Summary of Geomorphology Assessment Results for the Middle Huron River Watershed, Section 1

Overview

The geomorphic rapid assessment project is one part of a larger effort to update the Middle Huron River (Section 1) Watershed Management Plan (WMP). For this plan, HRWC employed a method to evaluate the stability of representative stream reaches (i.e. segments) throughout the watershed as was applied in Section 2 of the watershed. In summary, the rapid evaluation method assesses the erodibility of a stream reach's banks and the hydraulic forces impacting those banks to estimate erosion rates for each bank. These bank assessments can then be compiled into an overall erosion rate for the stream reach or average rates for all evaluated streams within a tributary creekshed. The erosion estimates individually should only be used to get a general sense of the scale of erosion relative to other streams in the system (rather than taken as precise estimates of sediment load), as the techniques are designed for a rapid and broad assessment.

The geomorphic survey effort is designed to achieve the following objectives.

Objective 1: To determine which representative stream reaches in the watershed are physically stable, which are actively eroding and which are aggrading. This was determined by an evaluation of Bank Assessment for Non-point source Consequences of Sediment (BANCS) model, which includes Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) metrics computed at stream survey locations. Specifically, observational metrics such as bank height, substrate, angle and root depth are evaluated along both banks of an assessed stream reach. The lengths of the erosive banks are then summed to estimate an overall erosion rate for the stream reach.

Objective 2: To develop a prioritized inventory of degraded stream reaches throughout the watershed. Stream reaches were ranked according to erosion rate estimates from the rapid BANCS assessments. Further, high-erosion potential reaches will be evaluated qualitatively for restoration potential. Reaches that are heavily altered by development (such as contained in concrete channels or heavily rip-rapped banks) will not be given high priority for stream restoration since restoration designs will be unlikely to be stable under such highly altered condition. Other physical, logistical or ownership issues may reduce the ability of watershed partners to restore a stream segment, while other factors may make a segment more desirable. Factors such as existing nutrient, pollutant, and sedimentation issues in the reach's watershed will also contribute to higher restoration potential.

HRWC assessed just under 62 miles of stream length using this method in 2020-21. Using the method, stream banks and lengths are evaluated to determine erosivity and site and full-length erosion rate metrics are generated. The metrics for all the stream reaches in the inventory will be compared, and from that future stream restoration targets will be prioritized. This analysis will result in a set of stream restoration recommendations for the WMP. Results can also be shared with interested land-owners by request.

Methods

Geomorphic analysis consisted of desktop and rapid field techniques that generally follow methods outlined in Watershed Assessment of River Stability and Sediment Supply (Rosgen, 2006), specifically a slightly altered version of the BANCS model technique. The analysis focuses on reaches that may be impaired by physical or previous hydrologic alterations. Specific selection criteria are discussed below. The study teams conducted rapid assessment using the BANCS model (section 2.1, objective 1), with the goal of following-up with estimated bankfull dimensions of selected reaches and cross-sections to further evaluate restoration priorities (section 2.1, objective 2).

The study began with an initial desktop analysis to identify and assess representative reaches. All mapped streams within the study watershed were subdivided into reaches designated as reasonable lengths between branch points. A reach contributing area (RCA, or drainage area) was created for each reach. A set of statistics was generated from available GIS and aerial data for each reach, including stream length, stream slope, valley slopes, and soil erosivity. Land use characteristics were generated for each RCA such as total area and percent cover in urban, impervious, agriculture, and natural (wooded/wetland).

Reaches that are dominated by urban piping and channelization were eliminated from field analysis consideration, as such reaches have lost natural geomorphology and function and must be treated for hydrologic alteration. Remaining stream reaches were further classified by chemical (phosphorus, nitrogen, DO, TDS, TSS) and biological (bacteria, macroinvertebrate diversity) impairment from previous monitoring results. Reaches were ranked by likelihood of hydrologic or sediment impairment.

Reaches were then prioritized into three groups, based on priority for assessment: high, medium, and low priority. Criteria used for evaluation included length of open surface water, likelihood of erosion (based on land uses and slope), past observations within the area, accessibility, stream size (or drainage area), and representativeness. The number of similar stream reaches with initial high priority designations was quite large (206 miles). This initial set of high priority reaches were classified by drainage area and stream order and then this stratified set was subsampled to identify a smaller set of reaches that would prioritized for assessment, so that the evaluated set would be representative of the variety of stream reach types in the broader watershed. This new high priority set of reaches included 65 miles of stream. Not all reaches ended up being accessible.

The high priority reaches were then segmented into “assessment” lengths that were between access points and between 0.5 and 1 mile in total length, which, following initial runs of the BANCS assessment methods, was determined to be a reasonable length for an assessment session. These assessments were then mapped onto Google maps along with parking and access instructions. Assessments were then assigned to teams of 3-4 assessors.

