7. MASTER DRAINAGE PLAN IMPROVEMENTS

This study has been prepared to facilitate the modeling and consideration of future improvements in this watershed. The level of detail is sufficient for a large watershed, establishing a good baseline for future modeling. Modelers building upon this effort should bear in mind the amount of guessing that was necessary to make up for missing information, particularly surveying data. As future models are constructed, they should be submitted to the City for review and possible incorporation into future updates of this study. Any new field surveying data would be of particular interest to the City.

The prior Master Drainage Plan study of the Milldam Creek watershed—completed in 1986—resulted in recommendations for five major watershed drainage improvements. URS carefully evaluated the 1986 recommendations using the modeling results of the current study, and was able to eliminate one of improvements from consideration altogether (i.e. the addition of four 72-inch RCP culverts at the Norfolk Southern railroad crossing).

Another one of the prior recommendations has been largely accomplished over time—specifically that the City should require developments in the upstream potions of the watershed near I-64 and Battlefield Boulevard to detain storm water runoff to prevent flooding. Significant development in this area has occurred since 1986, and substantial impoundments have been constructed.

The remaining 1986 recommendations were used as starting points to evaluate future improvements in the Milldam Creek watershed. After considerable trial-and-error design modeling, recommendations for four improvements were identified and validated. Three of the final recommendations are as described in the 1986 study. A fourth recommendation—for future detention basins east of Battlefield Boulevard—is also necessary to accommodate future development without adversely affecting drainage in the watershed. The four recommended improvements are shown in Figure 7-1 and described in the following sections.

