PUBLIC UTILITIES BOARD
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Step 2 Report

FEASIBILITY INVESTIGATION

Aquifer Storage and Recovery System

Submitted to

Brownsville Public Utilities Board
Brownsville, Texas

By

CH2MHILL

September 1997

CH2M HILL
613 NW Loop 410
Suite 200
Spectrum Building
San Antonio, TX
78216-5831
Tel 210.377.3081
Fax 210.349.8944

CH2MHILL

September 19, 1997

116700.M0.ZZ

Mr. Kelvin S. Hinrichs, P.E.
Brownsville Public Utility Board
1425 Robinhood Drive
PO Box 3270
Brownsville , TX 78520-3270

Dear Mr. Hinrichs:

Subject: Aquifer Storage Recovery Feasibility Investigation

CH2M HILL is pleased to transmit 10 copies of the final report for the second phase, Step 2, of the Aquifer Storage Recovery Feasibility Investigation. All review comments have been incorporated. Also included are nine bound copies and one unbound copy of the report to be forwarded to Mr. Steve Densmore at the TWDB in Austin.

It has been a pleasure working with you on this project. We are prepared to proceed with the next phase at your convenience.

Sincerely,

CH2M HILL

J. Michael Anglea, P.E.
Project Manager

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SECTION 1

Introduction

An Aquifer Storage Recovery (ASR) test program is currently being conducted for the Brownsville Public Utilities Board (PUB). The program was designed to determine the feasibility of ASR for the PUB and includes three steps:

1. Feasibility Investigation
2. Test Drilling Program
3. ASR Prototype Facility Construction and Testing

Step 1, the Feasibility Investigation, was completed in January 1996, and found that an ASR facility could benefit the PUB by providing large volume, treated water storage for Rio Grande water available through PUB Permit 1838. Permit 1838 allows the PUB to divert water from the Rio Grande whenever flows exceed 25 cubic feet per second (cfs). The ASR application could potentially help the PUB by extending the effective use of their existing water rights and water treatment plants' (WTP) ability to meet peak demands. Additionally, the Step 1 investigation identified three potential aquifer zones that had the potential for use as an ASR storage zone and recommended continuing the test program by conducting Step 2.

Step 2 of the ASR test program began in October 1995, and is the subject of this report. The work recently completed under Step 2 consisted of a test drilling program to investigate the three potential aquifer zones in the area. The focus of the investigation was to construct soil borings and monitoring wells to assess the potential for underground storage of treated drinking water in any of the three zones.

The test drilling was provided by the Texas Water Development Board (TWDB), using the TWDB drilling rig and crew. The construction work encompassed 7 months and included the construction of six borings and three monitoring wells.

This report presents a summary of the test drilling program, the test results, and recommendations regarding ASR feasibility for the PUB.

SECTION 2

Description of Field Investigation

The field investigation consisted of drilling test borings into the three geologic units of interest to investigate their potential use as ASR storage zones. TWDB provided all construction labor and equipment for the drilling and geophysical logging, and provided substantial testing assistance to the engineer, CH2M HILL. This work was provided by TWDB to the PUB for only the cost of materials and expenses incurred while performing the work. TWDB labor and use of equipment were provided through the TWDB grant program at no cost to the PUB. The involvement of the TWDB through this arrangement provided the construction services for this work at substantial savings to the PUB, and helped greatly in the success of this project.

Methodology

The intent of the drilling program was to investigate three potential geologic zones for their potential use as an ASR storage zone. These three zones were described in the Step 1 report, *Feasibility Investigation, Aquifer Storage and Recovery System,* CH2M HILL, January 1996, and are listed with their expected depth intervals in Table 2-1.

TABLE 2-1
Potential ASR Zones

Zone Designation	Expected Depth Interval (feet, below land surface [bls])	Typical Lithology
Gravel Zone	150 to 225	Gravel, Sand, Clay
Intermediate Zone	200 to 400	Sand, Gravel, Silt, Clay
Lower Zone	400 to 1500 +	Sand, Silt, Clay

If a suitable geologic zone was identified during this program, subsequent activities during this investigation would work toward developing that zone for future ASR use. For this reason, drilling sites were chosen that could support the drilling activities and that could also be used for future ASR testing. This required the site be within access to potable water for testing, and have a location for test water discharge. Furthermore, if ASR was found feasible at the testing location, it was desirable for the site to be conducive for future ASR development and be in a location where an ASR application could benefit the PUB.

The drilling program was initially structured to include three borings at two sites. If suitable geologic conditions were identified, each of the borings could be completed into a monitoring well for further testing. The two sites initially chosen were the two PUB WTPs. These sites met the criteria for future ASR testing and development, and were in locations that appeared promising based on previous test drilling in the area.

Two of the borings planned for the test program were to be drilled to approximately 450 feet and completed into monitoring wells in the Gravel or Intermediate Zone. These borings were termed the shallow borings. The plan was to construct one of these shallow borings at each WTP. The third boring was termed the deep boring and was to be drilled to approximately 1,500 feet and completed into a monitoring well in the Intermediate or Lower Zone. The plan was to construct this deep boring and monitoring well at the location found to be most suitable for ASR testing.

The borings constructed during this program were all drilled using the mud rotary method. Prior to or concurrent with the TWDB mobilizing to each site, the selected sites were secured by temporary fencing, and mud pits were constructed. During the drilling of all borings, cuttings were obtained at 5-foot intervals and stored onsite in sample bags. Geophysical logs were run on the borings by the TWDB, and short duration pumping tests and water samplings were conducted on the completed monitoring wells.

The soil boring logs are included in Appendix 1.

A second groundwater exploration program was conducted by the PUB during the time that overlapped with the ASR program. This was the "Development of Brackish Groundwater Resources," project that was conducted by the team of NRS Consulting Engineers, Boyle Engineering Corp., and R.W. Harden & Associates. The work under the brackish water project included construction of three new exploratory borings and test wells; however, the construction of two of these borings did not occur until after the ASR drilling program was complete. The information obtained from the brackish water project was used in the ASR project to support the conclusions and help confirm areas for future ASR applications. The brackish water project is cited where information from that project is presented herein.

Construction and Testing Activities

The construction of the soil borings during this program verified that the area investigated is generally underlain by semipermeable clays, silts, and fine sand. Although these materials are of geologic interest, they are not of prime interest to this ASR investigation. The intent of this work was to locate a geologic interval that could produce substantial quantities of groundwater and also be used as an underground storage reservoir. Geologic intervals considered to have that potential were identified previously as the Gravel, Intermediate, and Lower Zones.

The following discussion reports the general lithology observed in the depth intervals where the Gravel, Intermediate, and Lower Zones were expected. If not specifically discussed, intervals other than those mentioned were observed to be either clay, silt, and fine sand, or a combination of these materials.

Construction of Boring B-1 began on November 21, 1995, at Site No. 1, located adjacent to the PUB WTP No. 2. The boring was located on the south side of the water plant, between the PUB offices and the WTP. All borings and drilling sites are identified in Figure 2-1.

Boring B-1 was constructed to a depth of 463 feet. The results of the boring indicated the Gravel Zone was encountered at a depth of 198 to 219 feet below land surface (bls). Sand and silty sand were encountered from about 440 feet to the total depth of the boring at

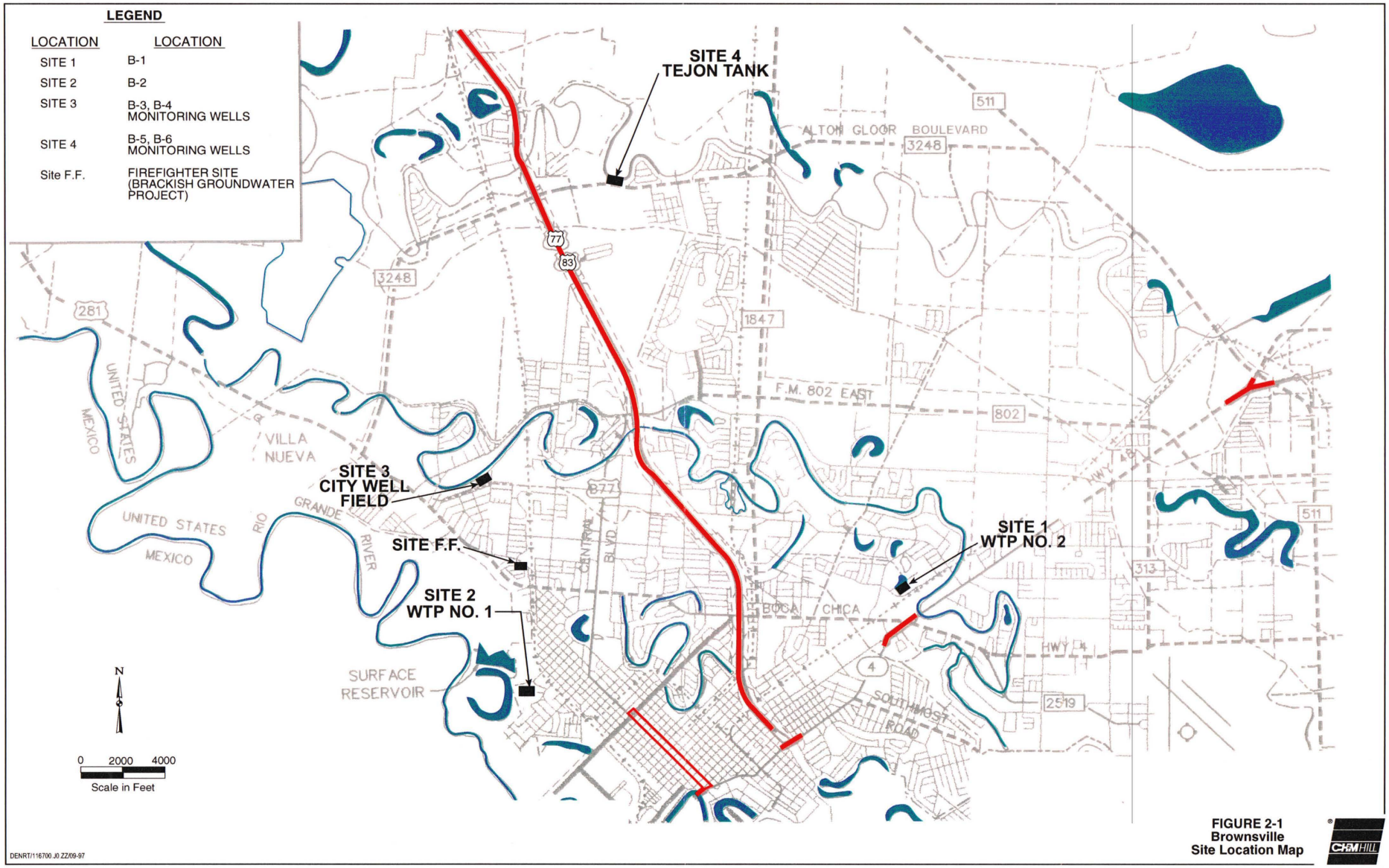

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FIGURE 2-1
Brownsville
Site Location Map

460 feet bls and would probably be considered to be the Intermediate Zone. However, the material at the Intermediate Zone depth was found not useable for ASR purposes because of its fine grains and apparent low water transmitting properties.

The Gravel Zone at the Boring B-1 site consisted of a total thickness of 21 feet. However, only about 10 feet of that thickness was clean gravel. The remaining 11 feet was comprised of sand (200 to 205 feet) and clayey gravel (215 to 220 feet), as identified by the drill cuttings.

The Gravel Zone at this site appeared useful for ASR purposes; however, it was estimated that at the location drilled, relatively low well yields would be expected. For this reason, Boring B-1 was plugged, and the drilling rig was moved to the next site, WTP No. 1.

Construction of Boring B-2 began on December 1, 1995, at Site No. 2, a location on the grounds of WTP No. 1. The boring was located just east of the WTP facilities, in an open area west of the railroad tracks. The boring was constructed at this site to a depth of 472 feet. The results of the boring indicated that the Gravel Zone did not exist at this location. Fine to medium sand was found at a depth of 155 to 190 feet bls. Sand, silty sand, and clay were encountered in various intervals from 190 feet to the total depth of the boring at 460 feet bls. The geologic material at the expected Gravel Zone depths and at the expected Intermediate Zone depths was found not useable for ASR purposes because of its fine grains and apparent low water-transmitting properties.

The construction of Boring B-2 was completed on December 13, 1995, 23 days after beginning the drilling program at WTP No. 2. The results of the drilling to this point did identify one location where ASR may be feasible (WTP No. 2); however, the location tested indicated that relatively low pumping yields may result there. However, the lithology encountered at the WTP No. 2 site indicated that if the Gravel Zone was found in an area where higher yields could be obtained, the zone may be a very good choice for ASR applications.

The progress of the test drilling was much faster than expected, and for this reason, it was proposed to the TWDB that additional sites around the PUB service area be investigated. Available information was reviewed to identify additional sites that met the criteria for future ASR activities and that may overlie an appreciable Gravel Zone. Part of this review included producing a map of potential Gravel Zone thickness from existing well logs in the area. This map was assembled primarily from the data presented in the TWDB Report 279, and is presented in Figure 2-2.

An area within the City of Brownsville that was the location of an old City wellfield was identified as a likely area to encounter the Gravel Zone. Additionally, areas in the north portions of the City were identified from TWDB reports as areas where the Gravel Zone potentially could exist. Based on this information, two additional drilling sites were selected. One was a City-owned lot in the City Wellfield area, which was the location of an old City well. The other was an elevated storage tank on Alton Gloor Boulevard in the north area of the PUB service area. This elevated tank is known as the Tejon Tank. These locations are shown in Figure 2-2 as Site Nos. 3 and 4, respectively.

Construction of Boring B-3 began on December 15, 1995, at Site No. 3 in the City Wellfield. The site is located on the west side of Center Street, just south of the resaca. The boring was

constructed at this site to a depth of 470 feet. The results of the boring indicated the presence of the Gravel Zone at a depth of 168 to 195 feet bls. Sandy silt, silty sand, and clay were encountered from about 415 feet to the total depth of the boring at 470 feet bls and would probably be considered to be the Intermediate Zone. However, the material at the Intermediate Zone depth was found not useable for ASR purposes because of fine grains and apparent low water-transmitting properties.

The Gravel Zone at this site was seen to consist of a total thickness of 27 feet however, only about 10 feet of that thickness was clean gravel. The remaining 12 feet was comprised of sand (168 to 180 feet) and clayey gravel (190 to 195 feet), as identified by the drill cuttings.

The drilling results at Boring B-3 were similar to those at Boring B-1 at the WTP No. 2 Site. However, Boring B-3 was constructed within 77 feet from an existing City Wellfield well. Previous reports (TWDB 279) and maps of the area indicate that the City Well on this site may be City Well No. 8. Well records indicate that this well was capable of producing 900 gallons per minute (gpm) with the pump set at 160 feet. Report TWDB 279 also indicates that at least one of the old City wells could produce groundwater at rates up to 800 gpm. This information suggested that reasonable quantities of water could possibly be produced from gravel deposits similar to what was found in Boring B-1 and B-3. It was decided to complete monitoring well TW-1 in the B-3 boring and conduct the first aquifer test.

Monitoring Well TW-1 was completed by plugging Boring B-3 with neat cement grout. The well was completed using 6-inch steel casing, 0.040-inch slot stainless steel shutter screen, and U.S. Standard Sieve Size 8 to 16 silica gravel for the gravel pack. The screen slot size was selected based on a sieve analysis of the cuttings. The screen was set from 160 to 200 feet bls. The sieve analysis results are included in Appendix 2.

Neat cement grout was placed in the well annulus from the top of the gravel pack to ground surface. After the cement set, the drilling mud was flushed out of the casing with fresh water using a tremmie pipe set in the bottom of the well. The well was then pumped using a 7-1/2 horsepower (hp) submersible pump for several hours until the produced water was clear.

A pumping test was conducted on TW-1 on January 23, 1996. The existing City Wellfield well was used as a monitoring well during the test. The well was pumped at the constant rate of 63 gallons per minute (gpm) for approximately 8 hours. Water levels were measured regularly throughout the test in both wells, and water quality samples were obtained. The test is discussed in more detail later in this report.

A second boring, B-4, was then constructed at Site No. 3, in the City Wellfield. Construction of Boring B-4 began on January 30, 1996. The boring was located approximately 100 feet to the northwest of TW-1. The intent of Boring B-4 was to investigate the Lower Zone at this site by drilling to approximately 1,500 feet. Boring B-4 was completed to 1,047 feet when the TWDB crew shut down activities at the end of a shift. During the down time, the boring collapsed and a small sink hole developed around the boring. The drill rig was moved offsite, and the boring was abandoned.

The collapse of Boring B-4 was attributed to the collapse of a washed out zone near the top of the boring. The boring was constructed without surface casing, which was the standard procedure followed for all of the borings to this point. It is believed that shallow

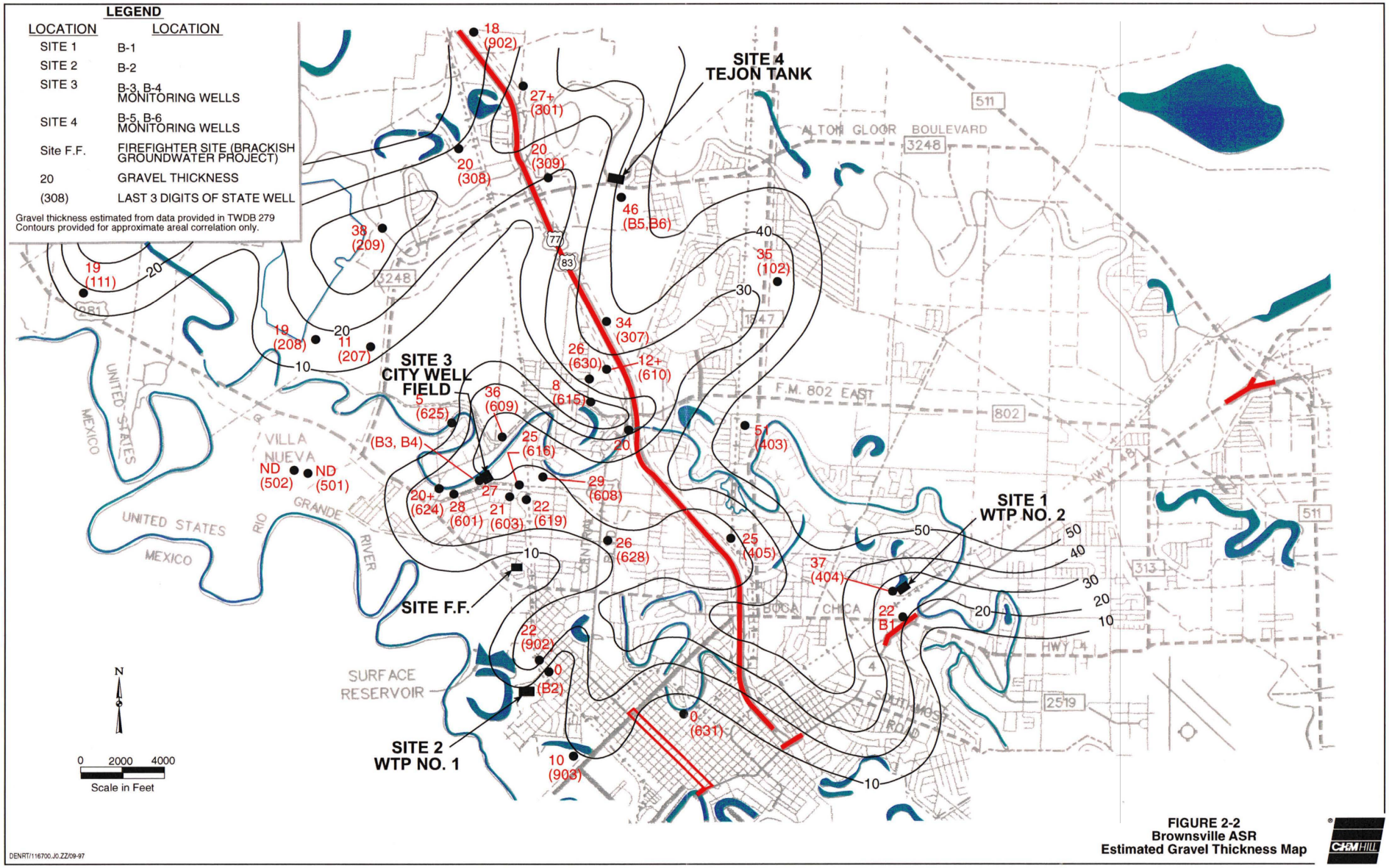

FIGURE 2-2
Brownsville ASR
Estimated Gravel Thickness Map

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groundwater caused the drilling mud in the borehole to thin, causing the washed out area to collapse.

The drilling rig was then moved to the fourth and final site, the Tejon elevated storage tank site on Alton Gloor Boulevard. The intent at the final site was to investigate the Lower Zone and to obtain information on the lateral extent of the Gravel Zone identified at Site No. 3. Construction of Boring B-5 began on February 16, 1996. The boring was located on the north side of Alton Gloor Boulevard and on the east side of the Tejon Tank. The boring was constructed at this site to a depth of 1,500 feet. The results of the boring indicated the presence of the Gravel Zone at a depth of 184 to 230 feet bls. Similar to the other borings, the sediments in the depths expected for the Intermediate Zone were clayey and silty with some sands. These sediments appeared to be capable of producing only minimal quantities of water and are not considered useful for ASR applications.

Sandy clay was encountered in the deep intervals of the boring. A distinct Lower Zone capable of producing more than minimal quantities of groundwater was not found. However, a monitoring well was completed in the deep intervals of this boring to obtain a water sample and characterize the quality from the Lower Zone.

Monitoring Well TW-2 was constructed in the borehole from Boring B-5. It was intended to set the well screen from 1,140 to 1,180 feet in the boring and a blank sump from 1,180 to 1,200 feet. However, while running the casing, resistance was encountered at a depth of 1,135 feet, and the casing would not move downward from this point. The drill string was then run inside the casing and bottom was tagged at a depth of 1,105 feet. It is believed that the screen either collapsed or separated at that point. A 5-foot-long precast cement plug was prepared and pushed into the well to plug the well above the collapsed zone. The gravel pack was then set around the well screen, and the casing was cemented to the ground surface. The final screen was set from a depth of 1,085 to 1,125 feet; however, the screen was damaged at 1,105 feet where a precast cement plug was placed.

A second boring, B-6, was then constructed at Site No. 4, the Tejon Tank. The intent of Boring B-6 was to install a monitoring well in the Gravel Zone identified at this site. Construction of Boring B-6 began on April 29, 1996. The boring was located approximately 50 feet to the south of TW-3. Boring B-6 was completed to 230 feet. The results of the boring indicated the presence of the Gravel Zone at a depth of 184 to 230 feet bls. The boring was completed as Monitoring Well TW-3. The details of all of the borings and monitoring wells are summarized in Tables 2-2 through 2-4. Monitoring well completion diagrams are included in Appendix 3.

Construction of the three borings completed under the brackish groundwater project began concurrently with the ASR project testing at the Tejon Tank site. The three borings for the brackish project consisted of an exploratory boring and test well at the following three locations:

- PUB WTP No.1
- Riverbend Site
- Firefighter Site

The exploratory boring at WTP No. 1 was constructed in the same area as the ASR exploratory Boring B-2. The boring was completed to 230 feet and resulted in similar

findings as in ASR Boring B-2. Appreciable gravel deposits were not found, and the boring confirmed that the well location was not suitable for ASR purposes.

The Riverbend site investigated under the brackish groundwater project is located approximately 6 miles west and 3 miles north of the Tejon Tank site. The boring was completed to 450 feet and again, did not encounter gravel deposits. The boring log indicates that the Intermediate Zone at this location is of low hydraulic conductivity and, therefore, not suitable for ASR purposes.

The Firefighter Site is located south of the City Wellfield and is shown in Figure 2-2. The boring was completed to 450 feet. The boring did not encounter appreciable gravel deposits and was completed as a test well in the Intermediate Zone. A pumping test was conducted on the test well, and the test report indicates the well was pumped at 71 gpm with approximately 75 feet of drawdown. This is a relatively low yield and indicates the Intermediate Zone at this location is not suitable for ASR purposes.

The results of the brackish groundwater project test drilling did not locate areas for future ASR applications that were better suited than the City Wellfield and the Tejon Tank site. The brackish groundwater drilling results confirmed that the location of the Gravel Zone is variable in the area and that the Intermediate Zone probably lacks adequate hydraulic conductivity to support an ASR system.

TABLE 2-2
Borings and Wells Completed

Construction Dates	Location	Borings/Wells Completed
11/21/95–11/30/95	Water Treatment Plant No. 2	B-1
12/1/95–12/13/95	Water Treatment Plant No. 1	B-2
12/15/95–2/6/96	Center Street, City Wellfield	B-3, B-4, TW-1
2/16/96–3/19/96	Tejon Tank, Alton Gloor Boulevard	B-5, B-6, TW-2, TW-3
4/9/96–5/2/96	Tejon Tank, Alton Gloor Boulevard	B-6, TW-3

TABLE 2-3
Boring Construction Details

Boring	Total Depth (feet)	Sand Interval (feet)	Sand and Gravel Interval (feet)	Monitoring Well Completed	Screen Interval (feet)
B-1	463	198 to 205	198 to 219	none	NA
B-2	472	155 to 190	not found	none	NA
B-3	470	168 to 180	168 to 190	TW-1	160 to 200
B-4	1,047	166 to 183	166 to 193	none	NA
B-5	1,500	184 to 205	184 to 230	TW-2	1,085 to 1,125
B-6	230	182 to 210	182 to 230	TW-3	180 to 220

TABLE 2-4
Monitoring Well Details

Monitoring Well	Total Depth Drilled (feet)	Plug Back Depth (feet)	Screen Material, Size, and Type	Screen Interval (feet)
TW-1	470	210	Stainless, 0.040, Shutter	160 to 200
TW-2	1,500	1,200	Stainless, 0.010, Wire Wrap	1,085 to 1,125
TW-3	230	230	Stainless, 0.040, Wire Wrap	180 to 220

Pumping Tests

Two pumping tests were conducted on the monitoring wells installed during this investigation. These tests occurred following the construction of the respective wells and are presented in Table 2-5. It was not possible to conduct a pumping test on Monitoring Well TW-2 because of the well's low yield.

TABLE 2-5
Pumping Test Summary

Test Designation	Date Conducted	Pumping Well	Pumping Rate	Duration	Observation Well
City Wellfield	1/23/96	TW-1	63 gpm	8 hours	City Well No. 8
Alton Gloor	5/1/96	TW-3	60 gpm	8 hours	None

City Wellfield Pumping Test

The pumping test at the City Wellfield incorporated Monitoring Well TW-1, constructed for this project, and an existing well presumed to be City Well No. 8. The existing well was identified from a well location map in TWDB Report 279 and well records located in the TWDB files. City Well No. 8 is recorded as State Well No. 89-04-602, and location maps for this well are somewhat incomplete. However, the well is identified from the information reviewed, and the interpretation is assumed to be correct.

Records on City Well No. 8 indicate the well is completed to a depth of 200 feet, with perforated casing from 185 to 200 feet. Records also indicate the well yielded 900 gpm with a turbine pump set at 160 feet.

City Well No. 8 was found to be filled with trash and debris. Water levels in the well were measured for this test by pushing a 20-foot section of 2-inch PVC pipe along the side of the trash to create an access pipe for water-level probe access. The visible trash was later removed from the well in an attempt to set a pump in the well. However, the well was found to be blocked at about 15 feet to the extent that a 4-inch submersible pump could not pass.

The results of the pumping test are presented as semi-log, time drawdown plots for the two wells in Figures 2-3 and 2-4. The time drawdown measurements at City Well No. 8 follow a Jacob straight line response throughout the test duration. This response suggests the aquifer transmissivity is in the range of 49,000 gallons per day per foot (gpd/ft). This value is in the range identified for the Gravel Zone during the previous Step 1 work.

The time drawdown plot for TW-1, the pumping well, demonstrates more drawdown per unit log time than the City well. This may indicate the pumped well is experiencing a boundary effect, where the lateral bounds of the aquifer are affecting the drawdown in this well. This could happen if TW-1 was located near the edge of the gravel deposit, or where the gravel deposit thins considerably.

It is important to note that the pumping test performed on this site lasted 8 hours and was too short to completely characterize the site. The purpose of the test was to gain an understanding of the hydraulic response of the Gravel Zone to evaluate if further ASR testing is warranted.

