

**BIO-PULSE AIR SPARGING EVALUATION**

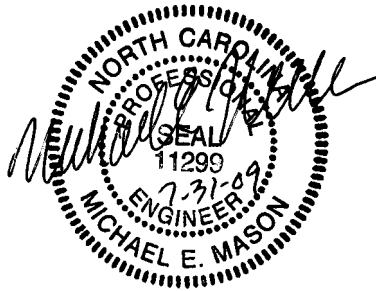
**FOR**

**HADNOT POINT FUEL FARM  
MARINE CORPS BASE  
CAMP LEJEUNE, NORTH CAROLINA**

**NC DENR UST INCIDENT NOS.: 3671, 10615 and 22788**

**JULY 31, 2009**

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**PREPARED BY:**

**CATLIN ENGINEERS AND SCIENTISTS  
P. O. BOX 10279  
WILMINGTON, NORTH CAROLINA 28404-0279  
(910) 452-5861**

**NC ENGINEERING LICENSE NO.: C-0585**

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**1.0 PURPOSE AND AUTHORIZATION**

The purpose of this report is to evaluate operational changes to the Hadnot Point Fuel Farm (HPFF) bio-pulse air sparging system based on data collected during the seventh, eighth, ninth, and tenth rounds of bio-pulse air sparge events performed by Shaw Environmental, Inc. (Shaw). An additional purpose of this report is to evaluate the groundwater quality data collected by Shaw as part of the semi-annual monitoring activities at the site. This evaluation and report was authorized by NAVFAC Mid-Atlantic, in accordance with Contract No. N62470-05-D-6200 Delivery Order No. 0044.

**2.0 SCOPE OF WORK**

The scope of work for this project included:

- Obtain air sparging duration and air flow rate data for the seventh, eighth, ninth, and tenth rounds of bio-pulse air sparge events from Shaw;
- Evaluate injection data;
- Evaluate laboratory analytical results from the latest groundwater sampling events performed by Shaw;
- Make operational recommendations to increase the effectiveness of the bio-pulse air sparging system operation.

The former Hadnot Point Fuel Farm is located in the industrial area of Marine Corps Base Camp Lejeune and is shown on Figure 1. Figure 2 illustrates the active remediation systems at the site including the location of the twenty five (25) bio-pulse air sparge wells. The overall HPFF remediation system includes aggressive fluid vapor recovery (AFVR) of free-phase product, a shallow Air Sparging and Soil Vapor Extraction (AS/SVE) system along with a deeper Biosparge system for dissolved-phase groundwater remediation. In addition, there is a groundwater recovery system that focuses on containment of the dissolved-phase contaminant plume by withdrawal of groundwater from the high permeability zone found from approximately 55 to 75 feet below land surface. The overall remediation system is described in the *Revised Corrective Action Plan* dated June 13, 2003. This report focuses mainly on the bio-pulse air sparging component of the remediation system in place at the HPFF site.

## 3.0 BACKGROUND

### 3.1 INITIAL BIO-PULSE AIR SPARGING

From September 28, 2006 through November 10, 2006 Shaw performed the first round of pilot test bio-pulse air sparging. The intent of this first round, and subsequent rounds was to sparge the outer-most wells away from the center of the dissolved contaminant plume and work toward the plume core.

As recommended in the *Revised Corrective Action Plan*, prepared by CATLIN Engineers and Scientists (CATLIN), dated June 2003, each of the initial sparging events was performed for a duration of twenty-four (24) hours. During each event, the injection pressure was kept constant (95 psi) and the flow was allowed to continually increase until pulse termination. Air flow measurements were taken and recorded on a two hour basis during each sparging event.

After initiation of the bio-pulse event on BP-13 on November 8, 2006, elevated Flame Ionization Detector (FID) readings were noted in the breathing zone at the north end of Building 1101 emanating from cracks in the concrete floor and from expansion joints around columns. An odor (presumably petroleum) was also noted. Similar findings were noted by Shaw on November 9, 2006 and again on November 13 and 14, 2006 and continued to be noted for at least a month after the pilot test sparge event.

Following discovery of the elevated FID readings and the conclusion of the initial round of sparging, CATLIN prepared a report, *Operational Addendum to Corrective Action Plan*, that recommended installation of a vapor extraction system within Building 1101 similar to those installed in other buildings on-site. In addition, CATLIN recommended modifying the duration of each bio-pulse air sparge event based on an evaluation of the air injection rate versus time graphs.

Based on the results of the first round of bio-pulse air sparging CATLIN proposed the following operational modifications:

- Modification of pulse durations based on observed departures from normal flow versus time curve geometry.
- Utilization of a continuous flow meter with recorder to develop an air flow versus time graph for each individual sparge well.
- Evaluate the improved flow versus time graphs and recommend adjustments in the duration prior to each pulse event.
- Continue to collect vapor readings within Building 1101 and other buildings within the assumed influence of the sparging events.
- Prepare a summary report after each round of sparging and make specific recommendations for the next pulse event at each of the twenty-five (25) sparging wells.

### **3.2 SECOND ROUND OF BIO-PULSE AIR SPARGING**

The second round of bio-pulse air sparging was performed by Shaw between April 17, 2007 and June 14, 2007. During this round, air was injection for durations generally consistent with CATLIN's recommendations in the Operational Addendum report. In addition, prior to beginning the second round of bio-pulse air sparging, Shaw installed and initiated the proposed vapor extraction system within Building 1101.

During each event, the injection pressure was kept constant (95 psi) and the flow was allowed to continually increase until pulse termination. Shaw personnel manually adjusted the pressure periodically if it varied from 95 psi during an event. Air flow measurements were taken and recorded using either an Oripac continuous flow meter with recorder or at one hour intervals using variable area flow meters. Air flow versus time graphs were created for each individual bio-pulse air sparge well. During this round, data from wells BP-1, BP-7, BP-10, BP-12, BP-21, BP-23 and BP-24 was obtained from a variable area flow meter. Data from all other wells was obtained and recorded using an Oripac continuous flow meter.

During collection of the data, a wiring problem was discovered with the Oripac flow meter and pressure differential transmitter resulting in unusable air flow data for wells BP-2, BP-4, BP-14, BP-15, BP-19, and BP-22. Following correction of the wiring, usable data for all subsequent injection events was obtained. In addition, while injecting air into wells BP-18 and SP-100 the system compressor shut down due to high temperatures. The pulse durations for both of these wells was extended to account for the time when the system was shut down.

### **3.3 THIRD ROUND OF BIO-PULSE AIR SPARGING**

The third round of the bio-pulse air sparging was conducted by Shaw from June 18, 2007 to July 27, 2007. During this round, air was injected into each sparge well in general accordance with recommendations made by CATLIN prior to the second round of sparging.

During each event, the injection pressure was kept constant at 95 psi and the flow was allowed to continually increase until pulse termination. Shaw personnel manually adjusted the pressure if at any time it varied from 95 psi during an event. Air flow measurements were recorded using an Oripac continuous flow meter. Data obtained was used to develop an air flow versus time graph for each individual bio-pulse air sparge well.

When injecting air into bio-pulse air sparge wells BP-5, BP-9, BP-18, BP-21, BP-24, and SP-100, the compressor shut down due to high temperatures. The site was experiencing high ambient temperatures at the time of these events. The pulse durations for the bio-pulse air sparge events for the above mentioned wells were extended to account for the time when the system was shut down.

Upon review of the second and third rounds of bio-pulse air sparging and subsequent sampling event, CATLIN noted that it appeared that the air flow versus time graph did not indicate that the dewatered volume was reaching “breakthrough” or the lower boundary of the 75 feet deep high permeability zone (HPZ) as proposed in the *Revised Corrective Action Plan*, dated June 2003. If the “dewatered volume” was reaching the lower boundary of the 75 feet deep HPZ you could expect an increase in air flow as the sparge air breaks into or short circuits into the HPZ. Consequently, an anomaly or a diversion in the air flow versus time graph would be evident. Based on our review of the air flow versus time graphs there were no obvious changes in air flow that would indicate this “breakthrough”. A review of the laboratory analytical data suggested evidence that the bio-pulse air sparging in conjunction with the existing AS/SVE, biosparging and pump and treat systems was aiding in the reduction of dissolved Benzene within the groundwater at the site.

After evaluating the first three rounds of bio-pulse air sparging, CATLIN made the following recommendations in a report, *Bio-Pulse Air Sparging Evaluation*, dated October 11, 2007:

- Modification of pulse durations based on total volume of air injected as an indicator of safe termination times.
- Continue the sparge sequence from the outer-most wells and work toward the dissolved contaminant plume core.
- Continue to collect vapor readings at a reduced frequency within Building 1101 and other buildings within the assumed influence of the sparging events.
- Perform groundwater sampling on a semi-annual basis in order to help gauge the effectiveness of the existing remediation systems on site.
- Prepare a summary report after the next semi-annual sampling event and make specific recommendations for the subsequent rounds of bio-pulse air sparging.
- Insure injection pressures are kept constant at 95 psi, by verifying every thirty minutes and adjusting as necessary.

### **3.4 FOURTH, FIFTH AND SIXTH ROUNDS OF BIO-PULSE AIR SPARGING**

The fourth, fifth and sixth rounds of bio-pulse air sparging were performed by Shaw between November 1, 2007 and December 12, 2007; January 3, 2008 and February 15, 2008; and between March 10, 2008 and April 12, 2008, respectively. During these rounds, air was injection for durations generally consistent with recommendations made by CATLIN in the *Bio-Pulse Air Sparging Evaluation*, dated October 11, 2007.

During each event, the injection pressure was kept constant (95 psi) and the flow was allowed to continually increase until pulse termination. Shaw personnel manually adjusted the pressure periodically if it varied from 95 psi

during an event. Air flow measurements were taken and recorded using an Oripac continuous flow meter with recorder. Pulse durations, maximum injection flow rates, and total injection volumes for each bio-pulse air sparge well used during these rounds are presented in Table 1.

While injecting air into bio-pulse air sparge wells BP-18 during the fourth cycle and BP-24 during the fifth cycle the compressor shut down due to high temperatures. The pulse durations for the bio-pulse air sparge events for the above mentioned wells were extended to account for the time when the system was shut down.

After evaluating the fourth, fifth and sixth rounds of bio-pulse air sparging, CATLIN made the following recommendations in a report, *Bio-Pulse Air Sparging Evaluation*, dated June 23, 2008:

- Modification of pulse durations based on total volume of air injected as an indicator of safe termination times.
- Continue the sparge sequence from the outer-most wells and work toward the dissolved contaminant plume core.
- Continue to collect vapor readings at a reduced frequency within Building 1101 and other buildings within the assumed influence of the sparging events.
- Perform groundwater sampling on a semi-annual basis in order to help gauge the effectiveness of the existing remediation systems on site.
- Prepare a summary report after the next semi-annual sampling event and make specific recommendations for the subsequent rounds of bio-pulse air sparging.
- Insure injection pressures are kept constant at 95 psi, by verifying every thirty minutes and adjusting as necessary

#### **4.0 SEVENTH, EIGHTH, NINTH AND TENTH ROUNDS OF BIO-PULSE AIR SPARGING**

The seventh, eighth, ninth and tenth rounds of bio-pulse air sparging were performed by Shaw between May 2008 and July 2008; August 2008 and September 2008; November 2008 and February 2009; and between March 2009 and April 2009, respectively. During these rounds, air was injection for durations generally consistent with recommendations made by CATLIN in the *Bio-Pulse Air Sparging Evaluation*, dated June 23, 2008.

During each event, the injection pressure was kept constant (95 psi) and the flow was allowed to continually increase until pulse termination. Shaw personnel manually adjusted the pressure periodically if it varied from 95 psi during an event. Air flow measurements were taken and recorded using an Oripac continuous flow meter with recorder. Air flow rate versus time graphs were created for each individual bio-pulse air sparge well. Air flow versus time graphs for the seventh, eighth, ninth and tenth rounds of bio-pulse air sparging are provided in Appendices A, B, C, and D, respectively. Pulse

durations, maximum injection flow rates, and total injection volumes for each bio-pulse air sparge well used during these rounds are presented in Table 1.

During the seventh round of bio-pulse air sparging, wells BP-3, BP-10, BP-11, BP-14, and BP-23 each had two dates where bio-pulse air sparging was performed; therefore, two air flow rate versus time graphs were created for each of these. In addition, data files obtained while injecting into bio-pulse sparge wells BP-3, BP-7, BP-9, BP-20, BP-23, and BP-24 were identified as containing "incomplete data blocks" due to each recording having been interrupted; however, the data obtained from these wells were accessible and therefore, used to create air flow rate versus time graphs and used to evaluate system performance

No data from sparge wells BP-3, BP-9, and BP-13 were received from Shaw for the eighth round of bio-pulse air sparging events and therefore, no air flow rate versus time graphs were created for these wells. In addition data files obtained while sparging at wells BP-7, BP-19, and BP-23 were identified as containing "incomplete data blocks"; however, the data obtained from these wells were accessible and therefore, used to create air flow versus time graphs and used to evaluate system performance.

For the ninth bio-pulse air sparging event, no data was available for wells BP-9, BP-10, BP-19 and BP-23; therefore, no air flow rate versus time graphs were created for these wells. In addition, no data was available for wells BP-10, BP-11, or BP-19 for the tenth bio-pulse air sparging event and no air flow rate versus time graphs were created for these wells.

## **5.0 GROUNDWATER QUALITY DATA**

Shaw completed groundwater sampling events in October/November 2008 and March 2009. During the October/November 2008 sampling event, all accessible monitoring wells were analyzed per EPA Method 8260B. During the March 2009 sampling event, twenty-nine (29) shallow (Type II) wells, six (6) wells with a depth of 50 feet, three (3) wells with depths ranging from 70 to 90 feet, and two (2) wells that have depths of greater than 100 feet were sampled and analyzed for EPA Method 8260B parameters.

### **5.1 DISSOLVED BENZENE - TYPE II WELLS**

Laboratory analysis of the groundwater samples collected during the October/November sampling event revealed thirty-seven (37) wells out of seventy eight (78) wells sampled contained dissolved Benzene concentrations above the North Carolina Administrative Code (NCAC) T15A:02L Groundwater Quality Standards (2L GWQS) of 1 ug/L. During the March 2009 sampling event, laboratory analysis of the groundwater samples collected revealed twenty-nine (29) wells containing dissolved Benzene concentrations above the 2L GWQS of 1 ug/L. The dissolved Benzene concentrations, from both the most recent event and historical events, are summarized in Table 2. The shallow Benzene plumes from the

October/November 2008 and March 2009 sampling events are illustrated on Figures 3A and 3B, respectively.

A review of the historic laboratory results from the shallow Type II monitoring wells indicates an overall trend of declining Benzene concentrations in the shallow groundwater. In addition, a majority of the shallow wells that were sampled in March 2009 showed a decline in Benzene concentrations as compared to the October/November 2008 data. The most dramatic reduction in Benzene concentrations are noted in the groundwater samples from monitoring wells IR78-GW22-1, USTHPFFC-MW20, and USTHPFFC-MW29, which decreased from 9,680 µg/L to 1,780 µg/L, 6,810 µg/L to 4,560 µg/L, and 15,000 µg/L to 8,740 µg/L, respectively.

There were eleven groundwater samples where the Benzene concentration increased from October/November 2008 to March 2009. The most dramatic increase in Benzene concentrations are noted in the groundwater samples from monitoring wells UST1115GT-MW06, USTHPFFC-MW19, USTHPFFC-MW22 and USTHPFFC-MW28, which increased from 1,770 µg/L to 4,000 µg/L, 8,790 µg/L to 12,900 µg/L, 532 µg/L to 2,590 µg/L, and 6,520 µg/L to 9,080 µg/L, respectively. As can be seen on Figure 3A, there has been an overall reduction in the size of the dissolved-phase Benzene plume as compared to the plume in 2003 when the last comprehensive sampling event was conducted.

## **5.2 DISSOLVED BENZENE - WELLS 50 FEET DEEP**

Laboratory analysis of the groundwater samples collected from wells 50 feet deep revealed nine (9) of the twenty eight (28) wells containing dissolved Benzene concentrations above the 2L GWQS from the October/November 2008 sampling event and six (6) wells from the March 2009 sampling event. The dissolved Benzene concentrations, from both the most recent event and historical events, are summarized in Table 2. The October/November 2008 and March 2009 Benzene plumes as they pertain to wells 50 feet deep are illustrated on Figures 4A and 4B, respectively.

As noted within the shallow groundwater, dissolved Benzene concentrations in monitoring wells 50 feet deep also show a general declining trend. The highest concentrations were noted in monitoring wells UST1115-MW20 at 7,670 µg/L and 14,300 µg/L (Oct/Nov 2008 and March 2009), USTHPFFC-MW08 at 7,270 µg/L (Oct/Nov 2008), and USTHPFFC-MW60 at 7,660 µg/L (March 2009). Laboratory analysis from samples collected from monitoring wells UST1115-MW20 and USTHPFFC-MW60 revealed Benzene concentrations increased from 7,670 µg/L to 14,300 µg/L and 956 µg/L to 7,660 µg/L, respectively. As illustrated on Figure 4A, the overall dissolved-phase Benzene plume as of October/November 2008 is significantly reduced in comparison to the plume in 2003.

### 5.3 DISSOLVED BENZENE - WELLS 70-90 FEET DEEP

Laboratory analysis of the groundwater samples collected from monitoring wells 70-90 feet deep revealed five (5) out of eighteen (18) wells containing dissolved Benzene concentrations above the 2L GWQS during the October/November 2008 sampling event and three (3) wells during the March 2009 sampling event. A maximum concentration of 797 µg/L was detected during the March 2009 sampling event in the sample from USTHPFFC-MW45. The dissolved Benzene concentrations, from both the most recent event and historical events, are summarized in Table 2. The October/November 2008 and March 2009 Benzene plumes as they pertain to wells 70 to 90 feet deep are illustrated on Figures 5A and 5B, respectively.

A review of the recent historical laboratory results indicates a slight increase in Benzene concentrations in the three wells sampled in March 2009. Monitoring wells IR78-GW32-02, UST1115-MW22, and USTHPFFC-MW45 had Benzene concentrations which increased from 13.3 µg/L to 23.5 µg/L, 305 µg/L to 314 µg/L, and 614 µg/L to 797 µg/L, respectively. As shown on Figure 5A, there has been a significant reduction in the overall dissolved-phase Benzene plume since 2003.

### 5.4 DISSOLVED BENZENE - WELLS GREATER THAN 100 FEET DEEP

During the October/November 2008 sampling event, laboratory analysis revealed four (4) out of eleven (11) wells containing dissolved Benzene concentrations above the 2L GWQS. Only two (2) groundwater samples were collected from monitoring wells greater than 100 feet deep during the March 2009 sampling event and one of the wells (USTHPFFC-MW12) contained dissolved Benzene concentrations above the 2L GWQS of 1 µg/L. The sample from monitoring well USTHPFFC-MW12 contained a concentration of 2,750 µg/L dissolved Benzene, which is an increase from 56.8 µg/L detected during the October/November 2008 sampling event. The dissolved Benzene concentrations, from both the most recent event and historical events, are summarized in Table 2. The October/November 2008 and March 2009 Benzene plumes as they pertain to wells greater than 100 feet deep are illustrated on Figures 6A and 6B, respectively.

## 6.0 INJECTION DURATION RECOMMENDATIONS

In the *Operational Addendum to Corrective Action Plan*, CATLIN recommended the optimum safe termination time for each air pulse based on the air flow versus time graphs from the first bio-pulse cycle. CATLIN then evaluated the second through sixth bio-pulse cycles, including the air flow versus time graphs, total air injected versus time graphs, and groundwater analytical data results. Based on CATLIN's understanding of the data at that time, it appeared that the air flow versus time graph did not indicate that the dewatered volume was reaching "breakthrough" or the lower boundary of the 75 feet deep high HPZ as proposed in the *Revised Corrective Action Plan*, dated June 2003. However, a review of the laboratory analytical data suggested evidence that the bio-pulse air sparging in conjunction

with the existing AS/SVE, biosparging and pump and treat systems was aiding in the reduction of dissolved Benzene within the groundwater at the site. Based on these observations, CATLIN used the total volume of injected air as an indicator of the safe termination time for each bio-pulse cycle. The average volume of air injected during the bio-pulse cycles was calculated and used as a target for “low flow” wells. Specifically, if the injected volume during a bio-pulse event was well below the calculated average, CATLIN recommended increasing the bio-pulse duration. Conversely, if a bio-pulse well had a total injected volume greater than 100,000 cubic feet; CATLIN recommended reducing the bio-pulse cycle duration at these wells to limit the amount of injected air to approximately 100,000 cubic feet. The 100,000 cubic feet of air was calculated as a conservative theoretical volume that would produce a dewatered sphere with a radius approximately equivalent to the design radius but safely below “breakthrough”.

In addition, concurrent to the sixth bio-pulse cycle, CATLIN reviewed laboratory analytical results from the subsequent sampling event. Review of this data indicated an overall reduction in the dissolved contaminant plume size; however, in some areas the reduction in dissolved contaminant concentrations was minimal or none. Closer inspection revealed that these areas were in the general vicinity of bio-pulse air sparge wells which were receiving volumes of air well below the average. Based on these observations, CATLIN made recommendations to increase pulse durations at wells with below average injection volumes while continuing to decrease pulse durations at wells receiving greater than 100,000 cubic feet of air per event.

As was done previously, CATLIN reviewed air flow versus time graphs created from data obtained during the seventh, eighth, ninth, and tenth rounds of bio-pulse sparging as well as laboratory analytical results from the October/November 2008 and March 2009 sampling events. Air flow data analysis included identifying bio-pulse sparge events that were performed for the prescribed pulse durations recommended in the *Bio-Pulse Air Sparging Evaluation* report dated June 23, 2008. All events that were either extended or shortened by more than 20% were considered non-representative and therefore not used to calculate the average injected volume. Based on this set of data, an average injection volume of approximately 61,200 cubic feet of air was calculated for the seventh through tenth cycles. In addition, the average volume of air injected during the seventh through tenth sparge cycle was calculated for each individual bio-pulse sparge well. These average volumes were then compared to the overall average and any well whose average injected volume during these cycles was less than 50% of the overall average (approximately 30,600 cubic feet) became a primary candidate for increased pulse duration. In addition, the previously imposed 100,000 cubic feet maximum volume was maintained. However, an evaluation of current groundwater quality and apparent treatment system effectiveness was also considered prior to making final recommendations.

All bio-pulse air sparge wells identified as candidates for increased injection durations were evaluated based on their location in proximity to dissolved groundwater contamination. Specifically, bio-pulse air sparge wells in areas of minimal dissolved groundwater contamination were removed from the list of

candidates. In addition, while performing this evaluation a number of wells located in areas of lower groundwater contamination levels were flagged as candidates for reduced pulse durations.

After completing the evaluation of the first ten bio-pulse air sparge cycles, the following recommendations are proposed:

1. CATLIN recommends the following modified pulse durations:

<b>No.</b>	<b>Well</b>	<b>Pulse Duration (min.)</b>
1	BP-1	<b>360 (-60)</b>
2	BP-21	360
3	BP-12	<b>420 (-60)</b>
4	BP-7	<b>480 (-120)</b>
5	BP-24	480
6	BP-4	300
7	BP-15	420
8	BP-22	300
9	BP-2	180
10	BP-14	<b>240 (+60)</b>
11	BP-19	200
12	BP-10	540
13	BP-23	<b>240 (-60)</b>
14	BP-9	<b>560 (+60)</b>
15	BP-11	300
16	BP-20	200
17	BP-5	<b>600 (-30)</b>
18	SP-100	480
19	BP-16	<b>600 (-210)</b>
20	BP-6	300
21	BP-17	<b>360 (+60)</b>
22	BP-8	<b>840 (-140)</b>
23	BP-13	120
24	BP-18	420
25	BP-3	<b>480 (-120)</b>
26*	SP-100	480
27*	BP-17	360
28*	BP-21	360
29*	BP-15	420
30*	BP-14	240

Bold indicates recommended pulse duration, number in parentheses indicates amount of increase/decrease from last bio-pulse event.

\* Five bio-pulse air sparge wells were selected based on their close proximity to source zone contamination to be pulsed twice during each cycle.

2. Continue the sparge sequence from the outer-most wells and work toward the plume core.

3. Continue to collect vapor readings within Building 1101 and other buildings within the assumed influence of the sparging events.
4. Continue the sampling events semi-annually; however, adjust the frequency of comprehensive groundwater sampling events (sampling all wells) to bi-annually. The next comprehensive sampling event should be performed in the third quarter of 2010. The remaining semi-annual events should consist of sampling selected monitoring wells. During these events, groundwater samples should be collected for EPA Method 602 analysis only.
5. Continue maintaining injection pressures at a constant at 95 psi, this pressure should be verified every thirty (30) minutes and adjusted as necessary.

## 7.0 REFERENCES

CATLIN Engineers and Scientists, *Revised Corrective Action Plan (CAP) for Hadnot Point Fuel Farm, Marine Corps Base, Camp Lejeune, North Carolina*, June 13, 2003.

CATLIN Engineers and Scientists, *Operational Addendum to Corrective Action Plan for Hadnot Point Fuel Farm, Marine Corps Base, Camp Lejeune, North Carolina*, March 29, 2007.

CATLIN Engineers and Scientists, *Bio-Pulse Air Sparging Evaluation for Hadnot Point Fuel Farm, Marine Corps Base, Camp Lejeune, North Carolina*, October 11, 2007.

CATLIN Engineers and Scientists, *Bio-Pulse Air Sparging Evaluation for Hadnot Point Fuel Farm, Marine Corps Base, Camp Lejeune, North Carolina*, June 23, 2008.

## TABLES

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**TABLE 1  
BIO-PULSE AIR SPARGE INJECTION DATA**

**HADNOT POINT FUEL FARM**

Bio-Pulse Sparge Well	First Cycle		Second Cycle		Third Cycle			Fourth Cycle			Fifth Cycle		
	Duration (min)	Max flow (cfm)	Duration (min)	Max flow (cfm)	Duration (min)	Max flow (cfm)	Total Volume (cf)	Duration (min)	Max flow (cfm)	Total Volume (cf)	Duration (min)	Max flow (cfm)	Total Volume (cf)
BP-1	1440	172	360	169	362	134	40,755	427	153	53,868	419	151	52,938
BP-2	1440	134			120	142	13,668	182	143	25,532	179	148	23,459
BP-3	1440	142	716	140	720	158	98,784	717	182	112,279	719	199	123,064
BP-4	1440	104			240	76	15,895	299	108	27,248	310	118	30,127
BP-5	1440	98.3	1426	175	1740	213	247,258	990	204	169,888	990	199	165,823
BP-6	1440	196.6	125	157	120	152	16,414	179	160	25,998	179	159	25,606
BP-7	1440	156	600	194	630	182	100,719	599	201	104,064	600	180	95,474
BP-8	1440	98.3	1447	126	1440	133	159,642	1,019	127	105,408	1,019	126	103,415
BP-9	1440	248.4	497	177	516	165	68,944	500	182	76,081	499	187	78,209
BP-10	1440	240	540	232	553	200	98,068	539	209	101,009	504	219	95,417
BP-11	1440	103.7	230	125	255	143	31,562	300	160	40,886	299	165	43,304
BP-12	1440	104	480	175	480	155	65,776	480	175	73,176	480	165	68,895
BP-13	1440	188	120	128	100	133	11,561	119	150	15,344	134	142	16,690
BP-14	1440	199			120	173	19,661	179	193	31,327	178	196	31,362
BP-15	1440	41			240	54	9,781	304	38	17,729	301	75	19,245
BP-16	1440	81.9	752	81	747	72	44,747	1,096	112	105,607	809	100	66,961
BP-17	1440	46.4	244	46	236	90	18,148	299	114	28,614	299	128	32,805
BP-18	1440	232.1	497	223	1080	254	72,438	477	212	87,468	429	236	85,328
BP-19	1440	205			140	52	6,315	202	61	9,905	212	58	11,024
BP-20	1440	65.5	141	63	150	92.9	12,720	203	93	17,294	200	125	22,058
BP-21	1440	186	370	93	435	230	77,031	359	222	71,350	366	225	72,943
BP-22	1440	60			255	89	19,865	315	107	29,103	299	111	29,086
BP-23	1440	237	240	246	325	229	66,347	299	223	62,557	307	218	62,680
BP-24	1440	213	480	246	525	230	102,259	479	228	100,312	587	248	107,298
SP-100	1440	218.4	487	180	791	209	94,115	479	198	80,652	480	187	75,639

Notes:

Max flow for first cycle is value recorded at proposed pulse duration for comparative purposes.

█ Indicates measurements were taken with VisiFlow Meter and later corrected

Blanks in Cycle 2 indicate missing (BP-14) data or faulty Flow Data (BP-2, BP-4, BP-15, BP-19 and BP-22)

VisiFlow Meter readings corrected using:  $Q2=Q1*((95+14.7)/14.7)^{(0.5)}$

**TABLE 1  
BIO-PULSE AIR SPARGE INJECTION DATA**

**HADNOT POINT FUEL FARM**

Bio-Pulse Sparge Well	Sixth Cycle			Seventh Cycle			Eighth Cycle			Ninth Cycle			Tenth Cycle		
	Duration (min)	Max flow (cfm)	Total Volume (cf)	Duration (min)	Max flow (cfm)	Total Volume (cf)	Duration (min)	Max flow (cfm)	Total Volume (cf)	Duration (min)	Max flow (cfm)	Total Volume (cf)	Duration (min)	Max flow (cfm)	Total Volume (cf)
BP-1	438	152.11	53,656	419	155.91	53,610	418	137.73	49,301	421	161.13	51,653	417	155.68	50,837
BP-2	179	145.24	23,097	295	230.86	20,910	251	136.54	30,947	217	107.23	21,644	218	130.17	25,409
BP-3	713	203.07	124,181	748	205.77	86,675				504	207.23	87,725	604	212.96	108,401
BP-4	299	114.42	28,975	297	116.07	28,793	419	128.07	44,749	295	103.43	26,462	201	133.28	20,780
BP-5	957	189.7	154,377	641	175.00	94,320	690	250.27	95,566	624	165.98	89,136	561	178.25	88,228
BP-6	219	176.88	34,587	338	177.56	53,887	316	256.36	49,812	365	186.31	59,915	212	192.86	38,362
BP-7	602	180.04	91,524	606	168.68	89,763	217	218.50	36,471	302	164.74	43,811	606	172.94	90,978
BP-8	1,010	157.14	126,001	983	143.09	117,857	984	147.85	117,143	1,028	164.79	134,889	980	158.65	125,964
BP-9	480	179.03	72,576	624	234.02	31,674							191	150.23	22,278
BP-10	539	220.7	105,039	1,072	211.08	190,851	542	200.73	97,404						
BP-11	301	163.51	42,602	486	171.20	47,352	303	168.36	43,604	288	171.93	41,937			
BP-12	421	155.45	55,269	430	375.05	53,505	473	216.71	46,786	487	148.17	56,056	302	116.44	28,074
BP-13	125	147.25	15,845	129	138.74	15,753				132	106.04	11,778	100	140.38	12,635
BP-14	179	189.06	31,061	385	187.59	62,690	189	188.92	33,234	149	51.60	7,012	170	176.10	27,800
BP-15	300	91.53	24,051	419	109.02	39,018	418	111.63	41,843	419	213.42	79,911	302	116.8	26,873
BP-16	814	134.39	96,013	809	97.66	68,282	811	169.96	122,320	625	105.04	61,274	201	86.17	16,035
BP-17	301	116.21	30,880	328	96.89	27,875	298	97.07	25,536	333	105.59	31,940	320	99.13	28,154
BP-18	419	241.03	88,343	421	210.94	80,327	512	196.52	94,070	420	186.95	73,000	448	240.16	99,814
BP-19	201	62.23	11,209	201	61.86	11,375	312	65.11	18,987						
BP-20	202	108.01	19,912	199	131.64	23,180	201	133.84	25,015	201	127.70	24,515	218	152.29	31,805
BP-21	368	222.62	72,253	359	215.75	70,068	406	191.12	40,925	357	214.79	62,405	368	185.16	62,345
BP-22	300	113.42	30,758	313	132.19	37,797	305	137.32	38,478	298	131.27	36,039	202	141.94	26,565
BP-23	298	231.59	63,157	522	282.46	93,830	201	262.45	36,384				295	212.13	60,087
BP-24	475	245.15	84,534	510	266.30	104,627	482	234.02	100,143	104	250.06	17,868	477	198.21	88,105
SP-100	476	193.04	80,219	493	164.29	72,046	477	193.18	74,666	488	182.88	79,467	484	188	82,426

Notes:

Blanks in Cycles indicate missing data or faulty Flow Data.

During the seventh cycle wells BP-3, BP-9, BP-10, BP-11, BP-14, BP-23 had two sparge events performed and the duration, and total volumes were added together from the two events.

min = minutes

cfm = cubic feet per minute

cf = cubic feet

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
UST1101-MW01	3-13	11/14/2000	BQL
		7/17/2002	<1
		8/16/2007 +	<1
		10/27/2008 +	<1
UST1101-MW02	3-13	11/13/2000	BQL
		10/27/2008 +	<1
UST1101-MW03	3-13	11/13/2000	BQL
		7/18/2002	<1
		10/27/2008 +	<1
UST1115-MW01	5-15	6/5/1997	1.3
		1/7/1999 +	310 B
		2/16/2000	BQL
		5/30/2000 +	<1.0
		11/13/2000	BQL
		1/24/2001 +	32
		7/29/2001 +	14
		2/2/2002 +	6
		8/5/2002 +	<1
		2/17/2003 +	187
		8/20/2003 +	<1
		2/21/2004 +	<1
		8/19/2004 +	17.7
		3/24/2005 +	3.8
		8/18/2005 +	<1
		1/23/2006 +	<1
		10/3/2006 +	163
8/21/2007 +	<1		
10/29/2008 +	<1		
UST1115-MW02	4-15	6/5/1997	0.9
		1/6/1999 +	29
		8/12/1999 +	53
		2/15/2000	BQL
		5/26/2000 +	<1
		11/13/2000	BQL
		1/24/2001 +	150
		7/29/2001 +	51
		2/2/2002 +	11.9
		8/6/2002 +	9.3
		2/19/2003 +	125
		8/19/2003 +	3.1
		2/25/2004 +	10.9
		8/19/2004 +	24.3
		3/22/2005 +	31.1
		8/18/2005 +	<1
		1/20/2006 +	14.9
10/2/2006 +	28.3		
8/23/2007 +	<1		
8/23/2007 + dup	<1		
10/24/2008 +	<1		

TABLE 2

**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
UST1115-MW03	5-20	6/5/1997	BQL
		2/15/2000	BQL
		11/13/2000	11
		10/27/2008 +	<1
UST1115-MW04	5-15	6/4/1997	BQL
		1/7/1999 +	190 B
		8/12/1999 +	28
		2/15/2000	BQL
		5/26/2000 +	<1
		11/13/2000	BQL
		1/23/2001 +	660
		7/27/2001 +	210
		2/2/2002 +	22.6
		8/7/2002 +	31.5
		2/19/2003 +	128
		8/19/2003 +	<1
		2/25/2004 +	16.8
		8/19/2004 +	31.5
		3/10/2005 +	42.7
		8/18/2005 +	0.63 J
1/20/2006 +	9.0		
10/2/2006 +	56.6		
8/22/2007 +	<1		
10/23/2008 +	<1		
UST1115-MW05	5-15	2/23/2000	1,500
		11/20/2000	1,900
		11/20/2000 dup	1,800
		10/24/2008	DRY
UST1115-MW06	5-20	6/4/1997	BQL
		2/22/2000	5
		11/13/2000	81
		11/13/2000 dup	67
10/23/2008 +	24		
UST1115-MW07	5-20	11/15/2000	3,000
		7/17/2002	6,000
		8/22/2007 +	6,230
		2/27/2008 +	4,250
		10/27/2008 +	2,180
3/12/2009 +	2,810		
UST1115-MW08	5-20	6/4/1997	BQL
		2/15/2000	BQL
		11/13/2000	BQL
		11/13/2000	BQL
		10/23/2008 +	<1

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
UST1115-MW09	5-20	6/4/1997	BQL
		2/15/2000	710
		11/14/2000	800
		7/18/2002	140
		7/18/2002 dup	150
		8/22/2007 +	120
		2/26/2008 +	107
		10/22/2008 +	125
		4/9/2009 +	460
UST1115-MW10	4-14	6/4/1997	3.1
		2/17/2000	11
		11/15/2000	200
		10/23/2008	3.7
UST1115-MW11	5-20	6/4/1997	BQL
		2/15/2000	150
		11/15/2000	140
		10/23/2008 +	57.6
UST1115-MW12	5-15	2/23/2000	4,200
		11/15/2000	2,000
		11/15/2000 dup	4,300
		10/23/2008 +	214
		3/11/2009 +	83.6
UST1115-MW13	46-51	6/4/1997	10,800
		1/7/1999 +	15,000 B
		8/12/1999 +	230
		2/17/2000	14,000
		5/26/2000 +	13,000
		11/20/2000	10,000
		1/24/2001 +	6,400
		7/29/2001 +	2,300
		2/2/2002 +	298
		8/12/2002 +	95.5
		2/19/2003 +	872
		8/20/2003 +	340
		2/24/2004 +	228
		8/25/2004 +	202
		3/22/2005 +	82.1
		8/17/2005 +	61.6
		1/23/2006 +	263
		10/3/2006 +	278
8/24/2007 +	78.5		
2/25/2008 +	40.8		
10/23/2008 +	<1		

TABLE 2

**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
UST1115-MW14	46-51	6/4/1997	11,760
		2/15/2000	120
		11/20/2000	300
		11/20/2000 dup	310
		7/18/2002	6,600
		7/18/2002	6,700
		8/22/2007 +	170
		2/25/2008 +	229
		10/23/2008 +	1,050
		3/10/2009 +	725
UST1115-MW15	46-51	6/4/1997	16,500
		2/23/2000	10,000
		11/20/2000	6,100
		7/18/2002	2,300
		8/24/2007 +	<1
10/23/2008 +	<1		
UST1115-MW17	45-50	6/4/1997	7,900
		1/7/1999 +	9,200
		8/12/1999 +	9,200
		2/15/2000	7,800
		5/26/2000 +	8,900
		11/13/2000	9,400
		2/23/2000	3,900
		1/23/2001 +	7,900
		7/27/2001 +	7,400
		2/2/2002 +	8,670
		8/7/2002 +	7,770
		2/19/2003 +	3,490
		8/19/2003 +	84.3
		2/25/2004 +	36.9
		8/19/2004 +	34.1
		3/10/2005 +	72.3
		8/18/2005 +	9.5
		1/20/2006 +	39.3
		10/2/2006 +	168
		8/22/2007 +	304
2/25/2008 +	442		
10/23/2008 +	494		
3/10/2009 +	372		

TABLE 2

**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
UST1115-MW18	45-50	6/5/1997	4,820
		1/6/1999 +	16,000
		8/12/1999 +	990
		2/22/2000	280
		5/26/2000 +	1,200
		11/13/2000	280
		1/22/2001 +	420
		7/29/2001 +	3.1
		2/2/2002 +	30.2
		8/7/2002 +	33.8
		8/20/2003 +	215
		3/2/2004 +	2,630
		3/22/2005 +	9.6 J
		1/25/2006 +	<1
		8/22/2007 +	5.5
2/26/2008 +	3.1		
10/21/2008 +	9.7		
UST1115-MW19	45-50	6/5/1997	13,900
		2/22/2000	15,000
		11/16/2000	2,200
		7/17/2002	2,400
		10/27/2008 +	<1
UST1115-MW20	45-50	6/5/1997	15,000
		2/23/2000	19,000
		11/16/2000	23,000
		7/18/2002	15,000
		8/20/2007 +	18,700
		2/27/2008 +	3,280
		10/27/2008 +	7,670
		3/11/2009 +	14,300
3/11/2009 dup +	14,100		
UST1115-MW21	45-50	6/5/1997	890
		1/6/1999 +	2,000
		8/12/1999 +	1,600
		2/15/2000	1,300
		5/26/2000 +	2,200
		11/13/2000	1,600
		1/24/2001 +	1,200
		7/29/2001 +	960
		2/2/2002 +	1,920
		8/6/2002 +	620
		2/19/2003 +	727
		8/19/2003 +	485
		2/25/2004 +	607
		8/19/2004 +	521
		3/10/2005 +	338
		8/18/2005 +	282
		1/20/2006 +	175
		10/2/2006 +	197
		8/23/2007 +	45.2
2/25/2008 +	1.7		
10/24/2008 +	<1		

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
UST1115-MW22	75-80	6/4/1997	1,640
		1/7/1999 +	460
		8/12/1999 +	1,100
		2/15/2000	890
		5/26/2000 +	900
		11/13/2000	1,100
		1/23/2001 +	940
		7/27/2001 +	700
		2/2/2002 +	1,250
		8/7/2002 +	<1
		9/4/2002 +	251
		2/19/2003 +	1,320
		8/19/2003 +	1,930
		2/25/2004 +	2,230
		8/19/2004 +	3,270
		3/10/2005 +	2,850
		8/18/2005 +	3,380
		1/20/2006 +	1,830
		10/2/2006 +	3,880
		8/22/2007 +	600
2/25/2008 +	174		
10/23/2008 +	305		
3/10/2009 +	314		
UST1115-MW23	75-80	6/5/1997	9,700
		1/6/1999 +	15,000
		8/12/1999 +	5,000
		2/22/2000	480
		5/26/2000 +	270
		11/13/2000	6
		1/22/2001 +	4.7 J
		7/29/2001 +	13
		2/2/2002 +	22
		8/5/2002 +	17.8
		2/18/2003 +	0.98 J
		8/20/2003 +	260
		2/21/2004 +	703
		8/19/2004 +	2,720
		3/24/2005 +	3,120
		8/19/2005 +	5,240
		1/23/2006 +	7,230
		10/2/2006 +	1,910
		8/22/2007 +	<5*
		10/21/2008 +	<2*

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
UST1115-MW24	75-80	6/5/1997	708
		1/6/1999 +	1,800
		8/12/1999 +	2,400
		2/15/2000	2,700
		2/15/2000 dup	2,800
		5/26/2000 +	3,200
		11/13/2000	3,100
		1/24/2001 +	2,700
		7/29/2001 +	2,900
		2/2/2002 +	2,480
		8/6/2002 +	3,060
		2/19/2003 +	4,120
		8/19/2003 +	3,990
		2/25/2004 +	4,100
		8/19/2004 +	3,630
		3/10/2005 +	1,030
		8/18/2005 +	3,120
		1/20/2006 +	1,750
		10/2/2006 +	2,250
		8/23/2007 +	4.4
2/25/2008 +	1.4		
10/24/2008 +	<1		
UST1115-MW25	75-80	6/4/1997	86
		1/7/1999 +	63 B
		8/12/1999 +	240
		2/22/2000	340
		5/26/2000 +	650
		11/20/2000	770
		1/24/2001 +	1,100
		7/29/2001 +	29
		2/2/2002 +	3.1
		8/12/2002 +	1,850
		9/4/2002 +	1,660
		2/19/2003 +	2,840
		8/22/2003 +	3,300
		2/24/2004 +	3,580
		8/25/2004 +	5,960
		3/22/2005 +	5,170
		8/17/2005 +	4,990
		1/23/2006 +	5,000
		10/3/2006 +	5,160
		8/24/2007 +	0.83 J
2/25/2008 +	3.9		
10/23/2008 +	27.7		
IR78-GW12	5-25	6/5/1997	BQL
		2/16/2000	BQL
		11/13/2000	BQL
		10/29/2008 +	<1

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
IR78-GW13	5-25	6/5/1997	BQL
		2/16/2000	BQL
		11/16/2000	BQL
		10/24/2008 +	4.8
IR78-GW14	5-25	6/5/1997	BQL
		2/16/2000	BQL
		11/13/2000	BQL
		10/29/2008 +	<1
IR78-GW15	5-15	6/5/1997	BQL
		2/16/2000	BQL
		11/13/2000	BQL
		10/24/08	NOT FOUND
IR78-GW16	5-25	6/5/1997	BQL
		2/15/2000	BQL
		11/13/2000	BQL
		10/28/2008 +	<1
IR78-GW17-01	5-25	6/5/1997	BQL
		2/15/2000	BQL
		11/16/2000	BQL
		10/29/2008 +	<1
IR78-GW17-02	53-73	2/22/2000	3
		11/15/2000	1
		11/15/2000 dup	1
		7/18/2002	2
		8/16/2007 +	9.8
		2/27/2008 +	9.4
		10/27/2008 +	<1
IR78-GW19	5-25	6/4/1997	BQL
		2/15/2000	BQL
		11/13/2000	25
		10/23/2008 +	<1
IR78-GW20	5-25	3/10/1987	<1
		5/28/1987	<1
		11/3/2008 +	<1
IR78-GW21	5-25	6/5/1997	BQL
		2/23/2000	BQL
		11/15/2000	BQL
		10/20/2008 +	<1
IR78-GW22-1	15-25	10/20/2008 +	9,680
		3/18/2009 +	1,780

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
IR78-GW22-02	7-17	6/5/1997	BQL
		1/6/1999 +	320
		8/12/1999 +	69
		2/23/2000	17
		5/26/2000 +	28
		11/13/2000	28
		1/22/2001 +	50
		7/27/2001 +	3.2
		2/2/2002 +	22.8
		8/5/2002 +	28.3
		2/17/2003 +	41.1
		8/20/2003 +	17.2
		2/21/2004 +	6.6
		8/19/2004 +	6.4
		3/24/2005 +	78.5
		8/18/2005 +	4.7
		1/23/2006 +	95.4
10/2/2006 +	98.3		
10/21/2008 +	101		
3/10/2009 +	75.8		
IR78-GW31-02	65-75	6/4/1997	BQL
		2/17/2000	BQL
		11/16/2000	BQL
		11/16/2000 dup	BQL
		8/28/2002	<1
		8/14/2007 +	<1
		10/29/2008 +	<1
IR78-GW31-03	140-150	6/4/1997	BQL
		2/17/2000	BQL
		11/16/2000	BQL
		8/28/2002	<1
		10/29/2008 +	<1
IR78-GW32-02	64-74	6/4/1997	64.2
		1/28/1999 +	170
		10/15/1999 +	<1
		2/18/2000	6
		7/20/2000 +	8.9
		11/14/2000	23
		1/13/2001 +	39
		7/22/2001 +	1.9
		2/9/2002 +	228
		8/14/2002 +	13.1
		2/21/2003 +	109
		8/25/2003 +	176
		2/23/2004 +	325
		9/13/2004 +	321
		4/6/2005 +	604
		8/18/2007 +	915
		3/3/2008 +	33.7
10/27/2008 +	13.3		
3/13/2009 +	23.5		

TABLE 2

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
IR78-GW32-03	140-150	6/4/1997	5.1
		1/28/1999 +	84
		10/15/1999 +	<1
		7/19/2000 +	25
		1/13/2001 +	7.3
		7/22/2001 +	98
		2/9/2002 +	2.7
		8/14/2002 +	124
		2/21/2003 +	7.1
		8/26/2003 +	0.64 J
		2/23/2004 +	20.9
		9/9/2004 +	28.9
		4/6/2005 +	8.2
		8/18/2007 +	74.6
3/3/2008 +	0.53 J		
10/27/2008 +	1.3		
UST1115GT-MW01	5-20	6/5/1997	BQL
		1/7/1999 +	310 B
		8/12/1999 +	8,300
		2/15/2000	14
		5/26/2000 +	13
		11/14/2000	120
		1/24/2001 +	25
		7/29/2001 +	12
		2/2/2002 +	4
		8/5/2002 +	0.88 J
		2/18/2003 +	80
		8/22/2003 +	<1
		2/21/2004 +	29.7
		8/25/2004 +	44.7
		3/24/2005 +	35.8
		8/17/2005 +	268
		1/23/2006 +	1,100
		10/3/2006 +	2,720
8/24/2007 +	<1		
10/23/2008 +	<1		
UST1115GT-MW02	5-20	2/17/2000	43,000
		11/14/2000	21,000
		10/23/2008	DRY
UST1115GT-MW03	5-20	6/4/1997	109
		2/17/2000	920
		11/14/2000	1,800
		10/23/2008 +	186 J
		3/11/2009 +	184
UST1115GT-MW04	5-20	6/4/1997	22
		2/17/2000	140
		11/15/2000	120
		11/7/2008 +	39
		3/11/2009 +	53.6

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
<b>2L GWQS (µg/L)</b>			<b>1</b>
UST1115GT-MW05	5-20	6/4/1997	4.2
		2/17/2000	20
		11/14/2000	7
UST1115GT-MW06	5-20	2/17/2000	8,400
		11/14/2000	4,000
		10/23/2008 +	1,770
		3/11/2009 +	4,000
UST1115GT-MW07	4-19	6/4/1997	BQL
		2/16/2000	540
		11/15/2000	1,000
		8/12/2002 +	2.9
		2/17/2003 +	205
		8/20/2003 +	235
		2/21/2004 +	0.74 J
		8/19/2004 +	37.9
		3/24/2005 +	11
		8/17/2005 +	22.7
		1/25/2006 +	421
		10/9/2006 +	220
		8/21/2007 +	0.65 J
		2/26/2008 +	71.0
10/21/2008 +	<1		
UST1115GT-MW08	4-19	6/4/1997	BQL
		2/16/2000	1
		11/13/2000	4
		7/18/2002	<1
		10/21/2008 +	<1
UST1115GT-MW09	5-20	6/4/1997	BQL
		2/16/2000	96
		11/13/2000	3
		8/7/2002 +	0.92 J
		2/21/2003 +	21.1
		8/20/2003 +	<1
		2/24/2004 +	<1
		8/27/2004 +	3.2
		3/22/2005 +	<1
		8/17/2005 +	<1
		1/23/2006 +	154
		10/2/2006 +	9.7
		8/22/2007 +	21.4
		2/26/2008 +	2.3
10/21/2008 +	16.7		

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFFC-MW01	5-15	12/1/1995	BDL
		6/4/1997	BQL
		1/27/1999 +	<1
		10/18/1999 +	5.4
		2/16/2000	BQL
		7/20/2000 +	2.2
		11/15/2000	BQL
		2/1/2001 +	42
		7/17/2002	<1
		8/13/2002 +	<1
		2/21/2003 +	32.3
		8/22/2003 +	<1
		2/13/2004 +	<1
		8/27/2004 +	3.8
		4/5/2005 +	<1
		8/20/2005 +	<1
		1/24/2006 +	<1
10/4/2006 +	26.3		
8/23/2007 +	<1		
8/23/2007 dup +	<1		
10/21/2008 +	<1		
USTHPFFC-MW02	5-15	12/1/1995	BDL
		6/4/1997	BQL
		2/15/2000	BQL
		11/16/2000	BQL
		7/18/2002	<1
		8/20/2007 +	<1
		8/20/2007 dup +	<1
10/21/2008 +	0.72 J		
USTHPFFC-MW03	6-16	12/1/1995	0.5
		6/5/1997	BQL
		2/17/2000	BQL
		11/15/2000	BQL
		7/18/2002	<1
		8/14/2007 +	<1
10/20/2008 +	<1		
USTHPFFC-MW04	5-15	11/30/1995	BDL
		6/5/1997	BQL
		2/16/2000	BQL
		11/13/2000	BQL
		10/30/2008	<1

TABLE 2

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFFC-MW05	5-15	12/1/1995	6.6
		6/5/1997	1.3
		2/17/2000	2
		11/14/2000	140
		7/17/2002	3
		8/14/2002 +	0.7 J
		2/21/2003 +	674
		8/25/2003 +	44.2
		2/13/2004 +	8.4
		8/27/2004 +	4.1
		4/5/2005 +	<1
		8/22/2005 +	<1
		1/24/2006 +	<1
		10/6/2006 +	156
		8/16/2007 +	<1
2/25/2008 +	3.9		
10/27/2008 +	<1		
USTHPFFC-MW06	45-50	11/30/1995	0.7
		6/5/1997	5.6
		2/18/2000	BQL
		11/20/2000	BQL
		7/18/2002	<1
		8/14/2007 +	0.76 J
		2/28/2008 +	14.1
10/20/2008 +	<1		
USTHPFFC-MW07	45-50	12/1/1995	320
		6/5/1997	41.5
		1/27/1999 +	79
		10/18/1999 +	63
		2/22/2000	13
		7/20/2000 +	23
		11/15/2000	6
		2/1/2001 +	13
		7/22/2001 +	4.2
		2/9/2002 +	24.9
		8/12/2002 +	1.6
		2/21/2003 +	9.5
		8/22/2003 +	0.79 J
		2/13/2004 +	<1
		8/27/2004 +	1.5
		4/5/2005 +	<1
		8/20/2005 +	<1
		1/24/2006 +	<1
10/4/2006 +	4.7		
8/23/2007 +	2		
2/26/2008 +	11.3		
10/21/2008 +	<1		

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFFC-MW08	45-50	11/30/1995	812.5
		6/5/1997	2,500
		1/28/1999 +	1,300
		10/18/1999 +	8,000
		2/22/2000	11,000
		7/24/2000 +	7,100
		11/15/2000	8,500
		1/13/2001 +	7,700
		7/22/2001 +	10,000
		2/9/2002 +	12,300
		8/13/2002 +	14,600
		2/21/2003 +	10,900
		8/25/2003 +	7,420
		2/20/2004 +	10,200
		8/31/2004 +	11,500
		4/13/2005 +	10,600
		8/31/2005 +	7,710
		1/24/2006 +	7,480
		10/6/2006 +	4,940
		8/15/2007 +	7,730
2/28/2008 +	2,760		
10/20/2008 +	7,270		
3/17/2009 +	6,240		
USTHPFFC-MW09	45-50	12/1/1995	8,170
		6/5/1997	10,500
		2/18/2000	18,000
		11/14/2000	17,000
		11/14/2000 dup	17,000
		7/17/2002	8,100
		8/14/2002 +	10,800
		2/21/2003 +	22,600
		8/22/2003 +	4,090
		2/13/2004 +	727
		8/27/2004 +	0.88 J
		4/5/2005 +	0.76 J
		8/22/2005 +	<5
		1/24/2006 +	<1
		10/6/2006 +	323
		8/16/2007 +	<1
		2/27/2008 +	15.9
2/27/2008 dup +	15.6		
10/27/2008 +	<1		
USTHPFFC-MW10	75-80	8/21/1997	168.0
		2/18/2000	1,400
		11/20/2000	2,000
		11/20/2000 dup	2,000
		7/17/2002	580
		8/16/2007 +	0.73 J
		2/28/2008 +	<1
		2/28/2008 dup +	<1
10/20/2008 +	0.56 J		

TABLE 2

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFFC-MW11	105-110	8/21/1997	25.9
		2/18/2000	130
		11/16/2000	59.0
		7/17/2002	370
		8/13/2002 +	809
		2/21/2003 +	489
		8/25/2003 +	348
		2/20/2004 +	114
		8/31/2004 +	89.6
		4/13/2005 +	<1
		8/20/2005 +	44.7
		1/24/2006 +	96.7
		12/1/2006 +	41.2
		8/15/2007 +	<1
10/20/2008 +	<1		
USTHPFFC-MW12	105-110	8/21/1997	51.8
		2/23/2000	1,500
		11/15/2000	1,600
		11/15/2000 dup	1,700
		7/17/2002	3,000
		8/20/2007 +	47
		2/27/2008 +	63.6
		10/21/2008 +	56.8
		3/17/2009 +	2,750
		3/17/2009 dup +	3,010
USTHPFFC-MW13	105-110	8/21/1997	14.7
		2/22/2000	150
		11/13/2000	180
		7/18/2002	160
		7/18/2002 dup	160
		8/24/2007 +	<1
		10/23/2008 +	99.9
		3/10/2009 +	<1
USTHPFFC-MW14	5-15	2/17/2000	1,400
		11/15/2000	1,400
		10/21/2008 +	38
		3/12/2009 +	21.9
USTHPFFC-MW15	5-15	8/20/1997	23,900
		8/16/2007 +	21,300
		10/20/2008 +	22,700
USTHPFFC-MW16	5-15	8/20/1997	BQL
		2/16/2000	19
		11/15/2000	580
		10/27/2008 +	77.8
		3/11/2009 +	21.7

TABLE 2

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFFC-MW17	5-15	8/20/1997	BQL
		2/16/2000	880
		11/16/2000	540
		10/27/2008 +	139
		3/12/2009 +	18.5
USTHPFFC-MW18	5-15	8/20/1997	BQL
		2/16/2000	WELL DAMAGED
USTHPFFC-MW19	5-15	8/20/1997	17,900
		1/28/1999 +	28,000
		10/15/1999 +	12,000
		2/23/2000	19,000
		7/26/2000 +	17,000
		11/14/2000	20,000
		1/13/2001 +	19,000
		7/22/2001 +	13,000
		2/9/2002 +	15,000
		8/13/2002 +	16,800
		2/18/2003 +	16,300
		8/27/2003 +	7,760
		2/14/2004 +	11,300
		9/8/2004 +	10,900
		4/18/2005 +	3,720
		1/24/2006 +	12,100
		10/6/2006 +	1,110
		8/20/2007 +	13,700
		8/20/2007 dup +	14,100
		2/27/2008 +	3,760
10/27/2008 +	8,790		
3/13/2009 +	12,900		
USTHPFFC-MW20	5-15	8/20/1997	4,850
		1/27/1999 +	2,600
		10/15/1999 +	3,400
		2/18/2000	13,000
		2/18/2000 dup	4,700
		7/20/2000 +	4,400
		11/15/2000	5,800
		2/1/2001 +	4,700
		7/22/2001 +	2,800
		2/9/2002 +	3,070
		8/14/2002 +	1,250
		2/18/2003 +	3,280
		8/27/2003 +	6,020
		2/20/2004 +	6,430
		9/8/2004 +	3,030
		4/18/2005 +	13,200
		8/31/2005 +	1,030
		1/24/2006 +	4,050
		10/4/2006 +	453
		8/14/2007 +	374
2/28/2008 +	3,210		
10/20/2008 +	6,810		
3/19/2009 +	4,560		

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFFC-MW21	5-15	1/28/2000	BQL
		11/16/2000	6
		10/21/2008 +	18.1
USTHPFFC-MW22	4-14	1/28/2000	11,000
		11/15/2000	11,000
		10/30/2008 +	532
		3/12/2009 +	2,590
USTHPFFC-MW23	3-13	1/28/2000	9,200
		11/16/2000	5,200
		10/27/2008 +	8.7
USTHPFFC-MW24	5-15	1/31/2000	3,600
		11/16/2000	1,700
		11/3/2008 +	126
		3/17/2009 +	25
USTHPFFC-MW25	5-15	1/28/2000	16,000
		11/16/2000	13,000
		10/24/2008	DRY
USTHPFFC-MW26	5-15	1/31/2000	5
		11/16/2000	BQL
		October-08	NOT FOUND
USTHPFFC-MW27	4-14	2/2/2000	11
		11/14/2000	45
		October-08	NOT FOUND
USTHPFFC-MW28	4-14	1/28/2000	29,000
		10/27/2008 +	6,520
		3/12/2009 +	9,080
USTHPFFC-MW29	4-14	1/28/2000	24,000
		11/16/2000	23,000
		10/30/2008 +	15,000
		3/12/2009 +	8,740
USTHPFFC-MW30	2-12	1/28/2000	510
		11/15/2000	150
		10/27/2008 +	659
		3/13/2009 +	432
USTHPFFC-MW31	4-14	1/31/2000	BQL
		11/13/2000	BQL
		7/18/2002	<1
		8/15/2007 +	<1
		10/27/2008 +	<1
USTHPFFC-MW32	4-14	1/31/2000	BQL
		11/13/2000	BQL
		10/28/2008	DRY
USTHPFFC-MW33	4-14	1/31/2000	BQL
		11/13/2000	BQL
		10/28/2008	DRY
USTHPFFC-MW34	4-14	1/31/2000	5
		11/13/2000	BQL
		10/29/2008 +	<1

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
<b>2L GWQS (µg/L)</b>			<b>1</b>
USTHPFFC-MW35	4-14	2/1/2000	BQL
		11/13/2000	BQL
		10/29/2008 +	<1
USTHPFFC-MW36	4-14	2/1/2000	BQL
		11/13/2000	BQL
		8/21/2007 +	<1
		10/29/2008 +	<1
USTHPFFC-MW37	4-14	2/1/2000	1
		11/13/2000	BQL
		10/29/2008 +	<1
USTHPFFC-MW38	4-14	2/1/2000	BQL
		11/15/2000	BQL
		7/17/2002	<1
		8/15/2007 +	<1
		10/30/2008 +	<1
USTHPFFC-MW39	5-15	3/7/2000	BQL
		11/13/2000	BQL
		7/18/2002	<1
		8/25/2007 +	5.7
		2/25/2008 +	<1
		10/24/2008 +	<1
USTHPFFC-MW40	5-15	3/7/2000	BQL
		11/15/2000	BQL
		10/28/2008 +	<1
USTHPFFC-MW41	5-15	3/7/2000	BQL
		11/16/2000	86
		10/28/2008 +	1,250
		3/19/2009 +	564
USTHPFFC-MW42	5-15	3/7/2000	BQL
		11/15/2000	BQL
		11/3/2008 +	104
		3/13/2009 +	31.6
USTHPFFC-MW43	75-80	3/26/2002	<1
		8/25/2007 +	<1
		10/24/2008 +	<1
USTHPFFC-MW44	45-50	3/26/2002	<1
		8/25/2007 +	<1
		10/24/2008 +	<1
		10/24/2008 dup +	<1
USTHPFFC-MW45	75-80	3/26/2002	710
		10/24/2008 +	614
		3/10/2009 +	797
USTHPFFC-MW46	145-150	3/26/2002	<1
		10/24/2008 +	<1

