APPENDIX D

St. Clair County Health Department Tributary Monitoring Program

D-1.0 Introduction

Three monitoring sites were established by the St. Clair County Health Department in 2005 to collect water quality data to "fill in the gaps" for tributaries with no existing sediment or nutrient data. Adequate data is available on the Black River and Bunce Creek (in the SRD subwatershed). They had been recently monitored as part of the Lake St. Clair Regional Monitoring Project. Therefore, two sites were selected in the LHD subwatershed, Burtch Creek (a more rural site), Carrigan Drain (a more urban site), and one site along Cuttle Creek was selected in the SRD subwatershed. The physical process of monitoring itself provided a "hands-on" means of quantifying the difference between the two subwatersheds for which there was a lack of data.

The following types of monitoring were conducted at the three stations:

1. Water quality samples were measured for nutrient concentrations which included total phosphorus and various forms of nitrogen. Quantifying excessive nutrient concentrations is important to evaluate excessive loadings to the stream, trophic state, and the ability of the stream to assimilate nutrients.
2. Stream discharge monitoring data was collected to provide a stage-discharge relationship for the stream so that sediment and nutrient concentrations could be correlated to flow. A cross-section was established at each monitoring site. The cross-sectional area (A) of the water could be calculated for each change in stage (or water surface elevation). The average velocity (V) was measured with a flow meter and discharge (Q) was calculated with the continuity equation $Q = AV$.
3. Sediment discharge data was collected for total suspended solids (TSS) and bedload using USGS calibrated equipment. A US DH-41 depth-integrated sampler was used for TSS and a US BLH-84 wading type Helley-Smith style sampler was used for bedload. Suspended sediment is the portion of the sediment load that moves in suspension above the streambed and is made up of small sediment particles. Bedload is the sediment that moves on or near the streambed. It is measured along the bottom 3 inches of the channel and is composed of sand-sized and larger particles. An understanding of excess sediment supply in comparison to a reference condition is important when evaluating stream health and stability.
4. A rapid biomonitoring screening was conducted for a general characterization of species density, diversity, and sensitivity to pollution or disturbance. Benthic organisms are a long-term indicator of habitat modification and chronic impacts to the stream. Unlike a water quality grab sample which provides an instantaneous "snapshot" of stream conditions, biomonitoring can be thought of as more like a movie clip that show the impacts of a combination of stressors to the aquatic community over time.
5. A Level I geomorphic characterization was performed. Geomorphology is the study of the origin of landforms, the processes that form them, and their material composition (Armantrout, 1998). Thus, fluvial geomorphology looks at the processes that operate in stream systems and the landforms they create. Several channel stability criteria were evaluated to assess the stability of a representative stream reach near the monitoring sites. This information was used to characterize and compare stream conditions and to attribute changes in conditions to geomorphic processes. The application of the science of fluvial geomorphology to watershed management is useful to relate channel form and processes that characterize stream conditions. A summary of terms is provided in Section D-5.1.

D-2.0 Burtch Creek

Burtch Creek is located within agricultural and rural land use areas. Most of the smaller tributaries have been channelized in the past and approximately one third of these tributaries appear to be poorly managed (Fig. D-2.1). Common practices with negative impacts include farming within and directly adjacent to tributaries, cattle access, mowing or burning riparian vegetation, channelization, perched culverts, and conversion of riparian vegetation to turf grass. At the monitoring site near State Street, sediment appears to have deposited within the floodplain to the extent that the channel is now relatively straight and incised due to historic land use practices (Fig. D-2.2). The floodplain refers to a geomorphic feature of the channel as opposed to the 100-yr floodplain (further described in Section D-5.1). As a result, the banks are severely eroding and the sediment discharge is very high during moderate and high storm events as noted by the steeper curve and higher Y-intercept in Figure D-2.2.

Figure D-2.1 Alluvial fan created by excess sediment supply from agricultural tributary

A cross-section was established and monitoring data was collected at State Street, south of Jeddo Road in Burtchville Township. The drainage area was 5.55 square miles. A monitoring site was initially established at Jeddo Road, just west of M-25; however, the site was re-located to State Street because it was not wadable during high water conditions.

H-2.1 Water Quality Data

The results of the water quality monitoring in Burtch Creek found that the total suspended sediment (TSS) load was very high during high flow conditions due to the instability of the channel. During low flow conditions, total phosphorus levels were low [compared to EPA reference conditions (Section D-5)]. The total phosphorus concentration may have been higher during high flows because phosphorus tends to adhere to sediment particles. Total nitrogen levels in Burtch Creek were high during all flow conditions, mostly in the form of nitrate.

