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Land & Water Resources Management Consultants

November 7, 2006
WER106-09 Nose Creek Partnership Assistance

Nose Creek Watershed Partnership – Technical Committee

% Municipal District of Rocky View #44
911 – 32nd Avenue NE
Calgary, Alberta T2E 6X6

Attention: Mr. Tim Dietzler

TECHNICAL MEMORANDUM

RE: Evaluation of Source Control Runoff Volume Criteria

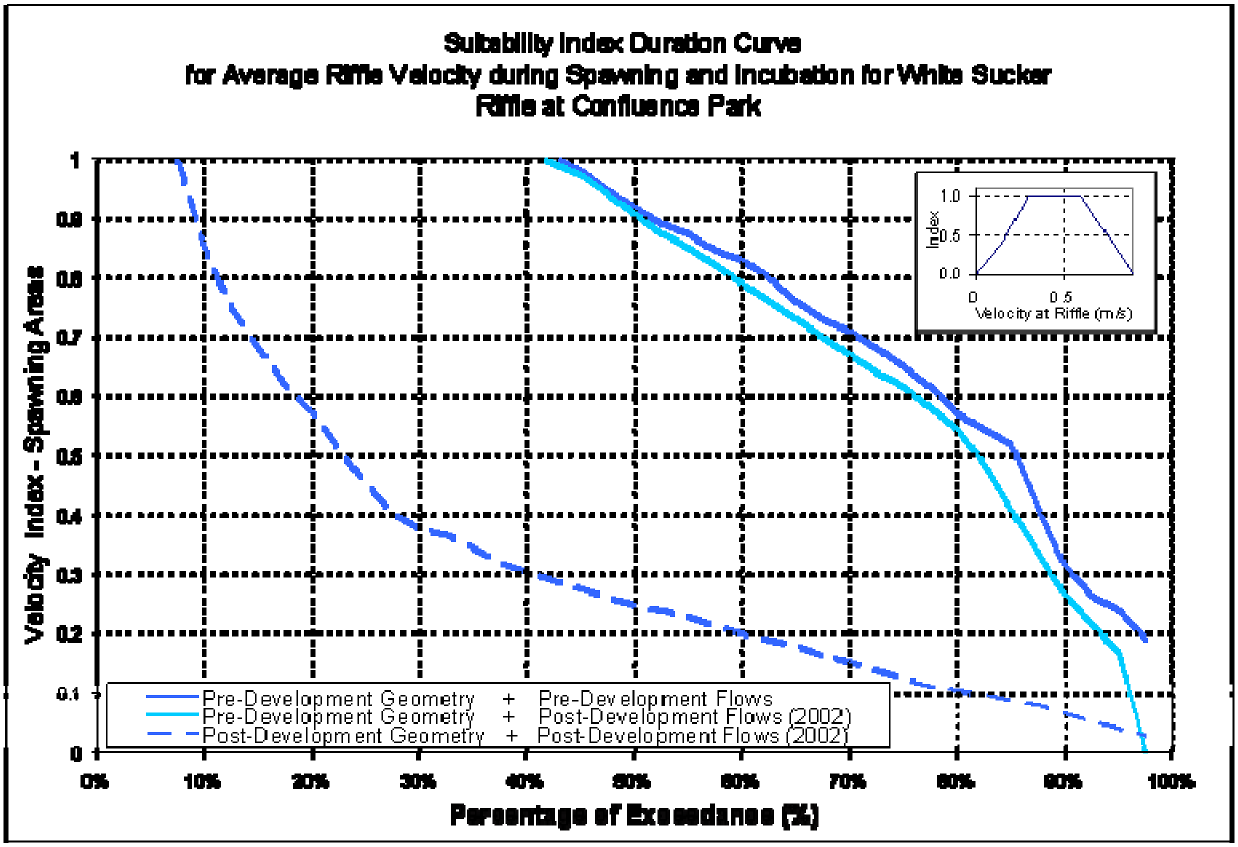
As per your recent request, we have evaluated the technical issues associated with the implementation of a source control runoff volume target for the Nose Creek Watershed. This Technical Memorandum provides a summary of our evaluation including the results of a preliminary water balance analysis in order to demonstrate what degree of runoff volume reduction could practically be accomplished within typical urban developments.

Background

One of the key recommendations of the *Nose Creek Basin Instream Flow Needs Study* is that one should try to mimic the existing hydrologic regime to the greatest extent practical in order to minimize the possibility of wholesale geometry changes along Nose Creek, West Nose Creek and their tributaries.

The geometry changes have several impacts, related to safety and water quality / environmental impacts:

1. Widening of the channel will ultimately result in a wider channel that has a shallower depth of flow during low flow conditions. As a result, it will be more susceptible to temperature and dissolved oxygen fluctuations, resulting in deteriorated habitat. The environmental impacts are illustrated in the figure below which shows Habitat Suitability Curves for a typical riffle in Confluence Park: it is striking that maintaining the channel geometry has a much greater effect than the change in flow itself.



Source: Presentation by Bert van Duin at September 2005 IWA Conference on River Basin Management

2. The changes to the morphology may lead to “planform” changes as well, i.e., meander patterns may change. In addition, the creek may become more prone to sudden avulsions. These changes could be deemed acceptable if not for the presence of urban infrastructure within the “critical” zone, which may be threatened by (sudden) changes to the “planform” of the stream, as can be observed in the form of undermining of bridge abutments, outfalls, gabions, etc. Necessary rehabilitation measures can be very expensive and very intrusive, possibly greatly diminishing natural habitat. The width of this “critical” zone is a function of the change in flow rate, i.e., if one increases the flow rate, the “critical” zone should be wider too. This observation is reflected in meander belt guidelines in Ontario, where the width of the meander belt is a function of the increase in flow rate from pre-development conditions.

3. Deepening of the channel, as can observed along the lower reaches of West Nose Creek, will lead to a disconnect of riparian vegetation from the creek, i.e., groundwater levels will be affected resulting in vegetation changes away from an aquatic vegetation to a more terrestrial vegetation type.