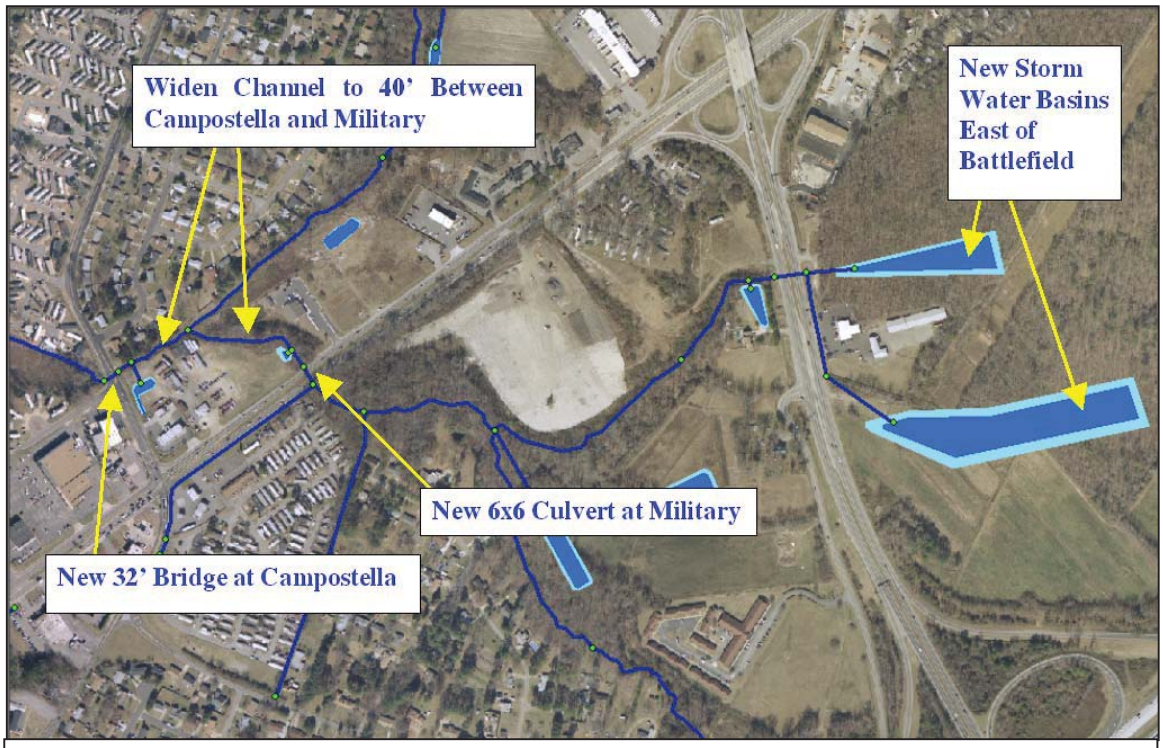

Figure 7-1. Recommended Watershed Improvements

Inherent in these recommended improvements is the assumption that Chesapeake will continue to follow State storm water management and erosion control regulations and guidelines, particularly Minimum Standard 19 of the Virginia Erosion and Sediment Control Regulations (4 VAC 50-30-10 et. seq.), requiring detention BMPs for inadequate channels. It is also required that the hydraulic storage capacity and conveyance properties of major drainage system components be maintained as modeled for this study. Specifically, future development plans must not reduce the flood storage that was modeled in this study, and channels and culverts must be maintained to have the hydraulic characteristics as modeled.

Figure 7-2 shows the 50-year peak hydraulic grade line values through the Milldam Creek watershed from node 1180 to node 325.

