Appendix B

LOG OF BORING NO. WTP-09 (WB-09)

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND with GRAVEL Light brown, dry, medium dense, weakly cemented, with estimated 25% low-plasticity fines, 60% fine to coarse sand, and 15% fine gravel.		SM	1	SPT	5	20			
	2.5									
	SILTY SAND Light brown, dry, medium dense to loose, weakly cemented, with estimated 20-35% low plasticity fines, 60-75% fine to coarse sand and 5% fine gravel.		SM	2	MC	7	15			
		5	SM	3	SPT	12	8			
	7.5									
	ELASTIC SILT with SAND Light brown, wet, loose, with estimated 80% medium plasticity fines and 20% fine to medium sand. ▽		MH	4	MC	18	7	54.6	61	
	10									
	SILTY SAND Blue-grey, wet, loose, with estimated 20% low plasticity fines, 75% fine to coarse sand, and 5% fine gravel. Organic smell.	10	SM	5	SPT	18	10			
			SM	6	MC	18	12			
	15	15								

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
/L	▽ 8	▼	
WL	▽	▼	
WL			

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CME 750	FOREMAN	SAN
		JOB #	67055025

LOG OF BORING NO. WTP-09 (WB-09)

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SANDY ELASTIC SILT Black, moist, stiff, with estimated 60% medium plasticity fines and 40% fine to medium sand. Some interbedded sand 1"-2" thick.		MH	7	SPT	18	4			
			MH	8	MC	18	2	240.5	22	
		20	MH	9	SPT	18	1			
	23 **CLAYEY SAND** Green to black, moist, medium dense, with estimated 35-40% low to medium plasticity fines and 60-65% fine to coarse sand. Organic smell and some interbedded clean sand 1-2" thick.		SC	10	MC	18	12			
		25	SC	11	SPT	18	9			
			SC	12	MC	18	10			
		30								

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ 8	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CME 750	FOREMAN	SAN
		JOB #	67055025

LOG OF BORING NO. WTP-09 (WB-09)

CLIENT: **ECO:LOGIC Engineering**

SITE: **Washoe County, Nevada**

PROJECT: **Fish Springs Water Supply Project**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	CLAYEY SAND Green to black, moist, medium dense, with estimated 35-40% low to medium plasticity fines and 60-65% fine to coarse sand. Organic smell and some interbedded clean sand 1-2" thick.									
	35	35	SP	13	SPT	18	28	29.9		
	POORLY-GRADED SAND with SILT Brown, moist, dense, with 9% non plastic fines, 90% fine to coarse sand, and trace fine gravel. clayey sand at top of sample.									
	40	40	SC	14	MC	18	15			
	CLAYEY SAND Brown, moist, medium dense, with estimated 40% medium plasticity fines, 55% fine to coarse sand, and 5% fine gravel. Rig losing water between 35-40'. Lense of Poorly Graded Gravel at top of unit.									
	45	45								

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
/L	▽ 8	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CME 750	FOREMAN	SAN
		JOB #	67055025

LOG OF BORING NO. WTP-09 (WB-09)

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND with GRAVEL Red-brown, moist, very dense, with estimated 20% non-plastic fines, 45% fine to coarse sand, and 35% fine to coarse gravel. Rock blocking sample cone on removal. Refusal at 48'.		SM	15	SPT	12	57			
	48									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ 8	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CME 750	FOREMAN	SAN
		JOB #	67055025

BOREHOLE 055025 GINT.GPJ TERRACON.GDT 6/7/2006

LOG OF TEST PIT NO. WTP-10

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, dry, loose, with estimated 30% low plasticity fines, 60% fine to coarse sand, and 10% fine gravel. Some cemented layers, shells present.		SM	1	GRAB					
		10.5								
	SILTY SAND with GRAVEL Grey, moist, medium dense, with estimated 15% non plastic fines, 65% fine to coarse sand, and 20% fine to coarse gravel.		SM	2	GRAB					
		12								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽ NE	▼	
WL	▽	▼	
WL			

Terracon

BORING STARTED	12-7-05		
BORING COMPLETED	12-7-05		
RIG	CAT 314C	FOREMAN	SAN
		JOB #	67055025

LOG OF TEST PIT NO. WTP-15

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf
	SILTY SAND with GRAVEL Brown, moist, loose, with estimated 20% non plastic fines, 65% fine to coarse sand, and 10-15% fine to coarse gravel. Organics present. Moderately cemented in areas.		SM	1 GRAB						
	2.7									
	SILTY SAND with GRAVEL Brown, moist, medium dense, with estimated 15% non plastic fines, 65% fine to coarse sand, and 15-20% fine to coarse gravel. No organic material, gravel size and amount increases with depth.									
	4									
	SILTY SAND with GRAVEL Brown, moist, medium dense, with estimated 20% non plastic fines, 65% fine to coarse sand, and 10-15% fine to coarse gravel.	5								
	7									
	SILTY SAND Brown, moist, loose to medium dense, with estimated 25% non plastic fines, 65% fine to coarse gravel, and 5-10% fine to coarse gravel.		SM	2 GRAB						
	10.5	10								
	SANDY SILT Brown, moist, stiff, with estimated 55% non plastic fines, 40% fine to coarse sand, and 5% fine to coarse gravel. Increasing gravel with depth.									
	14									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CAT 314C	FOREMAN	ZJB
		JOB #	67055025

LOG OF TEST PIT NO. WTP-16

CLIENT: **ECO:LOGIC Engineering**

SITE: **Washoe County, Nevada**

PROJECT: **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND with GRAVEL Dark brown, damp to moist, dense, with estimated 10-15% non plastic fines, 45% fine to coarse sand, and 35-40% fine to coarse gravel. Minor subrounded cobbles present.		SM	1	GRAB					
2										
	SILTY SAND with GRAVEL Brown, moist, medium dense, with estimated 15-20% non plastic fines, 60% fine to coarse sand, and 25-30% fine to coarse gravel.									
4										
	SILTY SAND with GRAVEL Brown, moist, medium dense, with estimated 15-30% non plastic fines, 60% fine to coarse sand, and 20% fine to coarse gravel.	5								
5.5										
	SILTY SAND Brown, moist, medium dense, with estimated 30% non plastic fines, 60% fine to coarse sand, and 10% fine to coarse gravel. Possible low plasticity Elastic Silt near bottom of trench.		SM	2	GRAB			11.1		
			SM	3	GRAB					
		10								
12.3										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CAT 314C	FOREMAN	ZJB
		JOB #	67055025

BOREHOLE 055025 GINT.GPJ TERRACON.GDT 6/7/2006

LOG OF TEST PIT NO. WTP-17

CLIENT
ECO:LOGIC Engineering

SITE
Washoe County, Nevada

PROJECT
Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SANDY SILT Dark brown, moist, medium stiff to stiff, with estimated 55% low to medium plasticity fines, 40% sand, and >5% gravel.									
	2		ML	1	GRAB					
	SANDY SILT Dark brown, moist, medium siff to stiff, with estimated 55% low to medium plastic clay, 40% sand and >5% gravel.									
	4.5		ML	2	GRAB					
	SILT with SAND Brown to light brown, moist, medium stiff to stiff, with estimated 75-80% low to medium plasticity fines, and 20% sand. Sand increases with depth to 45-50% at 11 feet.	5								
	13.2		ML	3	GRAB					
		10								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CAT 314C	FOREMAN	ZJB
		JOB #	67055025

BOREHOLE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006

LOG OF TEST PIT NO. WTP-18

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND with GRAVEL Brown, moist, very dense, with estimated 20% non-plastic fines, 55% sand, and 15-25% fine gravel.		SM	9	GRAB					
	2.25									
	SILTY SAND Brown, moist, very dense, with estimated 20-25% non-plastic fines, 65% sand, and 10% fine gravel.									
			SM	10	GRAB					
	9.25									
	SILT with SAND Light brown, moist, stiff to very stiff, with estimated 60% non-plastic to low plasticity fines, 35% sand, and >5% gravel. Sand percentage increases at 12.5 feet.		ML	11	GRAB					
	13									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CAT 314C	FOREMAN	ZJB
		JOB #	67055025

LOG OF TEST PIT NO. WTP-19

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND with GRAVEL Light brown, damp, loose, with estimated 10-15% fines, 70% sand, and 10-15% gravel. Charcoal colored sand lense at 1.5-2.0' followed by reddish brown at 2.0-2.5', and debris found at 4.5'.		SM	1	GRAB					
	6.5									
	POORLY GRADED SAND brown, damp, loose, with estimated 5% non-plastic fines, 90% sand, and >5% gravel.		SP	2	GRAB					
	9.5									
	POORLY GRADED SAND with GRAVEL brown, dry, medium dense, with estimated 5% non-plastic fines, 75% sand, and 15-20% gravel. Gravel in this unit is multilithic.		SP	3	GRAB					
	13.2									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CAT 314C	FOREMAN	ZJB
		JOB #	67055025

LOG OF TEST PIT NO. WTP-20

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Dark brown, moist, very dense, with estimated 30-35% non plastic to low plasticity fines, 65% sand, and > 5% gravel.		SM	1	GRAB					
	2.6									
	3 **SILTY SAND** Brown, moist, medium dense with estimated 15-20% non-plastic fines, 75% sand, and >5% gravel.									
	SILTY SAND Dark brown to brown, moist, very dense, with estimated 30-35% non plastic to low plasticity fines, 60% sand, and >5% gravel.									
	4.5									
	ELASTIC SILT with SAND Light brown, moist, medium dense, with estimated 80% medium plasticity fines, 20% sand, and trace gravel.		MH	2	GRAB			50.8		
	10.5 ▽									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ 10.5	▽
WL	▽	▽
WL		

Terracon

BORING STARTED	12-8-05		
BORING COMPLETED	12-8-05		
RIG	CAT 314C	FOREMAN	ZJB
		JOB #	67055025

BOREHOLE 055025 GINT.GPJ TERRACON.GDT 6/7/2006

LOG OF TEST PIT NO. WTP-21

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, damp to wet, medium dense to dense, with estimated 30% low to non-plastic fines and 70% fine to coarse sand. Fine gravel towards bottom.		SM	1	GRAB					
			SM	2	GRAB					
			SM	3	GRAB					
	6.5 ▽									
	CLAYEY SAND Brown to grey, moist, dense, with estimated 30% medium plasticity fines and 70% fine to coarse sand.		SC	4	GRAB					
			SC	5	GRAB					
	11									
	CLAYEY GRAVEL with SAND Grey, wet, dense, with estimated 20% medium plasticity fines, 30% fine to coarse sand, and 50% fine to coarse gravel.		GC	6	GRAB					
	12									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
/L	▽ 6	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-11-06		
BORING COMPLETED	4-11-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-22

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown to red-brown, moist, dense, weakly cemented, with estimated 30% non-plastic fines and 70% fine to coarse gravel.		SM	1	GRAB					
			SM	2	GRAB					
		6								
	CLAYEY SAND Brown, moist, dense, with estimated 30% low to medium plasticity fines and 70% fine to coarse sand.	7	SC	3	GRAB			17.0		
	SILTY SAND with GRAVEL Brown, moist, dense, with estimated 30% non-plastic fines, 50% fine to coarse sand, and 20% fine to coarse gravel. Cobbles up to 6 inches in diameter.		SM	4	GRAB					
		11								
	POORLY GRADED GRAVEL with SILT and SAND Grey-brown, moist, dense, with estimated 10% non-plastic fines, 40% fine to coarse sand, and 50% fine to coarse gravel. Cobbles up to 4 inches in diameter.	12	GW GM	5	GRAB					

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	NE	
WL		
WL		

Terracon

BORING STARTED	4-11-06		
BORING COMPLETED	4-11-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-23

CLIENT: **ECO:LOGIC Engineering**

SITE: **Washoe County, Nevada**

PROJECT: **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	LEAN CLAY with SAND Dark brown, moist, stiff, with estimated 80-90% medium plasticity fines and 10-20% fine to coarse sand. This unit is blocky.									
			CL	1	GRAB					
			CL	2	GRAB			12.9		
	6									
	CLAYEY SAND Dark olive brown, moist, very stiff, with estimated 40% medium plasticity fines, 55% fine sand and 5% gravel. Unit is blocky and silt content decreases with depth.									
			SC	3	GRAB					
			SC	4	GRAB					
			SC	5	GRAB					

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ 13	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-23

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	15.5									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ 13	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-24

CLIENT: **ECO:LOGIC Engineering**

SITE: **Washoe County, Nevada**

PROJECT: **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Dark brown, moist, medium dense, with estimated 15% non-plastic fines and 85% fine to medium sand. Disturbed by agricultural activities.	1								
	LEAN CLAY with SAND Brown, dry, very stiff, with estimated 80% low plasticity fines and 20% fine sand. Unit is blocky.	2.5	SM	1	GRAB					
	SILT with SAND Light brown, dry, very stiff, with estimated 80% non to low plasticity fines and 20% fine sand. Unit contains grain sized concretions.	4	CL	2	GRAB					
	LEAN CLAY Olive brown, moist, stiff, with estimated 90% low to medium plasticity fines and 10% fine sand. Unit has some dark yellow mottling.		ML	3	GRAB					
			CL	4	GRAB					
			CL	5	GRAB					
			CL	6	GRAB					

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-24

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	15.5									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-25

CLIENT
ECO:LOGIC Engineering

SITE
Washoe County, Nevada

PROJECT
Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Dark brown, very moist, loose, with estimated 15% non-plastic fines, 80-85% fine to coarse sand, and trace fine, subangular gravel. Unit is disturbed from roadway shoulder traffic.	1								
	LEAN CLAY with SAND Dark brown, moist, stiff, with estimated 60% low to medium plasticity fines, and 40% fine to coarse sand.	2	SM	1	GRAB					
	LEAN CLAY Light brown, damp, very stiff to hard, with estimated 95% low to medium plasticity fines, and trace sand. Color change to olive brown at 4-5'.		CL	2	GRAB					
		11.5								
	POORLY GRADED SAND with SILT Yellow brown, damp, medium dense, with estimated <10% non-plastic fines, and 90% fine sand. Sand layer at 11.5 to 13'		SP SM	3	GRAB					
		13								
			CL	4	GRAB					
		15								

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
/L	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-25

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	Lean Clay Light brown, damp, very stiff to hard, with estimated 95% light to medium plasticity fines, and trace sand. Unit is pale white and mottled. Color change to olive brown at 4-5'. Volcanic ash layer from 13.5-14'.									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
/L	▽ NE	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

BOREHOLE 055025 GINT.GPJ TERRACON.GDT 6/7/2006

LOG OF TEST PIT NO. WTP-26

CLIENT: **ECO:LOGIC Engineering**

SITE: **Washoe County, Nevada**

PROJECT: **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	0.5 **SILTY SAND** Dark brown, very moist, loose with estimated 20% non-plastic fines and 80% fine to medium sand.									
	LEAN CLAY with SAND Yellow brown to olive, with estimated 80% low plasticity fines and 20% fine to medium sand.		SM	1	GRAB					
	2 **LEAN CLAY** Brown, moist, stiff, with estimated >90% low plasticity fines and trace fine sand.		CL	2	GRAB					
	5.5 **SILT with SAND** Dark yellow brown, moist, stiff, with estimated 80% low plasticity fines and 20% fine to medium sand.		ML	3	GRAB			49.1		
			ML	4	GRAB					
	12.5 **LEAN CLAY** Dark olive brown, very moist, very stiff, with estimated >90% low to medium plasticity fines and trace fine sand. Ash layer present at 13.5'. ▽		CL	5	GRAB					

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
/L	▽ 14	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-26

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf
	16		CL	6	GRAB					

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ 14	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-27

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	LEAN CLAY with SAND Brown, moist, stiff to very stiff, with estimated 85% low plasticity fines and 15% fine to medium sand.		CL	1	GRAB					
	2.5									
	LEAN CLAY Dark olive brown, moist, very stiff to hard, with estimated >95% low to medium plasticity fines and trace fine sand.		CL	2	GRAB					
			CL	3	GRAB					
	10									
	SILT with SAND Olive gray, very moist to saturated, stiff, with estimated 70% non plastic to low plasticity fines and 30% fine sand. ▽		ML	4	GRAB					
	14									
	LEAN CLAY Olive gray, moist, hard, with estimated >90% fines and trace sand.		CL	5	GRAB					
	15									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ 11	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-28

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	LEAN CLAY Dark brown, very moist, stiff, with estimated 90% low to medium plasticity fines and 10% fine sand.	1	CL	1	GRAB					
	LEAN CLAY Olive brown, very moist, stiff, with >90% low plasticity fines and trace fine sand.	3	CL	2	GRAB					
	LEAN CLAY Olive brown, moist, very stiff to hard, with estimated >90% medium plasticity fines and trace fine sand.	5.5								
	ELASTIC SILT Olive brown, moist, stiff to very stiff, with estimated 95% high plasticity fines and 5% sand.	11	MH	3	GRAB			32.8		
			MH	4	GRAB					
	SILT with SAND Olive brown to gray, moist to wet, very stiff to hard, with estimated 80% low plasticity fines and 20% fine sand. ▽	14	ML	5	GRAB					
			ML	6	GRAB					
	LEAN CLAY Blue grey, moist, very stiff, with estimated >90% low plasticity clay, and trace fine sand.									

