Ten Years On: Project Goals and Outcomes

Beginning in 2002, landowners and farmers worked together with partners to plant native riparian vegetation along the banks of Fourmile Creek. As part of this program, water quality has been monitored at several sites along the Creek and continues with volunteer assistance. In this report we present the results of monitoring for the period 2003 to 2012, as well as additional information that helps to assess how well the original project goals are being met.

**Goal #1- Maintain drainage of agricultural land**: Control reed canary grass and decrease the rate of sediment accumulation in the Creek after an initial mechanical removal of both the grass and the accumulated sediments to maintain adequate drainage of the agricultural land in the Drainage Improvement District (DID) #3 area.

**Outcome**: The planted buffers have successfully controlled regrowth of reed canary grass where full shade cover was achieved. Since 2002, no dredging of the creek has been needed to maintain drainage of the agricultural fields. There isn’t sufficient data to measure how field drainage has changed over time, and landowners provided varying opinions on drainage effectiveness.

**Goal #2- Improve fish habitat and water quality in Fourmile Creek**: Reduce water temperatures and increase dissolved oxygen levels by providing shade cover. Improve fish passage by removing reed canary grass and reducing sediment build-up.

**Outcome**: Two critical measures of fish habitat, water temperature and dissolved oxygen concentrations, improved as the plants in the creek buffers grew and shade cover increased. Another measure of habitat quality, litterfall from the vegetated buffers into the stream, was found to be comparable to that of a more mature, natural riparian forest.

**Goal #3- Improve water quality for shellfish and public health downstream**: Improve water quality in the Tenmile Creek, downstream, where a TMDL limit was established in the year 2000 for fecal coliforms.

**Outcome**: The water quality for shellfish and public health in Tenmile Creek improved after buffers and filter strips were installed in the watershed, and changes in livestock, manure, and septic system management were adopted. Efforts in Fourmile Creek watershed contributed to this improvement. However, we don’t have sufficient data to clearly establish how much of the improvement in Tenmile Creek resulted directly from the Fourmile project.

This report was prepared by Cheryl Lovato Niles and Heather MacKay, with assistance from Glynis Gordon, David Hooper and Tim Anderson. The primary audience for this report is the Fourmile landowners, farmers, and members of Drainage Improvement District #3.

For more information, please contact:
- Heather MacKay heather@fhb3.com
- Dorie Belisle dorie@bellewoodfarms.com
Introduction

Fourmile Creek is 4.5 miles in length and is a tributary of Tenmile Creek, which is itself a tributary of the Nooksack River. Fourmile Creek flows through high-value commercial farmland that has historically been drained to support intensive berry and dairy production. Tenmile Creek also flows through agricultural land and provides rearing habitat for Chinook, chum, and coho salmon.¹ The Nooksack River hosts all five major Pacific salmon species and empties into Hale Passage near Portage Bay, a sensitive shellfish growing area maintained by the Lummi Nation.

Pre-project Condition of Fourmile Creek
Prior to the Fourmile Creek buffer planting project initiated in 2002, the creek had no native riparian vegetation and no canopy cover. The banks and channel were infested with reed canary grass and choked with sediments.² Regular dredging was necessary to maintain adequate drainage of the adjacent agricultural land.³ Instream fish habitat was poor due to limited water flow, high water temperatures, and low dissolved oxygen levels in the water. Fecal coliform counts were high in the Tenmile watershed, as in many other tributaries with livestock and manured fields throughout the lower Nooksack River basin.⁴ Because of high levels of fecal coliform bacteria entering Portage Bay, a shellfish growing area near the outlet of the Nooksack River, the Lummi Nation closed 180 acres of shellfish growing area between 1996 and 1998.¹ In the year 2000, a Total Maximum Daily Load (TMDL) limit for fecal coliform bacteria was established for the Nooksack River basin and its tributary watersheds,⁵ including Tenmile Creek. The Fourmile Creek buffer planting project was part of a larger restoration effort for the Tenmile Creek watershed.

