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TECHNICAL MEMORANDUM

CH2M HILL

Filter Pack and Well Screen Specifications for DDMT Extraction Wells

PREPARED FOR: File

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This Technical Memorandum presents filter pack and screen size calculations for groundwater extraction wells to be installed along the western perimeter of Dunn Field at the Defense Depot Memphis Tennessee. This memorandum was prepared to evaluate specific commercial filter packs and superceeds the January 2, 1997, memorandum used to establish the design requirements for the Dunn Field extraction wells as submitted in the *Groundwater Interim Remedial Action: Defense Depot Memphis, Tennessee Technical Specification and Appendices* (CH2M HILL, August 1997). This evaluation was required since the commercial filter pack originally identified was not available.

Methodology recommended by EPA (1975) was used to determine the appropriate filter pack and well screen design. The filter pack grain size distribution was selected based on analysis of grain size data from wells along the western and northern boundary of Dunn Field: MW-14, MW-08, MW-09, MW-10, MW-11, MW-12, MW-29, MW-33, and MW-35 (Law, 1990, Appendix C). Summary distributions presented in Table 1 and Figure 1 indicate a significant increase in grain size at the D10 sieve size at wells MW-08, MW-09, and MW-14.

Table 1. Sieve Data from Dunn Field Perimeter Wells
Units are Inches

Sample ID	Pass 10% [D90]	Pass 30% [D70]	Pass 50% [D50]	Pass 60% [D40]	Pass 90% [D10]	Coeff of Uniform
	90	**70**	**50**	**40**	**10**	
MW-14	0.014	0.024	0.079	0.147	0.476	10.3
MW-08	0.009	0.016	0.021	0.027	0.119	3
MW-09	0.006	0.009	0.017	0.024	0.202	4
MW-10	0.008	0.012	0.015	0.017	0.044	2.6
MW-11	0.008	0.012	0.015	0.017	0.032	2.4
MW-12	0.009	0.012	0.016	0.019	0.031	2.3
MW-29	0.006	0.008	0.010	0.012	0.019	2
MW-33	0.008	0.011	0.013	0.014	0.021	2
MW-35	0.009	0.016	0.021	0.024	0.044	2.3
Mean	**0.008**	**0.012**	**0.015**	**0.017**	**0.032**	**2.3**

To avoid sand pumping, the filter pack should be designed to exclude finer aquifer materials. Therefore, wells MW-08, MW-09, and MW-14 were considered outliers and removed from the analysis. Figure 2 presents the distributions used to size the filter pack. The mean distribution based on 6 grain-size distributions is nearly identical to that for well MW-11, therefore for graphical convenience the distribution from MW-11 will be used to base the filter pack distribution.

Following EPA (1975) criteria, the D70 value of the filter pack distribution was based on 5 times the D70 value for the mean value (well MW-11). The filter pack distribution was drawn based on a uniformity coefficient (D10/D40) of 2.0. The graphical analysis is presented in Figure 2 as the "design pack." Filter pack grading taken from Figure 2 is summarized in Table 2.

Table 2. Filter Pack Gradation.

Size Retained	% Finer by Weight	Size (mm)	Size (inch)	Closest U. S. Standard Sieve Size
D10	90	3.7	0.147	5
D30	70	2.3	0.091	8
D50	50	1.9	0.075	10
D60	40	1.6	0.064	12
D70	30	1.4	0.056	14
D90	10	1.0	0.040	18

An 18/5 (D10/D90) commercial filter pack with a uniformity coefficient of 2 will meet the above specifications.

Analysis of Commercial Filter Packs

Procedures identified in *Groundwater and Wells* (Driscoll, 1986) indicate using a filter pack with a D70 a factor of between 4 and 10 on the D70 value of the formation. A factor of 4 to 6 is to be used if the formation is uniform. A factor of 6 to 10 is to be used if the formation contains significant silt or thin clay stringers. The fluvial sands at Dunn Field are fairly uniform; however, the 40 percent retained size is above 0.010 inches. Filter packs close to a coefficient of 6 were selected to best fit the Fluvial Sands. Inspection of the filter packs plotted on Figure 2 indicate that the Filter Sil #2, Global #4, Filter Sil #3, and Red Flint 1.65-2 are between a D70 multiplier of 5.6 and 7 and are all acceptable.

Well Screen Calculation

Following criteria stated in Driscoll, (1986, pg 443) the screen slot size should retain 90% or more of the filter pack material. A #40 (0.040 in) screen slot size corresponds to the filter pack D90 size.

