



RATINGS REPORT FOR THE
2002 DUFFINS AND CARRUTHERS CREEK WATERSHEDS
REPORT CARD

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Toronto and Region Conservation

For the Duffins and Carruthers Watershed Task Forces

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1.0 Introduction

1.1 Objectives, Indicators, Measures, and Targets

In the process of developing an integrated watershed plan for the Duffins Creek and Carruthers Creek watersheds, the Task Forces have identified management strategies that address the eight technical components of:

- Surface Water Quantity;
- Groundwater Quantity and Quality;
- Surface Water Quality;
- Aquatic Habitat and Species;
- Terrestrial Habitat and Species;
- Public Use - Recreation;
- Human Heritage; and
- Sustainable Communities.

Each management strategy is composed of a set of objectives, which identify the approach necessary to address the key issues associated with each technical component. To better facilitate meaningful and replicable reporting on progress towards full achievement of the management objectives, specific indicators, measures and targets have been defined for each objective. An indicator is a fact or device that provides specific information about the objective of interest. Measures are quantitative or qualitative ways to measure the state of the indicator. Targets represent a numerical threshold or directional aim, associated with each measure, and were chosen as the minimum (or maximum) condition necessary to achieve the desired objective.

In addition to setting management directions, the Task Force has reported on current watershed conditions, thus providing a baseline "Report Card" from which progress can be measured. Reporting on current watershed conditions prior to implementation work being undertaken serves to document the level at which the goals, objectives and targets of the watershed plan are currently being achieved, which will assist in evaluating progress towards implementation of the watershed plan in future reporting periods.

1.2 Ratings Definition

For each goal, objective and measure, a rating has been assigned which represents an evaluation of current watershed conditions. Ratings of current watershed conditions are based on both quantitative and qualitative analyses. To the greatest extent possible, the ratings for each measure are based on a quantitative evaluation of the current level of achievement of the associated target. Ratings for each management objective are based on a qualitative evaluation of the ratings for the measures associated with the objective. The rating for each management goal are based on a qualitative evaluation of the ratings for the associated objectives.

For management objectives where the target is based on a quantitative measure, and where sufficient information regarding that measure is available, current watershed conditions have been evaluated and ratings have been assigned for each measure according to the current level of achievement of the target. The rating system applied to quantitative measures is defined as follows:

Achievement Rating	% of target achieved
Excellent	better than 80%
Good	between 70 and 79%
Fair	between 60 and 69%
Poor	between 50 and 59%
Fail	below 50%
Further study required	baseline data not available or insufficient at this time
Not applicable in 2002	not applicable to evaluate % of target achieved in the 2002 reporting period

For some objectives, the chosen indicators and measures are not amenable to quantitative evaluation. In some cases, the target associated with the objective is based on a qualitative condition or directional aim for the measure. In these instances evaluations involved a qualitative evaluation of all available information pertaining to the measure and ratings were assigned based on the best professional judgement of TRCA staff with regard to the current level of achievement of the target.

In some cases, quantitative measures and targets have been established for the objective but the amount of information available pertaining to these measures is insufficient for the purpose of evaluating the level of achievement of the target. In these instances further data collection and analysis is required to fill information gaps. In these instances, no ratings have been assigned in this reporting period and the need for further study has been indicated. Table 3.1 at the end of this document summarizes the information gaps that have been identified through the watershed strategy development process.

In other cases, targets have not yet been established for certain quantitative measures due to limits to our understanding of the conditions required to sustain watershed health and integrity. In these instances, ratings have been assigned based on qualitative comparisons of conditions in the Duffins and Carruthers Creek watersheds to conditions in other watersheds within the TRCA jurisdiction, and the best professional judgement of TRCA staff with regard to the current health of the watershed.

For several management objectives, the target is to maintain or enhance baseline conditions. In many cases, baseline conditions have been defined as those conditions existing in 2002, so it is not applicable to rate the level of achievement of this target in the 2002 reporting period. In these instances, an interim rating has been assigned based on the best professional judgement of TRCA staff with regard to the current health of the watershed. These ratings appear in italics to indicate that future ratings will be based on the quantitative rating method of evaluating the level of achievement of the target in subsequent reporting periods.

The following section contains descriptions of the evaluation method and rationale that supports the ratings assigned for each measure, and the overall rating for each objective.

More detailed descriptions of current conditions on the Duffins and Carruthers Creek watersheds, can be found in the State of the Watershed Reports and the supporting technical documents listed in Appendix A.

2.0 Methodologies and 2002 Ratings

2.1 Surface Water Quantity

GOAL: To maintain the existing hydrologic function of the watershed	Duffins	Carruthers
	Good	Good

Objective #1 Maintain the existing water balance within the watershed			OVERALL RATING	
			Duffins	Carruthers
			<i>Good</i>	<i>Good</i>
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> watershed hydrology 	<ul style="list-style-type: none"> total annual infiltration rate (mm/yr) run-off volume (m³/yr) seasonal and annual baseflow (m³/yr) at indicator sites 	<ul style="list-style-type: none"> maintain or enhance baseline infiltration rates and distribution*^f maintain or reduce baseline run-off volume^{††} maintain or enhance baseline seasonal and annual baseflows[§] 	Not applicable in 2002	Further study required
			Not applicable in 2002	Further study required
			Not applicable in 2002	Further study required

References:

- *Gerber Geosciences Inc. 2003, Duffins Creek Watershed Hydrogeology and Assessment of Land Use Change on the Groundwater Flow System.
- ^fClarifica Inc. 2002, Water Budget in Urbanizing Watersheds: Duffins Creek Watershed.
- [†]Aquafor Beech Ltd. 2002, Duffins Creek Hydrology Update.
- [§]TRCA 2003, Duffins and Carruthers Creek Low Flow Study and Management Plan, Appendix A and B

Comments on the 2002 Ratings

Ratings for this objective will be based on the measures of total annual groundwater infiltration rate, and seasonal and annual baseflow. In 2002, a water balance model was developed for the Duffins Creek watershed and used to describe current conditions pertaining to watershed hydrology with respect to the existing balance between rates of infiltration, evapo-transpiration, and run-off in response to storm events. Values for total annual groundwater infiltration and run-off volume have been calculated for the Duffins Creek watershed based on the output of the water balance model for 2002 conditions. These values will be considered the baseline values that are to be maintained through planning and management measures. In future reporting periods, the water balance model output will be updated and used to recalculate annual infiltration rates and run-off, which will permit evaluations to be made of the level at which this objective is being achieved with respect to maintaining baseline infiltration rates and distribution and run-off volume. Since baseline infiltration rates and distribution and run-off volumes have been defined as the 2002 conditions, and since the target for these measure is to maintain or enhance baseline values, assigning ratings for these measures is not applicable in the 2002 reporting period.

Further technical work is required to fill the information gaps that currently prevent ratings from being assigned with respect to the watershed hydrology of Carruthers Creek. Table 3.1 in the Summary and Recommendations section provides a summary of the areas where further study is required. The water balance model for the Carruthers Creek watershed is not

yet complete (scheduled for completion in 2003), and therefore, no baseline infiltration rates can be established at this time. Similarly, no continuous stream flow data is currently available for this watershed and the information on baseflow is limited to two seasons of monitoring field work. A permanent stream gauge was installed in Carruthers Creek in 2002 to address this critical information gap.

The information available on seasonal and annual baseflow in both Duffins and Carruthers Creek, from monitoring field work conducted in 1996 and 2001, provides an initial indication of the status of stream flow in these watersheds during dry periods (defined as periods with no rainfall in the previous 72 hours), yet it is insufficient to properly characterize the natural variability inherent in this type of measure. As additional baseflow measurements are collected and analyzed through on-going seasonal monitoring programs, our understanding of existing baseflow conditions will be improved, which will enable baseline seasonal and annual baseflow volumes to be established for these watersheds, and will permit trends in monitoring data to be identified and interpreted in future reporting periods.

When compared with other watersheds in the TRCA jurisdiction, the hydrologic response and water balance of the Duffins and Carruthers Creek watersheds reflect non-urbanized conditions, or watersheds that are predominantly under a combination of rural/agricultural land use and natural land cover, with a minor amount of urban development, which is the most significant cause of loss of infiltration capacity (see Duffins Creek State of the Watershed Report, Surface Water Quantity section, pgs 146 - 154). Although all existing urban areas in each of these watersheds have been developed without infiltration controls in place, the proportion of each watershed that is impervious (subject to urban land uses with no infiltration controls in place) is much less than all other watersheds in the TRCA jurisdiction. In the Duffins Creek watershed, most of the existing urban development is associated with the reaches of the Lower Duffins, which contribute less than 3% of the estimated total annual baseflow. Based on the predominance of rural, agricultural and natural land cover in both the Duffins and Carruthers Creek watersheds, overall ratings of "Good" have been assigned for this objective, which reflect a qualitative evaluation, based on the best professional judgement of TRCA staff.

Objective #2 Maintain or enhance baseflows			OVERALL RATING	
			Duffins	Carruthers
			Good	Fair
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> baseflow 	<ul style="list-style-type: none"> seasonal and annual baseflow (m³/yr) at indicator sites 	<ul style="list-style-type: none"> maintain or enhance baseline seasonal and annual baseflows* 	Not applicable in 2002	Not applicable in 2002

References:

*TRCA 2003. Duffins and Carruthers Creek Low Flow Study and Management Plan, Appendix A and B.

Comments on the 2002 Ratings

Information available on seasonal and annual baseflow in both the Duffins and Carruthers Creek, from monitoring work conducted in 1996 and 2001, provides an initial indication of the status of stream flow in these watersheds during dry periods (defined as periods with no rainfall in the previous 72 hours), yet it is insufficient to properly characterize the natural variability inherent in this type of measure. As additional baseflow monitoring data is collected and analyzed, our understanding of existing baseflow conditions will be improved, which will enable baseline values for seasonal and annual baseflow volumes to be established for these watersheds, and will permit trends in future monitoring data to be identified and interpreted.

In general, baseflow in Duffins Creek remains continuous for the majority of the reaches in the watershed throughout the year, owing to the small amount of urbanization, the large number of natural features, the predominance of sandy soils and extensive forest cover and wetlands, all of which promote groundwater infiltration and reduce stormwater run-off. A limited number of observations of very low flows in some reaches were made at indicator sites during the driest periods of the summer of 2001. It is also suspected that surface water takings are occurring in this watershed. An overall rating of "Good" has been assigned to Duffins Creek for this objective, based on a qualitative evaluation of historical stream flow data and the limited amount of baseflow monitoring data from indicator sites that is currently available.

Observations of baseflow in Carruthers Creek made in 2001 suggest that baseflow is less consistent than in Duffins Creek. During the driest periods of the summer of 2001, several reaches were observed to have no flow during baseflow monitoring. Surface water takings are occurring in this watershed to a greater extent than in the Duffins. Historical stream flow information for this basin is not sufficient to determine if reaches that were observed to have intermittent baseflow in 2001 have been this way in the past. Continuous stream flow data and additional baseflow monitoring data from indicator sites is needed to better characterize typical low flow conditions in this watershed. A permanent stream flow gauge was installed in Carruthers Creek in 2002 to address this information deficiency. It is suspected that surface water takings are having a significant impact on baseflow in Carruthers Creek. A comprehensive review of the MOE Permit To Take Water database is required to determine the proportion of annual flow that is currently permitted to be withdrawn. An overall rating of "Fair" has been assigned to Carruthers Creek for this objective, based on a qualitative evaluation of the limited amount of baseflow information that is currently available.