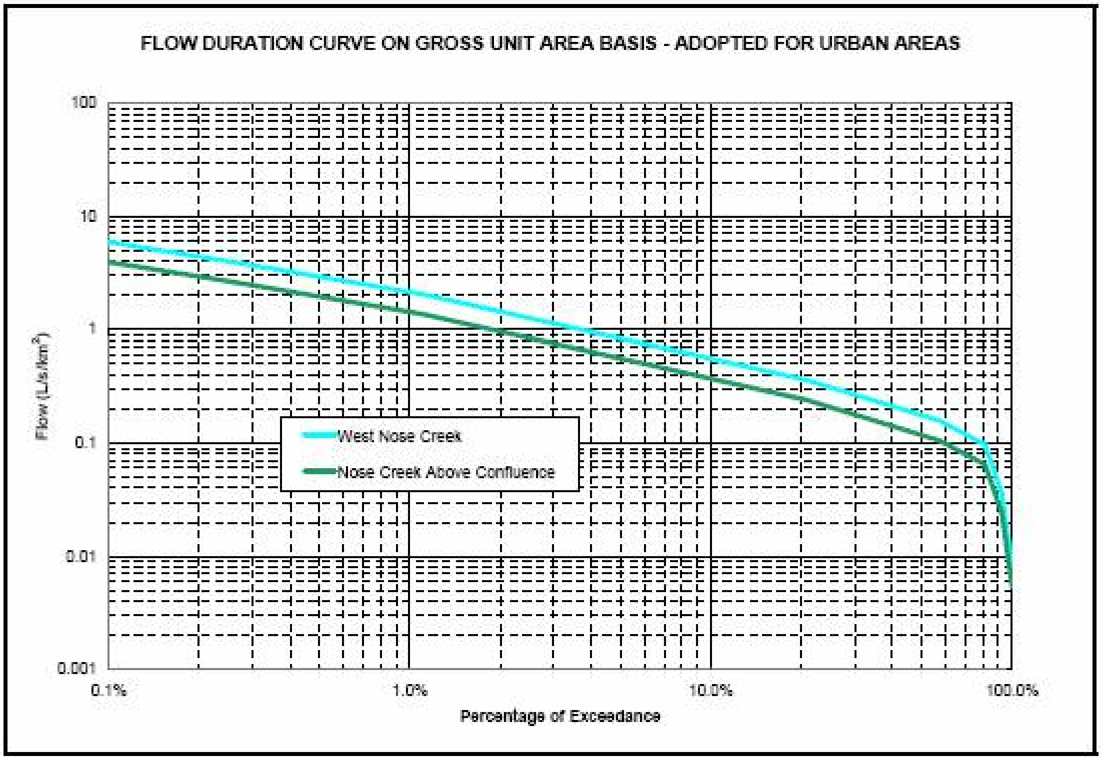
4. Intermittent pulses of stormwater flows will flush out invertebrates and lead to a much reduced habitat. The difference with high flows during pre-development conditions is that

invertebrates simply will not have the time to regenerate their habitat before the next high flow condition occurs.

The existing flow regime was expressed as a flow duration curve on a unit area basis for both Nose Creek and West Nose Creek, see Figure 22 (of the *Nose Creek Basin Instream Flow Needs Study* report) below. One significant challenge with adopting the recommendation of mimicking the existing hydrologic regime is how one would implement this in day-to-day stormwater management practice.

The *Nose Creek Basin Instream Flow Needs Study* suggested a source control target such that all runoff resulting from precipitation up to a certain precipitation depth would be retained on site. This would be to mimic pre-development conditions where the vast majority of precipitation replenishes soil moisture after which it evapotranspires. Please note that deep infiltration or percolation to replenish aquifers is typically very small as per the research by Professor Masaki Hayashi of the University of Calgary.

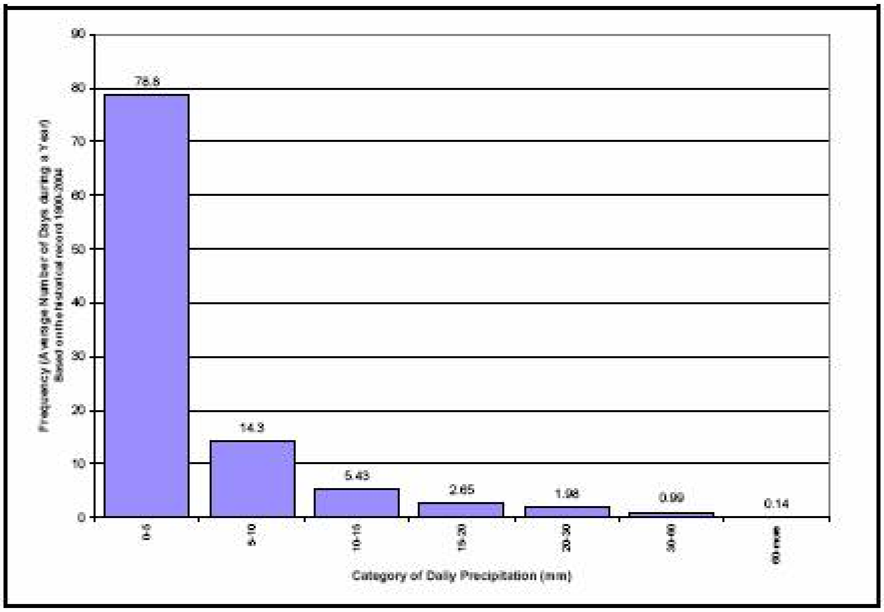
Figure 22 Flow Duration Curve on Gross Unit Area Basis to Prevent Channel Geometry Changes



Source: *Nose Creek Basin Instream Flow Needs Study*

Figure 24 below (from the *Nose Creek Basin Instream Flow Needs Study* report) presents a histogram of historical daily precipitation at the Calgary International Airport. Figure 25 (also from the *Nose Creek Basin Instream Flow Needs Study* report) shows a precipitation exceedance curve as a function of the interevent time, which defines whether events can be considered as a single independent event or whether they would constitute separate, independent events.