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
/L	▽ 12.5	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	12-22-05		
BORING COMPLETED	12-22-05		
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-28

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	16		CL	7	GRAB					

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ 12.5	▼
WL	▼	▼
WL		

Terracon

BORING STARTED			12-22-05
BORING COMPLETED			12-22-05
RIG	Case 330C	FOREMAN	JRO
		JOB #	67055025

LOG OF TEST PIT NO. WTP-29

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, moist, medium dense, with estimated 15% non-plastic fines and 85% fine to coarse sand. Trench walls collapsed.		SM	1	GRAB					
			SM	2	GRAB					
	3.5									
	POORLY GRADED SAND with SILT Tan, moist, medium dense, with estimated 10% non-plastic fines and 90% fine to coarse sand. Trench walls collapsed.		SP SM	3	GRAB					
	9									
	SILTY SAND Tan, dry, medium dense, with estimated 20% non-plastic fines and 80% fine to coarse sand.		SM	4	GRAB					
			SM	5	GRAB					
	12									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
/L	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-11-06		
BORING COMPLETED	4-11-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-30

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, moist, medium dense, with estimated 35% non-plastic fines and 65% fine to medium sand.		SM	1	GRAB					
	5									
	SILTY SAND Reddish brown, damp, medium dense, with estimated 25% non-plastic fines and 75% fine to coarse sand. Test pit collapsed at 6 feet.		SM	2	GRAB			6.1		
	7									
	SILTY SAND Tan, dry, medium dense, with estimated 20% non-plastic fines and 80% fine to medium sand. Unit is weakly cemented.		SM	3	GRAB					
	11									
	SILTY SAND Tan, dry, medium dense, with estimated 20% non-plastic fines and 80% fine sand.		SM	4	GRAB					
	12									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▼ NE	▼	
WL	▼	▼	
WL			

Terracon

BORING STARTED	4-11-06		
BORING COMPLETED	4-11-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-31

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, moist, medium dense, with estimated 25% non-plastic fines and 75% fine to medium sand.		SM	1	GRAB					
			SM	2	GRAB					
		5								
			SM	3	GRAB					
	6.5 **SILTY SAND** Tan, moist, medium dense, with estimated 25% non-plastic fines and 75% fine to coarse sand. Trench caved at 8 feet.									
	9 **SILTY SAND** Tan, moist, medium dense, with estimated 20% non-plastic fines and 80% fine to coarse sand. Unit is weakly cemented.		SM	4	GRAB					
	10.5 **SILTY SAND** Tan, dry, medium dense, with estimated 20% non-plastic fines and 80% fine to coarse sand.	10								
	11.5		SM	5	GRAB					

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-11-06		
BORING COMPLETED	4-11-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-32

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, moist, medium dense, with estimated 25% non-plastic fines and 75% fine to coarse sand.		SM	1	GRAB					
	4									
	SILTY SAND Brown to tan, moist, medium dense, with estimated 30% low plasticity fines and 70% fine to coarse sand.		SM	2	GRAB					
	6	5								
	SILTY SAND Tan, moist, medium dense, with estimated 15% non-plastic fines and 85% fine to coarse sand. Unit has a sugary texture.		SM	3	GRAB					
	7									
	SILTY SAND Tan, moist, medium dense, with estimated 15% non-plastic fines and 85% fine to coarse sand. Unit is weakly cemented.		SM	4	GRAB					
	10	10								
	SILTY SAND Tan, moist, medium dense with estimated 15% non-plastic fines and 85% fine to medium sand.		SM	5	GRAB					
	12									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-11-06		
BORING COMPLETED	4-11-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-33

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, moist, medium dense, with estimated 25% non-plastic fines and 75% fine to coarse sand.		SM	1	GRAB					
	2									
	SILTY SAND Tan to brown, moist, dense, with estimated 25% non-plastic fines and 75% fine to coarse sand.		SM	2	GRAB					
	4.5									
	SILTY SAND Tan, moist, dense, with estimated 25% non-plastic fines and 75% fine to coarse sand. Unit is weakly cemented.	5	SM	3	GRAB					
	7									
	POORLY GRADED SAND with SILT Tan, moist, dense, with estimated 10% non-plastic fines and 90% fine to coarse sand. Unit is weakly cemented.		SP SM	4	GRAB					
	9									
	POORLY GRADED SAND with SILT Tan, dry, dense, with estimated 10% non-plastic fines and 90% fine to coarse sand.	10	SP SM	5	GRAB					
	11.5									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-12-06		
BORING COMPLETED	4-12-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-34

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, moist, medium dense, with estimated 20% non-plastic fines and 80% fine to coarse sand.		SM	1	GRAB					
			SM	2	GRAB					
	2.5 **SILTY SAND** Brown, moist, dense, with estimated 20% non-plastic fines and 80% fine to coarse sand. Unit contains roots.									
	4.5 **POORLY GRADED SAND with SILT** Tan, moist, dense, with estimated 10% non-plastic fines and 90% fine to coarse sand.	5	SP SM	3	GRAB					
	9.5 **POORLY GRADED SAND with SILT** Tan, dry, dense, with estimated 10% non-plastic fines and 90% fine to medium sand.	10	SP SM	4	GRAB					
	12.5									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-12-06		
BORING COMPLETED	4-12-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-35

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SANDY FAT CLAY with GRAVEL Brown, moist, stiff, with estimated 40% high plasticity fines, 30% fine to coarse sand, and 30% fine to coarse gravel and cobbles up to 12 inches in diameter.	1	CH	1	GRAB					
	SANDY FAT CLAY with GRAVEL Brown, moist, dense, with estimated 30% high plasticity fines, 40% fine to coarse sand, and 30% fine to coarse gravel up to 12 inches in diameter.	3	CH	2	GRAB					
	Practical refusal at 3 feet due to boulders.									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-12-06		
BORING COMPLETED	4-12-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-36

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	CLAYEY SAND with GRAVEL Brown, moist, dense, with estimated 35% medium to high placticity, 40% fine to coarse sand, and 25% fine to coarse gravel. Unit contains boulders to 18 inch.		SC	1	GRAB					
1.5	**CLAYEY SAND with GRAVEL** Reddish brown, moist, dense, with estimated 30% medium plasticity fines, 45% fine to coarse sand, and 25% fine to coarse gravel. Unit contains trace boulders.		SC	2	GRAB					
5	**SILTY SAND with GRAVEL** Brown, moist, dense, with estimated 25% non-plastic to low plasticity fines, 45% fine to coarse sand and 30% fine to course gravel. Practical refusal at 6 feet due to boulders.	5	SM	3	GRAB					
6										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	4-12-06		
BORING COMPLETED	4-12-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

LOG OF TEST PIT NO. WTP-37

CLIENT: ECO:LOGIC Engineering

SITE: Washoe County, Nevada

PROJECT: Fish Springs Water Supply Project

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND Brown, moist, medium dense, with estimated 20% non-plastic fines and 80% fine to medium sand.		SM	1	GRAB					
			SM	2	GRAB					
	4.5									
	SILTY SAND with GRAVEL Tan, moist, dense, with estimated 20% non-plastic fines, 60% fine to coarse sand, and 20% fine gravel.	5								
	7		SM	3	GRAB					
	SILTY SAND Tan, moist, dense, with estimated 15% non-plastic fines and 85% fine to coarse sand.									
			SM	4	GRAB					
		10								
	11.5									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-12-06		
BORING COMPLETED	4-12-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

BOREHOLE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006

LOG OF TEST PIT NO. WTP-38

CLIENT **ECO:LOGIC Engineering**

SITE **Washoe County, Nevada**

PROJECT **Fish Springs Water Supply Project**

Boring Location: Well Field Collection System

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS DRY UNIT WT pcf	TESTS UNCONFINED STRENGTH, psf
	SILTY SAND with GRAVEL Brown, moist, medium dense, with estimated 30% non-plastic fines, 45% fine to coarse sand, and 25% fine to coarse gravel. Unit contains trace cobbles.		SM	1	GRAB					
5		5								
	SILTY SAND with GRAVEL Brown, moist, dense, with estimated 30% non-plastic fines, 45% fine to coarse sand, and 25% fine to coarse gravel. Unit contains cobbles to10 inches in diameter.		SM	2	GRAB					
8										
	SILTY SAND with GRAVEL Brown, moist, very dense, with estimated 30% non-plastic fines, 45% fine to coarse sand, and 25% fine to coarse gravel. Unit contains cobbles to 10 inches in diameter.		SM	3	GRAB					
11		10								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NE	▼
WL	▽	▼
WL		

Terracon

BORING STARTED	4-12-06		
BORING COMPLETED	4-12-06		
RIG	CAT 314C	FOREMAN	GCS
		JOB #	67055025

Borehole	Depth ft	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	USCS Class-ification	Water Content (%)	Dry Unit Weight (pcf)	Satur-ation (%)	Void Ratio
B-02 (TP-02)	3.0	NP	NP	NP	12.5	35	SM	5.8			
B-03 (TP-03)	6.0	NP	NP	NP	37.5	14	SM	3.6			
B-05 (TP-05)	2.0	NP	NP	NP	12.5	18	SM	6.2			
RTP-01	0.0	51	29	22	9.5	39	SM	27.2			
RTP-02	0.0	NP	NP	NP	12.5	14	SM	6.8			
STTP-01	3.5	32	23	9	37.5	16	SC	12.3			
STTP-02	2.5	NP	NP	NP	25	7	SP-SM	16.7			
TP-07	2.0							7.9			
TP-07	3.0	NP	NP	NP	50	19	SM				
TP-09	6.0	NP	NP	NP	9.5	29	SM	10.5			
TP-09	7.5							45.0	72.0		
TP-10 (B-10)	7.5							9.8	113.7		
TP-10 (B-10)	17.5	NP	NP	NP	2	7	SP-SM	26.4			
TP-10 (B-10)	25.0	28	23	5	12.5	34	SM	29.8			
TP-10 (B-10)	30.0	NP	NP	NP	4.75	16	SM	13.9			
TP-15	5.5	37	29	8	50	8	GP-GM	9.6			
TP-25	4.0							9.1			
TP-25	5.0	NP	NP	NP	19	19	SM				
TP-29	3.0							8.1			
TP-29	4.0	NP	NP	NP	19	12	SM				
TP-32	5.0	NP	NP	NP	25	37	SM	6.5			
TP-38	2.5							4.5			
TP-38	3.5	NP	NP	NP	4.75	7	SW-SM				
TP-55	3.0							10.4			
TP-55	4.0	35	26	9	50	23	GM				
TP-67	2.5							15.4			
TP-67	3.0	NP	NP	NP	19	43	SM				
TP-70	2.5							20.3			
TP-70	3.0	NP	NP	NP	12.5	46	SM				
TP-77	5.5	32	19	13	25	36	SC	20.1			
TP-79	1.5	71	34	37	37.5	39	SM	33.2			
TP-81	6.0	25	20	5	25	22	SC-SM	12.9			
TP-82	5.5	NP	NP	NP	37.5	24	SM	9.1			
TTTP-01	6.0	NP	NP	NP	12.5	9	SW-SM	6.3			
TTTP-02	3.0	NP	NP	NP	50	7	SW-SM	5.2			
TTTP-05	3.5	NP	NP	NP	50	9	SW-SM	6.6			
WTP-01	2.0	NP	NP	NP	9.5	42	SM	11.7			
WTP-02	6.0	NP	NP	NP	12.5	11	SP-SM	6.3			
WTP-03	2.0	NP	NP	NP	19	35	SM	7.9			
WTP-05	4.5	NP	NP	NP	19	36	SM	9.1			
WTP-09 (WB-09)	7.5	51	33	18	4.75	78	MH	54.6	61.2		
WTP-09 (WB-09)	17.5	92	64	28	4.75	62	MH	240.5	22.5		

Terracon

SUMMARY OF LABORATORY RESULTS

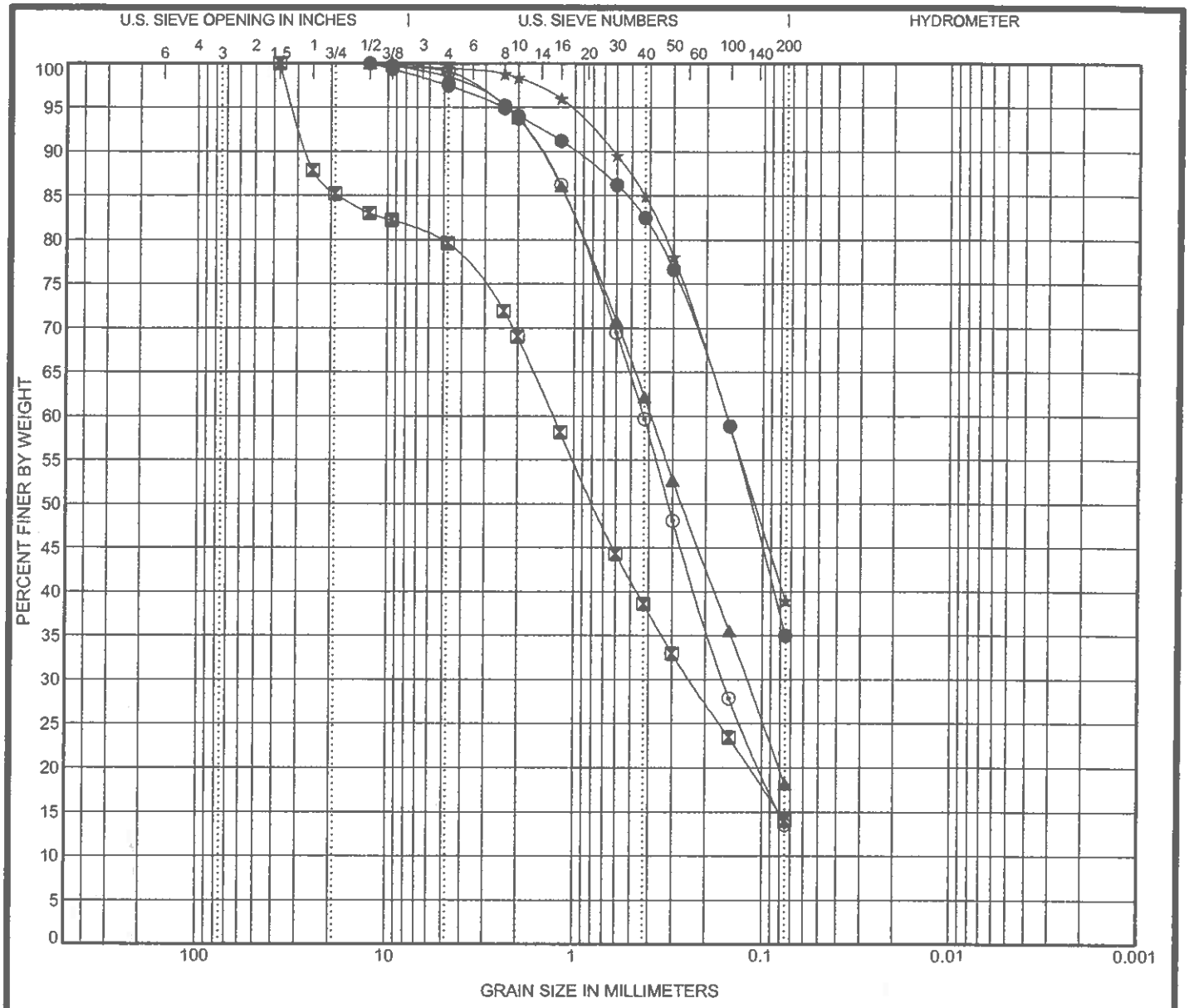
Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

Borehole	Depth ft	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	USCS Class-ification	Water Content (%)	Dry Unit Weight (pcf)	Satur-ation (%)	Void Ratio
WTP-09 (WB-09)	35.0	NP	NP	NP	9.5	9	SP-SM	29.9			
WTP-16	6.0	NP	NP	NP	25	31	SM	11.1			
WTP-20	4.5	56	39	17	9.5	81	MH	50.8			
WTP-22	6.0	27	19	8	19	36	SC	17.0			
WTP-23	5.0	34	21	13	19	44	SC	12.9			
WTP-26	6.0	52	31	21	12.5	50	MH	49.1			
WTP-28	6.0	71	35	36	4.75	94	MH	32.8			
WTP-30	5.0	NP	NP	NP	9.5	9	SP-SM	6.1			

Terracon

SUMMARY OF LABORATORY RESULTS

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-02 (TP-02)	3.0ft	SILTY SAND (SM)	NP	NP	NP		
⊠	B-03 (TP-03)	6.0ft	SILTY SAND with GRAVEL (SM)	NP	NP	NP		
▲	B-05 (TP-05)	2.0ft	SILTY SAND (SM)	NP	NP	NP		
★	RTP-01	0.0ft	SILTY SAND (SM)	51	29	22		
⊙	RTP-02	0.0ft	SILTY SAND (SM)	NP	NP	NP		

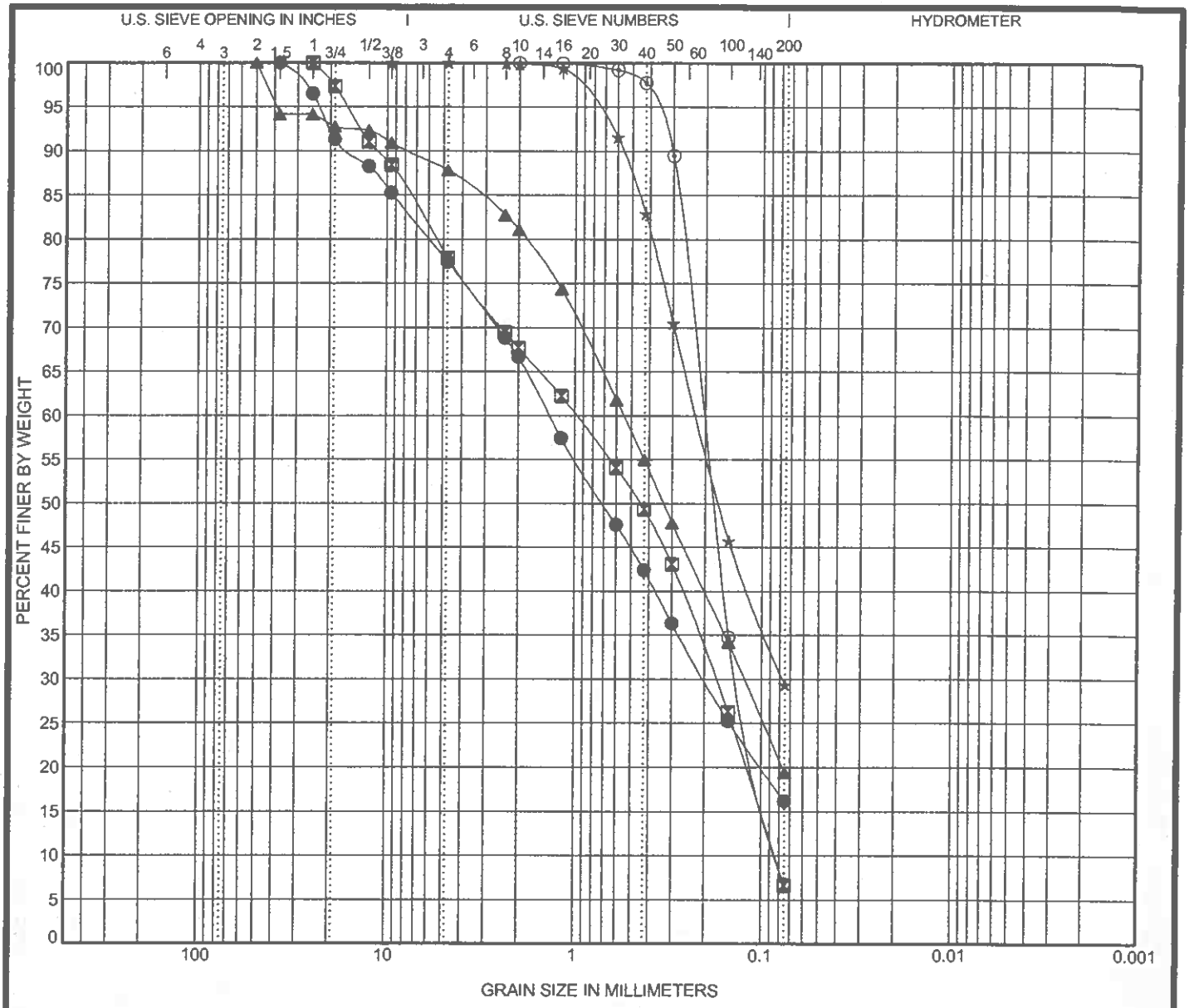
	Specimen Identification		D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	B-02 (TP-02)	3.0ft	12.5	0.157			5.8	2.5	62.5	35.0	
⊠	B-03 (TP-03)	6.0ft	37.5	1.289	0.242		3.6	20.4	65.6	14.0	
▲	B-05 (TP-05)	2.0ft	12.5	0.392	0.12		6.2	1.5	80.4	18.1	
★	RTP-01	0.0ft	9.5	0.156			27.2	0.6	60.5	39.0	
⊙	RTP-02	0.0ft	12.5	0.43	0.161		6.8	0.9	85.5	13.5	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC GRAIN SIZE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	STTP-01	3.5ft	CLAYEY SAND with GRAVEL (SC)	32	23	9		
⊠	STTP-02	2.5ft	POORLY GRADED SAND with SILT and GRAVEL (SP-SM)	NP	NP	NP	0.37	11.59
▲	TP-07	3.0ft	SILTY SAND (SM)	NP	NP	NP		
★	TP-09	6.0ft	SILTY SAND (SM)	NP	NP	NP		
⊙	TP-10 (B-10)	17.5ft	POORLY GRADED SAND with SILT (SP-SM)	NP	NP	NP	1.06	2.54