Table D-2.1 Summary of SCCHD 2006 Burtch Creek Monitoring Data at State Street

	Date	Time	Stage	Cross Section Area	Velocity	Discharge	TSS	Total P	Total N	Bedload
Sample			**ft**	**ft^2**	**ft/s**	**ft^3/s**	**mg/L**	**mg/L**	**mg/L**	**lb/day**
BUR-01	3/13/06	11:30	4.2	87.4	3.5	306	2,014	1.28	2.32	N/A
BUR-02	3/29/06	10:00	1.24	2.55	0.57	1.5	17	0.05	4.07	0
BUR-03	4/1/06	9:00	1.39	5.4	1.56	8.4	19	0.08	4.3	N/A
BUR-04	4/7/06	N/A	0.51	9.5	2.39	22.7	N/A	N/A	N/A	N/A

*Sample BUR-01 was taken at Jeddo Road, just west of M-25

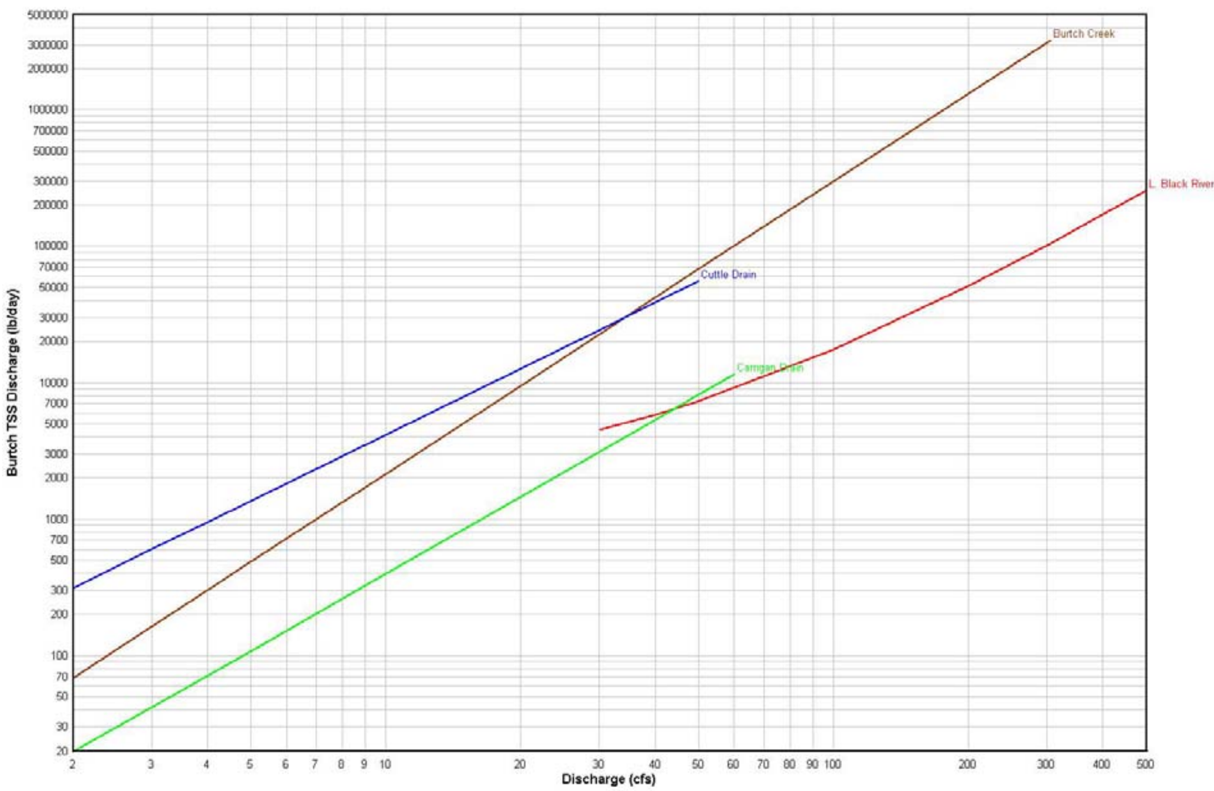

Figure D-2.2 Comparison of Suspended Sediment Discharge Rating Curves

D-2.2 Biomonitoring

The channel bed exhibited extensive scour and deposition and was mostly devoid of any aquatic organisms except tolerant blackfly larvae. Approximately 1,500 feet of the channel was walked until one small area of coarse substrate was located where the flow was concentrated below some large woody debris. As indicated in Table D-2.2, Burtch Creek had the best diversity of macroinvertebrates (bottom-dwelling aquatic insects); however, almost all of the organisms were found in this one small area. Although only a preliminary macroinvertebrate screening was performed, the results indicate the severe ecological impacts caused by the overall channel instability. Some sensitive species are present which indicates that, if the channel were to be restored, then there would be a source of these species to rapidly re-populate the creek.