Figure 24 Histogram of Historical Events recorded at the Calgary International Airport



Source: *Nose Creek Basin Instream Flow Needs Study*

As for Figure 26 (also from the *Nose Creek Basin Instream Flow Needs Study* report), the following excerpt is from the *Nose Creek Basin Instream Flow Needs Study* report:

> *Figure 26 shows flow exceedance curves for several scenarios: pre-development conditions, post-development conditions assuming about 55% hard surface area and three post-development source control scenarios. Figure 26 demonstrates that both the magnitude and frequency of flow, hence the runoff volume, would exponentially increase with development. A 20 mm source control target, however, appears to yield a similar frequency for the low flow range as pre-development conditions. Little improvement is achieved for a 30 mm source control target. The magnitude of the flow rate for the infrequent events would still have to be controlled by rate control.* ***Please note that the above assessment is very preliminary and does not account for hydrograph alterations due to large-scale stormwater management facilities or travel time effects within larger watersheds. Additional investigations are highly recommended to arrive at a fully defendable approach and source control targets*** (italics and bold added)

A 20 mm source control target would mean that all events with precipitation less than or equal to 20 mm would generate no runoff! Based on Figure 25 below, a source control of 20 mm would target 95% of all storm events based on a 6-hour interevent time.

Figure 25 Rainfall Depth Exceedance Curve

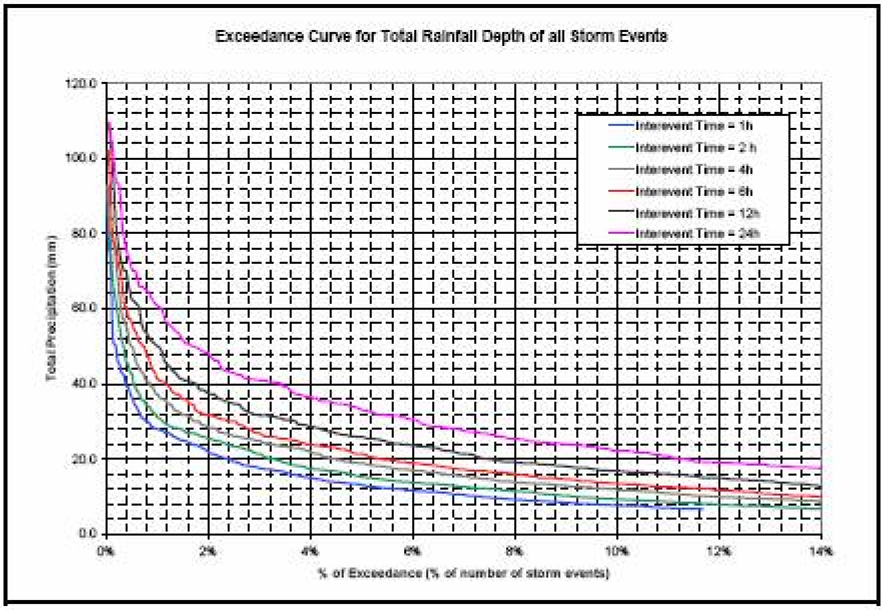
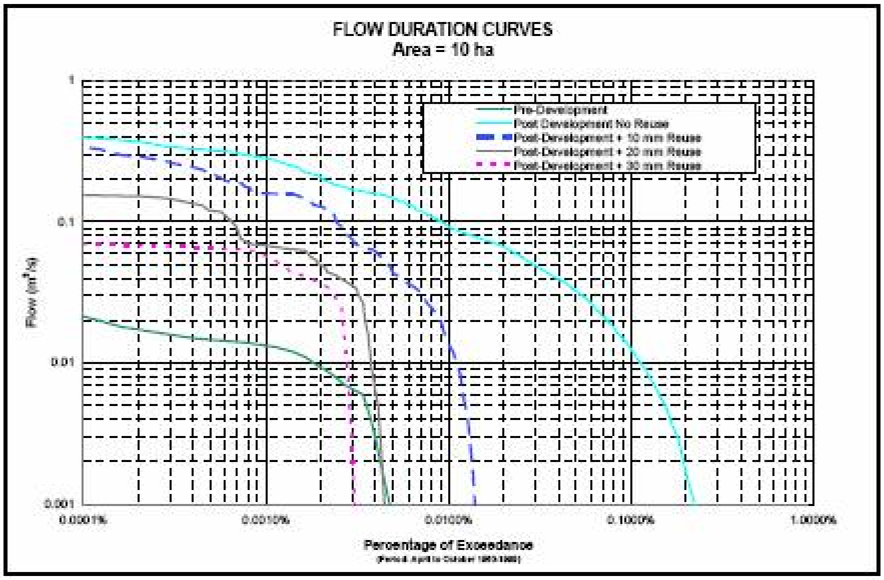


Figure 26 Flow Duration Curve for Several Source Control Targets



Source: *Nose Creek Basin Instream Flow Needs Study*

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Challenges with 20 mm Source Control Target

While the source control target concept is intrinsically fine, and is inherently clear to the general public, two questions arise:

1. What are the corresponding benefits with respect to minimizing wholesale geomorphic changes along the creeks in the Nose Creek Basin?
2. How would one practically implement such a source control target?

As identified in the above excerpt, the analysis upon which the 20 mm source control target is based is very preliminary. As communicated to the Nose Creek Watershed Partnership in the past, additional investigations are needed to “confirm”/establish the magnitude of this value.

As to the second question, the issue is not as much the magnitude of the source control target but the relationship between the required storage capacity and the emptying time of the storage unit so that at all times adequate capacity is available to fully capture the runoff up to a 20 mm event. We are concerned that this might become a significant challenge in stormwater management practice. In our opinion, the most promising options for runoff volume control are a combination of reductions in the amount of hard surface area, green roof systems, stormwater capture and re-use and absorbent landscape. We do not necessarily see (deep) infiltration practices as promising (except along the main river systems where gravels are present), simply because of the fact that this deep infiltration is not a significant component in the overall water balance.