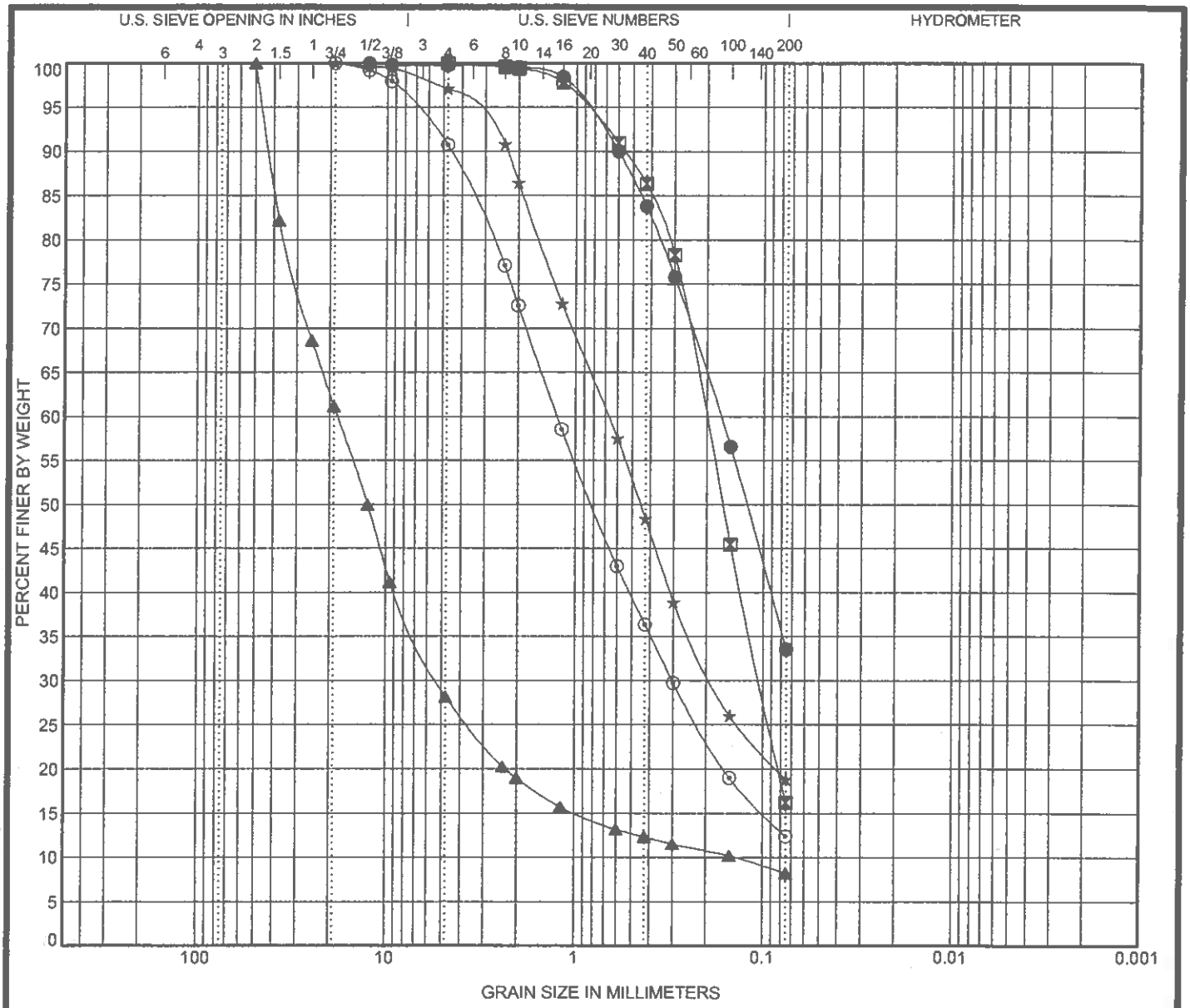
	Specimen Identification		D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	STTP-01	3.5ft	37.5	1.366	0.201		12.3	22.6	61.2	16.2	
⊠	STTP-02	2.5ft	25	0.98	0.175	0.085	16.7	22.1	71.3	6.6	
▲	TP-07	3.0ft	50	0.548	0.123			12.2	68.4	19.4	
★	TP-09	6.0ft	9.5	0.224	0.077		10.5	0.0	70.6	29.4	
⊙	TP-10 (B-10)	17.5ft	2	0.207	0.133	0.081	26.4	0.0	93.2	6.8	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC GRAIN SIZE 67055025.GINT.GPJ TERRACON.GDT 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	TP-10 (B-10)	25.0ft	SILTY SAND (SM)	28	23	5		
⊠	TP-10 (B-10)	30.0ft	SILTY SAND (SM)	NP	NP	NP		
▲	TP-15	5.5ft	POORLY GRADED GRAVEL with SILT and SAND (GP-GM)	37	29	8	10.75	129.14
★	TP-25	5.0ft	SILTY SAND (SM)	NP	NP	NP		
⊙	TP-29	4.0ft	SILTY SAND (SM)	NP	NP	NP	1.27	21.32

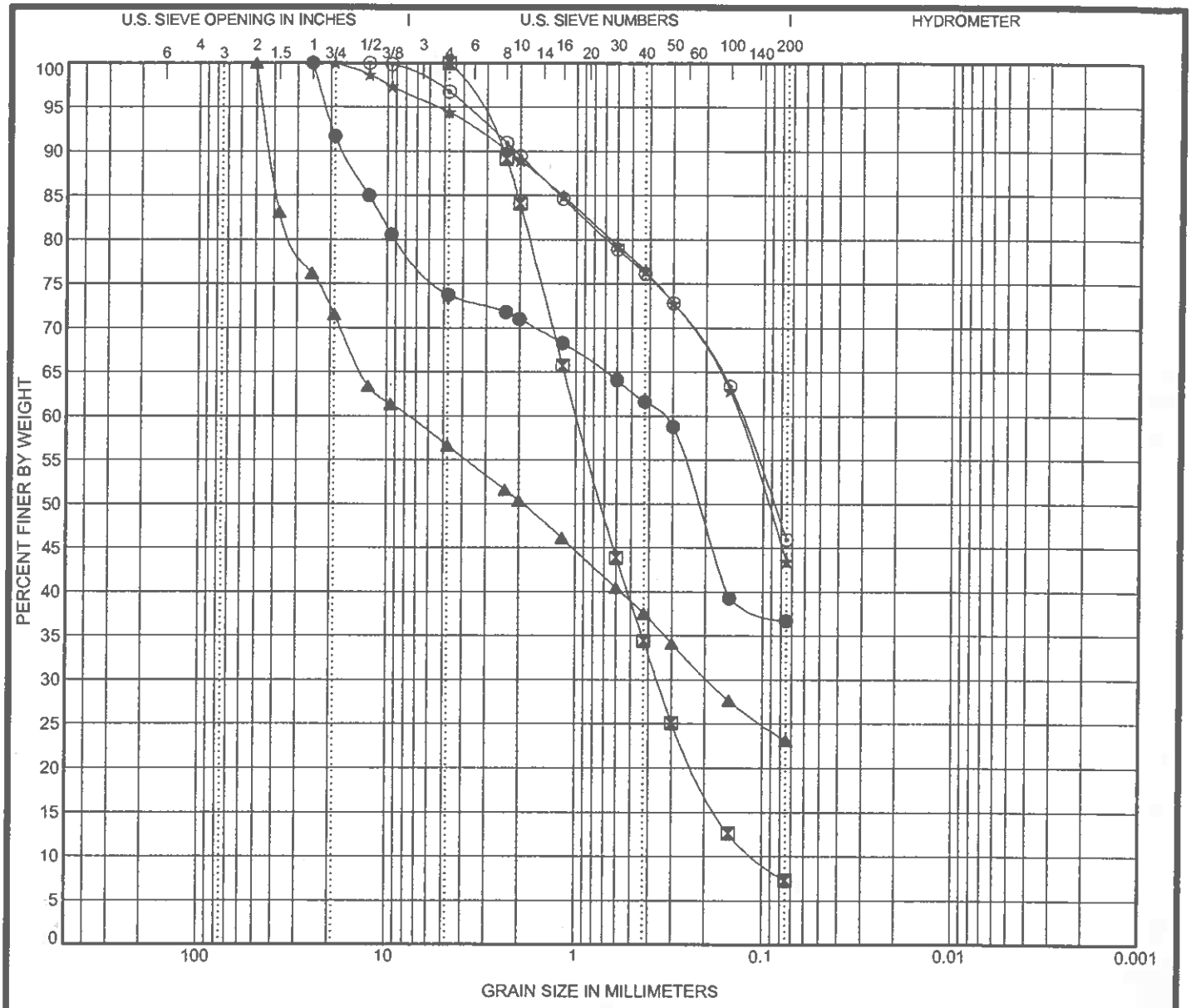
	Specimen Identification		D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	TP-10 (B-10)	25.0ft	12.5	0.17			29.8	0.2	66.2	33.5	
⊠	TP-10 (B-10)	30.0ft	4.75	0.204	0.104		13.9	0.0	83.8	16.2	
▲	TP-15	5.5ft	50	18.171	5.242	0.141	9.6	71.9	19.9	8.2	
★	TP-25	5.0ft	19	0.67	0.186			2.9	78.3	18.8	
⊙	TP-29	4.0ft	19	1.246	0.304			9.3	78.4	12.4	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC GRAIN SIZE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	TP-32	5.0ft	SILTY SAND with GRAVEL (SM)	NP	NP	NP		
⊠	TP-38	3.5ft	WELL-GRADED SAND with SILT (SW-SM)	NP	NP	NP	1.23	9.22
▲	TP-55	4.0ft	SILTY GRAVEL with SAND (GM)	35	26	9		
★	TP-67	3.0ft	SILTY SAND (SM)	NP	NP	NP		
⊙	TP-70	3.0ft	SILTY SAND (SM)	NP	NP	NP		

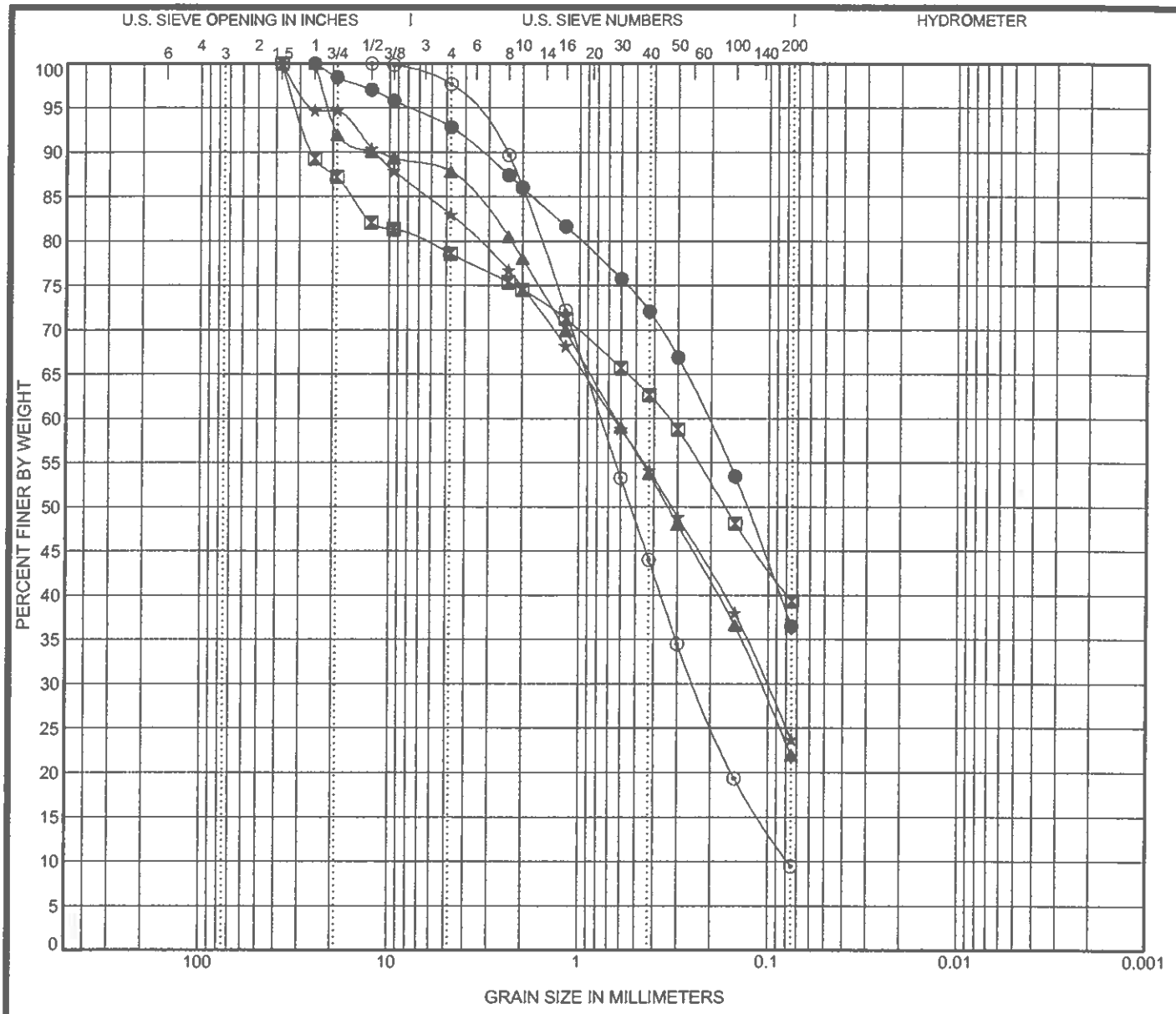
	Specimen Identification		D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	TP-32	5.0ft	25	0.348			6.5	26.3	37.0	36.7	
⊠	TP-38	3.5ft	4.75	0.988	0.36	0.107		0.0	92.7	7.3	
▲	TP-55	4.0ft	50	7.768	0.193			43.4	33.5	23.1	
★	TP-67	3.0ft	19	0.135				5.6	51.0	43.5	
⊙	TP-70	3.0ft	12.5	0.131				3.2	50.8	46.0	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC GRAIN SIZE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	TP-77	5.5ft	CLAYEY SAND (SC)	32	19	13		
⊠	TP-79	1.5ft	SILTY SAND with GRAVEL (SM)	71	34	37		
▲	TP-81	6.0ft	SILTY, CLAYEY SAND (SC-SM)	25	20	5		
★	TP-82	5.5ft	SILTY SAND with GRAVEL (SM)	NP	NP	NP		
⊙	TTTP-01	6.0ft	WELL-GRADED SAND with SILT (SW-SM)	NP	NP	NP	1.00	9.78

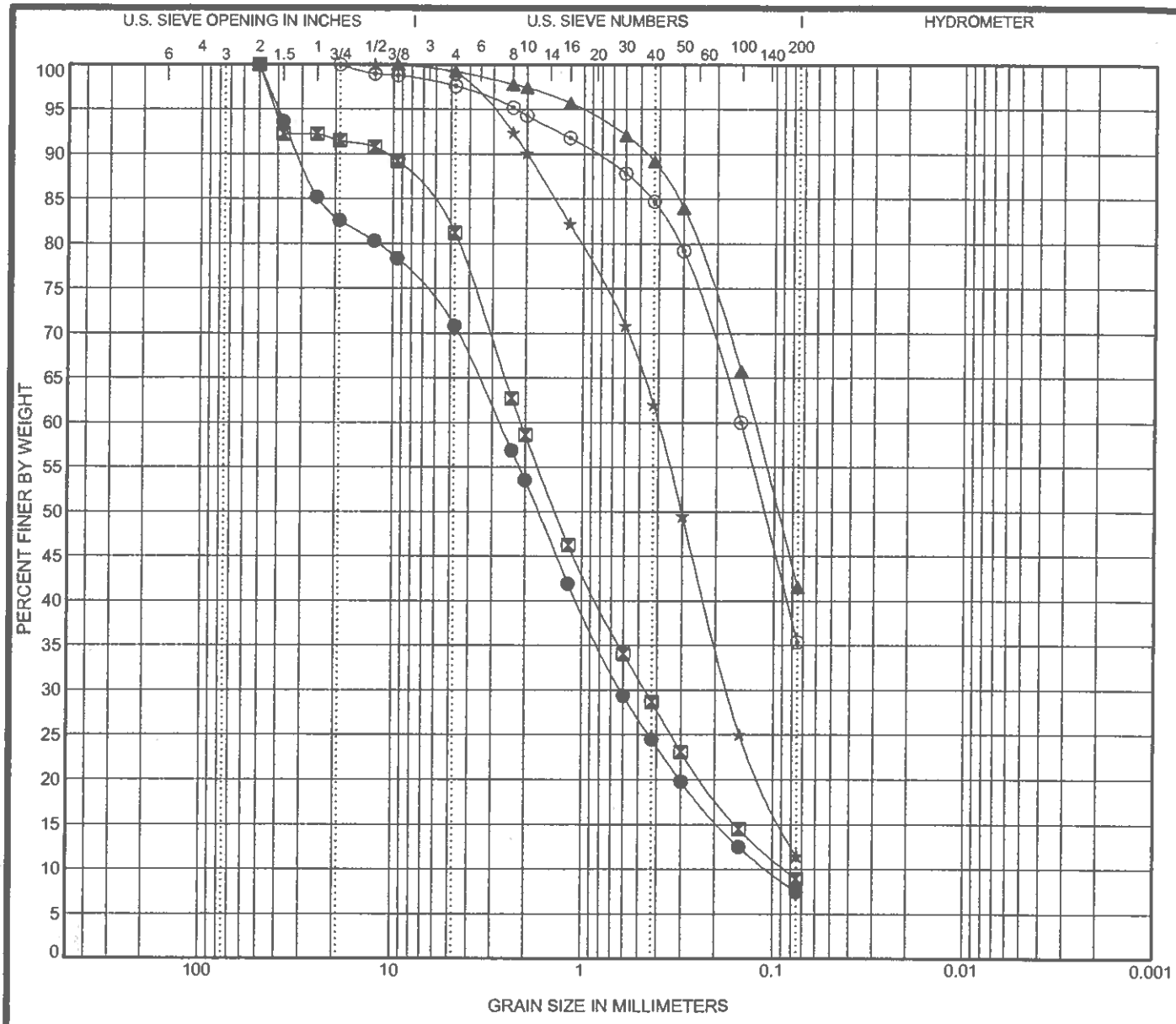
	Specimen Identification		D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	TP-77	5.5ft	25	0.21			20.1	7.2	56.3	36.5	
⊠	TP-79	1.5ft	37.5	0.335			33.2	21.4	39.3	39.3	
▲	TP-81	6.0ft	25	0.637	0.11		12.9	12.1	65.9	22.0	
★	TP-82	5.5ft	37.5	0.652	0.102		9.1	17.0	59.3	23.7	
⊙	TTTP-01	6.0ft	12.5	0.763	0.244	0.078	6.3	2.3	88.2	9.4	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC GRAIN SIZE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	TTTP-02	3.0ft	WELL-GRADED SAND with SILT and GRAVEL (SW-SM)	NP	NP	NP	1.31	25.88
⊠	TTTP-05	3.5ft	WELL-GRADED SAND with SILT and GRAVEL (SW-SM)	NP	NP	NP	1.17	24.57
▲	WTP-01	2.0ft	SILTY SAND (SM)	NP	NP	NP		
★	WTP-02	6.0ft	POORLY GRADED SAND with SILT (SP-SM)	NP	NP	NP	1.07	5.76
⊙	WTP-03	2.0ft	SILTY SAND (SM)	NP	NP	NP		