Table D-2.2 Summary of SCCHD 2006 Biomonitoring Data for Burtch Creek Near State Street

Common Name	Quantity	Sensitivity
Blackfly	TNTC	Tolerant
Caddisfly	3	Sensitive
Scuds	3	Somewhat Tolerant
Aquatic Worm	2	Very Tolerant
Crane Fly	1	Somewhat Tolerant
Dobsonfly	1	Sensitive
Midge	4	Very Tolerant
Leech	1	Tolerant

TNTC – Too numerous to count

D-2.3 Channel Stability Assessment

Natural stream channel stability is achieved by allowing the river to develop a stable dimension, pattern, and profile such that, over time, the channel features are maintained and the stream system neither aggrades nor degrades (Rosgen, 1996). For a stream to be stable, it must consistently be able to transport its sediment load. Therefore, a stream can fail by excess erosion or excess deposition. Rosgen describes stable, self-formed streams as being to be at their full potential when their physical and biological functions are at an optimum. Describing the current stream condition and departure from its potential state is critical to effective management.

Rosgen Level I Classification – Valley Type X (Valley Type V approx. 1 mile upstream)
Rosgen Stream Channel Type – predominantly F with reaches of C

General Stream Channel Condition – Conditions of the main channel of Burtch Creek are unstable with very high sediment loadings from both in-stream and upland sources. The spring season flows on Burtch Creek generally appeared to be more flashy than Carrigan Drain during storm events. Based on a windshield survey, approximately one third of the first order tributaries to Burtch Creek are unstable and poorly managed. A concrete culvert has been recently installed under State Street. The previous culvert was perched and may have been under-sized. Channel bed erosion downstream of the culvert is continuing to progress downstream.

Channel Stability Rating – The descriptive rating of the stability of the stream channel based on the modified Pfankuch evaluation was “poor”.

Vertical Stability – The degree of channel incision is measured by the bank height ratio. A bank height ratio >1.5 is considered highly unstable. The bank height ratio on Burtch Creek is almost 4, which indicates the severity of the channel degradation. The entrenchment ratio (ER) indicates the extent of vertical containment of the channel. Most of the channel is entrenched (ER<1.4). In some areas where the channel is much wider and side bars have formed, the entrenchment ratio is 2 which indicates that the channel is moderately entrenched. In these locations, the channel is beginning to form a new floodplain at the lower base elevation.

Lateral Stability – Some intermittent sediment bars are beginning to form at an elevation that may stabilize to become a new floodplain; however, due to the extent of the instability and the low gradient of the creek, this will not be possible without intervention. The Meander Width Ratio is less that 2 which is confined for a C channel (Rosgen, 2006).

Bed Features – A longitudinal profile of the creek was not measured. In a few locations, the bed was eroded down to a hardpan parent material. In most areas, significant sediment bars of sand and fine gravel were present because the creek does not have the capacity to transport its high sediment load. There were no riffles evident and the only pools were below the road culvert.

Figure D-2.3 Burtch Creek Downstream of the State Street Monitoring Site

D-2.4 General Management Implications

Different stream types are not similar in their sensitivity to disturbance, the role of riparian vegetation, and their potential for natural recovery. Although a variety of stream types exist within the Burtch Creek watershed, an understanding of the general management interpretations is useful. A summary of management interpretations for the F channel near the monitoring site are provided in Table D-2.3.

Table D-2.3 Summary of Management Interpretations for Burtch Creek assuming Rosgen F4 Stream (from Rosgen, 1996)

Management Practice	Interpretation	Comments
Sensitivity to Disturbance	extreme	Includes increases in streamflow magnitude and timing and/or sediment increases
Recovery Potential	poor	Assumes natural recovery once cause of instability is corrected
Sediment Supply	very high	Includes increases in streamflow magnitude and timing and/or sediment increases
Streambank Erosion Potential	very high	N/A
Vegetation Controlling Influence	moderate	Vegetation that influences width/depth ratio stability

Headwater tributaries that are contributing excessive sediment loads should be stabilized as a first priority (Fig. D-2.4a). Where agricultural drainage is required, a two-stage ditch design should be used by excavating a floodplain bench on one or both sides of the channel. The final capacity of the channel should allow for mature grasses, sedges, and some shrubs (Fig. D-2.4b). The main channel of Burtch Creek downstream of State Street is deeply incised and cannot be restored without active intervention (Table D-2.3 under Recovery Potential).

Figure D-2.4a Poor Riparian Management

Figure D-2.4b Better Riparian Management

D-3.0 Carrigan Drain

Carrigan Drain is an established County Drain located within predominantly suburban land use areas. It appears that when the drain was last maintained, it was constructed with a high width/depth ratio and a large capacity to contain flood-sized storm events. As constructed, the overly-widened drain did not have sufficient energy to transport its sediment load. Subsequently, deposition occurred along the margins of the channel to form vegetated floodplain benches along either side of the channel. This narrowed the active channel and created the stable channel that is evident through much of the drain. Exceptions occurred at overly-wide and shallow reaches near culverts or with excessive tree canopy.

