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# **AN ASSESSMENT OF THE POTENTIAL EFFECTS OF THE DAYS COVE RUBBLE LANDFILL ON AQUATIC RESOURCES**

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## CONTENTS

<b>UNIQUELY SENSITIVE AQUATIC RESOURCES ASSOCIATED WITH THE SITE</b> .....	<b>1</b>
<b>BROWN TROUT</b> .....	<b>1</b>
<b>UNPRECEDENTED FISH ABUNDANCE &amp; DIVERSITY</b> .....	<b>1</b>
<b>UNICORN FISH HATCHERY</b> .....	<b>1</b>
<b>STATE INVESTMENT IN ALLOWING HERRING TO ENTER UNICORN MILLPOND</b> .....	<b>1</b>
<b>RARE &amp; ENDANGERED SPECIES</b> .....	<b>1</b>
<b>NONTIDAL WETLAND OF SPECIAL STATE CONCERN</b> .....	<b>2</b>
<b>POTENTIAL IMPACTS UPON THESE UNIQUELY SENSITIVE AQUATIC RESOURCES</b> .....	<b>2</b>
<b>INTRUSION UPON THE EXPANDED BUFFER OF THE NONTIDAL WETLAND OF SPECIAL</b> <b>STATE CONCERN</b> .....	<b>2</b>
<b>LEACHATE TOXICITY</b> .....	<b>2</b>
<b>LINER &amp; IMPERMEABLE CAP FAILURE</b> .....	<b>6</b>
<b>LOSS OF GROUNDWATER RECHARGE</b> .....	<b>10</b>
<b>THERMAL IMPACTS</b> .....	<b>10</b>
<b>SUMMARY</b> .....	<b>13</b>
<b>REFERENCES</b> .....	<b>14</b>

## **UNIQUELY SENSITIVE AQUATIC RESOURCES ASSOCIATED WITH THE SITE**

The proposed site of the Days Cove Reclamation Company rubble landfill is located within the watershed of Unicorn Branch. This watershed contains a number of uniquely sensitive and uniquely important aquatic resources. Many of these resources exist nowhere else in Queen Anne's County. All of these resources are located in very close proximity to the proposed landfill. Following is a description of these resources.

### **Brown Trout**

The following discussion is based upon a letter from Mr. Richard K. Schaefer, the Eastern Regional Freshwater Fisheries Manager for the Maryland Department of Natural Resources, to Ms. Loretta Walls, of the Millington Quality of Life Preservation Coalition, dated July 27, 1999, and discussions between Mr. Schaefer and Richard Klein, of Community & Environmental Defense Services.

- A. Unicorn Branch supports year-round survival of brown trout.
- B. Unicorn Branch is the only stream on the Eastern Shore, south of Cecil County, which does support brown trout year-round.
- C. It is the unique high-quality of the stream and cool water temperature that allows brown trout to survive year-round.
- D. Unicorn Branch also has the potential to support brown trout spawning activity.

### **Unprecedented Fish Abundance & Diversity**

In addition to brown trout, Mr. Schaefer reports that Unicorn Branch supports an "unprecedented" diversity and abundance of fish species which includes the gamefish species chain pickerel and largemouth bass.

### **Unicorn Fish Hatchery**

The State's Unicorn Fish Hatchery is one of only two warmwater fish hatcheries in Maryland. The hatchery derives its water from Unicorn Millpond. Maintenance of the high quality waters in the pond is crucial to the continuance of the hatchery.

### **State Investment in Allowing Herring to Enter Unicorn Millpond**

The State of Maryland installed a fish ladder to allow fish migrating upstream in Unicorn Branch to ascend the dam forming Unicorn Millpond. This ladder has allowed thousands of river herring to ascend the dam. The loss of high quality waters in Unicorn Millpond would eliminate the benefits these forage fish provide to other fishery resources in Unicorn Branch and the Chester River.

### **Rare & Endangered Species**

Two uniquely important species of aquatic grasses occur in Unicorn Millpond. Prickly Hornwort (*Ceratophyllum muricatum*) is an endangered species in Maryland. Slender Pondweed (*Potamogeton pusillus*) is highly rare in Maryland. Both species depend upon the uniquely high-quality water conditions in the Millpond for survival.

### **Nontidal Wetland of Special State Concern**

Unicorn Millpond is one of 12 Nontidal Wetlands of Special State Concern in Queen Anne's County (COMAR 26.23.06.01Q(12)). The presence of the rare and endangered plant species is the most likely reason for designating the Millpond and associated wetlands as Nontidal Wetlands of Special State Concern. A map follows this page which shows the boundaries of this wetland. Note that the yellow line defining the boundary encompasses not only the pond proper but also the wetlands extending into the proposed rubble landfill site.

### **POTENTIAL IMPACTS UPON THESE UNIQUELY SENSITIVE AQUATIC RESOURCES**

Following is a description of the ways in which the Days Cove rubble landfill will damage these uniquely sensitive and important aquatic resources.

#### **Intrusion upon the Expanded Buffer of the Nontidal Wetland of Special State Concern**

Maryland Department of the Environment regulations require a 25-foot buffer for most nontidal wetlands. However, an expanded buffer of 100-feet is required for Nontidal Wetlands of Special State Concern (COMAR 26.23.01.04A(1)). As stated above, the Unicorn Millpond Nontidal Wetland of Special State Concern extends into the rubble landfill site.