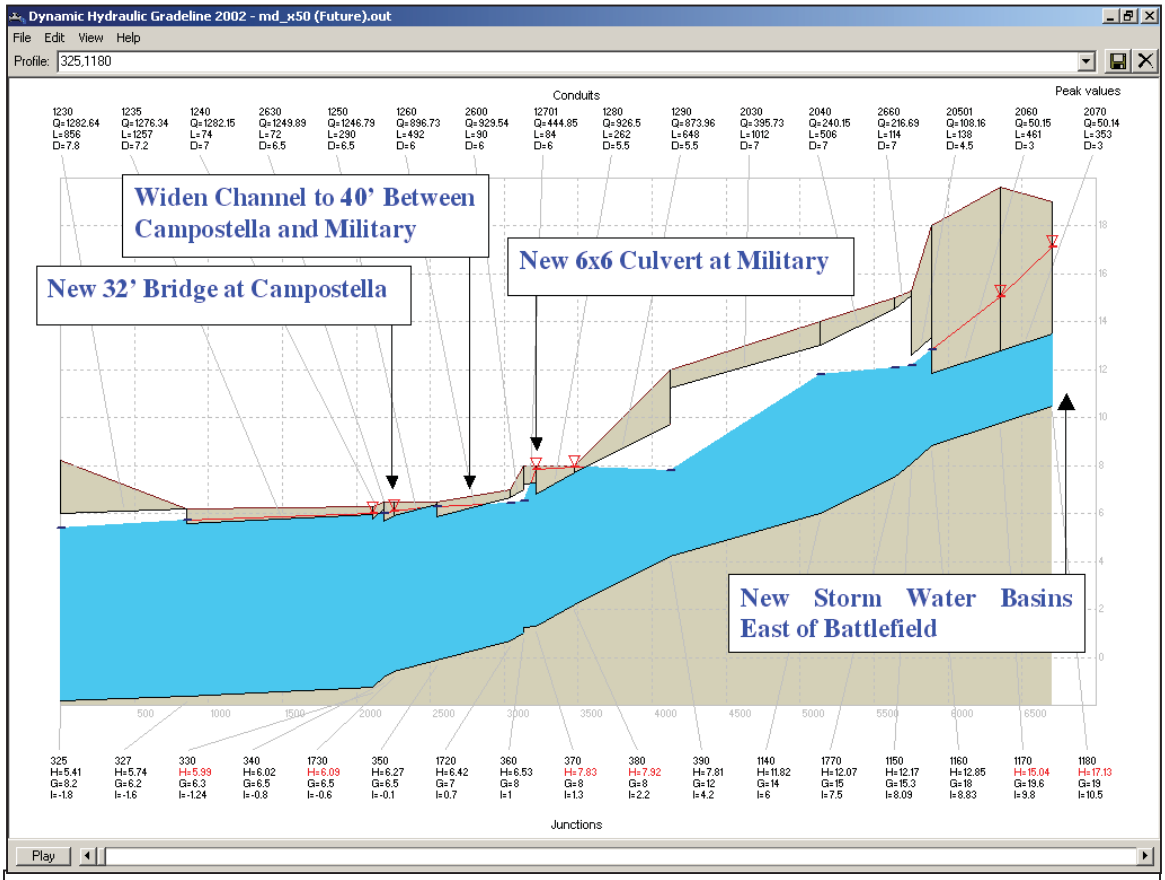

Figure 7-2. 50-Year Peak Hydraulic Grade line From Node 1180 Through Node 325

Note how close the peak 50-year hydraulic grade line is to the ground elevations in this figure. Many computer runs were made in an attempt to minimize the cost of the future improvements, to produce the final recommendations.

7.1. New 32-Foot Bridge at Campostella Road

The need for this improvement was identified in the previous study, and validated in the current models. Campostella Road over Milldam Creek is a very low roadway crossing that does not have sufficient capacity to pass even the 2-year design storm without flooding the roadway. The existing quadruple 36-inch RCP culverts are extremely inadequate and need to be replaced with a much more substantial opening.

After considerable trial and error, taking all the other improvements into account, the models indicate that the opening should have the characteristics of a 32-foot-by-7-foot box culvert—in other words a bridge

having a clear span of 32 feet, with vertical abutments, and a low steel elevation of 6.20 feet (NAVD88). The inverts of Milldam Creek through the bridge should be –0.80 and –1.24 feet at the upstream and downstream faces respectively. In order to accomplish this construction, Campostella Road will have to be raised approximately two feet at this crossing, which will help to keep the roadway passable during significant storm events. The minimum roadway grade at the crossing should be above elevation 6.20 feet. Properties to the east of Campostella Road should be checked to make sure their finished floor elevations are sufficiently above elevation 6.20. If they are not, the proposed road grade in the approach section can be lowered slightly to provide adequate flood protection.

The proposed 32-foot bridge is Link 1240 in the future conditions model, from Node 340 to Node 330.

A cost opinion was prepared for this recommendation, indicating that the new 32-foot bridge improvement will cost approximately **$685,000** in 2004 dollars, as indicated in Table 7-1.

Table 7-1. Cost Opinion for New 32-Foot Bridge at Campostella Road

Description of Work	Quantity	Units	Unit Rate	Total Cost
Mobilization Cost	1	LS	$ 40,000.00	$ 40,000.00
Traffic Control	1	LS	$ 25,000.00	$ 25,000.00
Construction Surveying	1	LS	$ 10,000.00	$ 10,000.00
Test Holes for Utilitity Location	8	EA	$ 600.00	$ 4,800.00
Slab Span Bridge, Pile Abutments	1,600	SF	$ 80.00	$ 128,000.00
Unsuitable Material	500	CY	$ 20.00	$ 10,000.00
Fill Material	600	CY	$ 20.00	$ 12,000.00
Fine Grading	1	LS	$ 3,000.00	$ 3,000.00
Disposal of Excavated Material	1,500	SY	$ 5.00	$ 7,500.00
Pavement	1,200	TONS	$ 40.00	$ 48,000.00
Road Base Aggregate	1,500	TONS	$ 17.00	$ 25,500.00
Geotechnical Fabric	1,500	SY	$ 2.50	$ 3,750.00
Milling	1	LS	$ 2,000.00	$ 2,000.00
Pavement Markings	1	LS	$ 3,000.00	$ 3,000.00
Dewatering	1	LS	$ 20,000.00	$ 20,000.00
Erosion and Sediment Control	1	LS	$ 10,000.00	$ 10,000.00
Topsoil, Seed, Fertilize	0.55	AC	$ 6,500.00	$ 3,581.27
Riprap	1,500	TONS	$ 35.00	$ 52,500.00
Utility Relocations	1	LS	$ 50,000.00	$ 50,000.00
Engineering Fees	1	LS	$ 48,000.00	$ 48,000.00
Sub Total				$ 506,631.27
Contingency Cost @ 25%				$ 126,657.82
ROW Acquisition	1	LS	$ 50,000.00	$ 50,000.00
Total Cost				**$ 683,289.08**

Multiple culverts could be used instead of the new bridge, as long as they maintain the hydraulic characteristics used in the SWMM models (i.e. a 32-foot-by-7-foot box culvert), but given the sizes and site constraints involved, a bridge is recommended. As indicated in the cost estimate, the bridge itself is only 19 percent of the total cost—the bulk of the total cost is associated with raising the road.

