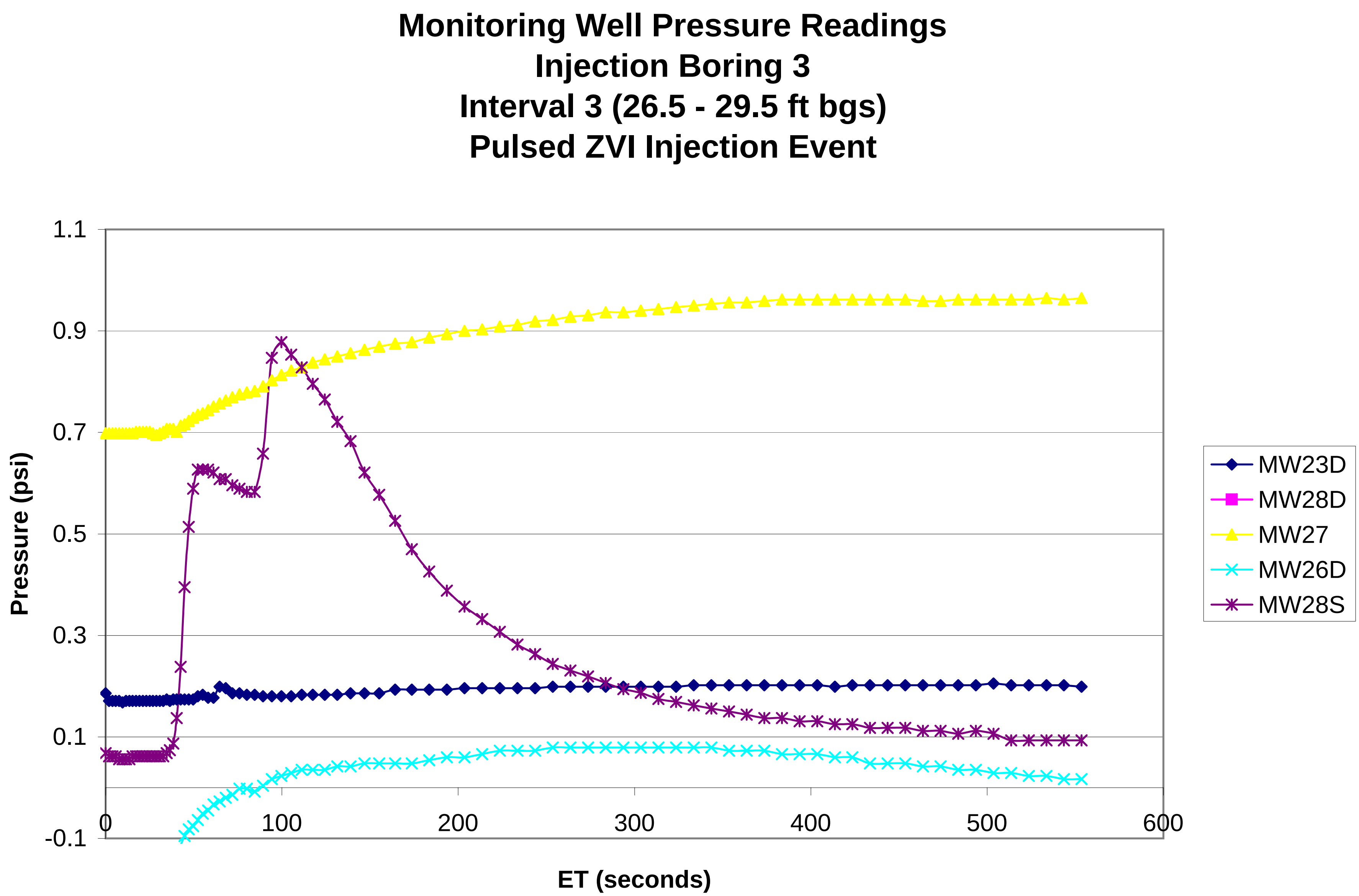


Monitoring Well Pressure Readings
Injection Boring 3
Interval 1 (32.5 - 34.5 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
8.9
7.9
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW23D
MW28D
MW27
MW26D
MW28S

MW3-1I


Monitoring Well Pressure Readings
Injection Boring 3
Interval 2 (29.5 - 32.5 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
ET (seconds)
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
100
200
300
400
500
600
MW23D
MW28D
MW27
MW26D
MW28S

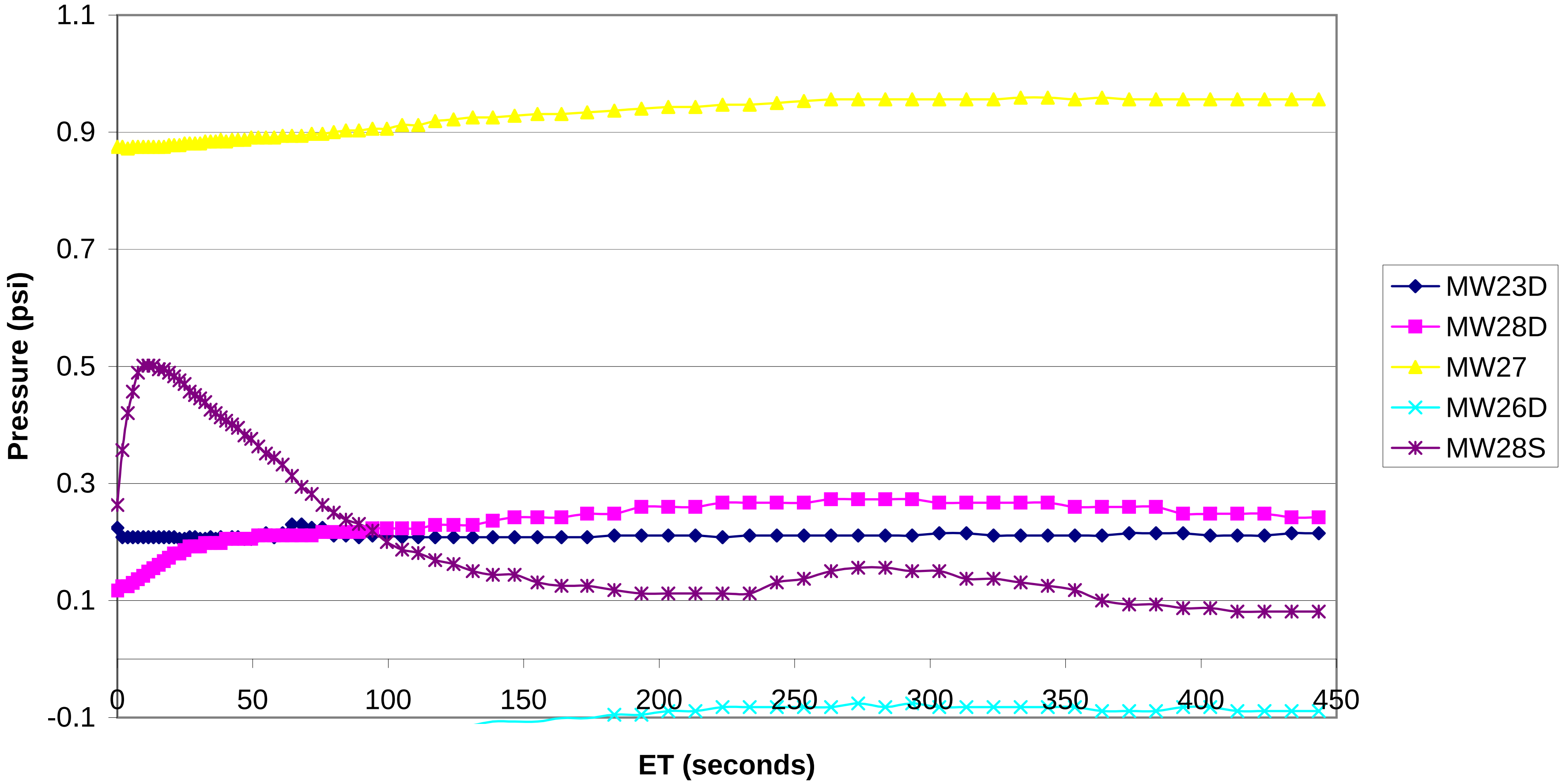
MW3-2I



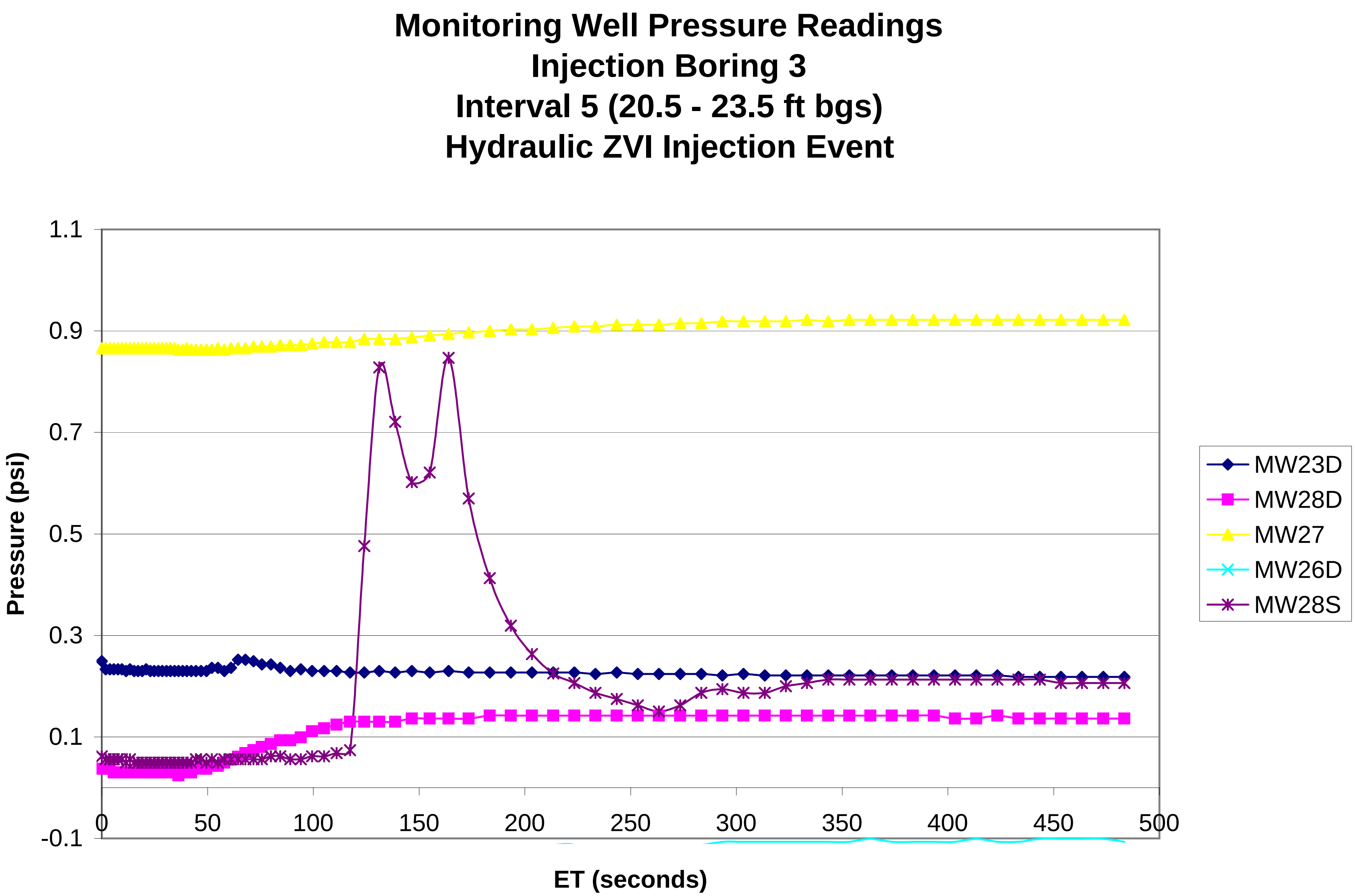
Monitoring Well Pressure Readings
Injection Boring 3
Interval 3 (26.5 - 29.5 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW23D
MW28D
MW27
MW26D
MW28S

MW3-3I

Monitoring Well Pressure Readings
Injection Boring 3
Interval 4 (23.5 - 26.5 ft bgs)
Hydraulic ZVI Injection Event

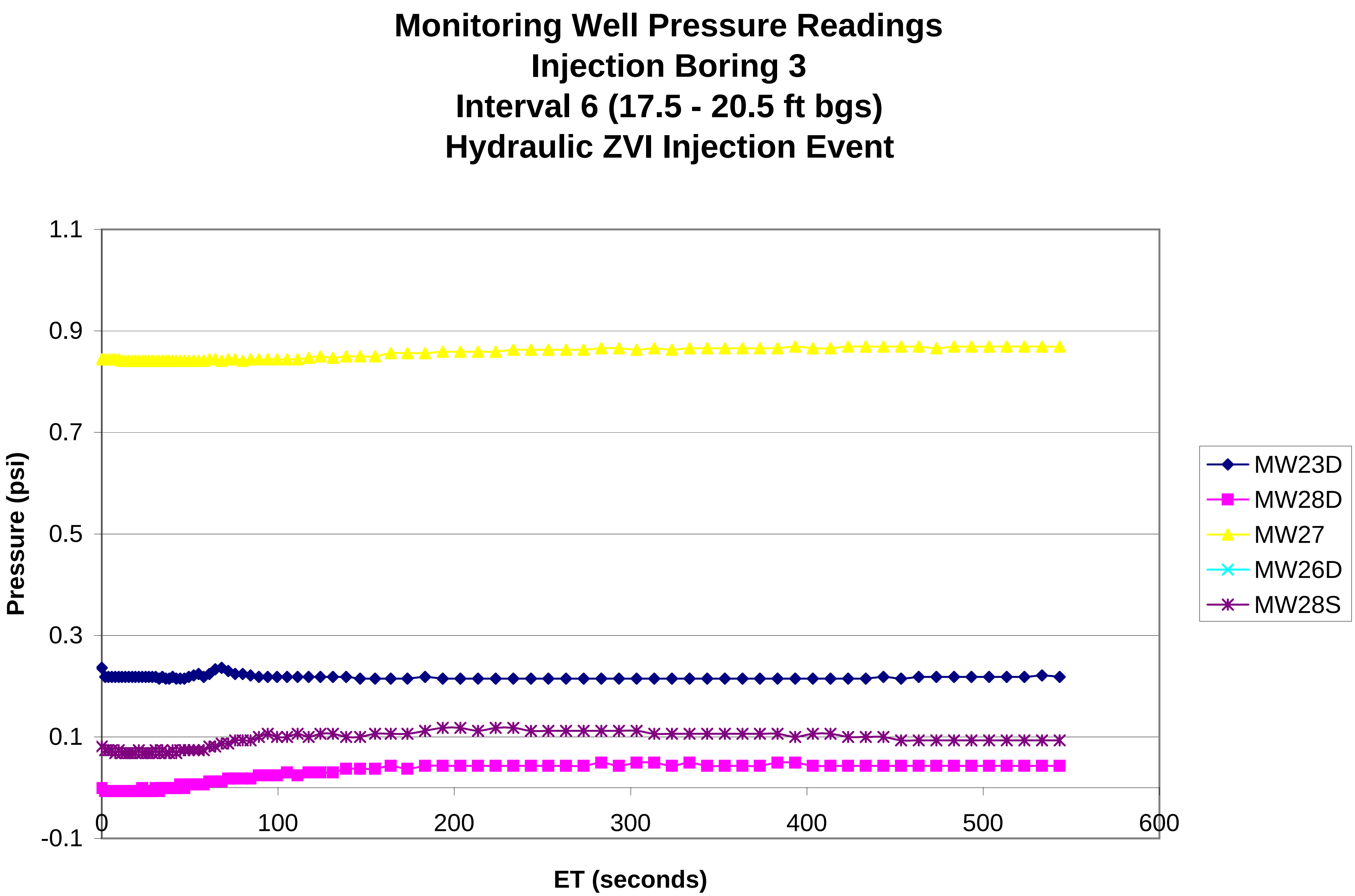


MW3-4I



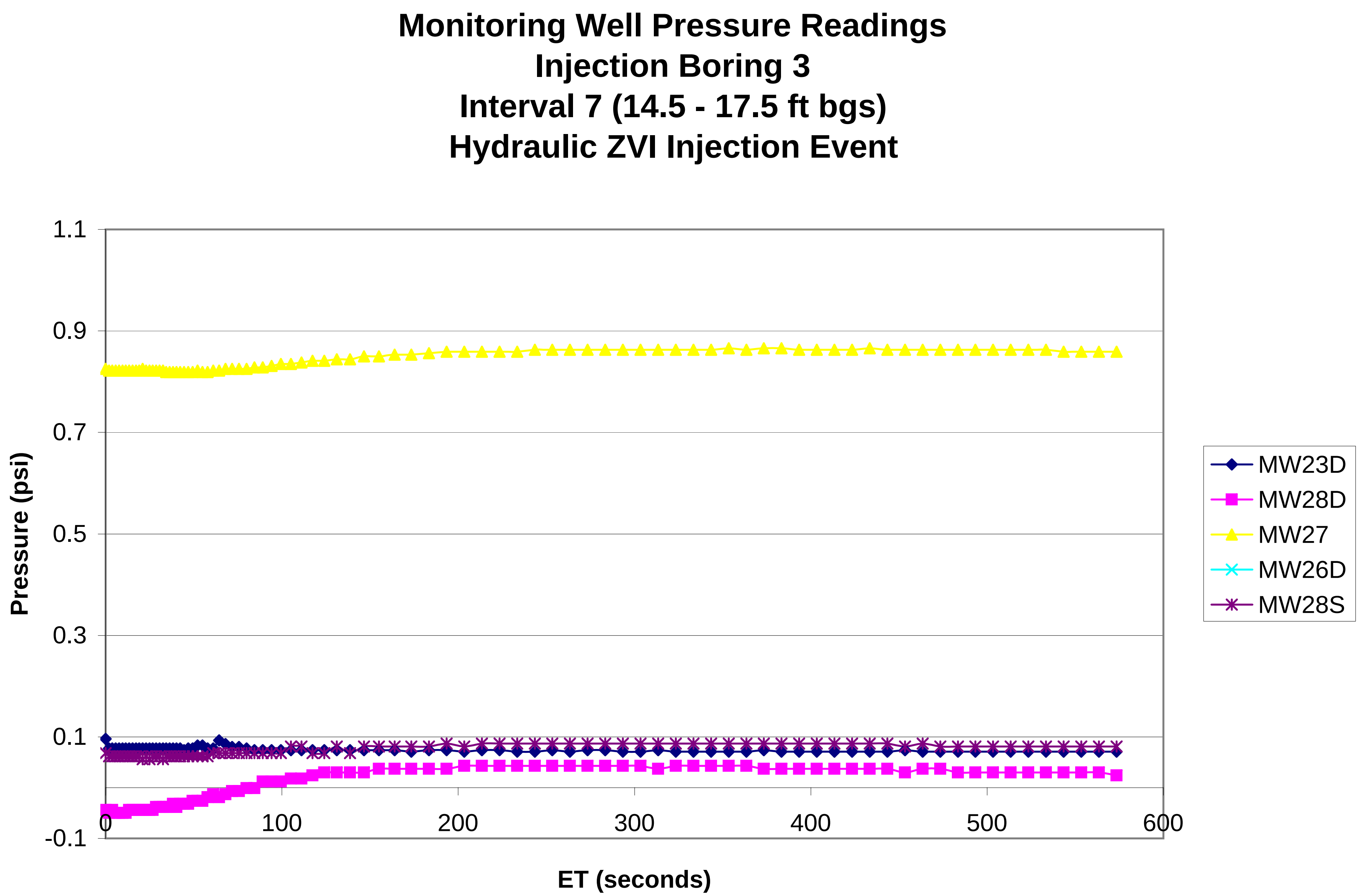
Monitoring Well Pressure Readings
Injection Boring 3
Interval 5 (20.5 - 23.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
50
100
150
200
250
300
350
400
450
500
ET (seconds)
MW23D
MW28D
MW27
MW26D
MW28S

MW3-5I



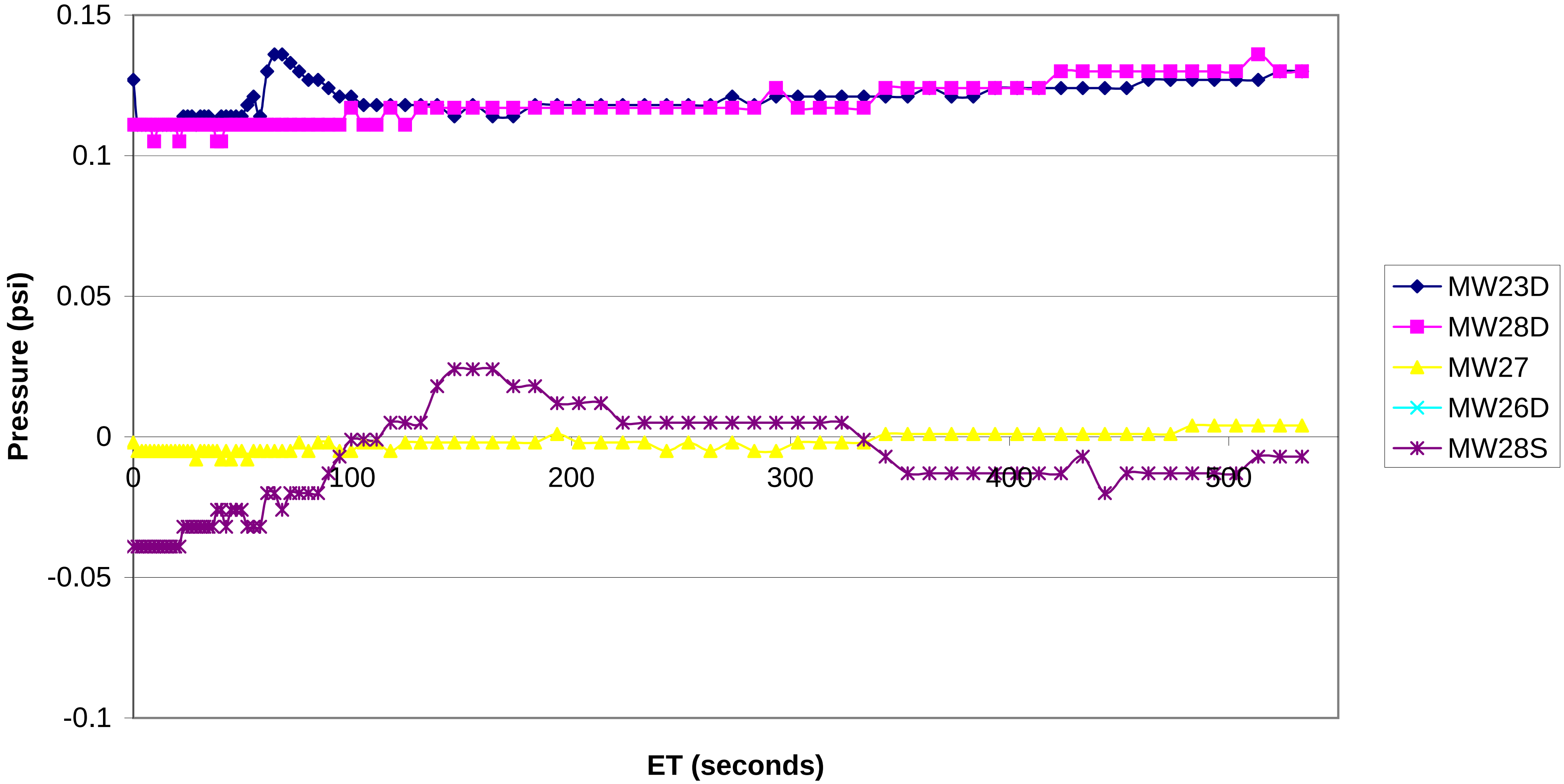
Monitoring Well Pressure Readings
Injection Boring 3
Interval 6 (17.5 - 20.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW23D
MW28D
MW27
MW26D
MW28S

MW3-6I

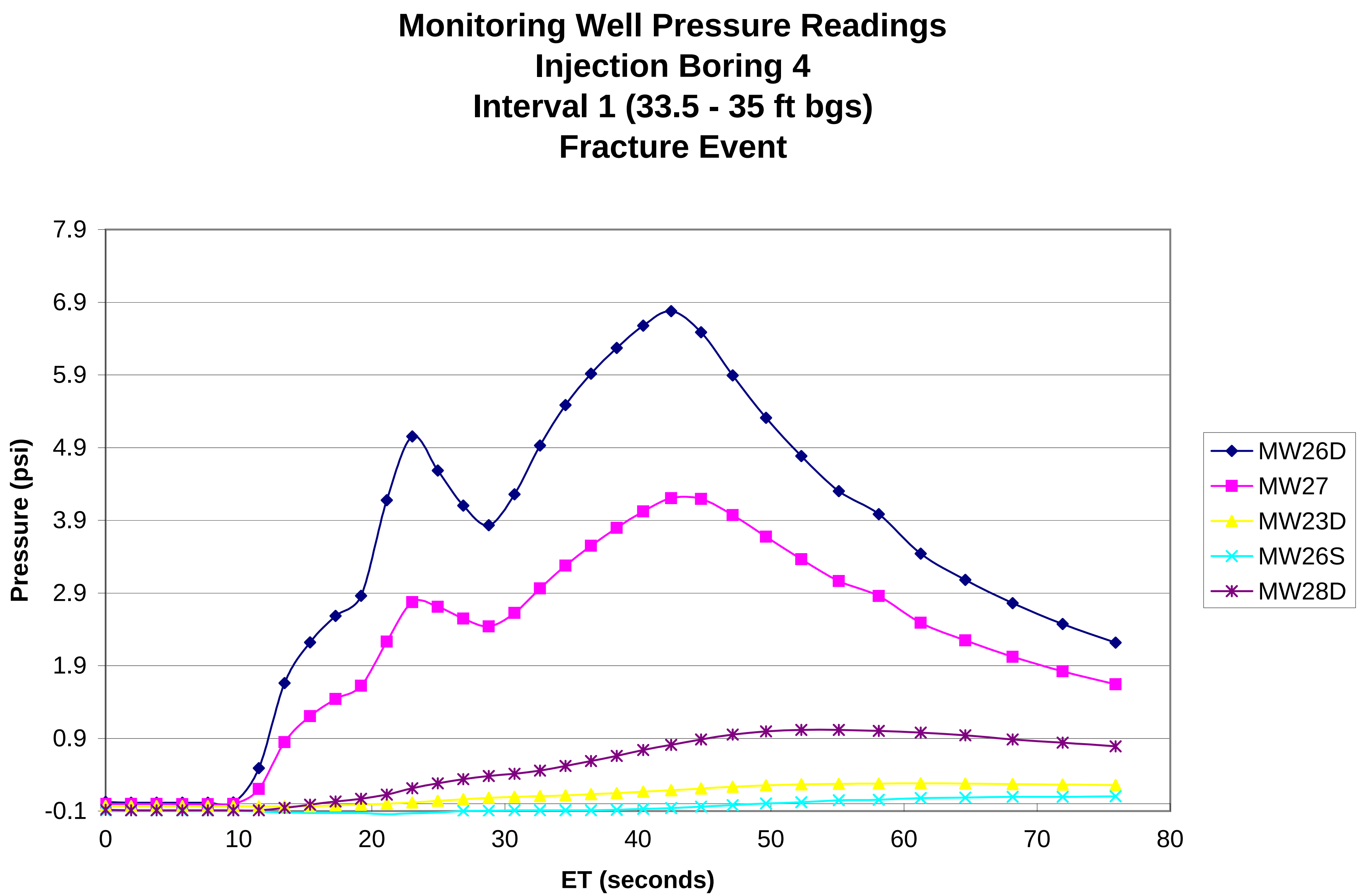

Monitoring Well Pressure Readings
Injection Boring 3
Interval 7 (14.5 - 17.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW23D
MW28D
MW27
MW26D
MW28S

MW3-7I

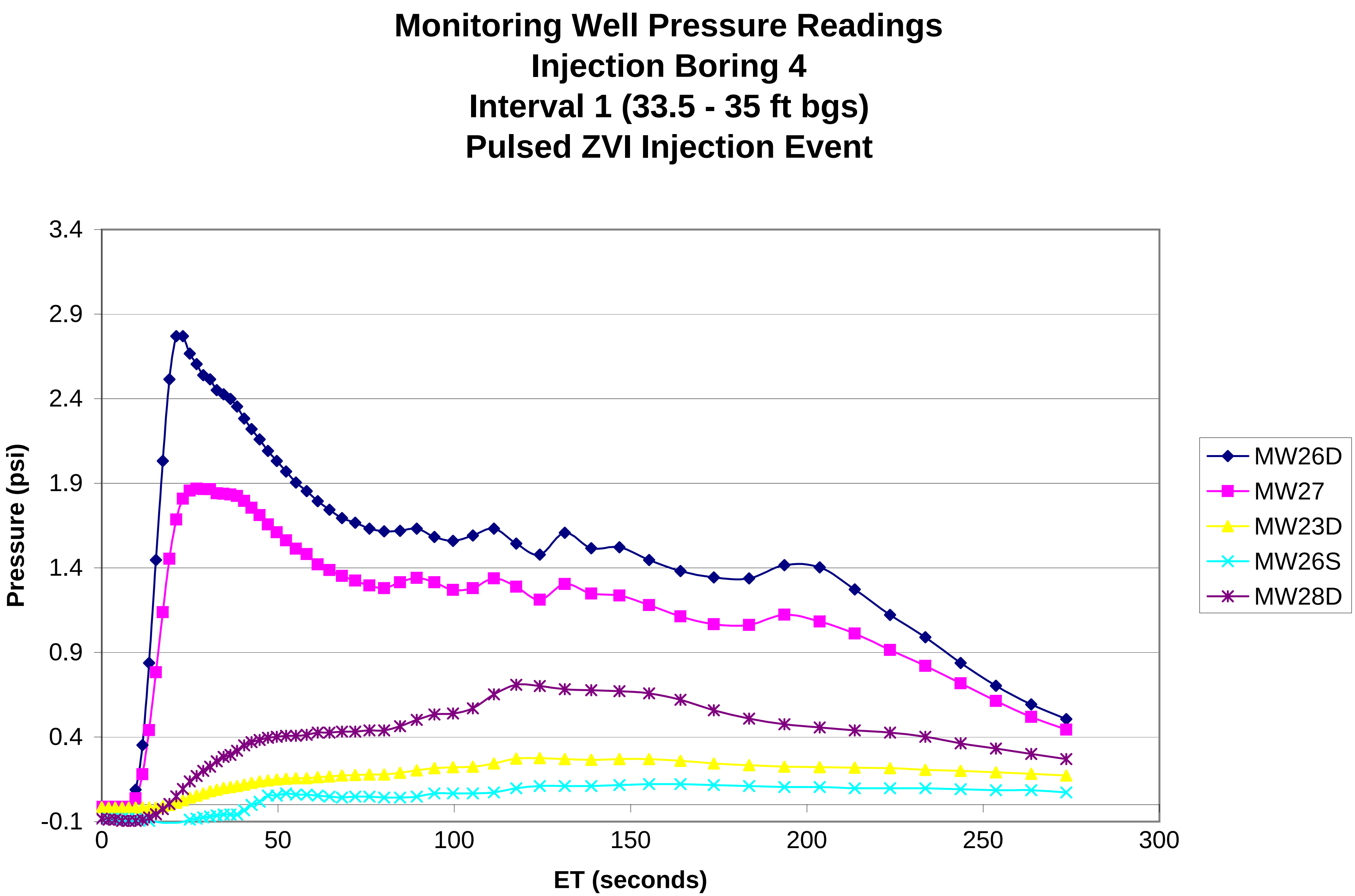
Monitoring Well Pressure Readings
Injection Boring 3
Interval 8 (11.5 - 14.5 ft bgs)
Hydraulic ZVI Injection Event



MW3-8I

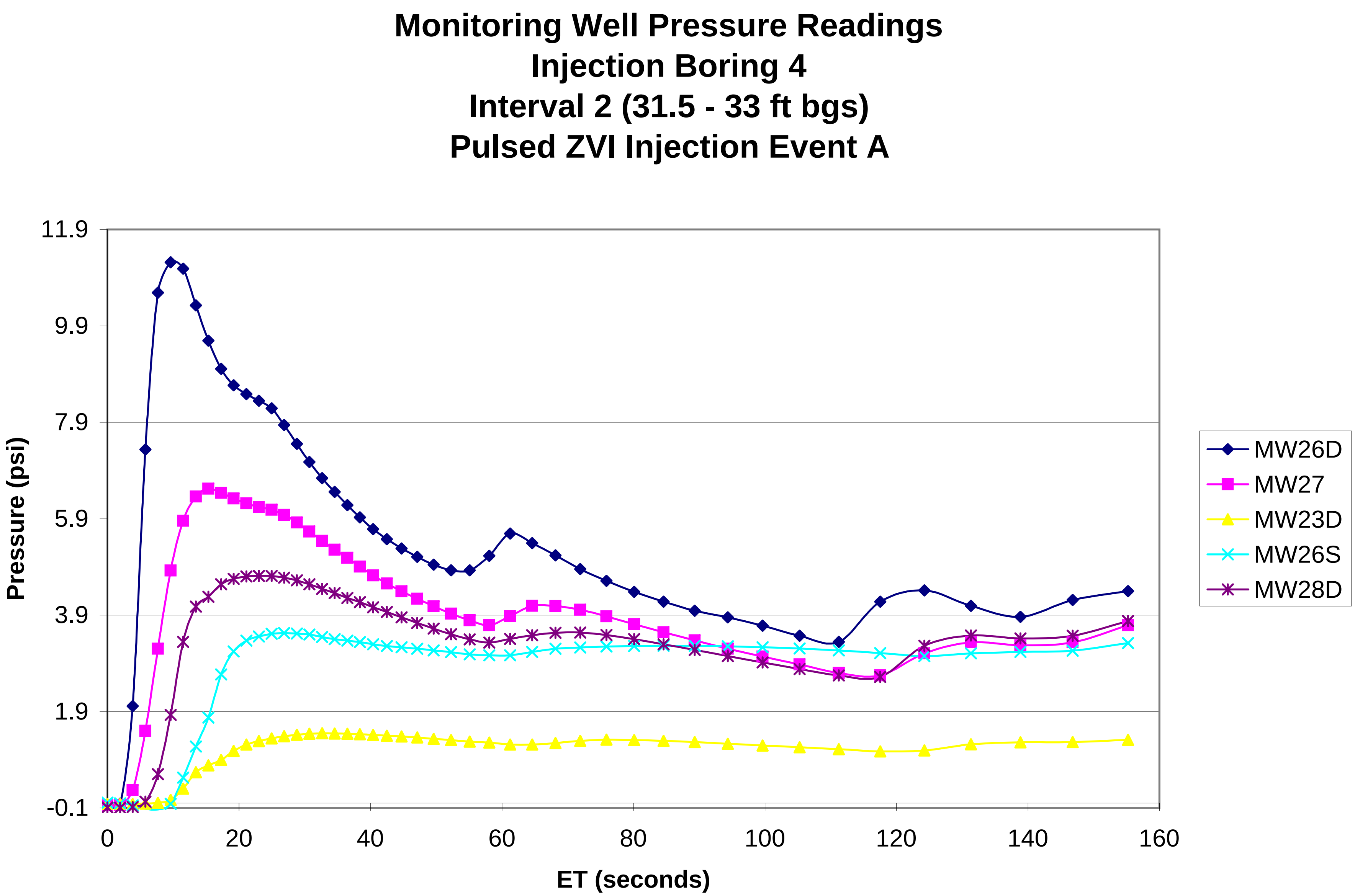

Monitoring Well Pressure Readings
Injection Boring 4
Interval 1 (33.5 - 35 ft bgs)
Fracture Event
7.9
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
Pressure (psi)
0
10
20
30
40
50
60
70
80
ET (seconds)
MW26D
MW27
MW23D
MW26S
MW28D

MW4-1F

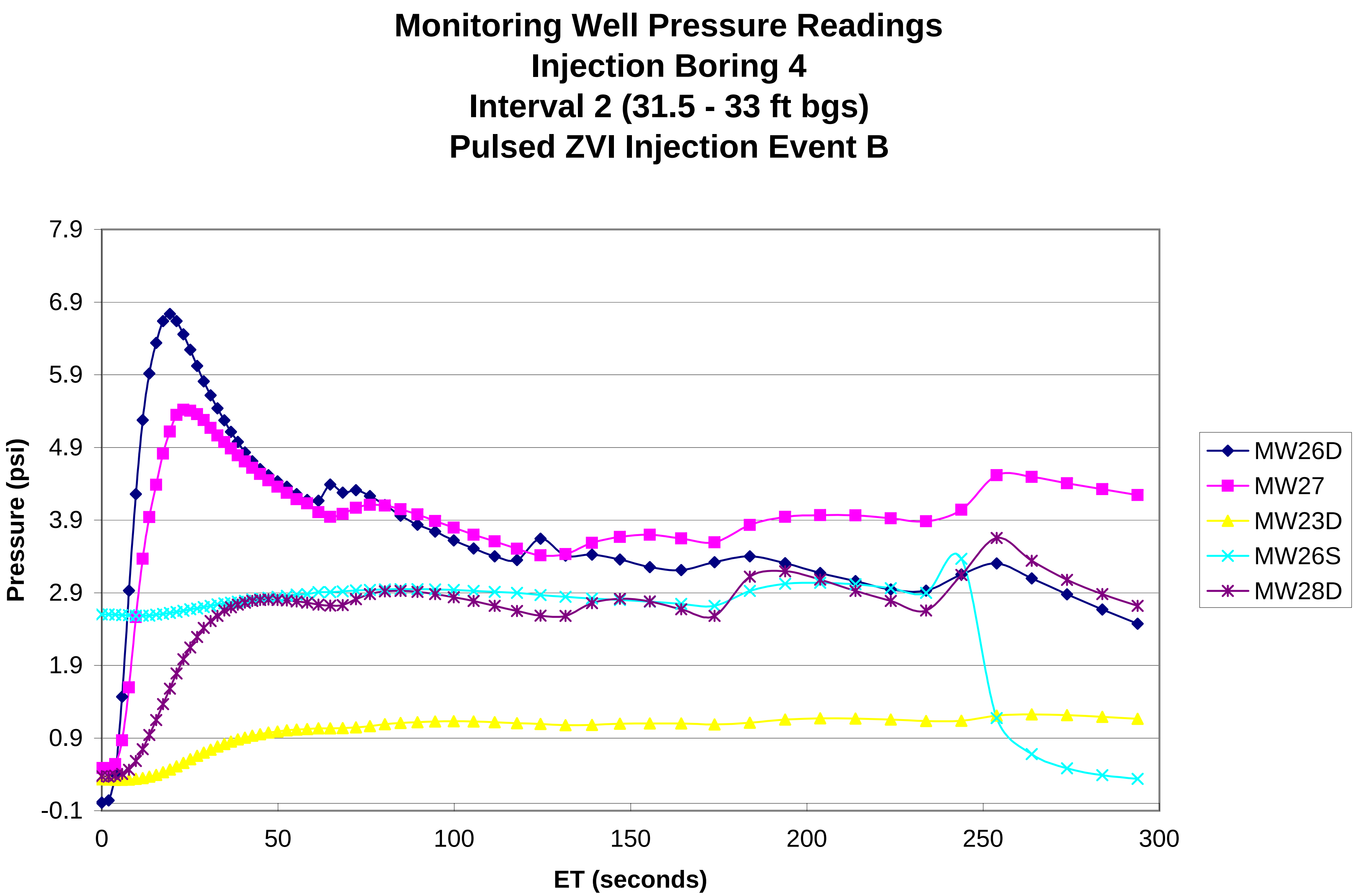


Monitoring Well Pressure Readings
Injection Boring 4
Interval 1 (33.5 - 35 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
3.4
2.9
2.4
1.9
1.4
0.9
0.4
-0.1
0
50
100
150
200
250
300
ET (seconds)
MW26D
MW27
MW23D
MW26S
MW28D

