Palliser Creek
Bronze Level
Watershed Report Card

July 2000
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A Partnership Project of:
Palliser Creek Improvement Association
Quinte Conservation
Trout Unlimited, Many Rivers Chapter
Bay of Quinte Remedial Action Plan
ACKNOWLEDGEMENTS

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PALLISER CREEK BRONZE LEVEL WATERSHED REPORT CARD

INTRODUCTION
The Palliser Creek Improvement Association (PCIA) is a voluntary group of cooperating landowners dedicated to the natural rehabilitation of Palliser Creek and its watershed. Since its inception in 1991, PCIA and other watershed landowners have completed many projects to improve the quality of Palliser Creek. Projects include: planting of over 15,000 trees and shrubs; construction of a low level water machinery crossing and 4 bridges; rip rap erosion control projects; and restricting cattle access to the stream through installation of 3 cattle watering stations, and fencing at 7 sites.

Besides landowners, the projects have involved a variety of other partners. These consist of government agencies, service clubs, local schools and other community groups. It is estimated that PCIA and project partners have invested more than $35,000 in the improvement of the watershed.

During the summer of 1999, PCIA, in partnership with Quinte Conservation, the Bay of Quinte Remedial Action Plan, and the Many Rivers Chapter of Trout Unlimited, completed a Bronze Level Watershed Report Card for the Palliser Creek watershed. The Watershed Report Card provides an easy to use, 3 level, methodology for community groups or individuals to assess their watershed. The purpose of the Bronze Level is to map current conditions and identify potential problems affecting the health of the watershed. Silver and Gold Levels provide guidance on detailed assessments of watershed sensitivities and planning remediation, respectively. It is anticipated that the Palliser Creek Bronze Level Watershed Report Card will provide a basis for development of a comprehensive rehabilitation plan for this watershed.

In addition to completion of the Bronze Level Watershed Report Card, riparian habitats along the main branch of the stream were described and a survey of thermal stability was conducted. The riparian assessment was completed to provide more detailed information on the location and quality of riparian habitats. The thermal stability study measured summer water temperatures to estimate whether sites are capable of supporting cold, cool or warm water aquatic communities. It is expected that both surveys will augment the Bronze Level Watershed Report Card and assist in directing future restoration actions.

SITE DESCRIPTION
Palliser Creek is one of the most southerly tributaries of the Moira River. Located in Sidney Ward of the City of Quinte West and part of Thurlow Ward of the City of Belleville, this subwatershed has an area of 5,700 ha (Cairns 1983). From its headwaters near Frankford, Ontario, Palliser Creek travels east for approximately 18 km to Foxboro where it discharges into the Moira River (Cairns 1983).

The physical landscape was created by the Wisconsin glaciation, which dominated southern Ontario from around 75,000 B.C. until 12,000 B.C. (Chapman and Putnam
Moira River Basin Subwatersheds

1. Potter Creek
2. Moira River (Belleville - Plainfield)
3. Bell Creek
4. Blessington Creek
5. Busk Creek
6. Coffithville Creek
7. Palliser Creek
8. Chrysalis Creek
9. Number Ten Creek
10. Unnamed Creek
11. Main River (Plainfield - Stoico Lake)
12. Pasta Creek

Clare River Drainage Area
13. Clare River
14. Goose Creek
15. Morin Creek
16. Demaul Creek
17. Otter Creek
18. West Fork Otter
19. Strow Lake Area
20. Delphine Creek
21. Moira River (Tweed - Deloro)
22. Deep Lake Area
23. Mindo Creek
24. Jarvis Lake Area
25. Moira River (Above Deloro)
26. Growley Creek
27. Jordan River

Black River Drainage Area
28. Black River
29. Railway Creek
30. Queensborough Creek
31. West Black River
32. Nioan Creek
33. Ford Creek

Skootamata River Drainage Area
34. Skootamata River
35. Elyati Creek
36. Little Skootamata River
37. Finniver Creek
38. Finch Place Creek
39. Meriiff Creek

Legend

Palliser Creek Watershed within the Moira River Watershed

1: 125,000

Legend

Palliser Creek Watershed
Moira River Watershed
Sub Basin Boundary
Subwatershed Boundary located within each Sub Basin Boundary
Larg Watershed
River
Creek
1984). Consequently, the landscape in the watershed is characterised by glacial features, such as drumlins, eskers and relict shorelines of the glacial Lake Iroquois (Chapman and Putnam 1984). The principal soils are sand, sandy loam and clay. These are also remnants of the preceding glaciation.

The stream harbours a remnant brown trout population in its upper reaches (Robinson 1996). Coldwater areas, however, are highly restricted, with most of the stream being characteristic of a warmwater aquatic community. Previous studies have reported high nutrient and bacteria levels in surface waters (Anon. 1980, Cairns 1983, Brunatti 1992).

Current land use is primarily agriculture. There are also numerous rural residential zones along transportation corridors and various hamlets. In addition, a number of aggregate resource extraction operations are located in the watershed.

METHODS

Watershed Report Card

Mapping

Refer to Mason et al. (1998) for a full description of the Bronze Level Watershed Report Card protocol. The Bronze Level consists primarily of a mapping exercise to document current watershed conditions. Six overlay maps are produced at a common scale. Table 1 summarizes the content of each map and the information source. Refer to Appendix 1 for definitions of terms used in map legends.

The base map for overlays for this report card was derived from 1:50,000 topographic maps. Overlay maps were produced by either enlarging or reducing source maps with a photocopying machine to achieve a scale of 1:50,000, consistent with the base map. Refer to Appendix 1 for lists of air photos, Ontario Base Maps (OBM’s) and topographic maps that were used. A series of detailed field checks were completed to verify mapped data. These included windshield surveys and extensive field walks.

The mapped information was greatly augmented by PCIA members and interviews with other landowners. PCIA members and other landowners provided much valuable information that was not available elsewhere, such as agricultural land uses, tile drainage, location of springs, well water quality and recharge areas.

Identifying Potential Watershed Sensitivities

On each map, potential watershed sensitivities were identified or "flagged". Flags may be either site-specific or regional. Site-specific flags apply to a particular area. Regional flags apply to the whole watershed. Table 2 summarizes sensitivities assessed for each overlay.

Flags were tracked on Flagging Tally Sheets for each map. Flagging Sheets for each map, in the form of tables, are located both in the Results and Discussion section of this report and on the accompanying maps.
Table 1. Information mapped and data sources used to produce 6 overlay maps for the Palliser Creek Bronze Level Watershed Report Card.