The site plan for the rubble landfill only shows a 25-foot buffer along the Nontidal Wetland of Special State Concern. On the next page of this report an excerpt is provided from the applicant's site plan. On the excerpt the applicant's proposed 25-foot wetland buffer is highlighted with green. The required 100-foot expanded buffer is highlighted with red. Note that the applicant has proposed intruding upon the 100-foot expanded buffer with a portion of the landfill, two stormwater management basins, two buffer yard berms, and a road. These proposed activities are clearly in conflict with Maryland Department of the Environment regulations and would pose a serious threat to the health of the wetland.

#### **Leachate Toxicity**

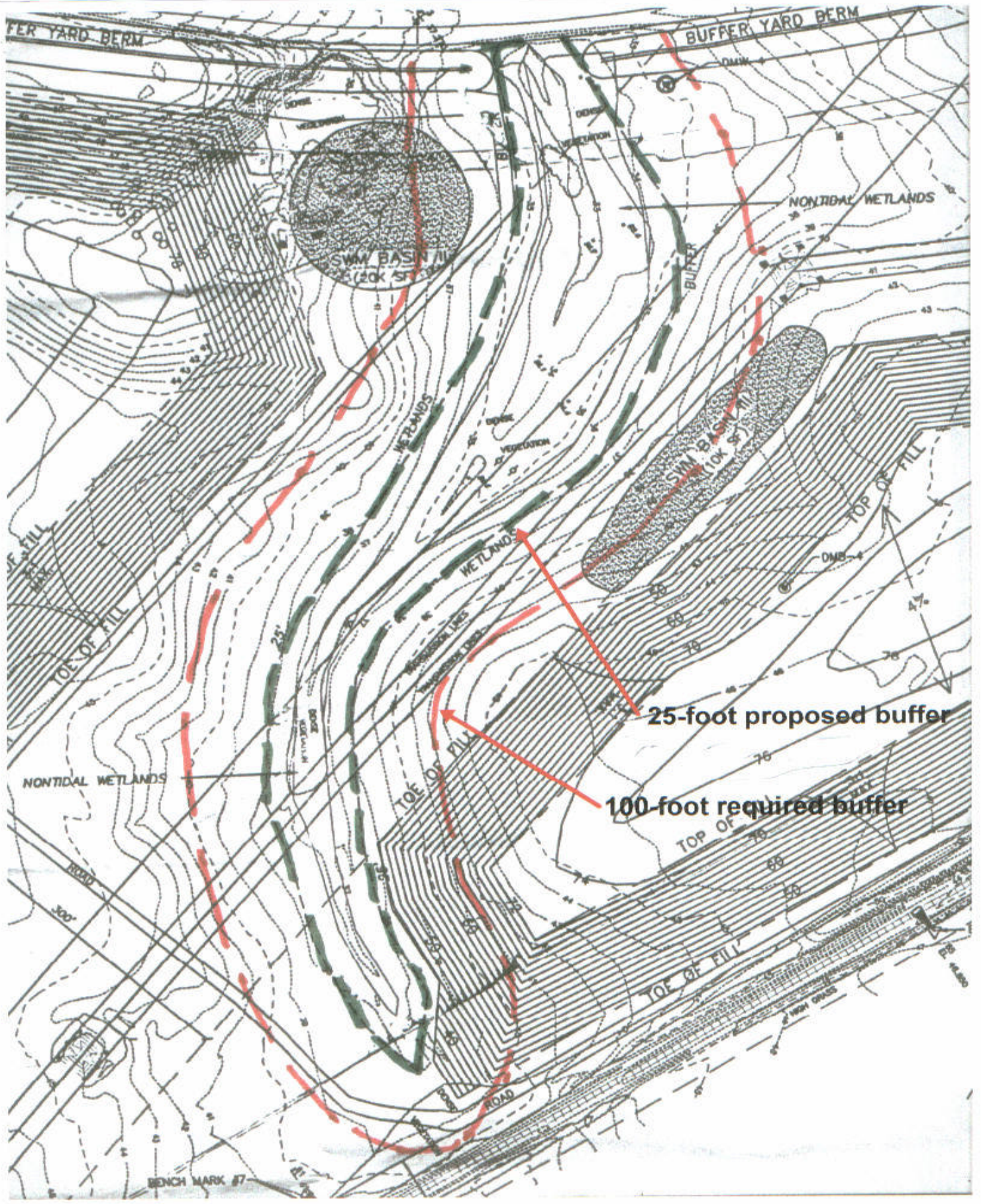
When rainfall or other waters pass through the construction and demolition debris buried in a rubble landfill, a highly toxic liquid known as leachate forms. Data from monitoring conducted at rubble landfills in Maryland and elsewhere in the nation, shows that metals are the contaminants of greatest concern.

Table 1, following the next two pages, compares rubble landfill leachate metal concentrations with the criteria adopted by the Maryland Department of the Environment for the protection of aquatic life. When one is dealing with a toxic substance, such as the metals shown in Table 1, it is not the average concentration which is of concern, but the maximum. Specifically, U.S. Environmental Protection Agency guidance documents call for not exceeding the criteria more frequently than once every three years. If aquatic communities are exposed to

- Estuarine Wetlands
- Lacustrine Wetlands
- Palustrine Wetlands
- Riverine Wetlands
- Nontidal Wetlands of Special State Concern
- 12 Digit Watershed Boundaries
- 8 Digit Watershed Boundaries
- Streams and Shorelines

