Results of Well Performance and Pilot Groundwater Recovery Testing, RSA-95 and RSA-96, Operable Unit 10

Redstone Arsenal
Madison County, Alabama

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List of Acronyms

ARAR	applicable or relevant and appropriate requirement
DCE	dichloroethene
EPA	U.S. Environmental Protection Agency
gpm	gallons per minute
IRA	interim remedial action
IT	IT Corporation
mg/L	milligrams per liter
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
OU	Operable Unit
Q/[C]	flow versus concentration
RA	remedial action
RBC	risk-based concentration
RSA	Redstone Arsenal
Rust	Rust Environment and Infrastructure
SI	site inspection
SSSI	supplemental site-specific investigation
TCA	trichloroethane
TCE	trichloroethene
VOC	volatile organic compound

1.0 Purpose

The purpose of this technical memorandum is to present the results of a pilot groundwater recovery test at new extraction wells installed at Buildings 7368 (RSA-95) and 7740 (RSA-96). Extraction wells were installed to recover groundwater contaminated by trichlorethene (TCE) and 1,1,1- or 1,1,2-trichloroethane (TCA). Well performance tests and discharge versus concentrations (Q/[C]) tests were conducted at new extraction wells at sites RSA-95 and RSA-96. Well performance tests consisted of four 2-hour step tests and were conducted to estimate the potential yield from each well. The Q/[C] tests consisted of pumping the extraction wells at three successively higher rates for three continuous 8-hour periods, and collecting samples for volatile organic compounds (VOC) and water quality parameters analysis every 2 hours. Water levels were monitored at nearby observation wells screened in either the bedrock or in residual soils during each test. These tests were conducted to obtain data to support the design of an interim remedial action (IRA) and groundwater treatment plant. The groundwater treatment plant is required to reduce concentrations in extracted groundwater for discharge to a National Pollutant Discharge Elimination System (NPDES) permitted discharge point. Specific data to be obtained include aquifer response to pumping, well yields, and contaminant concentrations in extracted groundwater.

The immediate objective of the pilot groundwater recovery test program was to determine specific capacity and specific yield of the wells, and to monitor changes in groundwater chemistry and contamination levels during pumping. Knowledge obtained from this pilot testing program is used to develop a conceptual design for the IRA to be taken at RSA-95 and RSA-96, Redstone Arsenal (RSA) in Madison County, Alabama. The site is located within Operable Unit (OU)-10 at RSA.

Appendix A contains the pilot test well performance analysis, a summary of the results of groundwater water quality monitoring and sample analysis, and the calculations referenced in this technical memorandum. Appendix B provides a graphic summary of changes in geochemical parameters at each pumping recovery well during the pilot test.

2.0 Site Conditions and Background

AL7

The Comprehensive Environmental Response, Compensation, and Liability Information System identification number for RSA is AL 210 020 742. The proposed remedial action (RA) is classified an IRA because it will only addresses the most contaminated groundwater pending the

findings of site investigations and development of a comprehensive OU-10 RA plan. An IRA is allowed for under the National Oil and Hazardous Substance Pollution Contingency Plan ~~provides for an IRA~~, (Title 40 Code of Federal Regulations Part 300.430[f] [1] [ii] [C1]). Specifically, if an action that does not attain the applicable or relevant and appropriate federal or state requirements (ARAR) will become part of a total RA that will attain the ARARs, then the action is considered an IRA. The proposed action is intended to reduce contaminant mass present in the most contaminated portions of the groundwater contaminant plumes at RSA-95 and RSA-96 while other remedial options are being considered and tested. The final remedy may incorporate the IRA and continue reducing contaminant mass in the suspected contaminant source area.

2.1 Site Description

2.1.1 Site History

Operable Unit 10 (OU-10) comprises the RSA Rocket Engine, North Plant facility (Figure 1). The two sites discussed in this technical memorandum are former degreaser areas, that were active from 1984 to late 1995. From 1984 to 1989, TCE was the primary solvent. In 1987, TCA began to be used in replacement of TCE. The degreasing units were 3 feet square by 5 feet high. Rocket or missile engines were placed in the tanks with chlorinated solvents that had been heated to the vaporization point. Releases of the solvents occurred either due to spills, leaks, or condensation of vapors.

2.1.2 Site Location

Figure 2 shows the extraction and monitoring well locations at RSA-95 and RSA-96. The sites are relatively flat areas. A surface water body is located to the southeast of RSA-96. The ground elevation ranges from approximately 570 to 580 above mean sea level. Grassy lawns, graveled areas, and asphalt-paved roadways cover portions of the site. Surface drainage of RSA-95 and RSA-96 flows toward the south and southeast into the drainage ditches and the surface water body.

2.1.3 Site Characteristics

The degreaser sites have been inactive since 1995. The surficial residual soils are characterized as having relatively how permeability. However, the deeper portions of the residual soils have a high secondary porosity. The thickness of the residual soils ranges from 15 to 80 feet across the sites. The limestone bedrock underlying the residual soils is fractured and exhibits dissolution features such as caverns, rubble zones, and channels. Groundwater is found in both the residual soils and the limestone bedrock at both sites.

2.1.4 Previous Investigations

Rust Environment and Infrastructure (Rust) conducted site inspection (SI) activities and site screening activities at RSA-95 and RSA-96 in 1995 and 1996 (Rust, 1997). Surface soil, subsurface soil, groundwater, surface water, and sediment samples were collected as part of the SI and site screening. Surface and subsurface soil samples indicated that soils at RSA-95 and RSA-96 have low detections of contaminants. However, groundwater sample analytical results showed groundwater concentrations of TCE and TCA at RSA-95 and RSA-96 exceeded U.S. Environmental Protection Agency (EPA) Region III risk-based concentrations (RBC) for screening. Because of these findings, IT Corporation (IT) conducted a supplemental site-specific investigation (SSSI) at RSA-95 and RSA-96 to assesses the extent of contamination. Results of the SSSI indicated that a RA would be required due to the high concentrations of solvents found in residual and bedrock groundwater. Extraction wells were installed in the area where the highest levels of contaminants were detected in groundwater.

2.1.5 National Priorities List Status

The EPA placed RSA on the National Priorities List (NPL) by publication in the *Federal Register,* 59FR27989, on May 31, 1994. The NPL listing was effective June 30, 1994.

2.2 Current Actions

There are no current RAs or activities ongoing at RSA-95 and RSA96.

3.0 Threats to Human Health or the Environment

Evaluation of VOC contaminant concentrations in groundwater at RSA-95 and RSA-96 suggest that human health risk associated with exposure to these media would exceed acceptable levels. Analytical results from groundwater collected at RSA-95 and RSA-96 shows that groundwater concentrations of TCE exceed the 1 milligram per liter (mg/L) goal in both shallow and deep groundwater. The federal maximum contaminant level for TCE is 0.005 mg/L and the EPA Region III RBC for TCE is 0.0016 mg/L. Groundwater is known to discharge to a nearby surface water body, thus there is a potential for immediate adverse ecological impact. The sites are wholly within the boundary of RSA property, and there is no groundwater use in the immediate vicinity, but there is a potential for migration of contaminated groundwater; therefore, a future potential threat to human health is possible.

4.0 Pilot Test Purpose and Procedures

This technical memorandum summarizes the results of the pilot groundwater recovery testing at RSA-95 and RSA-96 at OU-10. The pilot test was conducted to obtain data on the well yields, water surface drawdown during pumping, and concentrations of contaminants and groundwater chemistry to be expected during groundwater recovery. This data will be used to aid in the design of the OU-10 IRA groundwater recovery and treatment system. The OU-10 pilot groundwater recovery testing was conducted to:

- Determine IRA recovery well performance parameters at each groundwater recovery well using discharge and drawdown data to calculate well specific capacity and yield.
- Establish the maximum discharge at which the well can be pumped without bringing the water level below the top of the bedrock.
- Establish the drawdown at a discharge rate expected to be used in the IRA recovery wells.

The primary objective of the OU-10 IRA is mass removal of TCE from the bedrock groundwater within the area where the highest levels of contamination is found at RSA-95 and RSA-96. The distribution of TCE in groundwater at RSA-95 and RSA-96 is shown in Figure 2.

Pilot tests were performed at each groundwater extraction well installed at RSA-95 and RSA-96. The tests consisted of:

- 8-hour step-drawdown test to determine the well performance and estimate the pumping rates to be used in the later tests
- 24 hours of pumping and sampling test to determine how concentrations changed in response to pumping (Q/[C] testing).

During the three 8-hour well performance tests, pumping rates were doubled every 2 hours, and groundwater samples were collected at the end of the 8 hours of pumping. During the Q/[C] testing, pumping rates were increased every 8 hours and samples were collected every 2 hours. Water levels were monitored in the extraction wells and nearby wells during both types of testing.

Groundwater samples were collected for water quality parameters and VOCs during the Q/[C] test. Pumping rates were increased every 8 hours for an independent measure of the well

specific yield and specific capacity, and to determine the effect of changing pumping rates on the contaminant concentration in groundwater. By monitoring changes in water chemistry or contaminant concentration during the tests, discharge/concentration, concentration/time, and mass/time graphs, data could be constructed and used to establish if hydrogeological conditions changes with time or pumping rates occurred. Also, by plotting mass removal with time and cumulative mass removal over time, it is possible to ascertain if there is a point were increased pumping rates do not provide an additional mass removal benefit.

Extracted groundwater was treated by a portable air stripper unit and then discharged to the sanitary sewer system. The pilot test data was used in the conceptual design of the OU-10 (IRA) groundwater recovery and treatment system that was presented in the *Evaluation of Groundwater Treatment Alternatives* (IT, 1999).

5.0 Test Results

Details of the pilot tests performed and the results of tests are presented in Appendix A. Appendix A also provides a summary the well capacity test analyses, well drawdown analysis, and analytical testing performed at RSA-95 and RSA-96. Well construction details are given in Appendix A. An 8-hour well capacity test was performed at each new extraction well before the Q/[C] tests to establish the range in pumping rates that should be used in the Q/[C] test. Summary tables presented in Appendix A indicate a difference in well capacity between the well capacity tests and the Q/[C] tests performed during the pilot testing. The greater well capacity observed during the higher Q/[C] test rates may be either due to:

- Additional development of the well during the tests
- More accurate flow measurements during the tests
- Variation in performance for wells screened in rubble zones.

Based on the 8-hour step-drawdown tests, extraction wells RS592 and RS593 exhibit a lower capacity at higher rates. Wells screened in fractures and voids (RS715, RS730, RS847, and RS848) have higher capacity at higher rates.

Analysis of the step-drawdown data (Appendix A) indicates that all the recovery wells, except for RS715, could be pumped in excess of 100 gallons per minute (gpm) without lowering the water levels to below the top of the bedrock into the epikarst zone. In fact, the discharge rates used in the step-drawdown tests did not exceed the capacity of the wells or aquifer. The maximum pumping that could be used in the Q/[C] test was limited to 100 gpm

due to the hydraulic limit of the air stripper and head loses in the plumbing. The recommended pumping rates for the Q/[C] tests ranged from 25 to 100 gpm. The actual pilot test pumping rates used were close to the recommended rates and are given in Table B-1 through B-6 in Appendix B.

5.1 Impact of Pumping on the Potentiometric Surface

Tables 1 and 2 give the maximum measured drawdown for the observation wells used during pumping at each extraction well after a 24-hour period. These tables also give the estimated resultant groundwater potentiometric surface at RSA-95 and RSA-96 if the wells were pumped at the rates used in this analysis. The estimated potentiometric surface calculated in these tables is presented graphically in Figure 3 for RSA-95 and Figure 4 for RSA-96. Both figures show the effects of drawdown on the potentiometric surface due to pumping at three recovery wells simultaneously during simulated IRA system pumping conditions at moderate discharge rates. Both figures show drawdown is significant in pumping wells but quickly decreases in magnitude in surrounding monitoring wells. Bedrock well RS449 shows significant drawdown at the southern part of RSA-95, indicating restricted groundwater flow in selected parts of the bedrock aquifer. Residuum wells show a wide variation in response to the bedrock aquifer pumping conditions. These different responses show local variation in the connection (or lack of connection) between the residuum groundwater and the bedrock aquifer. The well drawdown shown at both sites is not circular, indicating preferred permeability pathways in the bedrock aquifer and probably irregular interconnections between the residuum and bedrock aquifers.

5.2 Changes in Groundwater Chemistry During Pumping

The changes in groundwater geochemistry during pumping at the extraction wells for both residuum and bedrock observation wells and the pumping well chemical parameters are presented in Appendix B. Tables B-1 through B-6 summarize the data in tabular form and graphic presentations follow each table. Extraction wells, observation wells, and the extent of the TCE plumes at RSA-95 and RSA-96 are shown on Figures 2 and 3.

Water Quality Parameters. As shown in the tables and graphs for the pumping tests, there are pulses in turbidity with increased pump rate at RS847, RS848, RS592, and RS730. This may indicate continuing well development during the test. Specific conductivity and field alkalinity measurements in pumping wells were generally consistent, with only very minor changes at each increment in well pumping rate. Temperature and dissolved oxygen measurements showed the least variation during the pilot tests.

Organic Compounds. Trichloroethene (TCE) was always the dominant organic compound in groundwater samples, however, other organic compounds detected consistently in groundwater included 1,1,1-TCA and 1,1- or 1,2-cis-dichloroethene (DCE). Concentrations are high enough that sample dilution was required to bring the sample concentrations into the calibration range of the instrument, resulting in elevated detection limits. Dilution factors at RSA-95 are between 20 to 200. At RSA-96, dilution factors are between 250 and 2,500. At RSA-95 TCA was consistently detected at levels between 20 and 26 percent of the concentrations of TCE. At RSA-96, 1,1,1-TCA is thought to be present but a concentrations below the elevated detection limits.

Concentrations of TCE, DCE, and where present, TCA, are plotted against time along with the pumping rates in the graphics in Appendix B. Examination of the graphics in Appendix B shows the following:

- At RS848 concentrations of TCE increased steadily during the test
- At RS592 concentrations of TCE began to increase during the third pumping rate
- At RS715 concentrations of TCE fluctuated but generally showed increasing concentrations with time
- At RS593 and RS730 TCE concentrations were very high (over 20 mg/L) and generally decrease with time, possibly correlating with increased pumping rate
- There was minor correlation between pumping rate and concentration at RS847 but there was very little change in groundwater concentration between the beginning and end of the test
- Aquifer response was measurable in both bedrock and residual soil monitoring wells up to 200 feet from the extraction wells.

5.2.1 RSA-95

During pumping recovery, well RS715 exhibited increasing TCE concentration with time, possibly correlating to increased discharge. There was a significant difference in drawdown between wells screened in the bedrock and wells screened in residual soil. Bedrock monitoring well RS446 (r=250 feet) exhibited the drawdown of about 3.5 feet during the test, but drawdown in residual soil monitoring well RS717 (r=280 feet) was less than 0.5 feet. These data suggest that if there is a connection between the residual soil and the bedrock, it is an indirect connection at best. Extraction well RS715 appears to be installed within the most

contaminated portion of the aquifer at RSA-95, and should be pumped at its highest achievable rate of 60 gpm to maximize the recovery TCE and TCA.

Extraction well RS847 exhibited no significant change in the TCE concentration with variations in the pumping rate, suggesting that this well is connected to a groundwater reservoir that homogeneously contaminated. Significant variations in the head differential between the pumped bedrock aquifer and the three residual soil wells (RS720, RS578, and RS683) monitored during the tests suggest irregular and probably unpredictable interconnections between the two aquifers. Significantly different drawdown between bedrock well RS720 and residual soil well RS446 indicates that the bedrock is more permeable than the soils in this area. This well should be pumped at a low rate of 30 gpm to limit the radius of influence and prevent pulling the contaminant plume away from RS715 and RS848.

The graphs of the RS848 test shows significant increase in the TCE concentration with increased pumping rates, indicating more TCE is being pulled into the recovery well from a more contaminated part of the bedrock aquifer, possibly from near RS715. Comparison of the water elevations in surrounding bedrock monitoring wells shows there is a significant variation of permeability in the bedrock aquifer. Wells RS579 and RS446 show influence of pumping at RS848, but bedrock well RS715 exhibits little response, indicating the anisotropy and preferred permeability pathways in the bedrock aquifer. The water level in residuum well RS717 shows little influence from the pumping well RS848 drawdown, indicating poor interconnection with the bedrock aquifer. Therefore, extraction well RS848 should be pumped at a low rate of 35 gpm to prevent drawing more contaminated groundwater away from RS715.

5.2.2 RSA-96

Well RS592 is located northeast of the RSA-96 release site (Figures 3 and 4). The TCE concentration versus rate curve indicates possible movement of more contaminated groundwater near RS730 is being drawn toward RS592. The aquifer response at RS448 (screened in bedrock) is similar to that observed at RS446 (screened in soil), indicating a good interconnection between the soil and bedrock aquifers at RSA-96. However, this well should be pumped at a low rate of 25 gpm to prevent drawing more contaminated groundwater away from RS593 and RS730.

Recovery well RS593 is located south and east of the suspected RSA-96 release site. The TCE Q/[C] curves exhibited decreasing TCE concentration with increased pump rate. The

location of RS593 near a large surface wetland area to the southeast water influences the amount of groundwater available during the well pumping conditions. Significant drawdown in residuum observation well RS449 indicates good interconnection between the residuum aquifer and the collapse breccia in the screen interval of RS593. Because of the high TCE concentrations at RS593, a pumping rate of 100 gpm would be most effective in efficiently recovering TCE at this area of the RSA-96 site.

Extraction well RS730 did not show a decrease of TCE concentration with increased pump rate through the duration of the test, and exhibits the highest concentrations of TCE (greater than 20 mg/L). This well is in the most contaminated portion of the aquifer and is located adjacent to the suspected RSA-96 release site. A significant variation in response to pumping at the bedrock wells suggests that the bedrock aquifer is heterogeneous and exhibits lateral variability in bedrock aquifer permeability. The drawdown response curves for bedrock monitoring wells show an initial drawdown followed by recovery, especially at higher pumping rates. This behavior probably indicates that the drawdown cone has intersected a recharge boundary, consequently allowing recovery in the wells. A pumping rate of 100 gpm would be most efficient in recovering TCE at RS730.

6.0 Summary

Well performance tests and Q/[C] tests were conducted at groundwater extraction wells at sites RSA-95 and RSA-96. Step-drawdown tests consisted of 4 2-hour steps and were conducted to estimate the potential yield from each well. The Q/[C] tests consisted of pumping the extraction wells at three successively higher rates for 8 hours at each rate over a 24-hour period, and collecting samples for analysis every 2 hours. Water levels were monitored at nearby observation wells screened in either the bedrock or in residual soils during each test. These tests were conducted to obtain data to support the design of an IRA and groundwater recovery and treatment system. The groundwater treatment plant is required to reduce concentrations in extracted groundwater for discharge to a NPDES permitted discharge point. Specific data to be obtained include aquifer response to pumping, well yields, and contaminant concentrations in extracted groundwater.

The IRA pilot tests at OU-10 sites RSA-95 and RSA-96 indicated aquifer properties are highly variable and anisotropic. Heterogeneity in permeability, flowpaths in the bedrock aquifer, and irregular and indirect interconnections between the bedrock and residual soil aquifer are characteristic of the karst features developed in the Tuscumbia Limestone. Such

high variability makes prediction and definition of groundwater flow paths, the extent of TCE contamination in the bedrock aquifer, and the fate and transport of the TCE very difficult and prone to error. Interpretation of the aquifer test results presented in this technical memorandum should be viewed as preliminary, especially with regard to specific capacity and potential pumping rates because well development appeared to continue during the well performance and Q/[C] tests.

The primary findings of the well capacity tests are that the bedrock aquifer is capable of yielding rather high discharge rates, and that the high yields are sustainable. Well performance was determined from the step-drawdown data. However, as the wells are pumped, higher specific yields may be realized at latter times. The long-term effects of pumping on surrounding bedrock wells cannot be accurately predicted at this time.

During pumping there was response to pumping in both bedrock and residual soil monitoring wells indicating that there is a connection between the soil and bedrock aquifers. However, the difference in response to pumping exhibited between the wells screened in the residual soils and bedrock at RSA-95 is direct evidence that the connection between the bedrock and soils is indirect.

Changes in contaminant concentrations observed during pumping at the extraction wells can be characterized as follows:

- Stable; no significant change in concentration during the pilot test
  - RS847 and RS730
- Increasing; concentrations increased relatively uniformly during the test
  - RS715, RS848, and RS592
- Decreasing; concentrations decreased relatively uniformly during the test
  - RS593
- Discharge dependent; changes in concentration were controlled by the discharge rate
  - Some impact of changes in discharge rate may be exhibited at high rates in RS175 (increased [C]), RS592 (increased [C]), and RS730 (decreased [C]).

In summary, pilot tests at RSA-95 and RSA-96 provided data on the bedrock well performance and effects on surrounding bedrock aquifer wells. Additional recommendations include:

- Maximum groundwater recovery rates from the karst bedrock aquifer were not determined during the pilot tests due to head losses and limitations of the air stripper to treat the water stream.

- Drawdown patterns for bedrock aquifer pumping is irregular, indicating preferred bedrock aquifer permeability and irregular interconnection with residuum groundwater zones.

- Bedrock groundwater remedial pumping rates should be minimized where TCE concentration indicates less significant TCE recovery.

- Bedrock groundwater remedial pumping rates should be maximized where TCE concentration indicates a significant potential for TCE mass recovery and minimal dilution by surrounding groundwater.

- Recovery wells RS730, RS593, and RS715 should be pumped at moderate rates (60 to 100 gpm) to maximize TCE mass recovery efficiency.

7.0 References

IT Corporation (IT), 1999, ***Evaluation of Groundwater Treatment Alternatives.***

Rust Environment and Infrastructure (Rust), 1997, ***Site Inspection Report, RSA-95, -96, Redstone Arsenal, Madison County, Alabama.***

TABLES

Table 1

Maximum Drawdown and Estimated Resultant Groundwater Surface
RSA-95 Pilot Test
Redstone Arsenal, Madison County, Alabama

Well No.	Ground Elevation	Top of Casing Elevation	RS715	RS848	RS847	Estimated Static Depth to Water[a]	Total Drawdown[b]	Resultant Potentiometric Surface[c]
Discharge (gpm)			**52**	**94**	**102**			
RS578	572.15	574.56			0.53	11.41	0.5	562.6
RS579	574.31	576.43	1.24	2.66		12.82	3.9	559.7
RS714	575.93	577.44	1.10	0.91	0.57	13.84	2.6	561.0
RS715	575.46	578.71	**14.96**	1.27	0.49	14.22	16.7	547.8
RS716	576.91	579.14	0.85	0.59		14.91	1.4	562.8
RS717	573.74	576.23	0.50	0.35		10.14	0.9	565.2
RS720	574.03	576.38			1.06	13.44	1.1	561.9
RS846	575.84	578.17	3.72	1.47	0.50	17.71	5.7	554.8
RS847	574.19	576.11			**4.12**	13.22	4.1	558.8
RS848	573.60	576.18	1.46	**8.17**	0.70	12.62	10.3	553.2
RS445	572.90	576.00	0.45	0.30	0.58	11.38	1.3	563.3
RS446	572.80	575.60	1.29	3.06	1.07	13.04	5.4	557.1
RS683	572.46	576.27	1.17	1.26	1.08	12.01	3.5	560.8

[a]Static depth to water was estimated from pre-pumping water levels.

[b]Total drawdown is the algebraic sum of drawdown due to pumping at each well.

[c]The potentiometric surface was computed by subtracting the estimated static depth to water and total drawdown from the top of casing elevation.

Table 2

Maximum Drawdown and Estimated Resultant Groundwater Surface
RSA-96 Pilot Test
Redstone Arsenal, Madison County, Alabama

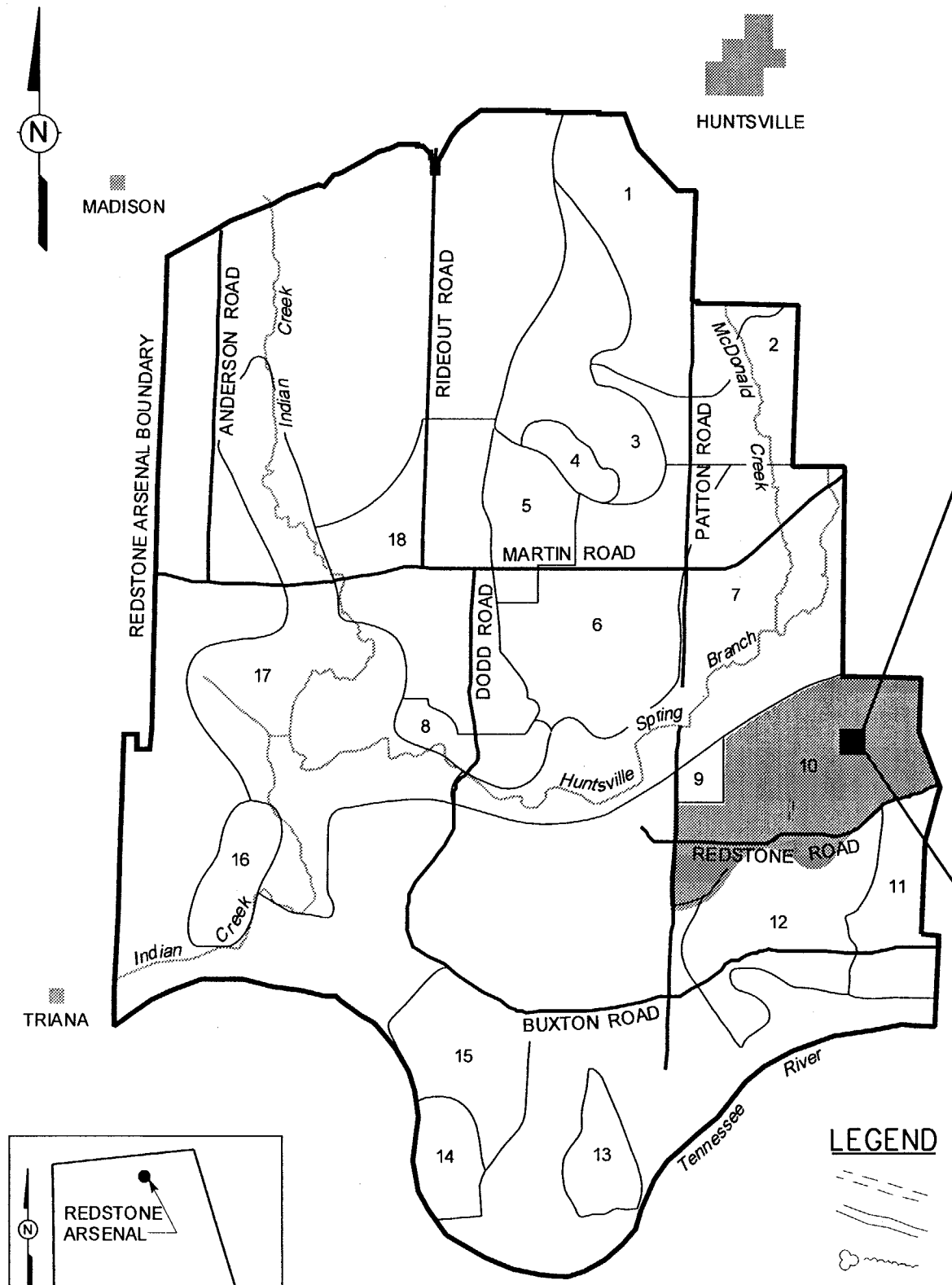
Well No.	Ground Elevation	Top of Casing Elevation	RS592	RS593	RS730	Estimated Static Depth to Water[a]	Total Drawdown[b]	Resultant Potentiometric Surface[c]
Discharge (gpm)			91	98	79			
RS586	574.42	576.83	0.29	0.78	1.34	14.16	2.4	560.3
RS587	571.93	571.64	0.36			8.94	0.4	562.3
RS588	572.02	571.84	0.24	0.90	2.00	9.07	3.1	559.6
RS589	572.92	575.36			1.55	12.65	1.6	561.2
RS592	571.64	574.34	**11.63**			11.2	11.6	551.5
RS593	570.38	573.52	0.35	**3.64**	1.21	11.04	5.2	557.3
RS594	571.66	571.47	0.28	1.06	2.09	9.26	3.4	558.8
RS730	573.40	575.10	0.29	0.86	**18.24**	12.48	19.4	543.2
RS447	572.80	574.70	0.00			11.57	0.0	563.1
RS448	572.80	575.40	0.32			13.7	0.3	561.4
RS449	570.90	573.30		3.08	1.20	11.28	4.3	557.7
RS450	570.90	573.57		3.00	1.21	11.53	4.2	557.8
RS455	572.40	575.27	0.28	0.76	-0.02	13.44	1.0	560.8
RS456	570.90	573.80	0.02	0.01	1.33	9.89	1.4	562.6

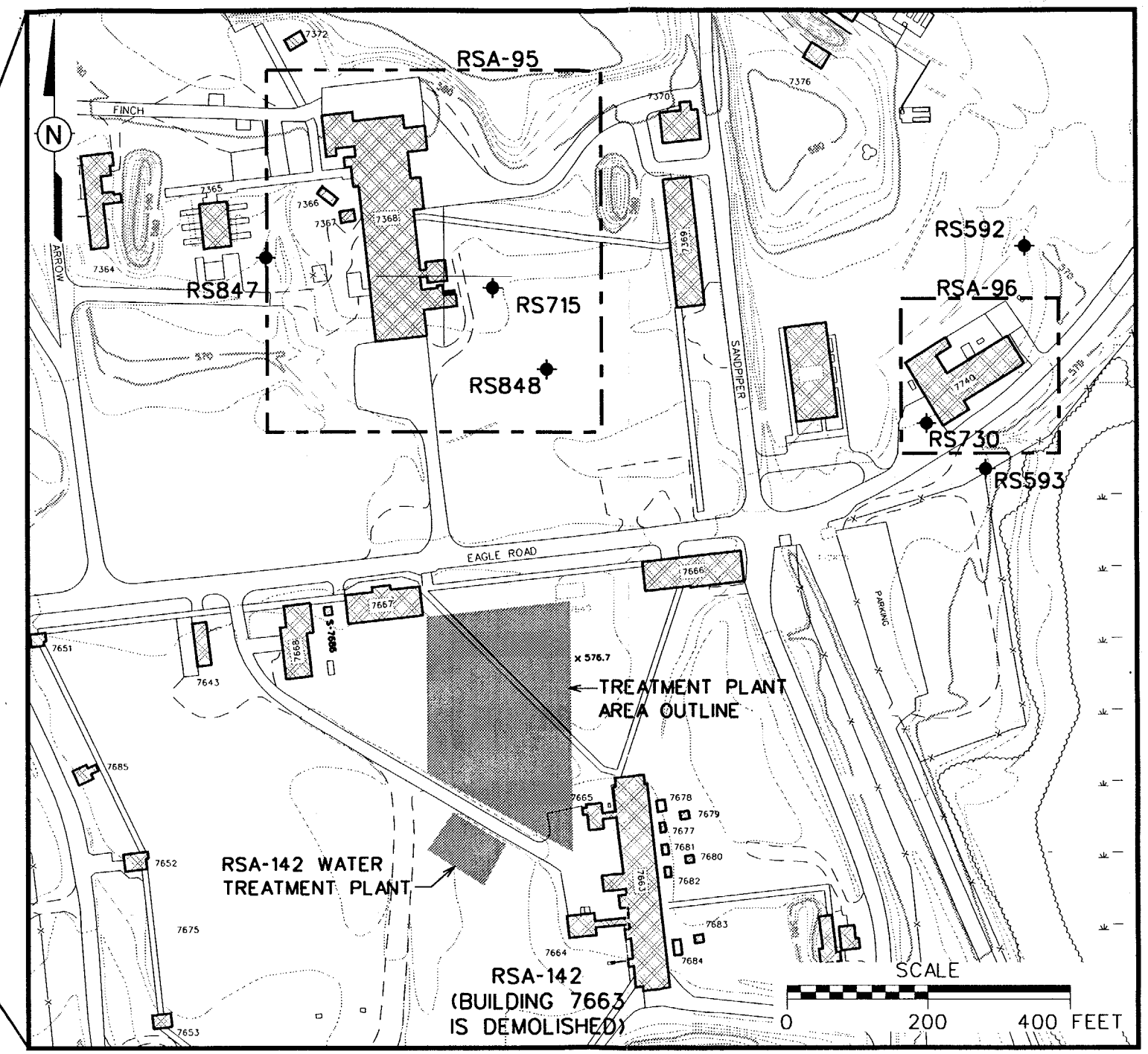
[a]Static depth to water was estimated from pre-pumping water levels.

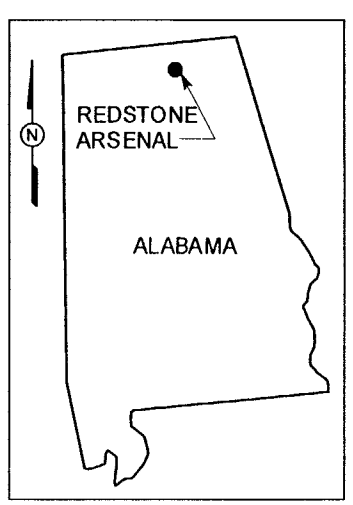
[b]Total drawdown is the algebraic sum of drawdown due to pumping at each well.

[c]The potentiometric surface was computed by subtracting the estimated static depth to water and total drawdown from the top of casing elevation.