About the monitoring program:
Six water quality monitoring stations were set up with the help of WSU Extension personnel (see map). Onset Tidbit continuous water temperature loggers record water temperature hourly at these stations. Dissolved oxygen concentrations are measured with a handheld meter approximately every two months, when the logger data are downloaded.
About the Project

Planning
In 2002, the 27 landowners along Fourmile Creek were invited to participate in the project. Landowners individually decided how much land area they wished to devote to the buffer, as well as whether shrubs only would be planted, or a mixture of trees and shrubs. Since these preferences varied from one landowner to the next, the buffer width and height, as well as the plant mix, now varies along the length of the creek.

All but two landowners allowed planting on both sides of the creek. One owner felt it was prudent to keep the north side of the channel clear in case the channel needed to be dredged again, and the other declined to participate in the planting project.

Cleaning and planting
The project was undertaken in three phases between 2002 and 2005 and began with clearing Fourmile Creek of reed canary grass and accumulated sediments. Native trees and shrubs were then planted in buffer areas along the creek.

Most of the completed buffers measured between 15 feet and 30 feet with some as wide as 75 feet. Landowners also created 20-foot wide grass filter strips outside of the buffer areas to help keep suspended sediments, nutrients, and other pollutants from entering the creek.

Funding
Funds for Tenmile Creek watershed restoration efforts came from two WA Department of Ecology Centennial Clean Water Fund grants and from a US Fish and Wildlife Service grant. Whatcom Conservation District managed the grants and worked with the Nooksack Salmon Enhancement Association and Whatcom County Sheriff’s Alternative Corrections Program crews to plant and maintain the vegetated buffers during the project. Match was provided by the Drainage and Irrigation District #3, the Nooksack Salmon Enhancement Association, the Whatcom Conservation District and volunteers.

Station 1, Fourmile Creek in 2006: After clearing and planting.
Photo by Steve Sevmour.

Station 1, Fourmile Creek in summer 2008. Canopy beginning to cover the stream. Photo by Dorie Belisle.
Goal #1: Maintain Drainage of Agricultural Land

Controlling Reed Canary Grass
In 2002, a dense monoculture of reed canary grass grew on the banks and in the channel of Fourmile Creek. Reed canary grass is an invasive non-native species. It traps sediment and slowly blocks drainage ditches and streams. The local Drainage Improvement District, DID #3, routinely dredged Fourmile Creek to remove sediments and reed canary grass in order to restore flow in the Creek and maintain drainage in their fields.

Shade Survey Results
Shading is one of the most effective means of controlling reed canary grass as it inhibits seed germination. Whatcom Conservation District staff conducted shade surveys along Fourmile Creek in the August of 2007, and volunteers repeated the survey in September 2012.

Prior to the project, there were no shrubs or trees casting shade on the creek. In July 2007, the shade from overhanging vegetation ranged from 4% to 100%, with a median value of 96%. In September 2012, shade ranged from 77% to 87%, with a median value of 84%. The areas planted with trees and shrubs had the densest shade. The areas planted with only shrubs had ample shade along the stream banks, but allowed full sun exposure in the middle of the channel.

Bottom left: Station 3 in 2003: The channel is filled with reed canary grass.
Upper right: Station 3 in June 2008, looking upstream. Canopy cover measured in August 2007 at this station was 96%.
Lower right: Inside the buffer at station 3 on September 21, 2012. The canopy cover was 77%. Autumn leaf fall probably accounts for the lower measurement compared with 2007. Little or no reed canary grass is present.

Photo by Steve Seymour.

Photo by Heather Mackay.

Photo by Dorie Belisle.
**Survey of Reed Canary Grass regrowth**

In November of 2012, Professor David Hooper, Department of Biology at Western Washington University, and student Tim Anderson surveyed reed canary grass regrowth along vegetation transects across the banks and in the creek channel along Fourmile, in the areas with and without planted riparian buffers. (See box-and-whisker plots below.)

They found that reed canary grass had regrown vigorously at the no-buffer (Unenhanced) sites, but strikingly less so at the sites with buffers (Enhanced). In the channel at the no-buffer sites, reed canary grass cover was 40% to 60%, but was close to zero at the buffer sites. On the banks of the Creek at the no-buffer sites, the reed canary grass cover was almost 100%, but at the buffer sites, they found almost no reed canary grass where the shade was dense, and patches dominated by reed canary grass where sunlight penetrated occasional gaps in the narrow shrub buffers.