LANDFILL SITE





25-foot proposed buffer

100-foot required buffer

**Table 1: Maximum Concentration of Metals Detected at Rubble Landfills**

Rubble Landfills Investigated		Maximum Concentration of Contaminant (milligrams per liter)									
Location	Number of Facilities	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
		Wisconsin <sup>1</sup>	2	<0.01		0.012	0.010	0.003	<0.00003		
Ohio <sup>2</sup>	4	0.330	<0.001		0.026	0.020	0.0004	0.130	<0.005		0.173
New York <sup>3</sup>	20	0.016	0.018	0.086	0.90.	3.586	0.003	0.078		0.006	4.456
Washington Co., MD <sup>4</sup>	1		0.005	0.023	0.130	0.053	0.0003		<0.005	0.023	0.320
Aquatic Life Protection Criteria <sup>5</sup>		0.360	0.0039		0.018	0.082	0.0024	1.40	0.020	0.0041	0.120
Highest Value ÷ Criteria		0.9	8		50	44	4	0.1	0.1	7	72

1. *Investigation of groundwater impacts at construction and demolition waste landfills*, presented at the 17th International Madison Waste Conference, September 21-22, 1994, Department of Engineering Professional Development, University of Wisconsin-Madison.
2. Data was provided in a letter from Ms. Annette DeHavilland, Ohio Division of Solid & Infectious Waste, to Richard Klein, of Community & Environmental Defense Services.
3. *Data Evaluation: Construction and Demolition Debris*, New York Department of Environmental Conservation, Division of Environmental Enforcement, 50 Wolf Road, Albany, NY 12233-5500. Two of the 20 C&D landfill included in this study were included in the USEPA report *Construction and Demolition Waste Landfills*, Office of Solid Waste, U.S. Environmental Protection Agency, Washington, D.C. 20460.
4. Based upon data enclosed with two letters 1) a letter dated August 31, 1999, from C. Steve Zies, Washington County Solid Waste Department (301-791-3101), to Richard Klein, of Community & Environmental Defense Services, and 2) a letter dated December 26, 1996, from Richard W. Collins, Director - Waste Management Administration, Maryland Department of the Environment, 2500 Broening Highway, Baltimore, MD 21224, 410-631-3304.
5. Acute freshwater criteria as set forth at COMAR 26.08.02.03-2G.

toxic conditions more frequently than once every three years then they will lose the ability to rebuild and maintain their populations.

The second to last row in Table 1 shows the Maryland Department of the Environment aquatic life protection criteria for most of the metals. The last row shows the degree to which the maximum rubble landfill leachate concentration exceeds the criteria. Note that the range is from 0.1 to 308. In other words, the highest concentration for these metal exceeds the aquatic life protection criteria by a factor of up to 308 times.

Table 2 summarizes the results of a study conducted by the U.S. Environmental Protection Agency. In this study EPA looked at the quality of leachate and groundwater from 21 rubble landfills located in the United States. This did not include many of the rubble landfills addressed in Table 1. Table 2 shows much the same pattern as Table 1. In other words, the maximum metal concentration measured in rubble landfill leachate greatly exceeds the concentration deemed safe by the Maryland Department of the Environment and EPA.

It is important to note that the data presented in Table 1 and Table 2 is by no means representative of the character of leachate from rubble landfills. At the time of the EPA study there were 1,800 rubble landfills in the United States. The two tables contain data for perhaps 40 rubble landfills or slightly more than 2%. It is highly unlikely that this limited amount of data revealed the actual maximum concentration of metals (and other contaminants) contained in leachate from rubble landfills. The actual concentrations are likely much higher.

The graph following this page provides a visual comparison of the maximum metal concentrations and the aquatic life protection criteria. The data presented in the graph shows that when leachate is released from the Days Cove rubble landfill, a severe threat will be posed to all of the sensitive aquatic resources associated with the site - the brown trout and other fisheries of Unicorn Branch, the rare and endangered plants in Unicorn Millpond, the river herring and other fisheries of the Millpond, and the Nontidal Wetland of Special State Concern located on the site.

### **Liner & Impermeable Cap Failure**

The applicant has proposed lining the rubble landfill to prevent leachate from reaching nearby waters. The leachate would be collected and taken to a wastewater treatment facility. At closure, the landfill will also be covered with an impermeable cap to prevent water from entering the waste.

While the landfill is in operation and for some time thereafter this system will probably be quite effective in protecting sensitive aquatic resources. But at some point after the landfill is closed the liner and the cap will begin leaking. The metals contained within the waste will not break down. Instead they will remain toxic and available for transport from the landfill for a very long period of time - essentially forever. When the liner and cap decompose the metals will be transported into the Nontidal Wetland of Special State Concern, Unicorn Branch, and Unicorn Millpond.

**Table 2: Maximum Concentration (in micrograms per liter) of Pollutants Documented by the U.S. Environmental Protection Agency in Leachate from Rubble Landfills <sup>1</sup>**

Water Quality Parameter	Concentration	Drinking Water Standard <sup>2</sup>	Aquatic Life Protection Standard <sup>3</sup>	Concentration Divided By Lowest Standard	Percent of Landfills Pollutant Was Detected At
<b>CONVENTIONAL PARAMETERS</b>					
Ammonia	480,000		29,000 <sup>4</sup>	??	100%
Nitrate <sup>5</sup>	13,000	10,000		1.3	71%
Biochemical Oxygen Demand (5	320,000				93%
Chlorides	2,400,000	250,000		10	100%
Fluoride	5,000	2,000		3	66%
Manganese	258,000	50		5,160	100%
Oil & Grease	50,000				86%
Total Phenolics	4,900				75%
Sulfates	2,700,000	250,000		11	88%
<b>INORGANICS</b>					
Aluminum	6,350	50-200		32-127	100%
Arsenic	120	50		2	75%
Barium	8,000	2,000		4	100%
Beryllium	2.1	4.0		0.5	20%
Cadmium	2,050	5	3.9	526	74%
Chromium	250	100		3	56%
Hexavalent chromium <sup>6</sup>	4,920		16	308	20%
Copper	620	1,000	18	34	78%
Cyanide	340	200	22	15	75%
Iron	172,000	300		573	100%
Lead	2,130	15	82	142	72%
Mercury	9.0	2.0	2.4	5	27%
Nickel	170	100	1,400	2	58%
Selenium	5	50	20		7%
Silver	30	100	4.1	7	17%
Vanadium	96	200			25%
Zinc	8,630	5,000	120	72	100%