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFFC-MW47	45-50	3/26/2002	1,300
		8/25/2007 +	993
		2/25/2008 +	747
		10/24/2008 +	1,140
		3/10/2009 +	910
USTHPFFC-MW48	5-15	3/26/2002	<1
		8/24/2007 +	<1
		8/24/2007 + dup	<1
		10/24/2008 +	<1
USTHPFFC-MW49	75-80	3/26/2002	<1
		10/24/2008 +	<1
USTHPFFC-MW50	45-50	3/26/2002	28
		8/24/2007 +	<1
		10/24/2008 +	<1
USTHPFFC-MW51	5-15	3/25/2002	<1
		8/25/2007 +	2.1
		8/25/2007 + dup	<1
		4/21/2008 +	<1
		10/23/2008 +	<1
USTHPFFC-MW52	145-150	3/26/2002	<1
		10/22/2008 +	<1
USTHPFFC-MW53	45-50	3/26/2002	1
		8/25/2007 +	<1
		10/22/2008 +	<1
USTHPFFC-MW54	2-17	3/26/2002	<1
		8/25/2007 +	<1
		10/22/2008 +	<1
USTHPFFC-MW55	75-80	3/26/2002	<1
		8/25/2007 +	<1
		10/22/2008 +	<1
USTHPFFC-MW56	145-150	3/26/2002	<1
		8/24/2007 +	<1
		10/23/2008 +	<1
USTHPFFC-MW57	45-50	3/26/2002	3,100
		10/29/2008 +	4.5
USTHPFFC-MW58	75-80	3/26/2002	7
		10/27/2008 +	<1
USTHPFFC-MW59	75-80	3/27/2002	210
		8/23/2007 +	<1
		10/21/2008 +	4.8
USTHPFFC-MW60	45-50	3/27/2002	3,000
		7/17/2002	2,700
		8/20/2007 +	6,700
		8/20/2007 + dup	8,170
		2/27/2008 +	8,650
		10/21/2008 +	956
		3/12/2009 +	7,660

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
<b>2L GWQS (µg/L)</b>			<b>1</b>
USTHPFFC-MW61	145-150	3/27/2002	<1
		3/27/2002 dup	<1
		8/20/2007 +	<1
		10/21/2008 +	<1
USTHPFFC-MW62	150-155	3/26/2002	1
		10/27/2008 +	<1
USTHPFFC-MW63	45-50	3/26/2002	6
		8/15/2007 +	<1
		10/28/2008 +	<1
USTHPFFC-MW64	45-50	3/27/2002	46
		11/17/2008 +	<1
USTHPFFC-MW65	75-80	3/27/2002	21
		10/20/2008 +	<1
USTHPFFC-MW66	45-50	3/27/2002	3,000
		3/27/2002 dup	3,100
		8/17/2007 +	3,830
		10/28/2008 +	<1
USTHPFFC-MW67	75-80	3/27/2002	<1
		11/3/2008 +	<1
USTHPFFC-MW68	5-25	3/25/2002	30
		10/28/2008 +	<1
USTHPFFC-MW69	45-50	3/27/2002	1
		10/29/2008 +	<1
USTHPFFC-MW70	45-50	3/27/2002	<1
		8/16/2007 +	<1
		10/30/2008 +	<1
USTHPFFC-MW71	75-80	3/27/2002	<1
		8/16/2007 +	<1
		10/30/2008 +	<1
USTHPFFC-MW72	18-30	3/25/2002	15,000
		7/18/2002	21,000
		8/17/2007 +	16,800
USTHPFFC-MW73	45-50	4/23/2003	<1
		4/23/2003 dup	<1
		8/23/2007 +	<50*
		10/24/2008 +	1.1
		10/24/2008 dup +	1.1
USTHPFFC-MW74	75-80	4/23/2003	<1
		8/23/2007 +	<10*
		10/24/2008 +	<1
USTHPFFC-MW75	55-75	5/7/2003	650
		5/14/2003	1,300
		11/4/2008	DRY

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
<b>2L GWQS (µg/L)</b>			<b>1</b>
USTHPFFC-MW76	45-50	4/23/2003	71
		8/25/2007 +	<1
		10/29/2008 +	<1
USTHPFFC-MW77	45-50	4/23/2003	<1
		8/15/2007 +	<1
		10/28/2008 +	<1
USTHPFFC-MW78	139-159	10/20/2008 +	2.5
USTHPFF-MW01	7-17	1/27/1999 +	16,000
		10/18/1999 +	9,400
		2/17/2000	11,000
		7/26/2000 +	11,000
		1/13/2001 +	8,300
		7/22/2001 +	7,700
		2/9/2002 +	3,280
		8/13/2002 +	5,710
		2/17/2003 +	5,380
		8/27/2003 +	6,670
		2/14/2004 +	4,970
		8/20/2004 +	3,180
		4/13/2005 +	4,480
		8/31/2005 +	4,140
		1/23/2006 +	2,860
		10/6/2006 +	2,790
8/15/2007 +	4,530		
2/28/2008 +	3,910		
USTHPFF-MW02	7-17	2/18/2000	40,000
		10/20/2008 +	7,720
		3/19/2009 +	5,840
USTHPFF-MW03	5-15	11/30/1995	BDL
		6/5/1997	BQL
		2/16/2000	BQL
		11/13/2000	BQL
		7/17/2002	<1
		10/29/2008 +	<1
USTHPFF-MW04	5-15	11/30/1995	BDL
		6/4/1997	BQL
		2/16/2000	BQL
		11/13/2000	BQL
		10/29/2008 +	<1
USTHPFF-MW05	5-15	6/5/1997	BQL
		2/17/2000	BQL
		11/16/2000	BQL
		10/24/2008	NOT FOUND

TABLE 2

**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFF-MW06	5-15	11/30/1995	30
		6/4/1997	9.3
		2/22/2000	9
		11/16/2000	28
		7/17/2002	<10*
		8/21/2007 +	38.1
		2/27/2008 +	92
		10/22/2008 +	105
USTHPFF-MW09	5-15	3/19/2009 +	196
		11/30/1995	1
		6/5/1997	BQL
		2/15/2000	BQL
		11/13/2000	BQL
		7/17/2002	<1
		8/16/2007 +	<1
10/28/2008 +	<1		
USTHPFF-MW10R	5-15	6/5/1997	700
		1/28/1999 +	5,200
		10/18/1999 +	2,200
		2/17/2000	3,400
		7/24/2000 +	3,300
		11/16/2000	3,800
		1/13/2001 +	5,200
		7/22/2001 +	5,800
		2/9/2002 +	4,410
		8/13/2002 +	3,780
		2/17/2003 +	2,340
		8/27/2003 +	2,830
		2/14/2004 +	197
		9/8/2004 +	480
		4/13/2005 +	487
		8/27/2005 +	1,060
		1/24/2006 +	1,770
		10/4/2006 +	1,280
8/21/2007 +	1,240		
2/28/2008 +	720		
10/21/2008 +	928		
3/18/2009 +	570		

TABLE 2

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY  
HADNOT POINT FUEL FARM

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFF-MW11	5-25	11/30/1995	2.1
		6/4/1997	BQL
		1/27/1999 +	1.2
		10/18/1999 +	40
		2/15/2000	1,500
		7/26/2000 +	2,500
		11/16/2000	550
		2/1/2001 +	480
		2/9/2002 +	64.4
		8/13/2002 +	26.2
		2/18/2003 +	274
		8/22/2003 +	957
		2/14/2004 +	6.5
		4/5/2005 +	5.2
		8/27/2005 +	1.3
		1/25/2006 +	53.6
		10/9/2006 +	3.7
8/16/2007 +	<1		
10/21/2008	DRY		
USTHPFF-MW12	5-25	8/20/2007 +	758
		2/26/2008 +	1,110
		10/21/2008 +	386
		3/12/2009 +	245
USTHPFF-MW15	5-25	11/30/1995	18.5
		6/5/1997	BQL
		8/17/2007 +	561
		3/3/2008 +	422
		10/28/2008 +	94.5
		3/13/2009 +	276
USTHPFF-MW17	5-25	11/30/1995	5,750
		6/5/1997	5,340
		1/28/1999 +	7,700
		10/18/1999 +	5,400
		2/18/2000	32,000
		7/24/2000 +	6,700
		11/15/2000	15,000
		1/13/2001 +	16,000
		7/22/2001 +	12,000
		2/9/2002 +	12,200
		8/13/2002 +	6,140
		2/21/2003 +	5,720
		8/25/2003 +	6,830
		2/20/2004 +	5,520
		9/13/2004 +	4,910
		4/13/2005 +	6,500
		8/31/2005 +	7,380
		1/24/2006 +	5,630
		10/6/2006 +	4,480
		8/16/2007 +	7,240
2/28/2008 +	6,480		
10/20/2008 +	7,460		
3/17/2009 +	5,700		

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
2L GWQS (µg/L)			1
USTHPFF-MW18	5-25	6/5/1997	20,450
		1/28/1999 +	28,000
		10/18/1999 +	15,000
		2/17/2000	20,000
		7/26/2000 +	16,000
		11/16/2000	15,000
		1/13/2001 +	12,000
		7/22/2001 +	11,000
		2/9/2002 +	18,900
		8/14/2002 +	18,200
		2/18/2003 +	16,900
		8/27/2003 +	5,440
		2/14/2004 +	12,900
		8/20/2004 +	7,040
		4/13/2005 +	12,800
		8/31/2005 +	12,300
1/23/2006 +	12,400		
10/6/2006 +	10,300		
8/15/2007 +	15,400		
USTHPFF-MW19	5-25	11/30/1995	3.3
		6/5/1997	5.6
		2/17/2000	BQL
		11/15/2000	BQL
		7/18/2002	210
		8/14/2007 +	<1
		10/20/2008 +	<1
USTHPFF-MW20	4-24	11/30/1995	4.9
		6/5/1997	BQL
		2/23/2000	BQL
		11/20/2000	BQL
		7/18/2002	4
		8/24/2007 +	<1
		10/30/2008 +	<1
USTHPFF-MW21	4-19	6/5/1997	BQL
		2/16/2000	BQL
		10/24/08	NOT FOUND
USTHPFF-MW23	8-18	6/5/1997	3.8
		2/23/2000	BQL
		10/24/08	NOT FOUND

**TABLE 2**  
**SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUNDWATER (EPA METHOD 602/8260B) - BENZENE ONLY**  
**HADNOT POINT FUEL FARM**

Well ID	Screen Interval (feet BLS)	Date Sampled	Benzene Concentration (µg/L)
<b>2L GWQS (µg/L)</b>			<b>1</b>
USTHPFF-MWA	4-14	11/13/2000	<b>2,900</b>
		11/7/2008 +	<b>284</b>
		3/17/2009 +	<b>775</b>
USTHPFF-RW01	9-34	10/30/2008 +	<b>327</b>
		3/17/2009 +	<b>210</b>
USTHPFF-RW04	9-34	10/30/2008 +	<b>326</b>
		3/17/2009 +	<b>329</b>

All results in micrograms per liter (µg/L).

Bold concentrations exceed the 2L GWQS.

BQL = Below Quantitation Limits. Refer to analytical report for a complete list of compounds and quantitation limits.

\* Laboratory practical quantitation limit is higher than the 2L GWQS.

Dup = Duplicate sample taken

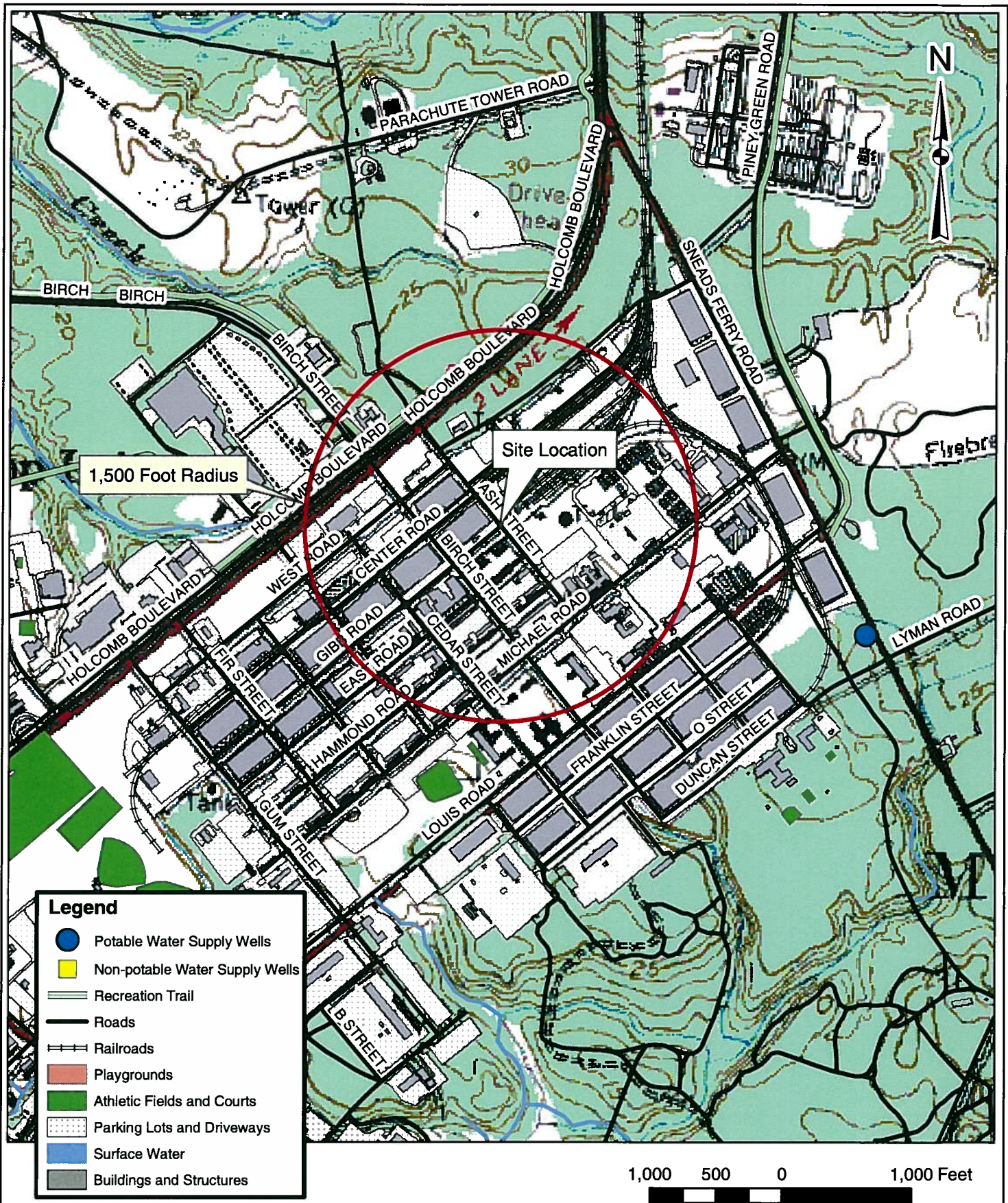
+ Wells sampled by Shaw Environmental & Infrastructure.

ND = Not Detected


B = Indicates analyte detected in associated method blank

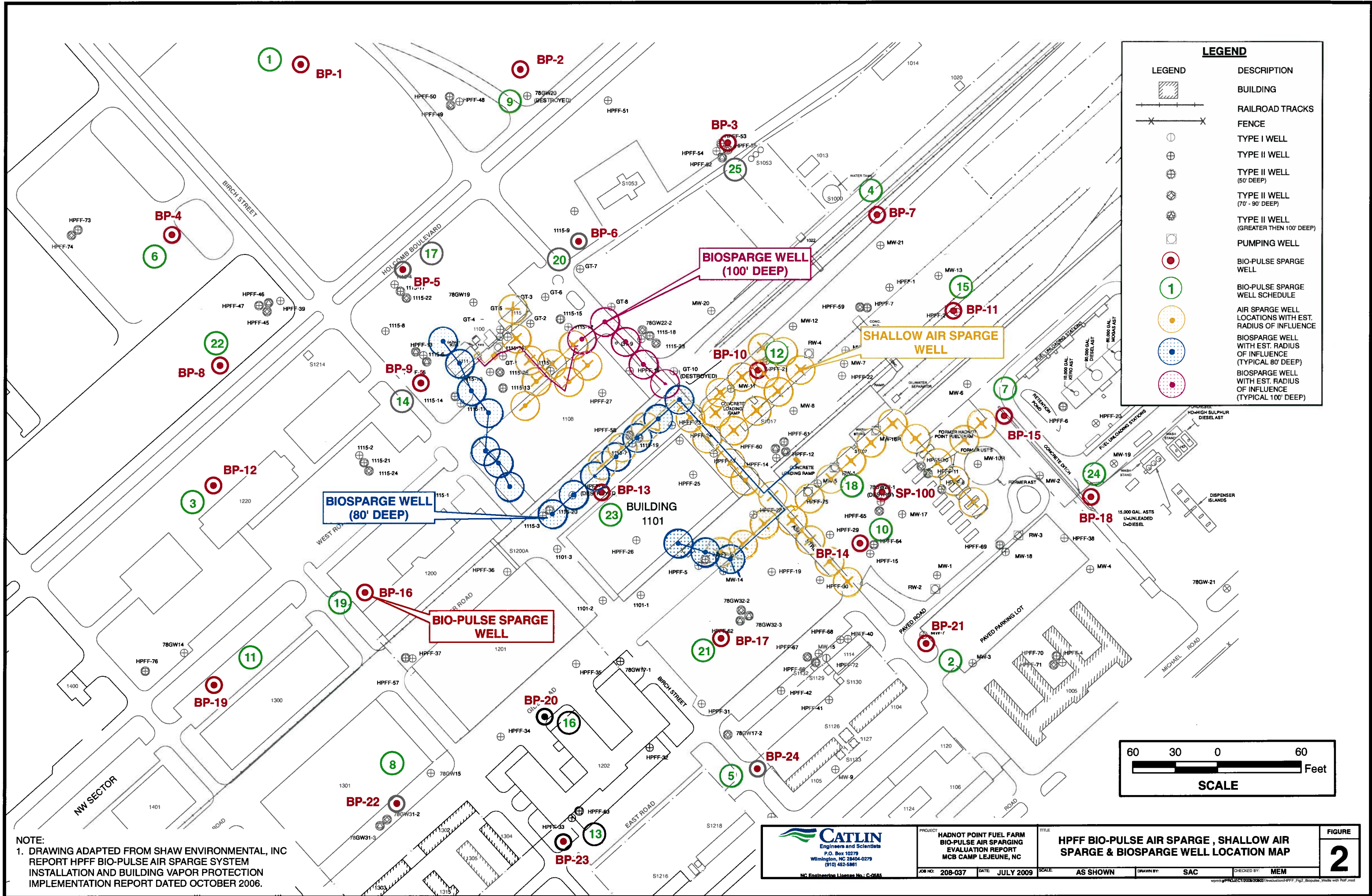
J = Estimated concentration, below calibration range and above method detection limit

## FIGURES

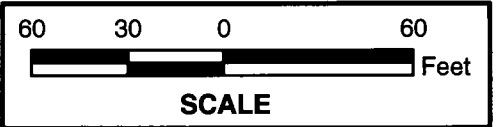


Data Sources: Data Layers provided by MCB Camp Lejeune GIS Office.

 <b>CATLIN</b> Engineers and Scientists P.O. Box 10279 Wilmington, NC 28404-0279 (910) 452-5861 NC Engineering License No.: C-0585	PROJECT HADNOT POINT FUEL FARM BIO-PULSE AIR SPARGING EVALUATION REPORT MCB CAMP LEJEUNE, NC		TITLE <b>SITE VICINITY MAP</b>		<b>FIGURE</b> <b>1</b>
	JOB NO. 208-037	DATE JULY 2009	SCALE AS SHOWN	DRAWN BY SAC	



LEGEND	
LEGEND	DESCRIPTION
[Hatched Box]	BUILDING
[Line with Cross-Ticks]	RAILROAD TRACKS
[Line with X-Ticks]	FENCE
[Circle with Center Dot]	TYPE I WELL
[Circle with Plus Sign]	TYPE II WELL
[Circle with Plus Sign]	TYPE II WELL (60' DEEP)
[Circle with Plus Sign]	TYPE II WELL (70' - 90' DEEP)
[Circle with Plus Sign]	TYPE II WELL (GREATER THEN 100' DEEP)
[Circle with Plus Sign]	PUMPING WELL
[Circle with Red Border]	BIO-PULSE SPARGE WELL
[Circle with Green Border]	BIO-PULSE SPARGE WELL SCHEDULE
[Circle with Dotted Pattern]	AIR SPARGE WELL LOCATIONS WITH EST. RADIUS OF INFLUENCE
[Circle with Blue Dotted Pattern]	BIOSPARGE WELL WITH EST. RADIUS OF INFLUENCE (TYPICAL 80' DEEP)
[Circle with Pink Dotted Pattern]	BIOSPARGE WELL WITH EST. RADIUS OF INFLUENCE (TYPICAL 100' DEEP)



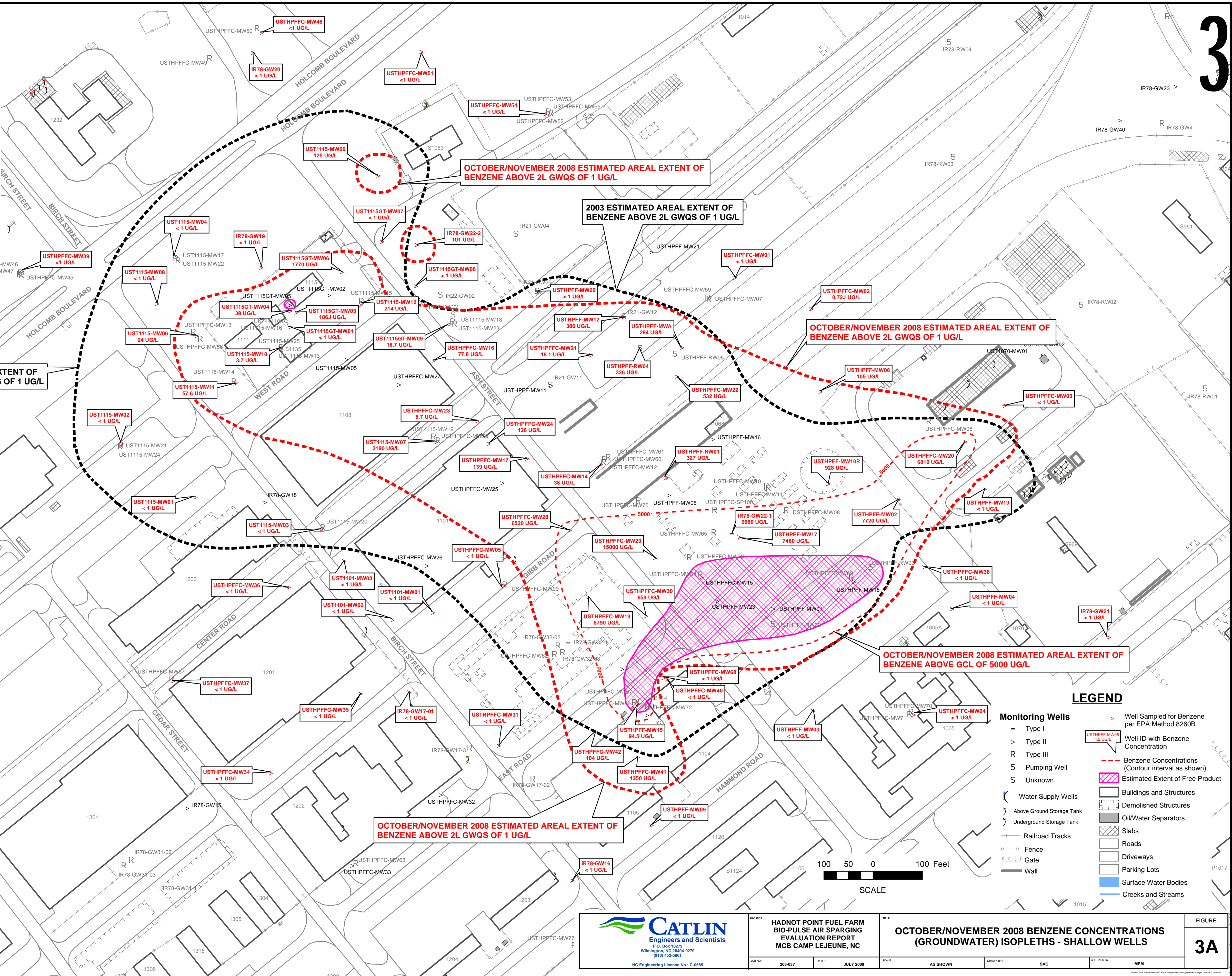
NOTE:  
 1. DRAWING ADAPTED FROM SHAW ENVIRONMENTAL, INC REPORT HPFF BIO-PULSE AIR SPARGE SYSTEM INSTALLATION AND BUILDING VAPOR PROTECTION IMPLEMENTATION REPORT DATED OCTOBER 2006.


<p><b>CATLIN</b>          Engineers and Scientists          P.O. Box 10279          Wilmington, NC 28404-0279          (910) 452-5861          NC Engineering License No. - C-0565</p>	PROJECT: HADNOT POINT FUEL FARM BIO-PULSE AIR SPARGING EVALUATION REPORT MCB CAMP LEJEUNE, NC	TITLE: HPFF BIO-PULSE AIR SPARGE, SHALLOW AIR SPARGE & BIOSPARGE WELL LOCATION MAP	FIGURE: 2
	JOB NO: 208-037 DATE: JULY 2009 SCALE: AS SHOWN	DRAWN BY: SAC	CHECKED BY: MEM

OCTOBER/NOVEMBER 2008 ANALYTICAL RESULTS							
SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	GCL
IR78-GW12	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
IR78-GW13	10/24/2008	8260B	Benzene	4.8		UG/L	1:5000
IR78-GW14	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
IR78-GW16	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
IR78-GW17-01	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
IR78-GW19	10/23/2008	8260B	Benzene	1.0		UG/L	1:5000
IR78-GW20	11/30/2008	8260B	Benzene	1.0		UG/L	1:5000
IR78-GW21	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
IR78-GW22-01	10/29/2008	8260B	Benzene	9660		UG/L	1:5000
IR78-GW22-2	10/21/2008	8260B	Benzene	101		UG/L	1:5000
UST1101-MW01	10/27/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1101-MW02	10/27/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1101-MW03	10/27/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115GT-MW01	10/23/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115GT-MW03	10/23/2008	8260B	Benzene	196		UG/L	1:5000
UST1115GT-MW04	11/27/2008	8260B	Benzene	39		UG/L	1:5000
UST1115GT-MW06	10/23/2008	8260B	Benzene	1770		UG/L	1:5000
UST1115GT-MW07	10/21/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115GT-MW08	10/21/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115GT-MW09	10/21/2008	8260B	Benzene	16.7		UG/L	1:5000
UST1115-MW01	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115-MW02	10/24/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115-MW03	10/27/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115-MW04	10/23/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115-MW06	10/23/2008	8260B	Benzene	24		UG/L	1:5000
UST1115-MW07	10/27/2008	8260B	Benzene	2180		UG/L	1:5000
UST1115-MW08	10/23/2008	8260B	Benzene	1.0		UG/L	1:5000
UST1115-MW09	10/22/2008	8260B	Benzene	162		UG/L	1:5000
UST1115-MW10	10/23/2008	8260B	Benzene	3.7		UG/L	1:5000
UST1115-MW11	10/23/2008	8260B	Benzene	57.8		UG/L	1:5000
UST1115-MW12	10/23/2008	8260B	Benzene	214		UG/L	1:5000

OCTOBER/NOVEMBER 2008 ANALYTICAL RESULTS							
SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	GCL
USTHPFFC-MW01	10/21/2008	8260B	Benzene	0.72	J	UG/L	1:5000
USTHPFFC-MW02	10/21/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW03	10/20/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW04	10/30/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW05	10/27/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW14	10/21/2008	8260B	Benzene	36		UG/L	1:5000
USTHPFFC-MW15	10/20/2008	8260B	Benzene	22700		UG/L	1:5000
USTHPFFC-MW16	10/27/2008	8260B	Benzene	77.8		UG/L	1:5000
USTHPFFC-MW17	10/27/2008	8260B	Benzene	159		UG/L	1:5000
USTHPFFC-MW19	10/27/2008	8260B	Benzene	8790		UG/L	1:5000
USTHPFFC-MW20	10/20/2008	8260B	Benzene	6810		UG/L	1:5000
USTHPFFC-MW21	10/21/2008	8260B	Benzene	16.1		UG/L	1:5000
USTHPFFC-MW22	10/30/2008	8260B	Benzene	532		UG/L	1:5000
USTHPFFC-MW23	10/27/2008	8260B	Benzene	8.7		UG/L	1:5000
USTHPFFC-MW24	11/2/2008	8260B	Benzene	158		UG/L	1:5000
USTHPFFC-MW28	10/27/2008	8260B	Benzene	6520		UG/L	1:5000
USTHPFFC-MW29	10/30/2008	8260B	Benzene	15000		UG/L	1:5000
USTHPFFC-MW30	10/27/2008	8260B	Benzene	659		UG/L	1:5000
USTHPFFC-MW31	10/27/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW34	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW35	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW36	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW37	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW38	10/30/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW39	10/24/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW40	10/28/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW41	10/28/2008	8260B	Benzene	1250		UG/L	1:5000
USTHPFFC-MW42	11/3/2008	8260B	Benzene	104		UG/L	1:5000
USTHPFFC-MW48	10/24/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW51	10/23/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW54	10/22/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW08	10/28/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW02	10/20/2008	8260B	Benzene	7720		UG/L	1:5000
USTHPFFC-MW03	10/29/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW04	10/21/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW06	10/22/2008	8260B	Benzene	105		UG/L	1:5000
USTHPFFC-MW09	10/28/2008	8260B	Benzene	328		UG/L	1:5000
USTHPFFC-MW12	10/21/2008	8260B	Benzene	386		UG/L	1:5000
USTHPFFC-MW15	10/28/2008	8260B	Benzene	64.5		UG/L	1:5000
USTHPFFC-MW17	10/20/2008	8260B	Benzene	1.0		UG/L	1:5000
USTHPFFC-MW20	10/30/2008	8260B	Benzene	284		UG/L	1:5000
USTHPFFC-MW21	11/7/2008	8260B	Benzene	284		UG/L	1:5000
USTHPFFC-MW01	10/30/2008	8260B	Benzene	327		UG/L	1:5000
USTHPFFC-MW04	10/30/2008	8260B	Benzene	326		UG/L	1:5000

1. GIS Layers provided by the MCB Camp Lejeune GIS Department.  
 2. Monitoring well IR78-GW12 was sampled in October 2008 and Benzene was not detected above the laboratory detection limit. This monitoring well is not shown on the figure, but is approximately 850 feet southwest of USTHPFFC-MW34.





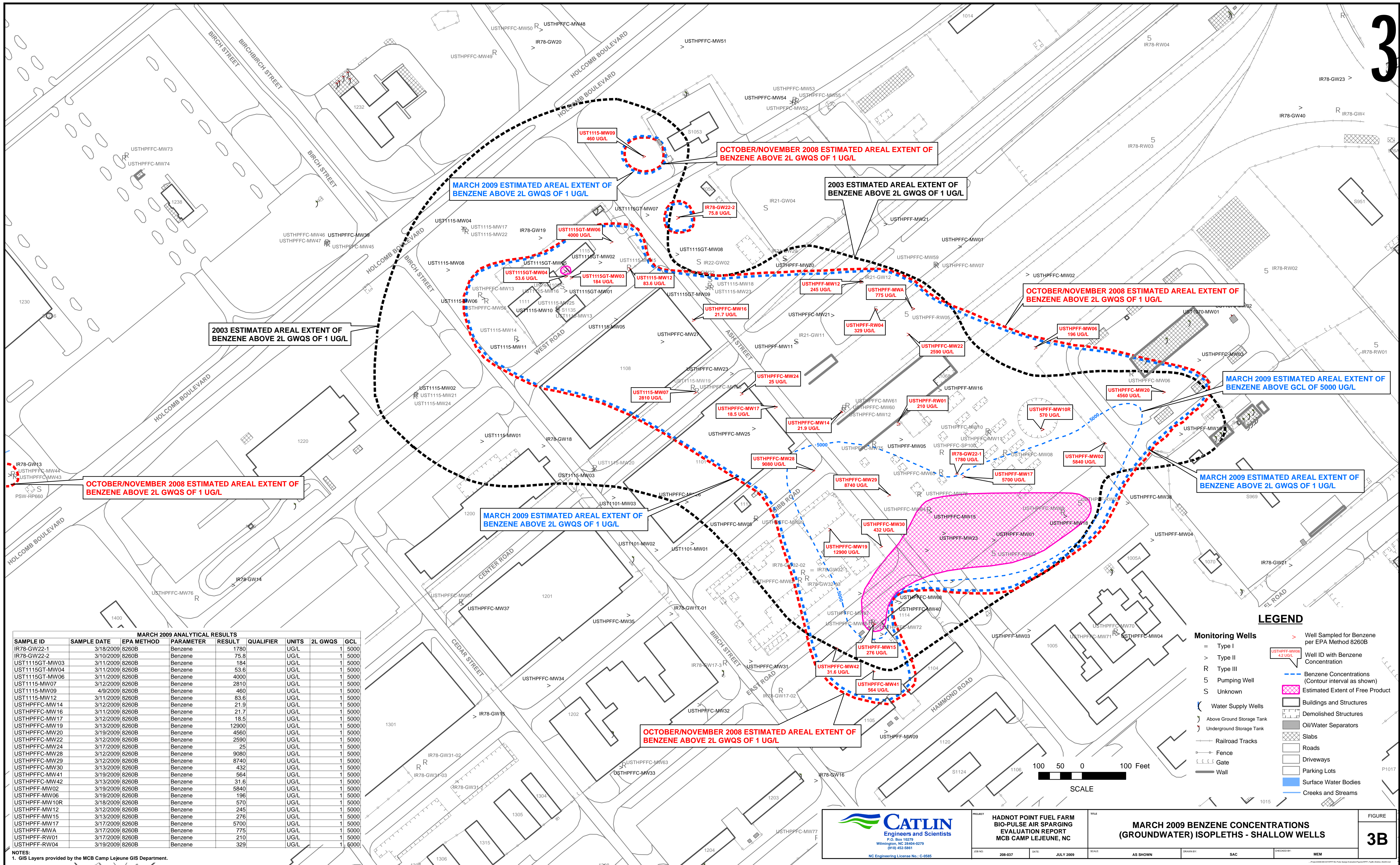
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Engineers and Scientists  
P.O. Box 1829  
Wilmington, NC 28404-0279  
(910) 852-5861  
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**HADNOT POINT FUEL FARM  
BIO-PULSE AIR SPARGING  
EVALUATION REPORT  
MCB CAMP LEJEUNE, NC**

**OCTOBER/NOVEMBER 2008 BENZENE CONCENTRATIONS  
(GROUNDWATER) ISOPLETHS - SHALLOW WELLS**

FIGURE  
**3A**

JOB NO. 208-037	DATE JULY 2009	SCALE AS SHOWN	DRAWN BY MEM	SAC	CREATED BY MEM
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**MARCH 2009 ANALYTICAL RESULTS**

SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	2L GWQS	GCL
IR78-GW22-1	3/18/2009	8260B	Benzene	1780		UG/L	1	5000
IR78-GW22-2	3/10/2009	8260B	Benzene	75.8		UG/L	1	5000
UST1115GT-MW03	3/11/2009	8260B	Benzene	184		UG/L	1	5000
UST1115GT-MW04	3/11/2009	8260B	Benzene	53.6		UG/L	1	5000
UST1115GT-MW06	3/11/2009	8260B	Benzene	4000		UG/L	1	5000
UST1115-MW07	3/12/2009	8260B	Benzene	2810		UG/L	1	5000
UST1115-MW09	4/9/2009	8260B	Benzene	460		UG/L	1	5000
UST1115-MW12	3/11/2009	8260B	Benzene	83.6		UG/L	1	5000
USTHPFFC-MW14	3/12/2009	8260B	Benzene	21.9		UG/L	1	5000
USTHPFFC-MW16	3/11/2009	8260B	Benzene	21.7		UG/L	1	5000
USTHPFFC-MW17	3/12/2009	8260B	Benzene	18.5		UG/L	1	5000
USTHPFFC-MW19	3/12/2009	8260B	Benzene	12900		UG/L	1	5000
USTHPFFC-MW20	3/19/2009	8260B	Benzene	4560		UG/L	1	5000
USTHPFFC-MW22	3/12/2009	8260B	Benzene	2590		UG/L	1	5000
USTHPFFC-MW24	3/17/2009	8260B	Benzene	25		UG/L	1	5000
USTHPFFC-MW28	3/12/2009	8260B	Benzene	9080		UG/L	1	5000
USTHPFFC-MW29	3/12/2009	8260B	Benzene	8740		UG/L	1	5000
USTHPFFC-MW30	3/13/2009	8260B	Benzene	432		UG/L	1	5000
USTHPFFC-MW41	3/19/2009	8260B	Benzene	564		UG/L	1	5000
USTHPFFC-MW42	3/13/2009	8260B	Benzene	31.6		UG/L	1	5000
USTHPFFC-MW02	3/19/2009	8260B	Benzene	5840		UG/L	1	5000
USTHPFFC-MW06	3/19/2009	8260B	Benzene	196		UG/L	1	5000
USTHPFFC-MW10R	3/18/2009	8260B	Benzene	570		UG/L	1	5000
USTHPFFC-MW12	3/12/2009	8260B	Benzene	245		UG/L	1	5000
USTHPFFC-MW15	3/13/2009	8260B	Benzene	276		UG/L	1	5000
USTHPFFC-MW17	3/12/2009	8260B	Benzene	5700		UG/L	1	5000
USTHPFFC-MWA	3/17/2009	8260B	Benzene	775		UG/L	1	5000
USTHPFFC-RW01	3/17/2009	8260B	Benzene	210		UG/L	1	5000
USTHPFFC-RW04	3/19/2009	8260B	Benzene	329		UG/L	1	5000

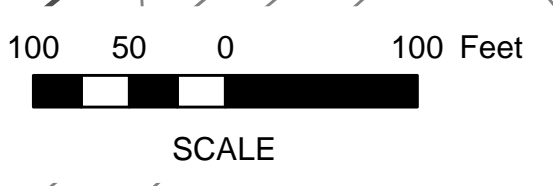
NOTES:  
1. GIS Layers provided by the MCB Camp Lejeune GIS Department.

**LEGEND**

- Well Sampled for Benzene per EPA Method 8260B
- Well ID with Benzene Concentration
- Benzene Concentrations (Contour interval as shown)
- Estimated Extent of Free Product
- Buildings and Structures
- Demolished Structures
- Oil/Water Separators
- Slabs
- Roads
- Driveways
- Parking Lots
- Surface Water Bodies
- Creeks and Streams

**Monitoring Wells**

- Type I
- Type II
- Type III
- Pumping Well
- Unknown
- Water Supply Wells
- Above Ground Storage Tank
- Underground Storage Tank
- Railroad Tracks
- Fence
- Gate
- Wall



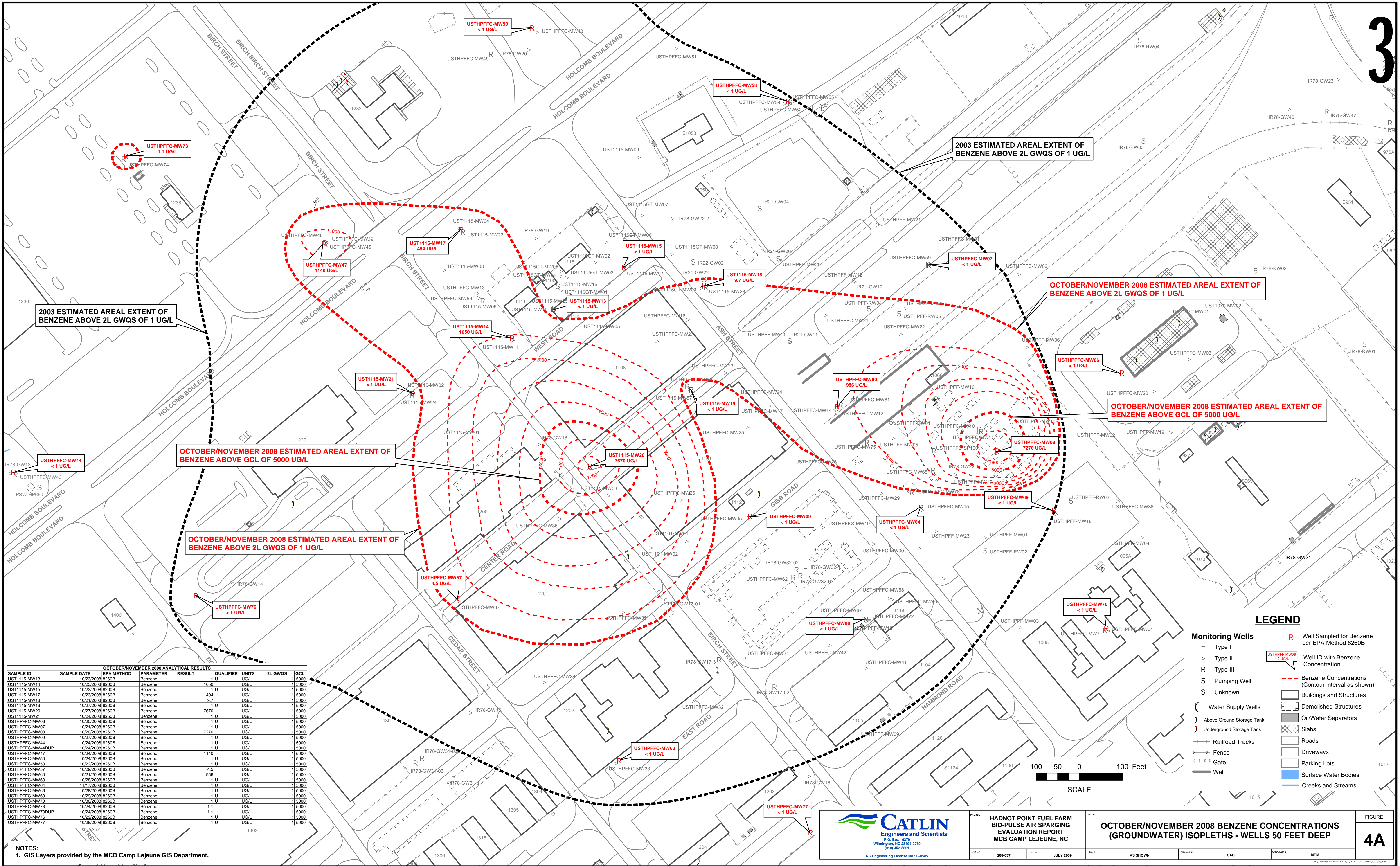
**CATLIN**  
Engineers and Scientists  
P.O. Box 10778  
Wilmington, NC 28404-0778  
910.432.8641  
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**HADNOT POINT FUEL FARM  
BIO-PULSE AIR SPARGING  
EVALUATION REPORT  
MCB CAMP LEJEUNE, NC**

**MARCH 2009 BENZENE CONCENTRATIONS  
(GROUNDWATER) ISOPLETHS - SHALLOW WELLS**

FIGURE **3B**

PROJECT: 208-037 DATE: JULY 2009 SCALE: AS SHOWN DRAWN BY: SAC CHECKED BY: MEM



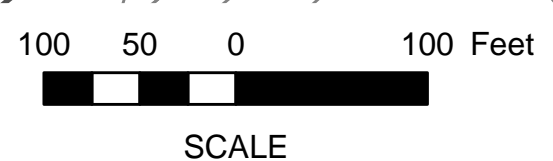
**OCTOBER/NOVEMBER 2008 ANALYTICAL RESULTS**

SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	2L GWQS	GCL
UST1115-MW13	10/23/2008	8260B	Benzene	1050	1	UG/L	1,500.0	5000
UST1115-MW14	10/23/2008	8260B	Benzene	1050	1	UG/L	1,500.0	5000
UST1115-MW15	10/23/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
UST1115-MW17	10/23/2008	8260B	Benzene	494	1	UG/L	1,500.0	5000
UST1115-MW18	10/21/2008	8260B	Benzene	9.7	1	UG/L	1,500.0	5000
UST1115-MW19	10/27/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
UST1115-MW20	10/27/2008	8260B	Benzene	7670	1	UG/L	1,500.0	5000
UST1115-MW21	10/24/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW06	10/20/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW07	10/21/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW08	10/20/2008	8260B	Benzene	7270	1	UG/L	1,500.0	5000
USTHPFFC-MW09	10/27/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW44	10/24/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW44DUP	10/24/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW47	10/24/2008	8260B	Benzene	1140	1	UG/L	1,500.0	5000
USTHPFFC-MW50	10/24/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW53	10/22/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW57	10/29/2008	8260B	Benzene	4.5	1	UG/L	1,500.0	5000
USTHPFFC-MW60	10/21/2008	8260B	Benzene	856	1	UG/L	1,500.0	5000
USTHPFFC-MW63	10/28/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW64	11/17/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW66	10/28/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW69	10/29/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW70	10/30/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW73	10/24/2008	8260B	Benzene	1.1	1	UG/L	1,500.0	5000
USTHPFFC-MW73DUP	10/24/2008	8260B	Benzene	1.1	1	UG/L	1,500.0	5000
USTHPFFC-MW76	10/29/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000
USTHPFFC-MW77	10/29/2008	8260B	Benzene	1	1	UG/L	1,500.0	5000

**NOTES:**  
1. GIS Layers provided by the MCB Camp Lejeune GIS Department.

**LEGEND**

- Monitoring Wells**
  - R Well Sampled for Benzene per EPA Method 8260B
  - Type I
  - Type II
  - Type III
  - R Pumping Well
  - S Unknown
- Well ID with Benzene Concentration**
  - USTHPFFC-MW06
- Benzene Concentrations (Contour interval as shown)**
  - 1000
  - 2000
  - 4000
  - 5000
  - 7000
  - 10000
- Buildings and Structures**
  - Buildings and Structures
  - Demolished Structures
- Water Supply Wells**
  - Water Supply Wells
  - Above Ground Storage Tank
  - Underground Storage Tank
- Railroad Tracks**
  - Railroad Tracks
- Fence**
  - Fence
- Gate**
  - Gate
- Wall**
  - Wall
- Other Features**
  - Slabs
  - Oil/Water Separators
  - Roads
  - Driveways
  - Parking Lots
  - Surface Water Bodies
  - Creeks and Streams

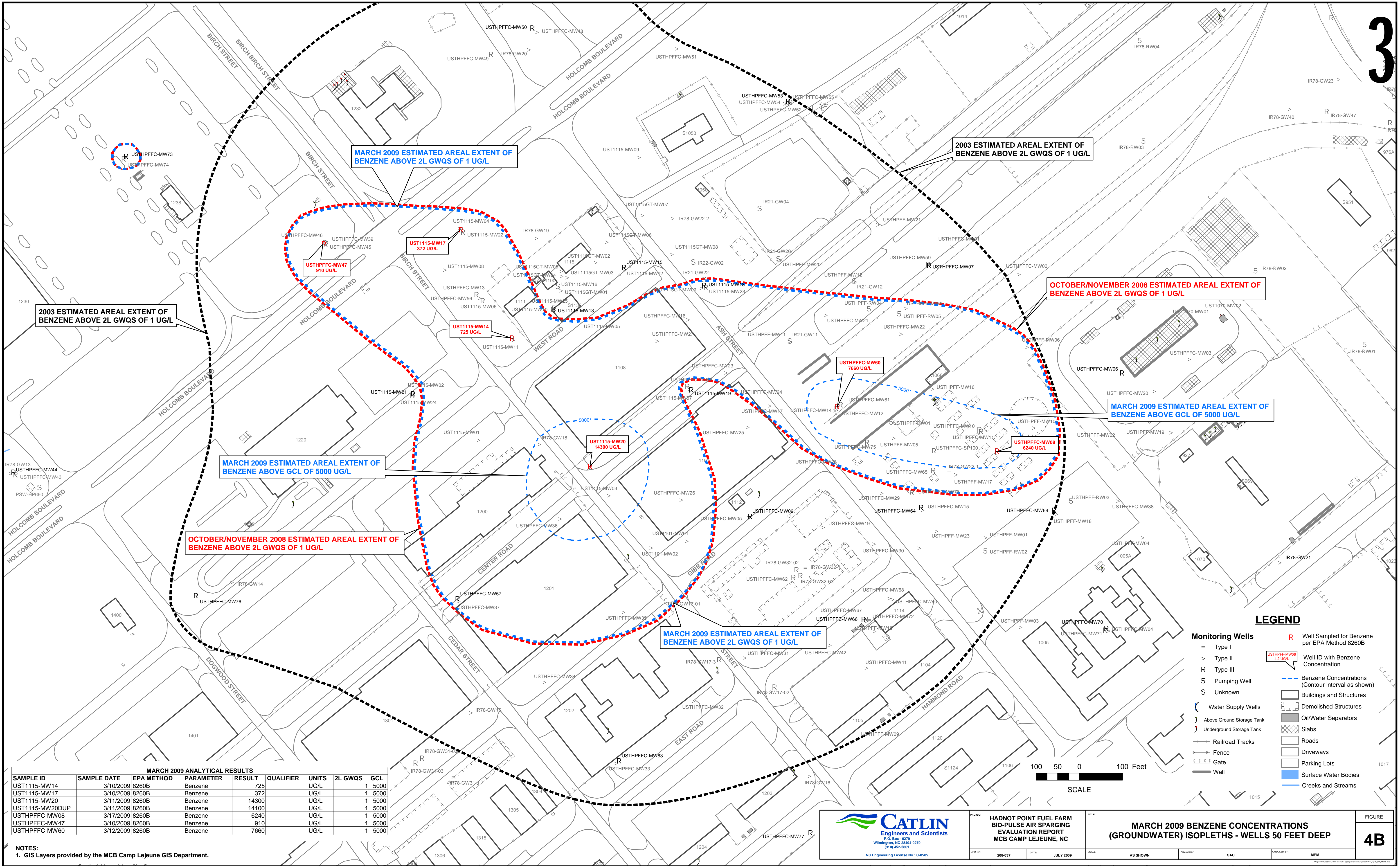


**CATLIN**  
Engineers and Scientists  
P.O. Box 9279  
Wilmington, NC 28404-0279  
(910) 452-3861  
NC Engineering License No. C-6585

**HADNOT POINT FUEL FARM  
BIO-PULSE AIR SPARGING  
EVALUATION REPORT  
MCB CAMP LEJEUNE, NC**

**OCTOBER/NOVEMBER 2008 BENZENE CONCENTRATIONS  
(GROUNDWATER) ISOPLETHS - WELLS 50 FEET DEEP**

FIGURE  
**4A**



MARCH 2009 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

2003 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

OCTOBER/NOVEMBER 2008 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

2003 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

MARCH 2009 ESTIMATED AREAL EXTENT OF BENZENE ABOVE GCL OF 5000 UG/L

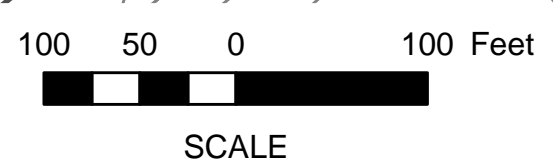
MARCH 2009 ESTIMATED AREAL EXTENT OF BENZENE ABOVE GCL OF 5000 UG/L

OCTOBER/NOVEMBER 2008 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

MARCH 2009 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

**LEGEND**

- Monitoring Wells**
  - Type I
  - Type II
  - Type III
  - Pumping Well
  - Unknown
  - Water Supply Wells
  - Above Ground Storage Tank
  - Underground Storage Tank
  - Railroad Tracks
  - Fence
  - Gate
  - Wall
- Well Sampled for Benzene per EPA Method 8260B (R)
- Well ID with Benzene Concentration (UST1115-MW08 6240 UG/L)
- Benzene Concentrations (Contour interval as shown) (---)
- Buildings and Structures (---)
- Demolished Structures (---)
- Oil/Water Separators (---)
- Slabs (---)
- Roads (---)
- Driveways (---)
- Parking Lots (---)
- Surface Water Bodies (---)
- Creeks and Streams (---)



**MARCH 2009 ANALYTICAL RESULTS**

SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	2L GWQS	GCL
UST1115-MW14	3/10/2009	8260B	Benzene	725		UG/L	1 5000	
UST1115-MW17	3/10/2009	8260B	Benzene	372		UG/L	1 5000	
UST1115-MW20	3/11/2009	8260B	Benzene	14300		UG/L	1 5000	
UST1115-MW20DUP	3/11/2009	8260B	Benzene	14100		UG/L	1 5000	
USTHPFFC-MW08	3/17/2009	8260B	Benzene	6240		UG/L	1 5000	
USTHPFFC-MW47	3/10/2009	8260B	Benzene	910		UG/L	1 5000	
USTHPFFC-MW60	3/12/2009	8260B	Benzene	7660		UG/L	1 5000	

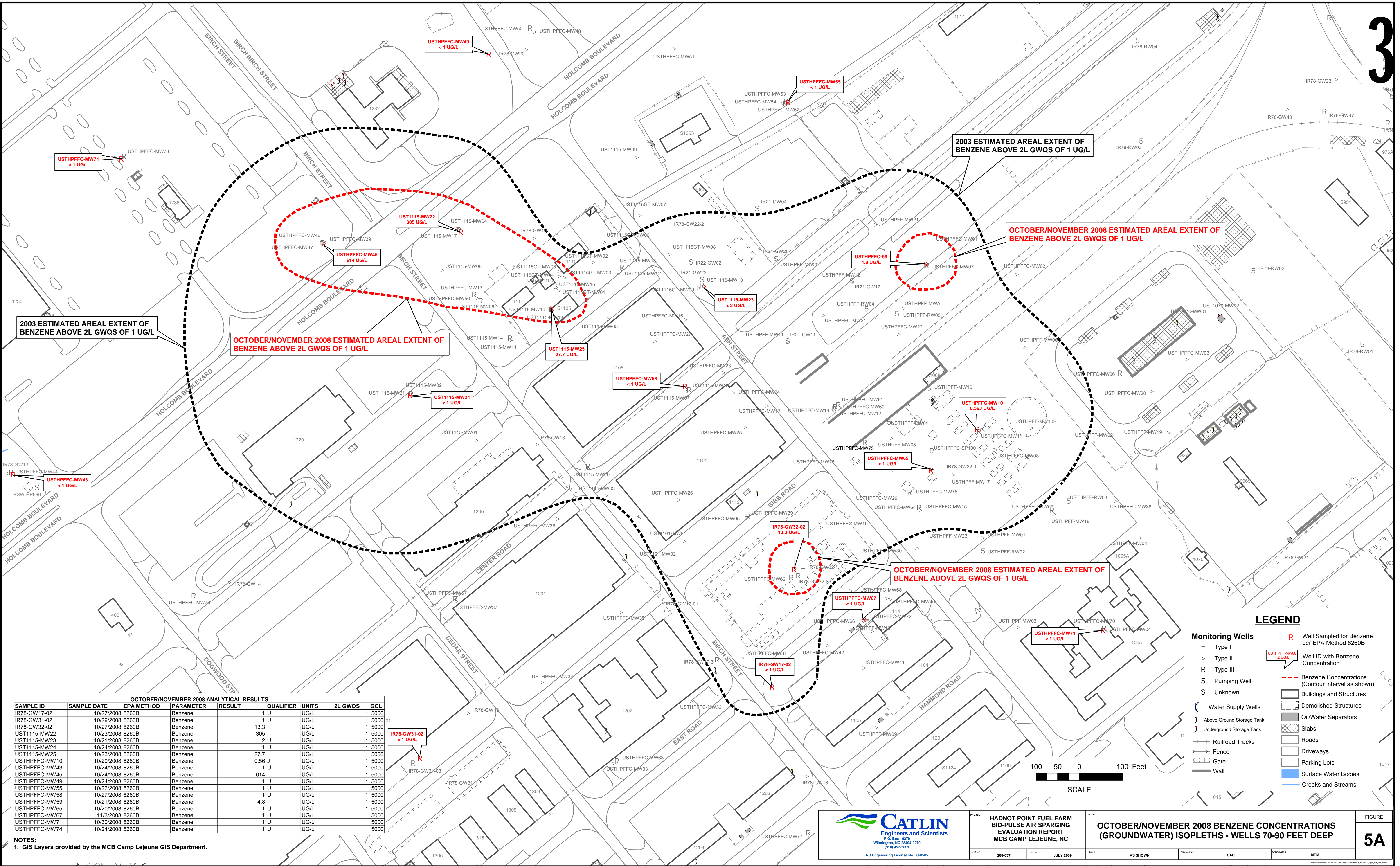
NOTES:  
1. GIS Layers provided by the MCB Camp Lejeune GIS Department.



HADNOT POINT FUEL FARM  
BIO-PULSE AIR SPARGING  
EVALUATION REPORT  
MCB CAMP LEJEUNE, NC

**MARCH 2009 BENZENE CONCENTRATIONS  
(GROUNDWATER) ISOPLETHS - WELLS 50 FEET DEEP**

FIGURE  
**4B**



**OCTOBER/NOVEMBER 2008 ANALYTICAL RESULTS**

SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	2L GWQS	GCL
IR78-GW17-02	10/27/2008	8260B	Benzene	1	U	UG/L	1 5000	
IR78-GW31-02	10/29/2008	8260B	Benzene	1	U	UG/L	1 5000	
IR78-GW32-02	10/27/2008	8260B	Benzene	13.3	U	UG/L	1 5000	
UST1115-MW22	10/23/2008	8260B	Benzene	305	U	UG/L	1 5000	
UST1115-MW23	10/21/2008	8260B	Benzene	2	U	UG/L	1 5000	
UST1115-MW24	10/24/2008	8260B	Benzene	1	U	UG/L	1 5000	
UST1115-MW25	10/23/2008	8260B	Benzene	27.7	U	UG/L	1 5000	
USTHPFFC-MW10	10/20/2008	8260B	Benzene	0.56	J	UG/L	1 5000	
USTHPFFC-MW43	10/24/2008	8260B	Benzene	1	U	UG/L	1 5000	
USTHPFFC-MW45	10/24/2008	8260B	Benzene	614	U	UG/L	1 5000	
USTHPFFC-MW49	10/24/2008	8260B	Benzene	1	U	UG/L	1 5000	
USTHPFFC-MW55	10/22/2008	8260B	Benzene	1	U	UG/L	1 5000	
USTHPFFC-MW58	10/27/2008	8260B	Benzene	1	U	UG/L	1 5000	
USTHPFFC-MW59	10/21/2008	8260B	Benzene	4.8	U	UG/L	1 5000	
USTHPFFC-MW65	10/20/2008	8260B	Benzene	1	U	UG/L	1 5000	
USTHPFFC-MW67	11/3/2008	8260B	Benzene	1	U	UG/L	1 5000	
USTHPFFC-MW71	10/30/2008	8260B	Benzene	1	U	UG/L	1 5000	
USTHPFFC-MW74	10/24/2008	8260B	Benzene	1	U	UG/L	1 5000	

NOTES:  
1. GIS Layers provided by the MCB Camp Lejeune GIS Department.