FIGURES







LEGEND

- UNIMPROVED ROADS AND PARKING
- PAVED ROADS AND PARKING
- TREES / TREELINE
- CREEK
- FENCE
- TOPOGRAPHIC CONTOURS (FT-MSL)
- RSA SITE BOUNDARY
- OPERABLE UNIT BOUNDARY
- EXTRACTION WELL LOCATION

FIGURE 1
SITE LOCATION MAP
RSA-95 AND RSA-96
DEGREASER SITES

U. S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

INTERNATIONAL TECHNOLOGY CORPORATION

DATE LAST REV.:	DRAFT. CHCK. BY: C.TUMLIN	INITIATOR: J. SHIREMAN	DWG. NO.: ...\768091es.399
DRAWN BY:	ENGR. CHCK. BY: J. SHIREMAN	PROJ. MGR.: D.BURTON	PROJ. NO.: 768091
STARTING DATE: 14JAN99			
DRAWN BY: T. BRADSHAW			

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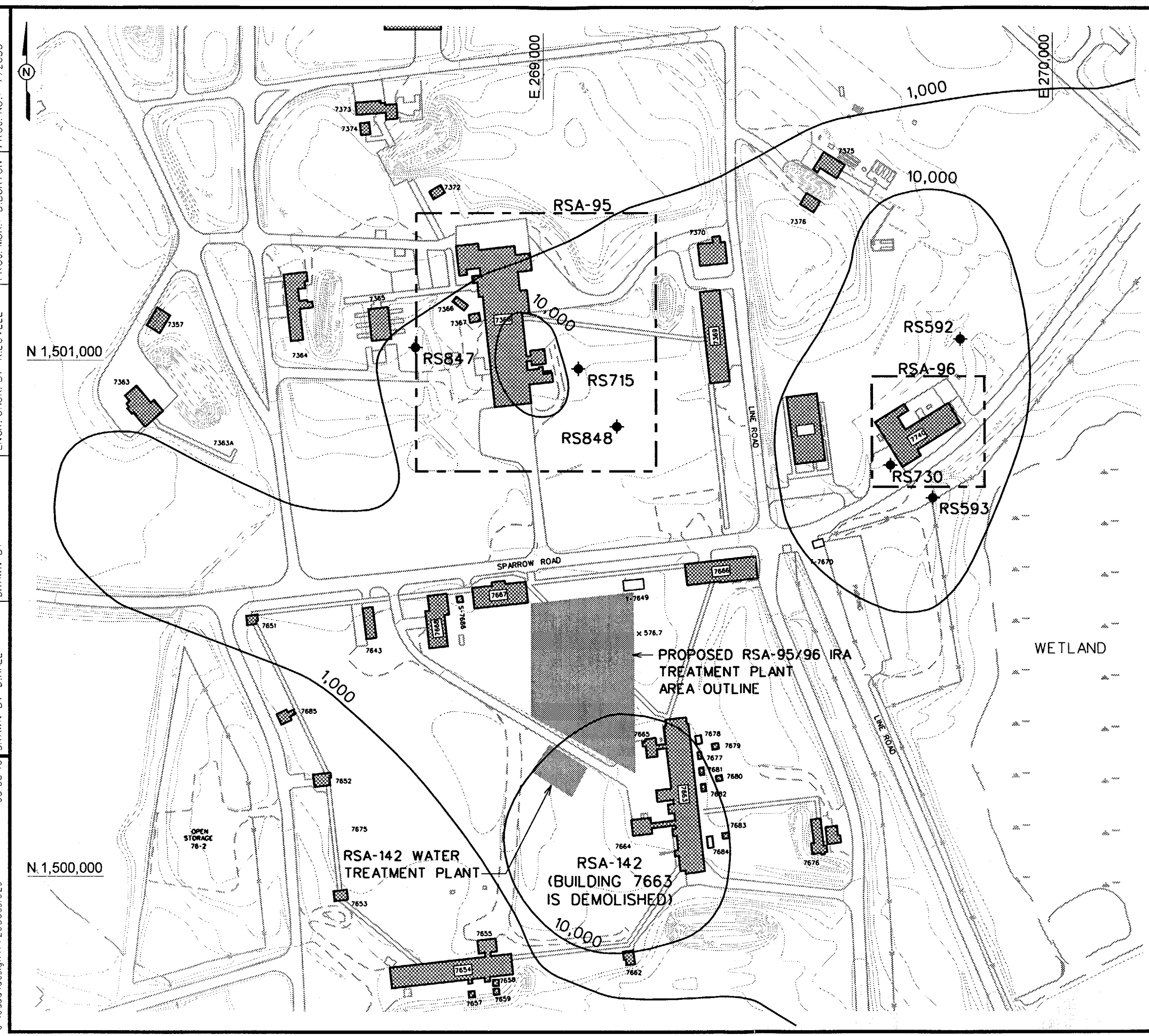

LEGEND

◆ EXTRACTION WELL LOCATION

NOTES

TCE CONTOURS IN ug/L

SCALE

0 200 400 FEET

FIGURE 2
EXTRACTION WELL LOCATIONS, TREATMENT PLANT LOCATION, SHOWING TCE GROUNDWATER PLUME RSA-95 AND RSA-96 DEGREASER SITES

U. S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

IT INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 4/26/99	DATE LAST REV.:	DRAFT. CHCK. BY: D.HALL	INITIATOR: M.MAKI
DRAWN BY: D.HALL	DRAWN BY:	ENGR. CHCK. BY: R.LOVELL	PROJ. MGR.: D.BURTON
22 JUN 1999			DWG. NO.: ...\772650es.629
08:58:45			PROJ. NO.: 772650

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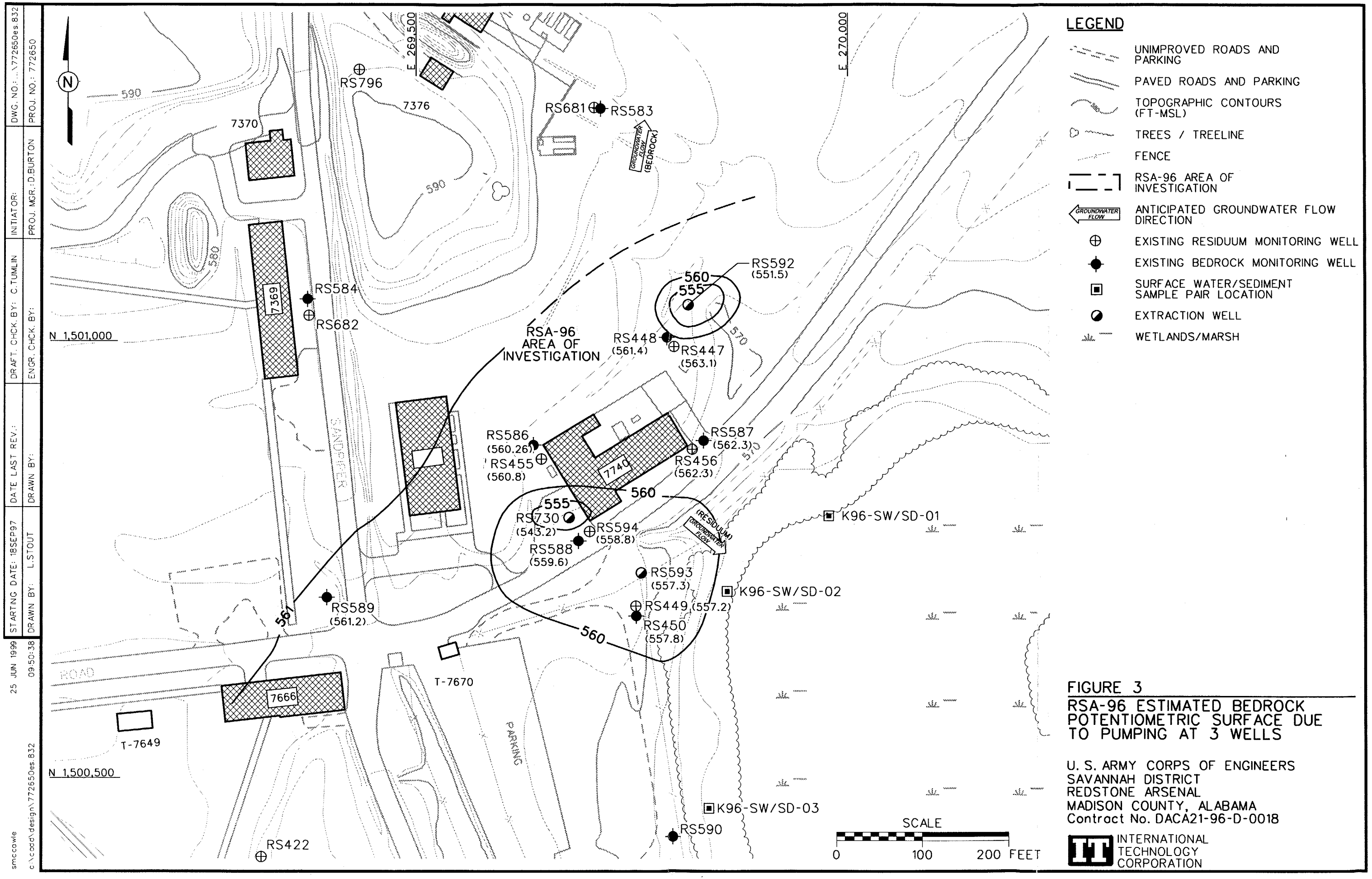

LEGEND

- UNIMPROVED ROADS AND PARKING
- PAVED ROADS AND PARKING
- TOPOGRAPHIC CONTOURS (FT-MSL)
- TREES / TREELINE
- FENCE
- RSA-96 AREA OF INVESTIGATION
- GROUNDWATER FLOW — ANTICIPATED GROUNDWATER FLOW DIRECTION
- EXISTING RESIDUUM MONITORING WELL
- EXISTING BEDROCK MONITORING WELL
- SURFACE WATER/SEDIMENT SAMPLE PAIR LOCATION
- EXTRACTION WELL
- WETLANDS/MARSH

FIGURE 3

RSA-96 ESTIMATED BEDROCK POTENTIOMETRIC SURFACE DUE TO PUMPING AT 3 WELLS

U. S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

INTERNATIONAL TECHNOLOGY CORPORATION

DWG. NO.: ...\772650es.832	PROJ. NO.: 772650
INITIATOR:	PROJ. MGR.: D.BURTON
DRAFT. CHCK. BY: C.TUMLIN	ENGR. CHCK. BY:
DATE LAST REV.:	DRAWN BY:
STARTING DATE: 18SEP97	DRAWN BY: L.STOUT

25 JUN 1999 09:50:38

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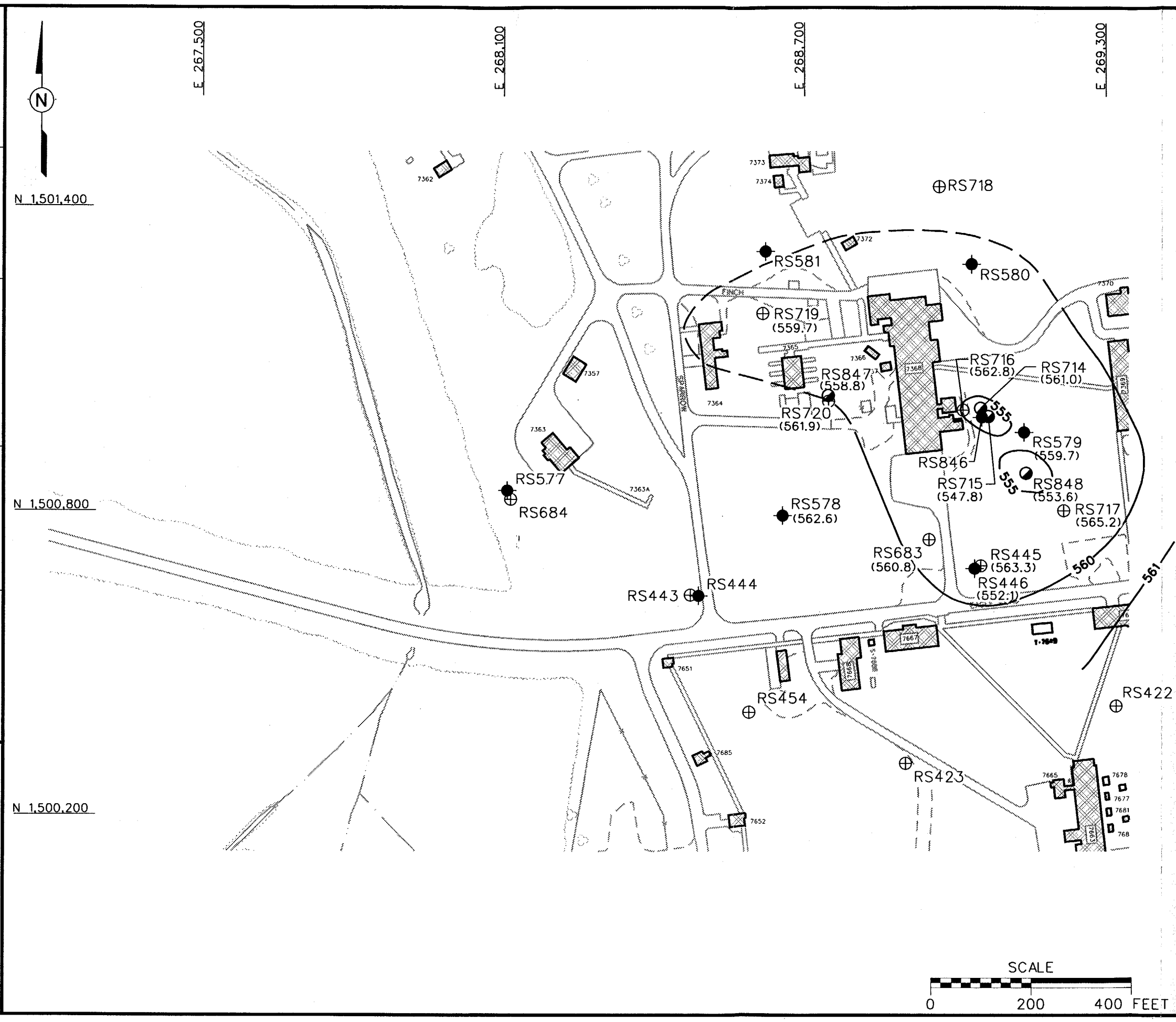

LEGEND

- UNIMPROVED ROADS AND PARKING
- PAVED ROADS AND PARKING
- TREES / TREELINE
- FENCE
- EXISTING REDIUUM MONITORING WELL
- EXISTING BEDROCK MONITORING WELL
- EXTRACTION WELL

FIGURE 4
RSA-95 ESTIMATED BEDROCK POTENTIOMETRIC SURFACE DUE TO PUMPING AT 3 WELLS

U. S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
Contract No. DACA21-96-D-0018

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 08SEP97	DATE LAST REV.:	DRAFT. CHCK. BY: C.TUMLIN	INITIATOR: W. WHITE
DRAWN BY: C.TUMLIN	DRAWN BY:	ENGR. CHCK. BY: W. WHITE	PROJ. MGR.: D.BURTON
			DWG. NO.: \772650es.831
			PROJ. NO.: 772650

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APPENDIX A

WELL PERFORMANCE CALCULATIONS

Objective: Conduct well performance analyses for wells at Operable Unit 10, Redstone Arsenal from step-drawdown data. Determine the maximum drawdown and discharge that can be allowed without drawing water levels below the top of the epikarst zone. The epikarst is the cavernous limestone bedrock below residual soils.

Method: *1)* Using discharge and drawdown rate data collected during the step drawdown tests, calculate the well specific capacity and yield.

2) Establish the maximum discharge at which the well can be pumped without bringing the water level into the weathered limestone bedrock (epikarst). If the maximum discharge rate is projected to be greater than the maximum pumping rate used in the step-drawdown test, the drawdown expected at 150% of the highest pumping rate will be calculated.

3) From the specific capacity data, establish the drawdown at the expected discharge rate

The tests were conducted by pumping each well at successively higher rates for fixed durations. Where possible, the pumping rate was roughly doubled to reach each successively higher pumping rate. Discharge rate was monitored using a variable area flow meter calibrated for water. Water level was monitored using an electronic water level tape and a pressure transducer connected to a Hermit 2000c data logging device.

Table 1 provides stratigraphic information on the soils, bedrock location of the static water table. Table 2 provides data on the well construction details for the extraction wells. At RSA-95 the extraction wells are constructed to straddle the transition between the soils and the epikarst zone so that contaminated groundwater in the soil can be recovered. At RSA-96 the soils and rubble above the bedrock exhibits a high yield and therefore, RSA-96 the extraction wells do not penetrate into the bedrock.

Table 1 - Stratigraphic Information

Well	Depth to Water (ft)	Depth to Top of Rock (ft)	Void or Fracture Intervals (ft)	Total Depth of Borehole (ft)
RS592	11.20	55	55-80(r)	80
RS593	11.13	44	40-51(r),54-64 (r)	70
RS715	13.86	39	59-60(f), 82-88(f)	91
RS730	12.75	44	48-59(r), 61/63/65(f)	66
RS847	11.06	38	43-57(v)	60
RS848	12.89	44	50-59(v)	60

Notes: (v) void, (f) fracture, (r) chert, mud and limestone rubble
Wells RS715, RS847 and RS-848 are associated with RSA-95
Wells RS592, RS593 and RS730 are associated with RSA-96

Table 2 - Well Construction Information

Well	Casing Diameter (inches)	Boring Diameter (inches)	Screen Interval (ft)	Well Depth (ft)
RS592	6	11	49.9-80	80
RS593	6	15	28.5-64.5	65
RS715	8	12	71-91	91
RS730	8	12	35-65	65
RS847	8	12	18-48	50
RS848	8	12	22.5-52.5	57

If the specific drawdown (s/Q) is plotted against discharge (Q) from a series of steps in a step-drawdown test, a straight line can be fitted to the data, with slope C and intercept B. This relationship was used by Jacob (1946) to examine the performance of wells having turbulent flow. The constants used in Jacob's well performance calculation are

derived from a least squares linear regression of Q against s/Q, expressed by the equation:

$$s = BQ + CQ^2 \qquad \text{Eq. (1)}$$

Where

B = intercept of the regression line
C = slope of the regression line
s = drawdown

Using Jacob's method, the drawdown in a well can be calculated for any discharge rate. Discharge rates, drawdown and specific capacity for pumping rate step-drawdown test are provided in the analysis sheets in Attachments I and II. Each analysis sheet also provides the slope and intercept (performance parameters) of the best fit line for Jacob's method of performance analysis. The projected pumping rate for each well and the expected drawdown is calculated form the performance parameters. The maximum pumping rate should not create drawdown of the water surface to below the top of rock. Table 3 gives the depth to the top of rock.

Two sets of step-drawdown tests were run, a 4 step, 2 hours/step well capacity test and a 3 step, 8 hours/step discharge/concentration (Q/[C]) test. The well capacity tests were conducted to determine the maximum well capacity and the maximum pumping rate that could be used without drawing the water level below the top of the epikarst zone. The Q/[C] tests were conducted to determine if pumping rates could be adjusted to obtain maximum mass removal at a lower groundwater recovery rate. However, analysis of the well capacity test data (Attachments 1 and 2) indicated that, except for RS715, the wells could all be pumped at higher rates than the pump could attain, an excess of 100 gpm. Therefore, a larger pump was obtained, and drawdown during the Q/[C] tests was included for estimation of the well capacity. So, in five of the six wells the pumping rates were higher during the Q/[C] testing than those used during the well capacity tests.

Table 3 - Depth to water, Top of rock and Saturated Thickness

Well	Depth to Water (ft)	Depth to Top of Rock (ft)	Saturated Thickness (ft)
RS592	11.20	55	43.80
RS593	11.04	44	32.96
RS715	13.86	39	25.14
RS730	12.10	44	31.90
RS847	11.06	38	26.94
RS848	12.89	44	31.11

Analysis Summary

A Comparison of the specific capacities (Q/s) determined from the well capacity and Q/[C] tests (Table 4) indicates that, except for RS592 and RS593, specific capacities during Q/[C] testing were higher than during well capacity tests. The pumping rates in three of the wells, RS730, RS847, and RS848 were also higher during the Q/[C] tests than during well capacity tests. The difference between the two tests may partially result from more accurate discharge rate measurements available from the Q/[C] tests, however, at least apart of the increased capacity is probably due to additional development of the well that occurred during the testing. For these reasons, the data from the Q/[C] test are used to calculate the pumping rates from the desired drawdown. The pumping rates given below are calculated using the drawdown data from the Q/[C] test, and the pumping rates are rounded to the nearest 5 gpm. The projected highest allowed pumping rate and expected drawdown for each well are given in Table 5.

Table 4 Estimation of Well Capacity

Well	Well Capacity Test		Q/[C] Tests	
	Max Q (gpm)	Q/s (gpm/ft)	Max Q (gpm)	Q/s (gpm/ft)
RS592	72	11.5	94	8.2
RS593	54	37.1	100	26.8
RS715	63	1.2	60	4.1
RS730	75	4.2	90	4.9
RS847	70	16.1	87	21.2
RS848	75	9.2	93	11.4

Table 5 - Projected Pumping Rate and Expected Drawdown

Well	Saturated Thickness (ft)	Q (gpm)	Expected Drawdown (ft)
RS592	43.80	140	23
RS593	32.96	150	7
RS715	25.14	70	22
RS730	31.90	125	32
RS847	26.94	130	7
RS848	31.11	140	15

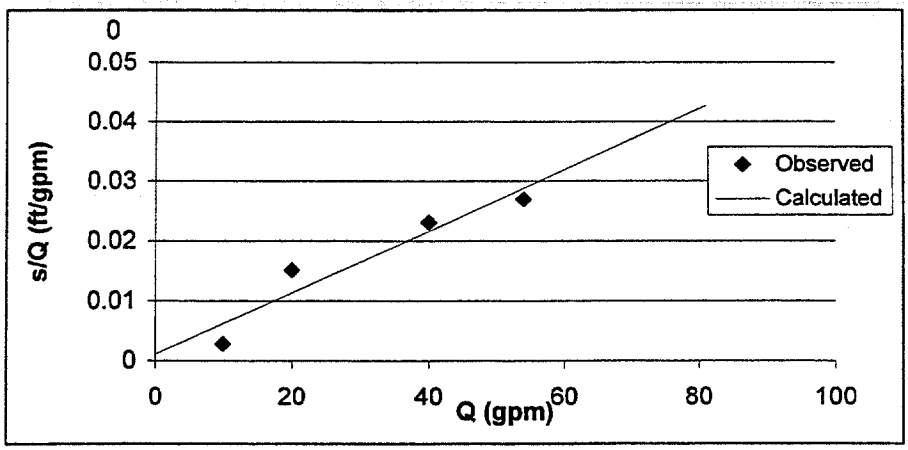
ATTACHMENT I

WELL CAPACITY TEST ANALYSIS

Jacobs Well Performance
Step-Drawdown Analysis
August 10, 1998
RS593, Site RSA-96

Redstone Arsenal
Huntsville, Alabama

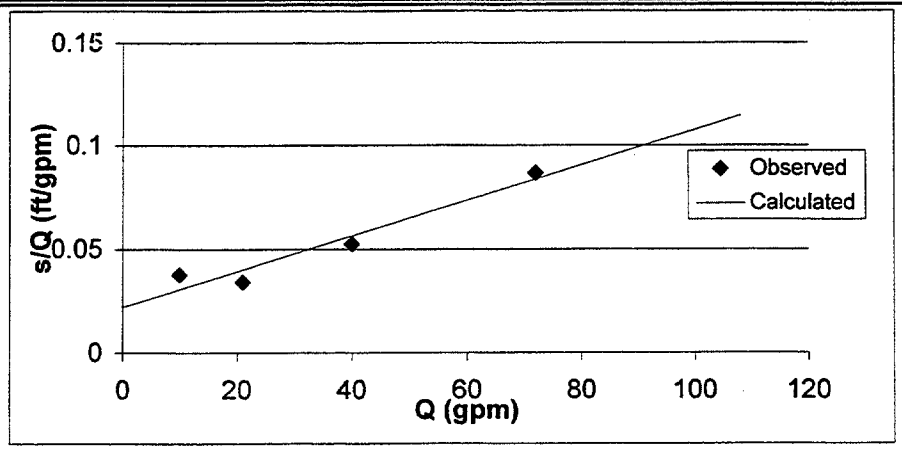
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	11.02			
10	11.05	0.03	0.00	357.14
20	11.32	0.30	0.02	66.23
40	11.95	0.93	0.02	43.24
54	12.47	1.45	0.03	37.14
Jacob's Well Performance Parameters				
B = 0.00		C = 0.0005		
81	14.5	3.5		



Jacobs Well Performance
Step-Drawdown Analysis
July 30, 1999
RS592, Site RSA-96

Redstone Arsenal
Huntsville, Alabama

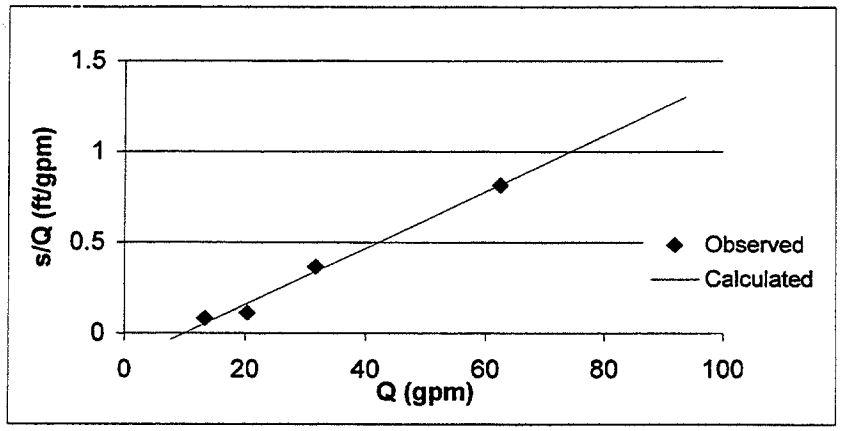
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	12.89			
10	13.27	0.38	0.04	26.46
21	13.61	0.72	0.03	29.25
40	14.99	2.10	0.05	19.07
72	19.14	6.25	0.09	11.52
Jacob's Well Performance Parameters				
B = 0.02		C = 0.001		
108	25.3	12.4		



Jacobs Well Performance
Step-Drawdown Analysis
March 12, 1999
RS715, Site RSA-95

Redstone Arsenal
Huntsville, Alabama

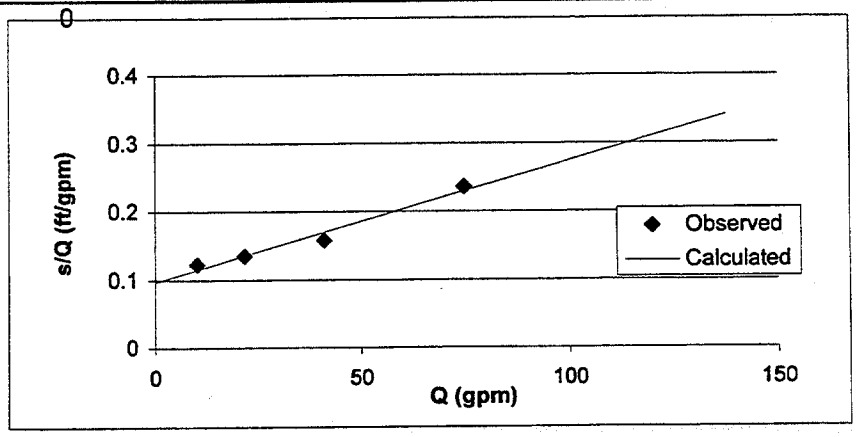
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	13.89			
13	14.97	1.08	0.08	12.32
20	16.13	2.24	0.11	9.10
32	25.49	11.60	0.37	2.74
63	64.75	50.86	0.81	1.23
Jacob's Well Performance Parameters				
B = -0.15		C = 0.016		
94	135.9	122.0		



Jacobs Well Performance
Step-Drawdown Analysis
March 17, 1999
RS730, Site RSA-96

Redstone Arsenal
Huntsville, Alabama

Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	9.65			
10	10.91	1.26	0.12	8.16
22	12.60	2.95	0.13	7.42
41	16.13	6.48	0.16	6.34
75	27.27	17.62	0.24	4.24
Jacob's Well Performance Parameters				
B = 0.10		C = 0.002		
137.5	56.6	46.9		

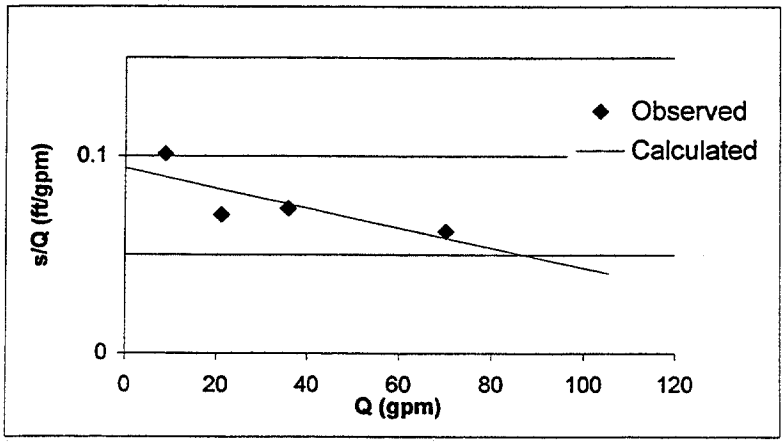


Jacobs Well Performance
Step-Drawdown Analysis
March 16, 1999
RS847, Site RSA-95

Redstone Arsenal
Huntsville, Alabama

Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	11.07			
9	11.97	0.90	0.10	9.88
21	12.56	1.49	0.07	14.20
36	13.71	2.64	0.07	13.59
70	15.43	4.36	0.06	16.13
Jacob's Well Performance Parameters				
B = 0.09		C = -0.0005		
105	15.3	4.3		

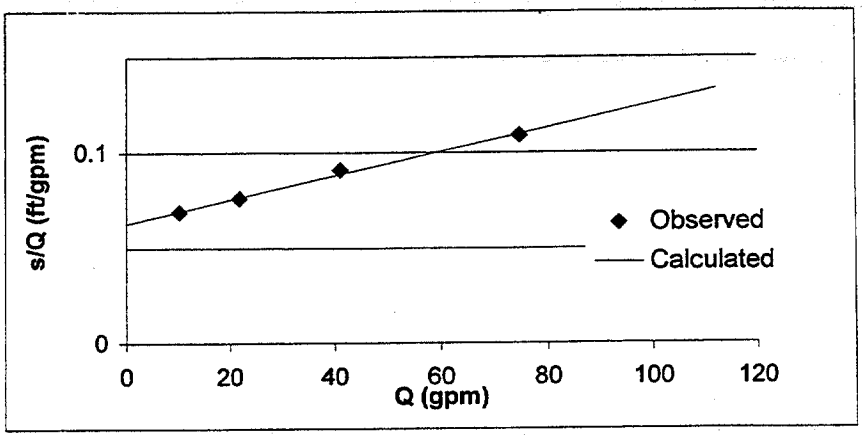
Note: Negative slope (C= -.0005) suggests development was incomplete and that the well efficiency increased during test.



Jacobs Well Performance
Step-Drawdown Analysis
March 11, 1999
RS848, Site RSA-95

Redstone Arsenal
Huntsville, Alabama

Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	12.89			
10	13.60	0.71	0.07	14.50
22	15.26	1.66	0.08	13.16
41	19.00	3.73	0.09	11.00
75	27.14	8.14	0.11	9.18
Jacob's Well Performance Parameters				
B = 0.06		C = 0.001		
112	27.8	14.9		



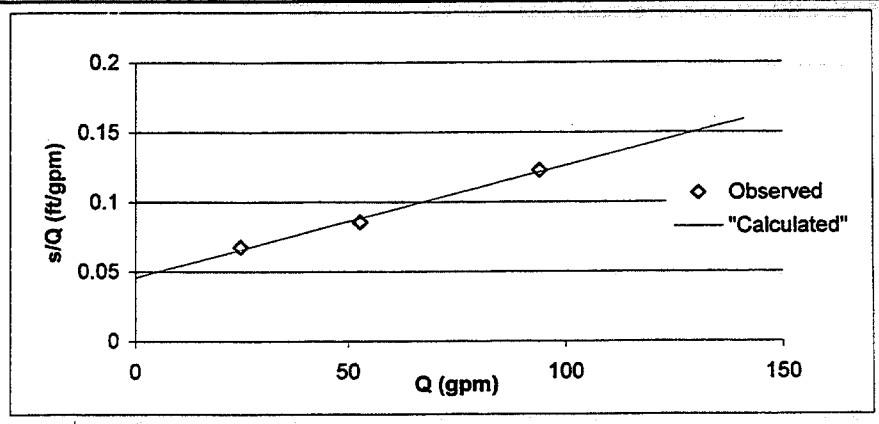
ATTACHMENT II

Q/[C] DRAWDOWN ANALYSIS

Jacobs Well Performance
Step-Drawdown Analysis
April 6, 1999
RS592, Site RSA-96

Redstone Arsenal
Huntsville, Alabama

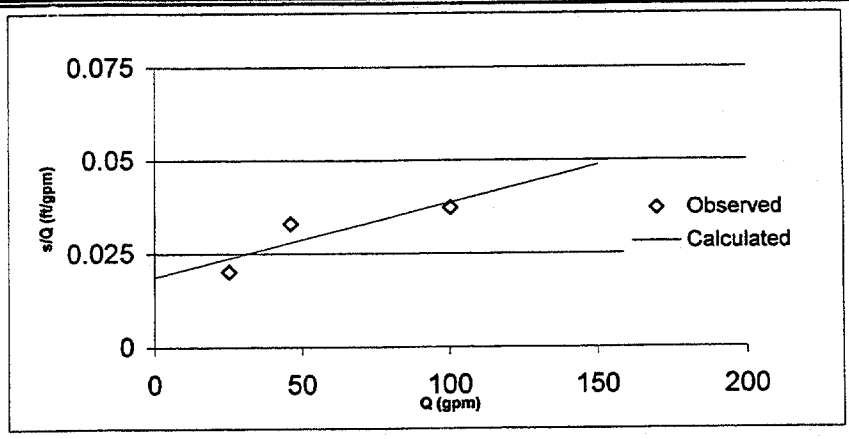
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	11.2			
25	12.87	1.67	0.07	14.80
53	15.71	4.51	0.09	11.70
94	22.75	11.55	0.12	8.15
Jacob's Well Performance Parameters				
B = 0.05		C = 0.0008		
141	33.7	22.5		



Jacobs Well Performance
Step-Drawdown Analysis
April 6, 1999
RS593, Site RSA-96

Redstone Arsenal
Huntsville, Alabama

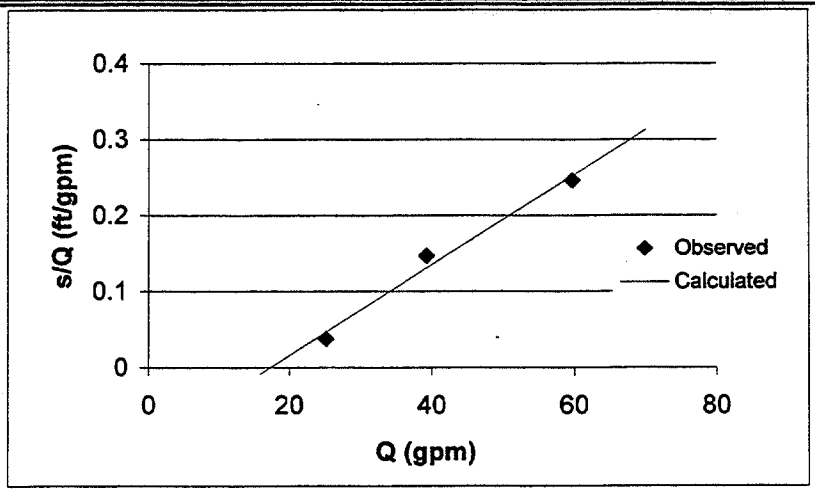
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	11.13			
25	11.64	0.51	0.02	49.44
46	12.66	1.53	0.03	30.32
100	14.88	3.75	0.04	26.79
Jacob's Well Performance Parameters				
B = 0.02		C = 0.0002		
150	18.5	7.3		



Jacobs Well Performance
Step-Drawdown Analysis
March 23, 1999
RS715, Site RSA-95

Redstone Arsenal
Huntsville, Alabama

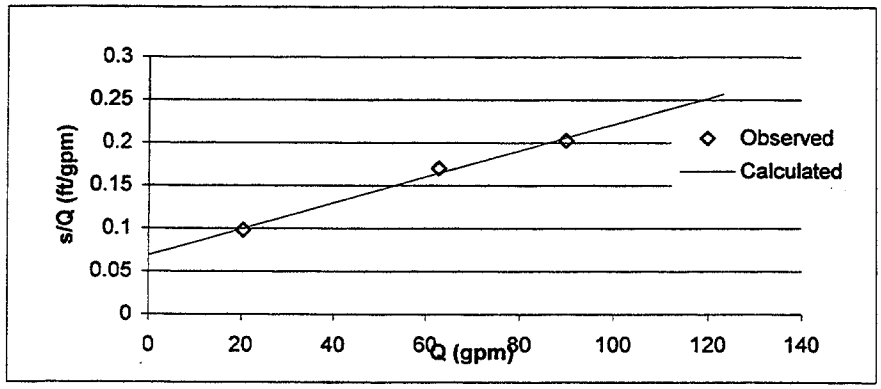
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	13.73			
25	14.68	0.95	0.04	26.53
39	19.47	5.74	0.15	6.84
60	28.41	14.68	0.25	4.07
B = -0.10		C = 0.006		
70	35.6	21.9		



Jacobs Well Performance
Step-Drawdown Analysis
March 31, 1999
RS730, Site RSA-96

Redstone Arsenal
Huntsville, Alabama

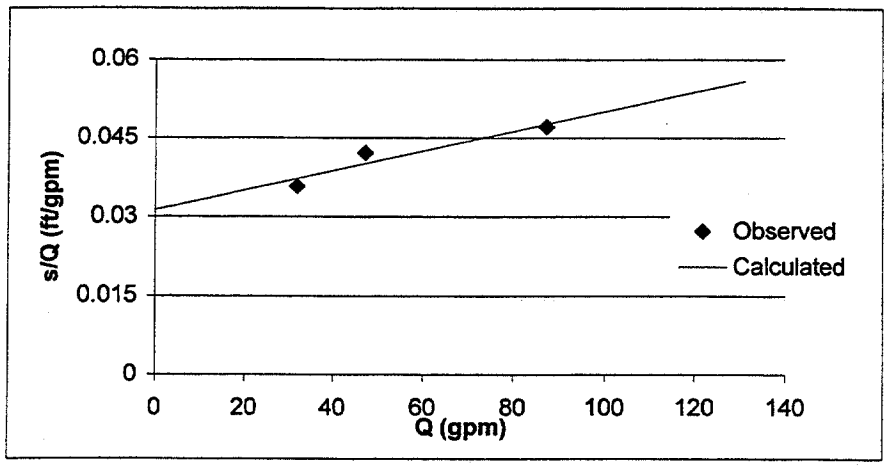
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	12.17			
20	14.17	2.00	0.10	10.21
63	22.87	10.70	0.17	5.88
90	30.41	18.24	0.20	4.93
Jacob's Well Performance Parameters				
B = 0.07		C = 0.0015		
123.5	43.9	31.7		



Jacobs Well Performance
Step-Drawdown Analysis
March 29, 1999
RS847, Site RSA-95

Redstone Arsenal
Huntsville, Alabama

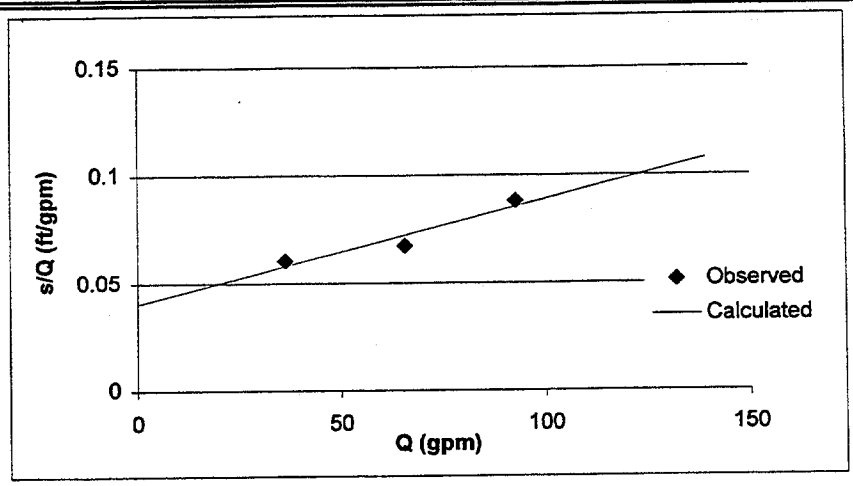
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	13.22			
32	14.36	1.14	0.04	27.97
47	15.21	1.99	0.04	23.71
87	17.34	4.12	0.05	21.22
Jacob's Well Performance Parameters				
B = 0.03		C = 0.0002		
131	20.6	7.3		



