

Table 5-6
West View Shores Subdivision Well Data (1991 - 1994)

WELL NO. PERMIT NO. SCRN MEDIUM	EPA Standards	217a CE 73-2227 Blue Clay	138a CE 81-1463 Coarse Wht Sand / Grv	76 CE 88-1774 Gray Tan Sand	40 CE 73-1473 Coarse White Sand	69 CE 93-0349 Coarse Tan Sand
DATE	DATE	DATE	DATE	DATE	DATE	DATE
Alkalinity	10	9/2/92	8/20/92	7/15/92	12/16/91	6/23/94
Nitrate	10	11	3	21	65	20
Nitrate-Nitrite		7.7	3.9	--	0.2 L	0.2 L
Chloride	250	810	15	132	11	144
Fluoride	2	0.1 L	0.1 L	0.1 L	0.11	0.10 L
Sulfate	250	39.7	28.6	107	3.8	670.0
Dissolved Solids	500	1426	94	396	58	1146
COD		10 L	10 L	--	10 L	10 L
Cadmium	0.005	0.005 L	0.005 L	0.005 L	0.005 L	0.005 L
Lead	0.015	0.01 L	0.01 L	0.01 L	0.01 L	0.014
Calcium		57.4	6.2	22.6	9.4	109.0
Copper	1	0.05 L	0.05 L	0.33	0.05 L	0.07
Iron	0.3	30.4	5.9	19.31	36.6	6.88
Magnesium		0.27	0.12	26.2	2.3	94.6
Manganese	0.05	0.05 L	0.05 L	1.08	0.05 L	21.5
Nickel	0.1	15.4	2.4	0.02	0.05 L	0.12
Potassium		461.3	9.8	73.4	7.1	8.60
Sodium	20	0.05 L	0.05 L	0.19	0.25	120.1
Zinc	5	2650	153	657	98	0.49
Cond. (umhos/cm)		1600	130	600	150	1484
PARAMETERS (mg/l)						

WELL NO. PERMIT NO. SCRN MEDIUM	EPA Standards	79 CE 88-1441 Med. Fine White Sand	147 CE 88-1923 Yellow / White Sand	2 CE 73-2006 Coarse White Sand	31 CE 93-0288 Coarse Tan Sand
DATE	DATE	DATE	DATE	DATE	DATE
Alkalinity	10	12/18/91	4/13/93	8/10/92	4/20/94
Nitrate	10	53	5	58	5
Nitrate-Nitrite		0.2 L	0.2	--	0.2 L
Chloride	250	12	240	8	107
Fluoride	2	0.1 L	0.1 L	0.1 L	0.1 L
Sulfate	250	19.1	760	4.1	1505
Dissolved Solids	500	118	1702	96	2108
COD		10 L	10 L	--	10 L
Cadmium	0.005	0.005 L	0.005 L	0.005 L	0.005 L
Lead	0.015	0.01 L	0.01 L	0.01 L	0.01 L
Calcium		11	143.8	12.9	146.6
Copper	1	0.05 L	0.05 L	0.05 L	0.21
Iron	0.3	20.88	2.09	6.80	185.6
Magnesium		2.7	137.4	2.1	136.7
Manganese	0.05	0.18	35.76	2.14	50.4
Nickel	0.1	0.05 L	0.40	0.05 L	0.12
Potassium		1.1	6.4	1.6	7.85
Sodium	20	6.8	145.7	7.3	82.7
Zinc	5	0.05 L	0.42	0.24	0.24
Cond. (umhos/cm)		137	2280	125	2390
PARAMETERS (mg/l)					

An "L" indicates that values reported are less than the detection limit

The exceptions are Well 147 where concentrations of chloride, sulfate, dissolved solids, calcium, iron, magnesium, manganese, sodium and zinc have increased from 1993 to 1994 and Well 217a where concentrations of sulfate, calcium, iron, magnesium and manganese have increased from 1992 to 1994.