1. The data contained in this table was presented in *Construction and Demolition Waste Landfills*, Office of Solid Waste, U.S. Environmental Protection Agency, Washington, D.C. 20460.

2. Maximum contaminant level or secondary MCL

3. Acute freshwater criteria from the Code of Maryland Regulations (COMAR) 26.08.02.03-2G.

4. U.S. EPA freshwater ammonia criteria assuming a pH of 6.5 and a water temperature of 25EC.

5. Ammonia is converted into nitrate as it enters oxygenated waters. Thus the actual nitrate concentration is closer to the value for ammonia presented above.

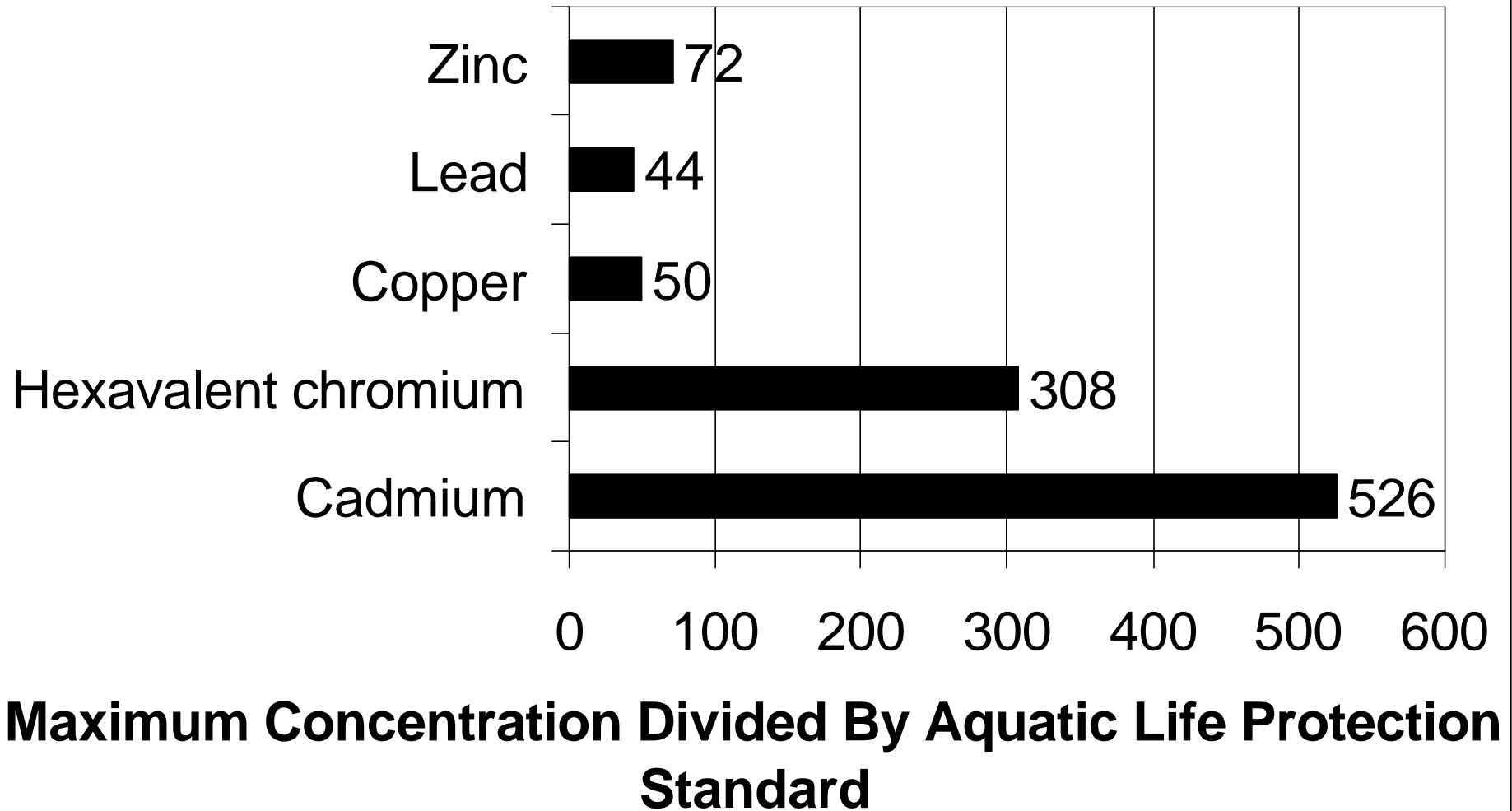
6. Hexavalent chromium levels are much higher than total chromium because of variances between landfills in the frequency of analysis for these two parameters.