MW4-1I

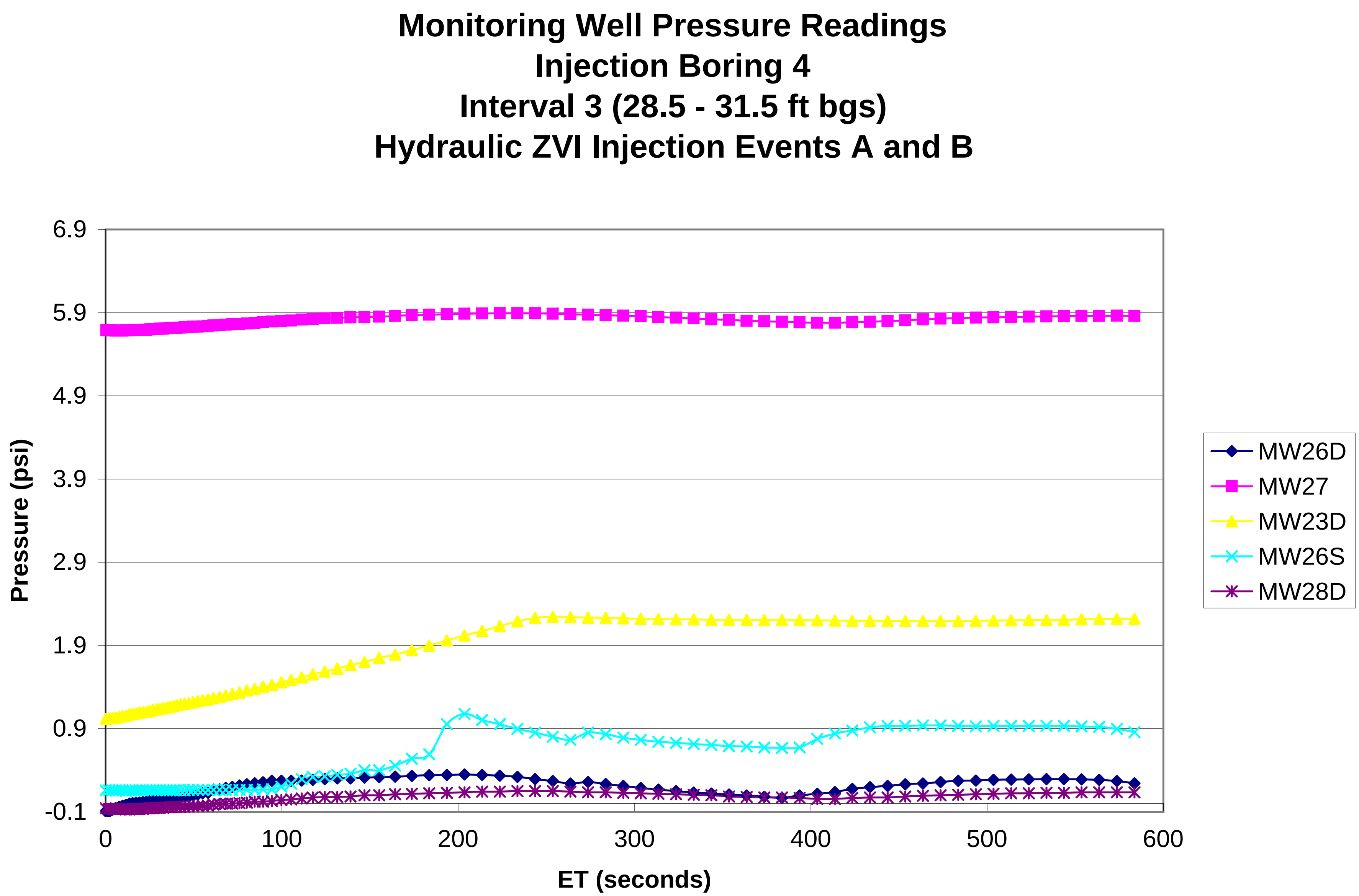

Monitoring Well Pressure Readings
Injection Boring 4
Interval 2 (31.5 - 33 ft bgs)
Pulsed ZVI Injection Event A
Pressure (psi)
11.9
9.9
7.9
5.9
3.9
1.9
-0.1
0
20
40
60
80
100
120
140
160
ET (seconds)
MW26D
MW27
MW23D
MW26S
MW28D

MW4-2IA



Monitoring Well Pressure Readings
Injection Boring 4
Interval 2 (31.5 - 33 ft bgs)
Pulsed ZVI Injection Event B
Pressure (psi)
7.9
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
0
50
100
150
200
250
300
ET (seconds)
MW26D
MW27
MW23D
MW26S
MW28D

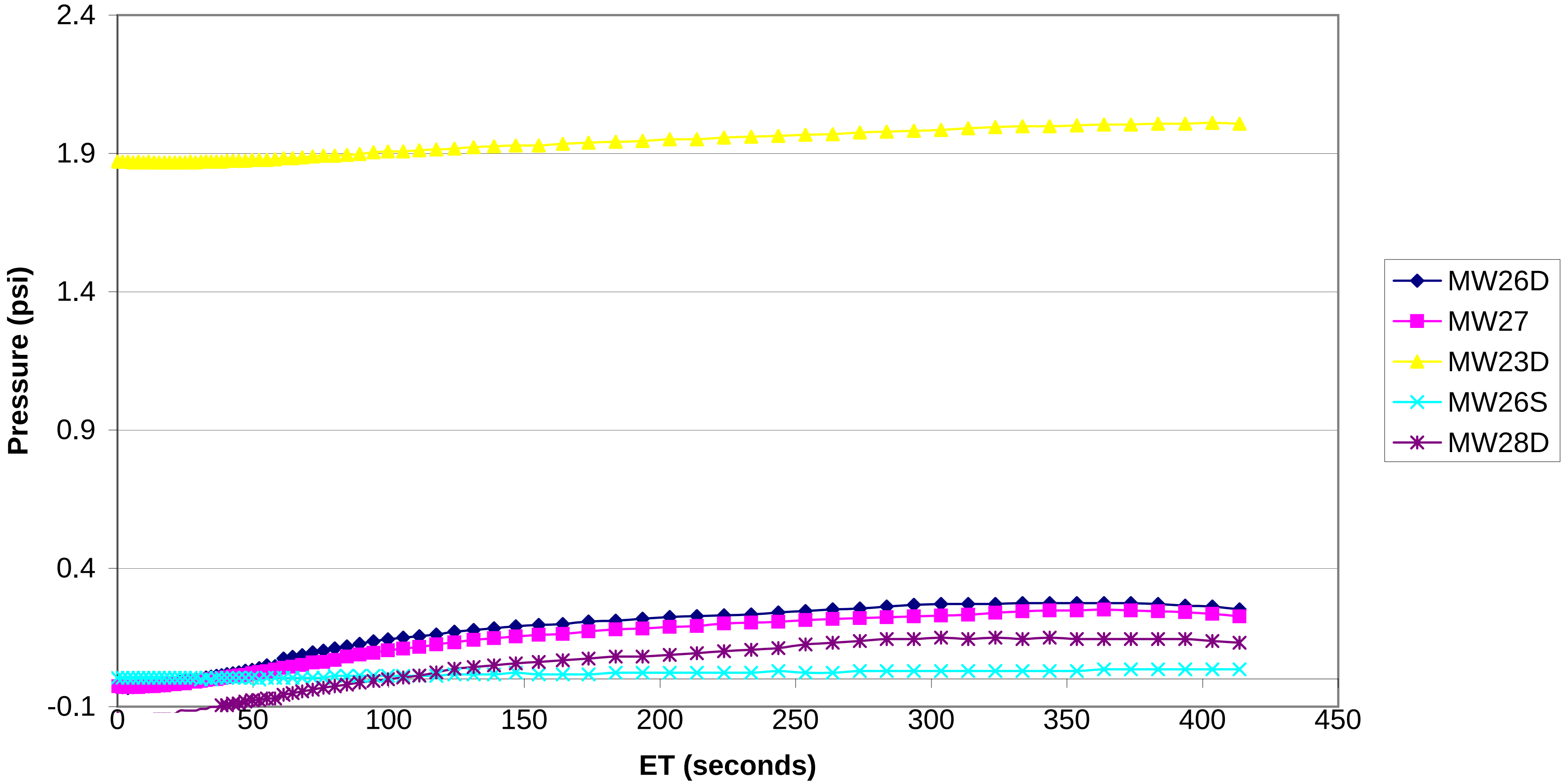
MW4-2IB



Monitoring Well Pressure Readings
Injection Boring 4
Interval 3 (28.5 - 31.5 ft bgs)
Hydraulic ZVI Injection Events A and B
Pressure (psi)
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW26D
MW27
MW23D
MW26S
MW28D

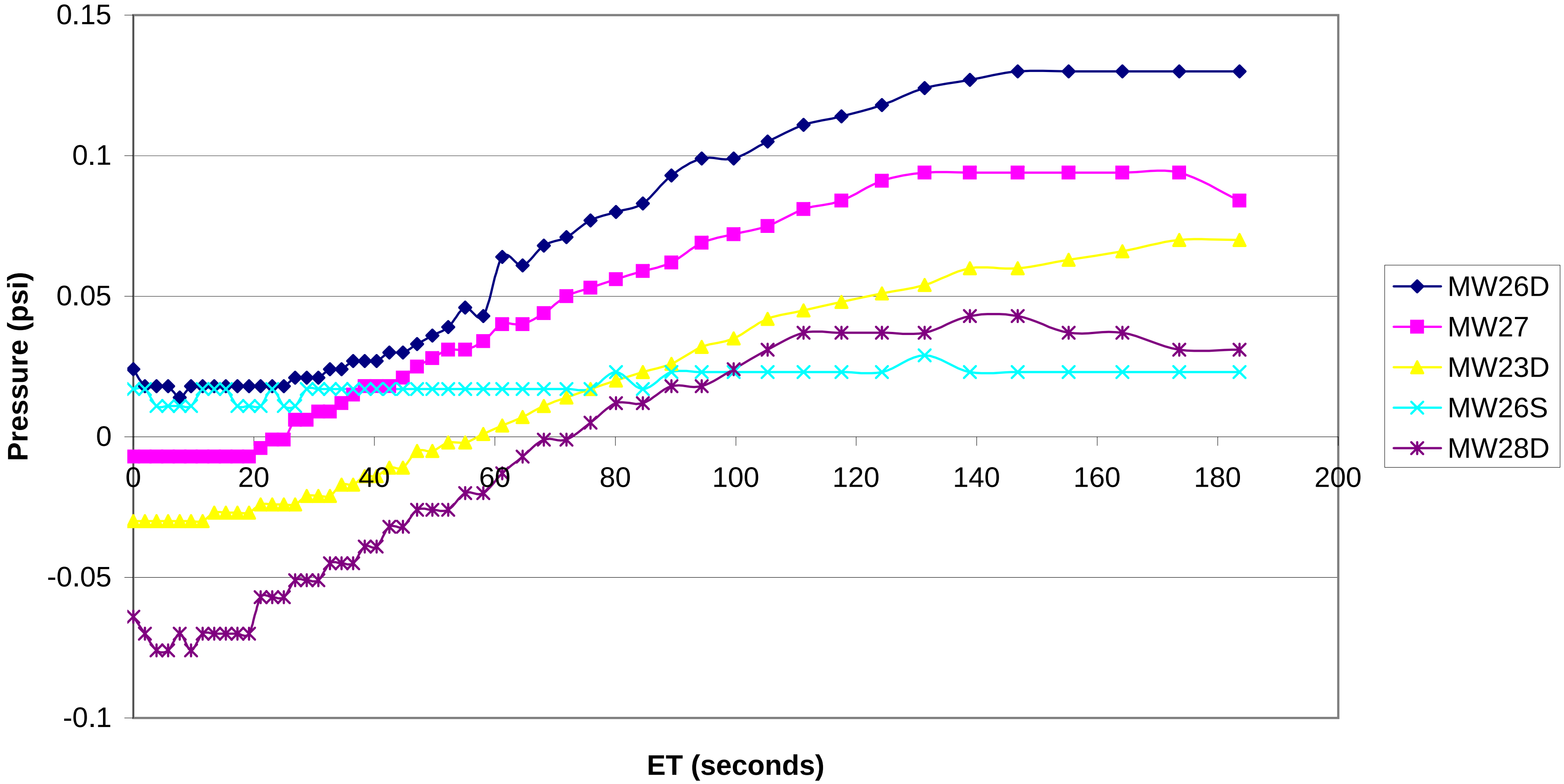
MW4-3I

Monitoring Well Pressure Readings
Injection Boring 4
Interval 4 (25.5 - 28.5 ft bgs)
Hydraulic ZVI Injection Event



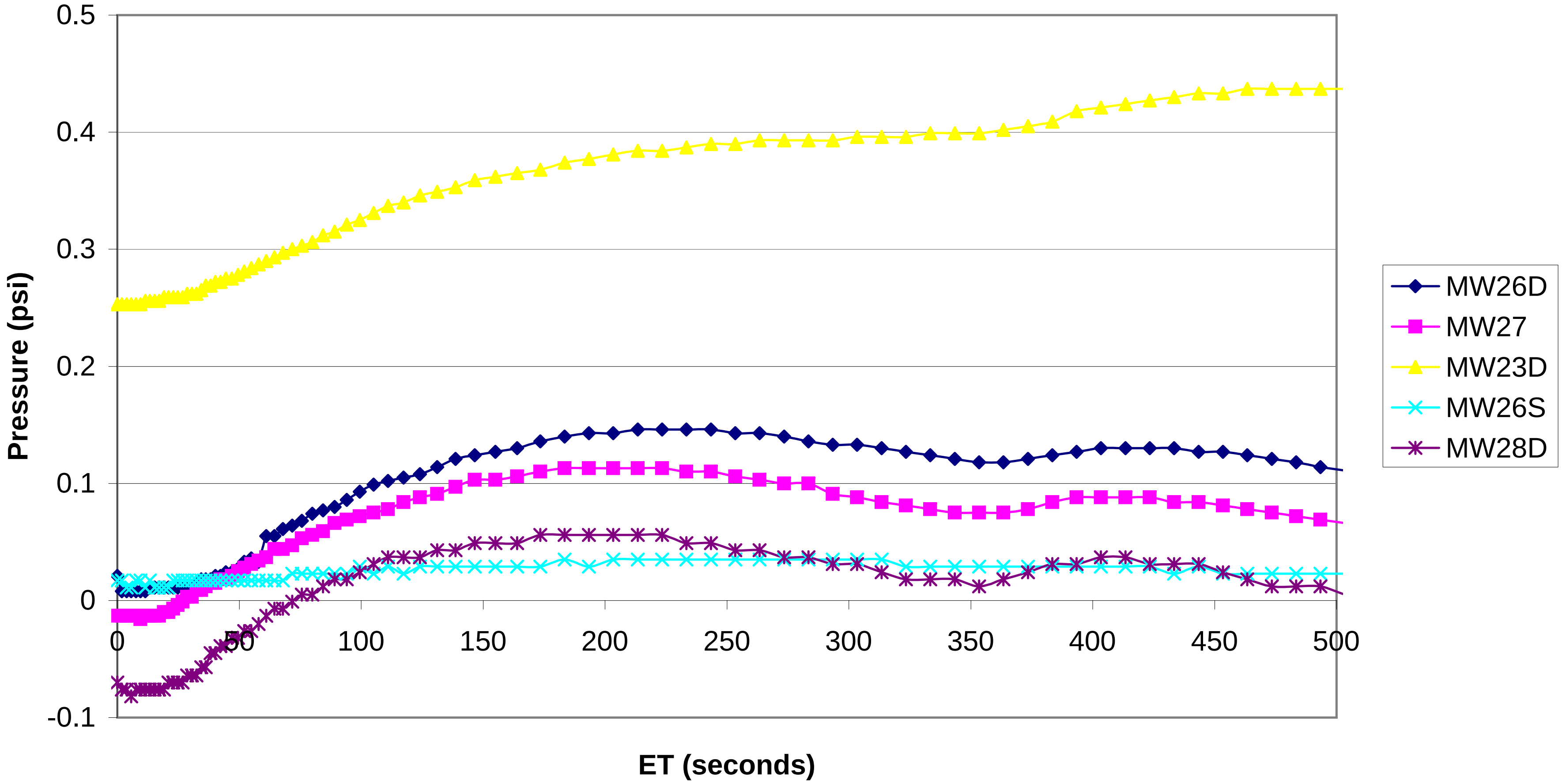
MW4-4I

Monitoring Well Pressure Readings
Injection Boring 4
Interval 5 (22.5 - 25.5 ft bgs)
Hydraulic ZVI Injection Event A

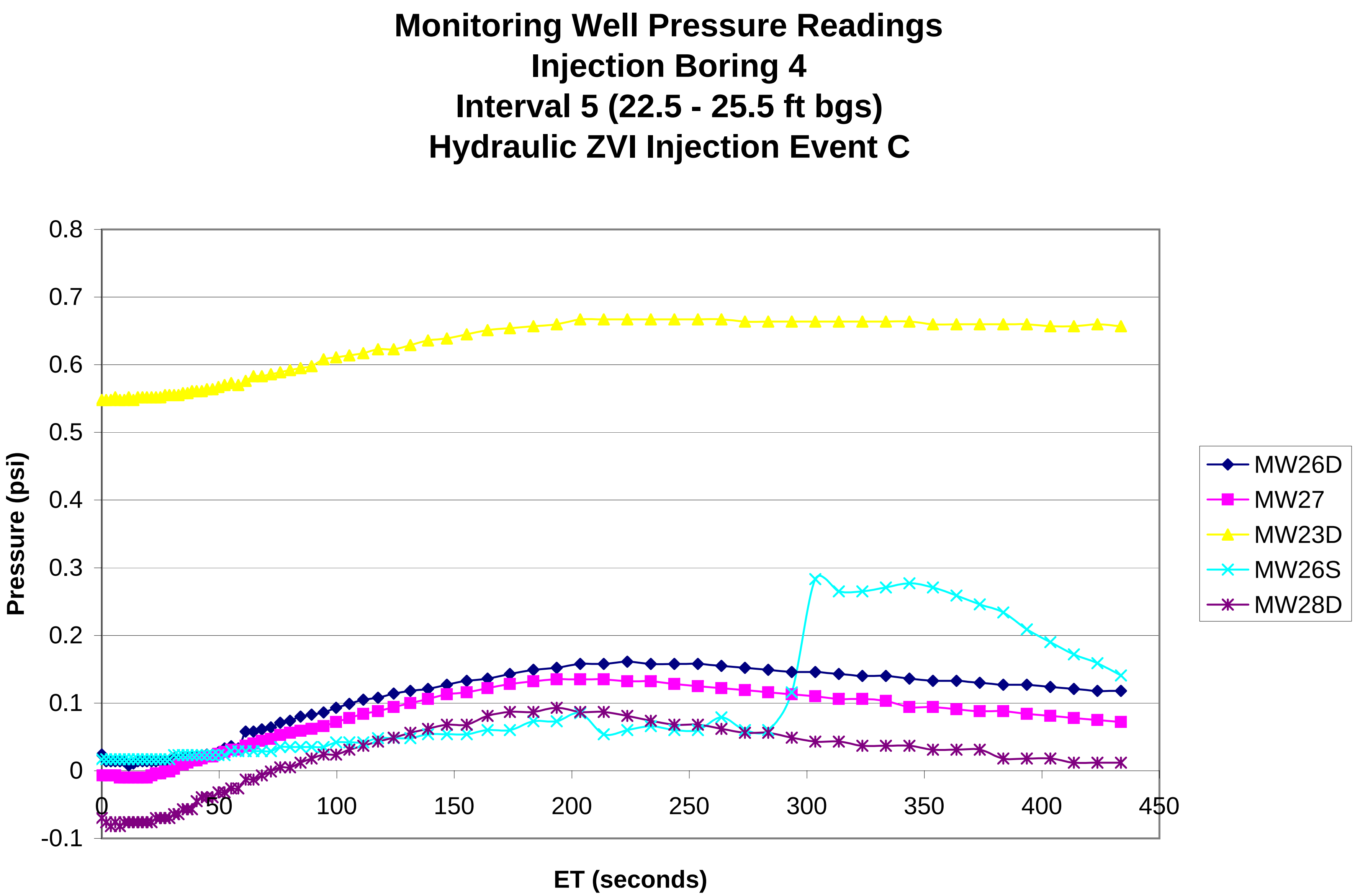


MW4-5IA

Monitoring Well Pressure Readings
Injection Boring 4
Interval 5 (22.5 - 25.5 ft bgs)
Hydraulic ZVI Injection Event B

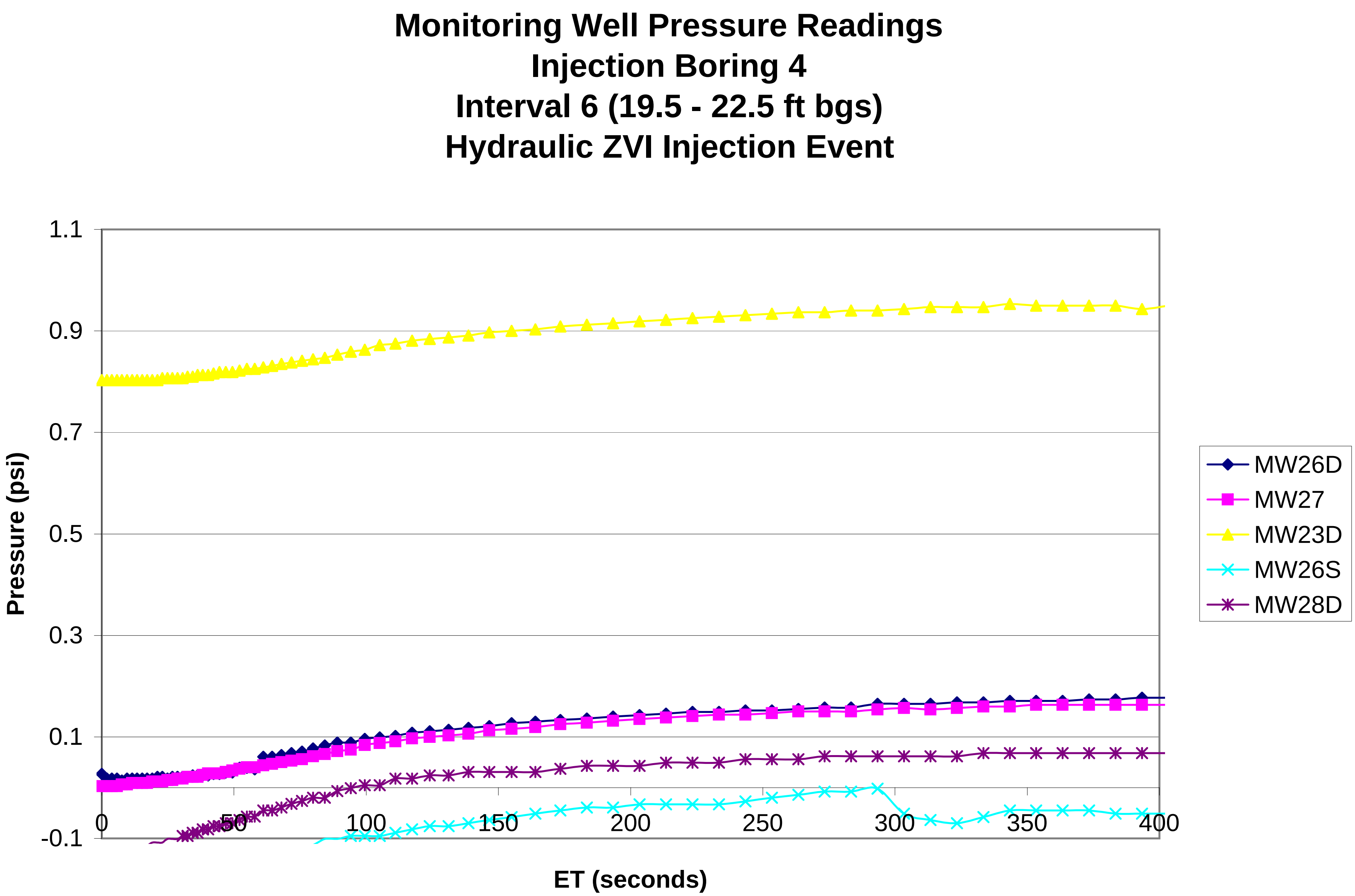


MW4-5IB

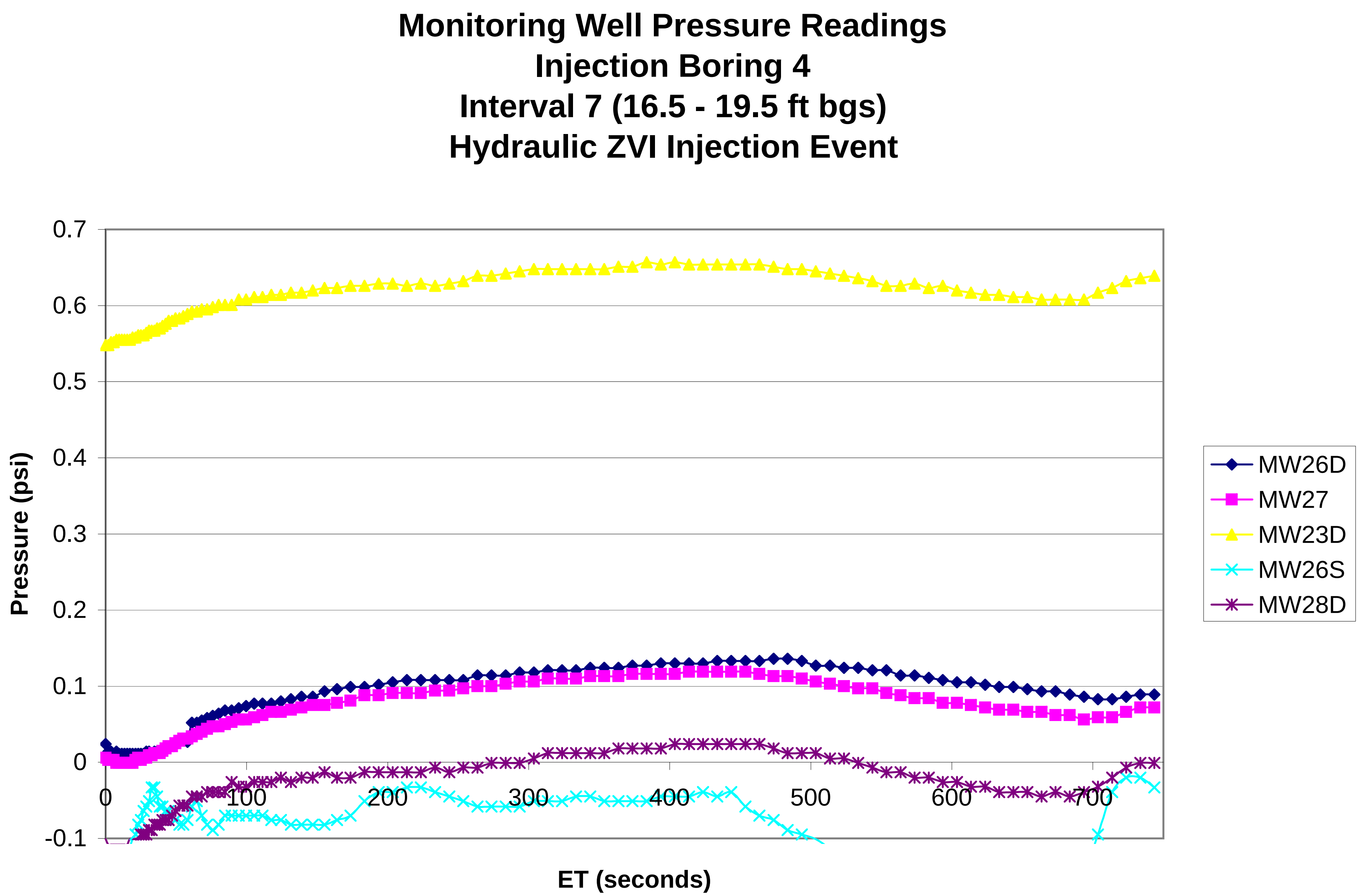


Monitoring Well Pressure Readings
Injection Boring 4
Interval 5 (22.5 - 25.5 ft bgs)
Hydraulic ZVI Injection Event C
Pressure (psi)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
50
100
150
200
250
300
350
400
450
ET (seconds)
MW26D
MW27
MW23D
MW26S
MW28D

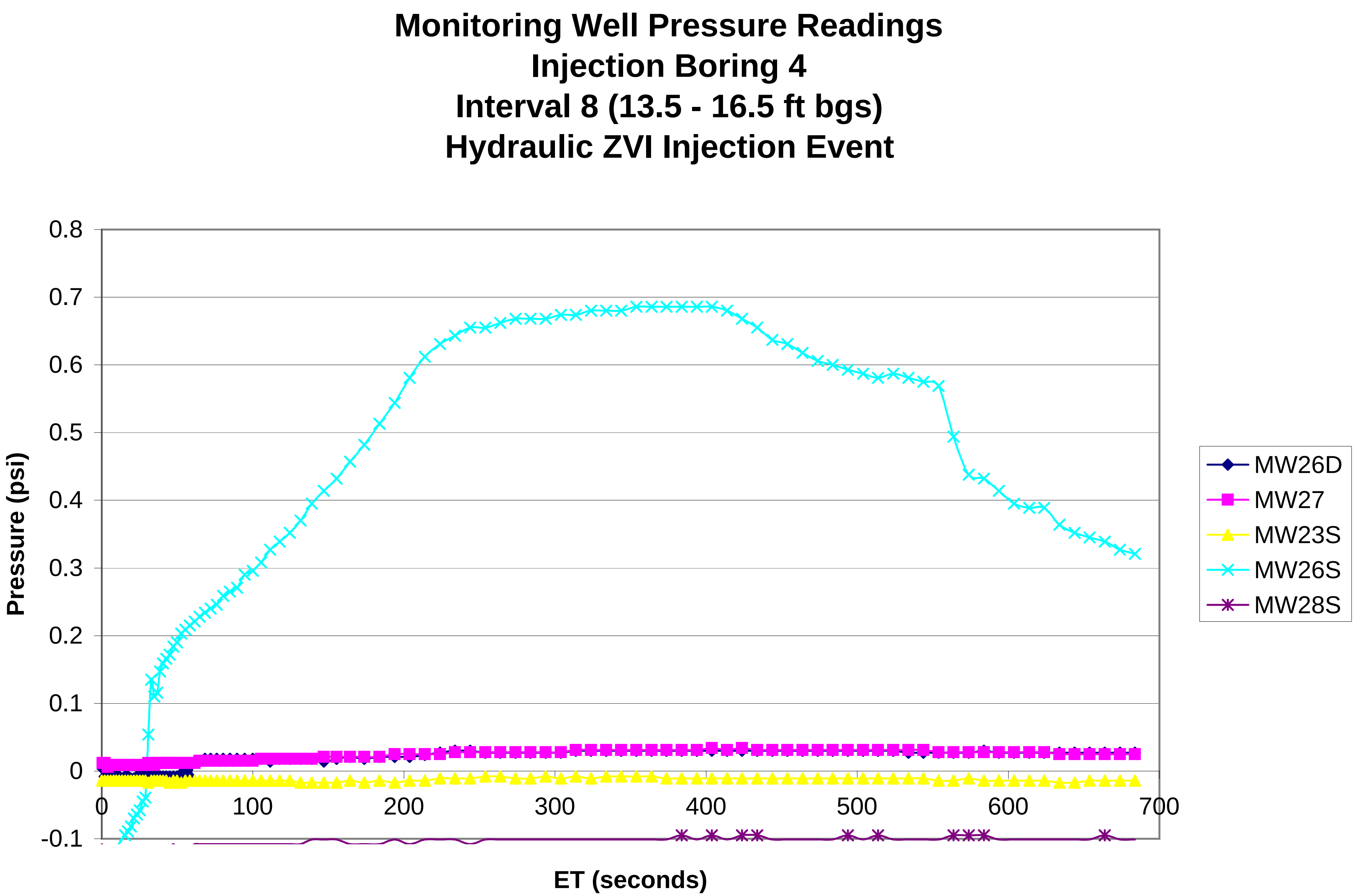
MW4-5IC


Monitoring Well Pressure Readings
Injection Boring 4
Interval 6 (19.5 - 22.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
50
100
150
200
250
300
350
400
ET (seconds)
MW26D
MW27
MW23D
MW26S
MW28D

MW4-6I

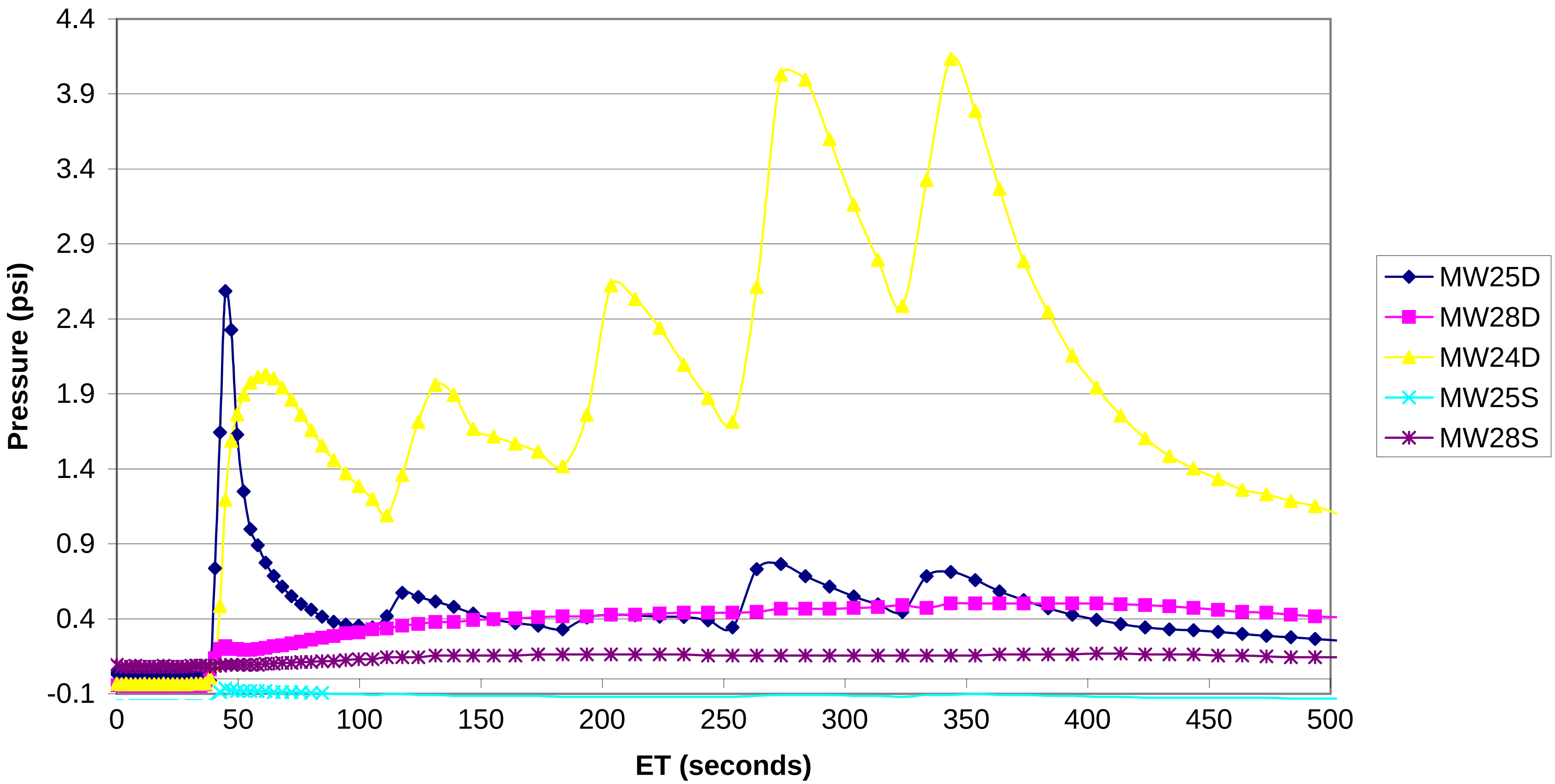

Monitoring Well Pressure Readings
Injection Boring 4
Interval 7 (16.5 - 19.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
100
200
300
400
500
600
700
ET (seconds)
MW26D
MW27
MW23D
MW26S
MW28D

MW4-7I


Monitoring Well Pressure Readings
Injection Boring 4
Interval 8 (13.5 - 16.5 ft bgs)
Hydraulic ZVI Injection Event
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
Pressure (psi)
0
100
200
300
400
500
600
700
ET (seconds)
MW26D
MW27
MW23S
MW26S
MW28S

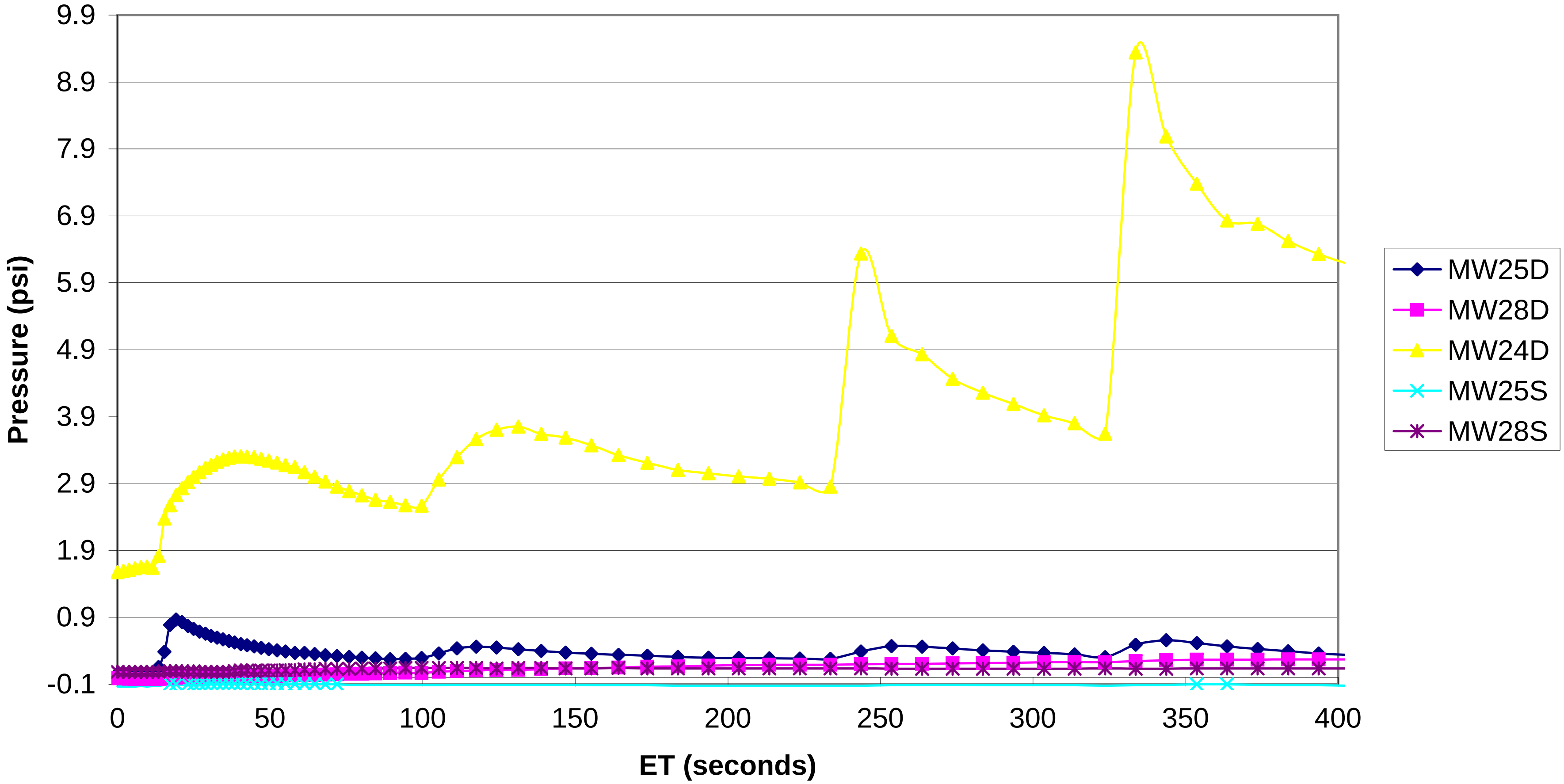
MW4-8I

Monitoring Well Pressure Readings
Injection Boring 5
Interval 1 (28.5 - 30.5 ft bgs)
Pulsed ZVI Injection Event