5.6 EVALUATION OF POTENTIAL CONTRIBUTION FROM SEPTIC SYSTEMS

The parameters that were reviewed during this study to determine if there is a potential impact from septic systems were BOD, nitrates, and ammonia. Although there are elevated levels of each of these compounds in various wells, without additional testing, in particular for coliforms, it is not possible to draw the conclusion that the elevated levels of these compounds are solely due to septic contamination. As previously stated in Section 4.0, it is possible to interpret that the Elk River is in direct contact with outcrop areas of the Potomac Group sediments and could be locally influencing the upper Potomac aquifer underlying the West View Shores Subdivision through recharge.

The nitrate concentration for one of the wells (217b) is above acceptable drinking water levels. Since the effluent from the containment site is very low in nitrates, the elevated level of nitrate in the well sample most likely occurs from some source other than the dredged material placement site. The source of the contamination could be fertilizers or septic contamination and cannot at this time be conclusively determined without additional information.

5.7 EVALUATION OF POTENTIAL CONTRIBUTION FROM SALT WATER INTRUSION

Salt water intrusion is a relatively common phenomenon in Maryland and saline water is the most common pollutant in fresh water. Salt water intrusion can result from several sources. One source is the upward advance of saline waters of geologic origin. Another source is in shallow aquifers from surface water discharges with saline characteristics. A third source is in coastal aquifers from the invasion of seawater (Todd, 1980).

Evaluation of saline intrusion into freshwater can be performed by evaluating the chemical characteristics of the water in question. There are certain concentrations of parameters which are characteristic of freshwater aquifers and other concentrations of parameters which are characteristic of saline waters.

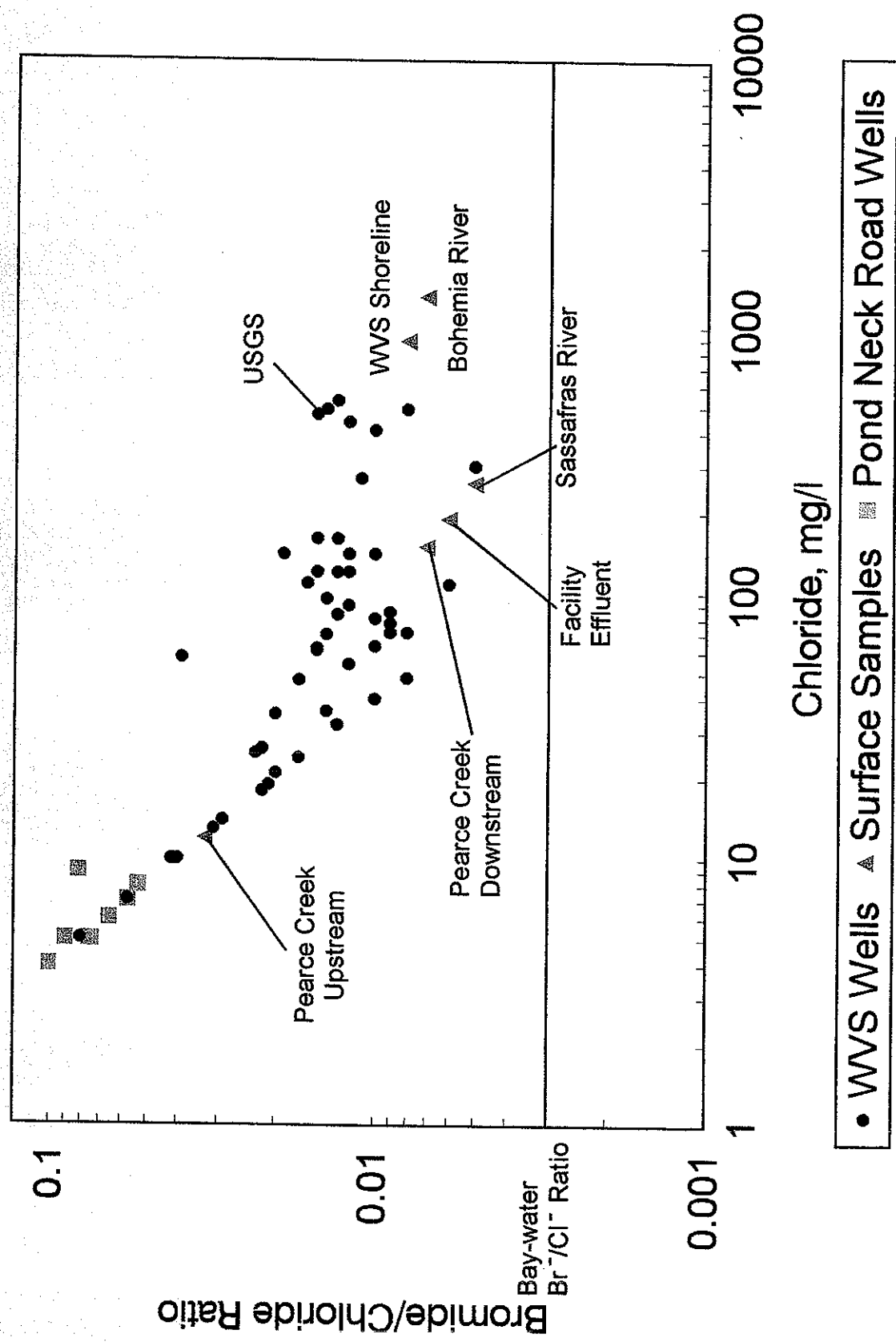
Evaluation of saline contamination can be performed using standard ratios of constituents in fresh water versus saline waters or through evaluation of individual constituents present in characteristic concentrations in either saltwater or fresh water. These evaluations must be qualified, however, as analysis of water samples collected in zones of seawater intrusion can show a chemical composition differing from a simple proportional mixing of seawater and water. In addition, more than one source can be responsible for the presence of saline waters.