7.2. Widen Channel to 40 Feet Between Campostella Road and Military Highway

The widening of the main channel between Campostella Road and Military Highway was recommended in the 1986 study, and it appears to be needed to pass the design storms without flooding the adjacent properties and overtopping Campostella Road. There is a new site plan for a proposed development at the northeast corner of Campostella Road and Military Highway. The development plan for this project, called

"Space Cadets 2," includes two proposed on-site detention basins, both of which have been included in the future conditions SWMM models.

Widening the channel to have a 40-foot bottom width in this location has several benefits, including increased conveyance capacity for upstream flows, and increased flood storage within the channels. In effect, the widened channel will serve as a new detention pond. The modeling effort indicated that without this additional conveyance capacity and storage, flows will overtop the existing channel banks and nodal flooding will occur. Several different widths were tried, and a 40-foot bottom just barely provides the needed hydraulic capacity. Given the lot line configurations and available remaining land after existing and future development is considered, a 40-foot bottom should fit well on the site.

Consideration was also given to providing an additional storm water management basin in this vicinity, but there is a considerable amount of existing flood storage already incorporated into these models, and there isn't enough suitable land at this location—or upstream of Military Highway—to sufficiently lower the hydraulic grade line at Campostella Road.

The proposed 40-foot wide channels are Links 1250, 1260 and 2630 in the future conditions model, from Node 1720 to Node 340.

A cost opinion was prepared for this recommendation, indicating that the channel improvements will cost approximately **$295,000** in 2004 dollars, as indicated in Table 7-2.

Table 7-2. Cost Opinion for Widening Channel to 40 Feet Between Campostella Road and Military Highway

Description of Work	Quantity	Units	Unit Rate	Total Cost
Mobilization Cost	1	LS	$ 10,000.00	$ 10,000.00
Traffic Control	1	LS	$ 5,000.00	$ 5,000.00
Construction Surveying	1	LS	$ 8,000.00	$ 8,000.00
Fine Grading	10,000	SY	$ 1.00	$ 10,000.00
Disposal of Excavated Material	4,000	CY	$ 8.50	$ 34,000.00
Fabric / Bank Stabilization	5,000	SY	$ 2.50	$ 12,500.00
Dewatering	1	LS	$ 20,000.00	$ 20,000.00
Erosion and Sediment Control	1	LS	$ 12,000.00	$ 12,000.00
Topsoil, Seed, Fertilize	1.74	AC	$ 6,500.00	$ 11,340.68
Wetlands Planting	1	LS	$ 20,000.00	$ 20,000.00
Riprap	200	TONS	$ 35.00	$ 7,000.00
Engineering Fees	1	LS	$ 25,000.00	$ 25,000.00
Sub Total				$ 174,840.68
Contingency Cost @ 25%				$ 43,710.17
ROW Acquisition	1	LS	$ 75,000.00	$ 75,000.00
Total Cost				**$ 293,550.85**

7.3. New 6x6 Box Culvert At Military Highway

A new 6-foot-by-6-foot box culvert at the Military Highway crossing was proposed in the 1986 study. This new culvert would double the existing flow capacity, and is needed to reduce existing and future flooding at Military Highway. According to the existing conditions models, the existing crossing floods under a 10-year design storm.

Several alternative culvert sizes were tried in the future models, but a 6x6 box culvert provides just the right amount of flow-through capacity, while restricting peak discharges to prevent downstream flooding that might otherwise occur if a larger culvert were used.