Because of the very different (seasonal) nature of the abstractions (e.g., compare water re-use and evapotranspiration) it is virtually impossible to specify an ‘emptying’ time for the proposed BMPs in question to meet the stipulated source control target. A water balance analysis is required to get an appreciation of the relationship between the amount of hard surface area, demand (i.e., either re-use or evapotranspiration), and on-site storage capacity. While it might be possible to conduct some generic water balance computations, in practice, it should be done for each and every development. At the same time, on a watershed basis, it is not clear whether this 20 mm source control target would achieve the minimization of wholesale geometric changes.

Runoff Volume Target Approach

Given the above challenges with the source control target suggested in the *Nose Creek Basin Instream Flow Needs Study* report, it is likely more appropriate and convenient to adopt an overall runoff volume target based on a water balance type analysis.

Table 4 below (again from the *Nose Creek Basin Instream Flow Needs Study* report) presents historical monthly flows in Nose Creek and West Nose Creek for the upper, rural catchments. The same source data used to generate Table 4 was used to generate the flow duration curves of Figure 22 above. Table 4 shows that the mean annual flows for Nose Creek varied from a low of 1.4 mm in 1977 to a high of 25.9 mm in 1974, with an average of 6.1 mm. Similar, for West Nose Creek, it varied from a low of 2.1 mm in 1977 to a high of 40.2 mm in 1974, with an average of 9.6 mm. For comparison purposes, the average precipitation at the Calgary International Airport for the period of April through October is about 350 mm (based on

Environment Canada's Climate Normals). This means that the actual amount of runoff is only in the order of about 2 to 3 percent of the total amount of precipitation.

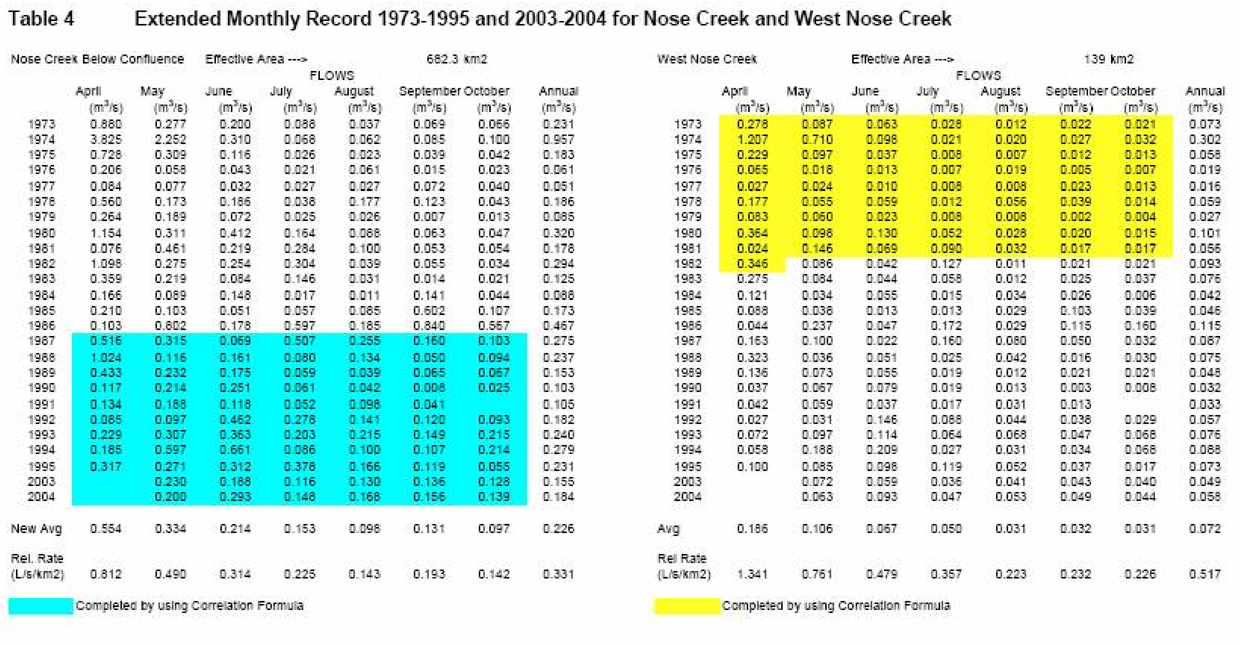

Table 4 Extended Monthly Record 1973-1995 and 2003-2004 for Nose Creek and West Nose Creek