Alton Gloor Pumping Test

A pumping test was conducted on Monitoring Well TW-3, at the Tejon Tank site on May 1, 1996. Water levels were monitored in the pumping well only during this test. The test lasted 8 hours, and the results are presented as time drawdown values in Figure 2-5.

The pumping test was intended to be conducted as a step drawdown test, using three or more pumping steps of 1-1/2-hour duration each. During the test setup, it was discovered that 60 gpm was the minimum rate at which the pumping equipment could be operated without causing high pressures in the discharge piping and discharge piping separation. The test was initiated at 60 gpm for the first 83 minutes of the test. The pumping rate was then turned up to begin the second pumping step; however, the pumping equipment could only produce 65 gpm while operating at its maximum rate. For this reason, the test was run at 65 gpm for the remaining time.

The test data were adjusted for the two pumping rates by proportionally reducing the drawdown observed at 65 gpm to represent drawdown at 60 gpm. Based on this response, a straight line Jacob analysis indicates the transmissivity of the area is about 24,000 gpd/ft. The data trend did not indicate an apparent boundary effect as was observed at the City Wellfield site. However, because the test only used one well for a limited duration test, it cannot be concluded that hydraulic boundaries do not exist at this site.

Water Quality Sampling

Groundwater Quality samples were obtained from each of the three monitoring wells constructed during this investigation. The samples were obtained from Monitoring Wells TW-1 and TW-3 during the pumping tests discussed previously. A water quality sample was also obtained from Monitoring Well TW-2 during development. The results of the sampling are summarized in Table 2-6. The table includes the groundwater quality parameters used in the Step 1 phase of the ASR investigation for comparison. A complete set of the geophysical logs is included in Appendix 4. The laboratory data sheets are included in Appendix 5.

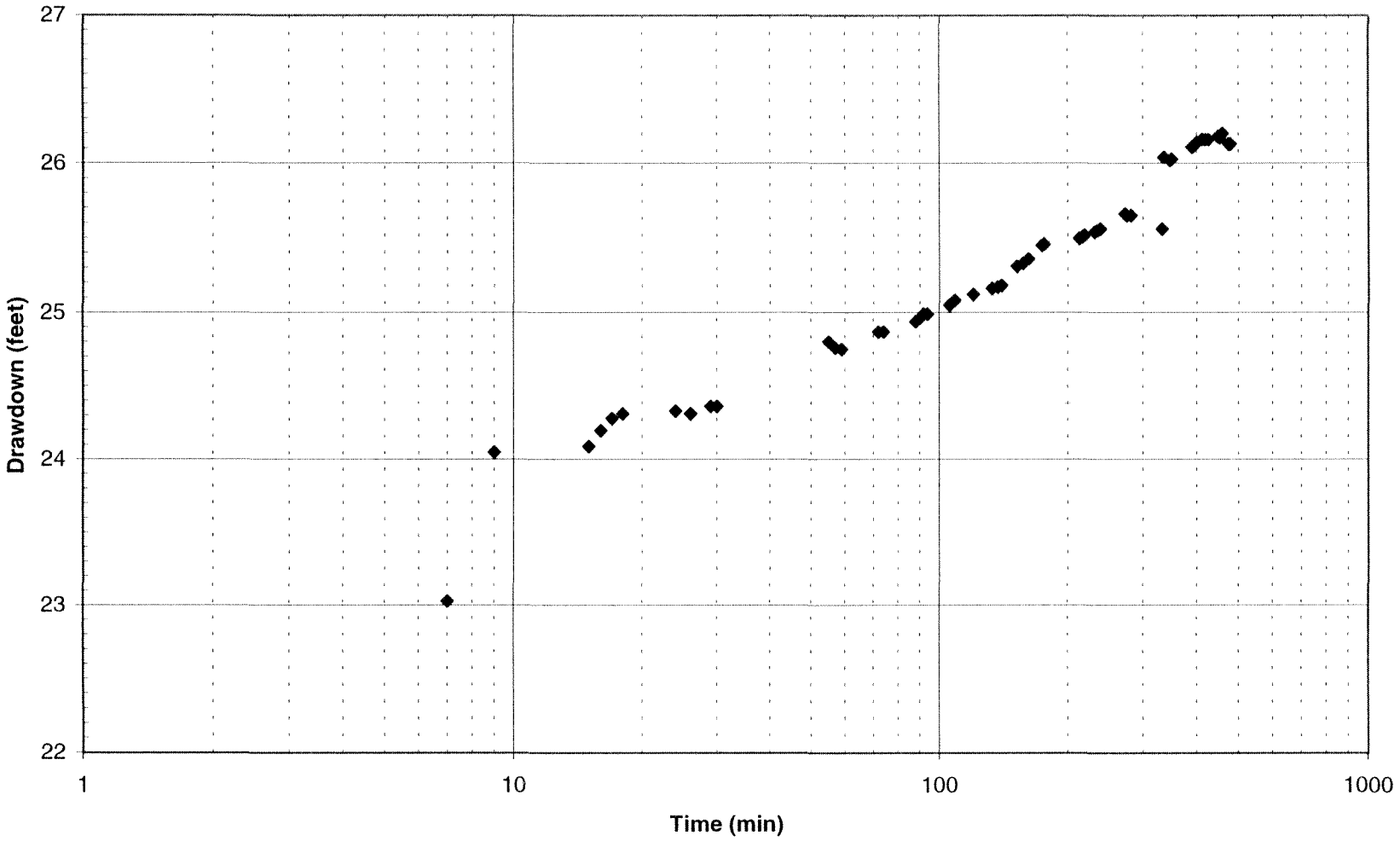

Figure 2-3 - TW-1 Drawdown During City Wellfield Pumping Test

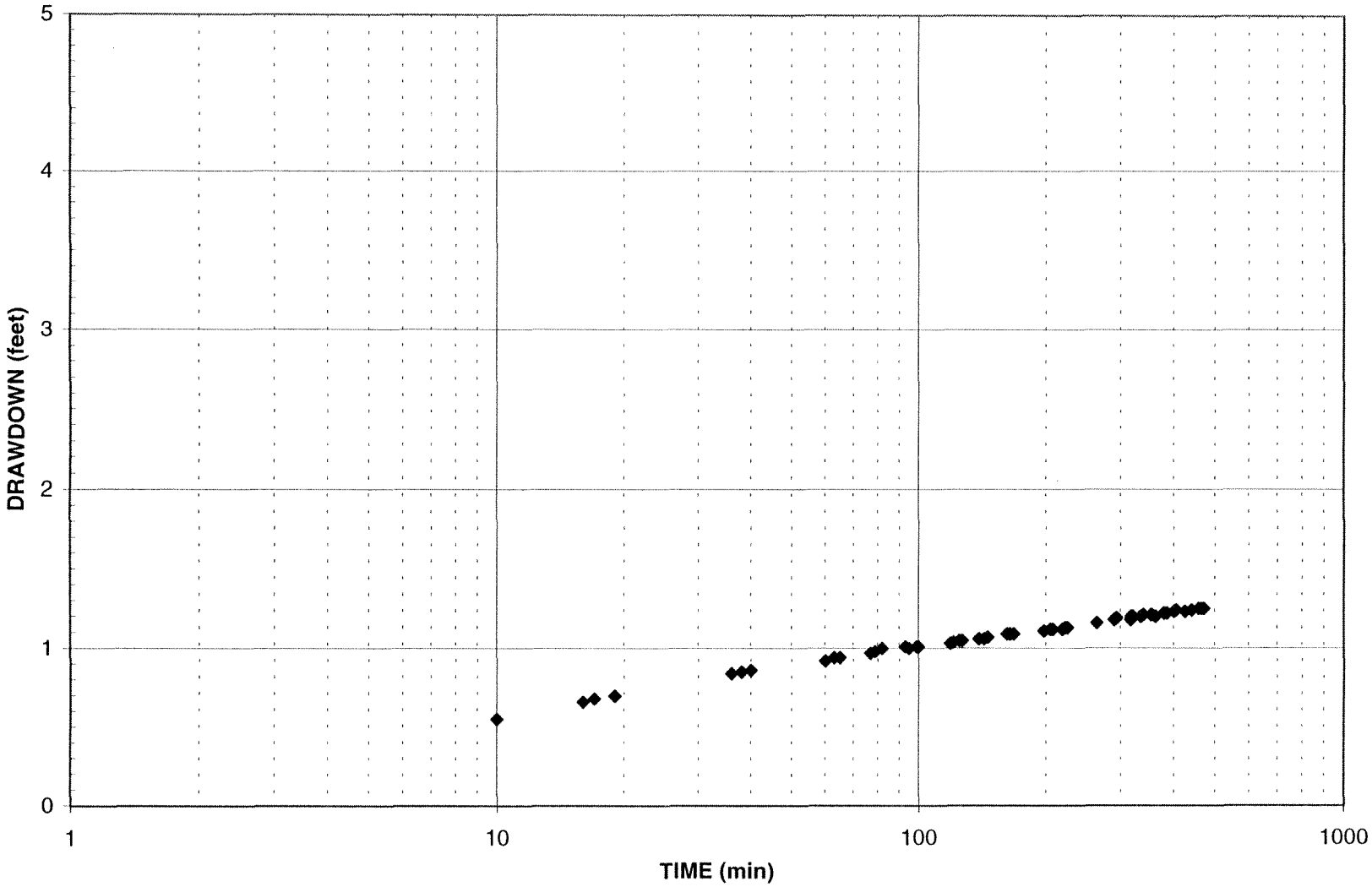

Figure 2-4 - City Well Drawdown During City Wellfield Pumping Test

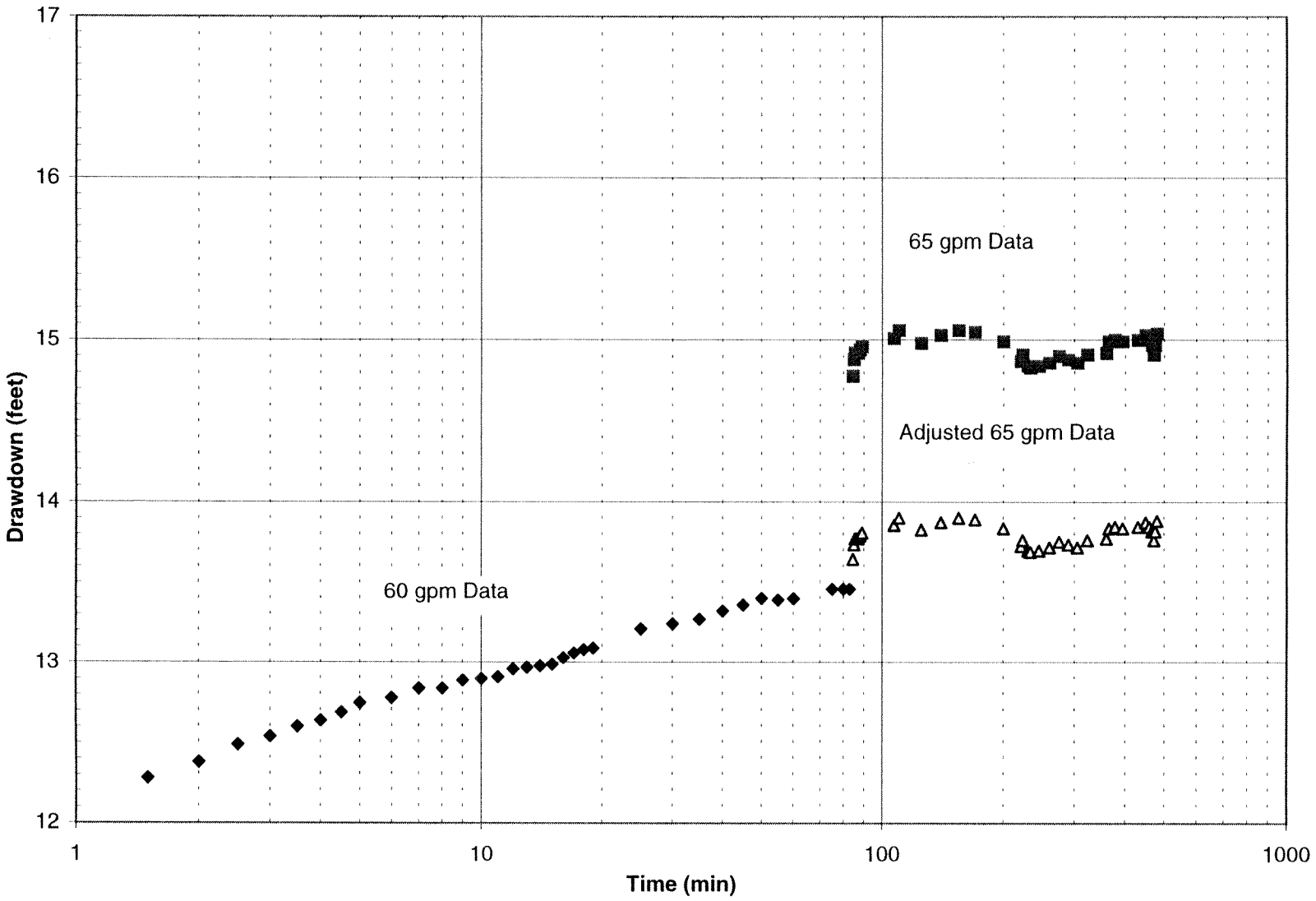

Figure 2-5 - TW-3 Drawdown Data During Alton Gloor Pumping Test

Table 2-6
Groundwater Quality

Parameter	1973 TWDB Test Drilling Results				Current Test Results	
	89-04-210	89-04-902 WTP 1 Site	89-04-903	89-05-404 WTP 2 Site	89-04-312 B-6, Tejon Tank	89-04-634 B-3, Center St.
pH (units)	8.2	8.2	7.8	7.4	7.5	7.3
TDS	2280	2860	11900	8400	na	3000
Alkalinity ($CaC0^3$)	402	224	328	246	450	440
Total Hardness ($CaC0^3$)	476	171	2800	1990		
Conductivity (µmhos/cm)	3060	4170	12000	10540	5500	5000
Color (Pt/Co)	na	na	na	na	20	<5
Turbidity (NTU)	na	na	na	na	13	0.6
Boron	2.5	2	6.6	3.6	na	na
Calcium	90	14	510	369	210	52
Magnesium	61	27	370	258	74	18
Potassium	na	na	na	16	7.2	3.1
Silica	34	<1	36	19	40	38
Sodium	600	1010	3260	2260	1200	350
Bicarbonate	490	273	400	300	540	530
Chloride	357	1000	5430	3680	1000	830
Fluoride	0.9	1.2	1.2	1.7	1.1	<0.5
Nitrate (as NO^3)	0.5	0.5	5.5	<0.4	<0.05	<0.05
Sulfate	890	670	2080	1610	1100	1100
Ammonia	na	na	na	na	1.3	<0.2
Iron	0.82	na	1.6	3.74	6.7	<0.1
Manganese	na	na	na	<0.05	0.36	0.16
Aluminum	na	na	na	na	2.3	0.0094
Arsenic	na	na	na	na	0.028	0.0077
Barium	na	na	na	na	0.046	0.026
Cadmium	na	na	na	na	nd	nd
Chromium	na	na	na	na	0.0066	0.019
Lead	na	na	na	na	0.01	nd
Mercury	na	na	na	na	nd	nd
Selenium	na	na	na	na	0.05	0.017
Silver	na	na	na	na	nd	nd

Geophysical Logging

Geophysical logs were run on the borings constructed during this investigation. The logs were all run by TWDB personnel using TWDB logging equipment. A list of logs obtained from the borings is presented in Table 2-7.

Discussion of Results

Aquifer Characteristics

During this drilling program, four sites throughout the PUB service area were investigated. At three out of four of these sites, the Gravel Zone was identified. The Gravel Zone was found to have the potential for the highest yield at Site 4, the Tejon Tank. At the other two sites where the Gravel Zone was identified, WTP No. 2 and the City Wellfield, the Gravel Zone was somewhat thinner than the Tejon Tank site, but is probably still capable of producing reasonable quantities of groundwater.

The Gravel Zone was found layered between less permeable clays, silts, and fine sands, which create good hydraulic confinement for ASR applications. However, the testing at Site 3, the City Wellfield, identified a potential lateral aquifer boundary during the pumping test, which may limit the volume of water that could be stored and produced at that site. The extent of this limit cannot be fully defined without extensive further testing of this site but may result in lower pumping rates or shorter pumping durations at this site relative to others.

Because of the nature of the gravel deposits, it is likely that some level of aquifer boundaries exist throughout the Gravel Zone. These boundaries are essentially the edges and thin areas of the aquifer. Based on the results of this program, substantial areas of the Gravel Zone exist, and it is expected that hydraulic properties exhibited by individual wells will vary. It appears likely that ASR wells could be developed in the Gravel Zone if care is taken on selection of areas for well groupings.

The Gravel Zone is expected to be capable of producing substantial quantities of water at certain locations. For example, at the Tejon Tank site, the test results indicated the aquifer transmissivity was approximately 24,000 gpd/ft. With the available drawdown in the well, it is reasonable that production wells at this location could produce groundwater in the range of 700 gpm (1 million gallons per day [mgd]) or more. The transmissivity observed at the City Wellfield was even higher and would indicate wells around that location could produce groundwater at the historically reported 900 gpm (1.3 mgd).

However, aquifer boundaries are expected to be encountered, and the continuity of the Gravel Zone is not known. Because of these uncertainties, it is recommended to assume individual well capacities in the Gravel Zone in the range of 500 gpm to 700 gpm (0.7 to 1.0 mgd), somewhat less than that assumed in the Step 1 report.

The drilling activities identified lithology changes in the depth interval where the Intermediate Zone was expected to exist. However, the material encountered at these depths did not exhibit the hydraulic characteristics required for typical production wells or

TABLE 2-7

Brownsville Geophysical Logging

Boring	Location	Depth Drilled	Date Logged	Geophysical Logs
B-1	WTP No. 2	463	11/30/96	Resistivity
			11/30/96	Spontaneous Potential
			11/30/96	Gamma Ray
			12/1/96	Caliper
B-2	WTP No. 1	472	12/5/95	Gamma Ray
			12/6/95	Caliper
			12/6/95	Resistivity
			12/6/95	Spontaneous Potential
B-3	Center Street	472	12/18/95	Resistivity
			12/18/95	Spontaneous Potential
			12/18/95	Gamma Ray
			12/18/95	Caliper
			1/22/96	Spinner 1
			1/22/96	Spinner 2
			1/22/96	Spinner 3
			1/22/96	Spinner 4
			1/22/96	Spinner 5
			1/22/96	Spinner 6
			1/22/96	Spinner 7
B-4	Center Street	1047	Well Collapsed, No Logs Run	
B-5	Tejon Tank (Alton Goor Boulevard)	1500	3/1/96	Resistivity & Spontaneous Potential Gamma Ray
			3/1/96	Gamma Ray
B-6	Tejon Tank (Alton Gloor Boulevard)	230	4/24/96	Resistivity & Spontaneous Potential

ASR applications. It is possible that the Intermediate Zone exists as a more suitable aquifer in other areas, but these were not encountered during this investigation.

The drilling activities also did not encounter suitable lithology in the intervals where the Lower Zone was reported to exist. Only one boring, Boring B-5, was completed deep enough to investigate this horizon. The other boring, Boring B-4, at the City Wellfield appeared to exhibit some coarser-grained sands in the Lower Zone before its collapse, but the boring was not completed, and geophysical logs were not obtained.

Water Quality

The water quality samples obtained during this program indicate the Gravel Zone groundwater quality at the City Wellfield site is a sodium dominate water, higher in total dissolved solids (TDS) but similar from a geochemical standpoint to the PUB-treated water. The groundwater at this site appears very compatible with the PUB-treated water.

The groundwater quality observed in the Gravel Zone at the Tejon Tank site is even higher in TDS than the City Wellfield and contains appreciable concentrations of calcium. The higher levels of calcium at the Tejon Tank site indicated a different type of groundwater chemistry and the possibility of precipitation during injection into this aquifer. However, this possibility can likely be controlled by operating the injection cycles to not recover all the injected water from the aquifer during each cycle. This is a typical operational control in ASR wells and is not expected to provide operational problems.

The groundwater quality observed in the sample obtained from Monitoring Well TW-2, completed in the Lower Zone at the Tejon Tank site, was very high in TDS. The chloride concentrations of this water were observed to be 43,000 milligrams per liter (mg/l), which demonstrates this water is as brackish, or more, than seawater. This water quality indicates that if other zones exist for ASR applications, they should be considered first.

SECTION 3

Recommendations

The results of this investigation indicate that the Gravel Zone exists within the PUB service area and that the zone has characteristics suitable for ASR applications. Three out of the four sites tested encountered the Gravel Zone, and it is expected that each site would result in different total yield if completely developed. It is recommended to continue this investigation with Step 3 and develop a prototype ASR well in the Gravel Zone.

Monitoring wells were only completed at two of the three sites where the Gravel Zone was encountered. Out of these two remaining sites, the Gravel Zone properties appear most promising at the Tejon Tank site. It is expected that this site will result in a prototype ASR well with a higher capacity than the other sites and overall will be a better test site.

The other two sites, WTP No. 2 and the City Wellfield, should be considered in the future if ASR feasibility is confirmed during Step 3. The other sites could potentially be developed into successful ASR locations if the ASR concept proves feasible and cost effective for the PUB.

General ASR Applications

The results of this program were used to update the ASR conceptual applications presented in the Step 1 report. That report was based on existing literature and conceptualized the size, benefits, and costs of an ASR application for the PUB. During this program, many of the assumptions and thoughts in the previous report were confirmed. This section addresses items where the additional information can refine those ideas.

This investigation identified that ASR wells in the Gravel Zone should be considered to provide a capacity of 500 to 700 gpm. These values are somewhat lower than those presented in the Step 1 report that assumed individual capacities of 1,000 gpm. Additionally, the results of this investigation indicated that the Gravel Zone areal variations may be quite pronounced and not be conducive to more than a few ASR wells in one location.

The ultimate size and configuration of an ASR application for the PUB will only be determined through testing and system development. However, at this time, it appears likely that the ultimate ASR application for the PUB will consist of several locations of three or four ASR wells. These locations could be located through the PUB system. Locations at the sites tested during this investigation are likely candidates, and others, where large volume treated water storage and pumping, could benefit the system. It appeared that locations in the more northern areas of the PUB system were more likely to encounter the Gravel Zone, but this can only be confirmed through further testing.

Locations for future ASR wells could be identified through test drilling, or a combination of surface geophysics and test drilling. Seismic reflection techniques could be very effective in identifying the location and extent of Gravel Zone deposits and could be conducted without altering or damaging land areas. This technique should be considered for future ASR well

locations, and potential mapping of the extent of the Gravel Zone in the selected prototype ASR well test area.

The results of this investigation were used to update the ultimate conceptual ASR system for the PUB. The drilling results indicate that individual ASR wells would have a capacity of 500 to 700 gpm. An ASR system located in the central and north areas of the PUB system should be able to support about 10 mgd of ASR capacity. Considering individual well capacity, the system would require about 12 to 16 wells. As discussed, the wells could be grouped in locations of one to four wells, which requires four or five sites for ASR wells throughout the system. This configuration is similar to that conceptualized in the Step 1 report but provides a lower-peaking capacity than originally assumed from the ASR wells. This configuration would still benefit the PUB by providing storage of treated Permit 1838 water, and by providing additional peaking capacity for the existing WTPs.

Preliminary estimated costs for a 10-mgd ASR facility as conceptually described were developed. Compared to the estimated costs presented in the Step 1 report, the costs presented here are somewhat lower because of the lower yield in each well and the corresponding lower cost per well. Additionally, the overall size of the ASR system discussed is smaller and capable of less peak pumping capacity. It is estimated that an ASR system with a firm recovery capacity of 10 mgd would consist of 12 to 16 wells at four or five locations within the PUB system. Based on the limited information currently available, the capital and engineering costs associated with this system would be approximately $5 million, which equates to about $0.50 per gallon per day of recovery capacity. The total cost presented here is less than that estimated in the Step 1 report because of overall lower well yields and the corresponding well and pump costs. The cost per gallon of recovery capacity is slightly less than that estimated in the Step 1 Report as a result of a more refined basis for the cost estimate. The estimated costs are summarized in Table 3-1.