Entrance Velocity Calculation

Assumptions:

304 stainless steel vee-wire screen will be used to maximize open surface area. Following specifications are from personal communication with Johnson Screens, (612) 636-3900 (6/11/96):

	Screen Diameter					
	6 in.		8 in.		12 in.	
Slot Size (in)	sq. in.	%	sq. in.	%	sq. in.	%
0.04	87	38%	101	33%	102	23%

Entrance velocity calculations were performed following procedures in Driscoll (1986, pg 450).

a) Total area of 6, 8, and 12 inch diameter screens (ft^2) per foot length of screen
= Π * diameter (ft) * 1 ft

b) Therefore, amount of open area per foot of screen
= Percent open area * total area

c) Entrance velocity = maximum pumping rate (ft^3/sec)/open area of screen (ft^2)
Open area of screen = saturated thickness(ft) x diameter(in) x ft/12 in x Π x percent open area of screen

Entrance velocities over a range of saturated thickness' and maximum pumping rates are presented below.

Pumping Rate =40 gpm			
Screen Size =	0.04		
Saturated Thickness after Drawdown (ft)	6 in	8 in	12 in
5	*0.03*	*0.03*	*0.03*
4	*0.04*	*0.03*	*0.03*
3	*0.05*	*0.04*	*0.04*
2	*0.07*	*0.06*	*0.06*
1	0.15	0.13	0.13
Units are in ft/sec			

Pumping Rate = 75 gpm			
Screen Size =	0.04		
Saturated Thickness after Drawdown (ft)	6 in	8 in	12 in
5	*0.06*	*0.05*	*0.05*
4	*0.07*	*0.06*	*0.06*

3	*0.09*	*0.08*	*0.08*
2	0.14	0.12	0.12
1	0.28	0.24	0.24
Units are in ft/sec			

Driscoll (1986, pg 996) suggests a maximum entrance velocity of 0.1 ft/sec. Review of the calculations indicates that at the expected low maximum pumping rate of 40 gpm, a 0.04-in screens allows drawdown to 1 ft saturated thickness. At the maximum expected pumping rate of 75 gpm, drawdown to a saturated thickness of about 3 ft can be maintained using a 0.04 screen size in a 6, 8, or 12 inch diameter well. Saturated thickness is expected to be maintained above 5 ft to keep the pump cool.

Extraction Well Screen Specification

0.04 inch slot size.
304 stainless steel.
Percent open area no less than 38% in a 6-inch well, 27% in an 8-inch well, and 18% in a 12-inch well.
Johnson Vee Wire slot design or equivalent.

Filter Pack Specification

A 18/5 (D10/D90) commercial filter pack with a uniformity coefficient of 2.
100% silica materials.

References

Driscoll, F. G., 1986. *Groundwater and Wells*. Johnson Infiltration Systems, Inc. 1089pp.

Law Environmental, Inc, 1990. *Remedial Investigation Final Report: Appendices.*

U.S. EPA, 1975. *Manual of water well construction practices; United States Environmental Protection Agency, Office of Water Supply*, EPA-570/9-75-001, 156 pp.