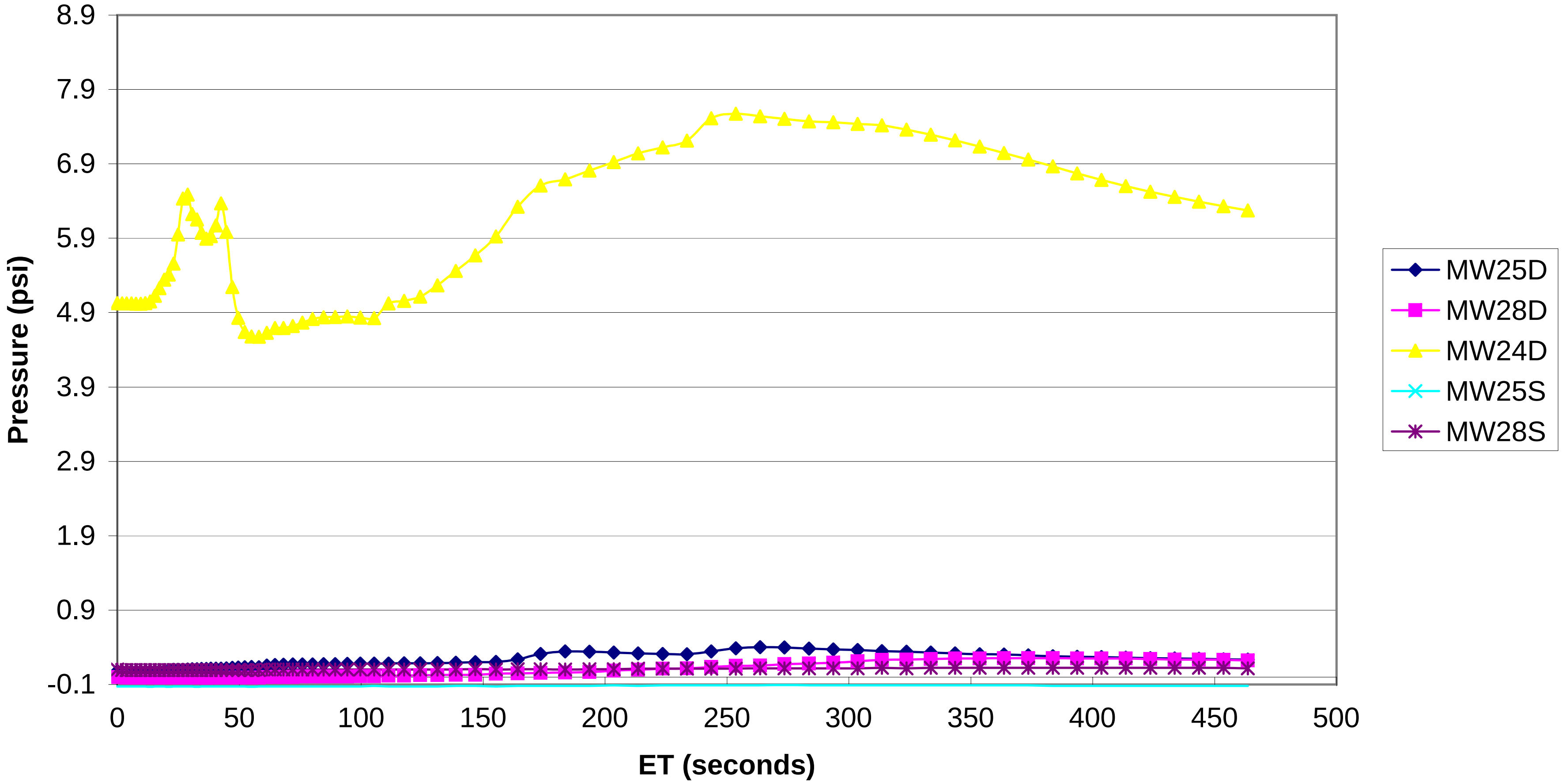
MW5-1I

Monitoring Well Pressure Readings
Injection Boring 5
Interval 2 (25.5 - 28.5 ft bgs)
Pulsed ZVI Injection Event

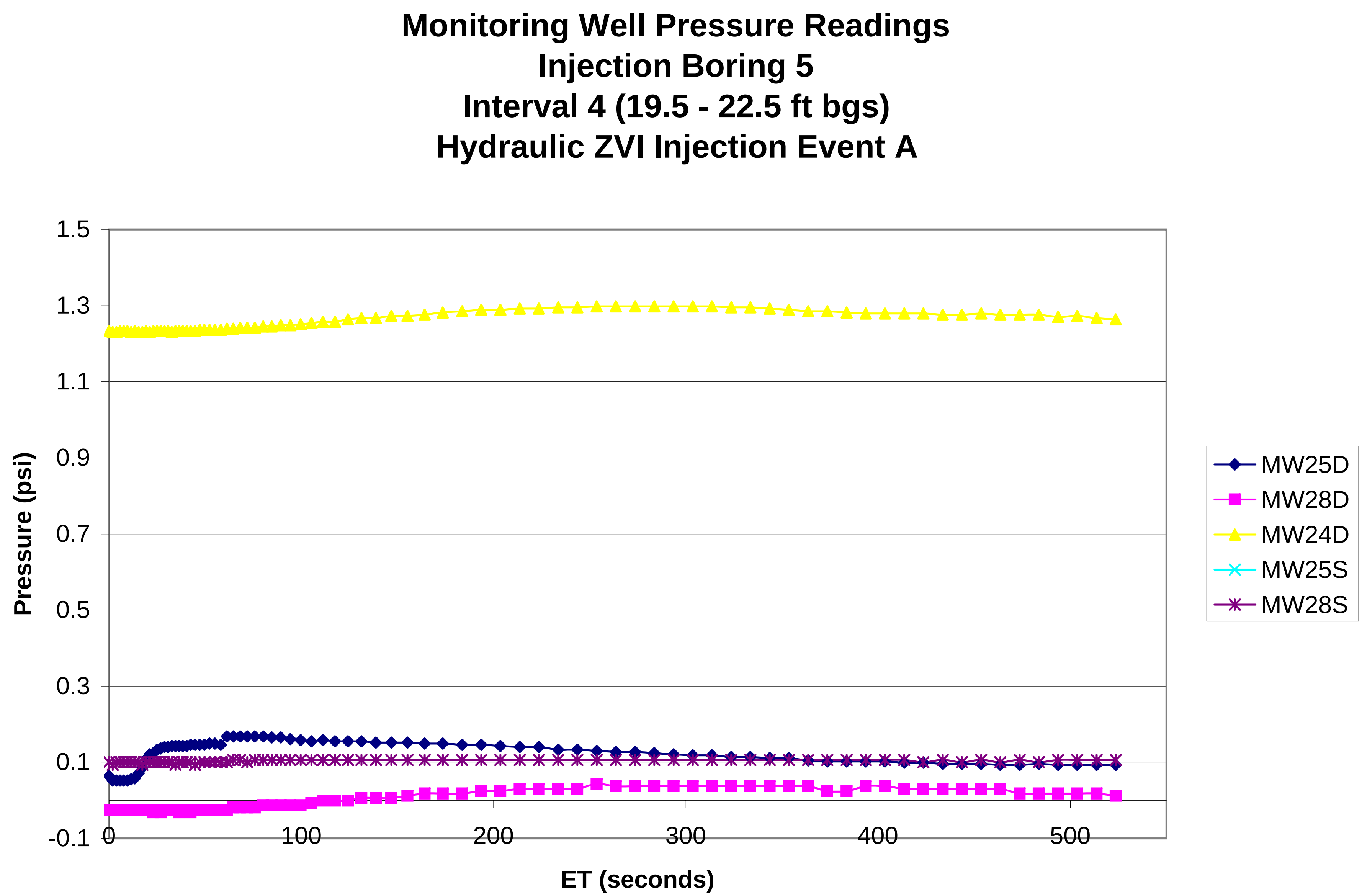


MW5-2I

Monitoring Well Pressure Readings
Injection Boring 5
Interval 3 (22.5 - 25.5 ft bgs)
Pulsed ZVI Injection Event



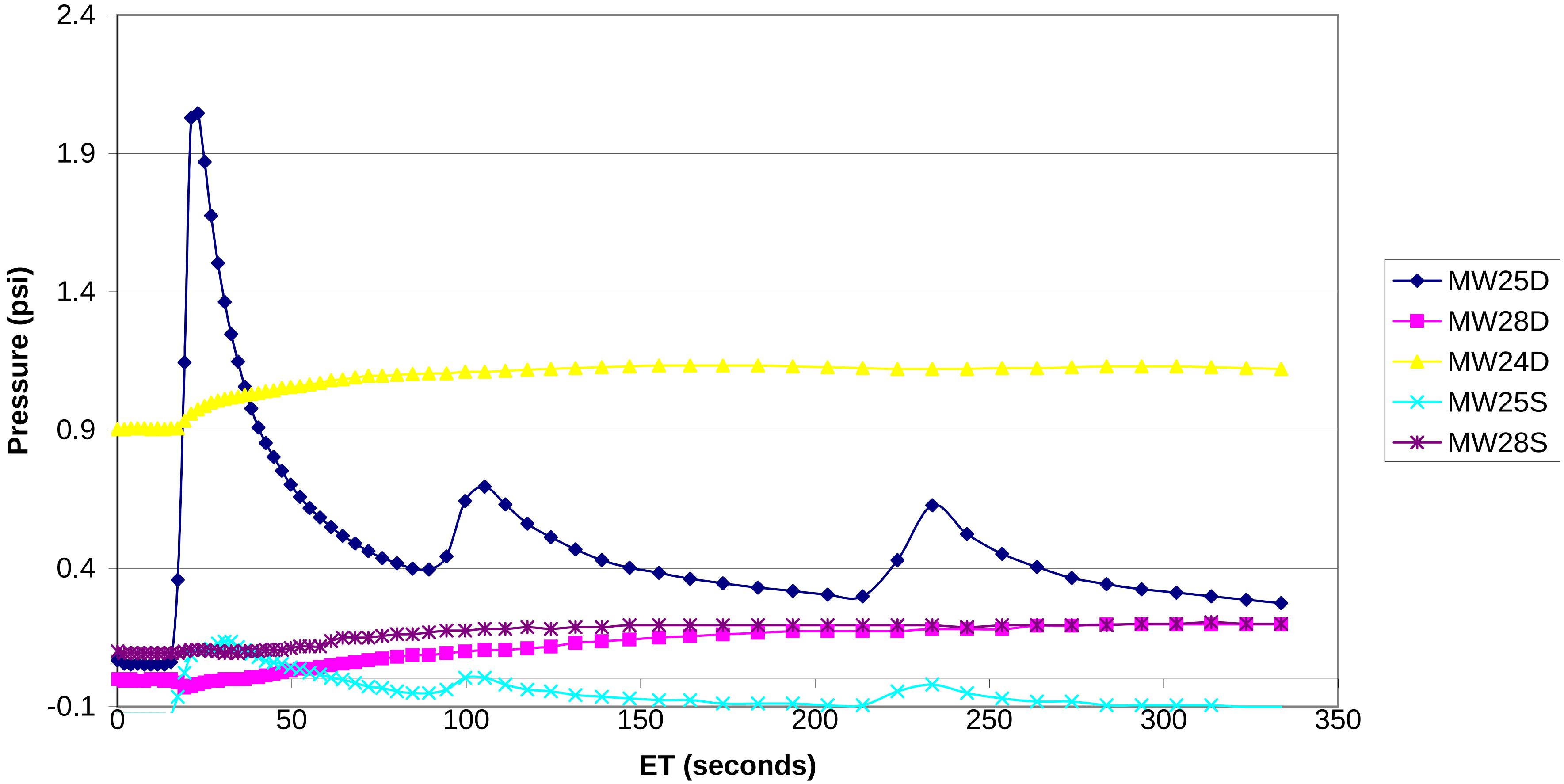
MW5-3I



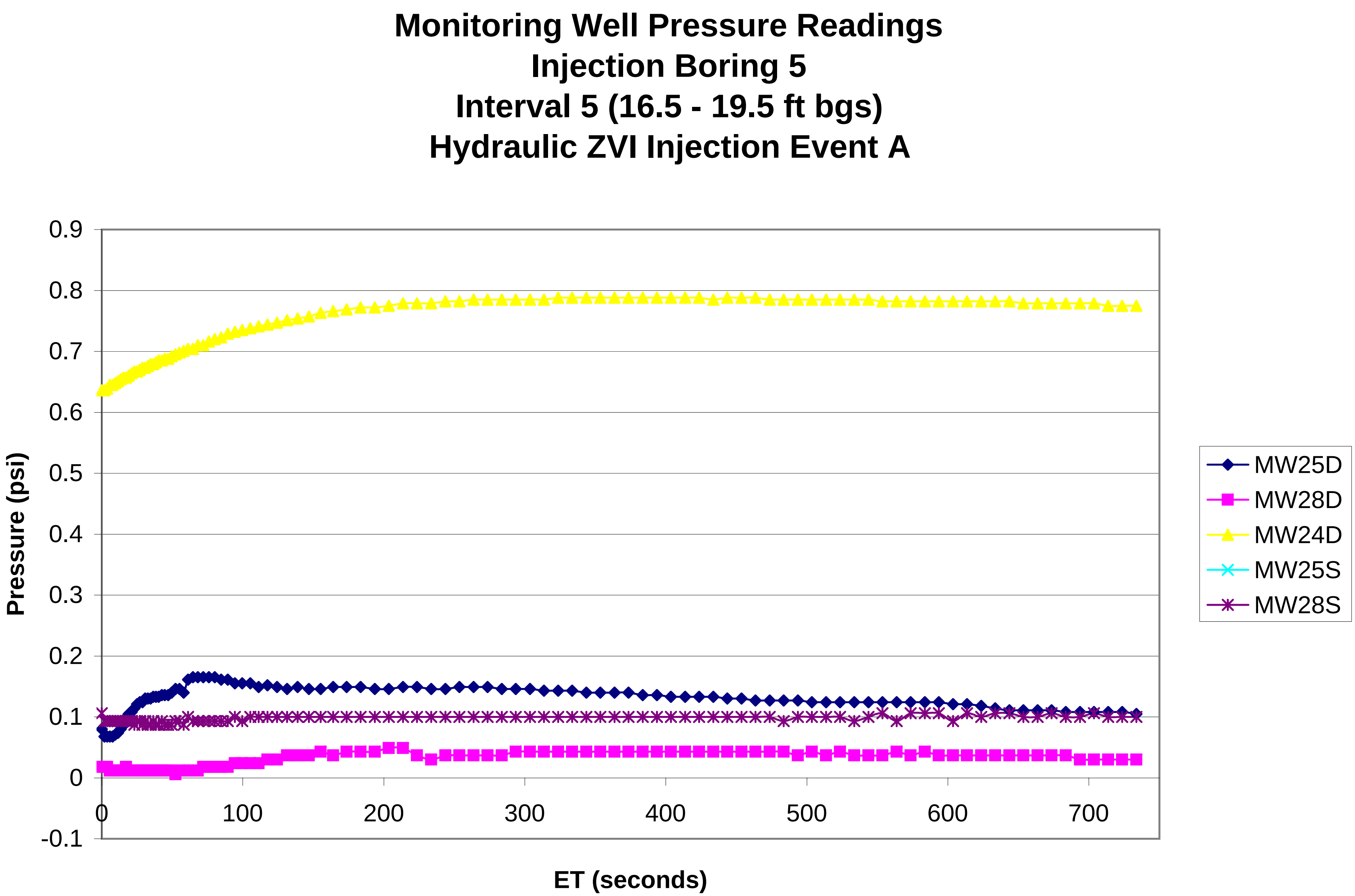
Monitoring Well Pressure Readings
Injection Boring 5
Interval 4 (19.5 - 22.5 ft bgs)
Hydraulic ZVI Injection Event A
Pressure (psi)
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
100
200
300
400
500
ET (seconds)
MW25D
MW28D
MW24D
MW25S
MW28S

MW5-4IA

Monitoring Well Pressure Readings
Injection Boring 5
Interval 4 (19.5 - 22.5 ft bgs)
Pulsed ZVI Injection Event B



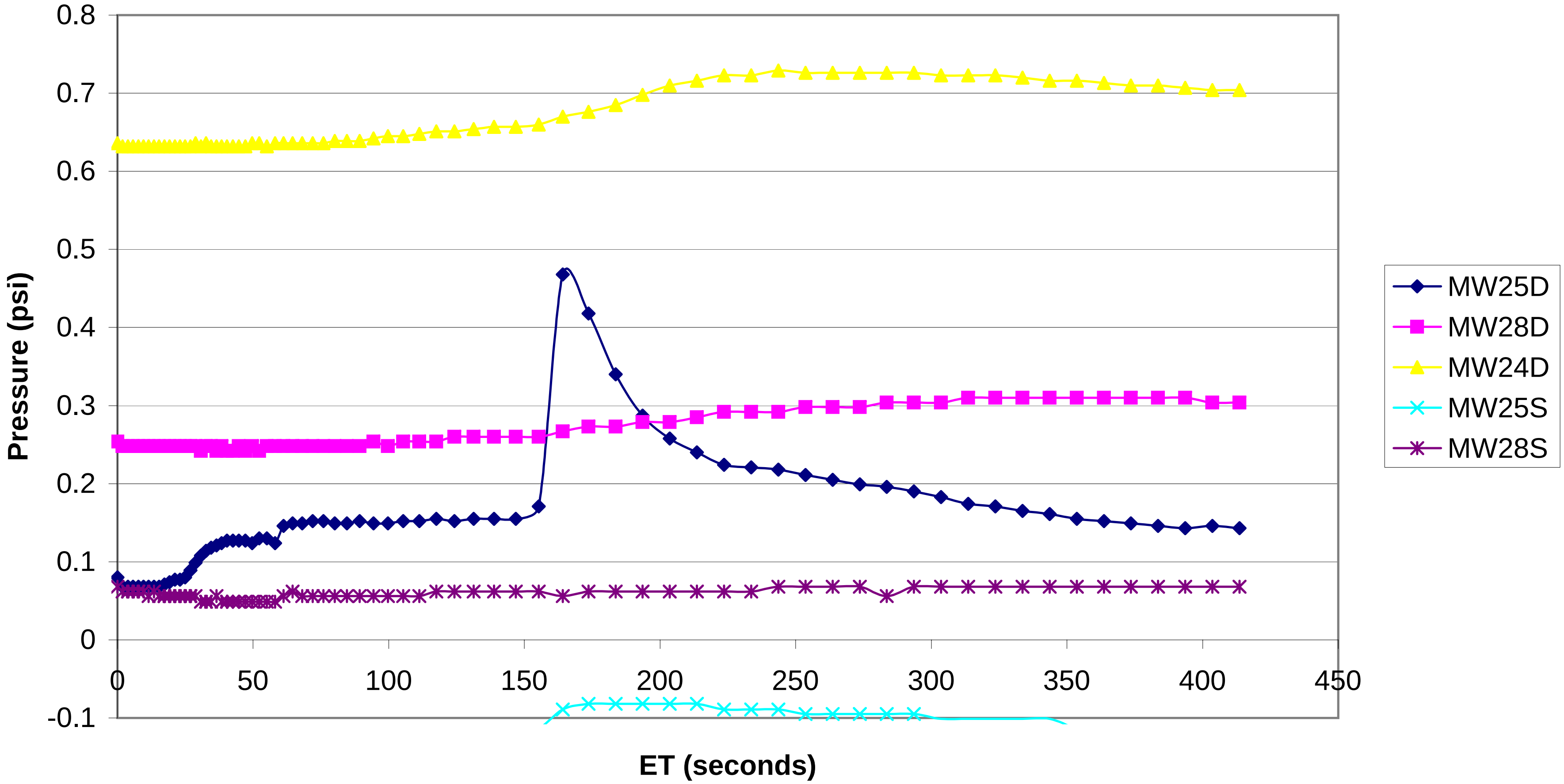
MW5-4IB



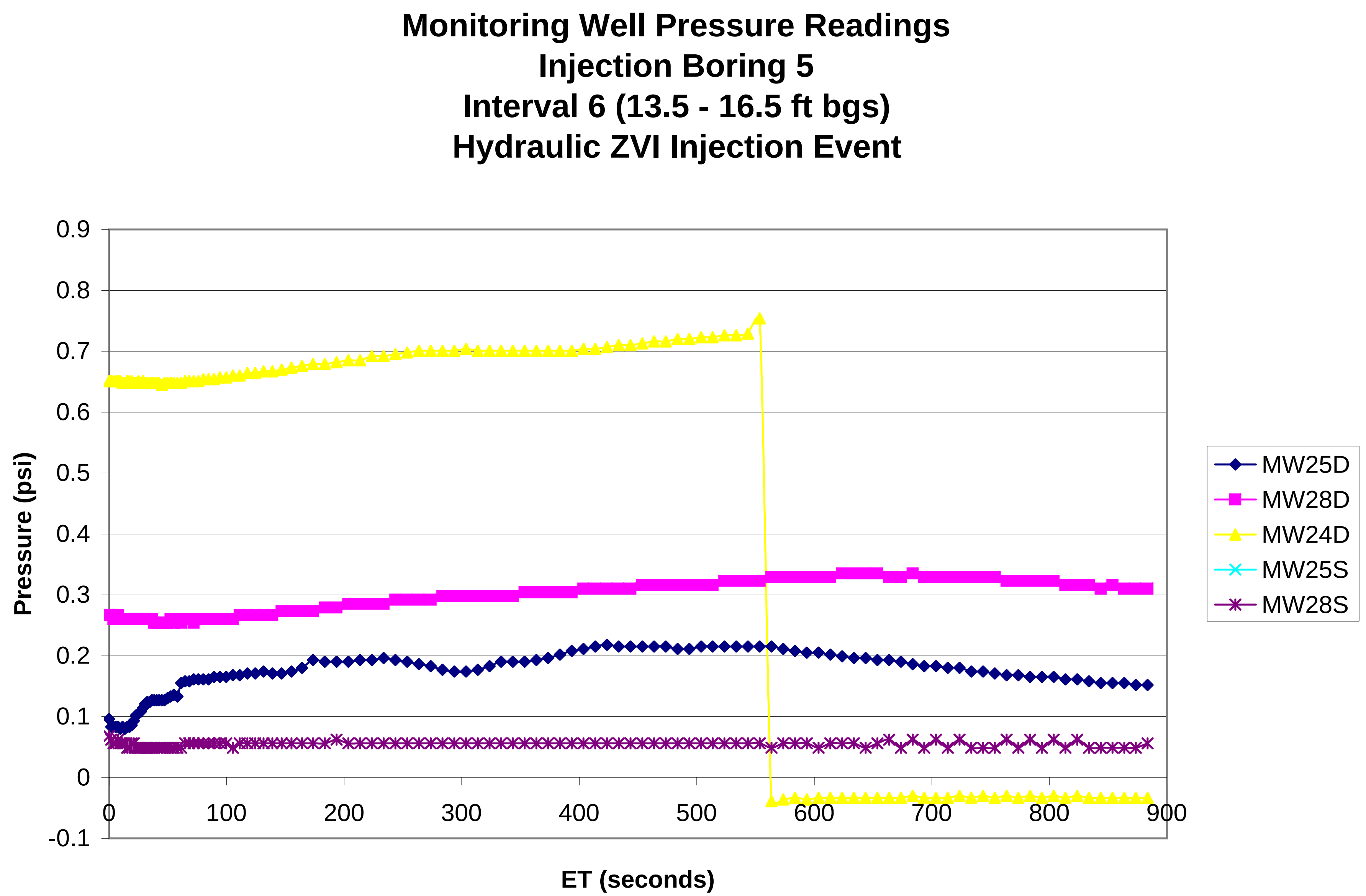
Monitoring Well Pressure Readings
Injection Boring 5
Interval 5 (16.5 - 19.5 ft bgs)
Hydraulic ZVI Injection Event A
Pressure (psi)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
100
200
300
400
500
600
700
ET (seconds)
MW25D
MW28D
MW24D
MW25S
MW28S

MW5-5IA

Monitoring Well Pressure Readings
Injection Boring 5
Interval 5 (16.5 - 19.5 ft bgs)
Hydraulic ZVI Injection Event B

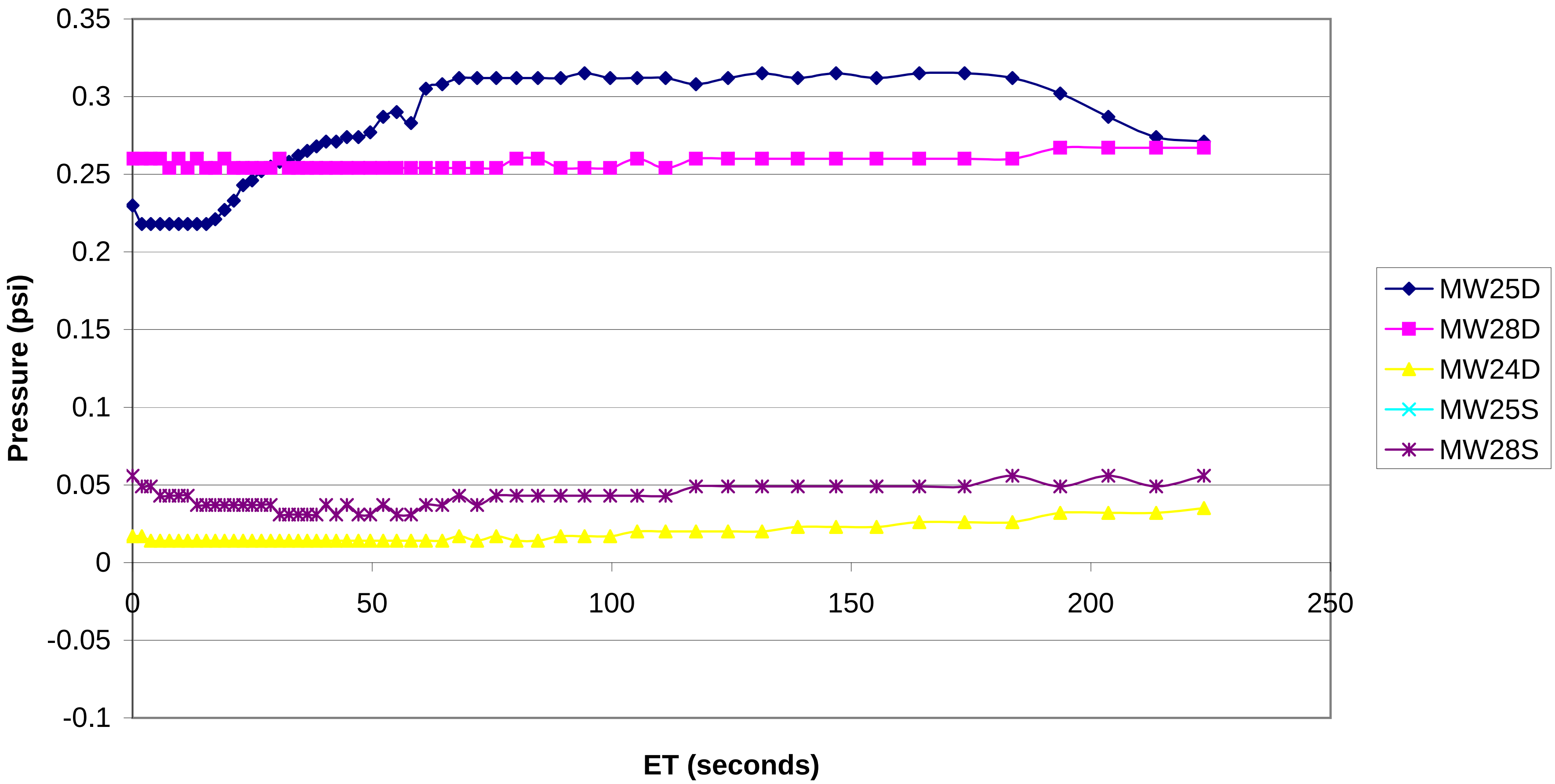


MW5-5IB

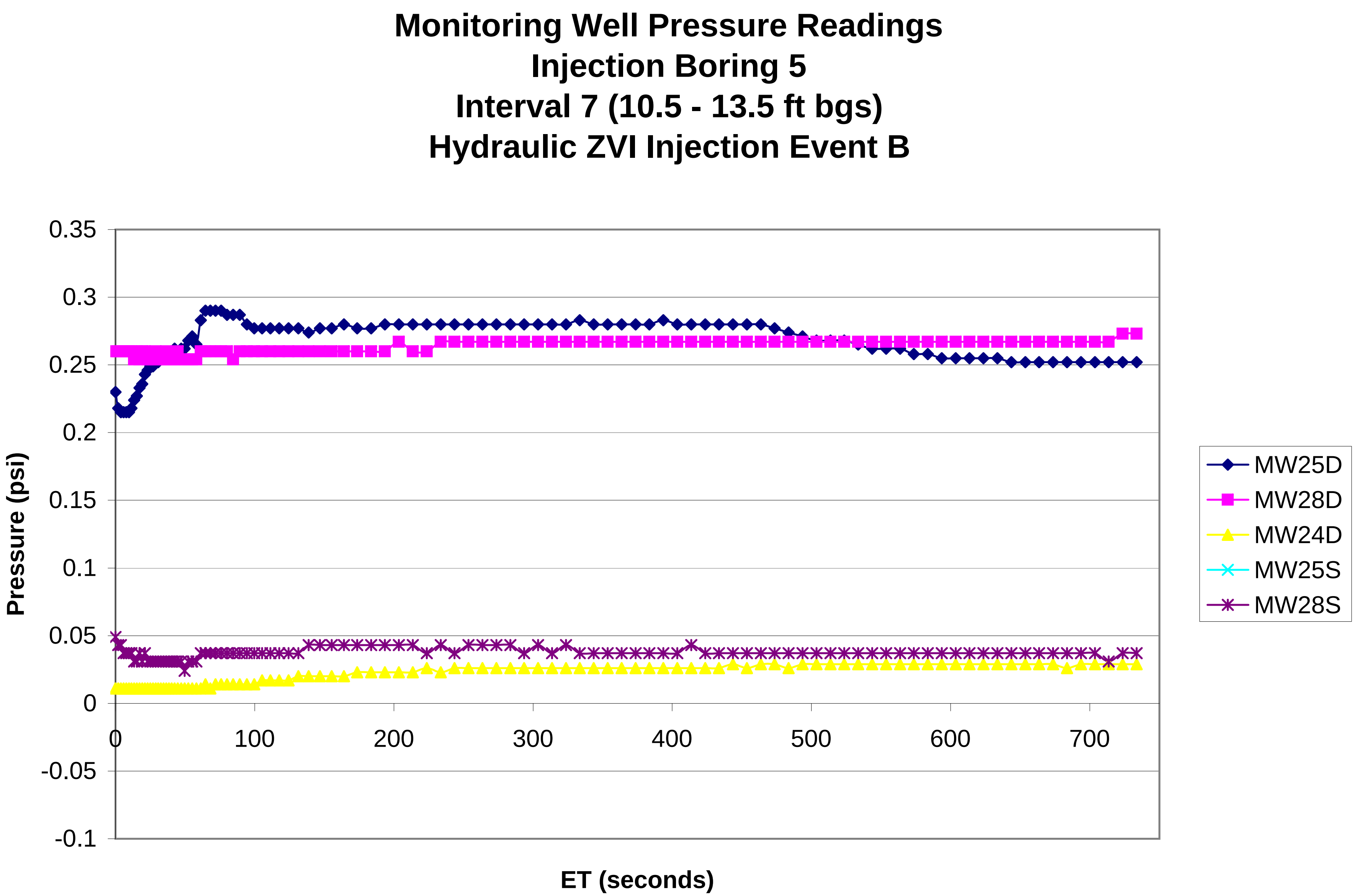

Monitoring Well Pressure Readings
Injection Boring 5
Interval 6 (13.5 - 16.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
100
200
300
400
500
600
700
800
900
ET (seconds)
MW25D
MW28D
MW24D
MW25S
MW28S

MW5-6I

Monitoring Well Pressure Readings
Injection Boring 5
Interval 7 (10.5 - 13.5 ft bgs)
Hydraulic ZVI Injection Event A

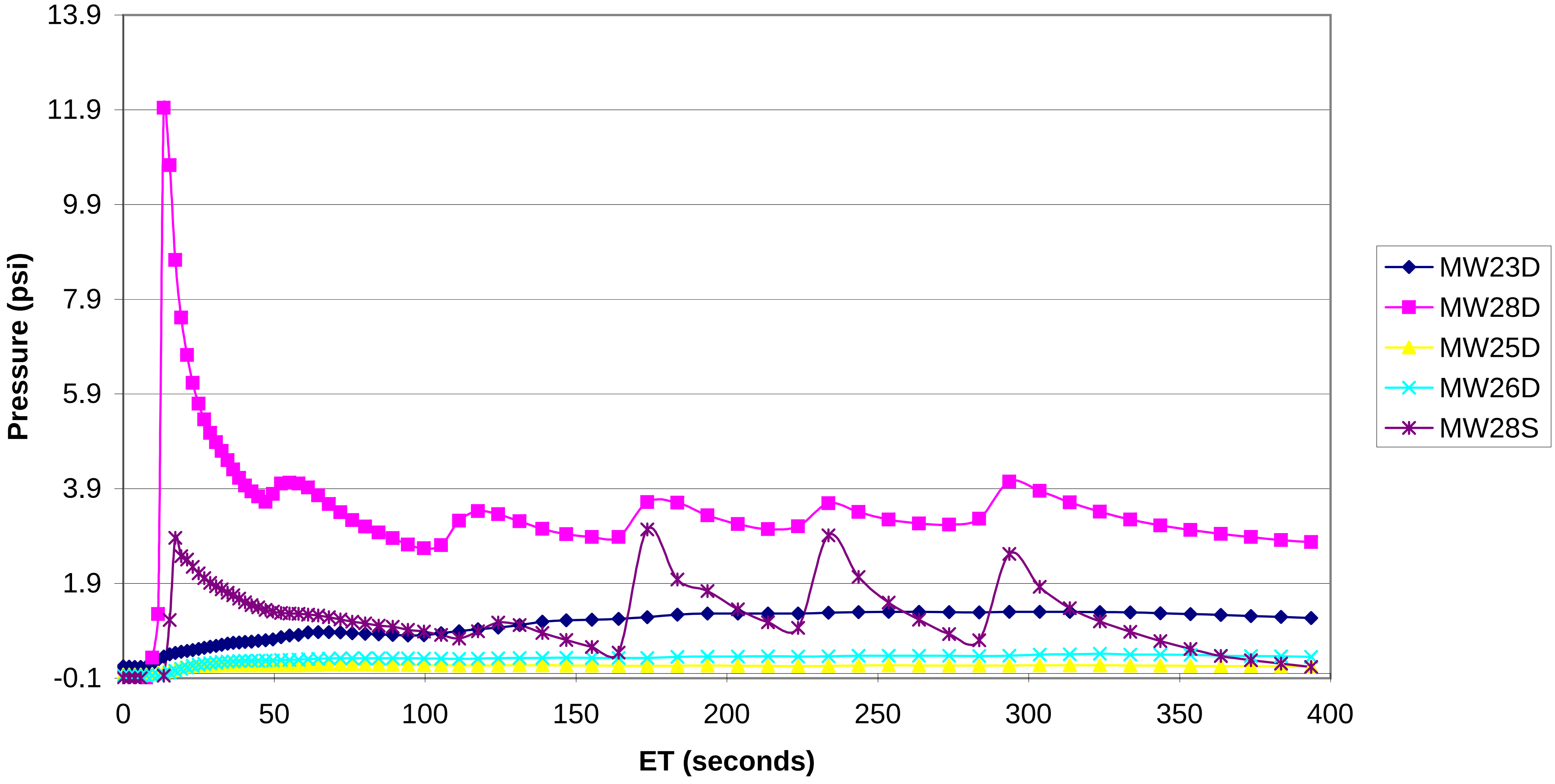


MW5-7IA

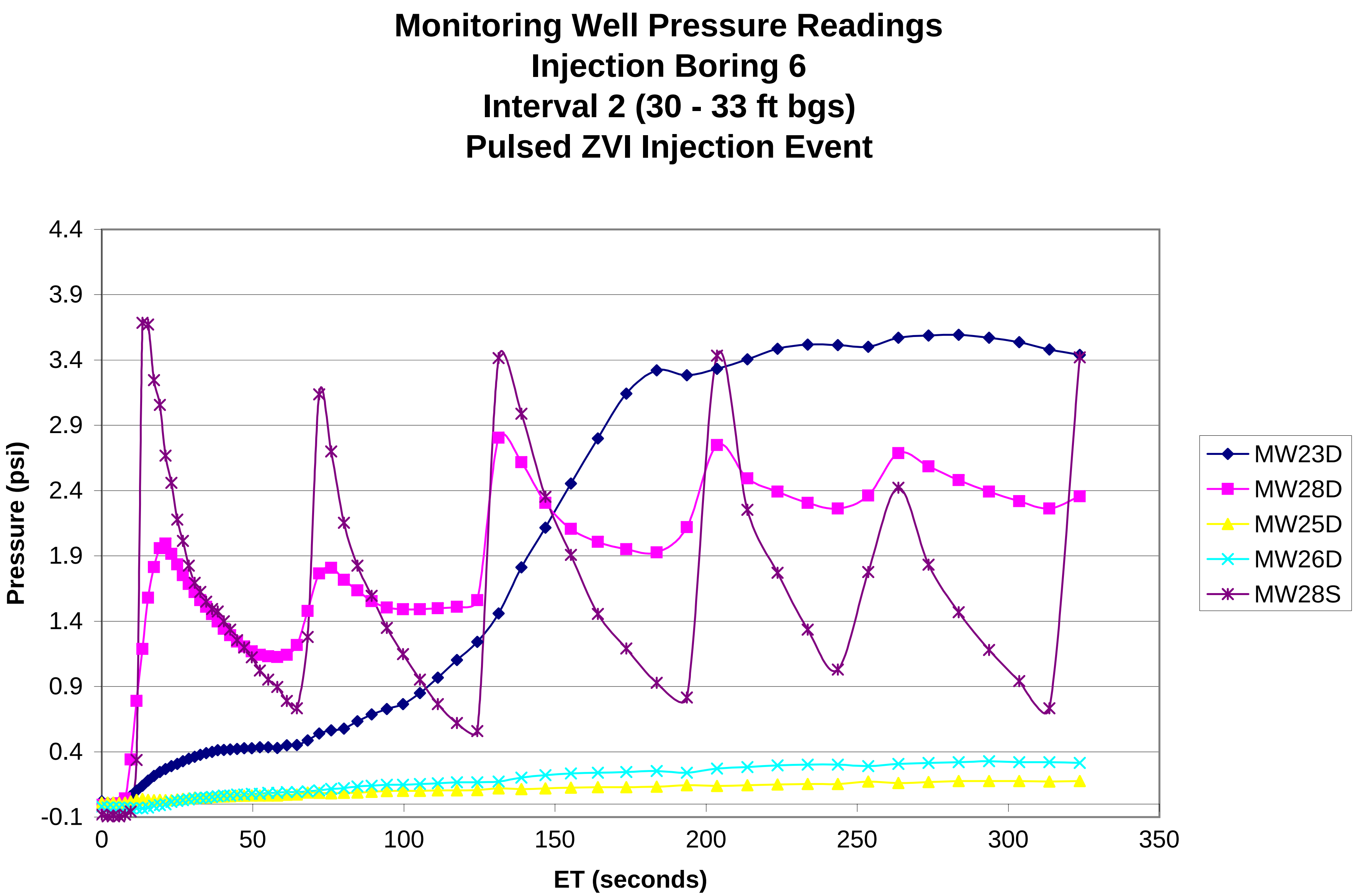

Monitoring Well Pressure Readings
Injection Boring 5
Interval 7 (10.5 - 13.5 ft bgs)
Hydraulic ZVI Injection Event B
Pressure (psi)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
0
100
200
300
400
500
600
700
ET (seconds)
MW25D
MW28D
MW24D
MW25S
MW28S