**LEGEND**

- Monitoring Wells**
  - Type I
  - Type II
  - Type III
  - R Pumping Well
  - S Unknown
- Water Supply Wells**
  - Above Ground Storage Tank
  - Underground Storage Tank
- Buildings and Structures**
  - Buildings and Structures
  - Demolished Structures
- Oil/Water Separators**
- Slabs**
- Roads**
- Driveways**
- Parking Lots**
- Surface Water Bodies**
- Creeks and Streams**



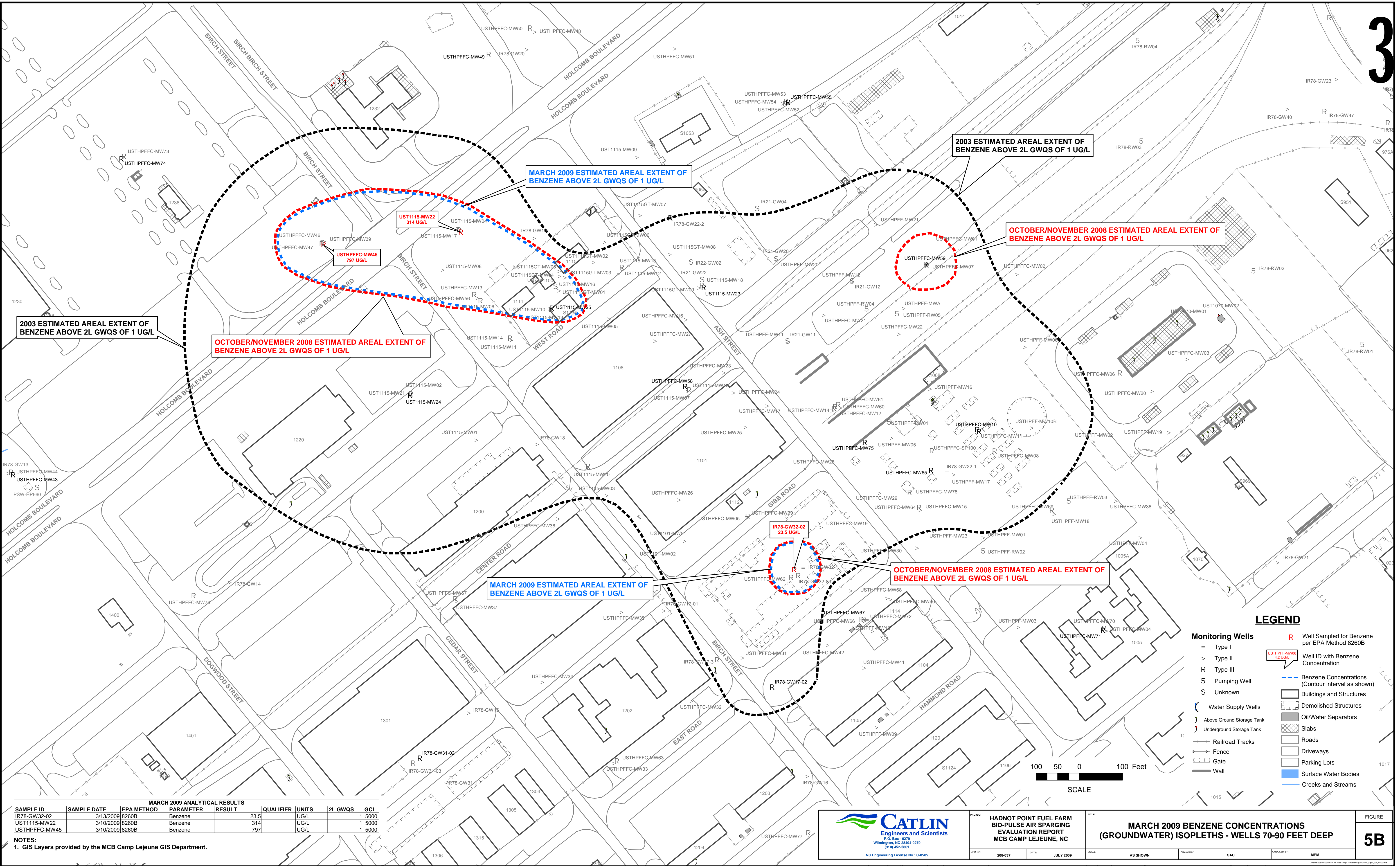
**CATLIN**  
Engineers and Scientists  
P.O. Box 9279  
Wilmington, NC 28404-0279  
919.432.9661  
NC Engineering License No. C-0585

**HADNOT POINT FUEL FARM  
BIO-PULSE AIR SPARGING  
EVALUATION REPORT  
MCB CAMP LEJEUNE, NC**

**OCTOBER/NOVEMBER 2008 BENZENE CONCENTRATIONS  
(GROUNDWATER) ISOPLETHS - WELLS 70-90 FEET DEEP**

FIGURE  
**5A**

PROJECT NO.	208-037	DATE	JULY 2009	SCALE	AS SHOWN	DRAWN BY	SAC	CHECKED BY	MEM
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2003 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

OCTOBER/NOVEMBER 2008 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

MARCH 2009 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

2003 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

OCTOBER/NOVEMBER 2008 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

MARCH 2009 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

OCTOBER/NOVEMBER 2008 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UG/L

**LEGEND**

- Monitoring Wells**
- Type I (R)
- Type II (>)
- Type III (R)
- Pumping Well (S)
- Unknown (S)
- Water Supply Wells (W)
- Above Ground Storage Tank (AGST)
- Underground Storage Tank (UST)
- Railroad Tracks (RR)
- Fence (F)
- Gate (G)
- Wall (W)
- Well Sampled for Benzene per EPA Method 8260B (R)
- Well ID with Benzene Concentration (USTHPFFC-MW45)
- Benzene Concentrations (Contour interval as shown) (Dashed lines)
- Buildings and Structures (Solid lines)
- Demolished Structures (Dotted lines)
- Oil/Water Separators (Cross-hatched)
- Slabs (Grid pattern)
- Roads (Double lines)
- Driveways (Single lines)
- Parking Lots (Dashed lines)
- Surface Water Bodies (Blue)
- Creeks and Streams (Blue line)



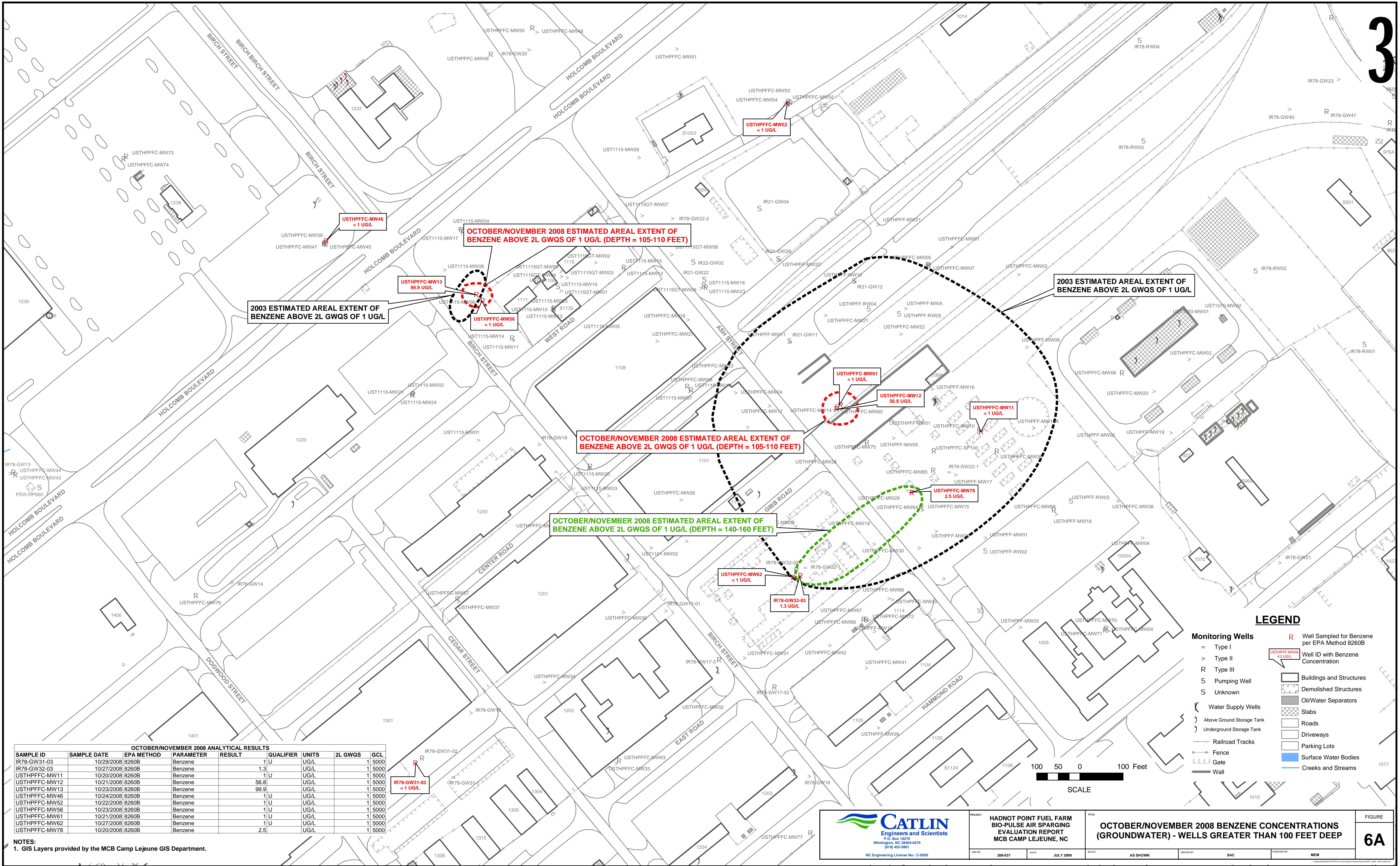
MARCH 2009 ANALYTICAL RESULTS							
SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	2L GWQS
IR78-GW32-02	3/13/2009	8260B	Benzene	23.5		UG/L	11,5000
UST1115-MW22	3/10/2009	8260B	Benzene	314		UG/L	11,5000
USTHPFFC-MW45	3/10/2009	8260B	Benzene	797		UG/L	11,5000

NOTES:  
1. GIS Layers provided by the MCB Camp Lejeune GIS Department.



HADNOT POINT FUEL FARM  
BIO-PULSE AIR SPARGING  
EVALUATION REPORT  
MCB CAMP LEJEUNE, NC

MARCH 2009 BENZENE CONCENTRATIONS  
(GROUNDWATER) ISOPLETHS - WELLS 70-90 FEET DEEP



2003 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UGL

OCTOBER/NOVEMBER 2008 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UGL (DEPTH = 105-110 FEET)

OCTOBER/NOVEMBER 2008 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UGL (DEPTH = 105-110 FEET)

OCTOBER/NOVEMBER 2008 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UGL (DEPTH = 140-160 FEET)

2003 ESTIMATED AREAL EXTENT OF BENZENE ABOVE 2L GWQS OF 1 UGL

OCTOBER/NOVEMBER 2008 ANALYTICAL RESULTS									
SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	2L GWQS	GCL	
IR78-GW31-03	10/29/2008	8260B	Benzene	1.1	U	UG/L	1.5000	1.5000	
IR78-GW32-03	10/27/2008	8260B	Benzene	1.3	U	UG/L	1.5000	1.5000	
USTHPFFC-MW11	10/20/2008	8260B	Benzene	1.1	U	UG/L	1.5000	1.5000	
USTHPFFC-MW12	10/21/2008	8260B	Benzene	56.8	U	UG/L	1.5000	1.5000	
USTHPFFC-MW13	10/23/2008	8260B	Benzene	99.9	U	UG/L	1.5000	1.5000	
USTHPFFC-MW46	10/24/2008	8260B	Benzene	1.1	U	UG/L	1.5000	1.5000	
USTHPFFC-MW52	10/22/2008	8260B	Benzene	1.1	U	UG/L	1.5000	1.5000	
USTHPFFC-MW56	10/23/2008	8260B	Benzene	1.1	U	UG/L	1.5000	1.5000	
USTHPFFC-MW61	10/21/2008	8260B	Benzene	1.1	U	UG/L	1.5000	1.5000	
USTHPFFC-MW62	10/27/2008	8260B	Benzene	1.1	U	UG/L	1.5000	1.5000	
USTHPFFC-MW78	10/20/2008	8260B	Benzene	2.5	U	UG/L	1.5000	1.5000	

NOTES:  
1. GIS Layers provided by the MCB Camp Lejeune GIS Department.

**LEGEND**

**Monitoring Wells**

- Type I
- Type II
- Type III
- Pumping Well
- Unknown
- Water Supply Wells
- Above Ground Storage Tank
- Underground Storage Tank
- Railroad Tracks
- Fence
- Gate
- Wall

**Well Sampled for Benzene per EPA Method 8260B**

**Well ID with Benzene Concentration**

- Buildings and Structures
- Demolished Structures
- Oil/Water Separators
- Slabs
- Roads
- Driveways
- Parking Lots
- Surface Water Bodies
- Creeks and Streams

**CATLIN**  
Engineers and Scientists  
P.O. Box 9279  
Wilmington, NC 28404-0279  
919.432.9661  
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PROJECT: HADNOT POINT FUEL FARM BIO-PULSE AIR SPARGING EVALUATION REPORT MCB CAMP LEJEUNE, NC

DATE: JULY 2009

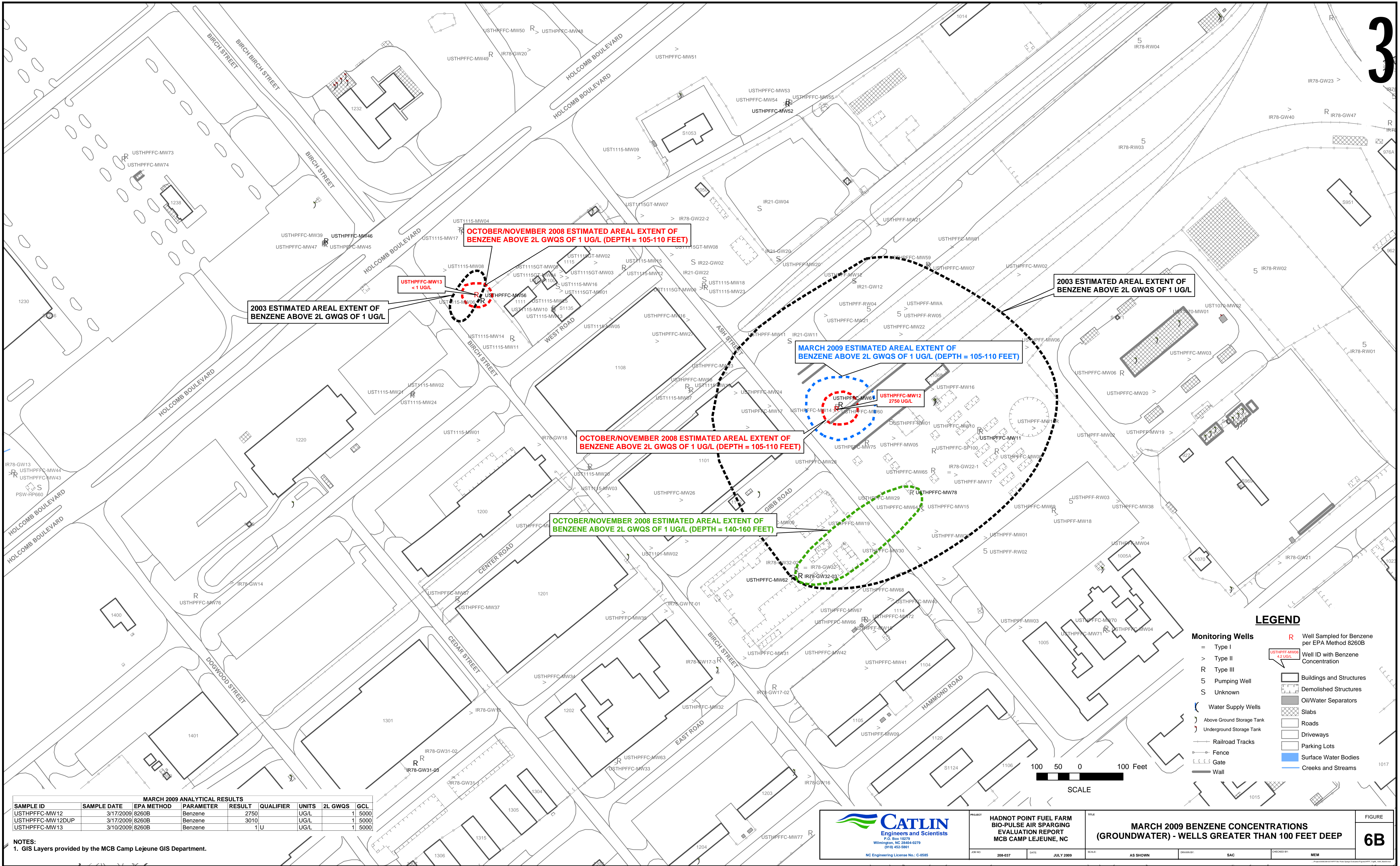
SCALE: AS SHOWN

DRAWN BY: SAC

CHECKED BY: MEM

**OCTOBER/NOVEMBER 2008 BENZENE CONCENTRATIONS (GROUNDWATER) - WELLS GREATER THAN 100 FEET DEEP**

FIGURE 6A



MARCH 2009 ANALYTICAL RESULTS							
SAMPLE ID	SAMPLE DATE	EPA METHOD	PARAMETER	RESULT	QUALIFIER	UNITS	2L GWQS
USTHPFFC-MW12	3/17/2009	8260B	Benzene	2750		UG/L	1 5000
USTHPFFC-MW12DUP	3/17/2009	8260B	Benzene	3010		UG/L	1 5000
USTHPFFC-MW13	3/10/2009	8260B	Benzene	11U		UG/L	1 5000

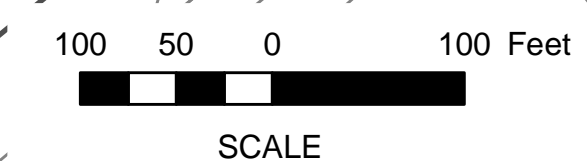
NOTES:  
1. GIS Layers provided by the MCB Camp Lejeune GIS Department.



HADNOT POINT FUEL FARM  
BIO-PULSE AIR SPARGING  
EVALUATION REPORT  
MCB CAMP LEJEUNE, NC

MARCH 2009 BENZENE CONCENTRATIONS  
(GROUNDWATER) - WELLS GREATER THAN 100 FEET DEEP

FIGURE  
6B



**LEGEND**

- Monitoring Wells**
- Type I
- Type II
- Type III
- R Type III
- S Pumping Well
- Unknown
- Water Supply Wells
- Above Ground Storage Tank
- Underground Storage Tank
- Railroad Tracks
- Fence
- Gate
- Wall
- Well Sampled for Benzene per EPA Method 8260B
- Well ID with Benzene Concentration
- Buildings and Structures
- Demolished Structures
- Oil/Water Separators
- Slabs
- Roads
- Driveways
- Parking Lots
- Surface Water Bodies
- Creeks and Streams

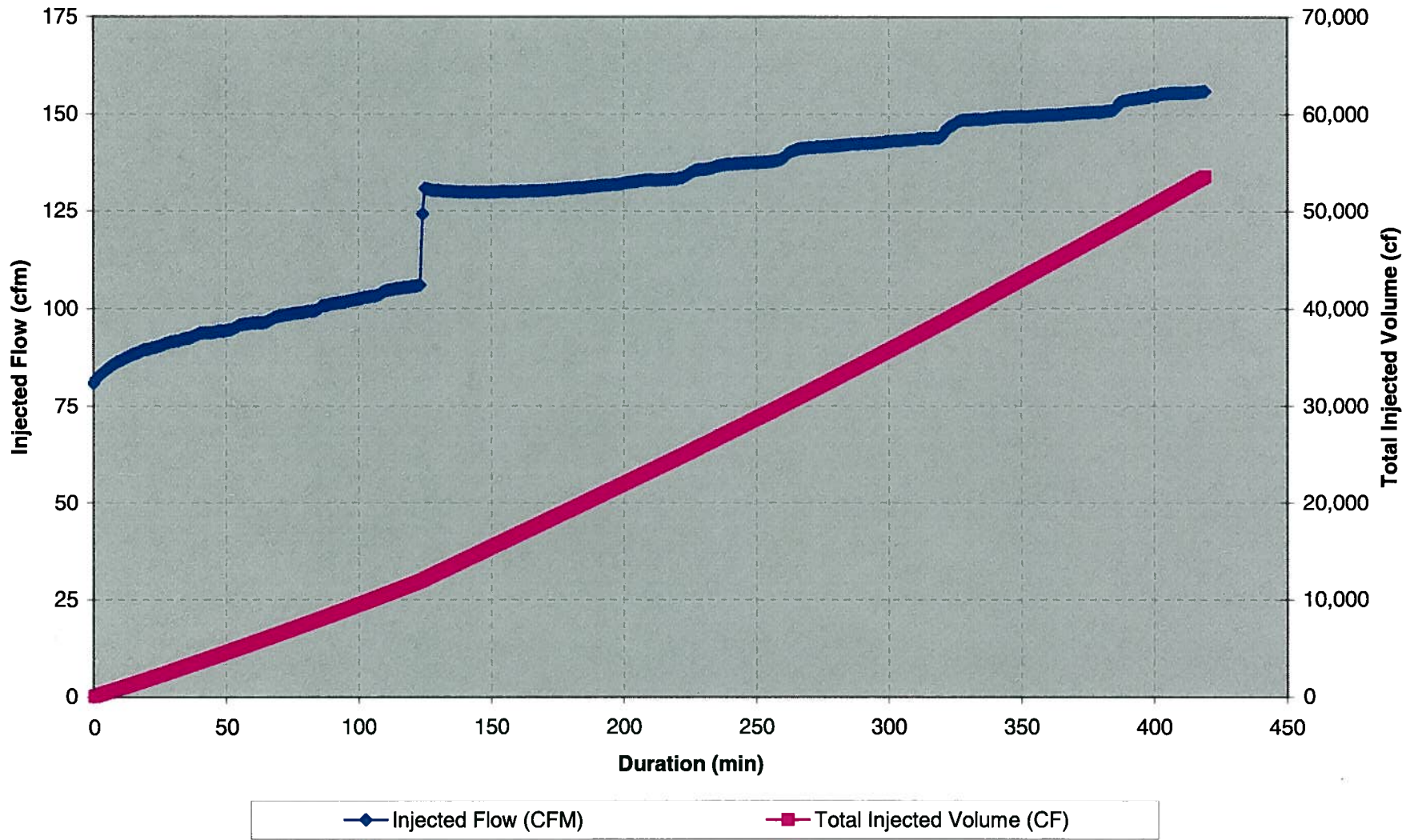
## APPENDICES

**APPENDIX A**

**AIR FLOW VS. TIME GRAPHS SEVENTH ROUND OF BIO-PULSE SPARGING**

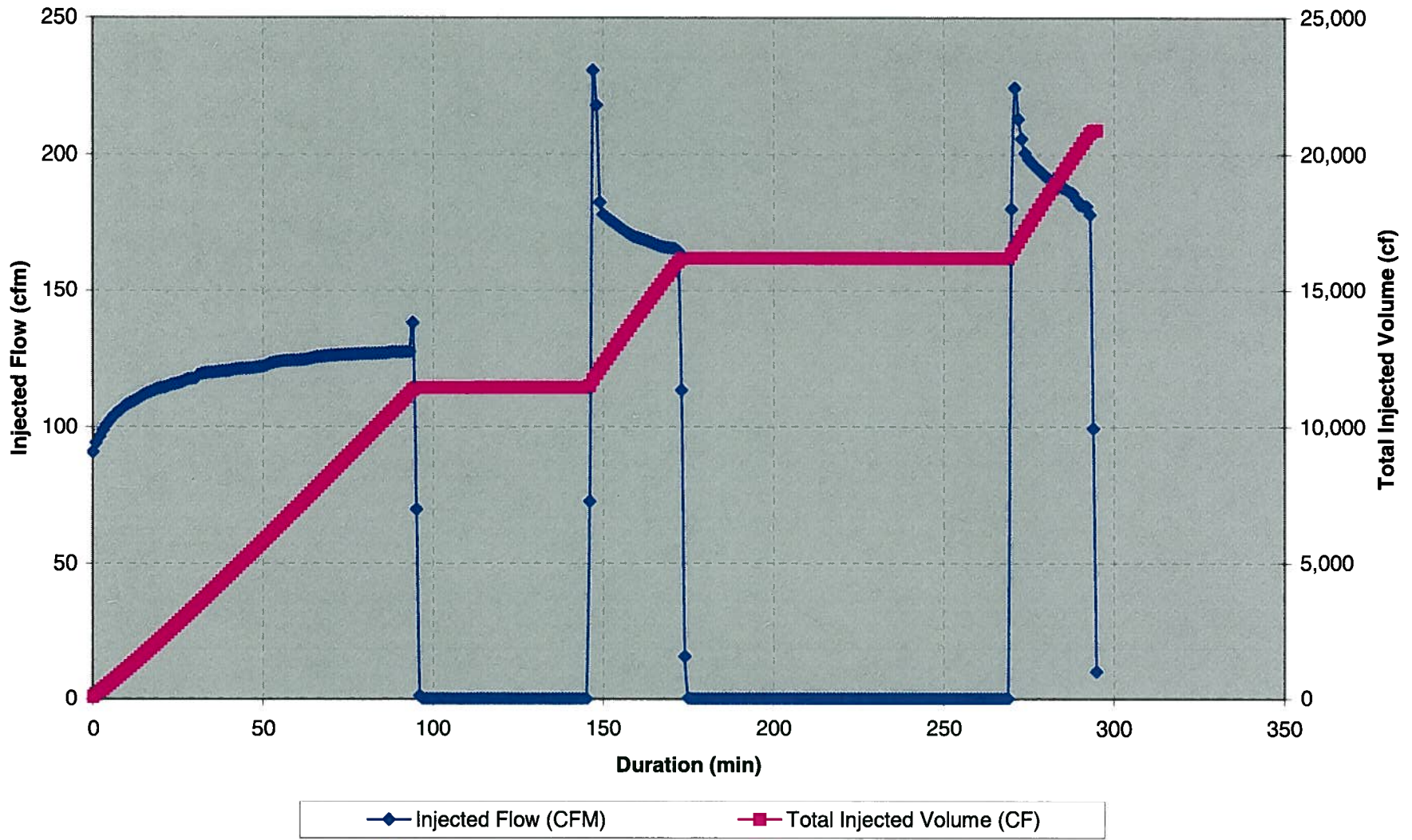
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-01  
5/20/2008**



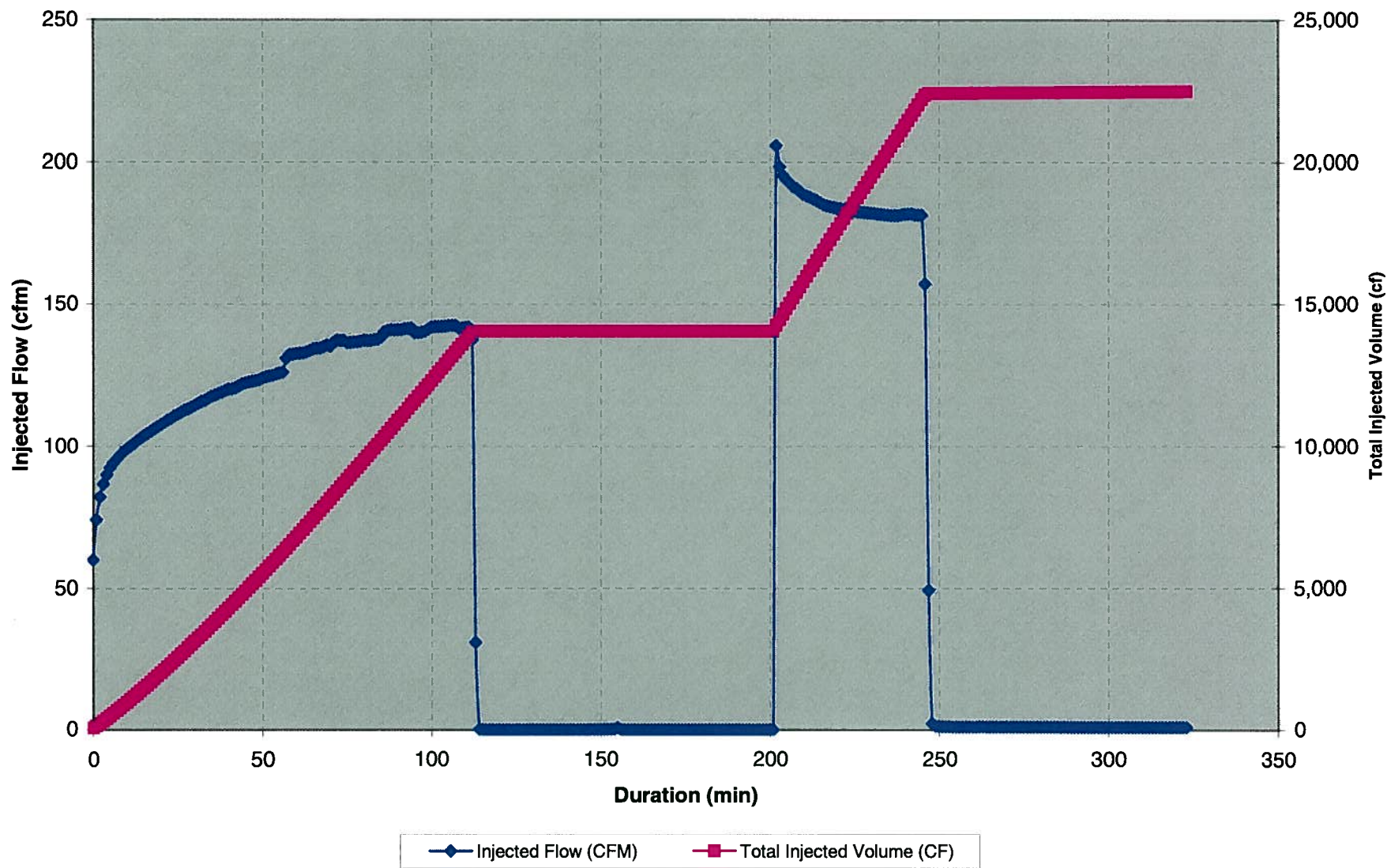
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-02  
6/4/2008**



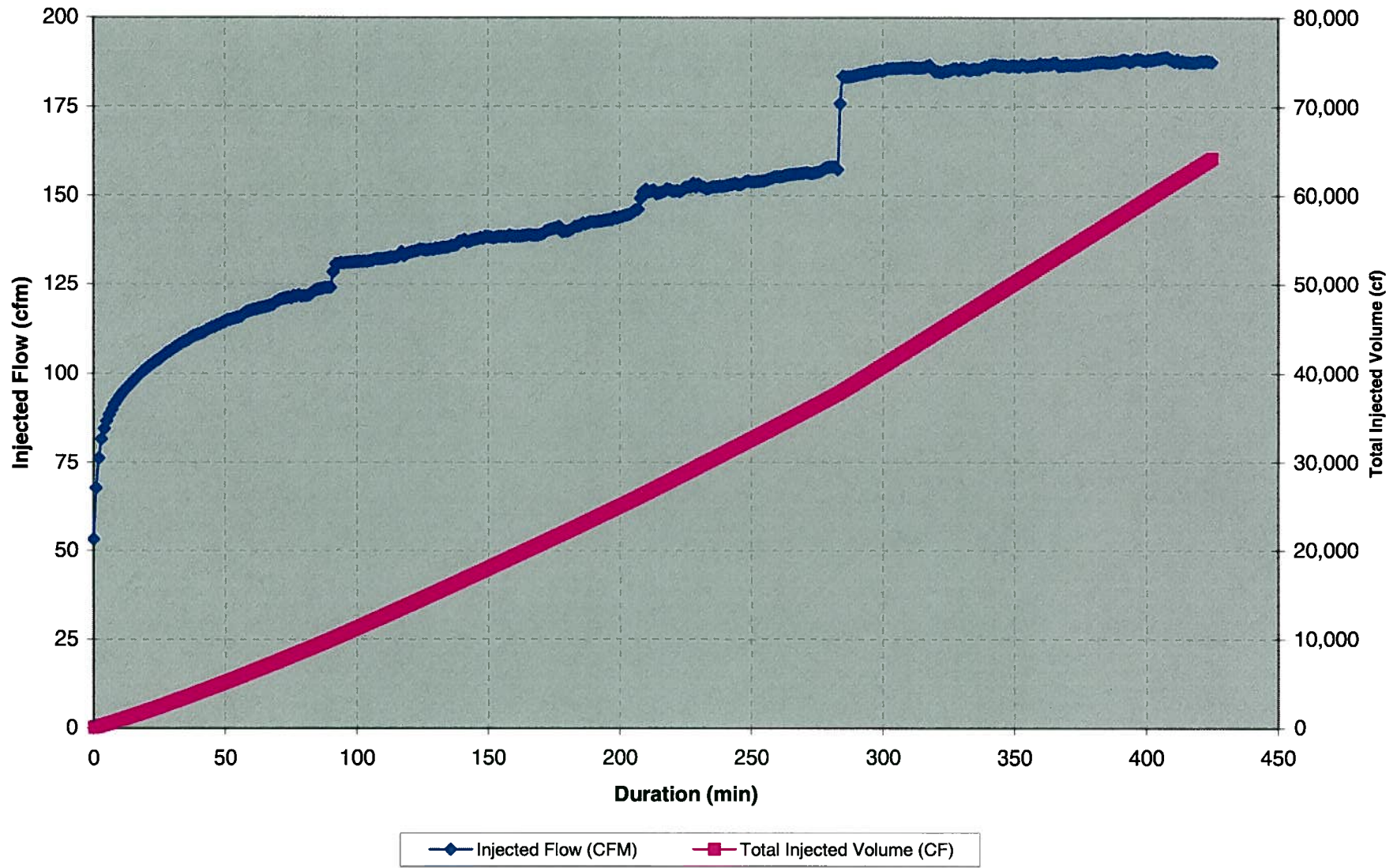
AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING

BP-03  
7/22/2008



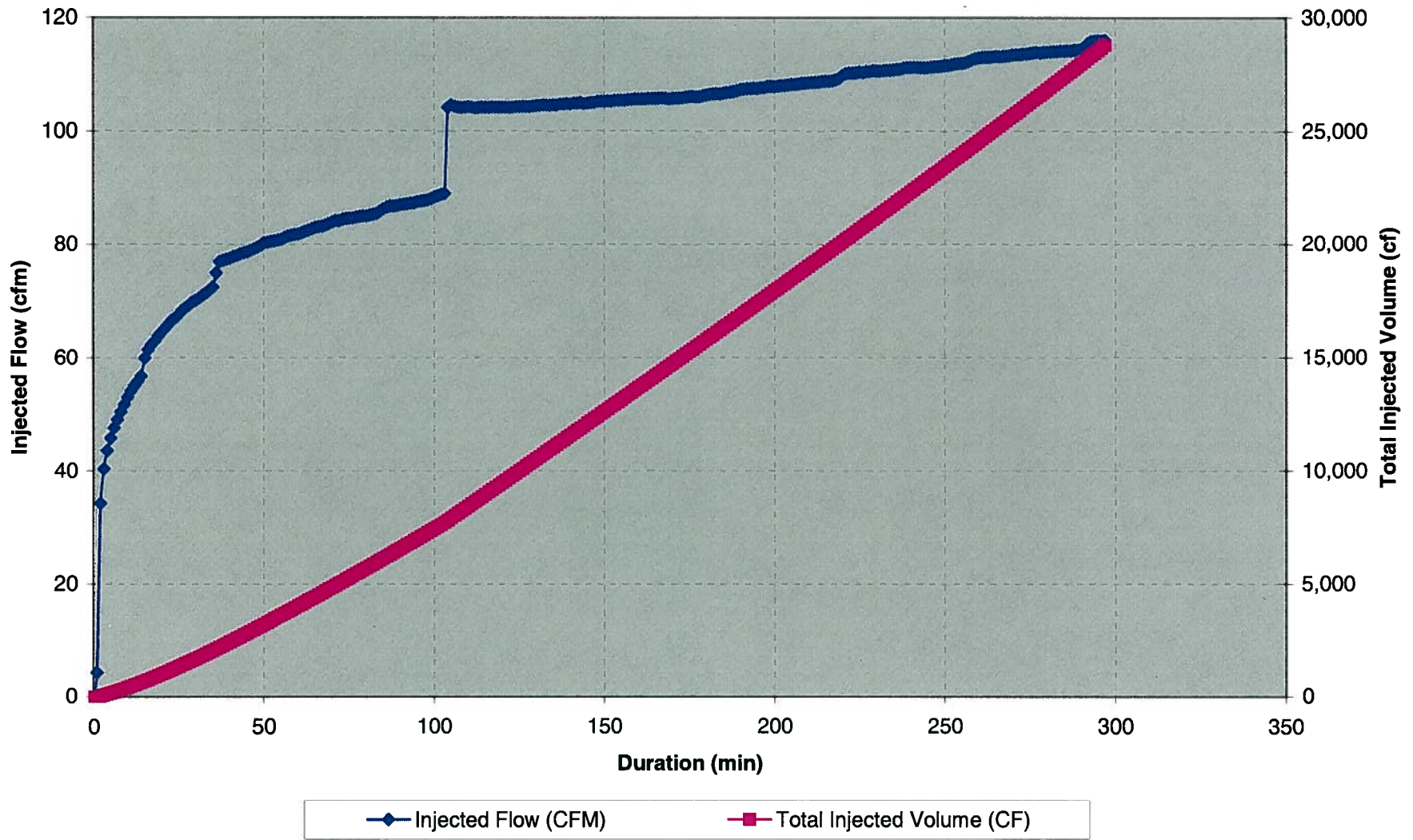
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-03  
Second Event - 7/23/2008**



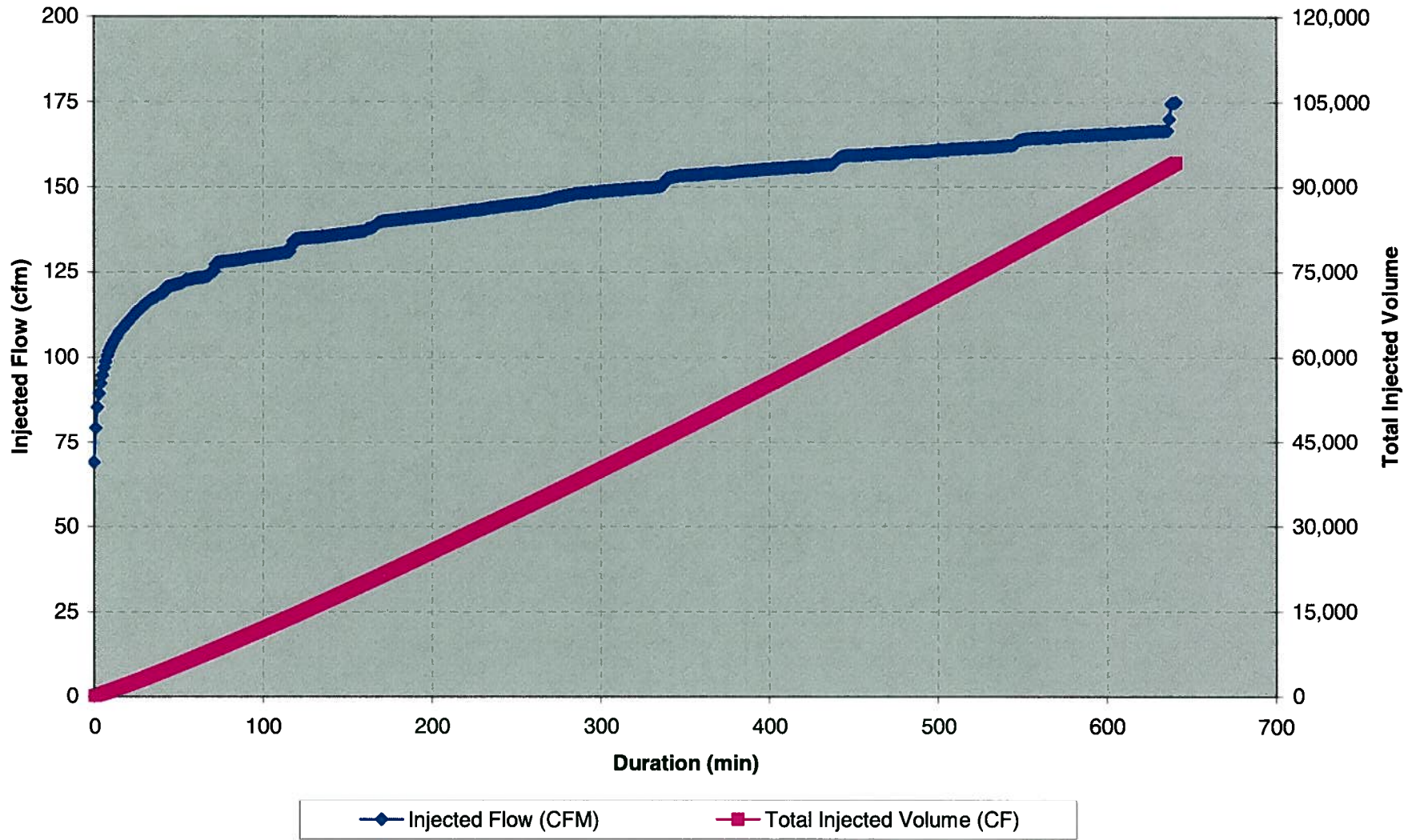
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-04  
5/30/2008**



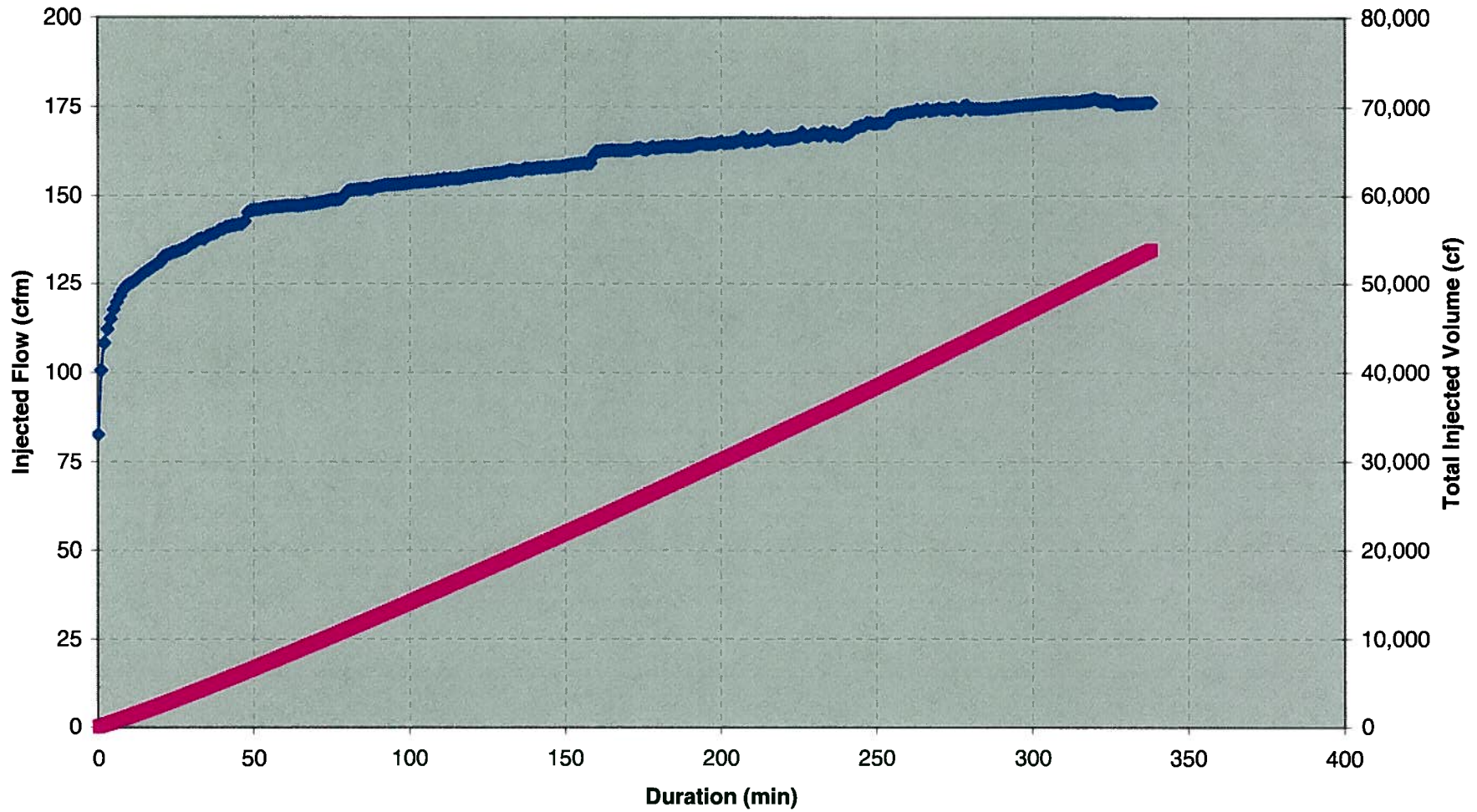
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-05  
7/2/2008**



**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

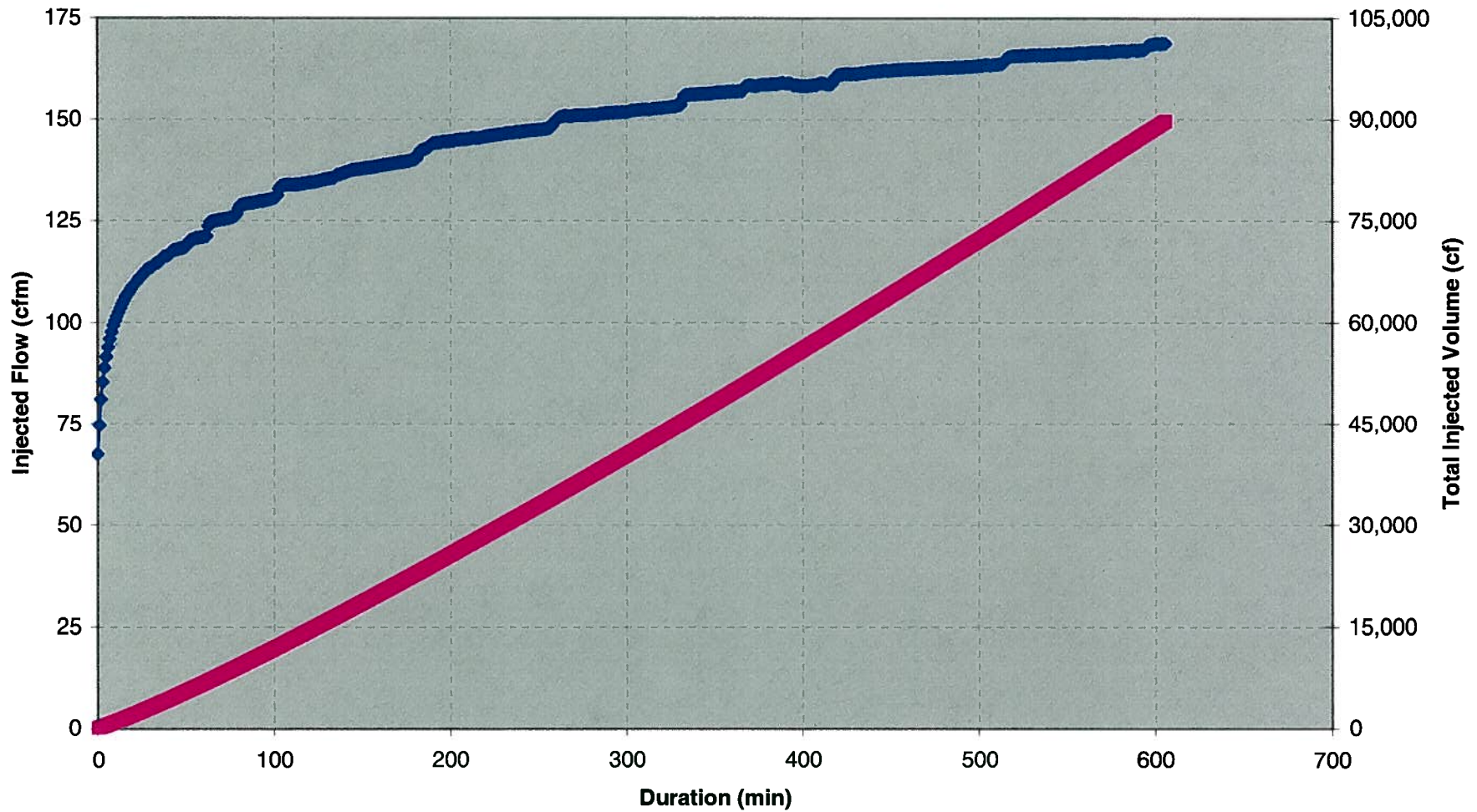
**BP-06  
7/9/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

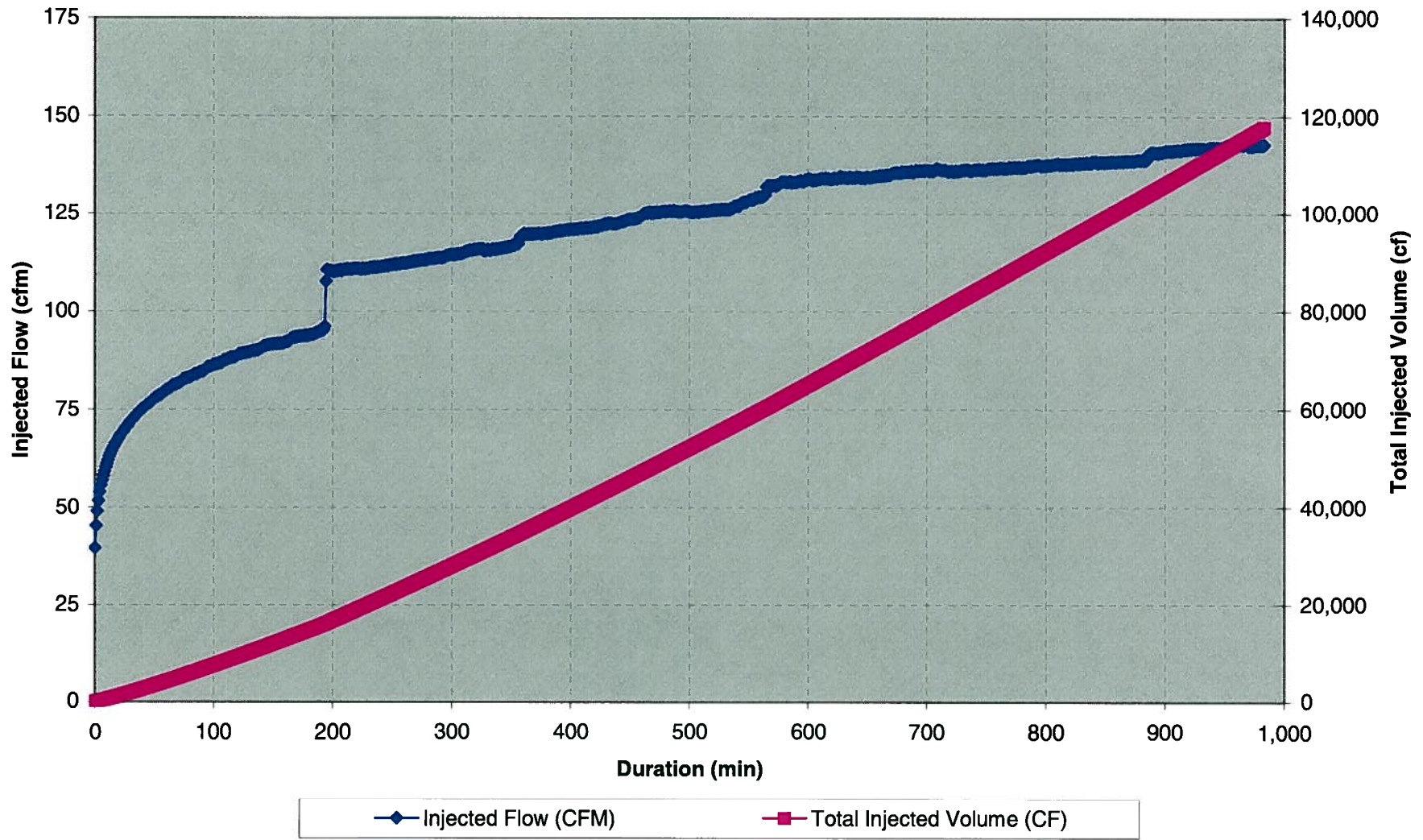
**BP-07  
5/27/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

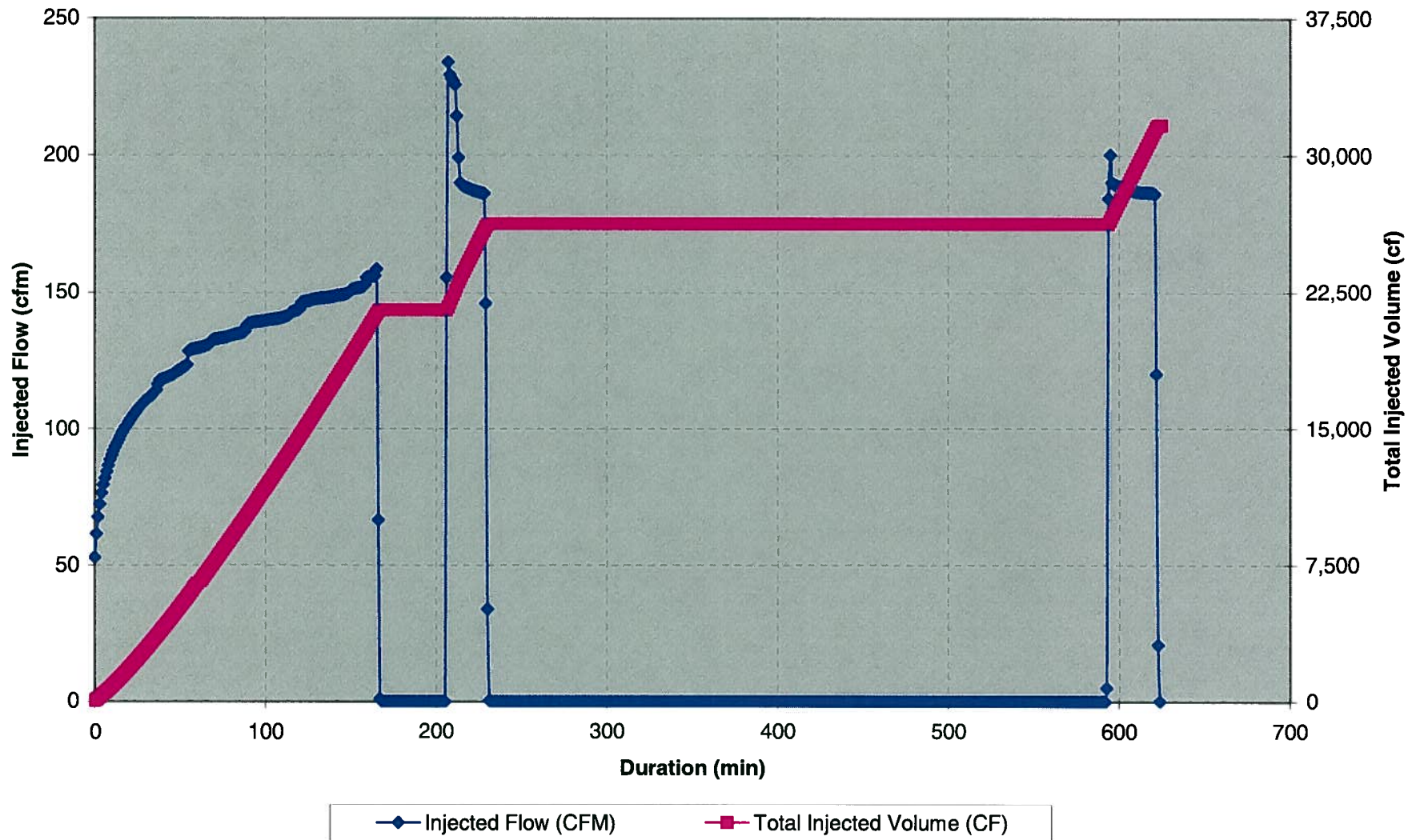
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-08  
7/14/2008**



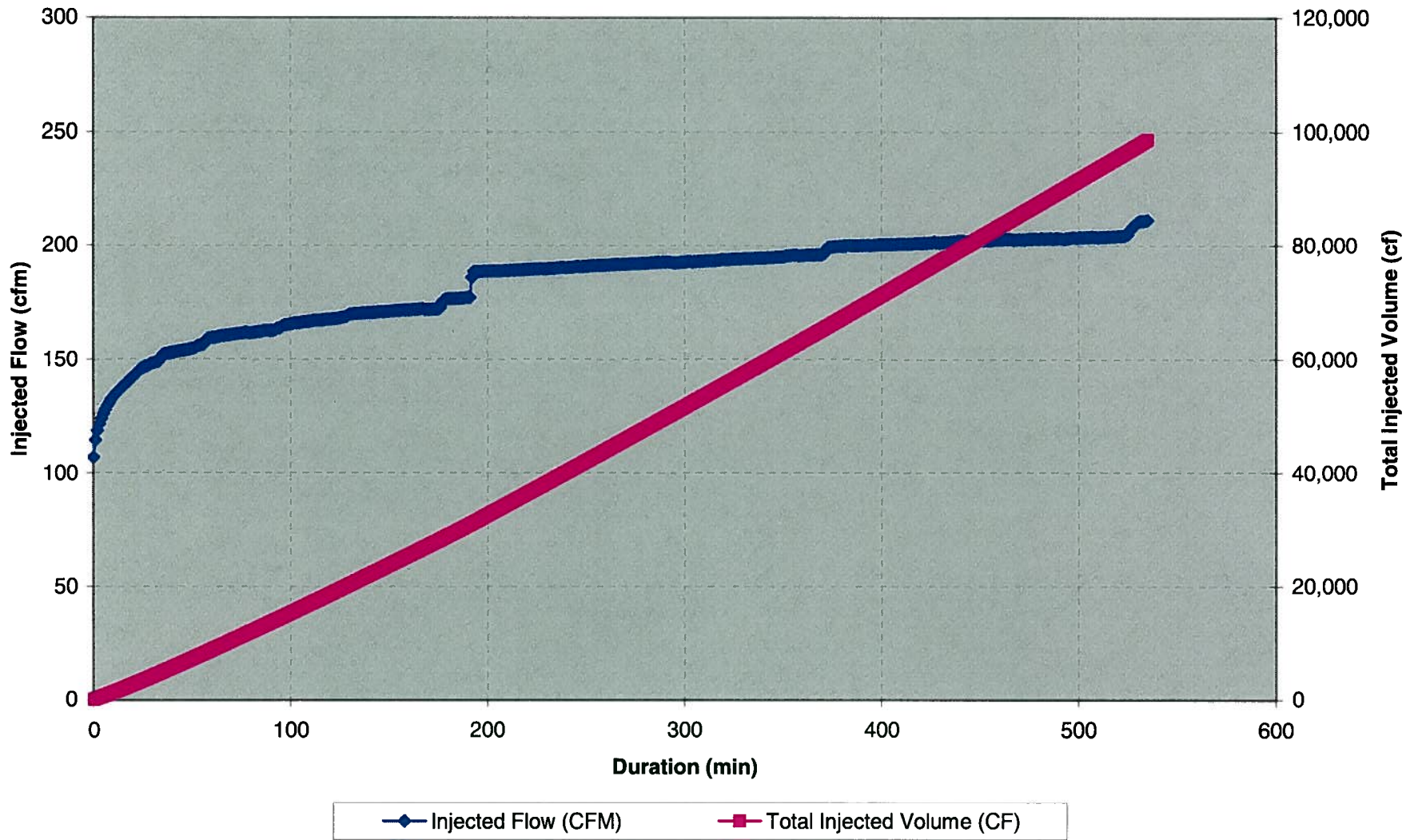
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-09  
6/12/2008**



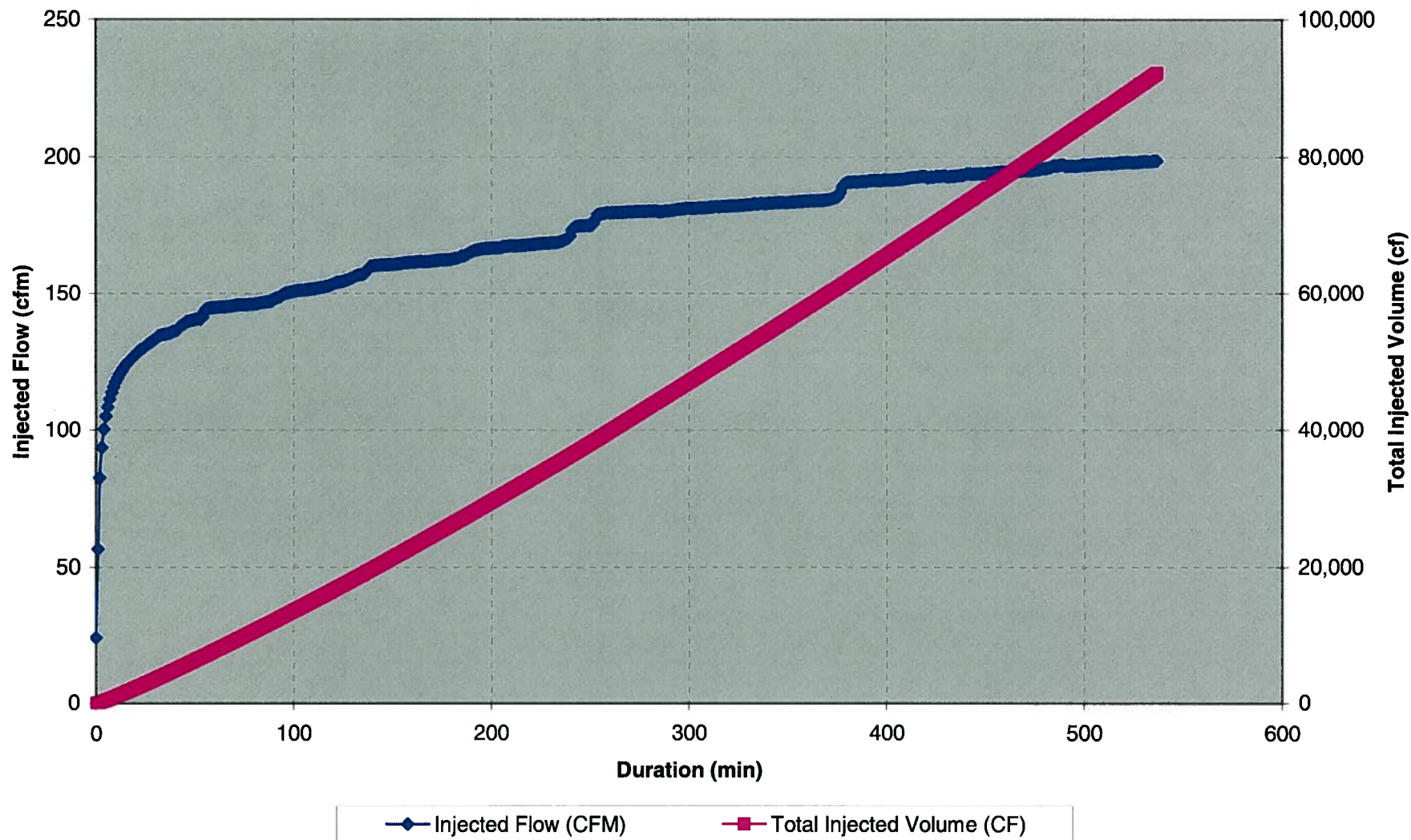
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-10  
6/10/2008**