Further correlation of baseflow field monitoring data with information on subsurface geology and water takings is required to improve our understanding of the factors and processes affecting baseflow in these systems. There is a need for further integration work to examine seasonal baseflow monitoring data within the context of the regional groundwater flow model that is scheduled to be finished in January 2003 (York-Peel-Durham Groundwater Management Project). Additionally, updated data on surface water and groundwater withdrawals within these watersheds is urgently needed to assess the impacts of current rates of water withdrawals and future water taking proposals on baseflow. The Region of Durham is currently conducting a region-wide assessment of water use, which is scheduled for completion in 2003.

Objective #3 Minimize or reduce risks to human life and property due to flooding			OVERALL RATING	
			Duffins	Carruthers
			Good	Good
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> number of flood vulnerable areas (FVAs) and flood vulnerable roads (FVRs) 	<ul style="list-style-type: none"> peak flow rate (unit flows) 	<ul style="list-style-type: none"> maintain baseline peak flows (2-100 year and Regional control if required)* 	Not applicable in 2002	Further study required
	<ul style="list-style-type: none"> water level (flood lines) 	<ul style="list-style-type: none"> maintain baseline water levels (flood lines)† 	Further study required	Further study required
	<ul style="list-style-type: none"> number of flood vulnerable areas and flood vulnerable roads 	<ul style="list-style-type: none"> reduce or as a minimum maintain the existing number of flood vulnerable areas and flood vulnerable roads (and the design storm frequency at which they flood)‡ 	Good	Good
	<ul style="list-style-type: none"> ice jams (frequency and location) 	<ul style="list-style-type: none"> develop and maintain documentation of the number of sites and frequency of ice jams 	Good	Excellent

References:

*Aquafor Beech Ltd. 2002. Duffins Creek Hydrology Update

†Marshall Macklin Monaghan Ltd., 2002. Duffins Creek Watershed Hydraulic Modeling and Flood Plain Mapping Project

‡TRCA 2000. Flood Vulnerable Areas Database; and, TRCA 2002, Duffins Creek State of the Watershed Report, Figure 7; and, TRCA 2002, Carruthers Creek State of the Watershed Report, Figure 4.

Comments on the 2002 Ratings

Ratings for this objective will be based on the measures of peak flow rate, water level (flood line elevations), the number of flood vulnerable areas and flood vulnerable roads, and the frequency of ice jams.

For the Duffins Creek watershed, the rating assigned for the measure of peak flow rate is based on the output of the updated Duffins Creek Hydrology Model which was completed in 2002. Peak flow rates that have been calculated using the updated Duffins Creek Hydrology Model will be considered to be the baseline for this measure. In future report cards, peak flow rates will be recalculated using hydrology model input parameters that reflect watershed conditions at that time, and the outputs will be compared with the 2002 results to evaluate progress towards achieving this objective. Since existing peak flow rates have been defined as the 2002 conditions, and since the target for this measure is to maintain existing rates, assigning ratings for the level of achievement with respect to this target is not applicable in the 2002 reporting period.

An update to the existing hydraulic model and associated floodplain mapping for the Duffins Creek watershed is planned over the next two years. This update will be carried out to define the limits of the regional floodplain based on flow information derived from the updated hydrology model. The water level elevations (flood lines) indicated in the updated floodplain maps

will be considered the baseline for this measure.

The hydrology model for Carruthers Creek is incomplete at this time due to a lack of stream flow data, which is needed for model calibration. A stream gauge has been installed in the Carruthers Creek watershed in 2002 and continuous monitoring of stream flow is underway to address this deficiency. The Carruthers Creek Hydrology Model is scheduled to be completed in 2003.

Updates to the Flood Vulnerable Areas (FVA) and Flood Vulnerable Roads (FVR) database for each of these watersheds will be carried out as required, once the hydraulic models and floodplain mapping have been updated. The ratings of "Good" for both the Duffins and Carruthers Creek watersheds with respect to the number of FVAs and FVRs reflects the fact that, based on existing records, flood vulnerable sites do exist in both watersheds, but historical accounts of flood events in these watersheds suggest that they occur very infrequently. The rating of "Good" allows for improvement to occur in the future.

In the absence of detailed historical information documenting the frequency of occurrences of ice jams, TRCA staff responsible for flood prediction and response indicate that these types of events occur very infrequently in both the Duffins and Carruthers Creek watersheds (see State of the Watershed Reports for Duffins and Carruthers Creek, TRCA 2002). Ratings of "Good" for Duffins Creek, and "Excellent" for Carruthers Creek have been assigned for this measure, based on a qualitative review of available information and the best professional judgement of TRCA staff.

The overall rating of "Good" assigned to both the Duffins and Carruthers Creek watersheds for this objective reflects a qualitative assessment of the current level of risk to human life and property due to flooding, based on the best professional judgement of TRCA staff.

In the future, updated land cover and hydraulic information will be input to the hydrology models for the Duffins and Carruthers Creek watersheds and used to predict peak flow rates, and conduct hydraulic assessments as a part of reviewing the status of floodplain maps. In future report cards, assessments will be made of the number of flood vulnerable areas, flood vulnerable roads, and the number and frequency of ice jam events and compared to the 2002/2003 results to evaluate progress towards achieving this objective.

Objective #4 Maintain or restore natural stream channel stability			OVERALL RATING	
			Duffins	Carruthers
			Further study required	Further study required
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> in-stream erosion 	<ul style="list-style-type: none"> erosion index 	<ul style="list-style-type: none"> maintain the baseline erosion index* 	Further study required	Further study required
	<ul style="list-style-type: none"> % of developed area that has adequate erosion controls in place (according to 2003 criteria) 	<ul style="list-style-type: none"> 100% of developed areas with adequate erosion controls in place 	Further study required	Further study required
	<ul style="list-style-type: none"> rate of erosion at indicator sites 	<ul style="list-style-type: none"> maintain or reduce the baseline rate of erosion† 	Further study required	Further study required

References:

*Cosburn Patterson Mather Ltd., 2001 (1997), Stormwater Management Study - A8 Secondary Plan (OPA 48), Town of Ajax, 2001 Addendum to May 1997 report; and,
 Ecotech International Systems Inc., pending approval, Functional Servicing Study - Northeast Quadrant OPA 101 Community of Stouffville, Town of Whitchurch-Stouffville; and,
 Parish Geomorphic Ltd., pending review, Erosion Assessment and Fluvial Geomorphic Update for Portions of West Duffins, Whitevale, Ganatsekiagon and Urfe Creeks; and,
 Planning and Engineering Initiatives Ltd., 2002, Green Space Project Lands Fluvial Geomorphology Study - Duffins Creek Watershed, Transport Canada, November 2002; and,
 URS Cole Sherman Ltd., pending approval, Functional Servicing Study - Southeast Quadrant OPA 101 Secondary Plan, Town of Whitchurch-Stouffville.
 † to be defined through the Regional Watershed Monitoring Network.

Comments on the 2002 Ratings

Ratings for this objective are based on the measures of erosion index, % of developed areas within the watershed that have adequate erosion controls in place, and rate of erosion. Modelling work to establish erosion indices for both the Duffins and Carruthers Creek watersheds will be carried out in 2003. The erosion index is a measure that reflects the relative potential for streambank erosion and downcutting of the stream channel due to exposure to flows with erosive capacities that are in excess of the natural cohesiveness strength of the streambank and bed material. When compared with pre-development conditions, the erosion index provides a means of evaluating the effectiveness of stormwater management measures with respect to mitigating the increased potential for erosion that is associated with the expansion of urban areas. Erosion index modelling work requires fluvial geomorphology assessments to be conducted in order to characterize the existing structure and composition of the stream channel and to identify the most sensitive reaches in terms of susceptibility to erosion. Based on modelled stream flow data that is generated by the hydrology model and knowledge of the structure and composition of the stream channel along the most sensitive reaches, erosion threshold values for volume, velocity, and depth of flow are established. The erosion threshold values are used to calculate the erosion index and provide the criteria needed to design stormwater management facilities to provide the necessary level of erosion control (i.e., storage volume and release rate criteria for stormwater management facilities).

Ratings cannot be assigned for the measure of % of developed areas within the watershed with adequate erosion control in place until new erosion control criteria are established. Once erosion indices and stormwater management facility design

criteria for erosion control are established for each watershed, the % of developed areas within each watershed that meet the new erosion control criteria will be assessed and quantitative ratings will be assigned for this measure in future reporting periods.

In areas of existing urban development in the Duffins and Carruthers Creek watersheds, monitoring of stream bank erosion will be conducted through the Regional Monitoring Network every three years, starting in 2003. The 2006 data will be compared with the 2003 data and used to establish erosion rates which will be considered the baseline measure to which comparisons will be made in future watershed report cards.

GOAL: To protect groundwater quality and quantity	Duffins	Carruthers
	Good	Fair

Objective #5 Maintain or enhance groundwater levels and baseflow for watershed functions			OVERALL RATING	
			Duffins	Carruthers
			Good	Fair
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> water table level 	<ul style="list-style-type: none"> water table level at indicator sites 	<ul style="list-style-type: none"> establish and maintain baseline water table levels 	Not applicable in 2002	Not applicable in 2002
<ul style="list-style-type: none"> aquifer water level 	<ul style="list-style-type: none"> piezometric surfaces at indicator sites 	<ul style="list-style-type: none"> maintain baseline piezometric surfaces*† 	Good	Fair
<ul style="list-style-type: none"> baseflow 	<ul style="list-style-type: none"> seasonal and annual baseflow 	<ul style="list-style-type: none"> maintain or enhance baseline seasonal and annual baseflows‡ 	Further study required	Further study required

References:

*Conservation Authorities Moraine Coalition 2003, York-Peel-Durham-Toronto MODFLOW Groundwater Flow Model - Core Area

†Gerber Geosciences Inc. 2003, Duffins Creek Watershed Hydrogeology and Assessment of Land Use Change on the Groundwater Flow System

‡ TRCA 2003, Duffins and Carruthers Creek Low Flow Study and Management Plan, Appendix A and B.

Comments on the 2002 Ratings

Groundwater levels have been monitored at a number of locations within the Duffins Creek watershed since the late 1970s on a discontinuous basis. A new, continuous groundwater monitoring program has been recently initiated by MOE and TRCA which commenced operation in June of 2001. Groundwater levels and aquifer water levels that will be established in through the monitoring program will be considered baseline measures and will be used to identify and interpret trends in future reporting periods. Since baseline groundwater and aquifer water levels have been defined as the 2002 conditions, and since the target for this measure is to maintain or enhance baseline levels, assigning a rating for this measure is not applicable in the 2002 reporting period.

Despite the discontinuous nature of the available information on historic groundwater levels, it does provide an indication of the extent to which groundwater levels have fluctuated in the past, which will assist in identifying trends in the continuous monitoring data that is now being collected. Annual water table levels within the till and lacustrine deposits situated south of the Oak Ridges Moraine have generally fluctuated between 2 to 3 metres in the past, except for one site (Site 1/94) where fluctuations of up to 5 metres have been observed. Information on water table levels within Oak Ridges Moraine deposits is currently lacking, but fluctuations are expected to be less than those observed in the lower permeability deposits situated to the south. The annual fluctuation of water levels within the deeper aquifers have been observed to be less than 2 metres.

Ratings assigned for this objective with respect to the measure of baseflow are based on a qualitative comparison of results of summer base flow monitoring in 1996 and 2001 with historic stream flow data for the Duffins and Carruthers Creek watersheds (see section 2.1 Surface Water Quantity; Objective #2 for an explanation of the rationale behind these ratings).

Based on consideration of the magnitude of groundwater level fluctuations in the past, the current understanding of baseflow in these watersheds and the best professional judgement of TRCA staff and consultants, overall ratings of “Good” for Duffins Creek and “Fair” for Carruthers Creek have been assigned for this objective. These ratings represent a qualitative review of existing information and the best professional judgement of TRCA staff.