Figure D-3.1 Stable Reach of Carrigan Drain Upstream of the Monitoring Site

A cross-section was established and monitoring data was collected at Lakeshore Road, north of Keewahdin in Fort Gratiot. The drainage area was 1.16 square miles. During several rain events, the sediment load and flashiness of flows were noticeably lower in Carrigan Drain than in Burtch Creek. The staff gauge became dislodged over the winter and had to be re-installed in the spring. The drain was previously excavated to increase capacity and over-widened. As deposition occurred along the margins of the channel and vegetation became established, the drain formed a flat bench of deposition and a smaller channel that effectively conveys the sediment and water produced by its catchment.

D-3.1 Water Quality Data

As with Burtch Creek, total phosphorus (TP) concentration increased with an increase in flow, but the levels of TP did not approach those in Burtch Creek. Nitrogen levels were high most of the time and spiked in mid-June during a moderate rain event. The TSS concentration was very low due to the stability of the channel. Most of the sediment loadings during high flows likely come from upland sources. Nutrient loadings may increase seasonally following lawn fertilizing or bank mowing.

Table D-3.1 Summary of SCCHD 2006 Carrigan Drain Monitoring Data at Lakeshore Road

	Date	Time	Stage	Cross Section Area	Velocity	Discharge	TSS	Total P	Total N	Bedload
Sample			ft	ft^2	ft/s	ft^3/s	mg/L	mg/L	mg/L	lb/day
CAR-01	3/13/06	12:00	0.84	13.9	1.75	24	16	0.4	0.76	943.5
CAR-02	3/29/06	12:30	0.25	4.9	N/A	0.9	ND	0.04	2.55	N/A
CAR-03	4/1/06	N/A	0.36	6.3	0.60	3.8	ND	0.05	2.56	N/A
CAR-04	4/7/06	N/A	0.51	8.4	1.10	9.2	N/A	N/A	N/A	N/A
CAR-05	6/20/06	1:45	1.75	34.2	1.83	62.5	37	0.29	10.34	175.6

D-3.2 Biomonitoring

The substrate near the monitoring site consisted of sand, fine gravel, broken concrete, and debris. The bed was somewhat featureless (no significant riffles or pools), which is typical of excavated drains. In late spring, an excessive growth of diatoms (microscopic algae) covered the bottom of the drain with a heavy brown layer. Very few organisms were found and there was poor diversity, but some sensitive species were present. More extensive sampling away from the bridge may have produced more numbers and diversity.

Table D-3.2 Summary of SCCHD 2006 Biomonitoring Data for Carrigan Drain Near Lakeshore Road

Common Name	Quantity	Sensitivity
Caddisfly	4	Sensitive
Sowbug	1	Somewhat Tolerant
Damselfly	2	Somewhat Tolerant

D-3.3 Channel Stability Assessment

Rosgen Level I Classification – Valley Type X
Rosgen Stream Channel Type – E with reaches of F
General Stream Channel Condition – Physical conditions of the main channel of Carrigan Drain are generally the most stable of the three streams monitored. Even though this tributary received runoff from commercial and highway areas, the discharge in the drain was consistently low (much less flashy) during rain events. It was difficult to establish stage-discharge relationships for moderate flows because the gauge height did not rise very often. The channel stability and flow attenuation may have been due to the larger width of the floodprone area (Fig. D-5.1).


Figure D-3.2 Carrigan Drain Upstream of Lakeshore Road Monitoring Station

Channel Stability Rating – The descriptive rating of the stability of the stream channel based on the modified Pfankuch evaluation was "good".

Vertical Stability – The degree of channel incision is measured by the bank height ratio. A bank height ratio of 1.0 to 1.05 is considered stable. The section of Carrigan Drain in Figure D-3.1 is typical of much of the drain. It has a bank height ratio of 1.0 and an entrenchment ratio of 7.9, which indicates the high level of stability in the channel. Most of the channel is only slightly entrenched (ER>2.2). In some areas where the channel bottom is wider, such as near the Lakeshore Road monitoring site, the bank height ratio is 2.8. At a bank height ratio >1.5, the banks tend to be highly unstable.

Lateral Stability – Regional studies have shown that a ratio of the bankfull width to the width of the floodprone area of at least 3 is recommended for channel stability and ecological function. The ratio of the bankfull width to the width of the floodprone area for the section of Carrigan Drain in Figure D-3.1 is >5.5, which indicates the lateral stability of the channel. When flows exceed the capacity of this small channel, they inundate the floodplain and the energy of the water is dissipated. The Meander Width Ratio is approximately 5.5 which is confined for an E channel, but unconfined for a C channel.

Bed Features – A longitudinal profile of the creek was not measured. There were no riffles or pools. The only areas that appeared similar to rifles are accumulations of broken concrete. This featureless bed topography is typical of roadside drains.

D-3.4 General Management Implications

A summary of management interpretations for the F channel near the monitoring site are provided in Table D-3.2.