Jacobs Well Performance
Step-Drawdown Analysis
March 25, 1999
RS848, Site RSA-95

Redstone Arsenal
Huntsville, Alabama

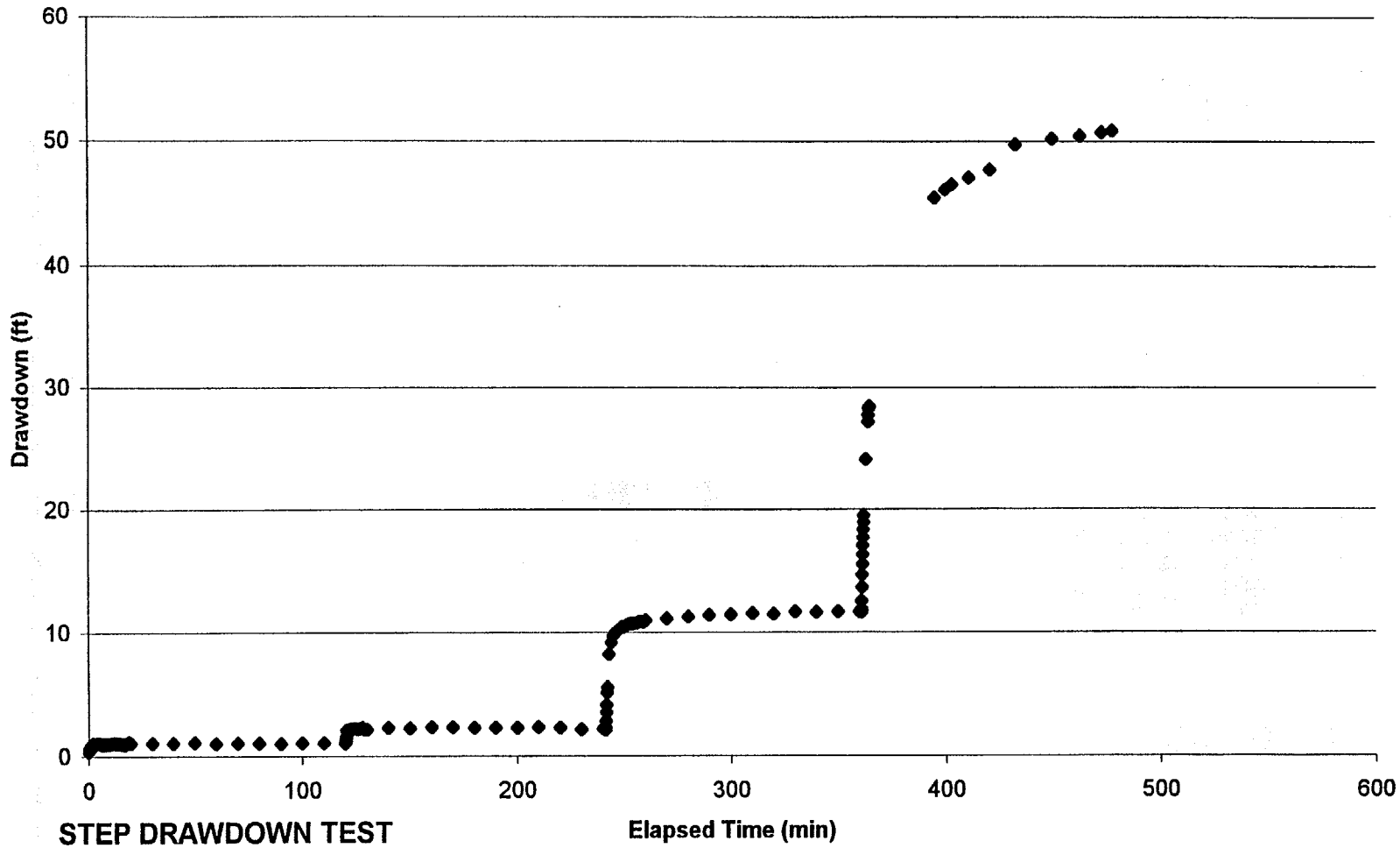
Discharge Rate Q (gpm)	Depth to Water (ft)	Drawdown s (ft)	s/Q (ft/gpm)	Q/s (gpm/ft)
0	12.62			
36	14.82	2.20	0.06	16.51
66	17.06	4.44	0.07	14.82
93	20.79	8.17	0.09	11.35
Jacob's Well Performance Parameters				
B = 0.04		C = 0.0005		
139	27.6	15.0		



ATTACHMENT III

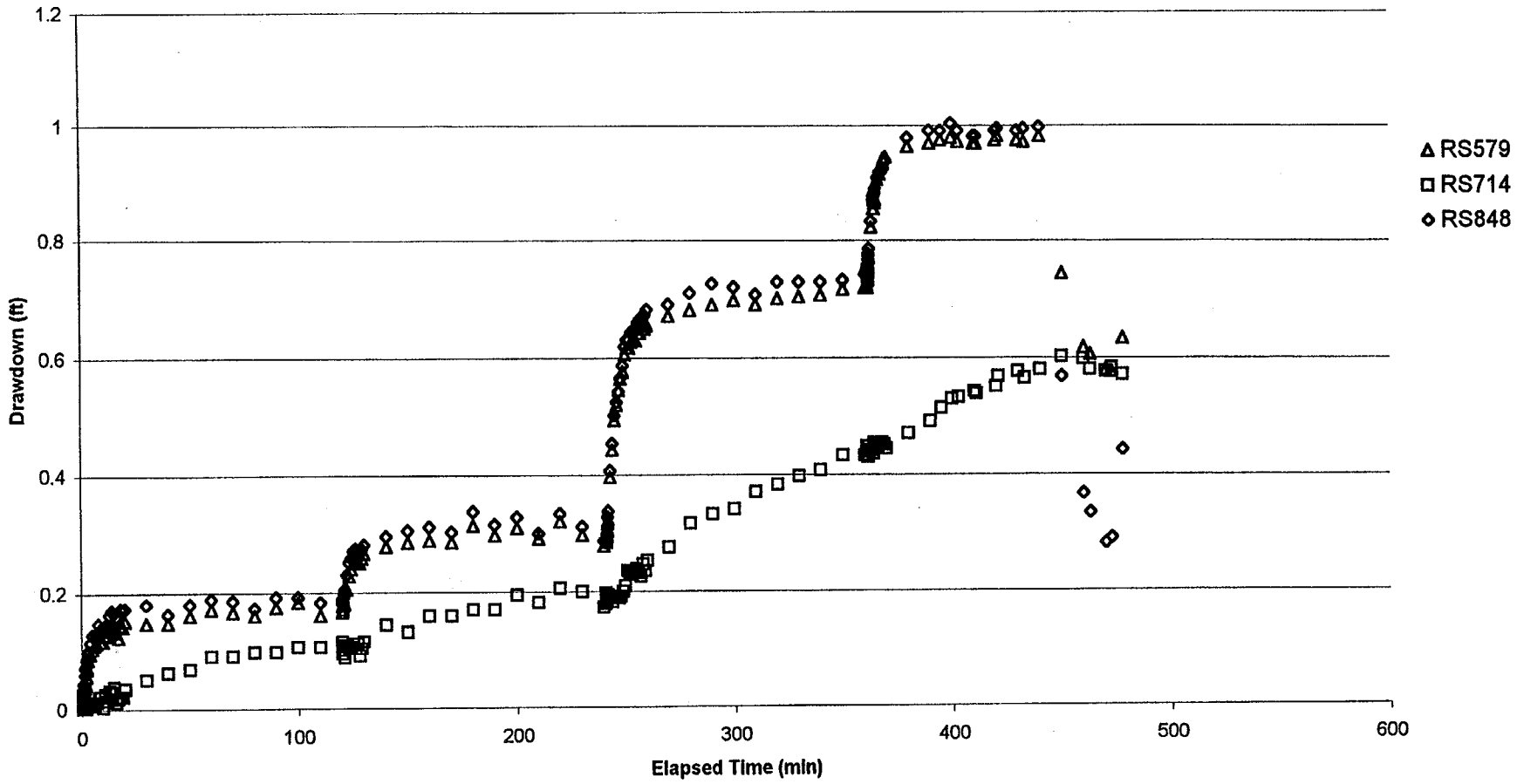
STEP DRAWDOWN TEST DATA

RSA 95



STEP DRAWDOWN TEST
MARCH 12, 1999
RS715 RSA-95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA



STEP DRAWDOWN TEST
OBSERVATION WELLS
MARCH 12, 1999
RS715 RSA-95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA

Pumping Well: RS715
Drawdown in Feet

STEP DRAWDOWN TEST
RSA-95

Test Date: 3/12/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS579	RS714	RS848	
0.0083	-0.955	0	0.021	0	**Step 1 12 gpm**
0.0166	-0.804	0	0.018	0.003	
0.1	0.388	0.009	0.025	0	
0.2	0.454	0.009	0.012	0.006	
0.3	0.501	0.009	0.025	0.022	
0.4	0.577	0.015	0.009	0.028	
0.5	0.577	0.015	0.006	0.031	
0.6	0.586	0.019	0.003	0.031	
0.7	0.624	0.022	0.006	0.034	
0.8	0.577	0.022	0.012	0.044	
0.9	0.7	0.028	0.009	0.034	
1	0.738	0.025	0.009	0.044	
1.2	0.87	0.031	0.006	0.044	
1.4	0.86	0.038	-0.003	0.06	
1.6	0.964	0.041	0	0.072	
1.8	0.955	0.044	0	0.072	
2	1.049	0.057	0	0.075	
2.2	0.993	0.057	0.003	0.085	
2.4	0.974	0.069	0.003	0.085	
2.6	0.983	0.072	0.006	0.088	
2.8	1.002	0.085	0.009	0.097	
3	0.974	0.085	0.009	0.101	
4	1.059	0.095	0.009	0.116	
5	1.068	0.104	0.012	0.129	
6	1.012	0.11	0.006	0.123	
7	0.983	0.114	0.012	0.132	
8	1.012	0.126	0.021	0.148	
9	1.031	0.117	0.021	0.139	
10	1.002	0.117	0.003	0.142	
11	1.059	0.126	0.025	0.145	
12	1.078	0.129	0.015	0.148	
13	1.068	0.136	0.031	0.164	
14	1.049	0.139	0.028	0.17	
15	1.012	0.142	0.037	0.167	
16	1.04	0.133	0.012	0.161	
17	0.964	0.123	0.018	0.157	
18	1.049	0.145	0.021	0.173	
19	1.153	0.142	0.021	0.17	
20	1.068	0.152	0.034	0.173	
30	1.059	0.148	0.05	0.18	
40	1.068	0.148	0.062	0.164	
50	1.116	0.161	0.068	0.18	
60	1.002	0.171	0.09	0.189	
70	1.049	0.167	0.09	0.186	
80	1.078	0.161	0.097	0.173	
90	1.031	0.174	0.097	0.192	
100	1.059	0.183	0.106	0.192	
110	1.059	0.161	0.106	0.183	
120	1.012	0.177	0.115	0.189	

Pumping Well: RS715
Drawdown in Feet

STEP DRAWDOWN TEST
RSA-95

Test Date: 3/12/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS579	RS714	RS848	
120.0083	1.059	0.167	0.106	0.186	**Step 2 20 gpm**
120.1	1.097	0.167	0.094	0.183	
120.2	1.352	0.171	0.106	0.183	
120.3	1.635	0.171	0.106	0.18	
120.5	2.098	0.177	0.1	0.192	
120.7	2.098	0.18	0.109	0.199	
120.9	2.004	0.18	0.087	0.205	
121	2.061	0.18	0.106	0.205	
122	2.127	0.205	0.109	0.23	
123	2.174	0.228	0.103	0.252	
124	2.202	0.24	0.106	0.259	
125	2.165	0.25	0.112	0.271	
126	2.165	0.253	0.103	0.274	
127	2.221	0.25	0.112	0.271	
128	2.25	0.25	0.09	0.268	
129	2.146	0.259	0.103	0.274	
130	2.146	0.266	0.115	0.281	
140	2.259	0.278	0.144	0.296	
150	2.202	0.285	0.131	0.306	
160	2.325	0.288	0.159	0.312	
170	2.306	0.285	0.159	0.303	
180	2.278	0.313	0.169	0.338	
190	2.259	0.297	0.169	0.315	
200	2.278	0.31	0.194	0.328	
210	2.325	0.291	0.181	0.3	
220	2.25	0.32	0.206	0.334	
230	2.146	0.297	0.2	0.312	
240	2.193	0.278	0.172	0.287	
241	2.136	0.285	0.197	0.284	

Pumping Well: RS715
Drawdown in Feet

STEP DRAWDOWN TEST
RSA-95

Test Date: 3/12/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS579	RS714	RS848	
241.01	2.098	0.285	0.188	0.287	**Step 3 45 gpm**
241.02	2.127	0.285	0.181	0.287	
241.03	2.098	0.285	0.181	0.287	
241.03	2.136	0.285	0.178	0.287	
241.04	2.165	0.285	0.191	0.287	
241.05	2.098	0.285	0.191	0.287	
241.06	2.127	0.285	0.181	0.287	
241.07	2.146	0.285	0.197	0.29	
241.08	2.183	0.285	0.188	0.29	
241.08	2.146	0.285	0.178	0.29	
241.09	2.174	0.285	0.184	0.29	
241.1	2.174	0.285	0.181	0.287	
241.1	2.07	0.285	0.181	0.29	
241.2	2.297	0.285	0.191	0.29	
241.3	2.807	0.288	0.188	0.29	
241.5	3.497	0.294	0.181	0.3	
241.7	4.092	0.304	0.188	0.312	
241.9	5.064	0.316	0.188	0.328	
242	5.517	0.323	0.194	0.338	
243	8.178	0.396	0.191	0.407	
244	9.15	0.443	0.181	0.454	
245	9.725	0.494	0.188	0.502	
246	9.98	0.519	0.188	0.524	
247	10.121	0.545	0.188	0.543	
248	10.262	0.564	0.191	0.565	
249	10.394	0.576	0.2	0.587	
250	10.404	0.605	0.209	0.619	
251	10.526	0.617	0.235	0.631	
252	10.621	0.617	0.231	0.631	
253	10.668	0.627	0.228	0.644	
254	10.715	0.63	0.235	0.647	
255	10.743	0.63	0.238	0.647	
256	10.743	0.643	0.231	0.66	
257	10.856	0.643	0.225	0.666	
258	10.856	0.649	0.247	0.669	
259	10.828	0.649	0.235	0.672	
260	10.951	0.655	0.253	0.682	
270	11.101	0.671	0.275	0.691	
280	11.215	0.681	0.316	0.71	
290	11.375	0.69	0.332	0.726	
300	11.403	0.697	0.341	0.72	
310	11.526	0.69	0.369	0.707	
320	11.441	0.7	0.382	0.729	
330	11.629	0.703	0.397	0.729	
340	11.591	0.706	0.407	0.729	
350	11.648	0.716	0.432	0.732	
360	11.667	0.719	0.432	0.742	
361	11.601	0.722	0.441	0.742	

Pumping Well: RS715
Drawdown in Feet

STEP DRAWDOWN TEST
RSA-95

Test Date: 3/12/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS579	RS714	RS848	
361.01	11.695	0.722	0.441	0.748	**Step 4 68 gpm**
361.05	11.902	0.725	0.448	0.739	
361.10	12.524	0.722	0.438	0.742	
361.20	13.644	0.719	0.429	0.745	
361.30	14.643	0.719	0.432	0.751	
361.40	15.518	0.738	0.432	0.748	
361.50	16.318	0.732	0.429	0.755	
361.60	17.071	0.744	0.448	0.758	
361.70	17.72	0.747	0.429	0.767	
361.80	18.36	0.751	0.448	0.774	
361.90	18.934	0.757	0.441	0.777	
362	19.488	0.77	0.438	0.786	
363	24.112	0.823	0.441	0.834	
364	27.247	0.855	0.435	0.871	
364.2	27.772	0.855	0.451	0.868	
364.4	28.316	0.871	0.454	0.878	
364.6	28.475	0.865	0.444	0.881	
364.8		0.865	0.451	0.884	
365		0.871	0.454	0.89	
366		0.906	0.448	0.909	
367		0.915	0.451	0.919	
368		0.931	0.454	0.919	
369		0.941	0.451	0.925	
370		0.944	0.444	0.938	
380		0.963	0.47	0.979	
390		0.969	0.491	0.991	
395	45.42	0.975	0.513	0.991	**Hand Measurments**
400	46.09	0.979	0.529	1.004	**at Pumping Well**
403	46.5	0.972	0.532	0.991	
410		0.969	0.542	0.982	
411	47.04	0.969	0.538	0.982	
420		0.975	0.551	0.991	
421	47.69	0.982	0.567	0.995	
430		0.975	0.576	0.991	
433	49.74	0.972	0.564	0.995	
440		0.982	0.579	0.998	
450	50.2	0.744	0.601	0.568	
460		0.617	0.598	0.366	
463	50.44	0.605	0.579	0.334	
470		0.579	0.576	0.281	
473	50.73	0.576	0.582	0.29	
478	50.86	0.633	0.57	0.442	

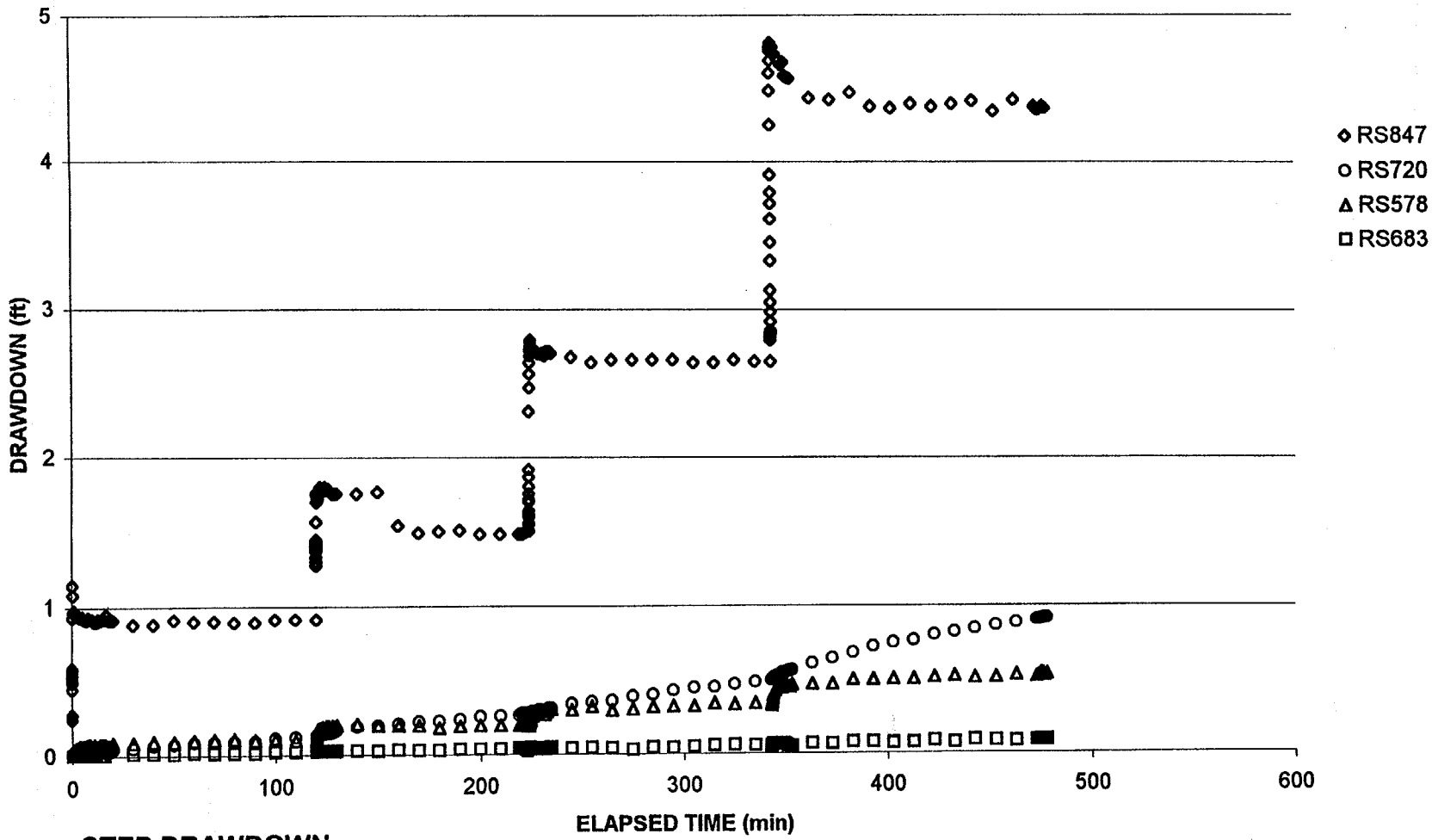
Elapsed Time	RS715	RS846	RS717	RS579	RS848	
965.0	5.722	1.674	0.491	0.613	0.641	***Step 3 60 gpm***
965.2	6.656	1.754	0.497	0.613	0.635	
965.4	7.637	2.035	0.491	0.619	0.641	
965.6	8.389	2.216	0.494	0.622	0.654	
965.8	9.275	2.434	0.497	0.635	0.66	
966.0	9.903	2.611	0.494	0.647	0.673	
966.2	10.389	2.75	0.494	0.657	0.679	
966.4	10.712	2.855	0.491	0.669	0.692	
966.6	11.064	2.934	0.494	0.676	0.701	
966.8	11.34	2.991	0.497	0.688	0.708	
967.0	11.578	3.042	0.494	0.698	0.72	
967.2	11.797	3.086	0.494	0.704	0.733	
967.4	11.959	3.121	0.494	0.714	0.736	
967.6	12.139	3.146	0.494	0.72	0.752	
967.8	12.187	3.159	0.494	0.726	0.755	
968.0	12.244	3.174	0.491	0.736	0.758	
969.0	12.691	3.244	0.494	0.758	0.79	
970.0	12.824	3.26	0.497	0.78	0.812	
971.0	12.948	3.288	0.494	0.793	0.822	
972.0	13.062	3.295	0.494	0.802	0.834	
973.0	13.119	3.301	0.5	0.808	0.837	
974	13.167	3.31	0.503	0.818	0.847	
975	13.319	3.32	0.503	0.827	0.856	
976	13.252	3.314	0.506	0.831	0.863	
977	13.309	3.326	0.503	0.837	0.869	
978	13.404	3.329	0.506	0.84	0.872	
979	13.404	3.32	0.509	0.843	0.878	
980	13.442	3.336	0.513	0.849	0.882	
981	13.471	3.329	0.516	0.849	0.885	
982	13.414	3.323	0.519	0.853	0.888	
983	13.509	3.339	0.519	0.856	0.891	
984	13.547	3.333	0.519	0.859	0.891	
985	13.537	3.329	0.522	0.856	0.894	
986	13.614	3.333	0.522	0.859	0.894	
987	13.604	3.329	0.525	0.862	0.894	
988	13.595	3.326	0.528	0.859	0.894	
989	13.661	3.339	0.528	0.862	0.901	
990	13.69	3.329	0.531	0.865	0.901	
1000	13.813	3.345	0.547	0.875	0.913	
1010	13.861	3.336	0.563	0.887	0.926	
1020	13.937	3.348	0.581	0.894	0.929	
1030	13.908	3.345	0.591	0.897	0.939	
1040	13.965	3.361	0.603	0.903	0.942	
1050	13.984	3.352	0.613	0.903	0.945	
1060	14.079	3.361	0.622	0.906	0.948	
1070	14.051	3.355	0.628	0.913	0.954	
1080	14.146	3.371	0.635	0.91	0.954	
1090	14.089	3.361	0.647	0.916	0.957	
1100	14.165	3.371	0.653	0.919	0.961	
1110	14.117	3.364	0.657	0.922	0.964	
1120	14.165	3.374	0.663	0.925	0.97	
1125	14.165	3.38	0.663	0.928	0.97	

Pumping Well: RS715
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-95

Test Date: 3/29/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS846	RS717	RS579	RS848
1150	14.26	3.377	0.675	0.932	0.973
1175	14.232	3.38	0.694	0.941	0.976
1200	14.365	3.399	0.713	0.947	0.995
1225	14.479	3.418	0.725	0.96	1.002
1250	14.517	3.434	0.732	0.966	1.008
1275	14.469	3.44	0.741	0.976	1.021
1300	14.488	3.44	0.75	0.982	1.024
1325	14.564	3.456	0.76	0.989	1.033
1350	14.564	3.462	0.769	0.995	1.037
1375	14.593	3.456	0.775	0.995	1.03
1400	14.612	3.462	0.782	1.004	1.043
1425	14.65	3.472	0.788	1.011	1.043
1443	14.678	3.469	0.797	1.02	1.052



STEP DRAWDOWN
MARCH 16, 1999
RS847 RSA-95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA

Pumping Well: RS847
Drawdown in Feet
Test Date: 3/16/99

STEP-DRAWDOWN TEST
RSA-95

Redstone Arsenal
Huntsville Alabama

Elapsed Time	RS847	RS720	RS578	RS683	
0.01	0.019	0	0.003	0	**Step 1 9 gpm**
0.02	0.569	0.01	0.003	0	
0.03	0.019	0	0.003	0	
0.03	0.028	0.006	0.006	-0.003	
0.04	0.275	0.013	0.003	0	
0.05	0.246	-0.003	0.006	-0.003	
0.06	0.493	0.006	0.009	-0.003	
0.07	0.445	0	0.009	-0.01	
0.08	0.512	0.006	0.006	-0.007	
0.08	0.54	0.01	0.003	-0.003	
0.09	0.54	0	0.009	-0.01	
0.1	0.588	0.003	0.006	0	
0.2	0.929	0.013	0.022	-0.003	
0.3	1.146	0.006	0.025	0.003	
0.5	1.08	0.003	0.031	0	
0.7	0.966	0.003	0.034	-0.007	
0.9	0.966	0.019	0.044	-0.003	
1	0.976	0.019	0.044	0	
2	0.948	0.016	0.053	-0.007	
3	0.938	0.013	0.059	-0.01	
4	0.929	0.019	0.069	-0.003	
5	0.938	0.029	0.066	0.003	
6	0.919	0.029	0.069	0	
7	0.91	0.022	0.072	0	
8	0.929	0.019	0.075	0	
9	0.919	0.025	0.075	0	
10	0.919	0.029	0.066	0.003	
11	0.9	0.035	0.075	0	
12	0.9	0.019	0.066	0	
13	0.919	0.032	0.069	-0.003	
14	0.91	0.035	0.078	0	
15	0.919	0.032	0.081	0	
16	0.919	0.032	0.078	0	
17	0.948	0.038	0.069	-0.003	
18	0.91	0.032	0.069	-0.003	
19	0.91	0.032	0.069	-0.007	
20	0.91	0.041	0.084	-0.003	
30	0.881	0.048	0.087	0.012	
40	0.881	0.063	0.094	0.012	
50	0.91	0.07	0.091	0.009	
60	0.9	0.082	0.1	0.015	
70	0.9	0.086	0.103	0.012	
80	0.891	0.092	0.106	0.012	
90	0.881	0.092	0.097	0.012	
100	0.9	0.108	0.103	0.019	
110	0.9	0.117	0.1	0.019	
120	0.9	0.117	0.109	0.022	

Pumping Well: RS847
Drawdown in Feet
Test Date: 3/16/99

STEP-DRAWDOWN TEST
RSA-95

Redstone Arsenal
Huntsville Alabama

Elapsed Time	RS847	RS720	RS578	RS683	
120.01	1.27	0.127	0.103	0.022	**Step 2 21 gpm**
120.02	1.27	0.124	0.106	0.022	
120.03	1.298	0.124	0.1	0.025	
120.03	1.298	0.121	0.103	0.022	
120.04	1.326	0.124	0.103	0.022	
120.05	1.364	0.121	0.106	0.022	
120.06	1.383	0.124	0.103	0.019	
120.07	1.393	0.127	0.106	0.019	
120.08	1.412	0.124	0.116	0.019	
120.08	1.421	0.124	0.119	0.022	
120.09	1.44	0.124	0.106	0.022	
120.1	1.44	0.124	0.106	0.022	
120.2	1.563	0.121	0.116	0.022	
120.3	1.696	0.124	0.134	0.022	
120.4	1.753	0.127	0.141	0.019	
120.5	1.743	0.127	0.141	0.019	
120.6	1.762	0.124	0.15	0.022	
120.7	1.753	0.127	0.147	0.022	
120.8	1.715	0.124	0.156	0.022	
120.9	1.724	0.136	0.175	0.025	
121	1.715	0.13	0.172	0.022	
122	1.791	0.133	0.178	0.022	
123	1.781	0.14	0.185	0.028	
124	1.791	0.14	0.178	0.028	
125	1.772	0.146	0.194	0.025	
126	1.781	0.146	0.191	0.022	
127	1.762	0.143	0.181	0.019	
128	1.753	0.152	0.194	0.022	
129	1.753	0.155	0.188	0.019	
130	1.753	0.165	0.197	0.028	
140	1.753	0.184	0.206	0.028	
150	1.762	0.193	0.194	0.022	
160	1.535	0.206	0.191	0.031	
170	1.488	0.219	0.194	0.025	
180	1.497	0.225	0.178	0.025	
190	1.506	0.235	0.188	0.034	
200	1.478	0.254	0.191	0.034	
210	1.478	0.257	0.194	0.034	
219	1.478	0.26	0.194	0.041	
220	1.478	0.273	0.194	0.038	
221	1.478	0.276	0.2	0.038	
222	1.488	0.273	0.188	0.031	
223	1.497	0.266	0.197	0.019	
224	1.487	0.276	0.21	0.038	

Pumping Well: RS847
Drawdown in Feet
Test Date: 3/16/99

STEP-DRAWDOWN TEST
RSA-95

Redstone Arsenal
Huntsville Alabama

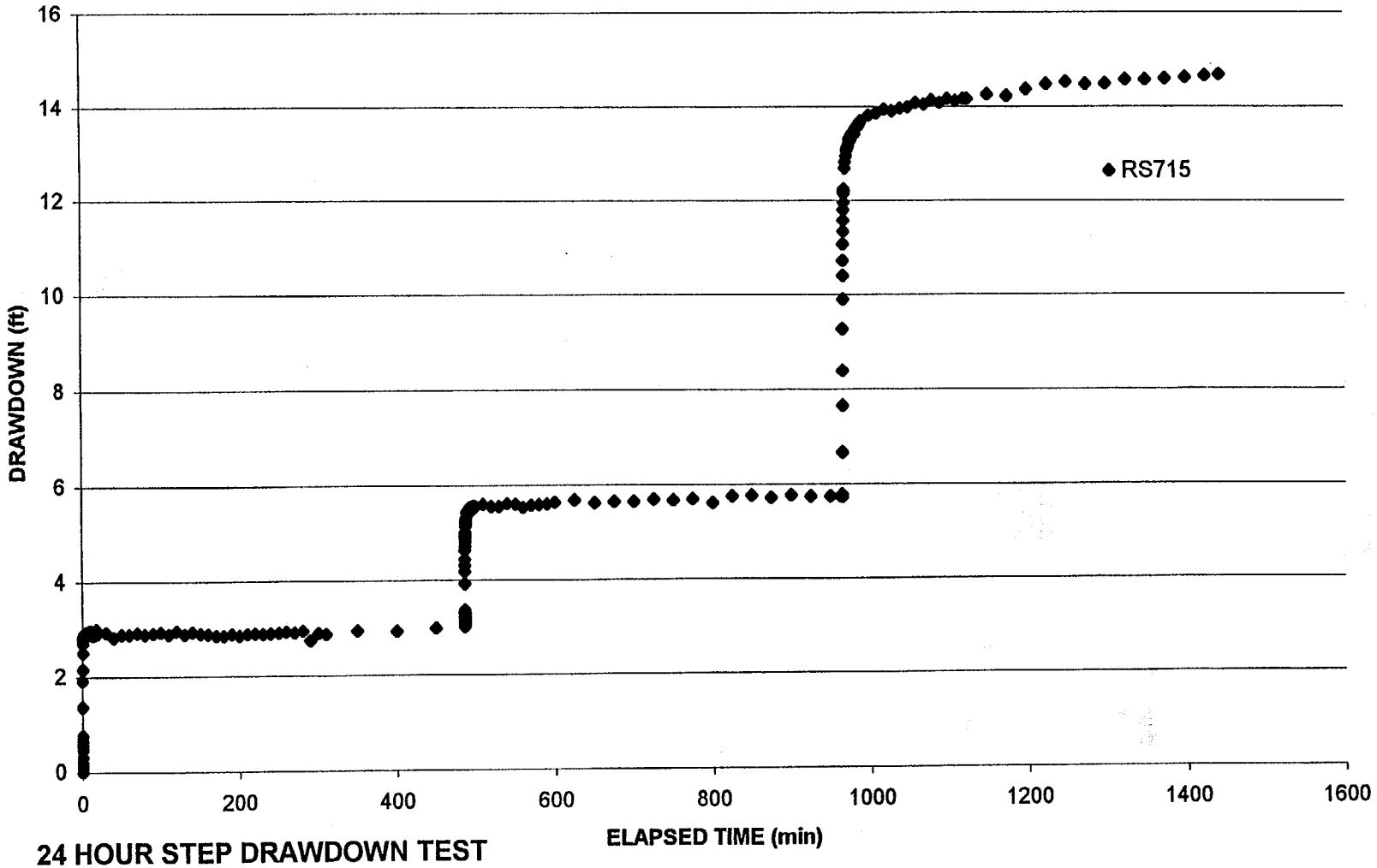
Elapsed Time	RS847	RS720	RS578	RS683	
224.01	1.506	0.273	0.194	0.044	**Step 3 36 gpm**
224.02	1.554	0.273	0.197	0.044	
224.03	1.544	0.273	0.191	0.044	
224.03	1.592	0.273	0.191	0.044	
224.04	1.611	0.273	0.197	0.044	
224.05	1.639	0.273	0.197	0.044	
224.06	1.696	0.273	0.194	0.044	
224.07	1.715	0.273	0.191	0.044	
224.08	1.753	0.273	0.188	0.047	
224.08	1.8	0.273	0.185	0.044	
224.09	1.866	0.273	0.191	0.044	
224.1	1.914	0.279	0.191	0.044	
224.2	2.312	0.273	0.194	0.044	
224.3	2.473	0.273	0.2	0.044	
224.4	2.567	0.276	0.2	0.044	
224.5	2.643	0.27	0.213	0.044	
224.6	2.69	0.273	0.225	0.041	
224.7	2.728	0.273	0.228	0.044	
224.8	2.757	0.276	0.225	0.041	
224.9	2.785	0.27	0.235	0.044	
225	2.794	0.282	0.25	0.044	
226	2.728	0.285	0.253	0.031	
227	2.719	0.276	0.269	0.038	
228	2.719	0.292	0.275	0.038	
229	2.7	0.295	0.288	0.038	
230	2.7	0.295	0.294	0.034	
231	2.709	0.292	0.282	0.041	
232	2.69	0.285	0.266	0.031	
233	2.719	0.301	0.282	0.034	
234	2.719	0.308	0.304	0.047	
235	2.709	0.305	0.3	0.044	
245	2.681	0.336	0.294	0.038	
255	2.643	0.349	0.316	0.041	
265	2.662	0.355	0.291	0.038	
275	2.662	0.384	0.3	0.028	
285	2.662	0.397	0.313	0.041	
295	2.662	0.422	0.319	0.038	
305	2.643	0.444	0.316	0.044	
315	2.643	0.447	0.338	0.053	
325	2.662	0.466	0.329	0.057	
335	2.652	0.479	0.335	0.053	
343	2.652	0.492	0.322	0.044	