MW5-7IB

Monitoring Well Pressure Readings
Injection Boring 6
Interval 1 (33 - 35 ft bgs)
Pulsed ZVI Injection Event

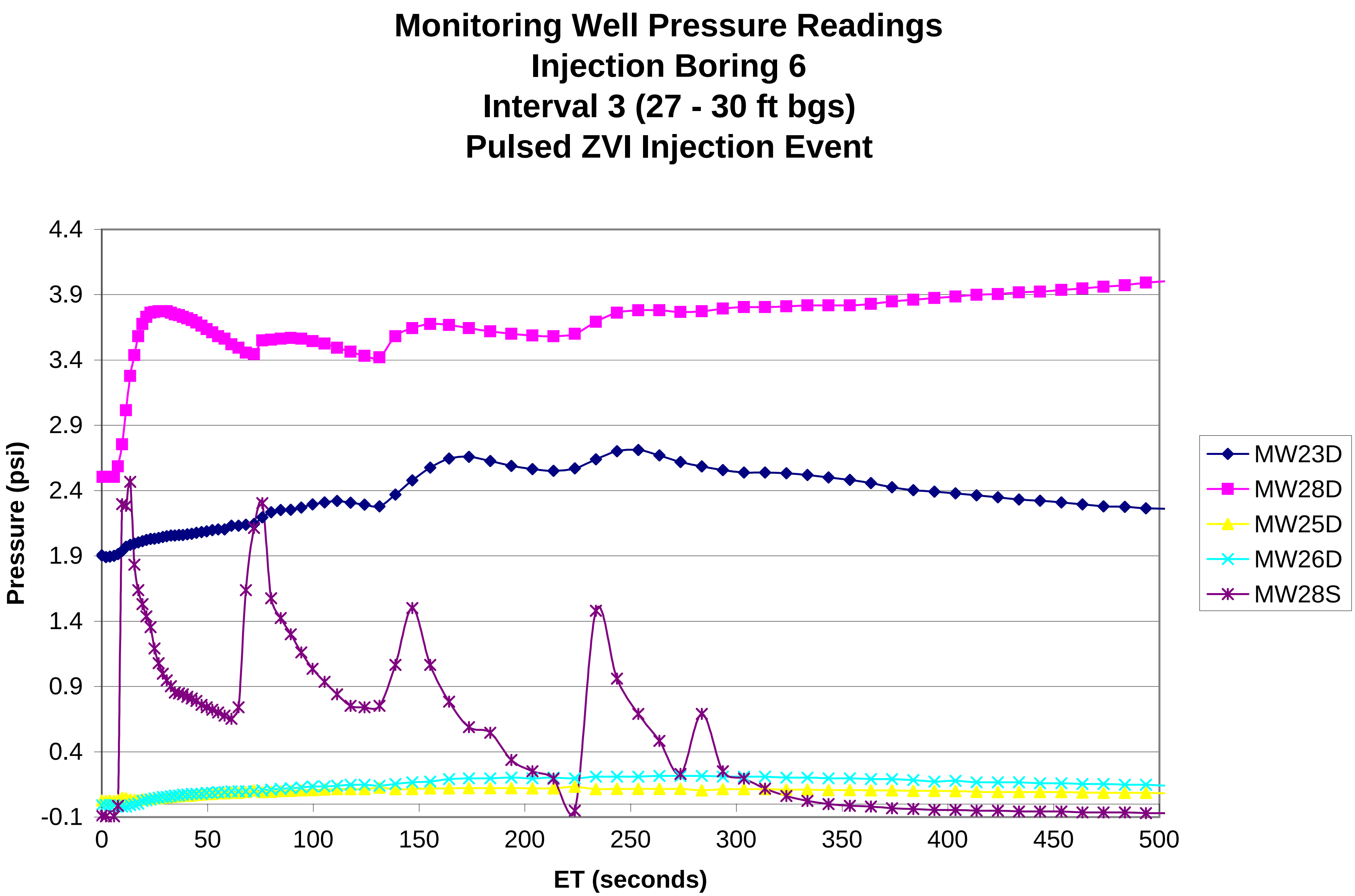


MW6-1I



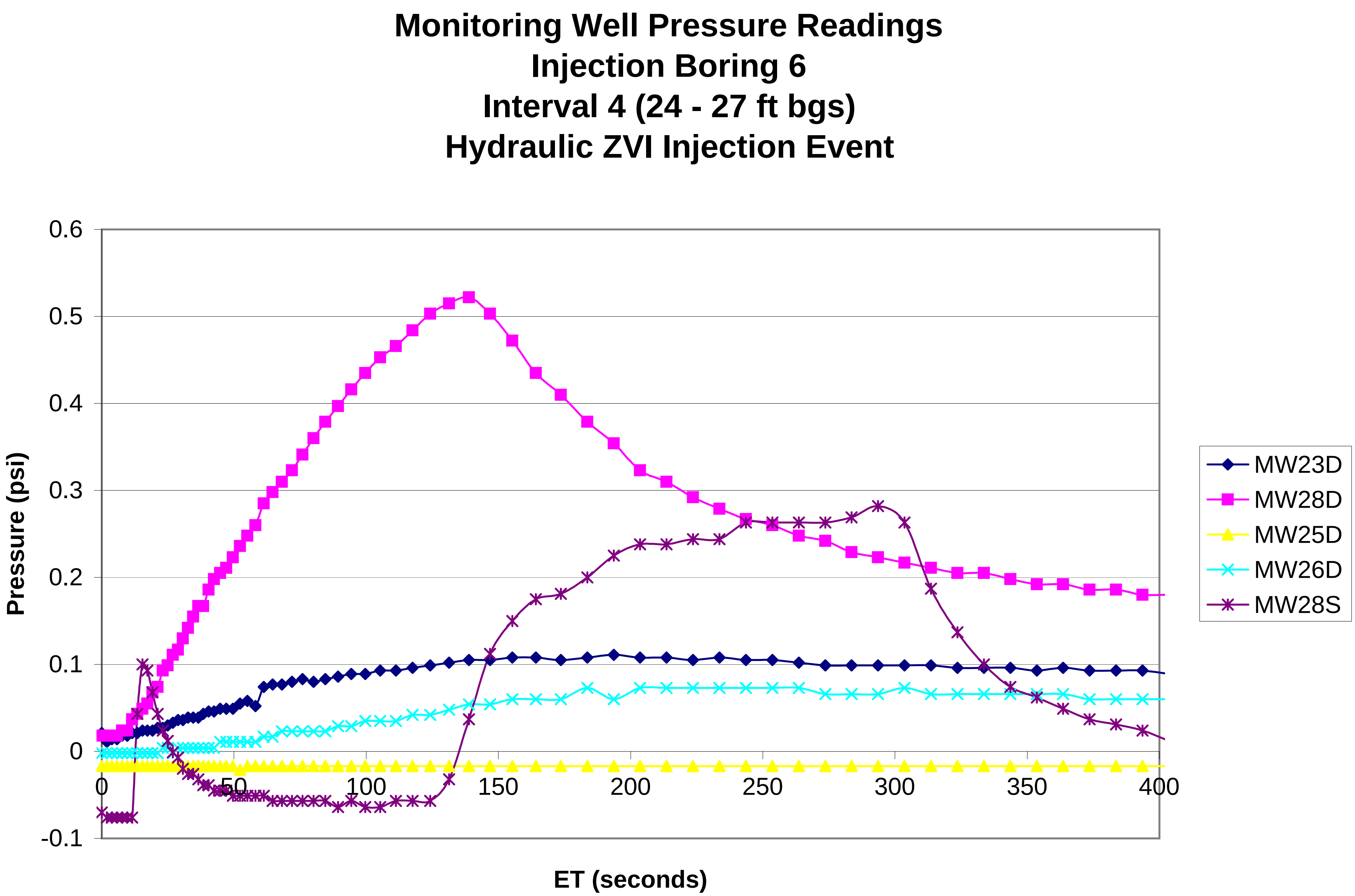
Monitoring Well Pressure Readings
Injection Boring 6
Interval 2 (30 - 33 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
4.4
3.9
3.4
2.9
2.4
1.9
1.4
0.9
0.4
-0.1
0
50
100
150
200
250
300
350
ET (seconds)
MW23D
MW28D
MW25D
MW26D
MW28S

MW6-2I



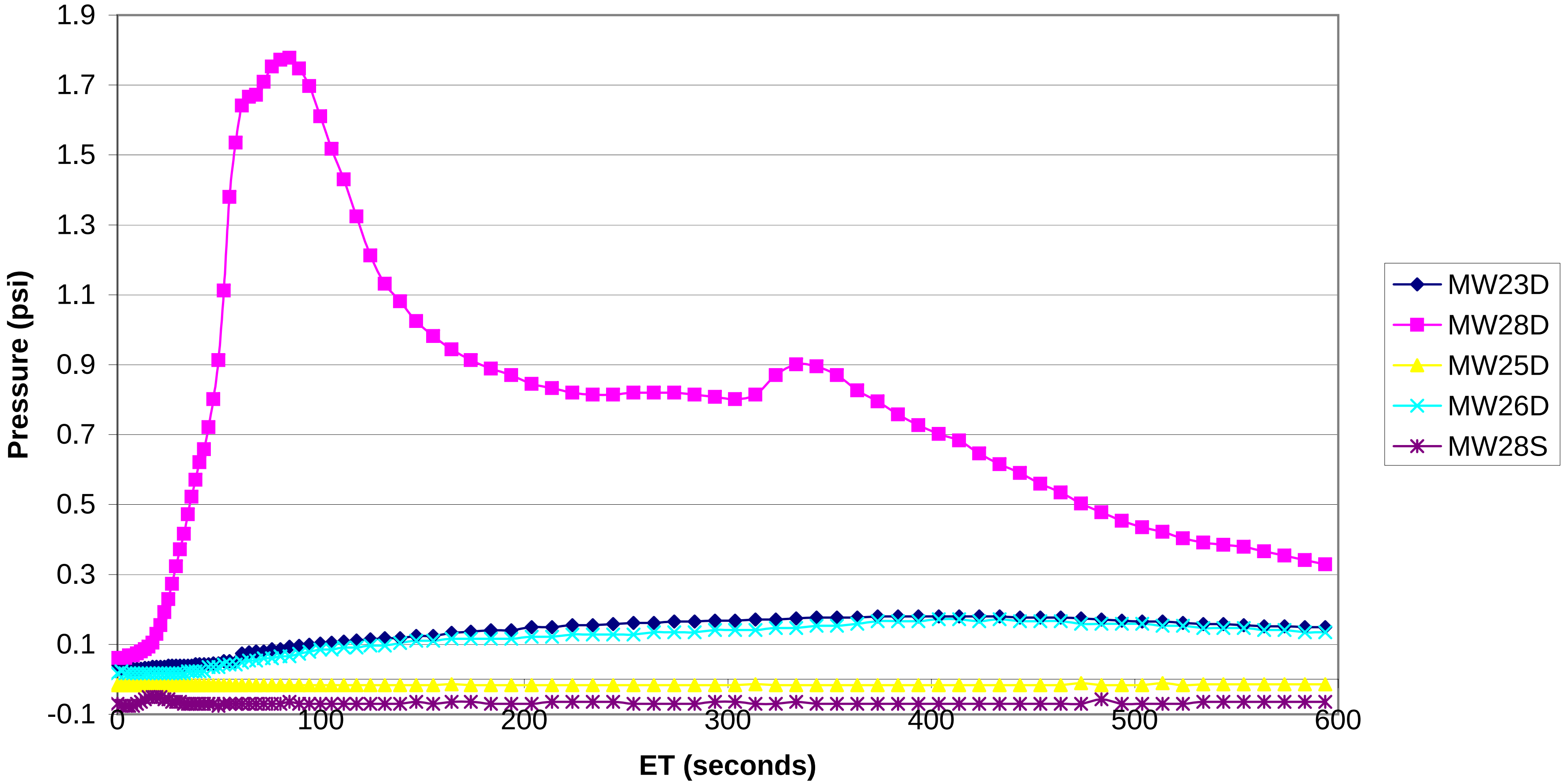
Monitoring Well Pressure Readings
Injection Boring 6
Interval 3 (27 - 30 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
4.4
3.9
3.4
2.9
2.4
1.9
1.4
0.9
0.4
-0.1
0
50
100
150
200
250
300
350
400
450
500
ET (seconds)
MW23D
MW28D
MW25D
MW26D
MW28S

MW6-3I

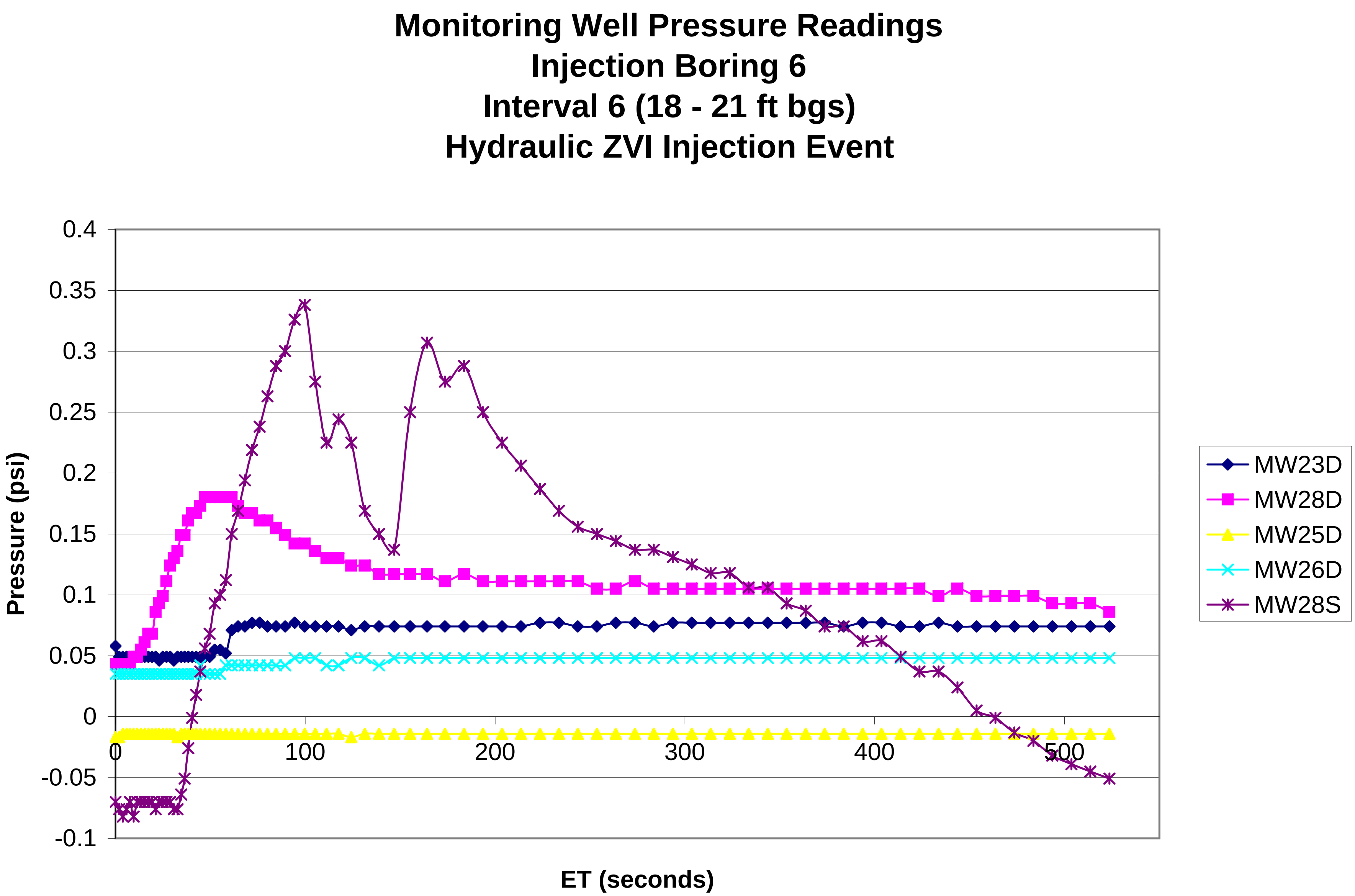

Monitoring Well Pressure Readings
Injection Boring 6
Interval 4 (24 - 27 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
50
100
150
200
250
300
350
400
ET (seconds)
MW23D
MW28D
MW25D
MW26D
MW28S

MW6-4I

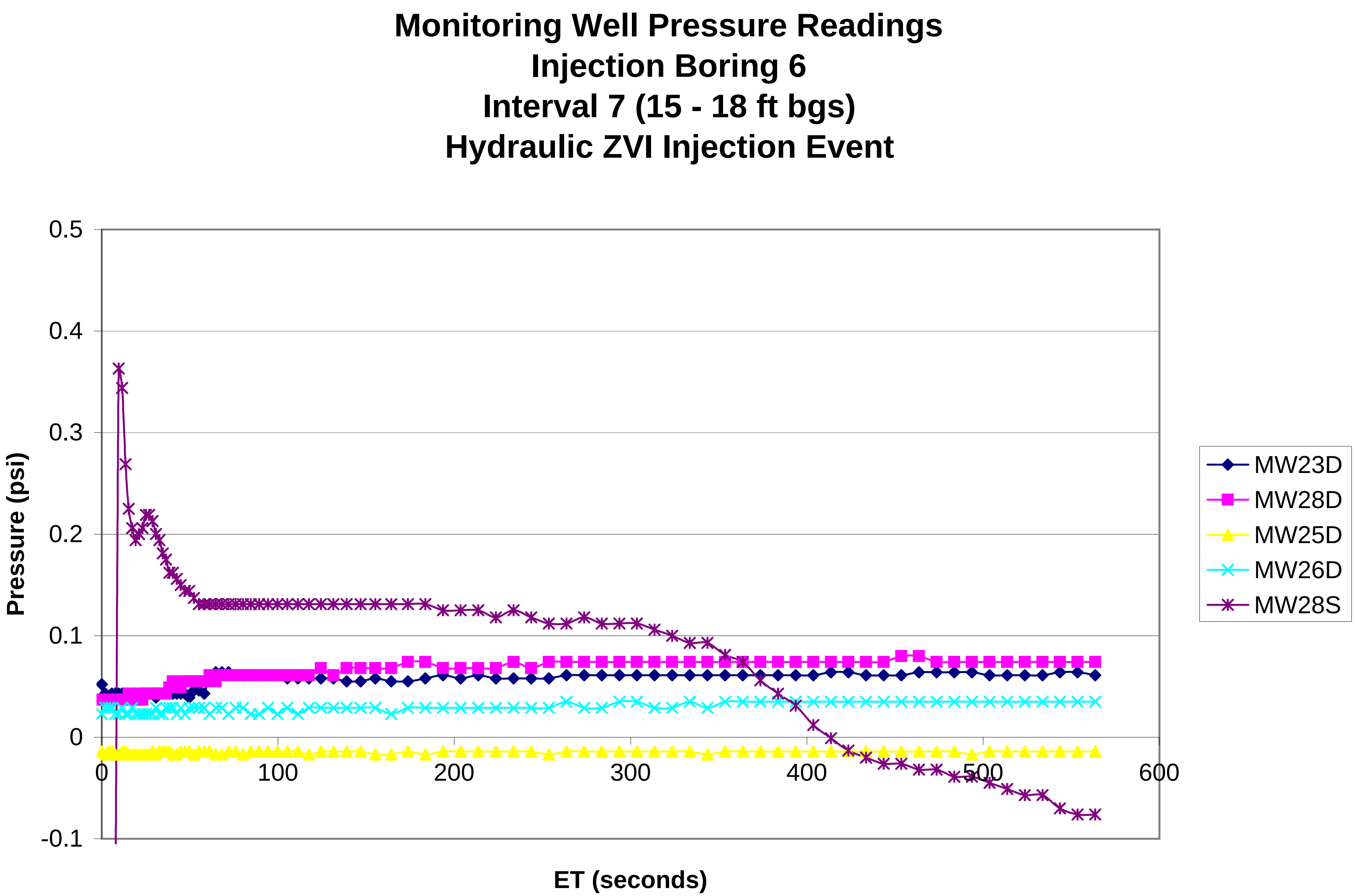
Monitoring Well Pressure Readings
Injection Boring 6
Interval 5 (21 - 24 ft bgs)
Hydraulic ZVI Injection Event



MW6-5I

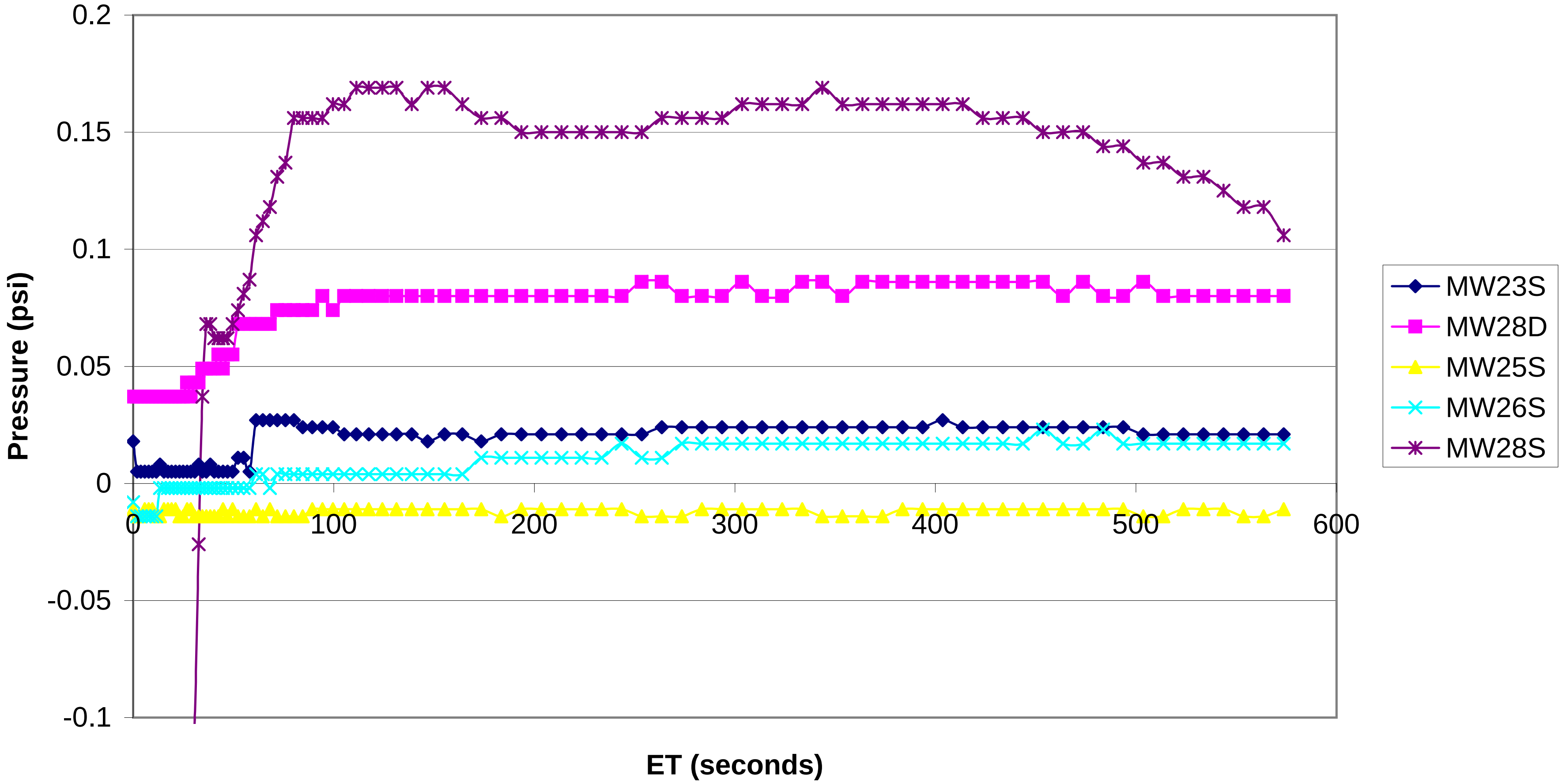

Monitoring Well Pressure Readings
Injection Boring 6
Interval 6 (18 - 21 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
0
100
200
300
400
500
ET (seconds)
MW23D
MW28D
MW25D
MW26D
MW28S

MW6-6I


Monitoring Well Pressure Readings
Injection Boring 6
Interval 7 (15 - 18 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW23D
MW28D
MW25D
MW26D
MW28S

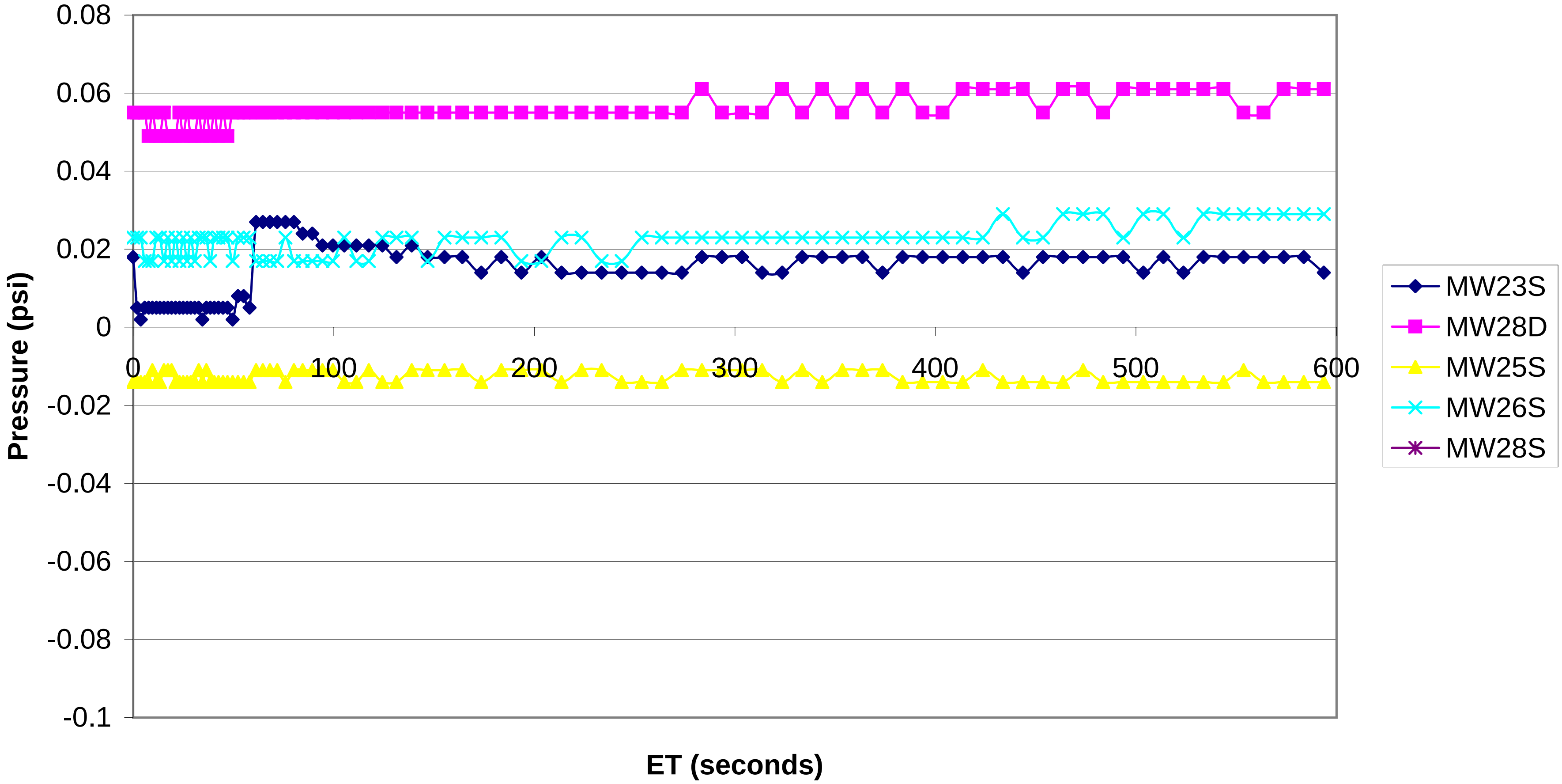
MW6-7I

Monitoring Well Pressure Readings
Injection Boring 6
Interval 8 (12 - 15 ft bgs)
Hydraulic ZVI Injection Event

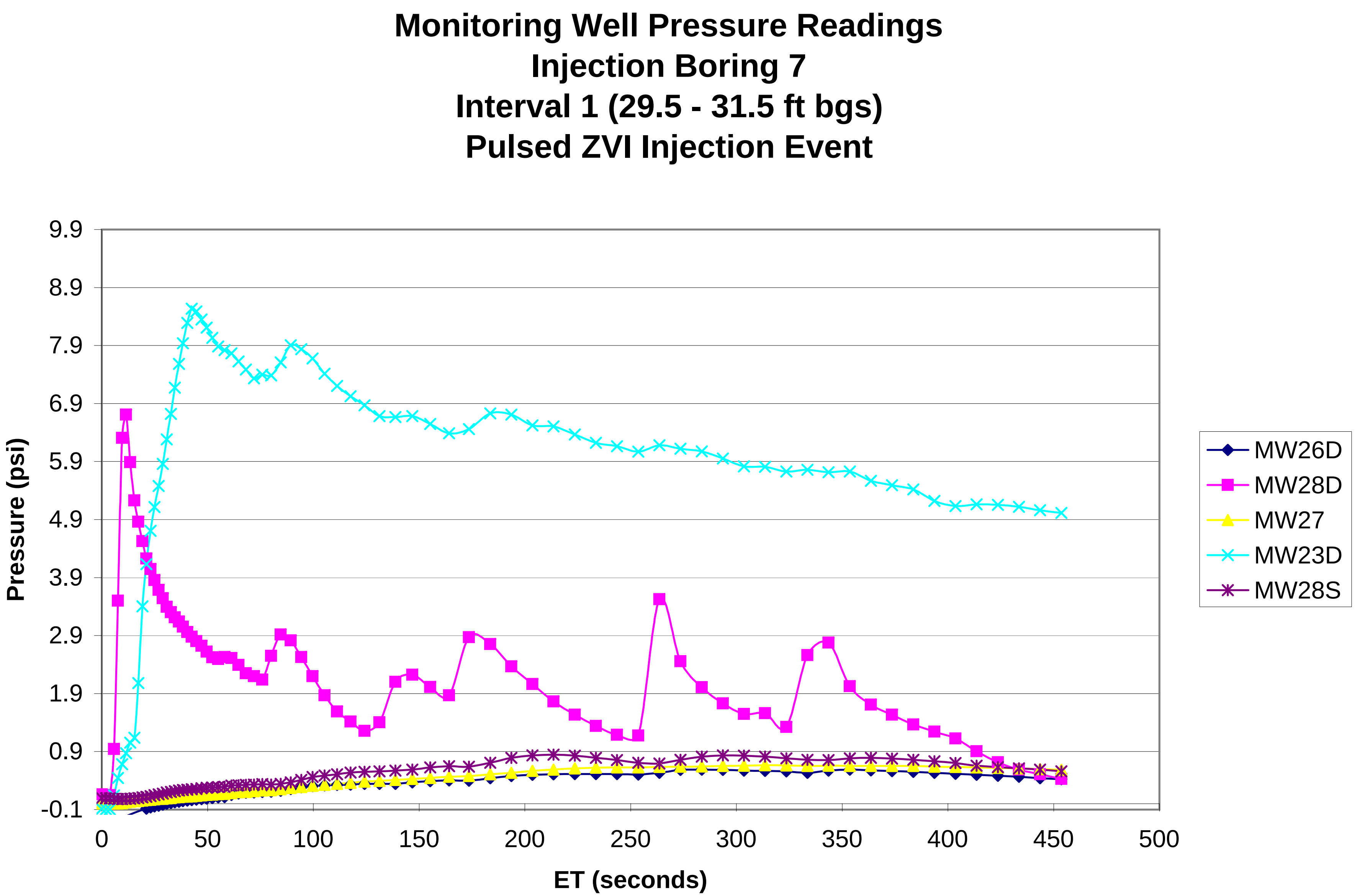


MW6-8I

Monitoring Well Pressure Readings
Injection Boring 6
Interval 9 (9 - 12 ft bgs)
Hydraulic ZVI Injection Event

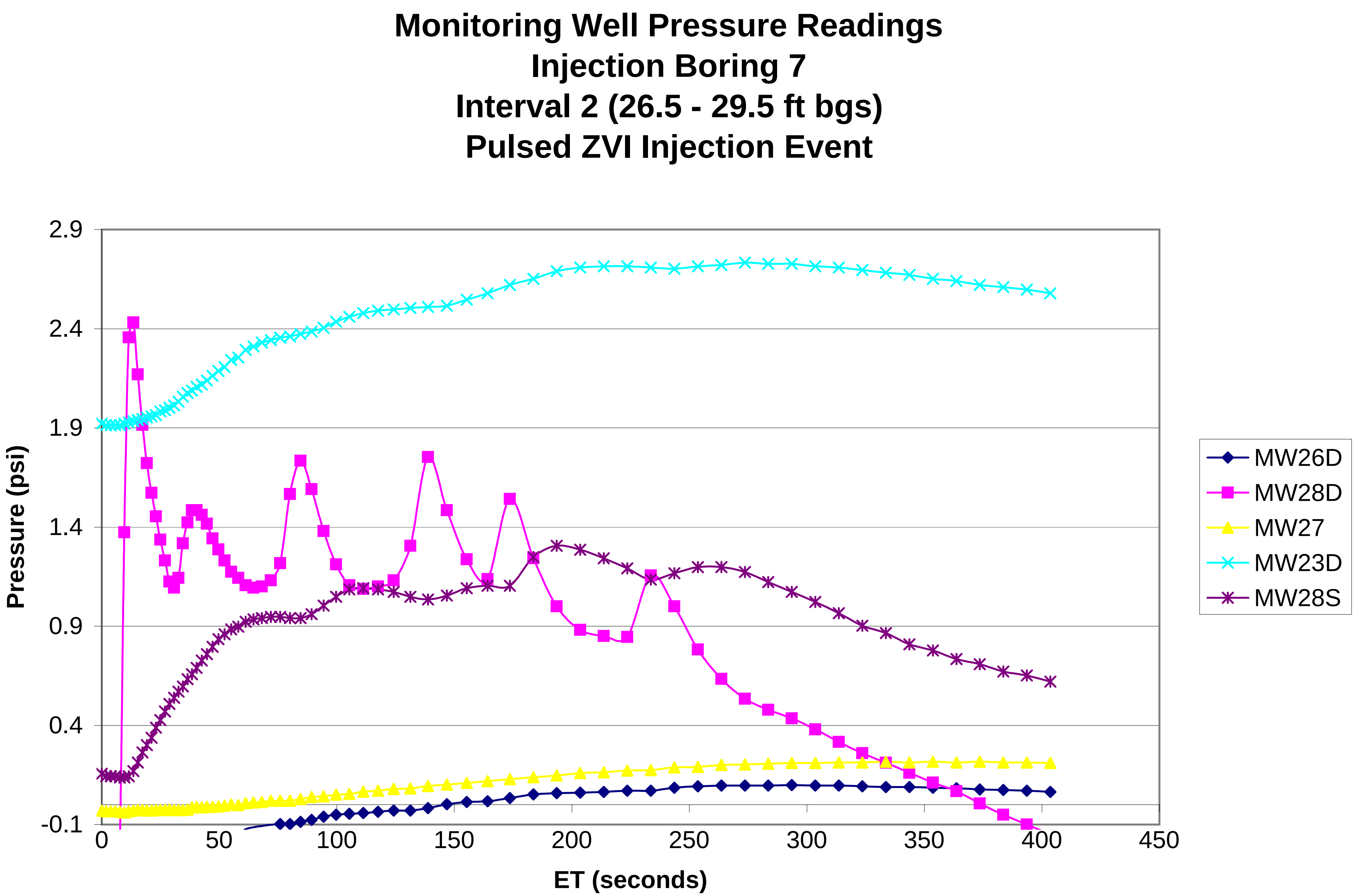


MW6-9I



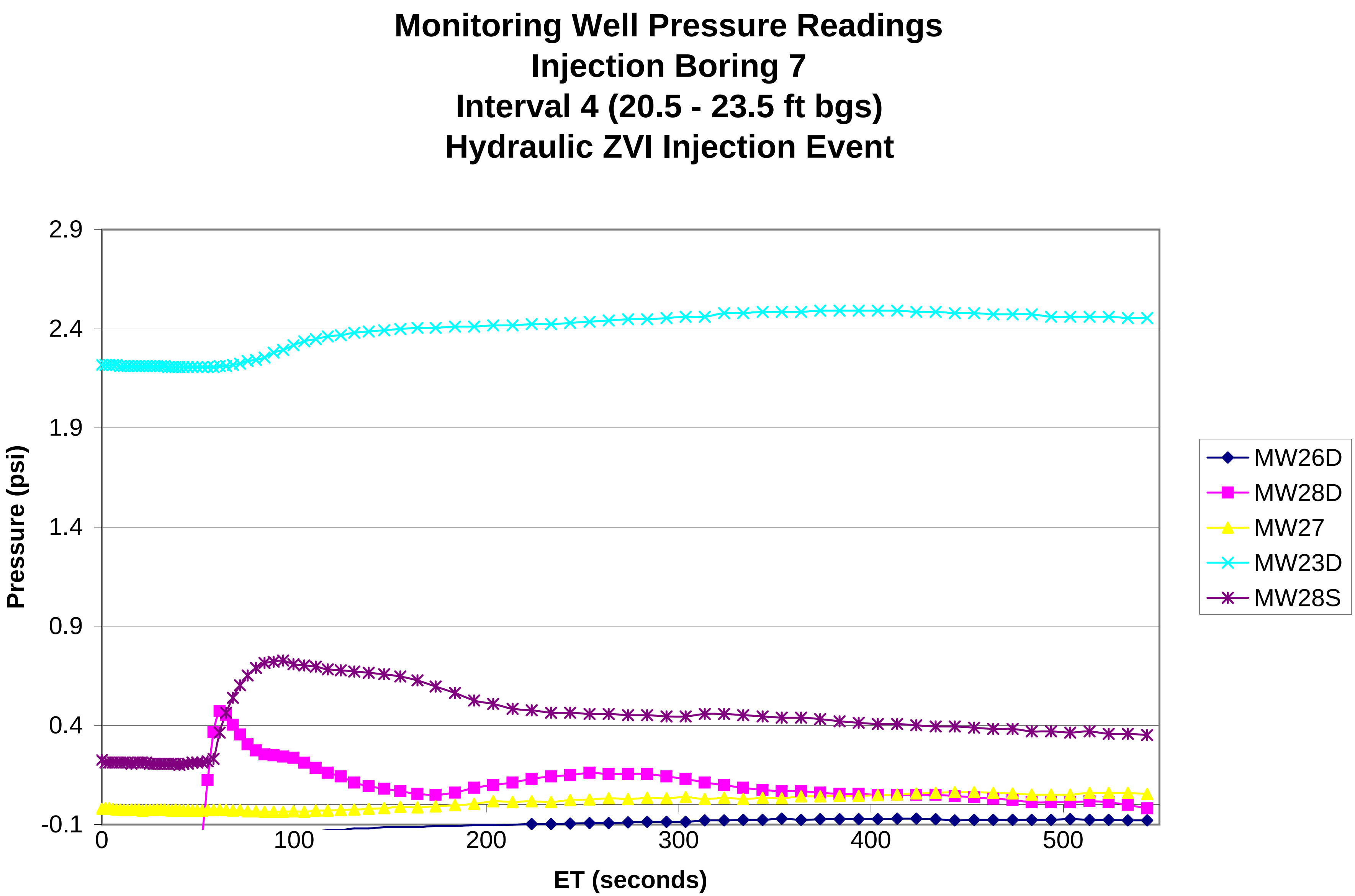
Monitoring Well Pressure Readings
Injection Boring 7
Interval 1 (29.5 - 31.5 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
9.9
8.9
7.9
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
0
50
100
150
200
250
300
350
400
450
500
ET (seconds)
MW26D
MW28D
MW27
MW23D
MW28S