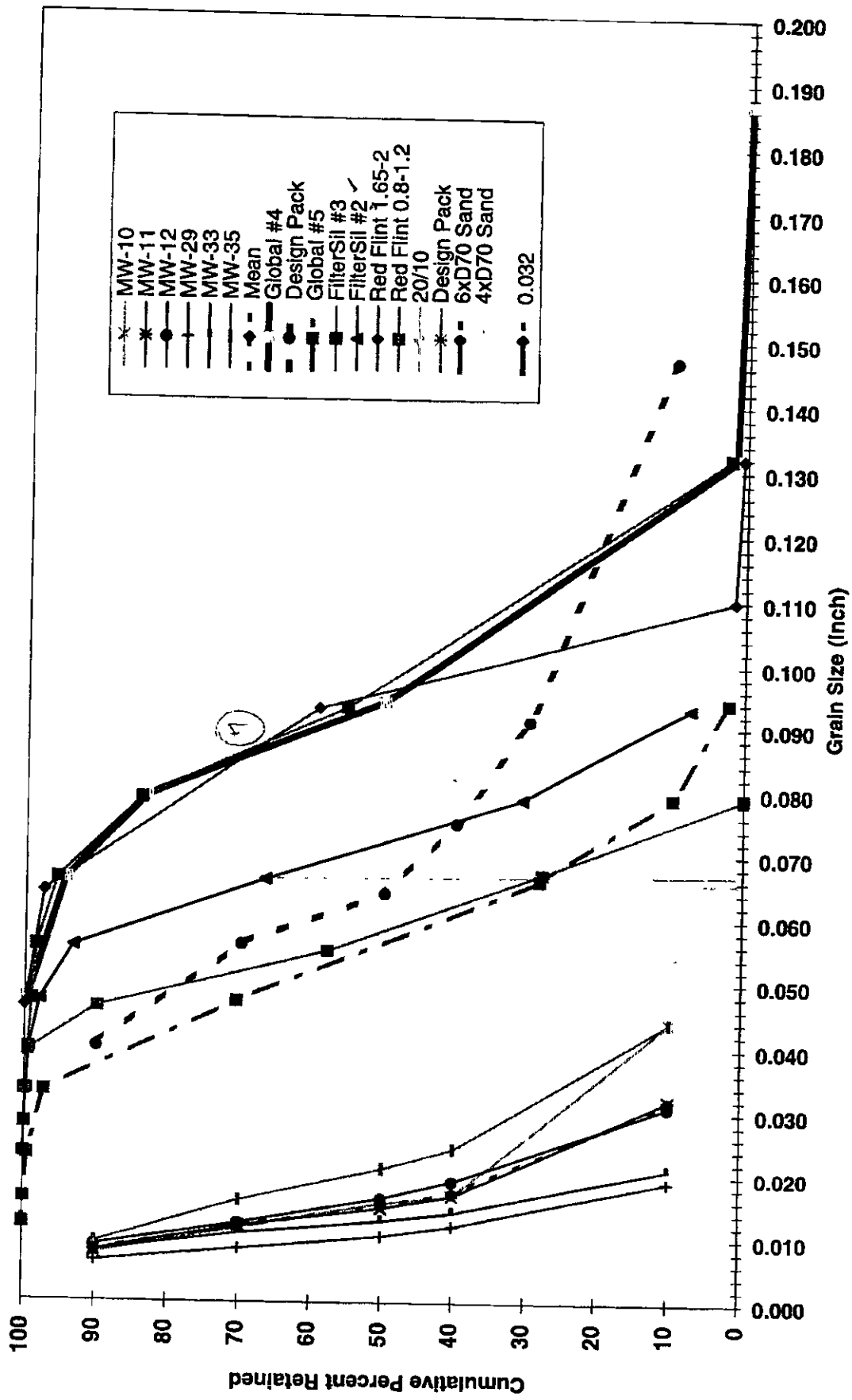

Figure 2. DDMT Extraction Well Filter Pack Analysis

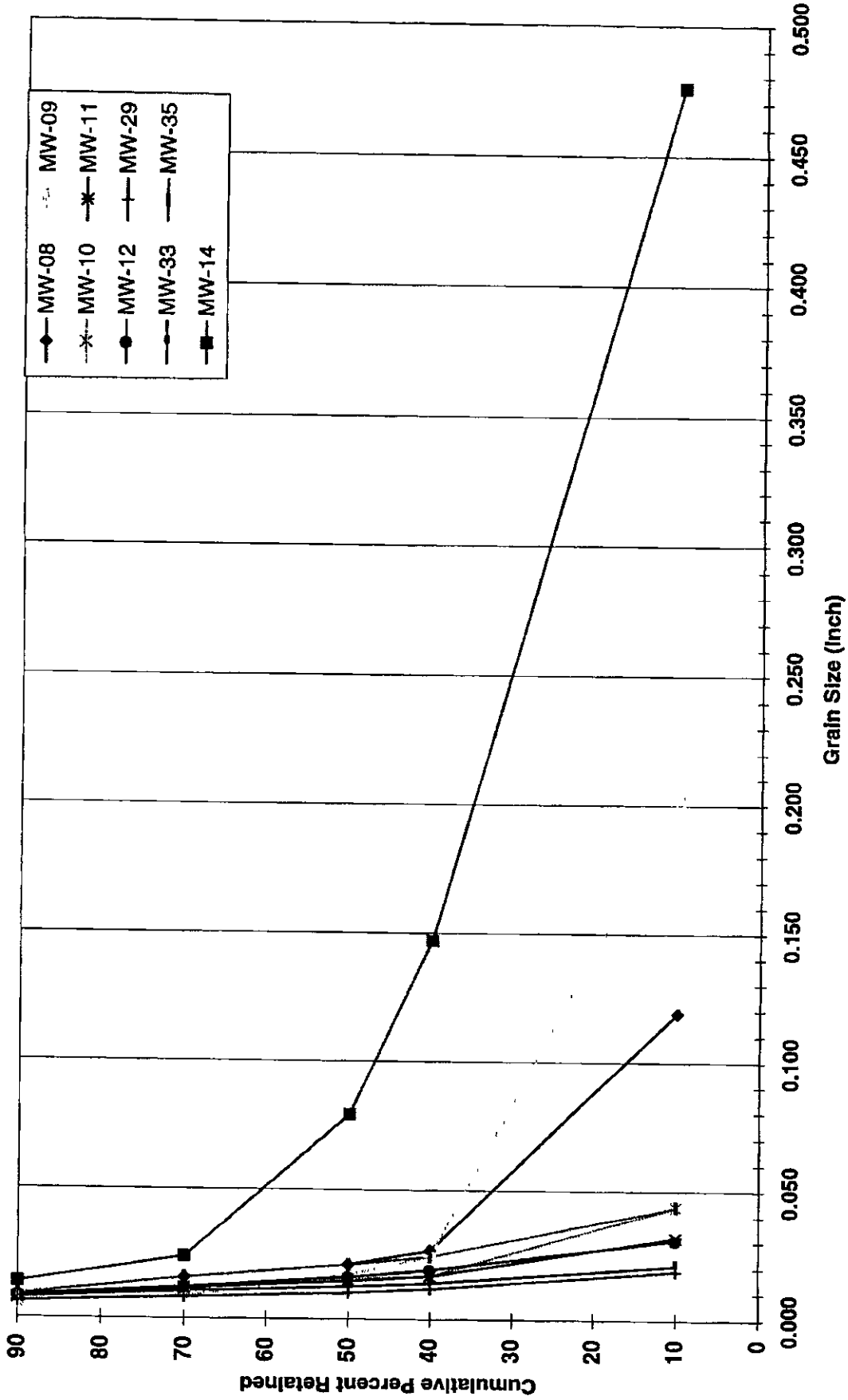

Figure 1. DDMT Extraction Well Filter Pack Analysis

Grain Size Analysis- Law Engineering 1990

Sample ID	Classification	Top Interval	Bottom Interval	D50 (mm)	D50 (In)	D70 (mm)	D70 (in)	Coef of Unif (D60/D10)	Barcelona (3X D50) in	Barcelona (5X D50) in	EPA (4X D70) in	EPA (6X D70) in
MW-29	Poorly Graded Sand	55	56.5	0 28	0.011	0.22	0.009	1.76	0.033	0.056	0.035	0.052
MW-31	Poorly Graded Sand	75	76.5	0 41	0.016	0.34	0.013	1.77	0 049	0.081	0.054	0.081
MW-33	Poorly Graded Sand	50	51.5	0.32	0 013	0.27	0.011	1.85	0.038	0 064	0.043	0.064
MW-28	Poorly Graded Sand	60	61.5	0.4	0.016	0.31	0.012	1.95	0.048	0.079	0.049	0.074
STB-5	Poorly Graded Sand	78.5	83.5	0 45	0 018	0.38	0.015	2.03	0.054	0 089	0.060	0.091
MW-12	Poorly Graded Sand	NA	74	0.42	0.017	0.32	0.013	2.04	0.050	0.083	0.051	0.076
MW-11	Poorly Graded Sand	73.5	75	0.39	0.015	0.29	0.012	2.1	0.046	0.077	0.046	0.069