For comparison, Hooper and Anderson also conducted reed canary grass surveys on Tenmile Creek and the south fork of Deer Creek at other sites without buffers and at sites with natural forest cover (Forested). They found reed canary grass cover to be much lower in areas with planted forested buffers than without, and that reed canary grass growth in the Fourmile channel at the buffer sites was comparable to that in

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**How to read a box plot**

*Extreme Score*  
*Outlier*  
“Upper Whisker”  
25th Percentile  
50th Percentile (Median)  
“Box”  
“Lower Whisker”  
Lower Bound

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*Notched box-and-whisker plots comparing reed canary grass cover at forested (F), Enhanced (with buffers) (E), and Unenhanced (no-buffer) (U) sites. Box plot on the left is of density in creek channels. Box plot on the right is of reed canary grass density on the creek banks. [In an earlier version of this report, the labels “In channel” and “On banks” were inadvertently switched. This has now been corrected.]*
forested sites. David Hooper and Tim Anderson conclude “The great reductions in RCG (reed canary grass) cover at enhanced sites should lead to less RCG obstruction of flow and less sediment build-up, thereby enhancing drainage.”

**Survey of Field Drainage effectiveness**

The project monitoring program did not include any actual measurements of field drainage effectiveness, so we used a simple questionnaire type of survey to gather observations from farmers and landowners. The survey was sent to 26 landowners or residents who had been involved in the project. A total of 15 responded. Of those, 13 were actively farming from 2002-2012. We asked them to share their observations about drainage during that time period. The table on the right summarizes their responses.

Interpreting the results of this survey is complicated by natural fluctuations in rainfall during this time. The spring and summer periods from 2010-2012 were significantly wetter than they had been during the previous seven years. Also, additional fields have been drained and planted in berries over the years so there may be more water entering the creek and affecting the drainage overall.

The current Drainage Management Plan for the Fourmile watershed states that most of the drainage related concerns are now caused by beaver; reed canary grass requires maintenance in the areas that lack creek buffers; and while the creek buffers have stabilized the banks and intercept much of the sediment, some sediment still reaches the creek. The plan also notes that much of the creek flows through unstable organic soils and soil migration will probably cause the channel to narrow over time.

<table>
<thead>
<tr>
<th>Landowner Observations of Field Drainage from 2002 – 2012</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage became less effective</td>
<td>4</td>
</tr>
<tr>
<td>Drainage became more effective</td>
<td>1</td>
</tr>
<tr>
<td>Drainage did not change</td>
<td>5</td>
</tr>
<tr>
<td>Drainage was more effective sometimes, less effective other times</td>
<td>2</td>
</tr>
<tr>
<td>Not sure</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>13</td>
</tr>
</tbody>
</table>

**Goal #1:** The planted buffers have successfully controlled regrowth of reed canary grass where full shade cover was achieved and maintained, but there isn’t enough data to measure whether or how field drainage has changed over time.
Goal #2: Improve Fish Habitat

Water Temperature and Dissolved Oxygen
Fourmile Creek provides some rearing, migration, and spawning habitat for coho salmon. More significantly, Fourmile flows into and influences water quality in Tenmile Creek in which Chinook, chum, and coho salmon migrate and rear.

The temperature and dissolved oxygen content of water heavily influence fish survival and reproductive success. They are also influenced by water chemistry – as water temperature rises, dissolved oxygen levels fall. Salmon are particularly sensitive to both increases in temperature and decreases in dissolved oxygen levels.

Fourmile In-Stream Water Temperature Monitoring
Stream temperatures are influenced by sun exposure, air temperature, groundwater, rainfall, irrigation, and flow rate. Research has demonstrated that shade from streamside plants significantly reduces stream temperatures. To evaluate whether the buffer planting led to reduced stream temperatures, water temperature in Fourmile Creek has been monitored continuously from 2004 to the present at various locations along the Creek (see map on page 2 for locations).