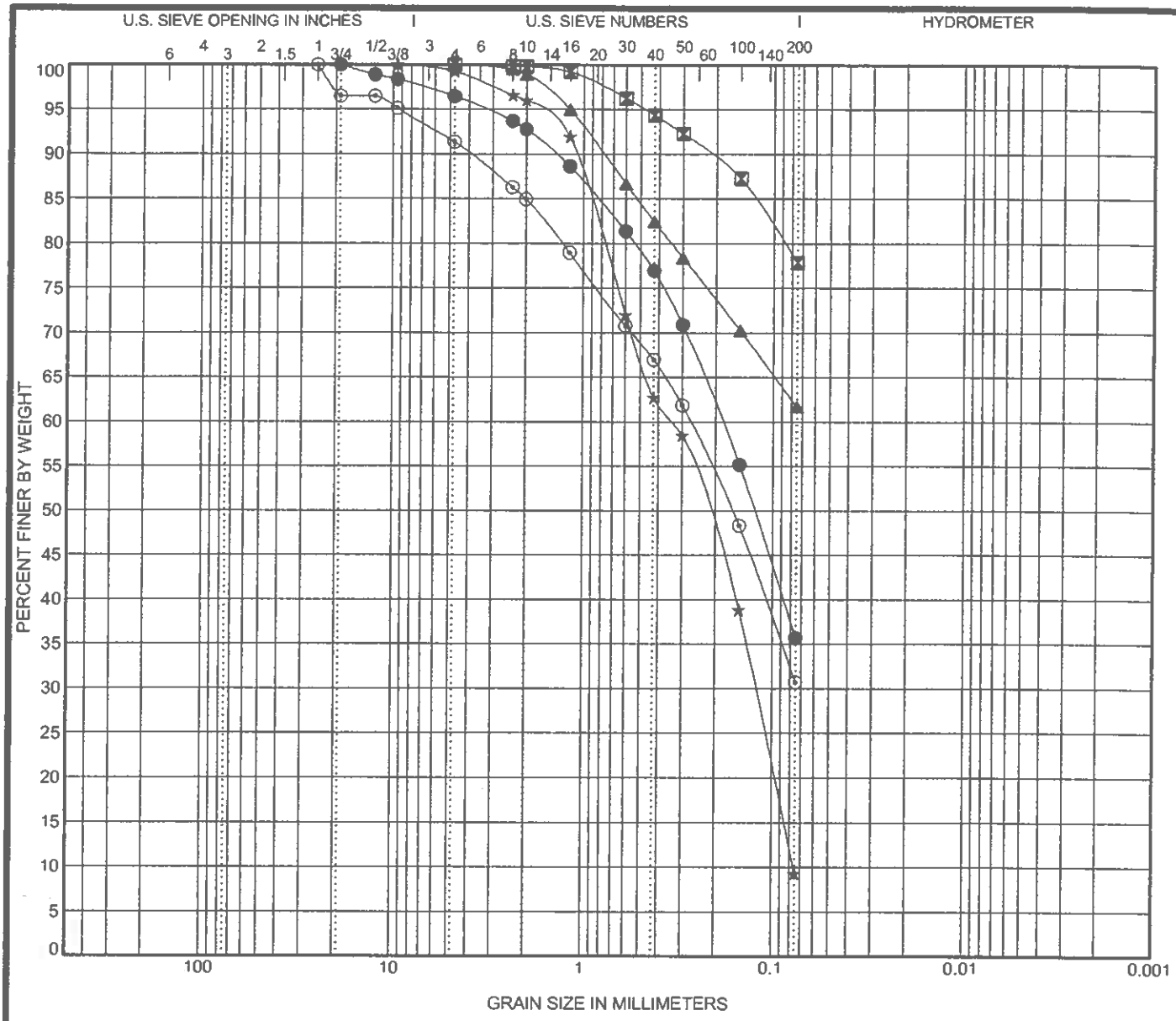
	Specimen Identification		D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	TTTP-02	3.0ft	50	2.758	0.621	0.107	5.2	29.1	63.4	7.5	
⊠	TTTP-05	3.5ft	50	2.116	0.463	0.086	6.6	18.8	72.3	8.9	
▲	WTP-01	2.0ft	9.5	0.127			11.7	0.8	57.7	41.5	
★	WTP-02	6.0ft	12.5	0.402	0.173		6.3	0.9	87.6	11.4	
⊙	WTP-03	2.0ft	19	0.15			7.9	2.4	62.2	35.4	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC GRAIN SIZE 67055025.GINT.GPJ TERRACON.GDT 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	WTP-05 4.5ft	SILTY SAND (SM)	NP	NP	NP		
⊠	WTP-09 (WB-09) 7.5ft	ELASTIC SILT with SAND (MH)	51	33	18		
▲	WTP-09 (WB-09) 7.5ft	SANDY ELASTIC SILT (MH)	92	64	28		
★	WTP-09 (WB-09) 5.0ft	POORLY GRADED SAND with SILT (SP-SM)	NP	NP	NP	0.57	4.45
⊙	WTP-16 6.0ft	SILTY SAND (SM)	NP	NP	NP		

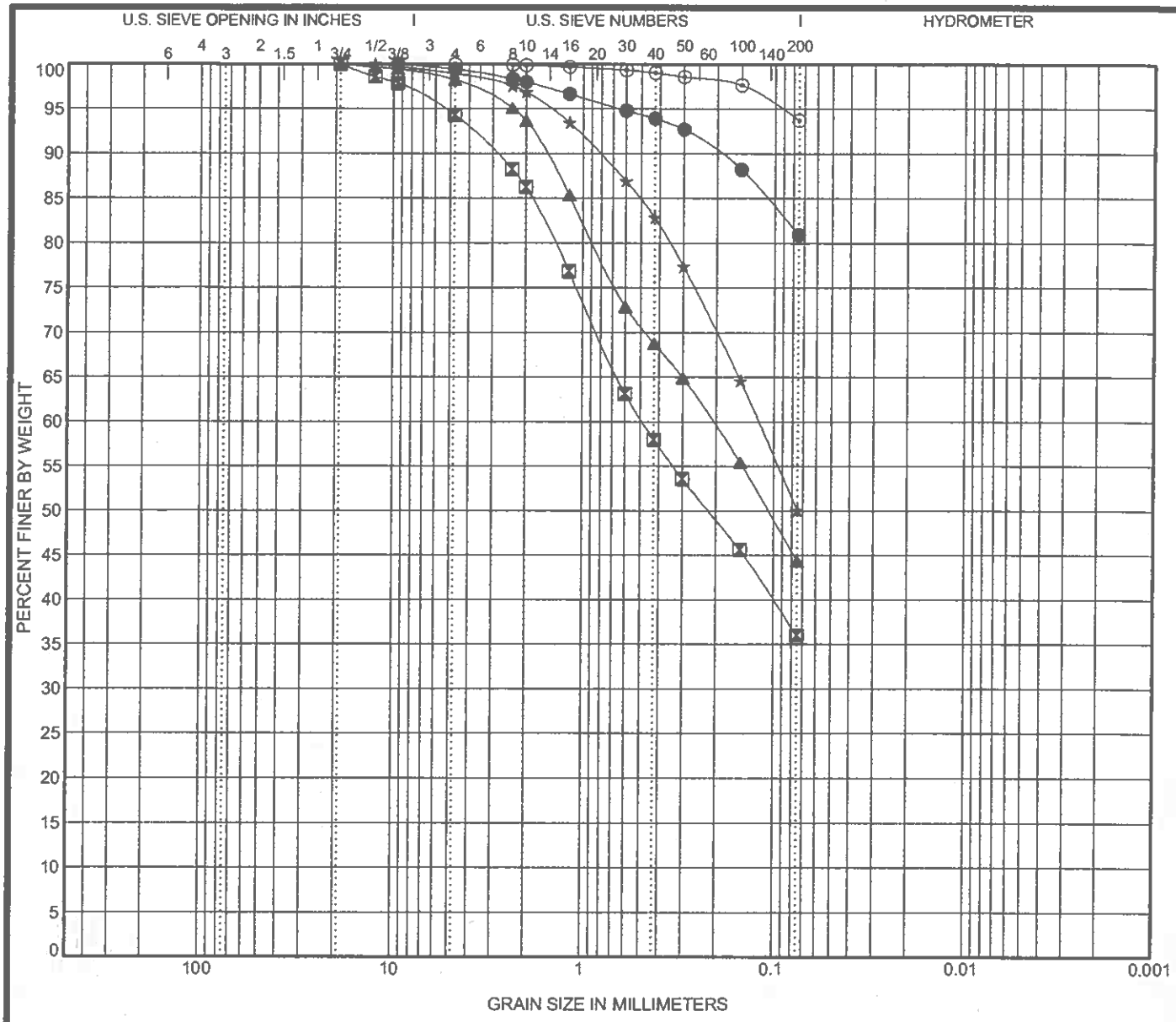
Specimen Identification		D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	WTP-05 4.5ft	19	0.185			9.1	3.5	60.8	35.7	
⊠	WTP-09 (WB-09) 7.5ft	4.75				54.6	0.0	22.1	77.9	
▲	WTP-09 (WB-09) 7.5ft	4.75				240.5	0.0	38.3	61.7	
★	WTP-09 (WB-09) 5.0ft	9.5	0.34	0.122	0.076	29.9	0.7	90.0	9.3	
⊙	WTP-16 6.0ft	25	0.273			11.1	8.6	60.6	30.7	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC GRAIN SIZE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	WTP-20	4.5ft	ELASTIC SILT with SAND (MH)	56	39	17		
⊠	WTP-22	6.0ft	CLAYEY SAND (SC)	27	19	8		
▲	WTP-23	5.0ft	CLAYEY SAND (SC)	34	21	13		
★	WTP-26	6.0ft	SANDY ELASTIC SILT (MH)	52	31	21		
⊙	WTP-28	6.0ft	ELASTIC SILT (MH)	71	35	36		

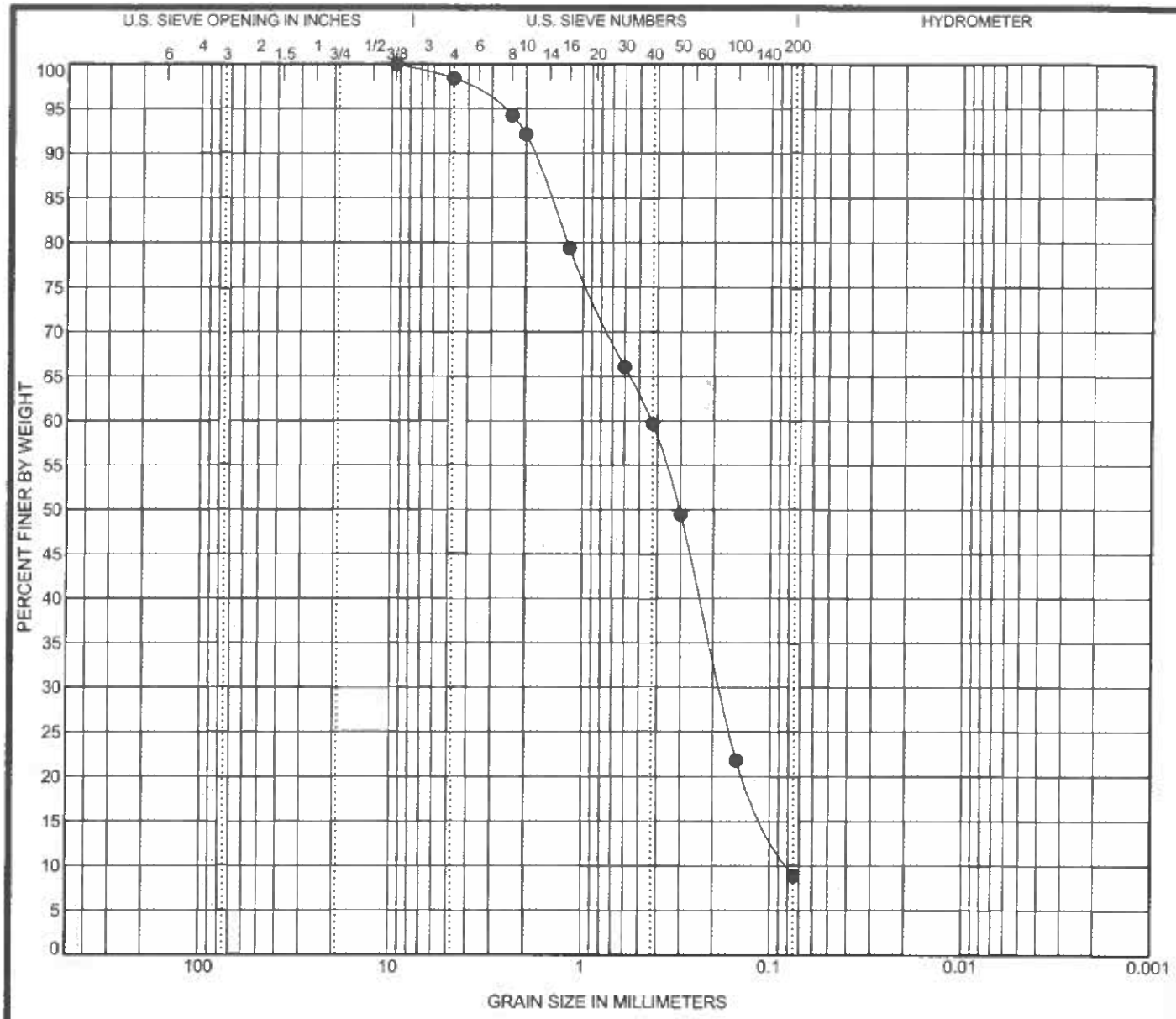
	Specimen Identification		D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	WTP-20	4.5ft	9.5				50.8	0.5	18.5	80.9	
⊠	WTP-22	6.0ft	19	0.486			17.0	5.7	58.3	36.0	
▲	WTP-23	5.0ft	19	0.209			12.9	1.7	53.9	44.4	
★	WTP-26	6.0ft	12.5	0.12			49.1	1.0	48.9	50.1	
⊙	WTP-28	6.0ft	4.75				32.8	0.0	6.3	93.7	

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC GRAIN SIZE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**WTP-30 5.0ft**	**POORLY GRADED SAND with SILT (SP-SM)**	**NP**	**NP**	**NP**	**0.99**	**5.43**

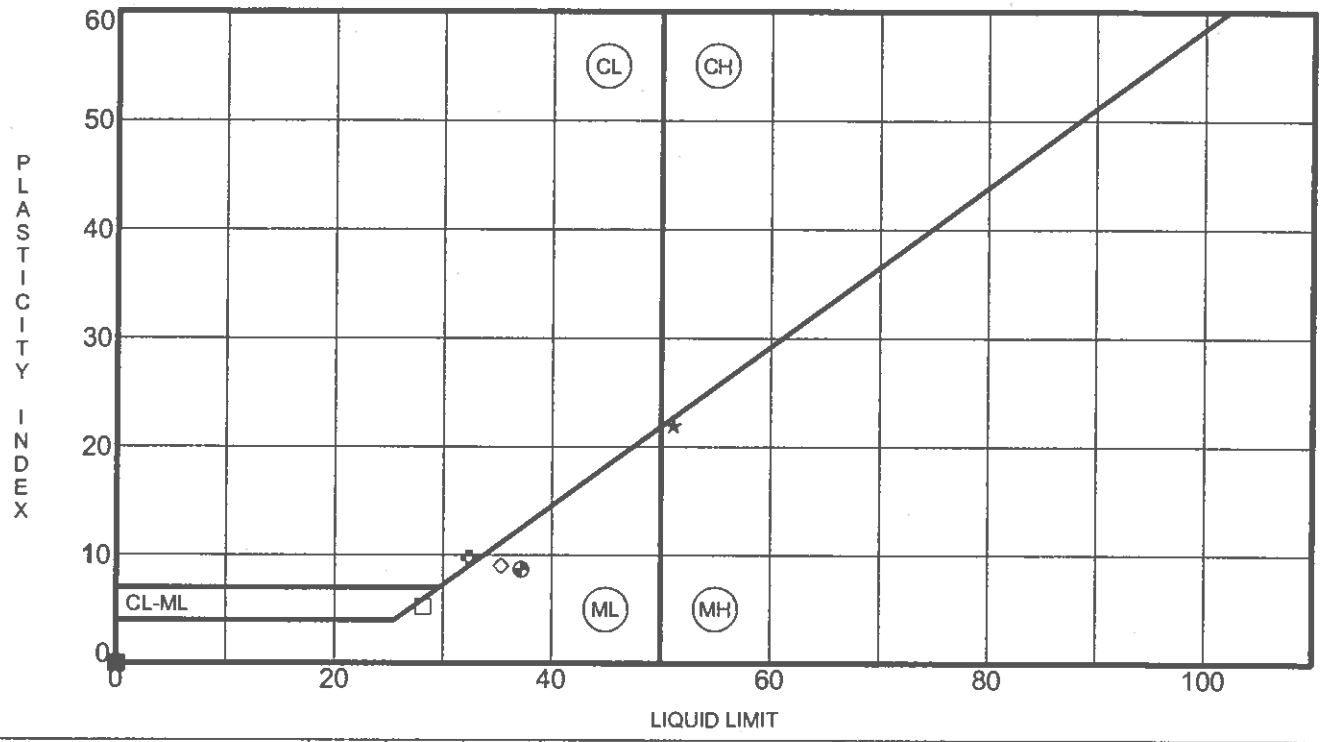
	Specimen Identification	D100	D60	D30	D10	%MC	%Gravel	%Sand	%Silt	%Clay
●	**WTP-30 5.0ft**	**9.5**	**0.432**	**0.184**	**0.08**	**6.1**	**1.6**	**89.5**	**8.9**	