MW7-1I



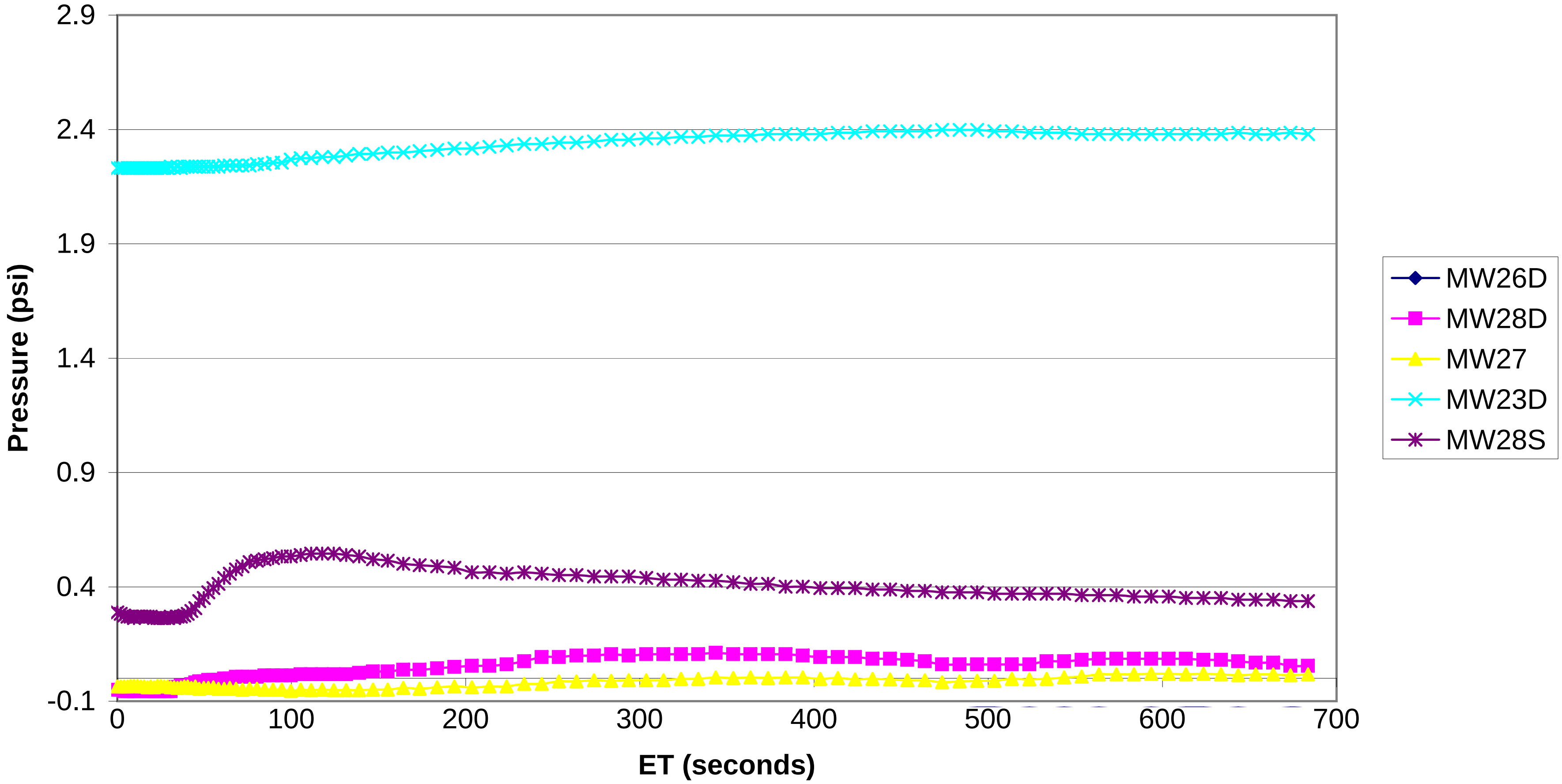
Monitoring Well Pressure Readings
Injection Boring 7
Interval 2 (26.5 - 29.5 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
2.9
2.4
1.9
1.4
0.9
0.4
-0.1
0
50
100
150
200
250
300
350
400
450
ET (seconds)
MW26D
MW28D
MW27
MW23D
MW28S

MW7-2I


Monitoring Well Pressure Readings
Injection Boring 7
Interval 4 (20.5 - 23.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
2.9
2.4
1.9
1.4
0.9
0.4
-0.1
0
100
200
300
400
500
ET (seconds)
MW26D
MW28D
MW27
MW23D
MW28S

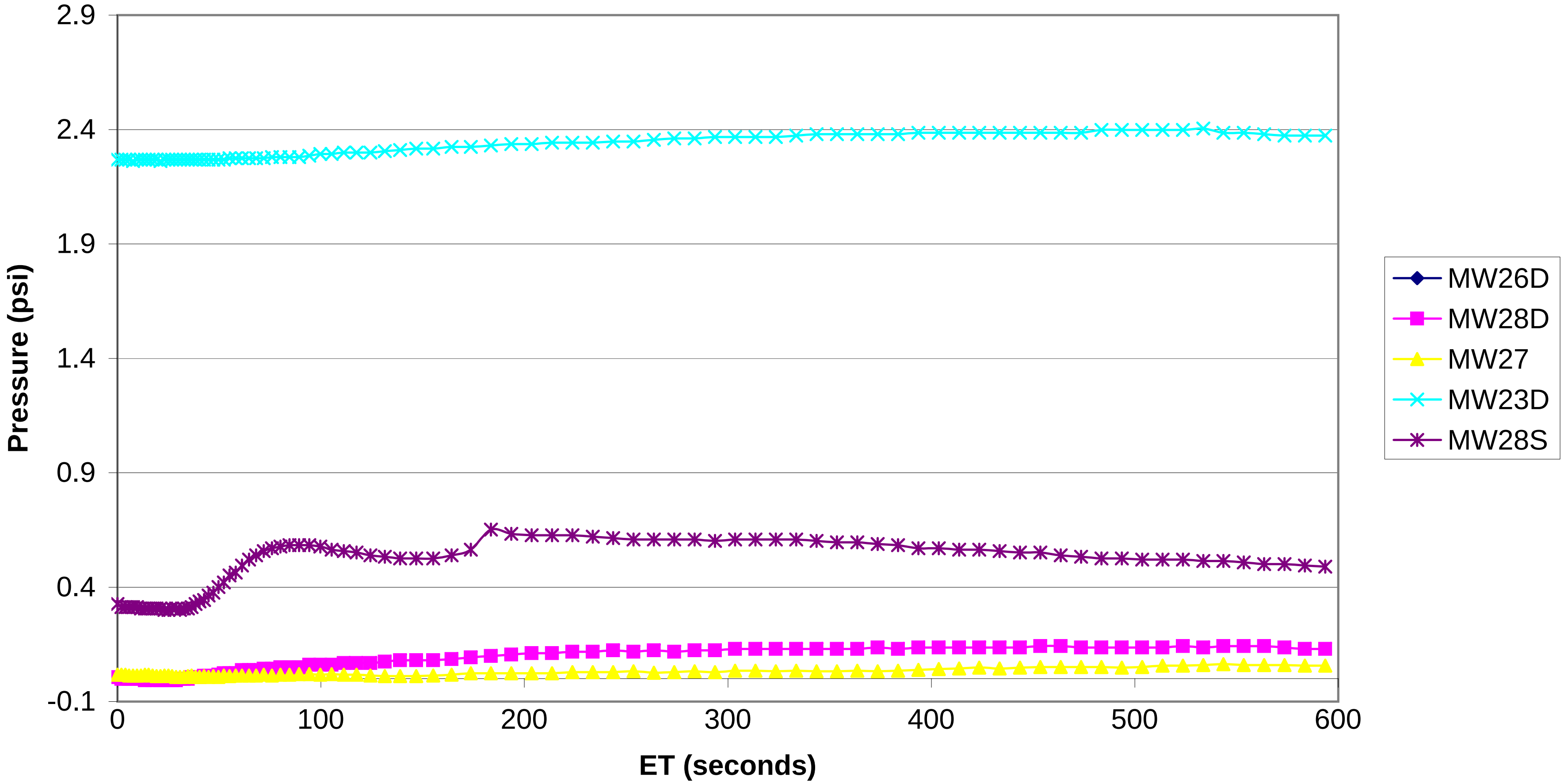
MW7-4I

Monitoring Well Pressure Readings
Injection Boring 7
Interval 5 (17.5 - 20.5 ft bgs)
Hydraulic ZVI Injection Event

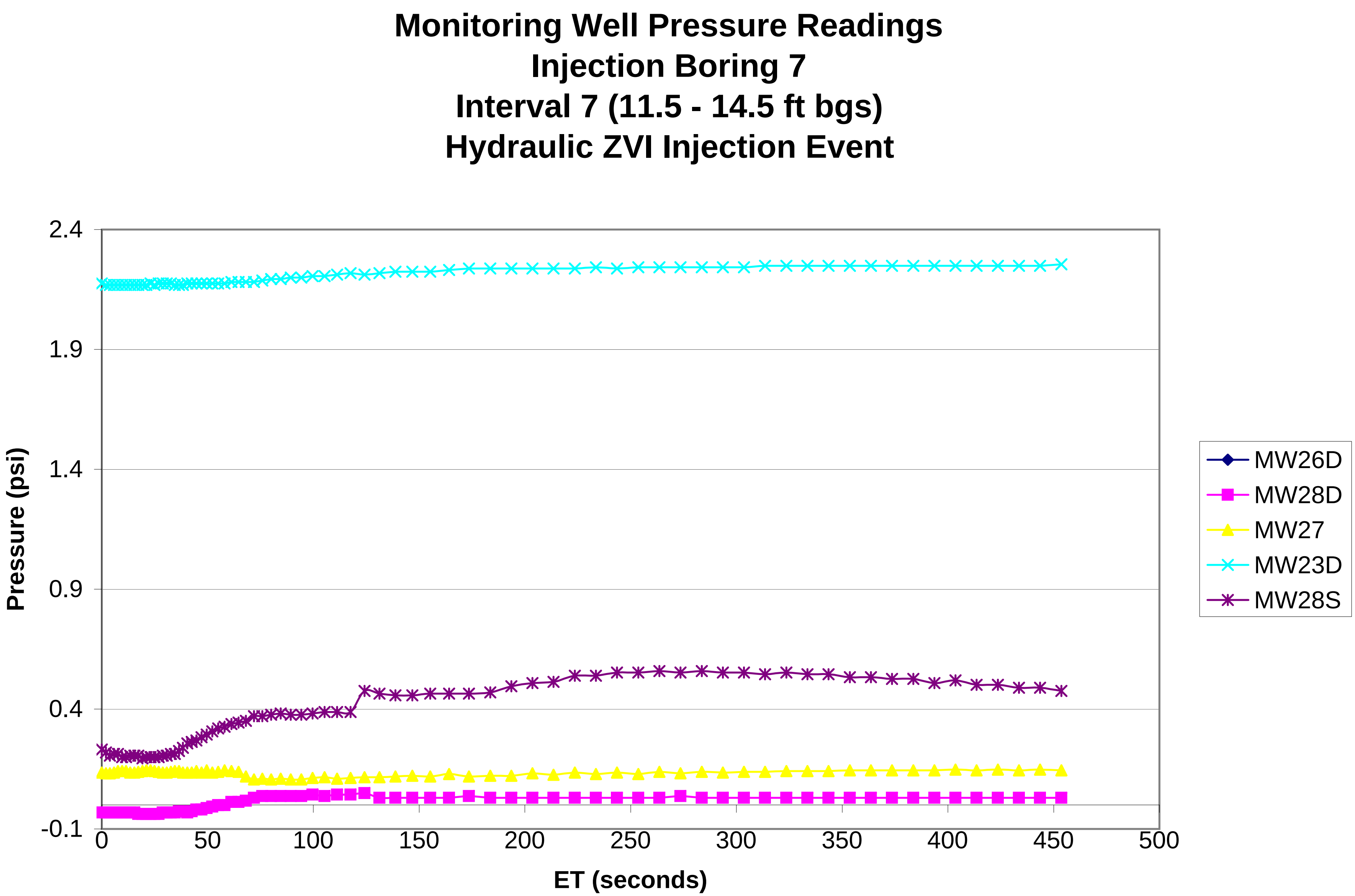


MW7-5I

Monitoring Well Pressure Readings
Injection Boring 7
Interval 6 (14.5 - 17.5 ft bgs)
Hydraulic ZVI Injection Event



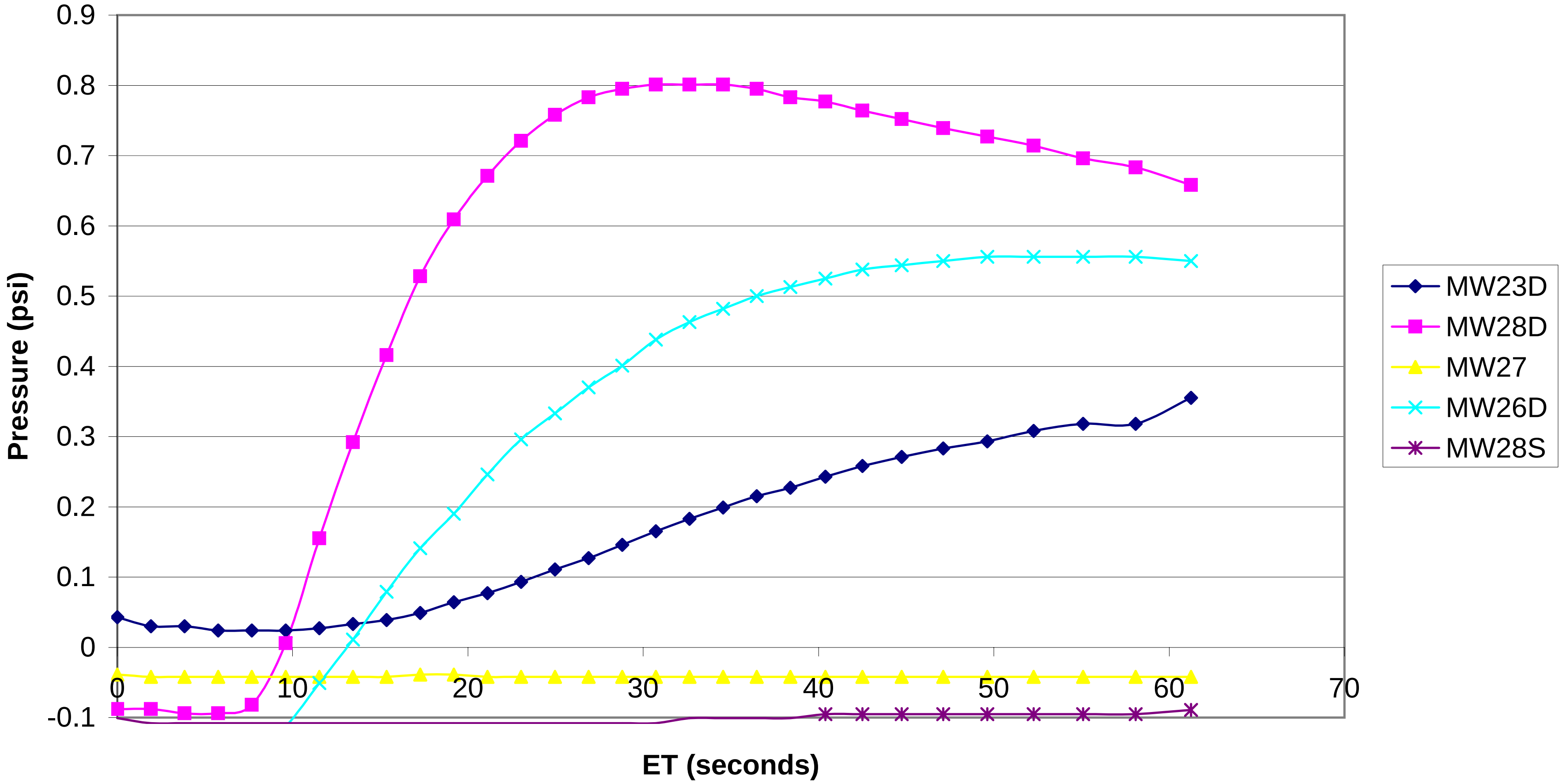
MW7-6I



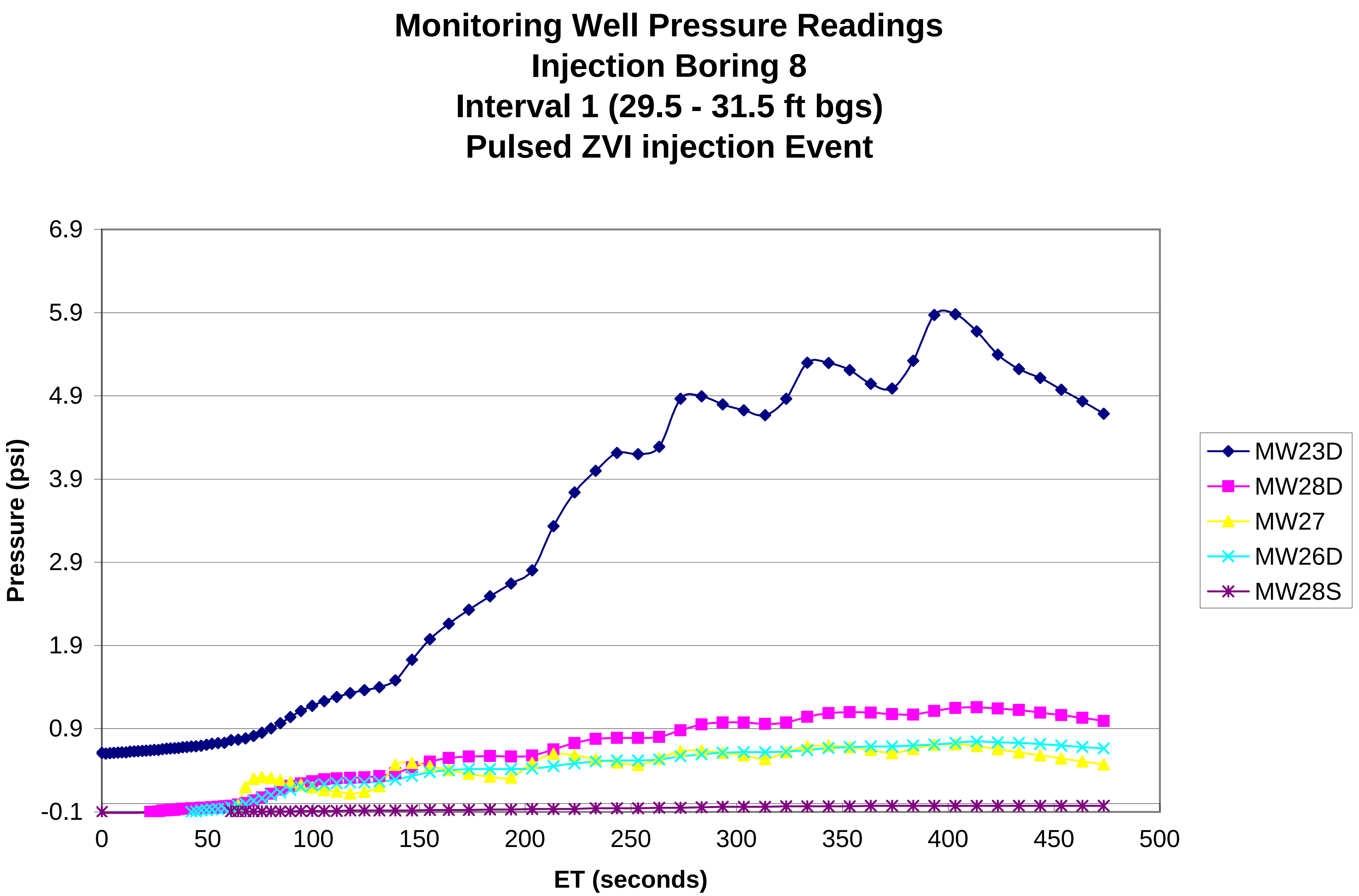
Monitoring Well Pressure Readings
Injection Boring 7
Interval 7 (11.5 - 14.5 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
2.4
1.9
1.4
0.9
0.4
-0.1
0
50
100
150
200
250
300
350
400
450
500
ET (seconds)
MW26D
MW28D
MW27
MW23D
MW28S

MW7-7I

Monitoring Well Pressure Readings
Injection Boring 8
Interval 1 (29.5 - 31.5 ft bgs)
Fracturing Event

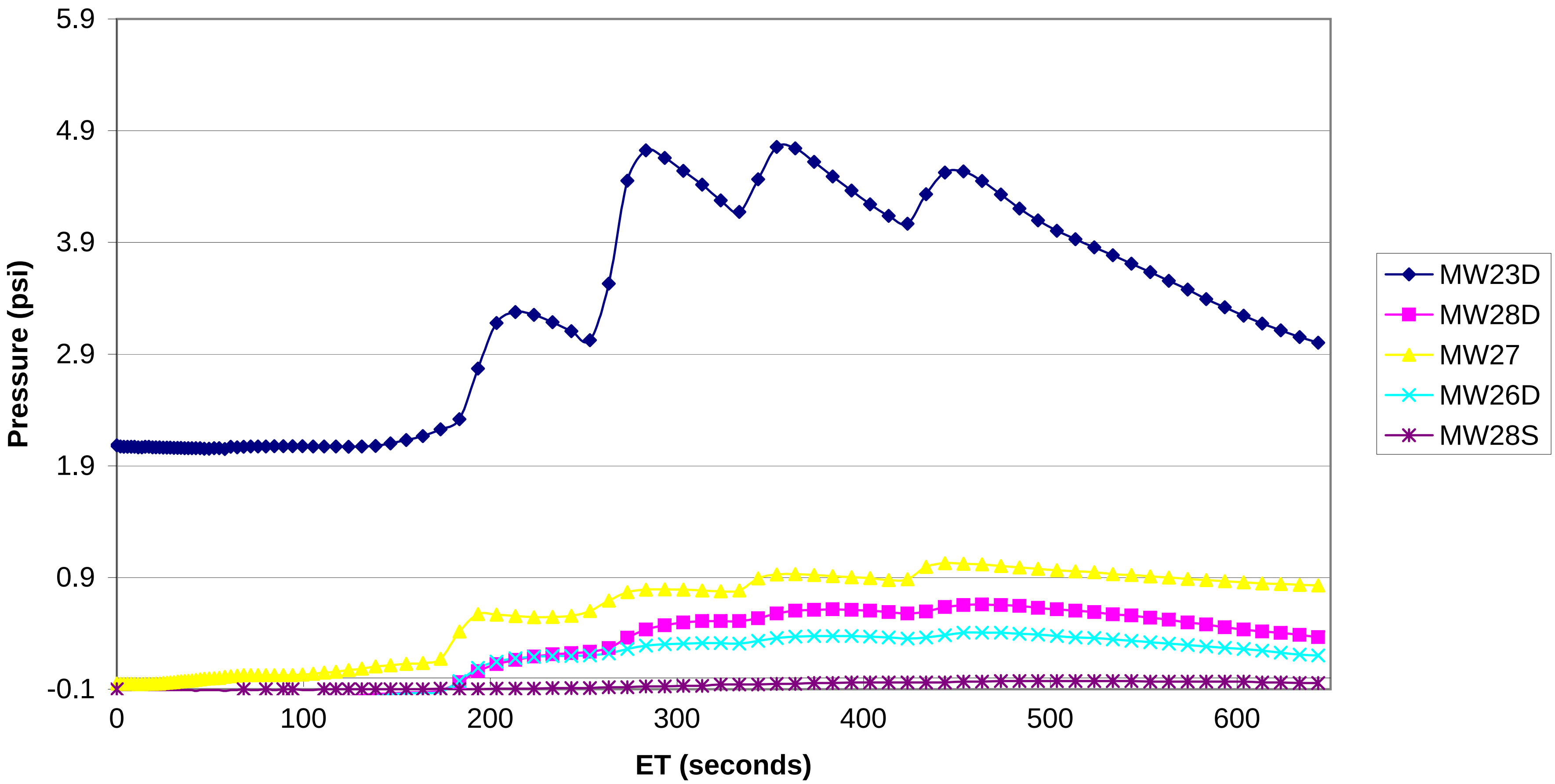


MW8-1F


Monitoring Well Pressure Readings
Injection Boring 8
Interval 1 (29.5 - 31.5 ft bgs)
Pulsed ZVI injection Event
Pressure (psi)
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
0
50
100
150
200
250
300
350
400
450
500
ET (seconds)
MW23D
MW28D
MW27
MW26D
MW28S

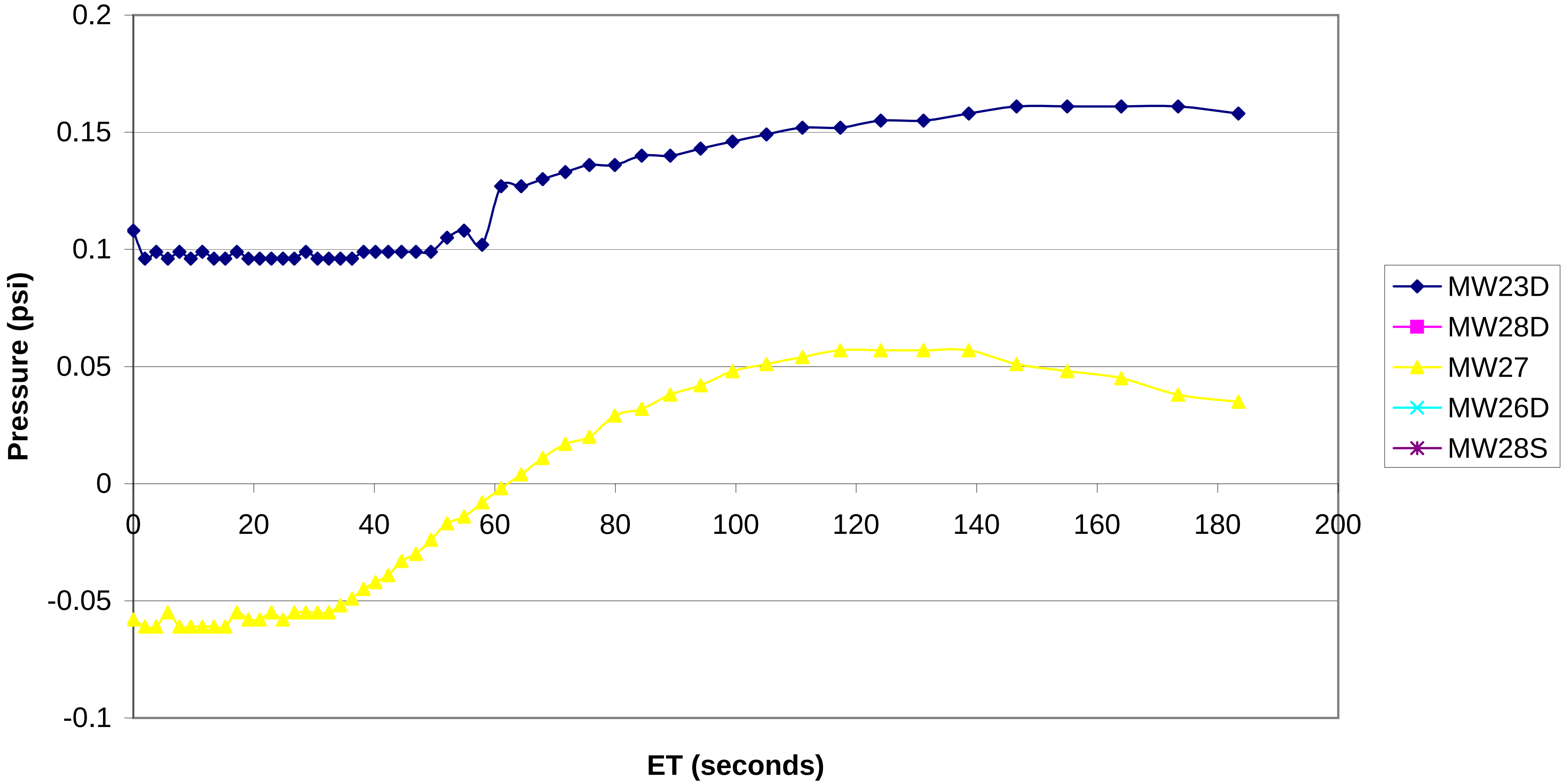
MW8-1I

Monitoring Well Pressure Readings
Injection Boring 8
Interval 2 (26.5 - 29.5 ft bgs)
Pulsed ZVI injection Event



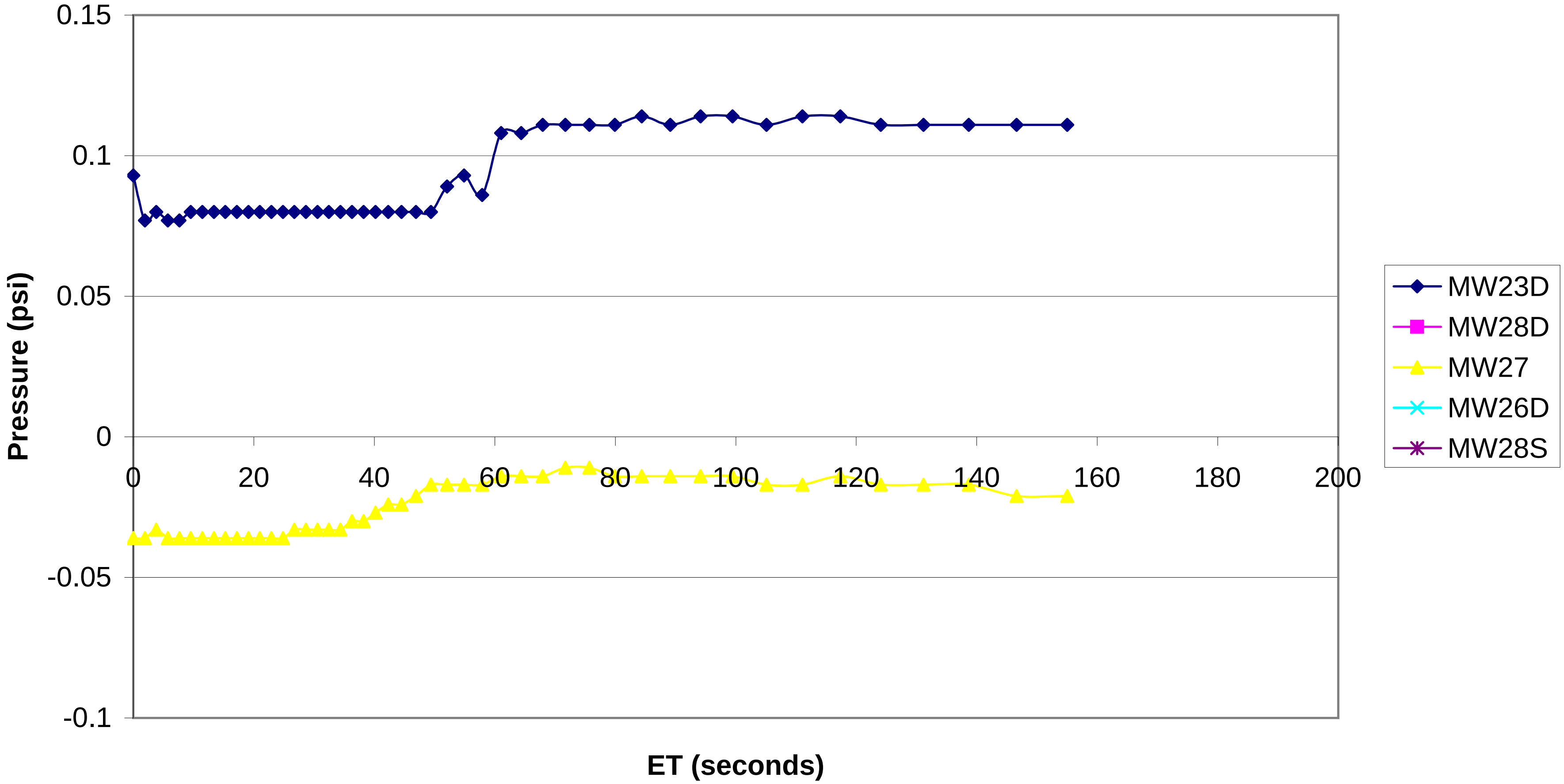
MW8-2I

Monitoring Well Pressure Readings
Injection Boring 8
Interval 3 (23.5 - 26.5 ft bgs)
Hydraulic ZVI injection Event A



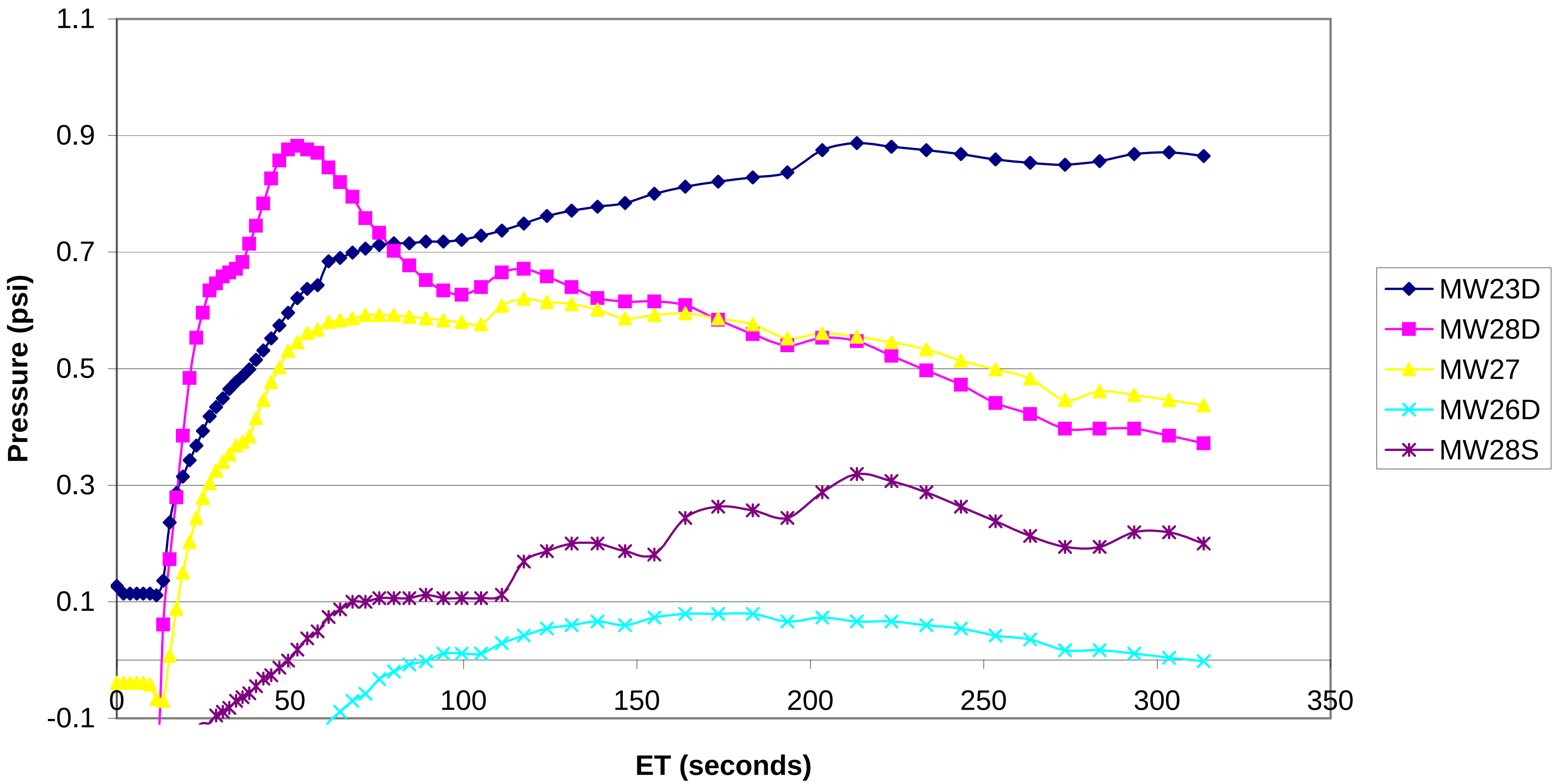
MW8-3IA

Monitoring Well Pressure Readings
Injection Boring 8
Interval 3 (23.5 - 26.5 ft bgs)
Hydraulic ZVI injection Event B