As an example, bicarbonate is an individual constituent used for evaluation as it is usually the most abundant anion in freshwater and occurs in only minor amounts in seawater (Todd, 1980). Thus, if higher bicarbonate concentrations are present in saline waters, the aquifer may contain saline waters of geologic origin versus seawater origin.

Chloride concentration is also useful for comparison as it is the dominant anion in ocean water, and is unaffected by many chemical reactions such as base exchanges, sulfate reductions, substitution of carbonic or other weak acid radicals, solution and precipitation processes. It also normally occurs in only small amounts in freshwater (Todd, 1980). Other major constituents such as sulfate, magnesium, potassium, calcium, sodium and bromide also dominate sea salt and their ratios are very constant (Stumm & Morgan, 1981). Due to this consistency, these ratios can be used to indicate whether salt water may be intruding into a freshwater system. The bromide/chloride ratio has been recommended by local resource agencies in evaluating the potential for saltwater intrusion in the West View Shores Subdivision (WVSS) wells. This evaluation is presented below.

Figure 5-1 presents bromide/chloride (Br/Cl) ratios for water samples from the WVSS wells, the Pond Neck Road well samples, Bay and river samples and the predicted

**Figure 5-1: Bromide/Chloride Ratio vs. Chloride
West View Shores Subdivision Wells**



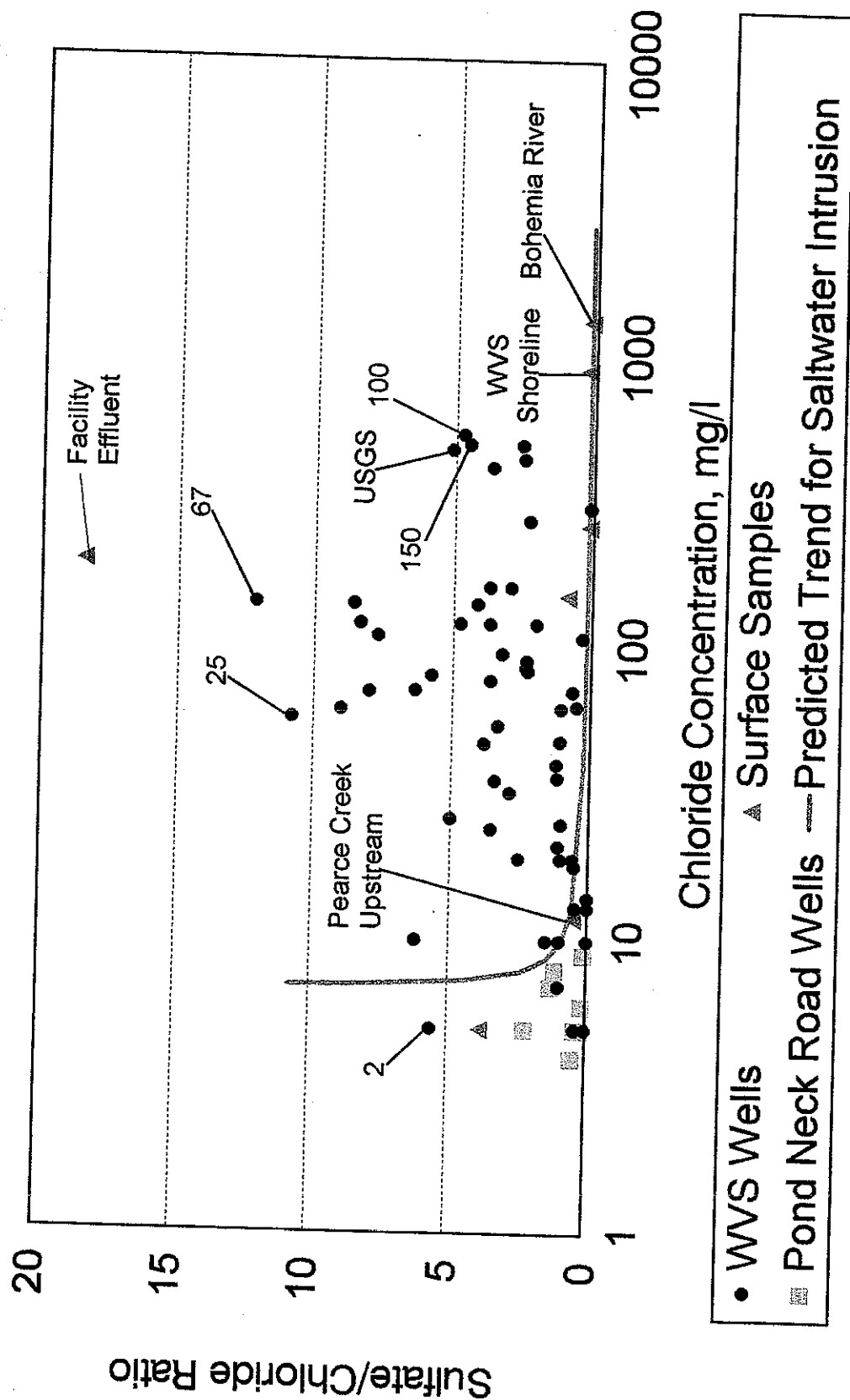
bromide/chloride ratio for the conservative mixing of regional Bay and aquifer waters. The Pond Neck Road wells are located outside WVSS and further from the shoreline. The predicted ratios for the conservative mixing of Bay and aquifer waters are calculated using known concentrations of constituents in each body of water. The conservative mixing model was provided by the Maryland Geological Survey and can be found in Appendix G. The bromide/chloride ratios for both the Pond Neck samples and the conservative mixing model can be used as a frame of reference in reviewing the WVSS data. However, it should be noted that the apparent elevated bromide/chloride ratios for the Pond Neck Road well samples may be lower than presented, since the reported concentrations for bromide on these wells are less than the 0.4 mg/l detection limit. Nonetheless, this information is useful in evaluating the relationship of the chloride concentrations in these wells.