Buffer Width Influence on Air and Stream Temperature

Another local study conducted recently by the WSU Whatcom County Extension Office included measurement of the influences of different riparian buffer widths on effective shade and air temperature over agricultural waterways in Whatcom County.

The authors of the study concluded that narrow, dense buffers, measuring 5 or 15 feet, provided as much effective shade over small streams (average stream width 8 feet) as did wider 35-foot and 180-foot buffers, and that the narrow buffers reduced the maximum air temperature over the waterway as effectively as the larger buffers. They also found that a more complex plant community developed in larger buffers. A greater variety of plants could be expected to provide better habitat for a wider variety of animals, but a wider buffer would necessarily take more agricultural land out of production.

One of the Onset Tidbit water temperature loggers. Photo by Heather MacKay.
Results: Water Temperature Decreased in Warmest Months
The box and whisker plots A and B show daily maximum air temperatures at Lynden and daily maximum water temperatures at monitoring station number 6 during the warmest months of the year. At Station 6 there was a marked decrease in maximum water temperatures between 2004 and 2008, as shade cover was established after the buffers were planted (no data were available for the 2009 late summer period). Maximum daily air temperatures over the same period were fairly stable by comparison.
**Results: Comparison with Water Quality Standards**

Graph C shows the 7-day average daily maximum water temperatures at stations 1, 4 and 6, compared to the Department of Ecology water temperature standards for salmonid habitat.\(^{15}\) It is encouraging to note that at station 6, just upstream of the confluence with Tenmile Creek, the 7-day average maximum daily temperature in the summer months from 2010 to 2012 has consistently been below the 63.5°F standard for salmon migration and rearing. This is observed even though maximum summer water temperatures at Station 4 (between stations 1 and 6) are often relatively high due to the warming of water in the Creek as it flows through wide and shallow Green Lake and then back to the channel.

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**7-day average daily maximum water temperature 2003-2012**

- **7-DADMax: salmonid survival**
- **7-DADMax: salmonid rearing & migration**
- **7-DADMax: core salmonid habitat**

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*C: 7-DADMax (7-day average daily maximum) water temp*
**Fourmile Dissolved Oxygen**

Between 2004 and 2012, dissolved oxygen levels at stations 1, 2, 3, and 6 increased over time. In recent years, measurements of dissolved oxygen at these stations have almost all been between 6.5 ppm and 8.0 ppm, levels acceptable for salmon migration (see graph below).

Dissolved oxygen levels at station 4 and 5 remained consistently lower, possibly due to slow flow through Green Lake directly upstream from station 4, as well as the effect of peat soils in the area. However, the data show consistent recovery in dissolved oxygen concentrations by the time the water reaches Station 6 downstream.

*Graph showing dissolved oxygen levels at each station. Red line indicates the minimum oxygen level required for salmon rearing and migration, only. Blue line shows the minimum oxygen level required for salmon spawning.*
**Litterfall Survey**

Litterfall, i.e. leaves and woody debris from streamside vegetation, provides habitat and food for aquatic insects, which are a primary food source for fish. While there were no pre-project measurements of litterfall to use for comparison, a study on Black Slough in Whatcom County indicated that reed canary grass litter has much lower nitrogen content than that of typical riparian trees and shrubs, and tends to come in a single pulse in late fall.16

In an on-going effort to assess the contribution of the shrub buffers to stream food webs, David Hooper and Tim Anderson measured litter inputs at 8 sites along Fourmile Creek from October 2012 to March 2013. Measurements will continue through September 2013.

Initial data from the Fourmile litterfall surveys were compared with the published literature on litterfall in other Pacific Northwest streams. Generally, litterfall increases with forest age. Litterfall from the Fourmile Creek buffers was most similar to an older forest with amounts between those found in early (<25 year old) and middle (ages 25-80 years) successional sites.9

Relatively high litterfall in the Fourmile creek may result because deciduous shrubs, which make up the majority of plants in the buffers, lose more leaves each year than the coniferous trees found in mid-successional forests. Additional information on litter nutrient content will help us to better understand how the shrub buffers affect nutrient cycling and food webs in Fourmile Creek.