Nose Creek Below Confluence Effective Area ---> 682.3 km2

FLOWS

	April (m^3/s)	May (m^3/s)	June (m^3/s)	July (m^3/s)	August (m^3/s)	September (m^3/s)	October (m^3/s)	Annual (m^3/s)
1973	0.880	0.277	0.200	0.088	0.037	0.069	0.066	0.231
1974	3.825	2.252	0.310	0.068	0.062	0.085	0.100	0.957
1975	0.728	0.309	0.116	0.026	0.023	0.039	0.042	0.183
1976	0.206	0.058	0.043	0.021	0.061	0.015	0.023	0.061
1977	0.084	0.077	0.032	0.027	0.027	0.072	0.040	0.051
1978	0.560	0.173	0.186	0.038	0.177	0.123	0.043	0.186
1979	0.264	0.189	0.072	0.025	0.026	0.007	0.013	0.085
1980	1.154	0.311	0.412	0.164	0.088	0.063	0.047	0.320
1981	0.076	0.461	0.219	0.284	0.100	0.053	0.054	0.178
1982	1.098	0.275	0.254	0.304	0.039	0.055	0.034	0.294
1983	0.359	0.219	0.084	0.146	0.031	0.014	0.021	0.125
1984	0.166	0.089	0.148	0.017	0.011	0.141	0.044	0.088
1985	0.210	0.103	0.051	0.057	0.085	0.602	0.107	0.173
1986	0.103	0.802	0.178	0.597	0.185	0.840	0.567	0.467
1987	0.516	0.315	0.069	0.507	0.255	0.160	0.103	0.275
1988	1.024	0.116	0.161	0.080	0.134	0.050	0.094	0.237
1989	0.433	0.232	0.175	0.059	0.039	0.065	0.067	0.153
1990	0.117	0.214	0.251	0.061	0.042	0.008	0.025	0.103
1991	0.134	0.188	0.118	0.052	0.098	0.041		0.105
1992	0.085	0.097	0.462	0.278	0.141	0.120	0.093	0.182
1993	0.229	0.307	0.363	0.203	0.215	0.149	0.215	0.240
1994	0.185	0.597	0.661	0.086	0.100	0.107	0.214	0.279
1995	0.317	0.271	0.312	0.378	0.166	0.119	0.055	0.231
2003		0.230	0.188	0.116	0.130	0.136	0.128	0.155
2004		0.200	0.293	0.148	0.168	0.156	0.139	0.184
New Avg	0.554	0.334	0.214	0.153	0.098	0.131	0.097	0.226
Rel. Rate (L/s/km2)	0.812	0.490	0.314	0.225	0.143	0.193	0.142	0.331

Completed by using Correlation Formula

West Nose Creek Effective Area ---> 139 km2

FLOWS

	April (m^3/s)	May (m^3/s)	June (m^3/s)	July (m^3/s)	August (m^3/s)	September (m^3/s)	October (m^3/s)	Annual (m^3/s)
1973	0.278	0.087	0.063	0.028	0.012	0.022	0.021	0.073
1974	1.207	0.710	0.098	0.021	0.020	0.027	0.032	0.302
1975	0.229	0.097	0.037	0.008	0.007	0.012	0.013	0.058
1976	0.065	0.018	0.013	0.007	0.019	0.005	0.007	0.019
1977	0.027	0.024	0.010	0.008	0.008	0.023	0.013	0.016
1978	0.177	0.055	0.059	0.012	0.056	0.039	0.014	0.059
1979	0.083	0.060	0.023	0.008	0.008	0.002	0.004	0.027
1980	0.364	0.098	0.130	0.052	0.028	0.020	0.015	0.101
1981	0.024	0.146	0.069	0.090	0.032	0.017	0.017	0.056
1982	0.346	0.086	0.042	0.127	0.011	0.021	0.021	0.093
1983	0.275	0.084	0.044	0.058	0.012	0.025	0.037	0.076
1984	0.121	0.034	0.055	0.015	0.034	0.026	0.006	0.042
1985	0.088	0.038	0.013	0.013	0.029	0.103	0.039	0.046
1986	0.044	0.237	0.047	0.172	0.029	0.115	0.160	0.115
1987	0.163	0.100	0.022	0.160	0.080	0.050	0.032	0.087
1988	0.323	0.036	0.051	0.025	0.042	0.016	0.030	0.075
1989	0.136	0.073	0.055	0.019	0.012	0.021	0.021	0.048
1990	0.037	0.067	0.079	0.019	0.013	0.003	0.008	0.032
1991	0.042	0.059	0.037	0.017	0.031	0.013		0.033
1992	0.027	0.031	0.146	0.088	0.044	0.038	0.029	0.057
1993	0.072	0.097	0.114	0.064	0.068	0.047	0.068	0.076
1994	0.058	0.188	0.209	0.027	0.031	0.034	0.068	0.088
1995	0.100	0.085	0.098	0.119	0.052	0.037	0.017	0.073
2003		0.072	0.059	0.036	0.041	0.043	0.040	0.049
2004		0.063	0.093	0.047	0.053	0.049	0.044	0.058
Avg	0.186	0.106	0.067	0.050	0.031	0.032	0.031	0.072
Rel Rate (L/s/km2)	1.341	0.761	0.479	0.357	0.223	0.232	0.226	0.517

Completed by using Correlation Formula

Source: *Nose Creek Basin Instream Flow Needs Study*

The intent of a runoff volume target approach based on a water balance analysis would be to not significantly increase these runoff volumes, if practical.

To get an appreciation of what, over the long run, might happen to some key geometric parameters, the following figure from the *West Nose Creek Stream Corridor Assessment Phase II – Hydrology and Hydraulics* document shows the relationship between main channel width and main channel capacity or dominant discharge for West Nose Creek. As per our discussions with Dr. Robert Newbury, P.Eng., the displayed relationship for the upper, non-urbanized reaches, i.e., $W = 4.5 * Q^{0.41}$ fairly well mimics what is reported in fluvial morphology literature. Please note that the channel evolution in the lower, urbanized reaches is incomplete and is expected to follow a similar relationship in the future.

The increase in flow for the lower reaches of West Nose Creek has already led to the widening that can be observed in for example Confluence Park. This widening is still ongoing because of the long duration that it may take and reflecting the ongoing additional stormwater discharges further upstream. When one "matches" the flow duration curves of Figure 22 above, there should be no departures from the relationship between the width and channel capacity.