Table D-3.2 Summary of Management Interpretations for Carrigan Drain assuming Rosgen E5 Stream (from Rosgen, 1996)

Management Practice	Interpretation	Comments
Sensitivity to Disturbance	very high	Includes increases in streamflow magnitude and timing and/or sediment increases
Recovery Potential	good	Assumes natural recovery once cause of instability is corrected
Sediment Supply	moderate	Includes increases in streamflow magnitude and timing and/or sediment increases
Streambank Erosion Potential	high	N/A
Vegetation Controlling Influence	very high	Vegetation that influences width/depth ratio stability

As previously described, the drain was likely excavated to increase capacity. Rather than excavating the stable floodplain benches periodically as an ongoing maintenance task, the natural channel processes demonstrated along this drain should be viewed as a template for future drain improvement projects. A two-stage channel should be constructed that will be more stable and require much less long-term maintenance (Fig. D-3.3). The St. Clair County Drain Commissioner's Office has constructed demonstration projects utilizing a two-stage channel design. Research and development of standard engineering details should continue as the NEW management plan is implemented.

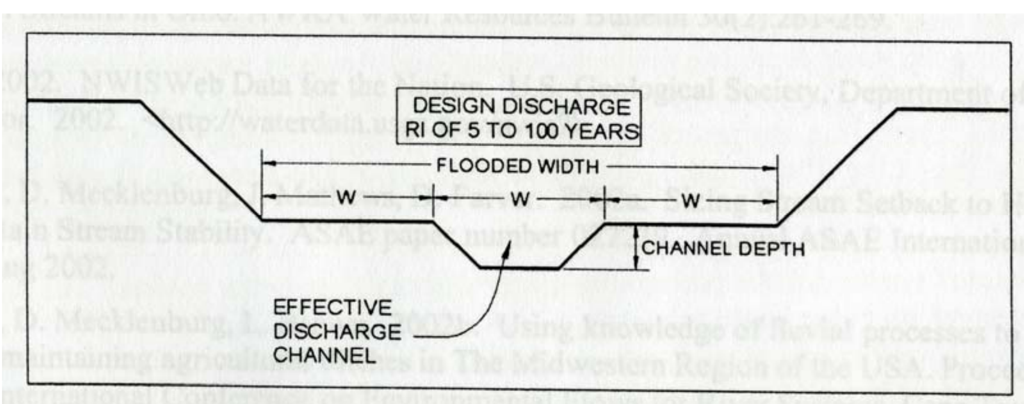

Figure D-3.3 Example of Two-Stage Channel Design (Ohio DNR)

The following general maintenance practices are recommended:

- Although the two-stage channel design requires less long-term maintenance, adequate soil erosion control measures should be used to stabilize the channel until vegetation becomes established. This will also minimize the growth of invasive plant species that can over-take the channel and reduce conveyance.
- The persons responsible for site maintenance should be consulted or riparian residents should be educated regarding appropriate mowing and maintenance practices.
- Clearing and snagging is defined as removing woody vegetation and large woody debris from channels to preserve flood capacity, minimize erosion, or maintain navigation (Brookes, 1988). Traditionally, all wood has been removed to the detriment of habitat and overall channel stability. It is now recognized that only logjams that cause sufficient blockage to flows should be managed. Large woody debris should be selectively removed and managed in accordance with the Clean and Open Method (RCMTAC, 2004).
- The overall design capacity of the channel should consider the roughness that will be produced by the final stand of vegetation.
- Natural vegetation should be allowed to grow along open drains and natural streams to control erosion and provide some shading. Shading is a preferred alternative to cutting and spraying where *Phragmites* and excessive aquatic vegetation is a concern. Trees and woody shrubs should be retained (by one-side excavation) or established on at least one side during open drain construction. Where woody vegetation can only be retained on one side, the priority is to maintain trees and/or shrubs on the east side of north-south flowing channels and on the south side of east-west flowing channels (or large trees on the north side). Tree and shrub coverage should be provided along 40-70% of the channel length for canopy shading and to reduce excessive aquatic plant growth.
- Periodically and following storm events, stabilized areas should be inspected for erosion and any rills or gullies repaired. Following the first two growing seasons, determine if reinforcement plantings are needed.

D-4.0 Cuttle Drain

Cuttle Drain is an established County Drain located within predominantly suburban land use areas. Similar to Carrigan Drain, when the drain was constructed, it was built with a large capacity to contain flood-sized storm events. However, the drain was not built to the same width as Carrigan Drain (although they had a comparable drainage area). As a result, it maintains a predominantly trapezoidal shape (Fig. D-4.2b). Exceptions occur where intermittent side bars have begun to form a floodplain bench (Fig. D-4.1). Much of the banks of the drains are mowed of regularly cleared of brush.