Upon examination of the data, it appears that the WVSS wells have higher concentrations of chloride than the Pond Neck Road wells indicating a source of chloride in the WVSS wells. Although elevated chloride concentrations could be indicative of saltwater intrusion, the bromide/chloride ratios in the WVSS well water are generally greater than the surface water samples suggesting a different chloride source. Contaminants such as road salt and sewage effluent can probably be ruled out because the Br/Cl⁻ signature for these are typically low (Andreason, 1995).

The sulfate/chloride ratios for the WVSS wells are presented in Figure 5-2. This Figure allows for further investigation of the potential for saltwater intrusion in these wells. The sulfate/chloride ratios are also presented for the Pond Neck wells, the Bay and river samples and for the conservative mixing of regional Bay and aquifer waters. This data serves as a frame of reference for evaluating the WVSS data.

Upon examination of the data, it appears that WVSS wells have elevated concentrations of sulfate and chloride in comparison with the Pond Neck Road wells indicating a source of sulfate in addition to chloride in the WVSS wells. Although elevated sulfate concentrations could be indicative of saltwater intrusion, the sulfate/chloride ratios for the WVSS wells are

Figure 5-2: Sulfate/Chloride Ratio vs. Chloride
West View Shores Subdivision Wells



generally higher than Bay and river ratios and predicted ratios for the conservative mixing of Bay and regional aquifer waters. As previously mentioned, sulfate/chloride ratios should remain relatively constant if saltwater is intruding into a freshwater system. However, this is not demonstrated by the WVSS sulfate/chloride ratios, again suggesting a non-conservative source of sulfate in the WVSS wells.

Although there is some evidence for mixing of Bay and aquifer waters in the West View Shores Subdivision wells, there appears to be a different source for the elevated constituents in the wells. As depicted in Figures 5-1 and 5-2, bromide/chloride and sulfate/chloride ratios for the West View Shores Subdivision wells were higher than Bay and river ratios and predicted ratios for the conservative mixing of Bay and regional waters for these constituents. The source for the elevated constituents in the wells may be identified after determination of local groundwater directional flow.

5.8 EVALUATION OF POTENTIAL CONTRIBUTION FROM PEARCE CREEK FACILITY

From studies of other upland dredged material placement sites conducted by the U.S. Army Engineer Waterways Experiment Station, degradation of local groundwater may potentially be identified by elevated levels of manganese, chloride, potassium, sodium, calcium, alkalinity and iron (EL, 1980). Several well water samples analyzed for this study show elevated concentrations of manganese, chloride, potassium, sodium, calcium, iron, sulfate and dissolved solids. The wells exhibiting concentrations notably higher than documented regional groundwater quality have been identified in Section 5.3 as 22a, 22b, 25, 49b, 52a, 52b, 54, 61, 62, 67, 71, 100, 132, 135, 138b, 147, 150, 161, 217a and USGS. In addition, samples from some of these wells contained elevated concentrations of alkalinity.