Pumping Well: RS847
Drawdown in Feet
Test Date: 3/16/99

STEP-DRAWDOWN TEST
RSA-95

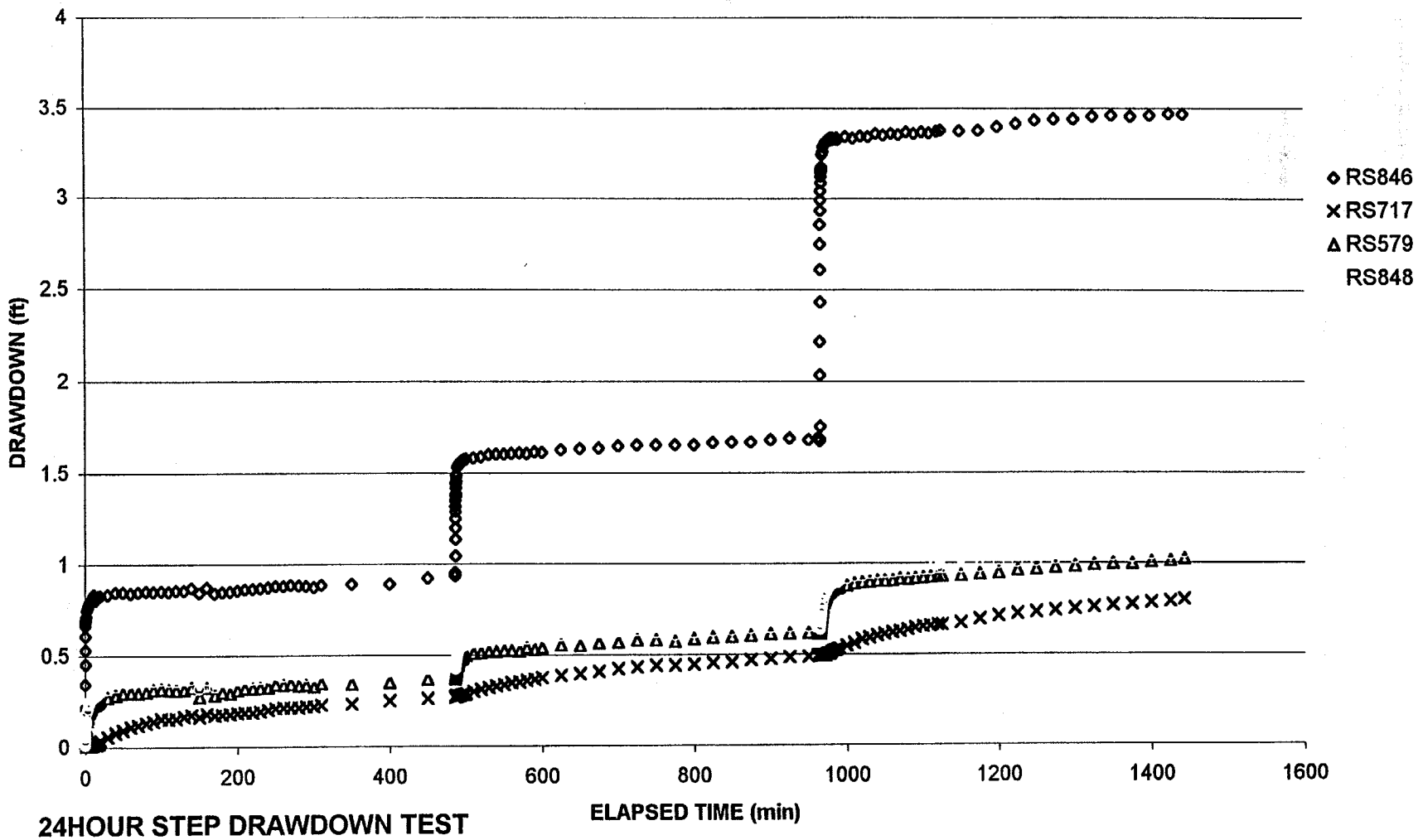
Redstone Arsenal
Huntsville Alabama

Elapsed Time	RS847	RS720	RS578	RS683	
343.01	2.642	0.492	0.326	0.05	**Step 4 70 gpm**
343.02	2.794	0.495	0.329	0.047	
343.03	2.823	0.495	0.332	0.05	
343.03	2.842	0.492	0.322	0.047	
343.04	2.861	0.495	0.322	0.05	
343.05	2.918	0.495	0.319	0.05	
343.06	2.984	0.492	0.319	0.05	
343.07	3.05	0.495	0.338	0.05	
343.08	3.126	0.495	0.338	0.05	
343.10	3.325	0.495	0.332	0.053	
343.12	3.448	0.495	0.326	0.05	
343.14	3.609	0.495	0.326	0.057	
343.16	3.713	0.495	0.335	0.053	
343.18	3.789	0.498	0.332	0.053	
343.2	3.912	0.498	0.335	0.053	
343.3	4.252	0.498	0.347	0.057	
343.4	4.48	0.501	0.354	0.053	
343.5	4.603	0.501	0.36	0.057	
343.6	4.688	0.504	0.366	0.057	
343.7	4.754	0.504	0.388	0.057	
343.8	4.782	0.508	0.385	0.057	
343.9	4.811	0.508	0.401	0.06	
344	4.811	0.511	0.401	0.063	
345	4.782	0.517	0.419	0.063	
346	4.735	0.523	0.441	0.063	
347	4.707	0.527	0.448	0.063	
348	4.688	0.539	0.438	0.063	
349	4.659	0.539	0.463	0.063	
350	4.678	0.546	0.466	0.057	
351	4.584	0.552	0.445	0.05	
352	4.574	0.552	0.445	0.047	
353	4.565	0.561	0.46	0.047	
363	4.432	0.606	0.466	0.063	
373	4.423	0.641	0.466	0.06	
383	4.47	0.676	0.495	0.072	
393	4.375	0.72	0.495	0.072	
403	4.366	0.745	0.498	0.063	
413	4.394	0.761	0.498	0.069	
423	4.375	0.799	0.51	0.079	
433	4.394	0.818	0.517	0.069	
443	4.413	0.841	0.507	0.082	
453	4.347	0.863	0.51	0.079	
463	4.423	0.882	0.526	0.076	
473	4.375	0.901	0.513	0.079	
474	4.357	0.901	0.523	0.079	
475	4.357	0.904	0.538	0.082	
476	4.356	0.907	0.538	0.085	
477	4.365	0.91	0.523	0.085	
478	4.356	0.91	0.529	0.085	



24 HOUR STEP DRAWDOWN TEST
MARCH 29, 1999
RS715 RSA-95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA



24HOUR STEP DRAWDOWN TEST
MARCH 29, 1999
RS715 RSA-95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA

Pumping Well: RS715
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-95

Test Date: 3/29/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS846	RS717	RS579	RS848	
0.01	0		0.003	-0.013	0.018	**Step 1 25 gpm**
0.02	0	0	-0.004	-0.013	0.015	
0.03	0.095	0.009	0.006	-0.013	0.015	
0.03	-0.23		-0.01	-0.007	0.015	
0.04	0.104	0.025	-0.01	-0.004	0.015	
0.05	0.2	0.019	-0.01	-0.01	0.015	
0.06	0.314	0.028	-0.007	-0.01	0.015	
0.07	0.458	0.041	-0.01	-0.01	0.018	
0.08	0.486	0.034	-0.007	-0.01	0.012	
0.08	0.563	0.053	0.006	-0.007	0.018	
0.09	0.648	0.066	-0.01	-0.004	0.015	
0.1	0.753	0.076	-0.007	-0.01	0.012	
0.2	1.364	0.215	0.003	-0.004	0.022	
0.3	1.918	0.345	-0.004	0.003	0.031	
0.4	2.156	0.456	-0.007	0.009	0.041	
0.5	2.509	0.532	0	0.022	0.056	
0.6	2.709	0.608	0.003	0.025	0.069	
0.7	2.852	0.665	0	0.037	0.079	
0.8	2.824	0.687	-0.004	0.041	0.088	
0.9	2.824	0.693	-0.004	0.053	0.091	
1	2.786	0.699	-0.004	0.06	0.104	
1.2	2.833	0.696	0	0.06	0.11	
1.4	2.843	0.702	0.006	0.072	0.116	
1.6	2.795	0.706	-0.004	0.088	0.126	
1.8	2.871	0.718	0	0.091	0.135	
2	2.824	0.718	-0.004	0.101	0.145	
3	2.919	0.75	-0.004	0.145	0.192	
4	2.938	0.763	0.003	0.164	0.211	
5	2.948	0.778	-0.004	0.186	0.233	
6	2.929	0.788	0.006	0.195	0.24	
7	2.881	0.797	0.006	0.208	0.252	
8	2.948	0.804	0.009	0.214	0.265	
9	2.967	0.813	0.006	0.224	0.265	
10	2.957	0.807	0.009	0.227	0.271	
11	2.976	0.813	0.009	0.23	0.271	
12	2.91	0.835	0.015	0.233	0.284	
13	2.871	0.81	0.015	0.233	0.281	
14	2.89	0.804	0.018	0.233	0.281	
15	2.89	0.81	0.012	0.24	0.287	
16	2.938	0.816	0.018	0.243	0.287	
17	2.976	0.823	0.025	0.246	0.303	
18	3.005	0.826	0.018	0.249	0.303	
19	2.91	0.826	0.028	0.259	0.313	
20	2.967	0.829	0.034	0.259	0.313	
30	2.929	0.835	0.056	0.271	0.319	
40	2.824	0.845	0.078	0.284	0.331	

Pumping Well: RS715
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-95

Test Date: 3/29/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS846	RS717	RS579	RS848
50	2.881	0.845	0.093	0.297	0.357
60	2.89	0.839	0.109	0.3	0.357
70	2.919	0.845	0.118	0.297	0.36
80	2.881	0.851	0.131	0.303	0.363
90	2.91	0.848	0.14	0.312	0.363
100	2.938	0.851	0.153	0.315	0.369
110	2.881	0.848	0.15	0.312	0.363
120	2.957	0.854	0.153	0.309	0.36
130	2.881	0.854	0.165	0.312	0.369
140	2.938	0.87	0.175	0.325	0.373
150	2.9	0.842	0.162	0.274	0.319
160	2.881	0.873	0.181	0.325	0.369
170	2.852	0.839	0.172	0.284	0.328
180	2.852	0.845	0.175	0.3	0.357
190	2.89	0.848	0.178	0.293	0.354
200	2.852	0.854	0.184	0.309	0.366
210	2.89	0.861	0.187	0.319	0.376
220	2.9	0.864	0.187	0.319	0.373
230	2.89	0.867	0.193	0.322	0.376
240	2.9	0.873	0.2	0.325	0.382
250	2.91	0.877	0.209	0.341	0.395
260	2.938	0.877	0.212	0.338	0.388
270	2.91	0.883	0.212	0.344	0.398
280	2.948	0.88	0.212	0.334	0.395
290	2.738	0.877	0.219	0.338	0.388
300	2.9	0.873	0.219	0.328	0.388
310	2.871	0.883	0.228	0.347	0.404
350	2.948	0.889	0.234	0.344	0.401
400	2.929	0.889	0.25	0.353	0.411
450	2.986	0.921	0.262	0.369	0.426
486	3.014	0.934	0.275	0.376	0.433

Pumping Well: RS715
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-95

Test Date: 3/29/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS846	RS717	RS579	RS848	
486.02	3.024	0.937	0.275	0.376	0.429	**Step 2 39 gpm**
486.03	3.072	0.937	0.275	0.372	0.429	
486.03	3.072	0.934	0.278	0.376	0.433	
486.04	3.234	0.937	0.275	0.376	0.426	
486.05	3.129	0.934	0.275	0.376	0.433	
486.06	3.196	0.94	0.275	0.379	0.436	
486.07	3.367	0.943	0.269	0.372	0.429	
486.08	3.186	0.946	0.275	0.382	0.426	
486.08	3.253	0.949	0.275	0.379	0.429	
486.09	3.32	0.953	0.275	0.376	0.433	
486.1	3.339	0.953	0.272	0.369	0.426	
486.2	3.93	1.044	0.275	0.382	0.429	
486.3	4.178	1.136	0.269	0.382	0.426	
486.4	4.302	1.196	0.275	0.379	0.433	
486.5	4.435	1.247	0.275	0.382	0.439	
486.6	4.626	1.285	0.275	0.385	0.439	
486.7	4.702	1.317	0.275	0.391	0.442	
486.8	4.807	1.348	0.275	0.388	0.445	
486.9	4.883	1.371	0.281	0.394	0.452	
487	4.931	1.386	0.272	0.404	0.455	
487.2	5.007	1.418	0.275	0.404	0.467	
487.4	5.131	1.443	0.272	0.41	0.471	
487.6	5.207	1.456	0.272	0.413	0.474	
487.8	5.245	1.481	0.272	0.429	0.48	
488	5.312	1.491	0.275	0.423	0.483	
489	5.426	1.532	0.275	0.442	0.502	
490	5.455	1.538	0.278	0.455	0.521	
491	5.474	1.545	0.278	0.467	0.528	
492	5.446	1.551	0.281	0.473	0.531	
493	5.531	1.56	0.278	0.48	0.537	
494	5.455	1.557	0.281	0.48	0.54	
495	5.493	1.564	0.284	0.48	0.543	
496	5.474	1.564	0.284	0.486	0.55	
497	5.56	1.573	0.287	0.496	0.55	
498	5.522	1.573	0.287	0.496	0.553	
499	5.55	1.573	0.284	0.496	0.553	
500	5.55	1.576	0.29	0.496	0.559	
510	5.588	1.583	0.303	0.508	0.569	
520	5.55	1.589	0.312	0.511	0.572	
530	5.541	1.598	0.322	0.518	0.578	
540	5.608	1.602	0.331	0.518	0.584	
550	5.598	1.602	0.337	0.524	0.588	
560	5.522	1.605	0.35	0.524	0.594	
570	5.569	1.608	0.353	0.521	0.578	
580	5.579	1.605	0.362	0.537	0.588	
590	5.588	1.614	0.366	0.53	0.594	
600	5.627	1.611	0.375	0.537	0.6	
625	5.674	1.627	0.387	0.552	0.607	
650	5.617	1.633	0.397	0.549	0.613	
675	5.636	1.636	0.409	0.565	0.622	
700	5.646	1.646	0.422	0.568	0.626	
725	5.693	1.652	0.431	0.578	0.632	

Pumping Well: RS715
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-95

Test Date: 3/29/99
Redstone Arsenal
Project 772650

Elapsed Time	RS715	RS846	RS717	RS579	RS848
750	5.665	1.652	0.441	0.578	0.622
775	5.693	1.652	0.441	0.571	0.607
800	5.608	1.652	0.447	0.584	0.619
825	5.75	1.665	0.456	0.594	0.626
850	5.76	1.668	0.459	0.597	0.632
875	5.712	1.668	0.469	0.603	0.641
900	5.76	1.678	0.475	0.613	0.644
925	5.731	1.687	0.484	0.616	0.651
950	5.741	1.678	0.488	0.619	0.651
962	5.741	1.687	0.494	0.616	0.648
963	5.741	1.681	0.491	0.619	0.644
964	5.77	1.681	0.497	0.619	0.644
965	5.741	1.684	0.491	0.616	0.641

Elapsed Time	RS847	RS720	RS578	RS683	
120.01	1.27	0.127	0.103	0.022	**Step 2 21 gpm**
120.02	1.27	0.124	0.106	0.022	
120.03	1.298	0.124	0.1	0.025	
120.03	1.298	0.121	0.103	0.022	
120.04	1.326	0.124	0.103	0.022	
120.05	1.364	0.121	0.106	0.022	
120.06	1.383	0.124	0.103	0.019	
120.07	1.393	0.127	0.106	0.019	
120.08	1.412	0.124	0.116	0.019	
120.08	1.421	0.124	0.119	0.022	
120.09	1.44	0.124	0.106	0.022	
120.1	1.44	0.124	0.106	0.022	
120.2	1.563	0.121	0.116	0.022	
120.3	1.696	0.124	0.134	0.022	
120.4	1.753	0.127	0.141	0.019	
120.5	1.743	0.127	0.141	0.019	
120.6	1.762	0.124	0.15	0.022	
120.7	1.753	0.127	0.147	0.022	
120.8	1.715	0.124	0.156	0.022	
120.9	1.724	0.136	0.175	0.025	
121	1.715	0.13	0.172	0.022	
122	1.791	0.133	0.178	0.022	
123	1.781	0.14	0.185	0.028	
124	1.791	0.14	0.178	0.028	
125	1.772	0.146	0.194	0.025	
126	1.781	0.146	0.191	0.022	
127	1.762	0.143	0.181	0.019	
128	1.753	0.152	0.194	0.022	
129	1.753	0.155	0.188	0.019	
130	1.753	0.165	0.197	0.028	
140	1.753	0.184	0.206	0.028	
150	1.762	0.193	0.194	0.022	
160	1.535	0.206	0.191	0.031	
170	1.488	0.219	0.194	0.025	
180	1.497	0.225	0.178	0.025	
190	1.506	0.235	0.188	0.034	
200	1.478	0.254	0.191	0.034	
210	1.478	0.257	0.194	0.034	
219	1.478	0.26	0.194	0.041	
220	1.478	0.273	0.194	0.038	
221	1.478	0.276	0.2	0.038	
222	1.488	0.273	0.188	0.031	
223	1.497	0.266	0.197	0.019	
224	1.497	0.276	0.21	0.038	

Pumping Well: RS847
Drawdown in Feet
Test Date: 3/16/99

STEP-DRAWDOWN TEST
RSA-95

Redstone Arsenal
Huntsville Alabama

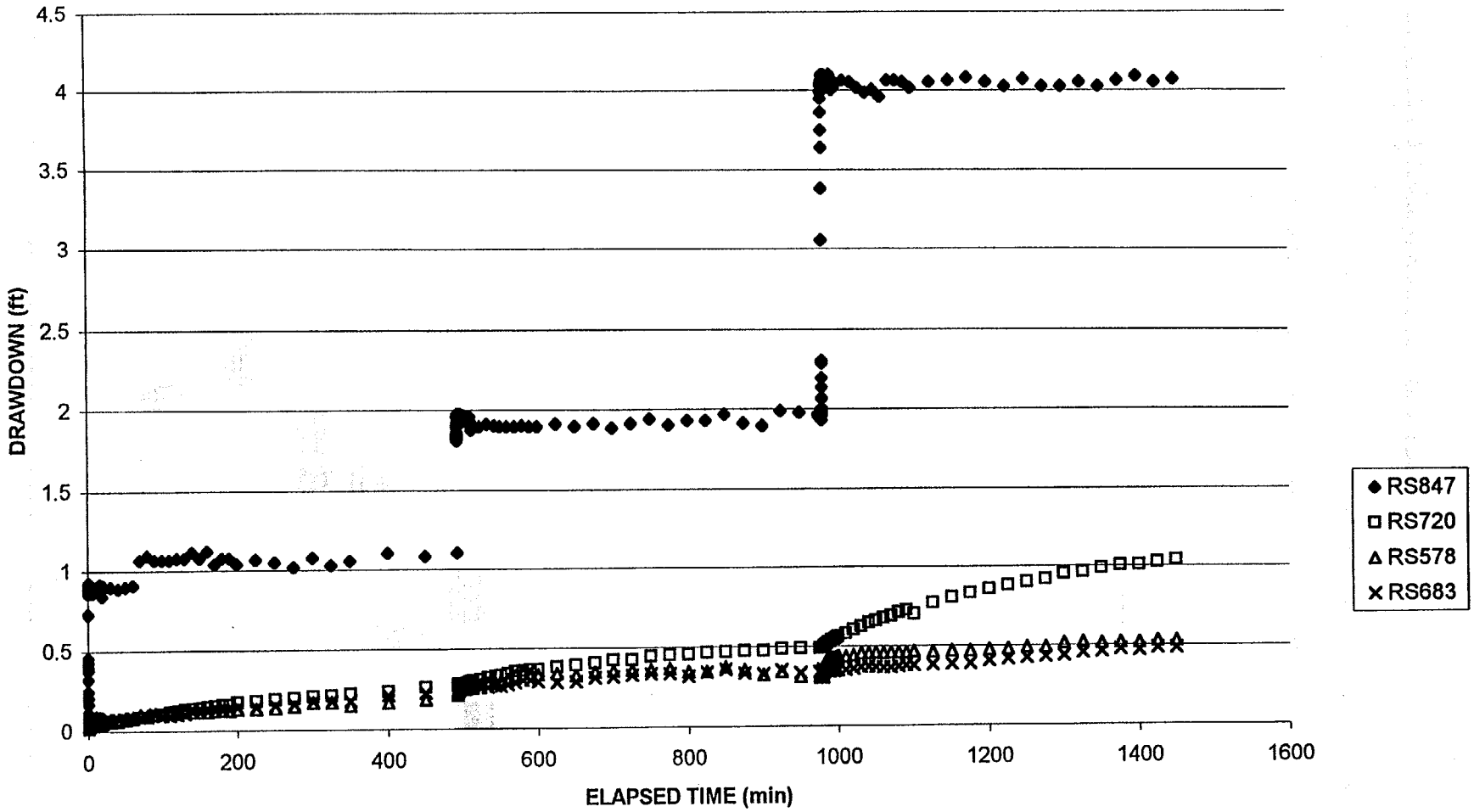
Elapsed Time	RS847	RS720	RS578	RS683	
224.01	1.506	0.273	0.194	0.044	**Step 3 36 gpm**
224.02	1.554	0.273	0.197	0.044	
224.03	1.544	0.273	0.191	0.044	
224.03	1.592	0.273	0.191	0.044	
224.04	1.611	0.273	0.197	0.044	
224.05	1.639	0.273	0.197	0.044	
224.06	1.696	0.273	0.194	0.044	
224.07	1.715	0.273	0.191	0.044	
224.08	1.753	0.273	0.188	0.047	
224.08	1.8	0.273	0.185	0.044	
224.09	1.866	0.273	0.191	0.044	
224.1	1.914	0.279	0.191	0.044	
224.2	2.312	0.273	0.194	0.044	
224.3	2.473	0.273	0.2	0.044	
224.4	2.567	0.276	0.2	0.044	
224.5	2.643	0.27	0.213	0.044	
224.6	2.69	0.273	0.225	0.041	
224.7	2.728	0.273	0.228	0.044	
224.8	2.757	0.276	0.225	0.041	
224.9	2.785	0.27	0.235	0.044	
225	2.794	0.282	0.25	0.044	
226	2.728	0.285	0.253	0.031	
227	2.719	0.276	0.269	0.038	
228	2.719	0.292	0.275	0.038	
229	2.7	0.295	0.288	0.038	
230	2.7	0.295	0.294	0.034	
231	2.709	0.292	0.282	0.041	
232	2.69	0.285	0.266	0.031	
233	2.719	0.301	0.282	0.034	
234	2.719	0.308	0.304	0.047	
235	2.709	0.305	0.3	0.044	
245	2.681	0.336	0.294	0.038	
255	2.643	0.349	0.316	0.041	
265	2.662	0.355	0.291	0.038	
275	2.662	0.384	0.3	0.028	
285	2.662	0.397	0.313	0.041	
295	2.662	0.422	0.319	0.038	
305	2.643	0.444	0.316	0.044	
315	2.643	0.447	0.338	0.053	
325	2.662	0.466	0.329	0.057	
335	2.652	0.479	0.335	0.053	
343	2.652	0.492	0.322	0.044	

Pumping Well: RS847
Drawdown in Feet
Test Date: 3/16/99

STEP-DRAWDOWN TEST
RSA-95

Redstone Arsenal
Huntsville Alabama

Elapsed Time	RS847	RS720	RS578	RS683	
343.01	2.652	0.492	0.326	0.05	**Step 4 70 gpm**
343.02	2.794	0.495	0.329	0.047	
343.03	2.823	0.495	0.332	0.05	
343.03	2.842	0.492	0.322	0.047	
343.04	2.861	0.495	0.322	0.05	
343.05	2.918	0.495	0.319	0.05	
343.06	2.984	0.492	0.319	0.05	
343.07	3.05	0.495	0.338	0.05	
343.08	3.126	0.495	0.338	0.05	
343.10	3.325	0.495	0.332	0.053	
343.12	3.448	0.495	0.326	0.05	
343.14	3.609	0.495	0.326	0.057	
343.16	3.713	0.495	0.335	0.053	
343.18	3.789	0.498	0.332	0.053	
343.2	3.912	0.498	0.335	0.053	
343.3	4.252	0.498	0.347	0.057	
343.4	4.48	0.501	0.354	0.053	
343.5	4.603	0.501	0.36	0.057	
343.6	4.688	0.504	0.366	0.057	
343.7	4.754	0.504	0.388	0.057	
343.8	4.782	0.508	0.385	0.057	
343.9	4.811	0.508	0.401	0.06	
344	4.811	0.511	0.401	0.063	
345	4.782	0.517	0.419	0.063	
346	4.735	0.523	0.441	0.063	
347	4.707	0.527	0.448	0.063	
348	4.688	0.539	0.438	0.063	
349	4.659	0.539	0.463	0.063	
350	4.678	0.546	0.466	0.057	
351	4.584	0.552	0.445	0.05	
352	4.574	0.552	0.445	0.047	
353	4.565	0.561	0.46	0.047	
363	4.432	0.606	0.466	0.063	
373	4.423	0.641	0.466	0.06	
383	4.47	0.676	0.495	0.072	
393	4.375	0.72	0.495	0.072	
403	4.366	0.745	0.498	0.063	
413	4.394	0.761	0.498	0.069	
423	4.375	0.799	0.51	0.079	
433	4.394	0.818	0.517	0.069	
443	4.413	0.841	0.507	0.082	
453	4.347	0.863	0.51	0.079	
463	4.423	0.882	0.526	0.076	
473	4.375	0.901	0.513	0.079	
474	4.357	0.901	0.523	0.079	
475	4.357	0.904	0.538	0.082	
476	4.366	0.907	0.538	0.085	
477	4.375	0.91	0.523	0.085	
478	4.366	0.91	0.529	0.085	



24 HOUR STEP-DRAWDOWN TEST
MARCH 29, 1999
RS847 RSA-95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA

Pumping Well: RS847
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-95

Test date: 3/29/90
Redstone Arsenal
Project 772650

Elapsed Time (min)	RS847	RS720	RS578	RS683	
0.01	0.018	0.025	0.025	0.053	***Step 1 30 gpm***
0.02	0.094	0.025	0.028	0.056	
0.03	0.207	0.025	0.031	0.053	
0.03	0.113	0.025	0.021	0.053	
0.04	0.17	0.034	0.031	0.056	
0.05	0.207	0.028	0.028	0.053	
0.06	0.245	0.025	0.034	0.053	
0.07	0.321	0.022	0.028	0.053	
0.08	0.378	0.031	0.028	0.056	
0.08	0.397	0.034	0.031	0.053	
0.09	0.425	0.031	0.025	0.053	
0.10	0.453	0.025	0.018	0.053	
0.20	0.727	0.031	0.034	0.053	
0.30	0.86	0.038	0.028	0.056	
0.40	0.888	0.028	0.028	0.056	
0.50	0.888	0.038	0.043	0.053	
0.60	0.869	0.038	0.037	0.056	
0.70	0.888	0.034	0.046	0.053	
0.80	0.926	0.034	0.05	0.053	
0.90	0.897	0.034	0.046	0.053	
1	0.897	0.025	0.043	0.05	
1.2	0.879	0.034	0.056	0.053	
1.4	0.926	0.034	0.059	0.056	
1.6	0.888	0.028	0.062	0.05	
1.8	0.869	0.038	0.059	0.056	
2	0.897	0.028	0.065	0.056	
3	0.869	0.031	0.059	0.056	
4	0.897	0.038	0.072	0.06	
5	0.907	0.038	0.068	0.056	
6	0.86	0.031	0.068	0.066	
7	0.879	0.031	0.068	0.063	
8	0.879	0.041	0.068	0.06	
9	0.897	0.044	0.078	0.066	
10	0.897	0.034	0.09	0.066	
11	0.879	0.044	0.09	0.069	
12	0.897	0.034	0.075	0.069	
13	0.869	0.038	0.081	0.063	
14	0.907	0.047	0.078	0.066	
15	0.888	0.034	0.087	0.066	
16	0.916	0.047	0.084	0.066	
17	0.897	0.05	0.084	0.066	
18	0.879	0.047	0.078	0.066	
19	0.841	0.041	0.081	0.06	
20	0.907	0.044	0.081	0.066	
30	0.897	0.057	0.072	0.063	
40	0.888	0.06	0.075	0.072	

Pumping Well: RS847
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-95

Test date: 3/29/90
Redstone Arsenal
Project 772650

Elapsed Time (min)	RS847	RS720	RS578	RS683
50	0.897	0.066	0.084	0.075
60	0.907	0.072	0.087	0.078
70	1.068	0.088	0.1	0.085
80	1.096	0.088	0.097	0.088
90	1.068	0.098	0.106	0.104
100	1.068	0.104	0.103	0.094
110	1.068	0.117	0.109	0.094
120	1.077	0.12	0.106	0.101
130	1.077	0.13	0.118	0.104
140	1.115	0.136	0.115	0.113
150	1.077	0.139	0.115	0.113
160	1.124	0.145	0.115	0.12
170	1.039	0.152	0.122	0.126
180	1.077	0.161	0.125	0.129
190	1.077	0.161	0.122	0.132
200	1.039	0.174	0.131	0.142
225	1.068	0.18	0.131	0.142
250	1.049	0.19	0.134	0.151
275	1.02	0.196	0.144	0.161
300	1.077	0.209	0.169	0.176
325	1.03	0.212	0.169	0.176
350	1.058	0.222	0.15	0.176
400	1.105	0.234	0.165	0.211
450	1.086	0.26	0.184	0.224
493	1.105	0.266	0.209	0.246

Elapsed Time (min)	RS847	RS720	RS578	RS683	
493.01	1.833	0.272	0.222	0.246	***Step 2 47 gpm***
493.02	1.814	0.269	0.216	0.243	
493.03	1.805	0.269	0.219	0.246	
493.03	1.824	0.269	0.222	0.246	
493.04	1.842	0.269	0.225	0.246	
493.05	1.861	0.269	0.216	0.246	
493.06	1.861	0.272	0.219	0.246	
493.07	1.89	0.269	0.225	0.246	
493.08	1.899	0.269	0.225	0.246	
493.08	1.89	0.269	0.219	0.246	
493.09	1.89	0.269	0.219	0.246	
493.1	1.899	0.269	0.228	0.246	
493.2	1.956	0.269	0.231	0.246	
493.3	1.956	0.269	0.228	0.246	
493.4	1.975	0.275	0.228	0.246	
493.5	1.918	0.275	0.231	0.246	
493.6	1.909	0.272	0.237	0.243	
493.7	1.918	0.269	0.237	0.243	
493.8	1.918	0.272	0.234	0.236	
493.9	1.927	0.279	0.237	0.243	
494	1.956	0.279	0.241	0.243	
494.2	1.899	0.275	0.237	0.243	
494.4	1.956	0.275	0.241	0.243	
494.6	1.956	0.272	0.241	0.243	
494.8	1.956	0.272	0.244	0.24	
495	1.927	0.272	0.244	0.243	
496	1.975	0.272	0.247	0.243	
497	1.975	0.272	0.247	0.243	
498	1.946	0.275	0.25	0.243	
499	1.937	0.279	0.25	0.243	
500	1.937	0.279	0.256	0.243	
501	1.937	0.282	0.259	0.243	
502	1.965	0.282	0.253	0.243	
503	1.927	0.282	0.25	0.243	
504	1.927	0.282	0.253	0.246	
505	1.956	0.285	0.256	0.249	
506	1.927	0.288	0.256	0.249	
507	1.937	0.288	0.256	0.249	
508	1.937	0.291	0.256	0.249	
509	1.937	0.291	0.259	0.249	
510	1.956	0.294	0.259	0.249	
511	1.927	0.298	0.259	0.249	
512	1.871	0.294	0.262	0.249	
513	1.899	0.298	0.266	0.252	
523	1.89	0.304	0.272	0.255	
533	1.909	0.317	0.284	0.255	

Elapsed Time (min)	RS847	RS720	RS578	RS683
543	1.899	0.329	0.281	0.265
550	1.89	0.333	0.294	0.265
560	1.89	0.342	0.306	0.274
570	1.89	0.358	0.331	0.284
580	1.899	0.361	0.344	0.3
590	1.89	0.367	0.341	0.3
600	1.89	0.367	0.334	0.29
625	1.909	0.38	0.338	0.284
650	1.89	0.393	0.325	0.287
675	1.909	0.405	0.347	0.312
700	1.88	0.424	0.353	0.315
725	1.909	0.424	0.356	0.325
750	1.937	0.444	0.356	0.331
775	1.899	0.45	0.363	0.331
800	1.927	0.453	0.344	0.315
825	1.927	0.463	0.344	0.341
850	1.965	0.469	0.369	0.357
875	1.909	0.475	0.353	0.331
900	1.89	0.475	0.322	0.325
925	1.984	0.485	0.338	0.35
950	1.975	0.488	0.309	0.334
975	1.965	0.488	0.309	0.338
976	1.946	0.491	0.303	0.334
977	1.956	0.488	0.306	0.338
978	1.956	0.491	0.309	0.338
979	1.927	0.491	0.309	0.341
980	1.956	0.497	0.309	0.344

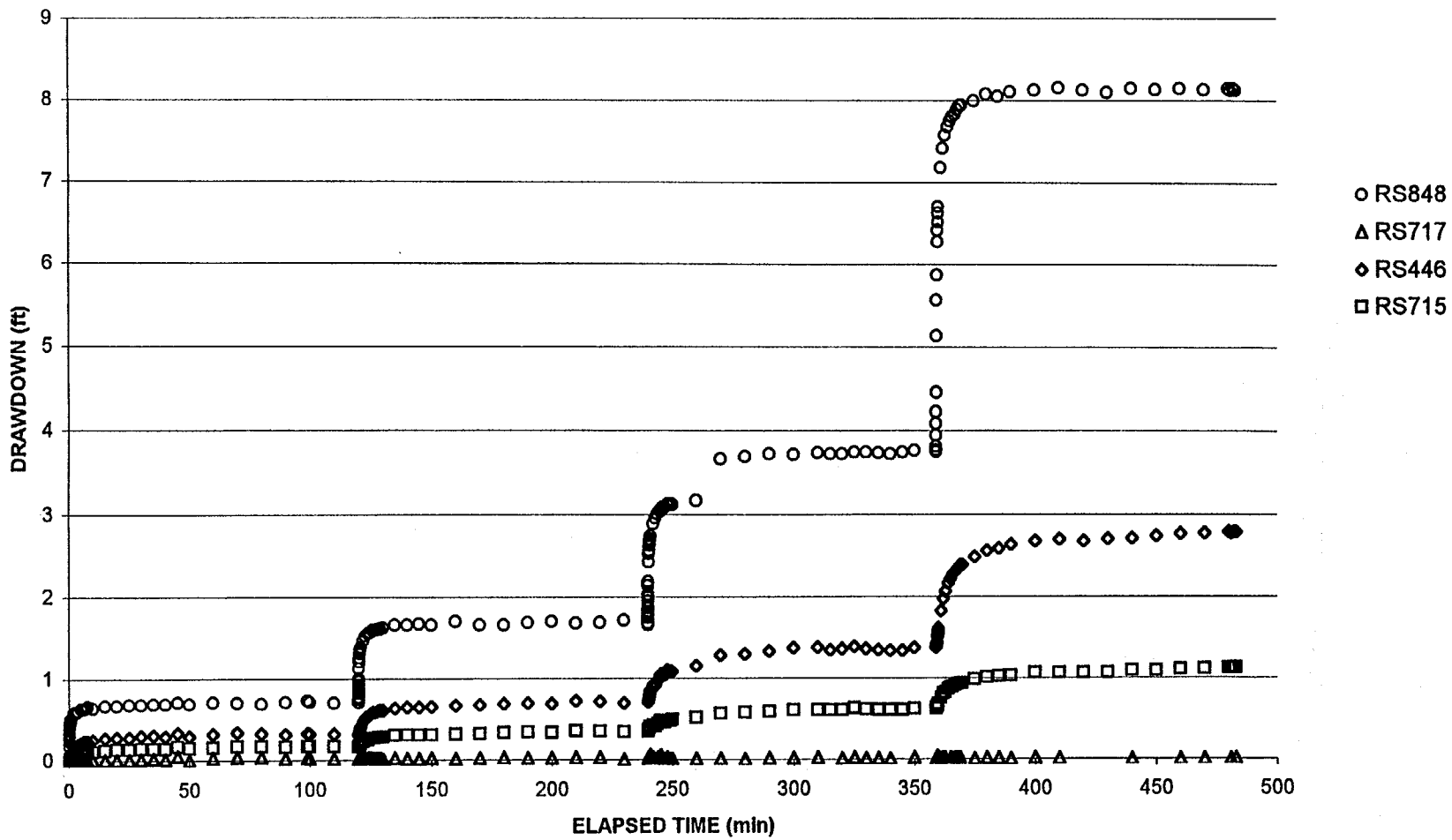
Elapsed Time (min)	RS847	RS720	RS578	RS683	
980.01	1.975	0.491	0.306	0.35	*Step 3 97 gpm*
980.02	1.994	0.494	0.306	0.35	
980.03	1.965	0.494	0.306	0.347	
980.03	1.984	0.491	0.309	0.347	
980.04	2.003	0.491	0.303	0.353	
980.05	2.06	0.491	0.303	0.347	
980.06	2.069	0.494	0.309	0.344	
980.07	2.06	0.491	0.313	0.341	
980.08	2.135	0.491	0.306	0.344	
980.08	2.192	0.494	0.306	0.347	
980.09	2.286	0.488	0.306	0.341	
980.1	2.305	0.494	0.309	0.347	
980.2	3.052	0.494	0.313	0.35	
980.3	3.382	0.497	0.316	0.347	
980.4	3.637	0.497	0.331	0.344	
980.5	3.75	0.497	0.334	0.338	
980.6	3.864	0.497	0.344	0.344	
980.7	3.949	0.501	0.347	0.338	
980.8	3.987	0.501	0.35	0.344	
980.9	3.996	0.504	0.356	0.341	
981	4.034	0.497	0.366	0.344	
981.2	4.053	0.501	0.369	0.341	
981.4	4.062	0.501	0.372	0.338	
981.6	4.034	0.501	0.381	0.331	
981.8	4.005	0.507	0.385	0.338	
982	4.024	0.501	0.385	0.338	
982.2	4.034	0.507	0.388	0.338	
982.4	4.1	0.507	0.388	0.338	
982.6	4.072	0.507	0.397	0.338	
982.8	4.024	0.51	0.397	0.344	
983	4.081	0.51	0.403	0.344	
984	4.072	0.513	0.406	0.338	
985	4.1	0.516	0.41	0.338	
986	4.062	0.52	0.413	0.341	
987	4.043	0.526	0.419	0.344	
988	4.034	0.526	0.422	0.344	
989	4.034	0.526	0.422	0.338	
990	4.043	0.529	0.425	0.347	
991	4.015	0.539	0.428	0.347	
992	4.1	0.539	0.428	0.35	
993	4.043	0.539	0.422	0.347	
994	4.024	0.542	0.425	0.341	
995	4.024	0.548	0.425	0.344	
996	4.005	0.548	0.428	0.35	
997	4.062	0.551	0.428	0.347	
998	4.015	0.554	0.432	0.347	