Table 3-1 ASR Preliminary Cost Estimate

Brownsville ASR Preliminary Cost Estimate
ASR System Completed into Gravel Zone
12 ASR Wells at Four Locations Within PUB System
Total System Capacity; 10 mgd Injection, 10 mgd Recovery

Item	Unit	No. Required	Estimated Unit Cost	Estimated Total Cost
ASR Well, 12-inch dia., 250 ft Total Depth	each	12	$50,000	$600,000
Well Pumps, Well Head Piping	each	12	$115,000	$1,380,000
Well Sites and Improvements	each	12	$60,000	$720,000
Disinfection Facilities	each	4	$40,000	$160,000
I & C Allowance	each	4	$100,000	$400,000
Miscellaneous Other Construction	10%	1	$326,000	$326,000
Engineering and Testing	15%	1	$537,900	$537,900
Contingency	20%	1	$824,780	$824,780

Total 10 mgd ASR Capacity **$4,948,680**

Estimated O&M Cost **$0.17 per 1000 gal pumped**

Note: O&M cost based on the following:
1. 12 ASR Wells with turbine pumps
2. Power Costs $0.07 per kw-hr
3. One operator full time to run and maintain system

Appendix 1

Boring Logs

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#1 Site 1	SHEET 1 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 2, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 11/21/95 FINISH 11/30/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	0.0	N/A	N/A	N/A	CLAY, (CL), light brown, dark brown in areas, isolated sand size caliche, trace of silt and organic material	
5.0	5.0	N/A	N/A	N/A	CLAY, (CL), as above	
10.0	10.0	N/A	N/A	N/A	CLAY, (CL), as above, no caliche	
15.0	15.0	N/A	N/A	N/A	CLAY, (CL), light brown, trace of yellowish silt in areas	
20.0	20.0	N/A	N/A	N/A	CLAY, (CL), as above with isolated medium sand	
25.0	25.0	N/A	N/A	N/A	CLAY, (CL), as above with black organic material	
30.0	30.0	N/A	N/A	N/A	CLAY, (CL), as above	
35.0	35.0	N/A	N/A	N/A	CLAY, (CL), as above	
40.0	40.0	N/A	N/A	N/A	CLAY, (CL), as above	
45.0	45.0	N/A	N/A	N/A	CLAY, (CL), as above with orangish yellow and greenish grey silt	
50.0	50.0	N/A	N/A	N/A	CLAY, (CL), as above trace of very fine sand	
55.0	55.0	N/A	N/A	N/A	CLAY, (CL), as above sandy streaks	
60.0	60.0	N/A	N/A	N/A	CLAY, (CL), as above	
65.0	65.0	N/A	N/A	N/A	CLAY, (CL), as above	
70.0	70.0	N/A	N/A	N/A	CLAY, (CL), as above	
	75.0	N/A	N/A	N/A		

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#1 Site 1 SHEET 2 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 2, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 11/21/95 FINISH 11/30/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	75.0	N/A	N/A	N/A	CLAY, (CL), as above	
80.0	80.0	N/A	N/A	N/A	CLAY, (CL), as above	
85.0	85.0	N/A	N/A	N/A	CLAY, (CL), as above	
90.0	90.0	N/A	N/A	N/A	SILTY CLAY, (CL), light brown, with orangish yellow and greenish gray silt, black organic material	
95.0	95.0	N/A	N/A	N/A	SILTY CLAY, (CL), light brown with nodules of dark brown clay	
100.0	100.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above	
105.0	105.0	N/A	N/A	N/A	CLAY, (CL), light brown with traces of yellowish silt	
110.0	110.0	N/A	N/A	N/A	CLAY, (CL), as above with traces of greenish gray silt	
115.0	115.0	N/A	N/A	N/A	CLAY, (CL), as above, trace of very fine sand	
120.0	120.0	N/A	N/A	N/A	CLAY, (CL), as above	
125.0	125.0	N/A	N/A	N/A	CLAY, (CL), light brown and greenish grey, trace silt, no sand	
130.0	130.0	N/A	N/A	N/A	CLAY, (CL), light brown and greenish gray mottled, fattish	
135.0	135.0	N/A	N/A	N/A	CLAY, (CL), as above, trace of yellowish orange silt	
140.0	140.0	N/A	N/A	N/A	CLAY, (CL), as above with nodules of dark brown organic material	
145.0	145.0	N/A	N/A	N/A	CLAY, (CL), as above, no organic nodules	
	150.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#1 Site 1 SHEET 3 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 2, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 11/21/95 FINISH 11/30/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	150.0					
		N/A	N/A	N/A	CLAY, (CL), light brown and greenish gray mottled	
	155.0					
155.0		N/A	N/A	N/A	CLAY, (CL), as above with nodules of dark brown organic material	
	160.0					
160.0		N/A	N/A	N/A	CLAY, (CL), as above, no organic nodules	
	165.0					
165.0		N/A	N/A	N/A	CLAY, (CL), as above with orangish brown silt	
	170.0					
170.0		N/A	N/A	N/A	CLAY, (CL), dark greenish brown with orange-brown nodules	
	175.0					
175.0		N/A	N/A	N/A	CLAY, (CL), as above, trace of silt	
	180.0					
180.0		N/A	N/A	N/A	CLAY, (CL), as above	
	185.0					
185.0		N/A	N/A	N/A	CLAY, (CL), as above	
	190.0					
190.0		N/A	N/A	N/A	CLAY, (CL), as above	
	195.0					
195.0		N/A	N/A	N/A	CLAY, (CL), orangish brown and greenish brown mottled	
	200.0					
200.0		N/A	N/A	N/A	SAND, (SW), tan and brown, moderately sorted, subrounded, quartz, isolated small gravel	
	205.0					
205.0		N/A	N/A	N/A	GRAVEL, (GP), gray and brown, subangular to subrounded, quartz gravel up to 1 cm	
	210.0					
210.0		N/A	N/A	N/A	GRAVEL, (GP), brown and gray as above, trace sand	
	215.0					
215.0		N/A	N/A	N/A	CLAYEY GRAVEL, (GC), brown and gray, subangular chert is 20-30% clay	
	220.0					
220.0		N/A	N/A	N/A	CLAY, (CL), orangish brown and brown, stiff, mottled, isolated gravel	
	225.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#1 Site 1	SHEET 4 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 2, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 11/21/95 FINISH 11/30/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	225.0					
		N/A	N/A	N/A	CLAY, (CL), orangish brown	
230.0	230.0					
		N/A	N/A	N/A	CLAY, (CL), orangish brown with greenish gray nodules	
235.0	235.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
240.0	240.0					
		N/A	N/A	N/A	CLAY, (CL), as above, fattish texture	
245.0	245.0					
		N/A	N/A	N/A	CLAY, (CL), orangish brown	
250.0	250.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
255.0	255.0					
		N/A	N/A	N/A	CLAY, (CL), orangish brown and grayish green with approximately 10% small subrounded gravel	
260.0	260.0					
		N/A	N/A	N/A	CLAY, (CL), orangish brown and greenish gray	
265.0	265.0					
		N/A	N/A	N/A	CLAY, (CL), as above with nodules of weathered caliche	
270.0	270.0					
		N/A	N/A	N/A	CLAY, (CL), as above, no caliche, with isolated quartz gravel	
275.0	275.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
280.0	280.0					
		N/A	N/A	N/A	CLAY, (CL), light brown and greenish gray with weathered caliche nodule	
285.0	285.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
290.0	290.0					
		N/A	N/A	N/A	CLAY, (CL), light brown and greenish gray, with yellowish orange silt, plastic in zones	
295.0	295.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
	300.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#1 Site 1	SHEET 5 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 2, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 11/21/95 FINISH 11/30/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	300.0	N/A	N/A	N/A	CLAY, (CL), greenish gray and brown mottled with yellow-orange staining, stiff, trace of silt	
305.0	305.0	N/A	N/A	N/A	CLAY, (CL), as above	
310.0	310.0	N/A	N/A	N/A	CLAY, (CL), as above	
315.0	315.0	N/A	N/A	N/A	CLAY, (CL), as above	
320.0	320.0	N/A	N/A	N/A	CLAY, (CL), as above	
325.0	325.0	N/A	N/A	N/A	CLAY, (CL), as above	
330.0	330.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above	
335.0	335.0	N/A	N/A	N/A	CLAY, (CL), as above	
340.0	340.0	N/A	N/A	N/A	CLAY, (CL), as above	
345.0	345.0	N/A	N/A	N/A	CLAY, (CL), as above	
350.0	350.0	N/A	N/A	N/A	CLAY, (CL), as above	
355.0	355.0	N/A	N/A	N/A	CLAY, (CL), as above	
360.0	360.0	N/A	N/A	N/A	CLAY, (CL), as above with isolated rounded gravel	
365.0	365.0	N/A	N/A	N/A	CLAY, (CL), as above	
370.0	370.0	N/A	N/A	N/A	CLAY, (CL), as above	
	375.0	N/A	N/A	N/A		

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#1 Site 1 SHEET 6 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 2, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 11/21/95 FINISH 11/30/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	375.0					
		N/A	N/A	N/A	CLAY, (CL), light brown, greenish gray with yellowish orange staining, stiff, trace of silt	
380.0	380.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
385.0	385.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
390.0	390.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
395.0	395.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
400.0	400.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
405.0	405.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
410.0	410.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
415.0	415.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
420.0	420.0					
		N/A	N/A	N/A	CLAY, (CL), as above with isolated small gravel, trace of sand	
425.0	425.0					
		N/A	N/A	N/A	CLAY, (CL), light brown, greenish gray with yellow-orange staining, stiff, trace of silt	
430.0	430.0					
		N/A	N/A	N/A	SILTY CLAY, (CL), as above with small isolated gravel	
435.0	435.0					
		N/A	N/A	N/A	CLAY, (CL), light brown, greenish gray with yellow-orange staining, stiff, trace of silt	
440.0	440.0					
		N/A	N/A	N/A	SAND, (SM), brown and black, fine to very fine, poorly sorted, subrounded, trace of silt	
445.0	445.0					
		N/A	N/A	N/A	SILTY SAND, (SM), tan, brown, black, fine to very fine sand with isolated small gravel	
	450.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#1 Site 1 SHEET 7 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 2, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 11/21/95 FINISH 11/30/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	450.0	N/A	N/A	N/A	SILTY SAND, (SM), brown and tan, poorly sorted fine to very fine sand, trace of clay	
455.0	455.0	N/A	N/A	N/A	SILTY SAND, (SM), brown and tan, poorly sorted fine to very fine sand, trace of clay	
460.0	460.0				END OF BORING	
465.0						
470.0						
475.0						
480.0						
485.0						
490.0						
495.0						
500.0						
505.0						
510.0						
515.0						
520.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#2 Site 2 SHEET 1 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 1, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/1/95 FINISH 12/13/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	0.0					
		N/A	N/A	N/A	CLAY, (OH), dark gray, stiff plastic, organic	
5.0	5.0					
		N/A	N/A	N/A	CLAY, (CL), brownish tan, stiff, plastic	
10.0	10.0					
		N/A	N/A	N/A	CLAY, (CL), as above, stiffer	
15.0	15.0					
		N/A	N/A	N/A	CLAY, (CL), as above, trace of sand	
20.0	20.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
25.0	25.0					
		N/A	N/A	N/A	CLAY, (CL), orangish tan with yellow staining, soft, plastic	
30.0	30.0					
		N/A	N/A	N/A	CLAY, (CL), orangish tan, stiff, plastic	
35.0	35.0					
		N/A	N/A	N/A	CLAY, (CL), orangish tan and grayish green with yellow-orange staining, very stiff, plastic	
40.0	40.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
45.0	45.0					
		N/A	N/A	N/A	SILTY CLAY, (CL), tan, soft, trace of sand	
50.0	50.0					
		N/A	N/A	N/A	SILTY CLAY, (CL), orangish tan with yellowish staining, soft, trace of sand	
55.0	55.0					
		N/A	N/A	N/A	CLAY WITH SILT, (CL), tan, firm, plastic	
60.0	60.0					
		N/A	N/A	N/A	SILTY CLAY, (CL), tan, soft, trace of very fine sand	
65.0	65.0					
		N/A	N/A	N/A	SAND WITH SILT AND CLAY, (SM), very fine	
70.0	70.0					
		N/A	N/A	N/A	SILTY SAND, (SM), very fine, poorly sorted, trace of clay	
	75.0					

CRM HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#2 Site 2 SHEET 2 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 1, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/1/95 FINISH 12/13/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	75.0	N/A	N/A	N/A	CLAY WITH VERY FINE SAND AND SILT (CL), tan and greenish gray, plastic	
80.0	80.0	N/A	N/A	N/A	SANDY SILT (MH), tan and greenish gray with orange-yellow staining, fine to medium sand, trace of gray	
85.0	85.0	N/A	N/A	N/A	CLAY WITH SILT (CL), orangish tan, soft	
90.0	90.0	N/A	N/A	N/A	CLAY WITH SILT (CL), as above	
95.0	95.0	N/A	N/A	N/A	CLAY (CL), orangish tan and greenish gray, soft, plastic, trace of silt	
100.0	100.0	N/A	N/A	N/A	CLAY (CL), orangish tan, stiff, plastic	
105.0	105.0	N/A	N/A	N/A	CLAY (CL), orangish tan with yellow staining, soft, trace of silt	
110.0	110.0	N/A	N/A	N/A	CLAY (CL), as above	
115.0	115.0	N/A	N/A	N/A	CLAY (CL), tan with greenish gray mottles, firm, plastic	
120.0	120.0	N/A	N/A	N/A	CLAY (CL), orangish tan with yellow-orange staining, stiff, plastic	
125.0	125.0	N/A	N/A	N/A	CLAY (CL), as above, trace of silt	
130.0	130.0	N/A	N/A	N/A	CLAY WITH SAND AND SILT (CL), tan, very fine to fine sand	
135.0	135.0	N/A	N/A	N/A	CLAY (CL), brownish tan, soft, trace of silt	
140.0	140.0	N/A	N/A	N/A	CLAY (CL), as above	
145.0	145.0	N/A	N/A	N/A	CLAY (CL), as above, softer, siltier	
	150.0	N/A	N/A	N/A		

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#2 Site 2 SHEET 3 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 1, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/1/95 FINISH 12/13/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	150.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), tan, blacks, gray, very fine to medium grain	
	155.0					
155.0		N/A	N/A	N/A	SAND, (SP), black, tan and brown, fine to medium grain, no fines	
	160.0					
160.0		N/A	N/A	N/A	SAND, (SP), as above	
	165.0					
165.0		N/A	N/A	N/A	SAND, (SP), as above	
	170.0					
170.0		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), tan, orangish and yellow, greenish gray, stiff	
	175.0					
175.0		N/A	N/A	N/A	SANDY SILT, (ML), tan, black, brown, soft, fine to medium sand, trace of clay	
	180.0					
180.0		N/A	N/A	N/A	SAND, (SP), brown, black, tan, fine to medium grain, no fines	
	185.0					
185.0		N/A	N/A	N/A	SAND, (SP), as above, trace of silt	
	190.0					
190.0		N/A	N/A	N/A	SILTY SAND, (SM), black and tan, very fine to medium grain, isolated coarse gravel, trace of clay	
	195.0					
195.0		N/A	N/A	N/A	SILTY SAND, (SM), as above	
	200.0					
200.0		N/A	N/A	N/A	SILTY SAND, (SW), as above, fine to very fine coarse grain, soft, trace of clay	
	205.0					
205.0		N/A	N/A	N/A	SILTY SAND, (SM), as above	
	210.0					
210.0		N/A	N/A	N/A	SILTY SAND, (SM), as above with isolated gravel	
	215.0					
215.0		N/A	N/A	N/A	SILTY SAND, (SM), as above	
	220.0					
220.0		N/A	N/A	N/A	SAND SILT, (ML), tan, black, yellow-orange iron staining, soft, very fine sand	
	225.0					

CRM HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#2 Site 2 SHEET 4 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 1, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/1/95 FINISH 12/13/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	225.0					
		N/A	N/A	N/A	SANDY SILT, (ML), as above, very fine to medium sand	
230.0	230.0					
		N/A	N/A	N/A	SILT WITH CLAY AND SAND, (ML), tan with orange staining, isolated coarse gravel	
	235.0					
236.0		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), orangish tan, greenish gray with yellow staining, isolated coarse grains, soft	
	240.0					
240.0		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
	245.0					
245.0		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
	250.0					
250.0		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL)	
	255.0					
255.0		N/A	N/A	N/A	SILTY SAND, (SM), brown, black, tan, very fine to coarse, trace of clay	
	260.0					
260.0		N/A	N/A	N/A	SILTY SAND, (SM), tan with yellow-orange staining, very coarse sand to gravel, 40% silt, trace of clay	
	265.0					
265.0		N/A	N/A	N/A	SAND SILT WITH CLAY, (ML), medium to very coarse sand	
	270.0					
270.0		N/A	N/A	N/A	CLAY WITH SILT, (CL), tan with yellow staining, isolated gravel	
	275.0					
275.0		N/A	N/A	N/A	CLAY WITH SILT AND VERY COARSE SAND, (CL), tan with greenish gray mottling, firm	
	280.0					
280.0		N/A	N/A	N/A	CLAY, (CL), tan with greenish gray mottles, stiff, plastic, isolated coarse grains	
	285.0					
285.0		N/A	N/A	N/A	CLAY, (CL), as above with yellowish stainings	
	290.0					
290.0		N/A	N/A	N/A	CLAY, (CL), as above	
	295.0					
295.0		N/A	N/A	N/A	CLAY, (CL), as above	
	300.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#2 Site 2	SHEET 5 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 1, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/1/95 FINISH 12/13/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	300.0	N/A	N/A	N/A	CLAY, (CL), as above	
305.0	305.0	N/A	N/A	N/A	CLAY, (CL), tan, greenish gray, yellow-orange staining with coarse sand and gravel	
310.0	310.0	N/A	N/A	N/A	CLAY, (CL), as above	
315.0	315.0	N/A	N/A	N/A	CLAY WITH SILT AND SAND, (CL), tan, greenish gray and yellow stained, stiff, plastic	
320.0	320.0	N/A	N/A	N/A	CLAY WITH SILT AND SAND, (CL), as above, softer	
325.0	325.0	N/A	N/A	N/A	CLAY WITH SILT AND SAND, (CL), as above	
330.0	330.0	N/A	N/A	N/A	CLAY, (CL), greenish gray and tan, soft, isolated very coarse sand	
335.0	335.0	N/A	N/A	N/A	CLAY WITH SILT, (CL), light greenish gray with yellowish-orange staining, plastic, trace of sand	
340.0	340.0	N/A	N/A	N/A	CLAY WITH SILT, (CL), as above	
345.0	345.0	N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), green gray with yellow-orange staining, soft, fine to very coarse grain	
350.0	350.0	N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
355.0	355.0	N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
360.0	360.0	N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
365.0	365.0	N/A	N/A	N/A	CLAY, (CL), tan, greenish gray, yellow-orange staining, soft, trace of sand, fine and coarse grains	
370.0	370.0	N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
	375.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#2 Site 2 SHEET 6 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Public Water Plant No. 1, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/1/95 FINISH 12/13/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	375.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
380.0	380.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
385.0	385.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
390.0	390.0					
		N/A	N/A	N/A	SILTY SAND WITH CLAY, (SM), tan, brown, black, medium grain	
395.0	395.0					
		N/A	N/A	N/A	SANDY SILTY WITH CLAY, (MH), tan with orange-yellow staining	
400.0	400.0					
		N/A	N/A	N/A	CLAY WITH SAND AND SILT, (CL), greenish gray and tan with some coarse grains	
405.0	405.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), tan with yellow-orange staining, trace of very coarse sand	
410.0	410.0					
		N/A	N/A	N/A	SILTY CLAY, (CL), tan and greenish gray, soft, trace of sand	
415.0	415.0					
		N/A	N/A	N/A	SANDY SILT WITH CLAY, (ML), medium gray with yellow-orange staining, soft	
420.0	420.0					
		N/A	N/A	N/A	SANDY SILT WITH CLAY, (ML), as above	
425.0	425.0					
		N/A	N/A	N/A	SANDY SILT WITH CLAY, (ML), as above	
430.0	430.0					
		N/A	N/A	N/A	CLAY, (CL), gray and greenish gray and yellow, stiff, trace of silt and sand	
435.0	435.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), tan, light greenish gray nodules, soft, fine to very fine sand	
440.0	440.0					
		N/A	N/A	N/A	CLAY WITH SILT AND SAND, (CL), medium gray, soft, isolated coarse grains	
445.0	445.0					
		N/A	N/A	N/A	SANDY SILT, (ML), brownish tan with black specks, yellow-orange staining, soft	
	450.0					

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#2 Site 2 SHEET 7 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR **LOCATION** Public Water Plant No. 1, Brownsville, TX

ELEVATION _____ **DRILLING CONTRACTOR** Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ **START** 12/1/95 **FINISH** 12/13/95 **LOGGER** L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	450.0	N/A	N/A	N/A	CLAY, (CL), tan, stiff, with very coarse sand and gravel	
	455.0					
455.0		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), tan, greenish gray with yellow-orange staining, stiff, trace of coarse sand	
	460.0					
460.0		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
	465.0					
465.0		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
	470.0					
470.0					END OF BORING	
475.0						
480.0						
485.0						
490.0						
495.0						
500.0						
505.0						
510.0						
515.0						
520.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#3 Site 3 (TW1)	SHEET 1 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR **LOCATION** City Well Field, Center Street, Brownsville, TX

ELEVATION _____ **DRILLING CONTRACTOR** Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ **START** 12/15/95 **FINISH** 12/19/95 **LOGGER** L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE DRILLING FLUID LOSS TESTS AND INSTRUMENTATION
	0.0					
		N/A	N/A	N/A	CLAY WITH SILT, (CL), brownish tan, soft	
	5.0					
5.0						
		N/A	N/A	N/A	CLAY WITH SILT, (CL), orangish tan, soft	
	10.0					
10.0						
		N/A	N/A	N/A	CLAY, (CL), orangish tan, stiff, plastic, trace of silt	
	15.0					
15.0						
		N/A	N/A	N/A	CLAY, (CL), orangish tan with greenish gray mottles, stiff, plastic, some silt	
	20.0					
20.0						
		N/A	N/A	N/A	CLAY, (CL), as above	
	25.0					
25.0						
		N/A	N/A	N/A	CLAY, (CL), as above	
	30.0					
30.0						
		N/A	N/A	N/A	CLAY, (CL), as above, stiffer	
	35.0					
35.0						
		N/A	N/A	N/A	CLAY, (CL), as above	
	40.0					
40.0						
		N/A	N/A	N/A	CLAY, (CL), as above	
	45.0					
45.0						
		N/A	N/A	N/A	CLAY, (CL), as above	
	50.0					
50.0						
		N/A	N/A	N/A	CLAY, (CL), yellowish orange and tan, stiff, plastic	
	55.0					
55.0						
		N/A	N/A	N/A	CLAY, (CL), orangish tan, very stiff, plastic	
	60.0					
60.0						
		N/A	N/A	N/A	CLAY, (CL), as above	
	65.0					
65.0						
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), orangish tan and gray, soft	
	70.0					
70.0						
		N/A	N/A	N/A	SAND, (SM), tan and black with orangish staining, fine to medium grain, moderately sorted, trace of silt and clay	
	75.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#3 Site 3 (TW1)	SHEET 2 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR **LOCATION** City Well Field, Center Street, Brownsville, TX

ELEVATION _____ **DRILLING CONTRACTOR** Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ **START** 12/15/95 **FINISH** 12/19/95 **LOGGER** L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE DRILLING FLUID LOSS TESTS AND INSTRUMENTATION
	75.0	N/A	N/A	N/A	SANDY SILT WITH CLAY, (ML), tan with black grains, fine to medium sand, soft	
80.0	80.0	N/A	N/A	N/A	SAND, (SM), tan and black, fine to medium grain, trace of silt and clay	
85.0	85.0	N/A	N/A	N/A	SAND, (SM), as above	
90.0	90.0	N/A	N/A	N/A	SILTY SAND, (SM), tan and black speckled, fine to very fine sand, trace of clay	
95.0	95.0	N/A	N/A	N/A	SAND WITH SILT, (SM), brown and black, soft, very fine to medium grain	
100.0	100.0	N/A	N/A	N/A	CLAY, (CL), tan, stiff, plastic, trace of silt, some pinkish staining	
105.0	105.0	N/A	N/A	N/A	SAND WITH CLAY AND SILT, (SM), tan and black, fine to medium grain	
110.0	110.0	N/A	N/A	N/A	CLAY WITH SILT, (CL), tan with orange staining, soft, trace of fine sand	
115.0	115.0	N/A	N/A	N/A	CLAY WITH SILT, (CL), tan with gray, stiff and soft in areas	
120.0	120.0	N/A	N/A	N/A	SILTY CLAY, (CL), tand and greenish gray with yellow staining, soft	
125.0	125.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above, trace of fine sand	
130.0	130.0	N/A	N/A	N/A	SILTY CLAY, (CL), medium gray, soft	
135.0	135.0	N/A	N/A	N/A	SILTY CLAY, (CL), tan and gray, stiff, trace of fine to medium sand	
140.0	140.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above	
145.0	145.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above	
	150.0	N/A	N/A	N/A		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#3 Site 3 (TW1)	SHEET 3 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/15/95 FINISH 12/19/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	150.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above	
155.0	155.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above	
160.0	160.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above,	
165.0	165.0	N/A	N/A	N/A	SILTY CLAY, (CL), tan, with yellow staining, trace of fine sand	
170.0	170.0	N/A	N/A	N/A	SAND, (SP), tan and black, loose, fine to very fine sand, few fines	
175.0	175.0	N/A	N/A	N/A	SAND, (SC), tan and black, loose, fine to very fine with 15-20% clay and silt	
180.0	180.0	N/A	N/A	N/A	GRAVEL, (GW), tan, clear, brown, black, white, angular to subrounded, very coarse sand to pea size gravel, quartz, chert, limestone, etc., trace of fine sand	
185.0	185.0	N/A	N/A	N/A	GRAVEL, (GW), as above up to 1" clasts	
190.0	190.0	N/A	N/A	N/A	CLAYEY GRAVEL, (GC), light brown, black and tan, angular to subrounded, very coarse sand to 1" clasts, 20-30% silt and clay	
195.0	195.0	N/A	N/A	N/A	CLAY, (CH), light brown, fat, plastic	
200.0	200.0	N/A	N/A	N/A	CLAY, (CL), greenish gray and tan with yellow-orange staining, stiff, plastic, trace silt	
205.0	205.0	N/A	N/A	N/A	CLAY, (CL), as above	
210.0	210.0	N/A	N/A	N/A	CLAY, (CL), as above	
215.0	215.0	N/A	N/A	N/A	CLAY, (CL), as above	
220.0	220.0	N/A	N/A	N/A	CLAY, (CL), as above	
	225.0	N/A	N/A	N/A		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#3 Site 3 (TW1)	SHEET 4 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/15/95 FINISH 12/19/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
	225.0	N/A	N/A	N/A	CLAY, (CL), as above	
230.0	230.0	N/A	N/A	N/A	CLAY, (CL), as above	
235.0	235.0	N/A	N/A	N/A	CLAY, (CL), as above	
240.0	240.0	N/A	N/A	N/A	CLAY, (CL), greenish gray and tan with yellow-orange staining, stiff, plastic	
245.0	245.0	N/A	N/A	N/A	CLAY, (CL), as above	
250.0	250.0	N/A	N/A	N/A	CLAY, (CL), as above	
255.0	255.0	N/A	N/A	N/A	CLAY, (CL), as above, trace silt	
260.0	260.0	N/A	N/A	N/A	CLAY, (CL), as above	
265.0	265.0	N/A	N/A	N/A	CLAY, (CL), as above	
270.0	270.0	N/A	N/A	N/A	CLAY, (CL), as above with 10-15% coarse sand	
275.0	275.0	N/A	N/A	N/A	CLAY WITH SILT, (CL), greenish gray and tan, stiff, medium to coarse sand	
280.0	280.0	N/A	N/A	N/A	CLAY, (CL), light greenish gray with yellow-orange staining, stiff with isolated very coarse grains	
285.0	285.0	N/A	N/A	N/A	CLAY, (CL), as above	
290.0	290.0	N/A	N/A	N/A	CLAY, (CL), greenish gray with yellow-orange staining, stiff, plastic, trace of silt	
295.0	295.0	N/A	N/A	N/A	CLAY, (CL), as above with isolated coarse sand	
	300.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#3 Site 3 (TW1)	SHEET 5 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR **LOCATION** City Well Field, Center Street, Brownsville, TX

ELEVATION _____ **DRILLING CONTRACTOR** Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ **START** 12/15/95 **FINISH** 12/19/95 **LOGGER** L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	300.0					
		N/A	N/A	N/A	CLAY WITH SILT, (CL), greenish gray with yellow-orange staining and black mottles, trace of medium to coarse sand	
305.0	305.0					
		N/A	N/A	N/A	CLAY, (CL), greenish gray and tan, stiff, trace of silt, some yellow-orange staining	
310.0	310.0					
		N/A	N/A	N/A	CLAY, (CL), as above with trace of fine sand	
315.0	315.0					
		N/A	N/A	N/A	CLAY, (CL), greenish gray and tan, stiff, plastic, with isolated coarse grains	
320.0	320.0					
		N/A	N/A	N/A	SANDY CLAY, (CL), greenish gray and tan, stiff with isolated coarse grains	
325.0	325.0					
		N/A	N/A	N/A	CLAY, (CL), greenish gray with yellow-orange staining, stiff, plastic, trace silt	
330.0	330.0					
		N/A	N/A	N/A	CLAY WITH SILT AND SAND, (CL), tan and greenish gray, soft	
335.0	335.0					
		N/A	N/A	N/A	CLAY, (CL), greenish gray and tan, soft, 15-20% SAND AND SILT, some yellow staining	
340.0	340.0					
		N/A	N/A	N/A	CLAY WITH SAND AND SILT, (CL), as above	
345.0	345.0					
		N/A	N/A	N/A	CLAY WITH SAND AND SILT, (CL), as above	
350.0	350.0					
		N/A	N/A	N/A	SILTY CLAY, (CL), medium gray and tan, soft, trace of fine sand	
355.0	355.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), tan, soft, fine to medium sand	
360.0	360.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above with fine to coarse sand	
365.0	365.0					
		N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), as above	
370.0	370.0					
		N/A	N/A	N/A	SILTY CLAY, (CL), tan, greenish gray and yellow-orange staining, soft, trace of sand	
	375.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#3 Site 3 (TW1)	SHEET 6 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR **LOCATION** City Well Field, Center Street, Brownsville, TX

ELEVATION _____ **DRILLING CONTRACTOR** Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ **START** 12/15/95 **FINISH** 12/19/95 **LOGGER** L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
380.0	375.0 – 380.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above with trace of fine to coarse sand	
385.0	380.0 – 385.0	N/A	N/A	N/A	SILTY CLAY, (CL), tan and medium gray, soft, trace of very fine sand	
390.0	385.0 – 390.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above	
395.0	390.0 – 395.0	N/A	N/A	N/A	SILTY CLAY, (CL), as above	
400.0	395.0 – 400.0	N/A	N/A	N/A		
405.0	400.0 – 405.0	N/A	N/A	N/A	SILTY CLAY, (CL), dark gray and tan, stiff, plastic, trace of sand	
410.0	405.0 – 410.0	N/A	N/A	N/A	CLAY, (CL), medium gray with yellow staining, soft, trace of silt and sand	
415.0	410.0 – 415.0	N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), gray and tan, soft	
420.0	415.0 – 420.0	N/A	N/A	N/A	SANDY SILT, (OL), dark gray and tan, fine to medium sand, trace of coarse material	
425.0	420.0 – 425.0	N/A	N/A	N/A	SILTY SAND, (SM), black and tan, soft, fine to coarse grain	
430.0	425.0 – 430.0	N/A	N/A	N/A	SANDY SILT, (OL), black, dark gray and tan, soft, trace of coarse grains	
435.0	430.0 – 435.0	N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), gray with yellow staining, soft	
440.0	435.0 – 440.0	N/A	N/A	N/A	SILTY SAND WITH CLAY, (SM), gray and tan and black, fine to very coarse sand, isolated gravel	
445.0	440.0 – 445.0	N/A	N/A	N/A	SILTY CLAY WITH SAND, (CL), medium gray, soft	
	445.0 – 450.0	N/A	N/A	N/A	SILTY SAND WITH CLAY, (SM), gray, black and tan, soft, fine to medium grain	