MW-21	Poorly Graded Sand w/gravel	93.5	95	0 4	0 016	0.31	0.012	2.17	0.048	0.079	0.049	0.074
MW-10	Poorly Graded Sand	63 5	65	0.38	0.015	0.28	0.011	2.22	0.045	0.075	0 044	0.067
MW-13	Poorly Graded Sand	NA	80	0.36	0.014	0.26	0.010	2.22	0.043	0.071	0.041	0.062
MW-35	Poorly Graded Sand	85.5	87	0.53	0.021	0 4	0 016	2.3	0.063	0.105	0.064	0.095
MW-23	Poorly Graded Sand w/gravel	103.5	105	0.45	0.018	0.32	0.013	2.72	0.054	0.089	0.051	0.076
MW-18	Poorly Graded Sand w/silt	138.5	140	0.22	0.009	0.18	0.007	2.77	0.026	0.044	0.029	0.043
MW-34	Poorly Graded Sand	156.5	158	0.6	0.024	0 46	0 018	3.1	0.071	0 119	0.073	0.110
MW-37	Poorly Graded Sand w/silt	170	171.5	0.2	0.008	0.17	0.007	3.14	0.024	0 040	0.027	0.040
MW-8	Poorly Graded Sand with gravel	63.5	65	0.6	0.024	0.4	0.016	3.2	0.071	0.119	0.064	0.095
MW-9	Poorly Graded Sand	73 5	75	0.42	0.017	0 25	0.010	3.52	0.050	0.083	0.040	0.060
MW-16	Poorly Graded Sand w/silt	63.5	65	0.48	0 019	0.35	0.014	3.52	0.057	0 095	0.056	0 083
MW-38	Poorly Graded Sand w/silt	142	143.5	0.29	0 012	0.2	0.008	4.13	0 035	0.058	0.032	0.048