Pumping Well: RS847
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-95

Test date: 3/29/90
Redstone Arsenal
Project 772650

Elapsed Time (min)	RS847	RS720	RS578	RS683
999	4.024	0.558	0.432	0.353
1000	4.043	0.561	0.435	0.35
1010	4.062	0.58	0.432	0.35
1020	4.053	0.602	0.441	0.357
1030	4.015	0.624	0.453	0.366
1040	3.987	0.643	0.453	0.369
1050	4.005	0.659	0.457	0.366
1060	3.958	0.675	0.453	0.363
1070	4.062	0.688	0.457	0.363
1080	4.062	0.71	0.457	0.372
1090	4.053	0.723	0.457	0.376
1100	4.015	0.7	0.463	0.376
1125	4.053	0.77	0.46	0.382
1150	4.062	0.802	0.466	0.385
1175	4.081	0.83	0.469	0.388
1200	4.053	0.856	0.475	0.404
1225	4.024	0.881	0.478	0.417
1250	4.072	0.9	0.488	0.423
1275	4.024	0.919	0.488	0.429
1300	4.024	0.951	0.513	0.436
1325	4.053	0.964	0.519	0.454
1350	4.024	0.986	0.513	0.461
1375	4.062	1.005	0.516	0.473
1400	4.09	1.008	0.516	0.467
1425	4.053	1.027	0.525	0.48
1450	4.072	1.04	0.525	0.483



STEP DRAWDOWN
MARCH 11, 1999
RS848 RSA -95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA

Pumping Well: RS848
Drawdown in Feet
Test Date 3/11/98

STEP-DRAWDOWN TEST
RSA-95

Redstone Arsenal
Huntsville Alabama
Project 772650

Elapse Time	RS848	RS717	RS446	RS715	
0.03	0.189	0.012	0.003	0	**Step 1 10 gpm**
0.04	0.283	0.009	0.003	0	
0.06	0.236	0.009	0.003	0	
0.08	0.255	0.012	0.006	0	
0.09	0.293	0.009	0.006	0	
0.10	0.293	0.009	0.006	0	
0.12	0.302	0.012	0.006	0	
0.14	0.321	0.006	0.012	0	
0.18	0.331	0.006	0.018	0	
0.20	0.368	0.009	0.025	0	
0.30	0.397	0.006	0.04	0.003	
0.40	0.425	0.003	0.05	0.006	
0.50	0.435	0.003	0.059	0.012	
0.60	0.472	0	0.068	0.015	
0.70	0.482	0.003	0.075	0.018	
0.80	0.501	0	0.084	0.025	
0.90	0.51	-0.003	0.09	0.028	
1.00	0.51	0	0.1	0.031	
2.00	0.586	0.003	0.15	0.056	
3.00	0.586	0.009	0.181	0.072	
4.00	0.605	0.009	0.203	0.082	
5.00	0.633	0.015	0.215	0.088	
6.00	0.624	0.015	0.228	0.094	
7.00	0.643	0.012	0.234	0.094	
8.00	0.662	0.009	0.237	0.097	
10.00	0.643	0.009	0.25	0.107	
15.00	0.671	0.009	0.269	0.12	
20.00	0.671	0.009	0.281	0.129	
25.00	0.68	0.009	0.281	0.129	
30.00	0.68	0.015	0.297	0.139	
35.00	0.69	0.019	0.303	0.142	
40.00	0.69	0.012	0.29	0.139	
45.00	0.709	0.047	0.337	0.167	
50.00	0.69	0	0.294	0.148	
60.00	0.709	0.031	0.319	0.154	
70.00	0.699	0.034	0.344	0.164	
80.00	0.69	0.034	0.328	0.17	
90.00	0.709	0.019	0.312	0.157	
99.00	0.728	0.028	0.328	0.167	
100.00	0.709	0.022	0.322	0.167	
110.00	0.699	0.022	0.322	0.167	
120.00	0.709	0.012	0.306	0.161	

Pumping Well: RS848
Drawdown in Feet
Test Date 3/11/98

STEP-DRAWDOWN TEST
RSA-95

Redstone Arsenal
Huntsville Alabama
Project 772650

Elapse Time	RS848	RS717	RS446	RS715	
120.01	0.70	0.01	0.31	0.16	**Step 2 20 gpm**
120.02	0.87	0.02	0.31	0.16	
120.03	0.75	0.01	0.31	0.16	
120.03	0.78	0.02	0.31	0.17	
120.04	0.82	0.02	0.31	0.16	
120.05	0.86	0.01	0.31	0.16	
120.06	0.88	0.02	0.31	0.16	
120.07	0.91	0.02	0.31	0.16	
120.08	0.93	0.02	0.31	0.16	
120.09	0.96	0.02	0.32	0.16	
120.10	1.00	0.02	0.31	0.16	
120.20	1.13	0.02	0.33	0.16	
120.30	1.21	0.02	0.34	0.17	
120.40	1.26	0.01	0.35	0.17	
120.50	1.31	0.02	0.37	0.18	
120.60	1.32	0.01	0.38	0.18	
120.70	1.35	0.01	0.39	0.19	
120.80	1.36	0.01	0.41	0.19	
120.90	1.38	0.01	0.42	0.20	
121.00	1.39	0.02	0.42	0.20	
122.00	1.47	0.03	0.48	0.22	
123.00	1.53	0.02	0.52	0.24	
124.00	1.56	0.03	0.54	0.25	
125.00	1.57	0.03	0.56	0.26	
126.00	1.60	0.02	0.59	0.27	
127.00	1.60	0.02	0.59	0.27	
128.00	1.61	0.02	0.60	0.27	
129.00	1.62	0.02	0.60	0.28	
130.00	1.63	0.01	0.61	0.28	
135.00	1.66	0.02	0.64	0.30	
140.00	1.66	0.01	0.65	0.31	
145.00	1.67	0.02	0.64	0.31	
150.00	1.66	0.02	0.65	0.31	
160.00	1.70	0.01	0.67	0.31	
170.00	1.66	0.02	0.68	0.32	
180.00	1.66	0.03	0.69	0.33	
190.00	1.69	0.02	0.70	0.34	
200.00	1.70	0.02	0.69	0.33	
210.00	1.68	0.03	0.72	0.35	
220.00	1.69	0.03	0.72	0.35	
230.00	1.72	0.00	0.70	0.34	
240.00	1.66	0.00	0.70	0.34	

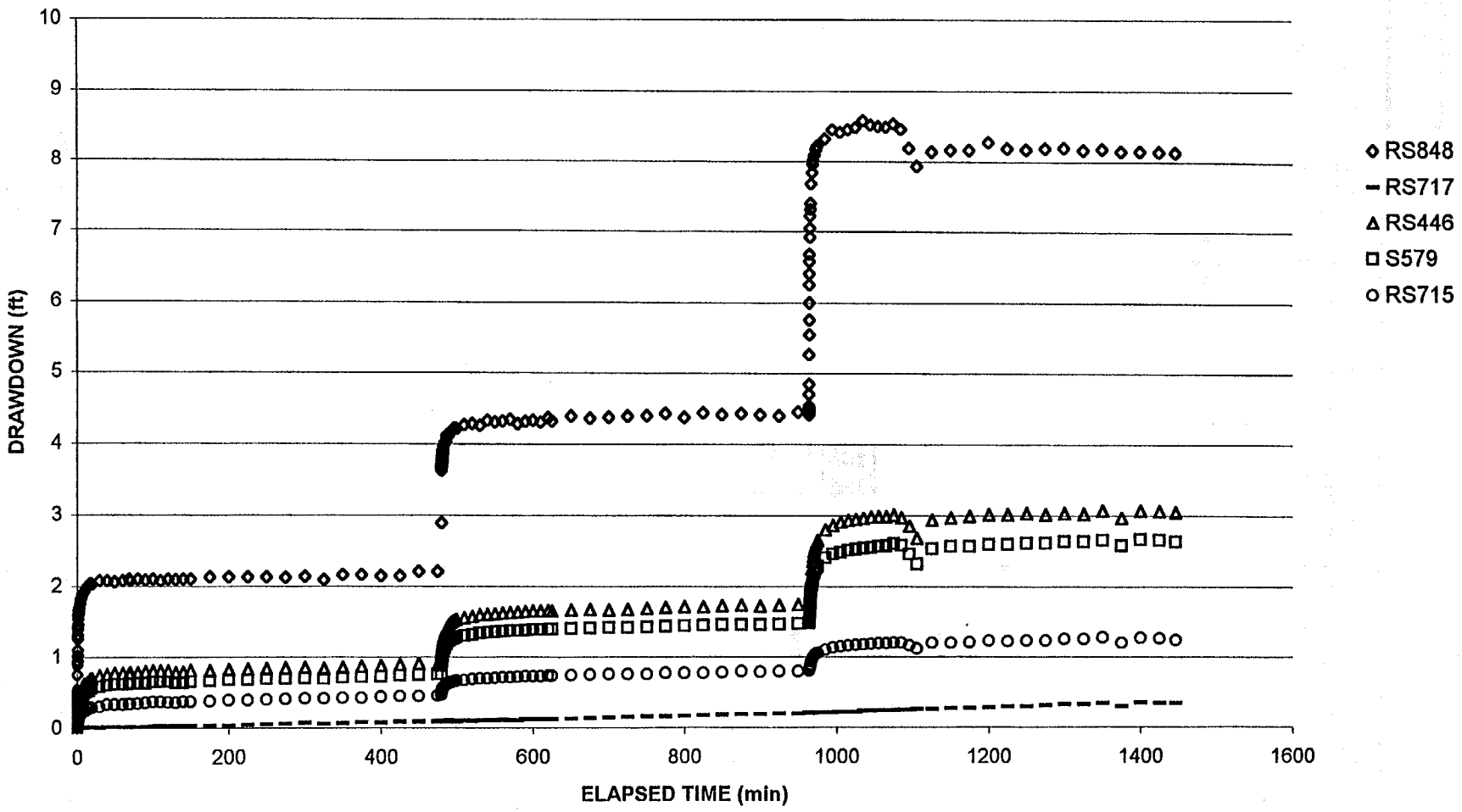
Pumping Well: RS848
Drawdown in Feet
Test Date 3/11/98

STEP-DRAWDOWN TEST
RSA-95

Redstone Arsenal
Huntsville Alabama
Project 772650

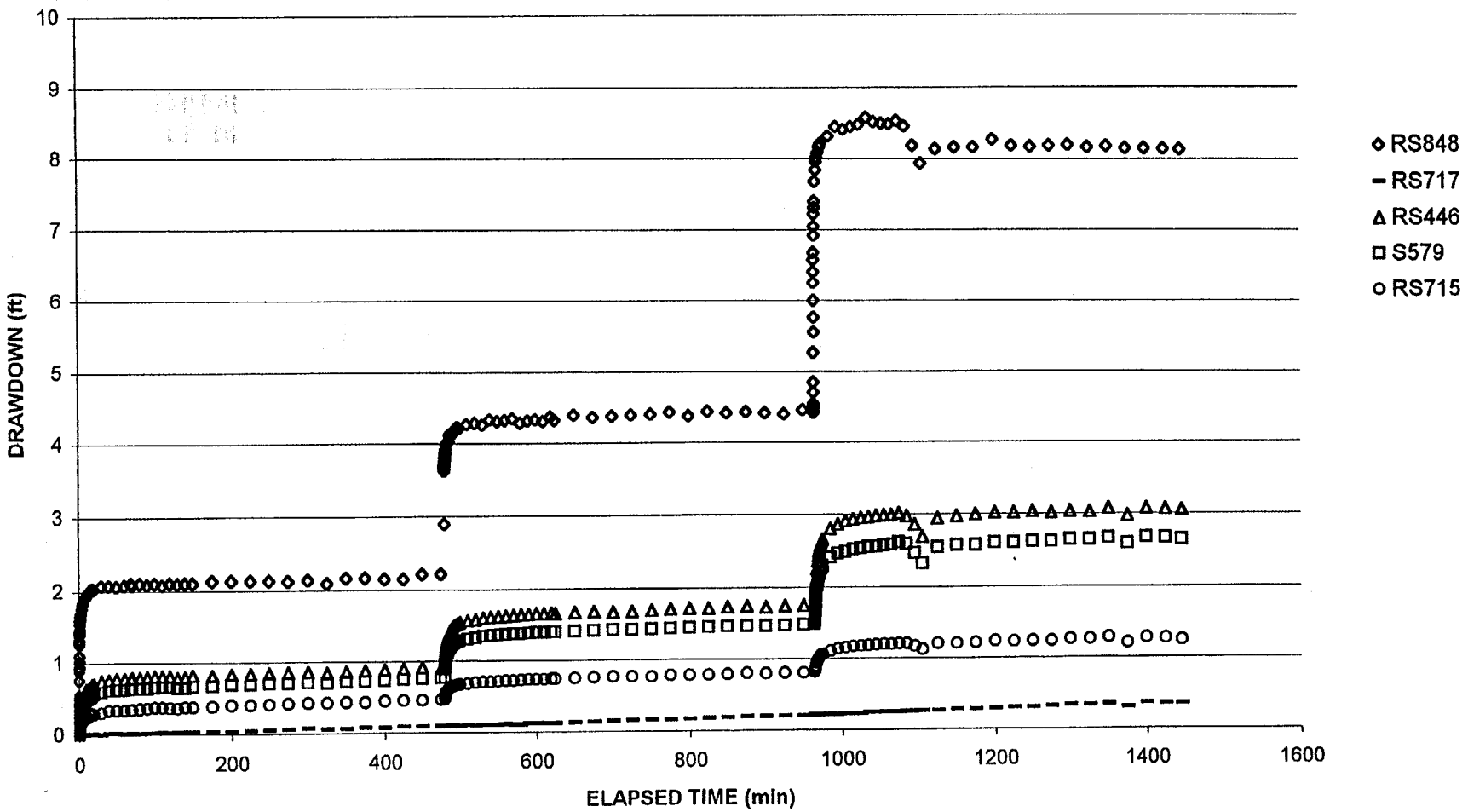
Elapse Time	RS848	RS717	RS446	RS715	
240.01	1.68	0.02	0.71	0.34	**Step 3 42 gpm**
240.02	1.75	0.01	0.71	0.34	
240.03	1.77	0.01	0.70	0.35	
240.03	1.82	0.01	0.71	0.35	
240.04	1.79	0.01	0.71	0.35	
240.05	1.87	0.02	0.71	0.35	
240.06	1.96	0.02	0.70	0.35	
240.07	2.00	0.02	0.71	0.35	
240.08	2.03	0.02	0.71	0.35	
240.09	2.14	0.02	0.71	0.35	
240.10	2.18	0.03	0.71	0.35	
240.20	2.42	0.02	0.72	0.36	
240.30	2.52	0.03	0.75	0.37	
240.40	2.56	0.03	0.77	0.38	
240.50	2.62	0.04	0.79	0.39	
240.60	2.65	0.04	0.81	0.39	
240.70	2.68	0.05	0.83	0.39	
240.80	2.70	0.05	0.84	0.40	
240.90	2.74	0.05	0.85	0.40	
241.00	2.74	0.03	0.85	0.40	
242.00	2.88	0.03	0.92	0.42	
243.00	2.96	0.00	0.91	0.40	
244.00	3.02	0.03	0.97	0.44	
245.00	3.04	0.04	1.03	0.47	
245.20	3.03	0.04	1.05	0.48	
245.40	3.06	0.05	1.06	0.47	
245.60	3.07	0.01	1.05	0.45	
245.80	3.08	0.02	1.05	0.45	
246.00	3.05	0.00	1.04	0.46	
247.00	3.09	0.01	1.04	0.46	
248.00	3.12	0.03	1.10	0.48	
249.00	3.12	0.01	1.09	0.48	
250.00	3.12	0.01	1.09	0.49	
260.00	3.17	0.01	1.16	0.51	
270.00	3.66	0.01	1.29	0.56	
280.00	3.69	0.00	1.30	0.57	
290.00	3.72	0.01	1.33	0.59	
300.00	3.72	0.02	1.38	0.61	
310.00	3.73	0.02	1.38	0.61	
315.00	3.72	-0.01	1.35	0.60	
320.00	3.72	0.01	1.36	0.60	
325.00	3.74	0.02	1.39	0.63	
330.00	3.74	0.01	1.36	0.61	
335.00	3.73	0.01	1.35	0.60	
340.00	3.72	0.00	1.35	0.61	
345.00	3.74	-0.01	1.35	0.61	
350.00	3.76	0.02	1.38	0.62	

Elapse Time	RS848	RS717	RS446	RS715	
359.00	3.75	0.00	1.38	0.62	
359.01	3.77	0.01	1.38	0.63	**Step 4 74 gpm**
359.02	3.81	0.01	1.38	0.63	
359.04	3.94	0.01	1.38	0.63	
359.06	4.08	0.01	1.39	0.63	
359.08	4.23	0.01	1.39	0.63	
359.10	4.45	0.02	1.38	0.63	
359.20	5.13	0.02	1.40	0.63	
359.30	5.57	0.01	1.42	0.63	
359.40	5.87	0.03	1.45	0.64	
359.60	6.27	0.03	1.51	0.65	
359.70	6.42	0.01	1.55	0.66	
359.80	6.51	0.02	1.56	0.67	
359.90	6.62	0.02	1.60	0.68	
360.00	6.70	0.02	1.62	0.68	
361.00	7.18	0.01	1.83	0.75	
362.00	7.42	0.02	1.97	0.81	
363.00	7.58	0.01	2.07	0.82	
364.00	7.68	-0.01	2.16	0.86	
365.00	7.75	0.02	2.22	0.88	
366.00	7.80	0.01	2.27	0.89	
367.00	7.82	0.01	2.31	0.91	
368.00	7.89	0.01	2.35	0.93	
369.00	7.94	0.02	2.38	0.94	
370.00	7.95	-0.01	2.39	0.94	
375.00	7.99	0.00	2.49	0.98	
380.00	8.08	0.02	2.56	1.01	
385.00	8.05	0.01	2.59	1.02	
390.00	8.11	0.00	2.64	1.03	
400.00	8.12	0.02	2.68	1.06	
410.00	8.15	0.01	2.70	1.07	
420.00	8.12	-0.02	2.68	1.06	
430.00	8.10	-0.01	2.71	1.06	
440.00	8.14	0.00	2.72	1.09	
450.00	8.13	-0.02	2.74	1.09	
460.00	8.14	0.00	2.77	1.11	
470.00	8.13	0.00	2.78	1.11	
480.00	8.14	-0.01	2.79	1.12	
481.00	8.12	0.00	2.78	1.12	
482.00	8.14	-0.01	2.79	1.12	
483.00	8.12	0.01	2.79	1.13	



24 HOUR STEP-DRAWDOWN TEST
MARCH 25, 1999
RS848 RSA-95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA



24 HOUR STEP-DRAWDOWN TEST
MARCH 25, 1999
RS848 RSA-95

REDSTONE ARSENAL
HUNTSVILLE ALABAMA

Pumping well: RS848
Drawdown in Feet

24 STEP DRAWDOWN TEST
RSA-95

Test Date 3/25/99
Redstone Arsenal
Project: 772650

Step 1 36 gpm

Elapsed Time	RS848	RS717	RS446	S579	RS715
0.01	0.094				
0.02	0.104				
0.03	0.17				
0.03	0.17				
0.04	0.237				
0.05	0.303				
0.06	0.35				
0.07	0.379				
0.08	0.436				
0.08	0.455				
0.09	0.493				
0.1	0.54				
0.2	0.758		0.028	0.003	
0.3	0.891		0.053	0.009	
0.4	0.948		0.087	0.022	0.006
0.5	1.024		0.097	0.041	0.015
0.6	1.1		0.118	0.05	0.025
0.7	1.261		0.14	0.063	0.025
0.8	1.318		0.159	0.078	0.041
0.9	1.394		0.181	0.094	0.05
1	1.432		0.209	0.113	0.06
1.2	1.47	0.003	0.241	0.148	0.075
1.4	1.545	0.009	0.278	0.18	0.098
1.6	1.602	0.012	0.3	0.202	0.101
1.8	1.612	0.015	0.319	0.221	0.113
2	1.659	0.012	0.338	0.243	0.12
3	1.697	0.003	0.422	0.312	0.167
4	1.763	0.006	0.469	0.363	0.18
5	1.82		0.525	0.398	0.208
6	1.839	0.009	0.554	0.429	0.218
7	1.896	0.006	0.576	0.442	0.218
8	1.906		0.594	0.461	0.237
9	1.925	0.003	0.601	0.483	0.24
10	1.934	0.015	0.635	0.511	0.265
12	1.982		0.632	0.505	0.25
14	1.991		0.657	0.521	0.278
16	2.029		0.666	0.53	0.278
18	2.038	0.012	0.698	0.556	0.291
20	2.029	0.009	0.704	0.565	0.287
30	2.076	0.003	0.745	0.59	0.303
40	2.076	0.012	0.763	0.609	0.332
50	2.067	0.012	0.773	0.622	0.332
60	2.076	0.009	0.773	0.619	0.332
69	2.105	0.009	0.776	0.631	0.338
70	2.076	0.012	0.785	0.635	0.344
80	2.105	0.009	0.782	0.635	0.348
90	2.086	0.019	0.798	0.638	0.36
100	2.105	0.025	0.807	0.654	0.37
110	2.076	0.028	0.81	0.657	0.37
120	2.105	0.022	0.81	0.657	0.363

Pumping well: RS848
Drawdown in Feet

24 STEP DRAWDOWN TEST
RSA-95

Test Date 3/25/99
Redstone Arsenal
Project: 772650

Elapsed Time	RS848	RS717	RS446	S579	RS715
130	2.095	0.028	0.785	0.644	0.357
140	2.105	0.028	0.795	0.647	0.37
150	2.105	0.028	0.817	0.66	0.373
175	2.133	0.034	0.807	0.669	0.382
200	2.133	0.034	0.82	0.679	0.392
225	2.133	0.038	0.829	0.679	0.395
250	2.133	0.044	0.835	0.698	0.405
275	2.124	0.057	0.848	0.695	0.411
300	2.143	0.069	0.854	0.707	0.417
325	2.095	0.057	0.835	0.701	0.42
350	2.162	0.063	0.851	0.714	0.424
375	2.162	0.076	0.87	0.72	0.43
400	2.152	0.066	0.876	0.733	0.439
425	2.152	0.082	0.895	0.748	0.449
450	2.209	0.082	0.904	0.755	0.452
475	2.209	0.085	0.895	0.758	0.458
480	2.892	0.085	0.907	0.764	0.462

Pumping well: RS848
Drawdown in Feet

24 STEP DRAWDOWN TEST
RSA-95

Test Date 3/25/99
Redstone Arsenal
Project: 772650

Elapsed Time	RS848	RS717	RS446	S579	RS715	
480.01	3.64	0.085	1.061	0.875	0.493	*Step 2 66 gpm*
480.02	3.621	0.085	1.055	0.875	0.49	
480.03	3.697	0.088	1.051	0.875	0.506	
480.03	3.669	0.085	1.064	0.878	0.496	
480.04	3.65	0.091	1.058	0.881	0.493	
480.05	3.64	0.088	1.061	0.881	0.499	
480.06	3.697	0.091	1.067	0.884	0.512	
480.07	3.688	0.082	1.07	0.881	0.509	
480.08	3.678	0.095	1.073	0.884	0.503	
480.08	3.697	0.088	1.073	0.884	0.503	
480.09	3.678	0.095	1.073	0.884	0.506	
480.1	3.688	0.091	1.076	0.884	0.515	
480.11	3.669	0.095	1.067	0.887	0.506	
480.2	3.716	0.095	1.092	0.897	0.512	
480.3	3.716	0.091	1.095	0.913	0.515	
480.5	3.754	0.088	1.12	0.932	0.522	
480.7	3.763	0.091	1.142	0.95	0.528	
480.9	3.811	0.085	1.164	0.966	0.537	
481	3.801	0.091	1.173	0.973	0.534	
481.2	3.849	0.091	1.189	0.992	0.541	
481.4	3.858	0.091	1.208	1.004	0.544	
481.6	3.896	0.091	1.22	1.02	0.556	
481.8	3.868	0.091	1.233	1.033	0.556	
482	3.925	0.091	1.249	1.042	0.566	
483	3.981	0.095	1.299	1.086	0.579	
484	4	0.088	1.346	1.121	0.594	
485	4.029	0.085	1.377	1.146	0.604	
486	4.038	0.095	1.383	1.168	0.61	
487	4.124	0.095	1.414	1.184	0.626	
488	4.095	0.095	1.433	1.2	0.629	
489	4.114	0.098	1.452	1.222	0.642	
490	4.124	0.095	1.465	1.225	0.636	
492	4.161	0.095	1.486	1.244	0.645	
494	4.18	0.091	1.505	1.26	0.651	
496	4.218	0.088	1.518	1.266	0.661	
498	4.218	0.095	1.53	1.279	0.661	
500	4.209	0.088	1.533	1.289	0.664	
510	4.266	0.104	1.558	1.304	0.677	
520	4.285	0.095	1.577	1.32	0.689	
530	4.256	0.101	1.596	1.342	0.699	
540	4.332	0.101	1.609	1.352	0.702	
550	4.304	0.098	1.615	1.355	0.705	
560	4.322	0.107	1.618	1.364	0.715	
570	4.341	0.104	1.627	1.371	0.715	
580	4.285	0.104	1.634	1.374	0.718	
590	4.313	0.117	1.646	1.38	0.727	
600	4.332	0.114	1.649	1.386	0.73	
610	4.304	0.12	1.649	1.386	0.727	
620	4.37	0.12	1.662	1.396	0.734	
625	4.322	0.117	1.656	1.393	0.734	

Pumping well: RS848
Drawdown in Feet

24 STEP DRAWDOWN TEST
RSA-95

Test Date 3/25/99
Redstone Arsenal
Project: 772650

Elapsed Time	RS848	RS717	RS446	S579	RS715
650	4.389	0.126	1.668	1.405	0.743
675	4.36	0.133	1.677	1.412	0.749
700	4.379	0.142	1.671	1.418	0.759
725	4.389	0.145	1.677	1.418	0.759
750	4.398	0.155	1.69	1.431	0.762
775	4.427	0.158	1.706	1.434	0.772
800	4.379	0.164	1.712	1.443	0.775
825	4.436	0.171	1.718	1.45	0.778
850	4.417	0.18	1.727	1.456	0.784
875	4.427	0.183	1.737	1.462	0.797
900	4.417	0.187	1.721	1.456	0.791
925	4.398	0.193	1.734	1.469	0.797
950	4.455	0.196	1.743	1.475	0.8
964	4.417	0.209	1.759	1.484	0.81

Pumping well: RS848
Drawdown in Feet

24 STEP DRAWDOWN TEST
RSA-95

Test Date 3/25/99
Redstone Arsenal
Project: 772650

Elapsed Time	RS848	RS717	RS446	S579	RS715	
964.01	4.465	0.206	1.759	1.484	0.813	***Step 3 93 gpm***
964.02	4.484	0.206	1.759	1.488	0.81	
964.03	4.465	0.206	1.759	1.488	0.813	
964.03	4.474	0.206	1.756	1.484	0.819	
964.04	4.446	0.206	1.759	1.488	0.81	
964.05	4.474	0.206	1.759	1.488	0.81	
964.06	4.455	0.206	1.759	1.488	0.81	
964.07	4.484	0.206	1.759	1.488	0.819	
964.08	4.484	0.206	1.759	1.488	0.813	
964.08	4.54	0.206	1.762	1.488	0.813	
964.09	4.521	0.206	1.759	1.488	0.819	
964.1	4.493	0.206	1.759	1.488	0.816	
964.15	4.701	0.206	1.759	1.488	0.816	
964.2	4.844	0.206	1.759	1.491	0.816	
964.3	5.26	0.206	1.765	1.497	0.825	
964.4	5.545	0.209	1.778	1.506	0.825	
964.5	5.753	0.209	1.793	1.516	0.825	
964.6	5.999	0.212	1.812	1.532	0.835	
964.7	6.255	0.209	1.831	1.551	0.838	
964.8	6.406	0.209	1.856	1.57	0.835	
964.9	6.577	0.209	1.881	1.589	0.841	
965	6.681	0.209	1.906	1.608	0.848	
965.2	6.918	0.206	1.953	1.645	0.867	
965.4	7.041	0.206	1.994	1.687	0.87	
965.6	7.221	0.206	2.034	1.721	0.886	
965.8	7.315	0.206	2.072	1.756	0.892	
966	7.4	0.202	2.109	1.788	0.895	
967	7.684	0.206	2.25	1.92	0.942	
968	7.845	0.206	2.357	2.015	0.971	
969	7.959	0.206	2.432	2.084	0.99	
970	8.025	0.206	2.494	2.138	1.003	
971	8.082	0.206	2.535	2.179	1.022	
972	8.091	0.209	2.576	2.214	1.037	
973	8.167	0.212	2.61	2.246	1.047	
974	8.158	0.209	2.632	2.268	1.05	
975	8.214	0.209	2.657	2.29	1.056	
985	8.319	0.206	2.798	2.403	1.101	
995	8.451	0.212	2.864	2.457	1.132	
1005	8.413	0.218	2.907	2.486	1.148	
1015	8.451	0.221	2.929	2.511	1.161	
1025	8.479	0.221	2.945	2.527	1.17	
1035	8.584	0.231	2.967	2.542	1.18	
1045	8.517	0.234	2.976	2.555	1.186	
1055	8.498	0.237	2.989	2.568	1.192	
1065	8.489	0.24	2.986	2.574	1.196	
1075	8.536	0.244	3.008	2.609	1.205	
1085	8.46	0.247	2.97	2.58	1.199	
1095	8.186	0.25	2.854	2.46	1.161	
1105	7.94	0.253	2.688	2.321	1.117	
1125	8.139	0.256	2.942	2.539	1.199	

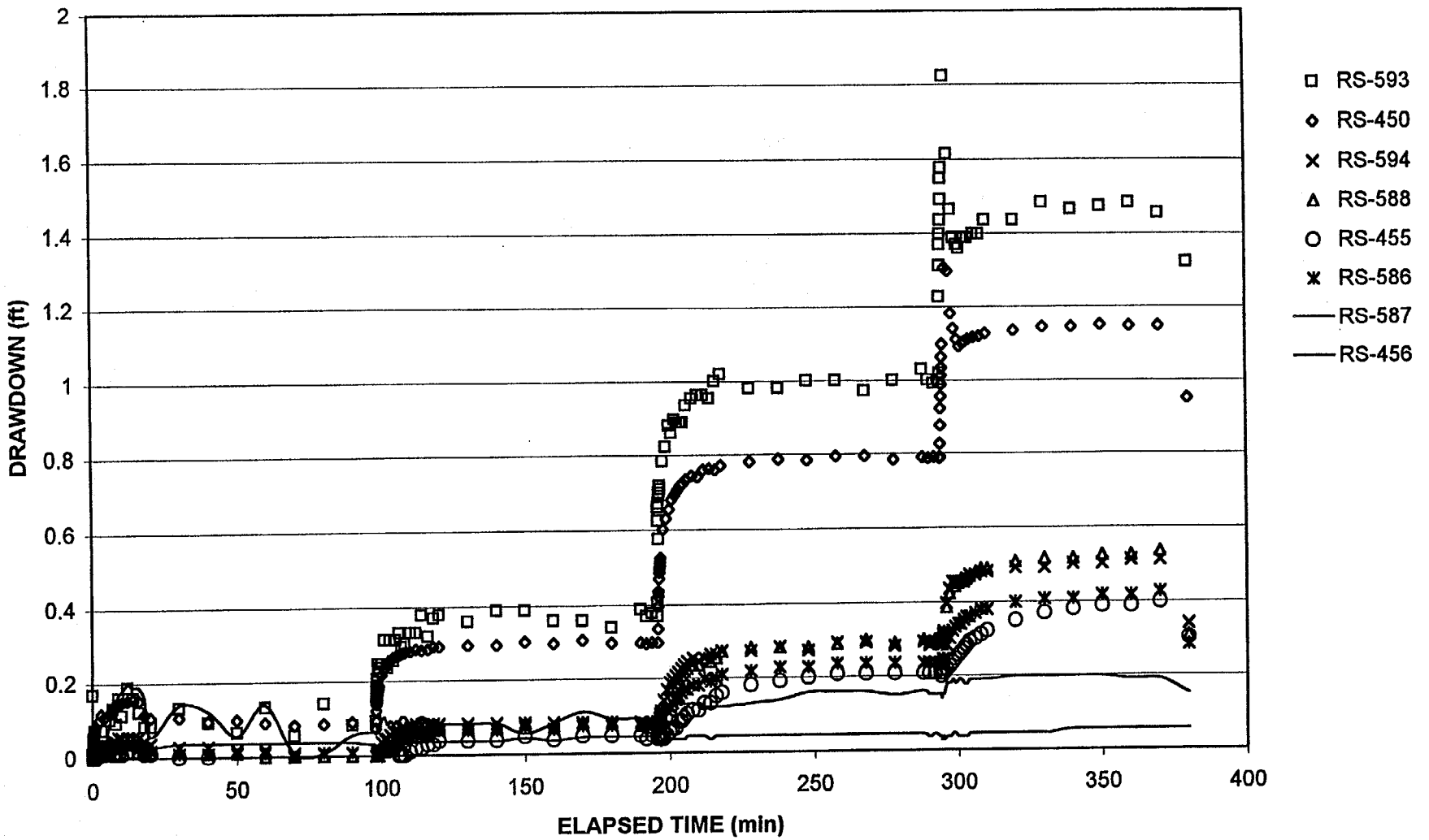
Pumping well: RS848
Drawdown in Feet

24 STEP DRAWDOWN TEST
RSA-95

Test Date 3/25/99
Redstone Arsenal
Project: 772650

Elapsed Time	RS848	RS717	RS446	S579	RS715
1150	8.158	0.272	2.97	2.568	1.205
1175	8.158	0.269	2.995	2.571	1.208
1200	8.271	0.282	3.017	2.596	1.234
1225	8.186	0.291	3.017	2.602	1.224
1250	8.167	0.298	3.033	2.615	1.237
1275	8.186	0.31	3.02	2.618	1.237
1300	8.195	0.326	3.033	2.637	1.259
1325	8.158	0.323	3.026	2.637	1.253
1350	8.177	0.342	3.07	2.659	1.281
1375	8.148	0.291	2.97	2.587	1.199
1400	8.148	0.348	3.073	2.666	1.275
1425	8.139	0.345	3.067	2.659	1.265
1446	8.129	0.342	3.045	2.64	1.243

RSA 96



STEP-DRAWDOWN TEST
AUGUST 10, 1998
RS593, SITE RSA-96

REDSTONE ARSENAL
HUNTSVILL ALABAMA

Pumping Well: RS593
Drawdown
August 1998

Step Drawdown Test

Redstone Arsenal
Site RSA-96
Madison county Alabama

	RS-593	RS-449	RS-450	RS-594	RS-588	RS-455	RS-586	RS-587	RS-456	
0	0.17	0	0	0	0	0			0	
0.0083	0		0.003			0.019			0	***Step 10 gpm***
0.1	0.038		0.063			0.01			0	
0.15	0.038		0.069			0.01			0.009	
0.2	0.029		0.056	0.009		0.019			0	
0.3	0.038		0.066	0.009		0			0	
0.4	0.029		0.069	0.009		0.019			0	
0.5	0.029		0.072	0.009		0			0	
0.6	0.038		0.075			0.01			0.009	
0.7	0.038		0.078	0.009		0			0.009	
0.8	0.076		0.082	0.009		0.01			0.009	
0.9	0.076		0.085	0.009		0.01			0	
1	-0.028		0.088	0.009		0			0.009	
2	0.01		0.1	0.028	0.01	0.01	0.019		0.018	
3	0.076	0.076	0.119	0.038	0.019	0.01	0.019	0.028	0.028	
4	0.048	0.047	0.11	0.038	0.019	0.01	0.019	0.028	0.018	
5	-0.066	0.114	0.038	0.038	0.019	0.019	0.029	0.057	0.028	
6	0.104	0.246	0.122	0.038	0.019	0.019	0.029	0.094	0.028	
7	0.133	0.379	0.135	0.047	0.028	0.01	0.029	0.123	0.028	
8	0.095	0.445	0.144	0.047	0.028	0.019	0.029	0.151	0.028	
9	0.161	0.511	0.144	0.057	0.038	0.01	0.029	0.17	0.028	
10	0.114	0.549	0.15	0.057	0.038	0.01	0.038	0.179	0.037	
12	0.189	0.634	0.154	0.057	0.038	0.019	0.038	0.198	0.037	
14	0.161	0.634	0.157	0.057	0.038	0.019	0.038	0.189	0.037	
16	0.123	0.71	0.154	0.057	0.038	0.019	0.029	0.189	0.037	
18	0.085	0.691	0.116	0.047	0.028	0.01	0.019	0.16	0.037	
20	0.085	0.398	0.107	0.038	0.028	0.01	0.019	0.057	0.028	
30	0.133	0.549	0.107	0.028	0.019	0	0.01	0.141	0.037	
40	0.095	0.53	0.097	0.028	0.01	0	0.01	0.123	0.037	
50	0.067	0.331	0.1	0.019	0.01	-0.009	0.01	0.057	0.037	
60	0.133	0.587	0.091	0.019	0	-0.009	0.01	0.141	0.037	
70	0.057	0.208	0.085	0.009	0	-0.019	0	0.009	0.037	
80	0.142	0.076	0.088	0.009	0	-0.009	0.01	0.009	0.037	
90	0.085	0.18	0.091	0.009	0	-0.009	0.01	0.057	0.037	
98	0.095	0.426	0.075	0	-0.009	-0.028	-0.009	0.066	0.028	

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Redstone Arsenal
Site RSA-96
Madison county Alabama