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#3 Site 3 (TW1)	SHEET 7 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 12/15/95 FINISH 12/19/95 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	450.0					
		N/A	N/A	N/A	SILTY SAND WITH CLAY, (SM), as above	
455.0	455.0					
		N/A	N/A	N/A	SILTY SAND WITH CLAY, (OL), greenish gray and tan with yellow-orange staining, soft	
460.0	460.0					
		N/A	N/A	N/A	SANDY SILT WITH CLAY, (OL), as above	
465.0	465.0					
		N/A	N/A	N/A	SANDY SILT WITH CLAY, (OL), as above	
470.0	470.0					
					END OF BORING Monitor Well TW-1 installed	Geophysical log run
475.0						
480.0						
485.0						
490.0						
495.0						
500.0						
505.0						
510.0						
515.0						
520.0						

CRM HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#4 Site 3	SHEET 1 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 1/30/96 FINISH 2/6/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0	0.0 5.0	N/A	N/A		FAT CLAY, (CH), brownish gray, trace brown clay, moist to wet, trace coarse sand	Samples obtained by drillers logged on 2/1/96, collected every 5 ft.
5.0	10.0	N/A	N/A		Same as above	
10.0	15.0	N/A	N/A		Same as above	
15.0	20.0	N/A	N/A		Same as above	
20.0	25.0	N/A	N/A		Same as above	
25.0	30.0	N/A	N/A		Trace mottling, iron magnesium oxidation, firm to stiff	
30.0	35.0	N/A	N/A		Fractures within clay	
35.0	40.0	N/A	N/A		Same, trace very fine sand and silt, buff-orange gray brown	
40.0	45.0	N/A	N/A		Same as above	
45.0	50.0	N/A	N/A		Same, becoming elastic silt/fat clay, high plasticity	
50.0	55.0	N/A	N/A		Same as above	
55.0	60.0	N/A	N/A		FAT CLAY, orange brown, gray brown, very stiff, mottled	
60.0	65.0	N/A	N/A		Same, soft	
65.0	70.0	N/A	N/A		Same as above	
70.0	75.0	N/A	N/A		CLAY, some trace reddish brown, stiff	
75.0	80.0	N/A	N/A		POORLY GRADED SAND, (SP), trace silt, likely (SP/SM), trace caliche fragments 1/8", trace clay fragments	
80.0	85.0	N/A	N/A		Same as above	
85.0	90.0	N/A	N/A		Same as above	
90.0	95.0	N/A	N/A		Same as above	
95.0	100.0	N/A	N/A		Trace clay, brown	
100.0	105.0	N/A	N/A		FAT CLAY, (CH/CL), light grayish brown, mottled, gray, orange brown, brown, stiff to firm	
105.0	110.0	N/A	N/A		Same as above	
110.0	115.0	N/A	N/A		Same as above	
115.0	120.0	N/A	N/A		Same as above	
120.0	125.0	N/A	N/A		Same as above	
125.0	130.0	N/A	N/A		Same as above	
130.0	135.0	N/A	N/A		Becoming soft with caliche fragments, and sand	
135.0	140.0	N/A	N/A		CLAYEY SAND, (SC), gray brown, with caliche	
140.0	145.0	N/A	N/A		SANDY CLAY, (CL), gray brown, soft	
145.0	150.0	N/A	N/A		Same as above	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#4 Site 3 SHEET 2 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 1/30/96 FINISH 2/6/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
155.0	150.0 155.0	N/A	N/A		CLAY WITH SAND/SANDY CLAY with caliche, soft	
160.0	163.0	N/A	N/A		Same FAT CLAY WITH SAND, soft	Begin coring at 160'
165.0			5.0		163-165.5': FAT CLAY, (CH), light grayish brown, mottled, moist to dry, 5-10% sand, very stiff	7 7/8", hole 3 7/8" core bit Quick gel mud
170.0	173.0				165.6-173': POORLY GRADED SAND, (SP), tannish brown, fine to medium sand laminated with silty sand and sandy silt layers, trace 1/8" brown clay lamination washout between 166.9 and 172.5'; running sand; at 172.5' grading to laminated sandy silt to silty sand	Drill change at 165'; increased core rate Pushed core out with mud plunger, broke up sample
175.0			1.5			
180.0	183.0				173-183', POORLY GRADED SAND WITH SILT, (SW/SM), brown, silt to medium sand, 1/2-3/4" gravel at base of bit approximately 10-15% silt	Drill change at 182', likely gravel
185.0			2.5			
190.0	193.0				183-193', CLAYEY GRAVEL, (GC), 3/4-2" subrounded gravel- 70%, 30% sandy clay clast supported matrix, interstitial pores filled with sandy clay	193-196': slow drilling, likely sand
195.0			1.3			
200.0	203.0				At 193', CLAYEY SAND TO CLAY, transition to CLAY WITH GRAVEL (base of barrel)	
205.0	205.0				196-203': FAT CLAY, light gray to light brown, dry, very hard FAT CLAY, greenish gray to orange gray brown, mottled, dry to very hard with trace coarse sand (caliche)	End coring at 205'. Begin mud logging, cuttings obtained at 5' intervals by drillers
210.0	210.0	N/A	N/A			
215.0	215.0	N/A	N/A			
220.0	220.0	N/A	N/A		205-220', FAT CLAY, (CH), grayish brown, high dry strength, medium plasticity, trace gravel carry over from 190', soft to firm	Water change
225.0	225.0	N/A	N/A			
230.0	230.0	N/A	N/A			
235.0	235.0	N/A	N/A		220-320', Same as above, trace sand, trace caliche gravel, streaks of light brown clay, mottled	
240.0	240.0	N/A	N/A		Same as above	
245.0	245.0	N/A	N/A		Same as above	
250.0	250.0	N/A	N/A		Same as above	
255.0	255.0	N/A	N/A		Same as above	
260.0	260.0	N/A	N/A		Same as above	
265.0	265.0	N/A	N/A		Same as above	
270.0	270.0	N/A	N/A		Same as above	
275.0	275.0	N/A	N/A		Same as above	
280.0	280.0	N/A	N/A		Same as above	
285.0	285.0	N/A	N/A		Same as above	
290.0	290.0	N/A	N/A		Same as above	
295.0	295.0	N/A	N/A		Same as above	
	300.0	N/A	N/A			

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#4 Site 3 SHEET 3 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 1/30/96 FINISH 2/6/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
305.0	300.0 305.0	N/A	N/A		Same as above	
	310.0	N/A	N/A		Same as above	
310.0	315.0	N/A	N/A		Same as above	
315.0	320.0	N/A	N/A		Same as above	
320.0	325.0	N/A	N/A		320-340', CLAYEY SAND, (SC), buff to tannish brown, fine to medium sand	Driller notes change at 320', suggests sandy shale to 327', sand at 327-344'
325.0	330.0	N/A	N/A		Same as above	
330.0	335.0	N/A	N/A		Same as above	
335.0	340.0	N/A	N/A		Same as above	
340.0	345.0	N/A	N/A		Same to 344'	
345.0	350.0	N/A	N/A		344-367', FAT CLAY, (CH), mottled gray brown and light brown, dry	
350.0	355.0	N/A	N/A		Same as above	
355.0	360.0	N/A	N/A		Same as above	
360.0	365.0	N/A	N/A		Same to 367'	
365.0	370.0	N/A	N/A		367-387', FAT CLAY WITH SAND, (CH)	Driller notes sand steaks from 367' to 387'
370.0	375.0	N/A	N/A		Same as above	
375.0	380.0	N/A	N/A		Same as above	
380.0	385.0	N/A	N/A		Same to 387'	
385.0	390.0	N/A	N/A		387', CLAYEY SAND TO SANDY CLAY OR CLAY WITH SAND, sample: soft clay/silt with sand clay fragments are dry to moist	Driller notes sand from 387' to 467'
390.0	395.0	N/A	N/A		Same as above	
395.0	400.0	N/A	N/A		Same as above	
400.0	405.0	N/A	N/A		Same as above	
405.0	410.0	N/A	N/A		Same as above	
410.0	415.0	N/A	N/A		Same as above	
415.0	420.0	N/A	N/A		Same as above	
420.0	425.0	N/A	N/A		420', Same as above, likely interlayered	Sample suggests clay/fines > sand % to 467'
425.0	430.0	N/A	N/A		Same as above	
430.0	435.0	N/A	N/A		Same as above	
435.0	440.0	N/A	N/A		Same as above	
440.0	445.0	N/A	N/A		Same as above	
445.0	450.0	N/A	N/A		Same as above	

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#4 Site 3 SHEET 4 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 1/30/96 FINISH 2/6/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
465.0	450.0 455.0	N/A	N/A		Same as above	
460.0	460.0	N/A	N/A		Same as above	
465.0	465.0	N/A	N/A		Same as above	
470.0	470.0	N/A	N/A		467-495', CLAYEY GRAVEL, (GC), to gravel, increasing 495' approximately 10-15%	Driller notes change to gravel at 467-507'
475.0	475.0	N/A	N/A		Same as above	467-495' (GC)
480.0	480.0	N/A	N/A		Same as above	
485.0	485.0	N/A	N/A		Same as above	
490.0	490.0	N/A	N/A		Same as above	
495.0	495.0	N/A	N/A		490-500': CLAY WITH GRAVEL	
500.0	500.0	N/A	N/A		Same as above	
505.0	505.0	N/A	N/A		500-507': GRAVEL WITH CLAY, (GC), 5-10% fines, probably 30-40% sand	
510.0	510.0	N/A	N/A		507-547': WELL GRADED SAND WITH CLAY/SILT, (SW/SC), brown, fine to medium sand, trace coarse sand, 5-10% fines, well indurated clay fragments (semi-consolidated) may comprise some coarse sand, dark gray	
515.0	515.0	N/A	N/A		Same as above	
520.0	520.0	N/A	N/A		Same as above	
525.0	525.0	N/A	N/A		Same as above	
530.0	530.0	N/A	N/A		Same as above	
535.0	535.0	N/A	N/A		Same as above	
540.0	540.0	N/A	N/A		Same as above	
545.0	545.0	N/A	N/A		Same as above	
550.0	550.0	N/A	N/A		Same as above	Driller logs sand and gravel from 547' to 567'
555.0	555.0	N/A	N/A		Same as above	
560.0	560.0	N/A	N/A		Same as above	
565.0	565.0	N/A	N/A		Same as above	
570.0	570.0	N/A	N/A		567-577' SANDY SHALE/SANDY CLAY, (CL), moderate brown, mottled with orange brown, reddish brown FAT CLAY WITH SAND, semi-indurated clay zones, dry, dark gray clay stone fragements	Driller logs hard streak at 565-567'
575.0	575.0	N/A	N/A		577-587': SAND	
580.0	580.0	N/A	N/A		Same as above	
585.0	585.0	N/A	N/A		587', SANDY SHALE	
590.0	590.0	N/A	N/A		Same as above	
595.0	595.0	N/A	N/A		Same as above	
600.0	600.0	N/A	N/A			

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#4 Site 3 SHEET 5 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Falling Mud Rotary

WATER LEVELS _____ START 1/30/96 FINISH 2/8/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
600.0	600.0 605.0	N/A	N/A		Rose barite fragments and trace gravel to 615'	Driller calls shale at 600'
605.0	610.0	N/A	N/A		607', SANDY SHALE	
610.0	615.0	N/A	N/A		Same as above	
615.0	620.0	N/A	N/A		615-680', SANDY CLAY TO CLAY WITH SAND, mottled bluish gray to reddish brown, soft, increasing sand content, with claystone fragments	
620.0	625.0	N/A	N/A		Same as above	
625.0	630.0	N/A	N/A		No evidence of discrete sand layers	627-647', sand and clay streaks
630.0	635.0	N/A	N/A		Same as above	
635.0	640.0	N/A	N/A		Same as above	
640.0	645.0	N/A	N/A		Same as above	
645.0	650.0	N/A	N/A		647-663': SAND	
650.0	655.0	N/A	N/A		Same as above	
655.0	660.0	N/A	N/A		Same as above	
660.0	665.0	N/A	N/A		663-680': CLAY	
665.0	670.0	N/A	N/A		Same as above	
670.0	675.0	N/A	N/A		Same as above	
675.0	680.0	N/A	N/A		Same as above	
680.0	685.0	N/A	N/A		680-690', CLAYEY SANDY (SC), to POORLY GRADED SAND WITH CLAY, (SP/SC), fine to stiff, trace sandy clayand clay fragments, semi-indurated to hard	
685.0	690.0	N/A	N/A		690-747', SANDY CLAY, (CL), mottled gray brown to bluish gray, some clay fragments approximately 20-25% sand in some zones, blue gray clay = (CH), no sand	
690.0	695.0	N/A	N/A		Same as above	
695.0	700.0	N/A	N/A		Same as above	
700.0	705.0	N/A	N/A		Same as above	
705.0	710.0	N/A	N/A		Same as above	
710.0	715.0	N/A	N/A		715-720': SAND	
715.0	720.0	N/A	N/A		720': CLAYSTONE, mottled blue-gray to dark brown	
720.0	725.0	N/A	N/A		Same as above	
725.0	730.0	N/A	N/A		Same as above	
730.0	735.0	N/A	N/A		Same as above	
735.0	740.0	N/A	N/A		Same as above	
740.0	745.0	N/A	N/A			
745.0	747.0				747-800', SANDY CLAY TO CLAYSTONE	
	750.0	N/A	N/A			

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#4 Site 3 SHEET 7 OF 7

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION City Well Field, Center Street, Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Falling Mud Rotary

WATER LEVELS _____ START 1/30/96 FINISH 2/6/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
900.0	900.0 905.0	N/A	N/A		Same as above	
905.0	910.0	N/A	N/A		905-925': CLAYSTONE with gravel (limestone fragments)	Carry-over
910.0	915.0	N/A	N/A		Same as above	
915.0	920.0	N/A	N/A		Same as above	
920.0	925.0	N/A	N/A		Same as above	
925.0	930.0	N/A	N/A		GRAVEL, sandstone fragments	
930.0	935.0	N/A	N/A		Drillers Log:	Logging of soils - not completed
935.0	940.0	N/A	N/A		Same as above	
940.0	945.0	N/A	N/A		940-947': SANDY SHALE	
945.0	950.0	N/A	N/A		947-967': SHALE, blue	
950.0	955.0	N/A	N/A		Same as above	
955.0	960.0	N/A	N/A		Same as above	
960.0	965.0	N/A	N/A		Same as above	
965.0	970.0	N/A	N/A		967-987': SANDY SHALE AND LIMESTONE, gray	
970.0	975.0	N/A	N/A		Same as above	
975.0	980.0	N/A	N/A		Same as above	
980.0	985.0	N/A	N/A		Same as above	
985.0	990.0	N/A	N/A		987-1007': SANDY SHALE, with limestone streaks	
990.0	995.0	N/A	N/A		Same as above	
995.0	1000	N/A	N/A		Same as above	
1000.0	1005	N/A	N/A		Same as above	
1005.0	1010	N/A	N/A		1007-1037', SANDY SHALE	
1010.0	1015	N/A	N/A		Same as above	
1015.0	1020	N/A	N/A		Same as above	
1020.0	1025	N/A	N/A		1022-1047': SANDY SHALE	
1025.0	1030	N/A	N/A		Same as above	
1030.0	1035	N/A	N/A		Same as above	
1035.0	1040	N/A	N/A		Same as above	
1040.0	1045	N/A	N/A		Same as above	Hole collapes, boring abandoned
1045.0	1047	N/A	N/A		END OF BORING	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 1 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
0.0	0.0 5.0	N/A	N/A		TOPSOIL, brown clay, trace rootlets, caliche, fine sand	2/27/96 logging drillers cuttings: 0-900'; also using drillers log
5.0					ELASTIC SILT WITH SAND, brown, trace caliche, rhizoliths	Samples obtained by drillers at 5 foot intervals
10.0	10.0	N/A	N/A			6 5/8" ID pilot hole 42' - TD
	15.0	N/A	N/A		FAT CLAY WITH SAND, brown, fine to medium sand, approximately 10-15%, including caliche fragments, firm	Approximately 12 3/4" OD surface casing set to = 42'
15.0	20.0	N/A	N/A		Same as above, becoming brownish gray	
20.0	25.0	N/A	N/A		Same as above, mottled, 20% fine sand	
25.0	30.0	N/A	N/A		Same as above, light brown, soft, mottled	
30.0	35.0	N/A	N/A		Same as above with caliche (<5%)	
35.0	40.0	N/A	N/A		Same as above, BROWN CLAY WITH WHITE/BUFF SILTSTONE, hard to slightly friable, likely caliche	
40.0	45.0	N/A	N/A		Same as above	
45.0	50.0	N/A	N/A		Same as above	
50.0	55.0	N/A	N/A		Same as above	
55.0	60.0	N/A	N/A		Same as above	
60.0	65.0	N/A	N/A		FAT CLAY, moderate brown, trace caliche	
65.0	70.0	N/A	N/A		Same as above	
70.0	75.0	N/A	N/A		FAT CLAY, light brown-grayish brown, with grayish white caliche, 1/16-1/8" thick fragments, trace iron oxide staining within clay	Samples obtained every 5 feet
75.0	80.0	N/A	N/A		Same as above	
80.0	85.0	N/A	N/A		Same as above	
85.0	90.0	N/A	N/A		Same as above	
90.0	95.0	N/A	N/A		Same as above	
95.0	100.0	N/A	N/A		Same as above with coarse (1/2-3/4") fragments of caliche limestone, less trace mottles of very fine sand/silt, orange brown oxidized	
100.0	105.0	N/A	N/A		Same as above, INTERBEDDED WITH SAND, dominant clay, fine to very fine sand	Can't confirm, no acid onsite
105.0	110.0	N/A	N/A		Same as above, mostly clay	
110.0	115.0	N/A	N/A		110-115', Same as above, mottled, dark gray, gray, BROWN CLAY, trace sand carryover, dark gray zones are semi-indurated claystone, trace silt	Carryover from previous intervals
115.0	120.0	N/A	N/A			
120.0	125.0	N/A	N/A		120-125', Same as above, with gray SANDY CLAY, zones 20-25% sand (very fine), soft to firm, mottled dark reddish brown, dark gray, trace 1-2mm shells, gastropods	
125.0	130.0	N/A	N/A		125-130', Same as above, trace elastic silt	

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#5 Site 4 (TW2) SHEET 2 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR **LOCATION** Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ **DRILLING CONTRACTOR** Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ **START** 2/16/96 **FINISH** 3/19/96 **LOGGER** P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	130.0					
135.0	135.0	N/A	N/A		130-135', Same as above, FAT CLAY, dark gray, mottled, firm to stiff, trace silt and elastic silt zones	
	140.0	N/A	N/A		Same as above	
140.0	145.0	N/A	N/A		Same as above	
145.0	150.0	N/A	N/A		Same as above	
150.0	155.0	N/A	N/A		Same as above	
155.0	160.0	N/A	N/A		155-160', Same as above, soft, with trace semi-indurated caliche	
160.0	165.0	N/A	N/A		Same as above	
165.0	170.0	N/A	N/A		Same as above, with semi-indurated claystone, gray to dark gray	
170.0	175.0	N/A	N/A		Same as above	
175.0	180.0	N/A	N/A		Same as above, trace reddish brown clay	
180.0	185.0	N/A	N/A		Same as above, trace, <5% fine sand	
185.0	190.0	N/A	N/A		Same as above, very soft with dark gray fine gravel, subrounded to rounded	
190.0	195.0	N/A	N/A		190-195', Same as above, trace sand, GRAVEL, sand with gravel, 1/8->1/4" fragments	
195.0	200.0	N/A	N/A		Same as above	Driller reports "sand gravel drilling rate" at 195-200'
200.0	205.0	N/A	N/A		Same as above	Lost circulation at 200'
205.0	210.0	N/A	N/A		GRAVEL WITH CLAY, 70/30 coarse fines, fine to medium sand, trace > 1/4" gravel - up to 30% fines, approximately 20-30% sand, 30- 40% gravel	
210.0	215.0	N/A	N/A		Same as above	
215.0	220.0	N/A	N/A		215-220', GRAVEL WITH SAND (20%), (GP), poorly graded 1/4-3/4" gravel, subrounded, angular	
220.0	225.0	N/A	N/A		222-230', Same as above, with clay to 222'; SILTY CLAYEY SAND, interbedded, 60/40 (coarse/fine), trace gravel, mottled clay: buff, tan, brown, trace reddish brown	
225.0	230.0	N/A	N/A			
230.0	235.0	N/A	N/A		230-235', CLAY WITH SAND, (5-10%) mottled, trace gravel carryover mottled	Drillers log: gravel drilling characteristics from 237-240'
235.0	240.0	N/A	N/A		Same as above	Gravel carryover
240.0	245.0	N/A	N/A		Same as above, 10-15% sand, soft	
245.0	250.0	N/A	N/A		Same as above to 260', CLAY WITH SAND to SANDY CLAY, with trace gravel - fine	
250.0	255.0	N/A	N/A		Same as above	
255.0	260.0	N/A	N/A		Same as above	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 3 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
265.0	260.0 265.0	N/A	N/A		Same as above, trace gravel	
270.0	270.0	N/A	N/A		Same as above	
275.0	275.0	N/A	N/A		270-275', Same as above, soft, trace firm to stiff zones, mottled, 25-30% coarse, 20-25% sand, 5% gravel	
280.0	280.0	N/A	N/A		Same as above, continued coarse, (approximately 35-40%) mottled clay	
285.0	285.0	N/A	N/A		SILTY/CLAYEY SAND WITH GRAVEL, tan brown, approximately 30-40% fines interbedded, fine gravel 1/8-3/8" approximately 20%	Drillers log: 264-280 gravel mixed with clay
290.0	290.0	N/A	N/A		SILTY/CLAY GRAVEL WITH SAND, interbedded	
295.0	295.0	N/A	N/A		290-295', Same as above, SILTY SAND, with interbedded clay, trace gravel	
300.0	300.0	N/A	N/A		295-300', Same as above, no gravel	
305.0	305.0	N/A	N/A		300-315', SILTY CLAYEY SAND, brown, 15-25% fines, fine to very fine sand	Drillers log: 295-383': clay 383-500', sandy and soft clay streaks
310.0	310.0	N/A	N/A		Same as above	
315.0	315.0	N/A	N/A		Same as above	
320.0	320.0	N/A	N/A		315-320', SANDY CLAY, mottled, tan to light gray, light brown, 15-20% sand, trace hard clay - claystone	
325.0	325.0	N/A	N/A		Same as above	
330.0	330.0	N/A	N/A		Same as above	
335.0	335.0	N/A	N/A		Same as above, 10% sand	
340.0	340.0	N/A	N/A		Same as above	
345.0	345.0	N/A	N/A		Same as above	
350.0	350.0	N/A	N/A		345-360', 15% sand, hard clay zone, semi-indurated, same to 360'	
355.0	355.0	N/A	N/A		Same as above	
360.0	360.0	N/A	N/A		Same as above	
365.0	365.0	N/A	N/A		360-385', FAT CLAY, with semi-indurated siltstone and claystone, 5-10% sand, trace 1/8-1/4" gravel	
370.0	370.0	N/A	N/A		Same as above	
375.0	375.0	N/A	N/A		Same as above	
380.0	380.0	N/A	N/A		Same as above	
385.0	385.0	N/A	N/A		Same as above	
	390.0	N/A	N/A		385-390', CLAY, with interbedded sand (no sand in clay fragments) 30-40% sand	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 4 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Falling Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	390.0					
	395.0	N/A	N/A		390-405', Same as above, to CLAYEY SAND, with interbedded mottled clay	
395.0						
	400.0	N/A	N/A		Same as above	
400.0						
	405.0	N/A	N/A		Same as above	
405.0						
	410.0	N/A	N/A		405-415', Same as above, becoming finer SANDY CLAY	
410.0						
	415.0	N/A	N/A		Same as above	
415.0						
	420.0	N/A	N/A		415-425', SANDY CLAY to CLAY WITH SAND	
420.0						
	425.0	N/A	N/A		Same as above	
425.0						
	430.0	N/A	N/A		425-430', CLAYEY SAND, interbedded, mottled 60% coarse, 30-40% fines	
430.0						
	435.0	N/A	N/A		430-450', CLAYEY SAND, brown-gray, trace gravel, interbedded clay, approximately 40% fines	Drillers log:
435.0						500-510', clay
	440.0	N/A	N/A		Same as above	510-520', firm sand
440.0						520-755', clay
	445.0	N/A	N/A		Same as above	
445.0						
	450.0	N/A	N/A		Same as above	
450.0						
	455.0	N/A	N/A		450-480', FAT CLAY WITH SAND, mottled, trace <5% gravel, 15-20% sand, variable, soft clay	
455.0						
	460.0	N/A	N/A		Same as above	
460.0						
	465.0	N/A	N/A		Same as above	
465.0						
	470.0	N/A	N/A		Same as above	
470.0						
	475.0	N/A	N/A		Same as above	
475.0						
	480.0	N/A	N/A		Same as above	
480.0						
	485.0	N/A	N/A		485-500', SANDY CLAY, tan to light gray brown, 30-40% SAND, 2-5% fine gravel, trace gravel, soft	
485.0						
	490.0	N/A	N/A		Same as above	
490.0						
	495.0	N/A	N/A		Same as above	
495.0						
	500.0	N/A	N/A		500-505', Same as above, approximately 10% sand, trace gravel (fine), mottled	
500.0						
	505.0	N/A	N/A		Same as above	
505.0						
	510.0	N/A	N/A		Same as above	
510.0						
	515.0	N/A	N/A		Same as above	
515.0						
	520.0	N/A	N/A			

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 5 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
625.0	520.0 525.0	N/A	N/A		Same as above 525-530', SANDY CLAY	
630.0	530.0	N/A	N/A		530-545', Same as above, trace gravel, light gray at 545', 15-20% sand	
635.0	535.0	N/A	N/A		Same as above	
640.0	540.0	N/A	N/A		Same as above	
645.0	545.0	N/A	N/A		545-600', Massive mottled SANDY CLAY TO CLAY WITH SAND	
650.0	550.0	N/A	N/A		Same as above	
655.0	555.0	N/A	N/A		Same as above	
660.0	560.0	N/A	N/A		Same as above	
665.0	565.0	N/A	N/A		Same as above	
670.0	570.0	N/A	N/A		Same as above	
675.0	575.0	N/A	N/A		Same as above	
680.0	580.0	N/A	N/A		Same as above	
685.0	585.0	N/A	N/A		Same as above	
690.0	590.0	N/A	N/A		Same as above	
695.0	595.0	N/A	N/A		Same as above	
700.0	600.0	N/A	N/A		600-635', Same as above, FAT CLAY, light gray, trace sand, up to 10%	
705.0	605.0	N/A	N/A		Same as above	
710.0	610.0	N/A	N/A		Same as above	
715.0	615.0	N/A	N/A		Same as above	
720.0	620.0	N/A	N/A		Same as above	
725.0	625.0	N/A	N/A		Same as above	
730.0	630.0	N/A	N/A		Same as above	
735.0	635.0	N/A	N/A		Same as above	
740.0	640.0	N/A	N/A		Same as above	
745.0	645.0	N/A	N/A		Same as above	
	650.0	N/A	N/A			