<table>
<thead>
<tr>
<th>Overlay Map</th>
<th>Source of Data</th>
<th>Information Mapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Land Use</td>
<td>• Topographic maps • Air photo mosaics • Landowner interviews • Field walks</td>
<td>• Forest • Scrubland • Hay Crops • Hay/Pasture • Grassland • Conservation Tillage without rotation • Conservation Tillage with rotation • Conventional Tillage without rotation • Conventional Tillage with rotation • Wetland • Aggregate Extraction • Built-up Areas</td>
</tr>
<tr>
<td>Physical Landscape</td>
<td>• Topographic maps • Soil survey and physiography maps</td>
<td>• Soils • Areas sensitive to erosion (sandy loam soils with &gt;15% slope (based on Watershed Report Card guidelines)</td>
</tr>
<tr>
<td>Water Pathways and Storage</td>
<td>• Air photos • Topographic maps • Palliser Creek WATERSHED REPORT CARD Landscape Map • Questionnaire • Landowner interviews • Field walks</td>
<td>• Dams and flood control structures • Channelized sections • Hardened shorelines • Tile Drainage • Groundwater recharge and discharge areas</td>
</tr>
<tr>
<td>Plant and Animal Communities</td>
<td>• Air photos • Field walks • Whitehead and Jones 1998 • Palliser Creek Watershed Report Card Water Pathways and Storage Map</td>
<td>• Forest • Scrubland • Grassland • Crop land • Barren Land • Wetland • Deer yards • Rehabilitation sites • Watercourse barriers</td>
</tr>
<tr>
<td>Land Use Planning</td>
<td>• Twp. of Sidney and Thurlow Official Plans • Twp. of Sidney Zoning By-Laws • Palliser Creek Watershed Report Card Fragile Areas Map</td>
<td>• Areas of potential development • Areas sensitive to development</td>
</tr>
<tr>
<td>Fragile Areas Map</td>
<td>• Current Land Use Map • Landscape Map • Water Pathways and Storage Map • Plant and Animal Communities Map</td>
<td>• Historically important sites • Areas sensitive to erosion • Unusual geological features • Recharge areas • Discharge Zones • Low gradient meandering stream sections • Unique or important plant or animal communities/species</td>
</tr>
</tbody>
</table>
Table 2. Summary of site-specific and regional flags assessed for each map overlay for the Palliser Creek Bronze Level Watershed Report Card.

<table>
<thead>
<tr>
<th>Overlay Map</th>
<th>Site-Specific Flags</th>
<th>Regional Flags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Land Use</td>
<td>None</td>
<td>• &gt;30% of watershed is intensively developed</td>
</tr>
<tr>
<td>Landscape</td>
<td>None</td>
<td>• Watershed is located on the Canadian Shield</td>
</tr>
<tr>
<td>Water Pathways &amp; Storage</td>
<td>Water Quality</td>
<td>Surface Water</td>
</tr>
<tr>
<td></td>
<td>• Unserviced subdivisions; small towns; industrial parks</td>
<td>• &gt;5% of the watershed has hardened or straightened shorelines</td>
</tr>
<tr>
<td></td>
<td>• Waterfront development where lots are &lt;30m wide</td>
<td>• 1 or more dams present</td>
</tr>
<tr>
<td></td>
<td>• Development around a lake or other waterbody where there is &gt;1 tier of development</td>
<td>Groundwater</td>
</tr>
<tr>
<td></td>
<td>• Point source problems affecting water pathways and storage (ex. Pits/quarries below the water table; landfills; sewage or water treatment plant outfalls; storm sewer outfalls; uncontrolled manure storage; land uses contributing to increased erosion; removal of natural shoreline vegetation; lawns)</td>
<td>• Well water not drinkable in 1 or more wells</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Changes have occurred in area well and spring levels; wetland changes not caused by draining</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• &gt;30% of recharge and storage areas affected by land use</td>
</tr>
<tr>
<td>Plant and Animal Communities</td>
<td>• Major transportation corridors that cut off one natural plant community from another</td>
<td>&lt;70% of watershed has natural vegetation along banks</td>
</tr>
<tr>
<td></td>
<td>• Intensive agriculture without hedgerows</td>
<td>• &lt;50% of terrestrial vegetation communities are connected</td>
</tr>
<tr>
<td></td>
<td>• Steep or rugged topography without deep-rooted vegetation</td>
<td>• &gt;1 artificial aquatic barrier is present</td>
</tr>
<tr>
<td></td>
<td>• Wetlands that have been filled or drained; filled or altered near-shore habitat</td>
<td></td>
</tr>
<tr>
<td>Land Use Planning</td>
<td>• fragile areas that have not been protected from development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• plant and animal communities needing protection that have not been identified on municipal planning and zoning maps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• water pathways or recharge areas that have not been protected</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• conflicting land uses occurring in areas that are supposed to be protected</td>
<td></td>
</tr>
</tbody>
</table>

Community Values
A component of the Bronze Level Watershed Report Card includes identifying and assessing values and goals that are shared among community members for their watershed. To address this, a questionnaire was distributed to 8 P.C.I.A. members querying their views on the values of the watershed, concerns, and goals. The questionnaire also included a section on well water quality to assist with an assessment of potential groundwater quality sensitivities for the Water Pathways and Storage Map.
Riparian Buffers
Riparian buffers on the main branch of the stream were also assessed and described to supplement the Watershed Report Card mapping and a previous watershed study of forest cover and riparian habitat (Whitehead and Jones 1998). During field walks, the width of naturally vegetated riparian areas was estimated and the vegetation described. This information was compiled on a Vegetative Buffer Map.

Thermal Stability
A survey of the thermal stability of Palliser Creek was completed using the methods described by Stoneman and Jones (1996). All sample sites were at road crossings to facilitate easy and rapid access. Sites with flowing water during a July reconnaissance survey were identified for potential sampling. A total of 14 sampling sites were selected. Sites were selected to sample as many tributaries as possible, and several points along the main branch from headwaters to mouth. Water temperatures at sample sites were measured with a standard thermometer on the upstream side of the road. Sampling was completed by 2 crews on July 15, 1999 between 4:00 pm and 5:00 pm.

RESULTS AND DISCUSSION
Watershed Report Card
Current Land Use
Land uses are summarized in Table 3. The dominant land use is agriculture, which accounts for 44.6% of the watershed area. Agricultural land uses are detailed in Table 4. The most common agricultural land use practice was conventional tillage with rotation (58.7%). Just over 14% of agricultural lands were under conservation tillage, with or without rotation.

Table 3. Summary of Land Uses in the Palliser Creek Watershed, 1999.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Area (ha)</th>
<th>% Subwatershed Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>1043.8</td>
<td>28.3</td>
</tr>
<tr>
<td>Scrublands</td>
<td>225.2</td>
<td>6.1</td>
</tr>
<tr>
<td>Wetland</td>
<td>304.9</td>
<td>8.3</td>
</tr>
<tr>
<td>Grassland</td>
<td>220.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>1641.2</td>
<td>44.6</td>
</tr>
<tr>
<td>Aggregate Resource Extraction</td>
<td>44.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Built-up Areas</td>
<td>203.3</td>
<td>5.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3683.7</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4. Agricultural Land Uses in the Palliser Creek Watershed, 1999.

<table>
<thead>
<tr>
<th>Agricultural Land Use</th>
<th>Area (ha)</th>
<th>% of Total Agricultural Land Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay</td>
<td>7.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Hay/Pasture</td>
<td>51.0</td>
<td>3.1</td>
</tr>
<tr>
<td>Pasture</td>
<td>149.6</td>
<td>9.1</td>
</tr>
<tr>
<td>Conservation Tillage</td>
<td>42.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Conservation Tillage (Rotation)</td>
<td>196.3</td>
<td>12.0</td>
</tr>
<tr>
<td>Conventional Tillage</td>
<td>230.5</td>
<td>14.0</td>
</tr>
<tr>
<td>Conventional Tillage (Rotation)</td>
<td>963.6</td>
<td>58.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1641.2</td>
<td>99.9</td>
</tr>
</tbody>
</table>

Forest occupies 28% of the watershed. This figure is comparable with a study by Whitehead and Jones (1998), which calculated forest cover in this subwatershed as 29.6 ha.

About 8% of the watershed is wetland. Wetlands are areas where water is at or near the surface, with wet soils and characterized by plants adapted to wet conditions (MNR1993). There are several wetlands in the Palliser Creek watershed, however, only one, the Foxboro Swamp, has been evaluated. A portion of this Provincially Significant Wetland dips into the Palliser Creek watershed. More information is required on other watershed wetlands.