TC_GRAIN SIZE 67055025 GINT.GPJ TERRACON.GDT 6/7/2006

Terracon

GRAIN SIZE DISTRIBUTION

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006



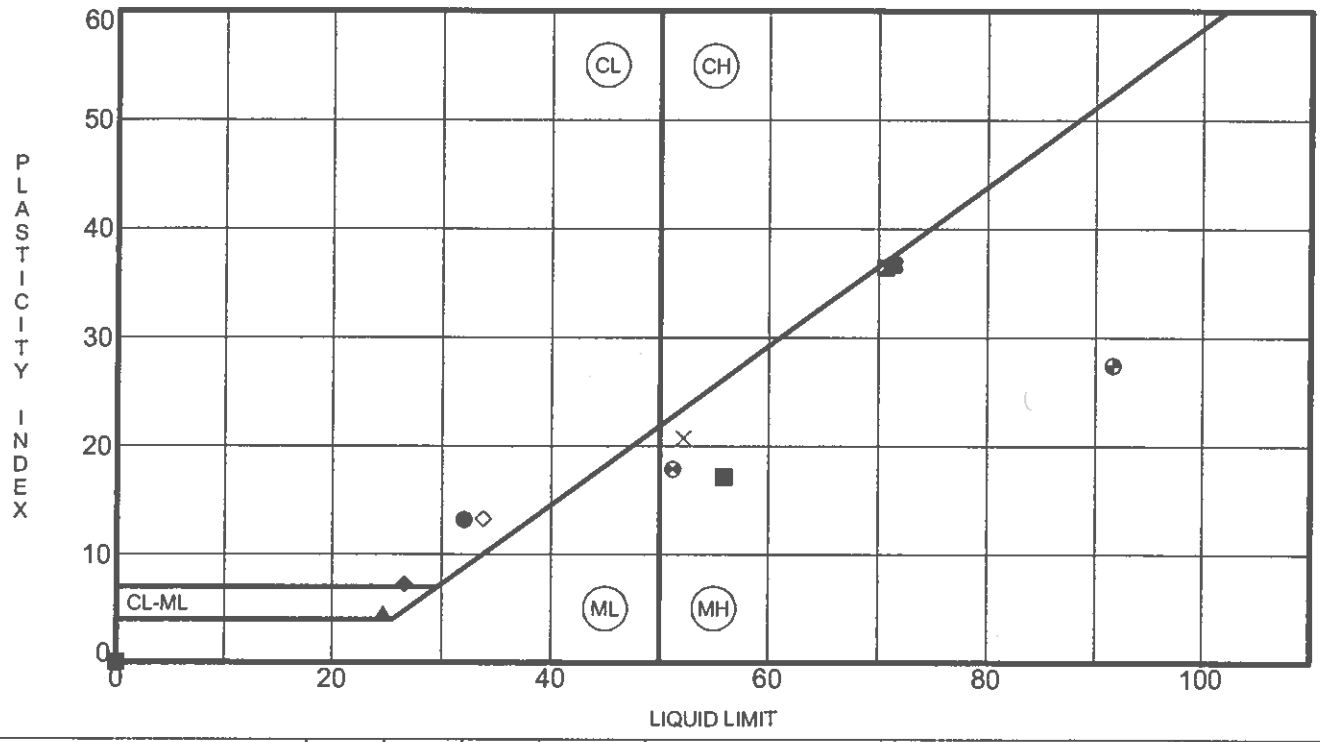
Specimen Identification			LL	PL	PI	%Fines	Classification
●	B-02 (TP-02)	3.0ft	NP	NP	NP	35	SILTY SAND (SM)
⊠	B-03 (TP-03)	6.0ft	NP	NP	NP	14	SILTY SAND with GRAVEL (SM)
▲	B-05 (TP-05)	2.0ft	NP	NP	NP	18	SILTY SAND (SM)
★	RTP-01	0.0ft	51	29	22	39	SILTY SAND (SM)
⊙	RTP-02	0.0ft	NP	NP	NP	14	SILTY SAND (SM)
✿	STTP-01	3.5ft	32	23	9	16	CLAYEY SAND with GRAVEL (SC)
○	STTP-02	2.5ft	NP	NP	NP	7	POORLY GRADED SAND with SILT and GRAVEL (SP-SM)
△	TP-07	3.0ft	NP	NP	NP	19	SILTY SAND (SM)
⊗	TP-09	6.0ft	NP	NP	NP	29	SILTY SAND (SM)
⊕	TP-10 (B-10)	17.5ft	NP	NP	NP	7	POORLY GRADED SAND with SILT (SP-SM)
□	TP-10 (B-10)	25.0ft	28	23	5	34	SILTY SAND (SM)
⊖	TP-10 (B-10)	30.0ft	NP	NP	NP	16	SILTY SAND (SM)
◍	TP-15	5.5ft	37	29	8	8	POORLY GRADED GRAVEL with SILT and SAND (GP-GM)
☆	TP-25	5.0ft	NP	NP	NP	19	SILTY SAND (SM)
⊠	TP-29	4.0ft	NP	NP	NP	12	SILTY SAND (SM)
■	TP-32	5.0ft	NP	NP	NP	37	SILTY SAND with GRAVEL (SM)
◆	TP-38	3.5ft	NP	NP	NP	7	WELL-GRADED SAND with SILT (SW-SM)
◇	TP-55	4.0ft	35	26	9	23	SILTY GRAVEL with SAND (GM)
✕	TP-67	3.0ft	NP	NP	NP	43	SILTY SAND (SM)
✖	TP-70	3.0ft	NP	NP	NP	46	SILTY SAND (SM)

Terracon

ATTERBERG LIMITS RESULTS

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC ATTERBERG LIMITS 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



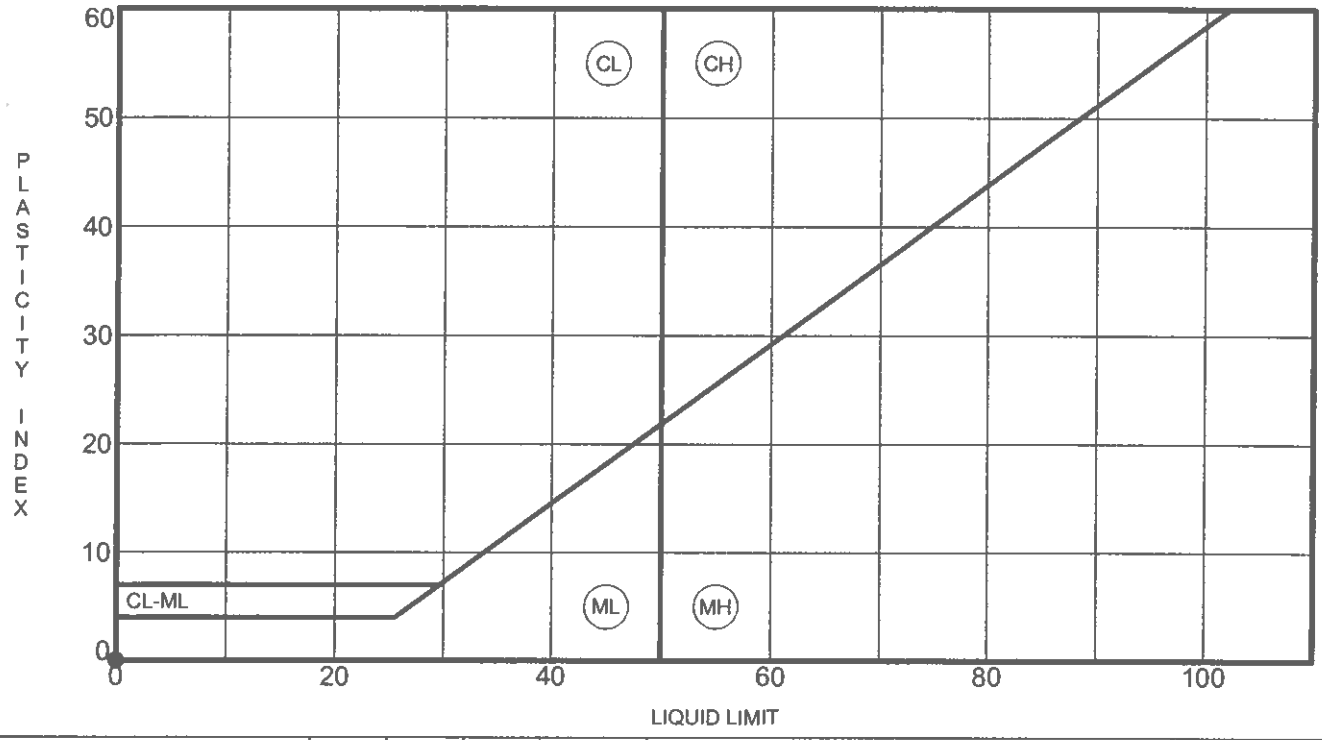
Specimen Identification		LL	PL	PI	%Fines	Classification
TP-77	5.5ft	32	19	13	36	CLAYEY SAND (SC)
TP-79	1.5ft	71	34	37	39	SILTY SAND with GRAVEL (SM)
TP-81	6.0ft	25	20	5	22	SILTY, CLAYEY SAND (SC-SM)
TP-82	5.5ft	NP	NP	NP	24	SILTY SAND with GRAVEL (SM)
TTTP-01	6.0ft	NP	NP	NP	9	WELL-GRADED SAND with SILT (SW-SM)
TTTP-02	3.0ft	NP	NP	NP	7	WELL-GRADED SAND with SILT and GRAVEL (SW-SM)
TTTP-05	3.5ft	NP	NP	NP	9	WELL-GRADED SAND with SILT and GRAVEL (SW-SM)
WTP-01	2.0ft	NP	NP	NP	42	SILTY SAND (SM)
WTP-02	6.0ft	NP	NP	NP	11	POORLY GRADED SAND with SILT (SP-SM)
WTP-03	2.0ft	NP	NP	NP	35	SILTY SAND (SM)
WTP-05	4.5ft	NP	NP	NP	36	SILTY SAND (SM)
WTP-09 (WB-09)	7.5ft	51	33	18	78	ELASTIC SILT with SAND (MH)
WTP-09 (WB-09)	17.5ft	92	64	28	62	SANDY ELASTIC SILT (MH)
WTP-09 (WB-09)	35.0ft	NP	NP	NP	9	POORLY GRADED SAND with SILT (SP-SM)
WTP-16	6.0ft	NP	NP	NP	31	SILTY SAND (SM)
WTP-20	4.5ft	56	39	17	81	ELASTIC SILT with SAND (MH)
WTP-22	6.0ft	27	19	8	36	CLAYEY SAND (SC)
WTP-23	5.0ft	34	21	13	44	CLAYEY SAND (SC)
WTP-26	6.0ft	52	31	21	50	SANDY ELASTIC SILT (MH)
WTP-28	6.0ft	71	35	36	94	ELASTIC SILT (MH)

Terracon

ATTERBERG LIMITS RESULTS

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC ATTERBERG LIMITS 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



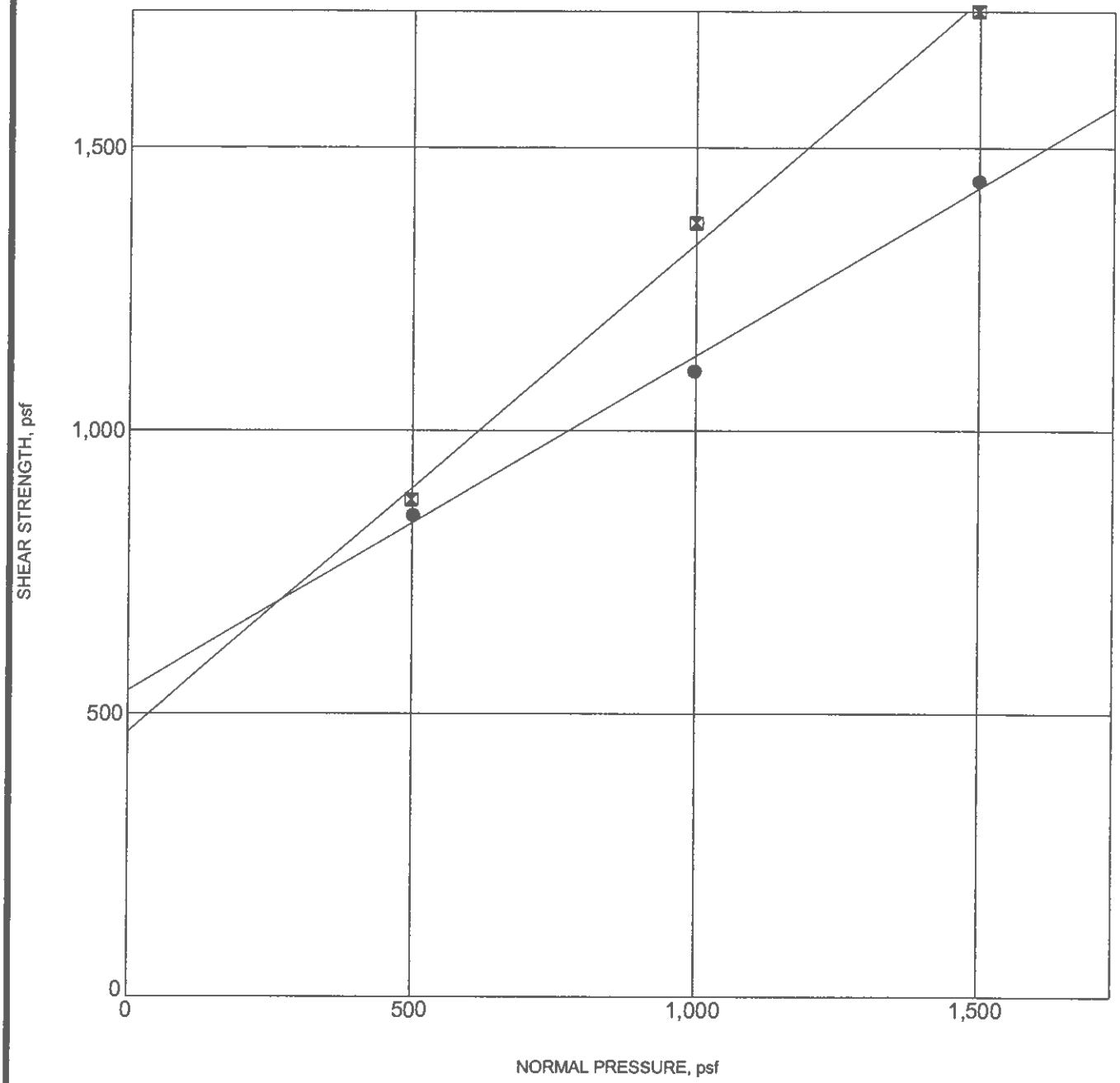
Specimen Identification	LL	PL	PI	%Fines	Classification
● WTP-30 5.0ft	NP	NP	NP	9	POORLY GRADED SAND with SILT (SP-SM)

Terracon

ATTERBERG LIMITS RESULTS

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC ATTERBERG LIMITS 67055025 GINT.GPJ TERRACON.GDT 6/7/2006



Specimen Identification		Classification	γ_d, pcf	WC,%	c, psf	$\phi°$
● TP-09	7.5ft		72	45	540	31
⊠ TP-10 (B-10)	7.5ft		114	10	467	41

Terracon

DIRECT SHEAR TEST

Project: Fish Springs Water Supply Project
Site: Washoe County, Nevada
Job #: 67055025
Date: 6/7/2006

TC DIRECT SHEAR 67055025 GINT.GPJ TERRACON.GDT 6/7/2006

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 12/08/05
Lab Sample ID: 512-091 01/03
Reported: 01/05/06

Project Name/Number: Fish Springs Water Supply Project (Well Field) / 67055025
Sample ID: 05-0885
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-01				
Total Acidity to pH 8.3	2310B	-26	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	<15 M	mg/kg	12/29/05
pH	150.1	8.10	SU	12/15/05
Redox Potential	2580B	+300	mV	12/13/05
Resistivity	2510B	2500	ohm.cm	12/13/05
Sulfate	300.0	16	mg/kg	12/29/05
SRB	BART	Negative	NA	12/13/05
TP-02				
Total Acidity to pH 8.3	2310B	-20	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	<15	mg/kg	12/29/05
pH	150.1	8.20	SU	12/15/05
Redox Potential	2580B	+320	mV	12/13/05
Resistivity	2510B	1200	ohm.cm	12/13/05
Sulfate	300.0	1.0	mg/kg	12/29/05
SRB	BART	Negative	NA	12/13/05
TP-03				
Total Acidity to pH 8.3	2310B	-8.0	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	<15	mg/kg	12/29/05
pH	150.1	7.83	SU	12/15/05
Redox Potential	2580B	+340	mV	12/13/05
Resistivity	2510B	1100	ohm.cm	12/13/05
Sulfate	300.0	260	mg/kg	12/29/05
SRB	BART	Negative	NA	12/13/05

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a salursted pasle. The analysis Total Alkalinity was performed on a 5:1 DI water extract.