Sample ID	Classification	Top Interval	Bottom Interval	D50 (mm)	D50 (in)	D70 (mm)	D70 (in)	Coef of Unif (D60/D10)	Barcelona (3X D50) in	Barcelona (5X D50) in	EPA (4X D70) in	EPA (6X D70) in
MW-26	Poorly Graded Sand w/gravel	105	106.5	0.51	0 020	0.34	0 013	4.35	0.061	0 101	0 054	0.081
MW-25	Poorly Graded Sand w/gravel	75	76.5	0.8	0 032	0.47	0.019	5	0 095	0.159	0.075	0.112
MW-22	Poorly Graded Sand w/gravel	103.5	105	6	0.238	0.36	0.014	5.18	0.715	1.191	0.057	0.086
MW-27	Well Graded Sand w/silt	85	86	0.66	0.026	0.41	0 016	5.71	0.079	0.131	0.065	0.098
MW-22	Poorly Graded Sand w/silt and gravel	108.5	110	0.7	0.028	0.37	0.015	6.5	0.083	0.139	0.059	0.088
MW-24	Poorly Graded Sand w/gravel	113.5	115	1 4	0.056	0.65	0.026	7.9	0.167	0.278	0.103	0.155
MW-39	Poorly Graded Sand w/gravel	110	111.5	0.7	0 028	0.35	0.014	8.5	0 083	0 139	0.056	0.083
MW-14	Poorly Graded Sand w/ gravel	NA	75	2	0.079	0.65	0.026	10.5	0 238	0.397	0.103	0.155
MW-32	Poorly Graded Silt	60	61.5	0.5	0.020	0.31	0.012	11.6	0.060	0.099	0.049	0.074
MW-20	Poorly Graded Sand w/silt and gravel	NA	86	0.27	0.011	0.19	0.008	14	0.032	0.054	0.030	0.045
MW-19	Poorly Graded Sand w/silt and gravel	88.5	90	1.7	0.067	0.5	0.020	20	0.202	0.337	0.079	0.119
MW-29	Well Graded Gravel	40	41.5	5	0 199	1.8	0 071	20	0.596	0.993	0.286	0.429
MW-17	Poorly Graded Sand w/silt and gravel	88.5	90	2.9	0.115	0.75	0 030	25	0.345	0.576	0 119	0.179
MW-30	Poorly Graded Silt	60	61.5	0.4	0.016	0.28	0.011	NA	0.048	0.079	0.044	0.067

Assumed D70 corresponds to the 70 percent retained line

DDMT Dunn Field Pumping Well Design										
Filter Pack Sieve Data										
Global #4										
Cum % retained	0	1.5	50.3	83.4	94.5	99.7				
Screen (inch):	0.187	0.132	0.094	0.079	0.066	0.047				
Design Pack										
Cum % retained	10	30	40	50	70	90				
Screen (inch):	0.147	0.091	0.075	0.064	0.056	0.04				
Global #5										
Cum % retained	2.3	10	28.3	70.6	97.2	99.5	99.9	100		
Screen (inch):	0.094	0.079	0.066	0.047	0.033	0.023	0.016	0.012		
FilterSil #3										
Cum % retained	2.3	55.6	84.1	95.6	98.5	99.1	99.5	99.7	99.9	100
Screen (inch):	0.132	0.0931	0.0787	0.0661	0.0555	0.0469	0.0394	0.0331	0.028	0.0232
FilterSil #2										
Cum % retained	7.6	30.9	66.8	93.4	97.9	99.4	99.7	99.9	100	
Screen (inch):	0.0931	0.0787	0.0661	0.0555	0.0469	0.0394	0.0331	0.028	0.0232	
Red Flint 1.65-2										
Cum % retained	0.5	1.5	59.5	97.5	100					
Screen (inch):	0.132	0.11	0.093	0.064	0.046					
Red Flint 0.8-1.2										
Cum % retained	0	28	58	90	99.5	100				
Screen (inch):	0.079	0.067	0.055	0.046	0.039	0.033				

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