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**Goal #2:** Two critical measures of fish habitat, water temperature and dissolved oxygen concentrations, improved as the plants in the creek buffers grew. Another measure of habitat quality, litterfall from the vegetated buffers into the stream, was found to be comparable to that of a more mature, natural riparian forest.
Goal #3: Improve Water Quality for Shellfish and Public Health

**Fecal Coliform Introduction and History in the Tenmile Watershed**
Fecal coliform bacteria come from human and animal waste, and their presence indicate the presence of pathogens such as *E. coli*. These pathogens pose a threat to human health from eating contaminated shellfish, or engaging in other contact recreation in contaminated water.\(^{15}\)

Historical data show chronically elevated levels of fecal coliform in the Tenmile Creek watershed. Suggested likely sources included manure from livestock entering the creek, runoff from livestock containment areas, manure applied to the fields, and failing septic systems.\(^{4, 5, 18, 19}\)

The closure of shellfish beds at Portage Bay due to high fecal coliform levels in the water there prompted the Washington Department of Ecology to establish fecal coliform (Total Maximum Daily Load) TMDL limits for tributaries to the Nooksack River, including the Tenmile watershed.\(^{20}\) The TMDL for the Tenmile Creek watershed, which includes Fourmile Creek, is 39 cfus/100 ml. \(^{5, 20}\)

The buffer planting project on Fourmile Creek was part of a larger water quality improvement effort in the Tenmile Creek watershed,\(^{2, 20}\) and ultimately the Nooksack River which also involved excluding livestock from the creeks, implementing nutrient management plans for dairy farmers, grass filter strips, and septic system education for area landowners.\(^{20}\)

**Fecal Coliform Sampling on Fourmile and Tenmile Creeks**
After the buffer project and other water quality improvement measures were initiated, fecal coliform samples were taken by Northwest Indian College personnel at two locations along Fourmile Creek between September 2004 and July 2008, and submitted to the Department of Ecology. This data shows fecal coliform levels in Fourmile Creek during this time period did not meet the Tenmile Creek watershed TMDL target of 39 cfus/100 ml. However, our analysis of this data showed that the fecal coliform standard for primary contact recreation\(^{15}\) was met at these sites for the years sampled.

The fecal coliform levels in Tenmile Creek declined significantly between 2000 and 2008 (see graph), and the uppermost segment of Tenmile Creek consistently met water quality standards and TMDL targets, prompting the Washington Department of Ecology to remove it from Washington’s impaired waters list in 2008.\(^{20}\) The success of the effort in the Tenmile Creek watershed overall continues to be featured on the US EPA’s Nonpoint Source Success Stories.\(^{1, 20}\)

**Goal #3:** The water quality for shellfish and public health improved in Tenmile Creek after the buffers and filter strips were installed, and changes in livestock, manure, and septic system management were adopted. Efforts in Fourmile Creek watershed contributed to this improvement, but there isn’t enough data to clearly establish how much of the improvement resulted directly from the Fourmile project.
Costs and Benefits of the Project

**Drainage Maintenance Costs**
Prior to the buffer planting project, Whatcom County Public works records show that landowners along Fourmile Creek spent $3,300 per year on average for ditch cleaning and maintenance.³ Dredging has not been needed since the buffers were installed and none is currently planned for the areas with creek buffers.¹¹ However, maintenance activities and costs have not been eliminated entirely, and have instead shifted to beaver control and buffer vegetation control along most of the creek.¹¹ Landowners have spent between $2,000 and $3,000 per year on beaver trapping since 2006.³ It is notable that beaver populations and control expenses have increased dramatically throughout Western Washington over the last decade.²¹ Buffer pruning is planned on an as-needed basis for all of the areas with buffers.

**Benefits**
Installing buffers of variable widths, heights, and plant mixes, according to farmer/landowner needs and preferences, has been successful by many measures. Regrowth of reed canary grass has been controlled where the buffers were installed, and is best controlled where full shade cover over the stream has been achieved. Fish habitat improved, and water quality downstream for shellfish and public health also improved. In our survey of area farmers and landowners, several respondents expressed pride in the project and were pleased to be participating in it still.