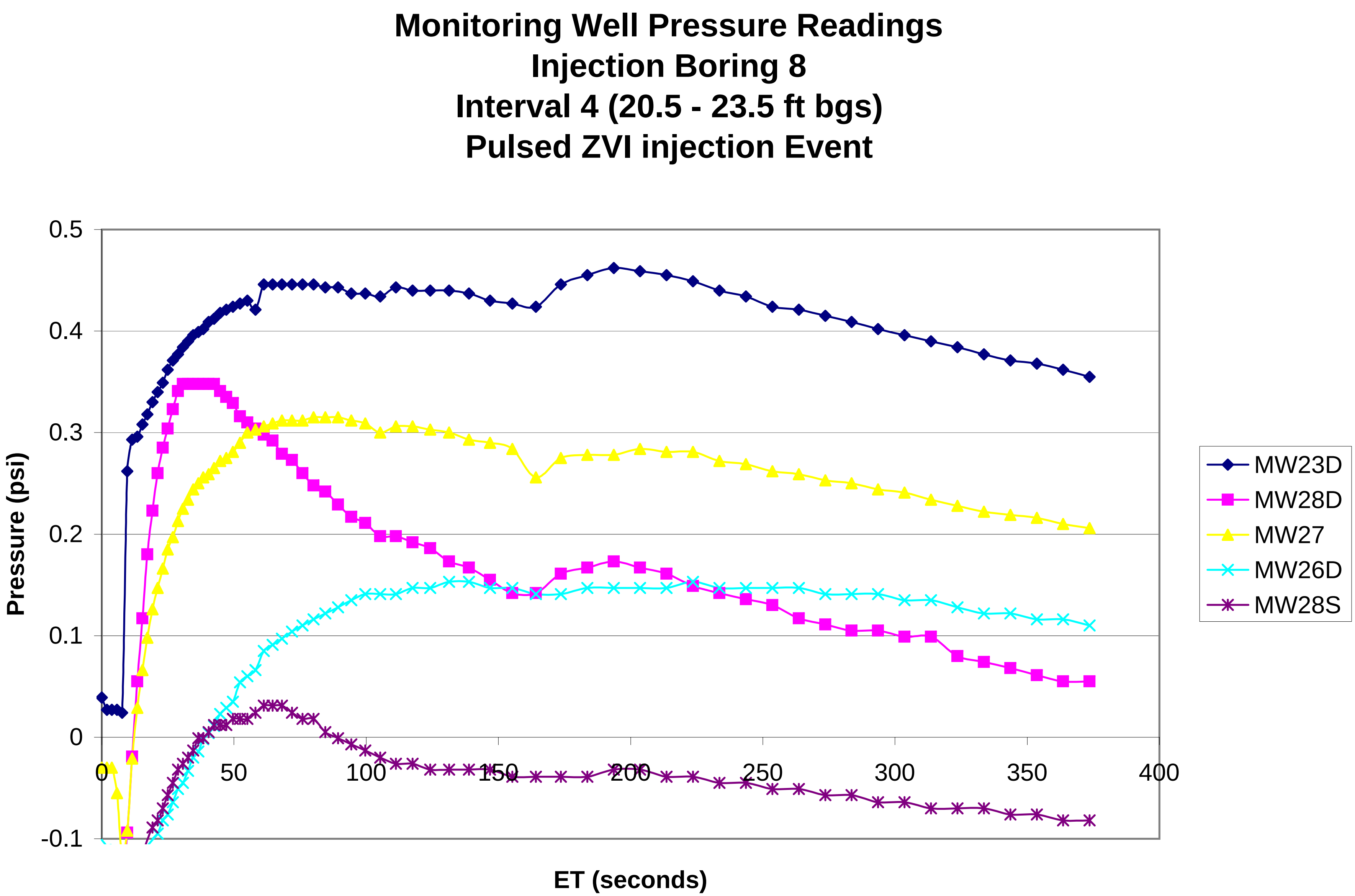


MW8-3IB

Monitoring Well Pressure Readings
Injection Boring 8
Interval 3 (23.5 - 26.5 ft bgs)
Pulsed ZVI injection Event C

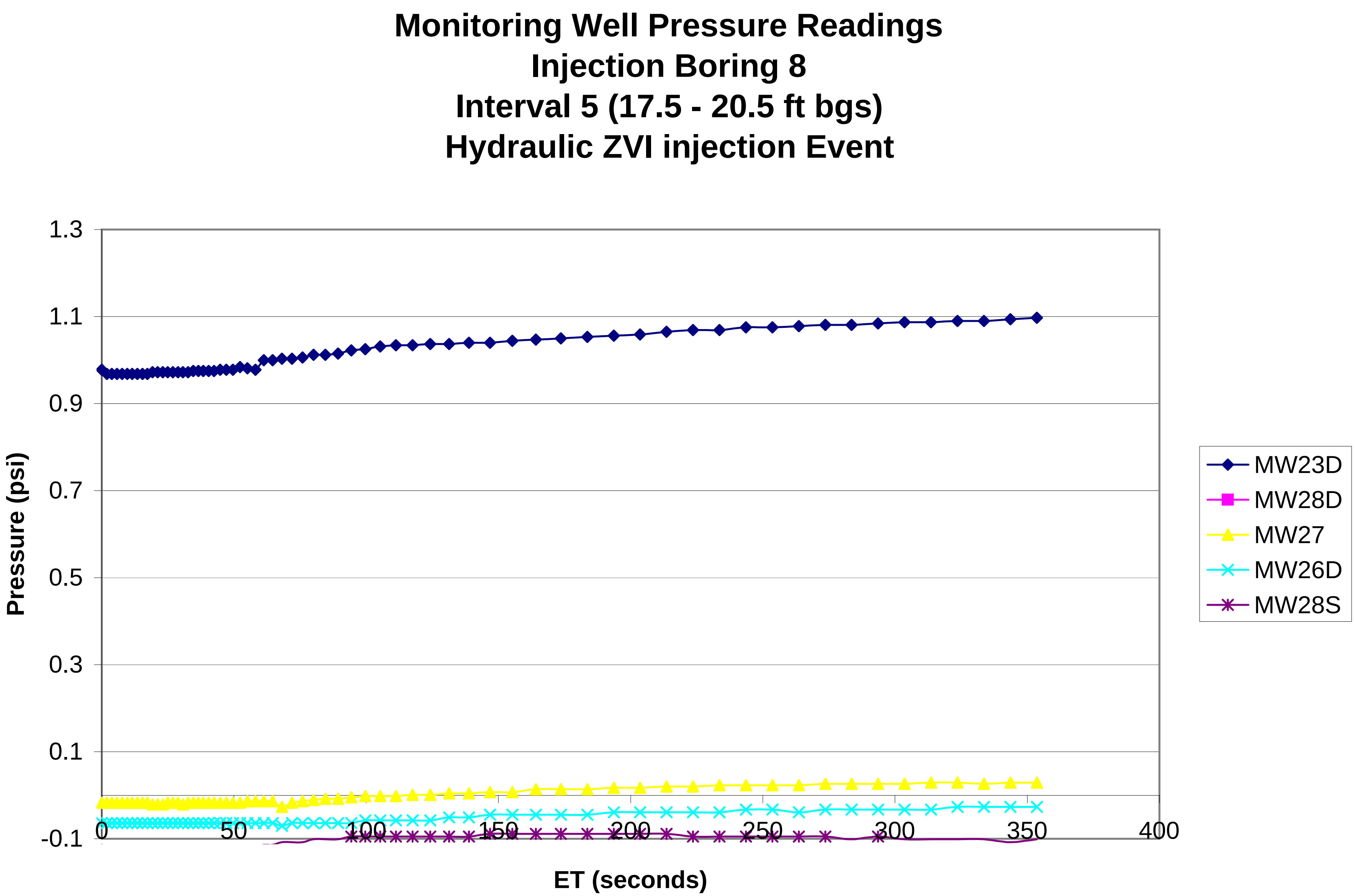


MW8-3IC



Monitoring Well Pressure Readings
Injection Boring 8
Interval 4 (20.5 - 23.5 ft bgs)
Pulsed ZVI injection Event
Pressure (psi)
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
50
100
150
200
250
300
350
400
ET (seconds)
MW23D
MW28D
MW27
MW26D
MW28S

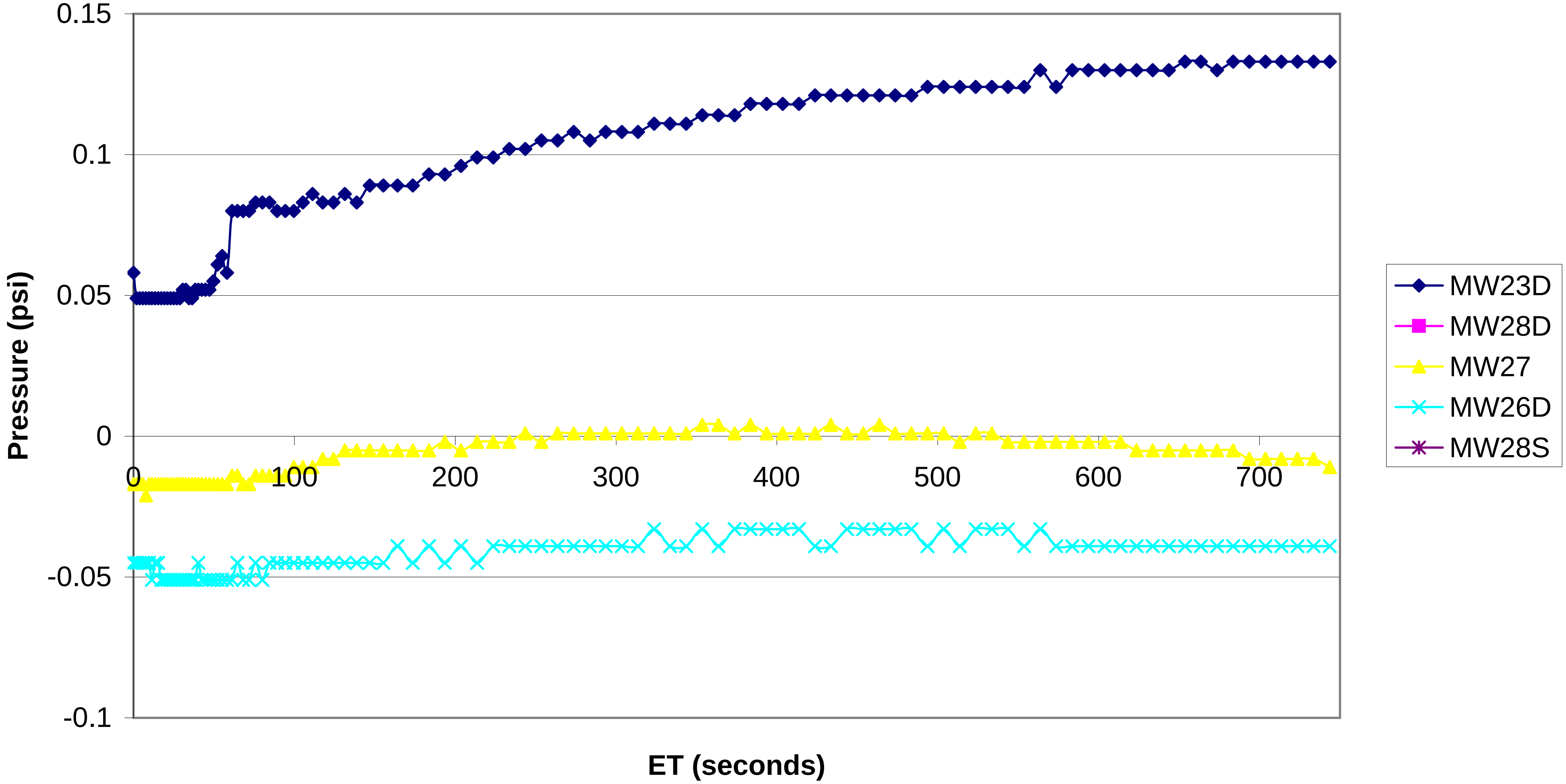
MW8-4I



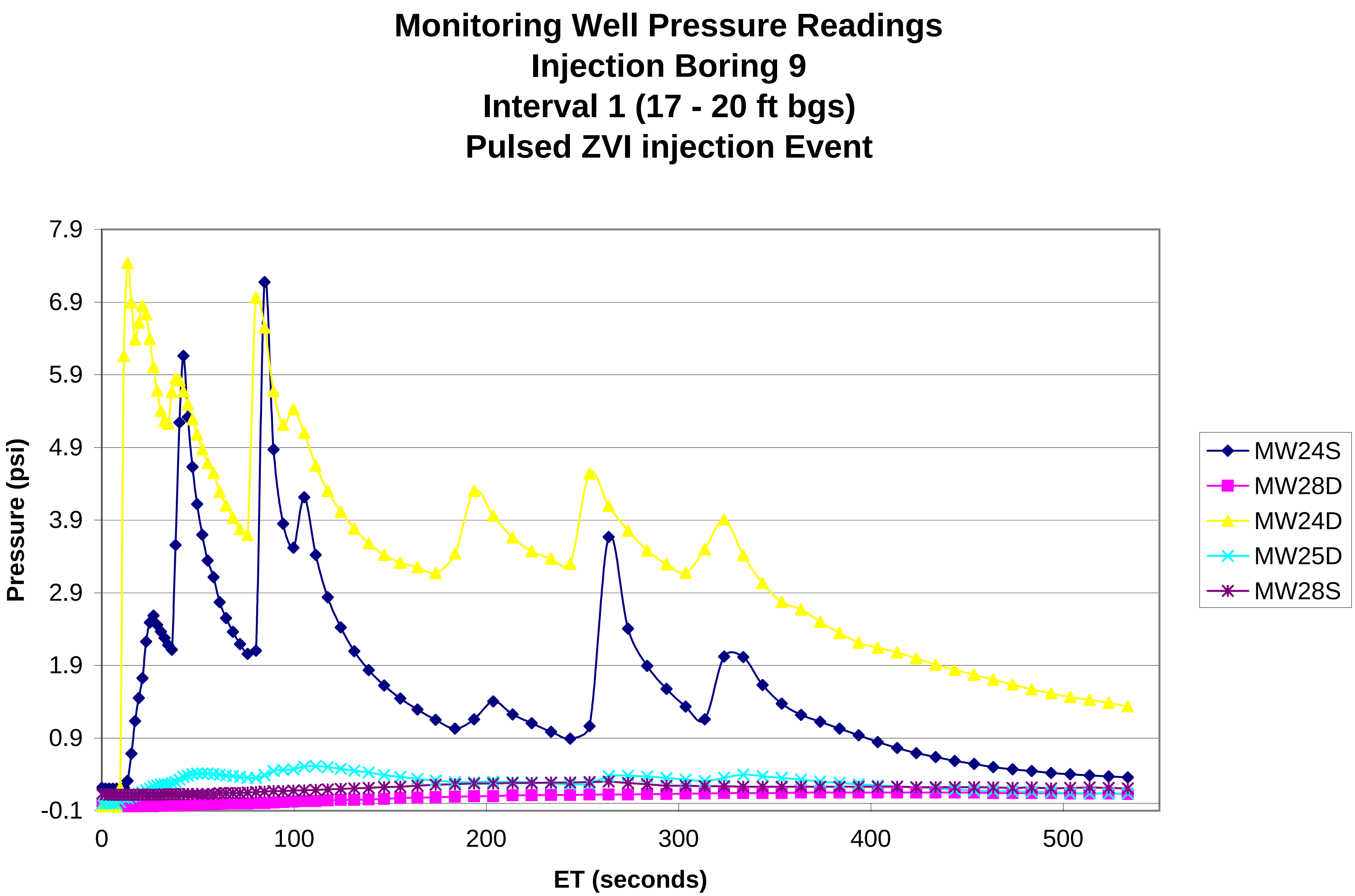
Monitoring Well Pressure Readings
Injection Boring 8
Interval 5 (17.5 - 20.5 ft bgs)
Hydraulic ZVI injection Event
Pressure (psi)
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
50
100
150
200
250
300
350
400
ET (seconds)
MW23D
MW28D
MW27
MW26D
MW28S

MW8-5I

Monitoring Well Pressure Readings
Injection Boring 8
Interval 6 (14.5 - 17.5 ft bgs)
Hydraulic ZVI injection Event

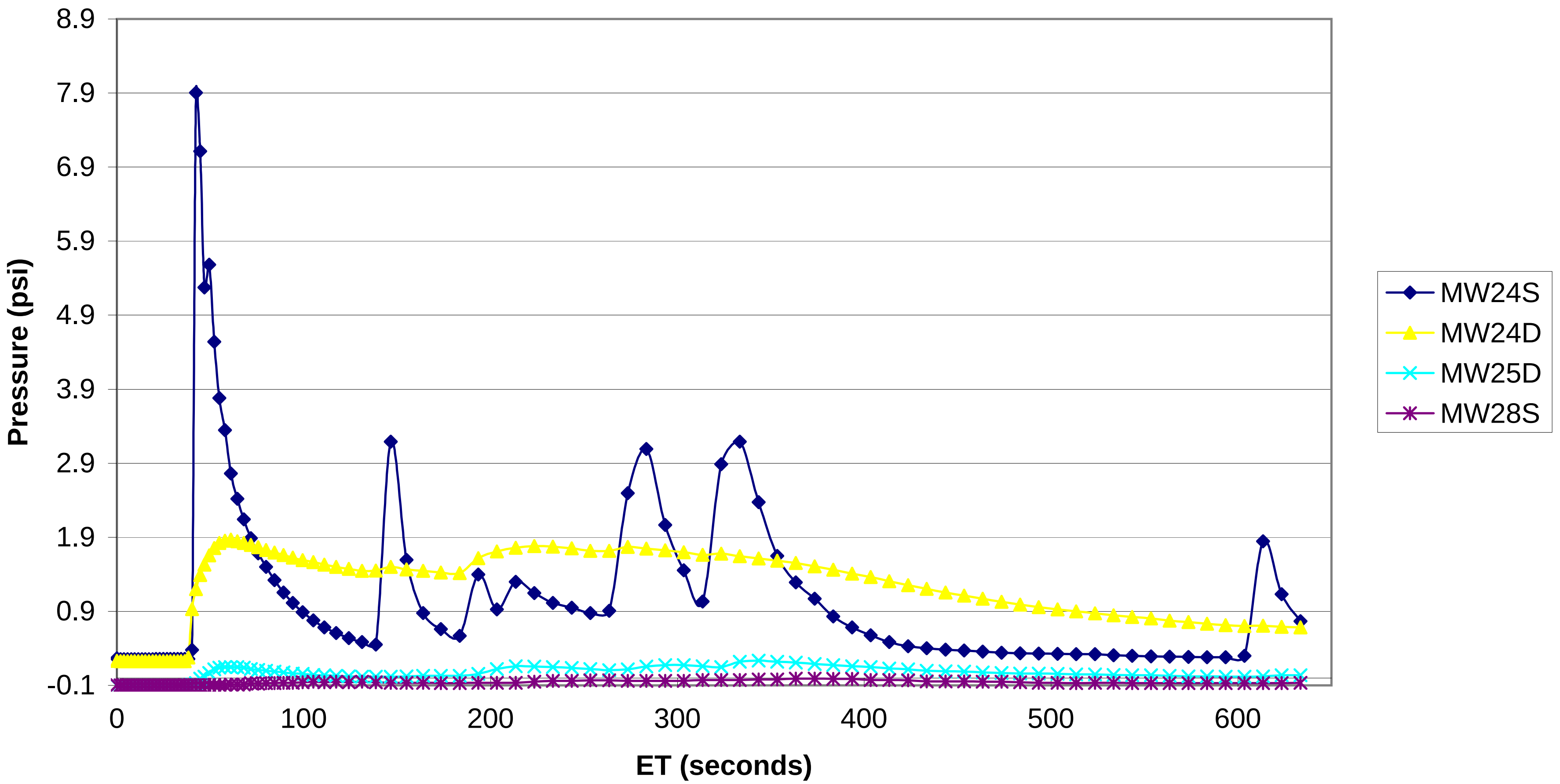


MW8-6I


Monitoring Well Pressure Readings
Injection Boring 9
Interval 1 (17 - 20 ft bgs)
Pulsed ZVI injection Event
Pressure (psi)
7.9
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
0
100
200
300
400
500
ET (seconds)
MW24S
MW28D
MW24D
MW25D
MW28S

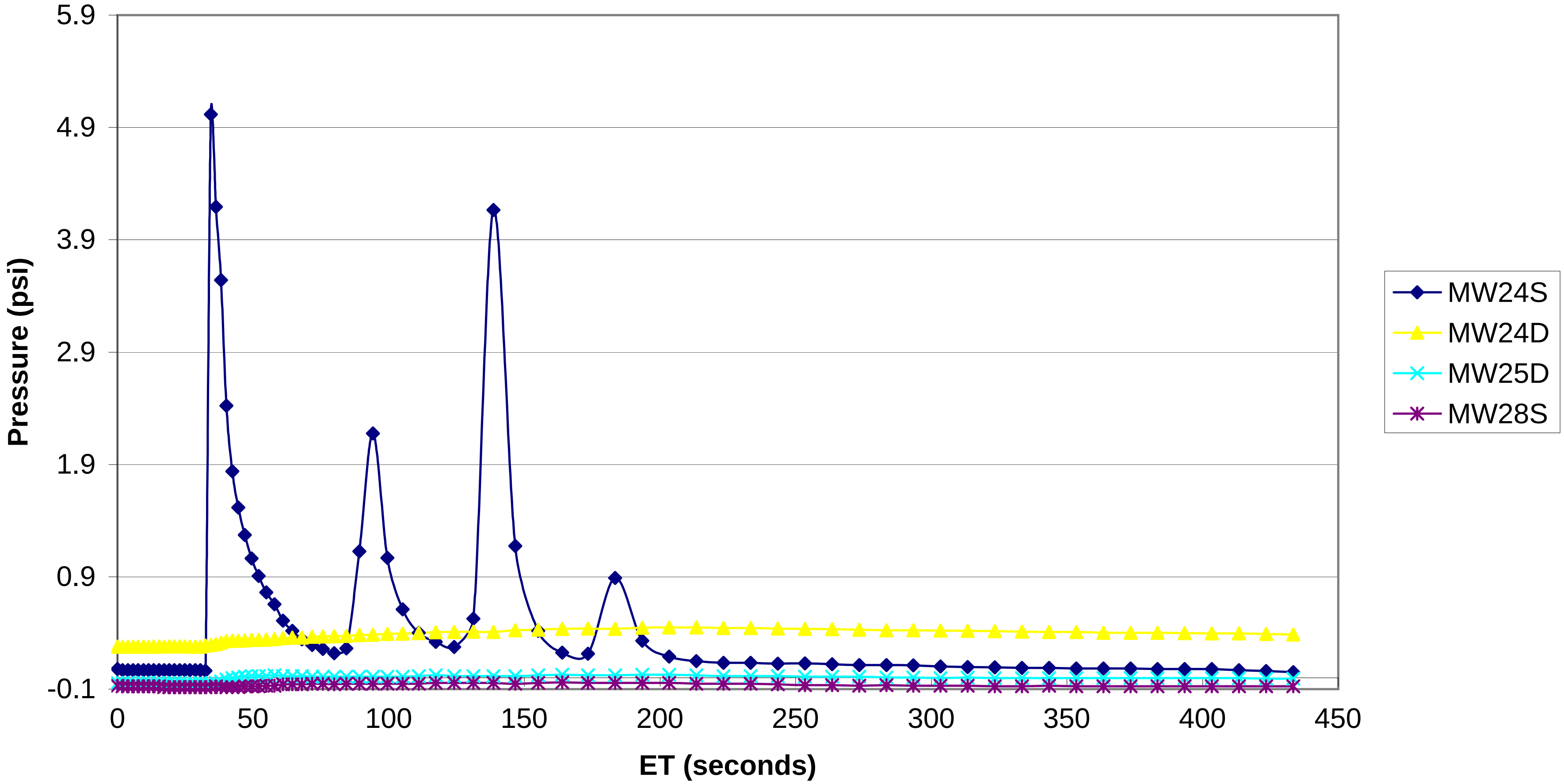
MW9-1I

Monitoring Well Pressure Readings
Injection Boring 9
Interval 2 (14 - 17 ft bgs)
Pulsed ZVI injection Event



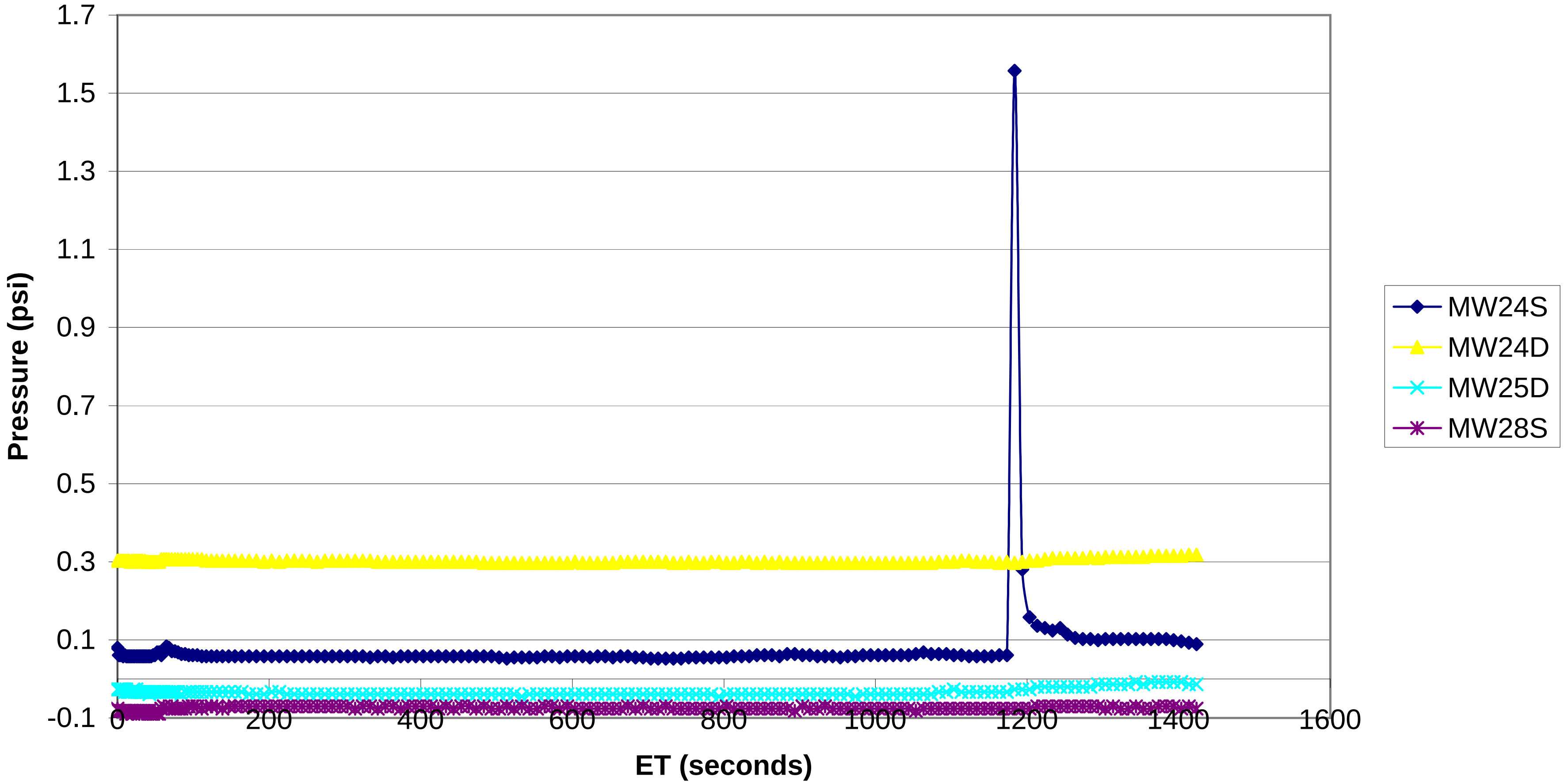
MW9-2I

Monitoring Well Pressure Readings
Injection Boring 9
Interval 3 (11 - 14 ft bgs)
Pulsed ZVI injection Event



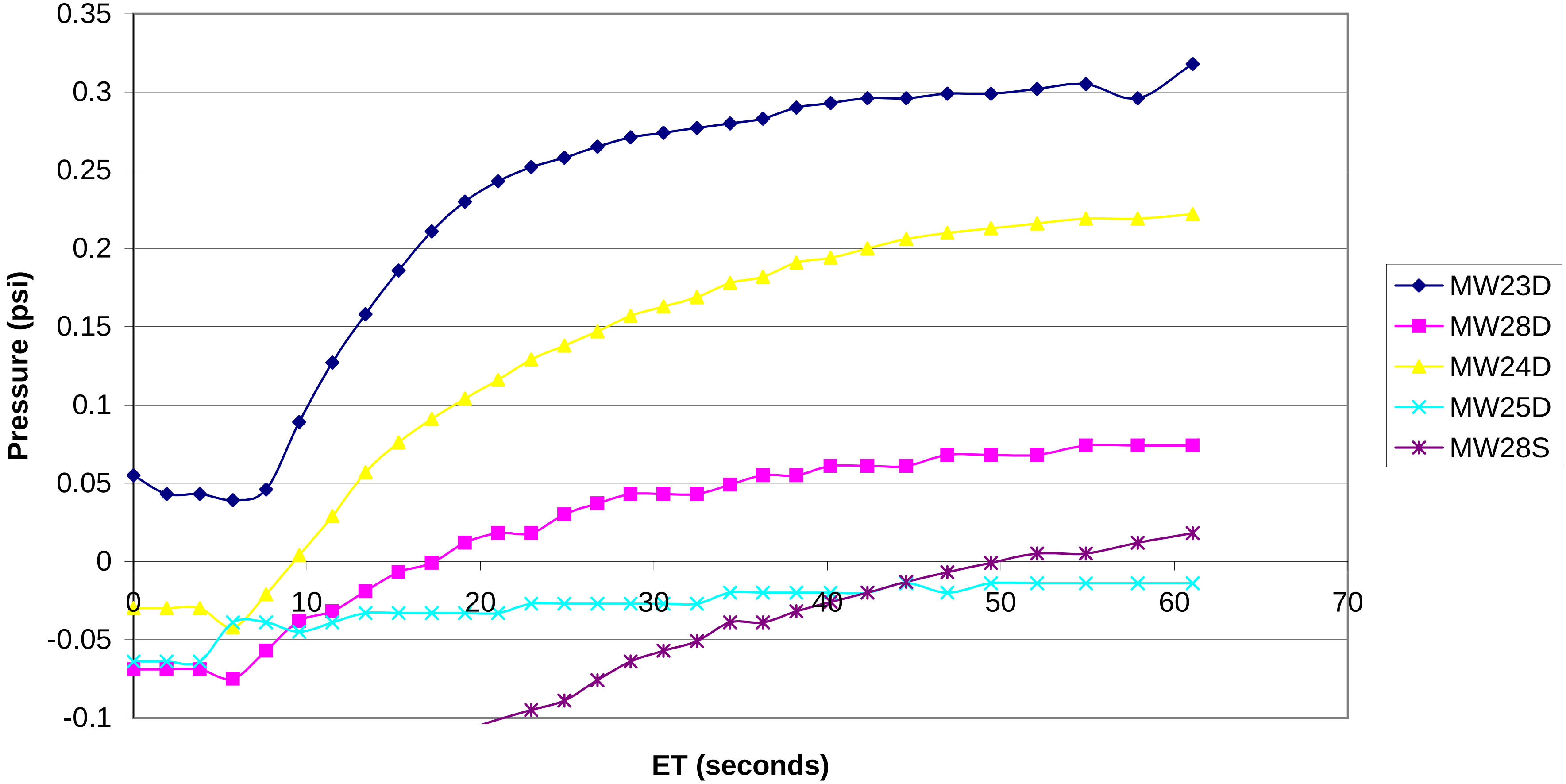
MW9-3I

Monitoring Well Pressure Readings
Injection Boring 9
Interval 4 (8 - 11 ft bgs)
Hydraulic ZVI injection Event



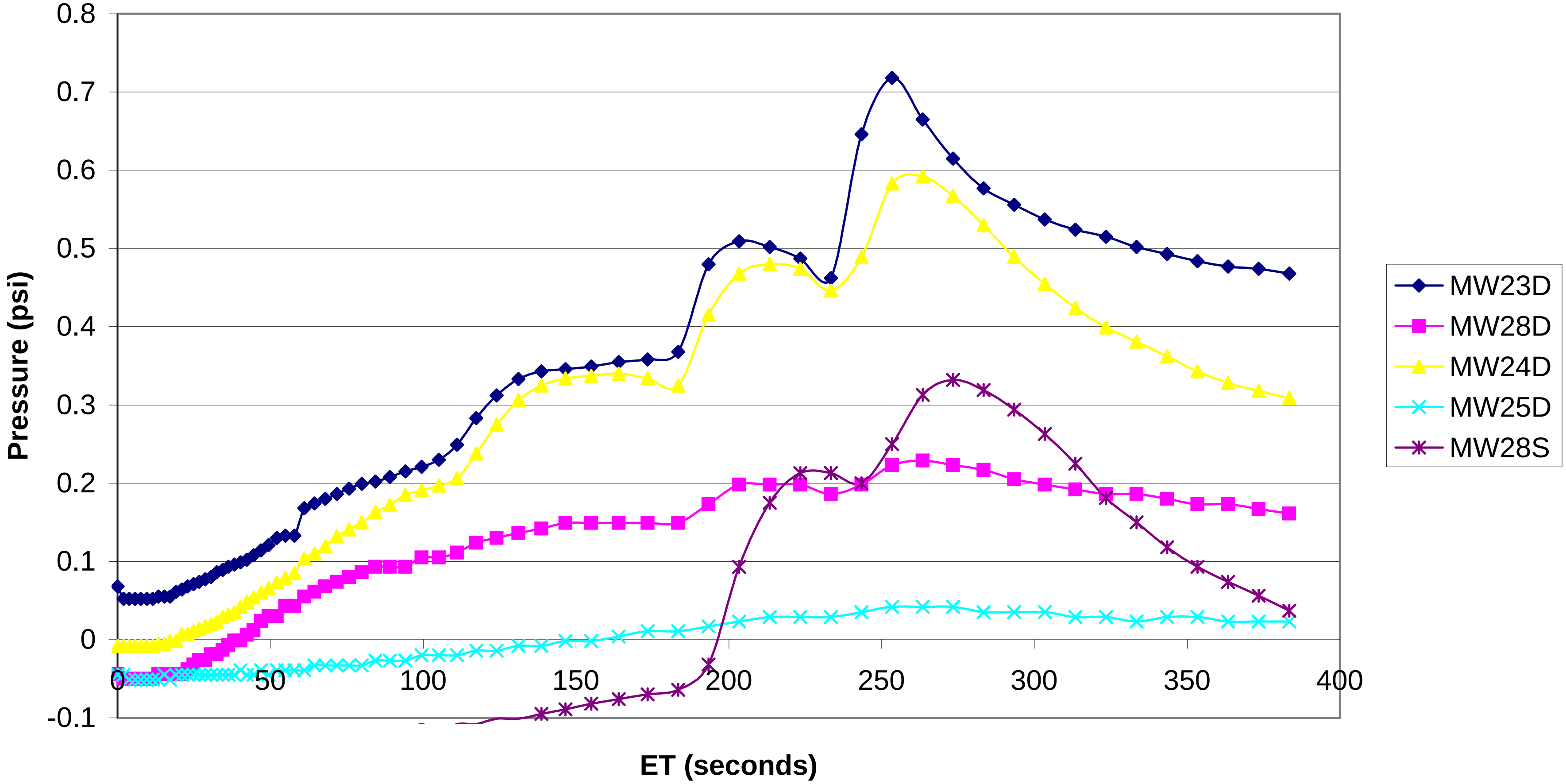
MW9-4I

Monitoring Well Pressure Readings
Injection Boring 10
Interval 1 (15.5 - 17.5 ft bgs)
Fracture Event



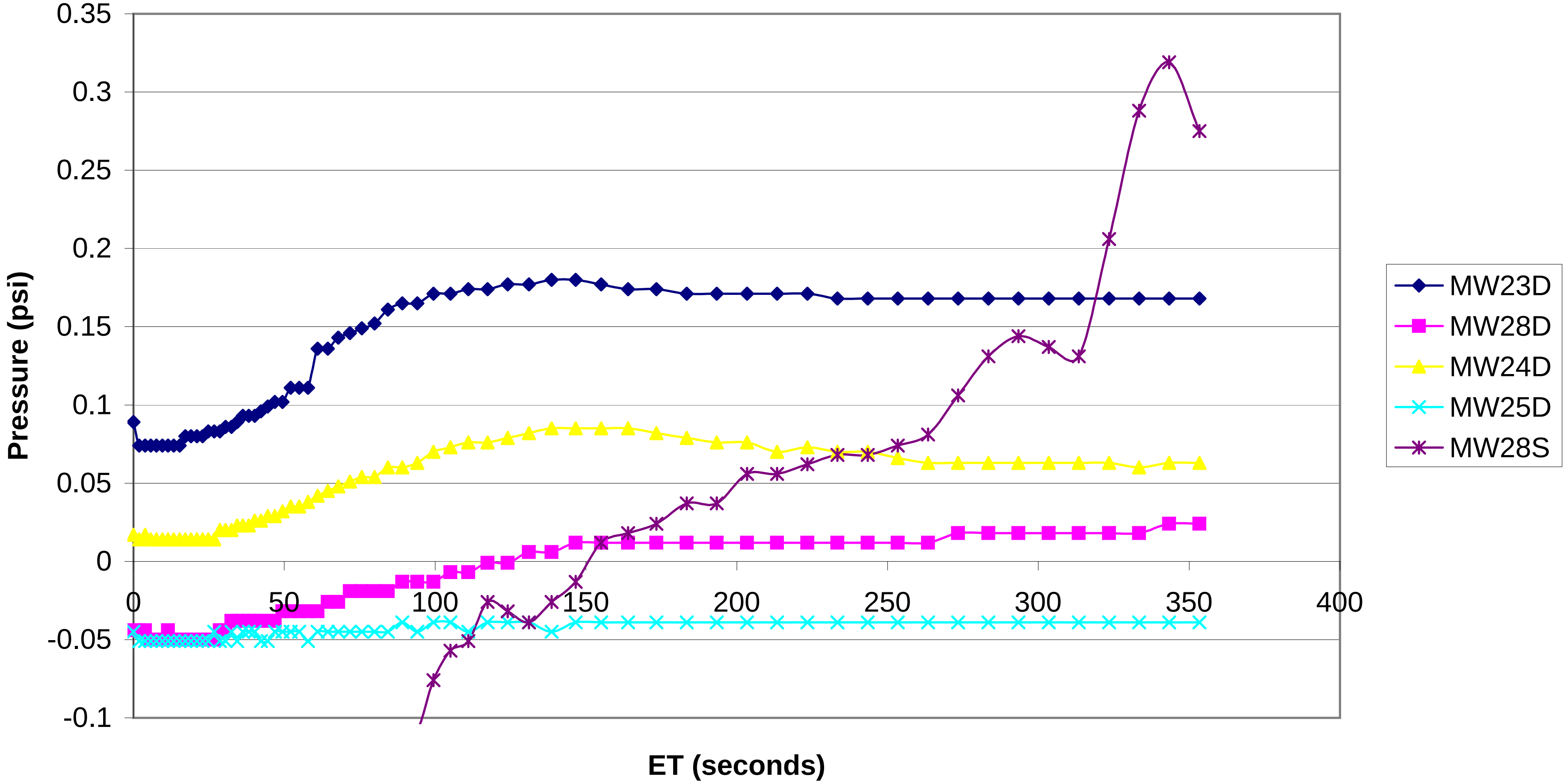
MW10-1F

Monitoring Well Pressure Readings
Injection Boring 10
Interval 1 (15.5 - 17.5 ft bgs)
Pulsed ZVI injection Event