These teams made observations of erosion and alteration using BEHI and NBS metrics, and made rough estimates of bankfull width and depth, bank angle, bank slope, and bank ratios. From this analysis, a rank-order list of stream reaches for the watershed was developed for making restoration or remediation recommendations in the WMP. One important difference in method between the assessments of Section 1 streams and Section 2 streams is that HRWC developed the data collection forms into an electronic survey format using ESRI's Survey 123 platform (see Appendix A). That tool allowed data to be collected electronically in the field, including GPS coordinates and photos, and uploaded directly to the geodatabase without the need for error-prone data entry. Data from all assessment observations were recorded through the field tool and uploaded to the field geodatabase. Once data was reviewed and corrected and approved, they was transferred to the master geodatabase to be used for analysis.

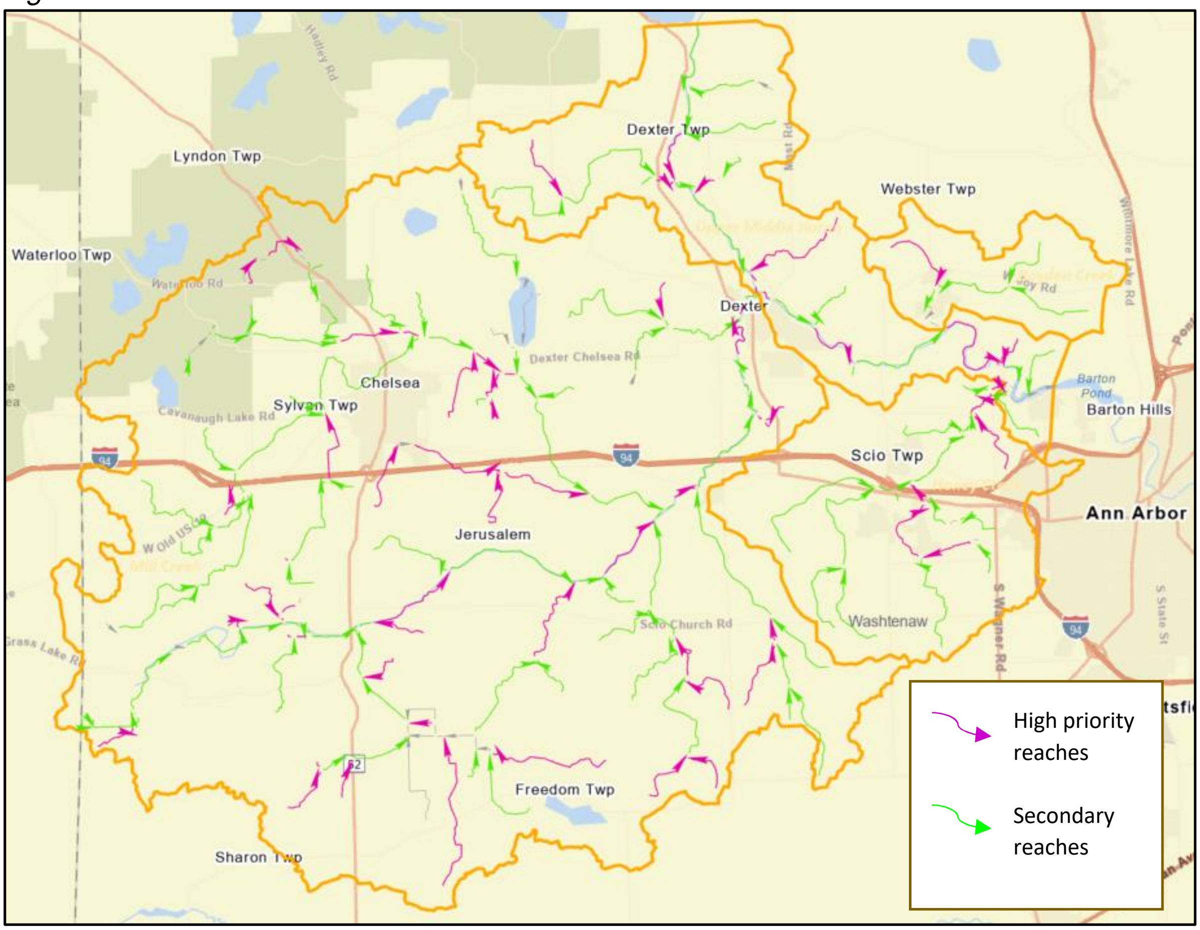
Return surveys to high priority reaches are planned to refine erosion rate calculations using more precise survey methods. Time and resources has not allowed for these surveys at this point in time. Further survey work may also be part of initial restoration project planning efforts.

More detailed methods are included in the monitoring Quality Assurance Project Plan, which can be obtained by request.

Results

The desktop stream reach identification and segmentation generated over 254 separate reaches in the watershed (see Figure 1). Reaches were defined by connectivity, as confluence to confluence (or start point to confluence). They varied in stream length from 19 feet to 3.5 miles. Ultimately, 60 reaches were assessed (nearly all high priority reaches and a few secondary reaches) for a total of 62 miles of evaluated stream banks. Given the variety of reach lengths, some reaches were combined into a single assessment, while longer reaches were divided into multiple assessments.