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 6 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Falling Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	650.0					
655.0	655.0	N/A	N/A		Same as above	
	660.0	N/A	N/A		Same as above	
660.0	665.0	N/A	N/A		Same as above	
665.0	670.0	N/A	N/A		Same as above	
670.0	675.0	N/A	N/A		670-690', CLAY, FAT WITH SAND, light gray, mottled with light brown clay, 10-15% sand (max)	Drillers log: 755-760', sandy 760-838', sandy clay streaks 838-840', hard streak 840-872', clay and sand streaks 872-880', hard streak 880-894', clay and sand streaks 894-900', hard streak
675.0	680.0	N/A	N/A		Same as above	
680.0	685.0	N/A	N/A		Same as above	
685.0	690.0	N/A	N/A		Same as above	
690.0	695.0	N/A	N/A		690-740', Same as above, variable consistency, soft to firm	
695.0	700.0	N/A	N/A		Same as above	
700.0	705.0	N/A	N/A		Same as above	
705.0	710.0	N/A	N/A		Same as above	
710.0	715.0	N/A	N/A		Same as above	
715.0	720.0	N/A	N/A		Same as above	
720.0	725.0	N/A	N/A		Same as above	
725.0	730.0	N/A	N/A		Same as above	
730.0	735.0	N/A	N/A		Same as above	
735.0	740.0	N/A	N/A		Same as above	
740.0	745.0	N/A	N/A		740-800', Same as above, sandier zones usually correlate with light gray to tan, buff colors	
745.0	750.0	N/A	N/A		Same as above	
750.0	755.0	N/A	N/A		Same as above	
755.0	760.0	N/A	N/A		Same as above	
760.0	765.0	N/A	N/A		Same as above	
765.0	770.0	N/A	N/A		Same as above	
770.0	775.0	N/A	N/A		Same as above	
775.0	780.0	N/A	N/A		Same as above	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 7 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	780.0					
785.0	785.0	N/A	N/A		Same as above	
	790.0	N/A	N/A		Same as above	
790.0	795.0	N/A	N/A		Same as above	
795.0	800.0	N/A	N/A		Same as above	
800.0	805.0	N/A	N/A		Same as above	
805.0	810.0	N/A	N/A		Same as above	
810.0	815.0	N/A	N/A		Same as above	
815.0	820.0	N/A	N/A		Same as above	
820.0	825.0	N/A	N/A		Same as above	
825.0	830.0	N/A	N/A		Same as above	
830.0	835.0	N/A	N/A		Same as above	
835.0	840.0	N/A	N/A		Same as above	
840.0	845.0	N/A	N/A		840-850', Same as above, with trace gravel, 10-15% sand	
845.0	850.0	N/A	N/A		Same as above	
850.0	855.0	N/A	N/A		850-875', SANDY CLAY, approximately 30% sand	
855.0	860.0	N/A	N/A		Same as above	
860.0	865.0	N/A	N/A		At 860', 40% coarse sand, trace fine gravel	
865.0	870.0	N/A	N/A		Same as above	
870.0	875.0	N/A	N/A		Same as above	
875.0	880.0	N/A	N/A		875-880', CLAY WITH SAND, 20-25% coarse sand	
880.0	885.0	N/A	N/A		880-890', SANDY CLAY, 5% fine gravel	
885.0	890.0	N/A	N/A		Same as above	
890.0	895.0	N/A	N/A		890-900', Very soft SANDY CLAY	
895.0	900.0	N/A	N/A		Same as above	
900.0	905.0	N/A	N/A		900-920', CLAY WITH SAND, mottled, approximately 15-20% coarse sand, 2-5% gravel, fine up to 25% coarse sand, 10% gravel at 905-910'	Bit change to rock bit, drillers indicate new bit will produce smaller cuttings
905.0	910.0	N/A	N/A		Same as above	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 8 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	910.0				Same as above	
915.0	915.0	N/A	N/A		Same as above	
	920.0	N/A	N/A		Same as above	
920.0	925.0	N/A	N/A			
925.0	930.0	N/A	N/A		SANDY CLAY, mottled, caly consistency varies from soft to very stiff, trace gravel, some gravel resembles dark gray sandstone, similar to B-4 hole	
930.0	935.0	N/A	N/A		Same as above	
935.0	940.0	N/A	N/A		Same as above	
940.0	945.0	N/A	N/A		At 940', trace gravel, trace caliche, gravel at 970', buff-tan, SANDY CLAY, dark gray CLAY WITH SAND, (mottled)	
945.0	950.0	N/A	N/A		Same as above	
950.0	955.0	N/A	N/A		Same as above	
955.0	960.0	N/A	N/A		Same as above	
960.0	965.0	N/A	N/A		Same as above	
965.0	970.0	N/A	N/A		Same as above	
970.0	975.0	N/A	N/A		Same as above	
975.0	980.0	N/A	N/A		Same as above	
980.0	985.0	N/A	N/A		980-1000', Same, mottles include light brown FAT CLAY, bluish gray clay, trace gravel, approximately 10-15% sand; bivalve shell fragments	
985.0	990.0	N/A	N/A		Same as above	
990.0	995.0	N/A	N/A		Same as above	
995.0	1000	N/A	N/A			
1000.0	1005	N/A	N/A		1000-1065', Same, SANDY CLAY, steel gray to light brown, mottled, trace 1/8-1/4" gravel, caliche gravel, shell fragments, increased silt content, clay appears to be dominant fine; up to 35% sand	Gravel includes angular fragments of gray sandstone, that may correlate to "hard streaks" reported by driller also possible carryover
1005.0	1010	N/A	N/A		Same as above	
1010.0	1015	N/A	N/A		Same as above	
1015.0	1020	N/A	N/A		Same as above	
1020.0	1025	N/A	N/A		Same as above	
1025.0	1030	N/A	N/A		Same as above	
1030.0	1035	N/A	N/A		Same as above	
1035.0	1040	N/A	N/A		Same as above	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 9 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	1040	N/A	N/A		Same as above	
1045.0	1045				Same as above	
	1050	N/A	N/A		Same as above	
1060.0	1055	N/A	N/A		Same as above	
1065.0	1060	N/A	N/A		Same as above	
1080.0	1065	N/A	N/A		1065–1080', Same, SANDY FAT CLAY, dominant dark gray with mottles of buff, greenish gray, light brown, trace 1/8–1/4" gravel, subrounded, trace gray silty sandstone within matrix shell fragments	Low dilatancy, 3" rolls, high dry strength
1070.0	1070	N/A	N/A		Same as above	
1075.0	1075	N/A	N/A		Same as above	
1080.0	1080	N/A	N/A		Same as above	
1085.0	1085	N/A	N/A		Same as above	
1090.0	1090	N/A	N/A		Same as above	
1095.0	1095	N/A	N/A		Same as above	
1100.0	1100	N/A	N/A		1100–1110', Same as above, SANDY CLAY, (Fat), dark gray, trace gravel, 1/8–1/4" bivalve fragments	Consistency, lack of cutting, shell presense indicates silty, very fine sand origin of deposits - 2/28/96
1105.0	1105	N/A	N/A			
1110.0	1110	N/A	N/A		At 1110', SILTY SANDSTONE AND SILTSTONE, friable, dark gray, very fine grained sand	1110–1115', chatter
1115.0	1115	N/A	N/A		Same as above, INTERBEDDED SANDSTONE/SILTSTONE AND SANDY CLAY, trace fine gravel	1117–1120', siltstone or sandstone streaks
1120.0	1120	N/A	N/A		Same as above	
1125.0	1125	N/A	N/A		Same as above	
1130.0	1130	N/A	N/A		Same as above	
1135.0	1135	N/A	N/A		Same as above	
1140.0	1140	N/A	N/A		1140–1160', SANDY CLAY TO CLAY WITH SAND, dark gray, trace gravel, shells, interbedded siltstone, trace light brown. FAT CLAY, SANDY SILTSTONE WITH INTERBEDDED CLAY WITH SAND, trace gravel	
1145.0	1145	N/A	N/A		Same as above	
1150.0	1150	N/A	N/A		Same as above	
1155.0	1155	N/A	N/A		Same as above	
1160.0	1160	N/A	N/A		Same as above	
1165.0	1165	N/A	N/A		Same as above	
	1170	N/A	N/A			

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 10 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	1170				Same as above	
1175.0	1175	N/A	N/A		1175-1200', CLAY WITH SAND, trace gravel and shells, siltstone, carryover	
1180.0	1180	N/A	N/A		Same as above	
1185.0	1185	N/A	N/A		Same as above	
1190.0	1190	N/A	N/A		Same as above	
1195.0	1195	N/A	N/A		Same as above	
1200.0	1200	N/A	N/A		1200-1270', FAT CLAY WITH SAND, dark gray, very fine sand to silt, mottled, increased mottled, buff to tan clay (inclusions) soft, 15-20% very fine sand Carryover of siltstone fragments (friable) from 1220-1240', trace 1/8-1/4" gravel, bivalve shells	
1205.0	1205	N/A	N/A			
1210.0	1210	N/A	N/A			
1215.0	1215	N/A	N/A			
1220.0	1220	N/A	N/A		Same as above	
1225.0	1225	N/A	N/A		Same as above	
1230.0	1230	N/A	N/A		Same as above	
1235.0	1235	N/A	N/A		Same as above	
1240.0	1240	N/A	N/A		Same as above	
1245.0	1245	N/A	N/A		Same as above	
1250.0	1250	N/A	N/A		Same as above	
1255.0	1255	N/A	N/A		Same as above	
1260.0	1260	N/A	N/A		1260-1270', FAT CLAY, mottling increases, sand content decreases, dark gray brown to tan to bluish gray, soft, <10% sand, trace gravel	
1265.0	1265	N/A	N/A		Same as above	
1270.0	1270	N/A	N/A		Same as above	12-15 minutes for return to surface
1275.0	1275	N/A	N/A		1275-1290', FAT CLAY WITH SAND, dark gray, mottled with tan to light brown clay and sandy clay, trace gravel, trace sandy siltstone carryover	
1280.0	1280	N/A	N/A			
1285.0	1285	N/A	N/A		Same as above	
1290.0	1290	N/A	N/A		1290-1308', Same as above, trace caliche, siltstone, tan to buff, trace gravel, selenite gypsum fragments	
1295.0	1295	N/A	N/A			
	1300	N/A	N/A			

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 11 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 2/16/96 FINISH 3/19/96 LOGGER P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	1300				Same as above	
1305.0	1305	N/A	N/A			
	1310	N/A	N/A		1308–1313', SILTSTONE WITH SAND, dark gray, friable	Hard chatter, slow drilling 1308–1313'
1310.0					1313–1326', FAT CLAY, dark gray with tan to buff mottles, clay with sand, very fine grained, shells, soft	
1315.0	1315	N/A	N/A			
	1320	N/A	N/A		Same as above	
1320.0					Same as above	
	1325	N/A	N/A			
1325.0					SILTSTONE	Chatter 1326–1327'
	1330	N/A	N/A		Same as above, higher silt content, elastic silt, dark gray, CH mottles, blue gray, light brown, soft	
1330.0						
	1335	N/A	N/A		Same as above	
1335.0						
	1340	N/A	N/A		Same as above	
1340.0						
	1345	N/A	N/A		Same as above	
1345.0						
	1350	N/A	N/A		Same as above	
1350.0						
	1355	N/A	N/A		Same as above	
1355.0						
	1360	N/A	N/A		Same as above	
1360.0						
	1365	N/A	N/A			
1365.0					CLAYEY SAND, (SC), grayish brown, becoming lighter with depth, very soft, very fine grained sand, trace firm blue gray clay	Driller reports faster drilling, likely sand
	1370	N/A	N/A			
1370.0					Same as above	Drillers use sand pump to segregate sand from mud
	1375	N/A	N/A			
1375.0					Same as above	
	1380	N/A	N/A			
1380.0					Same as above, light brown clay balls within sand matrix, trace gravel	
	1385	N/A	N/A			
1385.0					Same as above	
	1390	N/A	N/A			
1390.0					Same as above	
	1395	N/A	N/A			
1395.0					Same as above	
	1400	N/A	N/A			
1400.0					Same as above	
	1405	N/A	N/A			
1405.0					At 1405', clay streaks with CLAYEY SAND matrix	Slower drilling
	1410	N/A	N/A			
1410.0					1410–1446', same as above	
	1415	N/A	N/A			
1415.0						
	1420	N/A	N/A			Fast drilling to 1418', 23, 21, 26
1420.0					CLAY SAND/SILTSTONE at 1421 and 1426'	
	1425	N/A	N/A		Same as above	
1425.0						
	1430	N/A	N/A		CLAYEY SILTY SAND, with interbedded sandy clay to clay, light grayish brown,	

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#5 Site 4 (TW2)	SHEET 12 OF 12

SOIL BORING LOG

PROJECT Brownsville ASR **LOCATION** Alton Gloor Aka Rd "Tejon Rd", Brownsville, TX

ELEVATION _____ **DRILLING CONTRACTOR** Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ **START** 2/16/96 **FINISH** 3/19/96 **LOGGER** P. van Noort

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE DRILLING FLUID LOSS TESTS AND INSTRUMENTATION
	1430 1435	N/A	N/A		Same as above	
1435.0	1440	N/A	N/A		Same as above	
1440.0	1445	N/A	N/A		Same as above	
1445.0	1450	N/A	N/A		Same as above	
1450.0	1455	N/A	N/A		Same as above	
1455.0	1460	N/A	N/A		Same as abbove	
1460.0	1465	N/A	N/A		1462-1502', SANDY CLAY TO CLAY WITH SAND, light brown gray, very fine sand (approximately 35-40%)	Drills like clay
1465.0	1470	N/A	N/A		Same as above	
1470.0	1475	N/A	N/A		Same as above	At 1475' hard streak
1475.0	1480	N/A	N/A		Same as above	
1480.0	1485	N/A	N/A		Same as above	
1485.0	1490	N/A	N/A		Same as above	
1490.0	1495	N/A	N/A		END OF BORING	TWDB - Geophysical log run TW-2 installed
1495.0	1500	N/A	N/A			
1500.0						
1505.0						
1510.0						
1515.0						
1520.0						
1525.0						
1530.0						
1535.0						
1540.0						
1545.0						
1550.0						
1555.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#6 (TW-3) SHEET 1 OF 4

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor, Tejan Road, Brownsville, Tx

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 4/9/96 FINISH 4/28/96 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0	0.0				0-40', surface casing; no samples collected	Driller says all clay
5.0						
10.0						
15.0						
20.0		N/A	N/A	N/A		
25.0						
30.0						
35.0						
40.0	40.0					
	45.0	N/A	N/A	N/A	CLAY, (CL), light brown to tanish, soft, some chert plastic	Traces of cement grout in samples to 130'
45.0	50.0	N/A	N/A	N/A	CLAY, (CL), as above	
50.0	55.0	N/A	N/A	N/A	CLAY, (CL), as above	
55.0	60.0	N/A	N/A	N/A	CLAY, (CL), as above	
60.0	65.0	N/A	N/A	N/A	CLAY, (CL), as above	
65.0	70.0	N/A	N/A	N/A	CLAY, (CL), as above	
70.0	75.0	N/A	N/A	N/A	CLAY, (CL), as above	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#6 (TW-3)	SHEET 2 OF 4

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor, Tejan Road, Brownsville, Tx

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 4/9/96 FINISH 4/28/96 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	75.0	N/A	N/A	N/A	CLAY, (CL), as above	
80.0	80.0	N/A	N/A	N/A	CLAY, (CL), as above	
85.0	85.0	N/A	N/A	N/A	CLAY, (CL), as above	
90.0	90.0	N/A	N/A	N/A	CLAY, (CL), as above	
95.0	95.0	N/A	N/A	N/A	CLAY, (CL), as above	
100.0	100.0	N/A	N/A	N/A	CLAY, (CL), as above	
105.0	105.0	N/A	N/A	N/A	CLAY, (CL), as above	
110.0	110.0	N/A	N/A	N/A	CLAY, (CL), light brown to tannish, soft, moderately plastic	
115.0	115.0	N/A	N/A	N/A	CLAY, (CL), as above	
120.0	120.0	N/A	N/A	N/A	CLAY, (CL), as above	
125.0	125.0	N/A	N/A	N/A	CLAY, (CL), as above	
130.0	130.0	N/A	N/A	N/A	CLAY, (CH), medium gray and light brown, very soft, plastic	
135.0	135.0	N/A	N/A	N/A	CLAY, (CL), as above	
140.0	140.0	N/A	N/A	N/A	CLAY, (CL), as above	
145.0	145.0	N/A	N/A	N/A	CLAY, (CL), as above	
	150.0	N/A	N/A	N/A		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
116700.J0.ZZ	B#6 (TW-3)	SHEET 3 OF 4

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor, Tejan Road, Brownsville, Tx

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 4/9/96 FINISH 4/28/96 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	150.0	N/A	N/A	N/A	CLAY, (CL), medium gray and light brown, soft, moderately plastic, some yellowish orange staining, (iron stain)	
155.0	155.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
160.0	160.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
165.0	165.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
170.0	170.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
175.0	175.0					
		N/A	N/A	N/A	CLAY, (CL), as above	
180.0	180.0					
		N/A	N/A	N/A	CLAY, (CL), as above with trace of medium sand	
185.0	185.0					
		N/A	N/A	N/A	SAND, (SP), black and tan, moist, loose, subrounded, fine sand	
190.0	190.0					
		N/A	N/A	N/A	SAND, (SP), as above	Wash out - loss of drilling mud
195.0	195.0					
		N/A	N/A	N/A	SAND, (SC), black and tan, loose, fine sand, 40-50% fines	Note: drilling rougher her, probably gravel at 195', but loss of circulation caused gravel to be left below
200.0	200.0					
		N/A	N/A	N/A	COARSE SAND, (SW) and GRAVEL, (GW), black and tan, well graded, subangular to subrounded, quartz, etc.	
205.0	205.0					
		N/A	N/A	N/A	COARSE SAND, (SW), to FINE GRAVEL, (GW), black, brown, tan, angular to subrounded, trace of fines, quartz and dark minerals	
210.0	210.0					
		N/A	N/A	N/A	SAND AND GRAVEL, as above, 10-20% clay	
215.0	215.0					
		N/A	N/A	N/A	(SC) and (GC) as above, 20-30% clay	Driller out of gravel at approximately 220'
220.0	220.0					
		N/A	N/A	N/A	GRAVEL, (GC), and SAND, (SC), in sample, but probably mostly clay	
	225.0					

CH2M HILL

PROJECT NUMBER	BORING NUMBER
116700.J0.ZZ	B#6 (TW-3) SHEET 4 OF 4

SOIL BORING LOG

PROJECT Brownsville ASR LOCATION Alton Gloor, Tejan Road, Brownsville, Tx

ELEVATION _____ DRILLING CONTRACTOR Texas Water Development Board

DRILLING METHOD AND EQUIPMENT Failing Mud Rotary

WATER LEVELS _____ START 4/9/96 FINISH 4/28/96 LOGGER L. Saunders

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
230.0	225.0 230.0	N/A	N/A	N/A	END OF BORING Monitor Well T@-3 installed	Driller at 229' and recirculating 4/24/96 10:00 Geophysical log run
235.0						
240.0						
245.0						
250.0						
255.0						
260.0						
265.0						
270.0						
275.0						
280.0						
285.0						
290.0						
295.0						

Appendix 2

Sieve Analysis Results

ADVANCED TERRA TESTING, INC.

833 Parfet Street
Lakewood, Colorado 80215
(303) 232-8308

GRAIN SIZE ANALYSIS

3 Inch to -200 Sieve
ASTM D 422

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-422

CLIENT CH2M Hill

JOB NO. 2040-42

BORING NO.	PUB#3	SAMPLED	
DEPTH	165.0-170.0'	DATE TESTED	12-20-95 JS
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Rush Job	DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan	(g)	152.1
Wt. Dry Soil & Pan	(g)	99.6
Wt. Lost Moisture	(g)	52.5
Wt. of Pan Only	(g)	8.4
Wt. of Dry Soil	(g)	91.2
Moisture Content	%	57.6

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	152.1
Wt. Dry Soil & Pan Before Washing (g)	99.6
Weight of Pan (g)	8.4
Wt. of Dry Soil Before Washing	91.2
Wt. Dry Soil & Pan After Washing (g)	72.7
Wt. of Dry Soil After Washing (g)	64.3
-#200 Wash. Out %	29.4

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	0.00	0.00	0.00	0.00	0.0	100.0
#20	3.66	3.69	0.03	0.03	0.0	100.0
#40	3.69	3.83	0.14	0.17	0.2	99.8
#60	3.69	30.97	27.28	27.45	30.1	69.9
#100	3.56	28.73	25.17	52.62	57.7	42.3
#200	3.68	15.38	11.70	64.32	70.6	29.4

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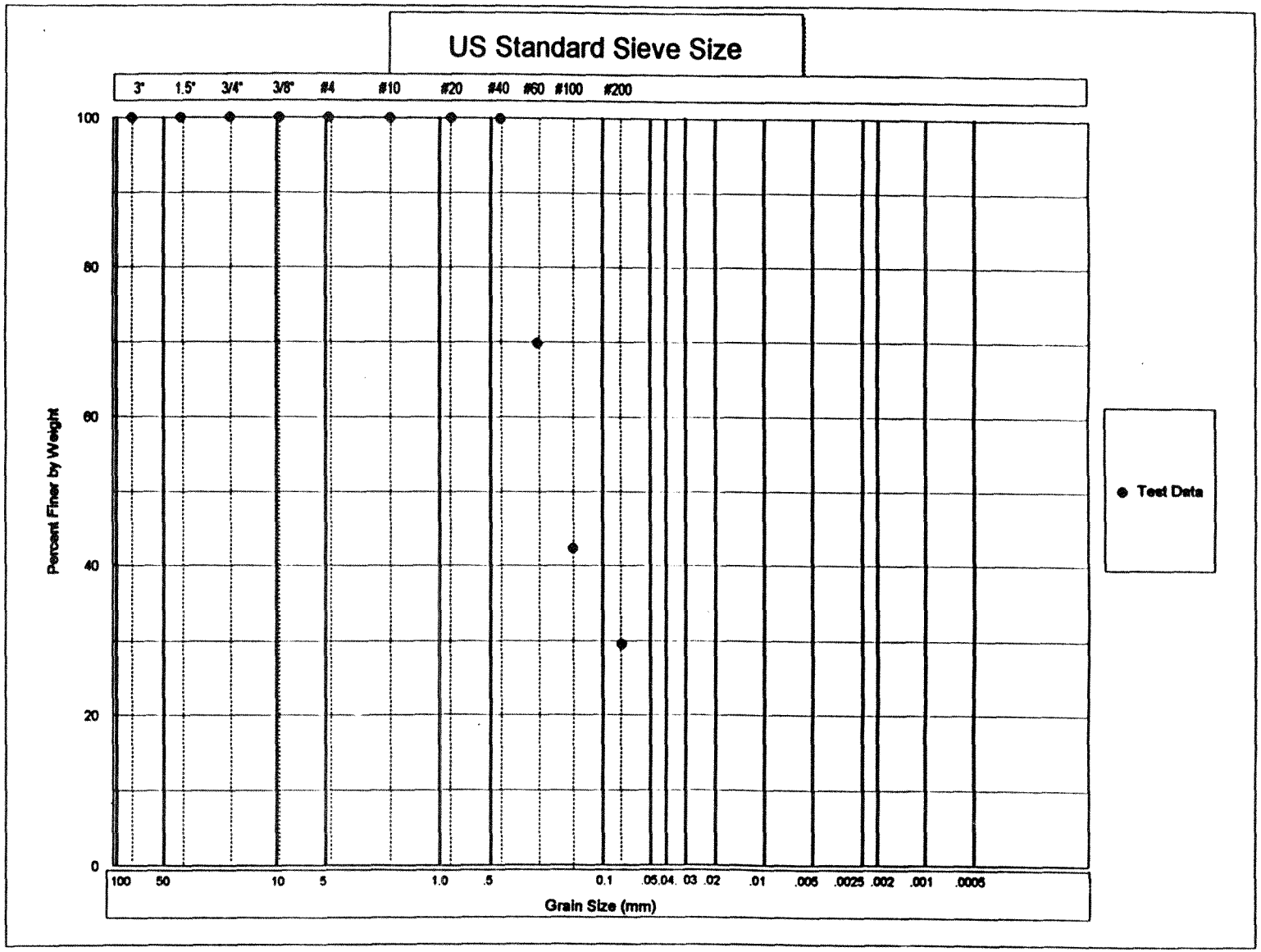
ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: CH2M Hill Boring No.: PUB#3 Depth: 165.0-170.0 Sample No.: Job Number: 2040-42

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-422

CLIENT CH2M Hill

JOB NO. 2040-42

BORING NO.	PUB#3	**SAMPLED**	
DEPTH	170-175'	**DATE TESTED**	12-20-95 JS
SAMPLE NO.		**WASH SIEVE**	Yes
SOIL DESCR.	Rush Job	**DRY SIEVE**	No

MOISTURE DATA

Wt. Wet Soil & Pan	(g)	186.8
Wt. Dry Soil & Pan	(g)	150.7
Wt. Lost Moisture	(g)	36.2
Wt. of Pan Only	(g)	8.4
Wt. of Dry Soil	(g)	142.3
Moisture Content	%	25.4

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	186.8
Wt. Dry Soil & Pan Before Washing (g)	150.7
Weight of Pan (g)	8.4
Wt. of Dry Soil Before Washing	142.3
Wt. Dry Soil & Pan After Washing (g)	138.1
Wt. of Dry Soil After Washing (g)	129.7
-#200 Wash. Out %	8.8

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	0.00	0.00	0.00	0.00	0.0	100.0
#20	3.63	3.65	0.02	0.02	0.0	100.0
#40	3.73	24.76	21.03	21.05	14.8	85.2
#60	3.63	65.56	61.93	82.98	58.3	41.7
#100	3.95	45.60	41.65	124.63	87.6	12.4
#200	3.71	8.79	5.08	129.71	91.2	8.8

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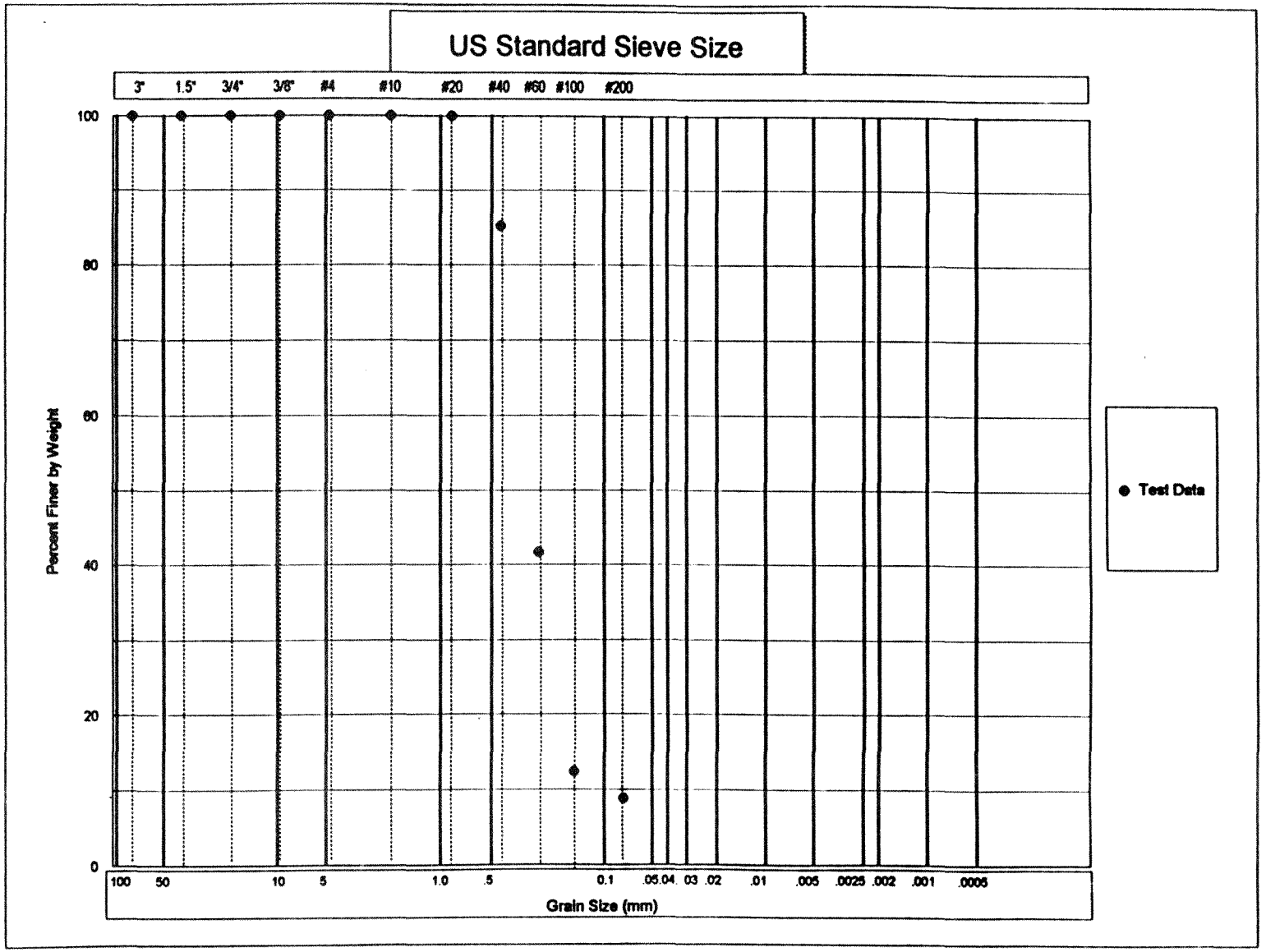
ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: CH2M Hill Boring No.: PUB#3 Depth: 170-175' Sample No.: Job Number: 2040-42