Objective #6 Protect groundwater quality to ensure provision of safe water supplies and ecological functions			OVERALL RATING	
			Duffins	Carruthers
			Good	Good
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> groundwater chemistry 	<ul style="list-style-type: none"> Chlorides Nutrients Total Organic Carbon (TOC) Phenols Conductivity Metals pH Bacteria parameters in MOE Ontario Drinking Water Standards 	<ul style="list-style-type: none"> MOE Ontario Drinking Water Standards (mg/L)* 	Good	Good

*Ontario Regulation 459/00
www.ene.gov.on.ca for up-to-date information

Comments on the 2002 Ratings

In order to monitor long-term trends in groundwater levels and groundwater quality, the MOE and TRCA have initiated a groundwater monitoring program in June of 2001 which includes the analysis of groundwater samples for various chemical parameters twice per year. Groundwater quality data collected through this program will provide a better understanding of background conditions associated with groundwater quality within the Duffins Creek watershed. No monitoring stations are planned for the Carruthers Creek watershed at this time. Until an additional monitoring station can be established in the Carruthers Creek watershed, monitoring data from the Duffins Creek watershed will be considered to be generally indicative of groundwater quality conditions in the Carruthers Creek watershed.

While long-term data trends for sites within the Duffins Creek watershed are unavailable, there have been a number of studies conducted which provide an indication of background groundwater quality. Groundwater quality within the Duffins Creek watershed does not appear to vary significantly within any of the three aquifers situated within the unconsolidated deposits above bedrock and is generally of good quality for domestic use. Local occurrences of natural high hardness and iron concentrations have been reported along with locally elevated nitrate and chloride concentrations which are above MOE Drinking Water Quality Objectives. Elevated nitrate and chloride levels are believed to indicate contamination from surface applications of nitrate fertilizers and road salt respectively. Groundwater quality concerns at the present time appear to be isolated occurrences of elevated nitrate and bacteria levels associated with septic system effluent entering private wells and occurrences of high chloride concentrations above drinking water criteria (250 mg/L) in private wells situated near salted roadways. Many of the rural residents in the upper parts of the watershed rely on the shallow aquifer system for their potable water supply, and therefore their wells are more susceptible to contamination.

Based on this information, a rating of "Good" has been assigned for both the Duffins and Carruthers Creek watersheds, which reflects a qualitative assessment of the limited monitoring data available at this time.

Development of a source protection plan for these watersheds will begin in 2002, which will especially benefit rural water users on private well systems. It will involve identifying potential contaminant sources, assessing the vulnerability of groundwater systems, and developing a management plan. On-going monitoring work will provide a better understanding of the number of monitoring sites where groundwater chemistry parameters are in excess of Provincial Drinking Water Quality Objectives which will allow quantitative ratings to be established for this objective in future report cards.

Objective #7 Ensure sustainable rates of groundwater use			OVERALL RATING	
			Duffins	Carruthers
			Further study required	Further study required
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> water table levels 	<ul style="list-style-type: none"> water table levels at indicator sites 	<ul style="list-style-type: none"> establish and maintain baseline water table levels 	Further study required	Further study required
<ul style="list-style-type: none"> aquifer water levels 	<ul style="list-style-type: none"> piezometric surfaces at indicator sites 	<ul style="list-style-type: none"> maintain baseline piezometric surfaces*† 	Not applicable in 2002	Not applicable in 2002
<ul style="list-style-type: none"> baseflow 	<ul style="list-style-type: none"> seasonal and annual baseflow 	<ul style="list-style-type: none"> maintain or enhance baseline seasonal and annual baseflows‡ 	<i>Good</i>	<i>Fair</i>
<ul style="list-style-type: none"> groundwater withdrawals 	<ul style="list-style-type: none"> maximum annual volume of groundwater withdrawals permitted by active MOE Permits To Take Water 	<ul style="list-style-type: none"> sustainable rate of groundwater use TBD pending further study 	Further study required	Further study required

*Conservation Authorities Moraine Coalition 2003. York-Peel-Durham-Toronto MODFLOW Groundwater Flow Model - Core Area

†Gerber Geosciences Inc. 2002. Duffins Creek Watershed Hydrogeology and Assessment of Land Use Change on the Groundwater Flow System

‡TRCA 2003. Duffins and Carruthers Creek Low Flow Study and Management Plan, Appendix A and B.

Comments on the 2002 Ratings

Ratings for this objective are based on the measures of groundwater and aquifer water levels at indicator sites, baseflow, and groundwater withdrawals. An explanation of the rationale for the ratings for groundwater and aquifer water levels and baseflow can be found under Objective #5 in this section. An explanation of the rationale for the ratings for baseflow can be found in section 2.1, Surface Water Quantity, under Objective #2.

At this time, a criteria for establishing a targeted “sustainable” rate of groundwater withdrawal has not yet been developed. A comprehensive review and update of the entire MOE Permit To Take Water Database is urgently needed to provide the detail of information needed to assess impacts of current rates of water use on groundwater and aquifer water levels, and to develop criteria for sustainable rates of groundwater withdrawal. The Region of Durham is currently conducting a region-wide assessment of water use, scheduled to be completed in 2003, which will address this information deficiency. Until the water use assessment is complete, it is difficult to determine whether or not current rates of groundwater withdrawal are significantly impacting groundwater quantity on a watershed basis. In future reporting periods ratings will be assigned for this objective by comparing estimates of groundwater recharge derived from the output of the Duffins and Carruthers Creek water budget models and groundwater withdrawal from the water use assessment.

A limited review of information on groundwater withdrawals in the Duffins Creek watershed was conducted as a part of the Duffins Creek Hydrogeology study, which provides an initial indication of the magnitude of groundwater withdrawals occurring in this watershed. The majority of wells within the Duffins Creek watershed are private and provide a household supply of water. Groundwater wells draw from both the shallow and deep aquifers, which makes evaluating the sustainability of current withdrawal rates difficult based on the incomplete understanding of water takings. Active permits to take water on file with the MOE indicate some larger groundwater takings for golf course irrigation, municipal water supply, and commercial uses. The

largest permitted taking of groundwater is the municipal water supply for the town of Whitchurch-Stouffville. This water is presently treated and discharged to Stouffville Creek, with some discharge to tile beds. In the future this water will be sent via the York-Durham sewer system to a treatment plant located on the shoreline of Lake Ontario, near the mouth of Duffins Creek. The rate of groundwater withdrawal for the Whitchurch-Stouffville water supply presently totals 4000 m³/day, which represents 29% of the average total stream flow measured in Stouffville Creek for the seven year period of record (1975 to 1981), and 2% of the average total stream flow measured in Duffins Creek at the Pickering stream gauge station located just upstream from Lake Ontario. Upon decommissioning of the Stouffville Water Pollution Control Plant in 2003, it can be anticipated that average total stream flow in Stouffville Creek will be reduced by approximately one third.

GOAL: To protect and improve surface water quality	Duffins	Carruthers
	Fair	Fair

Objective #8 Manage the quality and quantity of run-off from rural and urban areas to maintain in-stream uses			OVERALL RATING	
			Duffins	Carruthers
			Good	Good
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> in-stream water chemistry 	<ul style="list-style-type: none"> concentrations of: nutrients (phosphorus, nitrite), suspended solids, bacteria, chloride annual loads of suspended solids and phosphorous 	<ul style="list-style-type: none"> Concentration targets (based on PWQO or other guideline): <ul style="list-style-type: none"> Total Phosphorus <0.03 mg/L* Nitrite < 0.06 mg/L[†] Suspended Solids < 30 mg/L[†] Bacteria < 100 counts/100 mL* Chloride < 250 mg/L[‡] Un-ionized Ammonia < 0.02mg/L* Maintain annual loadings at or below the targeted “background annual load”: <ul style="list-style-type: none"> Duffins^{††}; Suspended Solids - 2670 tonnes Total Phosphorus - 2.67 tonnes 	Fail	Fail
			Excellent	Excellent
			Excellent	Excellent
<ul style="list-style-type: none"> stormwater management (SWM) 	<ul style="list-style-type: none"> percent of developed area within watershed having adequate stormwater controls in place (both quantity and quality control) 	<ul style="list-style-type: none"> 100% of area having Level 1 water quality control (80% total suspended solids removal) for all new and retrofitted development 	Fail	Fail
			Excellent	Further study required
			Poor	Further study required
			Fail	Fair

NOTE: In-stream water chemistry ratings are based on averaged results for each parameter from water quality monitoring conducted between 1988 to 1994, not from sampling conducted in 2002.

†† To be reviewed prior to next Report Card

References:

[†]Canadian Council of Ministers of the Environment (CCME), 1999. *Canadian Water Quality Guidelines (CWQG)*, Canadian Council of Ministers of the Environment, Winnipeg.

[‡]Environment Canada and Health Canada, 2001. *Road Salts: Priority Substances List Assessment Report*. Prepared for the Canadian Environmental Protection Act, 1999 Priority Substances List. Internet Publication.

*Ontario Ministry of Environment and Energy (OMOEE), 1994, revised in 1999, *Water Management: Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy*, Queens Printer for Ontario.

In-stream Water Chemistry: Concentrations

The ratings assigned for in-stream water chemistry concentration targets are based on data collected through the Provincial Water Quality Monitoring Network (PWQMN) between January 1988 to December 1994. Three PWQMN stations located on reaches of Duffins Creek, and one station on Carruthers Creek were active during this period. Six in-stream water chemistry parameters that reflect the major influences affecting water quality in these watersheds were selected as measures for the indicator of in-stream water chemistry. Water quality monitoring data for the parameters of Total Phosphorus, Nitrite, Total Suspended Solids (TSS), Bacteria (faecal coliforms), Chloride, and Un-ionized Ammonia were compiled from the PWQMN records. Monitoring results were compared with Provincial Water Quality Objectives (PWQO) or Interim Guidelines which have been established for the protection of aquatic life and recreation uses of water resources. For each PWQMN station, the number of samples taken between 1988 and 1994 that met PWQOs or Interim Guidelines for the selected parameters were calculated. Ratings based on the quantitative rating system described in section 1.2 were assigned for each in-stream chemistry parameter, according to the percentage of samples that met PWQOs or Interim Guidelines (see Tables 2.3.1 and 2.3.2). For Duffins Creek, the results at each PWQMN station were averaged for each in-stream water chemistry parameter to provide a quantitative rating for the watershed.

The ratings for individual in-stream water chemistry parameters in both Duffins and Carruthers Creek indicate that phosphorus and bacteria concentrations are consistently higher than the targeted condition. It should be noted that the while elevated phosphorus and bacteria levels can pose potential health risks in terms of human contact with water (i.e., recreation uses), they do not necessarily indicate poor water quality conditions in terms of aquatic ecosystem health. It should also be noted that the PWQMN data reflects water quality associated with dry weather stream flow conditions, and does not necessarily capture peak concentrations of these in-stream water chemistry parameters that occur during wet weather.