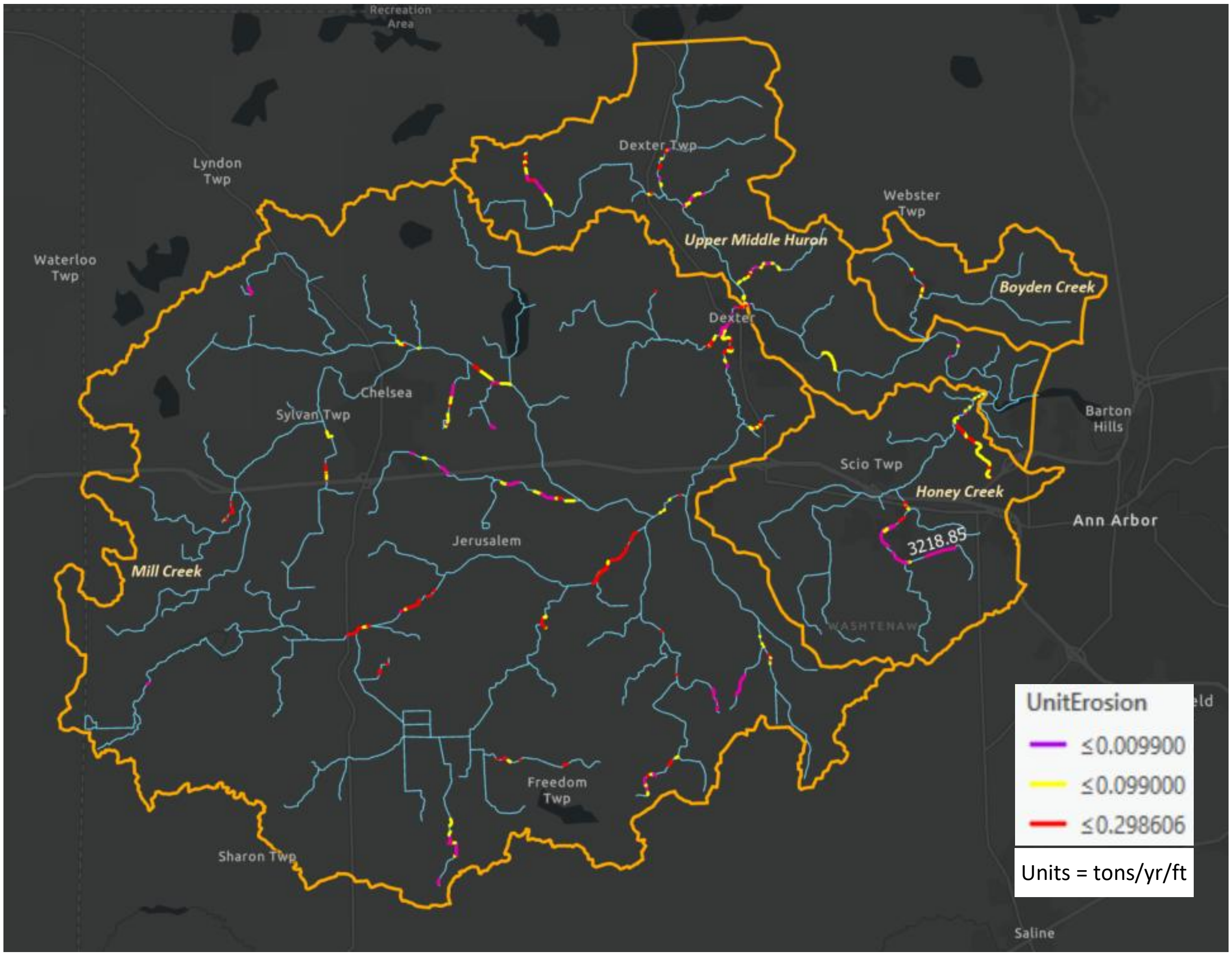
Figure 1. Stream Reaches in the Watershed Prioritized for Assessment



Complete data tables from the database for Reaches, Assessments, and BANCS observations are included in Appendix B (separate spreadsheet file).