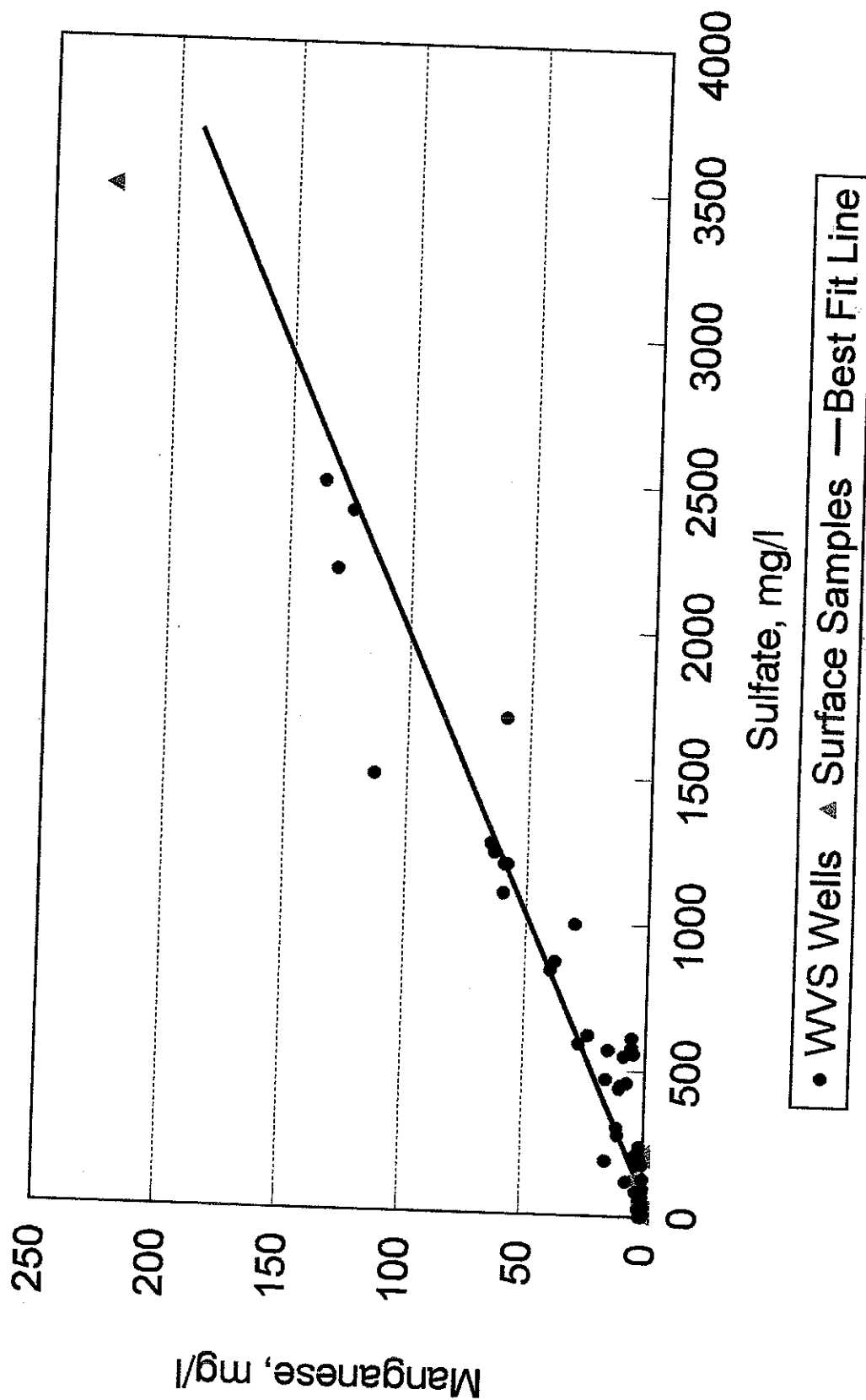
A preliminary evaluation of the existing data by the Maryland Geological Survey indicates evidence of influence to the local waters due to the oxidation of sulfide rich minerals (Appendix G). This oxidation process occurs when the sulfide minerals react with oxygen, such

as dissolved oxygen in the groundwater or through exposure to air or weathering, and releases sulfuric acid (EL, 1985). This reaction may occur due to pyritic soils from naturally existing geologic conditions or sulfide bearing marine sediments, including dredged material. The oxidation results in the release of acid forming salts and free sulfuric acid which causes the pH in the soils to drop and dissolved metals to form. Upon review of the groundwater sample data from this study, the oxidation process is evidenced by the presence of significantly low pH and exceedingly high sulfate and manganese concentrations which appear to be linearly related (Appendix G). Although the pH of groundwater in Cecil County is generally low, groundwater samples from some of the wells indicate pH levels lower than documented aquifer water quality. For instance, groundwater samples taken from wells 49b and USGS indicate pH levels of 3.01 and 2.7, respectively. The linear relationship between the manganese and sulfate concentrations in the groundwater sampled from the residential wells in this study can be observed in Figure 5-3. Manganese and sulfate concentrations in the groundwater samples range as high as 136 mg/l and 2500 mg/l, respectively. These concentrations are significantly higher than the documented regional groundwater quality as shown in Table 5-4. High manganese concentrations found in the groundwater samples may be related to the acidity which releases metals into solution (Appendix G).