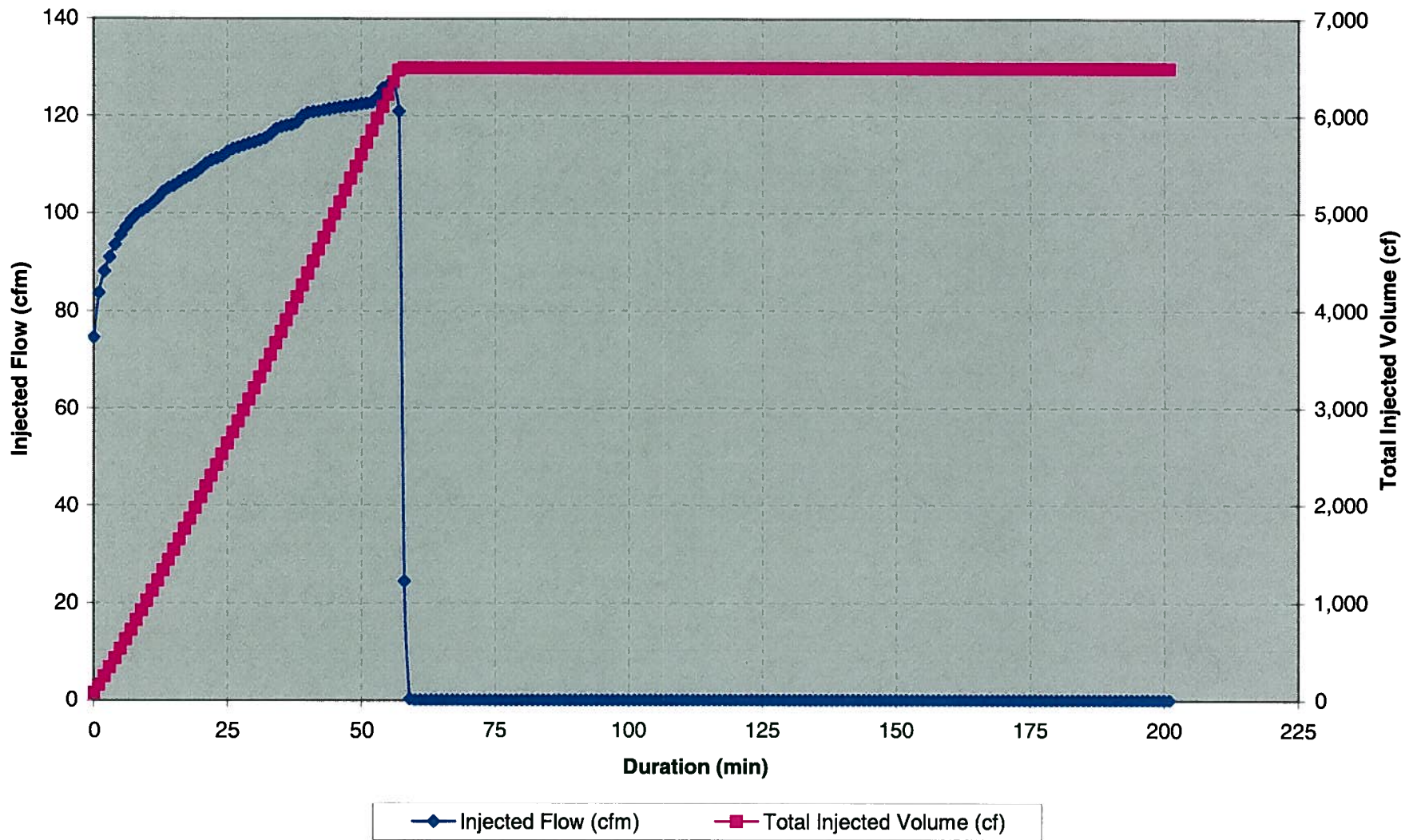
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-10  
Second Event - Date Unknown**



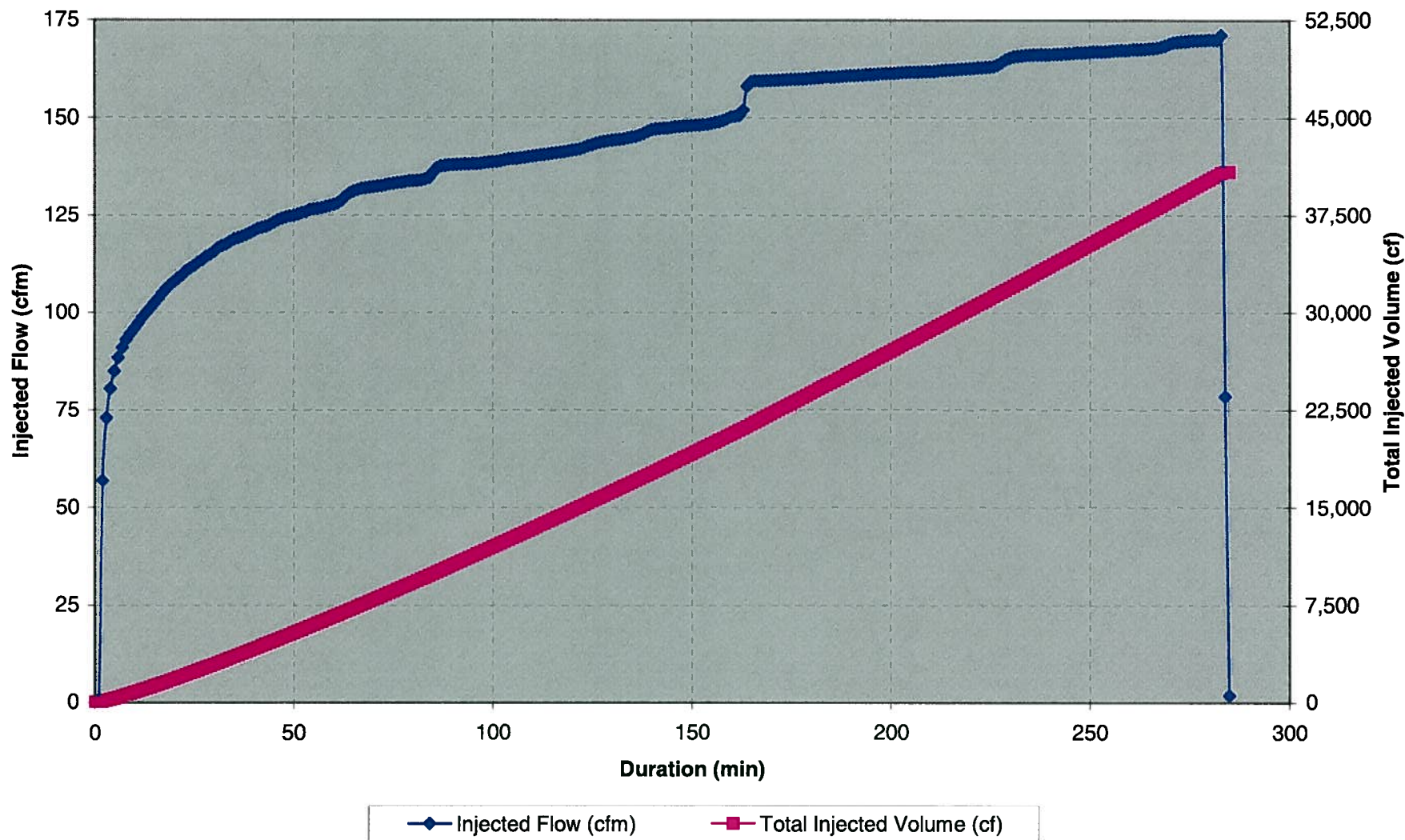
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-11  
6/16/2008**



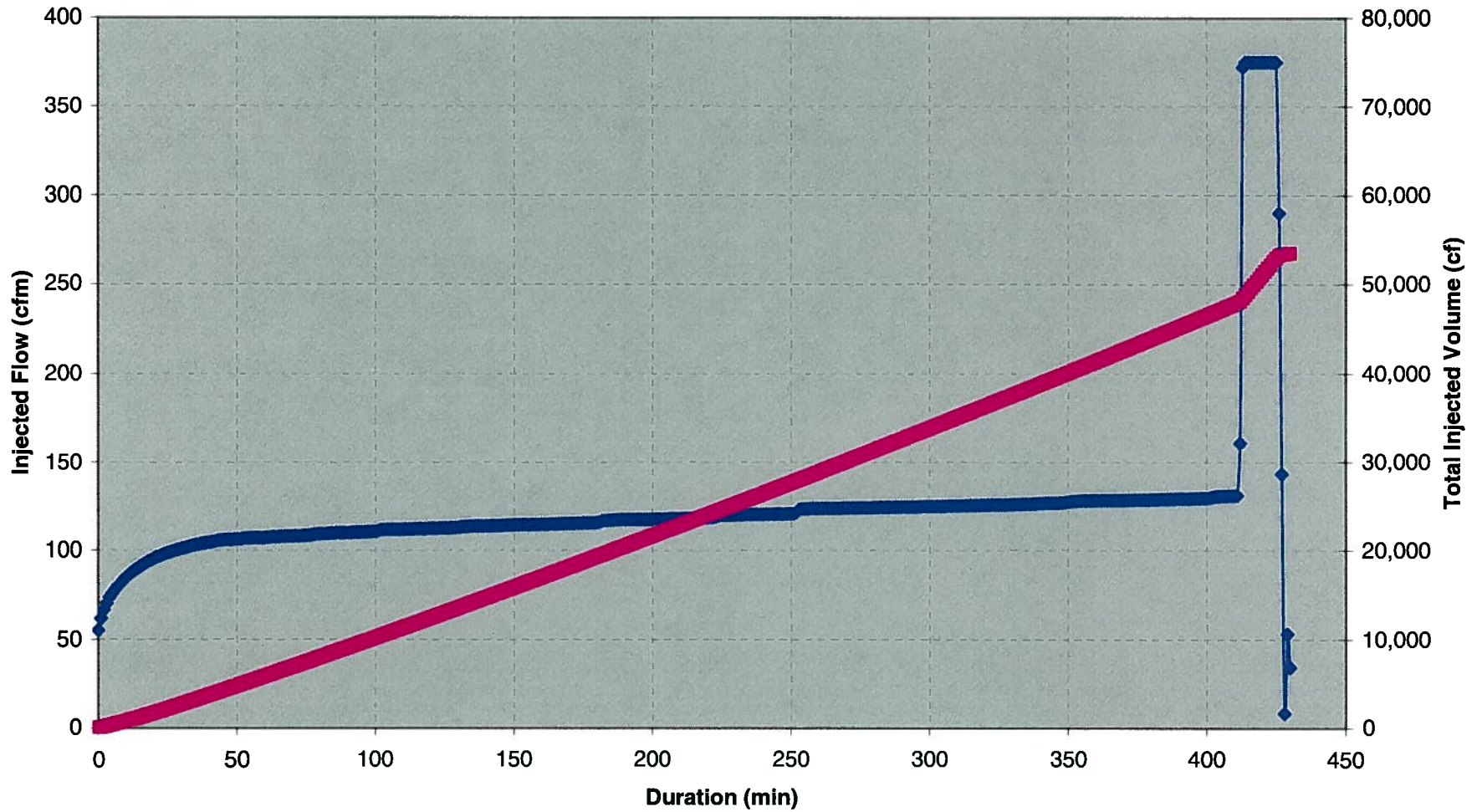
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-11  
Second Event - 6/30/2008**



**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

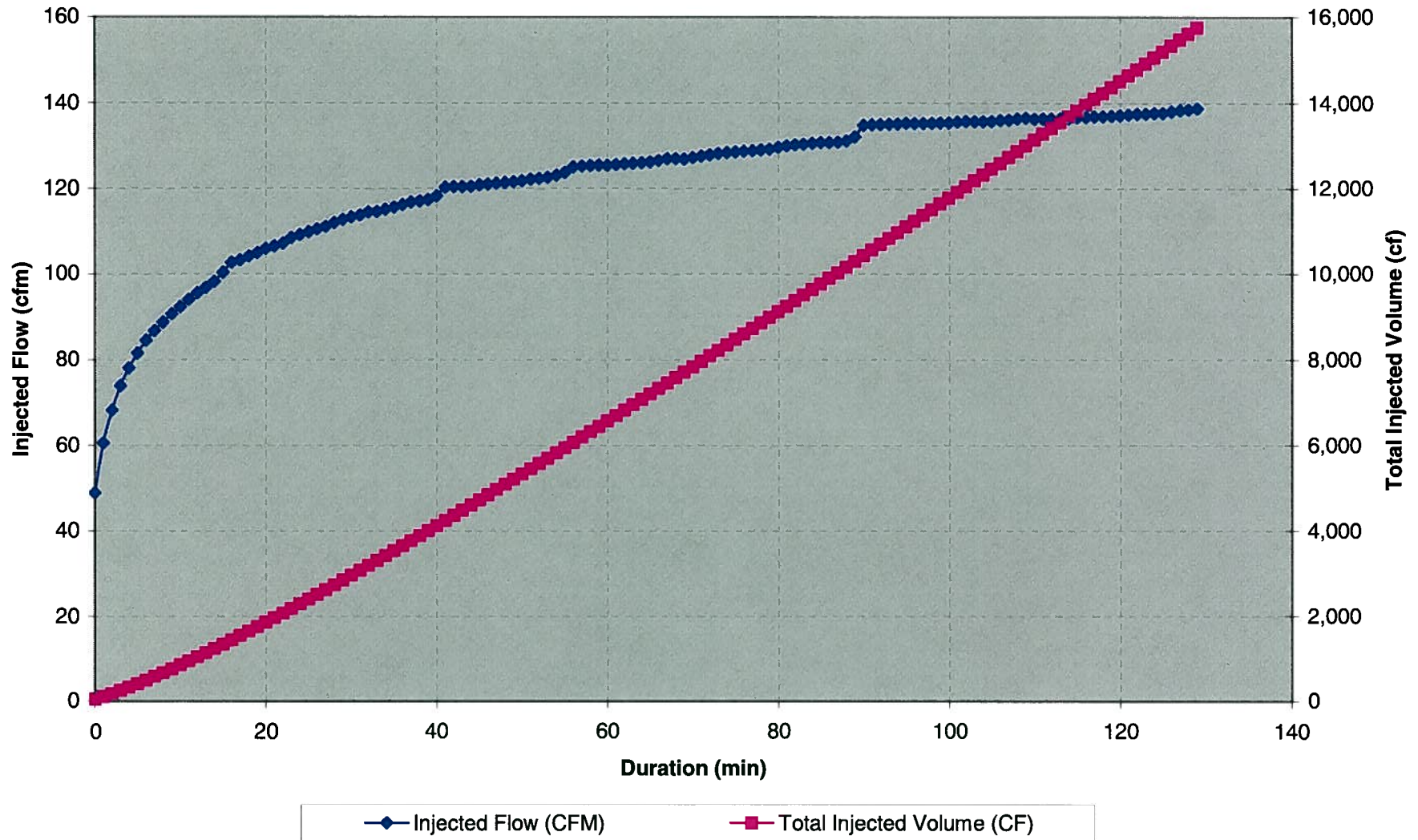
**BP-12  
5/22/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

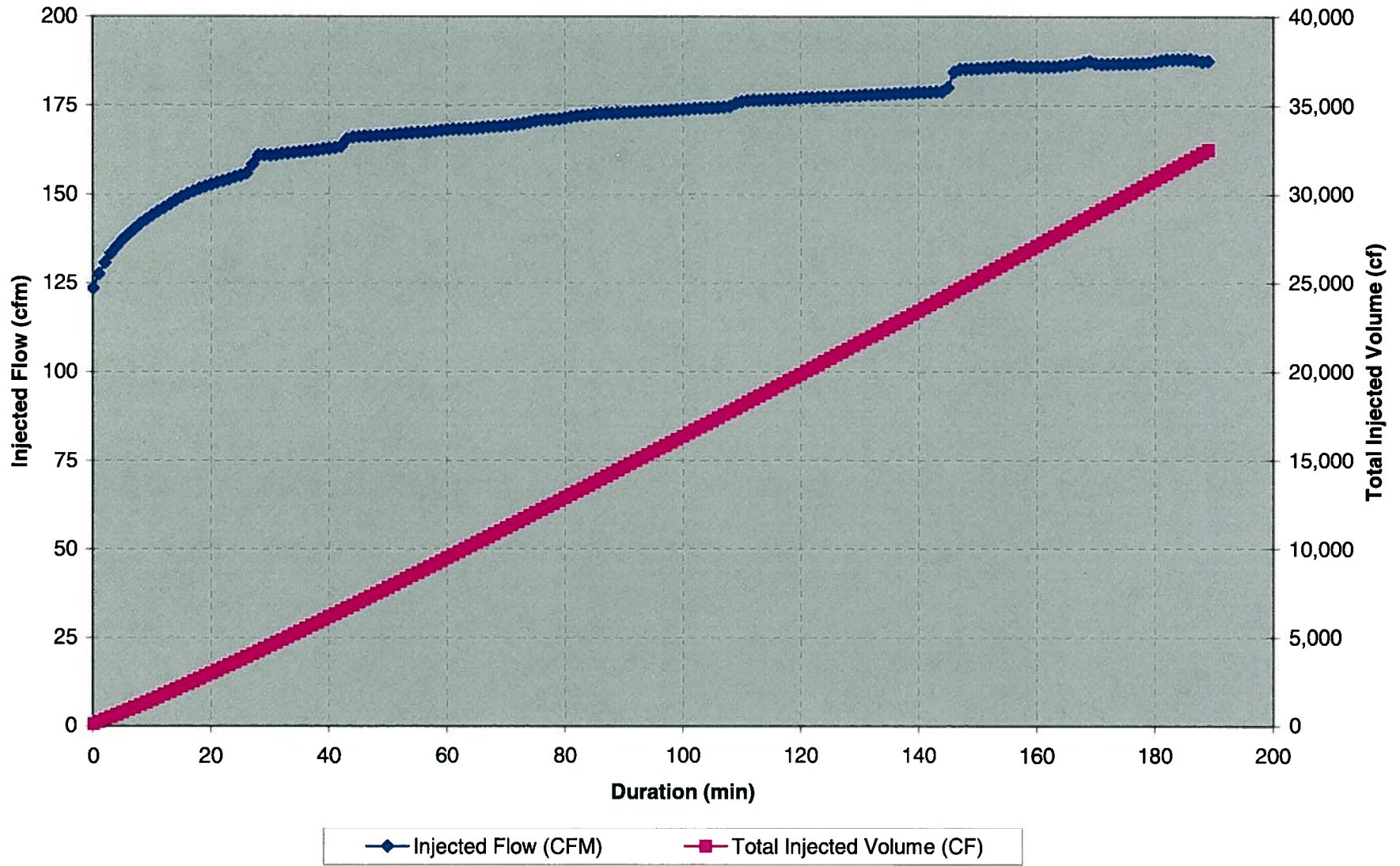
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-13  
7/15/2008**



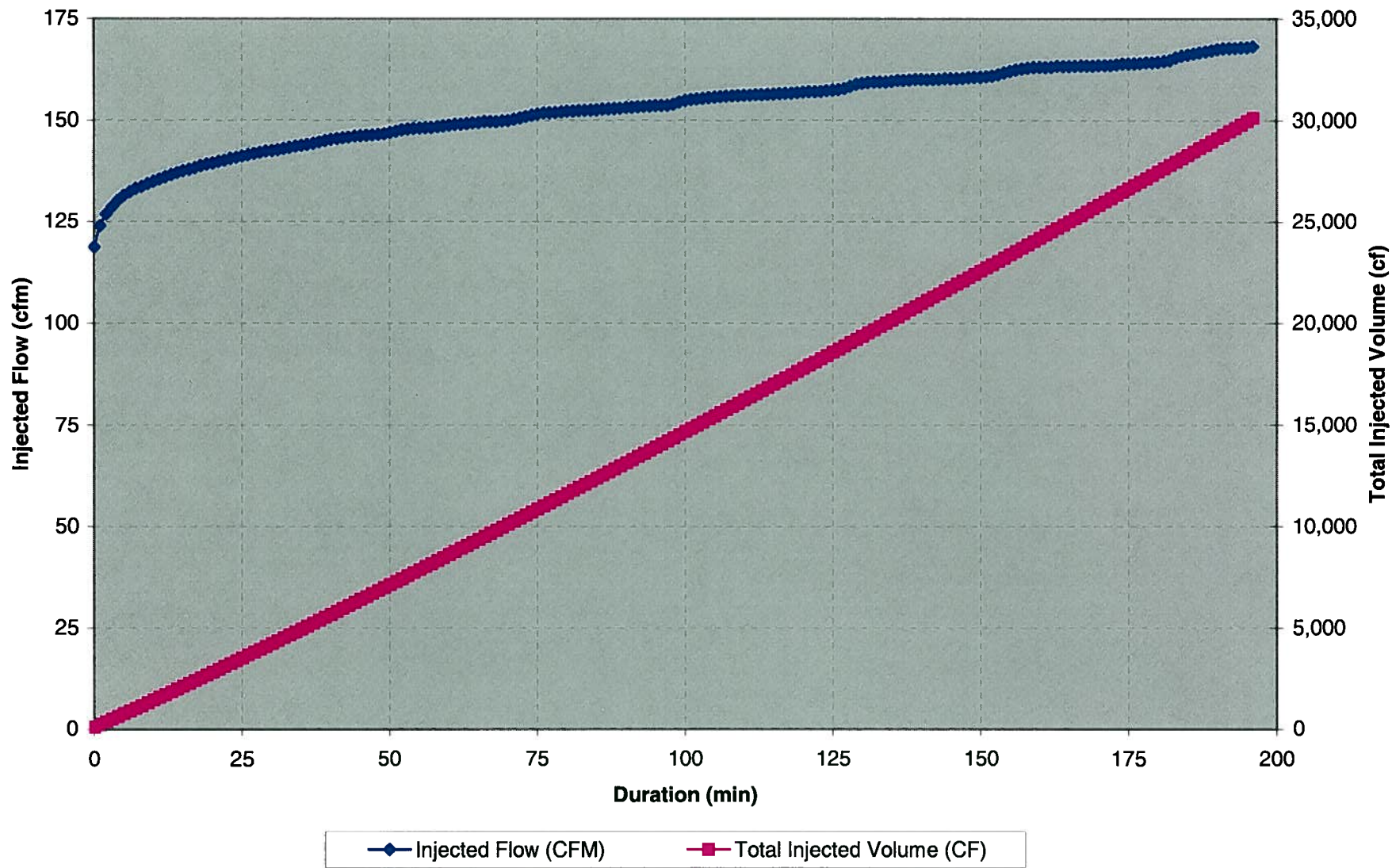
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-14  
6/5/2008**



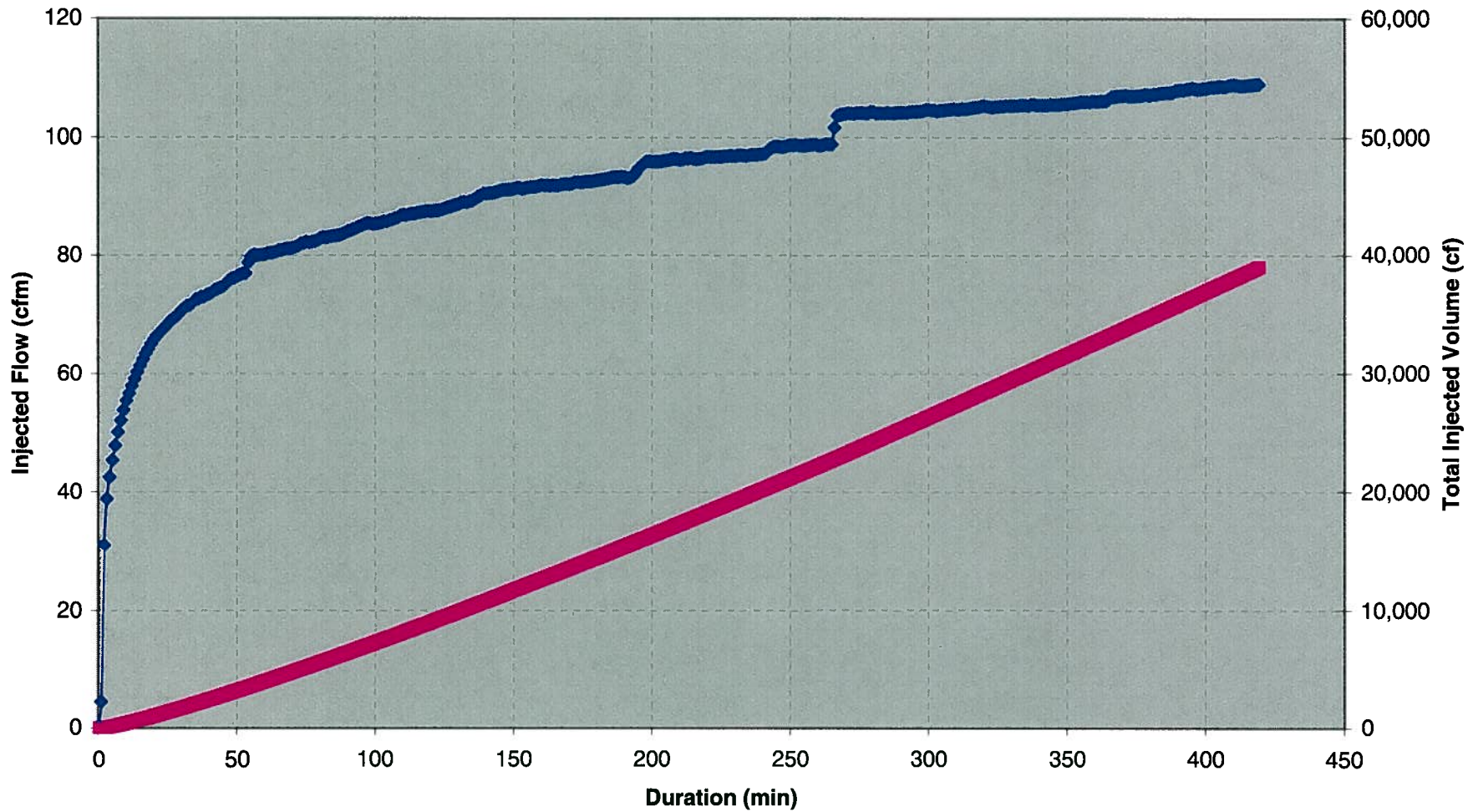
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-14  
Second Event - Date Unknown**



**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

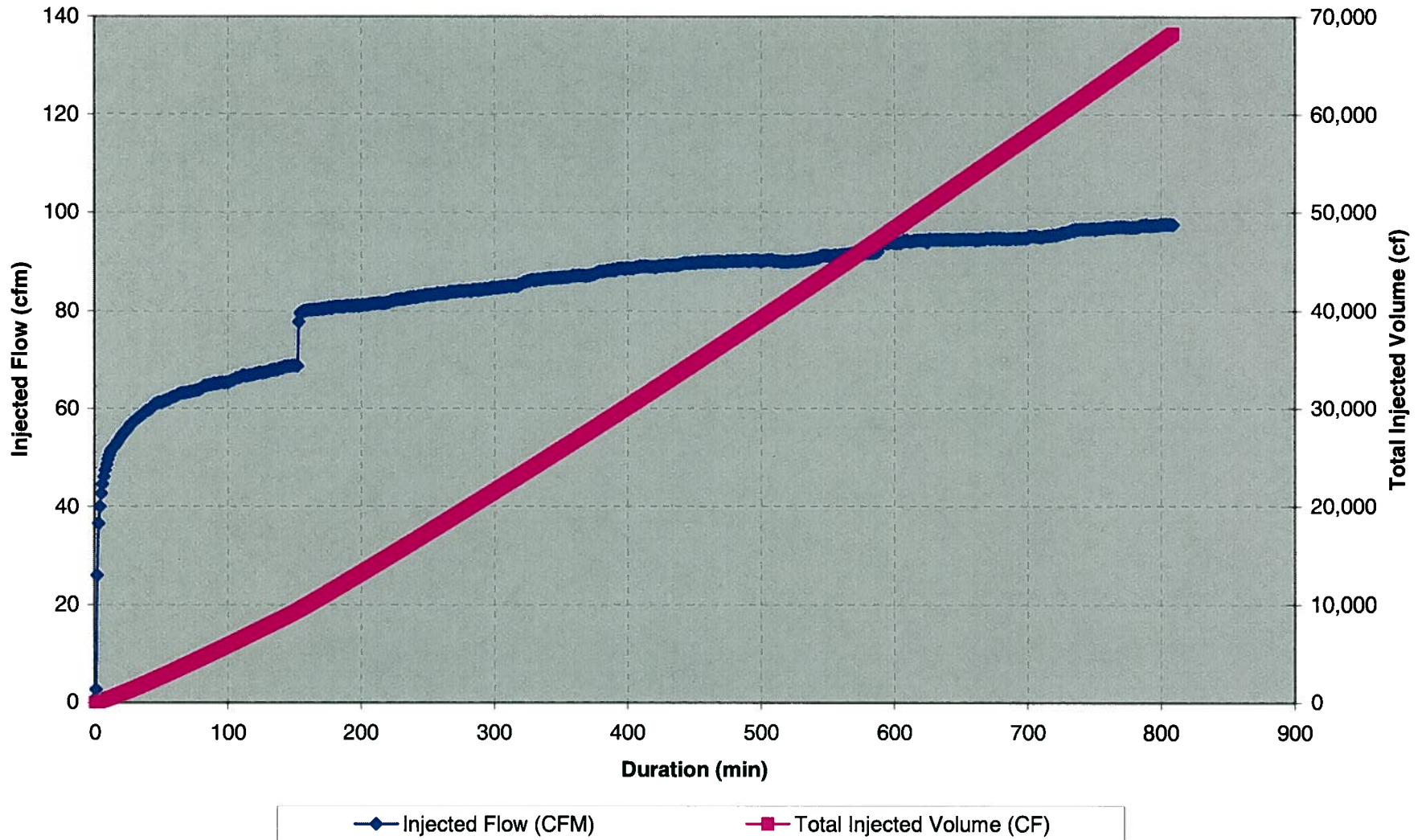
**BP-15  
6/2/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

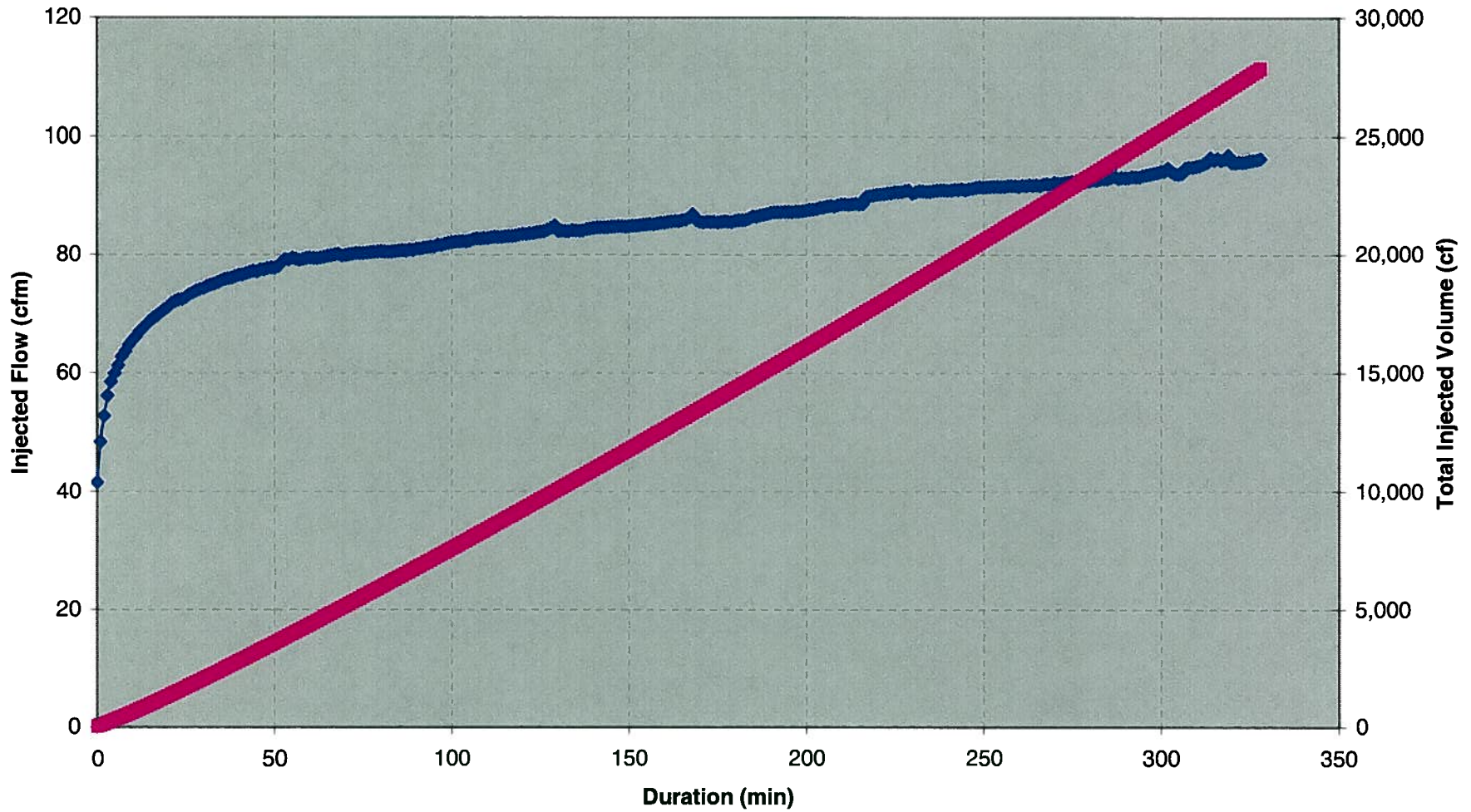
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-16  
7/8/2008**



**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

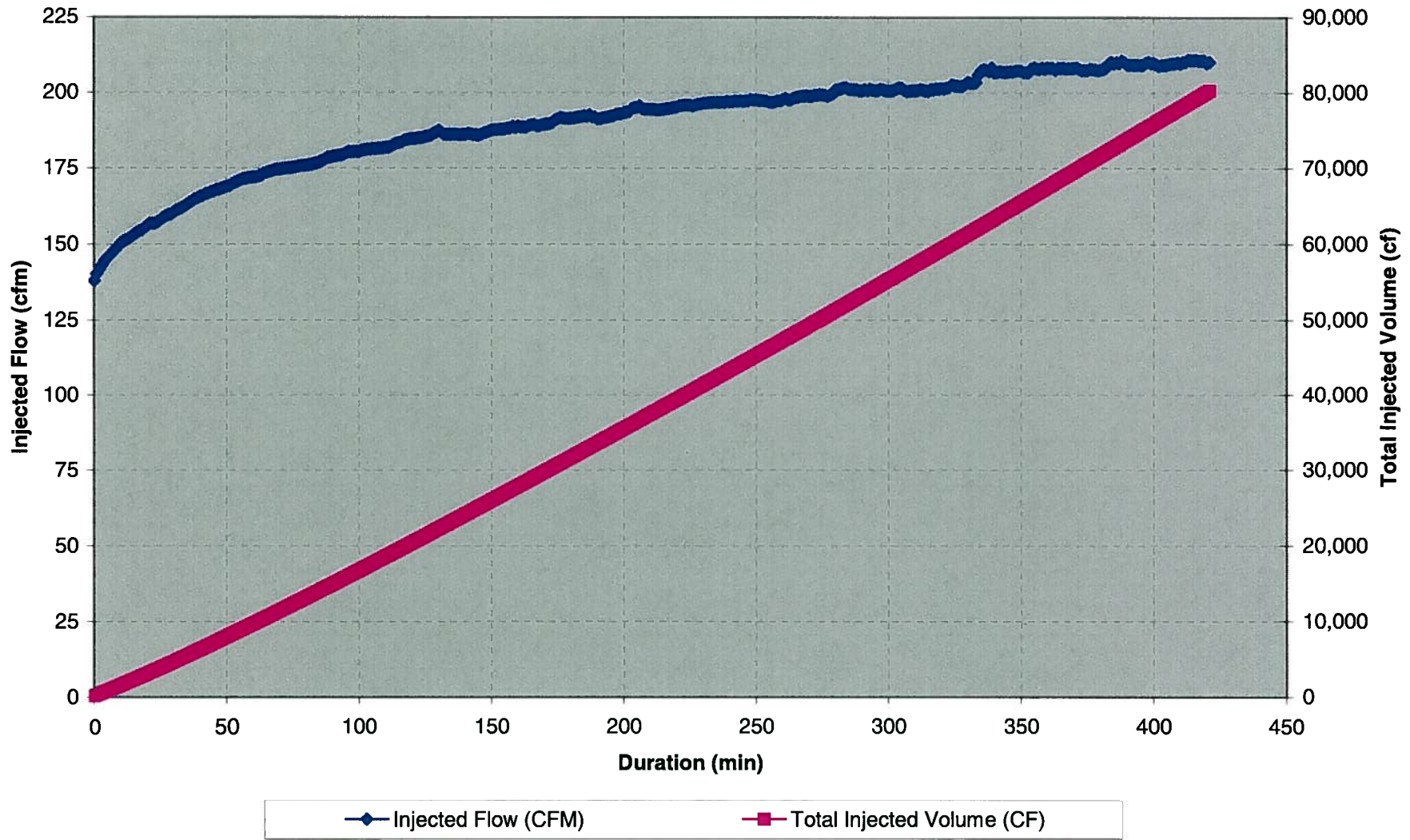
**BP-17  
7/10/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

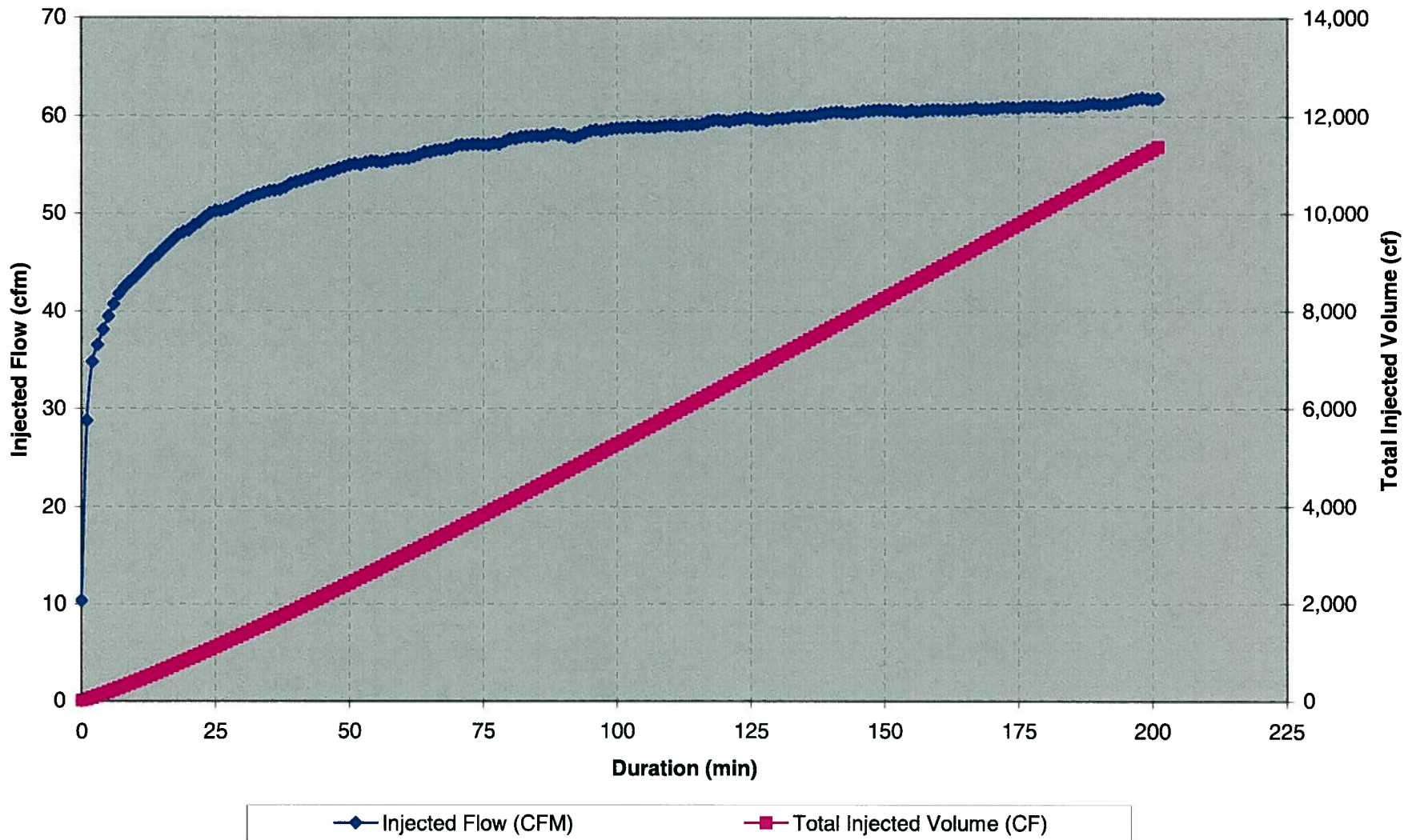
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-18  
7/17/2008**



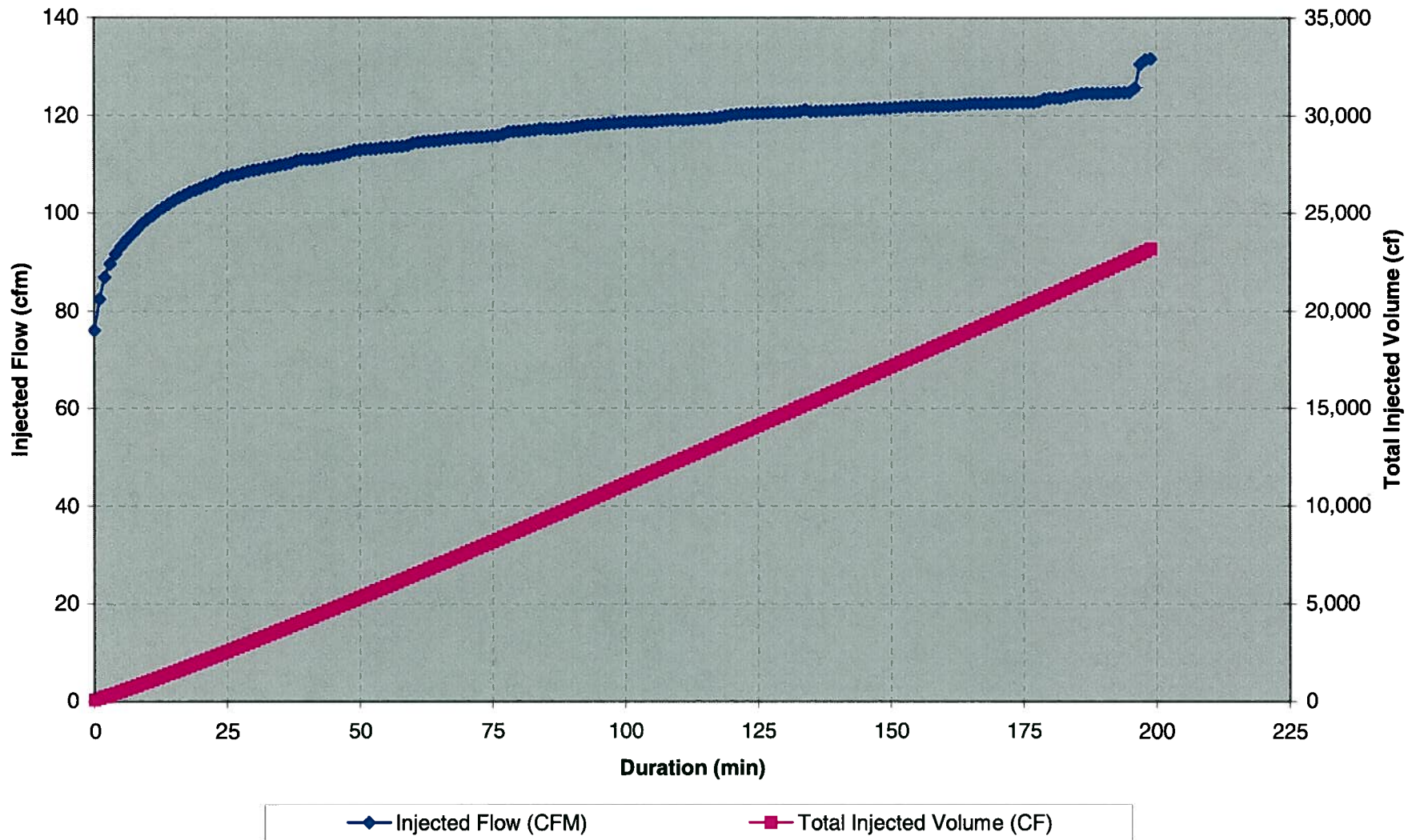
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-19  
6/6/2008**



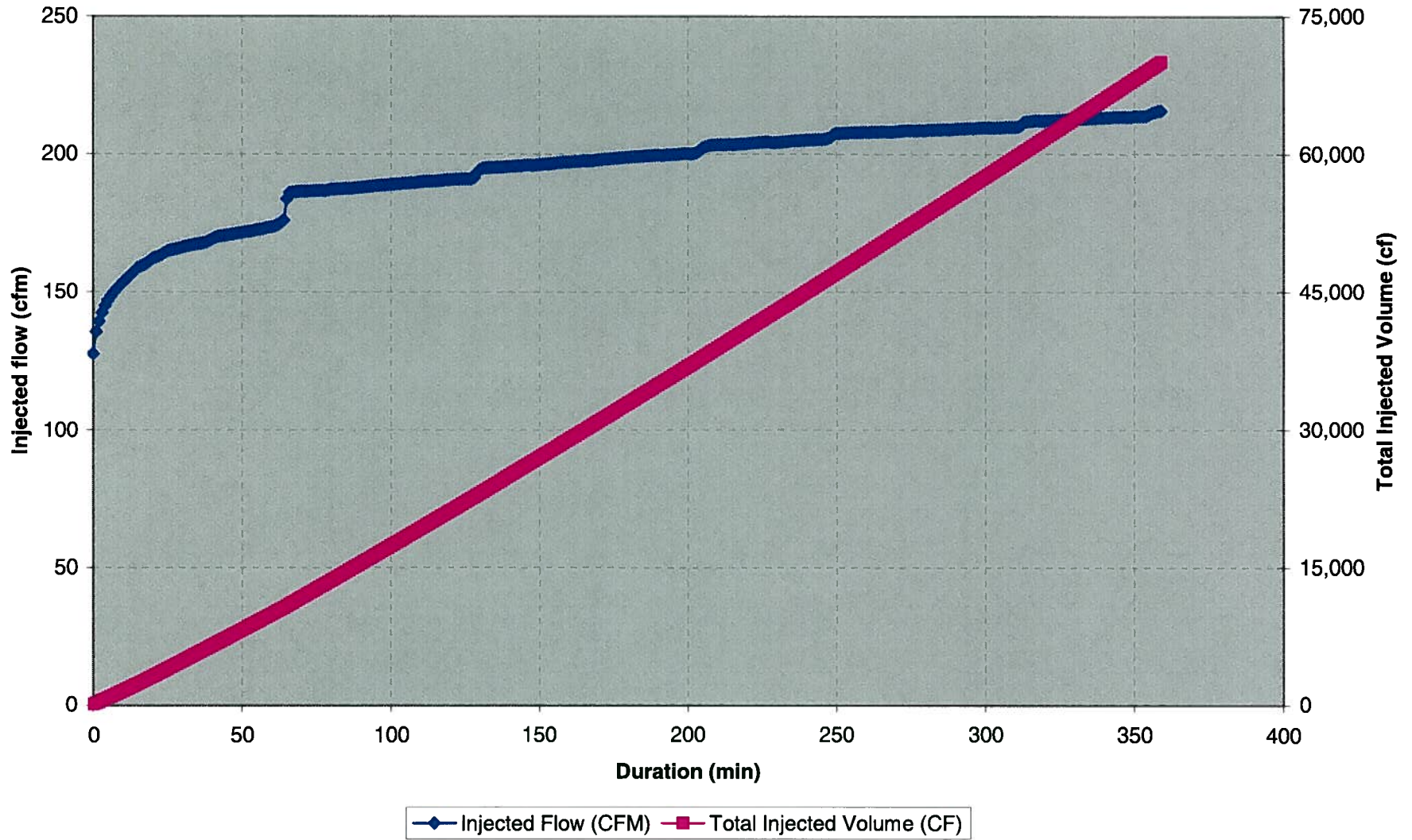
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-20  
7/1/2008**



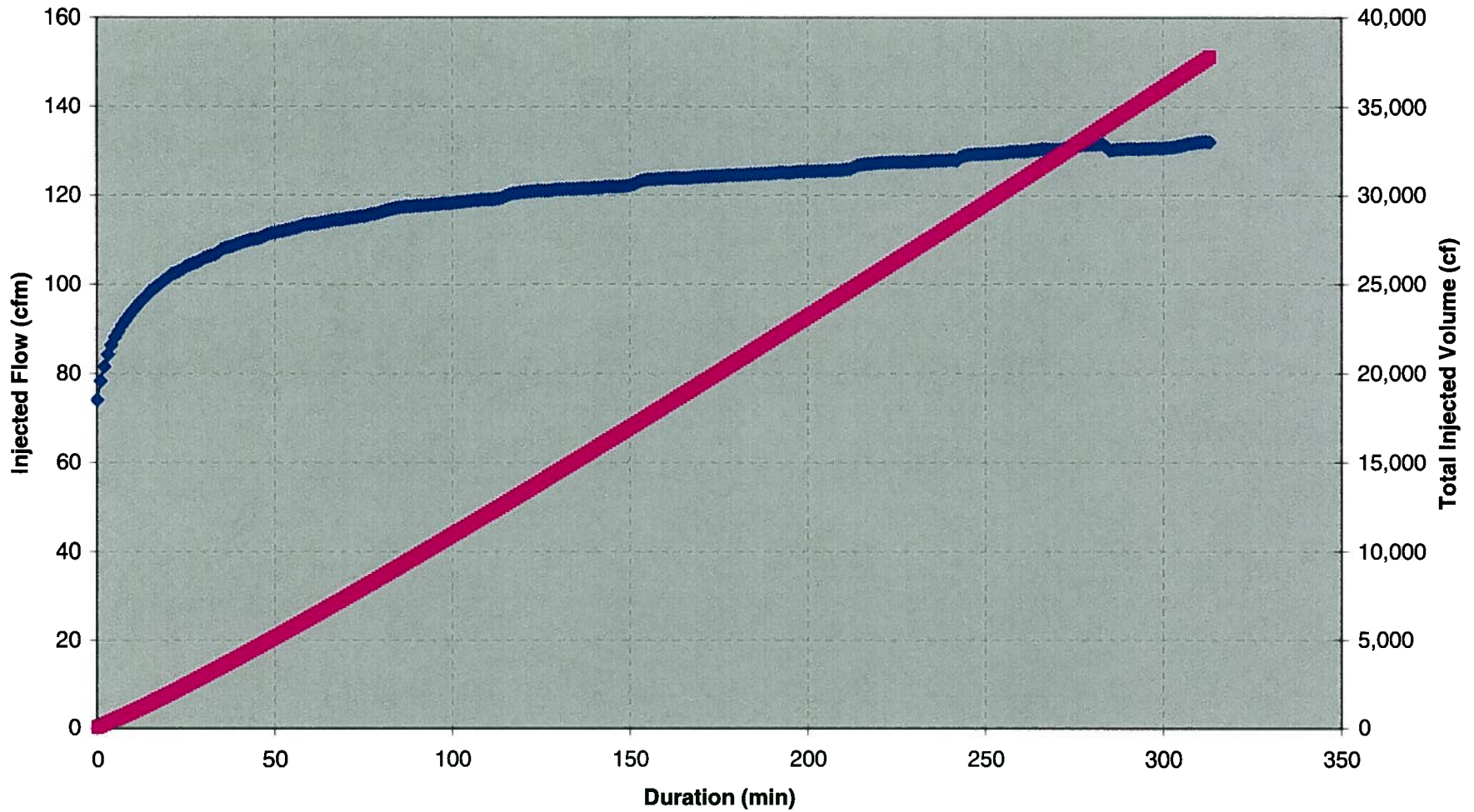
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-21  
5/21/2008**



**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

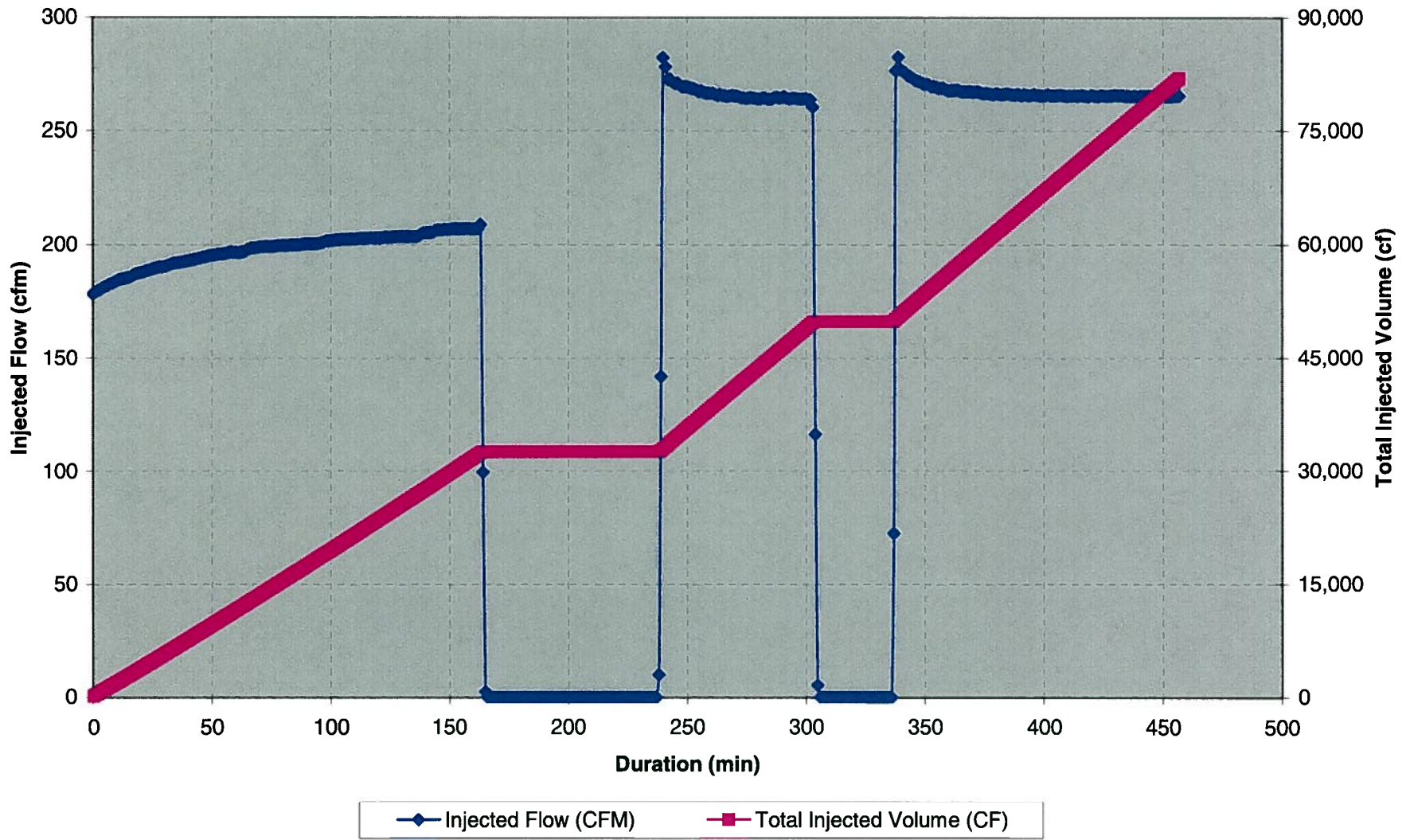
**BP-22  
6/3/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

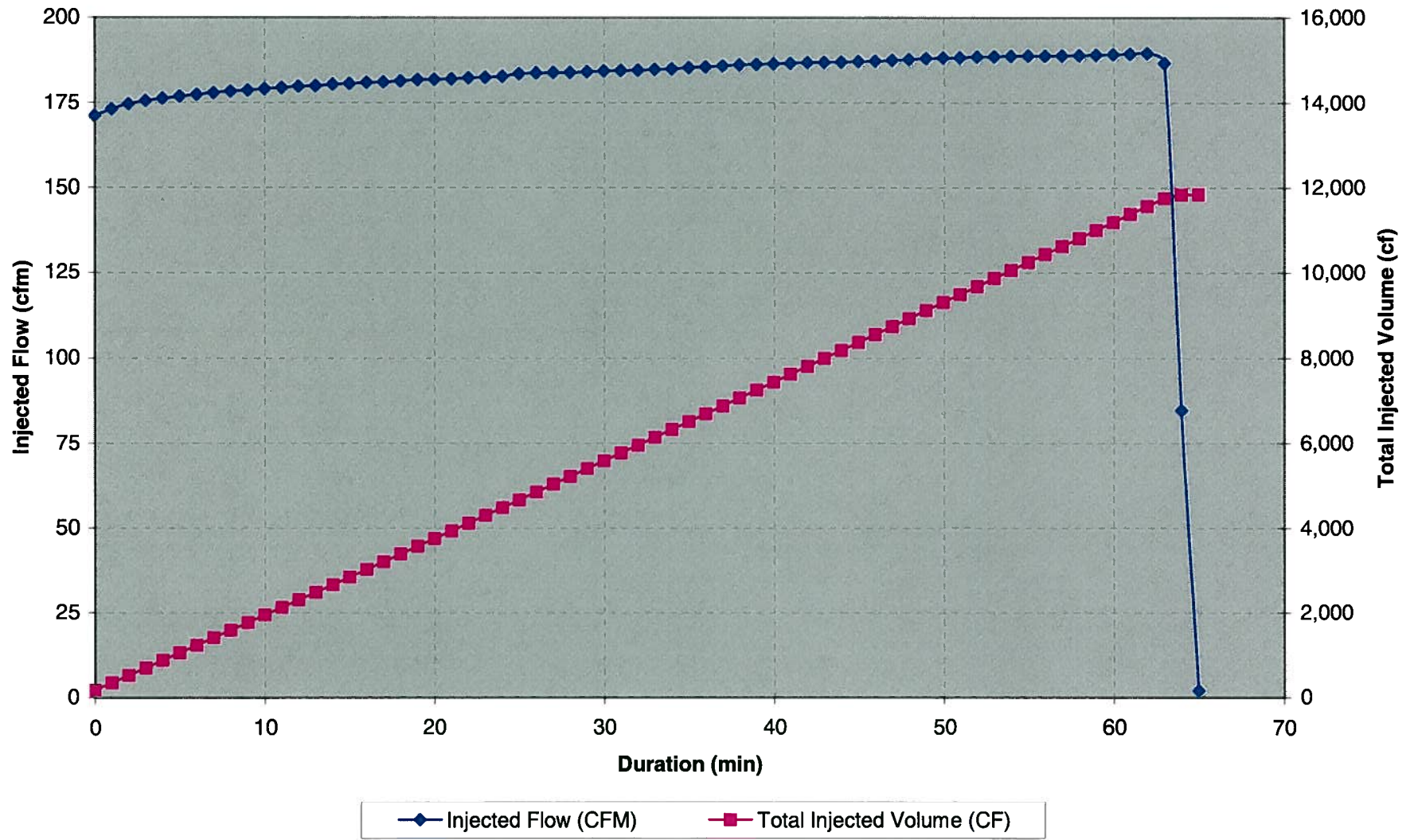
**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**BP-23  
6/11/2008**