Results from the geomorphic assessment can be presented in a variety of ways. First, as each bank segment is assessed, an erosion estimate can be generated such that each assessment can have many banks assessed. In most cases, one bank is eroding, while the other bank is aggrading or unaffected. However, in downcutting or widening segments, both banks may be eroding at the same time. This would result in twice the estimated erosion of a single bank impact. Many other lengths of streambank exhibit no significant observable erosion signs. Each potentially eroding bank length can be represented visually (see Figure 2) with its estimated unit erosion (in tons/yr per ft of stream length

Figure 2. Estimated Unit Erosion from Observed Stream Banks



observed), and in an area the size of the study watershed patterns can be observed. First, most of the stream length shown appears to be unevaluated. This is only partially true. Yes, more than half of the known stream length was not indeed assessed, but much of what was assessed (compare with Figure 1), was observed to have so little evidence of erosion that it did not merit mapping as an eroding bank. Such banks were observed, but recorded as "very low" BEHI and NBS ratings, or essentially estimated erosion rates of zero tons/year. In general, it can also be observed that erosion rates were in the lower ranges across the watershed. A second observation is that a number of the stretches of high erosion rates were along the larger main and southwestern branches of Mill Creek. Land use in that section of the watershed is dominated by row crop agriculture, and the creek in this area shows strong evidence of channelization with high, steep banks with little protection. Another important use of this fine-scale data is to isolate target lengths within a longer reach that have higher erosion potential and could serve as the best targets for restoration.

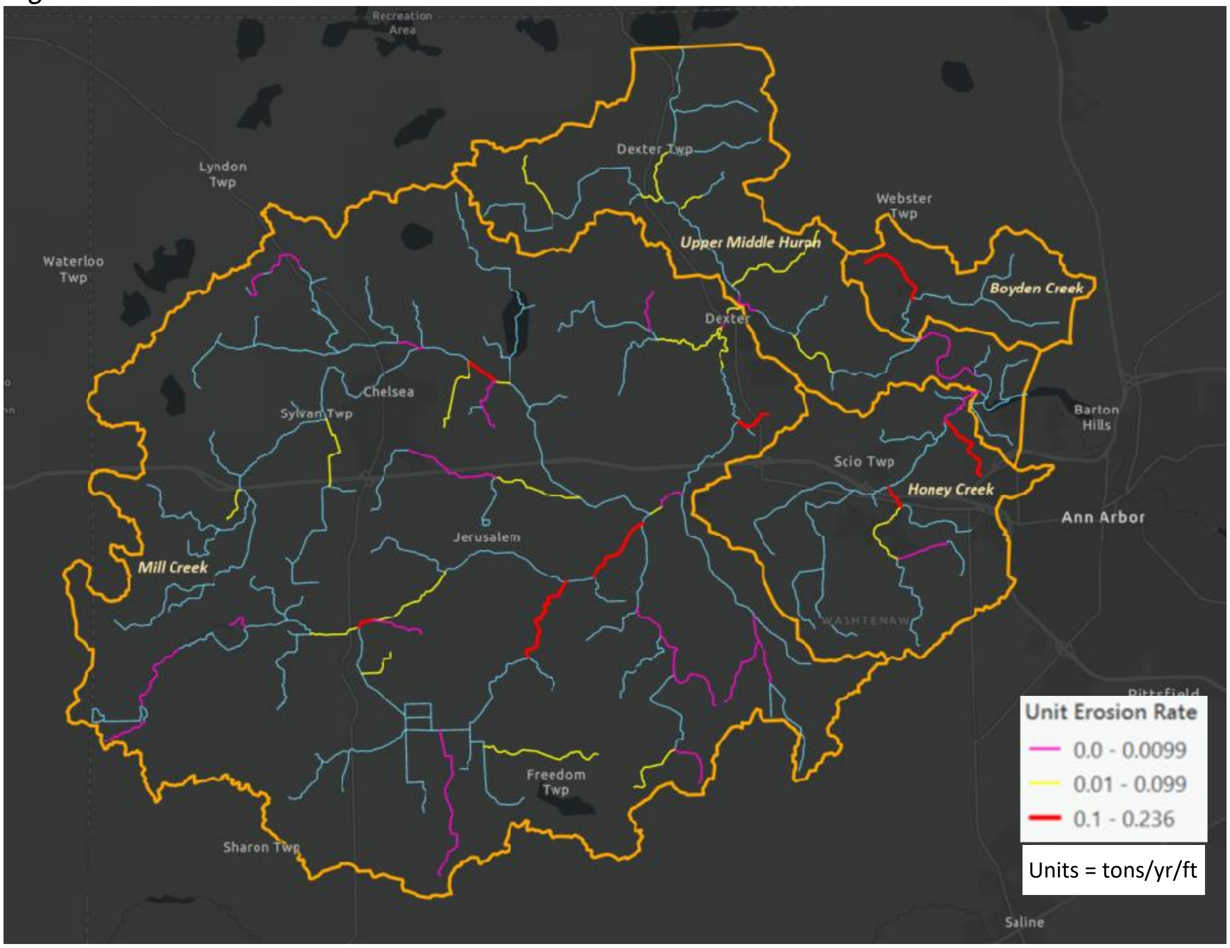
A second step in analysis is to compile assessment observations into mean erosion rates for entire reaches. Given the size of the study watershed and the total evaluated reach length, a comparative ranking of stream reaches is a good approach to identify initial restoration targets. Figure 3 shows the evaluated stream reaches and their erosion rates. Within the watershed, there are a small number (9) of stream reaches with high erosion rates (> 0.1 and <0.236 tons/yr/ft, marked red). A third of the streams (21 of 60 evaluated reaches) fall within a moderate erosion rate range of 0.01 to 0.099 tons/yr/ft, marked yellow. The remaining half of the reaches have stable banks with little evidence of active erosion (< 0.01 tons/yr/ft), marked purple, so the majority of stream reaches evaluated showed very little evidence of active erosion. This grouping of erosion rates differs somewhat from the set evaluated in the more urbanized Section 2 of the watershed just downstream. In that watershed, while there were a similar number of stream reaches with high erosion rates, the majority of streams fell into the middle or moderate erosion range.