	RS-593	RS-449	RS-450	RS-594	RS-588	RS-455	RS-586	RS-587	RS-456	
98.1	0.151	0.426	0.094	0	-0.019	-0.028	-0.009	0.066	0.018	***Step 2 20 gpm***
98.2	0.18	0.435	0.122	0	-0.019	-0.028	0	0.066	0.018	
98.3	0.18	0.435	0.138	0	-0.019	-0.028	0	0.066	0.018	
98.4	0.208	0.445	0.144	0.009	-0.019	-0.028	0	0.075	0.018	
98.5	0.189	0.445	0.15	0.009	-0.019	-0.028	0	0.066	0.018	
98.6	0.199	0.454	0.16	0.009	-0.009	-0.028	0	0.075	0.018	
98.7	0.246	0.464	0.169	0.009	-0.019	-0.028	0	0.075	0.018	
98.8	0.227	0.464	0.176	0.019	0	-0.019	0	0.075	0.028	
98.9	0.236	0.473	0.182	0.019	-0.009	-0.019	0	0.075	0.028	
99	0.236	0.473	0.188	0.019	-0.009	-0.028	0	0.075	0.018	
100	0.246	0.53	0.216	0.038	0.01	-0.028	0.01	0.094	0.028	
101	0.312	0.549	0.235	0.047	0.019	-0.028	0.01	0.104	0.037	
102	0.236	0.568	0.248	0.047	0.019	-0.028	0.019	0.085	0.028	
103	0.312	0.577	0.257	0.057	0.028	-0.009	0.029	0.094	0.028	
104	0.255	0.606	0.263	0.066	0.038	-0.009	0.019	0.085	0.037	
105	0.312	0.615	0.267	0.066	0.047	-0.009	0.038	0.094	0.028	
106	0.331	0.615	0.27	0.066	0.047	0	0.038	0.094	0.037	
107	0.293	0.644	0.273	0.076	0.047	0	0.048	0.104	0.028	
108	0.303	0.634	0.276	0.076	0.057	0	0.048	0.104	0.037	
110	0.331	0.615	0.279	0.076	0.066	0.01	0.048	0.085	0.037	
112	0.331	0.606	0.285	0.085	0.066	0.019	0.057	0.094	0.037	
114	0.378	0.672	0.282	0.085	0.066	0.019	0.057	0.104	0.037	
116	0.321	0.672	0.285	0.085	0.066	0.029	0.057	0.094	0.037	
118	0.369	0.672	0.292	0.085	0.075	0.029	0.067	0.085	0.037	
120	0.378	0.653	0.292	0.085	0.075	0.038	0.067	0.085	0.037	
130	0.359	0.606	0.295	0.085	0.075	0.038	0.067	0.085	0.037	
140	0.388	0.559	0.295	0.085	0.075	0.038	0.067	0.085	0.037	
150	0.388	0.398	0.304	0.085	0.085	0.048	0.076	0.057	0.046	
160	0.359	0.701	0.298	0.085	0.075	0.038	0.067	0.085	0.037	
170	0.359	0.369	0.307	0.085	0.085	0.048	0.076	0.113	0.046	
180	0.34	0.615	0.298	0.085	0.085	0.048	0.076	0.094	0.046	
190	0.388	0.606	0.298	0.085	0.075	0.048	0.076	0.094	0.046	
192	0.369	0.549	0.295	0.076	0.085	0.038	0.076	0.075	0.046	
194	0.378	0.54	0.298	0.085	0.085	0.048	0.076	0.075	0.046	
196	0.369	0.483	0.298	0.076	0.075	0.038	0.067	0.066	0.037	
196.017	0.406	0.483	0.298	0.085	0.075	0.048	0.076	0.066	0.028	

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Redstone Arsenal
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	RS-593	RS-449	RS-450	RS-594	RS-588	RS-455	RS-586	RS-587	RS-456	
196.1	0.624	0.492	0.335	0.085	0.066	0.038	0.067	0.066	0.028	***Step 3 40 gpm***
196.2	0.661	0.492	0.395	0.085	0.066	0.038	0.076	0.066	0.028	
196.3	0.576	0.511	0.423	0.085	0.066	0.048	0.076	0.066	0.028	
196.4	0.671	0.521	0.436	0.085	0.075	0.038	0.076	0.066	0.028	
196.5	0.699	0.54	0.47	0.094	0.075	0.038	0.076	0.066	0.028	
196.6	0.69	0.559	0.486	0.094	0.085	0.038	0.076	0.075	0.028	
196.7	0.69	0.568	0.495	0.104	0.085	0.038	0.076	0.075	0.028	
196.8	0.709	0.577	0.505	0.104	0.094	0.048	0.076	0.075	0.028	
196.9	0.718	0.596	0.514	0.104	0.085	0.038	0.085	0.075	0.018	
197	0.709	0.606	0.524	0.113	0.094	0.038	0.085	0.075	0.028	
198	0.784	0.729	0.602	0.142	0.122	0.038	0.095	0.104	0.028	
199	0.822	0.786	0.63	0.17	0.141	0.048	0.114	0.104	0.037	
200	0.879	0.805	0.655	0.189	0.169	0.057	0.123	0.113	0.037	
201	0.86	0.805	0.68	0.198	0.178	0.067	0.133	0.113	0.037	
202	0.897	0.824	0.693	0.208	0.188	0.067	0.142	0.113	0.037	
203	0.888	0.833	0.705	0.217	0.197	0.086	0.152	0.16	0.037	
204	0.888	0.852	0.718	0.227	0.207	0.086	0.161	0.132	0.037	
205	0.888	0.871	0.724	0.236	0.216	0.095	0.171	0.132	0.037	
206	0.935	0.871	0.734	0.246	0.225	0.104	0.171	0.132	0.046	
208	0.954	0.918	0.743	0.255	0.235	0.114	0.18	0.132	0.046	
210	0.963	0.786	0.74	0.246	0.235	0.114	0.18	0.132	0.046	
212	0.963	0.653	0.759	0.255	0.253	0.133	0.199	0.123	0.046	
214	0.954	0.748	0.762	0.265	0.244	0.133	0.19	0.123	0.037	
216	1.001	0.653	0.759	0.265	0.253	0.152	0.199	0.123	0.046	
218	1.02	0.682	0.771	0.274	0.272	0.161	0.209	0.123	0.046	
228	0.982	0.937	0.781	0.274	0.282	0.18	0.218	0.132	0.046	
238	0.982	0.824	0.787	0.284	0.282	0.19	0.228	0.141	0.046	
248	1.001	0.71	0.784	0.274	0.282	0.199	0.228	0.16	0.046	
258	1.001	0.871	0.793	0.293	0.291	0.208	0.237	0.16	0.046	
268	0.973	0.795	0.793	0.293	0.3	0.208	0.237	0.16	0.046	
278	1.001	0.663	0.784	0.284	0.291	0.208	0.237	0.151	0.046	
288	1.03	0.719	0.79	0.293	0.3	0.208	0.237	0.16	0.046	
290	1.001	0.719	0.787	0.284	0.291	0.208	0.237	0.151	0.037	
292	0.992	0.719	0.79	0.293	0.3	0.208	0.237	0.151	0.046	
294	0.992	0.71	0.787	0.284	0.291	0.208	0.237	0.151	0.037	
294.008	1.001	0.719	0.787	0.284	0.3	0.218	0.237	0.151	0.037	

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294.1	1.02	0.71	0.79	0.284	0.291	0.199	0.237	0.141	0.037	***Step 4 54 gpm***
294.2	1.228	0.729	0.825	0.284	0.291	0.208	0.237	0.151	0.028	
294.3	1.313	0.729	0.875	0.284	0.291	0.208	0.237	0.141	0.037	
294.4	1.37	0.748	0.922	0.293	0.291	0.208	0.237	0.151	0.037	
294.5	1.398	0.757	0.956	0.293	0.291	0.208	0.237	0.151	0.028	
294.6	1.436	0.786	0.988	0.303	0.3	0.208	0.237	0.151	0.028	
294.7	1.436	0.795	1.013	0.303	0.3	0.218	0.246	0.151	0.037	
294.8	1.492	0.814	1.035	0.303	0.31	0.208	0.246	0.151	0.037	
294.9	1.549	0.843	1.063	0.312	0.31	0.208	0.246	0.151	0.028	
295	1.577	0.852	1.097	0.321	0.319	0.208	0.246	0.151	0.028	
296	1.823	1.079	1.307	0.397	0.385	0.218	0.284	0.179	0.037	
297	1.615	1.183	1.298	0.435	0.422	0.227	0.303	0.179	0.037	
298	1.464	1.174	1.182	0.454	0.45	0.237	0.322	0.189	0.046	
299	1.388	1.108	1.141	0.454	0.441	0.246	0.332	0.179	0.046	
300	1.37	1.06	1.11	0.454	0.45	0.256	0.341	0.189	0.037	
301	1.36	1.032	1.091	0.454	0.46	0.265	0.341	0.189	0.037	
302	1.388	1.013	1.1	0.454	0.46	0.275	0.351	0.179	0.037	
303	1.388	1.004	1.104	0.463	0.469	0.284	0.36	0.179	0.037	
304	1.388	1.013	1.11	0.473	0.469	0.294	0.36	0.189	0.046	
306	1.398	1.022	1.116	0.473	0.478	0.303	0.37	0.189	0.046	
308	1.398	1.022	1.119	0.482	0.488	0.312	0.379	0.189	0.046	
310	1.436	1.032	1.126	0.482	0.488	0.322	0.379	0.189	0.046	
320	1.436	1.06	1.135	0.492	0.507	0.35	0.398	0.198	0.046	
330	1.483	0.994	1.144	0.492	0.516	0.369	0.407	0.198	0.046	
340	1.464	0.975	1.144	0.501	0.516	0.379	0.407	0.198	0.056	
350	1.473	0.975	1.151	0.501	0.525	0.388	0.417	0.198	0.056	
360	1.483	0.937	1.148	0.511	0.525	0.388	0.417	0.189	0.056	
370	1.454	0.909	1.148	0.511	0.535	0.398	0.426	0.189	0.056	
380	1.322	0.53	0.95	0.34	0.31	0.303	0.284	0.151	0.056	
388.008	1.445	0.899	1.16	0.511	0.488	0.331	0.389	0.189	0.046	

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388.1	0.756	0.89	1.047	0.501	0.488	0.331	0.389	0.179	0.046	Step 5 Recovery
388.2	0.671	0.871	0.878	0.492	0.478	0.322	0.389	0.17	0.046	
388.3	0.595	0.843	0.784	0.482	0.469	0.331	0.379	0.17	0.046	
388.5	0.473	0.767	0.646	0.454	0.46	0.341	0.379	0.16	0.046	
388.7	0.388	0.701	0.549	0.425	0.441	0.331	0.37	0.151	0.056	
388.9	0.321	0.615	0.477	0.397	0.422	0.331	0.351	0.151	0.046	
389	0.293	0.568	0.445	0.378	0.413	0.331	0.341	0.141	0.037	
390	0.151	0.237	0.26	0.255	0.328	0.331	0.294	0.123	0.046	
391	0.085	0.019	0.172	0.18	0.235	0.312	0.237	0.104	0.056	
392	0.048	-0.123	0.125	0.132	0.188	0.294	0.199	0.094	0.046	
393	0.019	-0.19	0.097	0.104	0.141	0.275	0.171	0.085	0.046	
394	0.01	-0.237	0.075	0.076	0.122	0.246	0.142	0.066	0.056	
395	-0.009	-0.265	0.06	0.066	0.085	0.227	0.123	0.066	0.046	
396	-0.018	-0.275	0.047	0.047	0.075	0.208	0.104	0.057	0.046	
397	-0.028	-0.284	0.038	0.038	0.066	0.18	0.095	0.057	0.046	
398	-0.028	-0.294	0.031	0.038	0.057	0.171	0.085	0.047	0.056	
400	-0.028	-0.294	0.019	0.019	0.038	0.142	0.067	0.047	0.056	
402	-0.037	-0.294	0.009	0.009	0.019	0.114	0.048	0.038	0.056	
404	-0.037	-0.294	0	0	0.01	0.086	0.038	0.038	0.056	
406	-0.047	-0.284	-0.006	-0.01	0	0.067	0.029	0.038	0.056	
408	-0.047	-0.275	-0.009	-0.01	-0.009	0.057	0.029	0.038	0.056	
410	-0.056	-0.265	-0.016	-0.019	-0.019	0.038	0.019	0.038	0.065	
412	-0.056	-0.265	-0.019	-0.019	-0.019	0.029	0.01	0.028	0.065	
414	-0.056	-0.256	-0.022	-0.019	-0.028	0.019	0.01	0.028	0.065	
424	-0.066	-0.256	-0.035	-0.038	-0.037	-0.009	-0.009	0.019	0.065	
434	-0.075	-0.237	-0.041	-0.047	-0.047	-0.028	-0.019	0.009	0.065	
444	-0.085	-0.227	-0.047	-0.047	-0.056	-0.047	-0.028	0.019	0.065	
454	-0.085	-0.199	-0.05	-0.047	-0.056	-0.047	-0.028	0.009	0.065	
464	-0.085	-0.18	-0.053	-0.057	-0.065	-0.056	-0.038	0.009	0.065	
474	-0.085	-0.161	-0.056	-0.057	-0.065	-0.056	-0.038	0.009	0.065	
484	-0.094	-0.152	-0.06	-0.057	-0.065	-0.056	-0.047	0	0.065	
498	-0.085	-0.114	-0.063	-0.066	-0.075	-0.066	-0.047	0	0.065	
508	-0.085	-0.095	-0.066	-0.066	-0.075	-0.066	-0.047	0	0.065	
518	-0.085	-0.095	-0.069	-0.066	-0.075	-0.066	-0.057	0	0.065	
528	-0.075	-0.085	-0.069	-0.076	-0.075	-0.075	-0.057	0.009	0.065	
538	-0.075	-0.038	-0.069	-0.076	-0.084	-0.075	-0.057	0.009	0.065	
548	-0.075	-0.029	-0.072	-0.076	-0.084	-0.075	-0.057	0.019	0.065	
558	-0.085	-0.019	-0.075	-0.076	-0.084	-0.075	-0.057	0.019	0.065	
568	-0.085	0	-0.075	-0.076	-0.084	-0.085	-0.057	0.009	0.065	
578	-0.085	0	-0.075	-0.076	-0.084	-0.085	-0.057	0	0.065	
588	-0.085	-0.01	-0.075	-0.076	-0.084	-0.085	-0.057	0	0.065	
598	-0.085	0.009	-0.078	-0.076	-0.084	-0.085	-0.066	0	0.065	
608	-0.085	0.019	-0.078	-0.085	-0.084	-0.085	-0.066	0	0.065	
618	-0.085	0.019	-0.078	-0.085	-0.094	-0.085	-0.066	0.009	0.065	
628	-0.085	0.028	-0.082	-0.085	-0.094	-0.085	-0.066	0	0.065	
638	-0.085	0.028	-0.082	-0.085	-0.094	-0.085	-0.066	0	0.065	
648	-0.085	0.057	-0.082	-0.085	-0.094	-0.085	-0.066	0.009	0.065	
658	-0.085	0.038	-0.082	-0.085	-0.094	-0.085	-0.066	0	0.065	
668	-0.085	0.038	-0.085	-0.085	-0.094	-0.085	-0.066	0.009	0.065	
678	-0.085	0.038	-0.085	-0.085	-0.094	-0.085	-0.066	0	0.065	
688	-0.085	0.038	-0.085	-0.085	-0.094	-0.085	-0.066	0	0.065	
698	-0.085	0.047	-0.085	-0.095	-0.094	-0.085	-0.066	0	0.065	
708	-0.085	0.047	-0.088	-0.085	-0.094	-0.085	-0.076	0	0.065	

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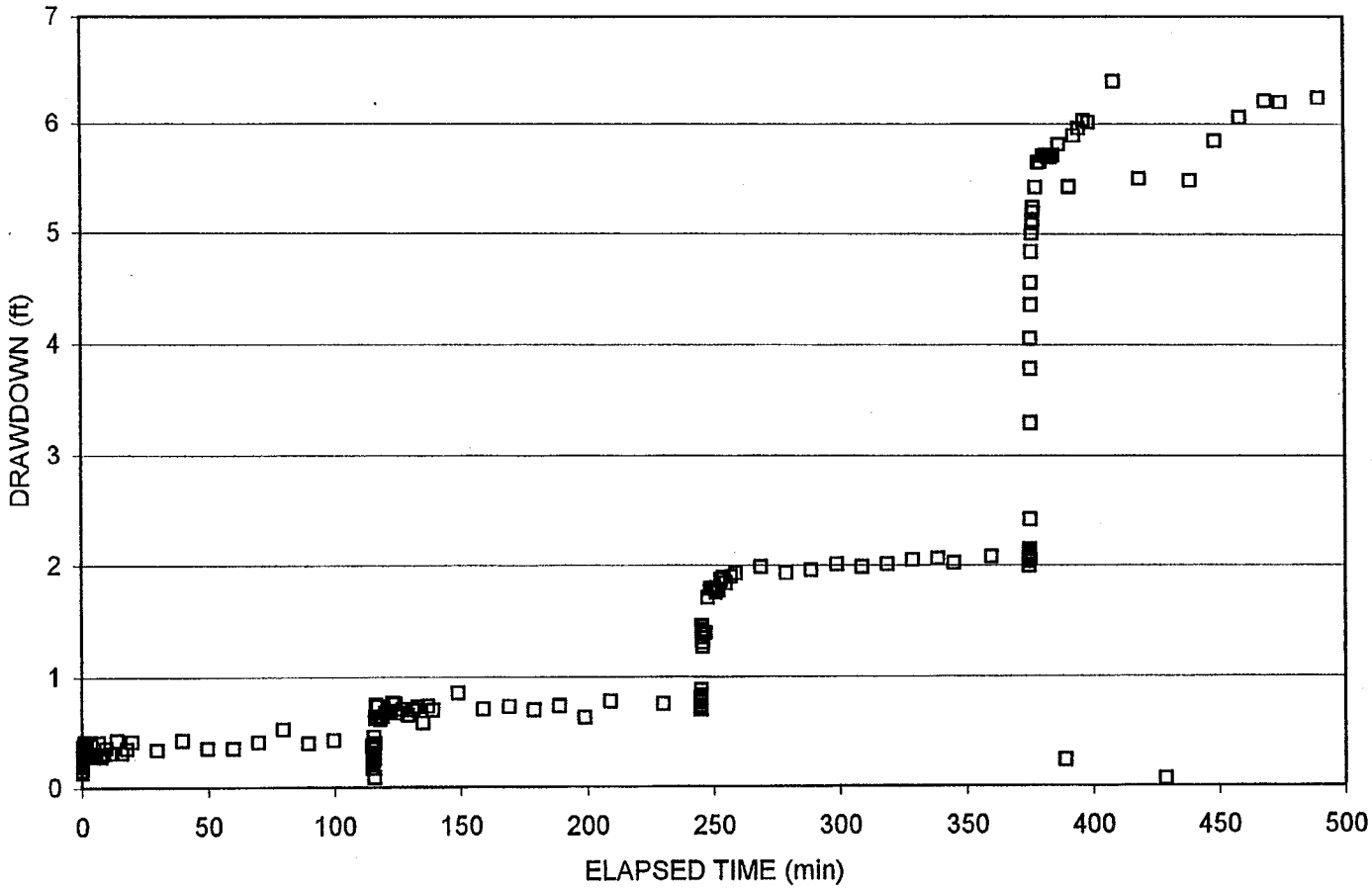
718	-0.085	0.047	-0.088	-0.095	-0.094	-0.085	-0.076	0	0.065
728	-0.085	0.066	-0.088	-0.095	-0.103	-0.085	-0.076	0.009	0.065
738	-0.085	0.057	-0.091	-0.095	-0.103	-0.094	-0.076	0.009	0.065
748	-0.085	0.057	-0.091	-0.095	-0.103	-0.094	-0.076	0	0.065
758	-0.085	0.066	-0.091	-0.095	-0.103	-0.094	-0.076	0.009	0.065
768	-0.085	0.057	-0.091	-0.095	-0.103	-0.094	-0.076	0	0.065
778	-0.085	0.057	-0.091	-0.095	-0.103	-0.094	-0.076	0	0.065
788	-0.085	0.066	-0.091	-0.095	-0.103	-0.085	-0.076	-0.01	0.065
798	-0.085	0.076	-0.091	-0.095	-0.103	-0.094	-0.076	0	0.065
808	-0.085	0.085	-0.091	-0.095	-0.103	-0.085	-0.076	0	0.065
818	-0.085	0.057	-0.091	-0.095	-0.103	-0.085	-0.076	-0.01	0.065
828	-0.085	0.057	-0.091	-0.095	-0.103	-0.094	-0.076	-0.01	0.065
838	-0.085	0.066	-0.091	-0.095	-0.103	-0.085	-0.076	-0.01	0.065
848	-0.085	0.085	-0.091	-0.095	-0.103	-0.094	-0.076	0	0.065
858	-0.085	0.085	-0.091	-0.095	-0.103	-0.085	-0.076	0	0.065
868	-0.085	0.104	-0.091	-0.095	-0.103	-0.085	-0.076	0	0.065
878	-0.085	0.104	-0.094	-0.095	-0.103	-0.094	-0.076	0.009	0.065
888	-0.085	0.095	-0.094	-0.095	-0.103	-0.094	-0.076	0.009	0.065
898	-0.085	0.076	-0.094	-0.095	-0.103	-0.094	-0.076	0	0.065
908	-0.085	0.076	-0.097	-0.104	-0.103	-0.094	-0.076	0	0.065
918	-0.085	0.085	-0.094	-0.095	-0.103	-0.094	-0.076	0	0.056
928	-0.085	0.095	-0.097	-0.104	-0.103	-0.094	-0.076	0.009	0.065
938	-0.085	0.085	-0.094	-0.095	-0.103	-0.094	-0.076	0	0.065
948	-0.085	0.095	-0.097	-0.104	-0.103	-0.094	-0.076	0	0.056
958	-0.085	0.104	-0.094	-0.095	-0.103	-0.094	-0.076	0	0.065
968	-0.085	0.095	-0.097	-0.095	-0.103	-0.094	-0.076	0.009	0.065
978	-0.085	0.076	-0.094	-0.095	-0.103	-0.085	-0.076	0	0.065
988	-0.085	0.047	-0.094	-0.095	-0.103	-0.085	-0.076	-0.019	0.065
998	-0.085	0.047	-0.094	-0.095	-0.103	-0.085	-0.076	-0.019	0.065
1008	-0.085	0.047	-0.097	-0.104	-0.103	-0.094	-0.076	-0.01	0.065
1018	-0.085	0.076	-0.094	-0.104	-0.103	-0.085	-0.076	-0.01	0.065
1028	-0.085	0.057	-0.094	-0.104	-0.103	-0.085	-0.076	0	0.065
1038	-0.085	0.066	-0.097	-0.104	-0.103	-0.094	-0.076	-0.01	0.065
1048	-0.085	0.076	-0.097	-0.104	-0.103	-0.094	-0.085	0	0.065
1058	-0.085	0.085	-0.1	-0.104	-0.103	-0.094	-0.085	0	0.056
1068	-0.085	0.095	-0.1	-0.104	-0.103	-0.094	-0.085	0	0.056
1078	-0.085	0.104	-0.1	-0.104	-0.103	-0.094	-0.085	0.019	0.065
1088	-0.085	0.123	-0.1	-0.104	-0.112	-0.094	-0.085	0.019	0.056
1098	-0.085	0.132	-0.097	-0.104	-0.103	-0.094	-0.076	0.019	0.056
1108	-0.085	0.161	-0.097	-0.104	-0.112	-0.094	-0.076	0.019	0.056
1118	-0.085	0.123	-0.094	-0.095	-0.103	-0.085	-0.076	-0.01	0.056
1128	-0.085	0.123	-0.094	-0.095	-0.103	-0.085	-0.076	0	0.065
1138	-0.085	0.227	-0.094	-0.095	-0.103	-0.085	-0.076	0.038	0.056
1148	-0.085	0.256	-0.097	-0.095	-0.103	-0.094	-0.076	0.047	0.056
1158	-0.085	0.246	-0.1	-0.104	-0.103	-0.094	-0.085	0.038	0.056
1168	-0.075	0.379	-0.094	-0.095	-0.103	-0.085	-0.076	0.094	0.056
1178	-0.085	0.417	-0.094	-0.104	-0.103	-0.094	-0.085	0.085	0.056
1188	-0.085	0.435	-0.094	-0.104	-0.103	-0.085	-0.076	0.085	0.056
1198	-0.085	0.644	-0.094	-0.095	-0.103	-0.085	-0.076	0.113	0.056
1208	-0.085	0.559	-0.094	-0.104	-0.103	-0.094	-0.076	0.094	0.056
1218	-0.085	0.473	-0.094	-0.104	-0.103	-0.094	-0.076	0.094	0.056
1228	-0.075	0.606	-0.091	-0.095	-0.103	-0.085	-0.076	0.094	0.056
1238	-0.085	0.521	-0.097	-0.104	-0.103	-0.085	-0.076	0.038	0.056

Pumping Well: RS593
Drawdown
August 1998

Step Drawdown Test

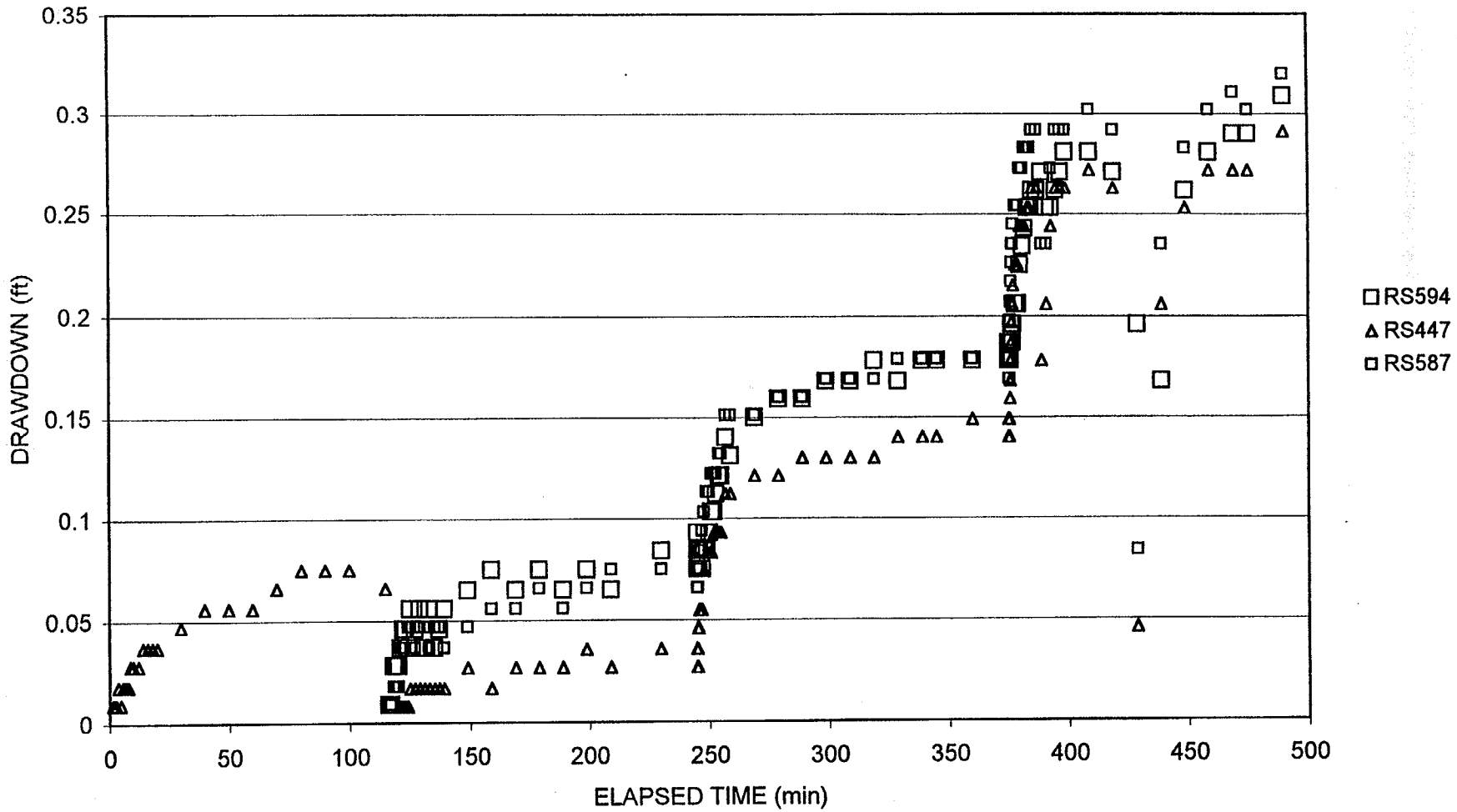
Redstone Arsenal
Site RSA-96
Madison county Alabama

	RS-593	RS-449	RS-450	RS-594	RS-588	RS-455	RS-586	RS-587	RS-456
1248	-0.075	0.388	-0.085	-0.095	-0.103	-0.085	-0.076	0.019	0.056
1258	-0.085	0.095	-0.091	-0.104	-0.103	-0.085	-0.076	-0.057	0.056
1268	-0.066	0.151	-0.082	-0.095	-0.094	-0.085	-0.076	0	0.056
1278	-0.085	0.256	-0.091	-0.095	-0.103	-0.085	-0.076	0.038	0.056
1288	-0.075	0.218	-0.091	-0.095	-0.103	-0.085	-0.076	0	0.046
1298	-0.085	0.312	-0.091	-0.095	-0.103	-0.085	-0.076	0.009	0.046
1308	-0.085	0.237	-0.091	-0.095	-0.094	-0.085	-0.076	0	0.046
1318	-0.075	0.189	-0.088	-0.095	-0.103	-0.085	-0.066	0.009	0.056
1328	-0.075	0.379	-0.082	-0.095	-0.094	-0.075	-0.076	0.047	0.056
1338	-0.085	0.274	-0.091	-0.095	-0.094	-0.075	-0.076	0.047	0.046
1348	-0.075	0.379	-0.091	-0.095	-0.103	-0.085	-0.076	0.057	0.046
1358	-0.066	0.511	-0.082	-0.095	-0.094	-0.075	-0.066	0.075	0.046
1368	-0.075	0.17	-0.091	-0.095	-0.103	-0.075	-0.076	0.009	0.046
1378	-0.075	0.35	-0.091	-0.095	-0.103	-0.085	-0.076	0.038	0.046
1388	-0.075	0.17	-0.088	-0.095	-0.103	-0.085	-0.076	0	0.046
1398	-0.075	0.521	-0.091	-0.104	-0.103	-0.085	-0.076	0.066	0.037
1408	-0.075	0.237	-0.085	-0.095	-0.094	-0.075	-0.066	0.019	0.046
1418	0	0.644	-0.013	-0.01	-0.028	-0.047	-0.009	0.123	0.046
1428	0.01	0.35	-0.003	0	0	-0.009	0.01	0.019	0.037
1438	-0.037	0.293	-0.047	-0.047	-0.037	-0.009	-0.019	0.047	0.046
1448	-0.056	-0.038	-0.063	-0.076	-0.065	-0.037	-0.038	-0.038	0.037
1458	-0.056	0	-0.072	-0.076	-0.075	-0.047	-0.047	0	0.046



STEP DRAWDOWN TEST
JULY 29, 1998
RW592, SITE RSA-96

REDSTONE ARSENAL
MADISON COUNTY, ALABAMA



STEP DRAWDOWN TEST
JULY 29, 1998
OBSERVATION WELLS
RS592, SITE RSA-96

REDSTONE ARSENAL
MADISON COUNTY, ALABAMA

Pumping Well: RS592
Drawdown
July 30, 1998

Step Drawdown Test

Redstone Arsenal
Site RSA-96
Madison County, Alabama

Elapsed Time	*RS592*	*RS448*	*RS447*	*RS456*	*RS594*	*RS587*
0.01	0.151			0.018		
0.02	0.198			0.009		
0.03	0.217			0.018		
0.03	0.321			0.009		
0.04	0.368			0.018		
0.05	0.245			0.018		
0.06	0.141			0.009		
0.07	0.207			0.009		
0.08	0.292			0.018		
0.08	0.254			0.009		
0.09	0.236			0.009		
0.1	0.16			0.009		
0.2	0.188			0.009		
0.3	0.132			0.009		
0.4	0.198			0.009		
0.5	0.339			0.009		
0.6	0.33			0.009		
0.7	0.292			0.009		
0.8	0.321			0.009		
1.0	0.406			0.018		
1.2	0.415		0.009	0.018		
1.4	0.368		0.009	0.018		
1.6	0.349		0.009	0.018		
1.8	0.387		0.009	0.018		
2	0.292		0.009	0.018		
3	0.311		0.009	0.018		
4	0.377		0.018	0.018		
5	0.292		0.009	0.018		
6	0.283		0.018	0.018		
7	0.406		0.018	0.028		
8	0.273		0.018	0.018		
9	0.302		0.028	0.018		
10	0.358		0.028	0.028		
12	0.311		0.028	0.065		
14	0.424		0.037	0.065		
16	0.311		0.037	0.065		
18	0.349		0.037	0.065		
20	0.415		0.037	0.046		
30	0.339		0.047	0.065		
40	0.424		0.056	0.075		
50	0.349		0.056	0.075		
60	0.349		0.056	0.056		
70	0.406		0.066	0.065		
80	0.528		0.075	0.056		
90	0.396		0.075	0.009		
100	0.424		0.075	0.065		
115	0.368		0.066	0.037		

Step 1	**10 gpm**

Pumping Well: RS592
Drawdown
July 30, 1998

Step Drawdown Test

Redstone Arsenal
Site RSA-96
Madison County, Alabama

Elapsed Time	*RS592*	*RS448*	*RS447*	*RS456*	*RS594*	*RS587*
0.01 15.01	0.351	0.071		0.009		
115.02	0.236	0.071		0.009		
115.03	0.217	0.071		0.009		
115.03	0.17	0.071		0.009		
115.04	0.35	0.071		0.009		
115.05	0.255	0.071		0.009		
115.06	0.312	0.071		0.009		
115.07	0.283	0.071		0.009		
115.08	0.35	0.071		0.009		
115.08	0.293	0.071				
115.09	0.293	0.071		0.009		
115.1	0.255	0.071				
115.2	0.283	0.061		0.009		
115.3	0.283	0.071		0.009		
115.4	0.236	0.071		0.009		
115.5	0.312	0.061		0		
115.6	0.265	0.071		0.009		
115.7	0.453	0.061		0.009		
115.8	0.085	0.061		0		
115.9	0.255	0.061		0		
116	0.397	0.061		0		
116.2	0.623	0.071		0.009	0.009	
116.4	0.746	0.071		0.018	0.009	
116.6	0.623	0.08		0.018	0.009	
116.8	0.633	0.071		0.018	0.009	0.009
117	0.727	0.071		0.018	0.009	0.009
118	0.614	0.08		0.037	0.028	0.018
119	0.642	0.08		0.037	0.028	0.018
120	0.68	0.08	0.008	0.037	0.028	0.018
121	0.68	0.08	0.008	0.065	0.037	0.037
122	0.689	0.08	0.008	0.065	0.046	0.037
123	0.765	0.08	0.008	0.075	0.046	0.037
124	0.756	0.071	0.008	0.056	0.037	0.047
125	0.671	0.08	0.017	0.084	0.056	0.047
127	0.708	0.08	0.017	0.056	0.046	0.037
129	0.652	0.08	0.017	0.075	0.056	0.047
131	0.699	0.08	0.017	0.037	0.037	0.047
133	0.727	0.08	0.017	0.046	0.056	0.037
135	0.586	0.08	0.017	0.037	0.037	0.047
137	0.737	0.08	0.017	0.037	0.046	0.047
139	0.699	0.08	0.017	0.028	0.056	0.037
149	0.85	0.08	0.027	0.046	0.065	0.047
159	0.708	0.08	0.017	0.046	0.075	0.056
169	0.727	0.08	0.027	0.046	0.065	0.056
179	0.699	0.071	0.027	0.056	0.075	0.066
189	0.737	0.071	0.027	0.037	0.065	0.056
199	0.633	0.071	0.036	0.056	0.075	0.066
209	0.774	0.071	0.027	0.037	0.065	0.075
230	0.756	0.071	0.036	0.056	0.084	0.075
245	0.708	0.071	0.036	0.075	0.093	0.075