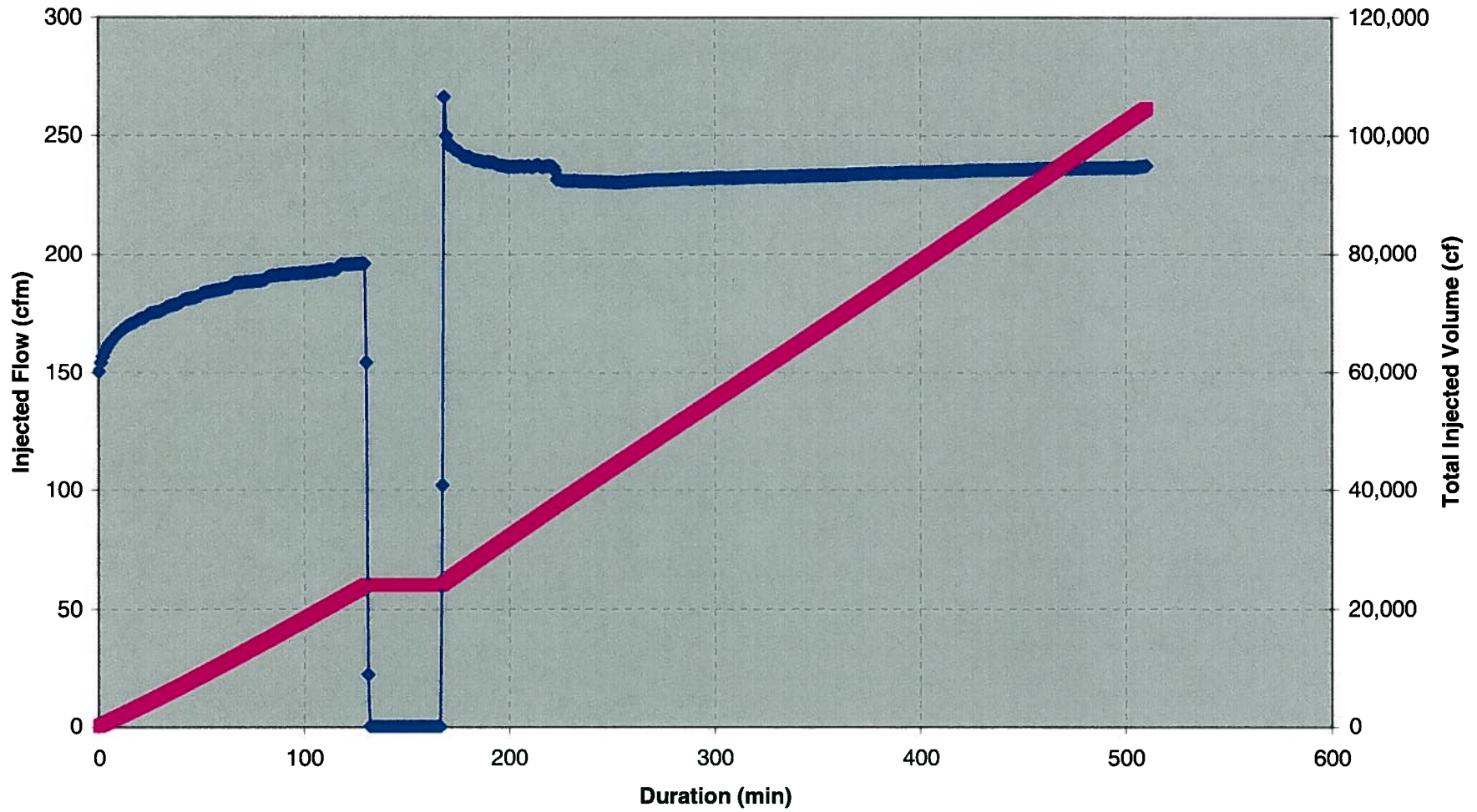
AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING

BP-23  
Second Event - Date Unknown



**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

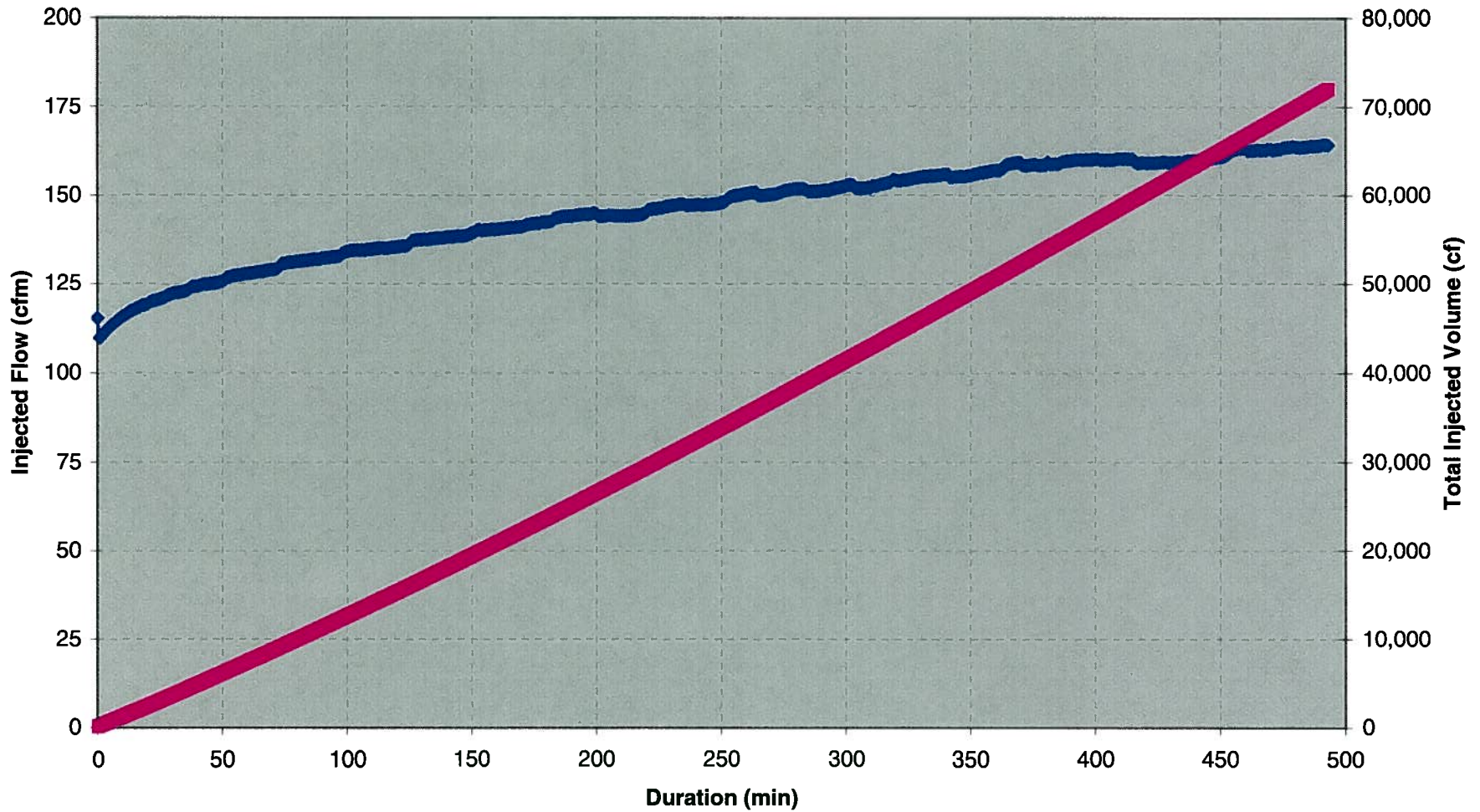
**BP-24  
5/28/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

**AIR FLOW -vs- TIME GRAPH  
SEVENTH ROUND OF BIO-PULSE SPARGING**

**SP-100  
7/7/2008**



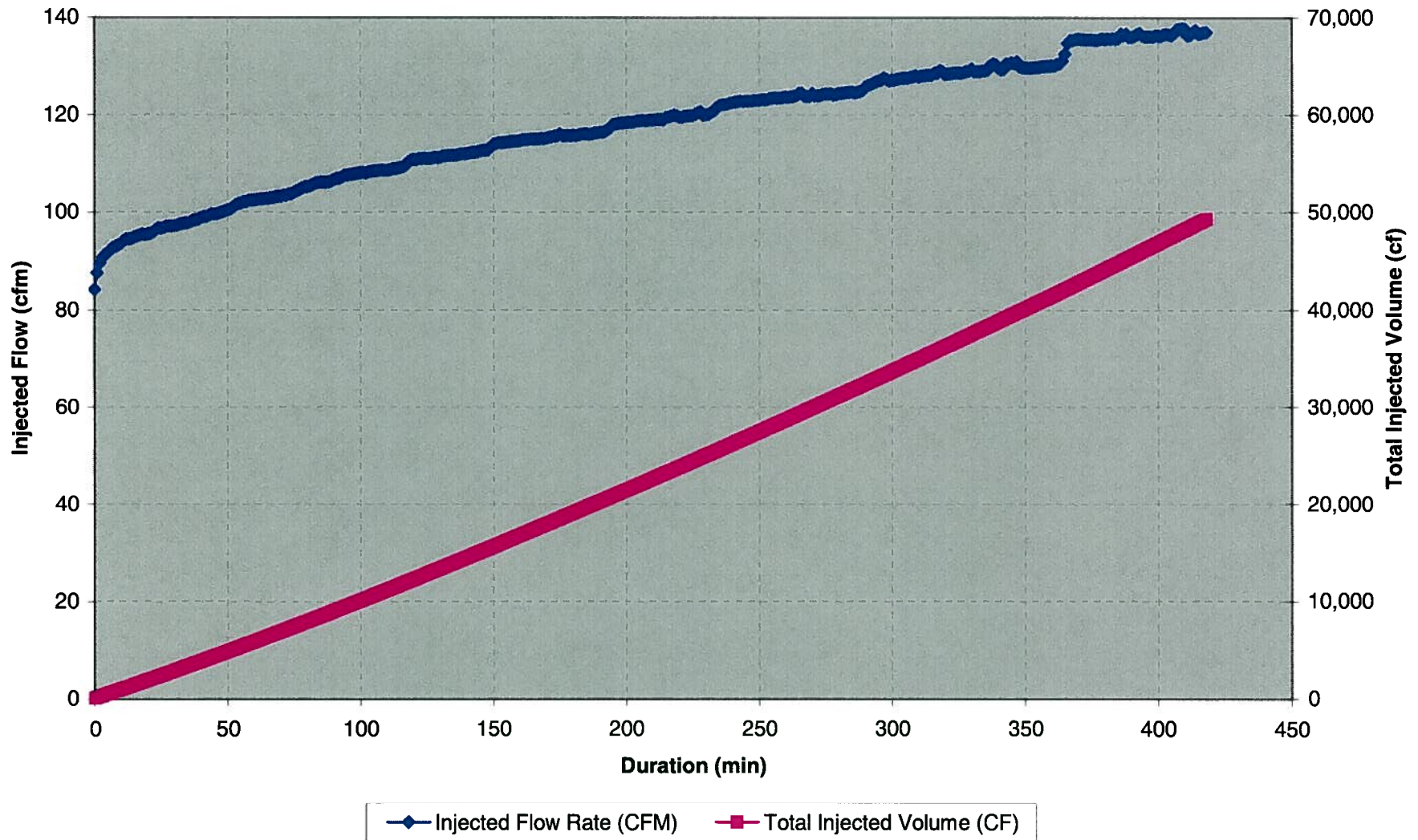
◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

**APPENDIX B**

**AIR FLOW VS. TIME GRAPHS EIGHTH ROUND OF BIO-PULSE SPARGING**

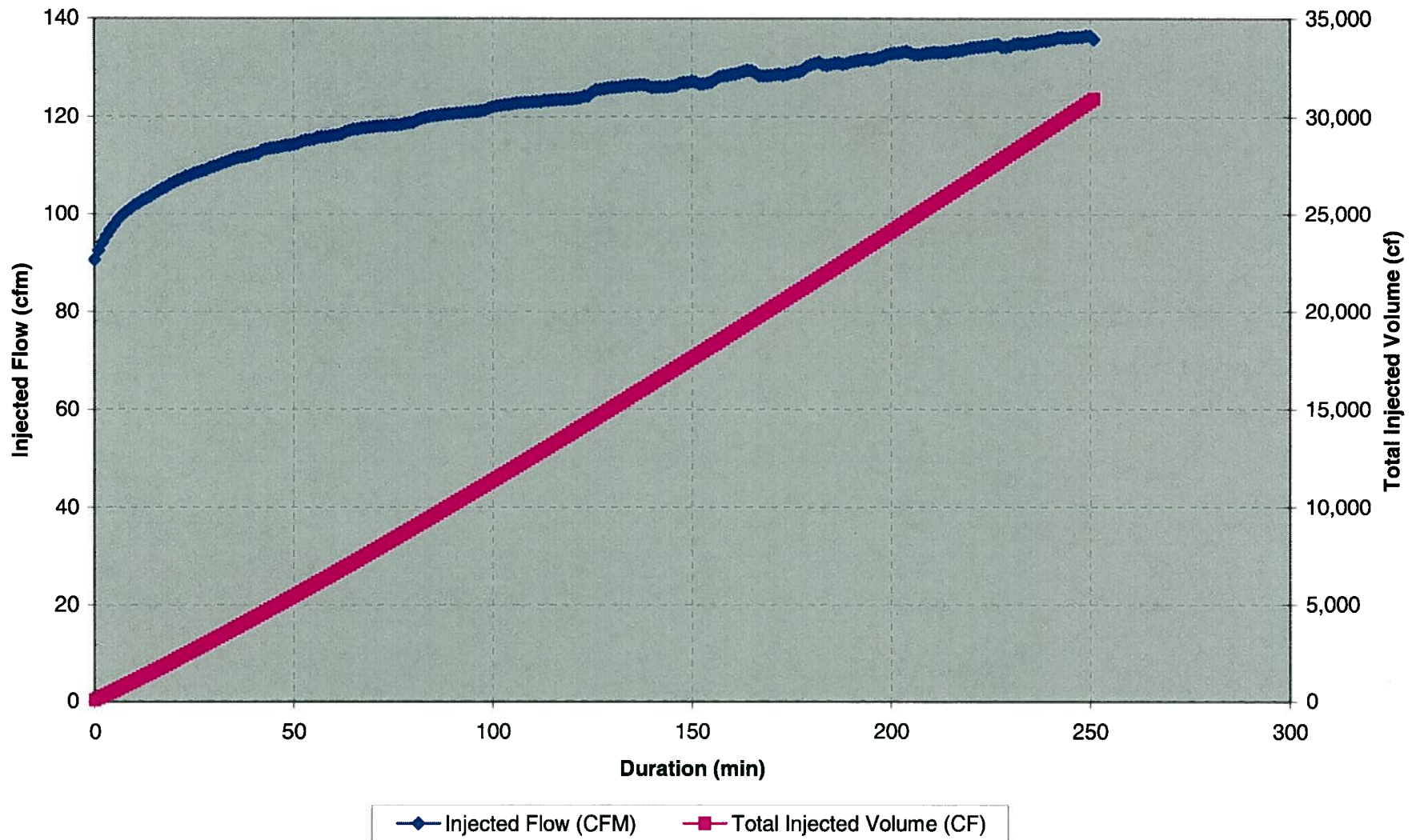
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-01  
8/4/2008**



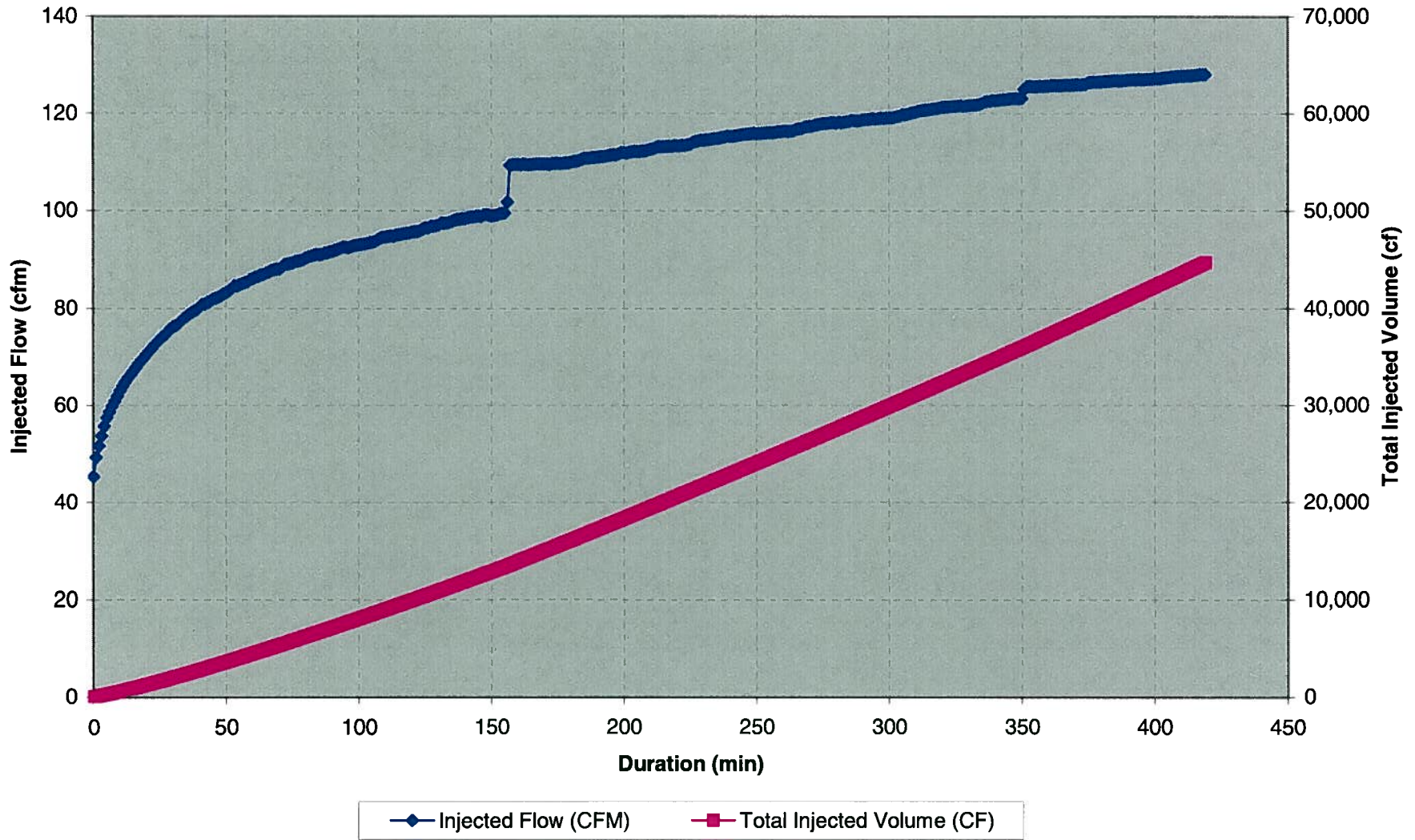
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-02  
8/18/2008**



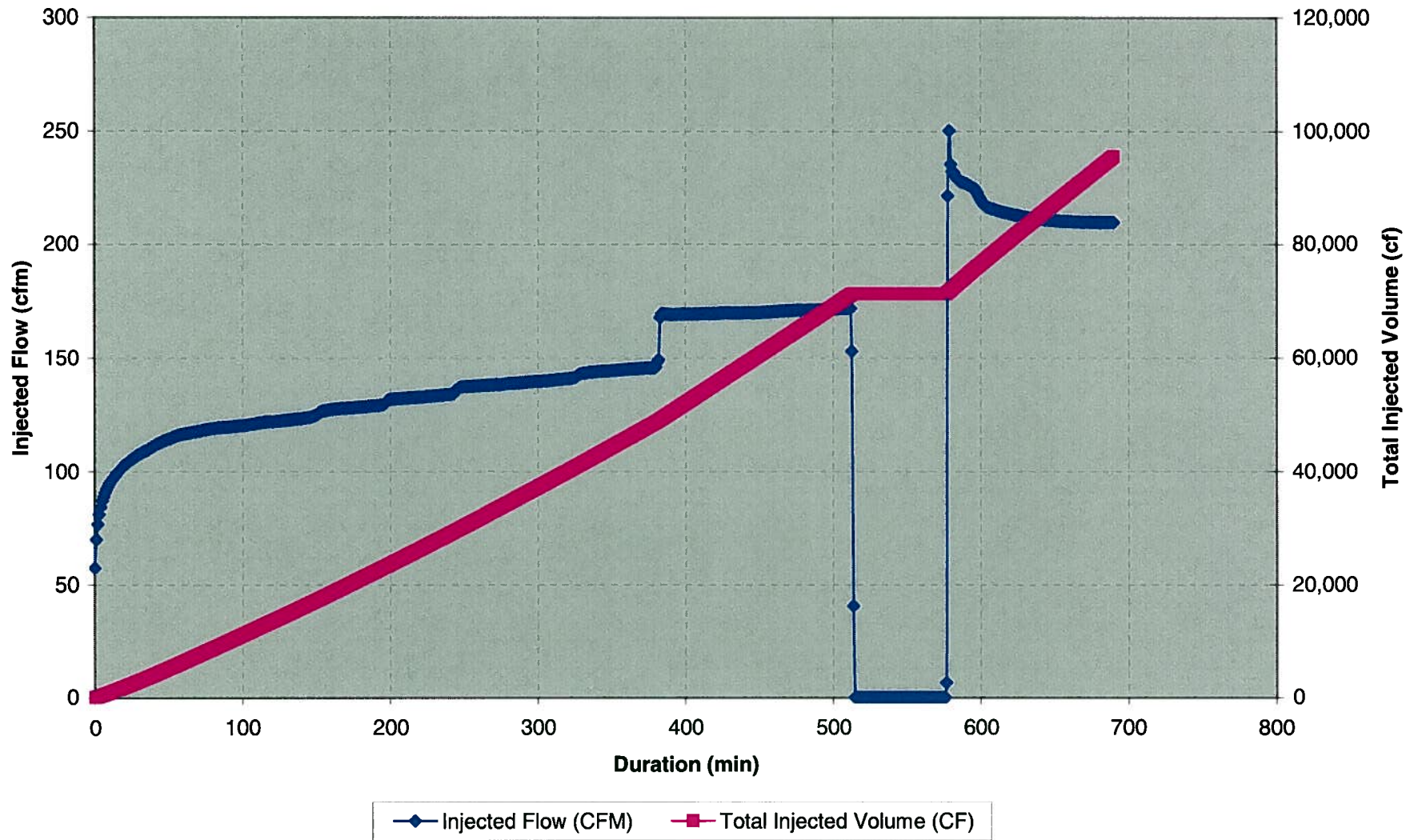
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-04  
8/12/2008**



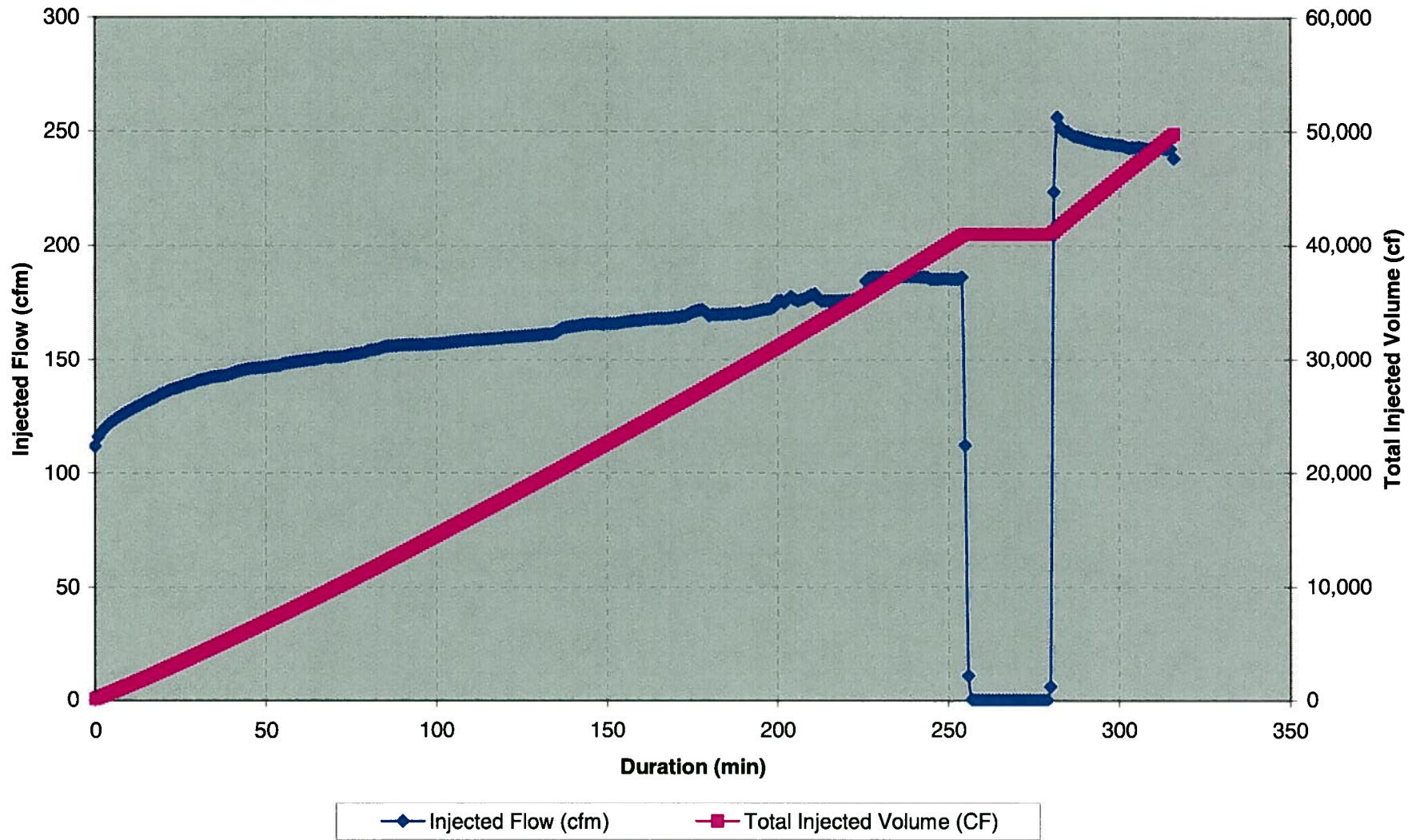
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-05  
9/2/2008**



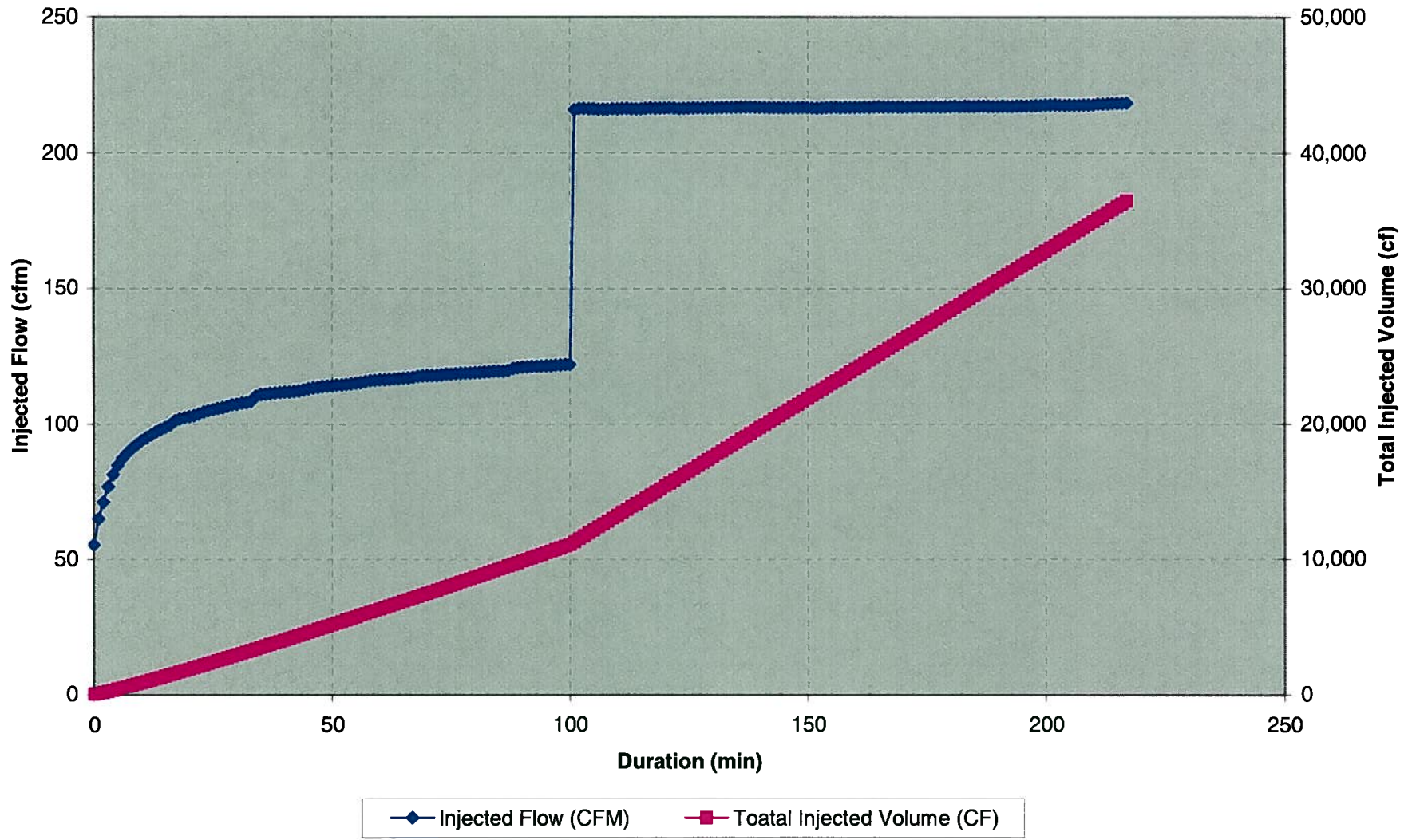
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-06  
9/8/2008**



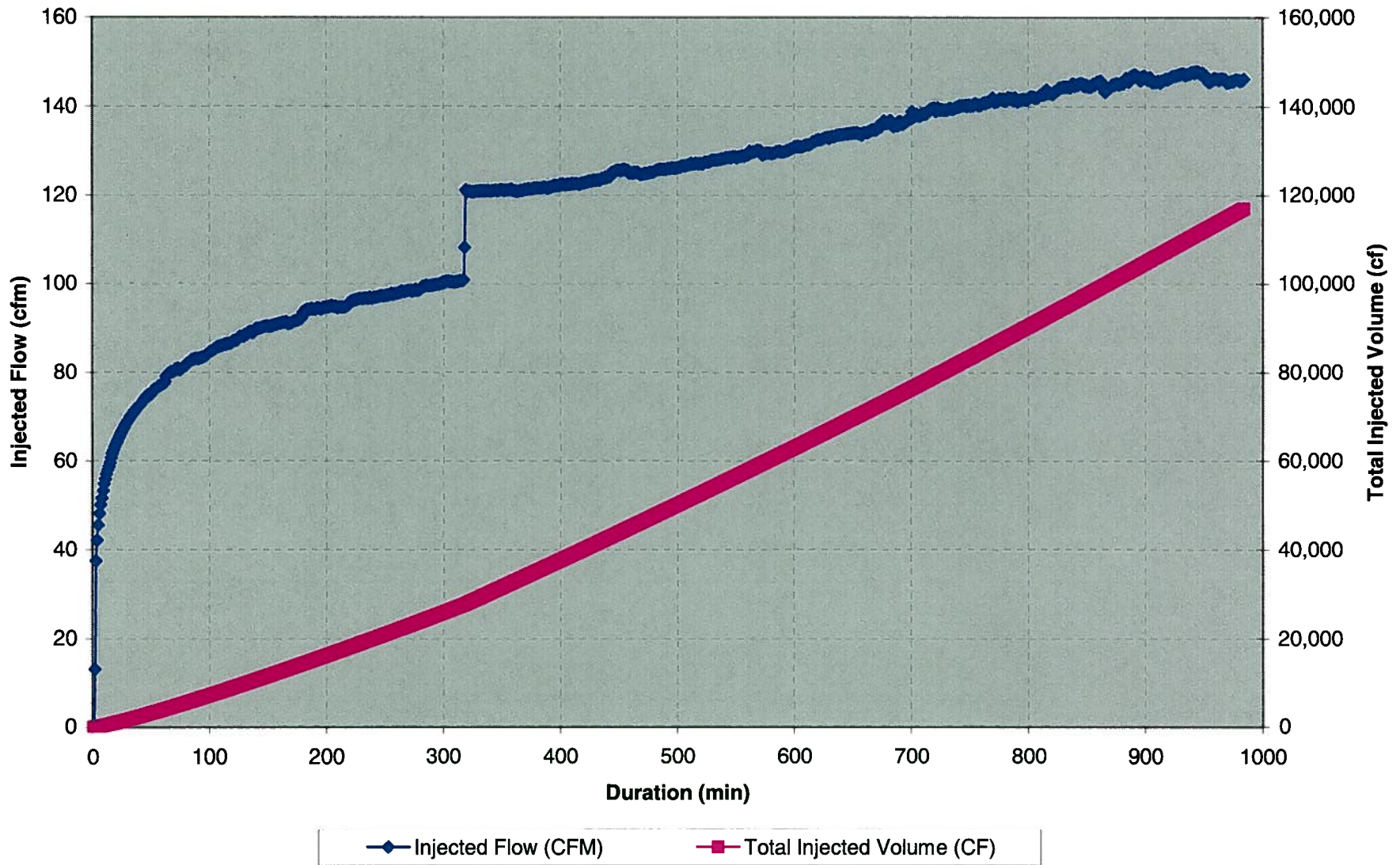
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-07  
8/7/2008**



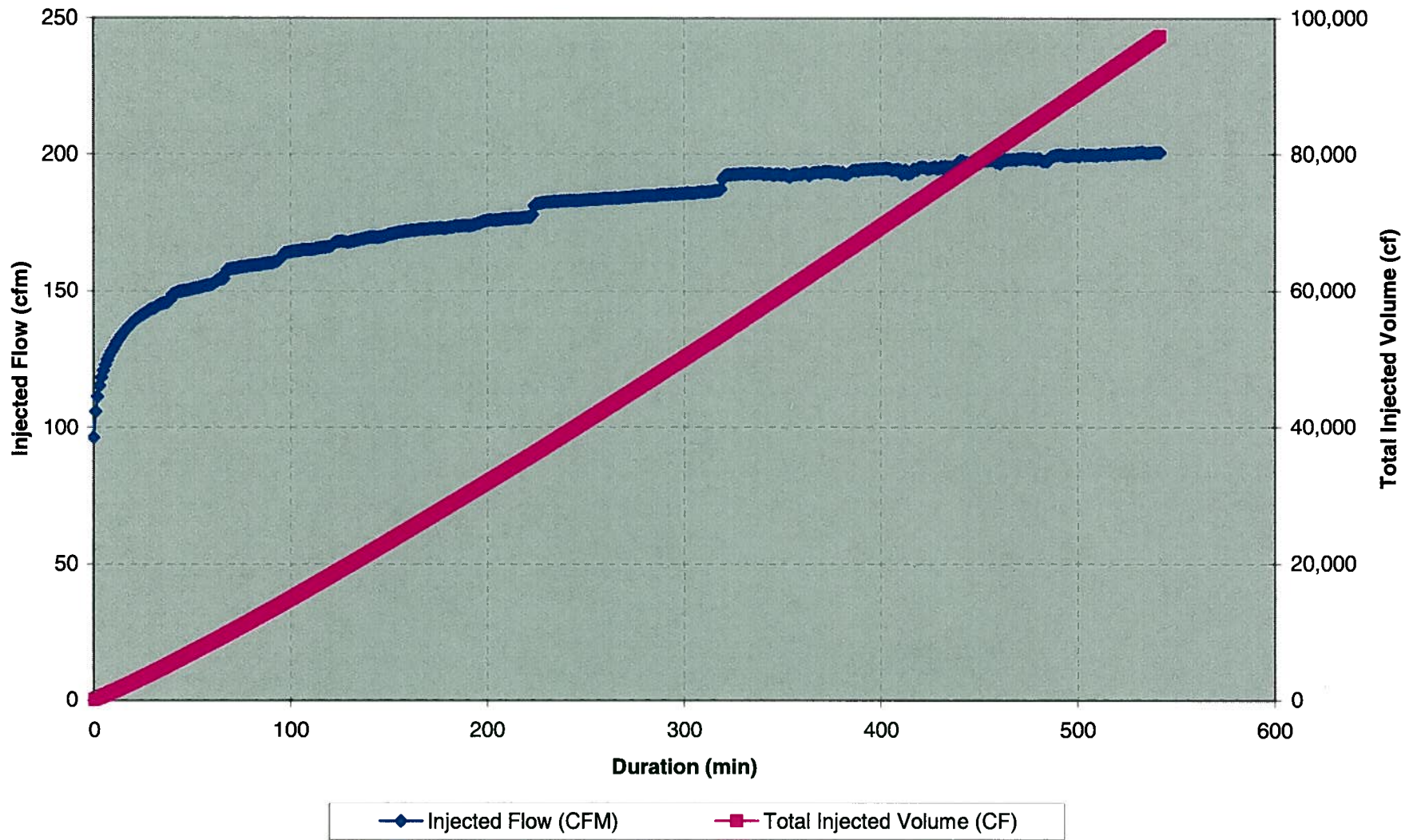
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-08  
9/11/2008**



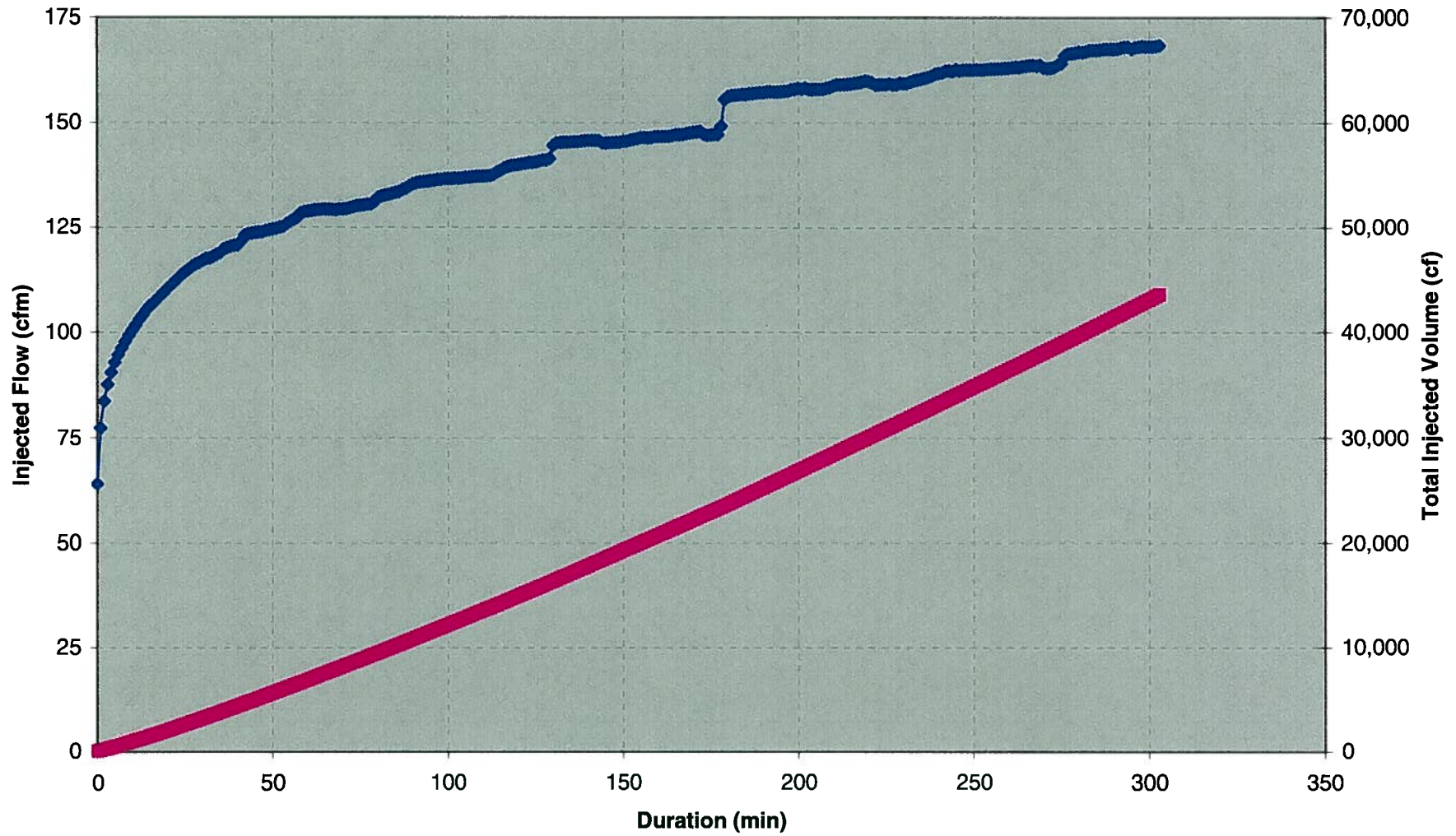
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-10  
8/21/2008**



**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

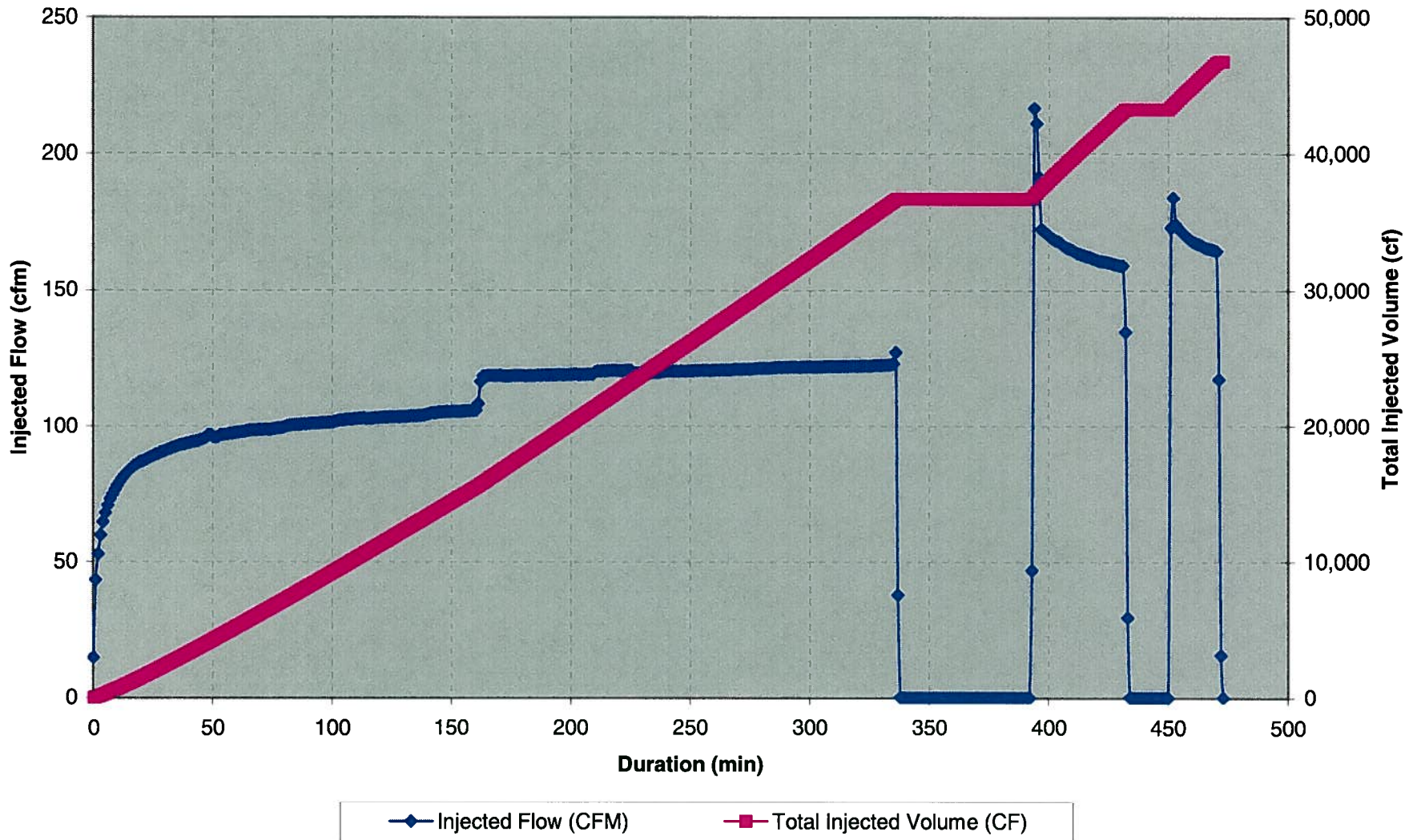
**BP-11  
8/27/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

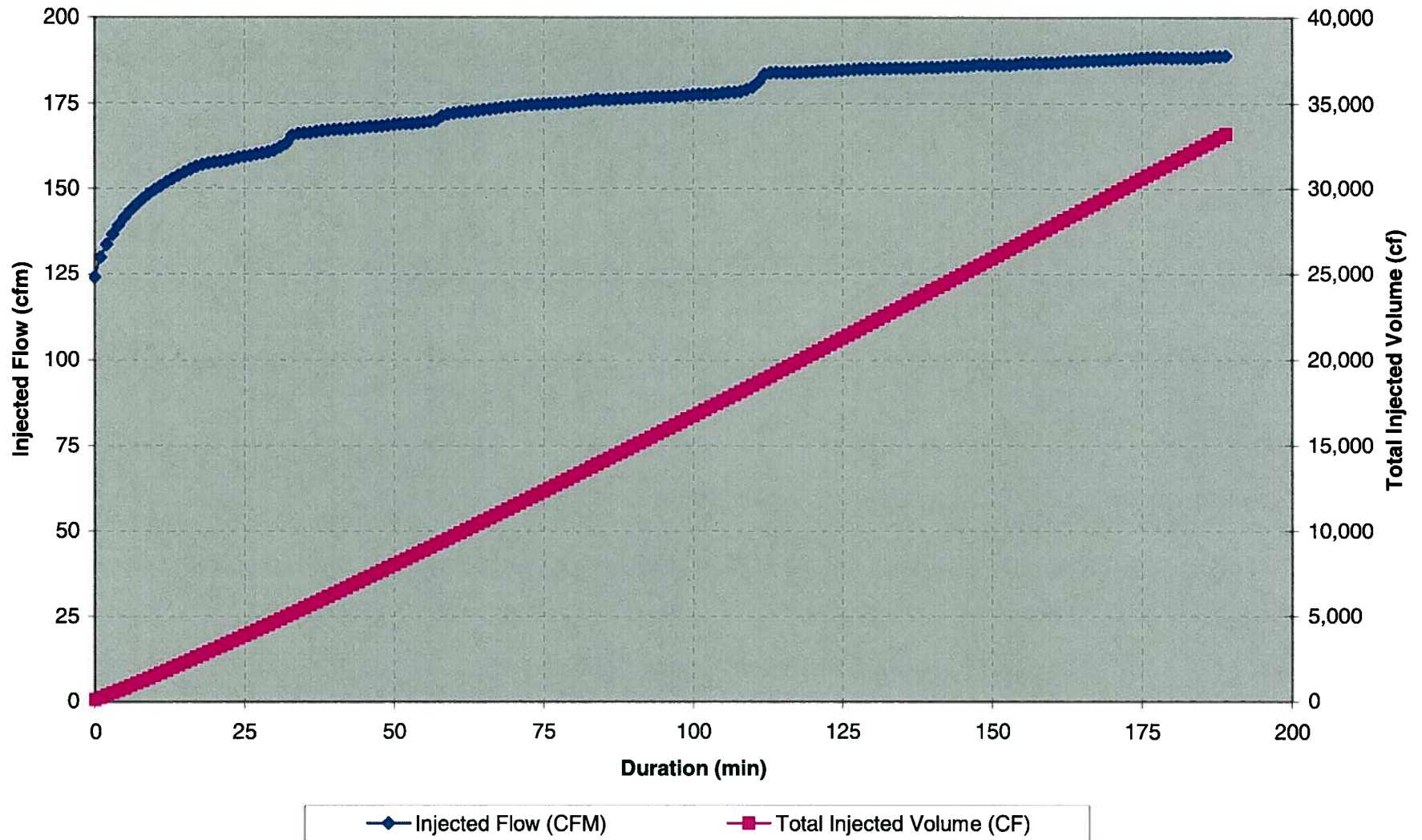
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-12  
8/6/2008**



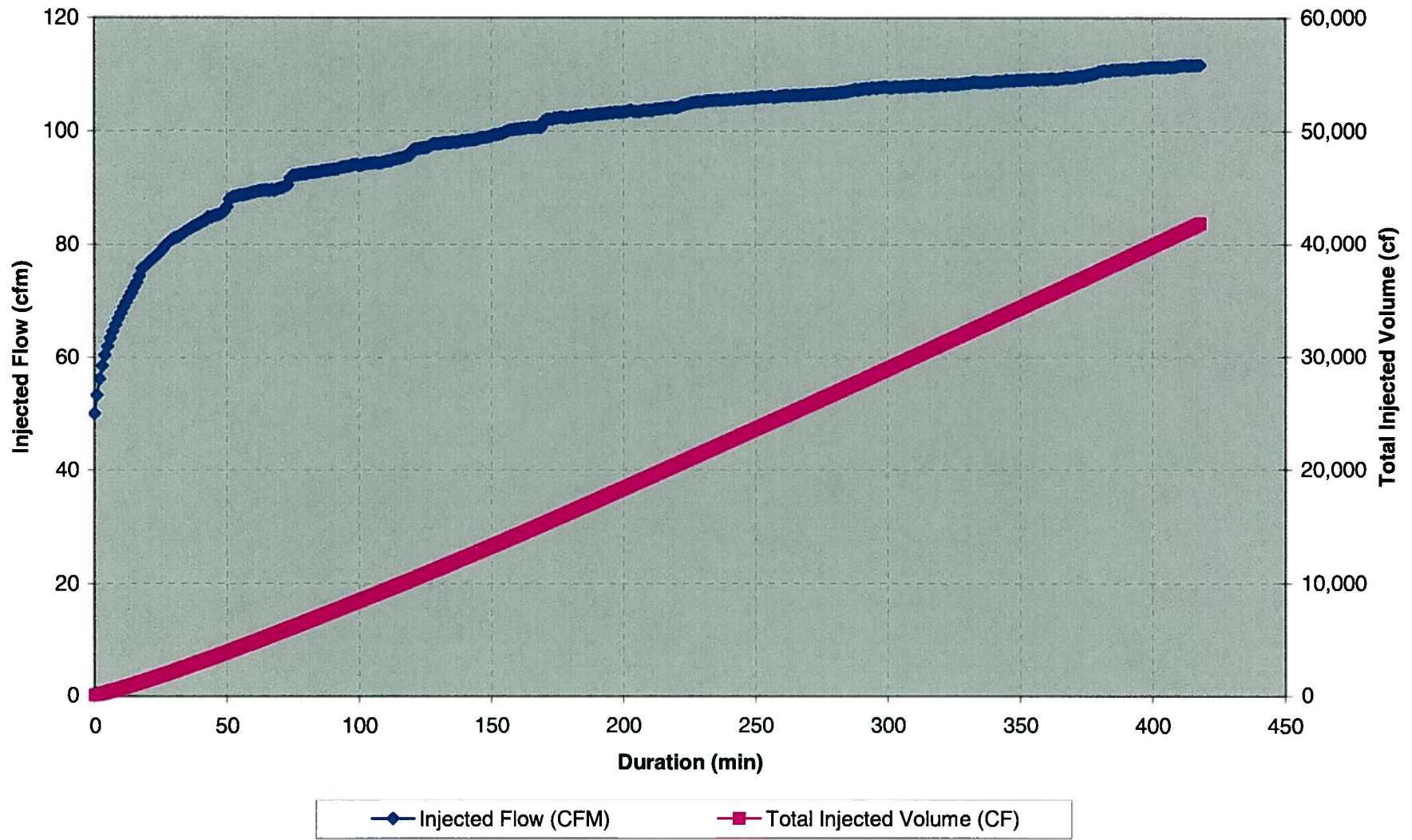
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-14  
8/19/2008**



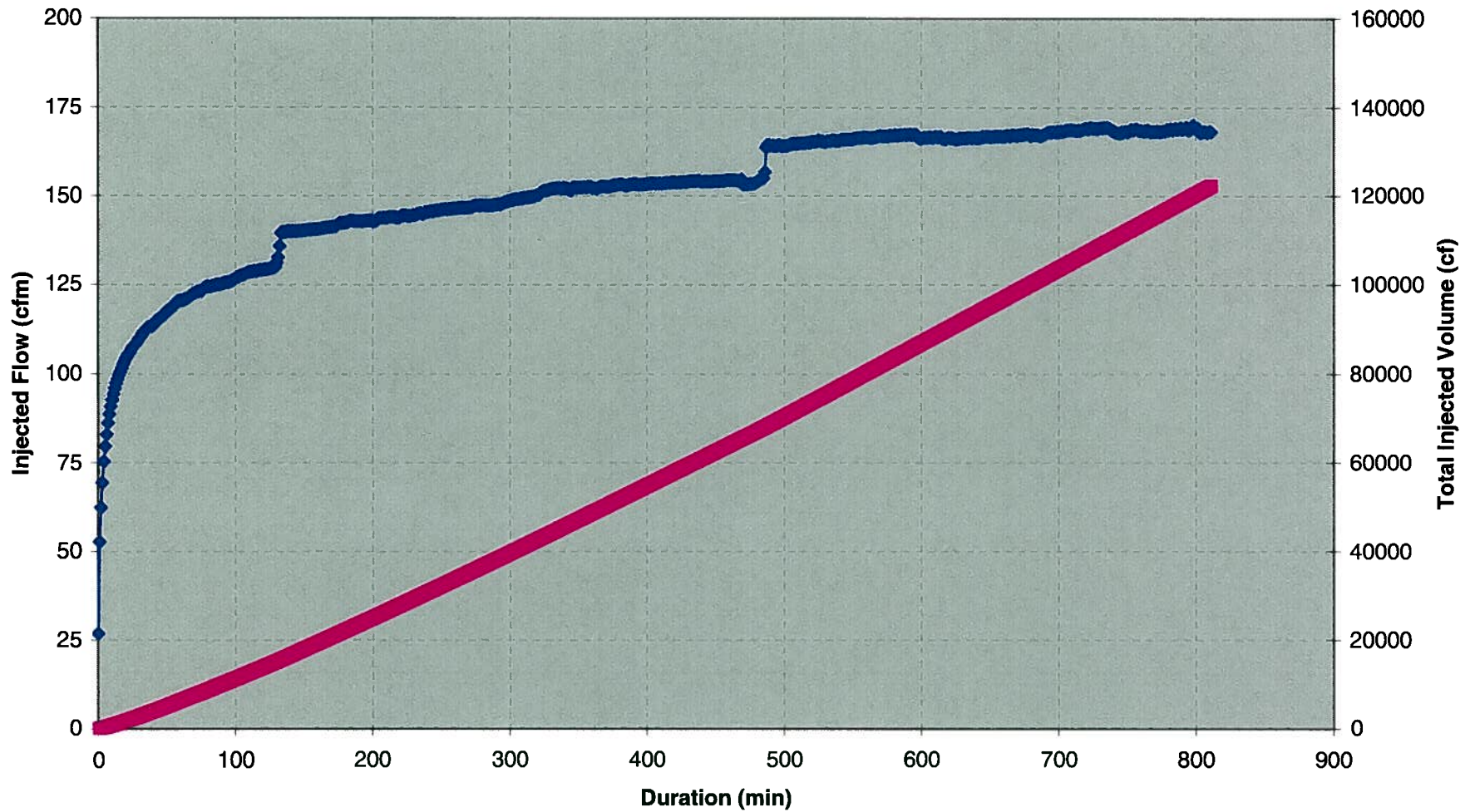
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-15  
8/14/2008**



**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

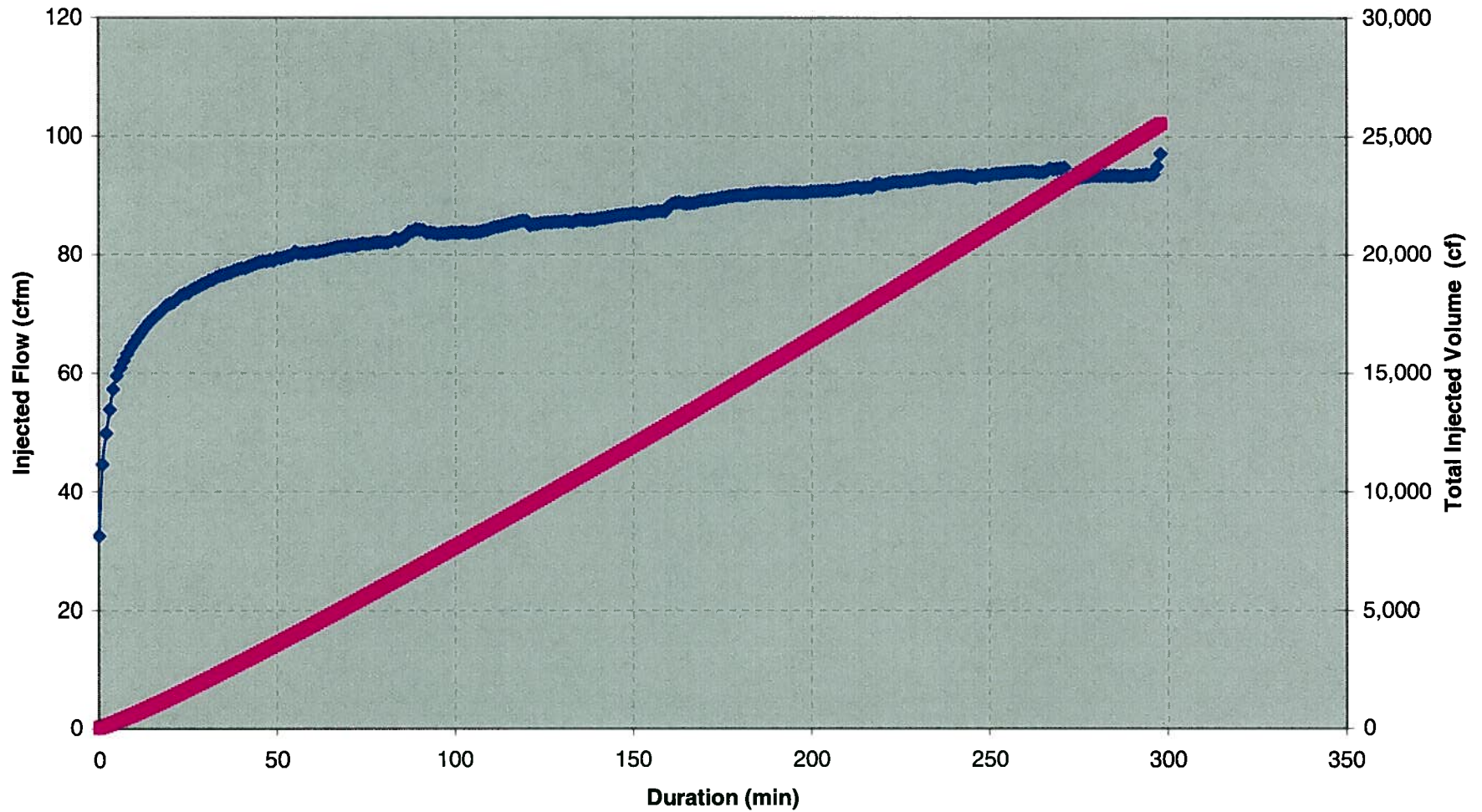
**BP-16  
9/9/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

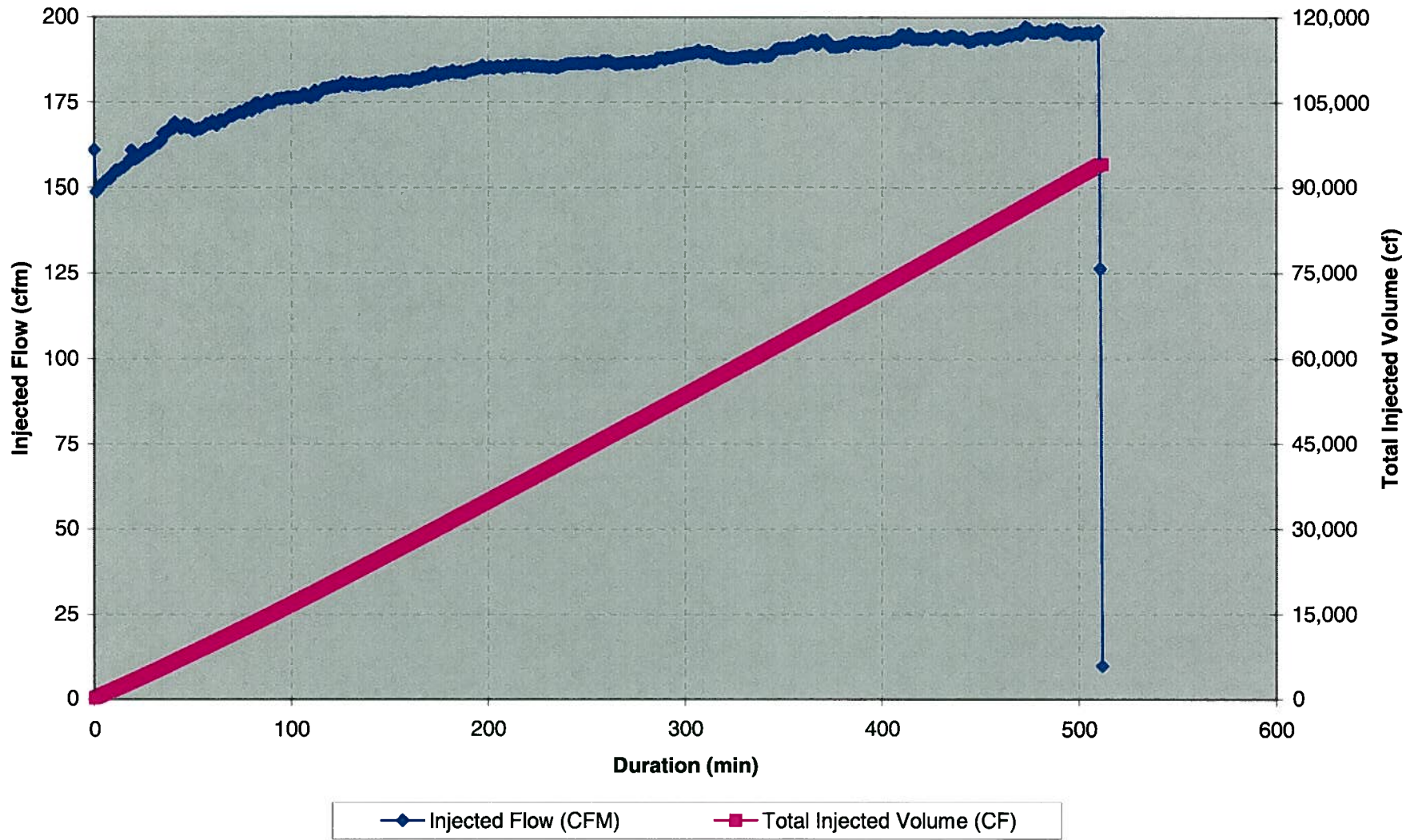
**BP-17  
9/10/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