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-422

CLIENT CH2M Hill

JOB NO. 2040-42

BORING NO.	PUB#3	SAMPLED	
DEPTH	175.0-180.0'	DATE TESTED	12-20-95 JS
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Rush Job	DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan	(g)	227.4
Wt. Dry Soil & Pan	(g)	181.6
Wt. Lost Moisture	(g)	45.8
Wt. of Pan Only	(g)	8.2
Wt. of Dry Soil	(g)	173.3
Moisture Content	%	26.4

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	227.4
Wt. Dry Soil & Pan Before Washing (g)	181.6
Weight of Pan (g)	8.2
Wt. of Dry Soil Before Washing	173.3
Wt. Dry Soil & Pan After Washing (g)	136.5
Wt. of Dry Soil After Washing (g)	128.2
-#200 Wash. Out %	26.0

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	3.76	4.13	0.37	0.37	0.2	99.8
#20	3.82	4.31	0.49	0.86	0.5	99.5
#40	3.67	4.89	1.22	2.08	1.2	98.8
#60	3.58	63.56	59.98	62.06	35.8	64.2
#100	3.81	55.39	51.58	113.64	65.6	34.4
#200	3.62	18.20	14.58	128.22	74.0	26.0

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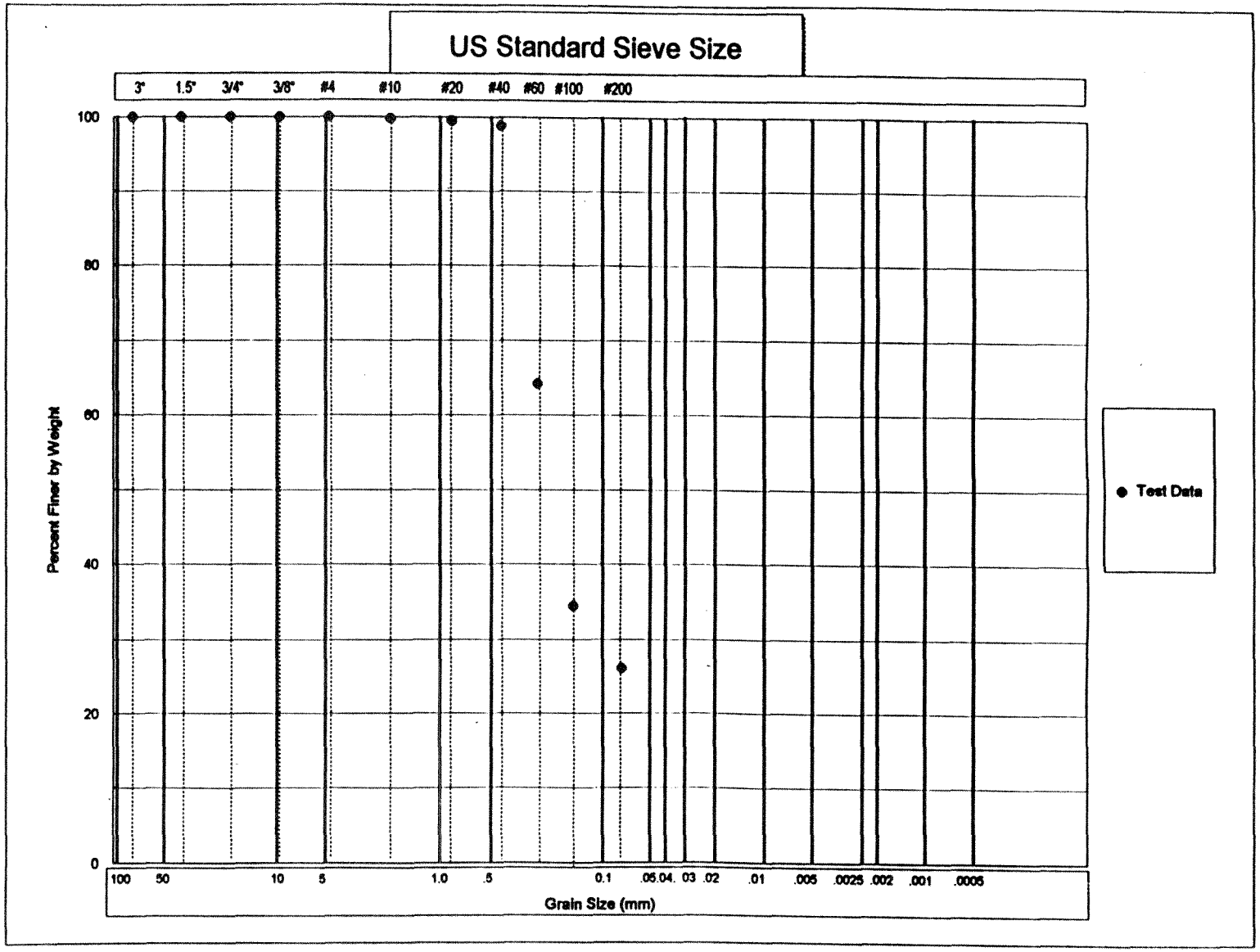
ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: CH2M Hill Boring No.: PUB#3 Depth: 175.0-180.0 Sample No.: Job Number: 2040-42

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-422

CLIENT CH2M Hill

JOB NO. 2040-42

BORING NO.	PUB#3	SAMPLED	
DEPTH	180.0-185.0'	DATE TESTED	12-20-95 JS
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Rush Job	DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan	(g)	516.6
Wt. Dry Soil & Pan	(g)	448.8
Wt. Lost Moisture	(g)	67.8
Wt. of Pan Only	(g)	8.2
Wt. of Dry Soil	(g)	440.6
Moisture Content	%	15.4

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	516.6
Wt. Dry Soil & Pan Before Washing (g)	448.8
Weight of Pan (g)	8.2
Wt. of Dry Soil Before Washing	440.6
Wt. Dry Soil & Pan After Washing (g)	385.3
Wt. of Dry Soil After Washing (g)	377.1
-#200 Wash. Out %	14.4

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	3.74	23.97	20.23	20.23	4.6	95.4
#4	3.71	226.04	222.33	242.56	55.1	44.9
#10	3.71	118.43	114.72	357.28	81.1	18.9
#20	3.71	11.82	8.11	365.39	82.9	17.1
#40	3.90	4.41	0.51	365.90	83.1	16.9
#60	3.51	5.83	2.32	368.22	83.6	16.4
#100	3.81	8.22	4.41	372.63	84.6	15.4
#200	3.64	8.13	4.49	377.12	85.6	14.4

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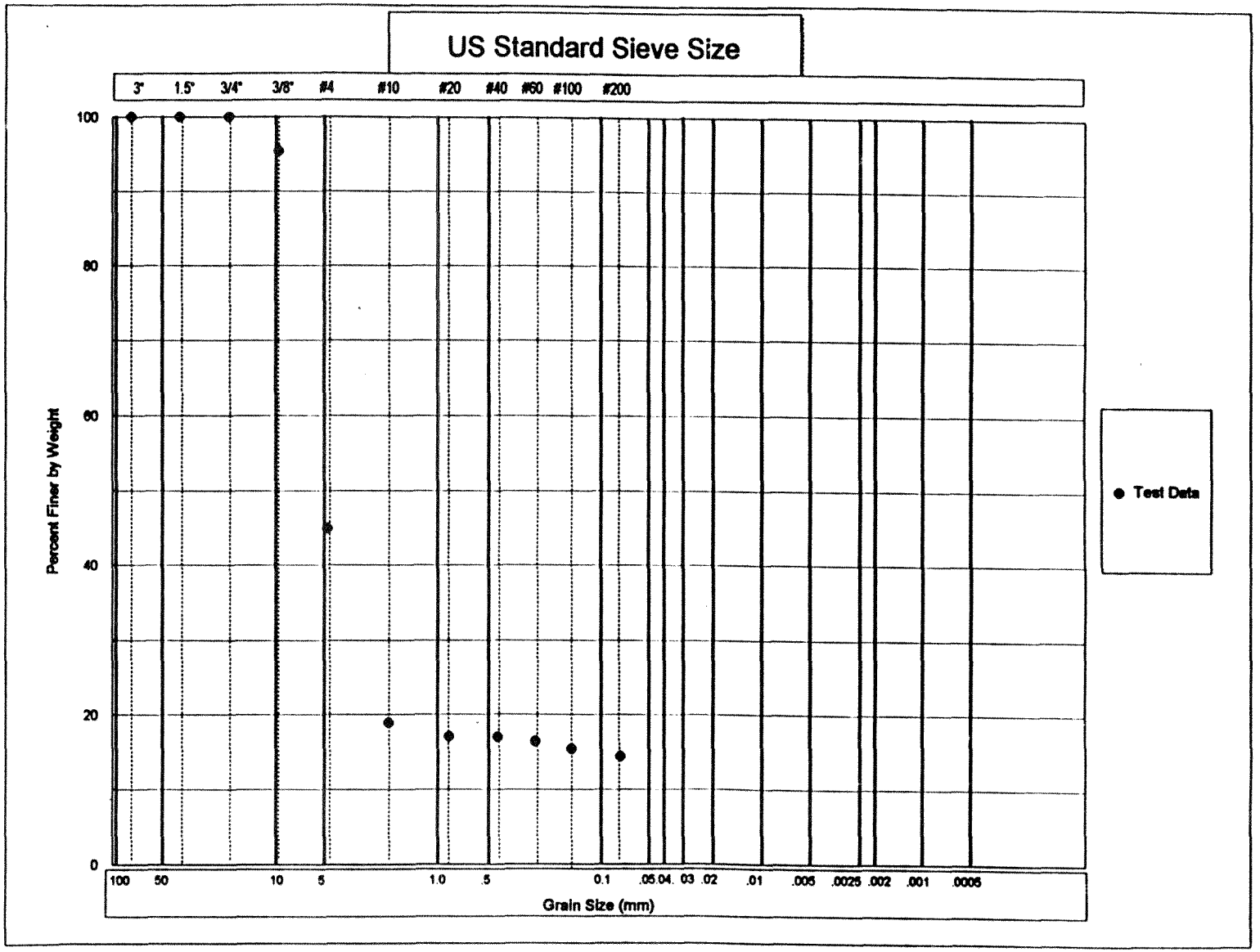
ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: CH2M Hill Boring No.: PUB#3 Depth: 180.0-185.0 Sample No.: Job Number: 2040-42

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-422

CLIENT CH2M Hill

JOB NO. 2040-42

BORING NO.	PUB#3	SAMPLED	
DEPTH	185.0-190.0'	DATE TESTED	12-20-95 JS
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Rush Job	DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan	(g)	467.3
Wt. Dry Soil & Pan	(g)	393.8
Wt. Lost Moisture	(g)	73.6
Wt. of Pan Only	(g)	8.5
Wt. of Dry Soil	(g)	385.3
Moisture Content	%	19.1

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	467.3
Wt. Dry Soil & Pan Before Washing (g)	393.8
Weight of Pan (g)	8.5
Wt. of Dry Soil Before Washing	385.3
Wt. Dry Soil & Pan After Washing (g)	322.3
Wt. of Dry Soil After Washing (g)	313.8
-#200 Wash. Out %	18.6

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	3.69	25.47	21.78	21.78	5.7	94.3
#4	3.68	179.32	175.64	197.42	51.2	48.8
#10	3.69	100.22	96.53	293.95	76.3	23.7
#20	3.70	10.46	6.76	300.71	78.0	22.0
#40	3.66	4.13	0.47	301.18	78.2	21.8
#60	3.59	5.29	1.70	302.88	78.6	21.4
#100	3.67	8.55	4.88	307.76	79.9	20.1
#200	3.59	9.66	6.07	313.83	81.4	18.6

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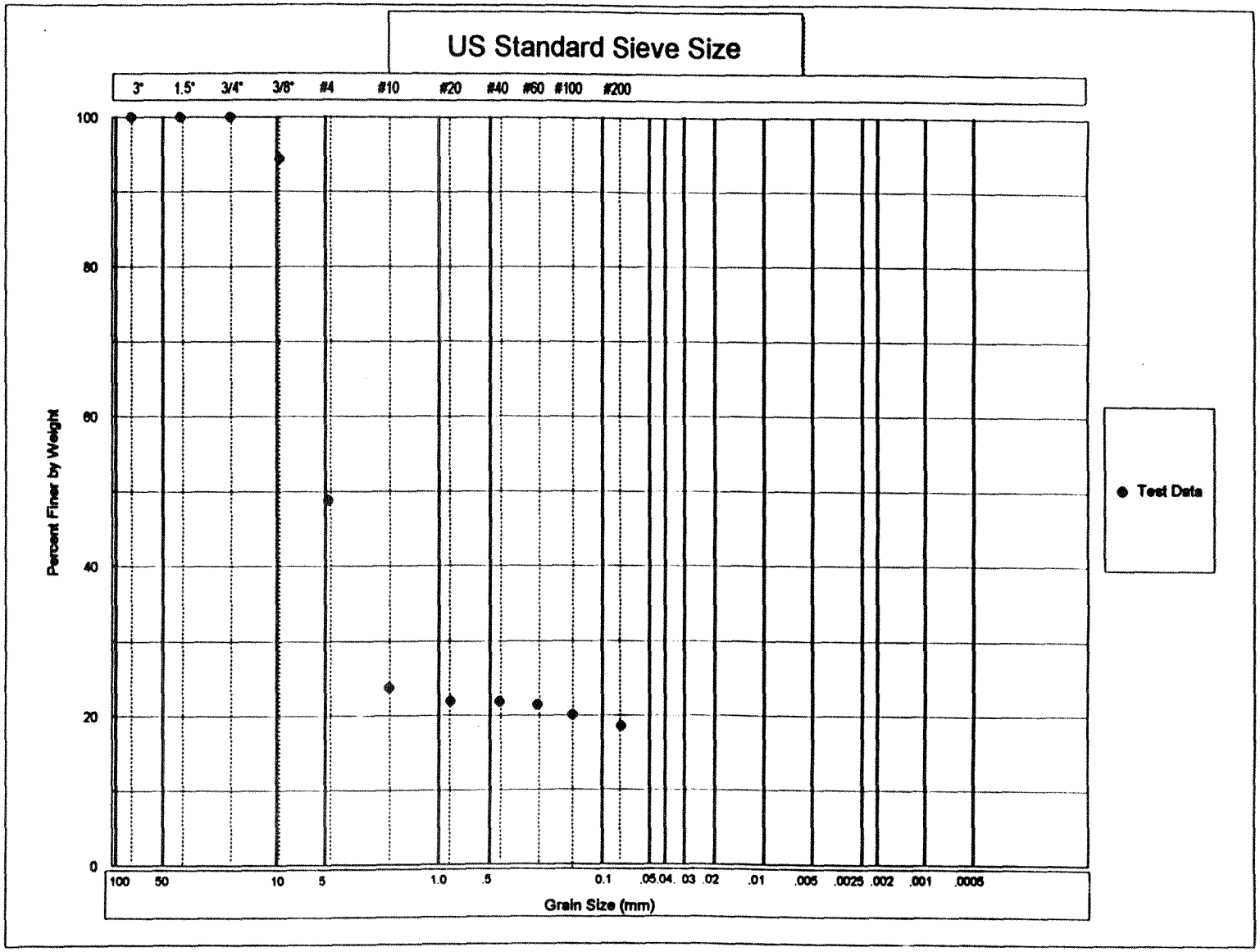
ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: CH2M Hill Boring No.: PUB#3 Depth: 185.0-190.0 Sample No.: Job Number: 2040-42

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-422

CLIENT CH2M Hill

JOB NO. 2040-42

BORING NO.	PUB#3	SAMPLED	
DEPTH	190.0-195.0'	DATE TESTED	12-20-95 JS
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Rush Job	DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan	(g)	524.5
Wt. Dry Soil & Pan	(g)	367.3
Wt. Lost Moisture	(g)	157.2
Wt. of Pan Only	(g)	8.2
Wt. of Dry Soil	(g)	359.1
Moisture Content	%	43.8

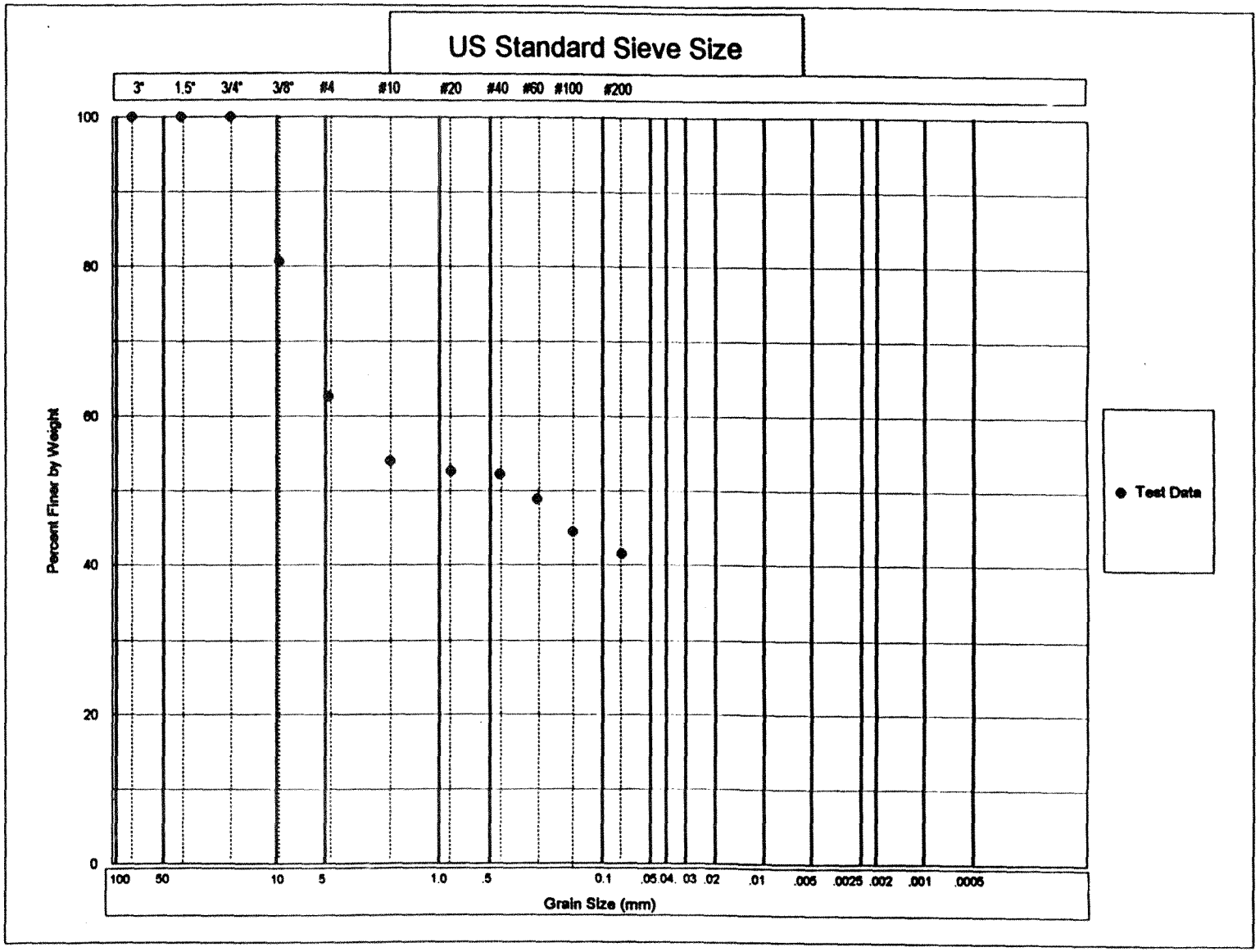
WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	524.5
Wt. Dry Soil & Pan Before Washing (g)	367.3
Weight of Pan (g)	8.2
Wt. of Dry Soil Before Washing	359.1
Wt. Dry Soil & Pan After Washing (g)	218.0
Wt. of Dry Soil After Washing (g)	209.9
-#200 Wash. Out %	41.6

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	3.76	73.18	69.42	69.42	19.3	80.7
#4	3.63	68.43	64.80	134.22	37.4	62.6
#10	3.71	34.66	30.95	165.17	46.0	54.0
#20	3.94	8.98	5.04	170.21	47.4	52.6
#40	3.72	5.36	1.64	171.85	47.9	52.1
#60	3.73	15.44	11.71	183.56	51.1	48.9
#100	3.65	19.59	15.94	199.50	55.6	44.4
#200	3.95	14.30	10.35	209.85	58.4	41.6

Data entered by: NAA Date: 12-21-95
Data checked by: [signature] Date: 12-21-95
FileName:C2MPUB3F

ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: CH2M Hill Boring No.: PUB#3 Depth: 190.0-195.0 Sample No.: Job Number: 2040-42

CHAIN-OF-CUSTODY RECORDS

JOB TESTING PROGRAM

DATE

PAGE____of____

PROJECT NO.:	PROJECT NAME:
PROJECT MGR.:	INSTRUCTIONS:
TECHNICIAN:	
EQPMT NO.:	

	~~BORING~~ SAMPLE	DEPTH	SOIL TYPE	SAMPLE TEST	INSTRUCTIONS	START	DONE	
1)	165-170			wash sieve analysis	Results by Friday 12/22 & Rush if necessary			
2)	170	175						
3)	175	180						
4)	180	185						
5)	185	190						
6)	190	195						

PREPARED BY:

REVIEWED/APPROVED BY:

JTP 3/93

ADVANCED TERRA TESTING INC

Appendix 3

Monitor Well Completion Diagrams

MONITORING WELL CONSTRUCTION LOG

Client: Brownsville Public Utilites Board

Location: City Well Field

Center Street, Brownsville, TX

Installed by: Texas Water Development Board

Installation Method: Mud Rotary

Field Engineer: Texas Water Development Board

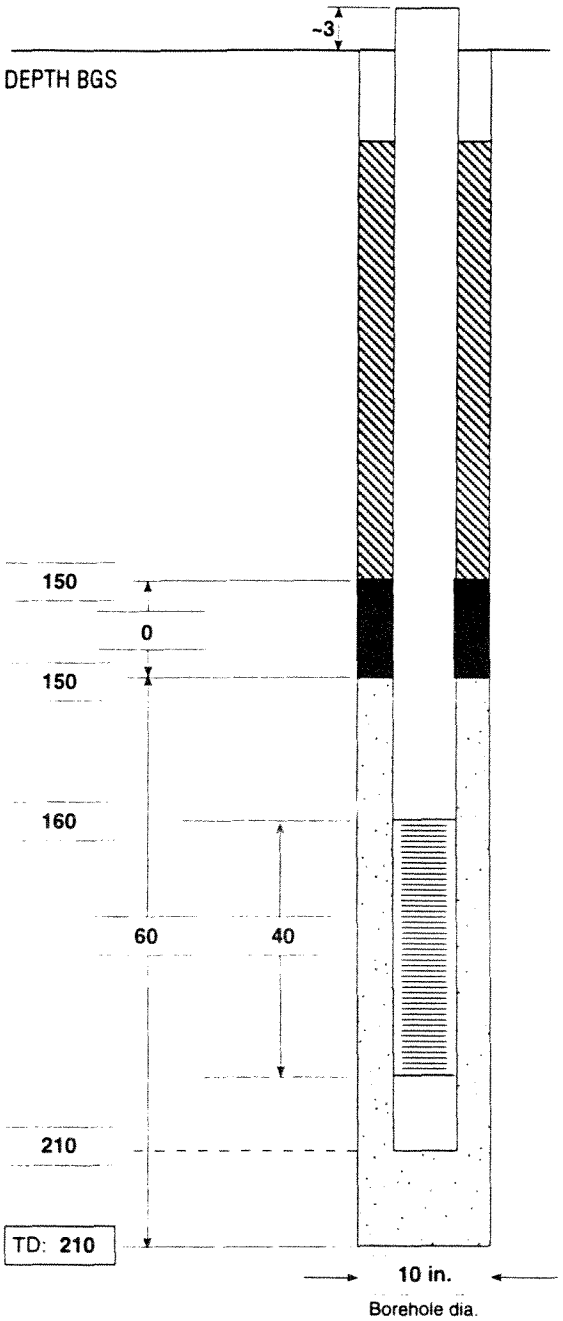
Well No. B-3 (TW-1)

Project No. 116700.J0.ZZ

Date

Start: 12/15/96

End: 12/19/96



PROTECTIVE CSG
Material / Type Steel With Lock
Diameter 6 5/8" Water Tight Seal (Y / (N))
Depth BGS Weep Hole (Y / (N))

SURFACE PAD
Composition & Size 2 x 2

RISER PIPE
Type Reused Sch 40 Carbon Steel
Diameter 6 inches in.
Total Length (TOC to TOS) 160 feet

GROUT
Composition & Proportions 68 sacks of cement, 228 gallons water
Tremied ((Y) / N)
Interval 0 - 160 feet

CENTRALIZERS (Y / (N))
Depth(s)

SEAL
Type None
Source

FILTER PACK
Type Silica Gravel
Amount Used 38 1/2 bags
Tremied (Y / (N))
Source Brownsville, TX
Gr. Size Dist. 8 - 16

SCREEN
Type Shutter Slotted Screen
Diameter 6 in.
Slot Size & Type Stainless Steel 0.040-Slot
Interval BGS 160 - 200'

DEVELOPMENT
Time Unknown
Method Used
Comments Pump Test Conducted

MONITORING WELL CONSTRUCTION LOG

Client: Brownsville Public Utilities Board

Location: Alton Gloor Blvd.
Brownsville TX (aka Tejon Rd)

Installed by: Texas Water Development Board

Installation Method: Mud Rotary

Field Engineer: Texas Water Development Board

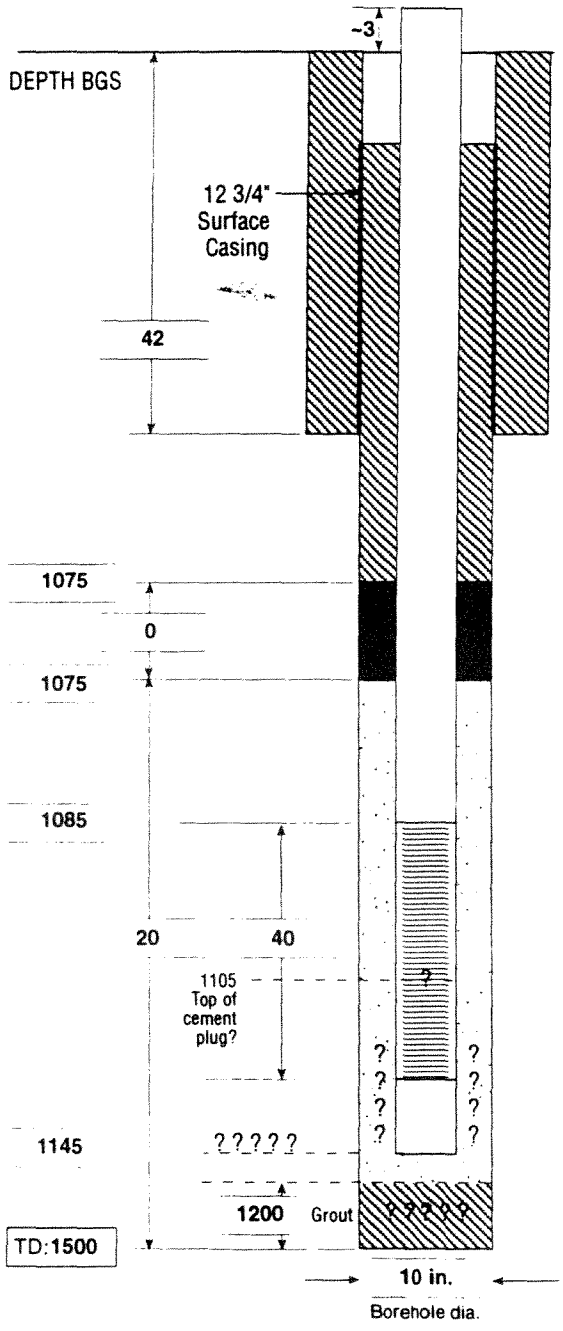
Well No. B-5 (TW-2)

Project No. 116700.J0.ZZ

Date 5/10/96

Start: 2/16/96

End: 3/19/96



PROTECTIVE CSG
Material / Type Steel Riser
Diameter 6 5/8" Water Tight Seal (Y / N)
Length Above Ground ~3' Weep Hole (Y / N)

SURFACE PAD
Composition & Size 2 x 2

RISER PIPE
Type Sch 40 Carbon Steel Welded Joints
Diameter 6 5/8" ID
Total Length (TOC to TOS) 1085 ft

GROUT
Composition & Proportions Cement and Water
Tremied (Y / N)
Interval 1200 - 1500', 1065' - ground

CENTRALIZERS (Y / N)
Depth(s)

SEAL
Type None
Source

FILTER PACK
Type Silica Sand
Amount Used 50 sacks
Tremied (Y / N)
Source Brownsville, TX
Gr. Size Dist. 20 - 40

SCREEN
Type Stainless Steel
Diameter 6 5/8"
Slot Size & Type 0.010-Slot Wire Wrapped
Interval BGS 1085 - 1125 ft *Unable to verify bottom of well. Cement plug installed at 1105 ft to seal likely break in screen.