Figure D-4.1 Cuttle Drain with Intermittent Side Bars

A cross-section was established and monitoring data was collected just upstream of Covington Lane in Marysville. The drainage area was 1.28 square miles. The flows were generally comparable to Carrigan Drain, but the sediment discharge was higher. The staff gauge became dislodged over the winter and had to be re-installed in the spring. The drain was previously excavated to increase capacity and over-widened. Deposition has begun to occur along the margins of some sections of the channel, but the channel width is too narrow to allow a stable effective discharge channel to become established. The Cuttle Drain channel was generally not as stable as the Carrigan Drain, but there was not extensive erosion near the monitoring site.

D-4.1 Water Quality

Similar to Carrigan Drain, an increase in total phosphorus concentration was related to an increase in flow (Table D-4.1). Nitrogen levels were high most of the time and spiked in mid-May during a small rain event. The TSS concentration was moderately low, but may be much higher during periods of higher discharge. The TSS and nutrient levels spiked during the small rain event on May 7, 2006. The shrubs had been recently cut from the channel banks upstream of the monitoring sites, but the flows did not reach that elevation. Similar to Carrigan Drain, the nutrient loadings may increase seasonally. Based on the moderate bank stability, much of the sediment loadings likely come from a combination of upland and in-stream sources.

Table D-4.1 Summary of SCCHD 2006 Cuttle Drain Monitoring Data at Covington Lane

	Date	Time	Stage	Cross Section Area	Velocity	Discharge	TSS	Total P	Total N	Bedload
Sample			**ft**	**ft^2**	**ft/s**	**ft^3/s**	**mg/L**	**mg/L**	**mg/L**	**lb/day**
CUT-01	3/13/2006	3:00	2.5	15.1	3.2	48	83	0.55	0.3	474.4
CUT-02	3/29/2006	3:00	0.94	2.31	N/A	0.7	19	0.09	1.63	N/A
CUT-03	4/1/2006	N/A	1.08	2.95	0.28	0.8	13	0.07	2.21	N/A
CUT-04	5/17/2006	7:45	1.67	6.23	1.41	8.8	209	0.56	10.31	90.9

H-4.2 Biomonitoring

The substrate near the monitoring site consisted of sand, fine gravel, broken concrete, and debris. The bed was somewhat featureless (no significant riffles or pools), which is typical of excavated drains. Similar to the other two monitoring sites, few organisms were found and there was poor diversity, but some sensitive species were present (Table D-4.2). Other tributaries upstream of the monitoring site appear to be just as channelized and may produce similar results.

Table D-4.2 Summary of SCCHD 2006 Biomonitoring Data for Cuttle Drain Near Covington Lane

Common Name	Quantity	Sensitivity
Pouch snail	4	Tolerant
Orb snail	1	Tolerant
Leech	4	Tolerant
Aquatic worm	1	Very Tolerant
Caddisfly	7	Sensitive

H-4.3 Channel Stability Assessment

Rosgen Level I Classification – Valley Type X
Rosgen Stream Channel Type – predominantly F with a few very short reaches of E channel

General Stream Channel Condition – Conditions of Cuttle Drain are moderately unstable with sediment discharge values typically between Burtch Creek and Carrigan Drain (Fig. D-1). The drain is highly entrenched and much of it is maintained. During recent construction, the floodplain was further filled on both sides of the tributary east of Covington Lane and soil erosion control measures were not adequate. The entire watershed was not evaluated, but upstream tributaries tended to be more entrenched than the monitoring site.

Figure D-4.2a&b Carrigan Drain at Monitoring Site: Facing Downstream (left) and Facing Upstream (right) Respectivley

Channel Stability Rating – The descriptive rating of the stability of the stream channel based on the modified Pfankuch evaluation was "fair".

Vertical Stability – The degree of channel incision is measured by the bank height ratio. A bank height ratio >1.5 is considered highly unstable. The bank height ratio on Cuttle Drain is >5, which indicates the high level of vertical containment.

Lateral Stability – The channel is highly confined within a moderately unstable trapezoidal channel. Toe scour is evident, but there are no signs of mass wasting (severe bank erosion). The Meander Width Ratio is approximately 3 which is moderately confined for a C channel and severely confined for an E channel.

Bed Features – A longitudinal profile of the creek was not measured. There were no riffles or pools. The only areas that appeared similar to rifles are accumulations of broken concrete. This featureless bed topography is typical of urban drains.

General Management Implications

The general management recommendations are similar to the Carrigan Drain but, because it is predominantly an F channel, the management interpretations are different (Table D-4.3).

Table D-4.3 Summary of Management Interpretations for Cuttle Creek assuming Rosgen F4 Stream (from Rosgen, 1996)

Management Practice	Interpretation	Comments
Sensitivity to Disturbance	extreme	Includes increases in streamflow magnitude and timing and/or sediment increases
Recovery Potential	poor	Assumes natural recovery once cause of instability is corrected
Sediment Supply	very high	Includes increases in streamflow magnitude and timing and/or sediment increases
Streambank Erosion Potential	very high	N/A
Vegetation Controlling Influence	moderate	Vegetation that influences width/depth ratio stability

D-5.1 Terminology

Bankfull Stage – in streams with an observable floodplain feature, it is the elevation on the bank where flooding begins. The bankfull stage corresponds to the discharge at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or re-forming bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels (Dunne and Leopold, 1978). In many channelized, urban, or incised streams, the bankfull stage is below the top of bank.