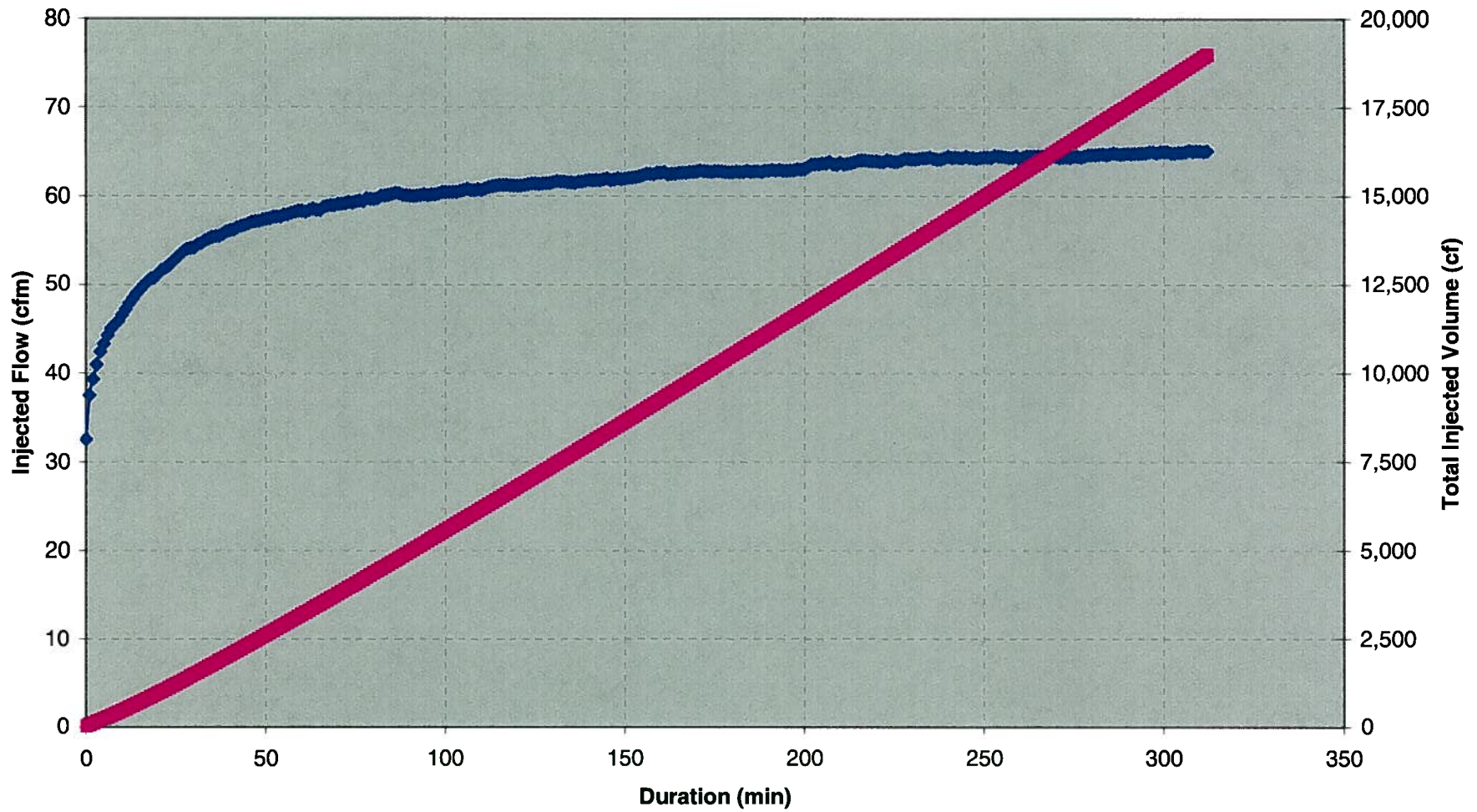
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-18  
9/15/2008**



**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

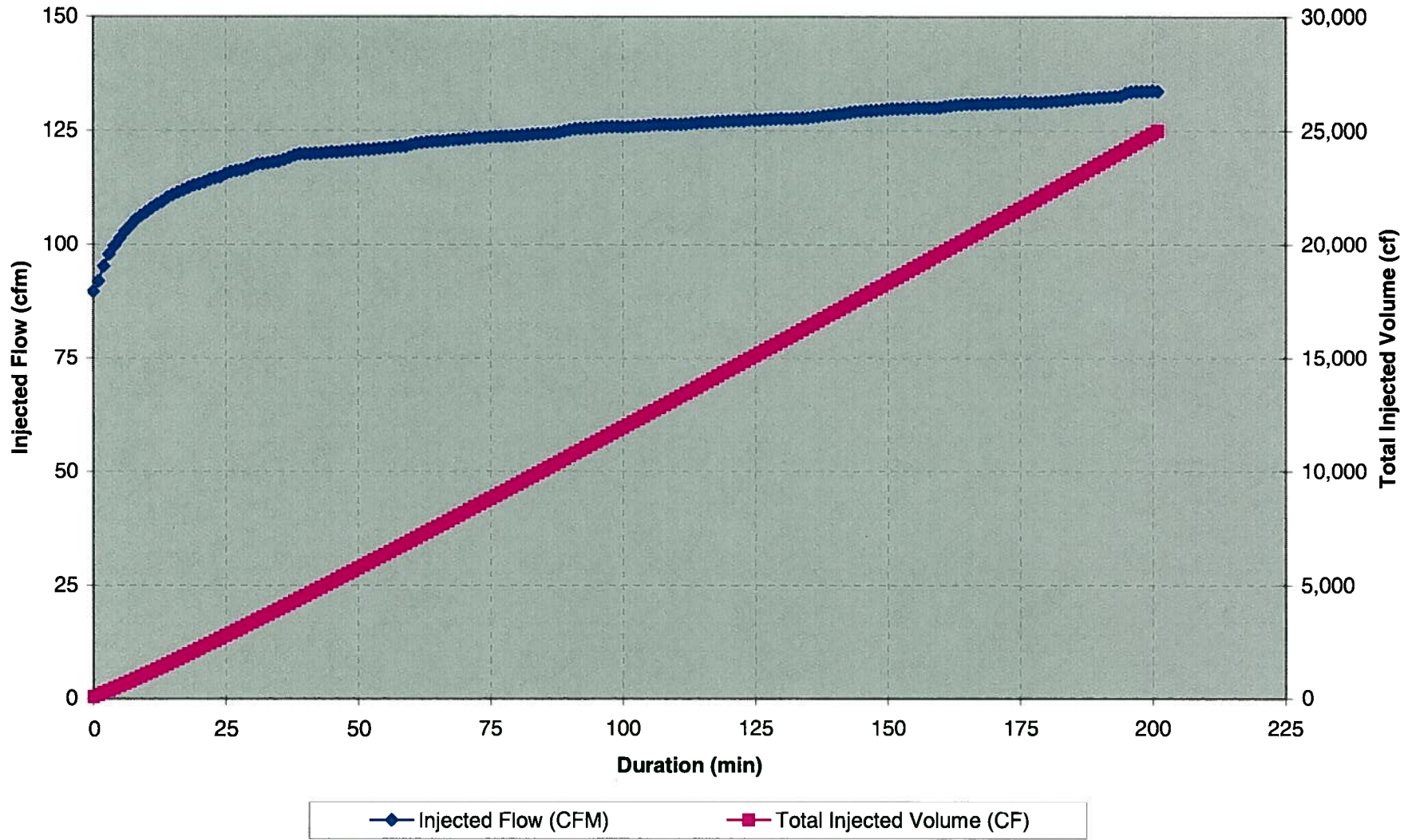
**BP-19  
8/20/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

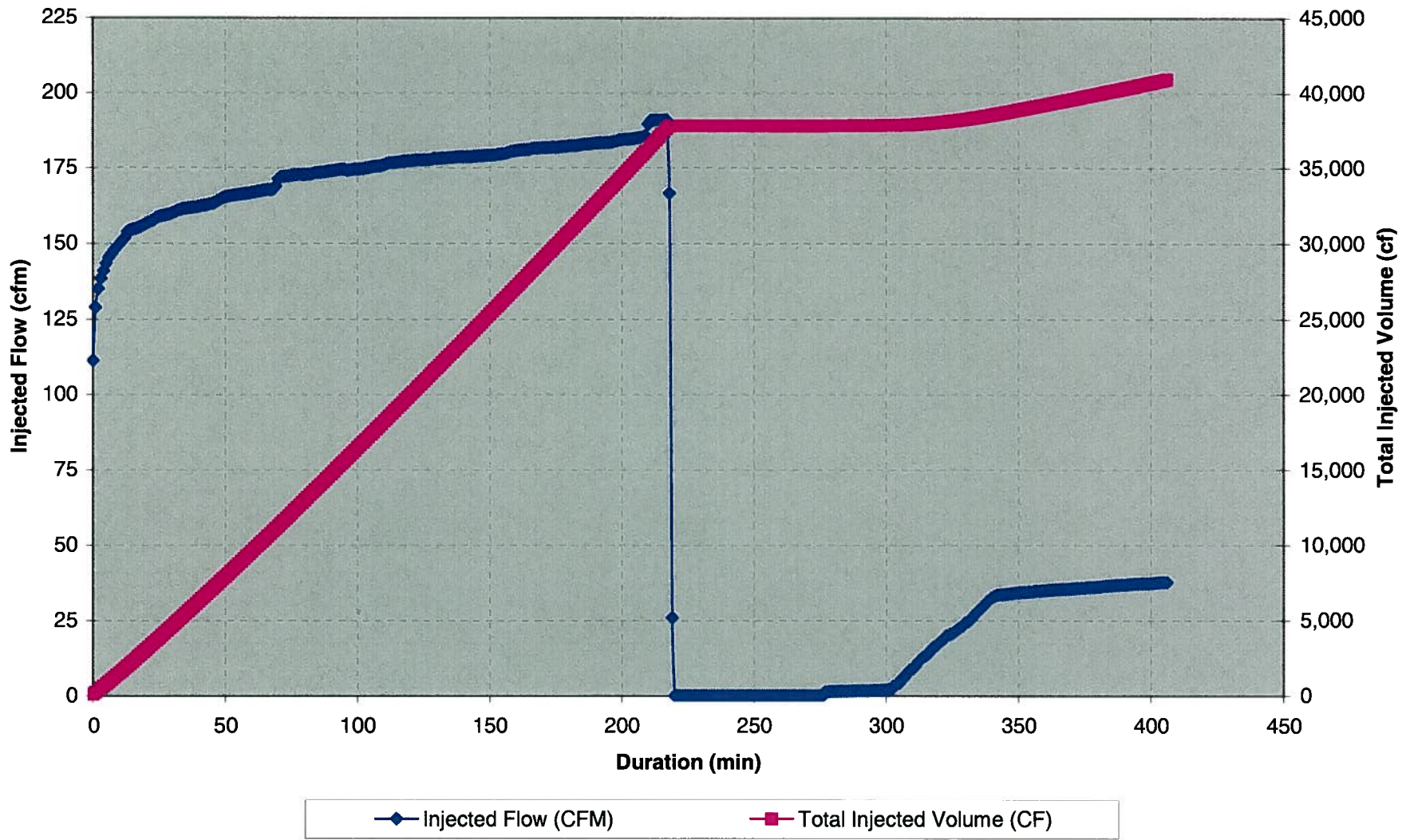
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-20  
8/28/2008**



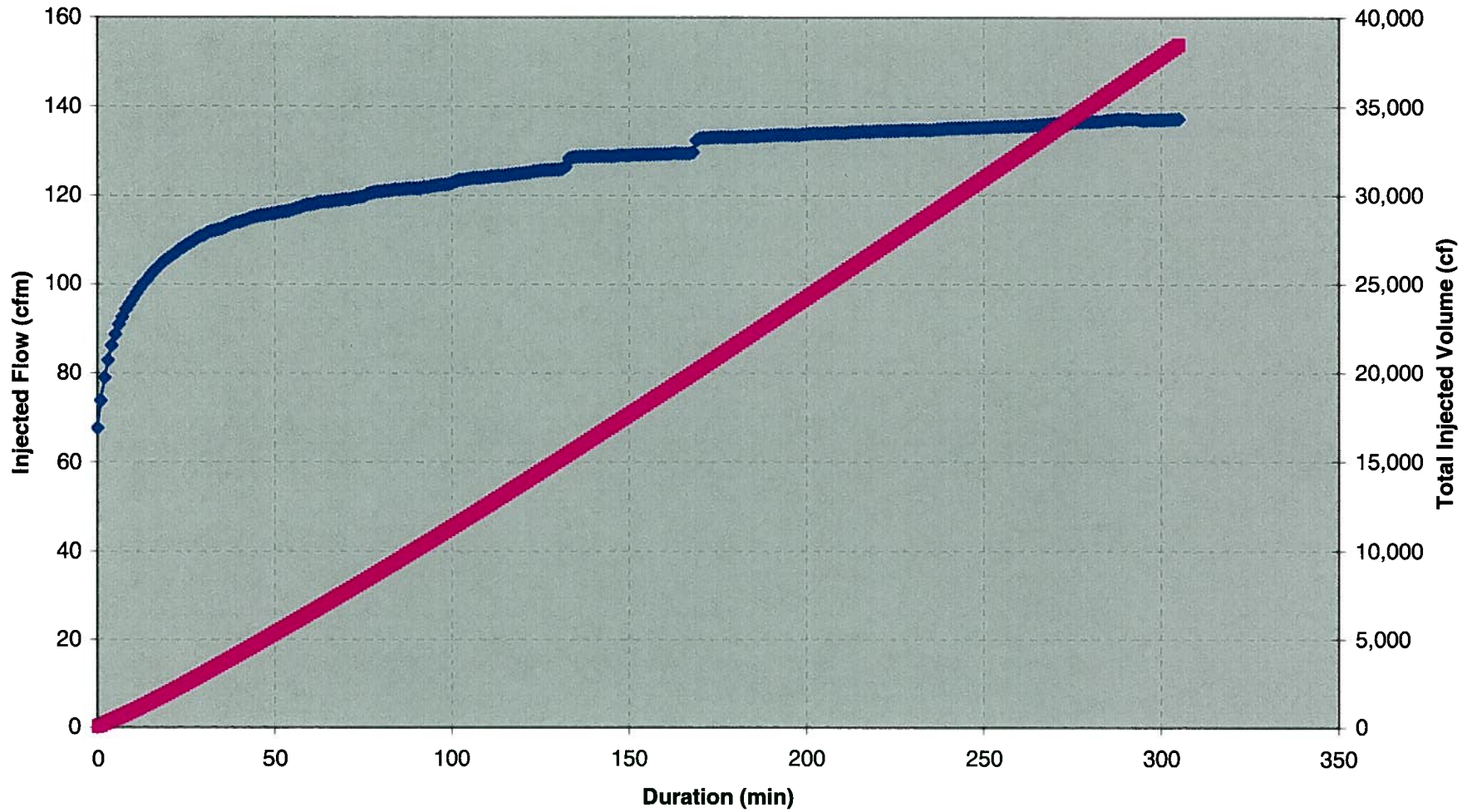
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-21  
8/5/2008**



**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

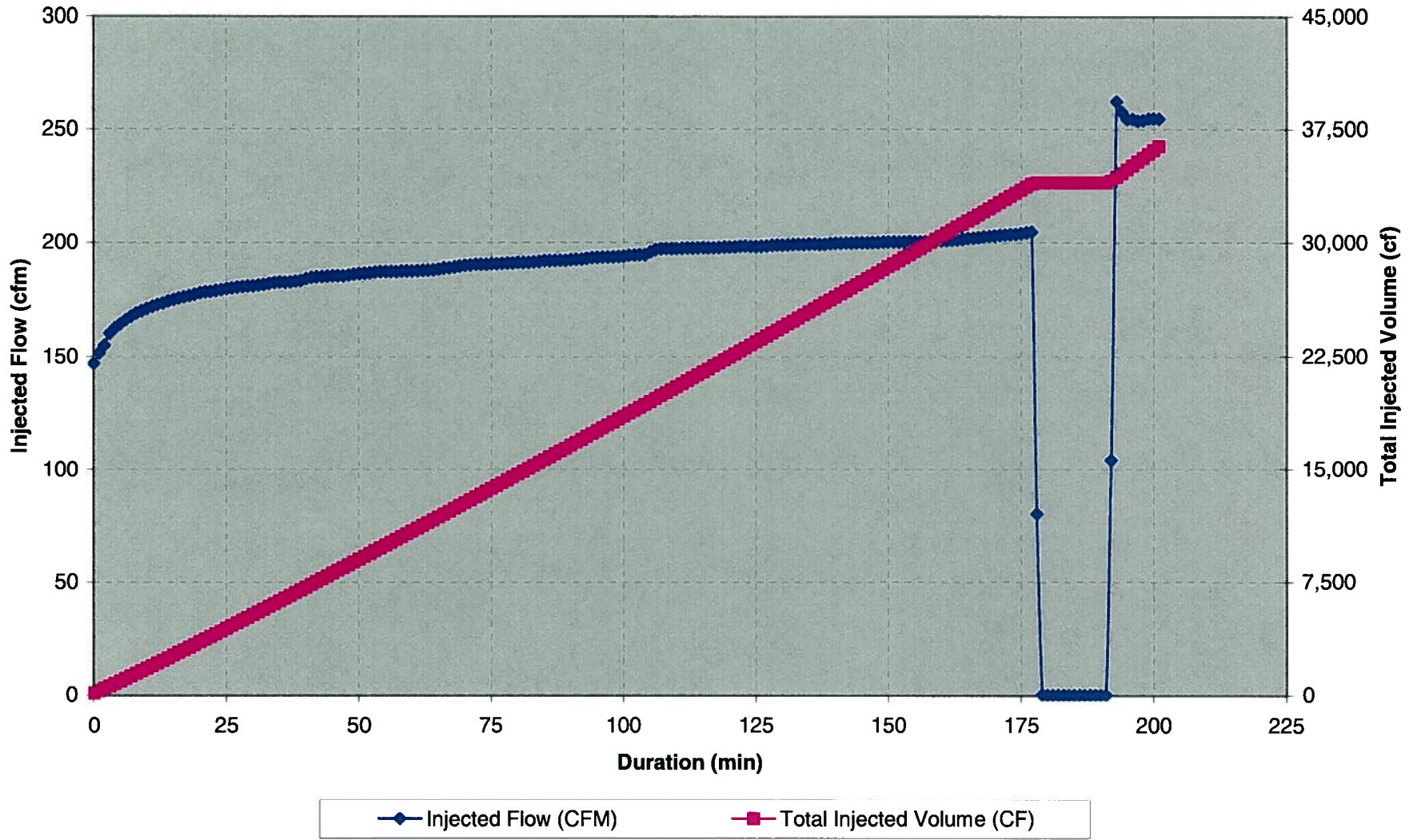
**BP-22  
8/15/2008**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

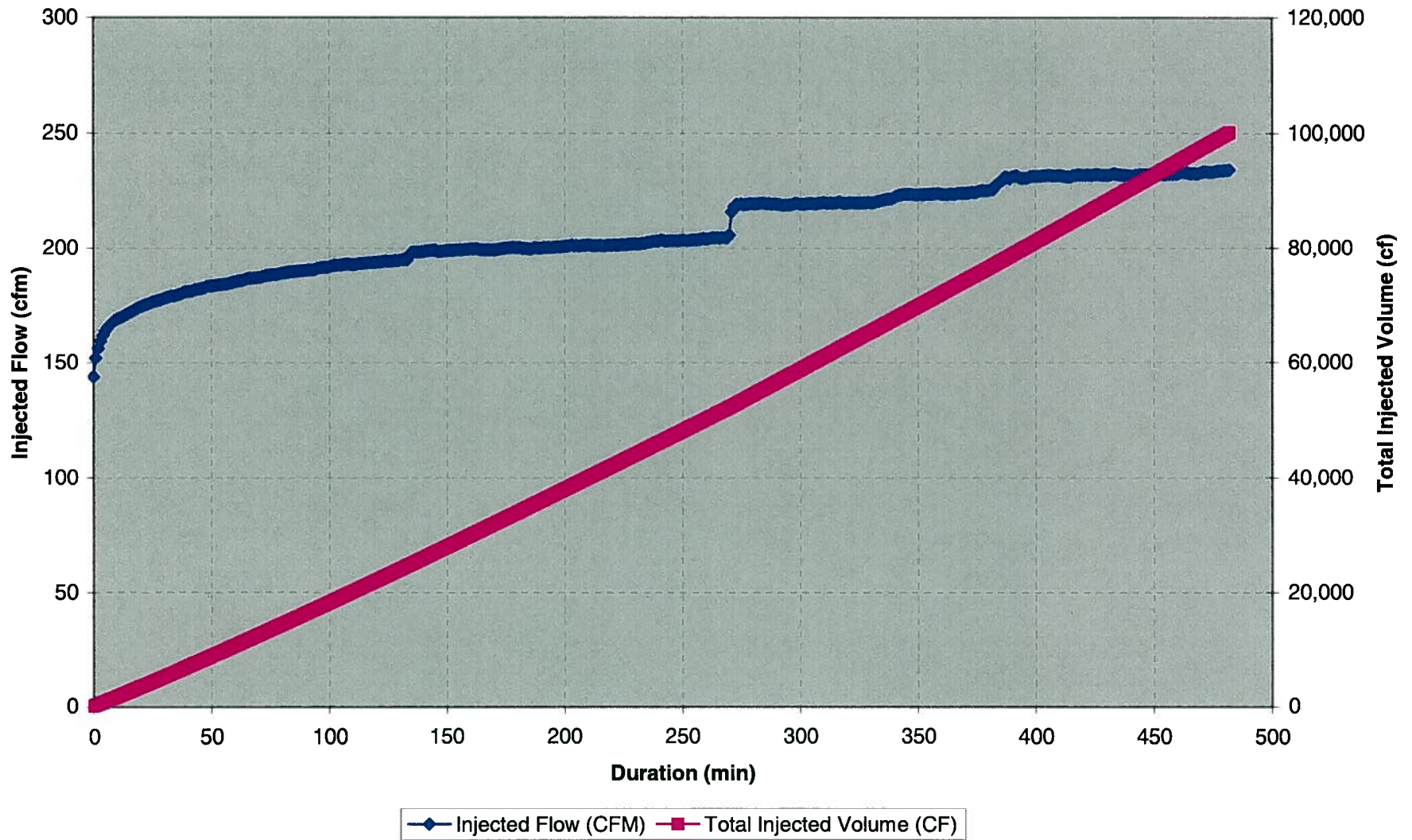
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-23  
8/22/2008**



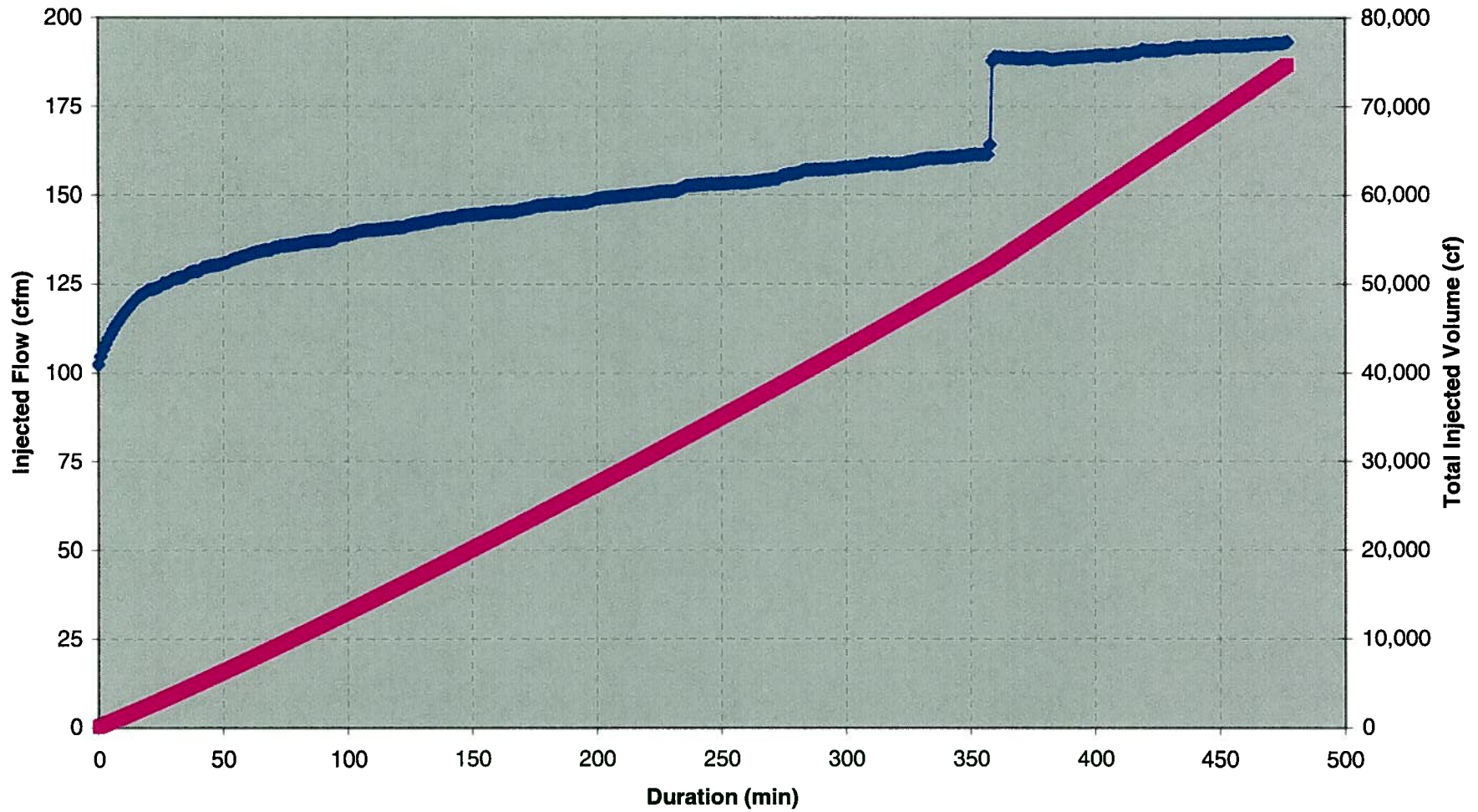
**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**BP-24  
8/8/2008**



**AIR FLOW -vs- TIME GRAPH  
EIGHTH ROUND OF BIO-PULSE SPARGING**

**SP-100  
9/4/2008**



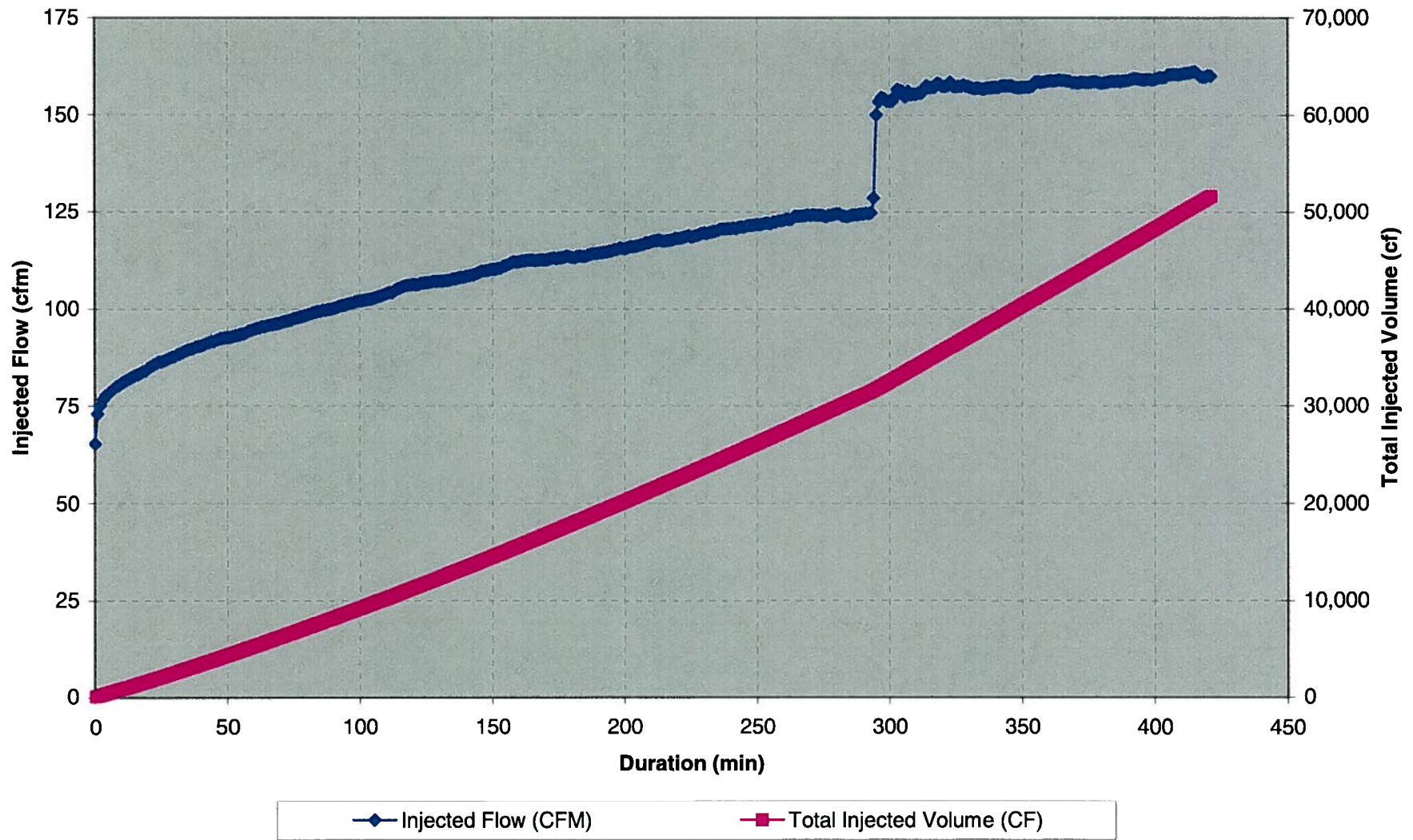
—◆— Injected Flow (CFM)      —■— Total Injected Volume (CF)

**APPENDIX C**

**AIR FLOW VS. TIME GRAPHS NINTH ROUND OF BIO-PULSE SPARGING**

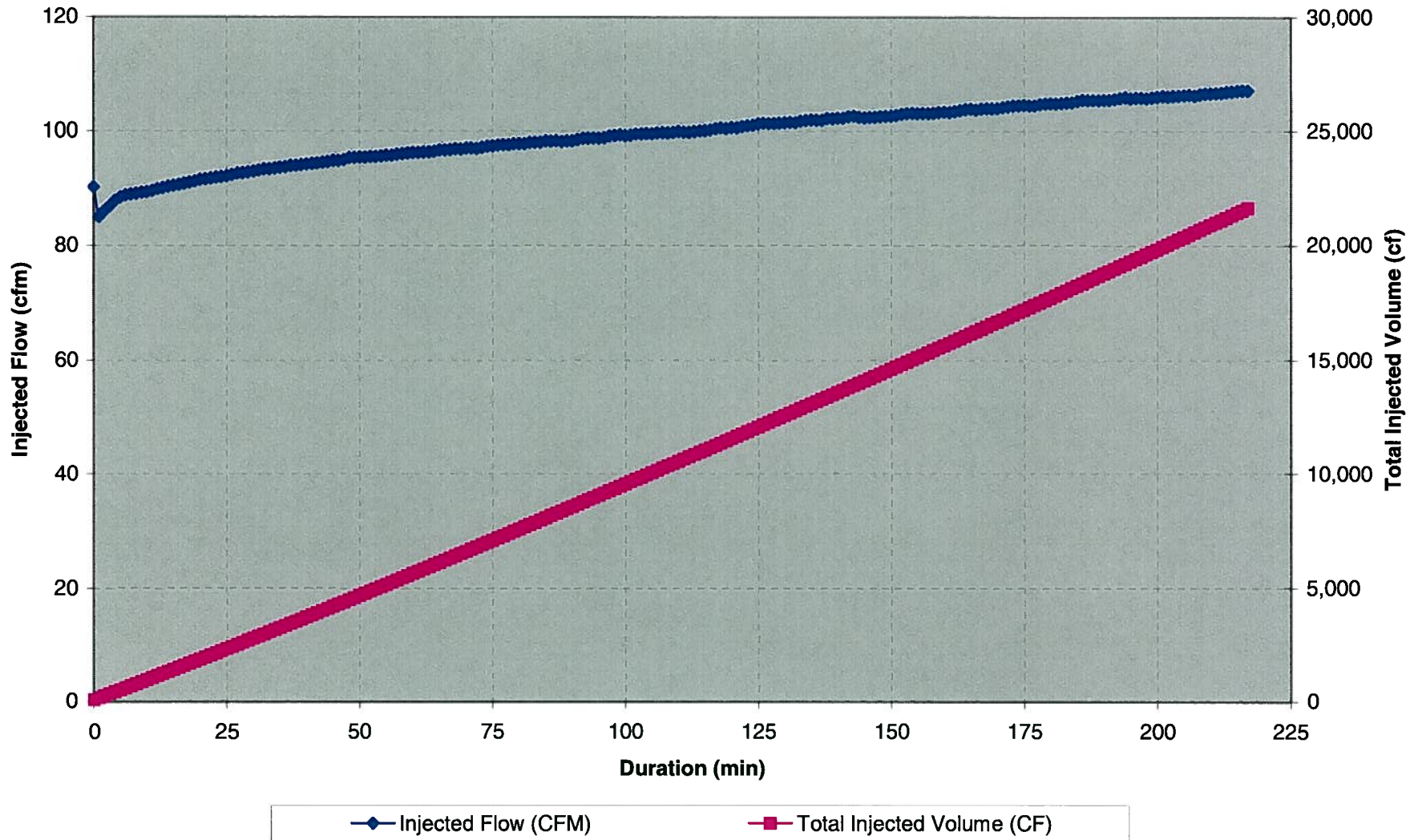
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-01  
11/18/2008**



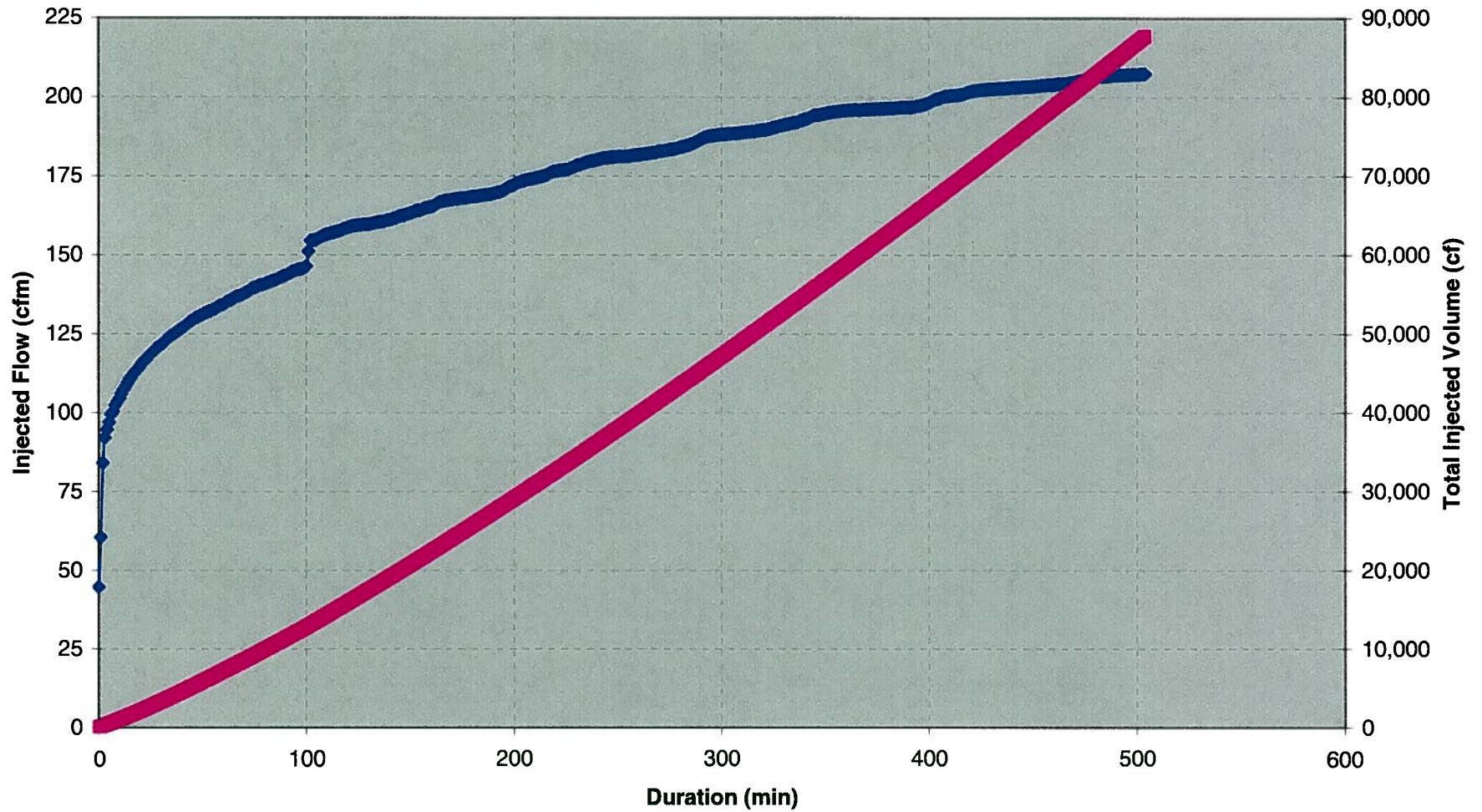
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-02  
12/2/2008**



**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

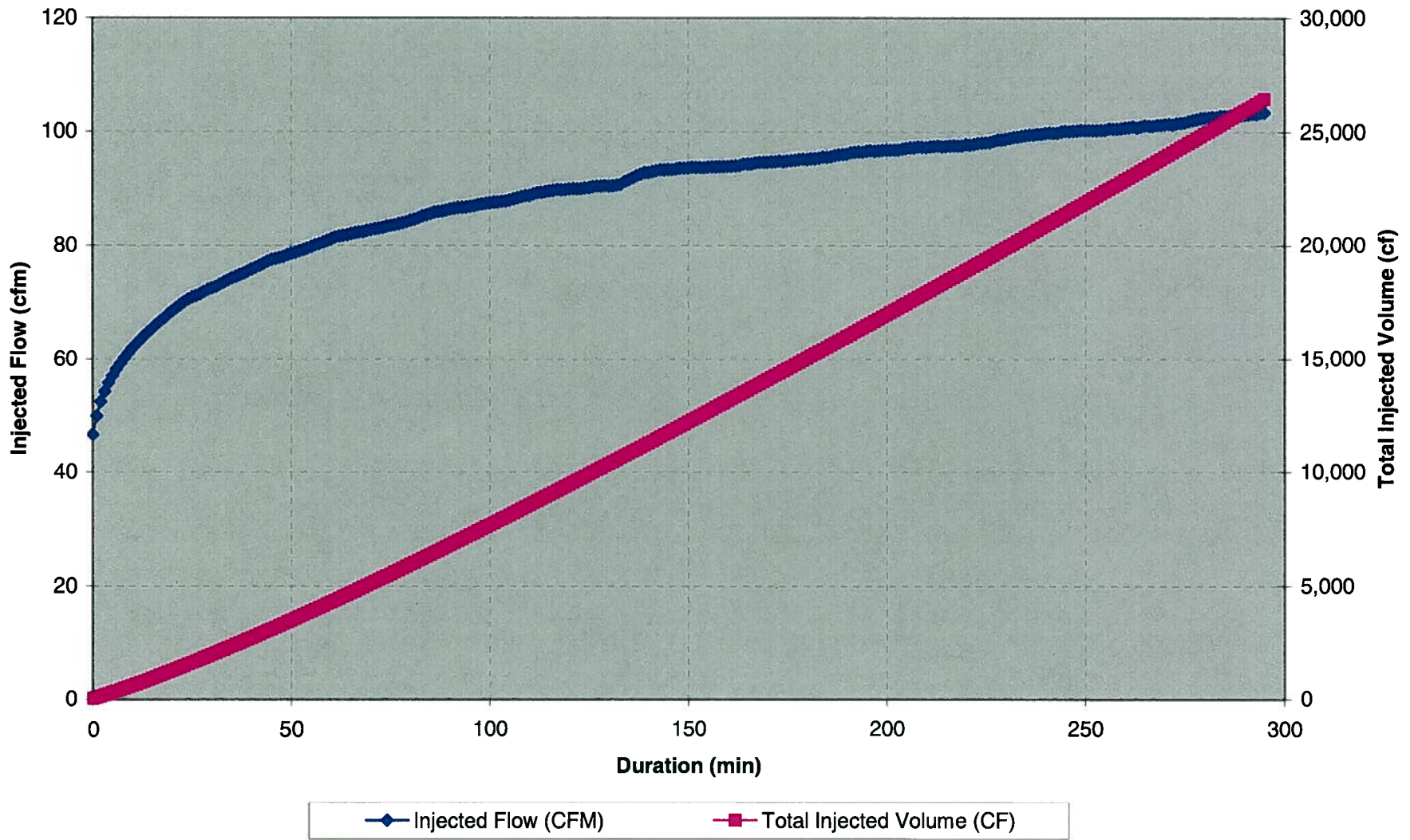
**BP-03  
2/5/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

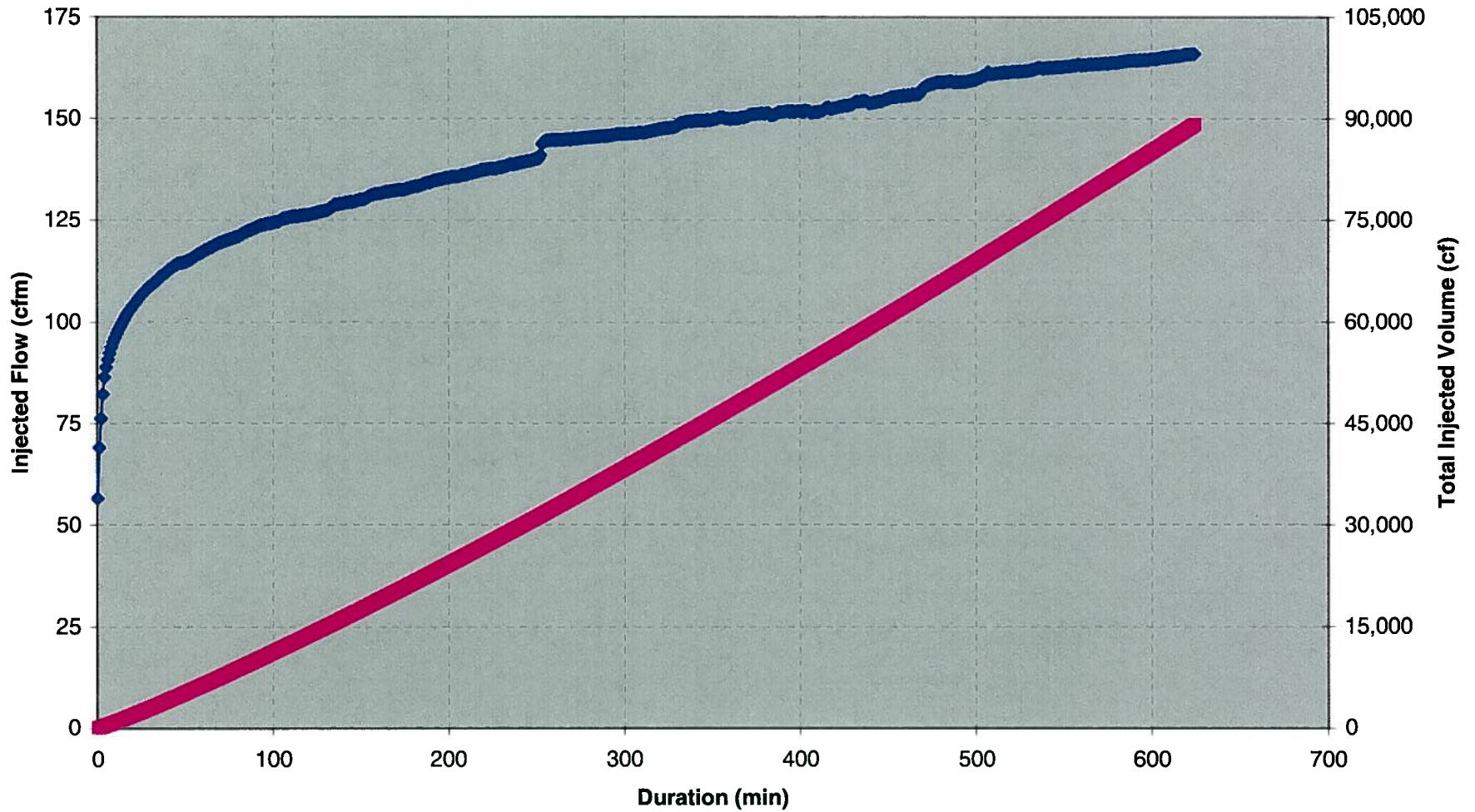
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-04  
11/25/2008**



**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

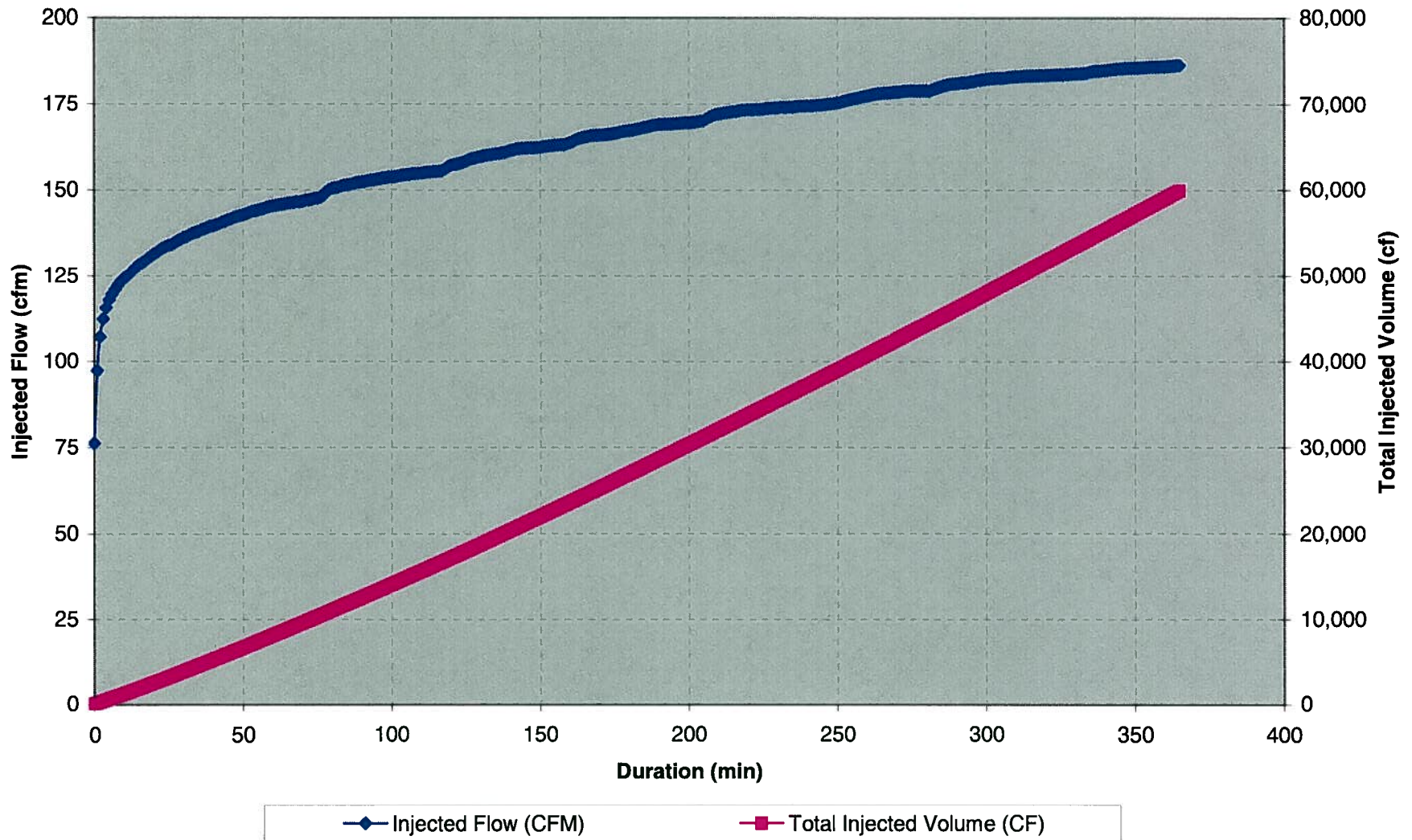
**BP-05  
1/7/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

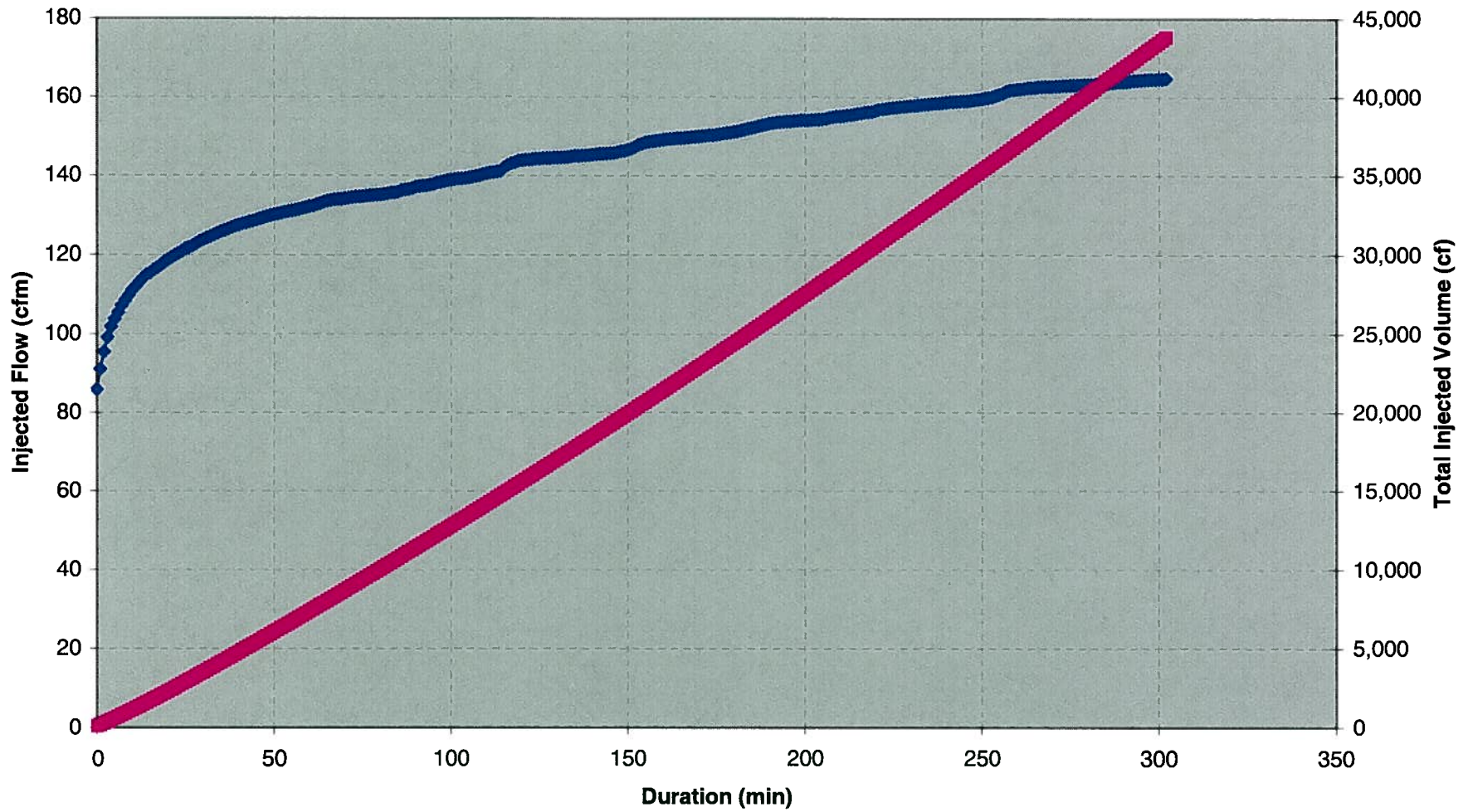
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-06  
1/12/2009**



**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

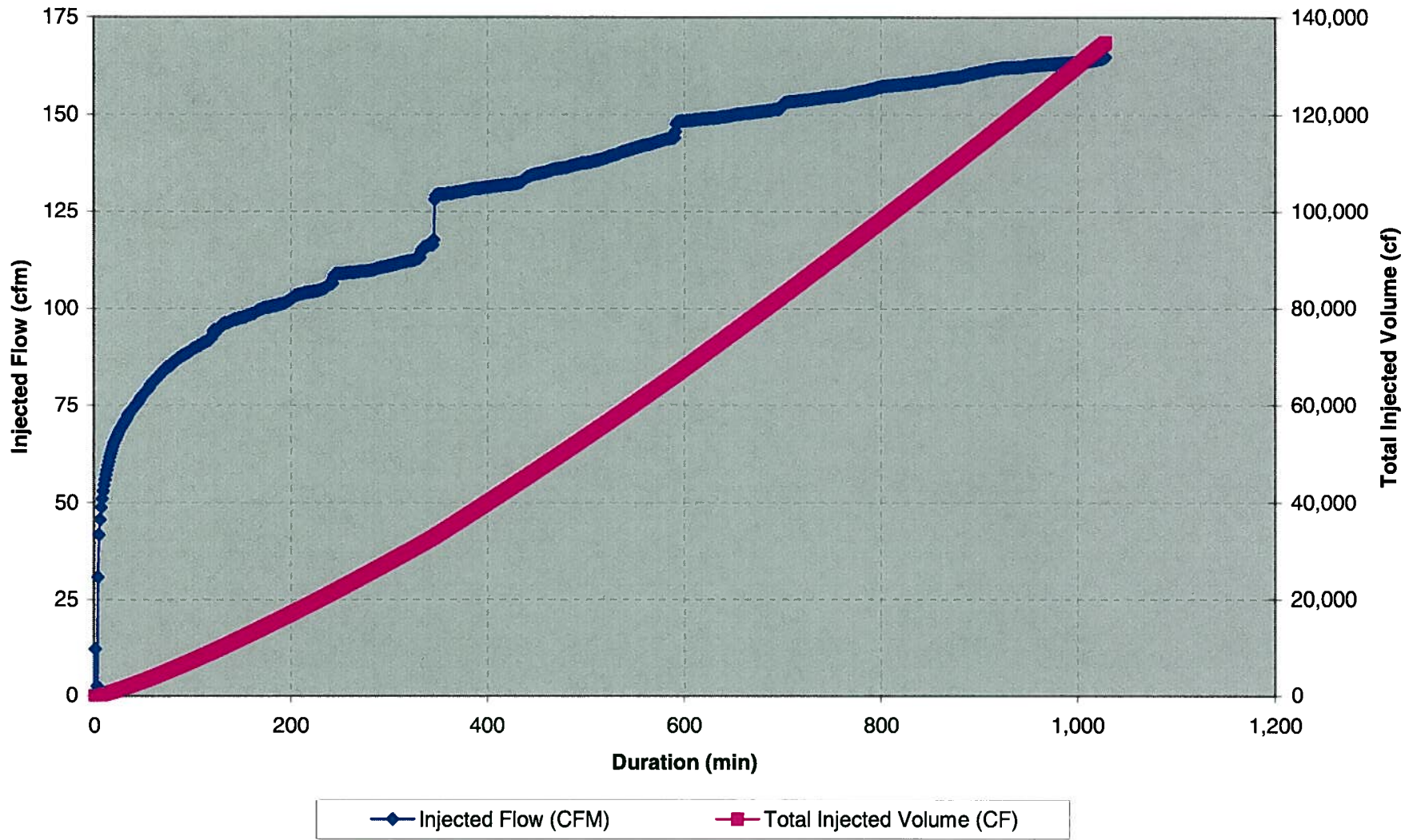
**BP-07  
11/21/2008**



—◆— Injected Flow (CFM)      —■— Total Injected Volume (CF)

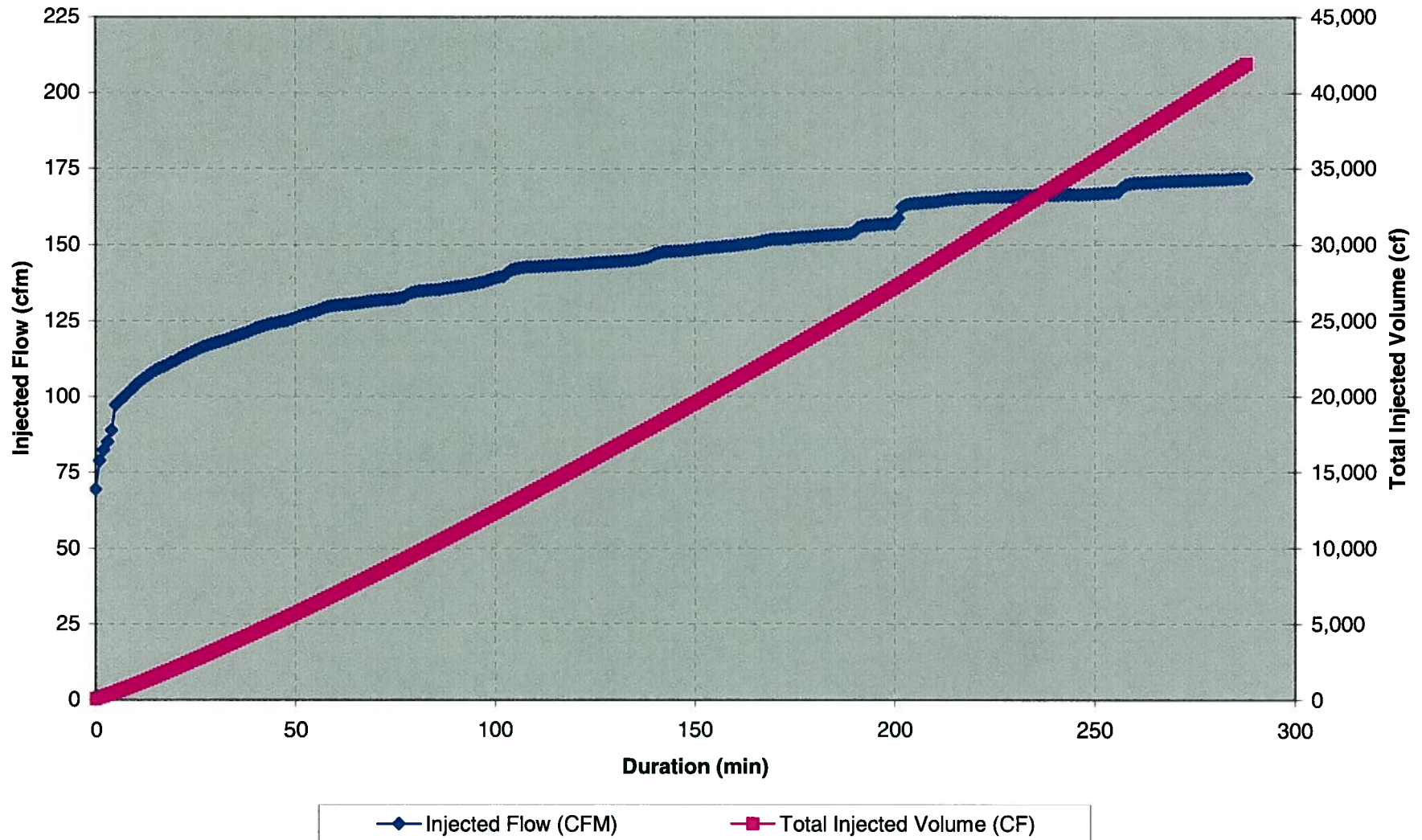
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-08  
1/14/2009**