**Table 2: Continued - Organics**

<b>Pollutant</b>	<b>Concentration</b>	<b>Drinking Water Standard</b>	<b>Aquatic Life Protection Standard <sup>1</sup></b>	<b>Concentration Divided By Lowest Standard</b>	<b>Percent of Landfills Pollutant Was Detected At</b>
Total Organic Halogens	910				100%
Acetone	5,100	4,000		1.3	66%
Acenaphthene	3	2,000			14%
alpha-BHC	0.12	0.006		20.0	17%
Benzene	2.70	5.00			22%
Chloroethane	353				22%
Chloroform	3	100			11%
Chloromethane	43				22%
1,2-Dichloroethane	26	5		5.2	33%
1,1-Dichloroethane	6.2	4,000			33%
1,1-Dichloroethene	3	7			11%
trans-1,2-Dichloroethene	4	100			25%
Dieldrin	0.065	0.002	2.5000	32.5	17%
Diethyl phthalate	16	30,000			14%
Disulfoton	0.96	1			33%
Di-n-butyl phthalata	16	4,000			25%
Ethylbenzene	18	700			56%
2-Hexanone (methyl butyl ketone)	4.8				20%
Methyl ethyl ketone	2,500	20,000			33%
Methylene chloride	60	5		12.0	33%
2-Methylphenol (o-cresol)	130				29%
4-Methyl-2-pentanone	250				33%
4-Methylphenol (p-cresol)	5,700				80%
Naphthalene	63	1,000			29%
Phenol	2,990	20,000			63%
Styrene	1.1	100			20%
Tetrachloroethene	4.8	5			11%
Toluene	240	1,000			44%
Trichloroethene	20	5			33%
Trichlorofluoromethane	20	10,000			40%
2,4,5-T, 2,4,5-Trichlorophenoxyacetic	0.53	50			50%
Xylene (total)	85	10,000			50%

1. The absence of aquatic life protection standards for many of the organics does not indicate that these substances are non-toxic. For many of these compounds there simply isn't sufficient information to establish criteria for the protection of aquatic life.

## Metals in Rubble Landfill Leachate



**Stormwater Runoff Pollutants**

In addition to metals released in leachate, stormwater runoff from the roads, parking area, and the landfill cells will release additional metals into the Unicorn Branch and Millpond system. These metals will come from the atmosphere (originating as pollutants released to the atmosphere) and from activities on and near the site. Table 3 and the graph which follows the table shows that the landfill will result in up to a 20-fold increase in metal releases from the site. This is even after taking into consideration pollutants captured in the stormwater ponds proposed by the applicant. Unfortunately these ponds can only keep about half the stormwater pollutants out of Unicorn Branch. The escaping metals will not settle out in a stormwater pond. They are either dissolved or attached to particles so fine that weeks are required for settling. The metals entrained in stormwater runoff will exacerbate the impact of metals eventually released from the site via leachate migration through liner defects.

**Loss of Groundwater Recharge**

The water supporting streams and wetlands during dry-weather originates as rain which fell upon the surrounding land, soaked into the soil, and traveled through the earth to seep into a stream channel or wetland. This water is known as groundwater recharge.

Table 3 shows that on average about 228,000 gallons of recharge occurs on each acre of land in eastern Queen Anne's County. Recharge is eliminated when the land surface is covered by asphalt, buildings, concrete, and other impervious surfaces. A rubble landfill cap and liner are also impervious materials.

Table 3 shows that presently about 13 million gallons of recharge occur on the landfill site each year. Once the landfill is constructed recharge will plummet to just 5 million gallons per year. This will greatly diminish the amount of groundwater entering the Nontidal Wetland of Special State Concern located on the site. This alone would have a devastating impact upon the health of this wetland ecosystem. Combined with metals entrained in leachate and stormwater discharges, it is highly unlikely this wetland will continue to function.

**Thermal Impacts**

Trout, such as those inhabiting Unicorn Branch, are extremely sensitive to water temperature increases. Trout prefer a temperature no higher than 68EF and trout may begin dying at a temperature of 75EF (Galli 1990). Even in July, Unicorn Branch currently does not exceed 68EF.<sup>1</sup>

The Days Cove landfill project will increase the temperature of Unicorn Branch by increasing the amount of impervious surface discharging to the stream and by allowing runoff waters to heat within the proposed stormwater ponds. Runoff from roads and other impervious surfaces attains a summertime temperature of 83EF (Yetman 1991).