M= Reported value for this analyte demonstrated a malrix effecl.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received. 12/08/05
Lab Sample ID: 512-091 04/06
Reported: 01/05/06

Project Name/Number: Fish Springs Water Supply Project (Well Field) / 67055025
Sample ID: 05-0885
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-04				
Total Acidity to pH 8.3	2310B	10	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	190	mg/kg	12/29/05
pH	150.1	7.87	SU	12/15/05
Redox Potential	2580B	+340	mV	12/13/05
Resistivity	2510B	350	ohm.cm	12/13/05
Sulfate	300.0	2200	mg/kg	12/29/05
SRB	BART	Negative	NA	12/13/05
TP-05				
Total Acidity to pH 8.3	2310B	12	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	140	mg/kg	12/29/05
pH	150.1	7.99	SU	12/15/05
Redox Potential	2580B	+330	mV	12/13/05
Resistivity	2510B	720	ohm.cm	12/13/05
Sulfate	300.0	250	mg/kg	12/29/05
SRB	BART	Negative	NA	12/13/05
TP-10				
Total Acidity to pH 8.3	2310B	-78	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	260	mg/kg	12/29/05
pH	150.1	9.21	SU	12/15/05
Redox Potential	2580B	+310	mV	12/13/05
Resistivity	2510B	430	ohm.cm	12/13/05
Sulfate	300.0	350	mg/kg	12/29/05
SRB	BART	Negative	NA	12/13/05

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis Total Alkalinity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID: NV004
Received: 12/09/05
Lab Sample ID: 512-104 01/03
Reported: 01/06/06

Project Name/Number: Fish Springs Water Supply Project (Well Field) / 67055025
Sample ID: 05-0887
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-09-3 at a depth of 5 ft.				
Total Acidity to pH 8.3	2310B	12	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	<15	mg/kg	01/04/06
pH	150.1	7.85	SU	12/15/05
Redox Potential	2580B	+300	mV	12/13/05
Resistivity	2510B	1400	ohm.cm	12/13/05
Sulfate	300.0	43	mg/kg	01/04/06
SRB	BART	Positive	NA	12/27/05
TP-15				
Total Acidity to pH 8.3	2310B	- 10	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	<15	mg/kg	01/04/06
pH	150.1	8.17	SU	12/15/05
Redox Potential	2580B	+ 270	mV	12/13/05
Resistivity	2510B	2500	ohm.cm	12/13/05
Sulfate	300.0	43	mg/kg	01/04/06
SRB	BART	Positive	NA	12/27/05
TP-16				
Total Acidity to pH 8.3	2310B	- 60	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	<15	mg/kg	01/05/06
pH	150.1	9.03	SU	12/15/05
Redox Potential	2580B	+ 250	mV	12/13/05
Resistivity	2510B	890	ohm.cm	12/13/05
Sulfate	300.0	91	mg/kg	01/04/06
SRB	BART	Negative	NA	12/27/05

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis Total Alkalinity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 12/09/05
Lab Sample ID: 512-104 04/06
Reported: 01/06/06

Project Name/Number: Fish Springs Water Supply Project (Well Field) / 67055025
Sample ID: 05-0887
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-17				
Total Acidity to pH 8.3	2310B	- 32	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	<15	mg/kg	01/05/06
pH	150.1	9.01	SU	12/15/05
Redox Potential	2580B	+ 250	mV	12/13/05
Resistivity	2510B	330	ohm.cm	12/13/05
Sulfate	300.0	110	mg/kg	01/04/06
SRB	BART	Negative	NA	12/27/05
TP-18				
Total Acidity to pH 8.3	2310B	- 2.0	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	30	mg/kg	01/05/06
pH	150.1	7.83	SU	12/15/05
Redox Potential	2580B	+ 250	mV	12/13/05
Resistivity	2510B	390	ohm.cm	12/13/05
Sulfate	300.0	4400	mg/kg	01/05/06
SRB	BART	Negative	NA	12/27/05
TP-19				
Total Acidity to pH 8.3	2310B	14	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	96	mg/kg	01/06/06
pH	150.1	7.67	SU	12/15/05
Redox Potential	2580B	+ 240	mV	12/13/05
Resistivity	2510B	670	ohm.cm	12/13/05
Sulfate	300.0	160	mg/kg	01/05/06
SRB	BART	Positive	NA	12/27/05

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis Total Alkalinity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 12/09/05
Lab Sample ID: 512-104 07
Reported: 01/06/06

Project Name/Number: Fish Springs Water Supply Project (Well Field) / 67055025
Sample ID: 05-0887
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-20 at depths of 6ft.				
Total Acidity to pH 8.3	2310B	-28	mg/kg as $CaCO_3$	12/14/05
Chloride	300.0	<15	mg/kg	01/05/06
pH	150.1	8.19	SU	12/15/05
Redox Potential	2580B	+ 240	mV	12/13/05
Resistivity	2510B	1400	ohm.cm	12/13/05
Sulfate	300.0	140	mg/kg	01/05/06
SRB	BART	Positive	NA	12/27/05

Comments: The analysis for pH, Realstivity, and Redox Potential were performed on a saturated paste. The analysis Total Alkalinity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 12/13/05
Lab Sample ID: 512-121 01/03
Reported: 01/06/06

Project Name/Number: Fish Springs Water Supply Project (Well Field) / 67055025
Sample ID: 67055025 / 05-0890
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-01 @ 6				
Total Acidity to pH 8.3	2310B	14	mg/kg as $CaCO_3$	12/19/05
Chloride	300.0	<15	mg/kg	01/06/06
pH	150.1	6.87	SU	12/15/05
Redox Potential	2580B	+300	mV	12/15/05
Resistivity	2510B	6600	ohm.cm	12/15/05
Sulfate	300.0	18	mg/kg	01/06/06
SRB	BART	Negative	NA	12/27/05
TP-02 @ 6				
Total Acidity to pH 8.3	2310B	14	mg/kg as $CaCO_3$	12/19/05
Chloride	300.0	<15	mg/kg	01/06/06
pH	150.1	6.61	SU	12/15/05
Redox Potential	2580B	+280	mV	12/15/05
Resistivity	2510B	12000	ohm.cm	12/15/05
Sulfate	300.0	<15	mg/kg	01/06/06
SRB	BART	Negative	NA	12/27/05
TP-03 @ 6				
Total Acidity to pH 8.3	2310B	7.0	mg/kg as $CaCO_3$	12/19/05
Chloride	300.0	<15	mg/kg	01/06/06
pH	150.1	7.14	SU	12/15/05
Redox Potential	2580B	+350	mV	12/15/05
Resistivity	2510B	10000	ohm.cm	12/15/05
Sulfate	300.0	<15	mg/kg	01/06/06
SRB	BART	Negative	NA	12/27/05

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis Total Alkalinity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

WET LAB 982 Spice Islands Drive Sparks, NV 89431 775-355-0202

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 12/13/05
Lab Sample ID: 512-121 04/06
Reported: 01/06/06

Project Name/Number: Fish Springs Water Supply Project (Well Field) / 67055025
Sample ID: 67055025 / 05-0890
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-04 @ 6				
Total Acidity to pH 8.3	2310B	11	mg/kg as $CaCO_3$	12/19/05
Chloride	300.0	<15	mg/kg	01/06/06
pH	150.1	7.58	SU	12/15/05
Redox Potential	2580B	+300	mV	12/15/05
Resistivity	2510B	5600	ohm.cm	12/15/05
Sulfate	300.0	<15	mg/kg	01/06/06
SRB	BART	Negative	NA	12/27/05
TP-05 @ 6				
Total Acidity to pH 8.3	2310B	12	mg/kg as $CaCO_3$	12/19/05
Chloride	300.0	<15	mg/kg	01/06/06
pH	150.1	7.29	SU	12/15/05
Redox Potential	2580B	+310	mV	12/15/05
Resistivity	2510B	14000	ohm.cm	12/15/05
Sulfate	300.0	<15	mg/kg	01/06/06
SRB	BART	Negative	NA	12/27/05
TP-06 @ 6				
Total Acidity to pH 8.3	2310B	8.0	mg/kg as $CaCO_3$	12/19/05
Chloride	300.0	24	mg/kg	01/06/06
pH	150.1	7.85	SU	12/15/05
Redox Potential	2580B	+300	mV	12/15/05
Resistivity	2510B	3800	ohm.cm	12/15/05
Sulfate	300.0	<15	mg/kg	01/06/06
SRB	BART	Negative	NA	12/27/05

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis Total Alkalinity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 12/13/05
Lab Sample ID: 512-121 07
Reported: 01/06/06

Project Name/Number: Fish Springs Water Supply Project (Well Field) / 67055025
Sample ID: 67055025 / 05-0890
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-07 @ 6				
Total Acidity to pH 8.3	2310B	9.0	mg/kg as $CaCO_3$	12/19/05
Chloride	300.0	<15	mg/kg	01/06/06
pH	150.1	8.24	SU	12/15/05
Redox Potential	2580B	+290	mV	12/15/05
Resistivity	2510B	4100	ohm.cm	12/15/05
Sulfate	300.0	20	mg/kg	01/06/06
SRB	BART	Negative	NA	12/27/05

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis Total Alkalinity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 12/27/05
Lab Sample ID: 512-069
Reported: 12/30/05

Project Name/Number: Fish Springs Water Supply Project / 67055027
Client Locations: B-03 @ 2.5 feet BGS
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
Soluble Sulfate	300.0	<15	mg/kg	12/27/05

Andy Smith, Lab Manager

WET LAB 992 Spice Islands Drive Sparks, NV 89431 775-355-0202

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 01/03/06
Lab Sample ID: 601-010
Reported: 01/26/06

Project Name/Number: Fish Springs Water Supply Project / 67055025
Sample ID: 05-0920
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
WTP-23 @5'				
Total Acidity to pH 8.3	2310B	-33	mg/kg as $CaCO_3$	01/10/06
Chloride	300.0	24	mg/kg	01/18/06
pH	150.1	9.37	SU	01/04/06
Redox Potential	2580B	+320	mV	01/06/06
Resistivity	2510B	660	ohm.cm	01/06/06
Sulfate	300.0	96	mg/kg	01/18/06
SRB	BART	Positive	NA	01/18/06
WTP-24 @ 6'				
Total Acidity to pH 8.3	2310B	-1.0	mg/kg as $CaCO_3$	01/10/06
Chloride	300.0	410	mg/kg	01/18/06
pH	150.1	7.92	SU	01/04/06
Redox Potential	2580B	+330	mV	01/06/06
Resistivity	2510B	130	ohm.cm	01/06/06
Sulfate	300.0	6300	mg/kg	01/18/06
SRB	BART	Negative	NA	01/18/06
WTP-25 @ 5'				
Total Acidity to pH 8.3	2310B	-66	mg/kg as $CaCO_3$	01/10/06
Chloride	300.0	500	mg/kg	01/18/06
pH	150.1	9.18	SU	01/04/06
Redox Potential	2580B	+300	mV	01/06/06
Resistivity	2510B	310	ohm.cm	01/06/06
Sulfate	300.0	760	mg/kg	01/18/06
SRB	BART	Negative	NA	01/18/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Elie Hajj

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 01/03/06
Lab Sample ID: 601-010
Reported: 01/26/06

Project Name/Number: Fish Springs Water Supply Project / 67055025
Sample ID: 05-0920
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
WTP-26 @ 6'				
Total Acidity to pH 8.3	2310B	-49	mg/kg as $CaCO_3$	01/10/06
Chloride	300.0	160	mg/kg	01/18/06
pH	150.1	8.88	SU	01/04/06
Redox Potential	2580B	+300	mV	01/06/06
Resistivity	2510B	460	ohm.cm	01/06/06
Sulfate	300.0	240	mg/kg	01/18/06
SRB	BART	Negative	NA	01/18/06
WTP-27 @ 5'				
Total Acidity to pH 8.3	2310B	-40	mg/kg as $CaCO_3$	01/10/06
Chloride	300.0	<15	mg/kg	01/18/06
pH	150.1	8.75	SU	01/04/06
Redox Potential	2580B	+310	mV	01/06/06
Resistivity	2510B	660	ohm.cm	01/06/06
Sulfate	300.0	39	mg/kg	01/18/06
SRB	BART	Negative	NA	01/18/06
WTP-28 @ 6'				
Total Acidity to pH 8.3	2310B	-160	mg/kg as $CaCO_3$	01/10/06
Chloride	300.0	150	mg/kg	01/19/06
pH	150.1	9.38	SU	01/04/06
Redox Potential	2580B	+310	mV	01/06/06
Resistivity	2510B	210	ohm.cm	01/06/06
Sulfate	300.0	510	mg/kg	01/18/06
SRB	BART	Negative	NA	01/18/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Jodi Miller

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 03/28/06
Lab Sample ID: 603-227 01/03
Reported: 04/21/06

Project Name/Number: Fish Springs Water Supply Project / 67055025
Sample ID: 06-1013
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-21-3 @ 6				
Total Acidity to pH 8.3	2310B	0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	7.03	SU	03/30/06
Redox Potential	2580B	+310	mV	03/30/06
Resistivity	2510B	3500	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06
TP-22-3 @ 6				
Total Acidity to pH 8.3	2310B	1.0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	7.17	SU	03/30/06
Redox Potential	2580B	+320	mV	03/30/06
Resistivity	2510B	10000	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06
TP-23-3 @ 4				
Total Acidity to pH 8.3	2310B	2.0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	7.22	SU	03/30/06
Redox Potential	2580B	+320	mV	03/30/06
Resistivity	2510B	12000	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Jodi Miller

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 03/28/06
Lab Sample ID: 603-227 04/06
Reported: 04/21/06

Project Name/Number: Fish Springs Water Supply Project / 67055025
Sample ID: 06-1013
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-24-2 @ 4				
Total Acidity to pH 8.3	2310B	2.0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	6.44	SU	03/30/06
Redox Potential	2580B	+340	mV	03/30/06
Resistivity	2510B	27000	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06
TP-24-3 @ 4				
Total Acidity to pH 8.3	2310B	-1.0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	6.42	SU	03/30/06
Redox Potential	2580B	+340	mV	03/30/06
Resistivity	2510B	25000	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06
TP-25-3 @ 4				
Total Acidity to pH 8.3	2310B	0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	6.90	SU	03/30/06
Redox Potential	2580B	+340	mV	03/30/06
Resistivity	2510B	13000	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a satursted paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite t t1& 112
Sparks, NV 89431
Attn: Jodi Miller

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 03/28/06
Lab Sample ID: 603-227 07/09
Reported: 04/21/06

Project Name/Number: Fish Springs Water Supply Project / 67055025
Sample ID: 06-1013
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-26-3 @ 6				
Total Acidity to pH 8.3	2310B	-1.0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	7.51	SU	03/30/06
Redox Potential	2580B	+330	mV	03/30/06
Resistivity	2510B	22000	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06
TP-27-3 @ 6				
Total Acidity to pH 8.3	2310B	-13	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	8.16	SU	03/30/06
Redox Potential	2580B	+340	mV	03/30/06
Resistivity	2510B	5700	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06
TP-28-2 @ 4				
Total Acidity to pH 8.3	2310B	1.0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	6.83	SU	03/30/06
Redox Potential	2580B	+340	mV	03/30/06
Resistivity	2510B	10000	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a satursted paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Jodi Miller

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 03/28/06
Lab Sample ID: 603-227 10
Reported: 04/21/06

Project Name/Number: Fish Springs Water Supply Project / 67055025
Sample ID: 06-1013
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-29-2 @ 4				
Total Acidity to pH 8.3	2310B	-3.0	mg/kg as $CaCO_3$	04/05/06
Chloride	300.0	<15	mg/kg	04/10/06
pH	150.1	6.96	SU	03/30/06
Redox Potential	2580B	+340	mV	03/30/06
Resistivity	2510B	14000	ohm.cm	03/30/06
Sulfate	300.0	<75	mg/kg	04/10/06
SRB	BART	Negative	NA	04/12/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Erik Hayes

Phone: 351-2400 Fax: 351-2423

EPA Lab ID: NV004
Received: 03/30/06
Lab Sample ID: 603-248 01/03
Reported: 04/21/06

Project Name/Number: Fish Springs Water Pipeline / 67055025
Sample ID: 06-1030
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-30 # 3 @ 5				
Total Acidity to pH 8.3	2310B	5.0	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	7.10	SU	03/31/06
Redox Potential	2580B	+280	mV	03/31/06
Resistivity	2510B	7600	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06
TP-31 # 2 @ 2.5				
Total Acidity to pH 8.3	2310B	6.0	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	6.95	SU	03/31/06
Redox Potential	2580B	+300	mV	03/31/06
Resistivity	2510B	11000	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06
TP-32 # 3 @ 5				
Total Acidity to pH 8.3	2310B	-11	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	8.03	SU	03/31/06
Redox Potential	2580B	+300	mV	03/31/06
Resistivity	2510B	3100	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

475 East GregStreet Suite # 119 Sparks, NV 89431 775-355-0202

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Erik Hayes

Phone: 351-2400 Fax: 351-2423

EPA Lab ID: NV004
Received: 03/30/06
Lab Sample ID: 603-248 04/06
Reported: 04/21/06

Project Name/Number: Fish Springs Water Pipeline / 67055025
Sample ID: 06-1030
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-33 # 2 @ 3.5				
Total Acidity to pH 8.3	2310B	0	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	7.00	SU	03/31/06
Redox Potential	2580B	+300	mV	03/31/06
Resistivity	2510B	29000	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06
TP-34 # 4 @ 7				
Total Acidity to pH 8.3	2310B	-3.0	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	8.29	SU	03/31/06
Redox Potential	2580B	+300	mV	03/31/06
Resistivity	2510B	5600	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06
TP-38 # 3 @ 7				
Total Acidity to pH 8.3	2310B	0	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	7.05	SU	03/31/06
Redox Potential	2580B	+310	mV	03/31/06
Resistivity	2510B	28000	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Erik Hayes

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 03/30/06
Lab Sample ID: 603-248 07/09
Reported: 04/21/06

Project Name/Number: Fish Springs Water Ptpeline / 67055025
Sample ID: 06-1030
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-42 # 3 @ 6				
Total Acidity to pH 8.3	2310B	-12	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	8.32	SU	03/31/06
Redox Potential	2580B	+300	mV	03/31/06
Resistivity	2510B	5100	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06
TP-46 # 4 @ 6				
Total Acidity to pH 8.3	2310B	-4.0	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	7.91	SU	03/31/06
Redox Potential	2580B	+310	mV	03/31/06
Resistivity	2510B	3800	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06
TP-48 # 3 @ 4				
Total Acidity to pH 8.3	2310B	-33	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150.1	8.33	SU	03/31/06
Redox Potential	2580B	+300	mV	03/31/06
Resistivity	2510B	3200	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Positive	NA	04/12/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Erik Hayes

Phone: 351-2400 Fax: 351-2423

EPA Lab ID: NV004
Received: 03/30/06
Lab Sample ID: 603-248 10/12
Reported: 04/21/06

Project Name/Number: Fish Springs Water Pipeline / 67055025
Sample ID: 06-1030
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-50 # 3 @ 6				
Total Acidity to pH 8.3	2310B	-2.0	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	<15	mg/kg	04/05/06
pH	150 1	6 93	SU	03/31/06
Redox Potential	2580B	+310	mV	03/31/06
Resistivity	2510B	5500	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06
TP-52 # 3 @ 6				
Total Acidity to pH 8.3	2310B	-39	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	18	mg/kg	04/06/06
pH	150.1	8.03	SU	03/31/06
Redox Potential	2580B	+320	mV	03/31/06
Resistivity	2510B	t900	ohm.cm	03/31/06
Sulfate	300.0	<75	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06
TP-55 # 3 @ 6				
Total Acidity to pH 8.3	2310B	0	mg/kg as $CaCO_3$	04/04/06
Chloride	300.0	220	mg/kg	04/06/06
pH	150.1	7.57	SU	03/31/06
Redox Potential	2580B	+360	mV	03/31/06
Resistivity	2510B	510	ohm.cm	03/31/06
Sulfate	300.0	<75M	mg/kg	04/05/06
SRB	BART	Negative	NA	04/12/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

M= Reported value for this analyte demonstrated a matrix effect.