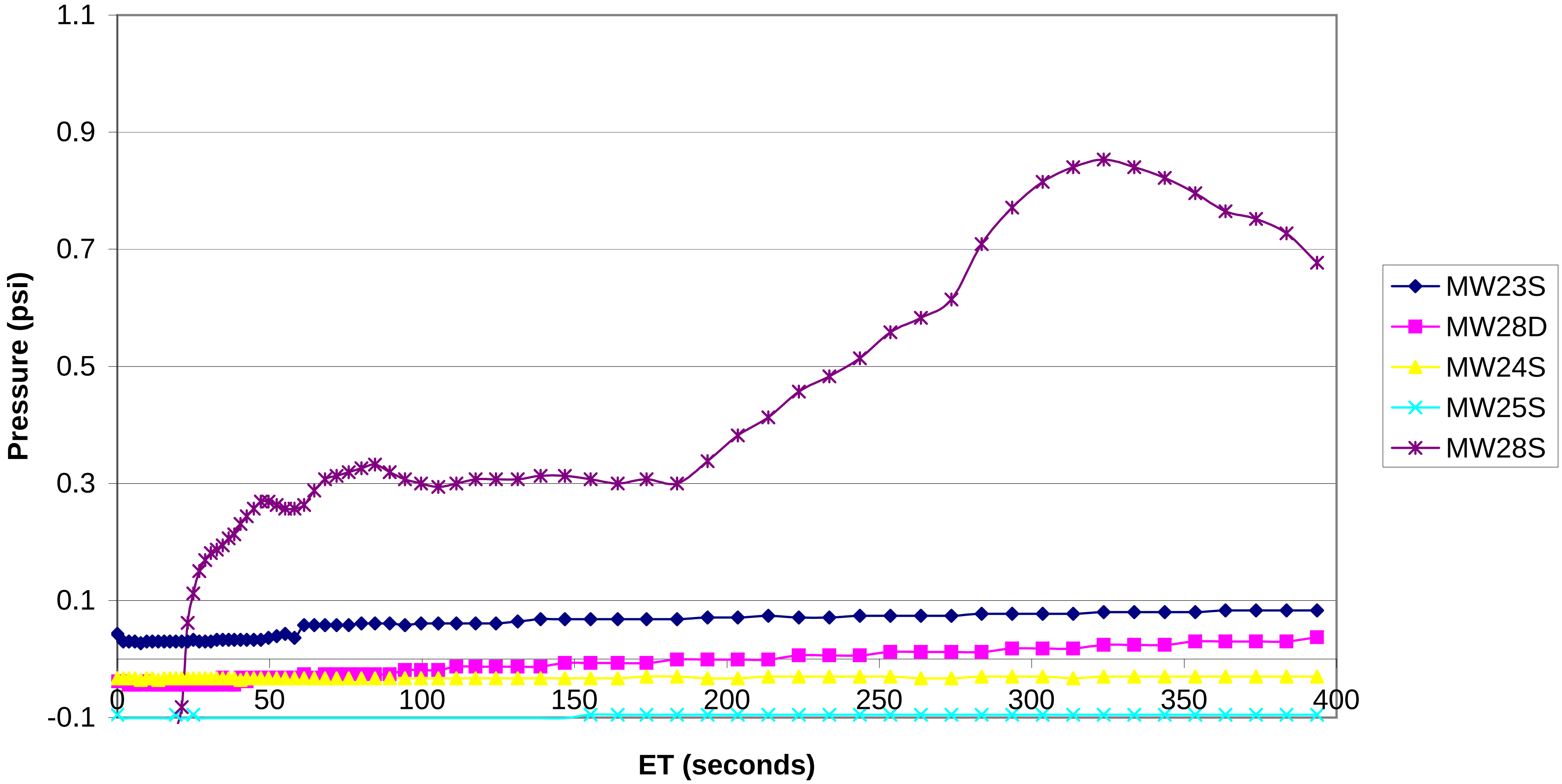
MW10-1I

Monitoring Well Pressure Readings
Injection Boring 10
Interval 2 (12.5 - 15.5 ft bgs)
Hydraulic ZVI injection Event

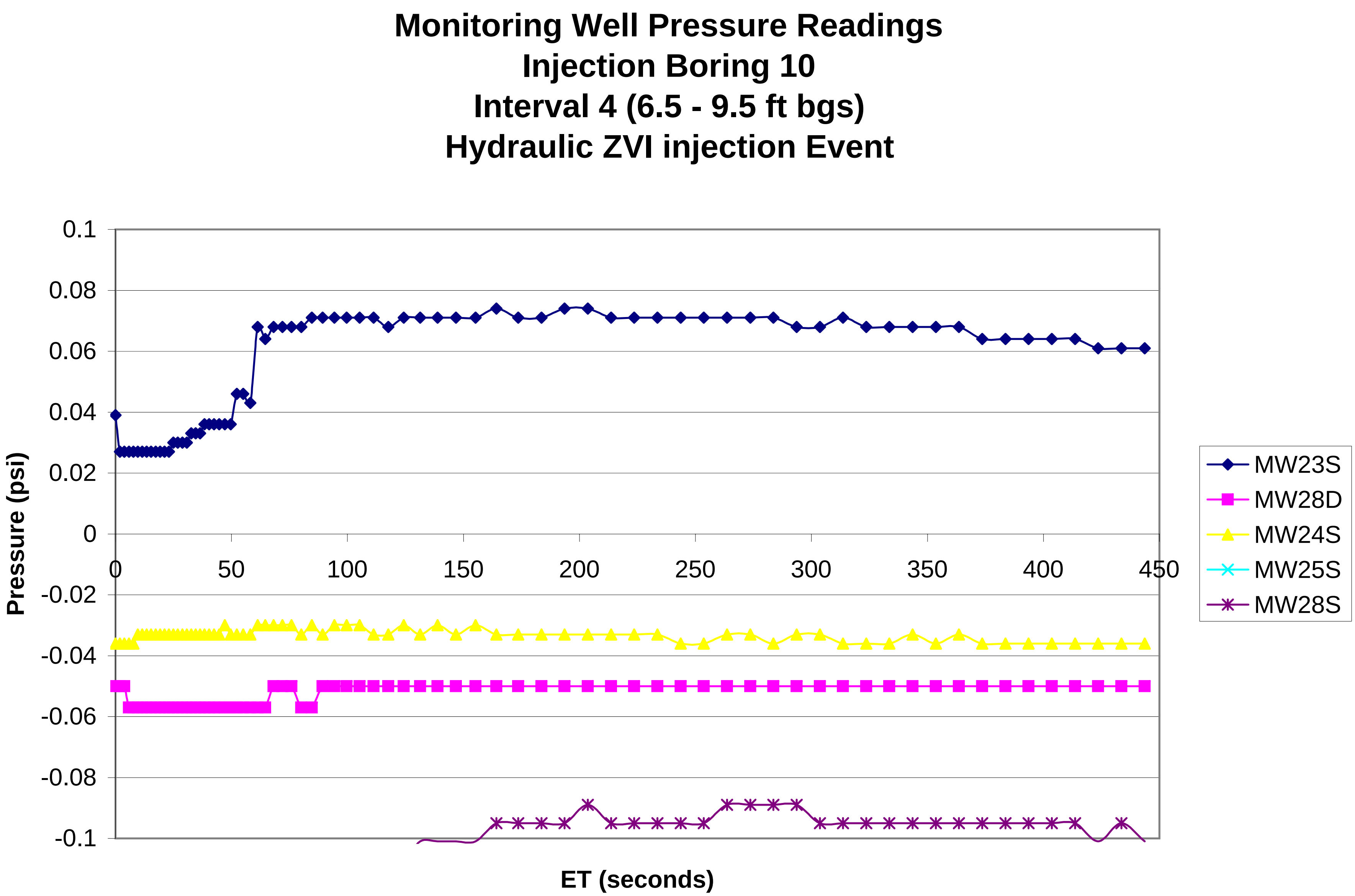


MW10-2I

Monitoring Well Pressure Readings
Injection Boring 10
Interval 3 (9.5 - 12.5 ft bgs)
Hydraulic ZVI injection Event

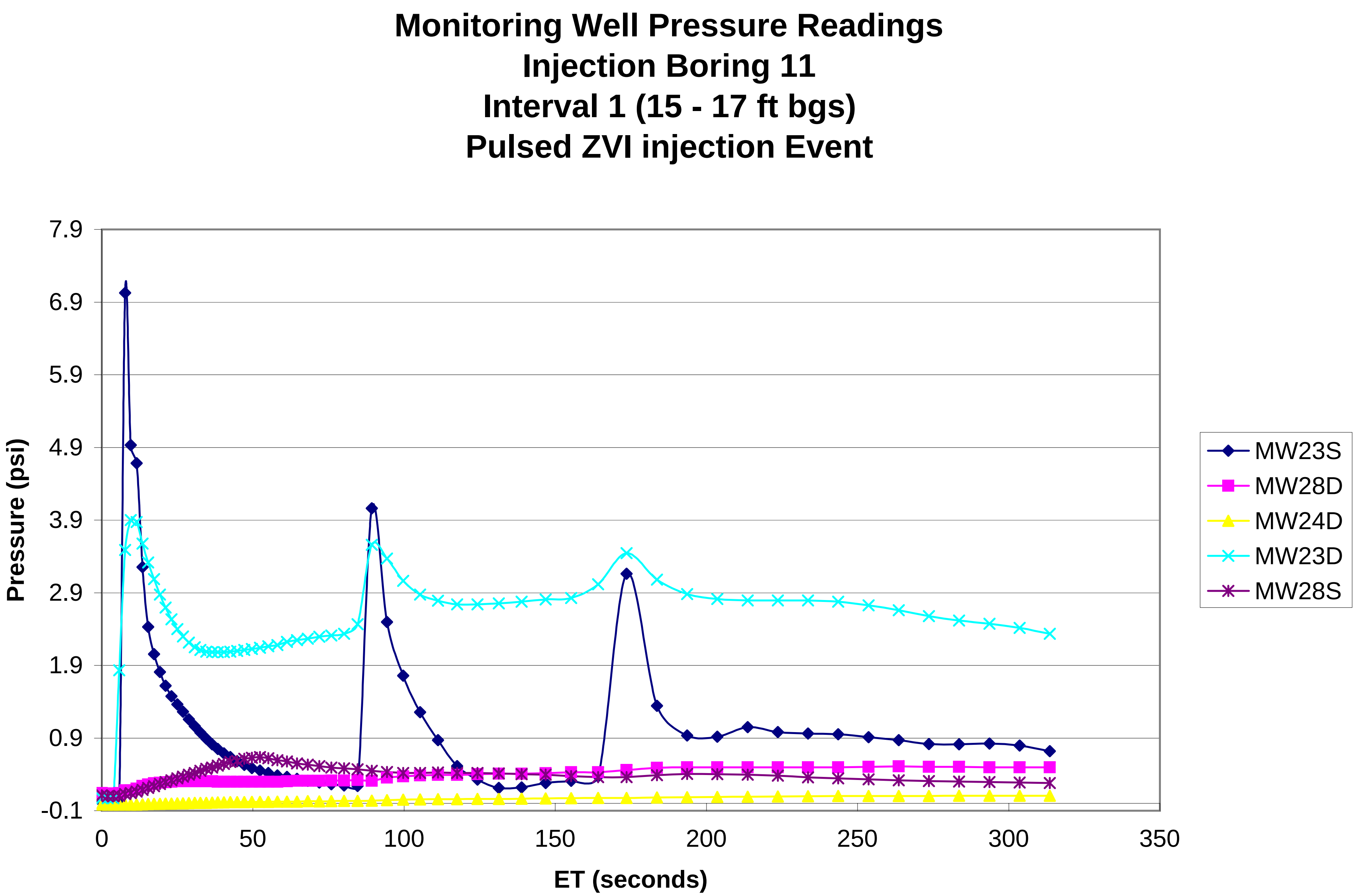


MW10-3I

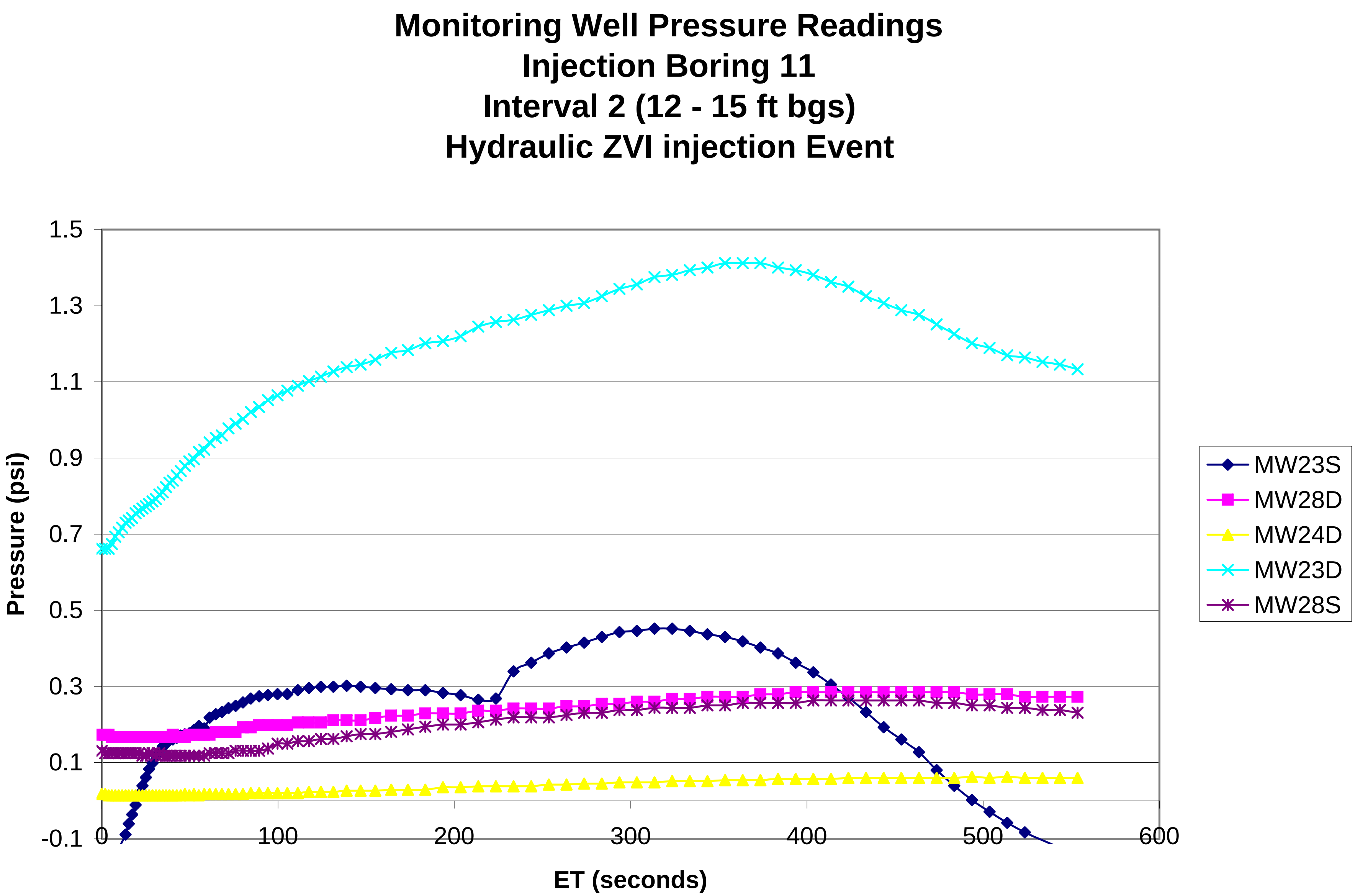


Monitoring Well Pressure Readings
Injection Boring 10
Interval 4 (6.5 - 9.5 ft bgs)
Hydraulic ZVI injection Event
Pressure (psi)
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0
50
100
150
200
250
300
350
400
450
ET (seconds)
MW23S
MW28D
MW24S
MW25S
MW28S

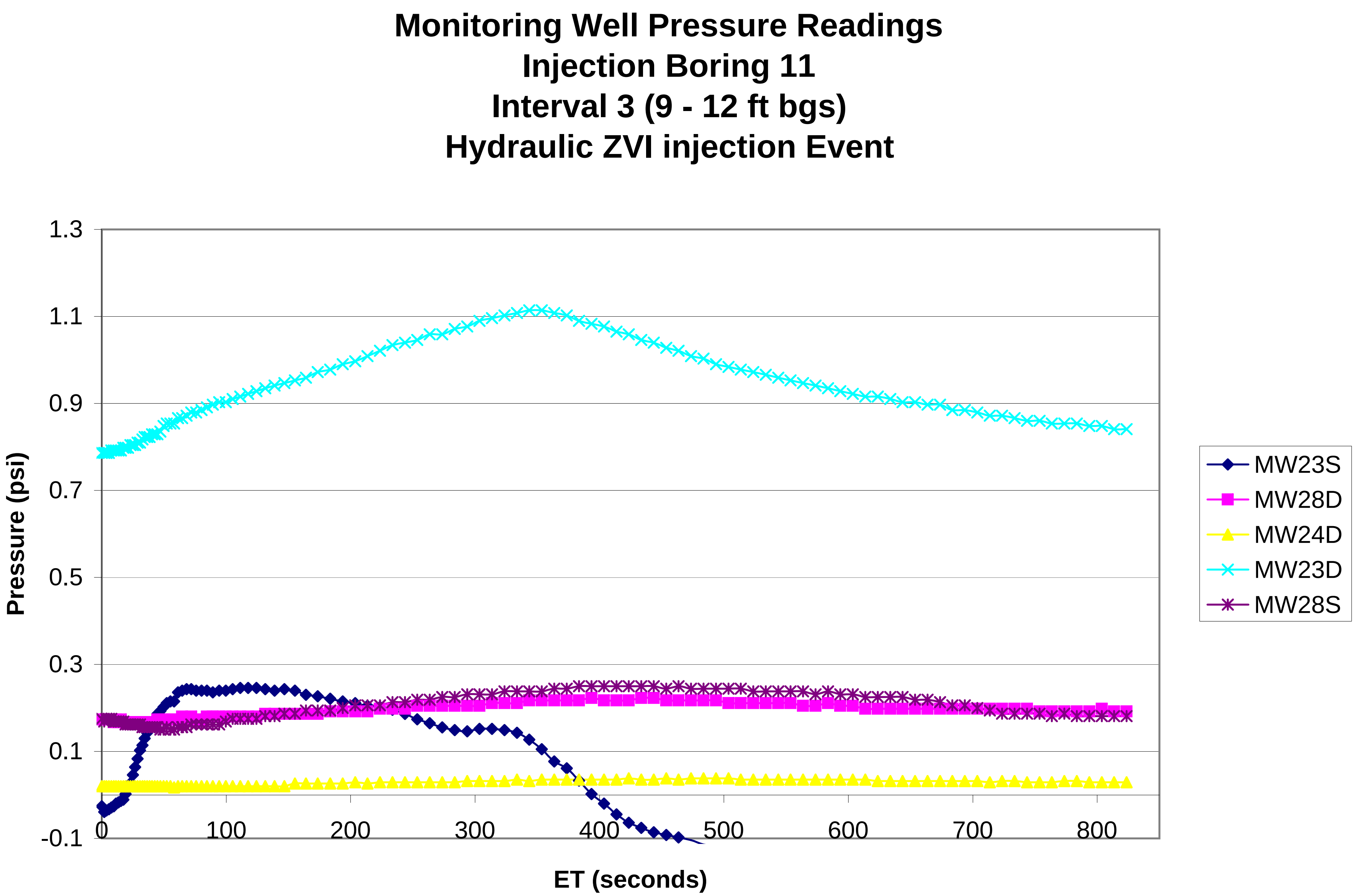
MW10-4I


Monitoring Well Pressure Readings
Injection Boring 11
Interval 1 (15 - 17 ft bgs)
Pulsed ZVI injection Event
Pressure (psi)
7.9
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
0
50
100
150
200
250
300
350
ET (seconds)
MW23S
MW28D
MW24D
MW23D
MW28S

MW11-1I

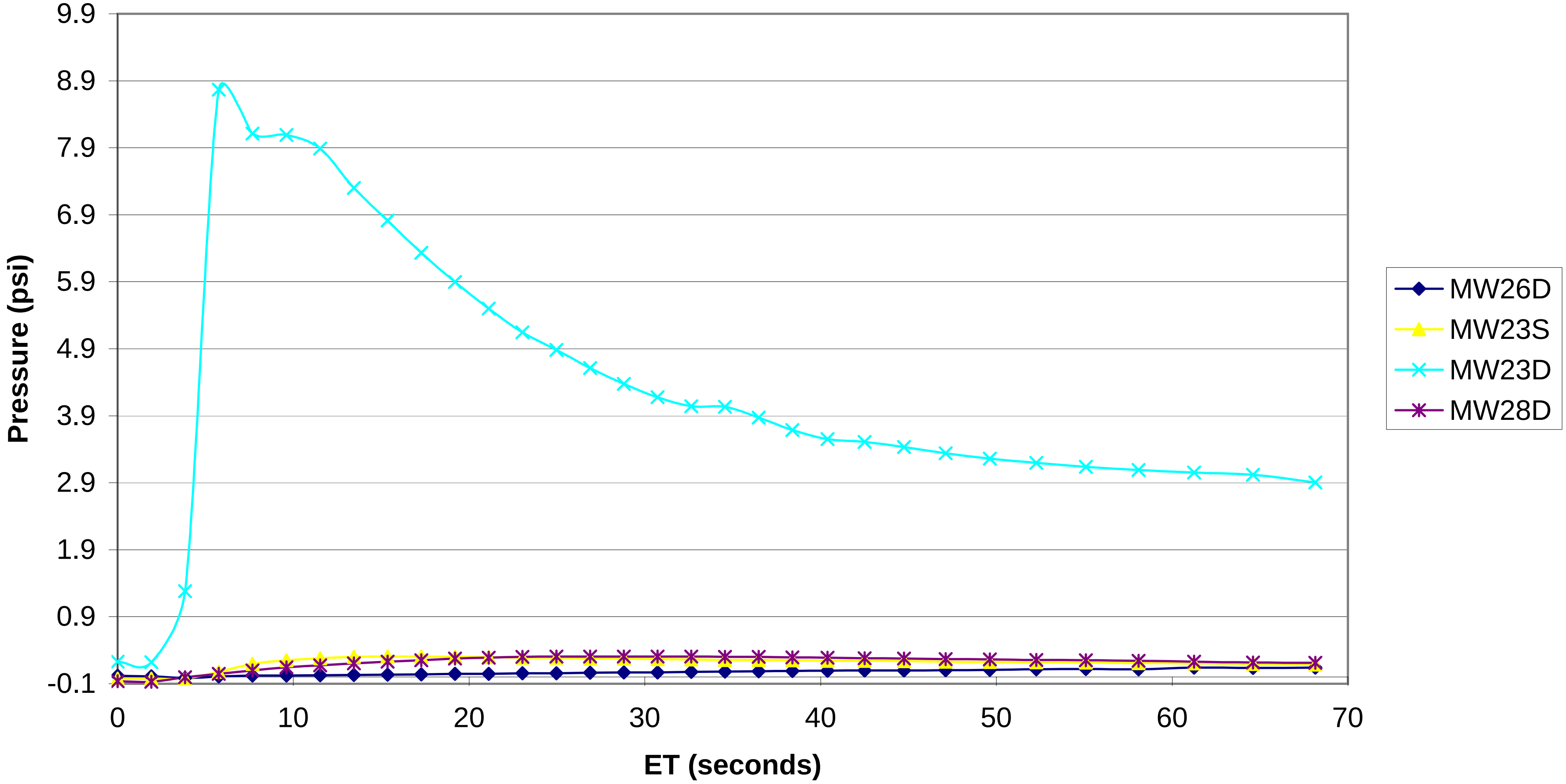

Monitoring Well Pressure Readings
Injection Boring 11
Interval 2 (12 - 15 ft bgs)
Hydraulic ZVI injection Event
Pressure (psi)
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW23S
MW28D
MW24D
MW23D
MW28S

MW11-2I

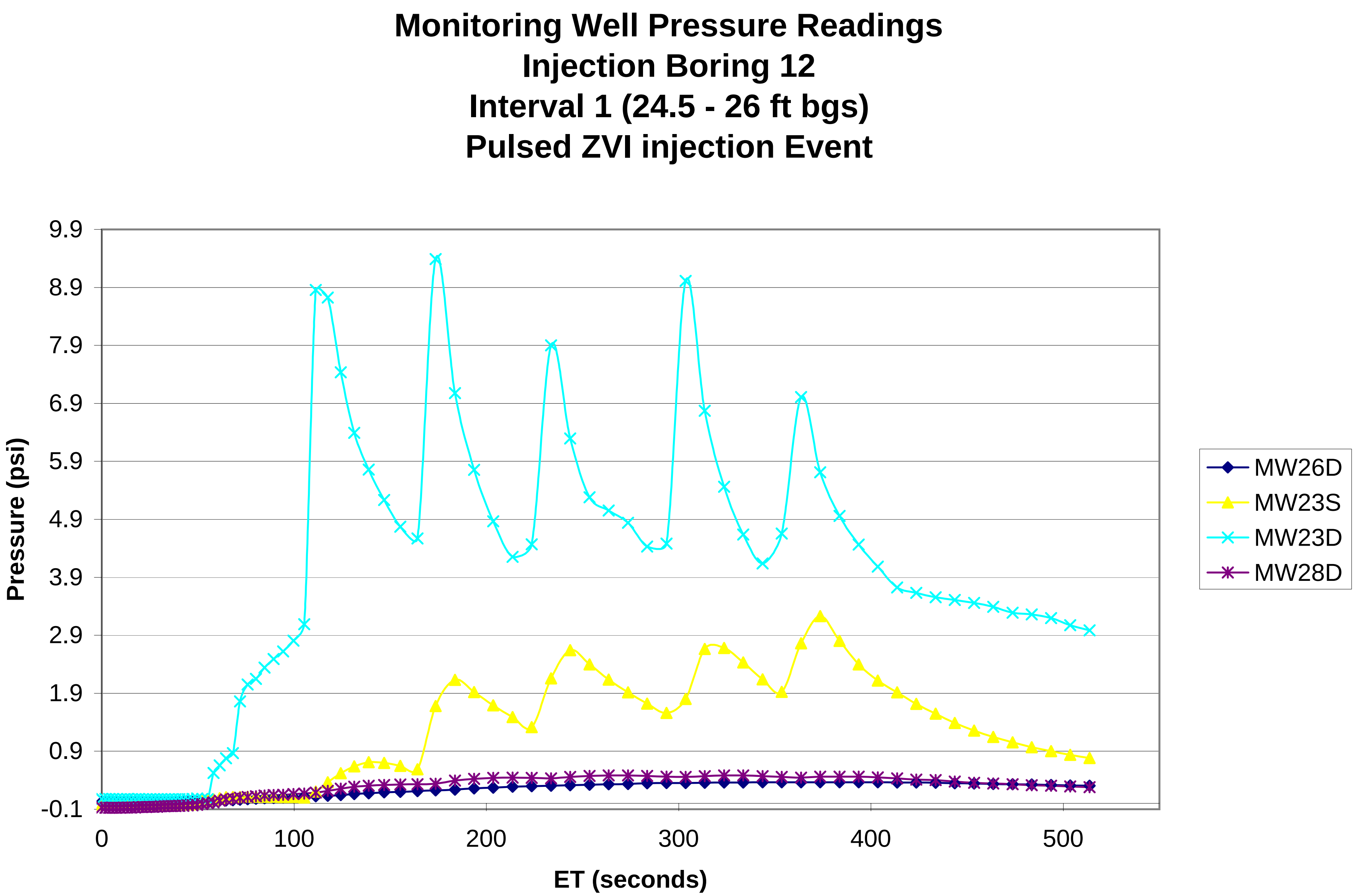

Monitoring Well Pressure Readings
Injection Boring 11
Interval 3 (9 - 12 ft bgs)
Hydraulic ZVI injection Event
Pressure (psi)
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
100
200
300
400
500
600
700
800
ET (seconds)
MW23S
MW28D
MW24D
MW23D
MW28S

MW11-3I

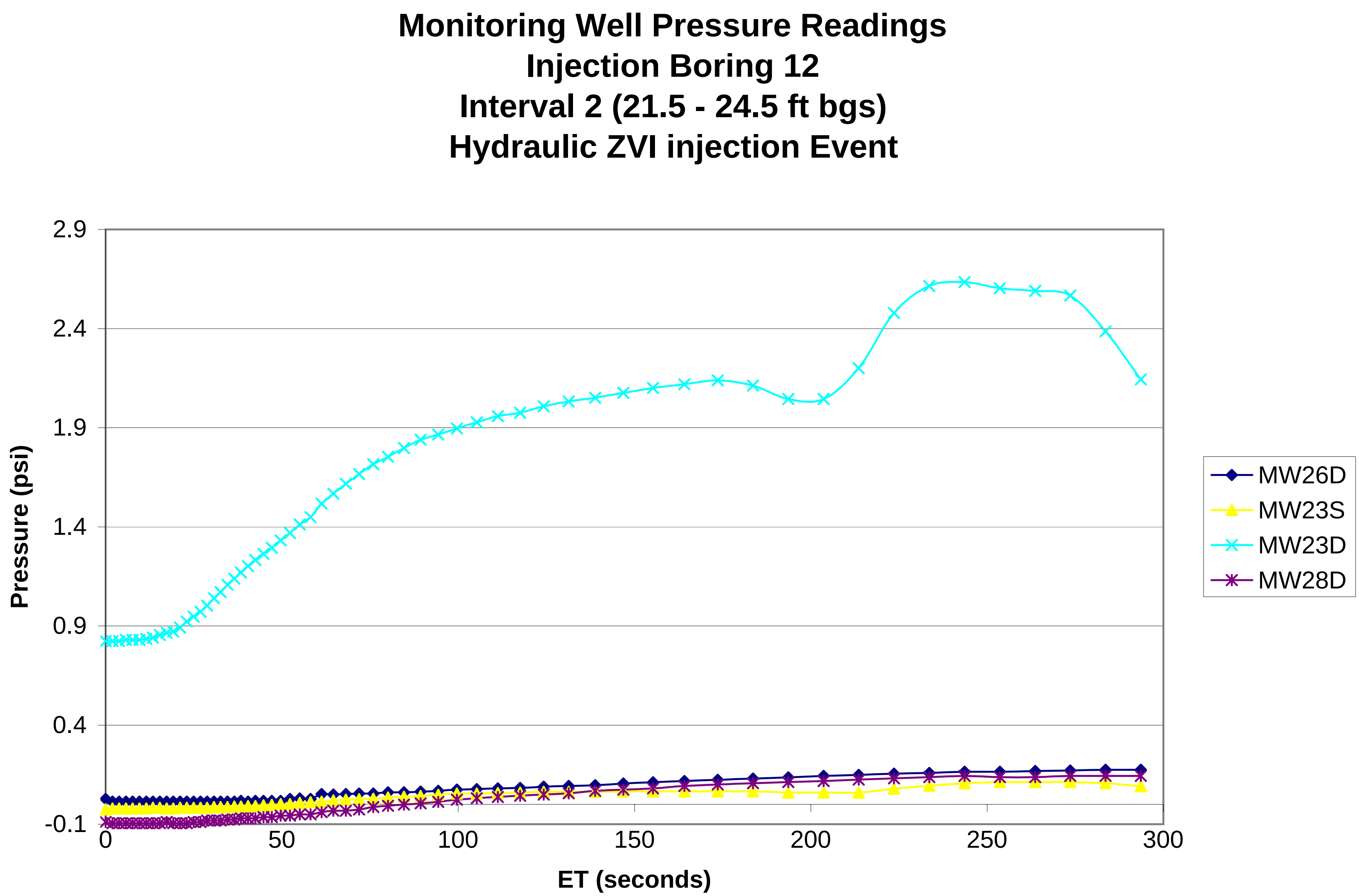
Monitoring Well Pressure Readings
Injection Boring 12
Interval 1 (24.5 - 26 ft bgs)
Fracture Event



MW12-1F

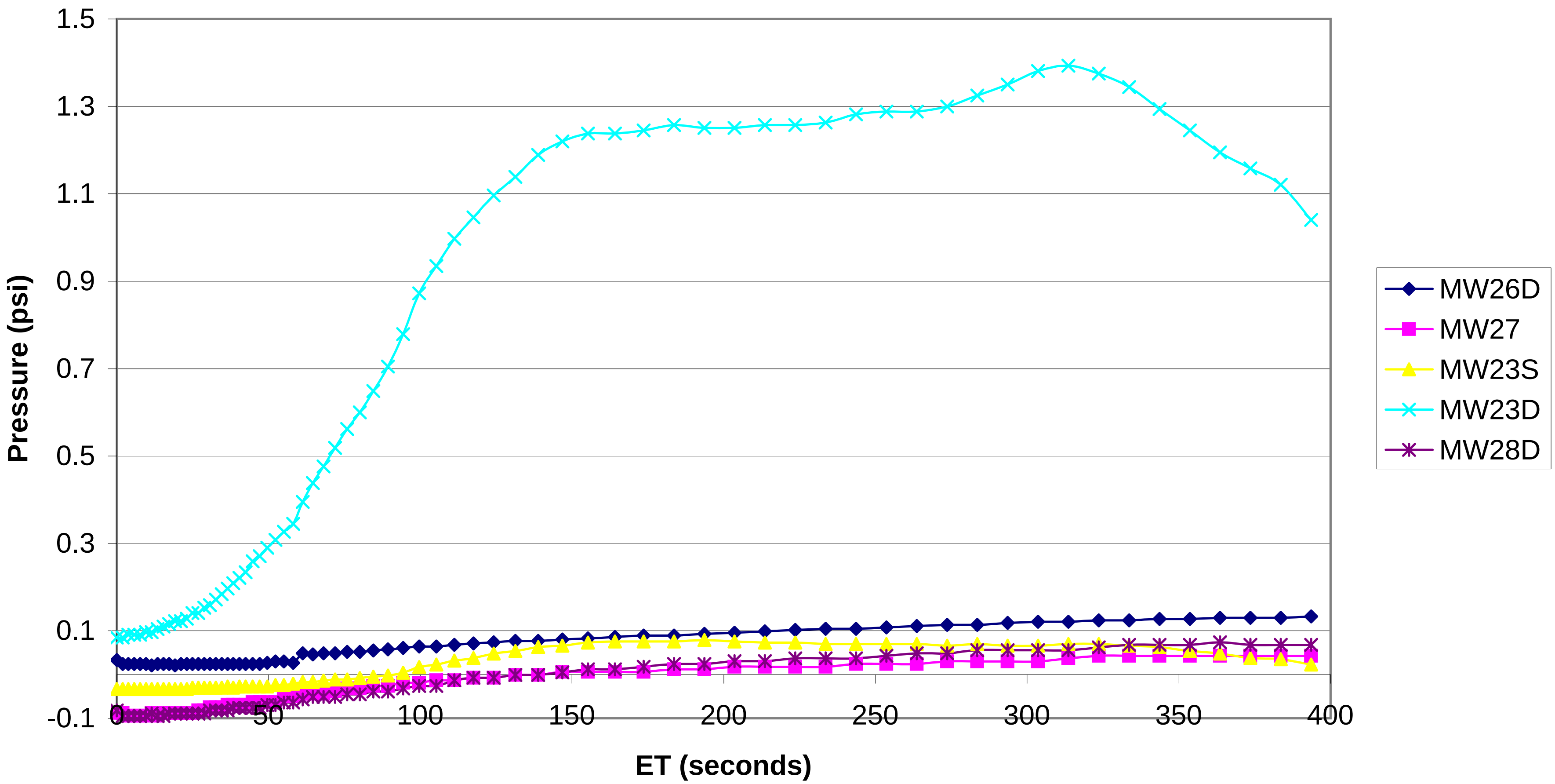

Monitoring Well Pressure Readings
Injection Boring 12
Interval 1 (24.5 - 26 ft bgs)
Pulsed ZVI injection Event
Pressure (psi)
9.9
8.9
7.9
6.9
5.9
4.9
3.9
2.9
1.9
0.9
-0.1
0
100
200
300
400
500
ET (seconds)
MW26D
MW23S
MW23D
MW28D

MW12-1I

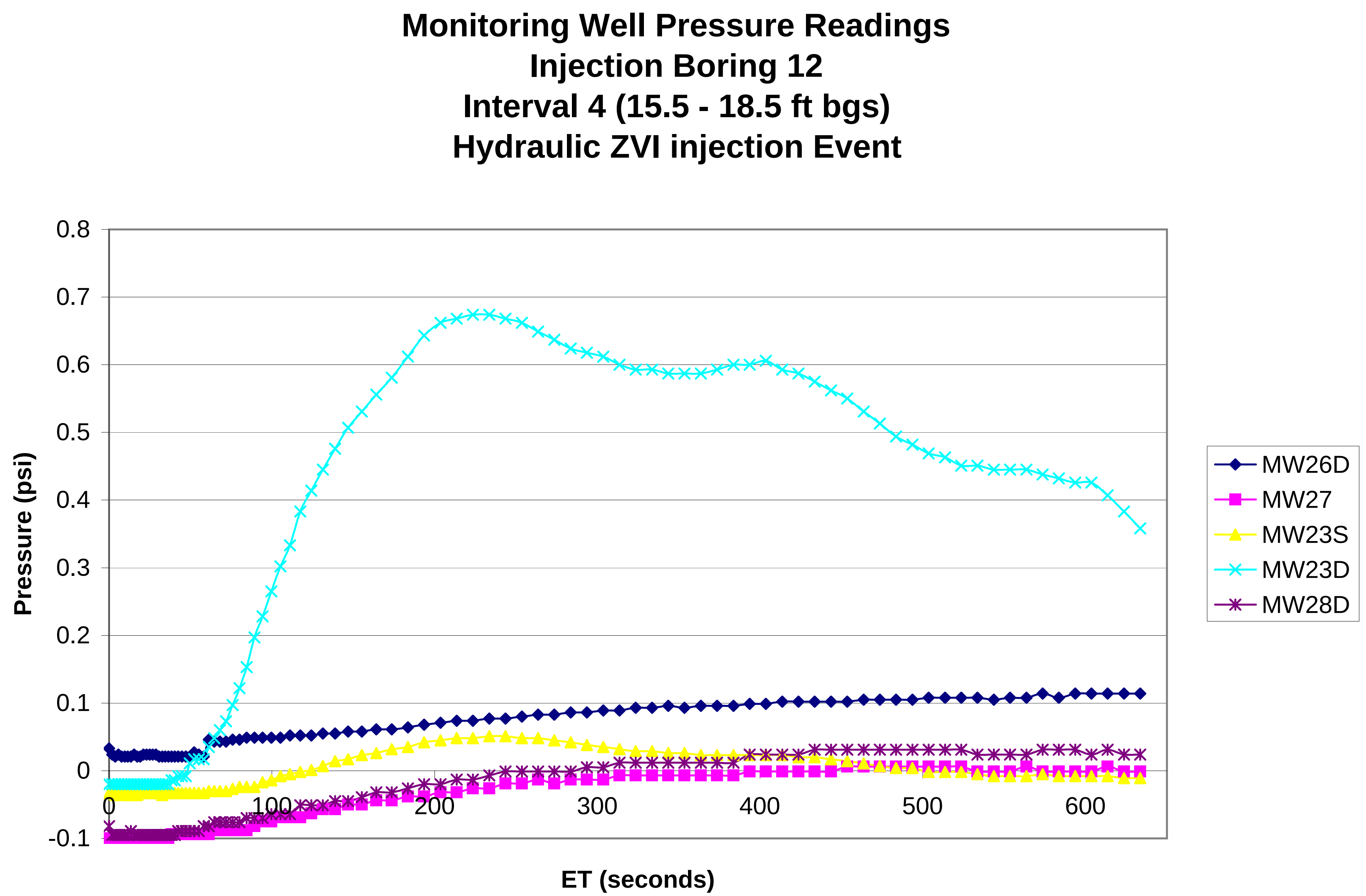

Monitoring Well Pressure Readings
Injection Boring 12
Interval 2 (21.5 - 24.5 ft bgs)
Hydraulic ZVI injection Event
Pressure (psi)
2.9
2.4
1.9
1.4
0.9
0.4
-0.1
0
50
100
150
200
250
300
ET (seconds)
MW26D
MW23S
MW23D
MW28D