Step 1 *21 gpm* **10 gpm**

Pumping Well: RS592
Drawdown
July 30, 1998

Step Drawdown Test

Redstone Arsenal
Site RSA-96
Madison County, Alabama

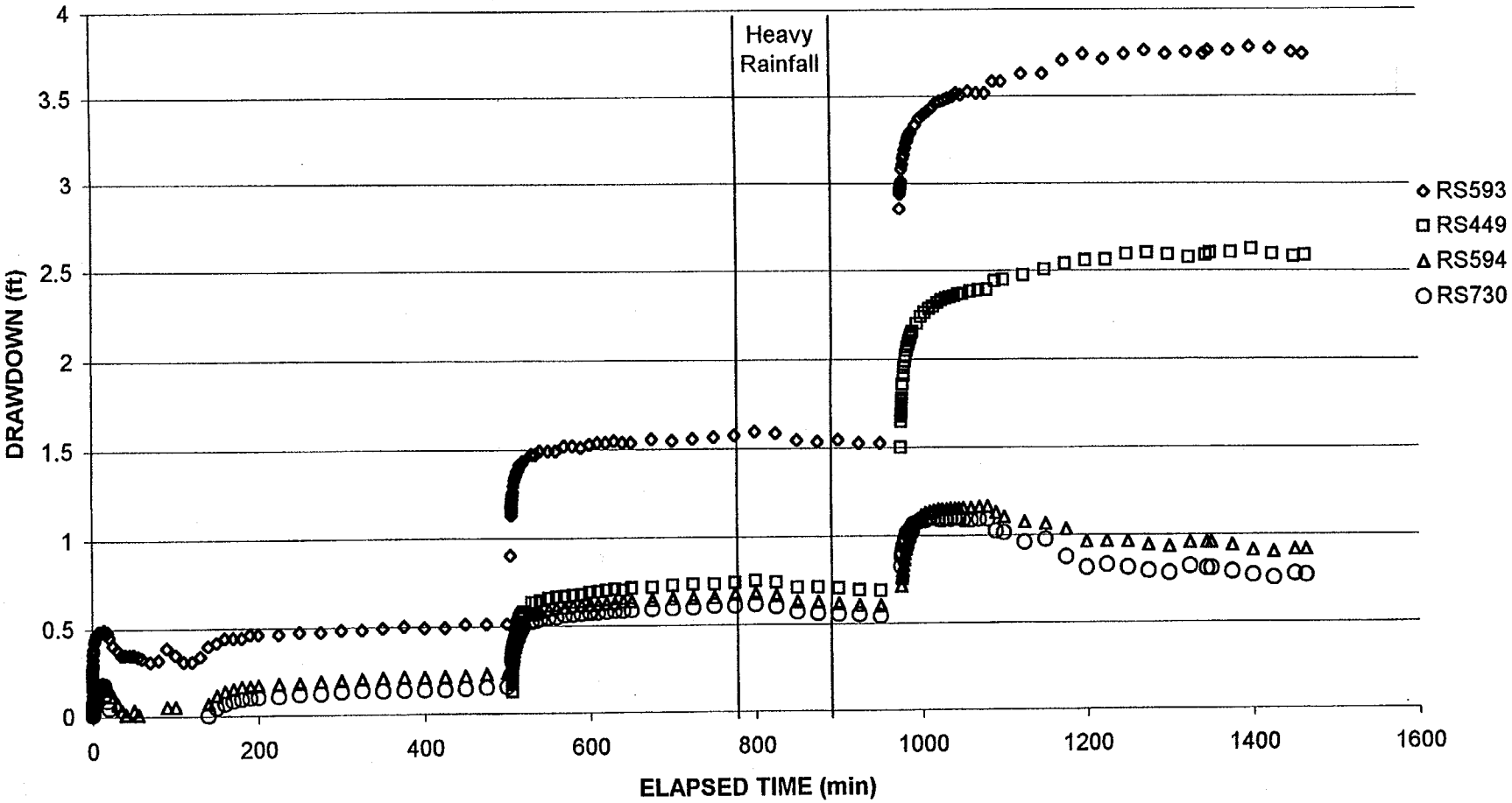
Elapsed Time	*RS592*	*RS448*	*RS447*	*RS456*	*RS594*	*RS587*	
0.01	0.801	0.052	0.027	0.065	0.075	0.066	***Step 3 40 gpm* 10 gpm**
245.01	0.801	0.052	0.027	0.065	0.075	0.066	
245.02	0.699	0.052	0.027	0.065	0.075	0.066	
245.03	0.727	0.052	0.027	0.065	0.084	0.066	
245.03	0.784	0.052	0.027	0.065	0.075	0.066	
245.04	0.803	0.052	0.027	0.065	0.084	0.066	
245.05	0.699	0.052	0.027	0.065	0.084	0.066	
245.06	0.765	0.052	0.027	0.065	0.084	0.066	
245.07	0.831	0.052	0.027	0.065	0.084	0.066	
245.08	0.765	0.061	0.027	0.065	0.084	0.066	
245.08	0.737	0.061	0.027	0.056	0.075	0.066	
245.09	0.803	0.061	0.027	0.065	0.084	0.066	
245.1	0.784	0.061	0.027	0.065	0.075	0.066	
245.2	0.878	0.061	0.027	0.065	0.084	0.066	
245.3	1.454	0.052	0.036	0.065	0.075	0.075	
245.4	1.379	0.052	0.046	0.065	0.084	0.075	
245.5	1.416	0.052	0.046	0.065	0.075	0.075	
245.6	1.265	0.052	0.046	0.065	0.075	0.075	
245.7	1.35	0.052	0.046	0.065	0.084	0.084	
245.8	1.398	0.052	0.046	0.056	0.075	0.084	
245.9	1.388	0.052	0.055	0.065	0.084	0.084	
246	1.303	0.052	0.055	0.065	0.084	0.084	
247	1.388	0.052	0.055	0.056	0.075	0.094	
248	1.709	0.052	0.074	0.056	0.084	0.103	
249	1.785	0.052	0.083	0.056	0.084	0.113	
250	1.794	0.052	0.083	0.056	0.093	0.113	
251	1.756	0.052	0.083	0.056	0.103	0.122	
252	1.775	0.052	0.093	0.065	0.103	0.122	
253	1.87	0.052	0.093	0.065	0.112	0.122	
254	1.889	0.052	0.093	0.065	0.121	0.132	
255	1.841	0.052	0.093	0.065	0.121	0.132	
257	1.898	0.061	0.112	0.075	0.14	0.151	
259	1.926	0.061	0.112	0.065	0.131	0.151	
269	1.983	0.061	0.121	0.065	0.15	0.151	
279	1.926	0.061	0.121	0.075	0.159	0.16	
289	1.955	0.061	0.13	0.075	0.159	0.16	
299	2.011	0.061	0.13	0.075	0.168	0.169	
309	1.983	0.061	0.13	0.065	0.168	0.169	
319	2.011	0.061	0.13	0.075	0.178	0.169	
329	2.049	0.061	0.14	0.075	0.168	0.179	
339	2.058	0.061	0.14	0.065	0.178	0.179	
345	2.021	0.061	0.14	0.075	0.178	0.179	
360	2.077	0.061	0.149	0.075	0.178	0.179	
375	2.087	0.052	0.149	0.075	0.187	0.188	

Pumping Well: RS592
Drawdown
July 30, 1998

Step Drawdown Test

Redstone Arsenal
Site RSA-96
Madison County, Alabama

Elapsed Time	*RS592*	*RS448*	*RS447*	*RS456*	*RS594*	*RS587*	
0.01	0.071	0.052	0.14	0.078	0.178	0.179	***Step 4 72 GPM 10 gpm***
375.01	2.071						
375.02	2.068	0.052	0.14	0.065	0.187	0.179	
375.03	2.03	0.052	0.14	0.065	0.187	0.179	
375.03	2.03	0.042	0.14	0.065	0.178	0.179	
375.04	1.992	0.052	0.14	0.065	0.178	0.179	
375.05	2.068	0.042	0.14	0.065	0.178	0.179	
375.06	2.115	0.052	0.14	0.065	0.178	0.179	
375.07	2.058	0.042	0.14	0.065	0.178	0.179	
375.08	2.143	0.042	0.14	0.065	0.178	0.179	
375.08	2.143	0.042	0.14	0.065	0.178	0.179	
375.09	2.115	0.052	0.14	0.065	0.178	0.179	
375.1	2.049	0.042	0.14	0.065	0.178	0.179	
375.2	2.106	0.042	0.14	0.065	0.178	0.179	
375.3	2.049	0.052	0.14	0.065	0.178	0.169	
375.4	2.058	0.042	0.14	0.065	0.178	0.179	
375.5	2.417	0.042	0.14	0.065	0.178	0.169	
375.6	3.295	0.042	0.149	0.065	0.178	0.179	
375.7	3.777	0.042	0.159	0.065	0.178	0.188	
375.8	4.051	0.042	0.168	0.065	0.178	0.198	
375.9	4.353	0.042	0.168	0.065	0.178	0.198	
376	4.561	0.042	0.178	0.065	0.178	0.207	
376.2	4.834	0.052	0.187	0.075	0.187	0.217	
376.4	5.004	0.052	0.197	0.075	0.196	0.226	
376.6	5.089	0.052	0.206	0.075	0.196	0.235	
376.8	5.184	0.052	0.206	0.075	0.187	0.235	
377	5.231	0.052	0.215	0.075	0.196	0.245	
378	5.41	0.052	0.225	0.075	0.206	0.254	
379	5.637	0.042	0.225	0.075	0.206	0.254	
380	5.646	0.052	0.244	0.075	0.225	0.273	
381	5.703	0.052	0.244	0.075	0.234	0.273	
382	5.712	0.052	0.244	0.075	0.243	0.283	
383	5.694	0.052	0.253	0.084	0.253	0.283	
384	5.694	0.052	0.253	0.075	0.253	0.283	
385	5.712	0.052	0.263	0.084	0.262	0.292	
387	5.807	0.052	0.263	0.075	0.262	0.292	
389	0.236	0.052	0.178	0.084	0.271	0.235	
391	5.42	0.052	0.206	0.075	0.253	0.235	
393	5.892	0.052	0.244	0.084	0.253	0.273	
395	5.958	0.052	0.263	0.075	0.262	0.292	
397	6.033	0.052	0.263	0.084	0.271	0.292	
399	6.015	0.052	0.263	0.075	0.281	0.292	
409	6.392	0.052	0.272	0.075	0.281	0.302	
419	5.495	0.052	0.263	0.075	0.271	0.292	
429	0.066	0.042	0.046	0.075	0.196	0.084	
439	5.476	0.042	0.206	0.065	0.168	0.235	
449	5.845	0.052	0.253	0.065	0.262	0.283	
459	6.062	0.042	0.272	0.075	0.281	0.302	
469	6.213	0.042	0.272	0.065	0.29	0.311	
475	6.203	0.042	0.272	0.065	0.29	0.302	
490	6.241	0.052	0.291	0.075	0.309	0.32	



24 HOUR STEP DRAWDOWN TEST
APRIL 6, 1999
RS593 RSA-96

REDSTONE ARSENAL
HUNTSVILLE ALABAMA

Pumping Well: RS593
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-96

Test date: 4/6/99
Redstone Arsenal
Project: 772650

Elapsed Time	RS593	RS449	RS594	RS730	
0.01	0.009		0.031		***Step 0 25 gpm***
0.02	0.009		0.031		
0.03	0.227		0.031		
0.03	0.189		0.031		
0.04	0.123		0.031		
0.05	0.151		0.031		
0.06	0.17		0.031		
0.07	0.189		0.031		
0.08	0.208		0.034		
0.08	0.246		0.034		
0.09	0.237		0.031		
0.1	0.275		0.031		
0.2	0.246		0.031		
0.3	0.265		0.034	0.009	
0.4	0.284		0.031	0.012	
0.5	0.303		0.031	0.015	
0.6	0.332		0.031	0.025	
0.7	0.332		0.034	0.031	
0.8	0.332		0.038	0.037	
0.9	0.36		0.041	0.044	
1	0.369		0.047	0.063	
2	0.388		0.057	0.079	
3	0.426		0.079	0.113	
4	0.445		0.091	0.132	
5	0.455		0.104	0.142	
6	0.474		0.117	0.151	
7	0.464		0.129	0.164	
8	0.483		0.148	0.173	
9	0.483		0.152	0.176	
10	0.483		0.155	0.18	
12	0.483		0.161	0.183	
14	0.493		0.174	0.18	
16	0.483		0.161	0.132	
18	0.483		0.164	0.088	
20	0.455		0.152	0.044	
25	0.407		0.114		
30	0.379		0.069		
35	0.35		0.034		
40	0.35		0.009		
45	0.35				
50	0.35		0.031		
55	0.341		0.009		
60	0.332				
70	0.313				
80	0.322				
90	0.388		0.053		
100	0.35		0.053		
110	0.313				
120	0.313				

130	0.341		
140	0.398	0.069	0.003
150	0.417	0.117	0.047
160	0.445	0.139	0.069
170	0.445	0.152	0.085
180	0.445	0.164	0.094
190	0.464	0.167	0.101
200	0.464	0.171	0.104
225	0.464	0.177	0.107
250	0.474	0.183	0.116
275	0.474	0.19	0.12
300	0.483	0.196	0.129
325	0.483	0.202	0.135
350	0.493	0.209	0.132
375	0.502	0.215	0.135
400	0.493	0.212	0.135
425	0.493	0.215	0.135
450	0.512	0.218	0.142
475	0.512	0.228	0.148
500	0.512	0.234	0.154

505	0.901		0.24	0.224	***Step 1 46 gpm***
506	1.128	0.122	0.266	0.3	
506.01	1.147	0.165	0.275	0.312	
506.02	1.157	0.175	0.278	0.316	
506.03	1.157	0.175	0.275	0.322	
506.03	1.185	0.175	0.272	0.316	
506.04	1.176	0.172	0.282	0.319	
506.05	1.176	0.178	0.278	0.316	
506.06	1.166	0.181	0.278	0.316	
506.07	1.176	0.181	0.278	0.316	
506.08	1.166	0.178	0.278	0.319	
506.08	1.176	0.181	0.282	0.322	
506.09	1.176	0.181	0.282	0.319	
506.1	1.185	0.184	0.278	0.319	
506.2	1.176	0.197	0.285	0.319	
506.3	1.195	0.209	0.288	0.328	
506.4	1.204	0.222	0.288	0.341	
506.5	1.214	0.237	0.294	0.341	
506.6	1.204	0.244	0.294	0.341	
506.7	1.204	0.256	0.294	0.347	
506.8	1.204	0.266	0.297	0.347	
506.9	1.223	0.275	0.301	0.35	
507	1.223	0.284	0.304	0.353	
507.2	1.242	0.303	0.31	0.36	
507.4	1.233	0.319	0.313	0.366	
507.6	1.251	0.334	0.32	0.372	
507.8	1.261	0.347	0.323	0.379	
508	1.261	0.363	0.332	0.382	
509	1.299	0.416	0.358	0.401	
510	1.327	0.453	0.38	0.423	
511	1.346	0.472	0.399	0.436	
512	1.356	0.497	0.415	0.448	
513	1.375	0.513	0.434	0.455	
514	1.384	0.525	0.446	0.467	
515	1.384	0.544	0.462	0.474	
516	1.413	0.553	0.475	0.48	
517	1.413	0.56	0.488	0.483	
518	1.422	0.569	0.491	0.486	
519	1.422	0.575	0.5	0.496	
520	1.432	0.585	0.513	0.499	
530	1.47	0.635	0.564	0.527	
535	1.47	0.635	0.573	0.53	
540	1.489	0.647	0.58	0.537	
550	1.489	0.66	0.595	0.546	
560	1.489	0.666	0.605	0.549	
570	1.517	0.669	0.608	0.562	
580	1.517	0.675	0.618	0.565	
590	1.508	0.679	0.621	0.568	
600	1.526	0.691	0.621	0.578	
601	1.526	0.691	0.621	0.571	
610	1.536	0.694	0.624	0.575	

620	1.536	0.7	0.63	0.578
630	1.545	0.707	0.63	0.584
640	1.536	0.7	0.64	0.584
650	1.536	0.713	0.64	0.587
675	1.555	0.716	0.646	0.594
700	1.545	0.726	0.652	0.597
725	1.555	0.732	0.656	0.6
750	1.564	0.732	0.659	0.609
775	1.574	0.741	0.675	0.609
800	1.593	0.751	0.678	0.616
825	1.583	0.741	0.665	0.603
850	1.545	0.71	0.63	0.571
875	1.536	0.71	0.627	0.562
900	1.545	0.704	0.618	0.556
925	1.526	0.691	0.608	0.553
950	1.526	0.688	0.602	0.543

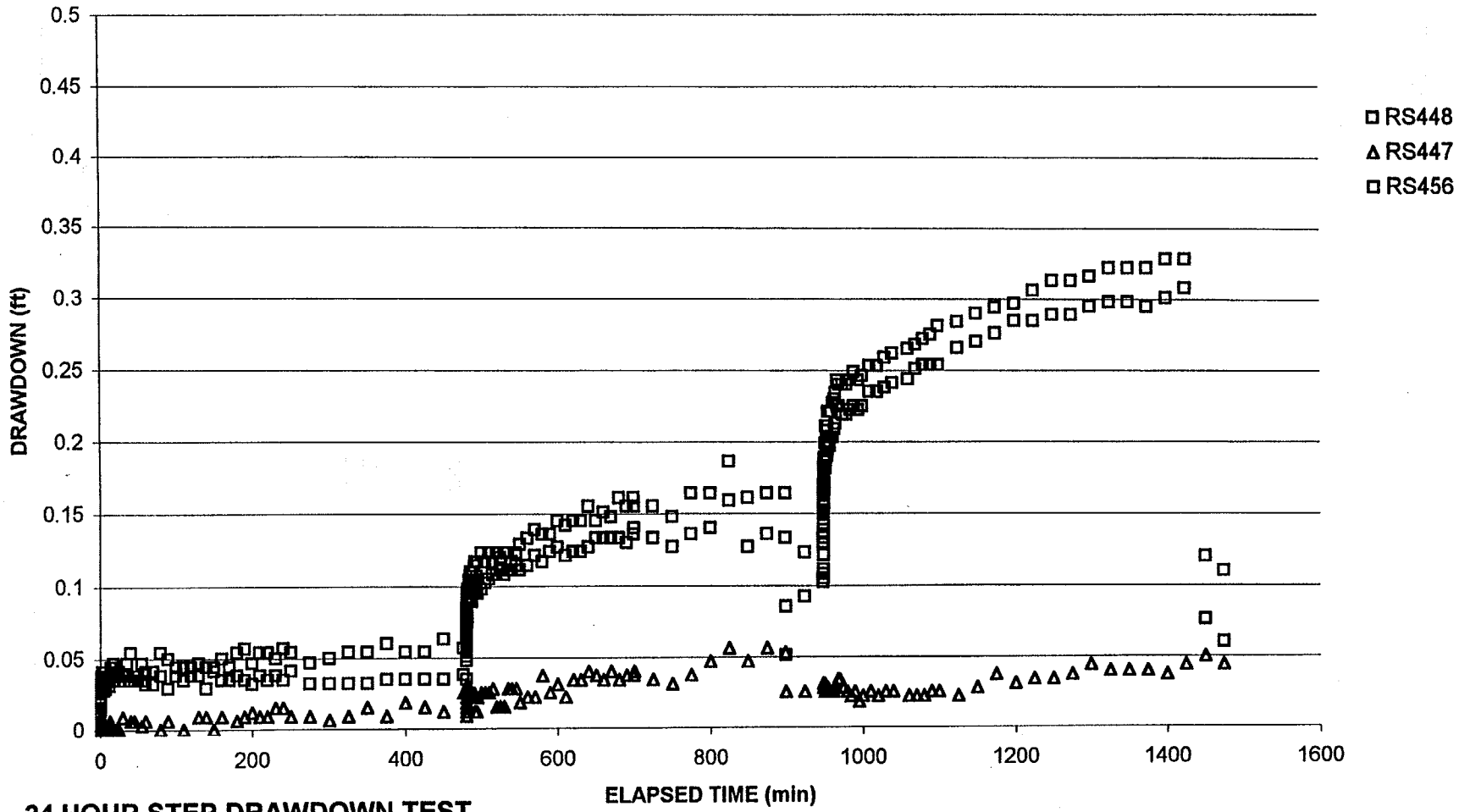
975	2.854	1.498	0.713	0.824	***Step 2 100 gpm***
976	2.939	1.645	0.757	0.875	
976.01	2.949	1.674	0.77	0.875	
976.02	2.958	1.683	0.76	0.881	
976.03	2.958	1.68	0.76	0.881	
976.03	2.958	1.683	0.763	0.887	
976.04	2.958	1.683	0.763	0.884	
976.05	2.977	1.683	0.767	0.881	
976.06	2.958	1.683	0.763	0.881	
976.07	2.949	1.68	0.767	0.887	
976.08	2.968	1.686	0.767	0.878	
976.08	2.968	1.683	0.767	0.878	
976.09	2.958	1.686	0.767	0.878	
976.1	2.958	1.683	0.773	0.884	
976.2	2.977	1.692	0.773	0.887	
976.3	2.968	1.708	0.786	0.887	
976.4	2.996	1.721	0.776	0.894	
976.5	2.996	1.724	0.779	0.891	
976.6	2.996	1.733	0.786	0.903	
976.7	2.996	1.746	0.786	0.903	
976.8	2.996	1.761	0.801	0.906	
976.9	3.015	1.774	0.801	0.9	
977	3.015	1.771	0.798	0.906	
978	3.081	1.855	0.83	0.941	
979	3.11	1.905	0.862	0.951	
980	3.148	1.949	0.896	0.979	
981	3.167	1.986	0.922	0.985	
982	3.195	2.021	0.941	1.011	
983	3.204	2.046	0.957	1.008	
984	3.233	2.068	0.979	1.017	
985	3.242	2.083	0.992	1.023	
986	3.261	2.102	1.007	1.03	
987	3.28	2.118	1.02	1.042	
988	3.28	2.133	1.03	1.045	
989	3.29	2.146	1.039	1.055	
990	3.299	2.155	1.049	1.064	
995	3.337	2.199	1.087	1.074	
1000	3.375	2.237	1.115	1.09	
1005	3.394	2.262	1.128	1.083	
1010	3.413	2.284	1.134	1.096	
1015	3.432	2.296	1.141	1.096	
1020	3.46	2.315	1.147	1.09	
1025	3.47	2.334	1.147	1.087	
1030	3.479	2.343	1.15	1.093	
1035	3.489	2.349	1.153	1.09	
1040	3.498	2.356	1.153	1.096	
1045	3.517	2.365	1.153	1.096	
1050	3.508	2.368	1.156	1.087	
1060	3.527	2.381	1.156	1.087	
1070	3.517	2.387	1.16	1.09	
1080	3.517	2.39	1.166	1.09	

Pumping Well: RS593
Drawdown in Feet

24 HOUR STEP DRAWDOWN TEST
RSA-96

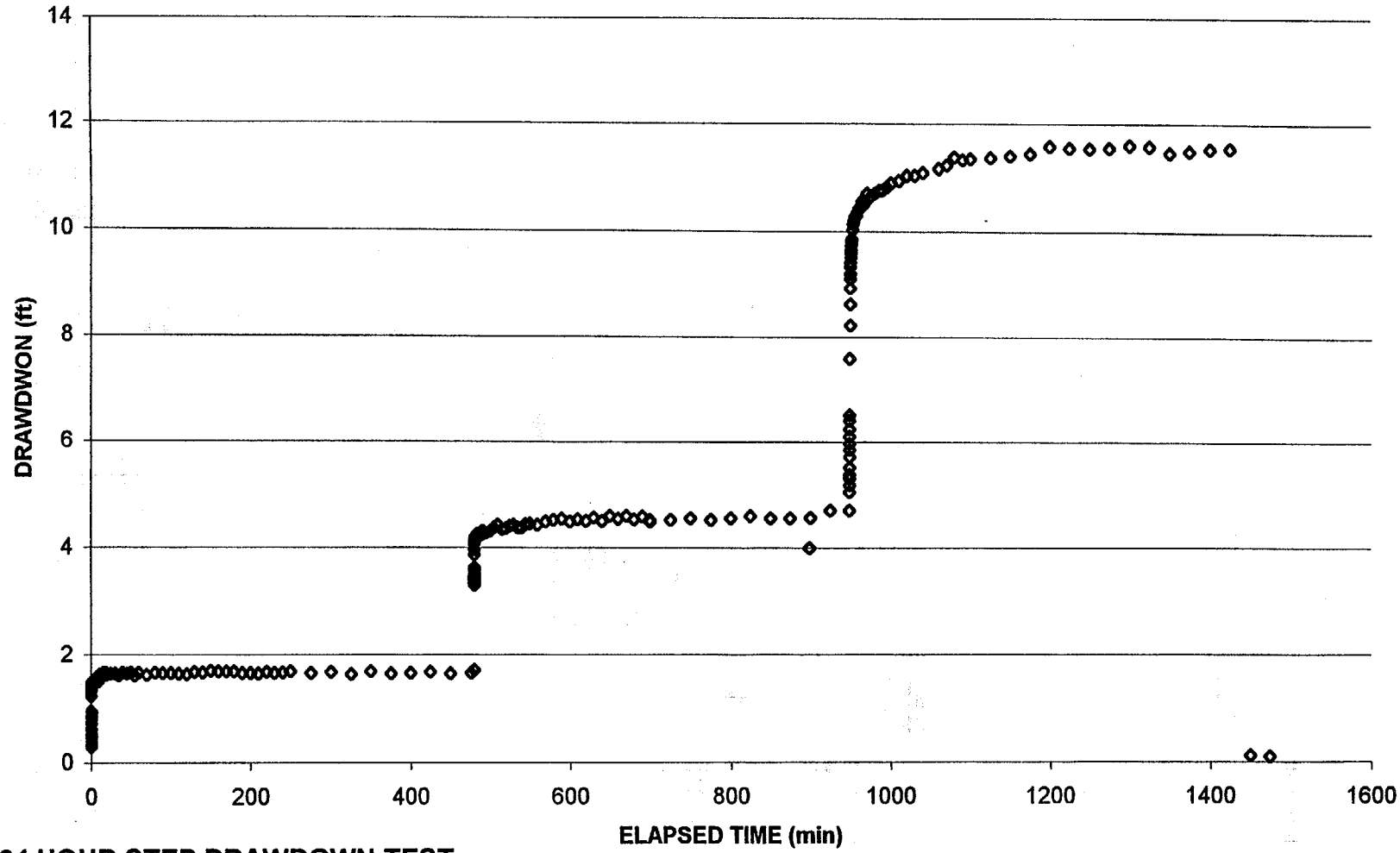
Test date: 4/6/99
Redstone Arsenal
Project: 772650

1090	3.584	2.44	1.128	1.023
1100	3.584	2.446	1.102	1.011
1125	3.631	2.471	1.074	0.957
1150	3.631	2.503	1.064	0.973
1175	3.707	2.537	1.033	0.872
1200	3.745	2.556	0.96	0.812
1225	3.716	2.559	0.963	0.827
1250	3.745	2.593	0.96	0.812
1275	3.764	2.6	0.941	0.793
1300	3.745	2.59	0.931	0.78
1325	3.754	2.571	0.954	0.818
1345	3.745	2.584	0.954	0.805
1350	3.764	2.6	0.954	0.805
1375	3.764	2.603	0.938	0.786
1400	3.783	2.622	0.909	0.764
1425	3.773	2.593	0.9	0.748
1450	3.754	2.578	0.912	0.771
1464	3.745	2.584	0.912	0.764



24 HOUR STEP DRAWDOWN TEST
OBSERVATION WELLS
APRIL 6, 1999
RS592 RSA-96

REDSTONE ARSENAL
HUNTSVILLE ALABAMA



24 HOUR STEP DRAWDOWN TEST
APRIL 6, 1999
RS592 RAS-96

REDSTONE ARSENAL
HUNTSVILLE ALABAMA

Pumping Well: RS592
Drawdown in Feet

24 HOUR STEP-DRAWDOWN TEST
RSA-96

Test Date: 4/6/99
Redstone Arsenal
Project 772650

Elapsed Time	RS592	RS448	RS447	RS456	
0.01	0.523	0.006	0.006	0.009	***Step 0 25 gpm***
0.02	0.466	0.003	0.003	0	
0.03	0.324	0	0.003	0.009	
0.03	0.295	0	0.003	0.003	
0.04	0.381	0.01	-0.003	0.009	
0.05	0.476	0.01	0	0.012	
0.06	0.609	0.003	-0.007	0.006	
0.07	0.714	0.013	0	0.009	
0.08	0.79	0.016	0.006	0.012	
0.08	0.847	0.01	0	0.003	
0.09	0.913	0.006	0.009	0	
0.1	0.942	0.019	0	0.009	
0.2	1.227	0.013	0	0.012	
0.3	1.322	0.026	0	0.019	
0.4	1.379	0.026	0.006	0.019	
0.5	1.398	0.016	0.003	0.028	
0.6	1.417	0.029	-0.003	0.022	
0.7	1.436	0.029	0	0.031	
0.8	1.465	0.022	0.003	0.031	
0.9	1.455	0.029	0.006	0.028	
1	1.474	0.032	-0.003	0.019	
1.2	1.484	0.035	0.009	0.031	
1.4	1.493	0.038	0.006	0.035	
1.6	1.493	0.029	0.009	0.035	
1.8	1.474	0.029	0	0.035	
2	1.474	0.038	0.003	0.038	
3	1.512	0.038	0.006	0.041	
4	1.484	0.035	0.006	0.028	
5	1.493	0.038	-0.01	0.028	
6	1.512	0.032	-0.013	0.041	
7	1.512	0.029	0.003	0.031	
8	1.484	0.032	-0.007	0.035	
9	1.484	0.035	0	0.038	
10	1.598	0.038	0	0.035	
11	1.626	0.035	-0.007	0.038	
12	1.588	0.035	0.003	0.031	
13	1.626	0.035	0.006	0.038	
14	1.626	0.041	0	0.044	
15	1.617	0.041	0.003	0.038	
16	1.655	0.038	0	0.041	
17	1.655	0.035	0	0.044	
18	1.626	0.041	0	0.047	
19	1.617	0.035	-0.003	0.044	
20	1.645	0.041	0	0.044	
25	1.636	0.035	0	0.041	
30	1.636	0.038	0.009	0.038	
35	1.607	0.038	-0.003	0.047	
40	1.655	0.035	0.006	0.054	

Elapsed Time	RS592	RS448	RS447	RS456
45	1.636	0.035	0.006	0.038
50	1.655	0.035	-0.007	0.038
55	1.607	0.035	0.003	0.047
60	1.655	0.032	0.006	0.041
70	1.617	0.032	-0.007	0.041
80	1.655	0.038	0	0.054
90	1.645	0.029	0.006	0.05
100	1.645	0.038	-0.003	0.044
110	1.636	0.035	0	0.044
120	1.626	0.038	-0.007	0.044
130	1.664	0.038	0.009	0.047
140	1.655	0.029	0.009	0.044
150	1.693	0.041	0	0.044
160	1.674	0.035	0.009	0.05
170	1.674	0.035	-0.003	0.044
180	1.674	0.038	0.006	0.054
190	1.645	0.035	0.009	0.057
200	1.645	0.032	0.012	0.047
210	1.636	0.038	0.009	0.054
220	1.664	0.035	0.009	0.054
230	1.645	0.038	0.015	0.05
240	1.655	0.035	0.015	0.057
250	1.674	0.041	0.009	0.054
275	1.645	0.032	0.009	0.047
300	1.664	0.032	0.006	0.05
325	1.626	0.032	0.009	0.054
350	1.674	0.032	0.015	0.054
375	1.636	0.035	0.009	0.06
400	1.645	0.035	0.018	0.054
425	1.664	0.035	0.015	0.054
450	1.636	0.035	0.012	0.063
476	1.645	0.038	0.025	0.057
480	1.702	0.035	0.025	0.054

Elapsed Time	RS592	RS448	RS447	RS456	
480.02	3.289	0.048	0.022	0.06	***Step 2 53 gpm***
480.03	3.346	0.054	0.015	0.069	
480.03	3.375	0.048	0.025	0.06	
480.04	3.432	0.054	0.022	0.072	
480.05	3.479	0.051	0.022	0.066	
480.06	3.47	0.054	0.028	0.066	
480.07	3.498	0.051	0.025	0.076	
480.08	3.565	0.057	0.012	0.069	
480.08	3.574	0.051	0.015	0.063	
480.09	3.603	0.048	0.022	0.066	
480.1	3.622	0.054	0.022	0.066	
480.2	3.859	0.06	0.015	0.069	
480.3	3.954	0.06	0.009	0.076	
480.4	4.068	0.06	0.018	0.082	
480.5	4.097	0.07	0.015	0.076	
480.6	4.097	0.067	0.015	0.085	
480.7	4.116	0.073	0.015	0.082	
480.8	4.116	0.076	0.031	0.088	
480.9	4.144	0.076	0.031	0.079	
481	4.163	0.079	0.018	0.088	
481.2	4.135	0.073	0.028	0.095	
481.4	4.201	0.076	0.018	0.091	
481.6	4.211	0.079	0.025	0.098	
481.8	4.211	0.076	0.022	0.091	
482	4.173	0.076	0.012	0.091	
484	4.258	0.092	0.025	0.104	
485	4.249	0.089	0.022	0.107	
486	4.22	0.095	0.022	0.11	
487	4.23	0.095	0.025	0.101	
488	4.268	0.089	0.025	0.107	
489	4.239	0.095	0.022	0.11	
490	4.306	0.095	0.025	0.104	
491	4.306	0.098	0.022	0.114	
492	4.296	0.095	0.012	0.117	
493	4.277	0.095	0.012	0.104	
494	4.277	0.098	0.012	0.107	
495	4.277	0.095	0.022	0.117	
500	4.306	0.098	0.025	0.123	
505	4.372	0.102	0.025	0.117	
510	4.42	0.105	0.025	0.123	
515	4.344	0.108	0.028	0.117	
520	4.363	0.108	0.015	0.123	
525	4.401	0.111	0.015	0.12	
530	4.42	0.108	0.015	0.123	
535	4.372	0.111	0.028	0.123	
540	4.372	0.111	0.028	0.117	
545	4.439	0.114	0.028	0.123	
550	4.448	0.111	0.018	0.129	

Elapsed Time	RS592	RS448	RS447	RS456
560	4.429	0.114	0.022	0.133
570	4.486	0.121	0.022	0.139
580	4.515	0.117	0.037	0.136
590	4.543	0.124	0.025	0.136
600	4.486	0.127	0.031	0.145
610	4.534	0.121	0.022	0.142
620	4.496	0.124	0.034	0.145
630	4.562	0.124	0.034	0.145
640	4.496	0.127	0.04	0.155
650	4.591	0.133	0.037	0.145
660	4.543	0.133	0.034	0.151
670	4.591	0.133	0.04	0.148
680	4.534	0.133	0.034	0.161
690	4.581	0.13	0.037	0.155
699	4.524	0.136	0.037	0.161
700	4.486	0.14	0.04	0.155
725	4.515	0.133	0.034	0.155
750	4.553	0.127	0.031	0.148
775	4.515	0.136	0.037	0.164
800	4.553	0.14	0.047	0.164
825	4.591	0.159	0.056	0.186
850	4.553	0.127	0.047	0.161
875	4.553	0.136	0.056	0.164
899	3.992	0.133	0.053	0.164
900	4.562	0.051	0.025	0.085
925	4.695	0.092	0.025	0.123
949	4.695	0.105	0.028	0.129

Elapsed Time	RS592	RS448	RS447	RS456	
949.01	5.047	0.105	0.028	0.133	***Step 2 94 gpm***
949.02	5.17	0.105	0.028	0.133	
949.03	5.303	0.102	0.028	0.129	
949.03	5.37	0.102	0.028	0.129	
949.04	5.512	0.102	0.031	0.133	
949.05	5.711	0.105	0.028	0.133	
949.06	5.844	0.108	0.028	0.133	
949.07	5.968	0.105	0.028	0.133	
949.08	6.101	0.108	0.028	0.133	
949.08	6.243	0.111	0.028	0.136	
949.09	6.395	0.105	0.028	0.133	
949.1	6.509	0.105	0.028	0.133	
949.2	7.591	0.121	0.028	0.142	
949.3	8.227	0.13	0.031	0.151	
949.4	8.625	0.136	0.031	0.158	
949.5	8.929	0.146	0.031	0.164	
949.6	9.109	0.149	0.031	0.167	
949.7	9.204	0.152	0.028	0.17	
949.8	9.337	0.155	0.031	0.174	
949.9	9.422	0.159	0.028	0.174	
950	9.517	0.155	0.028	0.177	
950.2	9.602	0.162	0.028	0.18	
950.4	9.65	0.165	0.028	0.183	
950.6	9.735	0.171	0.025	0.186	
950.8	9.811	0.168	0.025	0.189	
951	9.858	0.168	0.025	0.189	
952	10.029	0.181	0.025	0.199	
953	10.133	0.187	0.028	0.211	
954	10.2	0.19	0.028	0.208	
955	10.285	0.193	0.025	0.211	
956	10.276	0.2	0.025	0.221	
957	10.295	0.203	0.025	0.221	
958	10.371	0.197	0.025	0.221	
959	10.39	0.203	0.025	0.221	
960	10.446	0.203	0.025	0.221	
962	10.465	0.203	0.025	0.227	
964	10.579	0.209	0.028	0.23	
966	10.503	0.213	0.028	0.234	
968	10.56	0.225	0.034	0.243	
970	10.721	0.225	0.034	0.24	
975	10.665	0.219	0.028	0.24	
980	10.712	0.219	0.025	0.24	
985	10.769	0.222	0.022	0.243	
990	10.778	0.225	0.025	0.249	
995	10.835	0.222	0.018	0.243	
1000	10.911	0.225	0.022	0.246	
1010	10.949	0.235	0.025	0.253	
1020	11.044	0.235	0.022	0.253	

Elapsed Time	RS592	RS448	RS447	RS456
1030	11.044	0.238	0.025	0.259
1040	11.101	0.241	0.025	0.262
1060	11.167	0.244	0.022	0.265
1070	11.233	0.251	0.022	0.268
1080	11.385	0.254	0.022	0.272
1090	11.328	0.254	0.025	0.275
1100	11.347	0.254	0.025	0.281
1125	11.376	0.266	0.022	0.284
1150	11.404	0.27	0.028	0.29
1175	11.442	0.276	0.037	0.294
1200	11.584	0.285	0.031	0.297
1225	11.546	0.285	0.034	0.306
1250	11.537	0.289	0.034	0.313
1275	11.546	0.289	0.037	0.313
1300	11.603	0.295	0.044	0.316
1325	11.584	0.298	0.04	0.322
1350	11.461	0.298	0.04	0.322
1375	11.499	0.295	0.04	0.322
1400	11.537	0.301	0.037	0.328
1425	11.546	0.308	0.044	0.328
1450	0.115	0.076	0.05	0.12
1474	0.096	0.06	0.044	0.11

APPENDIX B

WATER QUALITY AND CHEMICAL MONITORING RESULTS

Table B-1

Water Quality and Chemical Monitoring Results
24 Hour Step-Drawdown Test, RS715 RSA-95
Redstone Arsenal, Madison County, Alabama

Q (gpm)	Elapsed Time (min)	Temp (°C)	pH	Specific Conductivity (mohs/cm^2)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	$CaCO_3$ (mg/L)	TCE	TCA	DCE	Chloroform	Other Compounds Detected
25	0	18.3	5.78	0.34	6.05	17	135	3400	640	35	30	B
	100	19	7.61	0.288	5.90	0	133	7800	2500	110	47	
	240	17.8	7.67	0.285	6.79	0	131	5800	1700	170	31	
	360	18.3	7.6	0.232	6.07	0	135	5400	1201	97	3.1	DCA, PCE
	480	18.5	7.66	0.282	6.26	0	131	5300	1500	77	<170	
39	600	17.5	7.56	0.283	6.06	0	136	6100	1800	89	38	
	720	17.01	7.58	0.282	6.44	0	135	6600	2100	110	44	
	840	16.4	7.6	0.282	6.45	0	124	5300	1400	81	35	
	960	17.4	7.59	0.282	6.38	0	122	5900	1500	94	<200	
60	1080	17.3	7.65	0.282	6.29	0	130	7300	2100	120	32	
	1200	16.7	6.91	0.274	7.06	0	132	7300	2000	120	<200	
	1320	19.2	7.41	0.315	6.39	0	133	7700	2100	130	31	
	1440	18.5	7.89	0.285	5.60	0	130	8000	2100	130	36	
	Mean	17.8	7.4	0.286	6.3		131.3					
	σ	0.9	0.5	0.024	0.4		4.2					

Notes:

Compounds: TCE- trichloroethene, TCA - 1,1,1, and 1,1,2 trichloroethane, DCE - 1,1 and 1,2 dichlorethene, B - benzene, DCA - 1,1 and 1,2 dichloroethane, PCE - tetrachloroethene

Methylene chloride was detected in the trip blank at 5.3 and 4.3 mg/L. Concentrations of methylene chloride were not detected in any sample at level above 10 X the blank concentration, after accounting for sample dilutions.