Channel Stability – natural channel stability is achieved by allowing the river to develop a stable dimension, pattern, and profile such that, over time, channel features are maintained and the channel neither aggrades (bed deposition) nor degrades (bed erosion) (Rosgen, 1996). Dimension refers to the cross-sectional channel measurements such as width and depth, pattern refers to the sinuosity, wavelength, and other characteristics as shown on the stream plan view, and the profile is related to the slope of the channel and its features.

Floodplain – a geomorphic feature, as opposed to the 100-yr floodplain. A flat, depositional feature immediately adjacent to the active channel. Through erosion and deposition, it is constantly being formed and re-formed by the river at its present condition and at its present climate (Leopold, 1978). Some stream types, such as F and G channels do not have well defined floodplains (Fig. D-5.1).

Lateral Stability – the degree of lateral containment (confinement) and potential for bank erosion. One method of determining the potential for bank erosion is the Bank Erosion Hazard Index (BEHI). The index is an erosion prediction model that integrates several streambank characteristics to determine susceptibility to detachment and bank collapse. In a more detailed level of evaluation, the BEHI values can be calibrated to measured streambank erosion values to accurately predict sediment loading rates over many stream miles.

Rosgen Stream Classification – Classification is the ordering of objects into sets on the basis of their similarities or their relationships (Platts, 1980). The Rosgen classification system of natural streams is a communication system and management tool that is often used by MDEQ. It can be used to predict stream behavior from objective, quantifiable criteria, develop hydraulic and sediment relationships by stream type and state, and management interpretations (Rosgen, 1996).

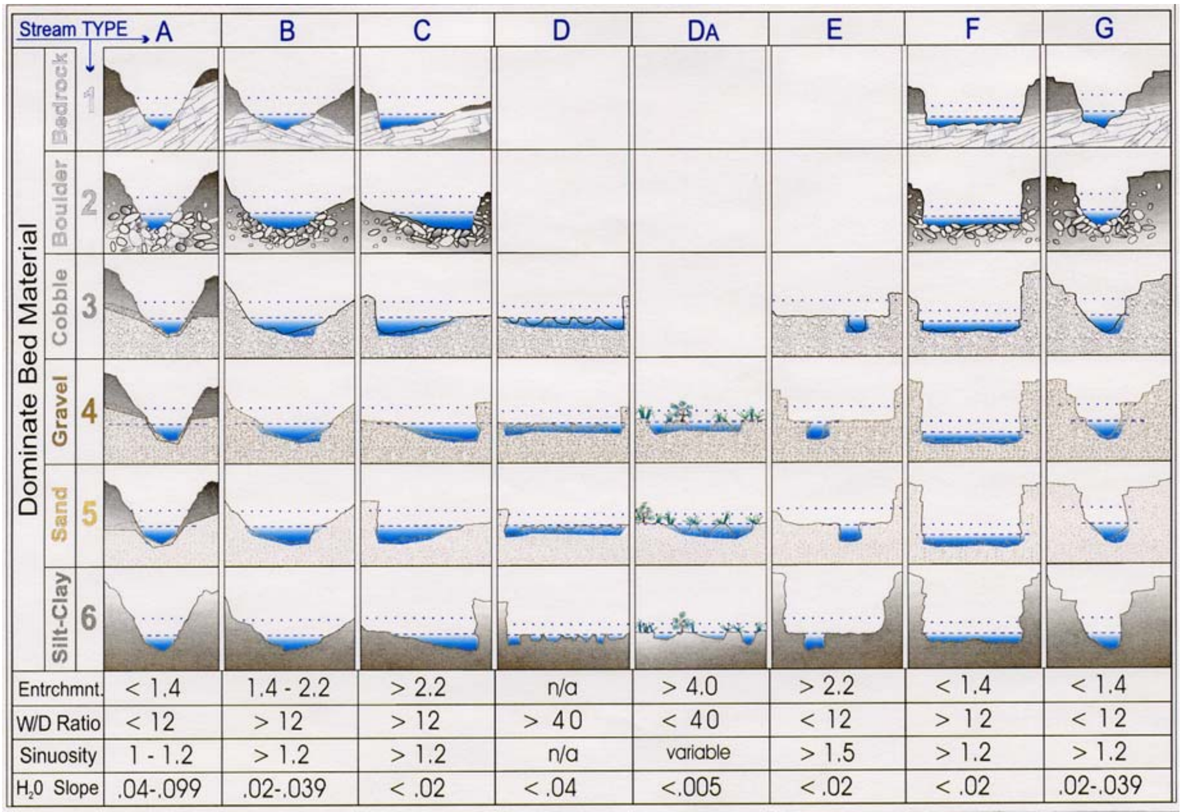

Figure D-5.1 Rosgen Classification System (Rosgen, 1998)