Table 2.3.1 Duffins Creek In-stream Water Quality Measures and Ratings (PWQMN results from 1988 - 1994)

Parameter	Target	% Samples that meet Target (Stn. #1)	% Samples that meet Target (Stn. #28)	% Samples that meet Target (Stn. #15)	Average	Rating
Total Phosphorus	<0.03 mg/L	63	56	22	47	Fail
Nitrite	<0.06 mg/L	96	100	77	91	Excellent
Total Suspended Solids	<30 mg/L	79	83	87	83	Excellent
Bacteria (faecal coliform)	<100 counts/100 mL	36	66	27	43	Fail
Chloride	<250 mg/L	99	100	100	100	Excellent
Un-ionized Ammonia	<0.02 mg/L	100	98	98	99	Excellent

NB: Station #1 = Duffins Creek at Bayly Street
 Station #15 = West Duffins Creek at 8th Concession Road
 Station #28 = Brougham Creek

Table 2.3.2 Carruthers Creek In-stream Water Quality Measures and Ratings (PWQMN results from 1988 - 1994)

Parameter	Target	% Samples that meet Target (Stn. #1)	Rating
Total Phosphorus	<0.03 mg/L	34	Fail
Nitrite	<0.06 mg/L	97	Excellent
Total Suspended Solids	<30 mg/L	87	Excellent
Bacteria (faecal coliform)	<100 counts/100 mL	45	Fail
Chloride	<250 mg/L	100	Excellent
Un-ionized Ammonia	<0.02 mg/L	100	Excellent

NB: Station 1 = Carruthers Creek at Bayly Street

Overall, the results for in-stream water chemistry in both Duffins and Carruthers Creek generally indicate “Good” water quality conditions. The low concentrations of Nitrite, Suspended Solids, Chloride, and Un-ionized Ammonia in both watersheds indicate that water quality in these watercourses is generally suitable for supporting a healthy aquatic ecosystem. Overall water quality in these watersheds are likely the best of all the watersheds in the TRCA jurisdiction with respect to aquatic ecosystem health. These results are indicative of the small proportion of urban development in these watersheds, as urban areas are often major sources of nutrient and sediment enrichment, and potentially toxic contaminants. Elevated concentrations of Phosphorus in both Duffins and Carruthers Creek highlights the importance of implementing strict stormwater quality controls associated with new urban development, and the need to implement agricultural best management practices to reduce nutrient enrichment in the rural portions of these watersheds. It is expected that in-stream concentrations of Phosphorus and Bacteria will be significantly reduced in the reaches of Duffins Creek that are downstream of the Stouffville Water Pollution Control Plant upon decommissioning of the plant, which is anticipated to occur in 2003.

In-stream Water Chemistry: Annual Loads

Historical stream flow data for the Duffins Creek watershed provides the information necessary to estimate annual loading values for Total Suspended Solids and Phosphorus, which are water quality parameters that are known to be closely correlated with stream flow. Ratings for annual loads were assigned by comparing calculations of existing annual loads for these parameters with estimates of “targeted background annual loads”. The rating represents the percentage of the existing condition that meets the targeted condition. “Targeted background annual loads” are defined as the mean total annual flow (as measured by PWQMN stream gauge 02HC006 in Pickering for the monitoring period of 1949 to 1989), multiplied by the targeted in-stream concentration for each parameter (Phosphorus: 0.03 mg/L, Total Suspended Solids: 30 mg/L).

The “targeted background annual load” for Phosphorus in Duffins Creek is 2670 kg, or 2.67 tonnes, based on a mean total annual flow of 88 931 520 cubic metres and a targeted concentration of 0.03 mg/L or 30 mg/m³. The “targeted background annual load” for Total Suspended Solids in Duffins Creek is 2,670,000 kg, or 2670 tonnes, based on a mean total annual flow of 88 931 520 cubic metres and a targeted concentration of 30 mg/L or 30,000 mg/m³.

Annual loads of Phosphorus and Total Suspended Solids for Duffins Creek were estimated by multiplying the mean total annual flow (as measured by the stream gauge 02HC006 in Pickering for the period of 1949 to 1989) by the mean concentration for each parameter, based on the results of PWQMN sampling between 1988 and 1994 at station #1 at Bayly Street. The table 2.3.3 summarizes this rating evaluation:

Table 2.3.3 Duffins Creek Existing and Targeted Annual Load Measures and Ratings

Parameter	Existing Annual Load (tonnes/yr.)	Targeted Annual Load (tonnes/yr.)	% of Existing Load that exceeds the Target (x)	% of Existing Load that meets the Target (100 - x)	Rating
Phosphorus	4.7	2.67	43	57	Poor
Total Suspended Solids	3113	2668	14	86	Excellent

NOTE: It is recommended that the methodology for establishing the “targeted background annual loads” and estimating annual loads be reviewed, particularly for phosphorus. The PWQO for phosphorus of 0.03 mg/L is more representative of dry weather conditions. Spreadsheet model calculations under existing conditions in the Duffins Creek watershed indicate phosphorus concentrations are 0.18 and 0.02 mg/L during wet and dry weather, respectively. Since wet weather run-off contributes approximately 46% of the total annual run-off in the Duffins watershed (Stantec and Aquafor Beech, 2003), loading rates exceed the target based on the 0.03 mg/L criteria. Alternative approaches to consider for target setting include: specifying a targeted percent reduction of the existing load; or, specifying separate wet and dry weather targeted loads.

Since no historical stream flow data is currently available for Carruthers Creek, the mean total annual flow for this watercourse cannot be properly characterized. Therefore no calculation of “targeted background annual load” can be made at this time, and the Carruthers Creek was not evaluated for the measures of annual loads for Phosphorus and Total Suspended Solids. A permanent stream flow gauge has been installed on Carruthers Creek in 2002 which will provide the data required to calculate mean total annual flow and annual loads for these parameters in future watershed report cards.

Stormwater Management

The percentage of developed land area with Level 1 stormwater quality control in place (both quality and quantity control) is the measure that will be used to evaluate progress towards this objective in terms of mitigating the impacts of urban stormwater run-off on water quality. Presently in the Duffins Creek watershed, only 31% of developed areas have Level 1 stormwater quality control measures in place. Therefore the Duffins Creek watershed is rated as a “Fail” for this measure. In the Carruthers Creek watershed, 64% of developed areas have Level 1 stormwater quality control measures in place, so it receives a rating of “Fair” for this measure.

It should be noted that prior to 1994, there was no requirement for the provision of Level 1 stormwater quality control in new urban development. While poor ratings for these watersheds in terms of the indicator of stormwater management indicate the need for investment in stormwater management retrofit initiatives for existing urban areas without adequate stormwater control, they do not indicate a lack of compliance with provincial stormwater management criteria because much of the existing urban areas in these watersheds were developed prior to 1994. Since current approvals processes for new urban development require Level 1 stormwater quality control, as development continues, this rating will improve.

Overall Rating

The overall ratings assigned to each watershed for this objective are based on a qualitative review of the ratings for each measure. Both the Duffins and Carruthers Creek watersheds received an overall rating of “Good” for this objective based on the rationale that dry weather water quality conditions (represented by the PWQMN results from 1988 - 1994) in these creeks are generally “Good” in terms of aquatic ecosystem health. The extensive areas of natural vegetation, sandy soils, and significant groundwater discharges to stream baseflow in Duffins Creek and in localized parts of Carruthers Creek play a key role in maintaining the relatively good water quality conditions that exist in these watercourses. The headwater tributaries of Duffins and Carruthers Creek exhibit some of the best water quality conditions of all streams in the Greater Toronto Area.

Considering that the indicator of stormwater management pertains only to the urban portions of the watersheds which at present do not represent a large proportion of the total land area, the rating for this measure should not be weighted equally with the ratings for in-stream water chemistry. Additionally, stormwater retrofit studies are currently underway to address pollutant loads from existing urban areas without Level 1 stormwater control.

Objective #9 Minimize in-stream sediment associated with construction activity			OVERALL RATING	
			Duffins	Carruthers
			<i>Poor</i>	<i>Poor</i>
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> compliance with Municipal Erosion and Sediment Control By-laws 	<ul style="list-style-type: none"> percent of construction permits found to be in compliance with Municipal Erosion and Sediment Control By-laws 	<ul style="list-style-type: none"> 100% compliance with approved permits under Municipal Erosion and Sediment Control By-laws 	<i>Poor</i>	<i>Poor</i>
	<ul style="list-style-type: none"> percent of sediment ponds checked annually 	<ul style="list-style-type: none"> 100% of sediment ponds checked annually 	Further study required	Further study required
	<ul style="list-style-type: none"> percent of sediment ponds maintained when required 	<ul style="list-style-type: none"> 100% of ponds maintained when required 	Further study required	Further study required

References:

Clarifica, Inc., 2002, TRCA Model By-law for Erosion and Sediment Control, Litter and Debris Control and Dust Control Relating to Urban Development Activities in the TRCA jurisdiction, The Toronto and Region Conservation Authority, April 2002.

Comments on 2002 Ratings

Despite efforts by all agencies, construction activities continue to be a major source of sediment contamination in local watercourses. Ratings of “Poor” for this objective in both Duffins and Carruthers Creek watersheds are based on observations over the past two years and best professional judgement with regard to current levels of implementation of erosion and sediment control best management practices on construction sites. In future reporting periods, information on the number of construction permits found to be in compliance with Municipal Erosion and Sediment Control by-laws will be used to assign a quantitative rating of the level of achievement of the target.

Erosion and sediment impacts on local watercourses associated with construction activities is an important issue that requires further study to develop effective monitoring programs, indices for evaluating levels of impact on aquatic communities, and targets for management measures. The TRCA has recently completed two important initiatives designed to improve the quality and effectiveness of erosion and sediment control measures being implemented on urban construction sites. The first initiative involved the development of a “model” by-law for erosion and sediment control, mud tracking control, litter and debris control, and dust control. Over the upcoming year, TRCA plans to meet with each of the municipalities in the Duffins and Carruthers Creek watersheds to discuss adoption and implementation options. Once new municipal by-laws are implemented, routine inspection of erosion and sediment control practices on active construction sites will be required to provide the information needed to evaluate levels of compliance. The second initiative was to develop a modelling framework to simulate erosion and sediment transport on construction sites and evaluate treatment facility performance. Over the next two to three years, TRCA will be monitoring a sediment and erosion control facility in the Town of Richmond Hill. Data collected from this exercise will be used to calibrate the modelling component. It is anticipated that new sizing criteria for the design of temporary erosion and sediment control ponds will be developed using this information. In the interim, TRCA has adopted a revised, more stringent criteria that requires both a permanent pool and an active storage component for all temporary erosion and sediment control ponds on construction sites. The revised criteria will be a requirement for new development applications until a new criteria is established. Additionally, there is a need to track the number of temporary sediment control ponds that have been designed according to the TRCA’s interim sediment control criteria..

Objective #10 Reduce water quality contamination associated with wastewater discharges			OVERALL RATING	
			Duffins	Carruthers
			Poor	Not applicable*
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> in-stream water chemistry 	<ul style="list-style-type: none"> in-stream phosphorus concentrations due to Sewage Treatment Plant 	<ul style="list-style-type: none"> in-stream phosphorus concentration due to Sewage Treatment Plant should meet Provincial Water Quality Objectives (0.03 mg/L) for all flow levels upon leaving the sub-catchment (i.e., at 8th Concession and Reesor Creek) 	Fail	Not applicable*
<ul style="list-style-type: none"> effluent quality 	<ul style="list-style-type: none"> sewage treatment plant effluent quality 	<ul style="list-style-type: none"> sewage treatment plant effluent quality meets Certificate of Approval 	Fail	Not applicable*
<ul style="list-style-type: none"> sewage treatment plant by-passes 	<ul style="list-style-type: none"> number of sewage treatment plant by-passes 	<ul style="list-style-type: none"> zero sewage treatment plant by-passes 	Excellent	Not applicable*

***Note: There are no point source discharges of Sewage Treatment Plant effluent in Carruthers Creek.**

In-stream water chemistry

Ratings for in-stream water chemistry are based on estimates of in-stream phosphorus concentrations at four locations downstream of the Stouffville Water Pollution Control Plant (WPCP). Dilution ratios and phosphorus concentrations attributed to the Stouffville WPCP under existing conditions were calculated for a range of flows at stream gauging stations downstream of the plant (see Table 2.3.4 for results). The Stouffville WPCP was not found to impact water quality during high flow conditions associated with wet weather conditions. During dry weather conditions on Stouffville Creek, at the stream gauge location immediately downstream of the plant, phosphorus concentrations attributed to the Stouffville WPCP failed to meet the Provincial Water Quality Objective (PWQO) for phosphorus (0.03 mg/L) for at least half of the monthly average flows. Further downstream, at 8th Concession on Reesor Creek, phosphorus concentrations are predicted to be above the PWQO for approximately one quarter of the monthly average flows as a result of plant effluent. During extreme low flow conditions, represented as the minimum observed 7 day flow over a twenty year recurrence interval (7Q20), phosphorus concentrations due to the Stouffville WPCP are predicted to exceed the phosphorus PWQO as far downstream as Taunton Road. These results suggest that impacts to aquatic life from chlorine levels in plant effluent are also likely. Based on these results, a rating of "Fail" was assigned to Duffins Creek for this objective.