Table 1 lists the stream reaches with the 20 highest erosion rates. Examining this table along with the geographic distribution high erosion reaches in Figure 3 shows that the most vulnerable reaches are distributed across the watershed, with six in Mill Creek (including the four worst reaches), two in Honey Creek and one in Boyden Creek above 0.1 tons/yr/ft. No direct drainages or reaches of the Huron River had high erosion rates.

Table 1. Stream Reaches with the 20 Highest Unit Erosion Rates

ReachID	ReachCode	Stream	Assessed Length (mi)	Total Erosion (tons/yr)	Unit Erosion (tons/yr/ft)
432	4090005000764	Mill	0.30947	384.8463	0.235524
501	4090005000275	Mill	0.343561	385.5569	0.212545
427	4090005000092	Mill	1.502273	1676.927	0.211413
474	4090005004821	Mill	0.031061	29.17593	0.177902
588	4090005000240	Honey	0.1875	151.8221	0.153356
373	4090005000245	Honey	1.51875	859.4161	0.107172
401	4090005004823	Mill	0.289394	160.0613	0.104752
368	4090005000086	Mill	0.659716	363.6249	0.104391
538	4090005000604	Boyden	0.695455	381.6399	0.103932
539	4090005004831	Mill	0.467803	220.8494	0.089413
426	4090005000764	Mill	1.098106	497.8359	0.085863
421	4090005000292	Mill	0.629735	274.7437	0.08263
378	4090005000095	Mill	0.177273	66.79902	0.071367
420	4090005000086	Mill	0.299432	110.2964	0.069764
549	4090005001938	Mill	1.125758	313.4343	0.052731
524	4090005000257	Mill	0.479545	131.0765	0.051768
630	4090005000298	Direct	1.298674	290.8446	0.042416
644	4090005006320	Direct	0.093182	14.4661	0.029403
393	4090005000189	Mill	0.795265	102.1815	0.024335
626	4090005000036	Huron River	0.492803	60.03546	0.023073

Figure 3. Estimated Unit Erosion Rates for Evaluated Stream Reaches



The other observation that can be made from Table 1 is that, the high erosion reaches vary in total length. While some reaches have high erosion rates for a short length, they may not generate as much total erosion as longer stream reaches.

Table 2 shows the twenty reaches with the overall highest *total* erosion rates for the entire reach length. The worst reach from a total erosion perspective (reach #427 in Mill Creek) generates almost twice the amount of the next one down the list and over three times the amount of the third on the list. The top two on the list would appear to be the best targets for focusing restoration efforts. Again, most of the reaches with the highest total erosion estimates are in Mill Creek, though one reach in each of Honey Creek and Boyden Creek deserve attention.

Finally, the different drainage watersheds can be evaluated on the whole. There are four distinct drainage areas, including direct drainages to the river, and the Huron River itself. Table 3 shows these drainages ranked by the mean unit erosion for all reaches within the drainage. Boyden Creek has the highest overall average, but only 1.6 miles of streams were assessed in that creekshed. Honey Creek and Mill Creek reaches also have high rates, and their geology and geography are similar. Looked at by total erosion, though (see Table 4), because of its much greater size, Mill Creek generates the greatest total amount of erosion. These totals are not directly comparable, however, as not all available reaches were evaluated within each drainage.

Table 2. Stream Reaches with the 20 Highest Total Erosion Rates

Reach ID	Reach Code	Stream	Assessed Length (mi)	Total Erosion (tons/yr)	Unit Erosion (tons/yr/ft)
427	4090005000092	Mill	1.502273	1676.927	0.211413
373	4090005000245	Honey	1.51875	859.4161	0.107172
426	4090005000764	Mill	1.098106	497.8359	0.085863
501	4090005000275	Mill	0.343561	385.5569	0.212545
432	4090005000764	Mill	0.30947	384.8463	0.235524
538	4090005000604	Boyden	0.695455	381.6399	0.103932
368	4090005000086	Mill	0.659716	363.6249	0.104391
549	4090005001938	Mill	1.125758	313.4343	0.052731
630	4090005000298	Direct	1.298674	290.8446	0.042416
421	4090005000292	Mill	0.629735	274.7437	0.08263
539	4090005004831	Mill	0.467803	220.8494	0.089413
438	4090005000285	Mill	1.369318	162.7686	0.022513
401	4090005004823	Mill	0.289394	160.0613	0.104752
588	4090005000240	Honey	0.1875	151.8221	0.153356
599	4090005000274	Mill	2.289773	143.8467	0.011898
524	4090005000257	Mill	0.479545	131.0765	0.051768
646	4090005006295	Direct	1.767424	128.9874	0.013822
637	4090005000038	Huron River	1.095833	125.7104	0.021727
463	4090005000258	Mill	1.69678	122.5465	0.013679
581	4090005000242	Honey	1.417803	117.9453	0.015755