Table 3

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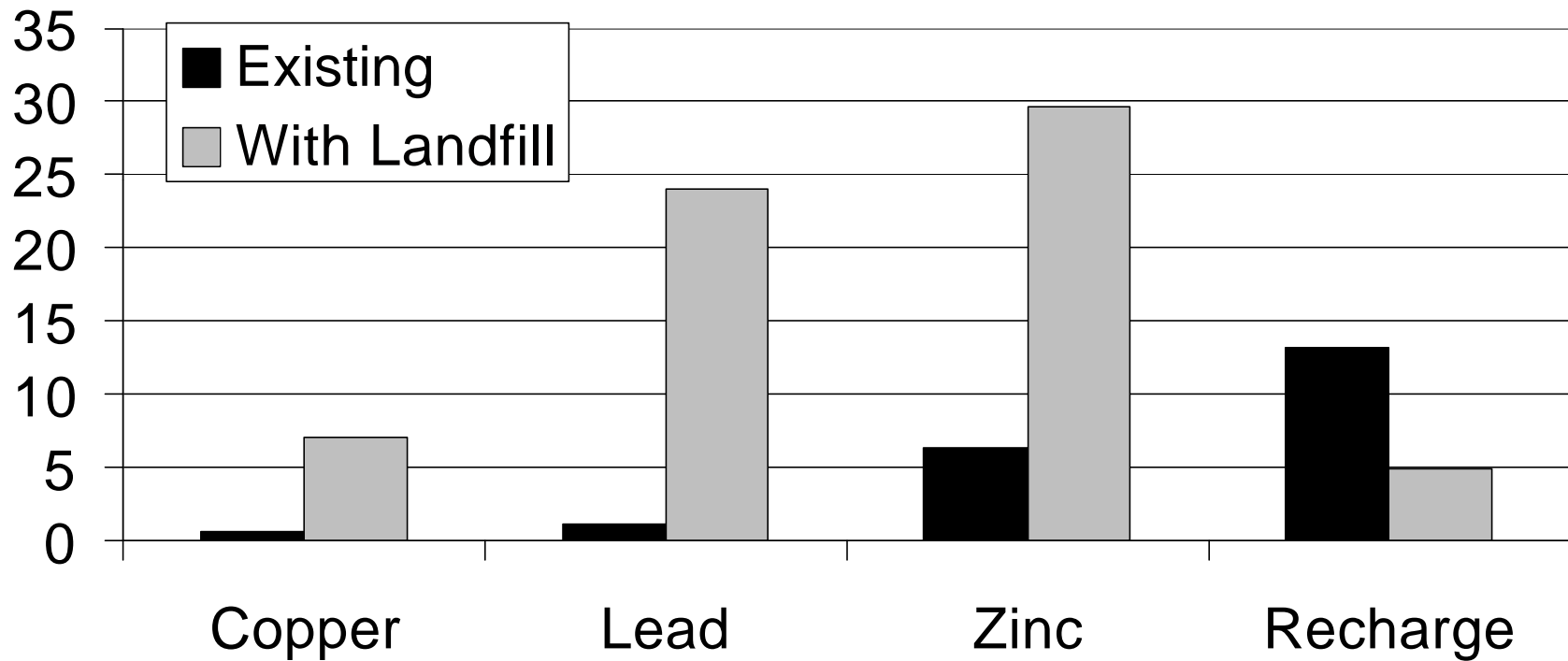
<sup>1</sup> Based on measurement made by Mr. Richard K. Schaefer, Eastern Regional Manager DNR Freshwater Fisheries, on July 27, 1999.

**Table 3: Comparison of the Stormwater Effects of the Days Cove Rubble Landfill**

LAND USE & BEST MANAGEMENT PRACTICE SCENARIOS <sup>1</sup>	Acres	Percent <sup>2</sup> Impervious	Ground <sup>3</sup> Water Recharge (million gal/year)	METALS <sup>4</sup>		
				Copper	Lead	Zinc
<b>Existing Land Use</b>						
Forest	5.80	0.0	1.32	0.06	0.12	0.64
Cropland	52.20	0.0	11.91	0.52	1.04	5.74
<b>Subtotal</b>	58.00		13.23	0.58	1.16	6.38
<b>Proposed Land Use</b>						
Roads, Parking, Scales	3.09	100.0	0.00	1.21	4.64	4.53
Landfill Cells	30.00	100.0	0.00	11.75	45.00	44.00
Open	24.91	13.0	4.94	0.25	0.50	2.74
<b>Subtotal</b>	58.00		4.94	13.21	50.13	51.27
<i>With Proposed Stormwater Ponds <sup>5</sup></i>			4.94	7.09	23.96	29.58

1. Existing and proposed land use is based upon the applicant's Conditional Use Permit application submittals.
2. Percent impervious area was determined from applicant's Plate 6 - Proposed Site Layout.
3. Groundwater recharge is the amount of precipitation which soaks sufficiently deep into the earth to become available to well users and to enter surface waters. A recharge rate of 228,080 gallons per acre per year was assumed based *Hydrogeology, Simulation of Ground-Water Flow, and Ground-Water Quality of the Upper Coastal Plain Aquifers in Kent County, Maryland*, Report of Investigations No. 68, Maryland Geological Survey, 2300 Saint Paul Street, Baltimore, MD 21218.
4. Metal loadings from undeveloped land uses are based upon *Environmental data summary for the Rhode River ecosystem (1970-1978)*, Chesapeake Bay Center for Environmental Studies, Post Office Box 28, Edgewater, MD 21037. Metal loads from developed land uses are based upon Equation 1.1, in *Controlling Urban Runoff: A Practical Manual for Planning & Designing Urban BMPs*, Metropolitan Washington Council of Governments, 777 N. Capitol St., N.E., Washington, D.C. 20002.
5. Plate 6 - Proposed Site Layout indicates that the site will drain to stormwater ponds. The effectiveness of stormwater ponds is based upon *National Pollutant Removal Performance Database for Stormwater Best Management Practices*, by Brown and Schueler, 1997, Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043. (410) 461-8323.

# Days Cove Landfill Stormwater Impacts



The applicant has proposed widening two existing roads (Glanding Road and Hackett Corner Road) that discharge into Unicorn Branch from 20 feet to 30 feet (11-foot lanes and 4-foot shoulders). By increasing the surface area of these roads the applicant will increase the volume of heated runoff discharged into Unicorn Branch.

The western portion of the landfill site will discharge into Unicorn Branch. The remainder will discharge into Unicorn Lake via the Nontidal Wetland of Special State Concern. Prior to exiting the site, runoff from the western portion of the site will be detained in a stormwater pond. Research supported by the Maryland Department of the Environment has shown that stormwater can heat to high temperatures while it is held within a pond (Bahr 1996). While runoff resides in the pond it will come up to the temperature of the air overlying the pond. Thus if runoff is discharging from the pond on a 90EF summer afternoon, then the water discharged from the pond will be 90EF. In fact, the research shows that stormwater ponds discharge water at a maximum temperature of 97EF (Bahr 1996). And this is based upon a very small database. So the actual maximum temperature may be even higher.