As discussed in Section 5.7, the graphed relationship of sulfate and chloride concentrations from the groundwater samples (Figure 5-2) indicates that sulfate concentrations are increased due to a source other than exclusively conservative mixing of bay water intrusion into aquifer waters. This increased sulfate concentration could potentially be explained by sulfide oxidation of marine sediments or pyritic soils (Appendix G).

The sulfide oxidation process is common in drying dredged material. Therefore, the presence of sulfates and other constituents in the WVSS groundwater suggests a possible chemical link between the degraded groundwater quality underlying the West View Shores Subdivision and the Pearce Creek Facility. However, additional physical evidence is required to substantiate a link between the two. The high levels of sulfates could also be indicative of naturally occurring pyritic soils and sediments found in Maryland. Such soils and sediments are

Figure 5-3: Manganese vs. Sulfate
West View Shores Subdivision Wells



known to produce high sulfates in waters of geologic origin in areas of the Eastern coast of the United States (EL, 1985).

Figures 5-4 through 5-11 present plan views of the community with chemical concentrations of alkalinity, calcium, chloride, iron, manganese, potassium, sodium and sulfate. The expected ranges of the various chemical constituents may be found in Table 5-4 and Appendix F for comparison. These figures are developed to identify potential patterns in the groundwater underlying the West-View Shores Subdivision. In each of these figures, there are no apparent patterns regarding the distribution of the wells having less desirable water quality within the community. Wells with poor water quality appear interspersed with wells yielding better water quality. What is observed from Figures 5-4 through 5-11 is that the wells yielding lesser quality have consistently high concentrations of the selected parameters with the exception of alkalinity, and where documentation is available, these wells are screened at lower elevations. The exception, lower alkalinity can be attributable to low pH values of the surrounding medium (EL, 1980).

To demonstrate the vertical distribution of wells yielding groundwater with elevated concentrations of sodium, chloride, manganese and sulfate, cross sections were taken of the subdivision as shown on Figure 5-12. The locations of the cross sections were selected to intersect as many wells as possible with available well boring information. In addition, borings from the dike of the dredged material facility were also included in some of the cross sections. The interpolated cross sections subsequently appear on Figures 5-13a and b through 5-16a and b. Although the soil conditions provided in these cross sections rely upon drillers' boring logs and assumptions of soil conditions between each documented boring, the information is helpful in portraying the vertical distribution of constituents in the sampled well water. Where documentation is available, it appears most of the wells with degraded groundwater quality are screened within the upper Potomac aquifer between elevations -50 and -100 feet (NGVD 1929) and that the concentrations increase with the depth of the screen elevation. In addition, the screening medium of most of these wells is documented as coarse yellow white sand.

Additional data are needed to conclusively describe the groundwater conditions within this area and the potential impact from the dredged material facility.

As described in Section 4.0, outcroppings of the Potomac Group sediments are located within the vicinity of the Pearce Creek Facility along the shoreline of Crystal Beach. The location of the Pearce Creek Facility may be locally influencing the upper Potomac aquifer underlying the West View Shores Subdivision, provided the geologic conditions underlying the Facility sustain. This condition could potentially allow for a significant vertical hydraulic gradient below the facility, particularly during dredged material inflow operations. Yet, without additional data to verify the water movement and to further identify the water quality in all areas of the subdivision, this cannot be conclusively determined since other factors may be influencing the water quality underlying the West View Shores community, such as salt water intrusion and naturally occurring pyritic soils.