DEVELOPMENT
Time 3 hours
Method Used Drill Stem and Submersible Pump
Comments Flushed high volume of silt and fine sand from pump set at 230'. Target interval not screened. Well screen probably collapsed or broke from 1105 to 1125, but unable to verify. Solid riser from 1125 to 1145.

MONITORING WELL CONSTRUCTION LOG

Client: Brownsville Public Utilities Board

Location: Alton Gloor Blvd.
Brownsville TX (aka Tejon Rd)

Well No. B-6 (TW-3)

Project No. 116700.J0.ZZ

Date 4-26-96

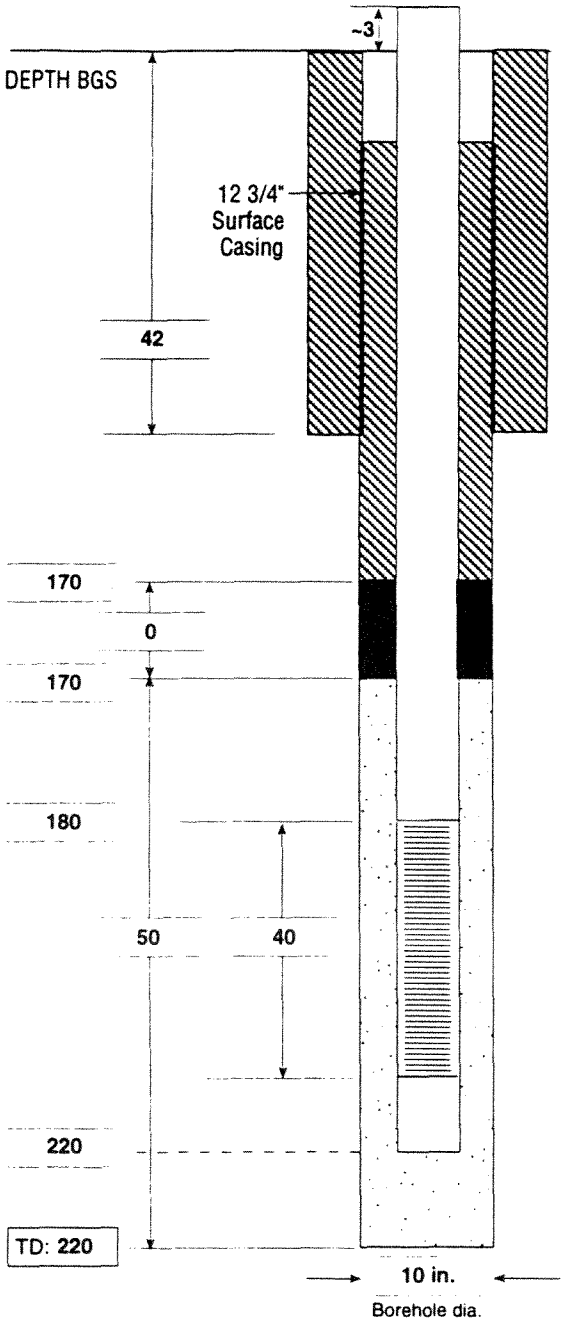
Installed by: Texas Water Development Board

Installation Method: Mud Rotary

Field Engineer: Texas Water Development Board

Start: 4-26-96

End: 4-29-96



PROTECTIVE CSG
Material / Type Steel Riser With Lock
Diameter 6 5/8" Water Tight Seal (Y / (N))
Depth BGS Weep Hole (Y / (N))

SURFACE PAD
Composition & Size

RISER PIPE
Type Sch 40 Carbon Steel Welded Joints
Diameter 6 5/8"
Total Length (TOC to TOS) 180 ft

GROUT
Composition & Proportions 41 Sacks Cement and Water
Tremied (Y) / N)
Interval 0 -170 feet

CENTRALIZERS (Y / (N))
Depth(s)

SEAL
Type None
Source

FILTER PACK
Type Silica Gravel
Amount Used 44 bags
Tremied (Y / (N))
Source Brownsville, TX
Gr. Size Dist. 8 - 16

SCREEN
Type Stainless Steel
Diameter 6 5/8"
Slot Size & Type 0.040-Slot Wire Wrapped
Interval BGS 180 - 220 ft

DEVELOPMENT
Time 1 hour
Method Used Pump
Comments Slightly turbid, 15' drawdown with 75 gpm pump

Appendix 4

Geophysical Logs

Well: Brownsville ASR TH #1 (SWN 89-05-406)
Bracs ID: 4815

Well: Brownsville ASR TH# 2 (SWN 89-04-904)
Bracs ID: 40032

Well: Brownsville ASR TH# 3 (SWN 89-04-634)
Bracs ID: 40029

Well: Brownsville ASR TH# 5 (SWN 3904-311)
Bracs ID: 40020

Well: Brownsville ASR TH# 6 (SWN 89-04-312)
Bracs ID: 40021

Appendix 5

Water Quality Lab Reports

ECS ENVIRONMENTAL CHEMISTRY SERVICES, INC.

February 5, 1996

Mr. Kevin Bral
CH2M Hill
P.O. Box 241325
Denver, CO 80224-9325

RE: ECS Project #CHM081

Dear Kevin:

Enclosed are the pH, TSS, TDS, major cations, metals, pesticides/PCBs, volatile organic compound, and semivolatile organic compound results for the CH2M Hill Brownsville ASR Project water sample we received on January 24.

The pH of the sample was measured using EPA Method 9040. The method consists of electrometrical measurement using a pH meter. The results are reported in Table 1.

The sample was analyzed for total suspended solids (TSS) by EPA Method 160.2. This analysis measures the amount of residue retained on a standard glass fiber filter. Sample and quality control results are listed in Table 2.

The sample was analyzed for total dissolved solids (TDS) by EPA Method 160.1. This analysis measures the amount of residue capable of passing through a standard glass fiber filter. Sample and quality control results are listed in Table 3.

The sample was analyzed for major cations, silica, and metals by EPA Method 200.8. This is an inductively coupled plasma/mass spectrometry (ICP/MS) method. The sample results are in Table 4; quality control results are in Tables 5, 6 and 7.

The sample was analyzed for organochlorine pesticides and polychlorinated biphenyls (PCB) by EPA Method 608. This is a gas chromatography/electron capture detector method. The analysis was performed on a hexane extract of the sample. The surrogate standard was added to all samples to monitor extraction and analysis efficiency. The sample results are tabulated in Table 8; Table 9 contains the quality control results.

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The sample were analyzed for volatile organic compounds by EPA Method 524.2. This is a gas chromatography/mass spectrometry method using purge and trap concentration and a capillary chromatography column. The surrogate standard is added to monitor purging efficiency. Sample results are listed in Table 10; quality control results are listed in Table 11.

The sample was analyzed for semivolatile organic compounds by EPA Method 625. This is a gas chromatography/mass spectrometry method. The analysis was performed on a methylene chloride extract of the sample. The results are tabulated in Table 12; Table 13 contains the quality control results.

The sample was sent to AccuLabs Research for the anion, TOC, TOX, BOD, COD, specific conductance, turbidity, color, and gross alpha & beta analyses. The results will be provided as soon as they are available.

Please call if you have any questions.

Sincerely,

Robert J. Keck

Robert J. Keck
Operations Manager

February 5, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
7108 S. Alton Way, Bldg. E
Englewood, CO 80112
(303) 850-7606

TABLE 1

ECS Project #:	CHM081	Date Received:	1/24/96
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	1/23/96
Method #:	EPA 9040A	Date Extracted:	n/a
Matrix:	Water	Date Analyzed:	1/24/96
Units:	n/a		

SAMPLE RESULTS		
Sample #	pH	Temperature (°C)
Well #1	7.3	19

February 5, 1996

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TABLE 2

ECS Project #:	CHM081	Date Received:	1/24/96
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	1/23/96
Method #:	EPA 160.2	Date Extracted:	n/a
Matrix:	Water	Date Analyzed:	1/26/96
Units:	mg/L (ppm)		

SAMPLE RESULTS	
Sample #	Total Suspended Solids
Well #1	ND

ND = Not detected at levels exceeding the reporting detection limit.

QUALITY CONTROL RESULTS	
	Total Suspended Solids
Well #1 Duplicate	9.0
Relative % Difference	NC
Blank	ND
Detection Limit	4

NC = Not calculable.

February 5, 1996

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TABLE 3

ECS Project #:	CHM081	Date Received:	1/24/96
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	1/23/96
Method #:	EPA 160.1	Date Extracted:	n/a
Matrix:	Water	Date Analyzed:	1/26/96
Units:	mg/L (ppm)		

SAMPLE RESULTS	
Sample #	Total Dissolved Solids
Well #1	3,000

ND = Not detected at levels exceeding the reporting detection limit.

QUALITY CONTROL RESULTS	
	Total Dissolved Solids
Well #1 Duplicate	3,200
Relative % Difference	6
Blank	ND
Detection Limit	10

February 5, 1996

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TABLE 4

ECS Project #: CHM081
CH2M Hill Project #: Brownsville ASR
Method #: EPA 200.8
Matrix: Water
Units: mg/L (ppm)

Date Received: 1/24/96
Date Sampled: 1/23/96
Date Digested: n/a
Date Analyzed: 1/31-2/1/96

PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
Aluminum	0.001	0.0094	ND
Arsenic	0.001	0.0079	ND
Barium	0.001	0.026	ND
Cadmium	0.001	ND	ND
Calcium	1.0	53	ND
Chromium	0.001	0.019	ND
Iron	0.005	0.12	ND
Lead	0.001	ND	ND
Magnesium	1.0	20	ND
Manganese	0.001	0.16	ND
Mercury	0.0002	ND	ND
Potassium	1.0	3.2	ND
Selenium	0.001	0.017	ND
Silica	0.10	38	ND
Silver	0.001	ND	ND
Sodium	1.0	400	ND

ND = Not detected at levels exceeding the reporting detection limit.

February 5, 1996

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TABLE 5

ECS Project #: CHM081
CH2M Hill Project #: Brownsville ASR
Method #: EPA 200.8
Matrix: Water
Units: mg/L (ppm)

Date Received: 1/24/96
Date Sampled: 1/23/96
Date Digested: n/a
Date Analyzed: 1/31-2/1/96

PARAMETER	DETECTION LIMIT	Well #1 DUPLICATE	RELATIVE % DIFFERENCE
Aluminum	0.001	0.0094	0
Arsenic	0.001	0.0077	3
Barium	0.001	0.026	0
Cadmium	0.001	ND	NC
Calcium	1.0	52	2
Chromium	0.001	0.019	0
Iron	0.005	0.11	8
Lead	0.001	ND	NC
Magnesium	1.0	18	8
Manganese	0.001	0.16	0
Mercury	0.0002	ND	NC
Potassium	1.0	3.1	3
Selenium	0.001	0.016	6
Silica	0.10	40	5
Silver	0.001	ND	NC
Sodium	1.0	350	13

ND = Not detected at levels exceeding the reporting detection limit.
NC = Not calculable.

February 5, 1996

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TABLE 6

ECS Project #:	CHM081	Date Received:	n/a
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	n/a
Method #:	EPA 200.8	Date Digested:	n/a
Matrix:	Water	Date Analyzed:	1/31-2/1/96
Units:	mg/L (ppm)		

PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	LCS SPIKE	% RECOVERY
Aluminum	0.001	0.1	0.10	104
Arsenic	0.001	0.1	0.10	104
Barium	0.001	0.1	0.10	102
Cadmium	0.001	0.1	0.11	107
Calcium	1.0	100	88	88
Chromium	0.001	0.1	0.10	102
Iron	0.005	0.2	0.20	98
Lead	0.001	0.1	0.099	99
Magnesium	1.0	100	90	90
Manganese	0.001	0.1	0.10	104
Mercury	0.0002	0.005	0.0036	73
Potassium	1.0	100	100	103
Selenium	0.001	0.1	0.11	105
Silica	0.10	0.42	0.51	120
Silver	0.001	0.1	0.095	95
Sodium	1.0	100	100	100

February 5, 1996

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TABLE 7

ECS Project #:	CHM081	Date Received:	n/a
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	n/a
Method #:	EPA 200.8	Date Digested:	n/a
Matrix:	Water	Date Analyzed:	1/31-2/1/96
Units:	mg/L (ppm)		

PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	MATRIX SPIKE	% RECOVERY
Aluminum	0.001	0.26	0.28	109
Arsenic	0.001	0.064	0.067	104
Barium	0.001	0.18	0.18	100
Cadmium	0.001	0.079	0.083	106
Calcium	1.0	100	250	103
Chromium	0.001	0.16	0.17	102
Iron	0.005	0.38	0.36	95
Lead	0.001	0.16	0.16	100
Magnesium	1.0	100	150	110
Manganese	0.001	0.24	0.24	101
Mercury	0.0002	0.0029	0.0034	117
Potassium	1.0	100	130	122
Selenium	0.001	0.11	0.12	104
Silica	0.10	-	-	-
Silver	0.001	0.096	0.095	99
Sodium	1.0	100	150	120

February 5, 1996

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TABLE 8

ECS Project #:	CHM081	Date Received:	1/24/96
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	1/23/96
Method #:	EPA 608	Date Extracted:	1/25/96
Matrix:	Water	Date Analyzed:	1/25/96
Units:	µg/L (ppb)		

PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
α-BHC	0.050	ND	ND
β-BHC	0.050	ND	ND
γ-BHC (Lindane)	0.050	ND	ND
δ-BHC	0.050	ND	ND
Heptachlor	0.050	ND	ND
Aldrin	0.050	ND	ND
Heptachlor epoxide	0.050	ND	ND
Endosulfan I	0.050	ND	ND
4,4-DDE	0.10	ND	ND
Dieldrin	0.10	ND	ND
Endrin	0.10	ND	ND
Endosulfan II	0.10	ND	ND
4,4-DDD	0.10	ND	ND
Endrin aldehyde	0.10	ND	ND
Endosulfan sulfate	0.10	ND	ND
4,4-DDT	0.10	ND	ND

PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
Methoxychlor	0.50	ND	ND
Chlordane	0.10	ND	ND
Toxaphene	5.0	ND	ND
Aroclor 1016	1.0	ND	ND
Aroclor 1221	2.0	ND	ND
Aroclor 1232	1.0	ND	ND
Aroclor 1242	1.0	ND	ND
Aroclor 1248	1.0	ND	ND
Aroclor 1254	1.0	ND	ND
Aroclor 1260	1.0	ND	ND

ND = Not detected at levels exceeding the reporting detection limit.

SURROGATE % RECOVERY

SURROGATE	SURROGATE AMOUNT	SAMPLE # Well #1	BLANK
DBC	0.040	98	99
TCMX	0.040	89	82

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TABLE 9

ECS Project #:	CHM081	Date Received:	n/a
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	n/a
Method #:	EPA 608	Date Extracted:	1/25/96
Matrix:	Water	Date Analyzed:	1/25/96
Units:	µg/kg (ppb)		

PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	MATIRX SPIKE	% RECOVERY	MATRIX SPIKE DUPLICATE	% RECOVERY	RELATIVE % DIFFERENCE
α-BHC	0.050	-	ND	-	ND	-	-
β-BHC	0.050	-	ND	-	ND	-	-
γ-BHC (Lindane)	0.050	0.20	0.19	95	0.19	94	1
δ-BHC	0.050	-	ND	-	ND	-	-
Heptachlor	0.050	0.20	0.22	110	0.22	108	2
Aldrin	0.050	0.20	0.16	78	0.16	78	0
Heptachlor epoxide	0.050	-	ND	-	ND	-	-
Endosulfan I	0.050	-	ND	-	ND	-	-
4,4,-DDE	0.10	-	ND	-	ND	-	-
Dieldrin	0.10	0.50	0.50	99	0.47	93	6
Endrin	0.10	0.50	0.50	100	0.48	96	4
Endosulfan II	0.10	-	ND	-	ND	-	-
4,4-DDD	0.10	-	ND	-	ND	-	-
Endrin aldehyde	0.10	-	ND	-	ND	-	-
Endrosulfan sulfate	0.10	-	ND	-	ND	-	-
4,4-DDT	0.10	0.50	0.40	81	0.40	81	0

PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	MATIRX SPIKE	% RECOVERY	MATRIX SPIKE DUPLICATE	% RECOVERY	RELATIVE % DIFFERENCE
Methoxychlor	0.50	-	ND	-	ND	-	-
Chlordane	0.10	-	ND	-	ND	-	-
Toxaphene	5.0	-	ND	-	ND	-	-
Aroclor 1016	1.0	-	ND	-	ND	-	-
Aroclor 1221	2.0	-	ND	-	ND	-	-
Aroclor 1232	1.0	-	ND	-	ND	-	-
Aroclor 1242	1.0	-	ND	-	ND	-	-
Aroclor 1248	1.0	-	ND	-	ND	-	-
Aroclor 1254	1.0	-	ND	-	ND	-	-
Aroclor 1260	1.0	-	ND	-	ND	-	-

ND = Not detected at levels exceeding the reporting detection limit.

SURROGATE % RECOVERY

SURROGATE	SURROGATE AMOUNT		MATRIX SPIKE		MATRIX SPIKE DUPLICATE		
DBC	0.040		111		110		
TCMX	0.040		90		86		

February 5, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
7108 S. Alton Way, Bldg. E
Englewood, CO 80112
(303) 850-7606

TABLE 10

ECS Project #: CHM081
CH2M Hill Project #: Brownsville ASR
Method #: EPA 524.2
Matrix: Water
Units: mg/L (ppm)

Date Received: 1/24/96
Date Sampled: 1/23/96
Date Extracted: n/a
Date Analyzed: 1/26/96

*	PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
	Dichlorodifluoromethane	0.002	ND	ND
	Chloromethane	0.002	ND	ND
	Bromomethane	0.002	ND	ND
	Vinyl chloride	0.002	ND	ND
	Chloroethane	0.002	ND	ND
	Trichlorofluoromethane	0.002	ND	ND
	Methylene chloride	0.005	ND	ND
	1,1-Dichloroethene	0.001	ND	ND
	1,1-Dichloroethane	0.001	ND	ND
	cis-1,2-Dichloroethene	0.001	ND	ND
	trans-1,2-Dichloroethene	0.001	ND	ND
	Chloroform	0.001	ND	ND
	Bromochloromethane	0.001	ND	ND
	Dibromomethane	0.001	ND	ND
	1,2-Dichloroethane	0.001	ND	ND
	1,1,1-Trichloroethane	0.001	ND	ND

*	PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
	Carbon tetrachloride	0.001	ND	ND
	Bromodichloromethane	0.001	ND	ND
	1,2-Dichloropropane	0.001	ND	ND
	1,1-Dichloropropene	0.001	ND	ND
	trans-1,3-Dichloropropene	0.001	ND	ND
	2,2-Dichloropropane	0.001	ND	ND
	cis-1,3-Dichloropropene	0.001	ND	ND
	Trichloroethene	0.001	ND	ND
	1,3-Dichloropropane	0.001	ND	ND
	1,1,2-Trichloroethane	0.001	ND	ND
	Dibromochloromethane	0.001	ND	ND
	1,2-Dibromoethane	0.001	ND	ND
	Bromoform	0.001	ND	ND
	1,1,1,2-Tetrachloroethane	0.001	ND	ND
	1,2,3-Trichloropropane	0.001	ND	ND
	1,1,2,2-Tetrachloroethane	0.001	ND	ND
	Tetrachloroethene	0.001	ND	ND
	Chlorobenzene	0.001	ND	ND
	1,3-Dichlorobenzene	0.001	ND	ND
	1,2-Dichlorobenzene	0.001	ND	ND
	1,4-Dichlorobenzene	0.001	ND	ND
	2-Chlorotoluene	0.001	ND	ND
	4-Chlorotoluene	0.001	ND	ND
	Bromobenzene	0.001	ND	ND
	Styrene	0.001	ND	ND
	Benzene	0.001	ND	ND

*	PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
	Toluene	0.001	ND	ND
	Ethylbenzene	0.001	ND	ND
	Total xylenes	0.001	ND	ND
	Isopropylbenzene	0.001	ND	ND
	n-Propylbenzene	0.001	ND	ND
	1,3,5-Trimethylbenzene	0.001	ND	ND
	1,2,4-Trimethylbenzene	0.001	ND	ND
	s-Butylbenzene	0.001	ND	ND
	t-Butylbenzene	0.001	ND	ND
	p-Isopropyltoluene	0.001	ND	ND
	n-Butylbenzene	0.001	ND	ND
	1,2-Dibromo-3-chloropropane	0.001	ND	ND
	Hexachlorobutadiene	0.001	ND	ND
	Naphthalene	0.001	ND	ND
	1,2,4-Trichlorobenzene	0.001	ND	ND
	1,2,3-Trichlorobenzene	0.001	ND	ND

ND = Not detected at levels exceeding the reporting detection limit.

SURROGATE % RECOVERY

SURROGATE	SURROGATE AMOUNT	SAMPLE # Well #1	BLANK
1,2 Dichloroethane-D4	0.010	87	96
Toluene-D8	0.010	97	102
Bromofluorobenzene	0.010	104	106

February 5, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
7108 S. Alton Way, Bldg. E
Englewood, CO 80112
(303) 850-7606

TABLE 11

ECS Project #:	CHM081	Date Received:	1/24/96
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	1/23/96
Method #:	EPA 524.2	Date Extracted:	n/a
Matrix:	Water	Date Analyzed:	1/26/96
Units:	mg/L (ppm)		

*	PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	Well #1 SPIKE	% RECOVERY	Well #1 SPIKE DUPLICATE	% RECOVERY	RELATIVE % DIFFERENCE
	Dichlorodifluoromethane	0.002	-	ND	-	ND	-	-
	Chloromethane	0.002	-	ND	-	ND	-	-
	Bromomethane	0.002	-	ND	-	ND	-	-
	Vinyl chloride	0.002	-	ND	-	ND	-	-
	Chloroethane	0.002	-	ND	-	ND	-	-
	Trichlorofluoromethane	0.002	-	ND	-	ND	-	-
	Methylene chloride	0.005	-	ND	-	ND	-	-
*	1,1-Dichloroethene	0.001	0.025	0.028	111	0.029	114	3
	1,1-Dichloroethane	0.001	-	ND	-	ND	-	-
	cis-1,2-Dichloroethene	0.001	-	ND	-	ND	-	-
	trans-1,2-Dichloroethene	0.001	-	ND	-	ND	-	-
	Chloroform	0.001	-	ND	-	ND	-	-
	Bromochloromethane	0.001	-	ND	-	ND	-	-
	Dibromomethane	0.001	-	ND	-	ND	-	-
	1,2-Dichloroethane	0.001	-	ND	-	ND	-	-
	1,1,1-Trichloroethane	0.001	-	ND	-	ND	-	-

*	PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	Well #1 SPIKE	% RECOVERY	Well #1 SPIKE DUPLICATE	% RECOVERY	RELATIVE % DIFFERENCE
	Carbon tetrachloride	0.001	-	ND	-	ND	-	-
	Bromodichloromethane	0.001	-	ND	-	ND	-	-
	1,2-Dichloropropane	0.001	-	ND	-	ND	-	-
	1,1-Dichloropropene	0.001	-	ND	-	ND	-	-
	trans-1,3-Dichloropropene	0.001	-	ND	-	ND	-	-
	2,2-Dichloropropane	0.001	-	ND	-	ND	-	-
	cis-1,3-Dichloropropene	0.001	-	ND	-	ND	-	-
*	Trichloroethene	0.001	0.025	0.028	112	0.027	107	5
	1,3-Dichloropropane	0.001	-	ND	-	ND	-	-
	1,1,2-Trichloroethane	0.001	-	ND	-	ND	-	-
	Dibromochloromethane	0.001	-	ND	-	ND	-	-
	1,2-Dibromoethane	0.001	-	ND	-	ND	-	-
	Bromoform	0.001	-	ND	-	ND	-	-
	1,1,1,2-Tetrachloroethane	0.001	-	ND	-	ND	-	-
	1,2,3-Trichloropropane	0.001	-	ND	-	ND	-	-
	1,1,2,2-Tetrachloroethane	0.001	-	ND	-	ND	-	-
	Tetrachloroethene	0.001	-	ND	-	ND	-	-
*	Chlorobenzene	0.001	0.025	0.027	108	0.026	105	3
	1,3-Dichlorobenzene	0.001	-	ND	-	ND	-	-
	1,2-Dichlorobenzene	0.001	-	ND	-	ND	-	-
	1,4-Dichlorobenzene	0.001	-	ND	-	ND	-	-
	2-Chlorotoluene	0.001	-	ND	-	ND	-	-
	4-Chlorotoluene	0.001	-	ND	-	ND	-	-
	Bromobenzene	0.001	-	ND	-	ND	-	-
	Styrene	0.001	-	ND	-	ND	-	-

*	PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	Well #1 SPIKE	% RECOVERY	Well #1 SPIKE DUPLICATE	% RECOVERY	RELATIVE % DIFFERENCE
*	Benzene	0.001	0.025	0.029	116	0.028	112	4
*	Toluene	0.001	0.025	0.028	112	0.027	110	2
	Ethylbenzene	0.001	-	ND	-	ND	-	-
	Total xylenes	0.001	-	ND	-	ND	-	-
	Isopropylbenzene	0.001	-	ND	-	ND	-	-
	n-Propylbenzene	0.001	-	ND	-	ND	-	-
	1,3,5-Trimethylbenzene	0.001	-	ND	-	ND	-	-
	1,2,4-Trimethylbenzene	0.001	-	ND	-	ND	-	-
	s-Butylbenzene	0.001	-	ND	-	ND	-	-
	t-Butylbenzene	0.001	-	ND	-	ND	-	-
	p-Isopropyltoluene	0.001	-	ND	-	ND	-	-
	n-Butylbenzene	0.001	-	ND	-	ND	-	-
	1,2-Dibromo-3-chloropropane	0.001	-	ND	-	ND	-	-
	Hexachlorobutadiene	0.001	-	ND	-	ND	-	-
	Naphthalene	0.001	-	ND	-	ND	-	-
	1,2,4-Trichlorobenzene	0.001	-	ND	-	ND	-	-
	1,2,3-Trichlorobenzene	0.001	-	ND	-	ND	-	-

ND = Not detected at levels exceeding the reporting detection limit.