Built up areas comprise 5.5% of the watershed area. These consist primarily of residential developments, which are concentrated in the hamlets of Wallbridge, Chatterton and Foxboro. The remainder occurs along transportation routes. The Watershed Report Card suggests that when greater than 30% of a watershed is intensively developed, the impacts of this type of land use may have negative impacts. "Intensive development" is defined as urban development. Based on this definition, although the Palliser Creek watershed has some concentrations of residential development, there is no intensive development. Since intensive development in the Palliser Creek watershed was far below the 30% threshold, no regional flag was assigned.

Aggregate extraction occurs in 1.2% of the watershed. The largest reserves are located in Sidney Township in association with an esker ridge (Map 6). This consists of both primary and secondary aggregate deposits (Ontario Geological Survey 1987).

<table>
<thead>
<tr>
<th>Map Code</th>
<th>Watershed Report Card Concern</th>
<th>Flag Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development</td>
<td>Percent of watershed intensively developed: 0</td>
<td>No Flag</td>
</tr>
</tbody>
</table>
Physical Landscape
Soils in the Palliser Creek watershed are dominated by sandy loam (Map 2). Other soil types include loam, sand, clay, muck and gravel. The topography is predominantly flat to rolling, with approximately 20% of the watershed having steep or rugged slopes. Steep slopes were approximated from topographical maps as areas where contour lines were close together. Taking into account the soil types and the degree of slope, 13% of the watershed is fragile and sensitive to erosion. The Watershed Report Card classifies slopes sensitive to erosion as 5% or steeper for silt soils, 15% or greater for clay, 40% or greater for sand and gravel and greater than 50% for any soil type (Mason et. al. 1998). These areas are also mapped on the Fragile Areas Map.

Many of the notable features of Palliser Creek's physical landscape are associated with deposits of glacial origin. These include drumlins and remnants of a kame moraine and old shorecliff and beach system of Lake Iroquois (Brownell and Blaney 1995, Chapman and Putnam 1984). A portion of a major esker ridge also occurs in the watershed. It has been identified on the Fragile Areas Map as an important feature of the glacial landscape.

Because the Palliser Creek watershed is situated on underlying limestone bedrock, its soils and water have a greater ability to buffer acid rain than those on the Canadian Shield. For these reasons, the Palliser Creek watershed did not receive a regional flag for this attribute.

<table>
<thead>
<tr>
<th>TABLE 6. PHYSICAL LANDSCPASE REGIONAL FLAGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map Code</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Geology</td>
</tr>
</tbody>
</table>

Water Pathways and Storage
Surface Pathways and Storage
Palliser Creek has been highly altered, primarily by channelization. At least one third of the main channel and tributaries have been straightened to accommodate farming operations or drainage. Channelization has the effect of reducing stream length, decreasing aquatic habitat diversity, increasing flows during storm events, and accelerating sediment transport.

Some sections of the stream bank have also been hardened with rock or other materials. Shoreline hardening can alter fish and wildlife habitats and affect how water and sediments are transported in the channel. Natural shorelines provide wildlife corridors, feeding, nesting, cover and breeding areas for fish and wildlife. Shoreline hardening can result in the loss of these functions. Erosion can also be increased in other areas of the stream as a result of shoreline hardening.

The Watershed Report Card threshold for hardened and straightened shorelines is 5%. Since this threshold is exceeded in Palliser Creek, a regional flag was assigned.
Another impact to surface water pathways and storage is the presence of dams. There is one dam on Palliser Creek. A few individual property owners, however, hold water back temporarily in some areas by blocking culverts and by other methods (G. Post, pers. comm.). Dams can reduce downstream flows, trap sediments, elevate water temperatures and increase evapotranspiration. The Watershed Report Card specifies that a watershed with 1 or more dams should receive a regional flag.

Surface water quality can be affected by surrounding land uses, particularly in areas where riparian buffers are absent or inadequate to intercept nutrients and sediments. Site-specific flags have been given for areas of the stream where the natural vegetation has been removed or replaced by lawns, cultivated crops or cattle access is permitted. These include flags 2, 3 and 7 to 16. Previous studies have indicated that surface water quality is impaired in Palliser Creek (Brunatti 1992, Blamire 1998). High nutrient and bacteria levels were attributed to cattle access and runoff from fields and pastures (Brunatti 1992).

**Groundwater Recharge, Storage and Discharge**

Because sandy loam deposits dominate the region, virtually the entire watershed is a potential zone of groundwater recharge (Map 3). A confirmed groundwater recharge area is identified on Map 3 as a flood storage zone along the main channel of the stream at Lot 11, Concession V, Sidney Ward. At this point, water in the channel appears to flow underground during summer low water levels and reemerge as springs at Lot 14.

A number of land uses in the watershed potentially affect groundwater recharge and storage. The area affected, however, is estimated to be less than the 30% threshold identified by the Watershed Report Card as a concern for the watershed. Built-up areas, such as the hamlets of Wallbridge and Chatterton, have a higher proportion of surfaces that are impervious to water infiltration than less intensively developed areas. Impervious surfaces, including roads, paved driveways and roofs, prevent water from entering the groundwater table. Tile drainage in some areas of the watershed may have a similar effect by piping water directly off fields, rather than permitting infiltration through the soil. Other agricultural practices may result in soil compaction, which would also decrease the amount of precipitation that reaches groundwater reserves.

Some land uses increase surface evaporation. Excavation below the water table at one gravel pit has resulted in a pond (Site Specific Flag #6, Map 3). There are also a number of artificial reservoirs, in-stream ponds and ponds adjacent to the stream that contribute to greater evaporation rates in the watershed (Site Specific Flag #4 and 5 on Map 3).

Discharge areas consist of wetlands, as well as a considerable number of springs. There are several wetlands in the watershed. Springs that were identified were located primarily along the headwaters of a southeast tributary near Wallbridge. A few other
springs were mapped along the main branch of the stream, west of Rose Road. Although more springs may be present in the watershed, no others were identified in the field or by PCIA members. Spring sources in the Oak Hills also contribute to the hydrology of the Palliser Creek watershed. Field checks also revealed the presence of watercress at certain points along the channel. Watercress is often associated with groundwater upwellings.

**Quality of Groundwater**

Insufficient information was collected on area wells to assess groundwater quality for the watershed. Of the 5 questionnaires that were returned, only 1 reported unpotable well water. Some reports of poor groundwater quality have been documented in well drillers’ records (Bengert 1993). The Watershed Report Card threshold for groundwater quality is 1 or more wells with unpotable water. A regional flag was therefore assigned for the Palliser Creek watershed.

Land uses can also affect the quality of groundwater. Rural subdivisions and other rural residences that rely on private septic systems and wells have the potential to degrade groundwater quality. Consequently, the hamlets of Wallbridge and Chatterton have been assigned a site-specific flag (Flag WQ#1 and WQ#2, Map 3).

**Groundwater Quantity**

Results of the questionnaires indicated that well levels did not fluctuate, however, there were only 5 respondents. A hydrogeologic study prepared for Sidney Township determined that the static groundwater level is between 0 to 40 ft. (Bengert 1993). While this suggests a large quantity of groundwater available in the watershed, the degree to which these water levels change is unknown.