The Stouffville WPCP is scheduled to be decommissioned by the Regional Municipality of York by the end of 2003, which will result in a significant improvement to in-stream water chemistry conditions in Duffins Creek.

Table 2.3.4 Dilution ratios and phosphorus concentrations attributed to the Stouffville WPCP at four downstream locations

Location	Average streamflow percentiles	Dilution ratio	P concentration attributed to WPCP (mg/L)
Stouffville Creek	median 25 th percentile 10 th percentile 7Q20	3.2 2.3 2 data not available	0.05 0.07 0.09 data not available
Reesor Creek @ 8 th Concession Road	median 25 th percentile 10 th percentile 7Q20	7 5 4 data not available	0.02 0.03 0.04 data not available
West Duffins Creek @ Green River Road	median 25 th percentile 10 th percentile 7Q20	data not available data not available data not available 2	data not available data not available data not available 0.09
Duffins Creek Mouth @ Kingston Road	median 25 th percentile 10 th percentile 7Q20	4633259	0.004 0.01 0.01 0.02

NB: Provincial Water Quality Objective for phosphorus is 0.03 mg/L;
7Q20 represents the minimum 7 day flow over a 20 year recurrence interval.

Effluent quality

The rating for effluent quality is based on a review of effluent quality records from the Stouffville WPCP covering the period of January 1998 to December 2001. Effluent quality records were examined to determine the number of monitoring periods during which no parameters were found to exceed the criteria set out in the Certificate of Approval for the Plant. The Certificate of Approval criteria define an exceedance as any instance when the average concentration or loading value for the preceding four month period is in excess of the criteria set out in the Certificate of Approval. These criteria apply to the parameters of Biological Oxygen Demand (B.O.D.), Suspended Solids, and Phosphorus. Special criteria apply to Ammonium, where an exceedance is defined as any observed concentration or loading value that is in excess of the Certificate of Approval criteria between June and September of each year.

During the period of 1998 to 2001, exceedances of Certificate of Approval criteria occurred most frequently for Ammonium (6 of 12 monitoring periods). Exceedances also occurred for B.O.D. (3 of 12 monitoring periods). Only 4 of 12 monitoring periods had no exceedances of any kind, which represents a 33% achievement of the target, and a rating of "Fail".

Sewage Treatment Plant By-passes

Ratings for this indicator are based on records from the Stouffville WPCP from the period of 1998 to 2001. During this period, no by-pass events occurred, which represents a 100% achievement of the target and a rating of "Excellent".

Overall Rating

The overall rating of "Poor" assigned to the Duffins Creek watershed for this objective are based on a qualitative review of the ratings for each measure.

2.4 Aquatic Habitat and Species

GOAL: To protect aquatic habitat and species	Duffins	Carruthers
	Good	Fair

Objective #11 Protect and restore native aquatic species and communities	OVERALL RATING	
	Duffins	Carruthers
	Good	Fair

INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> fish and invertebrate communities 	<ul style="list-style-type: none"> invertebrate indices Index of Biotic Integrity (IBI) presence and abundance of indicator species 	<ul style="list-style-type: none"> to be determined pending further study minimum IBI of "Good" maintain or achieve historical distribution of targeted indicator species as specified for reaches in the Fisheries Management Plan* 	Further study required	Further study required
			Fair	Fair
			Good	Fair
<ul style="list-style-type: none"> in-stream habitat 	<ul style="list-style-type: none"> percent in-stream woody cover percent riffle substrate ratio of baseflow to total annual flow 	<ul style="list-style-type: none"> to be determined pending further study to be determined pending further study as specified for reaches in Fisheries Management Plan* 	Further study required	Further study required
			Further study required	Further study required
			Good	Fair
<ul style="list-style-type: none"> water chemistry 	<ul style="list-style-type: none"> water temperature Total Suspended Solids Phosphorus Chloride 	<ul style="list-style-type: none"> as specified for reaches in Fisheries Management Plan* 	Further study required	Further study required
			Good	Good
			Fail	Fail
			Good	Good
<ul style="list-style-type: none"> fish passage to critical habitat (breeding, rearing, foraging grounds) 	<ul style="list-style-type: none"> presence of in-stream barriers 	<ul style="list-style-type: none"> only strategic barriers for fisheries management to remain* 	Good	Good

References:

*TRCA 2003. Duffins and Carruthers Creek Watersheds Fisheries Management Plan

Fish and Invertebrate Communities

Evaluating the current condition of the Duffins and Carruthers Creek watersheds in terms of fish and invertebrate communities involves the use of invertebrate indices, Index of Biotic Integrity (IBI) scores, and information on the presence and abundance of indicator species.

At this time there is an insufficient amount of monitoring data available on invertebrates associated with these watercourses to properly characterize these communities. Once more information is obtained through continued monitoring work by the Regional Watershed Monitoring Network, a better understanding of the invertebrate communities associated with the Duffins and Carruthers Creeks will be developed which will allow ratings to be assigned and trends to be identified in future watershed report card processes.

The presence or absence of aquatic communities and/or indicator species are considered to be good indicators of aquatic ecosystem health as they are integrators of a variety of disturbances to their environment. The Index of Biotic Integrity (IBI) is a method for evaluating aquatic ecosystem health based on fish community associations that is widely used in North America. In this method, IBI scores and ratings are calculated for individual monitoring stations based on measurements related to the diversity of fish species present, the presence of indicator species, an evaluation of the fish communities, and the abundance of fish. For example, in many Southern Ontario watersheds, the presence of brook trout is an indicator of a healthy coldwater ecosystem, while a high abundance of longnose dace or blacknose dace generally indicates a degraded aquatic ecosystem. Overall IBI ratings are assigned by examining the frequency and distribution of IBI scores over the entire watershed. Using a standard method such as IBI for assessing general aquatic ecosystem health allows the results to be compared over time to identify changes and monitor trends, and allows comparisons to be made with other watersheds in the Greater Toronto Region.

Based on IBI scores from 32 monitoring stations on Duffins Creek and 6 stations on Carruthers Creek, both the Duffins and Carruthers Creek receive overall Index of Biotic Integrity scores of "Fair". The rating of "Fair" indicates that there are a significant number of opportunities for improving aquatic habitat and fish communities in these watersheds.

The presence of cold water fish species such as brook trout and slimy and mottled sculpin are indicators of healthy aquatic ecosystems in these watersheds. In terms of the presence and abundance of indicator species, the Duffins Creek watershed is rated as "Good", based on the number and diversity of cold water species of fish that have been observed through monitoring work, and the presence of brook trout at several monitoring stations. Monitoring results from the Carruthers Creek watershed indicate a lower diversity of cold water fish species and no evidence of brook trout being present, and so it is rated as "Fair" for this measure. In both the Duffins and Carruthers Creek watersheds there is evidence suggesting that more reaches would have supported brook trout in the past than what has been observed at present. These ratings also reflect the fact that Atlantic salmon, which historically would have migrated into these creeks from Lake Ontario, have been extirpated.

In-stream habitat

Ratings assigned for in-stream habitat are based on assessments of in-stream woody cover, riffle substrate, and baseflow as a percent of total annual flow for individual reaches. At this time, information on in-stream woody cover and riffle substrate is not sufficiently detailed for setting targets and assigning ratings for these measures. Fluvial geomorphology work that is scheduled to be undertaken in 2003 will provide this type of detailed information about in-stream conditions that will allow targets and ratings to be established in the near future.

Ratings for the measure of baseflow as a percentage of total annual flow are based on Habitat Suitability Indices developed in the United States which utilize annual baseflow as a percentage of average annual flow to determine habitat suitability for trout species. This ratio provides an indication of the stability of stream flow throughout the year. Higher ratios indicate more stable flows which provide more suitable conditions for sensitive coldwater species of fish. Ratios greater than 50% are considered to be excellent for trout production, ratios between 25 to 50% are good for trout production, and ratios less than 25% are poor for trout production. Ratios of baseflow to total annual flow for the thirty reaches, or sub-basins of Duffins Creek were calculated based on outputs of the water balance model which estimates annual evapo-transpiration, groundwater infiltration and run-off for each sub-basin. Annual baseflow volumes were calculated based on the work by Gerber (2003). Total annual flow for each of the thirty sub-basins was calculated as the sum of baseflow volume plus run-off

volume.

The ratings of “Good” for Duffins Creek and “Fair” for Carruthers Creek for the ratio of baseflow to total annual flow represent qualitative assessments of the overall results for individual reaches because information available at this time is insufficient to properly establish quantitative targets for each of the overall watersheds. A detailed breakdown of the results for individual reaches can be found in the Duffins and Carruthers Creek Fisheries Management Plan.

Water Chemistry

Ratings assigned for water chemistry parameters are based on the percent of samples tested through the Provincial Water Quality Monitoring Network that meet Provincial Water Quality Objectives (PWQO) or Interim Guidelines (see section 2.3 Surface Water Quality; Objective #8 for a breakdown of the results). These guidelines have been established for the protection of aquatic life and recreation uses of water resources. In terms of aquatic ecosystem health, water quality conditions in both watersheds are generally good, with the exceptions of reaches immediately downstream of the Stouffville Water Pollution Control Plant on Duffins Creek, and locations along and downstream of Miller’s Creek, and the lower portions of the Duffins and Carruthers Creek watersheds, where suspended solids contamination from urban development activities is currently a problem. It should be noted that the in-stream water chemistry results are based on a limited number and frequency of samples and therefore will not reflect peak concentrations typically associated with the spring run-off or the “first flush” of stormwater run-off. Additionally, the PWQMN in-stream water chemistry results reflect conditions at monitoring stations that are located on higher order tributaries and do not provide any indication of the potential for elevated impacts on lower order, headwater streams. The health of lower order, headwater streams is being tracked by the Regional Watershed Monitoring Network through the use of biological monitoring indicators, rather than water chemistry indicators, which is a more cost-effective approach that integrates the cumulative effects of the presence of multiple contaminants.

Fish Passage to Critical Habitat

The measure for this indicator is the number of in-stream barriers to fish migration that are present in each watershed. Ratings of “Good” have been assigned to both watersheds, which reflects the fact that although many fish barriers exist in both Duffins Creek and Carruthers Creeks, they do not limit fish movement as severely as in other watersheds in the TRCA jurisdiction. However, some barriers are present that could be preventing fish from accessing critical habitat in the headwaters areas, and opportunities exist to improve fish passages in each of these watersheds. Concern over competition between resident populations of trout (native brook trout and naturalized brown trout) and migratory trout (rainbow trout and chinook salmon) necessitates maintenance of a partition between these two fish communities. The existing barriers on West Duffins Creek north of Whitevale Road, and north of Highway 7 on East Duffins Creek fulfill this role and should be maintained as fisheries management structures.

Overall Rating

The overall rating of “Good” assigned to Duffins Creek, and “Fair” for Carruthers Creek for this objective are based on a qualitative review of the ratings for each measure.