In Table 4a and Table 4b, an analysis is presented of the effects of heated stormwater from the landfill plus road runoff on the temperature of Unicorn Branch. Table 4a looks at the effect of the road and landfill once the impermeable cap is covered with soil and planted with grass. Row O, in Table 4a, shows that the volume of heated water released from the landfill will be sufficient to raise Unicorn Branch above the 68EF temperature preferred by brown trout and will approach the lethal range. Table 4b looks at the impact of the landfill during the most critical phase of construction. This phase will be when the impermeable cap has been installed, but has not been covered with soil. During this period runoff volumes will be at the greatest. Thus the amount of heated water entering Unicorn Branch will be at a maximum. Row O, in Table 4b, shows that the landfill will cause Unicorn Branch to reach a temperature of 79.2EF which is well in excess of the lethal level. The thermal effects of the landfill on Unicorn Branch are illustrated in the graph following Table 4b. In summary, brown trout will not continue to flourish in the portion of Unicorn Branch impacted by the landfill. When thermal impacts are combined with toxic metal releases, survival of the brown trout population is in serious doubt.

### **SUMMARY**

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In summary, aquatic resources which are uniquely important and sensitive are associated with the Days Cove rubble landfill site. Many of these resources do not exist anywhere else in Queen Anne's County. These resources are:

- ! the brown trout and other uniquely diverse and abundant fisheries of Unicorn Branch;
- ! the rare and endangered plants in Unicorn Millpond;
- ! the river herring and other fisheries of the Millpond, and ;
- ! the Nontidal Wetland of Special State Concern located on the site.

The rubble landfill will cause irreparable damage to these uniquely important and sensitive aquatic resources through:

- ! intrusion into the 100-foot expanded buffer of the Nontidal Wetland of Special State Concern;
- ! release of metals in rubble landfill leachate at a concentration more than 500 times the level deemed safe by the Maryland Department of the Environment;
- ! a 20-fold increase in stormwater pollutant loadings;
- ! a 62% reduction in groundwater recharge, due to impervious surfaces, with a dramatic reduction in groundwater inflow to the Nontidal Wetland of Special State Concern, and;
- ! the release of sufficient heated water to push Unicorn Branch over the temperature which is lethal to the brown trout inhabiting this stream.

#### **REFERENCES**

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Bahr, R.P., 1996. A temperature study of discharges from three extended detention/wetland stormwater management basins in Maryland. Chesapeake Biological Laboratory, University of Maryland, Solomons, MD 20688.

Galli, J., 1990. Thermal impacts associated with urbanization and stormwater management best practices. Department of Environmental Programs, Metropolitan Washington Council of Governments, 777 North Capitol Street, N.E., Washington, D.C. 20002. (202) 962-3200

SCS, 1986. Urban hydrology for small watersheds. Technical Release 55, U.S. Soil Conservation Service, Post Office Box 2890, Washington, D.C. 20013.

Yetman, K., 1991. Study of non-point source thermal pollution in Jabez Branch. Power Plant & Environmental Review Division, Maryland Tidewater Administration, Annapolis, MD 21401.

**Table 4a: Post-Closure Period - Effects of the Days Cove Rubble Landfill on the Temperature Regime of Unicorn Branch**

<b>Temperature Factor</b>	<b>Value</b>
<b>Volume of Runoff to Western Pond</b>	
A. Landfill Area Draining to Western Pond	12.2 acres
B. Rainfall Depth Producing Maximum Runoff from Landfill Areas, But No Runoff from the Unicorn Branch Watershed ( <i>Assuming Watershed RCN of 65 and Landfill RCN of 80 based on 2-2a in SCS 1986</i> )	1.30 inches
C. Runoff Depth ( <i>in inches</i> ) from Landfill Area Draining to Western Pond During 1.30 Inch Rainfall ( <i>Based on Landfill RCN of 80 and Table 2-1 in SCS 1986</i> )	0.195
D. Cubic Feet of Runoff from Landfill Area Draining to Western Pond During 1.30-Inch Rainfall ( $A \times 43560 \text{ ft}^2/\text{Acre} \times C/12$ )	8,636
E. Western Pond Discharge ( <i>Cubic Feet/Second</i> ) Assuming 12-Hour Drawdown ( $D \div 60 \text{ second} \times 60 \text{ minutes} \times 12 \text{ hours}$ )	0.2
<b>Road Runoff (After Proposed Widening)</b>	
F. Surface Area of Portions of Glanding Road and Hackett Corner Road Draining to Affected Area of Unicorn Branch after Proposed Widening ( $7,600 \text{ ft} \times 30 \text{ ft} + 5,500 \text{ ft} \times 20 \text{ ft}$ )	7.76 acres
G. Runoff Depth ( <i>in inches</i> ) from Roads During 1.30 Inch Rainfall ( <i>Based on Landfill RCN of 98 and Table 2-1 and 2-2a in SCS 1986</i> )	1.09
H. Cubic Feet of Runoff from Roads During 1.30-Inch Rainfall ( $F \times 43560 \text{ ft}^2/\text{Acre} \times G/12$ )	30,704
I. Road Discharge ( <i>Cubic Feet/Second</i> ) Assuming 6-Hour Runoff Period ( $H \div 60 \text{ second} \times 60 \text{ minutes} \times 6 \text{ hours}$ )	1.4
<b>Volume of Low-Flow in Unicorn Branch Available to Dilute Western Pond Discharge and Road Runoff</b>	
J. Seven-Day, 10-Year Low Stream Flow ( <i>Cubic Feet/Second</i> ) in Unicorn Branch ( <i>Derived from Characteristics of Streamflow in Maryland, Maryland Geological Survey Report of Investigations No 35</i> )	4.0
K. Total Flow in Unicorn Branch ( <i>Pond Discharge Plus Road Runoff Plus Stream Flow</i> )	5.6
<b>Temperature in Unicorn Branch After Mixing of Western Pond Discharge and Road Runoff with Stream Flow</b>	
L. Summertime Maximum Temperature (EF) of Pond Discharge ( <i>from Bahr 1996</i> )	97.0
M. Summertime Temperature (EF) of Road Runoff ( <i>from Yetman 1991</i> )	83.0
N. Unicorn Branch Water Temperature (EF) ( <i>Based on measurement made by Mr. Richard K. Schaefer, Eastern Regional Manager DNR Freshwater Fisheries, on July 27, 1999</i> )	68.0
O. Predicted Stream Temperature (EF) After Complete Mixing of Western Pond Discharge and Road Runoff with Flow in Unicorn Branch ( <i>Based upon volume-temperature of the discharge-runoff and stream flow volume-temperature given above</i> )	72.8
P. Upper Limit of Optimum Temperature (EF) for Trout ( <i>from Galli 1990</i> )	68.0
Q. Lethal Temperature (EF) for Trout ( <i>from Galli 1990</i> )	75.0