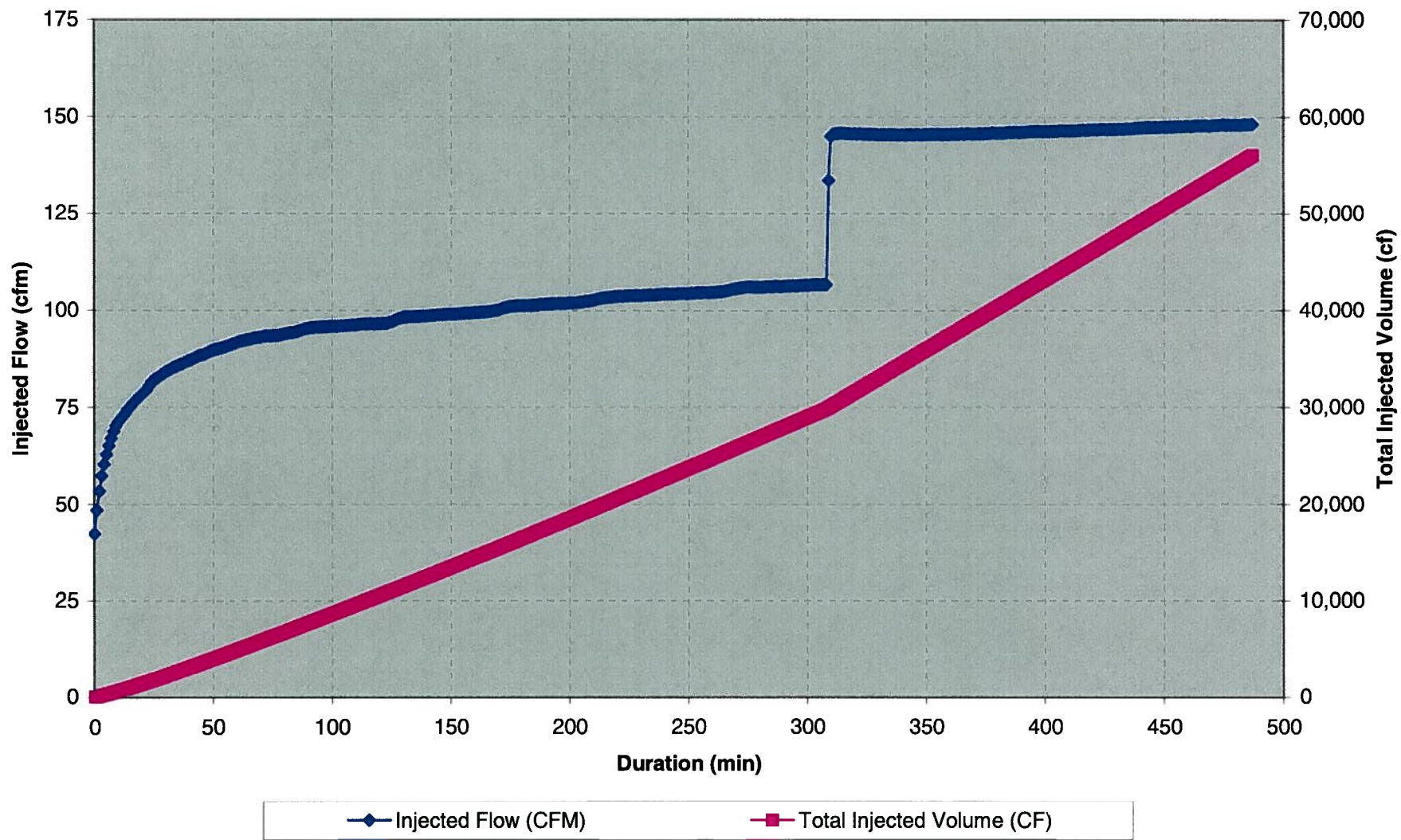
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-11  
1/5/2009**



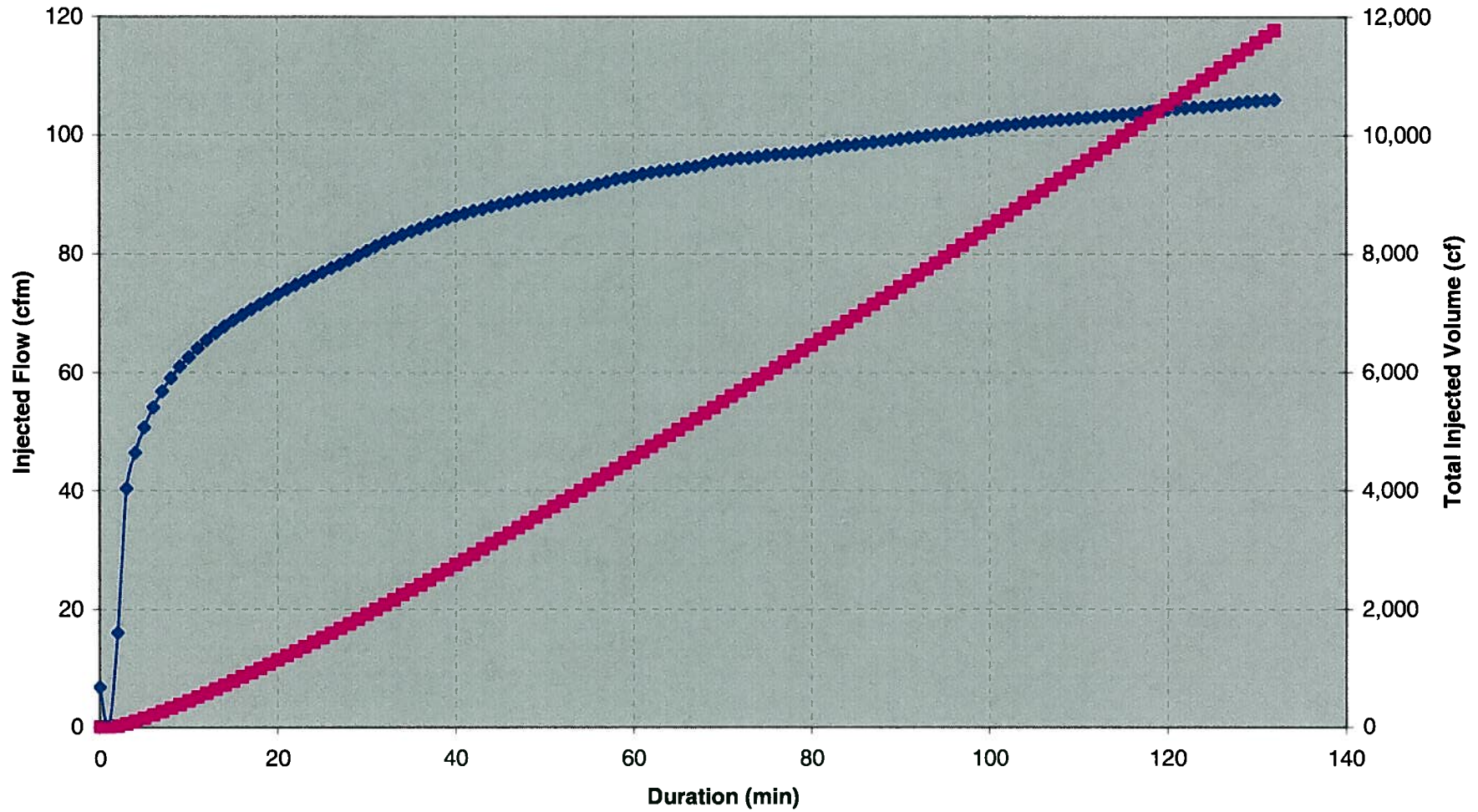
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-12  
11/20/2008**



**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

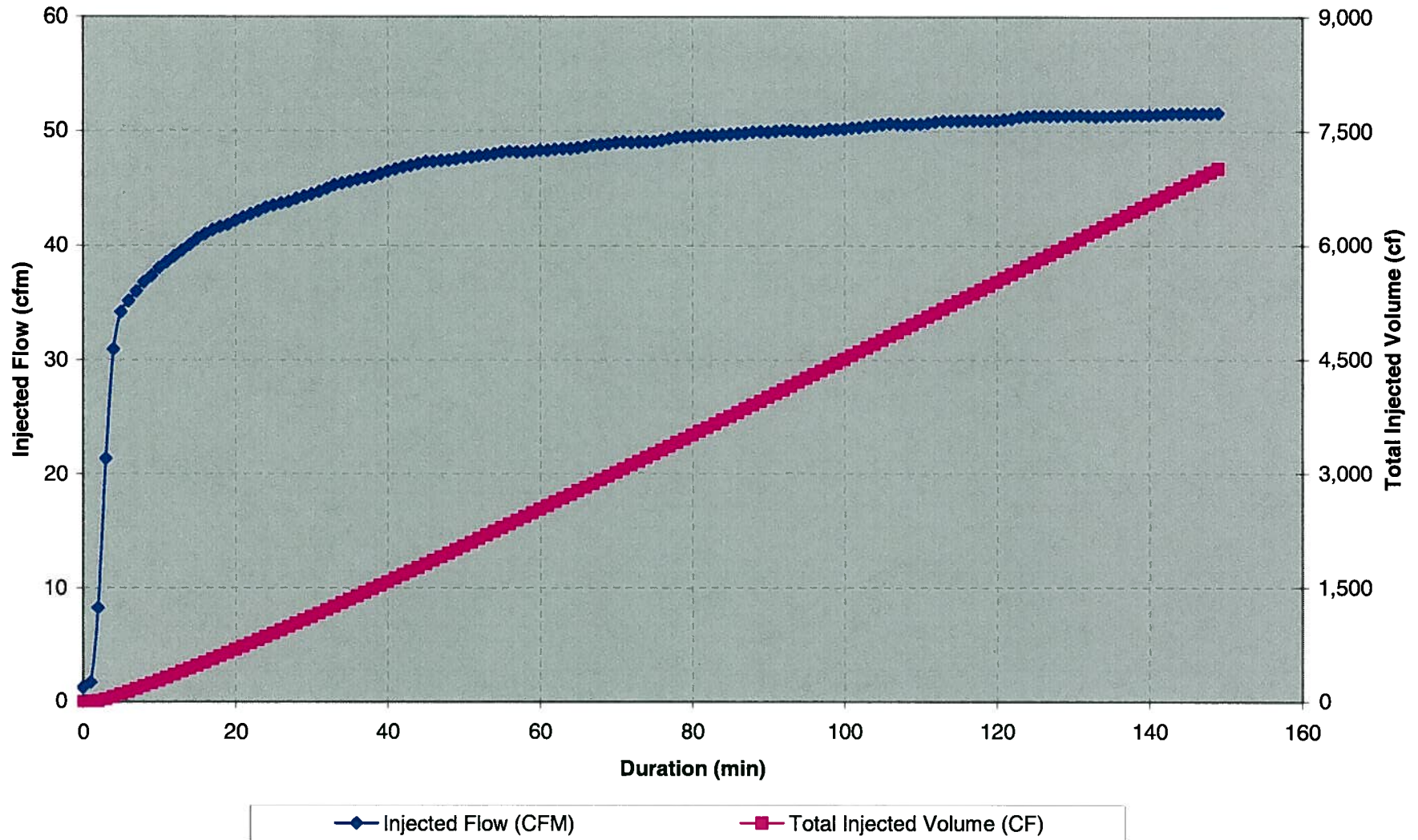
**BP-13  
2/4/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

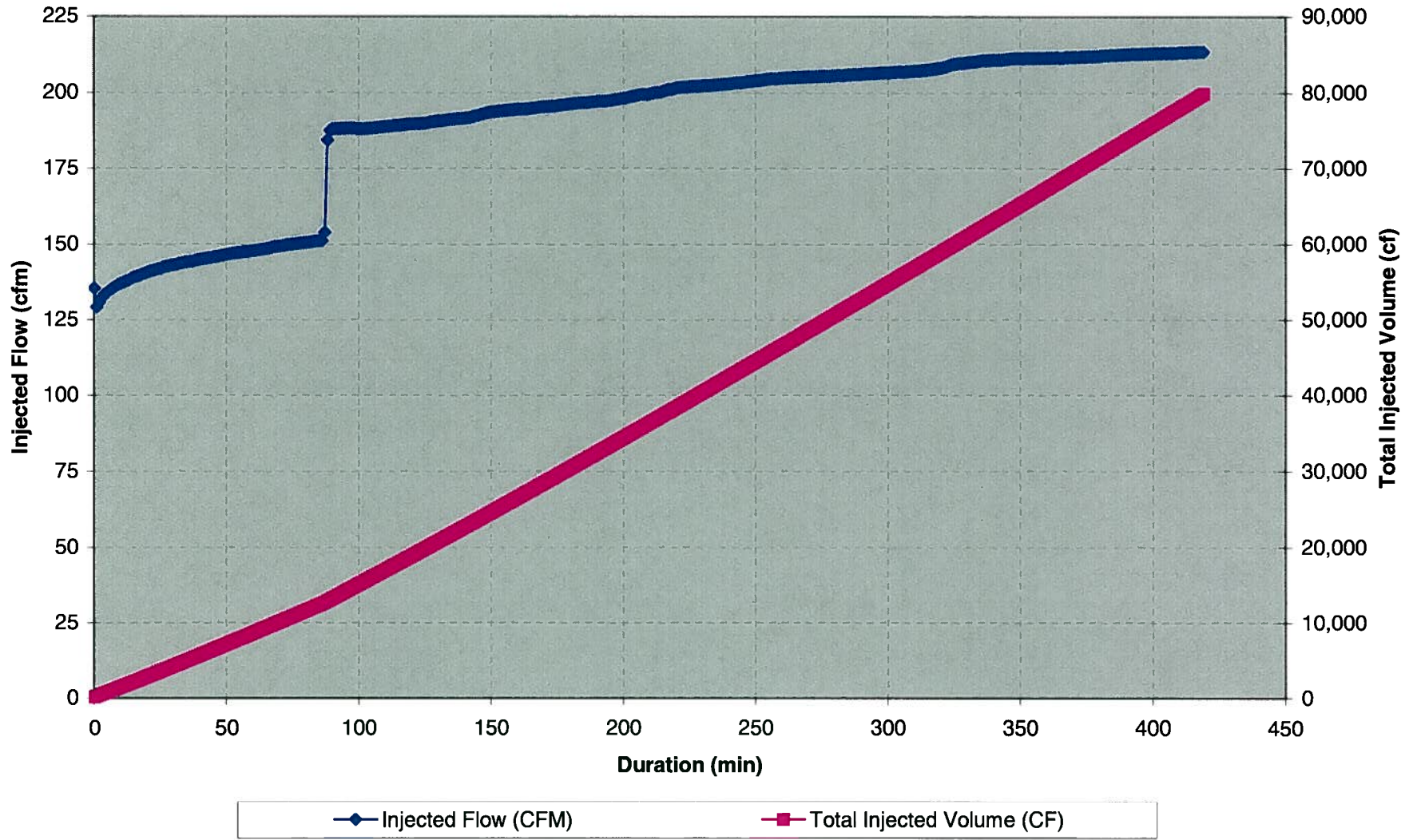
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-14  
12/9/2008**



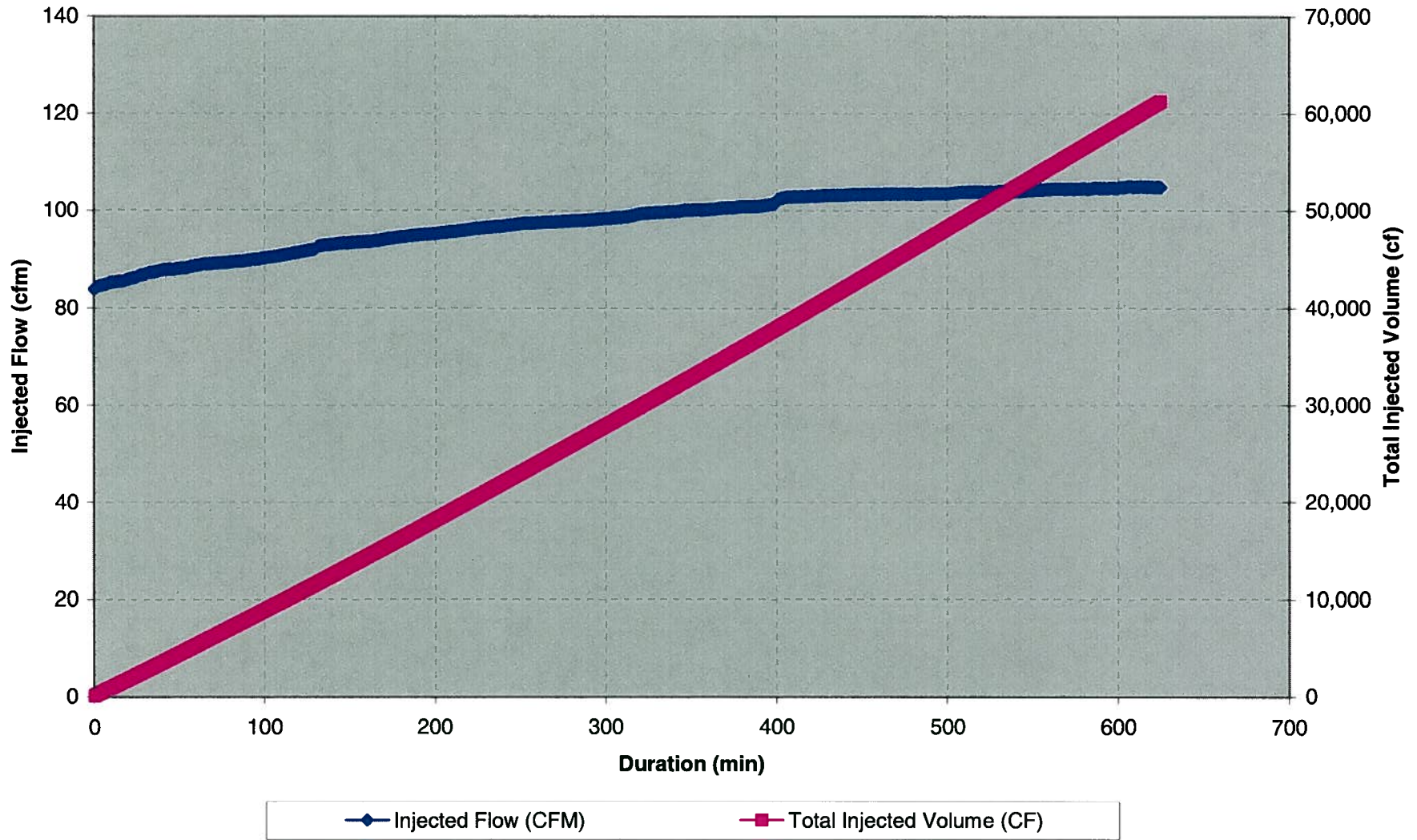
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-15  
11/26/2008**



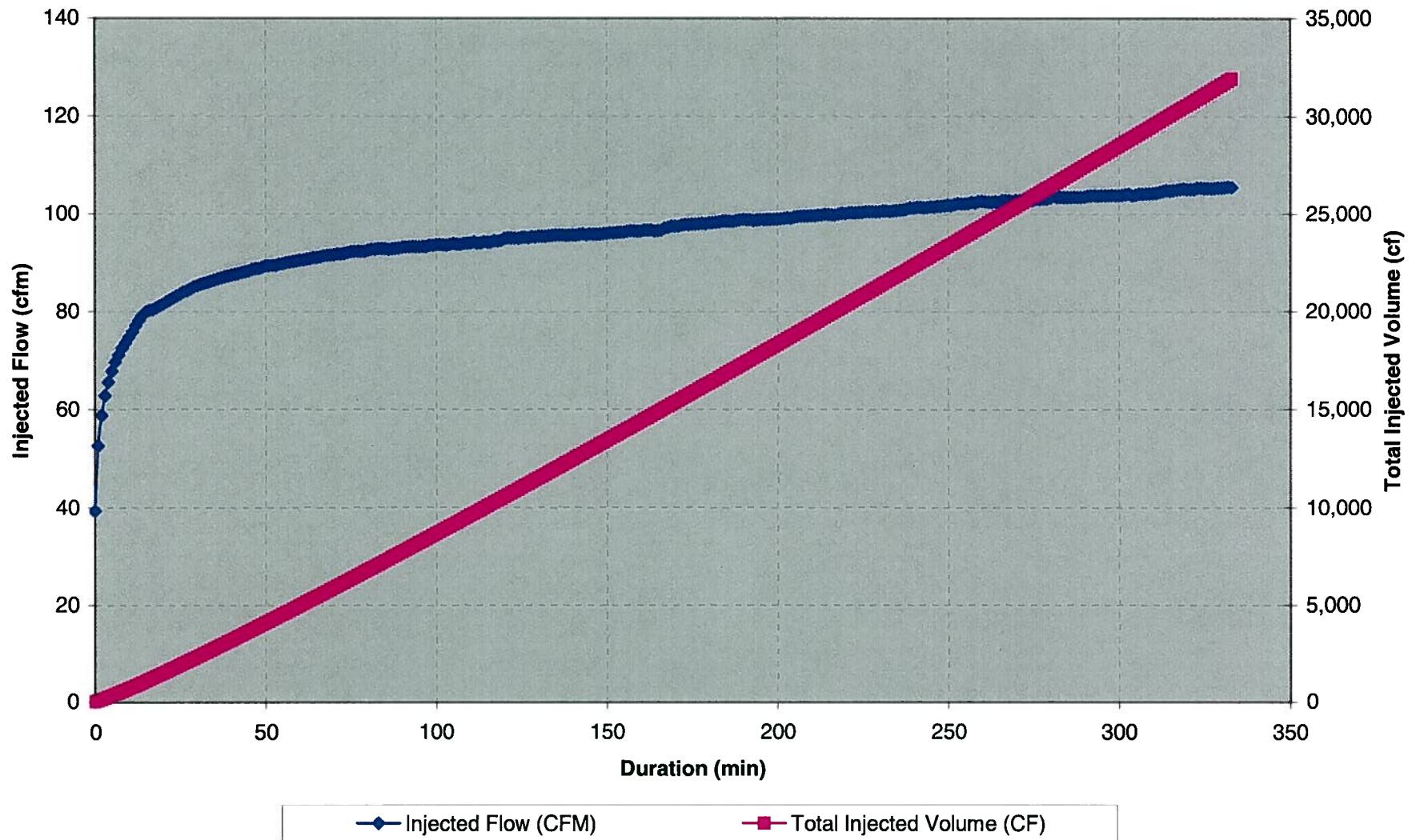
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-16  
1/9/2009**



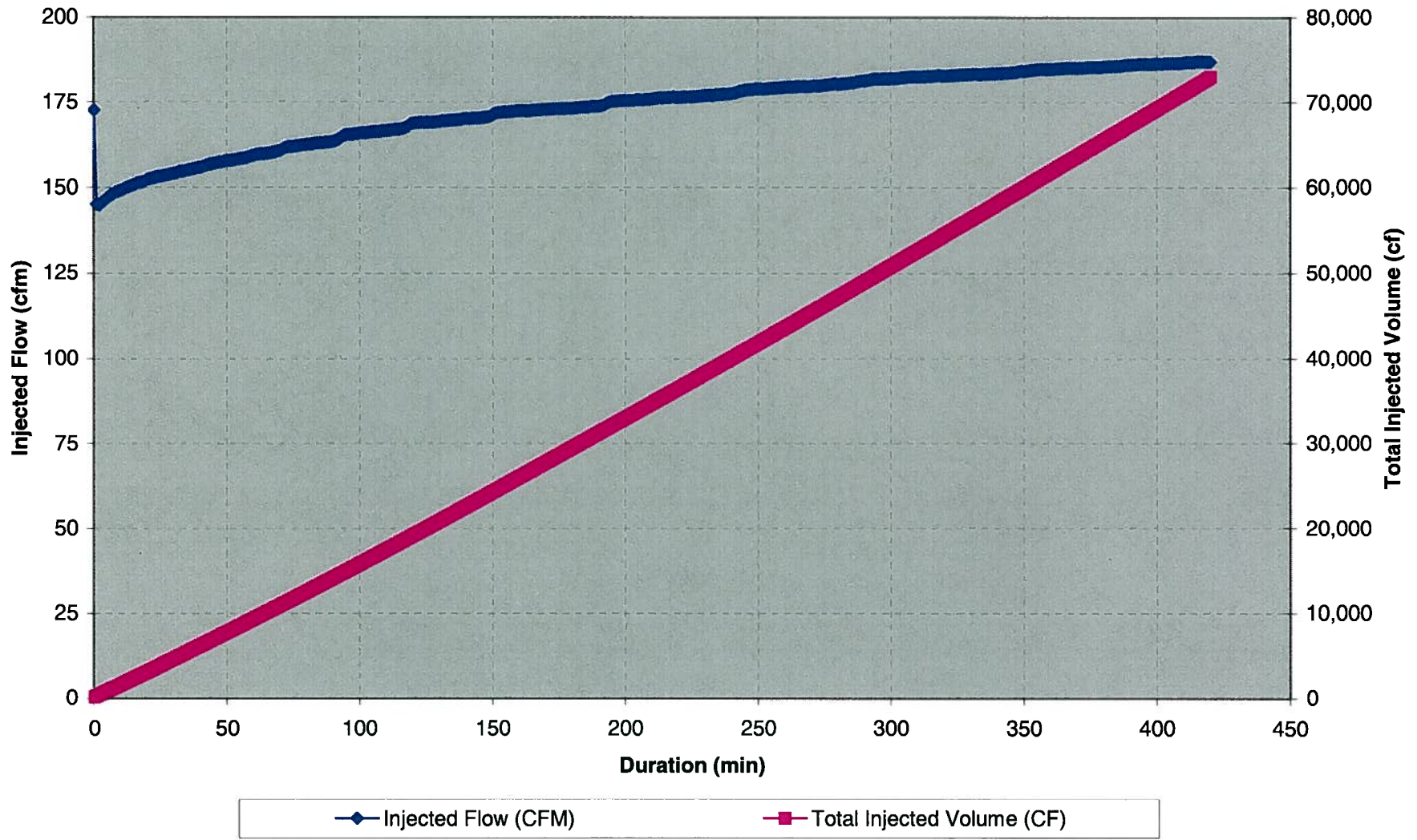
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-17  
1/13/2009**



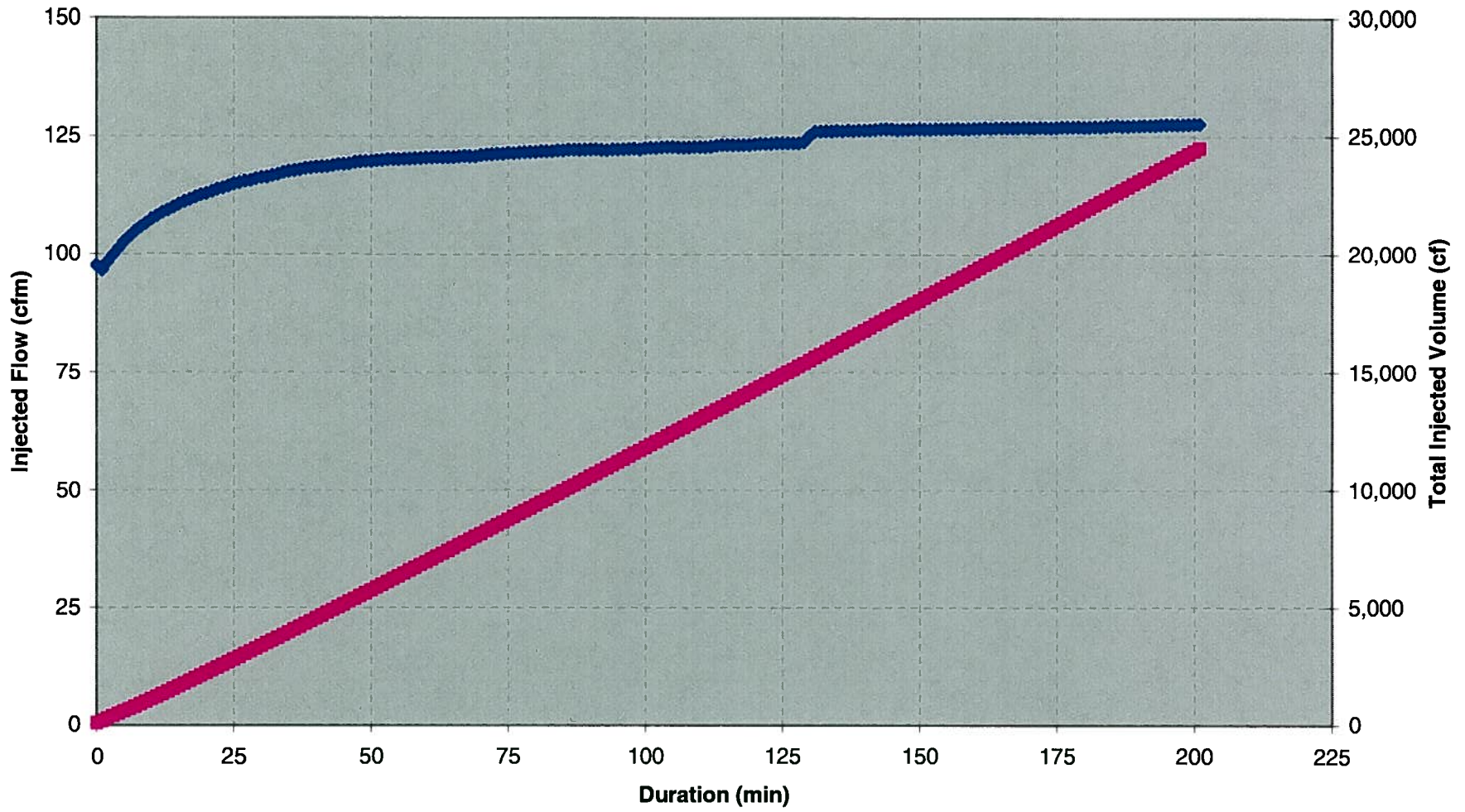
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-18  
1/28/2009**



**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

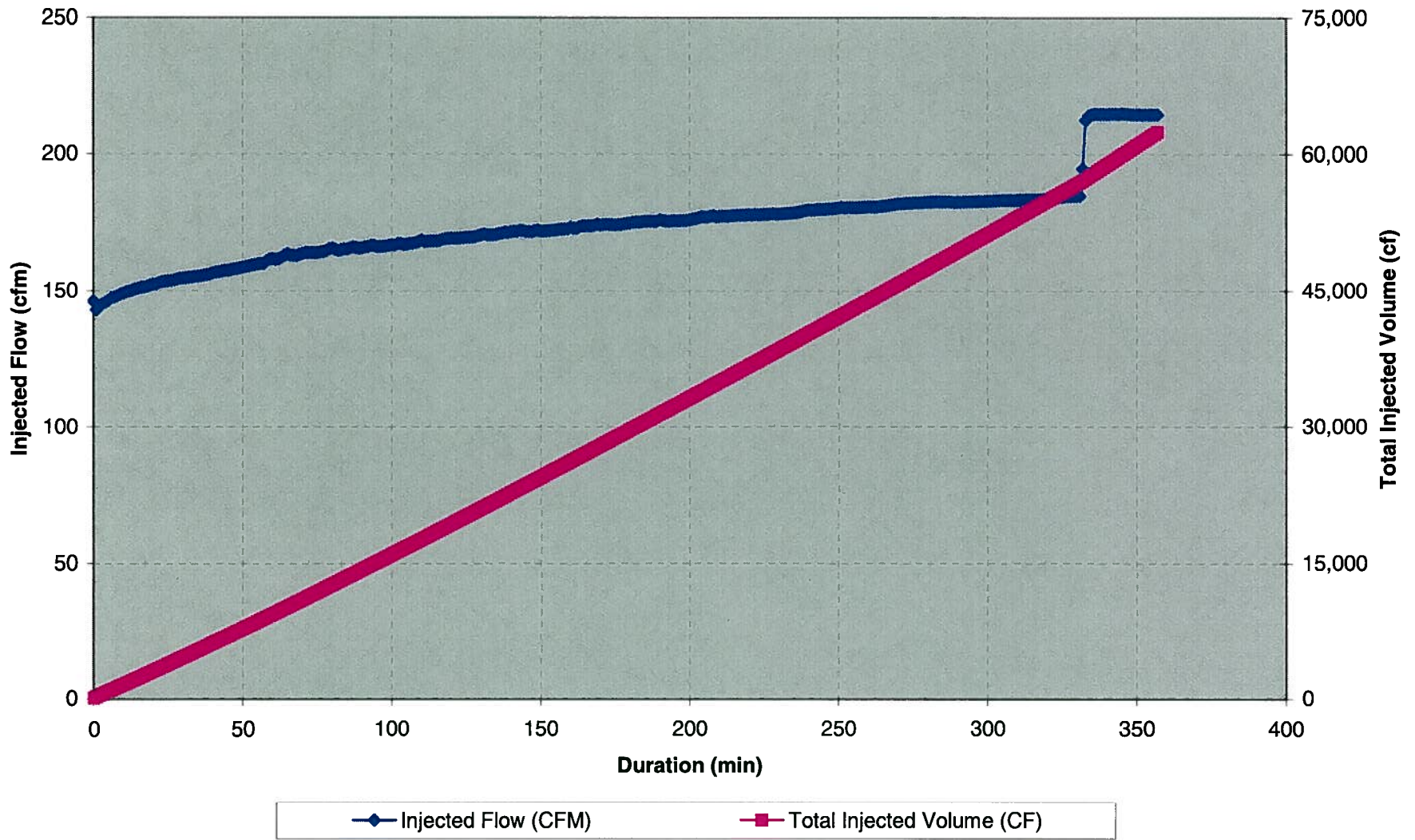
**BP-20  
1/6/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

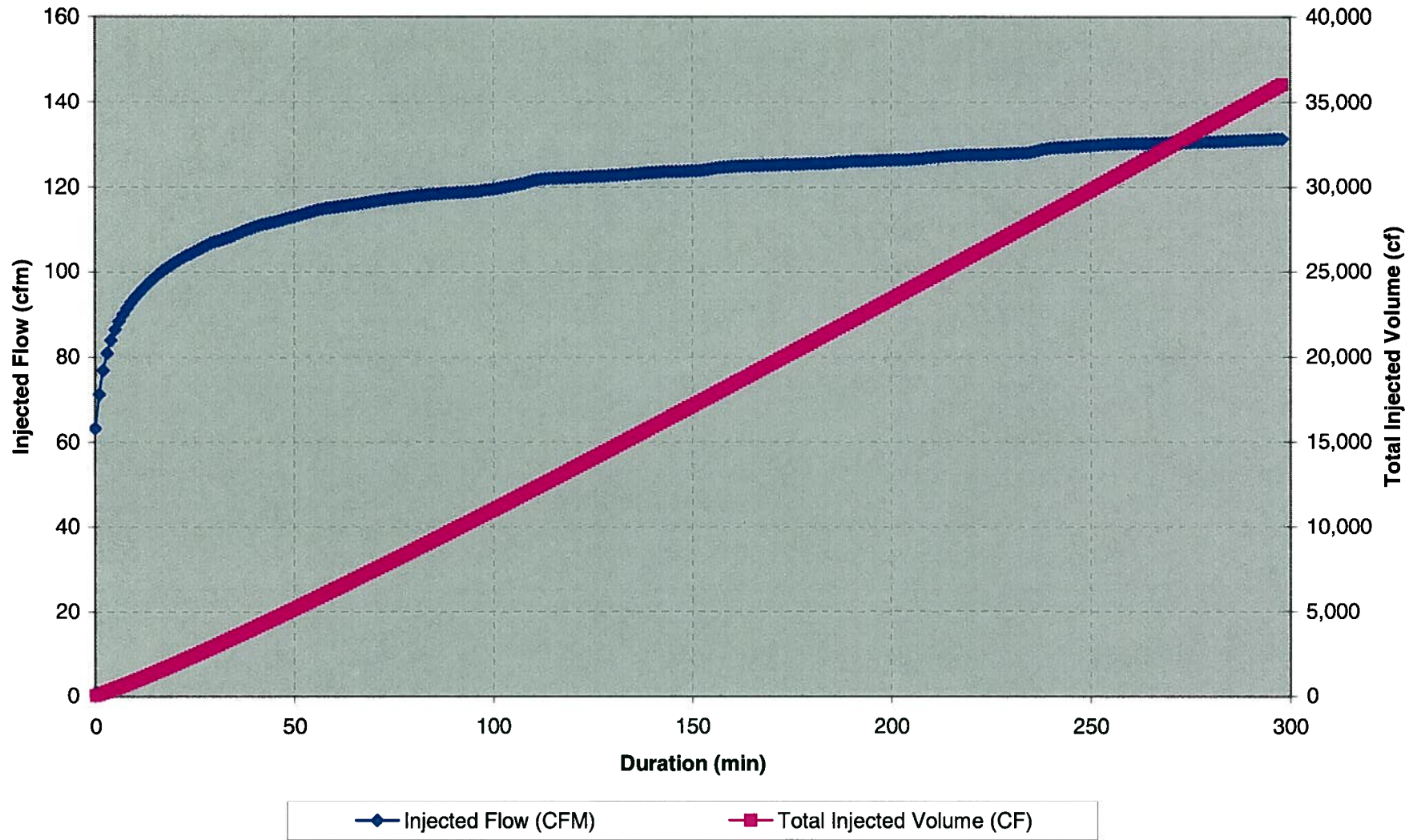
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-21  
11/19/2008**



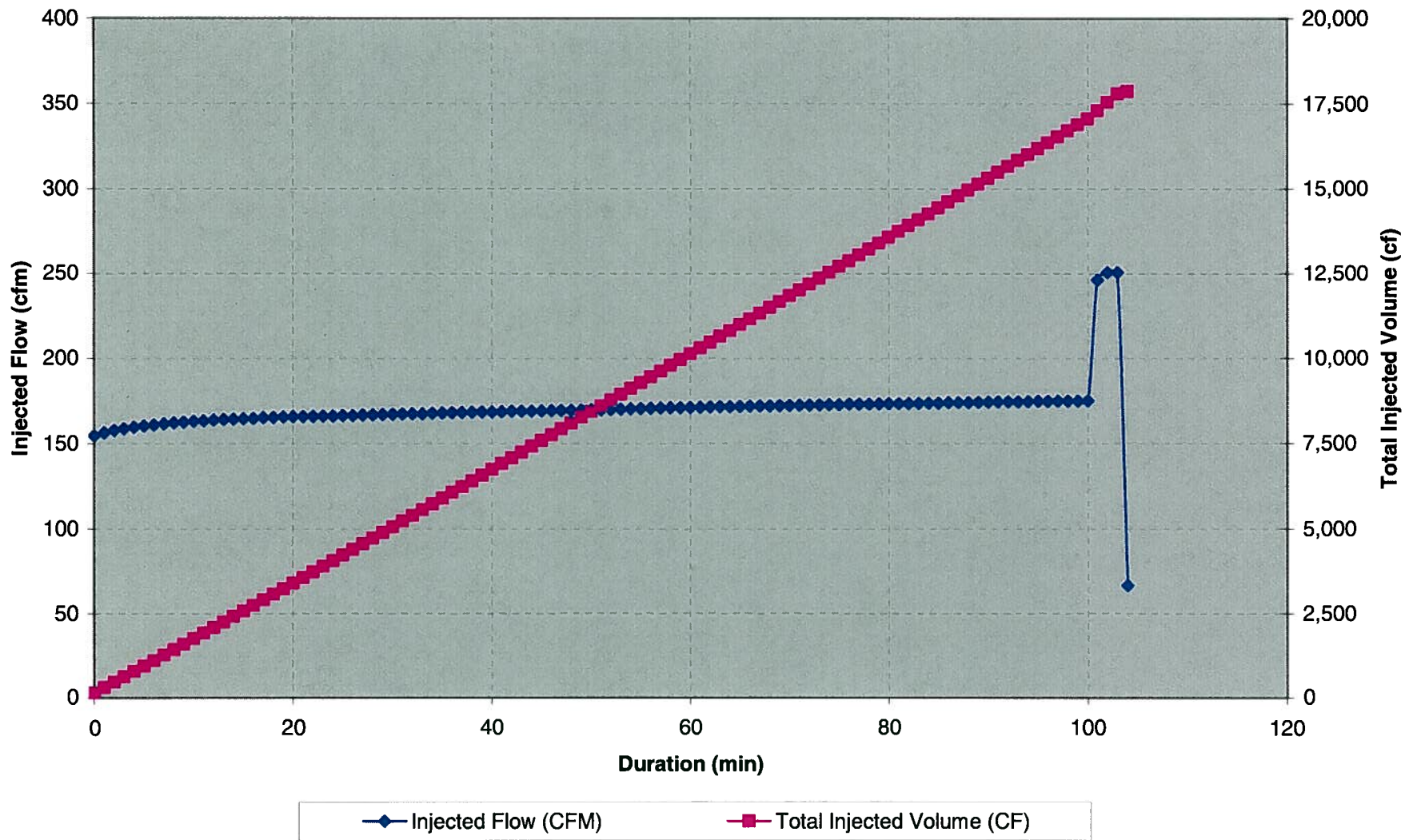
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-22  
12/1/2008**



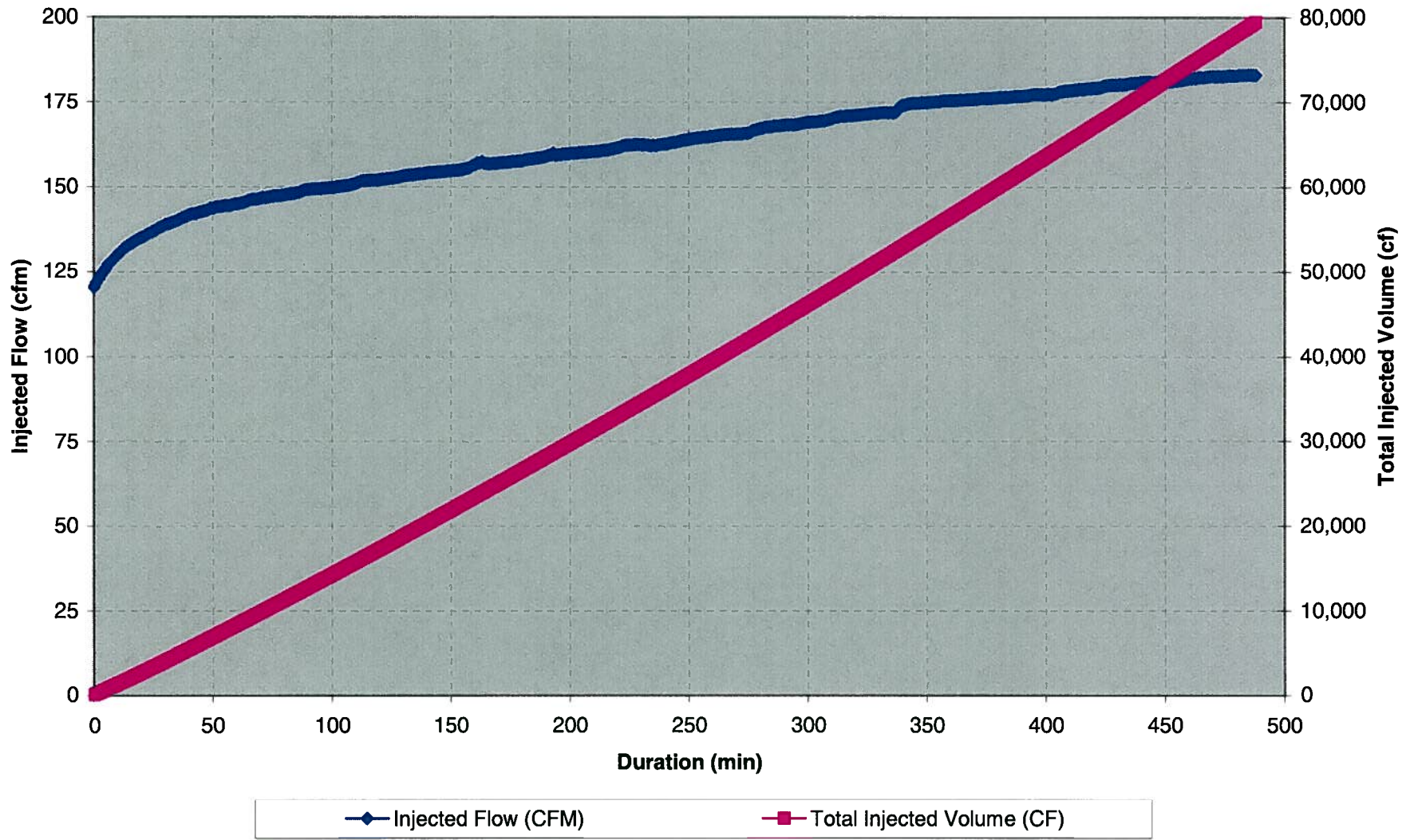
**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**BP-24  
11/24/2008**



**AIR FLOW -vs- TIME GRAPH  
NINTH ROUND OF BIO-PULSE SPARGING**

**SP-100  
1/8/2009**

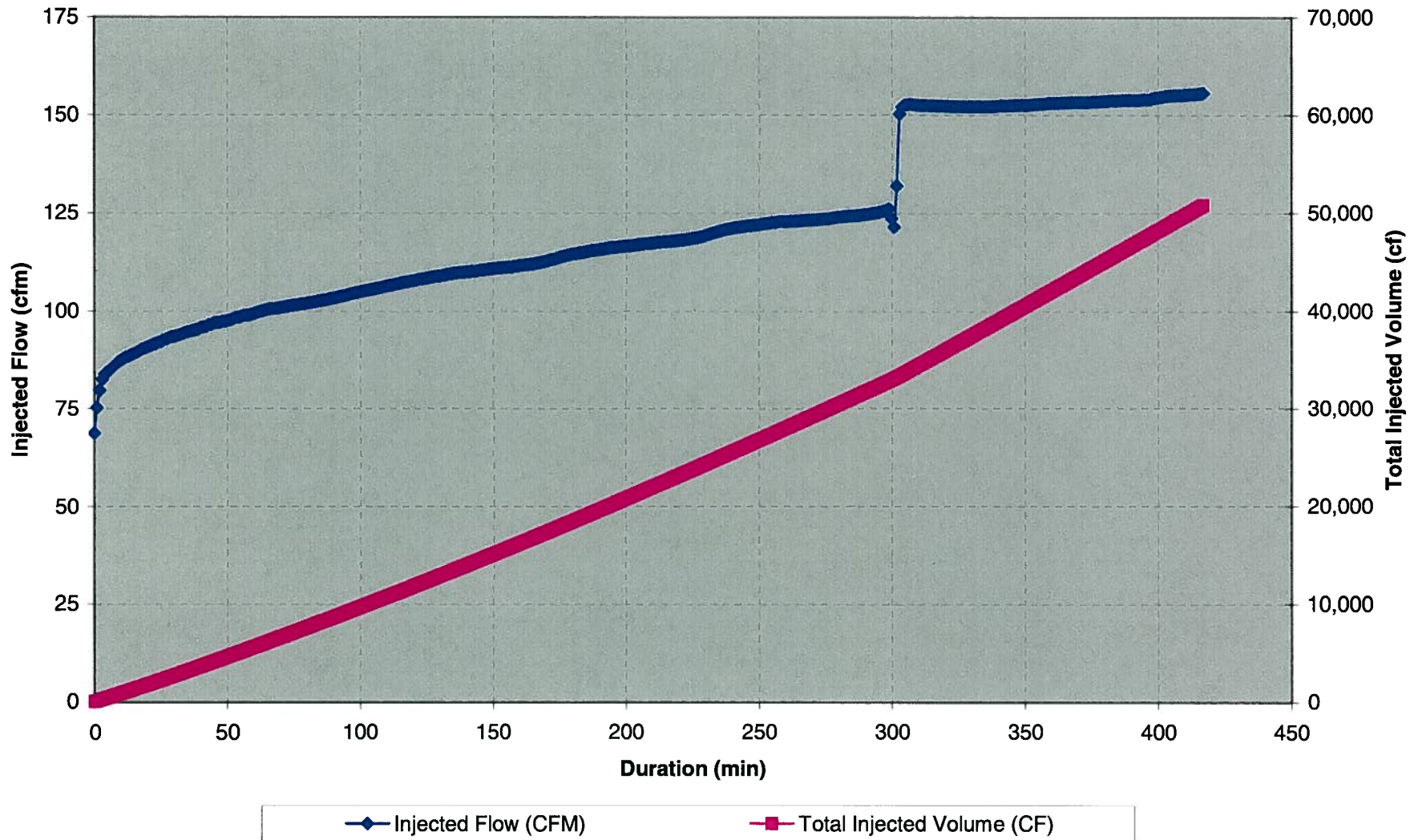


**APPENDIX D**

**AIR FLOW VS. TIME GRAPHS TENTH ROUND OF BIO-PULSE SPARGING**

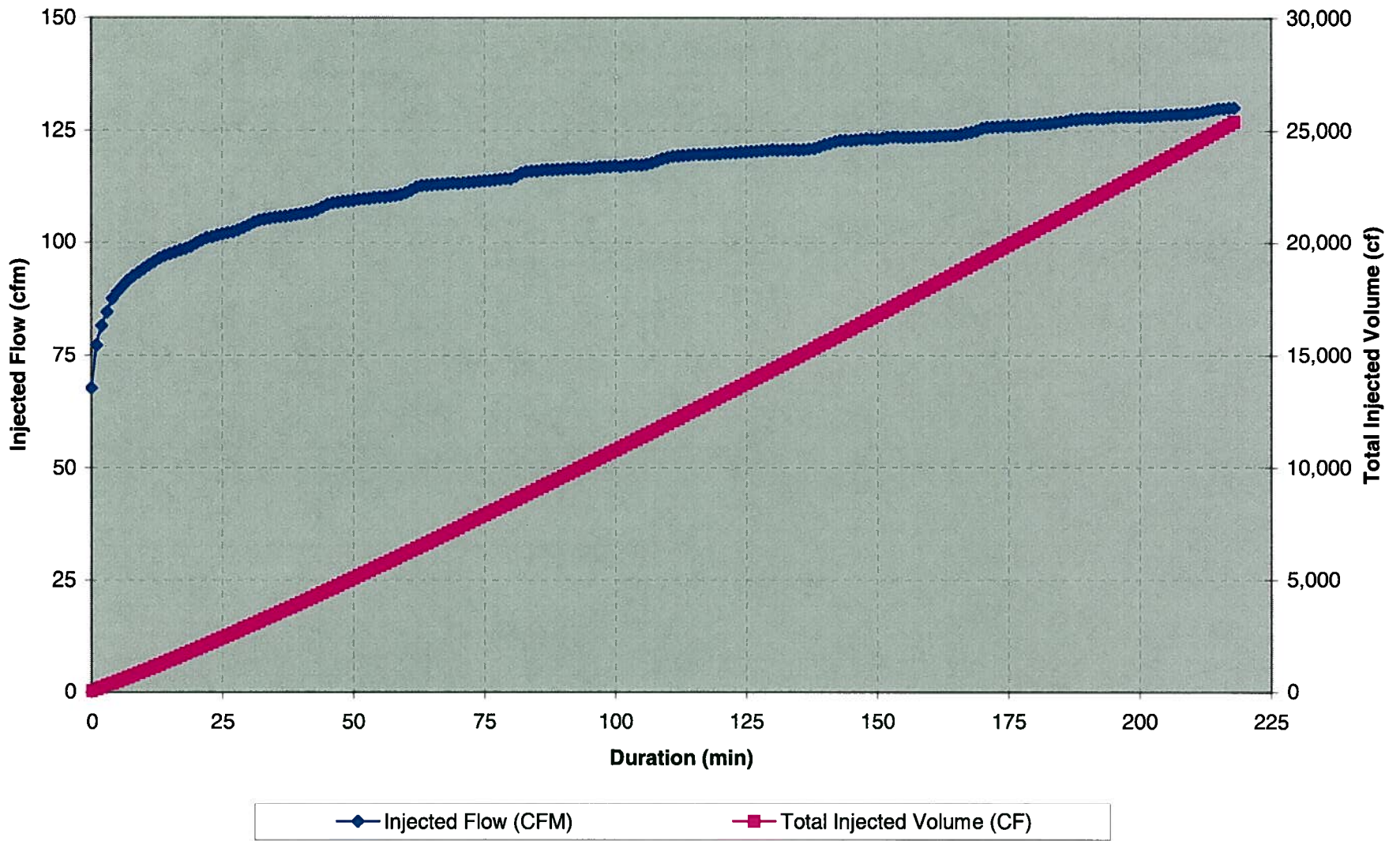
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-01  
3/5/2009**



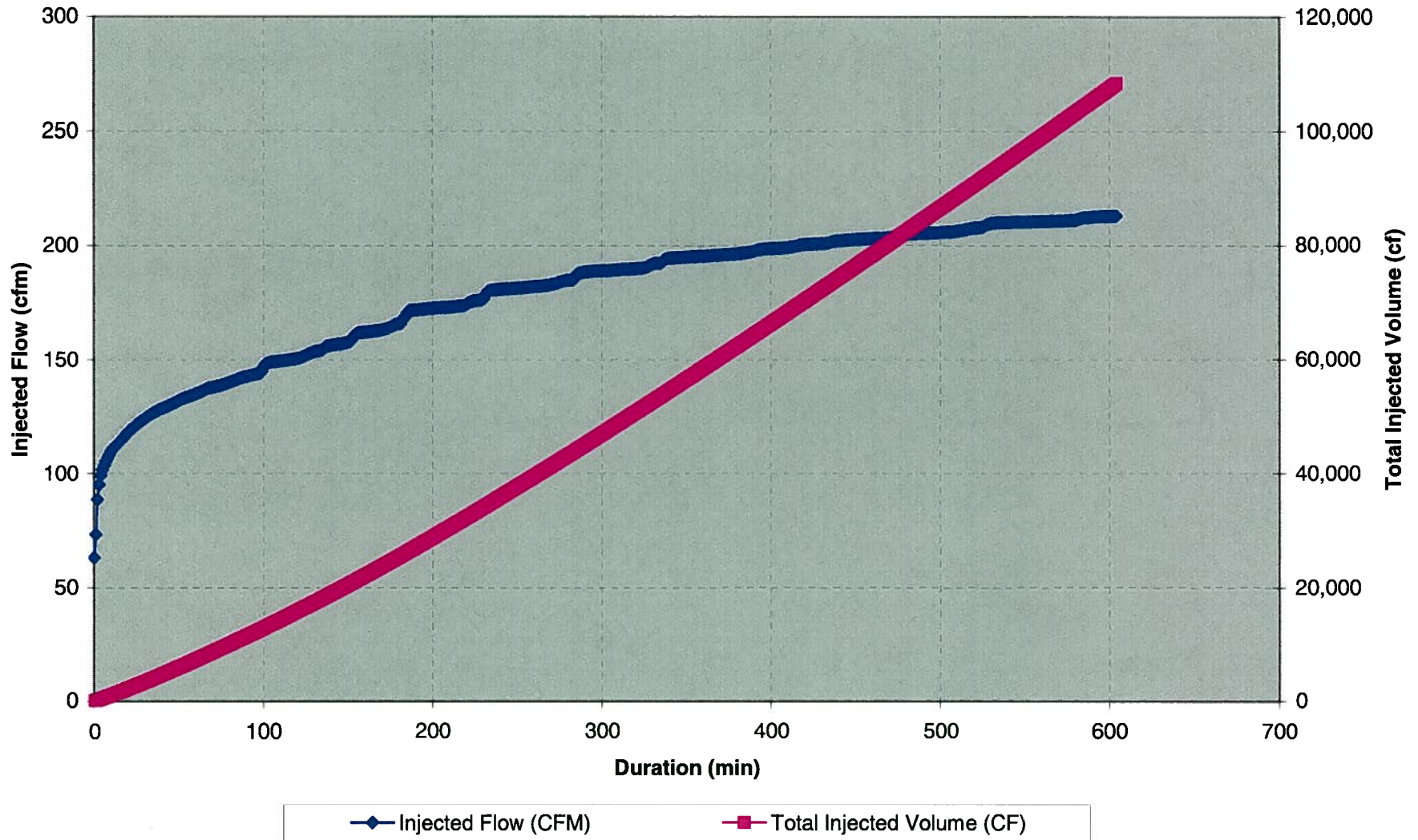
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-02  
3/17/2009**



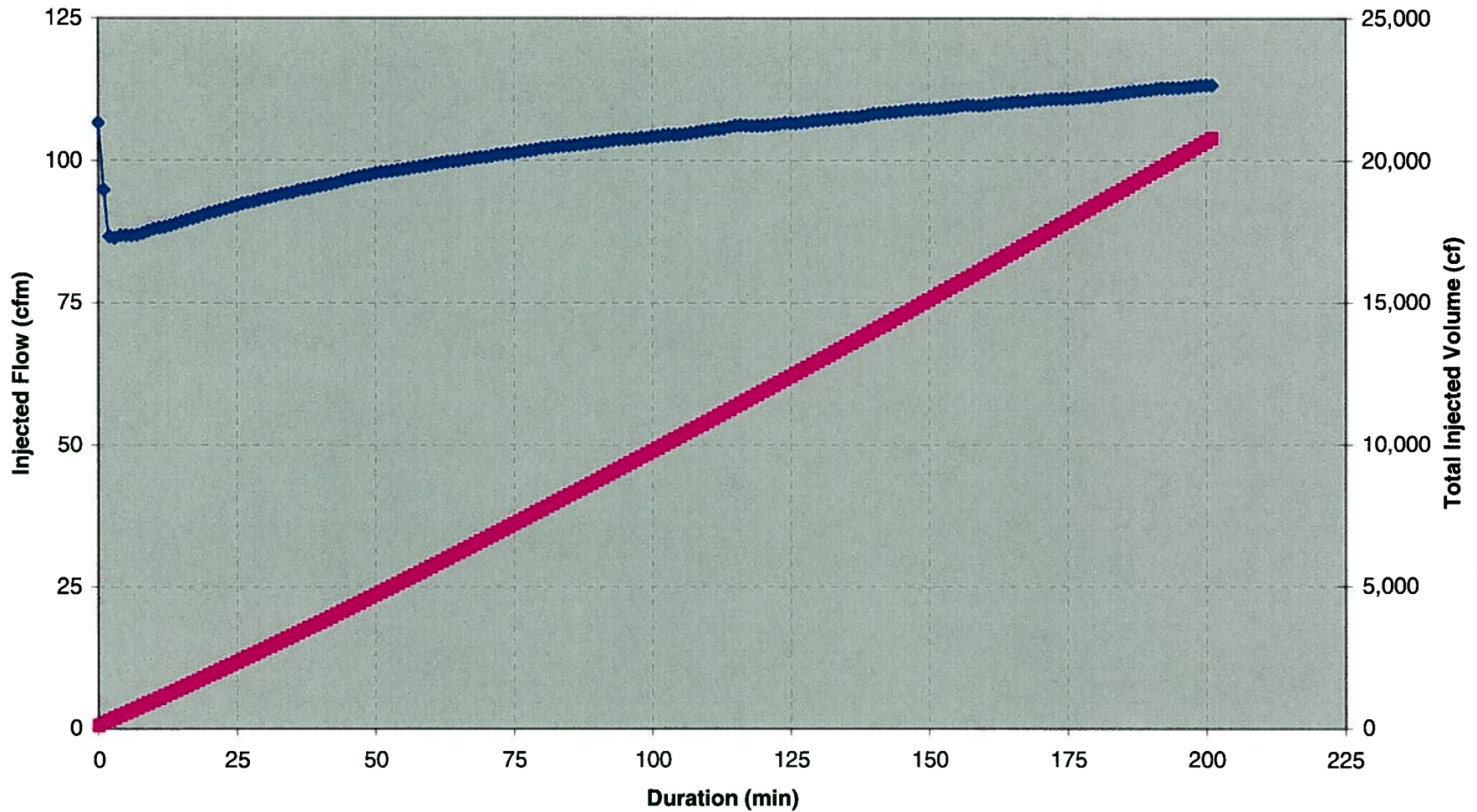
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-03  
4/8/2009**



**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

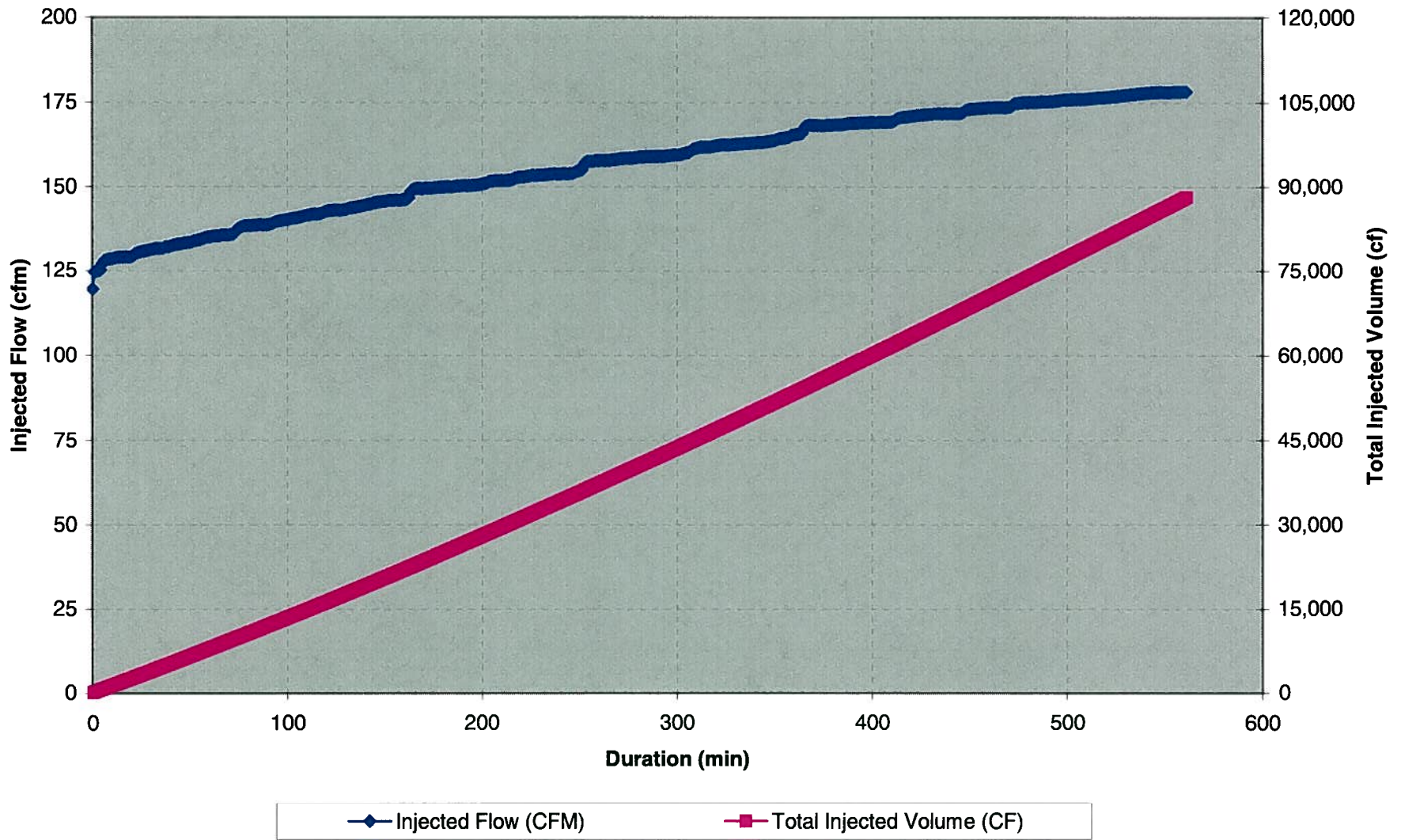
**BP-04  
3/12/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