MW12-2I

Monitoring Well Pressure Readings
Injection Boring 12
Interval 3 (18.5 - 21.5 ft bgs)
Hydraulic ZVI injection Event

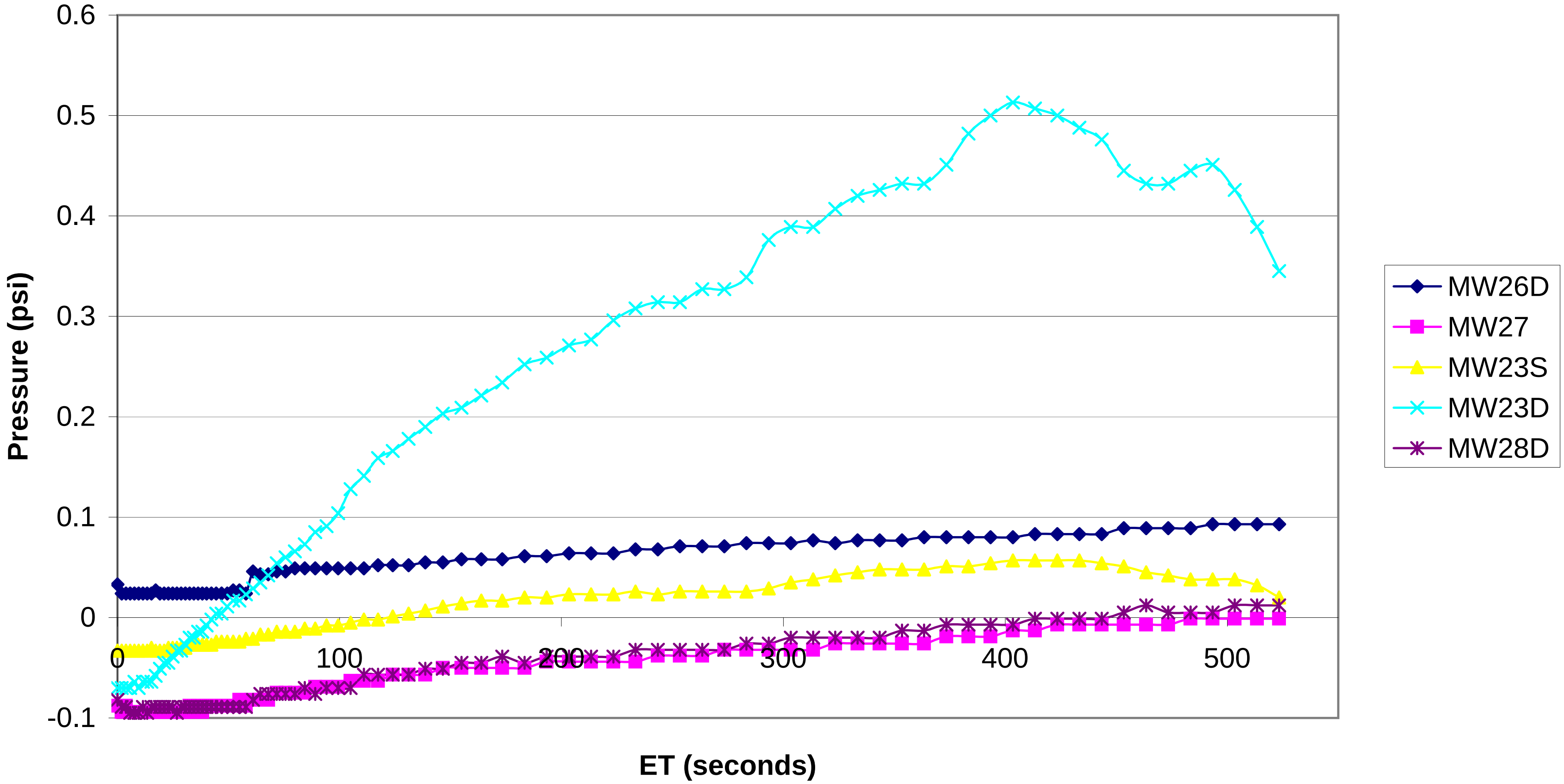


MW12-3I


Monitoring Well Pressure Readings
Injection Boring 12
Interval 4 (15.5 - 18.5 ft bgs)
Hydraulic ZVI injection Event
Pressure (psi)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW26D
MW27
MW23S
MW23D
MW28D

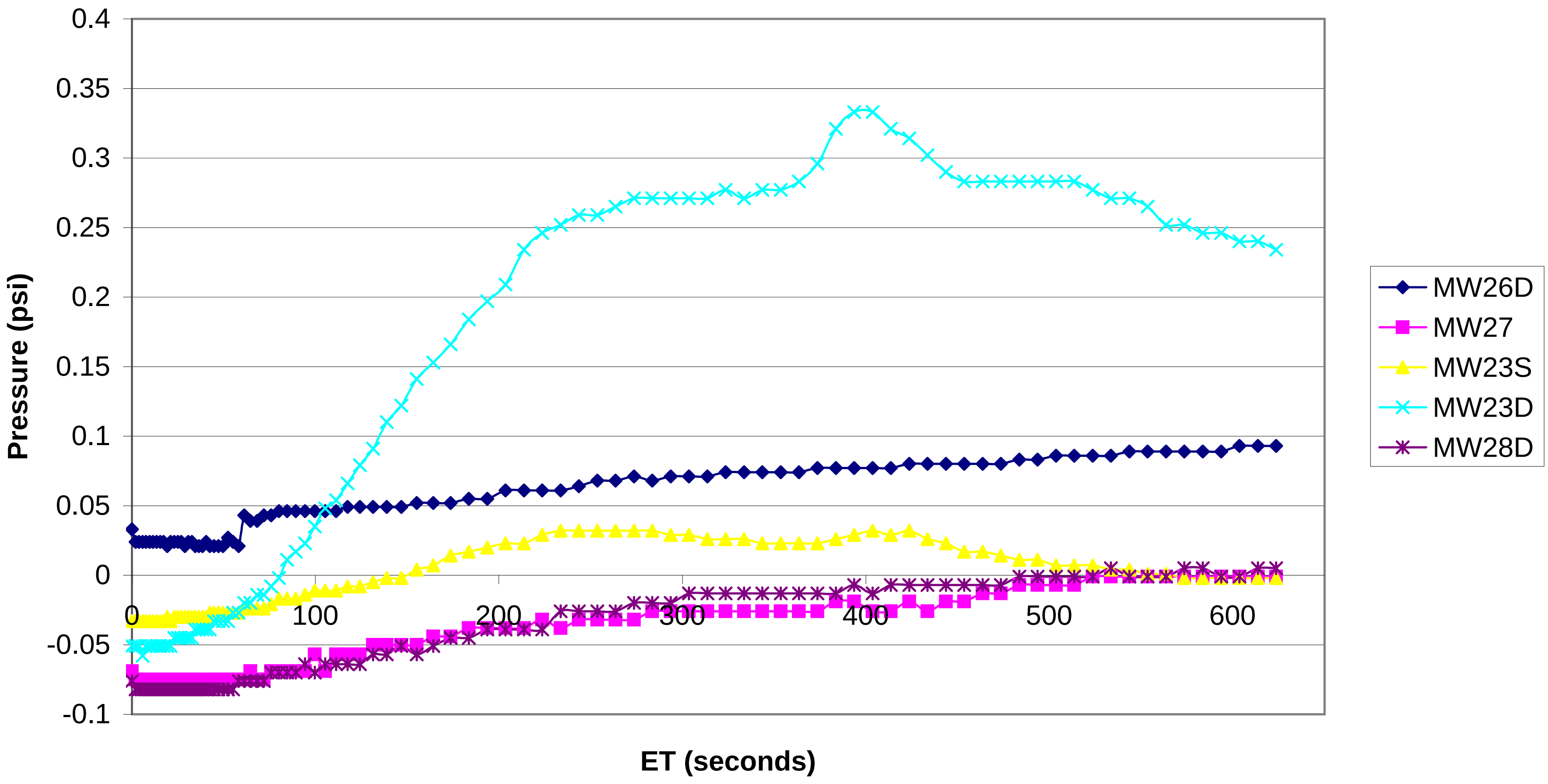
MW12-4I

Monitoring Well Pressure Readings
Injection Boring 12
Interval 5 (12.5 - 15.5 ft bgs)
Hydraulic ZVI injection Event



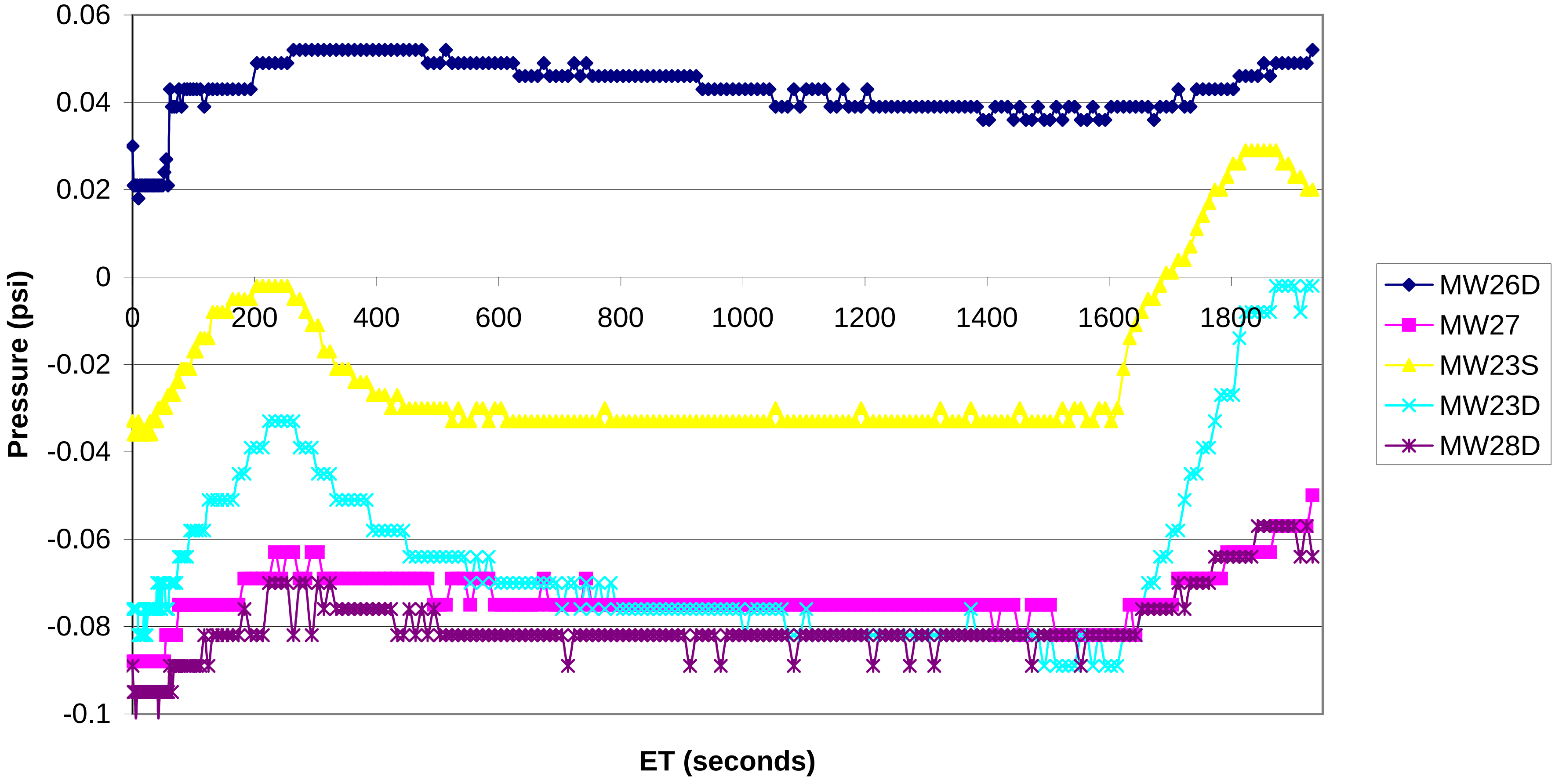
MW12-5I

Monitoring Well Pressure Readings
Injection Boring 12
Interval 6 (9.5 - 12.5 ft bgs)
Hydraulic ZVI injection Event

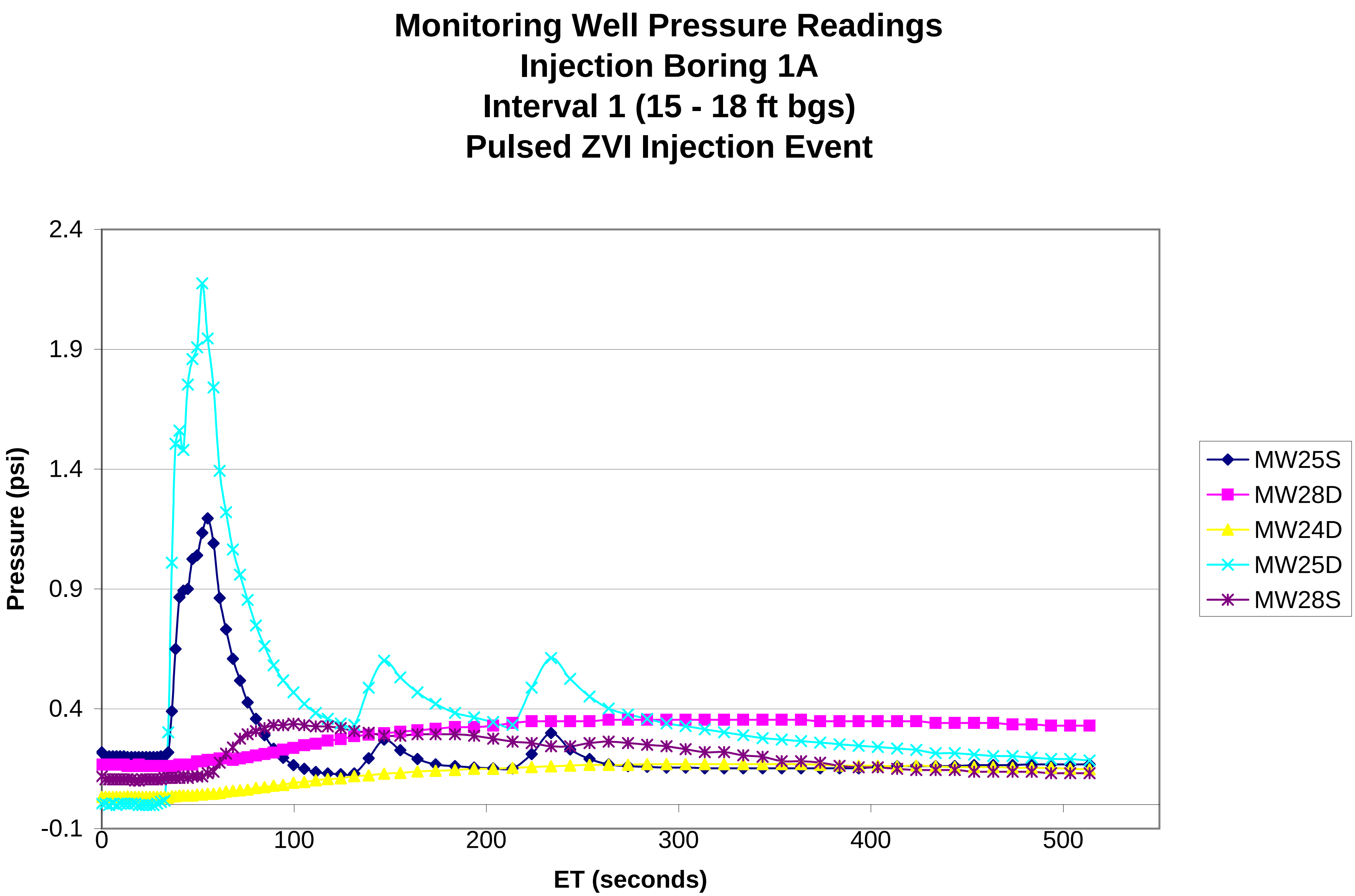


MW12-6I

Monitoring Well Pressure Readings
Injection Boring 12
Interval 7 (6.5 - 9.5 ft bgs)
Hydraulic ZVI injection Event



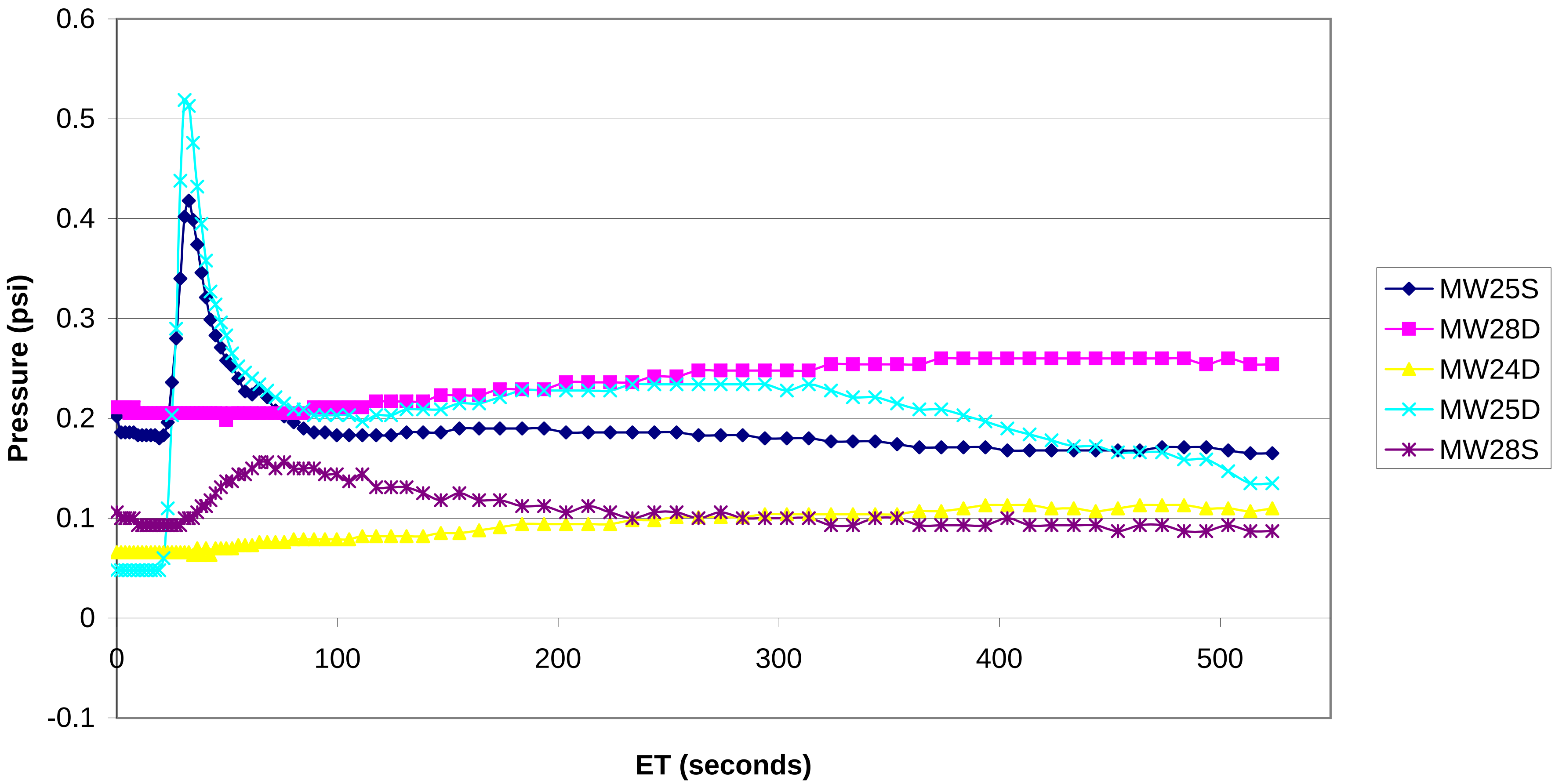
MW12-7I



Monitoring Well Pressure Readings
Injection Boring 1A
Interval 1 (15 - 18 ft bgs)
Pulsed ZVI Injection Event
Pressure (psi)
2.4
1.9
1.4
0.9
0.4
-0.1
0
100
200
300
400
500
ET (seconds)
MW25S
MW28D
MW24D
MW25D
MW28S

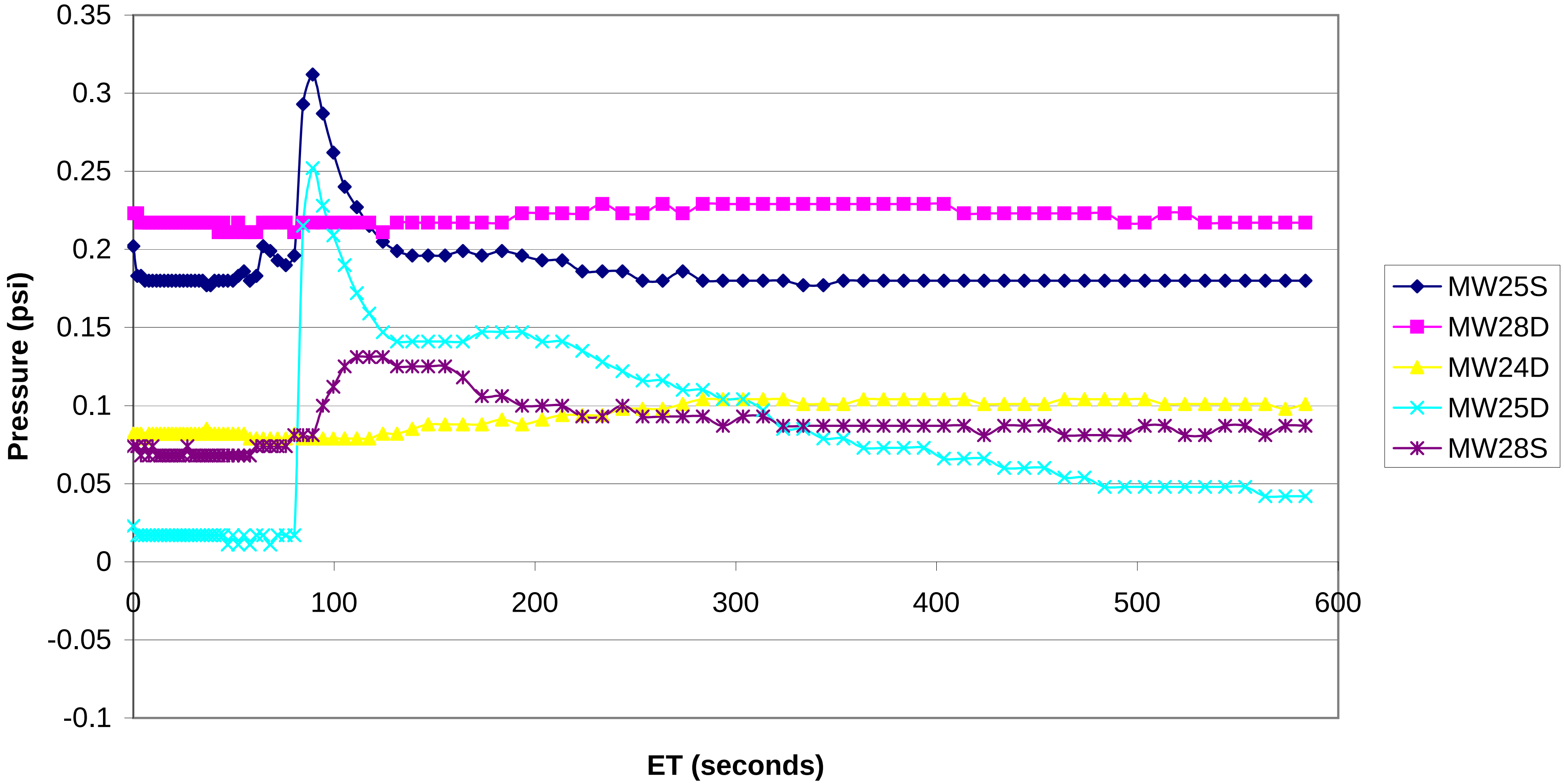
MW1A-1I

Monitoring Well Pressure Readings
Injection Boring 1A
Interval 2 (13 - 15 ft bgs)
Hydraulic ZVI Injection Event



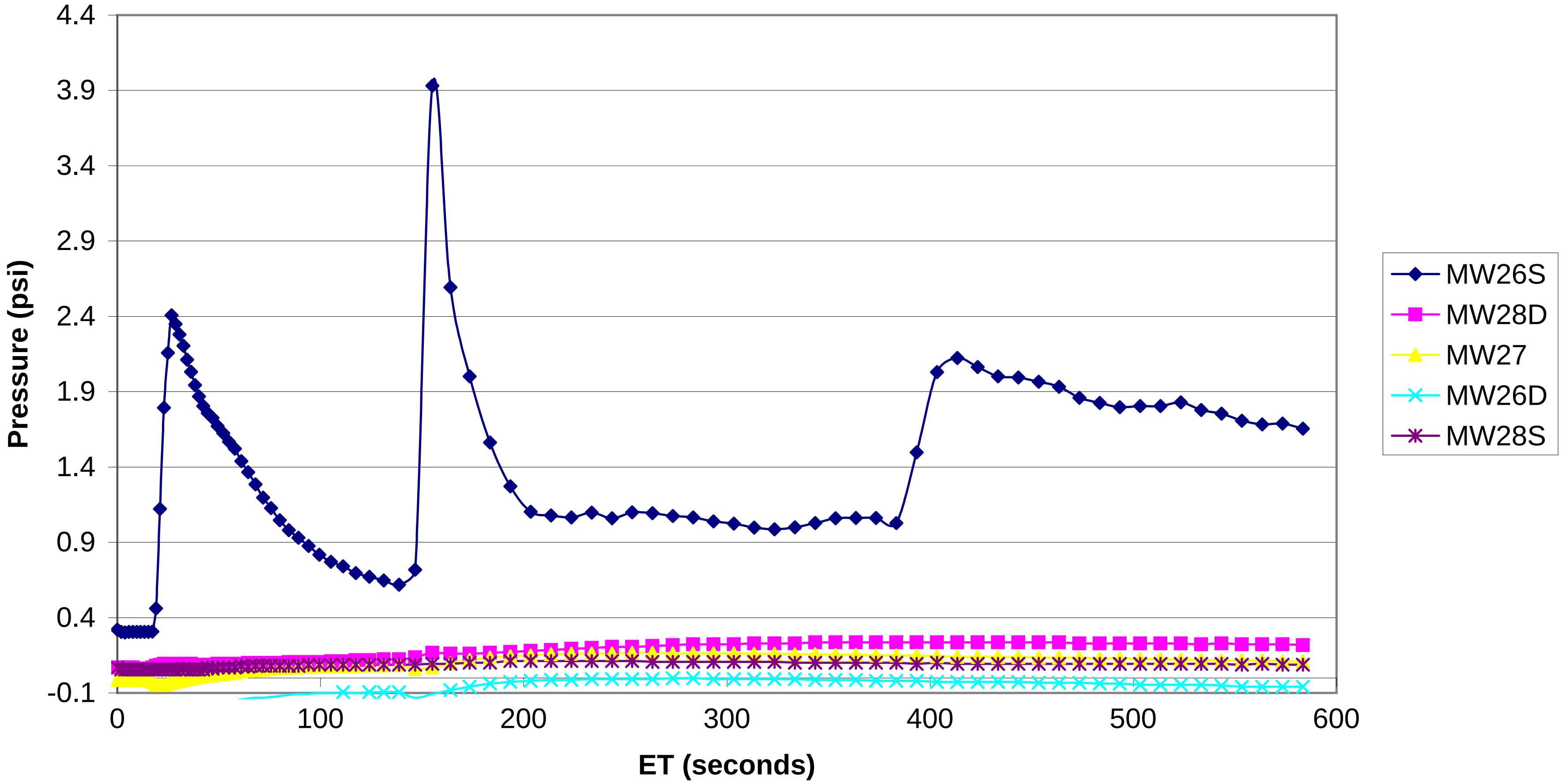
MW1A-2I

Monitoring Well Pressure Readings
Injection Boring 1A
Interval 3 (10 - 13 ft bgs)
Hydraulic ZVI Injection Event

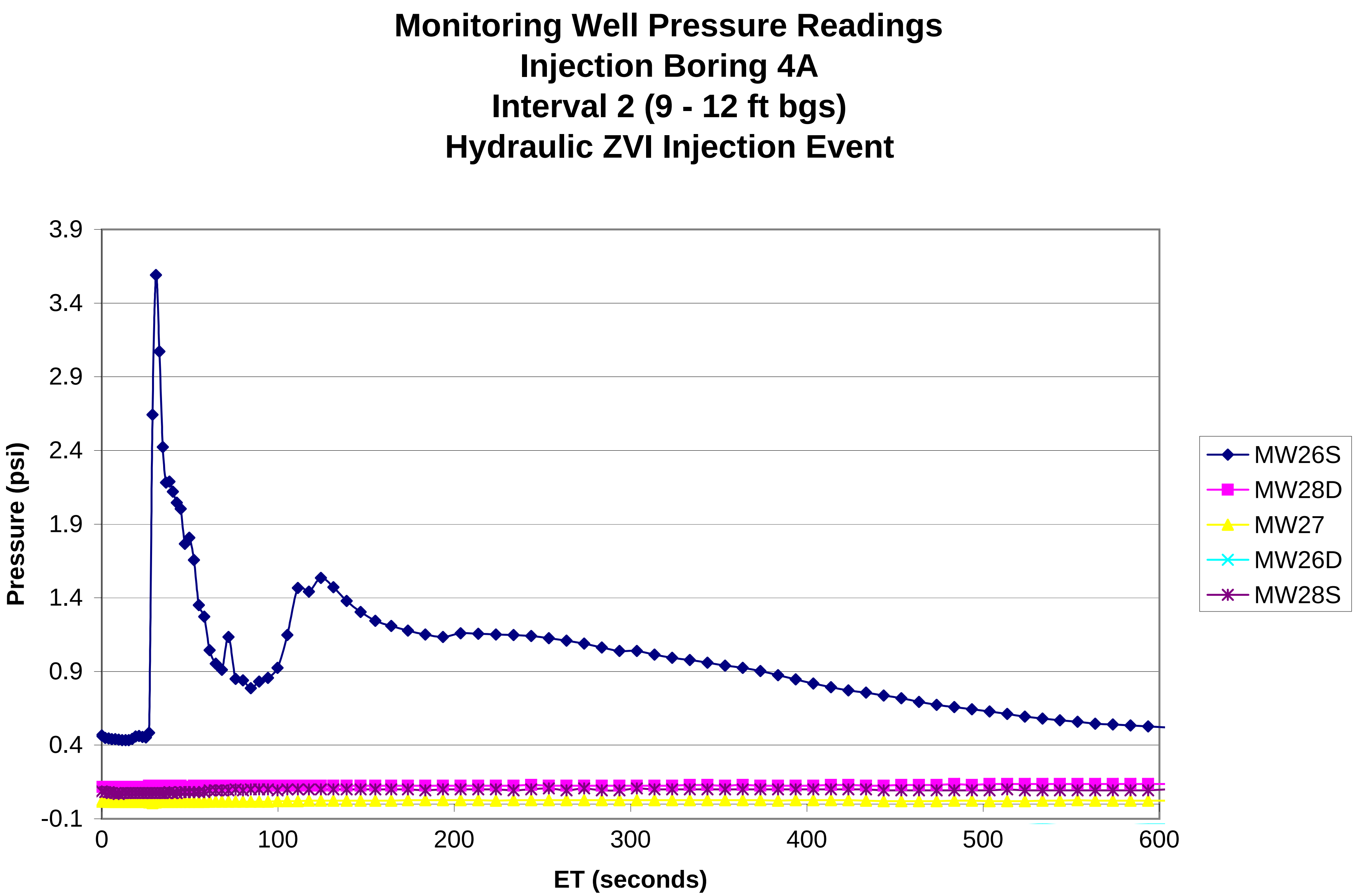


MW1A-3I

Monitoring Well Pressure Readings
Injection Boring 4A
Interval 1 (12 - 15 ft bgs)
Hydraulic ZVI Injection Event



MW4A-1I


Monitoring Well Pressure Readings
Injection Boring 4A
Interval 2 (9 - 12 ft bgs)
Hydraulic ZVI Injection Event
Pressure (psi)
3.9
3.4
2.9
2.4
1.9
1.4
0.9
0.4
-0.1
0
100
200
300
400
500
600
ET (seconds)
MW26S
MW28D
MW27
MW26D
MW28S

MW4A-2I

Farrand Controls, Valhalla, NY

Soil Sampling Event: Field Summary

ARS Technologies took continues cores (in 5 foot sections) from surface to refusal, using the Geoprobe DT325 sampling system, in nine (9) locations within the ZVI pilot test area at Farrand Controls. Cores were taken on January 22 -23, 2009. Core logs were created January 23 and 26, 2009.

Field observation confirmed the geology to be consistent across the site. The first four feet were typically surficial soils and fill material. In some cores, there were solid chunks of wood found up to 10 feet down. The predominant geologic unit was found below the surface soils. It consisted of sand of varying grain size (fine to coarse) and color (red-brown, brown, grey, black, tan), with seams of gravel and varying degrees of silt. Below the sand in some locations, a clayey till was found. In most cases, the sand transitioned into a weathered bedrock zone and then solid bedrock (gneiss).

The following is a list of the sample borings, their respective total depths, and approximate locations in relation to injection borings.

SB-1: 32.5 ft bgs; 9 feet South of IB-11
SB-2: 32.5 ft bgs; Between IB-5 & 6, 7 feet off each
SB-3: 44 ft bgs; Between IB-4 & 8, 7 feet off each
SB-4: 38 ft bgs; Between IB-2 & 3; 7 feet off each
SB-5: 40.5 ft bgs; 9 feet off of IB-1 towards IB-2
SB-6: 32.5 ft bgs; 10 feet North of IB-3 towards IB-7
SB-7: 28.5 ft bgs; 9 feet West of IB-12 out of grid
SB-8: 20 ft bgs; Between IB-9 & 10, South 5 feet
SB-9: 46.5 ft bgs; 10 feet West of IB-4 out of grid

The location of these soil borings in relation to the injection locations was mapped out by D&B personnel on January 26th, 2009.

Visual identification of iron was possible in some cores where the iron appeared as a solid mass embedded in the soil matrix or as seams or lenses in the native material. Some cores appeared to display no iron during visual field observations. Utilizing a magnet, iron particles were removed from the formation matrix in a number of cores where iron was not visible to the naked eye. Random grab samples were collected to verify that the magnetic material was indeed iron powder and not a naturally occurring magnetic mineral, as well as to determine an iron to soil mass ratio.

After extraction and comparison with samples of pure HC-15 ZVI, it was confirmed that the magnetic material identified in the cores was iron powder. The soil mass to iron ratio observed in the samples was approximately 0.35 to 0.6 % iron.

The following is a brief summary of the core logs for each sample boring.

SB-1:
Several large seams and small stringers of iron visually identified starting at 9 ft bgs to a depth of 32.5 ft bgs.

SB-2
No visible iron present. Iron particles removed from soil matrix between 9 – 26 ft bgs.

SB-3
Two seams of iron visually identified at 17 ft bgs and 28.5 ft bgs. Iron particles removed from soil matrix between 4 ft bgs and 36 ft bgs.

SB-4
No visible iron present. Iron particles removed from matrix between 6 ft bgs and 9 ft bgs, 11.5 ft bgs and 14 ft bgs, 20 ft bgs and 36 ft bgs.

SB-5
Several seams and small stringers of iron visually identified starting at 3 ft bgs. Iron particles removed from soil matrix in multiple locations.

SB-6
Iron seam visually identified at 2.5 ft bgs. Iron particles removed from soil matrix between 9 ft bgs and 14 ft bgs, 18 ft bgs and 32.5 ft bgs.

SB-7
No visible iron present. Iron particles removed from soil matrix between 4 ft bgs and 28.5 ft bgs.

SB-8
No visible iron present. Iron particles removed from soil matrix between 9ft bgs and 20 ft bgs.

SB-9
No visible iron present. I iron particles removed from soil matrix between 8 ft bgs and 40 ft bgs.

Technical Memorandum

<u>Extraction of Suspected Iron Powder Embedded in Core Samples</u>

Farrand Controls, Valhalla, New York

Geology:

Fine to coarse grained sand for the majority of cores, alternating in color. Bedrock was weathered gneiss that transitioned into competent rock.

Background:

While visually examining the cores as they were taken, seams of iron powder (that could be differentiated from native material with the naked eye) were observed in several cores. The majority of cores did not indicate the presence of iron based upon a visual observation. A magnet was utilized in the field in an attempt to locate iron powder that had been distributed in the formation matrix. Varying amounts of what appeared to be iron was removed by the magnet from most of cores taken. In order to better ascertain whether or not this is indeed the iron powder ARS Technologies emplaced, or perhaps a naturally occurring magnetic mineral, three grab samples of the formation were taken in order to extract the magnetic material and have it analyzed.

Sample #1 – Soil Boring #3, 9 – 14 ft bgs, Between IB-4 & 8, 7 feet off each
Sample #2 – Soil Boring #3, 24 – 29 ft bgs
Sample #3 – Soil Boring #4, 9 – 14 ft bgs, Between IB-2 & 3, 7 feet off each

Experimental Procedure:

The samples were massed prior to any other step. The sample will then be passed through sieves to separate the material into different sizes.

Sieve #8 was used to remove coarse gravels. Sieve #100 and #200 was used to determine if the magnetic material is of a particular size that would be consistent with the production specifications of the iron powder injected.

After the Sample was sieved, each sieve sample was massed. Then, each sieve sample was passed down a shoot with two magnets mounted beneath it. The magnets removed the magnetic material from the sand stream and retained it. Each sieve sample was passed through the shoot multiple times in order to remove as much of the magnetic material as possible. The magnetic material was then massed for each sieve sample. Samples of the magnetic material was examined and compared to samples of pure iron powder.

Results:

After extracting the magnetic material from the soil matrix, a sample of pure HC-15 Zero Valent Iron was used as a mean of comparison. The following images show the extracted samples, as well as the HC-15 sample.

Figure 1: Sample 1

Figure 2: Sample2

Figure 3: Sample 3

Figure 4: HC-15 Sample

Figure 5: Visual Comparison

Visual comparison of the samples indicated that the material extracted from the soil samples was nearly identical in color and consistency.

A magnetic field was then applied to each sample and the following images show the results. The material extracted from the samples behaved in exactly the same manner as the HC-15 sample becoming polarized in response to the induced magnetic field.

Figure 6: HC-15

Figure 7: Sample 1

Figure 8: Sample 2

Figure 9: Sample 3

Based upon the visual comparison of the extracted material and pure HC-15 ZVI, as well as the lack of a known magnetic material present in the formation, it can be concluded that the magnetic material extracted from the samples is iron powder.

Measurements of mass were taken on the samples during extraction and Table 1 summarizes the mass ratio data collected.

Table 1:

Sample	Total Mass (g)	Iron Mass (g)	Soil Mass / ZVI Ratio (%)
Sample 1	276.32	0.967	0.35%
Sample 2	272.49	0.84	0.31 %
Sample 3	270.39	1.21	0.44 %

Note – Once extracted, all magnetic material based through a 200 sieve indicating that ZVI particle size was less than 74 microns.