<table>
<thead>
<tr>
<th>Map Code</th>
<th>Watershed Report Card Concern</th>
<th>Palliser Creek Flag Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water #1</td>
<td>Percent of watershed hardened or straightened: 33</td>
<td>Flagged</td>
</tr>
<tr>
<td>Surface Water #2</td>
<td>Number of dams: 2</td>
<td>Flagged</td>
</tr>
<tr>
<td>Ground Water #1</td>
<td>Number of area wells identified as contaminated: 1</td>
<td>Flagged</td>
</tr>
<tr>
<td>Ground Water #2</td>
<td>The levels of the following groundwater bodies are affected in the following ways:</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Levels Up</td>
<td>Levels Down</td>
</tr>
<tr>
<td></td>
<td>Wells</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Springs</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Wetlands</td>
<td>Unknown</td>
</tr>
<tr>
<td>Ground Water #3</td>
<td>Percent of recharge and storage area affected by land use: &lt;30%</td>
<td>No Flag</td>
</tr>
</tbody>
</table>
**TABLE 8. WATER PATHWAYS AND STORAGE SITE SPECIFIC FLAGS**

<table>
<thead>
<tr>
<th>Flag # on Map 3</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Quality 1, 2</td>
<td>Hamlets of Chatterton and Wallbridge serviced by private septic and wells</td>
</tr>
<tr>
<td>2, 3, 14</td>
<td>Cattle have access to the stream.</td>
</tr>
<tr>
<td>4</td>
<td>Artificial in-stream pond.</td>
</tr>
<tr>
<td>5</td>
<td>Artificial pond adjacent to the stream.</td>
</tr>
<tr>
<td>6</td>
<td>Pond in an aggregate resource removal zone.</td>
</tr>
<tr>
<td>7, 8, 11</td>
<td>Maintenance of lawns may result in increased speed and volume of overland runoff.</td>
</tr>
<tr>
<td>1, 2, 9, 10, 12</td>
<td>Cultivation adjacent to the creek has caused removal of vegetative buffer, which may result in increased overland runoff.</td>
</tr>
<tr>
<td>15</td>
<td>Topsoil has been excavated and remaining sediment has not been vegetated and is susceptible to erosion.</td>
</tr>
<tr>
<td>16</td>
<td>Trees have been removed along a length of creek, thereby reducing the quality of the vegetative buffer.</td>
</tr>
</tbody>
</table>

**Plant and Animal Communities**

The most abundant natural community in the Palliser Creek watershed is forest. Approximately 28.3% of the watershed is forested. This is slightly below the level of 30% forest cover recommended to ensure the persistence of bird species that require interior forest habitats for breeding (Environment Canada et. al. 1998). Whitehead and Jones (1998) in their analysis of forest habitat in the Palliser Creek watershed, recommended that reforestation efforts to achieve the 30% target should be directed towards areas that would link existing forest patches and increase the area of interior forest habitat. Effort should also be directed at protecting existing woodlands to achieve and maintain the 30% target of forest cover.

Some of the woodlands in the watershed have been recognized for their special features. One of these woodlands is the Palliser Creek Drumlin Forest. The Palliser Creek Drumlin Forest is a woodland located on a twin drumlin in the south portion of Lots 7 to 10, Concession 5 in Sidney Ward (Ellis 1994). It has been recognized as a Site of Biological Interest by the Ministry of Natural Resources.

Another significant woodland is the 200 ha Stirling Slope Complex located on Lots 7 to 12, Concession 6 and Lots 8-14, Concession 7, Sidney Ward. A portion of this natural area extends into the northwest section of the watershed and is connected to a larger forest patch. The Stirling Slope Complex has been recommended to be designated as a provincially significant Area of Natural and Scientific Interest because of the special
features present. These include a high quality upland forest, several rare plants and provincially rare vegetation communities, such as Black Oak Savanna, White Oak-Red Oak Savanna and Spicebush Ravine (Brownell and Blaney 1995).

In addition to forest habitats, this natural area also includes prairie vegetation. A small tract of prairie has also been noted at Lot 13 Conc 6, but has not been inventoried. Prairie historically covered large tracts of southern Ontario, with the easternmost prairies extending to this region. Presently, less than 3% of original Ontario prairie habitats exist (Rodger 1998).

The Palliser Creek watershed also has woodlands that are important because of their size and contiguity. Large, uninterrupted forest habitats are critical to maintain populations of many plants and wildlife, such as birds that only nest a minimum of 100 m from a forest edge, and several mammal species with large home ranges (Larson et al. 1999, Environment Canada et. al. 1998). Forest patches greater than 100 ha and interior forest habitat in the Palliser Creek watershed have been identified by Whitehead and Jones (1998). These woodlands, at a minimum, should be protected through stewardship and municipal land use planning to maintain one component of the ecological integrity of the watershed. Forests over 100 ha and containing interior habitat have been mapped on the Palliser Creek Watershed Report Card Fragile Areas Map.

Approximately 8.3% of the watershed consists of wetlands. Wetland cover greater than 6% in a subwatershed is recommended to maintain water quality and other beneficial wetland functions (Environment Canada et. al. 1998). Wetland protection is a priority for the Palliser Creek watershed. Restoration of wetland habitat is recommended for watersheds that have less than the area suggested by Environment Canada et. al. (1998).

Wetlands can be protected through private stewardship and municipal land use planning. Wetland protection through land use planning requires that the area be identified in planning documents. Typically, this is facilitated by the wetland being mapped and assessed using the Ontario Wetland Evaluation System (Ministry of Natural Resources 1993). The wetland evaluation provides a broad baseline inventory of wetland features and functions. Of the major wetlands in the Palliser Creek watershed, only one of these wetlands has been evaluated and recognized in Official Plans, the provincially significant Foxboro Swamp. Some unevaluated wetlands have also been identified in the South Sidney Township Secondary Plan. Wetland evaluations would help to confirm wetland boundaries, assess their relative values, and provide a basic inventory.

A previous study determined that 69.59% of the creek possesses a forested buffer of at a minimum of 30 m width on at least one stream bank. Since this approaches the Watershed Report Card threshold of 70% natural vegetation along stream banks, no regional flag has been assigned for this concern. Although this issue has not been
flagged, riparian restoration would benefit marginal cold and cool reaches of the stream by providing shade and possibly extending the area of these types of stream habitat. Since much of the main branch of the stream has less than a 30 m buffer on either bank, reforestation of these sections would also help to improve water quality and the connectivity of habitats along this natural wildlife corridor.

Connectivity of terrestrial and aquatic habitats has been flagged as a concern for the Palliser Creek watershed. In combination with rehabilitated areas, only 37.7% of terrestrial communities were contiguous. This is below the Watershed Report Card threshold for this regional flag of 50% connected terrestrial habitats. This is an indication that habitats, including forest, scrub land and wetland, are fragmented. Fragmentation of habitats can result in increased predation and nest parasitism, decreased variety of plants and animals, and increased generalist species that are tolerant of disturbance (Riley and Mohr 1994).

Aquatic connectivity was also interrupted, primarily by beaver dams, natural log jams and parts of the watercourse that are seasonally dry. Human-related barriers include bridge pilings and a water control dam located on the tributary on Lot 35, Thurlow Ward. As a result of these barriers, the watershed contains 10 disconnected aquatic areas. These barriers affect the movement of aquatic species, such as fish. Because some of these barriers are caused by human activity, a regional flag has been identified.

Additionally, there are some potential thermal barriers, as revealed by the thermal stability study. Species like Brown Trout are restricted to coldwaters that do not experience large temperature fluctuations (Stoneman and Jones 1996). Warmwater portions of the channel are an obstacle to their movement.