5.9 EVALUATION OF POTENTIAL CONTRIBUTION FROM OTHER SOURCES

Since this document reports only the findings of a Phase I Study, data gathering is limited to the scope of a preliminary investigation. Some areas of the site still require additional examination, including the following factors:

Potential Solid Waste Dump Site

During the field sampling portion of this study, several residents reported that a dumping area had existed within the community near the intersection of North Street and Midway Drive. The disposal material and dates are unknown. Review of the existing data, does not confirm or refute these reports.

Other Potential Sources

There is no information available as to the conditions underlying the Pearce Creek

Facility. Therefore, it is not known if there are other potential sources beneath the facility which pre-date the facility and may be contributing to the degraded groundwater condition underlying the West View Shores Subdivision.

Subsurface Exploration, Hydrogeologic Investigation

The scope of this study is limited to existing available information. Therefore, no subsurface exploration was performed. Due to the lack of information regarding subsurface exploration and groundwater flow patterns from this Phase I Report, potential influences from other sources including pyritic soils cannot be determined without further study.

6.0 CONCLUSIONS

The purpose of this study was to perform a groundwater study of the area consisting of the Pearce Creek Placement Facility and the West View Shores Subdivision utilizing only readily obtainable data from existing sampling structures and documented data. This study provides information to further characterize the relationship of the degraded groundwater underlying the West View Shores Subdivision and designates potential sources of contribution, including salt water intrusion, naturally occurring sediments including pyritic soils, an abandoned dump site within the subdivision, and the Pearce Creek Dredged Material Placement Facility.

Based on evaluation of the available data, the following observations are made:

- groundwater quality within the West View Shores Subdivision exhibits elevated concentrations of certain parameters typical and atypical of existing geologic conditions for Cecil County;
- samples taken from several wells indicate that the groundwater underlying the West View Shores Subdivision contains higher concentrations of certain constituents when compared

to aquifer water quality within Cecil County, particularly for groundwater from the upper Potomac aquifer;

- several well water samples analyzed for this study show elevated concentrations of manganese, chloride, potassium, sodium, calcium, iron, and sulfate. General research performed by the U.S. Army Engineer Waterways Experiment Station suggests that the presence of these constituents may indicate groundwater degradation associated with the upland placement of marine sediments;
- most of the sampled wells yielding degraded groundwater quality are screened within the upper Potomac aquifer between the elevations -50 and -100 feet (NGVD 1929) and that the concentrations increase with the depth of the screen elevation;
- saltwater intrusion may be occurring within the West View Shores Subdivision, but the extent of this influence on the groundwater system cannot be determined with available data;
- evidence indicates that there is influence to the local groundwater due to the oxidation of sulfide rich minerals, although it is not certain whether this reaction is occurring due to pyritic soils from naturally existing geologic conditions or sulfide-bearing dredged material. High levels of sulfates can be indicative of pyritic soils and sediments commonly found in Maryland;
- the degraded groundwater from the upper Potomac aquifer underlying the West View Shores Subdivision is not likely due to residential septic systems;
- the Pearce Creek Upland Dredged Material Placement Facility cannot be either ruled out or positively identified as a contributor to the existing state of groundwater quality based on available data;

- additional groundwater study is required to estimate the water movement in the area of the Pearce Creek Dredged Material Placement Facility; and
- some homeowners have not installed water treatment systems, although water quality at some wells does not satisfy applicable federal drinking water standards.

7.0 RECOMMENDATIONS

Additional study is recommended in order to conclusively identify a potential source or sources as contributors to the existing quality of groundwater underlying the West View Shores Subdivision. In particular, the groundwater movement and hydrogeologic conditions underlying the West View Shores Subdivision, Pearce Creek Facility and Pearce Creek should be examined in further detail. In addition, subsurface exploration of the abandoned dumping site in community and investigation of existing geologic conditions including naturally occurring pyritic soils should be performed.

8.0 REFERENCES

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