The hydraulic response of the system to this improvement is quite evident in Figure 7-2, where 1.3 feet of head loss is observed through the improved opening (under Military Highway). Even with the new 6x6 culvert in place, a significant construction is formed, which helps keep enough of the flood volume in storage upstream from Military Highway, that the downstream system can function without flooding.

The proposed 6x6 box culvert is Link 12702 in the future conditions model, from Node 370 to Node 360. A cost opinion was prepared for this recommendation, indicating that the channel improvements will cost approximately **$255,000** in 2004 dollars, as indicated in Table 7-3.

Table 7-3. Cost Opinion for New 6x6 Box Culvert At Military Highway

Description of Work	Quantity	Units	Unit Rate	Total Cost
Mobilization	1	LS	$ 11,000.00	$ 11,000.00
Traffic Control	1	LS	$ 10,000.00	$ 10,000.00
Temporary Pavement & Base	1,800	SY	$ 26.00	$ 46,800.00
Construction Surveying	1	LS	$ 2,500.00	$ 2,500.00
6x6 Box Culvert	84	LF	$ 300.00	$ 25,200.00
Endwalls	2	EA	$ 2,500.00	$ 5,000.00
Dewatering	1	LS	$ 8,000.00	$ 8,000.00
Grading and Excavation	1,000	CY	$ 8.00	$ 8,000.00
Fill Material	750	CY	$ 8.00	$ 6,000.00
Disposal of Excavated Material	250	CY	$ 5.00	$ 1,250.00
Pavement Patch	1	LS	$ 1,000.00	$ 1,000.00
Erosion and Sediment Control	1	LS	$ 5,000.00	$ 5,000.00
Utility Relocations	1	LS	$ 50,000.00	$ 50,000.00
Topsoil, Seed, Fertilize	0.50	AC	$ 6,500.00	$ 3,250.00
Engineering Fees	1	LS	$ 20,000.00	$ 20,000.00
Sub Total				$ 203,000.00
Contingency @ 25%				$ 50,750.00
Total Cost				**$ 253,750.00**

7.4. New Storm Water Management Basins East of Battlefield Boulevard

There are approximately 150 acres of prime undeveloped land east of Battlefield Boulevard in the Milldam Creek watershed, a portion of which can be seen on the right side of Figure 7-1. There were no reliable future site plans available for this area during the course of this study, but it is obvious that this land has high development potential. It is currently covered with forest and pasture, so significant increases in storm water runoff volumes can be expected when this area is developed in the future.

The existing crossing at Battlefield Boulevard (twin 54-inch RCPs modeled as Links 20501 and 20502 from Node 1160 to Node 1150 in the future conditions models) produces several acre-feet of flooding upstream of Battlefield Boulevard in response to the 2-year design storm. This flooding probably spreads sufficiently that it does not overtop Battlefield Boulevard, but it is clear that the exiting crossing is under-sized.

Future improvements can be avoided at this crossing by providing adequate upstream storage. For the future conditions model, this storage was incorporated in the form of two large storage basins (Storage Nodes 1180 and 1780 in the future models). The exact shape and location of these basins is not critical, as long as they maintain the combined approximate storage characteristics shown in Table 7-4.

Table 7-4. Required Future Storage Basin Configurations East of Battlefield Boulevard				
Storage Basin	Bottom Elevation (Feet, NAVD88)	Bottom Area (Acres)	Top Elevation (Feet, NAVD88)	Top Area (Acres)
1180	10.50	3.40	19.00	5.88
1780	11.00	1.11	18.00	1.98

The connection of the ponds to Battlefield Boulevard is not critical, as long as the peak discharge rates mimic those produced in the future conditions model. Storage Basin 1180 should have an outfall that limits the 50-year peak outflow to 50 cfs, and Storage Node 1780 should have an outfall that limits the discharge to 178 cfs for the 50-year design storm.

The construction of storage basins east of Battlefield Boulevard is not necessary until the surrounding property is developed. There should be no appreciable cost to the City, because the improvements can be required of the developer(s) as part of the site development and site plan approval process, in accordance with existing ordinances and regulations.