<table>
<thead>
<tr>
<th>TABLE 9. PLANT AND ANIMAL COMMUNITIES REGIONAL FLAGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map Code</td>
</tr>
<tr>
<td>Connectivity #1</td>
</tr>
<tr>
<td>Connectivity #2</td>
</tr>
<tr>
<td>Connectivity #3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 10. PLANT AND ANIMAL COMMUNITIES SITE SPECIFIC FLAGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flag # on Map 4</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>
Landuse Planning
The Palliser Creek watershed is affected by the land use planning policies of 2 municipalities, the City of Quinte West and the City of Belleville. The City of Quinte West represents a recent amalgamation of the former City of Trenton, Village of Frankford, Sidney Township and Murray Township. The City of Belleville is also a newly amalgamated municipality consisting of the City of Belleville and Thurlow Township. Both Quinte West and Belleville are in the process of updating their Official Plans. The Official Plans will provide a long-term framework for guiding development and land uses in the municipalities. PCIA has an excellent opportunity to influence future land use planning decisions in the watershed by participating in this process.

Until the new Official Plans and Zoning By-Laws of each municipality are completed and approved, the existing planning documents for Sidney and Thurlow Townships continue to apply. These include The Corporation of the Township of Sidney Official Plan (1994), The Township of Sidney Zoning By-Law (1996), The Corporation of the Township of Thurlow Official Plan for Part of the Township of Thurlow (Office Consolidation- October 1991) and The Corporation of the Township of Thurlow Comprehensive Zoning By-Law No. 3014 (1987). In many instances, sensitive or significant features of the watershed that have been identified in the Current Land Use, Landscape, Water Pathways and Storage, and Plant and Animal Communities Maps are not adequately recognized or protected in municipal documents. The Land Use Planning Map of this Bronze Level report (Map 5) shows site specific flags associated with land use planning issues. The Fragile Areas Map (Map 6) also shows areas, such as wetlands, springs, recharge zones, slopes sensitive to erosion, and significant vegetation communities, that may be sensitive to development or certain land use activities.

Only one Provincially Significant Wetland in the watershed, the Foxboro Swamp, has been identified as wetland in planning documents. Other wetland areas are usually identified as Environmental Protection, which provides some protection, but may not be sufficient to protect the values and functions of these features. Potential Estate Residential development has been designated near some wetland areas (Map 5, Site Specific Flag 5). In addition, lands adjacent to the wetland at the headwaters of the stream and on Lot 19, Concession 6, Sidney Township, are designated as an Aggregate Resource Extraction area (Map 5, Site Specific Flag 1). These areas should be subject to land use planning policies that would ensure consideration of potential impacts of development on these features.

Springs have not been explicitly identified in planning documents. Springs within the watershed are generally located within Environmental Protection designations when they occur near the channel. In other areas, springs occur in areas designated as agricultural. These designations and a 15 m setback from watercourses specified in Zoning By-Laws may not be sufficient to maintain the integrity of these springs. These sites must be identified on planning documents and appropriate policies developed to
ensure that these resources are protected and maintained. Areas with springs have been assigned a site-specific flag in Map 5- Land Use Planning (Flags 4, 6, and 7).

A significant recharge zone at Lot 12, Concession 5, Sidney Ward, is not identified on planning documents (Map 5, Site-Specific Flag 3). This area should be recognized and subject to appropriate planning policies in order to protect groundwater resources.

Besides wetlands, other natural features are not adequately protected or identified in planning documents. Although the Palliser Creek Drumlin Forest and the Stirling Slope Complex are recognized in the Sidney Official Plan, planning policies are unlikely to be sufficient to protect these features. In some areas, Aggregate Resource and Potential Estate Residential designations overlap with these natural areas. In addition, policies and designations relating to significant woodlands and wildlife habitats are absent from planning documents. At a minimum, largest forest patches and woodlands with special features should be identified in planning documents. Criteria for identifying significant woodlands is also being developed by the Bay of Quinte Remedial Action Plan as part of a Natural Heritage Strategy for several municipalities, including the Palliser Creek area. The updated Official Plans for Quinte West and Belleville should address these issues in order to comply with the Provincial Policy Statement, which identifies protection of significant woodlands and wildlife habitats.

Slopes sensitive to erosion are shown on Map 5: Land Use Planning and Map 2: Landscape. Because of their relief, these regions should be protected from development that could result in erosion and sediment discharge to Palliser Creek. Increased erosion could negatively impact downstream reaches of Palliser Creek. The slope south of Wallbridge has received a Site Specific Flag (Map 5: Land Use Planning, Flag 5). These areas have not been identified in planning documents.

<table>
<thead>
<tr>
<th>Flag # on Map 5</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wetland zone that is adjacent to a potential estate residential zone.</td>
</tr>
<tr>
<td>2</td>
<td>Wetland ponds located at headwaters that are adjacent to a potential aggregate resource removal zone</td>
</tr>
<tr>
<td>3, 4</td>
<td>Zones of spring discharge that require protection from certain types of development.</td>
</tr>
<tr>
<td>5</td>
<td>High relief zone located south of Wallbridge.</td>
</tr>
</tbody>
</table>

**TABLE 1: LAND USE PLANNING SITE SPECIFIC FLAGS**

**Community Values**

Stakeholders within the Palliser Creek watershed recognise various aspects of the watershed to be of value. Based on the questionnaire results, values may be dependent upon the requirements individuals have for the resources, such as water for agricultural or residential uses. Beyond its functional value to humans, the value of the
watershed may be seen in terms of the habitat it provides for wildlife. Some landowners see value in the watershed features as an educational tool where students can discover and learn. Finally, the value of the watershed may relate to factors such as recreation or scenery.

There are certain concerns that relate to these values. Based on the results of the questionnaire, concerns include erosion, impacts of residential developments and other land uses, as well as water quality. In addition, some landowners have concerns relating to issues concerning cattle access to the creek. The concerns of the respondents have generally not changed since initial attempts to improve the quality of Palliser Creek. However, certain views have expressed an interest in recognising and addressing watershed quality at a broader scale. The objective, therefore, would be to understand linkages between concerns at a range of scales. For example, some researchers have sought to recognise how drainage patterns at the farm or micro-scale can be related to the hydrological system at the landscape scale (Spaling and Smit 1995).

The respondents had certain longer term objectives. These included a general objective to maximise the contribution of the watershed to the quality of life. More specific objectives involved increasing the use of conservation tillage methods, improving water quality and stabilising thermal regimes by enhancing riparian buffers. Concern for the watershed was linked by the respondents to community issues, such as development pressures. In order to assist in reconciling community issues with watershed concerns, the respondents suggested that communication between grassroots organizations and administrative bodies be maintained and improved.

**Riparian Buffers**

Results of the riparian survey are shown and described on Map 7- Vegetative Buffer and Appendix 1. The nature of the buffer along the main channel varies considerably. Few stream sections had buffers 30 m or greater and there were many extensive areas with less than 5 m of natural vegetation. Riparian vegetation was predominantly grasses, particularly in the lower reaches.

Environment Canada et. al. (1998) recommends naturally vegetated riparian zones of 30 m or greater to provide water temperature moderation, organic inputs, erosion control, wildlife corridors and to prevent sediments and nutrients from entering the stream. Riparian vegetation is most important on first to third order streams, which are streams that occur at or near headwaters, and are characterized by low flow and narrow widths (Environment Canada 1998). First order streams are headwater streams. The convergence of 2 first order streams is classified as a second order stream and a third order stream is the convergence of 2 second order streams. Stream order does not increase with convergence with a lower order stream (ie. a second order stream receiving a first order stream would be classified as second order). As stream order increases, flow and width tends to increase. Since Palliser Creek consists of stream
orders one through 3, the majority of the drainage network would benefit from riparian restoration.