While this project has not eliminated all drainage maintenance activities or costs for farmers and landowners, many additional watershed benefits have been realized as a result of the project, for roughly the same management costs (see table below).

<table>
<thead>
<tr>
<th>Benefits Achieved</th>
<th>Prior to Buffer Planting</th>
<th>After Buffers Matured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>- Maintain drainage network to keep fields in production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Reduce need for dredging</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Watershed – Water Temperature</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Watershed – Dissolved oxygen</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Watershed – Reduced fecal coliform load into Tenmile Creek</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Watershed – Habitat for fish</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
**What next?**

**Some Areas of Uncertainty and Concern**

Of the 13 active farmers who responded to our survey, 4 believed that the drainage had become less effective and 5 believed that the drainage had not changed. Interpreting these observations about drainage is complicated by wetter spring-summer seasons for the most recent years (2010-2012), as well as new berry fields coming into production, all of which affect drainage and flows in the Creek.

Many of the landowners believe the beaver dams are impairing drainage and are very concerned about beaver control for this reason. Landowners also expressed strong concerns about the buffer vegetation encroaching on their fields as well as the need to maintain drainage ditches in the future. Berry farmers also raised a question about whether certain plants, if present in the buffers, might provide habitat for berry crop pests such as fruit flies. These concerns highlight the importance of the plant choices for buffers.

There has been little communication with landowners since funding for the Fourmile project manager position ceased. Some property has changed hands and new owners may know little about the project or its goals, and may not understand how to incorporate management of the buffers into their drainage maintenance activities.

**Ongoing monitoring**

Volunteer monitoring of water temperature and dissolved oxygen will continue for as long as possible. We hope to be able to report on the project in future years, and that the information will help landowners and the DID to manage the buffers and keep their land in production while contributing to the health of the Fourmile watershed.

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**Afterword**

As project coordinator from 2000 - 2008, it has been of great interest to read this report. How many times do we work on a project never to learn about its long term effects? With this report we know where we have been and where we need to go.

I wish to thank every landowner who took the time to share their ideas. Without you this project would have not happened. Thanks to Heather MacKay and Cheryl Lovato Niles, who worked so diligently to help us understand the results of our hard work.

However, as landowners, we knew that this would not be a project with a BEGINNING and an END! We understand that the Fourmile Creek system needs to be a maintained system. That is true for every stream running through productive agricultural land. Protecting fish and farming is an ongoing project using adaptive management to meet the needs of both farmers and the natural resource. Drainage will always be a concern and we will always be responsible for clean water. Working with Drainage District #3, we should be able to use that funding source to trap beavers where needed and maintain a workable buffer width. Our grass buffers should continue to be maintained as the original contract stated. We should be able to work with our neighbors to achieve common goals. Our work is not done – nor will ever be.

This project demonstrated that we as neighbors worked together to begin this project but now must work together to maintain it. We can do this without regulation, but with coordination between Drainage District #3 and each of us who own the land along the Fourmile Creek.

Thanks again to each of you,

*Dorie Belisle*
Acknowledgements

Thanks to:
Dorie Belisle for initiating the Fourmile project, for her advice and guidance and ongoing support of the monitoring program, and for her contribution to this report; Glynis Gordon for processing and analyzing the water temperature and dissolved oxygen data sets; Fourmile landowners for hosting the monitoring sites and for providing responses to the drainage survey questions; Frank Corey for information and data on the planting project; Richard Zehnder for providing information relating to the Drainage Improvement District; David Hooper and Tim Anderson for sharing the results of their research; and Andrew Phay for preparing maps.

FHB Consulting Services Inc. supported the contributions of Heather MacKay, Glynis Gordon and Cheryl Lovato Niles. Western Washington University supported the contributions of David Hooper and Tim Anderson.

Suggested citation:

Available online:
www.whatcomcd.org/tenmile
www.fhb3.com/links

Left: Aerial view of Fourmile Creek, looking west with Hannegan Road in the foreground. Photo by John Gillies.
References