Andy Smith, Lab Manager

WET LAB 475 East GregStreet Suite # 119 Sparks, NV 89431 775-355-0202

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Steve Bowman

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 04/12/06
Lab Sample ID: 604-099 01/03
Reported: 04/27/06

Project Name/Number: Fish Springs Water Pipeline / 67055025
Sample ID: 06-1046
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
WTP-21 @ 6.5'				
Total Acidity to pH 8.3	2310B	-56	mg/kg as $CaCO_3$	04/13/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	7.83	SU	04/13/06
Redox Potential	2580B	+290	mV	04/14/06
Resistivity	2510B	1200	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Positive	NA	04/18/06
WTP-22 @ 6'				
Total Acidity to pH 8.3	2310B	-45	mg/kg as $CaCO_3$	04/13/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	8.49	SU	04/13/06
Redox Potential	2580B	+300	mV	04/14/06
Resistivity	2510B	1400	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Positive	NA	04/18/06
WTP-29 @ 4.5'				
Total Acidity to pH 8.3	2310B	-27	mg/kg as $CaCO_3$	04/13/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	8.25	SU	04/13/06
Redox Potential	2580B	+300	mV	04/14/06
Resistivity	2510B	18000	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Steve Bowman

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 04/12/06
Lab Sample ID: 604-099 04/05
Reported: 04/27/06

Project Name/Number: Fish Springs Water Pipeline / 67055025
Sample ID: 06-1046
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
WTP-30 @ 5'				
Total Acidity to pH 8.3	2310B	-8.0	mg/kg as $CaCO_3$	04/13/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	8.04	SU	04/13/06
Redox Potential	2580B	+310	mV	04/14/06
Resistivity	2510B	26000	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06
WTP-31 @ 4'				
Total Acidity to pH 8.3	2310B	-26	mg/kg as $CaCO_3$	04/13/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	7.86	SU	04/13/06
Redox Potential	2580B	+310	mV	04/14/06
Resistivity	2510B	6400	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Steve Bowman
Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 04/13/06
Lab Sample ID: 604-112 01/03
Reported: 04/27/06

Project Name/Number: Fish Springs Water Pipeline / 67055025
Sample ID: 06-1048
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
WTP-33 @ 4.5'				
Total Acidity to pH 8.3	2310B	-17	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	8.22	SU	04/14/06
Redox Potential	2580B	+280	mV	04/14/06
Resistivity	2510B	19000	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06
WTP-34 @ 5.5'				
Total Acidity to pH 8.3	2310B	-26	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	<15M	mg/kg	04/17/06
pH	150.1	8.29	SU	04/14/06
Redox Potential	2580B	+290	mV	04/14/06
Resistivity	2510B	11000	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06
WTP-35 @ 1'				
Total Acidity to pH 8.3	2310B	-89	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	8.12	SU	04/14/06
Redox Potential	2580B	+280	mV	04/14/06
Resistivity	2510B	3000	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Positive	NA	04/18/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

M= Reported value for this analyte demonstrated a matrix effect.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Steve Bowman
Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 04/13/06
Lab Sample ID: 64-112 04/07
Reported: 04/27/06

Project Name/Number: Fish Springs Water Pipeline / 67055025
Sample ID: 06-1048
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
WTP-36 @ 5'				
Total Acidity to pH 8.3	2310B	4.0	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	7.80	SU	04/14/06
Redox Potential	2580B	+280	mV	04/14/06
Resistivity	2510B	2700	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06
WTP-37 @ 5.5'				
Total Acidity to pH 8.3	2310B	-17	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	8.37	SU	04/14/06
Redox Potential	2580B	+280	mV	04/14/06
Resistivity	2510B	12000	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Positive	NA	04/18/06
WTP-38 @ 5'				
Total Acidity to pH 8.3	2310B	4.0	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	6.90	SU	04/14/06
Redox Potential	2580B	+300	mV	04/14/06
Resistivity	2510B	17000	ohm.cm	04/14/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06
TP-7 @ 3'				
Sulfate	300.0	<75	mg/kg	04/17/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5:1 DI water extract.

Andy Smith, Lab Manager

Western Environmental Testing Laboratory
Analytical Report

Terracon
1380 Greg St., Suite 111& 112
Sparks, NV 89431
Attn: Steve Bowman

Phone: 351-2400 Fax: 351-2423

EPA Lab ID NV004
Received: 04/17/06
Lab Sample ID: 604-131 01/03
Reported: 04/27/06

Project Name/Number: Fish Springs Water Pipeline / 67055025
Sample ID: 06-1049
Sample Locations: See Below
Date/Time Collected: Not Specified
Sampled By: Client

Parameter	Method	Results	Units	Analyzed
TP-80 @ 2'				
Total Acidity to pH 8.3	2310B	2.0	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	19	mg/kg	04/17/06
pH	150.1	8.21	SU	04/18/06
Redox Potential	2580B	+350	mV	04/19/06
Resistivity	2510B	1500	ohm.cm	04/18/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06
TP-81 @ 6'				
Total Acidity to pH 8.3	2310B	2.0	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	6.77	SU	04/18/06
Redox Potential	2580B	+370	mV	04/19/06
Resistivity	2510B	13000	ohm.cm	04/18/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06
TP-82 @ 5.5'				
Total Acidity to pH 8.3	2310B	2.0	mg/kg as $CaCO_3$	04/18/06
Chloride	300.0	<15	mg/kg	04/17/06
pH	150.1	6.97	SU	04/18/06
Redox Potential	2580B	+370	mV	04/19/06
Resistivity	2510B	12000	ohm.cm	04/18/06
Sulfate	300.0	<75	mg/kg	04/17/06
SRB	BART	Negative	NA	04/18/06

Comments: The analysis for pH, Resistivity, and Redox Potential were performed on a saturated paste. The analysis for Total Acidity was performed on a 5.1 DI water extract.

Andy Smith, Lab Manager

Appendix C

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]					Soil Classification	
					Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3^E$		GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3^E$		GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH		GM	Silty gravel[F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3^E$		SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3^E$		SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH		SM	Silty sand[G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]		CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]		ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line		CH	Fat clay[K,L,M]
			PI plots below "A" line		MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried	< 0.75	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

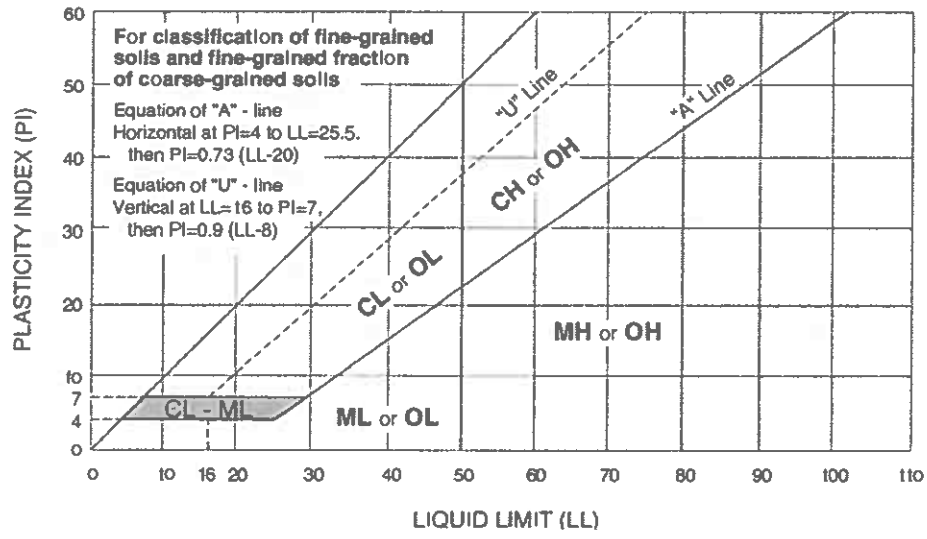
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
[illegible]:	Thin-Walled Tube - 2" O.D., unless otherwise noted	PA:	Power Auger
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB:	Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value".

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	N/E:	Not Encountered
WCI:	Wet Cave in	WD:	While Drilling		
DCI:	Dry Cave in	BCR:	Before Casing Removal		
AB:	After Boring	ACR:	After Casing Removal		

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	<2	Very Soft
500 – 1,000	2-3	Soft
1,001 – 2,000	4-6	Medium Stiff
2,001 – 4,000	7-12	Stiff
4,001 – 8,000	13-26	Very Stiff
8,000+	26+	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 49	Dense
50+	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifiers	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	30+

Terracon

Appendix D

of Results," *Technical Note N-1178*, Naval Civil Engineering Laboratory, Port Hueneme, Calif., 1971.
14. Monney, N. T., "An Analysis of the Vane Shear Test at Varying Rates of Shear," *Deep Sea Sediments: Physical and Mechanical Properties*, A. L. Inderbitzen, ed., Plenum Press, New York, N.Y., pp. 151–167.
15. Perlow, M., Jr., "Influence of Sample Disturbance and Test Method on Key Engineering Properties of Marine Soils," thesis presented to Lehigh University, at Bethlehem, Pa., in 1974, in partial fulfillment of the requirements for the Degree of Master of Science in Civil Engineering.
16. Perlow, M., Jr., and Richards, A. F., "Geotechnical Variability Measured In-Place from a Submersible," *Marine Technology Society Journal*, Vol. 7, No. 4, 1973, pp. 27–32.
17. Perlow, M., Jr., and Richards, A. F., "Sampling Densification in Marine Clayey-Silts," *EOS Transactions*, American Geophysical Union, Vol. 55, No. 4, 1974, pp. 313.
18. Richards, A. F., "Geotechnical Ocean Engineering Test Areas," *6th Annual Conference Preprints*, Marine Technology Society, Vol. 2, 1970, pp. 1355–1363.
19. Richards, A. F., "Standardization of Marine Geotechnics Symbols, Definitions, Units and Test Procedures," *Deep Sea Sediments: Physical and Mechanical Properties*, A. L. Inderbitzen, ed., Plenum Press, New York, N.Y., 1974, pp. 271–292.
20. Richards, A. F., et al., "In-Place Measurement of Deep Sea Soil Shear Strength," *Underwater Sampling, Testing, and Construction Control*, American Society for Testing and Materials, STP 501, 1972, pp. 55–68.
21. Richards, A. F., and Parker, H. W., "Surface Coring for Shear Strength Measurements," *Proceedings of the Conference on Civil Engineering in the Oceans*, San Francisco, Calif., ASCE, 1968, pp. 445–489.
22. Richards, A. F., and Parks, J. M., "Marine Geotechnology: Average Sediment Properties, Selected Literature and Review of Consolidation, Stability and Bioturbation—Geotechnical Interactions in the Benthic Boundary," *The Benthic Boundary Layer*, I. N. McCave, ed., Plenum Press, New York, N.Y., 1976, pp. 157–181.
23. Richardson, A. M., Brand, E. W., and Menon, A., "In Situ Determination of Anisotropy of a Soft Clay," *Proceedings*, In Situ Measurement of Soil Properties, ASCE, Vol. 1, 1975, pp. 336–349.
24. Shepard, F. P., "Nomenclature Based on Sand-Silt-Clay Ratios," *Journal of Sedimentary Petrology*, Vol. 24, No. 3, 1954, pp. 151–158.
25. Simpson, F., "Statistical Analysis of Sediment Properties from the San Diego Trough," *LMSC D 359428*, Lockheed Missiles and Space Company, San Diego, Calif., 1974.
26. Smith, A. D., and Richards, A. F., "Vane Shear Strength at Two High Rotation Rates," *Civil Engineering in the Oceans/III*, ASCE, 1976, pp. 421–433.

Appendix II.—Notation

The following symbols are used in this paper:

r = vane blade radius;
S_u = undrained shear strength;
v = vane angular shear velocity;
z = depth; and
ω = vane rotation rate.

JOURNAL OF THE GEOTECHNICAL ENGINEERING DIVISION

Modulus of Soil Reaction Values for Buried Flexible Pipe

By Amster K. Howard[1]

Introduction

The Earth Sciences Branch of the U.S. Bureau of Reclamation (USBR) has been investigating the load-deflection relationship of buried flexible pipe for several years using laboratory soil container tests and special field installations. The result is a table of modulus of soil reaction E' values for use in the Iowa Formula for predicting the deflection of buried flexible pipe. At this point in its development, use of the table of E' values along with a simplified method of calculating the backfill load on a pipe can reasonably predict the initial (no-time effect) deflection of flexible pipe under fills up to 50 ft (15 m).

The soil load on a flexible pipe causes a decrease in the vertical diameter and an increase in the horizontal diameter of the pipe. In the design of structural members, the strain or deformation of an element of the material being used can be determined from the ratio of the load or stress on the member to its modulus of elasticity (strain = stress/modulus of elasticity). The modulus is either known for the material or it can be determined from laboratory tests.

The deflection of a buried circular conduit can be predicted in a similar fashion. The cross-sectional ring deflects (deforms) according to the ratio of the load on the ring to the modulus of elasticity of the material. However, the material modulus becomes more complicated because a soil-structure interaction takes place. The material modulus becomes a combination of the structural modulus (stiffness) of the pipe and the modulus (stiffness) of the soil, so that:

Note.—Discussion open until June 1, 1977. To extend the closing date one month, a written request must be filed with the Editor of Technical Publications, ASCE. This paper is part of the copyrighted Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 103, No. GT1, January, 1977. Manuscript was submitted for review for possible publication on October 7, 1976.

[1]Head, Soil Properties Testing Section, Div. of General Research, Bureau of Reclamation, Denver, Colo.

$$\text{pipe deflection} = \frac{\text{load on pipe}}{\text{pipe stiffness} + \text{soil stiffness}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This is basically the form of the Iowa Formula, widely used for predicting deflections of buried flexible pipe. A constant value for the soil stiffness has been used for all compacted soil types. The originator of the formula and others

TABLE 1.—Bureau of Reclamation Values of E' for Iowa Formula (For Initial Flexible Pipe Deflection)

Soil type-pipe bedding material (Unified Classification System[a]) (1)	E' for Degree of Compaction of Bedding, in pounds per square inch: Dumped (2)	Slight, <85% Proctor, <40% relative density (3)	Moderate, 85%–95% Proctor, 40%–70% relative density (4)	High, >95% Proctor, >70% relative density (5)
Fine-grained Soils (LL > 50)[b] Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; Otherwise use $E' = 0$			
Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles; Coarse-grained Soils with Fines GM, GC, SM, SC[c] contains more than 12% fines	100	400	1,000	2,000
Coarse-grained Soils with Little or No Fines GW, GP, SW, SP[c] contains less than 12% fines	200	1,000	2,000	3,000
Crushed Rock	1,000	3,000	3,000	3,000
Accuracy in Terms of Percentage Deflection[d]	±2	±2	±1	±0.5

[a]ASTM Designation D-2487, USBR Designation E-3.
[b]LL = Liquid limit.
[c]Or any borderline soil beginning with one of these symbols (i.e., GM-GC, GC-SC).
[d]For ±1% accuracy and predicted deflection of 3%, actual deflection would be between 2% and 4%.

Note: Values applicable only for fills less than 50 ft (15 m). Table does not include any safety factor. For use in predicting initial deflections only, appropriate Deflection Lag Factor must be applied for long-term deflections. If bedding falls on the borderline between two compaction categories, select lower E' value or average the two values. Percentage Proctor based on laboratory maximum dry density from test standards using about 12,500 ft-lb/cu ft (598,000 J/m³) (ASTM D-698, AASHO T-99, USBR Designation E-11). 1 psi = 6.9 kN/m².

are now recognizing that the soil stiffness varies according to soil type and degree of compaction. However, there has been no successful effort to organize the information on buried flexible pipe deflections to determine what soil stiffness values should be used for various pipe support conditions.

Reclamation experience with laboratory and field tests of buried flexible pipe

has resulted in an empirical relationship between pipe deflection and soil stiffness values for different pipe bedding construction conditions. In Table 1 are the values of the soil stiffness (modulus of soil reaction E') found to represent the types of soils and degrees of compaction for buried flexible pipe. As examined later, the modulus of soil reaction, E', is a misnomer because it is more than just a property of the soil, although empirically it only varies with soil type and compaction effect.

Iowa Formula

In 1941, Spangler published a design procedure (6) for the underground installation of flexible pipe. Spangler and Watkins (7) later modified the formula to include a more realistic value for the soil parameter. The modified Iowa Formula is given as

$$\Delta X = D_l \frac{KWr^3}{EI + 0.061\,E'r^3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

in which ΔX = horizontal deflection of the pipe, in inches; D_l = deflection lag factor to compensate for the volume change of the soil with time, dimensionless; K = bedding constant which varies with the angle of the bedding, dimensionless; W = load on the pipe per unit length, in pounds per linear inch; r = pipe radius, in inches; EI = pipe wall stiffness per inch length, in inch-pounds; and E' = modulus of soil reaction, in pounds per square inch.

Rearranged Iowa Formula.—If the Iowa Formula is rearranged as

$$\Delta X = \frac{D_l KW}{\dfrac{EI}{r^3} + 0.061E'} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\Delta X = \frac{\text{Load Factor}}{\text{Ring Stiffness Factor} + \text{Soil Stiffness Factor}} \quad \ldots\ldots\ldots\ldots (4)$$

then the following terms can be used to describe the three separate factors that affect the pipe deflection: Load factor = $D_l KW$; ring stiffness factor = EI/r^3; and soil stiffness factor = $0.061E'$.

Load Factor $D_l KW$.—The load factor incorporates the parameters that have to do with the magnitude and distribution of the soil pressures on a buried pipe.

The pipe deflection is directly proportional to the load factor and, yet, less is known about its components than any others in the Iowa Formula. Changes in construction procedures or bedding materials along a pipeline could significantly vary the load factor.

Deflection Lag Factor D_l.—After soil has been initially loaded it continues to reduce in volume with time. The deflection lag factor converts the immediate deflection of the pipe to the deflection of the pipe after many years. Spangler recommends a value of 1.5 for D_l. The actual value, however, depends on when the immediate deflection is measured, the volume change rate of the soil, and the load on the soil. Deflection lag factor D_l is basically empirical and ranges from 1.0–6 in observed tests.

Bedding Constant K.—The bedding constant ranges from 0.110 for a 0° bedding angle (line load on the bottom of the pipe) to 0.083 for a 90° bedding angle (full support under the bottom half of the pipe). The angle of bedding describes the load resisting area of the bedding under the pipe. As the angle of bedding increases, the loaded area increases and the pipe deflects less. No further study has been done on this constant since its conception, even though it can influence the results of the Iowa Formula by as much as 25%. Most investigators of the behavior of flexible pipe now use a bedding constant of 0.1 as a typical value.

Load on Pipe W.—The Marston theory is the most common method of calculating the load on the pipe and is recommended by Spangler for the Iowa Formula. In the Marston theory the load depends on whether the pipe is in a trench or embankment (or combination), the type of backfill soil, the settlement of the pipe in relation to the backfill material, and the distance that the pipe projects into the natural soil foundation. The trend in recent years has been to assume the load on the pipe to be the weight of the column of earth above the pipe, with the width equal to the pipe diameter.

Ring Stiffness Factor EI/r^3.—In most cases the ring stiffness has very little influence on the pipe deflection because the soil stiffness factor is much larger. Considering the magnitude of the variations that can occur in the load factor and in the soil stiffness and the small influence of the ring stiffness, the use of nominal values for E, I, and r of each pipe provide sufficient accuracy for the Iowa Formula.

The ring stiffness is the product of the modulus of elasticity of the pipe wall material, and the moment of inertia, of a 1-in. (25-mm) length of pipe, divided by the pipe radius cubed. The moment of inertia is equal to $t^3/12$, in which t = the wall thickness. The EI value may be found using nominal or empirical values for E and t or EI can be determined by conducting three-edge bearing tests on a section of pipe.