Riparian restoration should target on reconnecting cold/cool water reaches and areas where existing buffers are insufficient to mitigate adjacent land uses or less than 30 m. This includes residential lawns, pasture or feed lots, and agricultural fields. This would also build on actions already taken by PCIA, such as fencing of cattle, tree planting along the stream and construction of cattle and machinery crossings.

**Thermal Stability**

Maximum daily air temperatures on the preceding 2 days of the survey were 26.5°C on July 13, 1999 and 28.0°C on July 14. The day of the survey, July 15, maximum daily air temperature was 30.0°C.

Of the 14 sites sampled for thermal stability, 1 location had coldwater characteristics (Station 2), 4 were classed as coolwater (Stations 1, 3, 4 and 11), 2 were marginal coolwater sites (Stations 5 and 8) and the remainder were warmwater (Stations 6, 7, 9, 10, 12, 13, 14) (Table 5 and Figure 2). The single coldwater site occurred near the headwaters of the main branch, just downstream of spring inputs. The only other coolwater site on the main branch was located a short distance downstream from Station 2 at Rose Road. The next sampling station on the main branch, Station 7, was warmwater. Other coolwater sites occurred near the headwaters of tributaries.

Vegetative buffers between Station 2 and 7 are predominantly grasses with some trees and less than 5 m wide. Riparian restoration along this reach to increase forest cover and buffer width may help to extend cold and coolwater habitats. Similarly, riparian restoration in other areas along the tributaries where coolwater or marginal coolwater habitats were identified may enhance the thermal stability of these habitats and increase brown trout habitats.

Sites where coolwater or marginal habitats were identified, but riparian vegetation was absent or minimal at the site and upstream, may be an indication of springs that have not been identified by this Watershed Report Card. Further investigation may reveal other spring sources. This applies particularly to Station 11, where riparian vegetation was absent, and no flow was observed further downstream. In addition, sampling of the thermal regime at stations along the tributary located east of Wallbridge may identify more cold or coolwater habitats, since many springs have been identified here.
Figure 2. Thermal stability of 14 stations on Palliser Creek and its tributaries sampled on July 14, 1999.

Thermal Regime
- Warm Water
- Warm/Cool Water
- Cool Water
- Cold Water
Table 12. Water temperatures at 14 sites along Palliser Creek on July 15, 1999 and their thermal classification.

<table>
<thead>
<tr>
<th>Station No.</th>
<th>Water Temperature (°C)</th>
<th>Thermal Stability Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>Cool</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>Cold</td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>Cool</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
<td>Cool</td>
</tr>
<tr>
<td>5</td>
<td>23</td>
<td>Warm/cool</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>Warm</td>
</tr>
<tr>
<td>7</td>
<td>24</td>
<td>Warm</td>
</tr>
<tr>
<td>8</td>
<td>23</td>
<td>Warm/cool</td>
</tr>
<tr>
<td>9</td>
<td>27</td>
<td>Warm</td>
</tr>
<tr>
<td>10</td>
<td>26</td>
<td>Warm</td>
</tr>
<tr>
<td>11</td>
<td>22</td>
<td>Cool</td>
</tr>
<tr>
<td>12</td>
<td>25</td>
<td>Warm</td>
</tr>
<tr>
<td>13</td>
<td>28</td>
<td>Warm</td>
</tr>
<tr>
<td>14</td>
<td>25</td>
<td>Warm</td>
</tr>
</tbody>
</table>

**RECOMMENDATIONS AND TARGETS**
The Palliser Creek Bronze Level Watershed Report Card has identified potential problems in the watershed at a regional and site specific scale. The following are general recommendations and targets that can be used as a guide for directing future actions of P.C.I.A. to address many of the problems identified. Recommendations relate primarily to regional flags, but in some cases may be at least partially addressed by remediation of site-specific flags. Some recommendations require further investigation of identified problems, using tools, such as the Silver Level Watershed Report Card, while others may be implemented in the short term.

**Water Pathways and Storage**
1. Further channelization of the stream should be discouraged by relevant review agencies, including the Conservation Authority, Ministry of Natural Resources and Department of Fisheries and Oceans, and PCIA.

2. Impacts of channelization on stream features, such as aquatic habitat diversity, and baseflow, should be investigated. The information gained can be used to plan, design and implement remedial actions to improve in-stream habitats. It will also provide a measure of baseline conditions that can be used to assess the effects of restoration actions.

3. Stream habitat restoration should be linked to fish community targets and watershed characteristics. More detailed information on the existing fish community is needed, as well as other stream features, such as baseflow, annual flow, substrates, etc. is needed to be able to set realistic, achievable goals for stream habitat rehabilitation.
4. Stream habitats should be restored and enhanced as opportunity permits. This may include natural channel design to restore meanders, pools, riffles and other features, retrofits of channelized sections to improve habitat diversity, or other approaches.

5. Further damming of the stream should be discouraged by relevant review agencies, including the Conservation Authority, Ministry of Natural Resources and Department of Fisheries and Oceans, and PCIA.

6. Surface water quality should continue to be monitored to re-evaluate surface water quality and assess the effects of previous and future remedial actions.

7. In-stream ponds should be discouraged by relevant review agencies, including the Conservation Authority, Ministry of Natural Resources and Department of Fisheries and Oceans, and PCIA.

8. Relevant review agencies, including the Conservation Authority, Ministry of Natural Resources, municipalities, and PCIA, should ensure that activities that have the potential to increase evapotranspiration or intercept groundwater are assessed and mitigation developed to avoid impacts to the groundwater regime and stream hydrology. Examples of mitigation include stormwater management for development proposals, best management and/or innovative practices for tile drains, and restriction of aggregate activities above groundwater levels.

9. PCIA should encourage municipalities and relevant agencies to inventory groundwater resources. Insufficient information was available to assess groundwater quality and quantity on a watershed basis. In addition, although only one recharge area was confirmed, a large proportion of the watershed has the potential to provide recharge functions. More detailed knowledge of recharge areas would assist in protecting critical areas and assessing impacts of development proposals.

10. Agricultural Best Management Practices should be encouraged and promoted to maintain and protect surface and groundwater quality, such as conservation tillage, livestock fencing, riparian buffers, tile drain mitigation, etc. Several site-specific flags were identified on Map 3 - Water Pathways and Storage, where remedial action would be expected to contribute to water quality improvements.

Plant and Animal Communities

1. Private stewardship of natural features in the watershed, such as forests, wetlands, stream buffers, wildlife corridors and special habitats, should be encouraged and promoted. Besides protection of these features, stewardship could also include actions to enhance or restore natural heritage values. Examples of actions include fencing livestock out of forests and wetlands, wetland buffers, creation or
enhancement of fencerows, retirement of fragile lands, as well as implementation of the suggested targets listed below.

2. Restoration of riparian habitats should be encouraged and promoted. Suggested priorities include areas of cold and cool water habitats, the main branch of the stream, and areas where existing buffers are unforested and/or less than 30 m. A suggested target is 70% of the main branch with a forested riparian buffer at least 30 m wide on one or both banks.