**Table 4b: Impermeable Cap Exposure Period - Effects of the Days Cove Rubble Landfill on the Temperature Regime of Unicorn Branch**

<b>Temperature Factor</b>	<b>Value</b>
<b>Volume of Runoff to Western Pond</b>	
A. Impermeable Cap Area Draining to Western Pond	12.2 acres
B. Rainfall Depth Producing Maximum Runoff from Impermeable Cap, But No Runoff from the Unicorn Branch Watershed ( <i>Assuming Watershed RCN of 65 and Cap RCN of 98 and based on 2-2a in SCS 1986</i> )	1.30 inches
C. Runoff Depth ( <i>in inches</i> ) from Impermeable Cap Area Draining to Western Pond During 1.30 Inch Rainfall ( <i>Based on Cap RCN of 98 and Table 2-1 in SCS 1986</i> )	1.08
D. Cubic Feet of Runoff from Impermeable Cap Area Draining to Western Pond During 1.30-Inch Rainfall ( $A \times 43560 \text{ ft}^2/\text{Acre} \times C/12$ )	47,829
E. Western Pond Discharge ( <i>Cubic Feet/Second</i> ) Assuming 12-Hour Drawdown ( $D \div 60 \text{ second} \times 60 \text{ minutes} \times 12 \text{ hours}$ )	1.1
<b>Road Runoff (After Proposed Widening)</b>	
F. Surface Area of Portions of Glanding Road and Hackett Corner Road Draining to Affected Area of Unicorn Branch after Proposed Widening ( $7,600 \text{ ft} \times 30 \text{ ft} + 5,500 \text{ ft} \times 20 \text{ ft}$ )	7.76 acres
G. Runoff Depth ( <i>in inches</i> ) from Roads During 1.30 Inch Rainfall ( <i>Based on Landfill RCN of 98 and Table 2-1 in SCS 1986</i> )	1.09
H. Cubic Feet of Runoff from Roads During 1.30-Inch Rainfall ( $F \times 43560 \text{ ft}^2/\text{Acre} \times G/12$ )	30,704
I. Road Discharge ( <i>Cubic Feet/Second</i> ) Assuming 6-Hour Runoff Period ( $H \div 60 \text{ second} \times 60 \text{ minutes} \times 6 \text{ hours}$ )	1.4
<b>Volume of Low-Flow in Unicorn Branch Available to Dilute Western Pond Discharge and Road Runoff</b>	
J. Seven-Day, 10-Year Low Stream Flow ( <i>Cubic Feet/Second</i> ) in Unicorn Branch ( <i>Derived from Characteristics of Streamflow in Maryland, Maryland Geological Survey Report of Investigations No 35</i> )	4.0
K. <b>Total Flow in Unicorn Branch (Pond Discharge Plus Road Runoff Plus Stream Flow)</b>	6.5
<b>Temperature in Unicorn Branch After Mixing of Western Pond Discharge with Stream</b>	
L. Summertime Maximum Temperature (EF) of Pond Discharge ( <i>from Bahr 1996</i> )	97.0
M. Summertime Temperature (EF) of Road Runoff ( <i>from Yetman 1991</i> )	83.0
N. Unicorn Branch Water Temperature (EF) ( <i>Based on measurement made by Mr. Richard K. Schaefer, Eastern Regional Manager DNR Freshwater Fisheries, on July 27, 1999</i> )	68.0
O. Predicted Stream Temperature (EF) After Complete Mixing of Western Pond Discharge and Road Runoff with Flow in Unicorn Branch ( <i>Based upon volume-temperature of the discharge-runoff and stream flow volume-temperature given above</i> )	79.2
P. Upper Limit of Optimum Temperature (EF) for Trout ( <i>from Galli 1990</i> )	68.0
Q. Lethal Temperature (EF) for Trout ( <i>from Galli 1990</i> )	75.0

### Days Cove Landfill Temperature Impacts