Objective #12 Protect and restore the riparian zone and associated functions			OVERALL RATING	
			Duffins	Carruthers
			Fair	Fair
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> riparian zone vegetation 	<ul style="list-style-type: none"> percent of total stream bank length with riparian vegetation cover 	<ul style="list-style-type: none"> 100% coverage with riparian vegetation 	Good	Good
	<ul style="list-style-type: none"> percent of total stream bank length with woody riparian vegetation cover 	<ul style="list-style-type: none"> minimum of 75% coverage with woody riparian vegetation 	Fair	Poor

Comments on the 2002 Ratings

The ratings for this objective are based on assessments of riparian vegetation cover and the woody component of vegetation along stream banks. The total stream length for each watershed was calculated with the aid of a Geographic Information System (GIS), and the value was multiplied by two to provide the total length of stream bank. Information on riparian vegetation cover was derived by interpreting 1999 aerial photographs. Areas of riparian vegetation cover were delineated and classified according to the following five categories: forest; successional; meadow; wetland; and bare.

Table 2.4.1 Riparian Vegetation Cover Category Definitions and Results of 2002 Assessment

Riparian Vegetation Cover Category	Definition	Duffins		Carruthers	
		Length of Stream Bank (m)	% of Total	Length of Stream Bank (m)	% of Total
Forest	Areas having a woody component of greater than 25%, and a minimum of 3 trees wide	377990	50	47986	38
Successional	Sparsely vegetated areas having a minor woody component (10 - 25% woody vegetation)	6908	1	4626	4
Meadow	Areas dominated by uncultivated grasses (does not include fallow fields, pastures, or manicured grass)	120140	16	33800	27
Wetland	Areas dominated by wetland: marsh; bog (Difficulty exists in distinguishing between swamp and forest due to the canopy cover)	70534	9	7832	6
Bare	Areas lacking riparian vegetation where it is either dominated by cropped grasses or is devoid of any vegetation at the time of the air photo	175492	23	30412	24
Total		751064	99	124656	99

Based on the delineation and classification of riparian vegetation cover, calculations were made of the length of stream bank, and percent of the total length under each riparian cover category. Table 2.4.1 describes the characteristics that define each of the riparian vegetation cover categories and the results of the assessments of length of stream bank under each type of riparian vegetation cover for each watershed.

Ratings for the measure of percent of total stream length with riparian vegetation cover are based a quantitative evaluation of the current level of achievement of the target. Values for the percent of total stream length with riparian vegetation cover were calculated by adding the results in Table 2.4.1 for all riparian vegetation cover categories except for the “Bare” category, for each watershed. In the Duffins Creek watershed, 76% of the total stream bank length has riparian vegetation cover which corresponds to an achievement rating of “Good”. In the Carruthers Creek watershed, it was found that 75% of the total stream bank length has riparian vegetation cover, which also corresponds to an achievement rating of “Good”.

Ratings for the measure of percent of total stream bank length with woody riparian vegetation cover are also based on a quantitative evaluation of the current level of achievement of the target. Values for this measure were calculated by adding the Table 2.4.1 results for the categories of Forest and Successional, which are the only categories that contain a woody vegetation component. In the Duffins Creek watershed, it was found that 51% of the total stream bank length has riparian vegetation with a woody component, which corresponds to a 68% achievement of the target and an achievement rating of “Fair”. Similarly, in the Carruthers Creek watershed, it was found that 42% of the total stream bank length has riparian vegetation cover with a woody component, which corresponds to a 56% achievement of the target and an achievement rating of “Poor”. Tables 2.4.2 and 2.4.3 summarize the results for Duffins and Carruthers Creek, respectively.

Table 2.4.2 Duffins Creek Riparian Vegetation Target and Achievement Ratings in 2002

Measure	Existing (2002)	Target	% of Target Achieved	Achievement Rating
% of total stream bank length with riparian vegetation cover (includes all categories except Bare)	76	100	76	Good
% of total stream length with woody riparian vegetation cover (Forest and Successional categories only)	51	75	68	Fair

Table 2.4.3 Carruthers Creek Riparian Vegetation Target and Achievement Ratings in 2002

Measure	Existing (2002)	Target	% of Target Achieved	Achievement Rating
% of total stream bank length with riparian vegetation cover (all categories except Bare)	75	100	75	Good
% of total stream length with woody riparian vegetation cover (Forest and Successional categories only)	42	75	56	Poor

Overall ratings for this objective were assigned based on a qualitative review of the ratings for each measure and the best professional judgement of TRCA staff with regard to the overall state of riparian zones in each watershed. These results indicate that riparian vegetation coverage on stream banks is generally good in each watershed. However there is a need to continue with restoration plantings of woody species along stream banks in order to improve the proportion of woody riparian vegetation, which will benefit the food chain of the stream ecosystem, improve the stability of the stream banks and, as the woody vegetation matures, will help to regulate water temperature by providing shade to the stream channel.

Objective #13 Maintain or restore the natural variability of annual and seasonal stream flow			OVERALL RATING	
			Duffins	Carruthers
			Further study required	Further study required
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> stream hydrograph (annual and seasonal variation in hydrological regimes) 	<ul style="list-style-type: none"> flow events (timing, duration, frequency, and rate of change) ratio of baseflow to total annual flow ratio of seasonal baseflow to total seasonal flow 	<ul style="list-style-type: none"> to be determined with consideration for maintaining or restoring historical variability of the hydrograph, and consideration of the timing of low flows with respect to sensitive life cycle requirements of aquatic communities 	Further study required <i>Good</i> Further study required	Further study required <i>Fair</i> Further study required

Comments on the 2002 Ratings

At this time, more detailed examination of historical stream flow data with consideration of the requirements of aquatic communities is required for both watersheds in order to improve our understanding of the relationship between the stream hydrograph and aquatic community health. An evaluation of the stream hydrographs of the Duffins and Carruthers Creeks with respect to the life cycle requirements of aquatic communities will be provided in the forthcoming Duffins and Carruthers Creek Fisheries Management Plan.

An explanation of the rationale behind the ratings for the measure of ratio of baseflow to total annual flow can be found under Objective #11 in this section.

2.5 Terrestrial Natural Heritage

GOAL: To protect and enhance terrestrial habitat and species	Duffins	Carruthers
	Good	Fair

Objective #14 Increase the percent natural cover to a quantity which provides targeted biodiversity and supports recreational uses			OVERALL RATING	
			Duffins	Carruthers
			Good	Fair
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> quantity 	<ul style="list-style-type: none"> percent natural land cover 	<ul style="list-style-type: none"> ≥49% in Duffins Creek and ≥30% in Carruthers Creek 	Good	Excellent
<ul style="list-style-type: none"> distribution 	<ul style="list-style-type: none"> distribution of the natural land cover in relation to total watershed area (as measured by distance-to-centroid) 	<ul style="list-style-type: none"> distance-to-centroid ≤2350 m for Duffins Creek and ≤1750 m for Carruthers Creek 	Excellent	Excellent
<ul style="list-style-type: none"> size 	<ul style="list-style-type: none"> average patch size scores 	<ul style="list-style-type: none"> ≥3.87 in Duffins Creek, ≥2.89 in Carruthers Creek 	Poor	Good
<ul style="list-style-type: none"> shape 	<ul style="list-style-type: none"> average patch shape scores 	<ul style="list-style-type: none"> ≥2.79 in Duffins Creek, ≥1.89 in Carruthers Creek 	Poor	Excellent

Reference:

TRCA Terrestrial Natural Heritage Strategy (under development)

Comments on the 2002 ratings

To monitor and evaluate progress towards this objective, TRCA staff have selected four indicators that address critical aspects of terrestrial ecosystems: quantity of natural cover; distribution of natural cover; size of natural cover patches; and shape of natural cover patches. Quantity of natural cover was measured by calculating the percent of the total watershed area that is under natural land cover, which includes forest, meadow, wetland and successional land cover types. The measure of “distance-to-centroid” was used to evaluate the distribution of natural cover over the watershed. For this measure, a GIS is used to determine the Cartesian coordinates of the centroid (the theoretical “centre of mass”) of the mosaic of patches of natural cover that make-up the existing terrestrial system, and the Cartesian coordinates of the centroid of the watershed. The measure of “distance-to-centroid” is the distance that separates the two sets of coordinates. The ideal condition for this measure is a distance of zero, which occurs when the patches of natural cover that make up the terrestrial system are distributed evenly across the watershed. Similarly, the existing and targeted terrestrial systems were evaluated in terms of size and shape indicators by using a GIS to quantify the area of each patch of natural land cover (size indicator), and to establish the ratio of patch area to perimeter length (shape indicator) which provides a means of quantifying the extent to which each natural land cover patch is being influenced by “edge effects”. These values were transformed into patch size and shape scores which are based on a scale of 0 to 5. Patches that score high are considered to be quality habitats capable of supporting a variety of sensitive species, mid-scoring patches are considered to be in fair condition, and low scoring patches support only the most robust species.

Ratings for each indicator were assigned by comparing existing natural land cover conditions to the targeted terrestrial system. The results of these assessments and the associated ratings are provided in table 2.5.1, and table 2.5.2.

Table 2.5.1 Duffins Creek Watershed Terrestrial Natural Heritage Targets and 2002 Ratings

Measure	Existing (2002)	Target*	% of Target Achieved	Achievement Rating
Percent natural land cover	37	≥ 48	77	Good
Distance to centroid (metres)	992	≤ 2351	100	Excellent
Average patch size score	2.23	≥ 3.87	58	Poor
Average patch shape score	1.621	≥ 2.79	58	Poor

* The technical analyses conducted to develop these targets utilized the Duffins Creek watershed boundary that was derived from 1:50 000 scale topographic mapping data. Subsequent technical studies utilized a new watershed boundary that was derived using higher resolution data (1:10 000 scale digital elevation model). This discrepancy accounts for the difference between the target for natural cover indicated here (48% using the lower resolution watershed boundary) and the target indicated in the watershed plan (49% using the higher resolution watershed boundary). In this reporting period, the technical analyses required to calculate the targets were not repeated using the new watershed boundary. These targets will be updated in the next reporting period.

The targeted condition for the terrestrial natural heritage system of the Duffins Creek watershed represents a net increase in area under natural land cover in such a way that also improves the average size and shape scores for natural land cover patches. In the targeted condition, increases to natural land cover are concentrated in the northern portions of the watershed, which results in a greater distance-to-centroid value, and represents a less-desirable condition for the distribution of natural land cover over the watershed. However, the benefits to other scores (i.e., average patch size and shape), and to the connectivity of the natural system as a whole that are associated with this change makes this condition a preferable option. When the measure of distance-to-centroid is examined independently of other measures, the 2002 scores are more preferable than those associated with the targeted condition, so they are considered to represent a 100% achievement of the target.

Table 2.5.2 Carruthers Creek Terrestrial Natural Heritage Targets and 2002 Ratings

Measure	Existing (2002)	Target	% of Target Achieved	Rating
% of watershed under natural land cover	28	≥ 27	100	Excellent
Distance-to-centroid (metres)	784	≤ 1750	100	Excellent
Average patch size score	2.1	≥ 2.89	73	Good
Average patch shape score	2.02	≥ 1.89	100	Excellent

* The technical analyses conducted to develop these targets utilized the Carruthers Creek watershed boundary that was derived from 1:50 000 scale topographic mapping data. Subsequent technical studies utilized a new watershed boundary that was derived using higher resolution data (1:10 000 scale digital elevation model). This discrepancy accounts for the difference between the target for natural cover indicated here (27% using the lower resolution watershed boundary) and the target indicated in the watershed plan (30% using the higher resolution watershed boundary). In this reporting period, the technical analyses required to calculate the targets were not repeated using the new watershed boundary. These targets will be updated in the next reporting period.