SURROGATE % RECOVERY

SURROGATE	SURROGATE AMOUNT		Well #1 SPIKE		Well #1 SPIKE DUPLICATE		
1,2 Dichloroethane-D4	0.010	-	99	-	103	-	-
Toluene-D8	0.010	-	98	-	100	-	-
Bromofluorobenzene	0.010	-	104	-	104	-	-

February 5, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
7108 S. Alton Way, Bldg. E
Englewood, CO 80112
(303) 850-7606

TABLE 12

ECS Project #: CHM081
CH2M Hill Project #: Brownsville ASR
Method #: EPA 625
Matrix: Water
Units: mg/L (ppm)

Date Received: 1/24/96
Date Sampled: 1/23/96
Date Extracted: 1/24/96
Date Analyzed: 1/26/96

*	PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
	Phenol	0.010	ND	ND
	Bis(2-chloroethyl)ether	0.010	ND	ND
	2-Chlorophenol	0.010	ND	ND
	1,3-Dichlorobenzene	0.010	ND	ND
	1,4-Dichlorobenzene	0.010	ND	ND
	1,2-Dichlorobenzene	0.010	ND	ND
	Bis(2-chloroisopropyl)ether	0.010	ND	ND
	Hexachloroethane	0.010	ND	ND
	N-Nitrosodi-n-propylamine	0.010	ND	ND
	Nitrobenzene	0.010	ND	ND
	Isophorone	0.010	ND	ND
	2-Nitrophenol	0.010	ND	ND
	2,4-Dimethylphenol	0.010	ND	ND
	Bis(2-chloroethoxy)methane	0.010	ND	ND
	2,4-Dichlorophenol	0.010	ND	ND
	1,2,4-Trichlorobenzene	0.010	ND	ND
	Naphthalene	0.010	ND	ND
	Hexachlorobutadiene	0.010	ND	ND
	4-chloro-3-methylphenol	0.020	ND	ND

*	PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
	2,4,6-Trichlorophenol	0.010	ND	ND
	2-Chloronaphthalene	0.010	ND	ND
	Dimethylphthalate	0.010	ND	ND
	Acenaphthylene	0.010	ND	ND
	Acenaphthene	0.010	ND	ND
	2,4-Dinitrophenol	0.020	ND	ND
	4-Nitrophenol	0.020	ND	ND
	2,4-Dinitrotoluene	0.010	ND	ND
	Diethylphthalate	0.010	ND	ND
	Fluorene	0.010	ND	ND
	4-Chlorophenylphenylether	0.010	ND	ND
	4,6-Dinitro-2-methylphenol	0.020	ND	ND
	4-Bromophenylphenylether	0.010	ND	ND
	Hexachlorobenzene	0.010	ND	ND
	Pentachlorophenol	0.010	ND	ND
	Phenanthrene	0.010	ND	ND
	Anthracene	0.010	ND	ND
	Di-n-butylphthalate	0.010	ND	ND
	Fluoranthene	0.010	ND	ND
	Pyrene	0.010	ND	ND
	Butyl benzyl phthalate	0.010	ND	ND
	Chrysene	0.010	ND	ND
	3,3'-Dichlorobenzidine	0.020	ND	ND
	Benz(a)anthracene	0.010	ND	ND
	Bis(2-ethylhexyl)phthalate	0.010	ND	ND
	Di-n-octyl phthalate	0.010	ND	ND

*	PARAMETER	DETECTION LIMIT	SAMPLE # Well #1	BLANK
	Benzo(b)fluoranthene	0.010	ND	ND
	Benzo(k)fluoranthene	0.010	ND	ND
	Benzo(a)pyrene	0.010	ND	ND
	Indeno(1,2,3-cd)pyrene	0.010	ND	ND
	Dibenz(a,h)anthracene	0.010	ND	ND
	Benzo(g,h,i)perylene	0.010	ND	ND
	Hexachlorocyclopentadiene	0.010	ND	ND
	Benzidine	0.050	ND	ND
	2,6-Dinitrotoluene	0.010	ND	ND
	N-Nitrosodiphenylamine	0.010	ND	ND
	N-Nitrosodimethylamine	0.020	ND	ND

ND = Not detected at levels exceeding the reporting detection limit.

SURROGATE % RECOVERY

SURROGATE	SURROGATE AMOUNT	SAMPLE # Well #1	BLANK
Phenol-D5	0.10	35	54
2-Fluorophenol	0.10	58	73
Nitrobenzene-D5	0.050	77	69
2-Fluorobiphenyl	0.050	80	64
2,4,6-Tribromophenol	0.10	89	79
Terphenyl-D14	0.050	97	91

February 5, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
7108 S. Alton Way, Bldg. E
Englewood, CO 80112
(303) 850-7606

TABLE 13

ECS Project #:	CHM081	Date Received:	n/a
CH2M Hill Project #:	Brownsville ASR	Date Sampled:	n/a
Method #:	EPA 625	Date Extracted:	1/24/96
Matrix:	Water	Date Analyzed:	1/26/96
Units:	mg/L (ppm)		

*	PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	MATRIX SPIKE	% RECOVERY	MATRIX SPIKE DUPLICATE	% RECOVERY	RELATIVE % DIFFERENCE
*	Phenol	0.10	0.10	0.038	38	0.039	39	3
	Bis(2-chloroethyl)ether	0.010	-	ND	-	ND	-	-
*	2-Chlorophenol	0.010	0.10	0.075	75	0.082	82	9
	1,3-Dichlorobenzene	0.010	-	ND	-	ND	-	-
*	1,4-Dichlorobenzene	0.010	0.050	0.028	57	0.030	59	3
	1,2-Dichlorobenzene	0.010	-	ND	-	ND	-	-
	Bis(2-chloroisopropyl)ether	0.010	-	ND	-	ND	-	-
	Hexachloroethane	0.010	-	ND	-	ND	-	-
*	N-Nitrosodi-n-propylamine	0.010	0.050	0.034	68	0.036	73	7
	Nitrobenzene	0.010	-	ND	-	ND	-	-
	Isophorone	0.010	-	ND	-	ND	-	-
	2-Nitrophenol	0.010	-	ND	-	ND	-	-
	2,4-Dimethylphenol	0.010	-	ND	-	ND	-	-
	Bix(2-chloroethoxy)methane	0.010	-	ND	-	ND	-	-
	2,4-Dichlorophenol	0.010	-	ND	-	ND	-	-
*	1,2,4-Trichlorobenzene	0.010	0.050	0.030	60	0.032	63	5
	Naphthalene	0.010	-	ND	-	ND	-	-
	Hexachlorobutadiene	0.010	-	ND	-	ND	-	-
*	4-chloro-3-methylphenol	0.020	0.10	0.077	77	0.083	83	8

*	PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	MATRIX SPIKE	% RECOVERY	MATRIX SPIKE DUPLICATE	% RECOVERY	RELATIVE % DIFFERENCE
	2,4,6-Trichlorophenol	0.010	-	ND	-	ND	-	-
	2-Chloronaphthalene	0.010	-	ND	-	ND	-	-
	Dimethylphthalate	0.010	-	ND	-	ND	-	-
	Acenaphthylene	0.010	-	ND	-	ND	-	-
	2,6-Dinitrotoluene	0.010	-	ND	-	ND	-	-
*	Acenaphthene	0.010	0.050	0.037	75	0.038	77	3
	2,4-Dinitrophenol	0.020	-	ND	-	ND	-	-
*	4-Nitrophenol	0.020	0.10	0.027	27	0.027	27	0
*	2,4-Dinitrotoluene	0.010	0.050	0.040	79	0.041	83	5
	Diethylphthalate	0.010	-	ND	-	ND	-	-
	Fluorene	0.010	-	ND	-	ND	-	-
	4-Chlorophenylphenylether	0.010	-	ND	-	ND	-	-
	4,6-Dinitro-2-methylphenol	0.020	-	ND	-	ND	-	-
	4-Bromophenylphenylether	0.010	-	ND	-	ND	-	-
	Hexachlorobenzene	0.010	-	ND	-	ND	-	-
*	Pentachlorophenol	0.010	0.10	0.074	74	0.083	83	11
	Phenanthrene	0.010	-	ND	-	ND	-	-
	Anthracene	0.010	-	ND	-	ND	-	-
	Di-n-butyl phthalate	0.010	-	ND	-	ND	-	-
	Fluoranthene	0.010	-	ND	-	ND	-	-
*	Pyrene	0.010	0.050	0.050	100	0.052	105	5
	Butyl benzyl phthalate	0.010	-	ND	-	ND	-	-
	Chrysene	0.010	-	ND	-	ND	-	-
	3,3'-Dichlorobenzidine	0.020	-	ND	-	ND	-	-
	Benzo(a)anthracene	0.010	-	ND	-	ND	-	-
	Bis(2-ethylhexyl)phthalate	0.010	-	ND	-	ND	-	-

*	PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	MATRIX SPIKE	% RECOVERY	MATRIX SPIKE DUPLICATE	% RECOVERY	RELATIVE % DIFFERENCE
	Di-n-octylphthalate	0.010	-	ND	-	ND	-	-
	Benzo(b)fluoranthene	0.010	-	ND	-	ND	-	-
	Benzo(k)fluoranthene	0.010	-	ND	-	ND	-	-
	Benzo(a)pyrene	0.010	-	ND	-	ND	-	-
	Indeno(1,2,3-cd)pyrene	0.010	-	ND	-	ND	-	-
	Dibenzo(a,h)anthracene	0.010	-	ND	-	ND	-	-
	Benzo(g,h,i)perylene	0.010	-	ND	-	ND	-	-
	Hexachlorocyclopentadiene	0.010	-	ND	-	ND	-	-
	Benzidine	0.050	-	ND	-	ND	-	-
	2,6-Dinitrotoluene	0.010	-	ND	-	ND	-	-
	N-Nitrosodiphenylamine	0.010	-	ND	-	ND	-	-
	N-Nitrosodimethylamine	0.010	-	ND	-	ND	-	-

ND = Not detected at levels exceeding the reporting detection limit.

SURROGATE % RECOVERY

SURROGATE	SURROGATE AMOUNT		MATRIX SPIKE		MATRIX SPIKE DUPLICATE		
Phenol-D5	0.10		35		37		
2-Fluorophenol	0.10		55		61		
Nitrobenzene-D5	0.050		65		73		
2-Fluorobiphenyl	0.050		59		63		
2,4,6-Tribromophenol	0.10		83		91		
Terphenyl-D14	0.050		87		94		

ECS CHEMISTRY SERVICES, INC.

CHAIN OF CUSTODY RECORD

REQUESTED TURNAROUND TIME: "two weeks"

PROJ. NO.	PROJECT
	CH2M HILL (Brownsville ASR)

SAMPLERS: (Signature)
Alida M Saunders

REPORT TO: (Print Name & Company)
KEVIN BRAL / CH2M HILL (303) 771-0900

SAMPLE ID	DATE	TIME	SAMPLE LOCATION	SAMPLE MATRIX	# OF CONTAINERS	524.2	625	TSS/TDS	608	GENERAL	TOX	TOC	METALS	SULFIDE	NUTRIENT	REMARKS
VOC's	1-23-96	17:20	Well #1 (Brownsville ASR)	H_2O	3	✓										
SVOC	1-23-96	17:20	" "	H_2O	1		✓									
SULFIDE	"	"	"	"	1									✓		
NUTRIENT	"	"	"	"	1										✓	
TSS/TDS	"	"	"	"	1			✓								
608	"	"	"	"	1				✓							
GENERAL	"	"	"	"	2					✓						
TOX	"	"	"	"	1						✓					
TOC	"	"	"	"	1							✓				
METALS	"	"	"	"	2								✓			

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Alida Saunders	1/23/96 18:30				

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time
		Amy Teff	1/24/96 1100

REMARKS:
Rcvd. Chilled. (2°) VIA FedEx.

Environmental Chemistry Services, Inc.
7108 S. Alton Way, Bldg. E
Englewood, CO 80112
303-850-7606

ECS ENVIRONMENTAL CHEMISTRY SERVICES, INC.

TRANSMITTAL

DATE: February 8, 1996

TO: Mr. Kevin Bral

COMPANY: CH2M Hill

RE: ECS Project #CHM081

DESCRIPTION:

Anion, TOC, TOX, BOD, COD, specific conductance, turbidity, color, and gross alpha & beta results for CH2M Hill Brownsville ASR Project.

Signed: Vikki VanDeusen

7108 S. Alton Way, Bldg E • Englewood, CO 80112 • OFFICE: (303) 850-7606 • FAX: (303) 850-7609

Accu-Labs® Research, Inc.

4663 Table Mountain Drive Golden, Colorado 80403-1650
(303) 277-9514 FAX (303) 277-9512

Date: 02/06/96

REPORT OF ANALYSIS

Ms Lisa Graves
Environmental Chemistry Serv
7108 S Alton Way Bldg E
Englewood, CO 80112

Lab Job Number: 006783 ENV003
Date Samples Received: 01/24/96

ALR Designation:	96-A1493
Client Designation:	WELL #1
Sample Location:	
Location II:	
Date/Time Collected	01/23/96 17:20
Gross Alpha, total (pCi/L)	38 +/- 18
Gross Beta, total (pCi/L)	18 +/- 18

NOTES: When present, *** indicates that the analyte in question was not requested for that sample.

Variability of the radioactive disintegration process (counting error) at the 95% confidence level is 1.96 sigma and the level of significance may exceed that of the reported analytical result.

Scheduled sample disposal/return date: March 7, 1996.

Bud Summers
Radiochemistry Supervisor

Accu-Labs® Research, Inc.

4663 Table Mountain Drive Golden, Colorado 80403-1650
(303) 277-9514 FAX (303) 277-9512

Date: 02/06/96

REPORT OF ANALYSIS

Ms Lisa Graves
Environmental Chemistry Serv
7108 S Alton Way Bldg E
Englewood, CO 80112

Lab Job Number: 006783 ENV003
Date Samples Received: 01/24/96

ALR Designation:	96-A1493
Client Designation:	WELL #1
Sample Location:	
Location II:	
Date/Time Collected	01/23/96 17:20
Alkalinity, Total (mg/L CaCO3)	440
Ammonia (as N) (mg/L)	< 0.2
Bicarbonate (as HCO3-) (mg/L HCO3-)	530
Biochemical Oxygen Demand (mg/L)	< 2
Carbonate (as CO3=) (mg/L CO3=)	< 5
Chemical Oxygen Demand (mg/L)	12
Chloride (mg/L)	830
Color (Pt/Co)	< 5
Fluoride (mg/L)	< 0.5
Hydroxide (as OH-) (mg/L OH-)	< 5
Nitrate (as N) (mg/L)	< 0.05
Nitrate plus Nitrite (mg/L)	< 0.05
Nitrite (as N) (mg/L)	< 0.05
Orthophosphate (as P) (mg/L)	0.02
Phosphorus, Total (as P) (mg/L)	0.04
Specific Conductance (umhos/cm)	5
Sulfate (as SO4) (mg/L)	1100
Sulfide (as S) (mg/L)	< 0.02
Total Kjeldahl Nitrogen (TKN) (mg/L)	< 1
Total Nitrogen (mg/L)	< 1
Total Organic Carbon (mg/L)	4
TOX (as Cl) (ug/L)	41
Total Solids (mg/L)	2900
Turbidity (NTU)	0.6
pH ()	7.3

NOTES: When present, *** indicates that the analyte in question was not requested for that sample.

Scheduled sample disposal/return date: March 7, 1996.

Susan J. Barker
Inorganic Chemistry Supervisor

Accu-Labs Research, Inc. QA/QC DATA SHEET

ALR ID: 006783

Date Received: 01/24/96

Analyte*	Date of Analysis	Time of Analysis	Analyst	Replicate		Spike		CV	Calibration Blank	Method
				ALR #	% RPD	ALR #	% Rec	% Rec		
Alk	02/01/96	11:30	LA	96-A1493	0	96-A1684	91	100	<5	310.1
NH_3	01/26/96	11:30	LMH	96-A1493	0	96-A1516	100	104	<0.2	350.3
B.O.D.	01/25/96	10:15	CM/SA/GH	N/A	N/A	N/A	N/A	99	<2	405.1
COD	01/26/96	08:30	AKW	96-A1493	±DL	96-A1493	98	115	<5	410.4
Cl	01/30/96	13:23	LMH	96-A1493	1	96-A1516	100	108	<1	325.2
Color	01/25/96	15:30	GH	96-A1493	0	NA	NA	NA	NA	110.1
F	01/29/96	10:55	AKW	96-A1493	0	96-A1229	105	104	<0.5	340.2
NO_2+NO_2	01/29/96	11:26	LMH	96-A1493	0	96-A1516	106	101	<0.05	353.2
NO_2	01/24/96	18:00	YS	96-A1493	0	96-A1464	102	100	<0.05	354.1
O-P	01/24/96	22:30	DE	96-A1454	0	96-A1455	98	106	<0.02	365.2
P	01/26/96	20:00	DE	96-A1493	0	96-A1493	96	104	<0.02	365.2
Spec. Cond	01/24/96	16:30	TM	96-A1493	0	96-A1493	110	103	<2	120.1
SO_4	01/26/96	16:00	AB	96-A1493	0	96-A1508	80	104	<10	375.4
$S^=$	01/27/96	11:00	TM	96-A1684	0	96-A1605	88	104	<0.02	376.2
TKN	02/01/96	09:00	TM	96-A1493	0	96-A1605	115	104	<0.2	351.3

Comments:

Approved: SA

Date: 2·7·96

* mg/L unless otherwise noted.

Accu-Labs Research, Inc.

QA/QC DATA SHEET

ALR ID: 006783

Date Received: 01/24/96

Analyte*	Date of Analysis	Time of Analysis	Analyst	Replicate		Spike		CV	Calibration Blank	Method
				ALR #	% RPD	ALR #	% Rec	% Rec		
TOC	01/30/96 01/26/96	09:30 10:00	SRB SRB	- 96-A1493	- ± DL	96-A1606 -	90 -	97 97	<1 <1	415.1
TOX	02/05/96	11:30	SRB	96-A1493	19	96-A1493	91	108	<5	450.1
TS	01/25/96	17:00	JK	96-A1493	0	NA	NA	98	<5	160.3
Turb	01/26/96	16:00	BSG	96-A1493	0	NA	NA	100	<0.2	180.1
pH	01/24/96	12:00	MS	96-A1493	0	NA	NA	102	6.4	150.1

Comments:

Approved: SA

Date: 2-7-96

* mg/L unless otherwise noted.

ECS ENVIRONMENTAL CHEMISTRY SERVICES, INC.

May 18, 1996

Mr. Kevin Bral
CH2M Hill
P.O. Box 241325
Denver, CO 80224-9325

RE: ECS Project #CHM083

Dear Kevin:

Enclosed are the pH and metals results for the CH2M Hill Project #116700.JO.77 water samples we received on May 3.

The pH of the samples was measured using EPA Method 9040A. The method consists of electrometrical measurement using a pH meter. The results are reported in Table 1.

The samples were analyzed for metals by EPA Method 6020. This is an inductively coupled plasma/mass spectrometry (ICP/MS) method. The sample results are in Tables 2 and 3; quality control results are in Tables 4 and 5.

The samples were sent to AccuLabs Research for the remainder of the analyses. The results are enclosed.

Please call if you have any questions.

Sincerely,

John Graves
Technical Director

7108 S. Alton Way, Bldg E • Englewood, CO 80112 • OFFICE: (303) 850-7606 • FAX: (303) 850-7609

May 18, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
7108 S. Alton Way, Bldg. E
Englewood, CO 80112
(303) 850-7606

TABLE 1

ECS Project #:	CHM083	Date Received:	5/3/96
CH2M Hill Project #:	116700.JO.77	Date Sampled:	5/1-5/2/96
Method #:	EPA 9040A	Date Extracted:	n/a
Matrix:	Water	Date Analyzed:	5/3/96
Units:	n/a		

SAMPLE RESULTS		
Sample #	pH	Temperature (°C)
B-6	7.6	23
B-5	7.2	23

May 18, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
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TABLE 2

ECS Project #: CHM083
CH2M Hill Project #: 116700.JO.77
Method #: EPA 6020
Matrix: Water
Units: mg/L (ppm)

Date Received: 5/3/96
Date Sampled: 5/1/96
Date Digested: 5/9/96
Date Analyzed: 5/10-5/18/96

PARAMETER	DETECTION LIMIT	SAMPLE # B-6	BLANK
Aluminum	0.001	2.3	ND
Arsenic	0.001	0.028	ND
Barium	0.001	0.046	ND
Cadmium	0.001	ND	ND
Calcium	1.0	210	ND
Chromium	0.001	0.0066	ND
Iron	0.005	6.7	ND
Lead	0.001	0.010	ND
Magnesium	1.0	74	ND
Manganese	0.001	0.36	ND
Mercury	0.0002	ND	ND
Potassium	1.0	7.2	ND
Selenium	0.001	0.050	ND
Silica	0.10	40	ND
Silver	0.001	ND	ND
Sodium	1.0	1,200	ND

ND = Not detected at levels exceeding the reporting detection limit.

May 18, 1996

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TABLE 3

ECS Project #: CHM083
CH2M Hill Project #: 116700.JO.77
Method #: EPA 6020
Matrix: Water
Units: mg/L (ppm)

Date Received: 5/3/96
Date Sampled: 5/2/96
Date Digested: 5/9/96
Date Analyzed: 5/10-5/18/96

PARAMETER	DETECTION LIMIT	SAMPLE # B-5
Aluminum	0.10	1.3
Arsenic	0.10	0.44
Barium	0.10	0.37
Cadmium	0.10	ND
Calcium	10	4,800
Chromium	0.10	ND
Iron	0.50	55
Lead	0.10	ND
Magnesium	10	1,500
Manganese	0.10	7.7
Mercury	0.02	ND
Potassium	10	150
Selenium	0.10	0.84
Silica	1.0	18
Silver	0.10	ND
Sodium	10	26,000

ND = Not detected at levels exceeding the reporting detection limit.

May 18, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
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Englewood, CO 80112
(303) 850-7606

TABLE 4

ECS Project #:	CHM083	Date Received:	n/a
CH2M Hill Project #:	116700.JO.77	Date Sampled:	n/a
Method #:	EPA 6020	Date Digested:	5/9/96
Matrix:	Water	Date Analyzed:	5/10-5/18/96
Units:	mg/L (ppm)		

PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	LCS SPIKE	% RECOVERY
Aluminum	0.001	0.1	0.090	90
Arsenic	0.001	0.1	0.11	113
Barium	0.001	0.1	0.12	120
Cadmium	0.001	0.1	0.10	104
Calcium	1.0	2.0	2.3	115
Chromium	0.001	0.1	0.11	107
Iron	0.005	0.1	0.11	108
Lead	0.001	0.1	0.12	115
Magnesium	1.0	2.0	2.3	114
Manganese	0.001	0.1	0.095	95
Mercury	0.0002	0.005	0.0046	92
Potassium	1.0	2.0	2.0	98
Selenium	0.001	0.1	0.11	109
Silica	0.10	2.0	2.0	100
Silver	0.001	0.1	0.11	112
Sodium	1.0	2.0	2.0	98

May 18, 1996

ENVIRONMENTAL CHEMISTRY SERVICES, INC.
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Englewood, CO 80112
(303) 850-7606

TABLE 5

ECS Project #:	CHM083	Date Received:	n/a
CH2M Hill Project #:	116700.JO.77	Date Sampled:	n/a
Method #:	EPA 6020	Date Digested:	5/9/96
Matrix:	Water	Date Analyzed:	5/10/96
Units:	mg/L (ppm)		

PARAMETER	DETECTION LIMIT	SPIKE AMOUNT	MATRIX SPIKE	% RECOVERY
Aluminum	0.001	0.26	0.34	133
Arsenic	0.001	0.064	0.076	119
Barium	0.001	0.18	0.19	106
Cadmium	0.001	0.079	0.079	100
Calcium	1.0	2,200	2,600	109
Chromium	0.001	0.16	0.16	99
Iron	0.005	0.38	0.39	104
Lead	0.001	0.16	0.16	105
Magnesium	1.0	2,200	2,500	108
Manganese	0.001	0.24	0.26	106
Mercury	0.0002	0.0029	0.0029	101
Potassium	1.0	2,200	2,100	93
Selenium	0.001	0.11	0.13	113
Silica	0.10	470	400	77
Silver	0.001	0.096	0.10	105
Sodium	1.0	2,200	3,200	95

Accu-Labs® Research, Inc.

4663 Table Mountain Drive Golden, Colorado 80403-1650
(303) 277-9514 FAX (303) 277-9512

Date: 05/14/96

REPORT OF ANALYSIS

Ms Lisa Graves
Environmental Chemistry Serv
7108 S Alton Way Bldg E
Englewood, CO 80112

Lab Job Number: 008573 ENV003
Date Samples Received: 05/03/96

ALR Designation:	96-A8312	96-A8313
Client Designation:	B-6	B-5
Sample Location:		
Location II:		
Date/Time Collected	05/01/96 13:15	05/02/96 15:30
Alkalinity, Total (mg/L CaCO3)	450	25000
Ammonia (as N) (mg/L)	1.3	6.5
Bicarbonate (as HCO3-) (mg/L HCO3-)	540	30000
Carbonate (as CO3=) (mg/L CO3=)	< 5	< 5
Chloride (mg/L)	1000	43000
Color (Pt/Co)	20	10
Fluoride (mg/L)	1.1	0.6
Hydroxide (as OH-) (mg/L OH-)	< 5	< 5
Nitrate (as N) (mg/L)	< 0.05	0.05
Nitrate plus Nitrite (mg/L)	< 0.05	0.05
Nitrite (as N) (mg/L)	< 0.05	< 0.05
Orthophosphate (as P) (mg/L)	0.05	< 0.02
Phosphorus, Total (as P) (mg/L)	0.93	0.03
Specific Conductance (umhos/cm)	5500 ▲	200000
Sulfate (as SO4) (mg/L)	1100	3300
Sulfide (as S) (mg/L)	0.05	0.05
Turbidity (NTU)	13	30000
pH ()	7.5 ▲	7.2

NOTES: When present, *** indicates that the analyte in question was not requested for that sample.
▲ Indicates that samples were received and analyzed past holding time.

Scheduled sample disposal/return date: June 13, 1996.

Eyda Hergenreder
Trudy L. Scott
Laboratory Managers

Accu-Labs Research, Inc.

QA/QC DATA SHEET

ALR ID: 008573

Date Received: 05/03/96

Analyte*	Date of Analysis	Time of Analysis	Analyst	Replicate		Spike		CV	Calibration Blank	Method
				ALR #	% RPD	ALR #	% Rec	% Rec		
Alk. (T)	05/06/96	10:45	AKW	96-A8312	1	96-A8312	95	100	<5	310.1
NH_3	05/07/96	12:55	LMH	96-A8312	7	96-A8323	84	94	<0.2	350.3
Cl	05/06/96	10:59	LMH	96-A8312	0	96-A8322	100	102	<1	325.2
Color	05/04/96	09:00	BSG	96-A8312	0	NA	NA	NA	<5	110.2
F	05/10/96	13:00	AKW	96-A8669	0	96-A8670	98	102	<0.5	340.2
$NO_3 + NO_2$	05/08/96	15:37	LMH	96-A8114	0	96-A8355	106	96	<0.05	353.2
NO_2	05/03/96	16:00	BSG	96-A8312	0	96-A8312	89	108	<0.05	354.1
Ortho Phos.	05/03/96	17:30	DE	96-A8312	0	96-A8312	104	103	<0.02	365.2
Total Phos.	05/08/96	19:00	DE	96-A8345	6	96-A8518	98	100	<0.02	365.2
Spec. Cond.	05/04/96	10:00	BSG	96-A8322	2	96-A8322	106	102	<2	120.1
SO_4	05/08/96	15:00	AB	96-A8312	10	96-A8350	90	108	<10	375.4
$S^=$	05/08/96	07:00	SRB	96-A8312	±DL	96-A8322	110	98	<0.02	376.2
Turbidity	05/03/96	14:40	BSG	96-A8312	0	NA	NA	96	<0.2	180.1
pH	05/03/96	18:00	DE	96-A8312	0	NA	NA	100	7.6	150.1

Comments:

Approved: EH

±DL = Plus or minus detection limit.

Date: 5/14/96

*mg/L unless otherwise noted.

ECS CHEMISTRY SERVICES, INC.

CHAIN OF CUSTODY RECORD

REQUESTED TURNAROUND TIME:

PROJ. NO.	PROJECT
116700.JO.77	Brownsville ASR

SAMPLERS: (Signature) Peter van Noort / CH2M Hill

REPORT TO: (Print Name & Company) Kevin Bral / CH2M HILL 303-771-0952 xt. 5517

SAMPLE ID	DATE	TIME	SAMPLE LOCATION	SAMPLE MATRIX	# OF CONTAINERS	ANALYSES REQUIRED: Nutrients	Sulfide	General Metals	pH	REMARKS
B-6	5/1/96	1915	B-6, Tejas Rd	Aq	5	X	X	X	X	X		
B-5	5/2/96	1530	B-5, Tejas Rd	"	"	X	X	X	X	X		

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
	5/2/96 1805				

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time
		John Graves	5/3/96 1020

REMARKS: Samples received chilled.

Environmental Chemistry Services, Inc.
7108 S. Alton Way, Bldg. E
Englewood, CO 80112
303-850-7606