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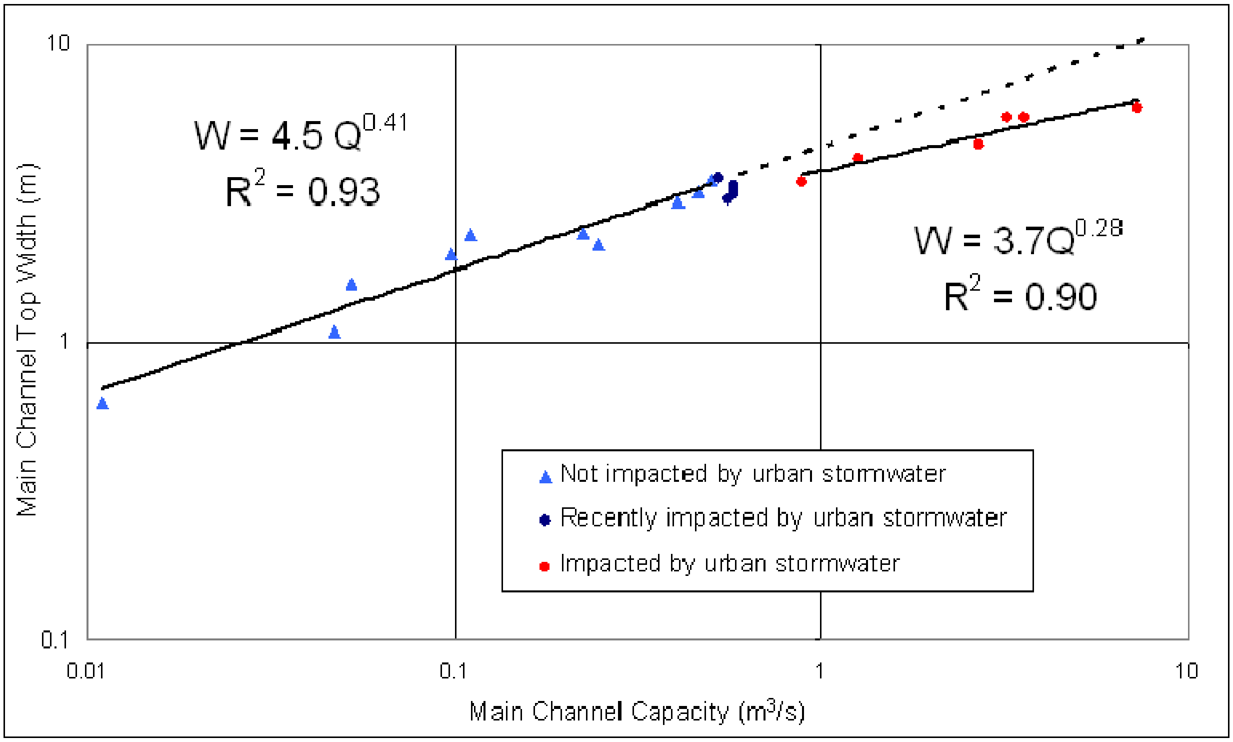


Source: *West Nose Creek Stream Corridor Assessment Phase II – Hydrology and Hydraulics*

We postulate that the resulting capacity reflects the change in runoff volumes. This concept was most recently confirmed by Dr. Brian Bledsoe of Colorado State University as part of his presentation about the impacts of urbanization on streams at the Low Impact Development Conference in Cochrane, October 19-20, 2006. Using the relationship $W = 4.5 * Q^{0.41}$, one would then be able to “estimate” what kind of flow rate increase/runoff volume increase would be “necessary” to yield a corresponding change in width. In this case, the widening factor wf and/or increase in flow rate are equal to:

$$wf = \left(\frac{\Delta Q}{Q}\right)^{0.41} \quad or\ alternatively,\ \Delta Q = Q * wf^{\frac{1}{0.41}}$$

For instance:

50% widening allowed	wf =	1.5	new Q ~ 2.7 times Q original
100% widening allowed	wf =	2	new Q ~ 5.4 times Q original
200% widening allowed	wf =	3	new Q ~ 14.6 times Q original

Based on average runoff depths for the months April through October of 6.1 and 9.6 mm for Nose Creek and West Nose Creek respectively, the resulting runoff depths would be 16.5 mm, 32.9 mm and 89.1 mm, respectively for Nose Creek and 25.9 mm, 51.8 mm and 140.2 mm for West Nose Creek. For comparison purposes, hard surface areas yield on average close to 300 mm per year.

We acknowledge that the above approach assumes that the dominant discharge, which was estimated as the 1-3% flow rate as per the flow exceedance curves, changes linearly with the runoff volume. Preferably, this should be verified which likely could be done for the West Nose Creek analyses. Until that time, a conservative approach ought to be adopted.

Our preliminary water balance computations indicate that significant reductions in runoff volume are possible if one would adopt low impact development strategies. An example of potential benefits is provided below. A runoff volume target rather than a source control target would be convenient in that it would be relatively simple to report, and it would follow what has been become provincial mandate in British Columbia. **It would still require significant caution in how the supporting computations and subsequent design and construction would be carried out as the "devil is definitely in the details".**

Example of Water Balance Analysis

As requested, we conducted a water balance analysis to demonstrate the kind of benefits that could theoretically be achieved from the introduction of low impact development strategies. The approach to this analysis was discussed during three meetings with representatives of the City of Calgary Parks who acted on behalf of the Nose Creek Watershed Partnership. The results of this analysis were presented at the Friday, October 27, 2006 meeting with members of the Technical Committee of the Partnership. A copy of the PowerPoint presentation presented at that time is attached.

Based on discussions with Calgary Parks, the objectives of the water balance analysis were threefold:

1. The resulting drainage system should minimize discharges to nearby streams;
2. The system should provide adequate storage to accommodate extreme events; and
3. The resulting configuration should minimize impacts on existing wetland resources.

The highly touted Water Balance Model, see http://www.waterbalance.ca, was not appropriate for this analysis because its current version does neither include provisions for stormwater management facilities nor allow for rainfall harvesting and the capture and re-use of stormwater for non-potable uses such as irrigation. For this reason, a custom-designed water balance analysis spreadsheet was created, which mimics some of the features of the Water Balance Model but also allows for stormwater management facilities and rainfall harvesting, etc. It is expected that appropriate software will be commercially released over time as interest in low impact development initiatives continues to grow.

The spreadsheet uses a daily time step. It is more conservative than typical urban drainage software used in the Calgary area because infiltration was set at zero during the winter season. In spite of assertions in the technical documentation, typical urban drainage software such as QUALHYMO / QHM does not distinguish in infiltration characteristics for the summer and winter season. During the summer season, irrigation was applied on a daily basis for days with little to no rain, based on an average application rate of 25 mm per week, reflecting current City of Calgary recommendations to the general public. No irrigation was assumed for days with the amount of precipitation exceeding 25/7 = 3.57 mm.