Toluene was detected in the trip blank at 0.14 mg/L. Concentrations of toluene were not detected in any sample at level above 5 X the blank concentration after accounting for sample dilution.

RS-715

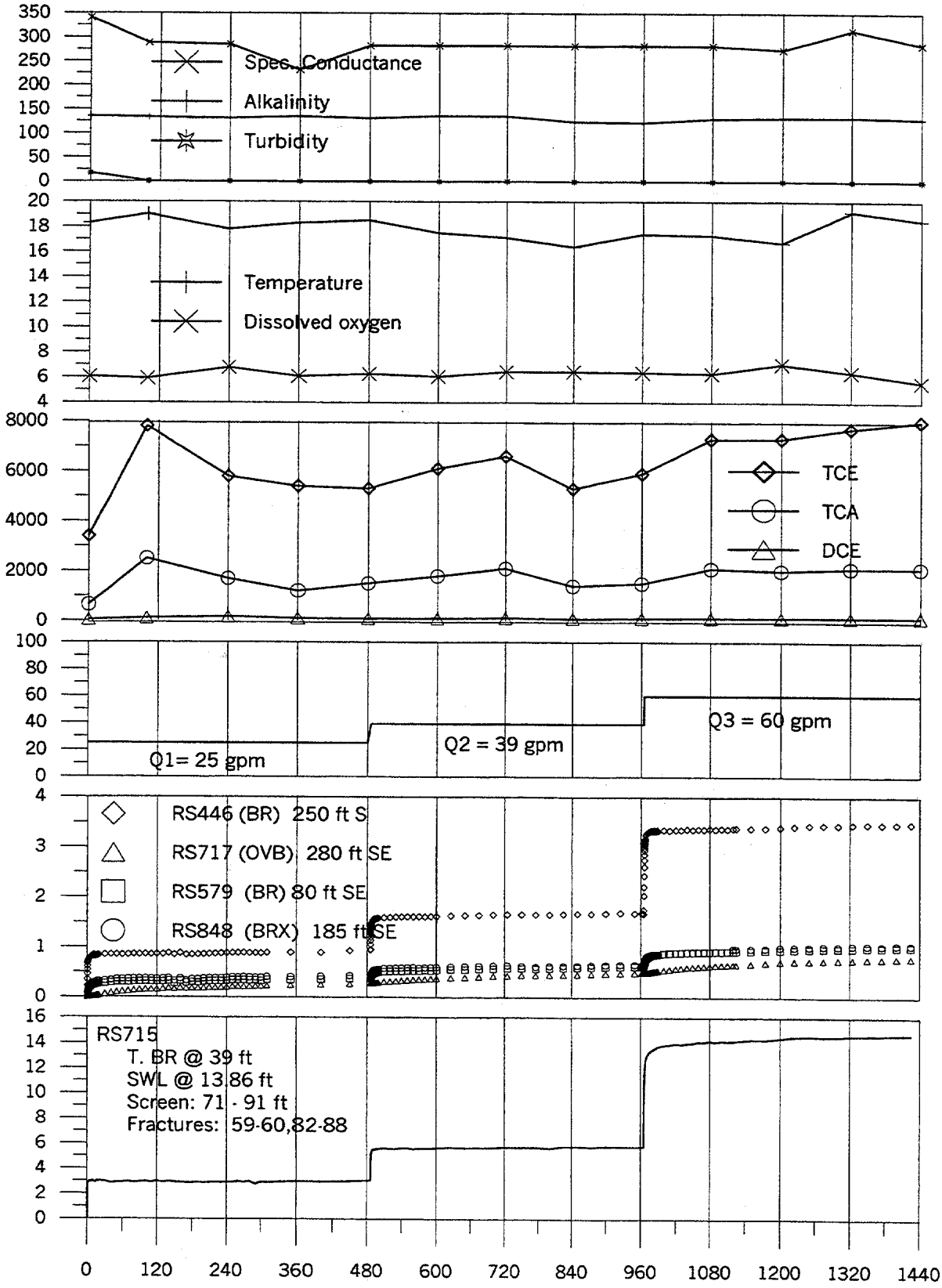

Spec. Conductance
Alkalinity
Turbidity
Temperature
Dissolved oxygen
TCE
TCA
DCE
Q1= 25 gpm
Q2 = 39 gpm
Q3 = 60 gpm
RS446 (BR) 250 ft S
RS717 (OVB) 280 ft SE
RS579 (BR) 80 ft SE
RS848 (BRX) 185 ft SE
RS715
T. BR @ 39 ft
SWL @ 13.86 ft
Screen: 71 - 91 ft
Fractures: 59-60,82-88
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440

Table B-2

Water Quality Monitoring Results
24 Hour Step-Drawdown Test, RS847 RSA-95
Redstone Arsenal, Madison County, Alabama

Q (gpm)	Elapsed Time (min)	Temp (°C)	pH	Specific Conductivity (mohs/cm^2)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	CACO3 (mg/L)	TCE	TCA	DCE
30	0	17.9	6.29	0.415	3.77	298	153	4100	420	75
	120	17.5	7.1	0.374	4.91	46	154	3900	460	86
	240	17.1	6.83	0.368	3.93	35	158	4900	480	95
	360	17.2	6.98	0.361	3.74	27	151	5000	440	87
	480	17.4	7.11	0.356	4.54	21	148	4000	390	55
47	600	17.7	7.12	0.354	4.3	54	150	6900	370	90
	720	18.7	7.07	0.346	4.06	52	143	4100	440	64
	840	18.8	7.09	0.341	4.04	44	135	3200	380	70
	960	18.7	7.05	0.339	4.38	32	135	4100	570	84
97	1080	18.5	6.83	0.335	3.82	156	135	4200	640	110
	1200	17.9	6.64	0.331	3.8	136	137	4400	760	120
	1320	18.3	6.85	0.329	4.29	89	142	4200	520	140
	1440	17.4	6.9	0.328	3.68	67	136	4800	950	150
	Mean	17.93	6.91	0.352	4.10		144.38			
	σ	0.61	0.24	0.024	0.37		8.35			

Notes:
Compounds: TCE- trichloroethene, TCA - 1,1,1, and 1,1,2 trichloroethane, DCE - 1,1 and 1,2 dichlorethene.

RS-847

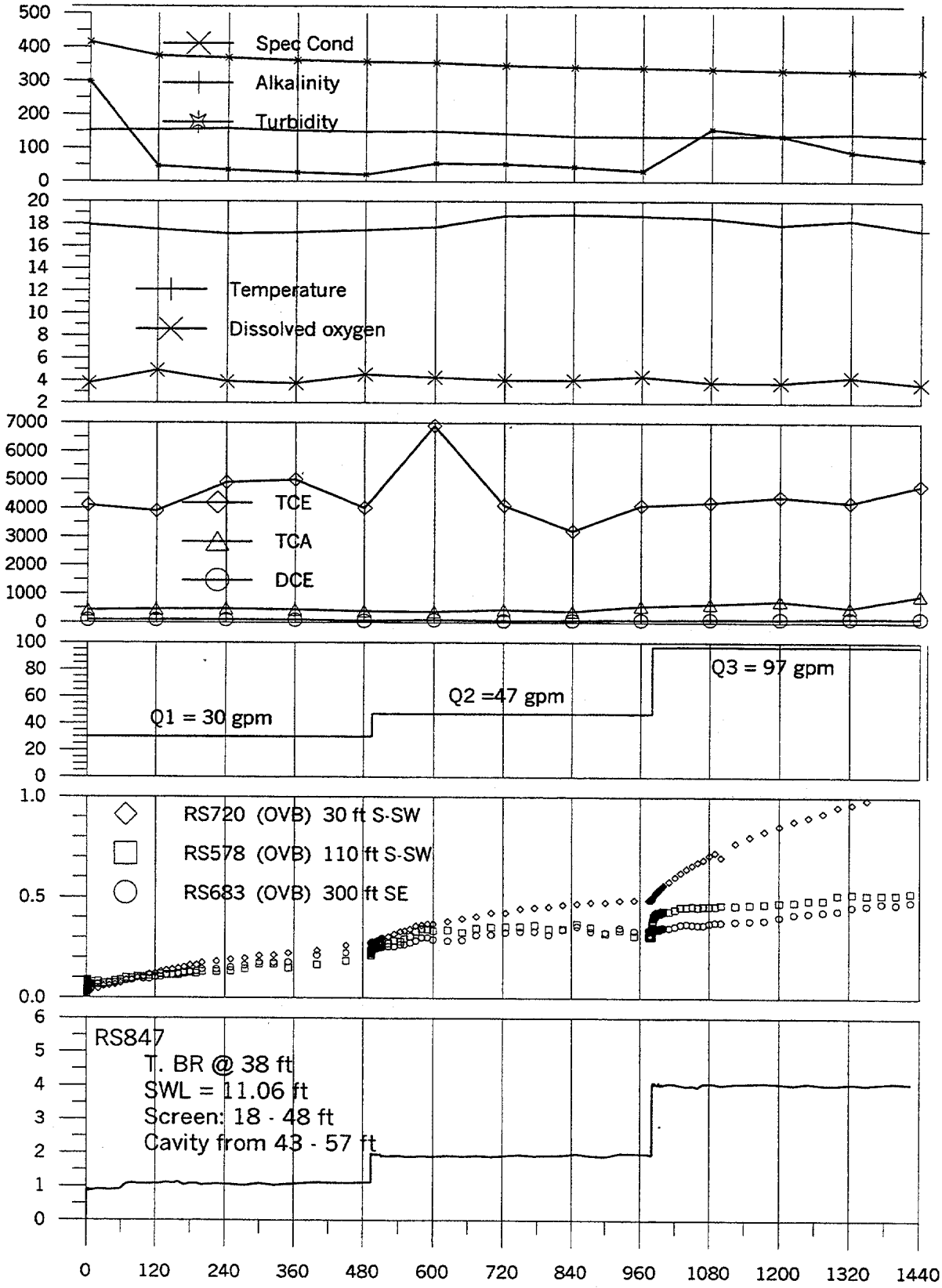

Spec Cond
Alkalinity
Turbidity
Temperature
Dissolved oxygen
TCE
TCA
DCE
Q1 = 30 gpm
Q2 =47 gpm
Q3 = 97 gpm
RS720 (OVB) 30 ft S-SW
RS578 (OVB) 110 ft S-SW
RS683 (OVB) 300 ft SE
RS847
T. BR @ 38 ft
SWL = 11.06 ft
Screen: 18 - 48 ft
Cavity from 43 - 57 ft
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440

Table B-3

Water Quality and Chemical Monitoring Results
24 Hour Step-Drawdown Test, RS848 RSA-95
Redstone Arsenal, Madison County, Alabama

Q (gpm)	Elapsed Time (min)	Temp (°C)	pH	Specific Conductivity (mohs/cm^2)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	$CaCO_3$ (mg/L)	TCE	TCA	DCE	Clf	Other Compounds Detected
36		18.1	6.3	0.280	5.41	1000	138	470	0	12.8	<20	
	120	18	7.45	0.245	5.81	24	119	650	50	7.7	<50	
	240	17.8	7.39	0.248	5.18	16	116	810	98	11	<50	
	360	16.7	7.24	0.251	4.72	10	111	1100	180	15	<50	
	480	16.6	7.22	0.255	5.19	9	115	1300	220	17	<50	
66	600	16.2	7.2	0.250	4.87	94	107	1400	250	29.6	<20	Cb Tet
	720	15.6	7.19	0.257	5.14	74	124	1500	290	32.6	2.8	Cb Tet
	840	17	7.33	0.256	4.81	38	119	1700	330	35	<20	Cb Tet
	960	15.7	7.19	0.260	4.76	41	114	1800	380	37	<50	
93	1080	16.2	7.11	0.260	4.72	320	121	2000	410	28	<100	
	1200	16.3	7.28	0.264	4.78	156	125	2100	450	28	<100	
	1320	17.1	7.46	0.265	4.77	115	126	2300	510	31	<100	
	1440	17.8	7.48	0.265	5.42	65	125	2400	520	33	<100	
	Mean	16.85	7.22	0.258	5.04		120.00					
	σ	0.86	0.30	0.009	0.35		7.94					

Notes:
Compounds: TCE- trichloroethene, TCA - 1,1,1, and 1,1,2 trichloroethane, DCE - 1,1 and 1,2 dichlorethene, DCA - 1,1 and 1,2 dichloroethane, Cb tet - carbon tetrachlorid

RS-848

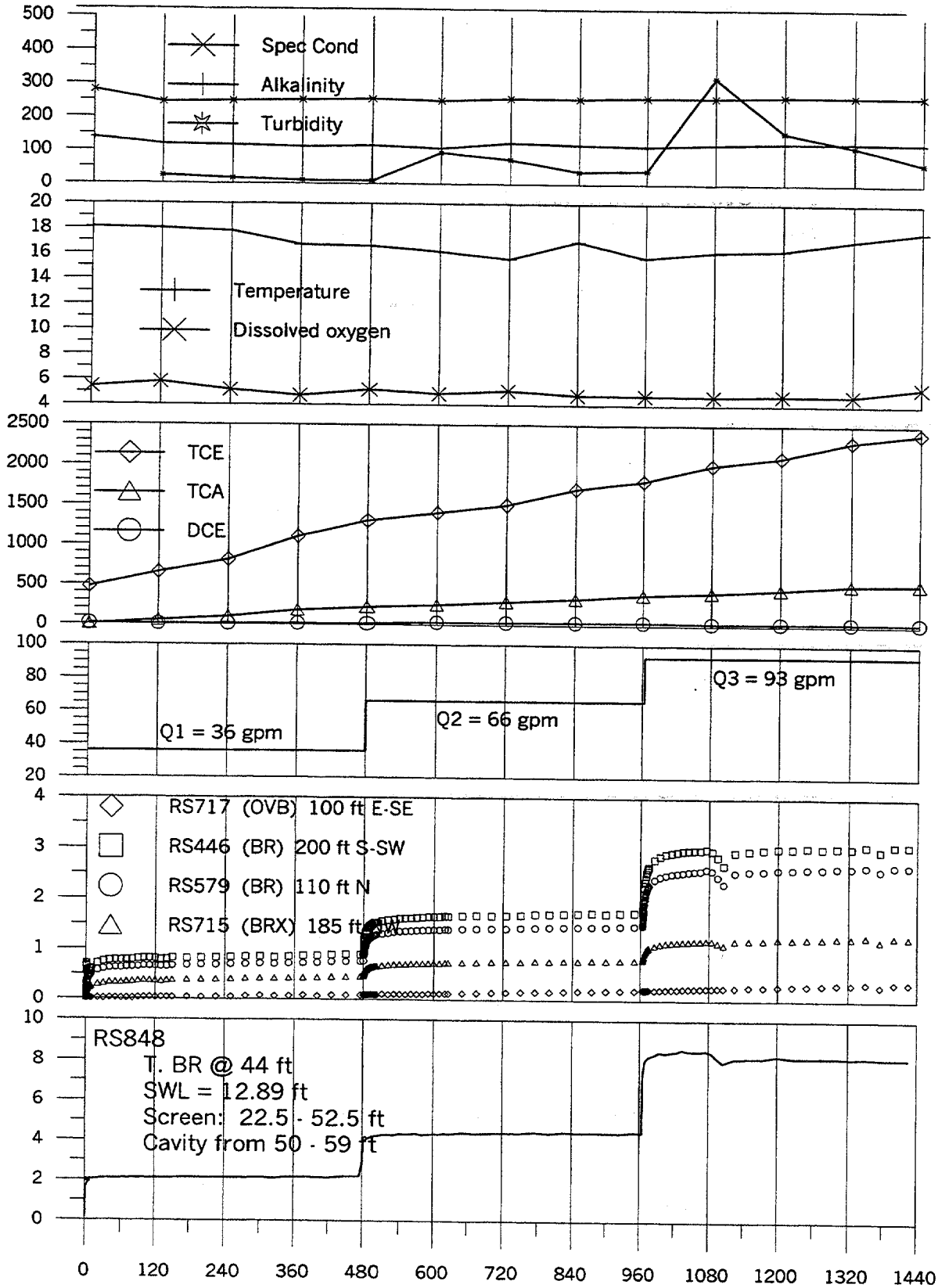

Spec Cond
Alkalinity
Turbidity
Temperature
Dissolved oxygen
TCE
TCA
DCE
Q1 = 36 gpm
Q2 = 66 gpm
Q3 = 93 gpm
RS717 (OVB) 100 ft E-SE
RS446 (BR) 200 ft S-SW
RS579 (BR) 110 ft N
RS715 (BRX) 185 ft SW
RS848
T. BR @ 44 ft
SWL = 12.89 ft
Screen: 22.5 - 52.5 ft
Cavity from 50 - 59 ft
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440

Table B-4

Water Quality and Chemical Monitoring Results
24 Hour Step-Drawdown Test, RS592 RSA-96
Redstone Arsenal, Madison County, Alabama

Q (gpm)	Elapsed Time (min)	Temp (°C)	pH	Specific Conductivity (mohs/cm^2)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	$CaCO_3$ (mg/L)	TCE	TCA
25		17.6	m	0.320	m	173	177	2700	<250
	120	16.8	m	0.321	m	0	168	2500	<250
	240	16.5	m	0.321	m	0	167	2700	<250
	360	16.5	m	0.321	m	0	170	2900	<250
	480	16.7	m	0.322	m	0	162	2900	<250
62	510	16.6	m	0.322	m	13	-		
	600	16.7	m	0.322	m	0	163	2500	<250
	720	17.5	m	0.319	m	0	162	2700	<250
	840	18.8	m	0.315	m	0	155	2800	<250
	1020	19.7	m	0.312	m	0	-		
	1080	17.7	7.31	0.353	3.72	2	162	3400	<360
94	1095	17.6	7.29	0.353	3.66	383	-		
	1200	17.3	7.26	0.352	2.8	62	160	3900	<330
	1230	17.2	7.28	0.352	3.03	58	-		
	1320	17.2	7.28	0.352	3.03	39	162	4100	<400
	1440	17	7.32	0.352	3.66	23	163	4600	<500
	1560	16.9	7.36	0.352	3.91	9	166	4100	<400
	Mean	17.31	7.30	0.333	3.40		164.38		
	σ	0.84	0.03	0.017	0.43		5.38		

Notes:
Compounds: TCE - trichloroethene, TCA - 1,1,1 Trichloroethane.
m: Dissolved oxygen meter malfunction.
- Sample not collected.

RS-592

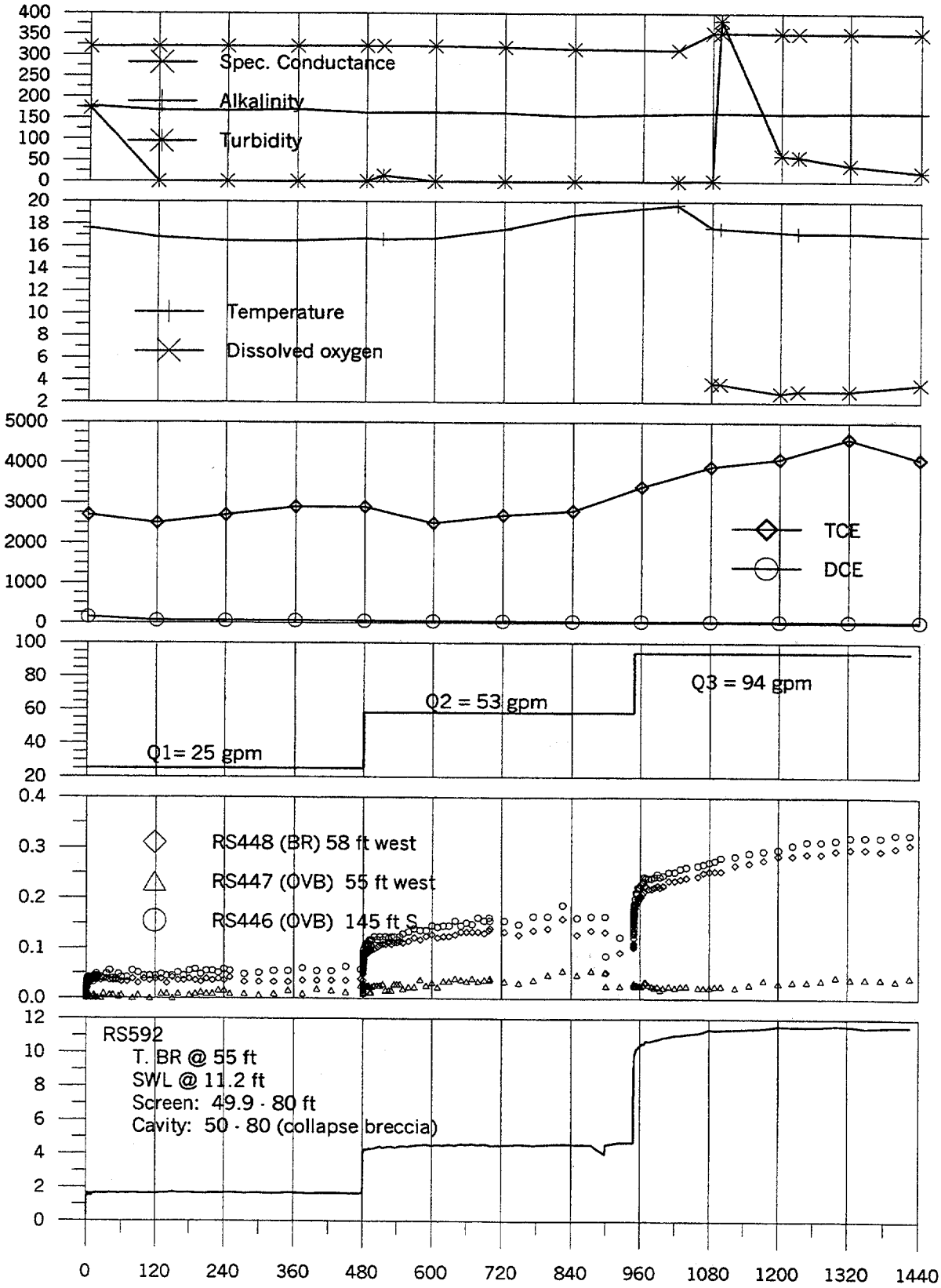

Spec. Conductance
Alkalinity
Turbidity
Temperature
Dissolved oxygen
TCE
DCE
Q1= 25 gpm
Q2 = 53 gpm
Q3 = 94 gpm
RS448 (BR) 58 ft west
RS447 (OVB) 55 ft west
RS446 (OVB) 145 ft S
RS592
T. BR @ 55 ft
SWL @ 11.2 ft
Screen: 49.9 - 80 ft
Cavity: 50 - 80 (collapse breccia)
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440

Table B-5

Water Quality and Chemical Monitoring Results
24 Hour Step-Drawdown Test, RS593 RSA-96
Redstone Arsenal, Madison County, Alabama

Q (gpm)	Elapsed Time (min)	Temp (°C)	pH	Specific Conductivity (mohs/cm^2)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	$CaCO_3$ (mg/L)	TCE	TCA	DCE	Other Compounds Detected
25		20.5	6.87	0.366	3.38	0	160	57000	<1500	<1500	
	135	21	7.06	0.333	2.86	0	172	37000	<1000	230	
	255	19.3	6.86	0.337	2.54	0	164	35000	<1500	<1500	Mth C
	375	18.9	6.88	0.337	3.59	0	164	31000	<1500	<1500	Mth C
	495	18.9	6.91	0.338	2.85	0	160	31000	960	<1500	Mth C
56	615	18.3	7.08	0.337	3.65	0	168	34000	<1500	<1500	Mth C
	735	18.4	7.16	0.339	3.14	0	174	31000	<1500	<1500	
	915	18.4	7.3	0.305	m	0	165	29000	<1000	310	
	985	17.9	7.32	0.293	m	0	-				
100	1095	17.8	7.42	0.325	m	22	164	22000	<1700	<1700	Brom
	1215	17.9	7.53	0.319	m	11	164	23000	<2000	<2000	Brom
	1335	18.4	m	0.324	m	6	164	25000	<2500	<2500	
	1455	21.2	m	0.332	m	0	167	31000	<2000	960	
Mean		19.0	7.1	0.330	3.1		165.5				
σ		1.2	0.2	0.018	0.4		4.2				

Notes:
Compounds: TCE - trichloroethene, TCA - 1,1,1-Trichloroethane, DCE - 1,1 Dichloroethene *and*,2-Dichloroethene Mth C - methylene chloride
Brom - Bromomethene.
m: Dissolved oxygen meter malfunction.
- Sample not collected.

RS-593

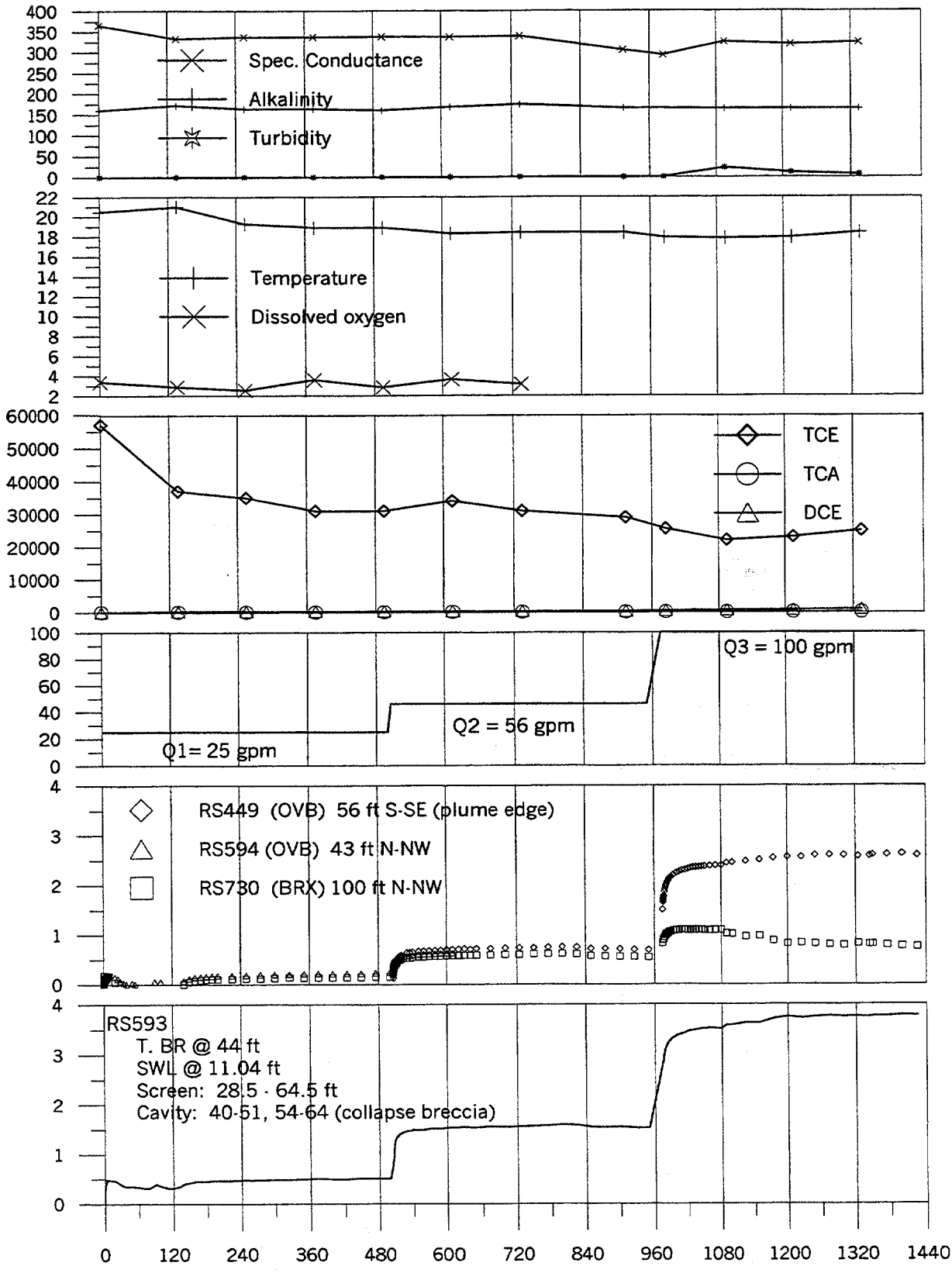

Spec. Conductance
Alkalinity
Turbidity
Temperature
Dissolved oxygen
TCE
TCA
DCE
Q1= 25 gpm
Q2 = 56 gpm
Q3 = 100 gpm
RS449 (OVB) 56 ft S-SE (plume edge)
RS594 (OVB) 43 ft N-NW
RS730 (BRX) 100 ft N-NW
RS593
T. BR @ 44 ft
SWL @ 11.04 ft
Screen: 28.5 - 64.5 ft
Cavity: 40-51, 54-64 (collapse breccia)
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440

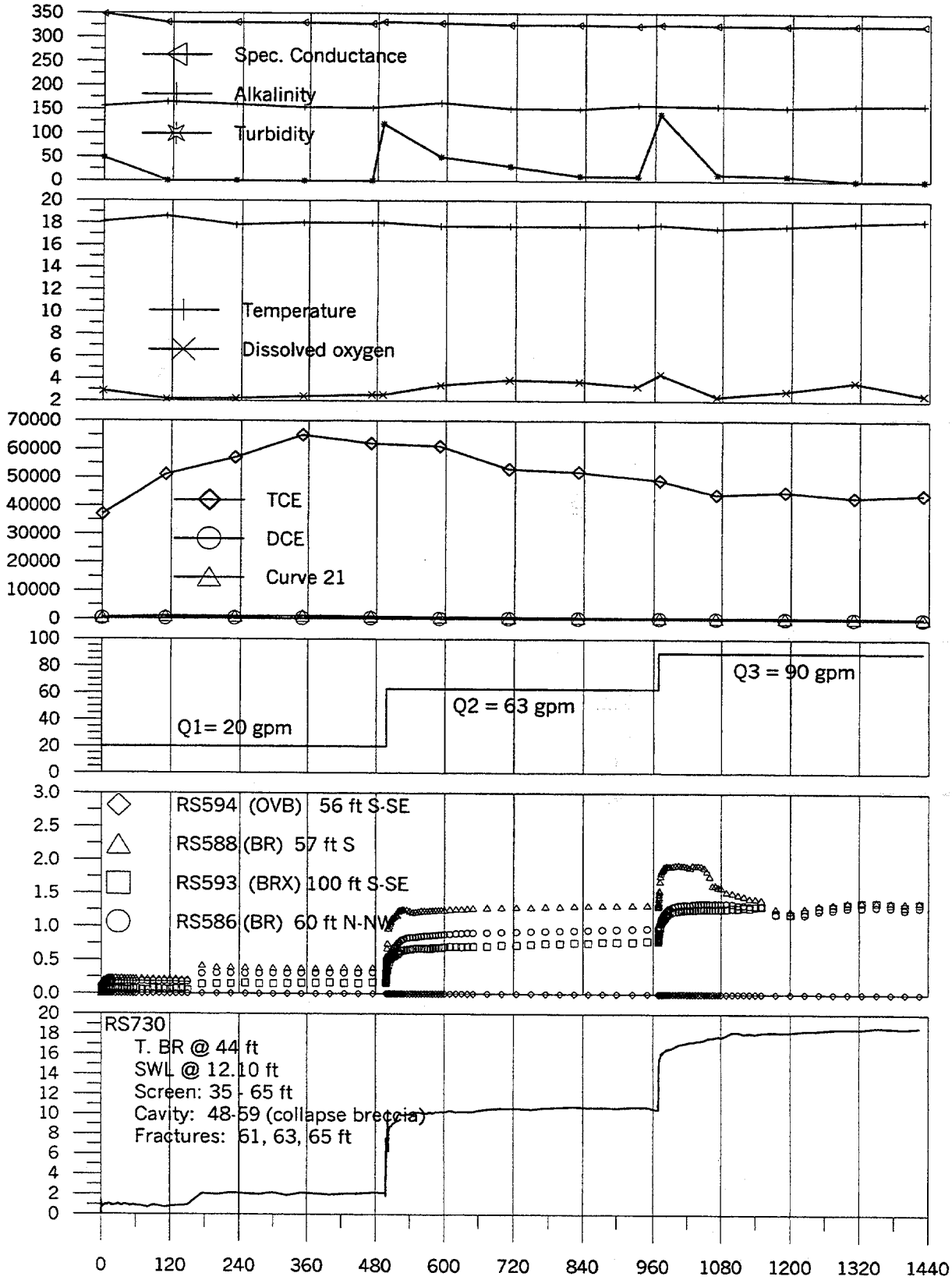
Table B-6

Water Quality Parameter Monitoring
24 Hour Step-Drawdown Test, RS730 RSA-96
Redstone Arsenal, Madison County, Alabama

Q (gpm)	Elapsed Time (min)	Temp (°C)	pH	Specific Conductivity (mohs/cm²)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	$CaCO_3$ (mg/L)	TCE µg/L	TCA µg/L	DCE µg/L	Other Compounds Detected
20		18.1	6.78	0.348	2.89	48	156	37000	310	530	
	110	18.6	7.13	0.33	2.16	0	165	51000	<2000	1100	
	230	17.8	7.15	0.33	2.2	0	160	57000	<2000	1000	
	350	18	7.18	0.33	2.41	0	154	65000	360	1200	
	470	18	7.16	0.328	2.55	0	153	62000	<2000	1000	
63	490	18	7.16	0.332	2.55	120	-				
	590	17.8	7.25	0.329	3.4	50	164	61000	<2000	800	
	710	17.7	7.28	0.326	3.89	30	152	53000	<2000	710	
	830	17.7	7.2	0.326	3.73	10	151	52000	<2000	660	
	930	17.7	7.19	0.324	3.31	9	159				
90	970	17.8	7.21	0.326	4.42	140	-	49000	<2000	610	
	1070	17.5	7.14	0.325	2.39	13	157	44000	<2000	590	
	1190	17.7	7.17	0.324	2.89	10	154	45000	<2000	620	
	1310	18	7.18	0.325	3.7	0	158	43000	<2000	520	
	1430	18.2	7.18	0.325	2.55	0	160	44000	<2000	500	
	Mean	17.9	7.2	0.329	3.0		157.2				
	s	0.3	0.1	0.006	0.7		4.4				

Notes:
Compounds: TCE- trichloroethene, TCA - 1,1,1, and 1,1,2 trichloroethane, DCE - 1,1 and 1,2 dichlorethene, B - benzene, DCA - 1,1 and 1,2-dichloroethene.
- Measurement or sample was not collected.
No other compounds were detected.

RS-730


Spec. Conductance
Alkalinity
Turbidity
Temperature
Dissolved oxygen
TCE
DCE
Curve 21
Q1= 20 gpm
Q2 = 63 gpm
Q3 = 90 gpm
RS594 (OVB) 56 ft S-SE
RS588 (BR) 57 ft S
RS593 (BRX) 100 ft S-SE
RS586 (BR) 60 ft N-NW
RS730
T. BR @ 44 ft
SWL @ 12.10 ft
Screen: 35 - 65 ft
Cavity: 48-59 (collapse breccia)
Fractures: 61, 63, 65 ft
0
120
240
360
480
600
720
840
960
1080
1200
1320
1440