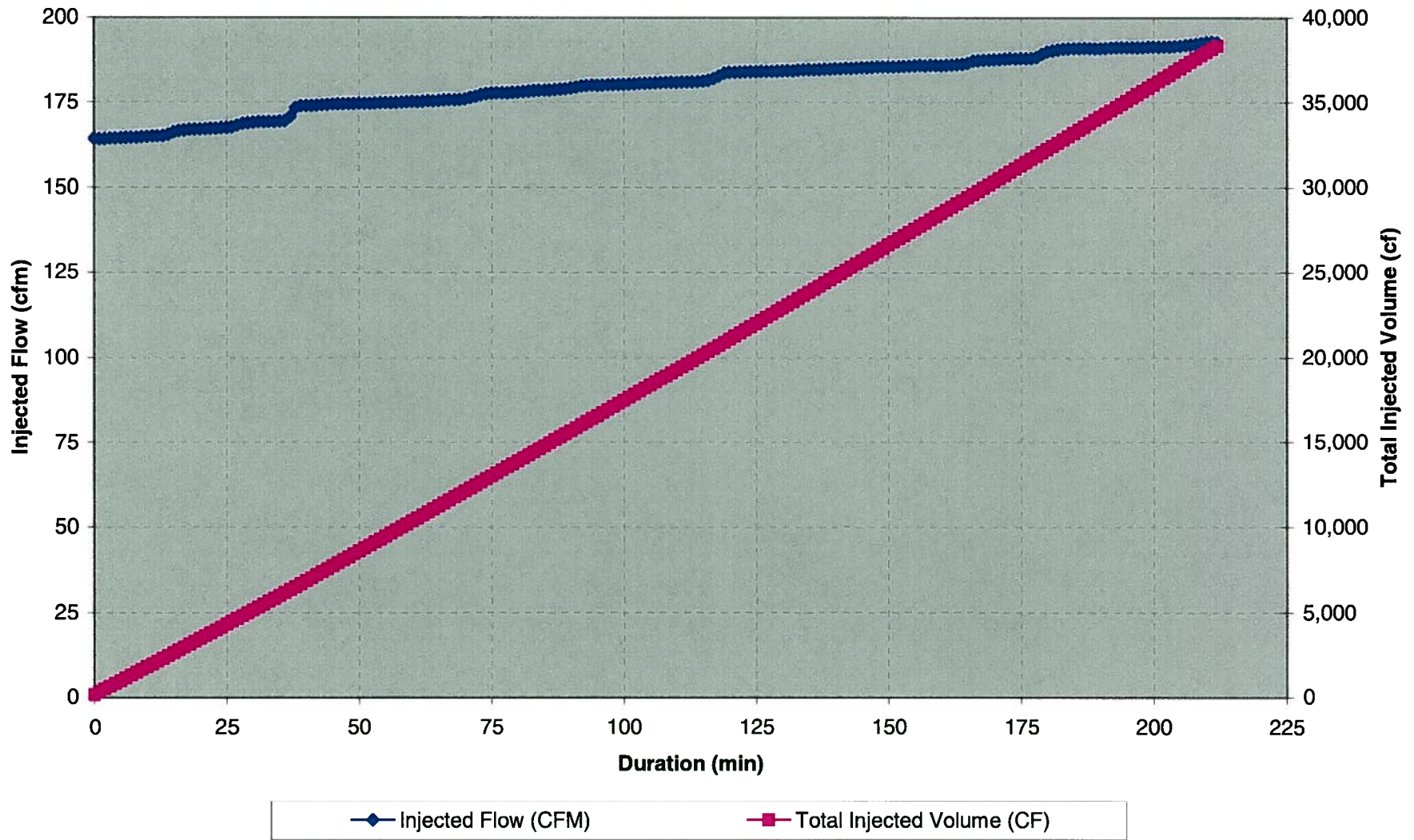
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-05  
3/30/2009**



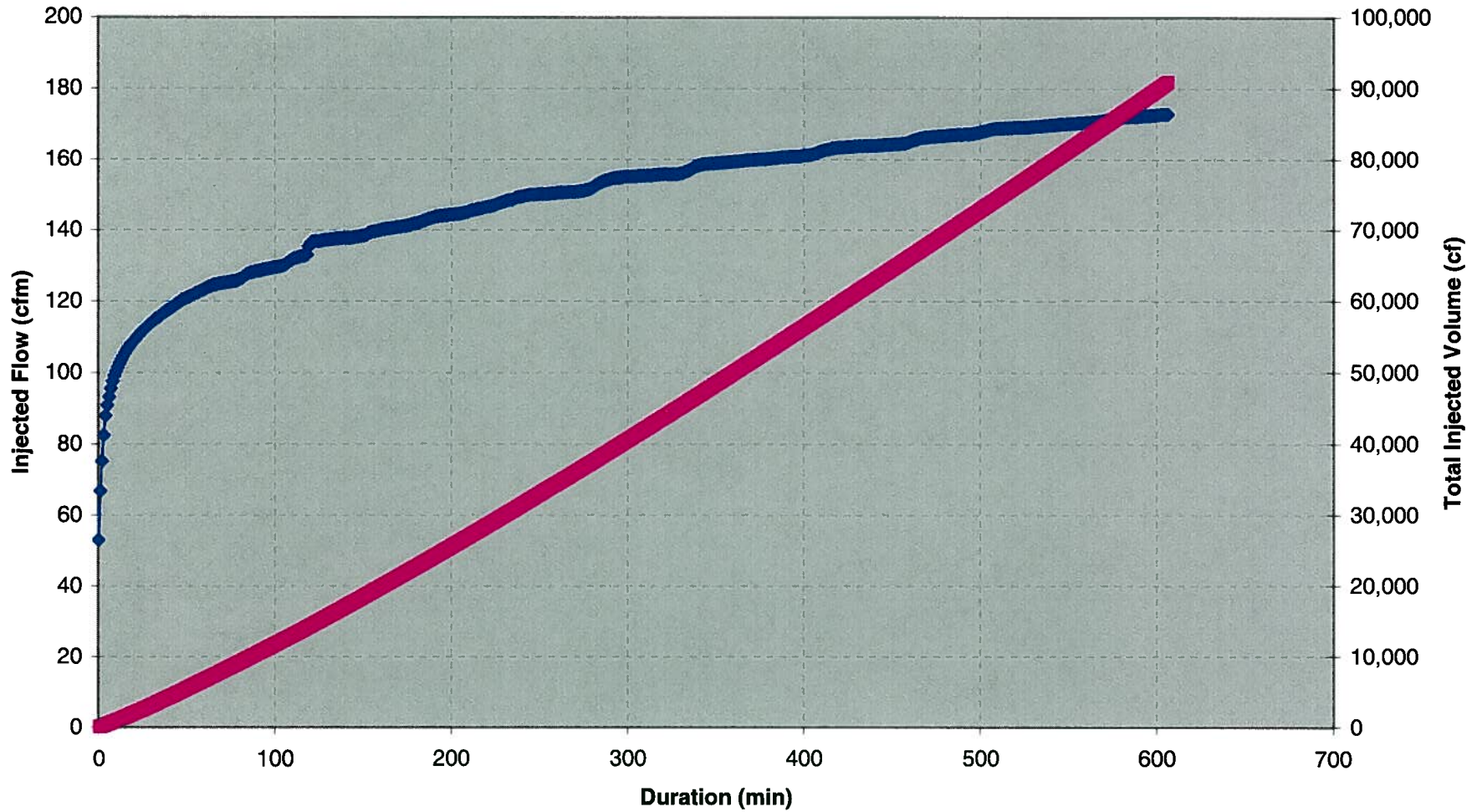
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-06  
4/1/2009**



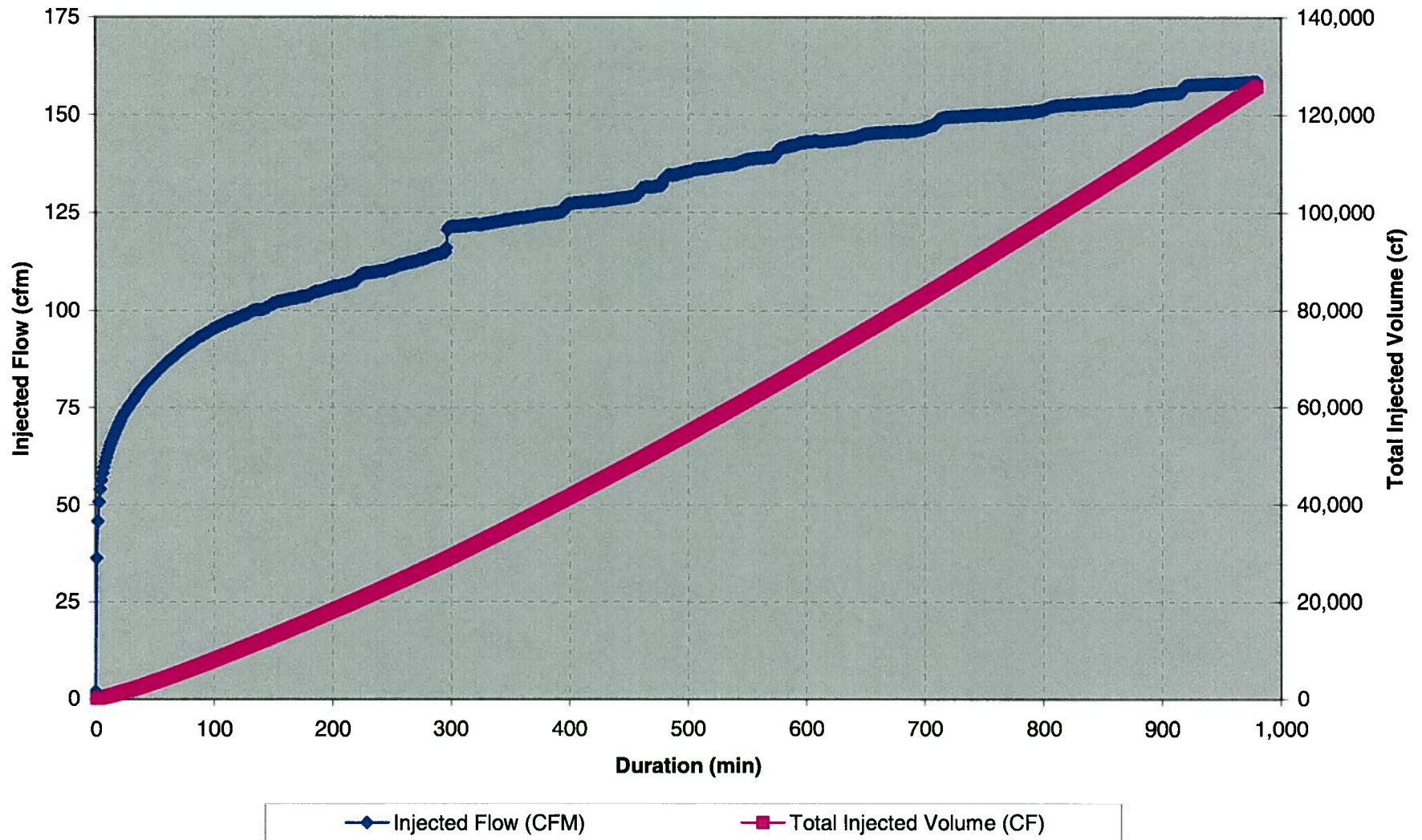
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-07  
3/10/2009**



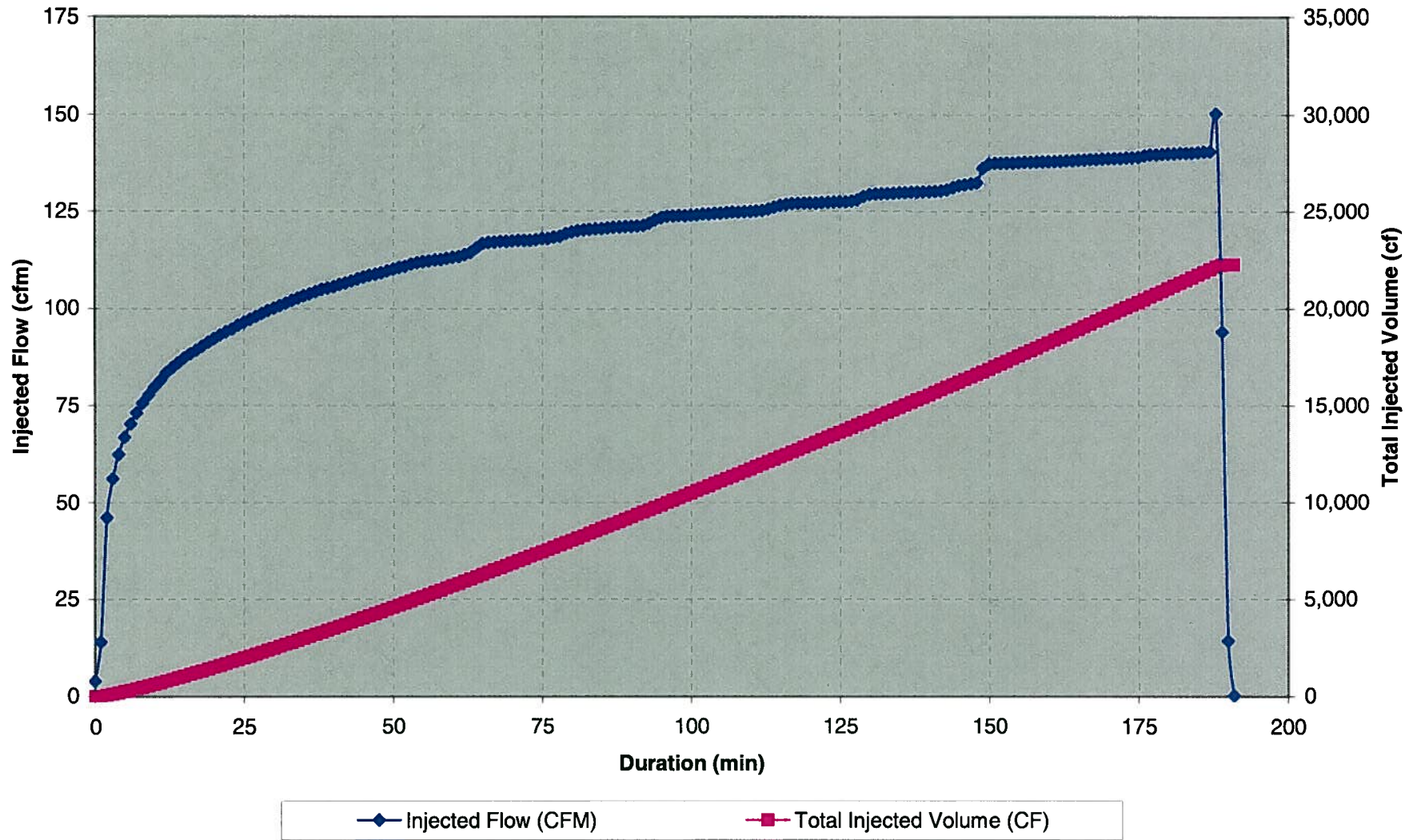
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-08  
4/7/2009**



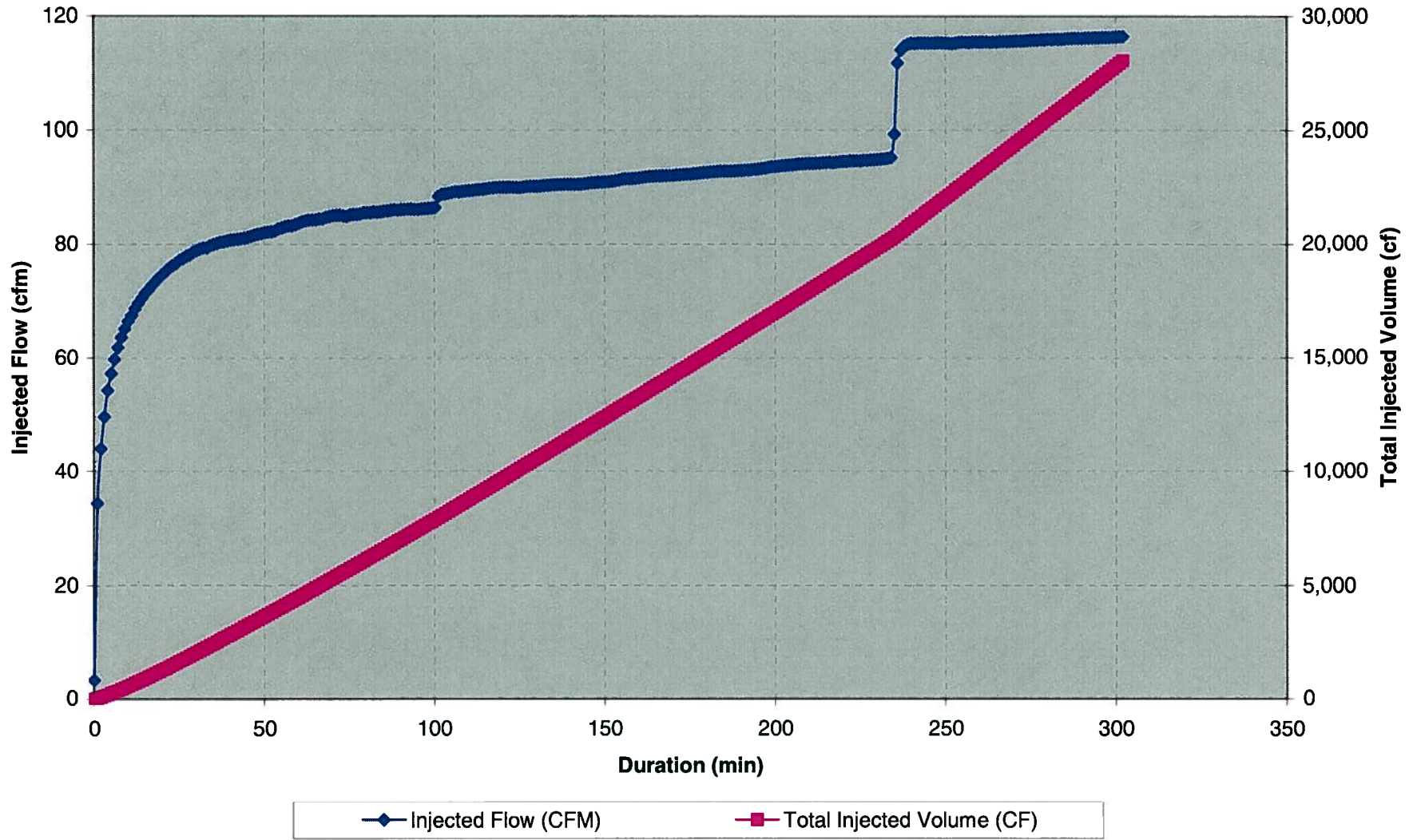
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-09  
3/19/2009**



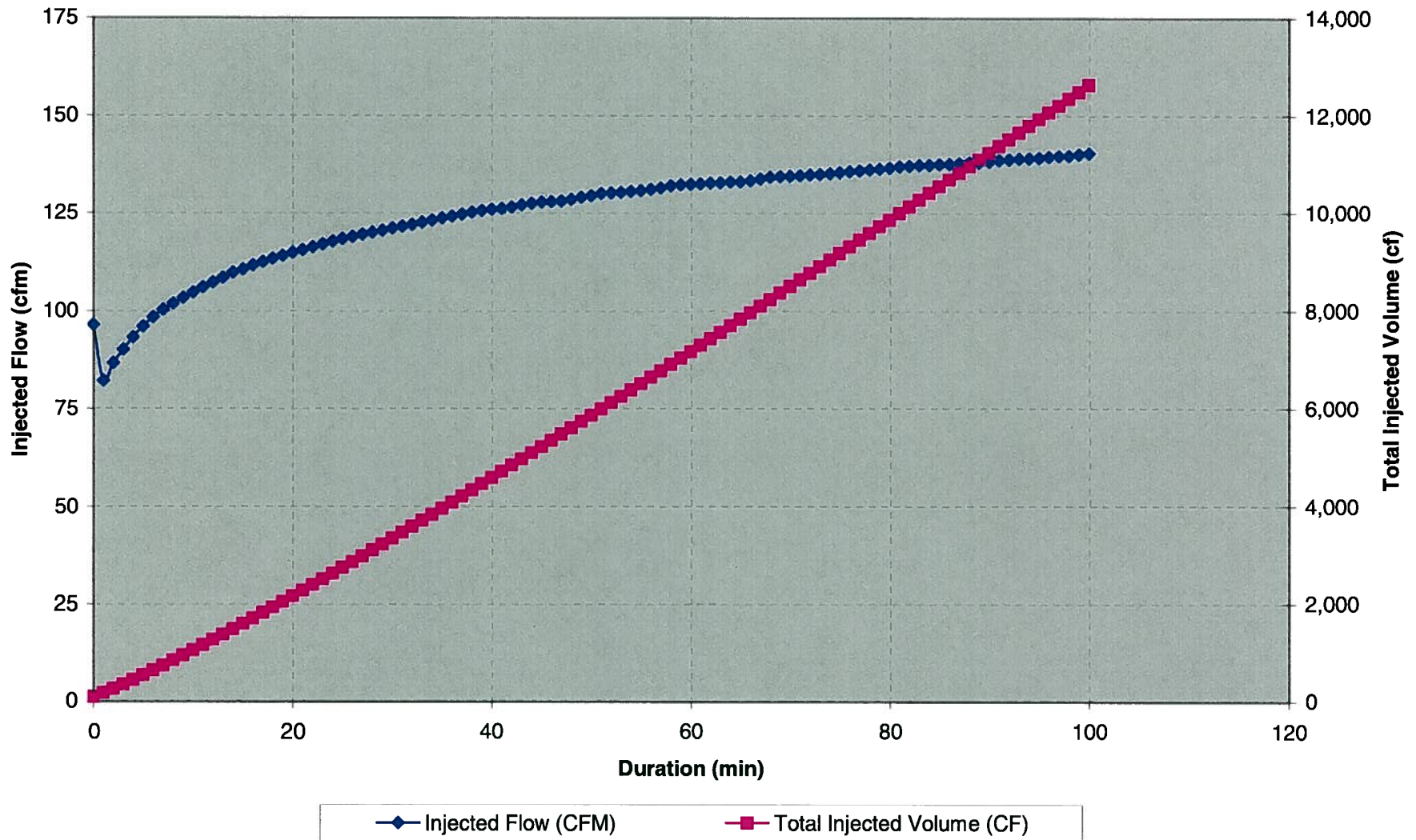
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-12  
3/9/2009**



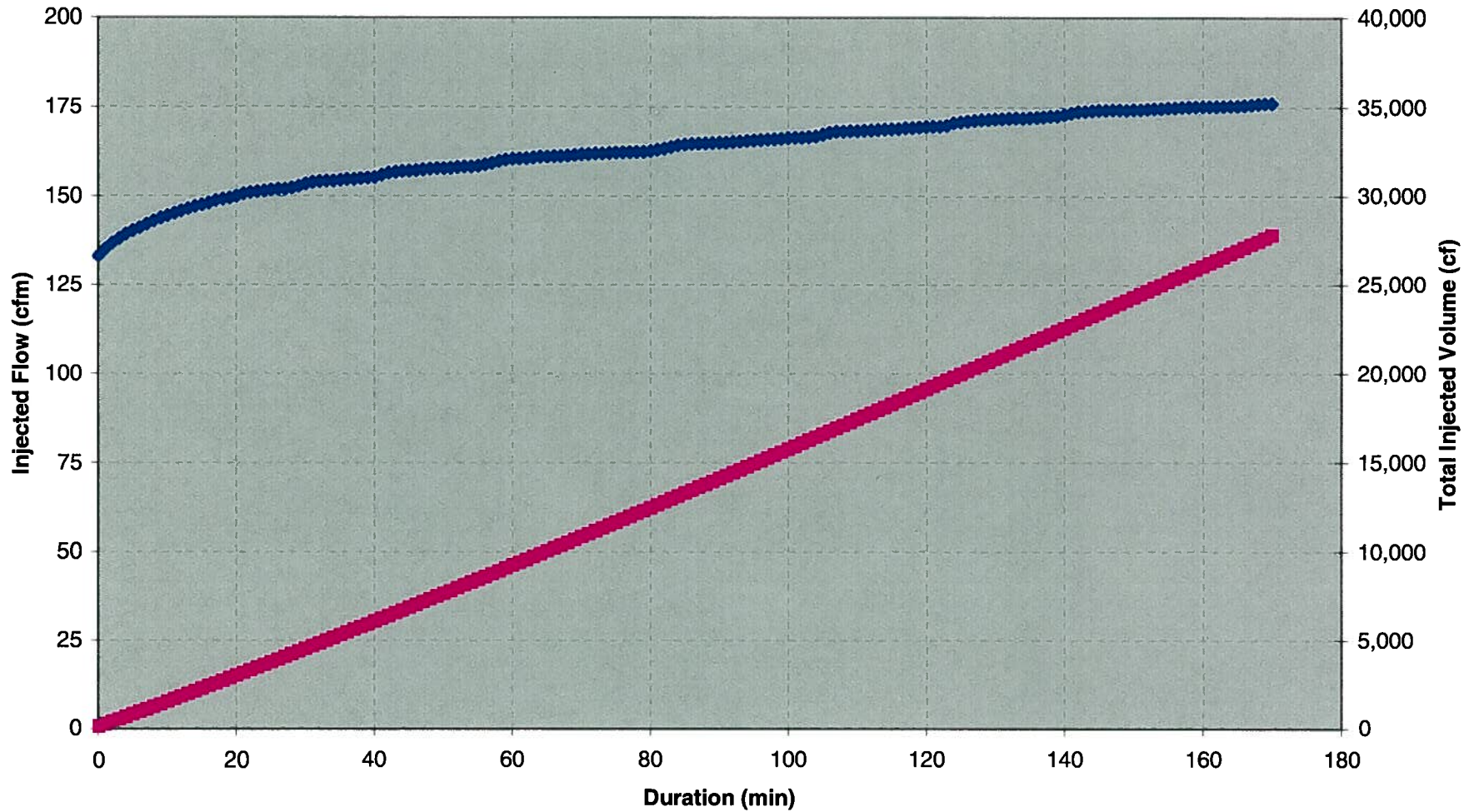
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-13  
4/3/2009**



**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

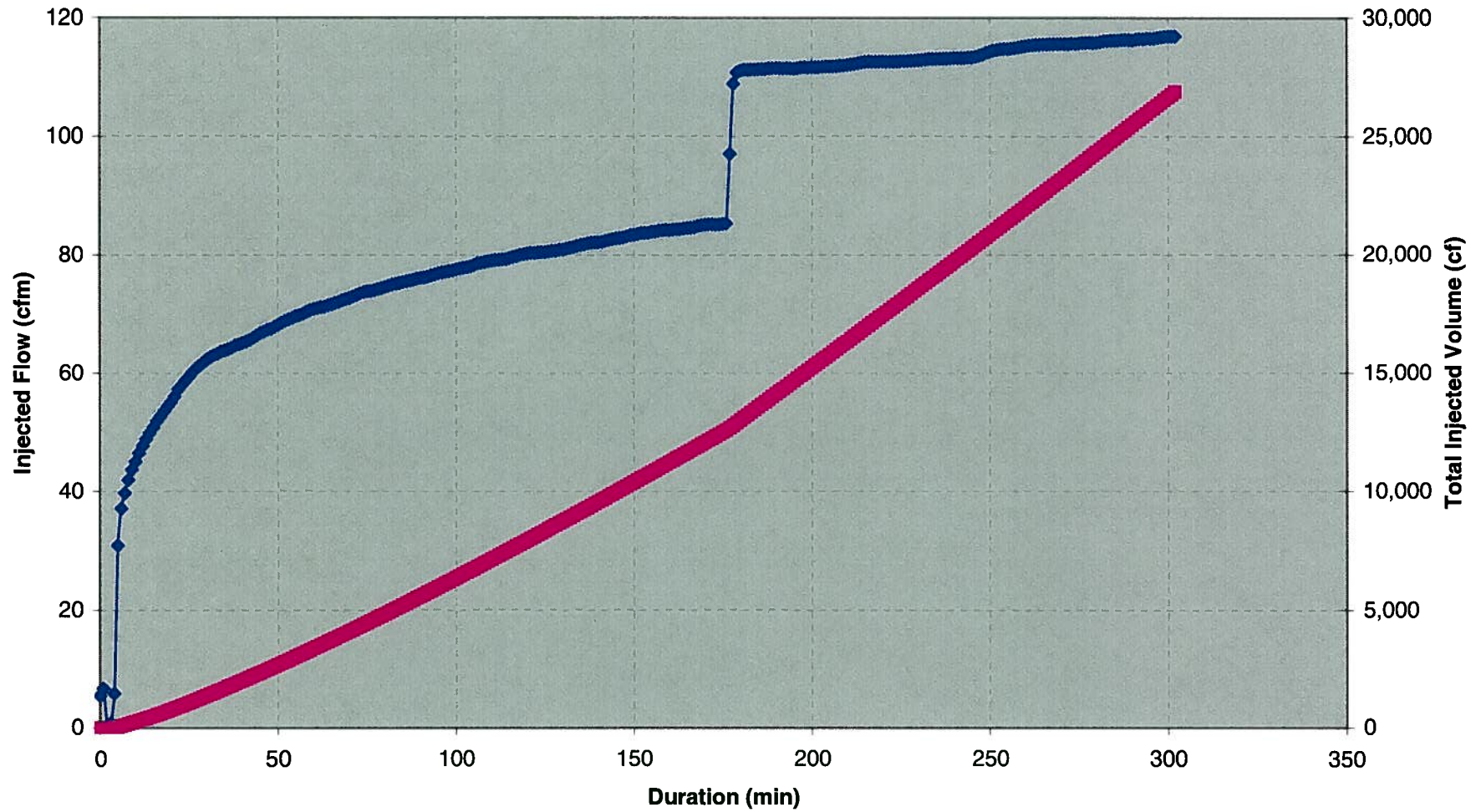
**BP-14  
3/20/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

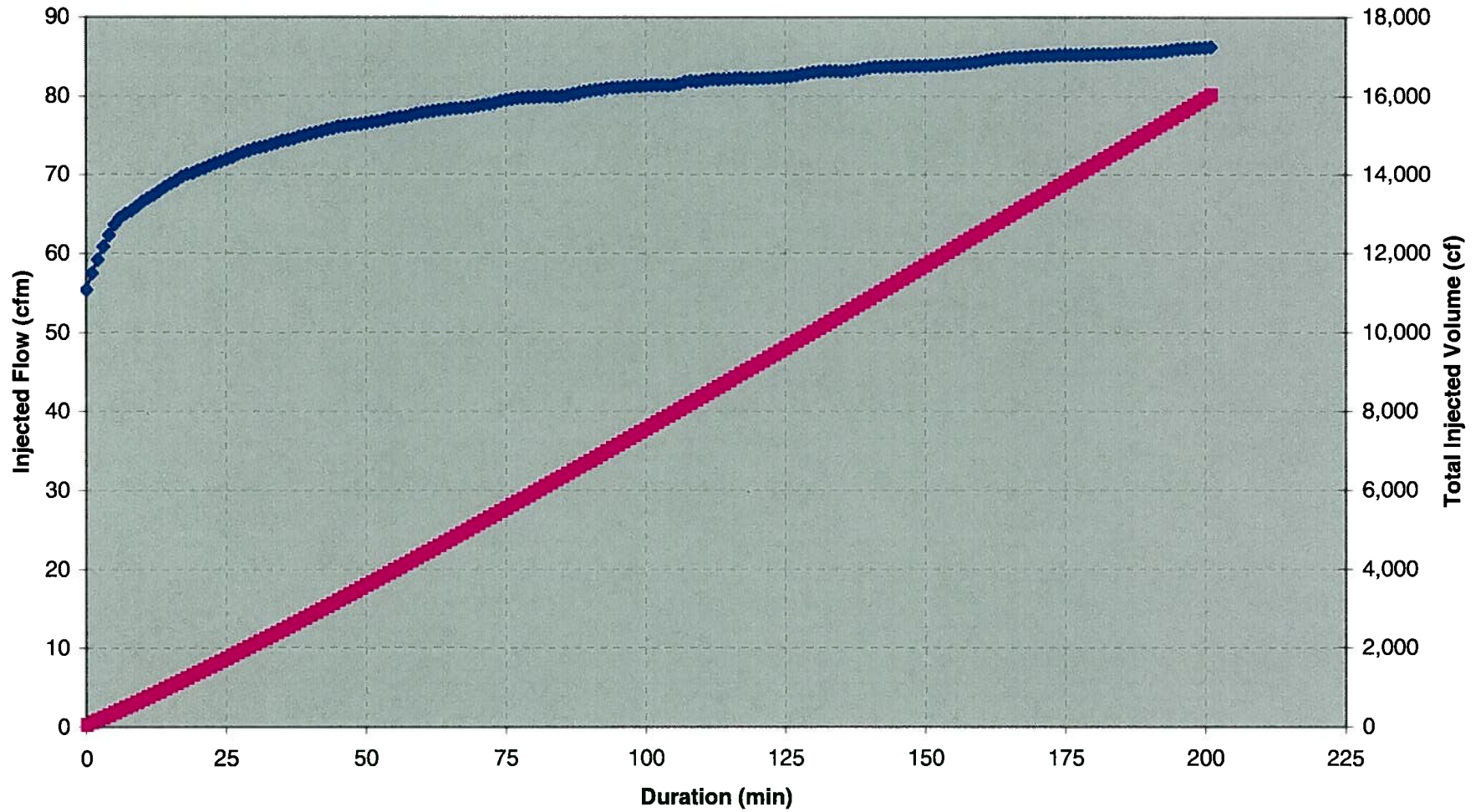
**BP-15  
3/24/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

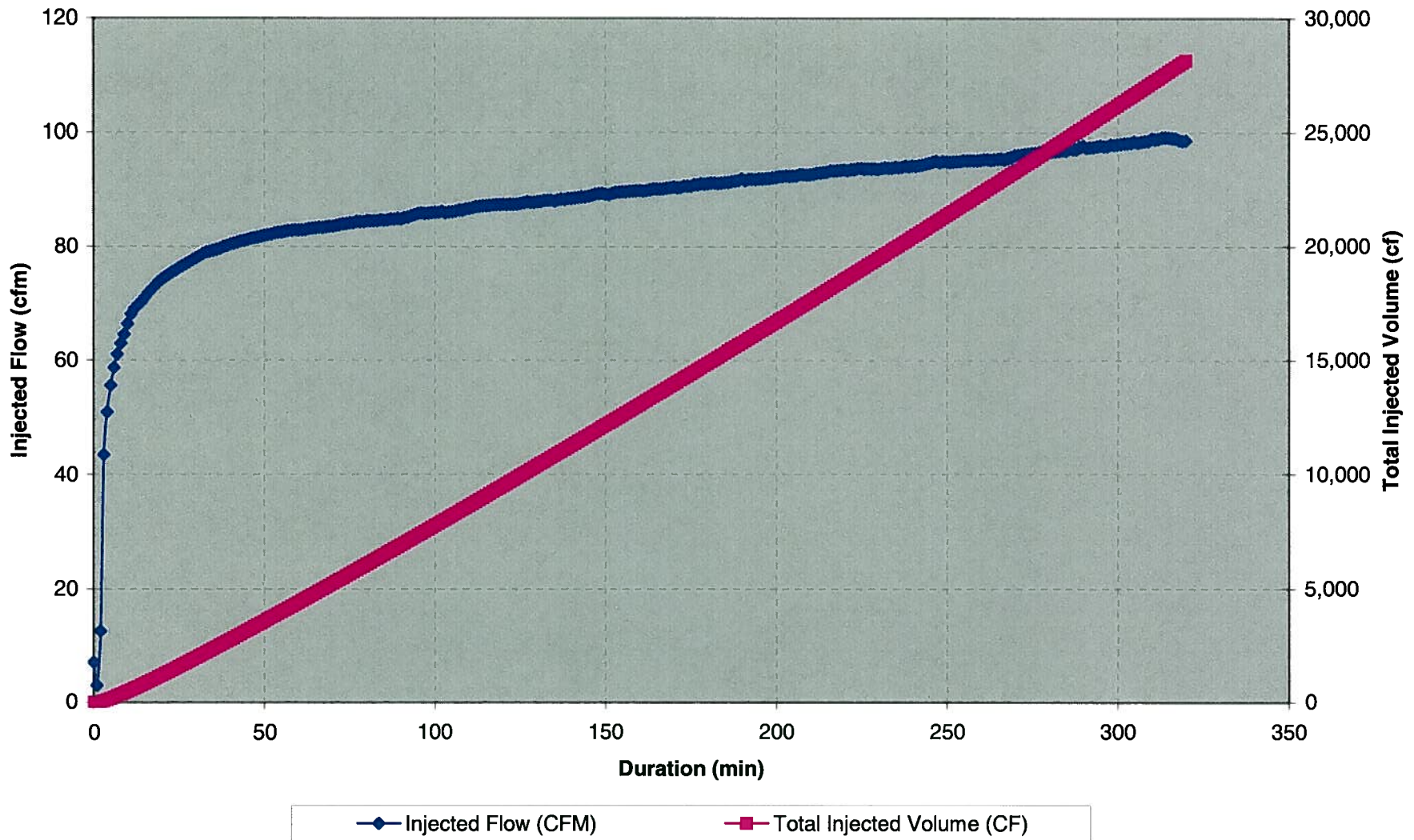
**BP-16  
3/31/2009**



—◆— Injected Flow (CFM)      —■— Total Injected Volume (CF)

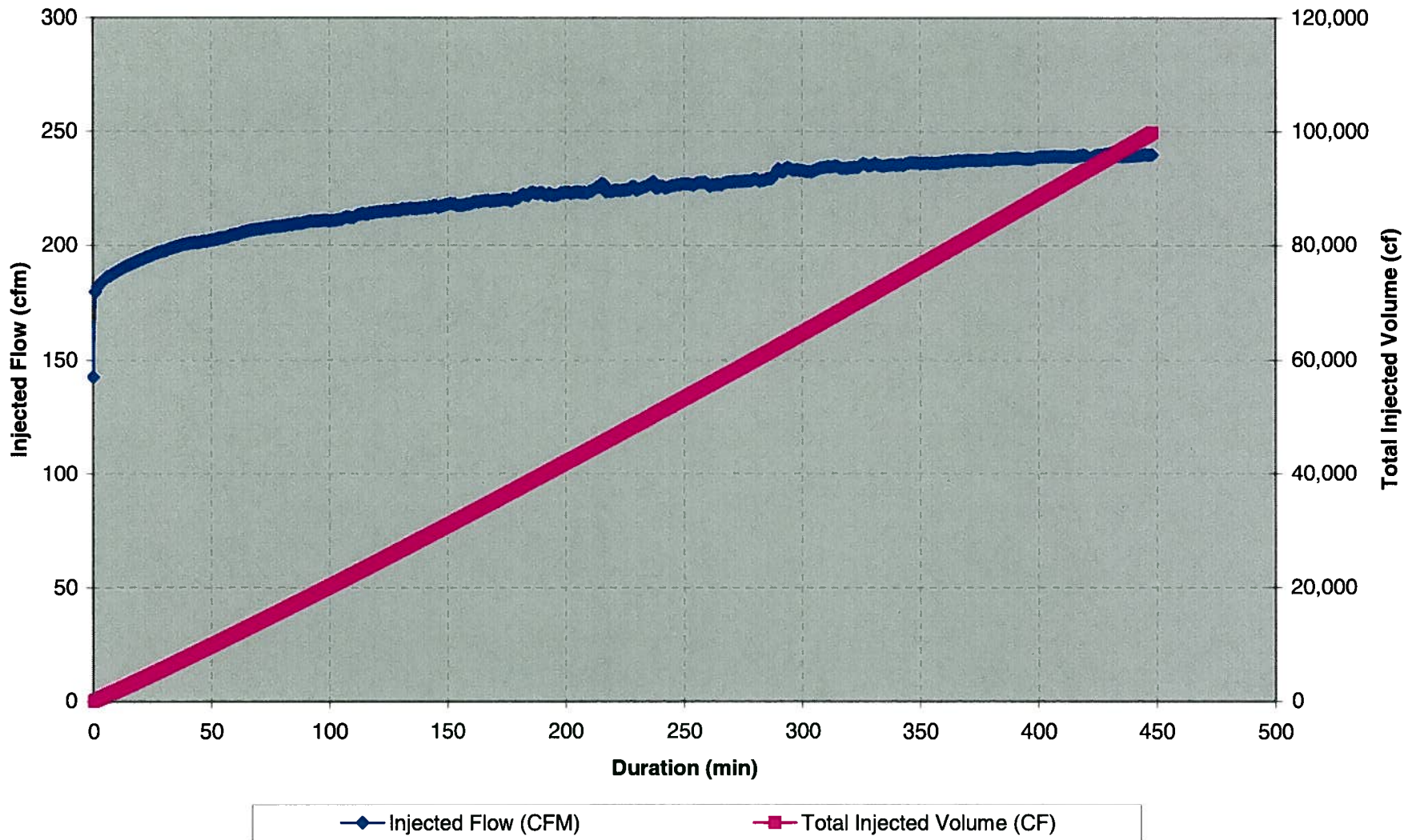
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-17  
4/2/2009**



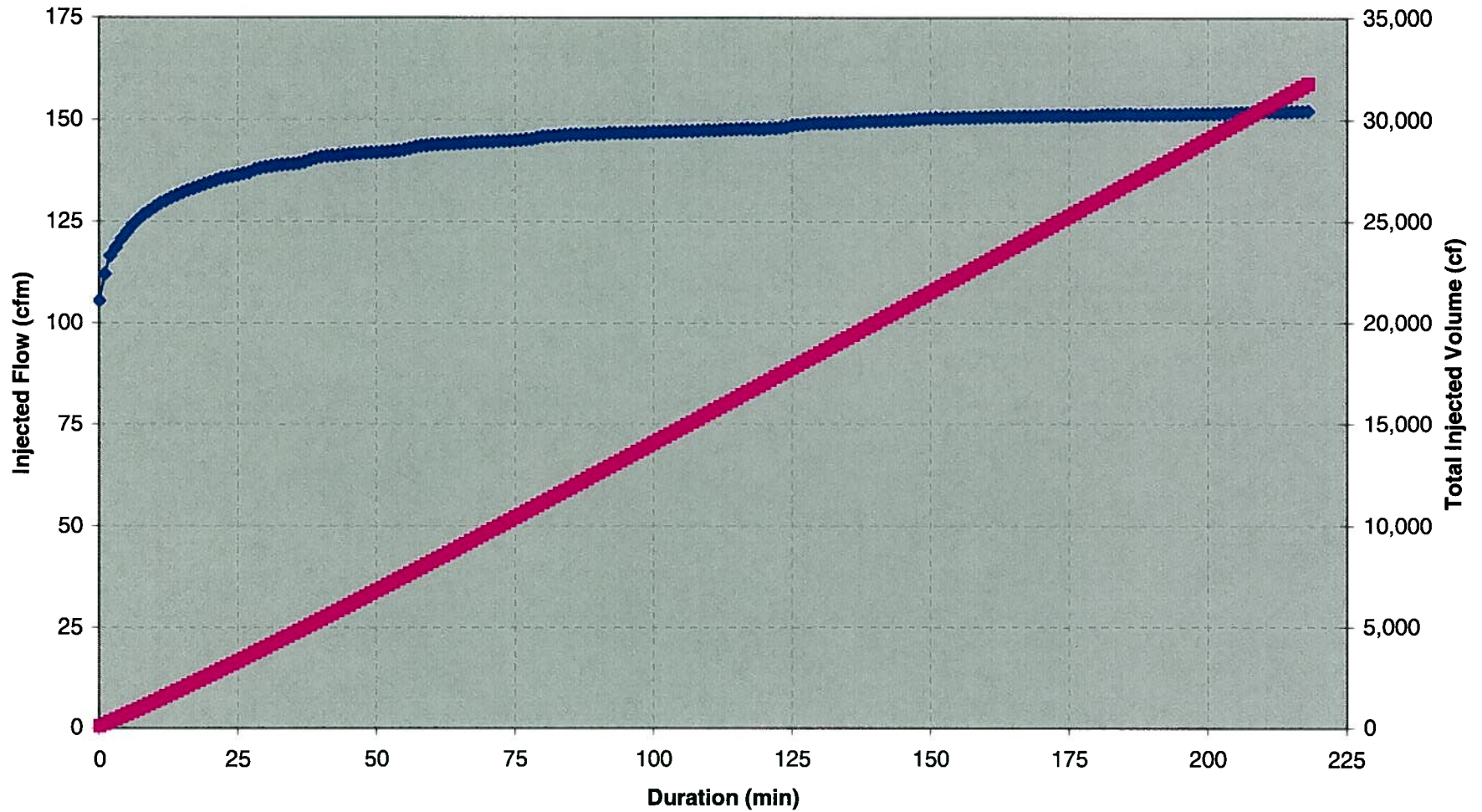
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-18  
4/6/2009**



**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

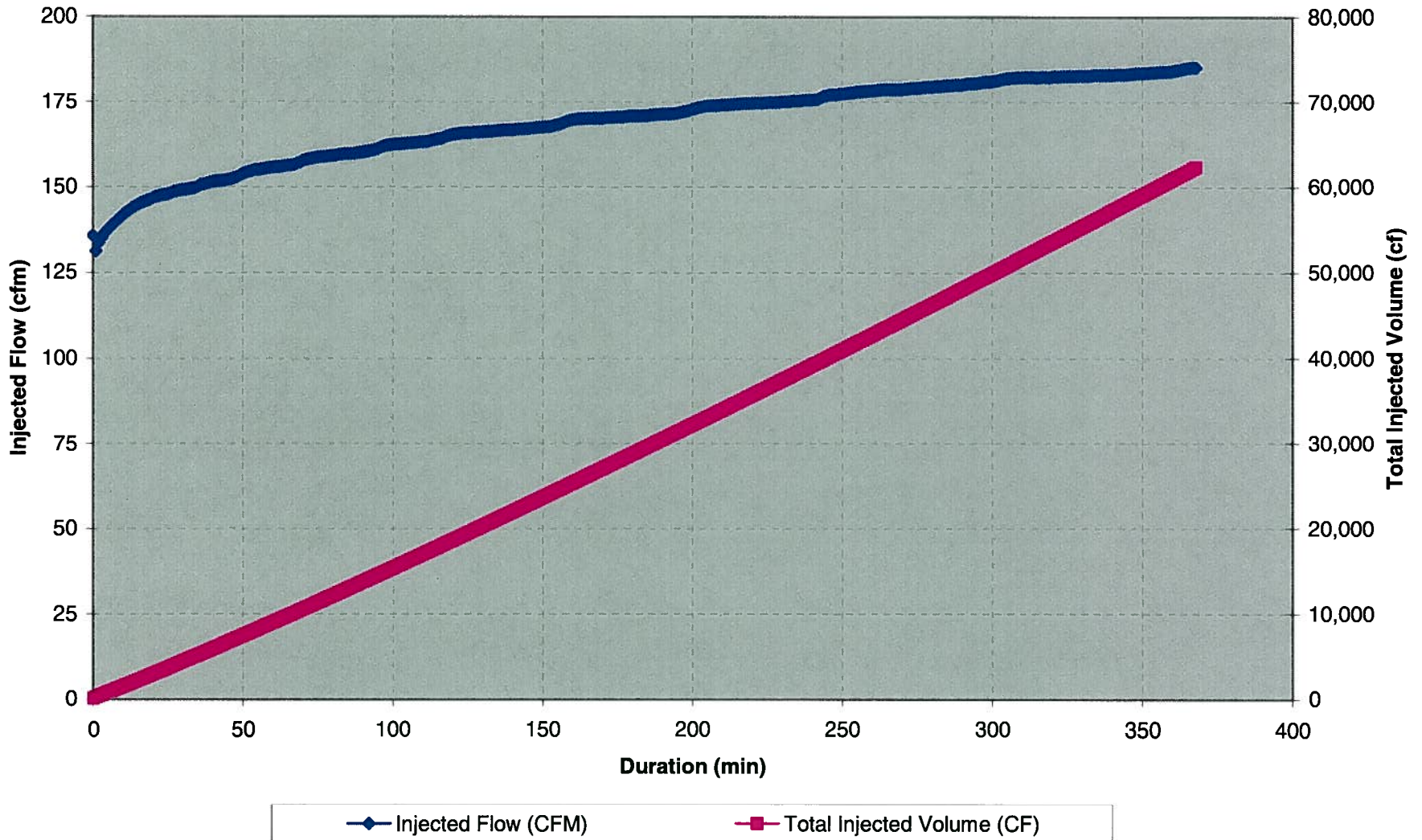
**BP-20  
3/26/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

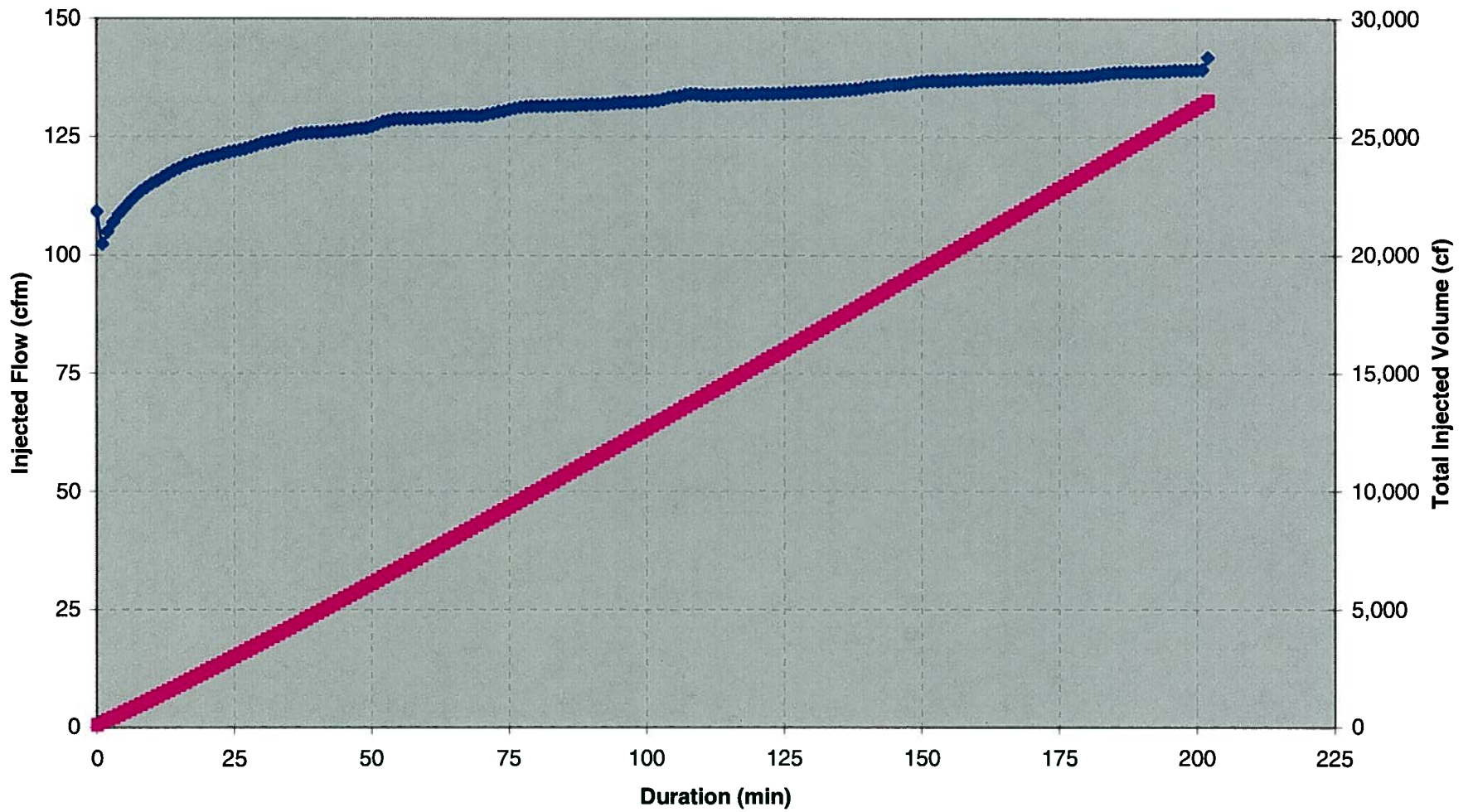
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-21  
3/6/2009**



**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

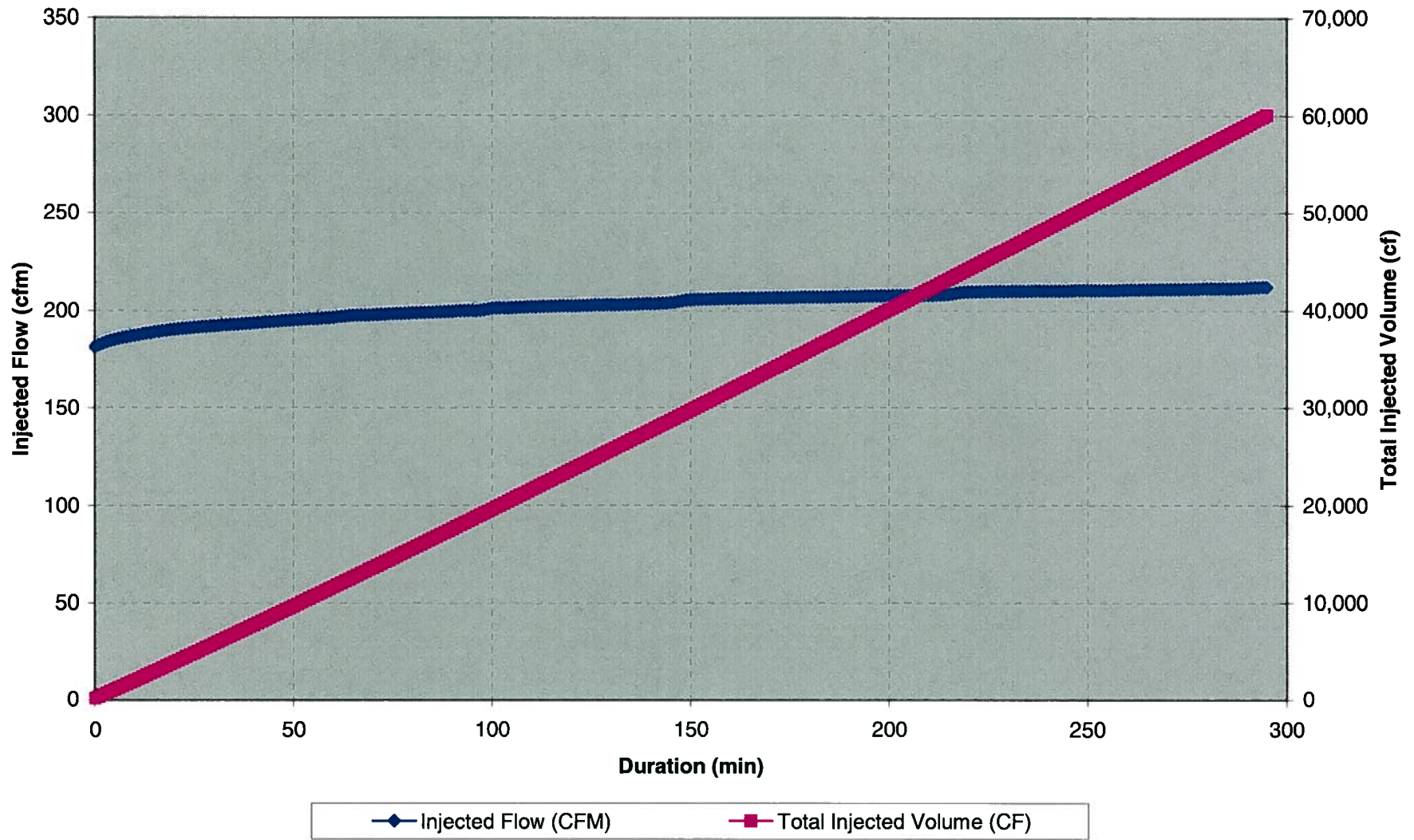
**BP-22  
3/16/2009**



◆ Injected Flow (CFM)      ■ Total Injected Volume (CF)

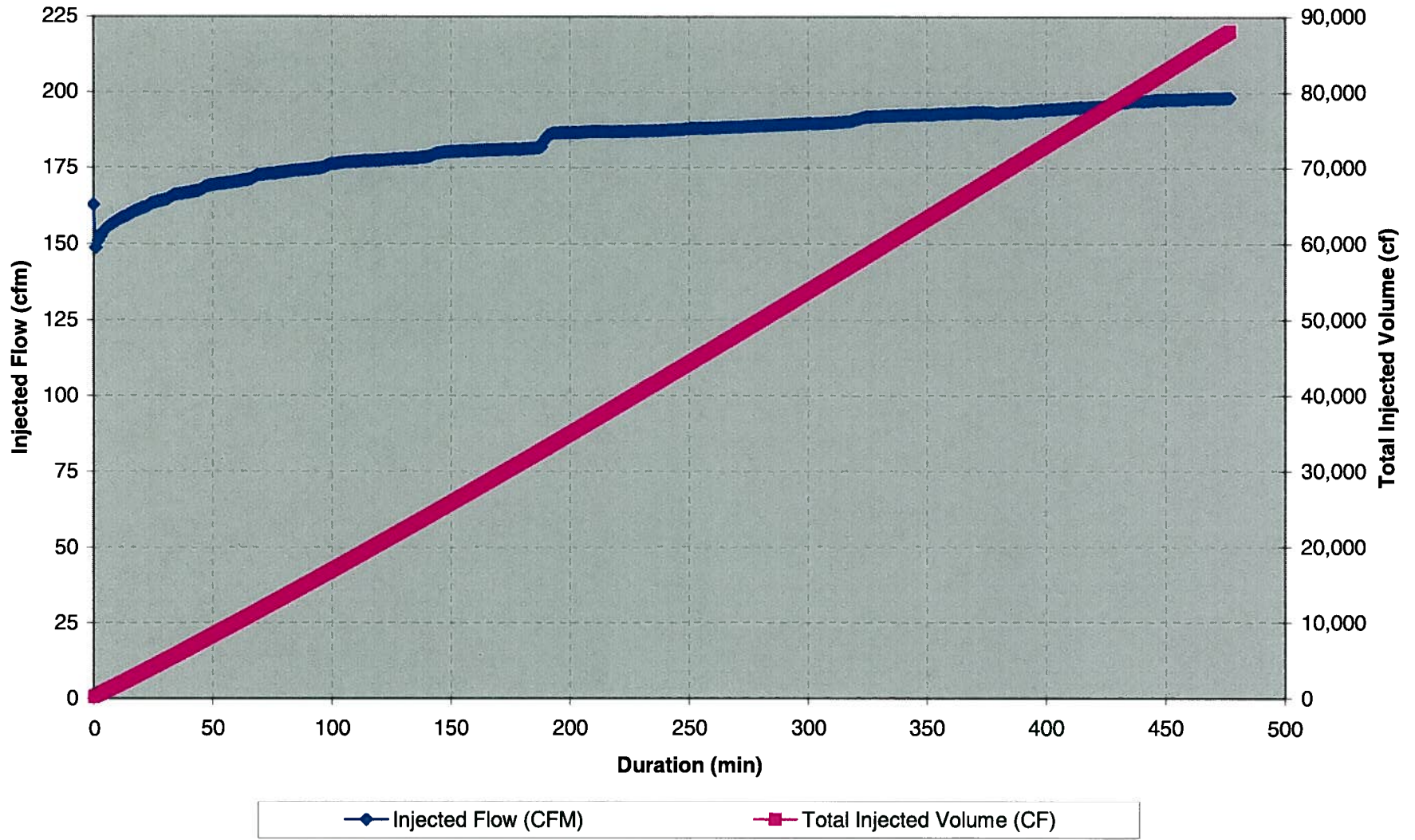
**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-23  
3/13/2009**



**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**BP-24  
3/11/2009**



**AIR FLOW -vs- TIME GRAPH  
TENTH ROUND OF BIO-PULSE SPARGING**

**SP-100  
3/27/2009**