The water balance analysis was conducted for a typical urban subdivision, based on land use data provided by the City of Calgary. The following land uses were considered as part of the example:

- Roads
- Single and multi-family residential
- Commercial
- Municipal reserve
- Environmental reserve composed of Class IV/V wetlands and other environmentally significant areas
- Public utility lot representing stormwater management wet ponds

It was assumed that all runoff from the various land uses would be directed to the wet pond(s). It was also assumed that the Class IV/V wetlands, which are provincial resources and as such as owned by the crown, would not be allowed to receive untreated stormwater. This reflects evolving provincial policies that these wetlands are greatly impacted if they are allowed to operate as stormwater management facilities. The use of these wetlands for stormwater management purposes therefore contradicts provincial policies to first of all avoid impacts, followed by mitigation of impacts. Compensation will need to be provided in case impacts are unavoidable and cannot be mitigated. Please note that typical forebays are not considered to be adequate for treatment purposes.

Water accumulated in the wet pond(s) would be utilized for irrigation of municipal reserve and environmental reserve. Irrigation of municipal reserve space would require the cooperation of the school boards since they control large tracts of this land. It is however not a new concept: examples in Calgary include Cardel Place in northeast Calgary and the Inland Pit in southeast Calgary. Irrigation of environmental reserve lands is not yet practised, however, it would allow for the replenishment of soil moisture after the original catchments have been cut off due to development. Included in this irrigation scheme is the replenishment of soil moisture in the Class IV/V wetlands by treated stormwater. The relatively small flow rate required to replenish the wetlands would reduce the size of any pumping and distribution facilities as well as provide opportunity to treat the stormwater from the wet ponds through a filter system.

The above approach allows for conventional servicing in the urban subdivisions while simultaneously preserving the wetlands. The wet pond(s) will be deeper than the wetlands, which are typically shallow, to allow for adequate cover on the incoming storm sewer system. Water would be (a) discharged to the stream at a permissible flow rate of 1 L/s/ha, representing the rate for the Nose Creek main stem, (b) would be utilized for irrigation of municipal reserve and/or environmental reserve, including (c) the replenishment of moisture within Class IV/V wetlands. The current version of the spreadsheet includes the provision of an emergency high flow rate discharge from the wet pond(s) into the wetland(s) in case of extreme events.

Four types of BMPs and low impact development strategies are envisioned within the fictional development:

1. 300 mm thick absorbent landscaping within single-family residential areas;
2. Green roof systems within multi-family and commercial areas;

3. Capture and re-use of runoff within multi-family and commercial areas; and
4. Irrigation of stormwater accumulated in wet pond for municipal and environmental reserve.

Please note that no BMPs were provided along any of the roadways. In addition, the amount of area covered by the absorbent landscaping or green roof systems was not maximized. Stormwater re-use in the multi-family development was based on an average use of about 30 L/cp/day, assuming 30 units per acre (75 units per hectare) and on average 2.5 people per unit. Stormwater re-use in the commercial development was arbitrarily increased by 50%.

It is emphasized that bioretention (i.e., raingardens), (bio)swales and permeable pavement were not considered as part of the current spreadsheet analysis. Because of the controversial nature of some of these BMPs or the fact that might primarily contribute to water quality improvement, they were left out at this time. Implementation of these types of BMPs would constitute a bonus on the runoff reduction that is achieved as part of the current spreadsheet analysis.

The table below summarizes some of the key characteristics of the drainage system, based on the period 1960-2005. As shown, the precipitation ranged from a low of 256 mm (in 1967) to a high of 590 mm (in 1965), with an average of just over 400 mm. Close to 75% of all precipitation on hard areas generates runoff; this value is less than 100% because of wetting losses that occur when precipitation hits a dry pavement. In addition, 30% of the snowfall during the winter months is assumed to be lost to sublimation.

Statistics of Water Balance Analysis – Period 1960 through 2005

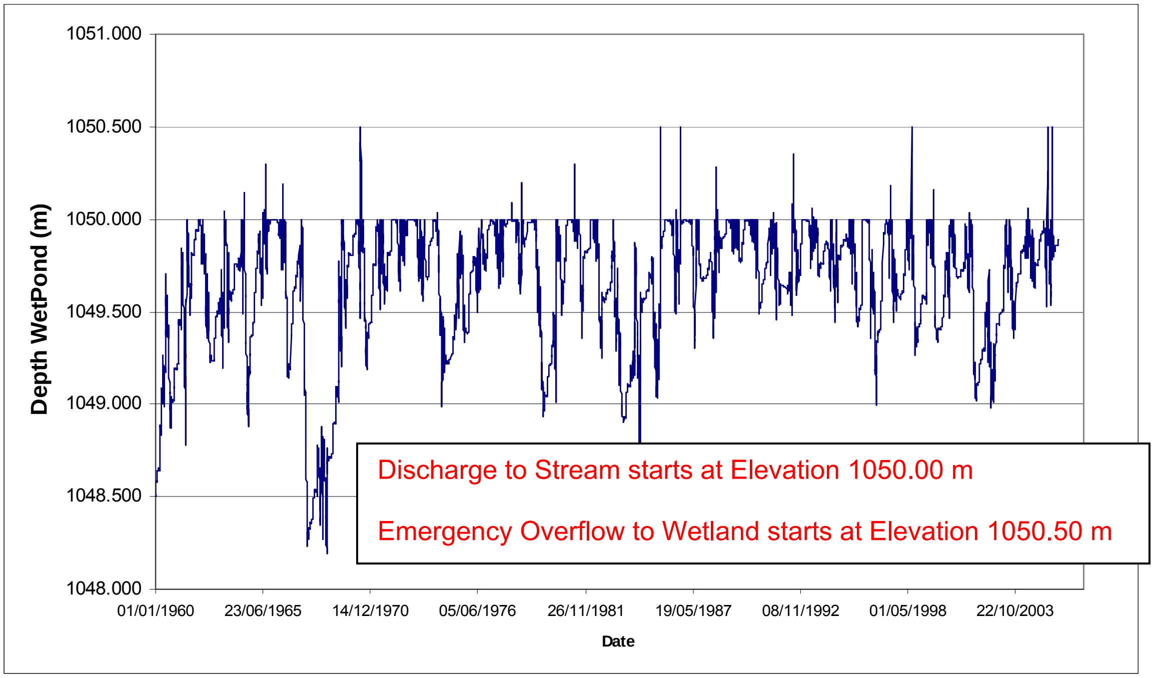
	Minimum	Maximum	Average	Median	
Precipitation	256	590	406	401	mm
Runoff	52	205	100	95	mm
	20	38	24	23	% of precipitation
Discharge to Stream	0	107	35	29	mm
	0	20	8	7	% of precipitation