Table 3. Mean Unit Erosion Rates for Drainages in the Study Watershed

Drainage	Unit Erosion (tons/yr/ft)
Boyden	0.104
Honey	0.044
Mill	0.044
Direct Drainage	0.025
Huron River	0.011

Table 4. Mean Total Erosion Rates for Drainages in the Study Watershed

Drainage	Total Erosion (tons/yr)
Mill	5373.1
Honey	1158.3
Direct Drainage	481.0
Boyden	381.6
Huron River	195.5

Potential Restoration Targets

Nine stream reaches stand out as potential high-value restoration targets, based on the results of the rapid BANCS assessment. Each reach was evaluated to have a much higher than average potential for erosion along all or part of its length. While there may be other reaches that offer potential for restoration and reduction of erosion, sedimentation and nutrient transport, these eight reaches stand out among the rest of the inventoried stream reaches. Each reach was qualitatively examined to determine the relative feasibility of addressing the potential erosion along all or parts of the stream banks. Evaluation criteria included: ease of access for equipment, willingness of landowners to support restoration work, and the potential for control of upstream hydrology. Each of the target reaches is presented on the following pages with a brief description of conditions and considerations for the reach.

432 – W. Branch of Mill Creek

This short (< 1/3 mi) bend of Mill Creek is downstream of a significant confluence in an area with a history of channelization and drain tiling for agriculture. The reference bankfull depth is > 2 ft. Banks are high on both sides with limited riparian cover (< 50 ft in some places) protecting the bank slopes. Floodplain is non-existent.

The upstream hydrology should be fairly stable with little impactful development, gentle slopes and a mix of agriculture and wooded/wetland land cover. Land ownership is private agriculture adjoining stream, and access would require easement.

At bend curve, natural stablilization techniques should be applied. Downstream of bend, some form of 2-stage ditch or modified floodplain connection could be designed. Riparian cover along downstream section could provide more room to work with, but slopes are still high.

501 & 427 – Main fork of Mill Creek

These two reaches are quite long (~3.5 miles combined). Both reaches have been significantly deepened by intentional channelization or by upstream alteration of hydrology leading to downcutting.

Only a short section (1/3 mi) of 501 was assessed, but visually was determined to be representative of upstream creek. Further evaluation of upstream sections may be needed.

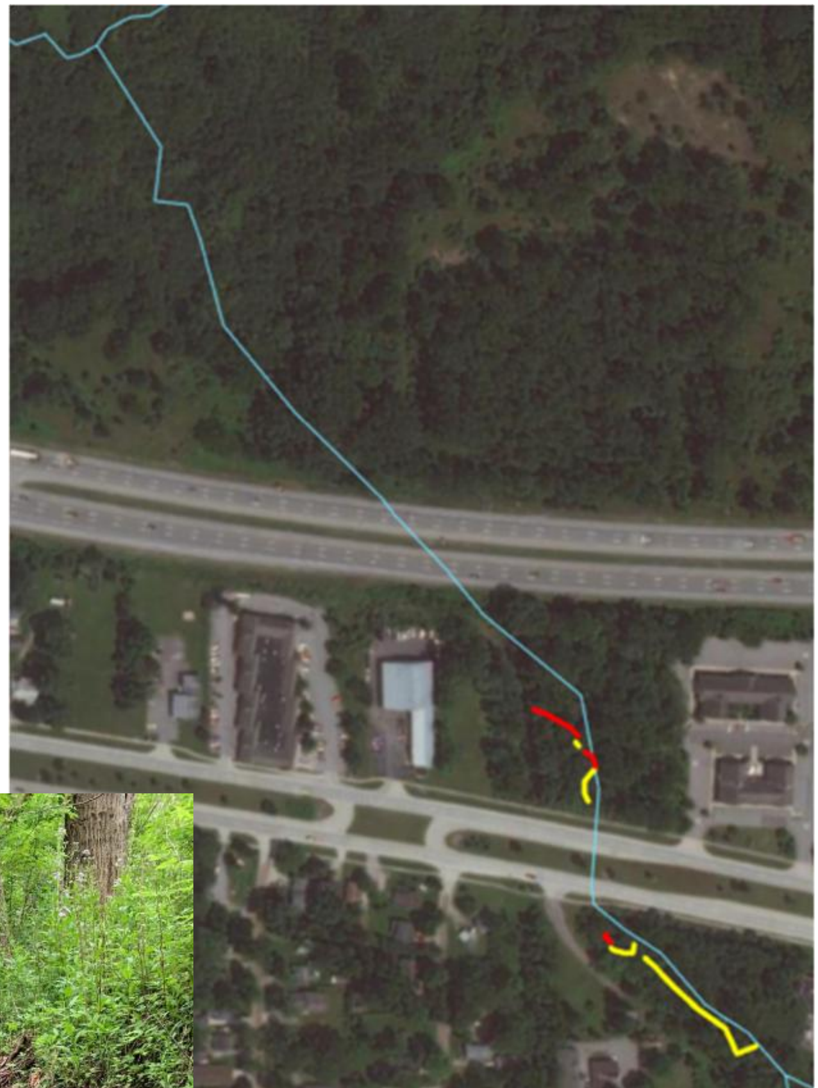
Together, these two reaches generate an estimated 2,063 tons of sediment per year from streambank (and bottom?) erosion.