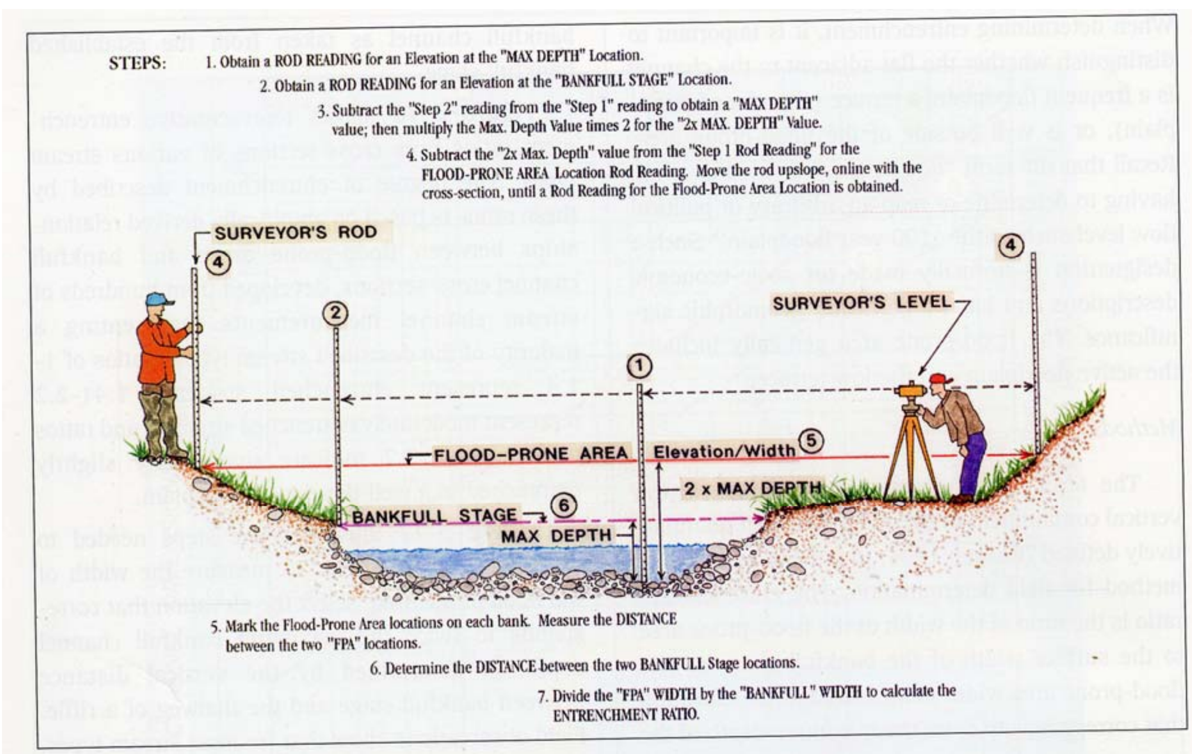

Figure D-5.2 Terms Related to Cross Section Dimensions (Rosgen, 1996)

Vertical Stability – the susceptibility of the streambed to excessive degradation or aggradation. The entrenchment of the channel and the bank height ratio are two ways to evaluate the degree of degradation. The entrenchment ratio, which indicates vertical containment, is the width of the floodprone area (the channel width at an elevation of two times the maximum bankfull depth) divided by the width at the bankfull stage. If the entrenchment ratio is less than 1.4 (+ or – 0.2), then the stream is entrenched. The bank height ratio is the height of the lowest bank divided by the maximum bankfull depth.

D-5.2 Ambient Nutrient Criteria

In 2000, EPA developed ambient water quality criteria recommendations for a region (Ecoregion 56) that includes the NEW to assist states in developing ambient nutrient criteria for reference conditions. The recommended criteria are based data from local streams. The document can be viewed online: http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/rivers/rivers_7.pdf. As stated in Chapter 2, water with TSS levels between 40 and 80 mg/L tends to appear cloudy, while water with concentrations over 150 mg/L usually appears "dirty". Comparison to reference conditions is one way to provide a preliminary screening for data that exceed the criteria. Measured nutrient values may be compared to the P-25 values in Table D-5.1. Total nitrogen is reported here as a summary so the data can be compared to reference values, but separate values of nitrate, nitrite, ammonia-N, and total kjeldahl nitrogen are provided in the Water Quality Data Resource Directory.

Table D-5.1 Reference Conditions for Level III Ecoregion 56 (includes NEW)

Parameter (mg/L)	**Reported Values**		**25th Percentiles based on data from all seasons**
	Min.	**Max.**	**P25 – all seasons**
Total Nitrogen (N)	0.90	2.55	1.15
Total Phosphorus (P)	0.00375	0.295	0.03125