The amount of runoff to the wet pond is in the order of 25% of the average annual precipitation, ranging from a low of about 20% in dry years to a high of 38% in wet years. These values reflect the presence of the various low impact development initiatives within this fictional development. For comparison purposes, the roads, which covered in this example only about 22% of the total catchment, generated over 50% of the total runoff. This reflects the fact that no BMPs were assumed to be implemented within the road right-of-ways. Close to 60% of all precipitation generated runoff for the roads; this has dropped to about half, i.e., 30%, for the multi-family and commercial land-uses which would have had similar percentages of hard surface area in conventional subdivision design.

The discharge to the stream ranges from a low of 0 mm for 5 out of 45 years to a high of 107 mm in the extreme year of 2005. The median is close to 30 mm, or about 7.5% of the average precipitation.

The following two figures illustrate the resulting water level fluctuations in the wet pond(s) and wetland(s), respectively.

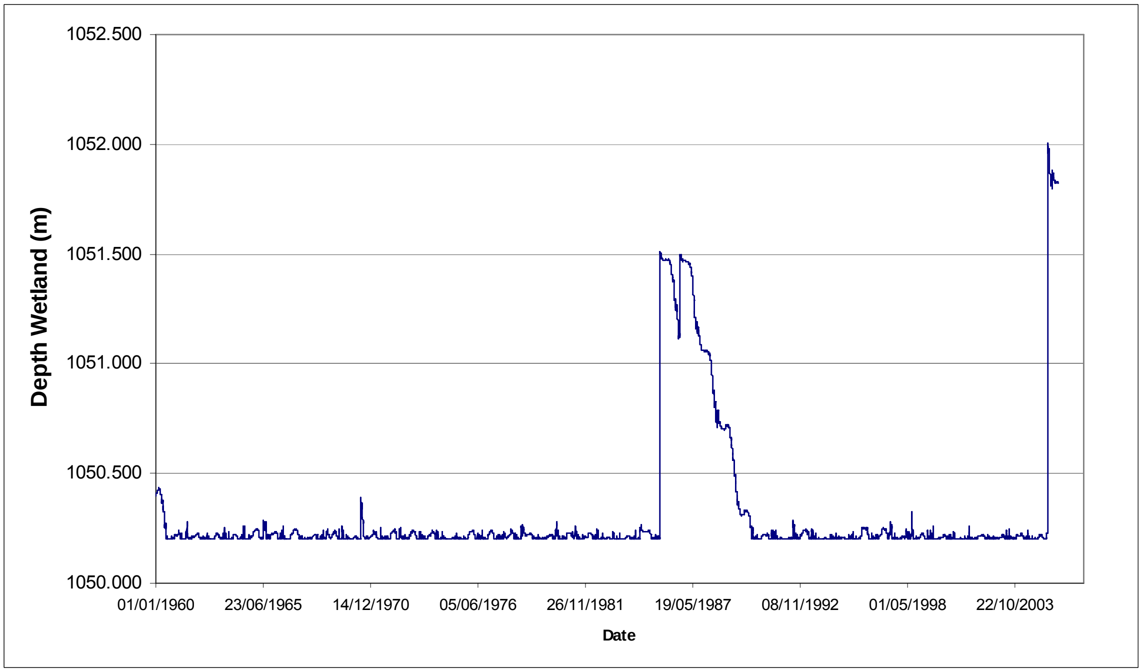
Water Level Fluctuations in Wet Pond



Discharge to Stream starts at Elevation 1050.00 m

Emergency Overflow to Wetland starts at Elevation 1050.50 m

Water Level Fluctuations in Wetland



It is readily acknowledged that many different permutations are possible, both with respect to the implementation of low impact development initiatives within the fictional subdivision and with respect to the operation of the wet pond(s) and wetland(s). It is important to note that the design of wet pond(s) should change in order to reflect the potential change in (normal) water levels. Where in the past the water level in wet ponds would have been close to a permanent normal water level, this level will be subject to change as part of any configuration where the accumulated stormwater is used for irrigation purposes. A stepped side slope approach rather than a constant side slope would likely be preferred.

This approach will provide more flexibility in creating a desired hydrologic regime for the Class IV/V wetlands that are to be retained. In addition, the water to replenish these wetlands could be treated. In our opinion this should constitute mitigation to the extent that compensation should not be required.

The example discussed above demonstrates that, technically, the introduction of low impact development strategies should be able to meet or at least get close to meeting the desired objectives.

Closure

We trust that the above review suits your needs at this time. We are available to further elaborate on the above if the need would so arise. Please contact us at 264-9366 if you should have any questions, comments and/or concerns.

Yours sincerely,

Bert van Duin, M.Sc., P.Eng.
Urban Drainage Specialist
Westhoff Engineering Resources, Inc.

Att: PowerPoint Slides of Water Balance Analysis

c.: Yin Deong, City of Calgary
Chris Manderson, City of Calgary
Terry Thompson, Calgary Airport Authority
Sandi Riemersma, Palliser Environmental Consulting Ltd.
Dennis R. Westhoff, M.Eng., P.Eng.