3. Re-connection of fragmented habitats should be encouraged and promoted. This can be achieved through in-filling of forests, riparian restoration, and creation or restoration of other types of habitats to link existing natural areas. The Watershed Report Card suggests a target of a minimum of 50% connected terrestrial habitats.

4. Rehabilitation, creation and inventory of other specialized habitats, such as prairie, should be encouraged and promoted at appropriate locations to enhance and restore the biodiversity of the watershed.

5. A target of achieving and maintaining 30% forest cover is recommended. In addition a target of maintaining forest patches greater than 100ha or with interior forest habitat is suggested.

6. A target of maintaining existing wetland habitat is recommended.

7. A target of maintaining and expanding rare vegetation communities, such as prairie is recommended.

**Land Use Planning**

1. Wetlands should be evaluated using the Ontario Wetland Evaluation System (MNR 1993) to provide baseline information on these sites and to facilitate protection through municipal planning. Wetlands located in areas where potential for development has been identified should be prioritized for evaluation.

2. Known sensitive groundwater resources, including springs and recharge areas, should be identified in municipal planning documents and subject to appropriate policies to protect the quality and quantity of groundwater in the Palliser Creek watershed.

3. Significant natural features in the watershed should be identified in municipal planning documents and subject to appropriate policies to protect the area and functions of these features. Protection of significant wetlands, habitat of threatened and endangered species, ANSI's, woodlands, valleylands and wildlife habitat by municipalities is consistent with the Provincial Planning Statement. Existing municipal planning documents do not protect the full range of natural heritage features referenced in the Provincial Planning Statement.
4. Areas identified as slopes sensitive to erosion should be identified in municipal planning documents. These slopes should be subject to appropriate land use designations and policies to regulate future development in these areas that would result in erosion and sediment discharge to the stream.

5. PCIA should formally review and participate in the Official Plan updates for the City of Quinte West and the City of Belleville to ensure that land use planning concerns for the watershed are addressed.

6. PCIA should provide input to development of the Natural Heritage Strategy being prepared for the City of Quinte West, the City of Belleville and Campbellford/Seymour/Percy/Hastings. The Natural Heritage Strategy is an initiative of the Bay of Quinte Remedial Action Plan, Lower Trent and Quinte Conservation Authorities, participating municipalities and other partners. The intent of the initiative is to provide a tool for identifying and protecting significant natural features, and connections between them, through municipal planning, stewardship and rehabilitation. The process includes an opportunity for input from interest groups.

REFERENCES


Ellis, S. 1994. Selected significant features of the Oak Hills study area. Planning Department, Township of Sidney.


Robinson, R. 1996. Aquatic habitat resource inventory of Palliser Creek. Palliser Creek Improvement Association and Moira River Conservation Authority.


Stoneman, C.L. and M.L. Jones. 1996. A simple method to evaluate the thermal stability of southern Ontario trout streams. Fisheries and Oceans Canada and Ontario Ministry of Natural Resources. Habitat Management Series.

APPENDIX 1
Definitions of Map Legends

Map 1: Current Land Use

**Forest:** Natural wooded area that includes a variety of tree species and other vegetation.

**Scrubland:** Refers to land that has been taken out of agricultural use and is gradually returning to a natural community. Usually has sparsely spaced trees and mixed shrubs and grasses.

**Conservation Tillage:** Tillage practices that leave some or all of the previous crop residue on the soil surface. Conservation tillage methods include mulch tillage, no till and ridge tillage.

**Conventional Tillage:** These tillage practices do not leave any of the previous crops residues on the soil surface.

**Rotation:** A farming system in which a systematic succession of different crops is grown on the same piece of land so that the maximum use is made of soil nutrients but soil fertility is not exhausted (Clark 1990).

**Hay:** The stems and leaves of grasses cut and used as fodder.

**Pasture:** Land covered with growing grass and/or other herbs on which livestock can feed (Clark 1990).

**Wetland:** A natural or artificial landscape in which fresh or salt water plays a key role and where the water table is at or near the surface or the land is covered occasionally, periodically or permanently by shallow fresh or salt water (Clark 1990)

**Areas of Natural and Scientific Interest:** Areas selected and assessed by the Ministry of Natural Resources to be the best and most representative examples of the full range of ecological landscapes and communities in Ontario.

Map 2: Physical Landscape (Bates and Jackson 1984)

**Clay:** An earthy, extremely fine-grained sediment or soft rock composed primarily of clay-size (diameter of less than 1/256 mm) or colloidal particles.

**Muck:** Dark, decomposed organic matter, intermixed with a high percentage of silt.

**Loam:** A rich, permeable soil composed of a mixture of clay, silt, sand and organic matter.
Sandy Loam: This is a mixture of approximately 50-6-% sand, 15-20% clay and 0-50% silt.

Gravel: An unconsolidated natural accumulation of rounded fragments, mostly particles larger than sand (diameter greater than 200 mm), such as boulders, cobbles, pebbles, granules or any combination of these.

Esker: A serpentine ridge of roughly stratified gravel and sand that was deposited by a stream flowing in or beneath the ice of stagnant or retreating glacier and was left behind when the ice melted.

Sensitive to erosion: Areas particularly susceptible to the wearing away of soil and rock by weathering, mass wasting and the action of forces exerted by elements such as streams.

Map 3: Water Pathways and Storage
Groundwater Recharge: Area where groundwater seeps into the ground. Usually associated with sand and gravel deposits or highly fractured rock such as limestone.

Groundwater Discharge: Area where the water table comes to the surface to feed surface rivers, lakes, wetlands and other water bodies.

Groundwater Storage: This involves aquifers, which are bodies of rocks such as sandstone that are sufficiently permeable to conduct groundwater.

Tile Drains: Drainage system in which underground pipes drain waters from agricultural lands, thus allowing farmers to plant their crops earlier in the spring. This type of drainage is commonly used in agricultural areas with clay or peat soils.

Hardened or Straightened Shorelines: Hardened shorelines include sections of the streambank that have been reinforced with rock, concrete, steel or other materials in place of natural vegetation. Straightened shorelines refers to those that have been channelised.

Groundwater Quality: Drinkability of groundwater.

Groundwater Quantity: Refers to the stability of local groundwater levels.

Map 4: Plant and Animal Communities
Grassland: Includes natural grasslands, as well as pasture, hay and forage production.

Forest: Natural wooded area the includes a variety of tree species and other vegetation.
**Scrubland:** Refers to land that has been taken out of agricultural use and is gradually returning to a natural community. Usually has sparsely spaced trees and mixed shrubs and grasses.

**Crop Land:** Land currently being tilled often with a single crop planted in rows with bare ground between.

**Barren Land:** Land without any vegetation. This includes rock outcrops, mine tailing areas and aggregate resource sites.

**Rehabilitation Tree Planting:** Refers to the areas where tree planting has occurred to return an area to a natural or healthy state.

**Map 5: Land Use Planning**

**Potential Estate Residential Development:** Based on the Official Plan of Sidney Township, lands that are intended for low density single family residential use. Development is limited to those areas possessing substantial physical attributes, such as gently rolling topography, scenic vistas, well wooded areas, adjacent valley lands or other aesthetic qualities (The Corporation of the Township of Sidney 1994).

**Potential Aggregate Resource Extraction:** These areas of significant aggregate resources where the predominant use of the land shall be for the extraction and processing of raw materials from the earth (The Corporation of the Township of Sidney 1994).