Given the total length of these reaches, restoration will need to be approached in phases. Stretches of 427 that pass through wooded parcels could be approached first. Banks are a bit lower in some of the downstream portions of the reach, but it will still require significant effort to reconstruct banks to connect them to some form of floodplain. Natural stabilization will be required in places, as well. These lands are privately held, but may have conservation easements and could be eligible for state and federal grants or partnerships with land conservancies.

Once a section of the reach is stabilized and restored to connected function, additional projects could be pursued. Hydrology is likely stable at this point, if that was the original cause of downcutting. Moving upstream, there are additional sections with good forest/wetland land cover in riparian areas. Again, restoration techniques would include earth alteration to re-establish some amount of floodplain connection to give the floodwaters room to expand and drop sediment rather than carrying it all downstream.

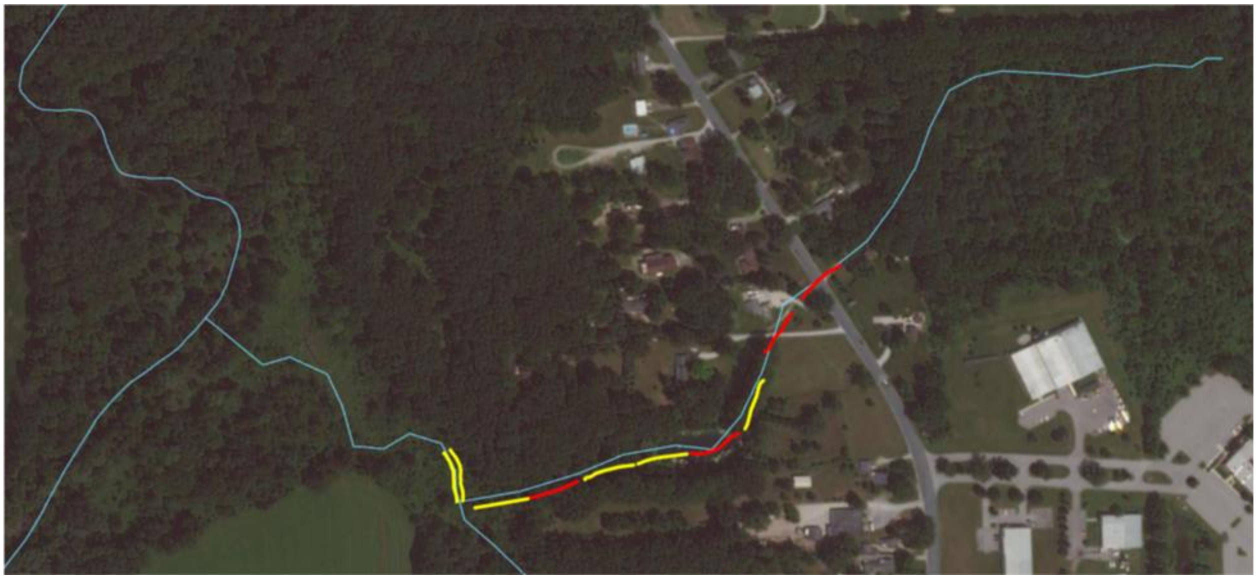
588 – Honey Creek

This reach is interrupted by two major road crossings – I-94 and the Jackson Road business corridor. The stream has been highly impacted by development of these throughfares and the retail development in between. It appears that flood flows may backup behind the crossings when woody debris blocks through flow. The crossings first need to be evaluated to determine if significant maintenance or re-engineering is needed. The creek approaches Jackson Road at an angle that could present issues at the upstream end of the culvert.



The downstream portion of the reach was not evaluated. If culverts are determined to be functioning properly, the downstream section should be assessed to determine if road runoff is impacting banks downstream. Ample floodplain is available for any needed restoration.