The targeted condition for the terrestrial natural heritage system of the Carruthers Creek watershed incorporates a net loss in natural land cover associated with the expansion of urban settlement areas, while improving the average size of natural land cover patches. While improvements to the size of existing natural cover patches will contribute to shifting the centroid of all natural land cover patches further away from the centroid of the watershed and decreasing the average patch shape score, this change is still considered to be the most preferable option in consideration of constraints associated with future plans for urban development. When the measures of both distance-to-centroid and average patch shape are examined independently of other measures, the 2002 scores are more preferable than those associated with the targeted condition. Therefore the existing (2002) conditions for these measures are considered to represent full achievement of the target (100%).

It is important to acknowledge that the target for natural land cover in the Carruthers Creek watershed was established with consideration of the constraints associated with existing developed areas and lands that are designated for development in the future. Fewer opportunities exist for restoring natural land cover in the Carruthers Creek watershed, than in the Duffins Creek watershed because the proportion of the watershed in public ownership is much less.

It is acknowledged that the target for natural land cover in the Carruthers Creek watershed does not reflect conditions required to achieve biodiversity targets (i.e., support species-of-concern) or to significantly enhance recreational use opportunities to the same extent that the targets for the Duffins Creek watershed do. However, the target does represent a significant improvement from existing conditions and is believed to be the best condition that could be achieved within the constraints to regeneration that currently exist.

The overall ratings reflect a qualitative assessment of the current level of achievement of this objective which is based on a review of individual ratings for each measure and the best professional judgement of TRCA staff. The overall rating of "Good" for the Duffins Creek watershed reflects the fact that the existing amount of natural land cover provides a good basis on which to build a healthy and functioning terrestrial system, although improvements to the size, shape and distribution of natural land cover patches are needed to provide the conditions necessary to achieve biodiversity targets (i.e., support species-of-concern). The overall rating of "Fair" for the Carruthers Creek watershed reflects the fact that although a large percent of the target has already been achieved, the terrestrial system remains in a "Fair" state of health in terms of ability to support species-of-concern (biodiversity targets) and to provide the land base needed for outdoor recreation uses.

Objective #15 Protect the natural system quality and function from the influence of surrounding land uses			OVERALL RATING	
			Duffins	Carruthers
			Fair	Fair
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> matrix influence 	<ul style="list-style-type: none"> compatibility of surrounding land uses within 2 km of the edge of each natural cover patch 	<ul style="list-style-type: none"> targeted ratio of urban, natural and rural/agricultural land cover surrounding each natural cover patch, as defined by the Regional Terrestrial Natural Heritage model matrix influence scores 	Fair	Excellent

Comments on the 2002 Ratings

Ratings for this objective are based on a landscape analysis that considers the influence of adjacent land uses on the status of individual patches of natural land cover as viable habitat areas. Matrix influence scores are assigned to each natural land cover patch and an average score is calculated for each watershed. The targeted condition for the terrestrial system of the Duffins Creek watershed involves increasing natural land cover from 37% to 48%. The average matrix influence score in the targeted condition is 4.16. The average matrix influence score for existing conditions on the Duffins Creek watershed is 2.68, which represents an achievement of 64% of the target and a rating of "Fair".

In order to accommodate plans for future urban development in accordance with the Regional Official Plan, the targeted condition for the terrestrial system of the Carruthers Creek watershed involves a small increase in natural land cover from 29% to 30%. The average matrix influence score for the targeted condition is 3.11. The average matrix influence score for existing conditions on the Carruthers Creek watershed is 2.67, which represents an achievement of 86% of the target and a rating of "Excellent".

Based on the state of health of the terrestrial system in the Carruthers watershed, and in consideration of the surrounding land uses which impose similar impacts to those in the Duffins, a "Fair" rating is more appropriate. It is recommended that application of the matrix influence score on a watershed scale be reviewed prior to the next report card and consideration be given to developing a variation of this score that may be more appropriate for watershed scale applications.

Objective #16 Protect and restore all native vegetation community types and species to targeted levels			OVERALL RATING	
			Duffins	Carruthers
			Further study required	Further study required
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> • vegetation type diversity 	<ul style="list-style-type: none"> • number of vegetation types represented 	<ul style="list-style-type: none"> • to be determined pending further technical analysis 	Further study required	Further study required
<ul style="list-style-type: none"> • species diversity 	<ul style="list-style-type: none"> • number of species represented 	<ul style="list-style-type: none"> • to be determined pending further technical analysis 	Further study required	Further study required

Comments on the 2002 Ratings

In order to establish targets for these measures further inventory work and technical analysis of information on flora and fauna abundance and distribution in the Duffins and Carruthers Creek watersheds is required.

GOAL: To provide appropriate sustainable public use which promotes environmental awareness and enhancement	Duffins	Carruthers
	Good	Poor

Objective #17 Create continuous watershed trails in the greenspace system linking Lake Ontario and the Oak Ridges Moraine			OVERALL RATING	
			Duffins	Carruthers
			Fair	Fair
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> Inter-regional trail network 	<ul style="list-style-type: none"> Percent completion of the inter-regional trail network 	<ul style="list-style-type: none"> 100% completion 	Fail	Fail

Comments on the 2002 Ratings

Ratings for this objective are based on a quantitative evaluation of the total length of trails that have been completed in each watershed, compared to the target condition, which represents fully implemented plans by local municipalities to extend the Trans Canada Trail, the Oak Ridges Moraine Trail, the Waterfront Trail through these watersheds.

In the Duffins Creek watershed, there are currently 40 km of trails completed, with plans to complete a total of 120 km, which represents a total achievement of 33% of the target, and a rating of "Fail".

In the Carruthers Creek watershed, there are currently 3 km of trails completed, with plans to complete a total of 33 km, which represents a total achievement of 9% of the target, and a rating of "Fail".

The overall ratings of "Fair" reflects the fact that there are significant opportunities to extend the current trail network into a more continuous system linking the Lake Ontario waterfront to the Oak Ridges Moraine. Although ratings for this objective are low based on the proportion of proposed trails that have been completed to date, there are strong efforts being put towards planning and implementing the remaining sections of the inter-regional trails by municipalities in each watershed. Therefore significant improvements with regard to the achievement of this objective are anticipated in the near future.

Objective #18 Manage the greenspace system for planned sustainable uses and public enjoyment			OVERALL RATING	
			Duffins	Carruthers
			Good	Poor
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> Sustainable public use and enjoyment 	<ul style="list-style-type: none"> Participation in planned uses as defined in the Management Plan 	<ul style="list-style-type: none"> Increase participation in planned uses and decrease participation in unplanned uses 	Further study required	Further study required
<ul style="list-style-type: none"> Management Plans 	<ul style="list-style-type: none"> Number of Management Plans completed for areas identified 	<ul style="list-style-type: none"> 100% completion 	Further study required	Further study required

Comments on the 2002 Ratings

Despite the fact that information is not available to quantitatively rate the selected indicators and measures, adequate local knowledge is available to provide a basis for a qualitative evaluation of the overall objective.

Within the Duffins watershed, the following factors were considered: number of completed management plans for public lands (e.g., Greenwood Mgmt Plan, Headwaters Mgmt. Plan, Duffins Marsh Restoration Plan, etc.); available public use opportunities (e.g., Seaton Trail, Oak Ridges Trail,); and municipal parks and recreation strategic plans.

Within the Carruthers watershed, the Town of Ajax Parks and Recreation Department has been proactive in developing Management and Trails Plans, and the Waterfront Regeneration Trust has established the waterfront trail, yet there are still opportunities to be realized in the middle and upper reaches of that watershed.

There is a need to ensure that environmental management system-based approaches to the management of publicly-accessible greenspace be employed to minimize impacts associated with public use.

Objective #19 Improve greenspace accessibility while ensuring compatibility between social benefits and ecological health			OVERALL RATING	
			Duffins	Carruthers
			Good	Poor
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> • Accessible greenspace 	<ul style="list-style-type: none"> • Number of access points to publically owned greenspace as identified in the management plan 	<ul style="list-style-type: none"> • 100% completion of the development of all planned access points 	Further study required	Further study required

Comments on the 2002 Ratings

Ratings for this objective are based on qualitative comparisons of the amount of accessible publicly-owned greenspace land in the Duffins and Carruthers Creek watersheds with other watersheds in the TRCA jurisdiction, most notably, the Humber River watershed which received an overall rating of “Good” in the Watershed Report Card of 2000.

In the Duffins Creek watershed, a rating of “Good” reflects the fact that over 50% of the total watershed area is under ownership and care of the TRCA, Federal and Provincial governments and regional and local municipalities, providing great potential to increase the amount of publicly owned and accessible greenspace as development proceeds and population densities increase in each watershed. At the present time, publicly accessible greenspace still remains fragmented and the number of year round access points needs improvement.

In the Carruthers Creek watershed, a rating of “Poor” has been assigned due to the fact that only 25 hectares of public greenspace exists, that being the lands around the Carruthers Creek Marsh, at the mouth of Carruthers Creek, which represents less than 1% of the total watershed area..

The overall ratings reflect the fact that in both watersheds, the current greenspace network is somewhat fragmented, and that opportunities exist to significantly increase the value of individual areas of greenspace by linking them together into a continuous, integrated, and accessible system. Future initiatives to link these areas include proposed extensions to the Trans Canada Trail, the Oak Ridges Moraine Trail, the Waterfront Trail and other trail planning initiatives proposed by local municipalities.

GOAL: To preserve and interpret our evolving human heritage resources	Duffins	Carruthers
	<i>Fair</i>	<i>Fair</i>

Objective #20 Identify and document human heritage resources for protection			OVERALL RATING	
			Duffins	Carruthers
			<i>Fair</i>	<i>Fair</i>
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> number of human heritage resources 	<ul style="list-style-type: none"> number of registered archaeological sites 	<ul style="list-style-type: none"> maintain or increase the number of registered archaeological sites 	<i>Fair</i>	<i>Fair</i>
	<ul style="list-style-type: none"> number of Designated structures (i.e., built heritage) 	<ul style="list-style-type: none"> maintain or increase the number of Designated structures 	<i>Fair</i>	<i>Fair</i>
	<ul style="list-style-type: none"> number of Listed structures (not yet Designated) 	<ul style="list-style-type: none"> maintain or increase the number of Listed structures 	<i>Fair</i>	<i>Fair</i>

Comments on the 2002 Ratings

The rating for this objective represents a qualitative assessment of the number of human heritage resources (archaeological sites and Designated and Listed structures) that have been identified within these two watersheds as compared with other watersheds in the TRCA jurisdiction. The ratings of “Fair” for individual measures and the overall rating reflect the fact that relatively few built heritage sites have been Designated, and also that there are large areas within these two watersheds that have not yet been surveyed for archaeological sites. This situation is due in part to the extensive amounts of land in public ownership and, therefore, relatively small portions of each watershed have been subject to urban development which would prompt the required studies.

Archaeological sites are most often identified through investigations initiated by the development approvals process. Attention has been focused primarily on the Airport lands, and to some degree the Seaton lands, to the exclusion of the Oak Ridges Moraine, the eastern subwatersheds of the Duffins, and the Carruthers Creek watershed as a whole. These ratings suggest that there is significant room for improvement in the initiation of archaeological site investigations.

The current assessment of the numbers of built heritage structures is a compilation of the separate inventories held by each of the five municipal Local Architectural Conservation Advisory Committees (LACACs) or equivalent heritage agencies. Their ability to conduct inventories and research, and to designate structures (under the Ontario Heritage Act) varies, depending upon priorities and funding within each municipality. These ratings suggest that there is significant room for improvement regarding the updated listing and designation of heritage structures across these two watersheds.