**Potential ANSI:** These have been recognised in the Official Plan for the Township of Sidney as areas that are being considered by the Ministry of Natural Resources for ANSI designation, or that have been recommended for ANSI designation through Environmentally Significant Areas Studies.
APPENDIX 2

Mapping Resources used for Completion of Palliser Creek
Bronze Level Watershed Report Card

Coloured Air Photos (1992)
Moira River Conservation Authority
Scale= 1:15,000

<table>
<thead>
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<th>Line</th>
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<td>6</td>
<td>180, 182, 183</td>
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<td>7</td>
<td>208, 210, 212</td>
</tr>
<tr>
<td>8</td>
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Ontario Base Maps
Scale= 1:10,000

| 1018 2900 48950 |
| 1018 2950 48950 |
| 1018 2950 49000 |
| 1018 3000 48950 |
| 1018 3000 49000 |
| 1018 3050 49000 |

Topographic Maps
Scale= 1:50,000

| 31C/3, 31C/4, 31C/5, 31C/6 |
As part of the Watershed Report Card project, it is important to understand how the people in the community view the Palliser Creek Watershed. It would be very helpful if you could take some time and respond to a number of questions/statements. Afterwards, perhaps you can discuss the similarities and differences in your responses. Could you also respond to some questions regarding groundwater quantity and quality on your property? Thank you very much for your assistance!

**Watershed Values**

1. Please give two or three aspects of the Palliser Creek watershed that you consider to be of greatest value (for example, source of water for livestock, recreation, scenery et c.).

   i) 

   ii) 

   iii) 

2. Have these values changed since the first rehabilitation projects were completed? If yes, briefly explain how they have changed?

3. Please write down two or three concerns regarding the watershed (for example, water quality, development pressures, water levels, erosion, certain types of land uses et c.).

   i) 

   ii) 

   iii)
4. Have your concerns changed since your initial attempts to improve the quality of the watershed? If yes, briefly describe how and why you think they have changed.

5. Are there any objectives you have for the portion of the creek on your property that have not yet been dealt with by your association or other agencies?

6. What would be some of your long term objectives for the watershed as a whole?

7. Can any community issues be linked to watershed concerns? (for example, community issues may include environmental degradation, development pressures, unemployment et c.)

8. If there are links between community issues and watershed concerns, what are some ways they could be reconciled?
GROUNDBWATER

1. Is/Are the well(s) dug or drilled?  
   ___  ___  ___  ___

2. What is the Lot and Concession where the well(s) is/are located?  
   ___  ___  ___  ___

3. What is the depth of the well(s)?  
   ___  ___  ___  ___

4. Does the depth of water vary in your well(s)?  
   ___  ___  ___  ___

5. Is/Are your well(s) a constant source of water?  
   ___  ___  ___  ___

6. Is the water in each of your wells potable?  
   ___  ___  ___  ___

(Please use the reverse side if you have information for more than 4 wells.)

7. Do you have any field(s) that is/are tile drained which border the creek?  
   Yes ___  No ___

Any further comments?


Thanks again for your help and co-operation!!
APPENDIX 4
Description of Vegetative Buffer along the main branch of Palliser Creek, Concession 5, Sidney Township, 1999

Lot 4-8:
Collins ponds are located on lots 4-6. This is a flooded area (approximately 0.5-1.0 m in depth). Along the perimeter of the ponds are short water plants such as duckweed which grade to grasses such as loosestrife and cattails. Around the ponds are a variety of coniferous and deciduous trees. Selective logging has taken place south of the east pond.

Lot 9-10:
The buffer consists of willow shrubs, cattails and forest along the south of the ponded area. There are two beaver dams on the east side of this ponded area.

Lot 11:
The western half of lot 11, trees are located adjacent to the channel. On the east half of lot 11, the adjacent vegetation consists of natural grasses with sporadic trees. Pasture is located on both the north and south sides of the channel.

Lot 12:
Corn is being cultivated very close to the channel on the south side. On the north side, the channel flows through a cattle yard. This area is vegetated with some deciduous trees. On the east half of the lot, the channel is ditched. There is some tree vegetation.

Lot 13:
A forested (deciduous) area is located on the north side of the stream. The channel develops into a marsh zone immediately south of Frankford Road. North of Frankford Road, the vegetation is primarily deciduous.

Lot 14:
On the west half of this lot, the channel is ditched. The adjacent vegetation is cultivated land and pasture. There is mixed forest (eg. alder along the creek) on the eastern portion of this lot. Immediately west of Rose Road, trees cover the banks on the north and south sides of the creek.

Lot 15-18:
The creek travels south of Frankford Road where the adjacent vegetation consists of grasses and sporadic trees that were planted as part of a rehabilitation project. As the channel loops briefly on to lot 14, the edge vegetation are lawns on the east side and trees and grass on the west side.
Between lots 15 and 18 (east of Rose Road), there are points where cultivation is occurring very close to the creek channel. The bordering vegetation varies with some sections having heavy grasses with sporadic trees (near to Rose Road, the trees were planted as part of a rehabilitation project) while other sections have no trees. There are some points where the channel has a large number of trees along the banks. Some of the trees are large and overhang the channel. There are certain locations where the cultivated crop is very close to the channel. On lot 18, trees have been planted in heavy grasses as part of rehabilitation projects.

Lot 19:
East of Scott's Church Road, the banks are covered by lawn on the north and grasses along the south. Further east, prior to the channel flowing north of Frankford Road, grasses are located along the edge of the creek. These grade to shrubs and trees. As the channel curves northward, cultivated land occurs adjacent to the channel. North of Frankford Road, there is a marsh area with vegetation such as cattails, loosestrife and duckweed. Cultivation is also occurring along the edge of the marsh zone.

Lot 20:
Along the north edge of the channel, there is a mixed deciduous and coniferous forest. On the west side of a tributary on this lot, there is a stand of trees.

Lot 21:
Shrubs and grasses occur along the edge of the channel. On the north side of the creek on the eastern half of the lot, there is a forested zone.

Lot 22:
The western half of the lot is bounded on both the north and south sides by pasture land. In the middle part of the lot (east of a laneway), the vegetation is comprised of grasses on the south side and forested on the north side.

There are long grasses along both the north and south sides of the channel on the eastern half of the lot.

Lot 23:
The bordering vegetation ranges from heavy long grasses along the tributary entering the channel from the north to a forested zone along the main channel.

Lot 24:
The vegetation consists of mixed trees and grasses.

Lot 25:
On the western part of the lot, the vegetation is mainly deciduous forest. East of Ketcheson's Road, the adjacent vegetation is exclusively natural grasses.
Lot 26:
Adjacent vegetation consists of grasses and tree willows.

Lot 27:
Adjacent vegetation is comprised of grasses and tree willows.

Lot 28:
The vegetation consists primarily of grasses and weeds on the western portion of the lot while the eastern portion has grasses only.

Lot 29:
There is mainly deciduous forest along the north side of the creek and grasses indispersed with shrubs and trees along the south edge.

Lot 30:
There is grass vegetation on the north side of the creek and some tree growth on the south side.

Lot 31-33:
There are predominately heavy grasses along the channel boundary. There are also some willow and ash trees which have been cut.

Lot 34:
Vegetation along the edge consists of grasses with sporadic trees.

Lot 35:
The western portion of the lot is vegetated by trees such as spruce and ash while the eastern portion is forested.

Lot 36-37:
Adjacent vegetation includes grasses, weeds and very sparse trees.

Lot 38:
Surrounding vegetation consists of grasses with sporadic trees.

Foxboro:
Adjacent vegetation is lawn on the north side and generally lowland bush along the south.