Soil Stiffness Factor $0.061E'$.—The soil load on a flexible pipe causes a decrease in the vertical diameter and an increase in the horizontal diameter. The horizontal movement develops a passive soil resistance that acts to help support the pipe. The magnitude of the pipe deflection then depends on the vertical soil load on the pipe and the passive resistance of the soil at the sides of the pipe. The passive soil resistance is expressed as "modulus of passive resistance," e, and is defined as the ratio of the pressure on the soil to the horizontal movement of the soil. It is usually expressed in unit pressure per unit of movement and it is similar to the coefficient of subgrade reaction. The coefficient of subgrade reaction is the ratio of the pressure on an element of soil under a footing to the corresponding settlement. Spangler used a constant value for this modulus in the original Iowa Formula. Watkins and Spangler later modified the e value to E' ($E' = er$, in which r = pipe radius) so that it would be dimensionally correct and similar to the compressive modulus of elasticity of soil. This results in E' becoming more of a pipe-soil interaction modulus rather than a soil modulus alone. A constant $E' = 700$ psi (4,800 kN/m²) was suggested for soils over 90% of their maximum laboratory dry density. Spangler now regards E' as a semi-empirical constant that is difficult to obtain from laboratory tests. Rather than using a constant E', he now recommends values based on experience and judgment.

Laboratory Tests

U.S. Bureau of Reclamation Laboratory soil container tests have demonstrated the effects of the pipe modulus, the soil type, and degree of compaction on the deflections of buried flexible pipe. These tests have been described in a series of reports and papers (2,5).

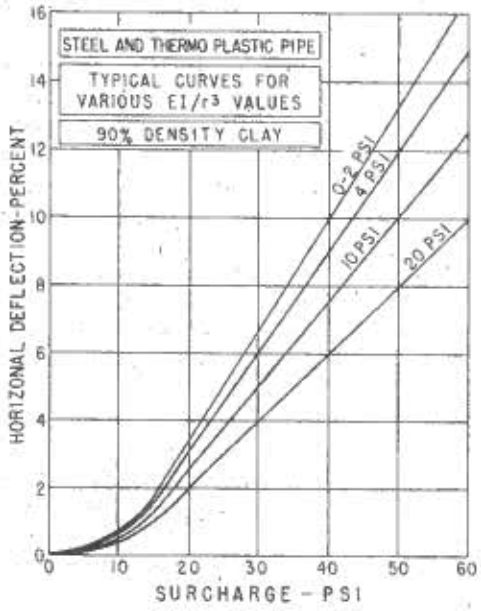


FIG. 1.—Typical Load-Deflection Curves for Steel and Thermoplastic Pipe of Various Stiffnesses in 90% Clay (1 psi = 6.9 kN/m²)

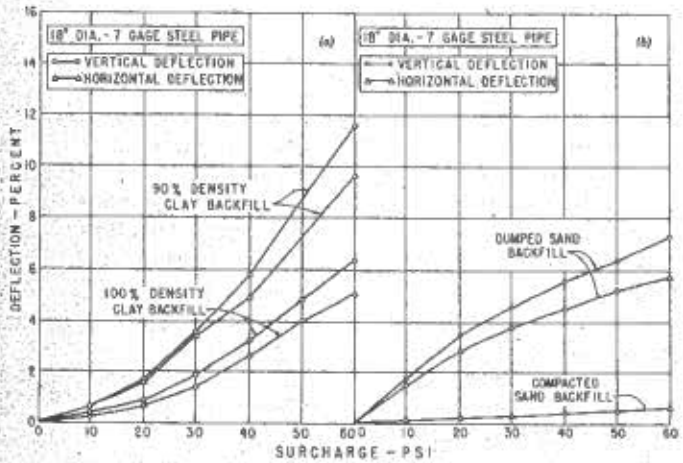


FIG. 2.—Load-Deflection Curves for Steel Pipe of Identical Stiffness in: (a) 90% and 100% Density Clay; (b) Dumped and Compacted Sand (1 psi = 6.9 kN/m²)

The analysis of the test results took two approaches: (1) Comparing pipe with various pipe modulus values for a constant soil modulus value; and (2) comparing pipe of equal pipe modulus for various soil modulus values. The pipe modulus was varied by using different types of pipe (steel, fiberglass-reinforced plastic, reinforced plastic mortar, polyethylene, and polyvinyl chloride) of varying diameters and wall thicknesses.

The soil modulus was varied by bedding the pipe in different soils, a sandy clay (fine-grained soil—CL) and a clean poorly graded sand (coarse-grained soil—SP) at various degrees of compaction (90% and 100% of the laboratory maximum density for the sandy clay and 80% relative density for the sand).

The pipe was buried in a large steel soil container and surcharge loads applied to the soil surface over the pipe. Pipe deflections, soil pressures, and soil strains were measured as the load was increased over the pipe.

Fig. 1 shows the laboratory load-deflection relationships for pipe with various moduli placed in a constant soil modulus condition. The soil was the sandy clay placed at 90% Proctor density (moderate degree of compaction) and the pipe moduli had a significant effect on the pipe deflection. When a high degree of compaction was used, 100% Proctor density for the sandy clay and 80% relative density for the sand, varying the pipe moduli had an insignificant effect on the pipe deflection.

The deflection curves for pipes of equal modulus in various soil modulus conditions are shown in Fig. 2(*a*). Increasing the initial soil density of the sandy clay from 90%–100% Proctor density significantly reduced the pipe deflection. The pipe deflection in the highly compacted sand (80% relative density) was much less than the deflection in the 100% Proctor density sandy clay. The density, in terms of pounds per cubic foot, was identical for the 100% Proctor density sandy clay and for the 80% relative density sand, illustrating the effect of soil type on pipe deflection.

Fig. 2(*b*) shows the difference in deflections for a pipe tested in the sand at a high degree of compaction and the same pipe tested in a dumped sand condition.

Development of Table of E' Values

Following the laboratory investigations, data from a few field tests were evaluated to see if the relationships observed in the laboratory tests occurred in actual pipeline installations. Initial investigations of field tests appeared to substantiate the laboratory findings. For example, Fig. 3 shows the variation in pipe deflection for five different types of bedding conditions on a USBR test installation near Yuma, Ariz. (3). This was a 600-ft (180-m) section of 30-in. (762-mm) diam RPM pipe with 4.5 ft (1.4 m) of backfill over the pipe. As shown, the soil type and the degree of compaction had a significant effect on the pipe deflection.

Data from 113 field installations were collected and E' values back-calculated (4). The E' values showed similarities for certain categories of soil type and degrees of compaction and these categories were used to develop Table 1. A representative single E' value was selected for each category of soil type and compaction.

The value of the actual deflection used to calculate E' represents:

1. The initial deflection measured after construction.
2. The deflection of the pipe between the time the soil was placed to the top of the pipe and the time of completion of backfilling (when reported).
3. The measured horizontal deflection, ΔX, or if that was not measured, $\Delta X = 0.913\ \Delta Y$, in which ΔY is the measured vertical deflection. The value 0.913 is the ratio between the vertical and horizontal diameter changes as a circular section deforms elliptically.
4. The average deflection if numerous measurements were made along the pipeline.

The initial deflections were made anytime from 1 day to a few months after construction. Data in the literature, when the deflections were measured a year or more after construction, were not used since the deflection lag factor for pipe is quite varied. In the cases studied, D_l ranged from 1–4. In some of

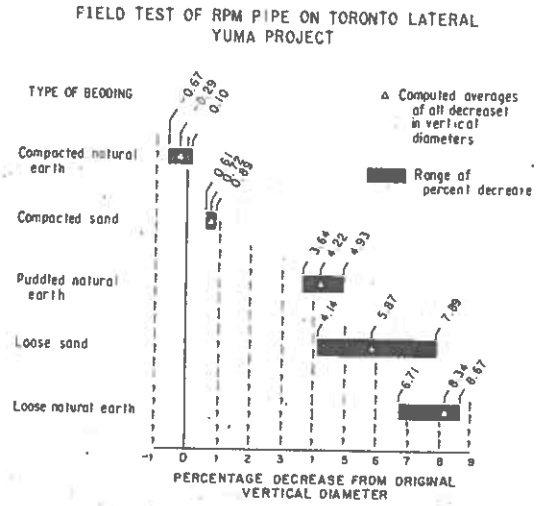


FIG. 3.—Deflections of Reinforced Plastic Mortar Pipe on Yuma Project, Arizona

the tests, a difference of even a few days increased the deflection 20%–30%. In a few cases, deflection data measured after several years were used in this comparison because the deflections were quite small and had no effect on the basic conclusions.

The various types of pipe and construction conditions in the field tests surveyed included: (1) Pipe diameters—12 in.–180 in. (300 mm–4,600 mm); (2) backfill depths—2 ft–42 ft (0.6 m–13 m); (3) trench and embankment installations; (4) soft to hard soil beneath the pipe; (5) various projection conditions; (6) varying water-table conditions; and (7) types of pipe—corrugated metal pipe (CMP), steel and aluminum: Cast iron, smooth iron, ductile iron, straight steel, reinforced plastic mortar (RPM); fiberglass reinforced plastic (FRP), polyvinyl chloride (PVC), and pretensioned concrete (PT).

Range of Deflections Along Pipelines

The deflections along a pipeline can vary considerably due to normal soil variations and inherent differences in compacting soil along a pipeline. The data from field installations where measurements were made along a stretch of pipeline showed quite a range of deflections. For the field tests where measurements were made over a 100-ft (30-m) or more length of pipeline, the range of deflections are plotted about the average deflections for each line in Fig. 4. A deflection range of about ±2% deflection can be expected, particularly when the pipe stiffness is much less than the soil stiffness. The value ±2% deflection is used here to mean that if the average deflection was found to be 3%, the deflections would range between 1% and 5%.

Surprisingly, this wide range in deflection appears to be independent of the

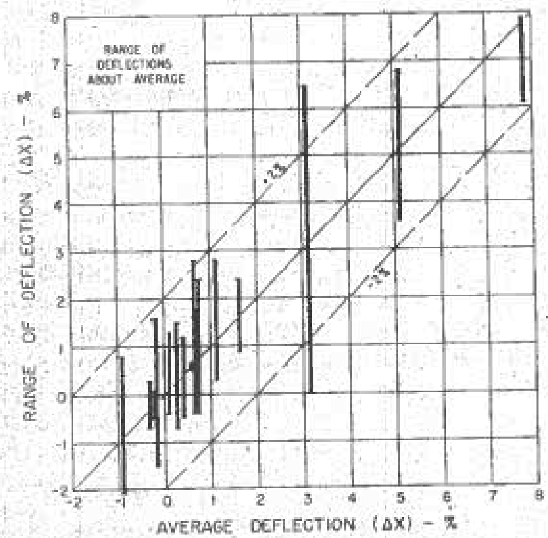


FIG. 4.—Range of Deflections Measured along Pipelines

pipe type, soil type, and degree of compaction. The stiffer pipe did, however, show less variation in deflection.

Gehrels (1) reported on the measurements of 9 miles (14 km) of PVC pipe in Europe using a deformation gage pulled through the pipe. Generally, the differences below the low and high deflections were about 6% deflection (±3% deflection about the average) although he reported differences as high as 18% in the 8-in. to 16-in. (200-mm to 400-mm) PVC pipe.

Reliability of Table 1

Although the back-calculated E' values varied within each category shown in Table 1, a single E' value was selected to represent each category. The data from the field installations were reviewed again to see if the single E' value could have been used to predict the actual measured deflection within an acceptable degree of accuracy.

To calculate the predicted deflection, 1.0 was used for the deflection lag factor, 0.1 for the bedding constant, and nominal values for the modulus of elasticity, E; wall thickness t (or I, moment of inertia) and pipe radius r were used. The load on the pipe was assumed to be a vertical prism of soil. The soil type and degree of compaction for the soil *beside the pipe* were used to get the appropriate E' value from Table 1.

The predicted deflection was then calculated using the Iowa Formula rearranged as

$$\Delta X(\%) = 0.0694 \frac{\gamma h}{\frac{EI}{r^3} + 0.061 E'} \qquad (5)$$

in which $\Delta X(\%)$ = percentage deflection, change in diameter divided by nominal diameter times 100; γ = soil density, in pounds per cubic foot; h = fill height,

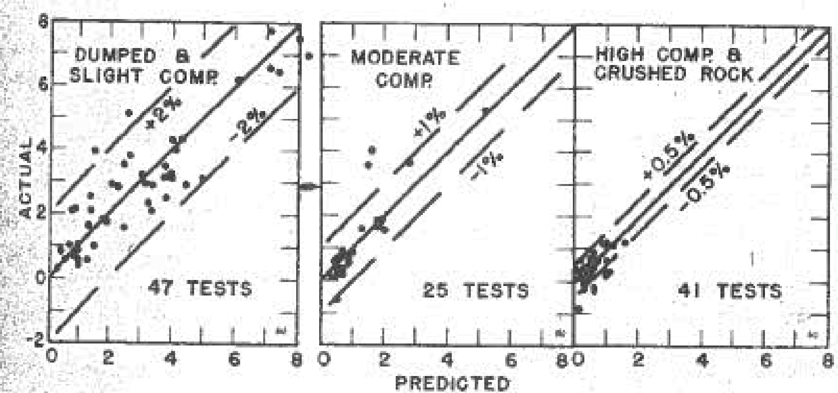


FIG. 5.—Comparison of Actual and Predicted Deflections for: (*a*) Dumped and Slightly Compacted Beddings; (*b*) Moderately Compacted Beddings; (*c*) Highly Compacted Beddings

in feet; EI/r^3 = ring stiffness factor, in pounds per square inch; and E' = modulus of soil reaction, in pounds per square inch.

The variations between the actual deflection and the deflection predicted using E' values from Table 1 appear to be affected more by the degree of compaction than any other factor.

The comparisons between the actual and predicted deflections are shown in Fig. 5(*a*) for the dumped and slightly compacted field tests. Over 90% of the comparisons showed the actual deflection was within ±2% deflection of the predicted deflection. The value, ±2% deflection, means that if the predicted deflection were 3%, the actual deflection was between 1% and 5%.

Fig. 5(*b*) shows the comparison of the actual deflection versus the predicted deflection for the field tests with moderate degrees of compaction. About 90% of the actual deflections were within ±1% deflection of the predicted value.

The comparison of actual deflection versus predicted deflection for the tests with a high degree of compaction is shown in Fig. 5(*c*). Over 80% of the actual

deflections were within ±0.5% deflection of the predicted deflection. However, all those tests that had more than a 0.5% deflection variation were those where the actual deflections were *less* than the predicted deflection. One-hundred percent of the comparisons were within ±1% deflection.

The use of E' values from Table 1 to predict the deflections of the over 100 field tests surveyed would have predicted the deflection of the tests with (1) Dumped or slight compaction to within ±2% deflection; (2) moderate compaction to within ±1% deflection; and (3) high compaction to within ±0.5% deflection. The expected reliability of using the E' values from Table 1 is summarized in the last row of Table 1.

At the worst, the variation of the actual deflection from the predicted deflection using the E' values from Table 1 is about the same as the natural variation in deflections along a length of pipeline (±2% deflection).

Limitations of Table 1

Obviously, this is an empirical method of determining E' values and the values reported will probably be modified by the collection and evaluation of more field installation data, especially for those categories of soil type and compaction where data from only a few tests were available.

These results apply only to the initial deflections, deflections measured soon after construction. A similar study is now underway to evaluate the time-lag effect on the deflection.

These results are not applicable for flexible pipe buried under fills over 50 ft (15 m). Evaluation of data on high fills in the literature showed the actual deflections reported to be much less than deflections calculated using the E' values from Table 1. Values of E' have been reported as high as 8,000 psi (55,000 kN/m²) for high fills.

Caution should be used when applying values from Table 1 when the trench walls are more compressible than the bedding material. The bedding material needs firm support. When trenching through highly compressible in-situ material, a minimum of two pipe diameters should be excavated on either side of the pipe and the bedding material placed at a high degree of compaction so the resistance to the pipe deflection will come from the bedding material without depending on support from the trench walls.

When the trench wall material is fine-grained soil and the bedding material is gravel, infiltration of the fines into the gravel should be considered.

Summary and Conclusions

A table of E' (modulus of soil reaction) values has been empirically developed for use in the Iowa Formula for predicting buried flexible pipe initial (no time effect) deflections for fills less than 50% (15 m).

A series of laboratory soil container load tests on flexible pipe established the effect of the load on the pipe, the pipe stiffness, the soil type, and the degree of compaction of the soil beside the pipe on the pipe deflection.

After using data from over 100 field tests to establish E' values for specific soil types and degrees of compaction, the E' values were used in the Iowa Formula to show that the values of E' could have been used to predict the

actual pipe deflection for dumped and slight degrees of compaction to within ±2%, for moderate degrees of compaction to within ±1% deflection, and for high degrees of compaction to within ±0.5% deflection. The percentage deflection refers here to the variation in the actual deflection from the predicted deflection. For ±1% deflection accuracy, if the predicted deflection were 3%, the actual deflection would be between 2% and 5%.

The data from the field measurements of buried pipe showed that the deflection along a pipeline can vary ±2% deflection about the average deflection for any soil type or degree of compaction.

Appendix I.—References

1. Gehrels, J. R., "Experience with Plastic Sewers and Drainage Pipes," *Proceedings*, 2nd International Plastic Pipe Symposium, Southhampton, Great Britain, Sept., 1972.
2. Howard, A. K., "Laboratory Load Tests on Buried Flexible Pipe," *Journal of the American Water Works Association*, Vol. 64, No. 10, Oct., 1972, pp. 655–662.
3. Howard, A. K., "Field Test Deflections of Reinforced Plastic Mortar Pipe," *Transportation Research Board Record 518*, Washington, D.C., 1974.
4. Howard, A. K., "Modulus of Soil Reaction (E') Values for Buried Flexible Pipe," Bureau of Reclamation, Denver, Colo., Dec., 1976.
5. Howard, A. K., and Selander, C. E., "Laboratory Load Tests on Buried Reinforced Thermosetting, Thermoplastic, and Steel Pipe," *Journal of the American Water Works Association*, Vol. 66, No. 9, Sept., 1974, pp. 540–552.
6. Spangler, M. G., "The Structural Design of Flexible Pipe Culverts," *Iowa Engineering Experiment Station Bulletin No. 153*, Ames, Iowa, 1941.
7. Watkins, R. K., and Spangler, M. G., "Some Characteristics of the Modulus of Passive Resistance of Soil: A Study of Similitude," *Highway Research Board Proceedings*, Vol. 37, Washington, D.C., 1958, pp. 576–583.

Appendix II.—Notation

The following symbols are used in this paper:

- D_l = deflection lag factor;
- E = modulus of elasticity;
- EI = pipe wall stiffness;
- EI/r^3 = ring stiffness factor;
- E' = modulus of soil reaction;
- h = fill height;
- I = moment of inertia;
- K = bedding constant;
- LL = liquid limit;
- r = pipe radius;
- t = pipe wall thickness;
- W = load on pipe per unit length;
- ΔX = horizontal deflection of pipe;
- ΔY = vertical deflection of pipe; and
- γ = soil density.