Objective #21 Increase awareness and appreciation of the inherent value of human heritage resources			OVERALL RATING	
			Duffins	Carruthers
			Fair	Poor
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> awareness and appreciation 	<ul style="list-style-type: none"> percent of population which places value on human heritage 	<ul style="list-style-type: none"> net increase of awareness and appreciation of human heritage 	Fair	Poor

Comments on the 2002 Ratings

At this time, no public opinion survey has been conducted to gauge the percent of watershed residents who place value on Human Heritage resources. The ratings for this objective reflect a qualitative evaluation of the status of current levels of public awareness and appreciation of human heritage resources that is based on the best professional judgement of TRCA staff.

In future reporting periods, consideration should be given to the use of other surrogate measures to evaluate progress towards this objective such as the number of visitors to human heritage interpretive facilities, public events that promote local history, or amount of funding contributed to heritage programs from public and private sources.

Objective #22 Apply a standardized approach to protecting human heritage resources at all levels of government			OVERALL RATING	
			Duffins	Carruthers
			<i>Fair</i>	<i>Fair</i>
INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> standardized approach 	<ul style="list-style-type: none"> number of agencies who agree with applying a standardized approach 	<ul style="list-style-type: none"> 100% agreement 	<i>Fair</i>	<i>Fair</i>

References:

TRCA, 2002, *Archaeological Resource Management Procedures: Guidelines*

Comments on the 2002 Ratings

At this time, no standardized approach to protecting human heritage resources has been adopted by all levels of government. The ratings for this objective reflect a qualitative evaluation of current levels of agreement on a standardized approach by local agencies, based on the best professional judgement of TRCA staff.

GOAL: To achieve a behavioural shift in lifestyles, community design and resource use in keeping with environmental objectives for the watersheds	Duffins	Carruthers
	Fair	Fair

Objective #23 Increase awareness of watershed issues and use of available watershed knowledge in decision making to foster sustainability and sustainable living practices	OVERALL RATING	
	Duffins	Carruthers
	Further study required	Further study required

INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> Awareness 	<ul style="list-style-type: none"> percent of surveyed population having awareness of watershed issues 	<ul style="list-style-type: none"> increase the level of awareness of watershed issues 	Further study required	Further study required
<ul style="list-style-type: none"> Outdoor Environmental Education 	<ul style="list-style-type: none"> number of students participating in outdoor education programs 	<ul style="list-style-type: none"> increase the number of students participating in outdoor education programs 	Further study required	Further study required

Comments on the 2002 Ratings

At this time, no surveys on public awareness of watershed issues, nor student participation in outdoor education programs have been conducted. There is a need to conduct a survey of public awareness in the near future, in order to establish the current level of awareness, which will permit progress towards achieving this objective to be meaningfully evaluated in the next reporting period in 2005.

In the absence of information with regard to the current level of public awareness of watershed issues in these watersheds, no overall ratings have been assigned for this objective in this reporting period. Results of the forthcoming surveys of public awareness will provide the information needed to rate the current level of achievement of this objective for each of these watersheds.

Objective #24 Promote lifestyles that are ecologically sustainable	OVERALL RATING	
	Duffins	Carruthers
	Further study required	Further study required

INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
• water efficiency	• amount of water used per capita	• reduce the amount of water used per capita	Further study required	Further study required
• materials and resources	• degree of waste generation/diversion	• reduce degree of waste generation and increase diversion	Further study required	Further study required
• energy efficiency	• non-renewable energy consumption	• decrease non-renewable energy consumption	Further study required	Further study required
• renewable energy	• number of homes and industries using green power	• increase proportional use for renewable green vs. non-renewable energy	Further study required	Further study required
• urban forests	• hectares of urban canopy	• increase urban canopy	Further study required	Further study required
• naturalization on private lands	• hectares of naturalized lawns and gardens	• increase hectares of naturalized lawns and gardens	Further study required	Further study required
• stewardship initiatives	• participation in stewardship initiatives	• increase participation in stewardship activities	Further study required	Further study required

Comments on the 2002 Ratings

During this reporting period no information has been collected to document the current condition of each of these measures.

Objective #25 Use sustainable urban design approaches to guide urban growth and development	OVERALL RATING	
	Duffins	Carruthers
	Fair	Fair

INDICATORS	MEASURES	TARGETS	2002 RATING	
			Duffins	Carruthers
<ul style="list-style-type: none"> • Sustainable Communities • sprawl 	– application of sustainable community principles.	– increased % of land developed or redeveloped using sustainable community principles.	Further study required	Further study required
	– public transit opportunities	– increase public transit opportunities	Fair	Fair
	– neighborhood mixture of jobs, shops and housing	– increase percentage of neighborhoods offering a mixture of jobs, shops and housing	Further study required	Further study required
	– density	– increase percentage of urban area that are high density	Further study required	Further study required

Comments on the 2002 Ratings

The ratings of “Fair” that have been assigned for the measure of public transit opportunities are based on the qualitative observation that currently, the public transit system within these watersheds is very underdeveloped. The existing condition of extreme traffic congestion on the 401, 407, and Highway 7 is evidence of a heavy reliance on the automobile as the primary means of transportation in this area. The rating of “Fair” suggests that considerable improvement to access and use of public transit and overall urban design to provide more opportunities for residents to adopt alternative means of transportation (e.g., biking, walking) is necessary to achieve the principles of Sustainable Communities in these watersheds.

During this reporting period no information has been collected to document the current condition of the remainder of these measures.

Overall ratings of “Fair” have been assigned to both the Duffins and Carruthers Creek watersheds based on a qualitative review of the limited amount of available information pertaining to the measures associated with this objective and the best professional judgement of TRCA staff.

3.0 Summary and Recommendations

The results of the watershed report card process for the Duffins and Carruthers Creek watersheds has provided an indication of “baseline” conditions with respect to the current level of achievement of the goals, objectives, and targets of the Duffins and Carruthers Creek Watershed Plan. These ratings will better enable progress to be monitored and evaluated in future report card processes. This rating process has highlighted the need for further data collection and analysis to provide the detail of information required to evaluate each watershed with respect to all of the indicators and measures that have been chosen for each objective of the plan. The following table (Table 3.0.1) provides a summary of the types of data collection and technical analysis that should be completed for these watersheds to provide the information needed to prepare the next watershed report card.

Table 3.0.1 Summary of Management Strategies and Ratings

TOPIC	GOAL		OBJECTIVES	RATINGS		
	Duffins	Carruthers		Duffins	Carruthers	
Surface Water Quantity	Good	Good	Objective #1	Maintain the existing water balance within the watershed	Good	Good
	To maintain the existing hydrologic function of the watershed.		Objective #2	Maintain or enhance baseflows.	Good	Fair
			Objective #3	Minimize or reduce risks to human life and property due to flooding	Good	Good
			Objective #4	Maintain or restore natural stream channel stability	Further study required	Further study required
Groundwater Quality and Quantity	Good	Fair	Objective #5	Maintain or enhance groundwater levels and baseflow for watershed functions	Good	Fair
	To protect groundwater quality and quantity		Objective #6	Protect groundwater quality to ensure provision of safe water supplies and ecological functions	Good	Good
			Objective #7	Ensure sustainable rates of groundwater use	Further study required	Further study required
Surface Water Quality	Fair	Fair	Objective #8	Manage the quality and quantity of run-off from rural and urban areas to maintain in-stream uses.	Good	Good
	To protect and improve surface water quality		Objective #9	Minimize in-stream sediment associated with construction activity.	Poor	Poor
			Objective #10	Reduce water quality contamination associated with wastewater discharges	Poor	Not applicable
Aquatic Habitat and Species	Good	Fair	Objective #11	Protect and restore native aquatic species and communities	Good	Fair
	To protect aquatic habitat and species		Objective #12	Protect and restore the riparian zone and associated functions	Fair	Fair
			Objective #13	Maintain or restore the natural variability of annual and seasonal stream flows	Further study required	Further study required
Terrestrial Habitat and Species	Good	Fair	Objective #14	Increase the percent natural cover to a quantity which provides targeted biodiversity and supports recreational uses	Good	Fair
	To protect and enhance terrestrial habitat and species		Objective #15	Protect the natural system quality and function from the influence of surrounding land uses	Fair	Fair
			Objective #16	Protect and restore all native vegetation community types and species to targeted levels	Further study required	Further study required

TOPIC	GOAL		OBJECTIVES	RATINGS		
	Duffins	Carruthers		Duffins	Carruthers	
Public Use - Recreation	Good	Poor	Objective #17	Create continuous watershed trails in the greenspace system linking Lake Ontario and the Oak Ridges Moraine	Fair	Fair
	To provide appropriate sustainable public use which promotes environmental awareness and enhancement		Objective #18	Manage the greenspace system for sustainable uses and public enjoyment	Good	Poor
			Objective #19	Improve greenspace accessibility while ensuring compatibility between social benefits and ecological health	Good	Poor
Human Heritage	Fair	Fair	Objective #20	Identify and document human heritage resources for protection	Fair	Fair
	To preserve and interpret our evolving human heritage resources		Objective #21	Increase awareness and appreciation of the inherent value of human heritage resources	Fair	Poor
			Objective #22	Apply a standardized approach to protecting human heritage resources at all levels of government	Fair	Fair
Sustainable Communities	Fair	Fair	Objective #23	Increase awareness of watershed issues and use of available watershed knowledge in decision making to foster sustainability and sustainable lifestyle practices	Further study required	Further study required
	To achieve a behavioural shift in lifestyles, community design and resource use in keeping with the environmental objectives for the watersheds		Objective #24	Promote lifestyles that are ecologically sustainable	Further study required	Further study required
			Objective #25	Use sustainable urban design approaches to guide urban growth and development	Fair	Fair

Table 3.0.2 Data and Information Needs for Future Reporting

Component	Areas for further study	Duffins	Carruthers
Surface Water Quantity	establish total annual infiltration rates by sub-catchment	completed	x
	collection and analysis of baseflow data at indicator sites	x	x
	documenting occurrences of flood events and ice jams	x	x
	erosion index technical analysis	x	x
	inventory of surface water withdrawals	x	x
	stream flow monitoring - average annual stream flow data	completed	x
	water budget analysis	completed	x
Groundwater	groundwater modelling and analysis	completed	x
	correlation of subsurface geology information with baseflow	x	x
	inventory of groundwater withdrawals	x	x
	establishing "sustainable" rates of groundwater withdrawal	x	x
	inventory of potential sources of groundwater contamination	x	x
	further correlation and analysis of groundwater quality data	x	x
Surface Water Quality	average annual loading values - TSS and TP	completed	x
	% of construction projects found to be in compliance with the new Municipal Erosion and Sediment Control By-law	x	x
	% of temporary sediment ponds checked annually	x	x
	% of temporary sediment ponds maintained as required	x	x
Aquatic Habitat and Species	establish an invertebrate index	x	x
	fluvial geomorphology assessment (percent in-stream woody cover and percent riffle substrate)	x	x
	water temperature monitoring and analysis	x	x
Terrestrial Natural Heritage	inventory and mapping of vegetation type and species diversity	x	x
	establish biodiversity indices	x	x
Recreational Use	% public greenspace maintained using an Environmental Management System approach	x	x
	% public greenspace maintained in naturalized conditions	x	x
	# of publically-accessible recreation facilities and destinations	x	x
Human Heritage	survey of public awareness and appreciation of human heritage resources	x	x
	survey of government agencies in support of a standardized approach	x	x
Sustainable Communities	survey on public awareness of watershed issues	x	x
	assessment of levels of participation in stewardship activities	x	x
	assessment of public transit use	x	x

Appendix A - SUPPORTING DOCUMENTS

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TRCA 2003, Duffins Creek Headwaters Management Plan.

TRCA 2003, Duffins Creek Marsh Restoration Plan.

TRCA 2003, Ratings Report for the 2002 Duffins and Carruthers Creek Watersheds Report Card.

TRCA 2003, Terrestrial Natural Heritage Program Methodology Report.

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