474 & 401 – small tributary to Mill Creek



This small tributary system draining to the main branch of Mill Creek may have been impacted by local residential and industrial development. Banks are significantly higher that reference bankfull depths for a drainage area of this size. Bank material may be more susceptible to erosion than in other parts of the Mill Creek watershed.

Banks may be stabilized at bends and restored to reference heights within a floodplain that currently has good riparian cover. Participation from private land owners would be required to succeed.

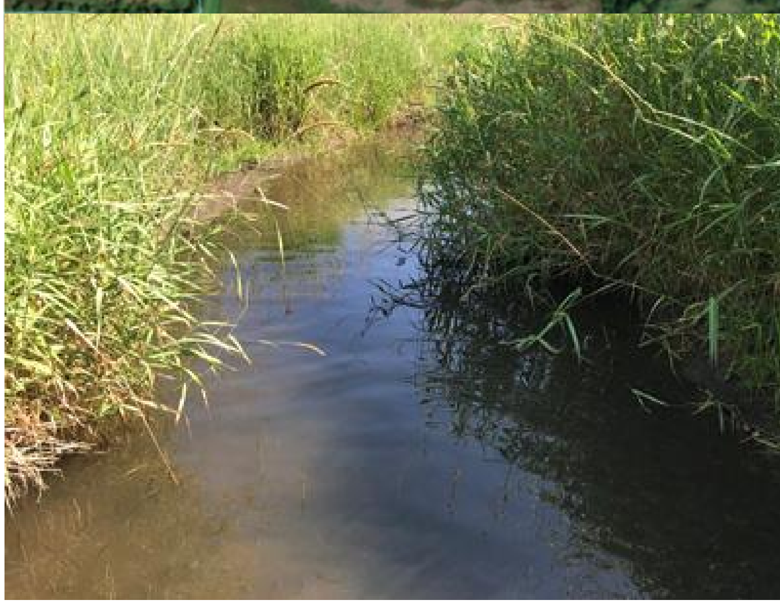
Unfortunately, bank photos were lost in the survey collection process, so specific examples are not shown.

373 – Honey Creek

This relatively long reach has been significantly altered in a number of places by local residents and by development in the drainage area overall. Residents have constructed ad hoc crossings and bank stabilizations over the years with mixed success. The estimated erosion rate is not as high as previous examples, but the overall length, slope and geology suggest that it may generate a significant amount of sedimentation.

Restoration should focus on the downstream portion, with targeted crossing reconstructions, a natural bank stabilization where the creek is carving close to a property boundary and reconnection to floodplains throughout. There is ample riparian cover along this lower part of the reach. Access is feasible at a number of points, but will require easements from local residents.

368 – North Fork of Mill Creek



This small reach has been severely altered, to deepen the channel and completely disconnect it from its floodplain. The channel was straightened at one point and several tributary drains were also carved, likely to drain wetlands and allow for farming. Bottom substrate is very mucky. The creek at this point would naturally be quite large with a reference bankfull depth of over 2 feet.

Restoration will be challenging. Ideally, dikes and artificial embankments would be broken or removed to allow waters to flow back onto fields to restore wetlands. This would require landowner participation, but could be funded through Farm Bill programs. It might be more possible on the lower parcel that is not actively being farmed at this time. A wetland connection there could capture and settle sedimentation generated upstream.

538 – West Branch of Boyden Creek

This reach of Boyden Creek is generally in good condition, with long lengths showing no evidence of active bank erosion. However, there are a few spots that show impact from human interaction. The most significant area is the section of stream that runs through a former golf course in the Loch Alpine residential community. Streambanks look to be artificially confined in places to maintain golfing fairways.

The few active erosion areas could be stabilized with natural materials and techniques, while allowing the rest of the stream reconnect to its floodplain within the defunct golf course, which is no longer being actively managed and is returning to a natural state. The golf course property is currently in ownership and land use dispute, however, so ensuring long term management of the stream may be difficult until disputes are resolved.

Conclusions

The modified BANCS rapid geomorphic assessment applied across the upper section (section 1) of the Middle Huron Watershed proved to be useful in identifying stream erosion targets. The technique was applied with a modest amount of training and used to evaluate to a considerable proportion of available stream miles in the watershed. Despite implementation by multiple teams assessing somewhat subjective metrics, the evaluation was able to identify a short list of restoration candidates that are generating significantly more sedimentation than other streams in the watershed. While the ultimate erosion estimate values may not have a high level of accuracy taken individually, the calculations allow watershed planners to reasonably classify stream reaches into a range of categories from highly erosive to completely stable. The approach applies well across streams in different land use contexts. The BANCS surveys revealed that the majority of streams in this mostly agricultural and rural watershed remain in good condition. That was not the case in the more urbanized section 2 of the watershed. Finally, the compilation of a BANCS survey for a large portion of the Huron River Watershed provides a reference resource to help explain water chemistry, habitat and biological monitoring results beyond its direct use in the watershed management plan.