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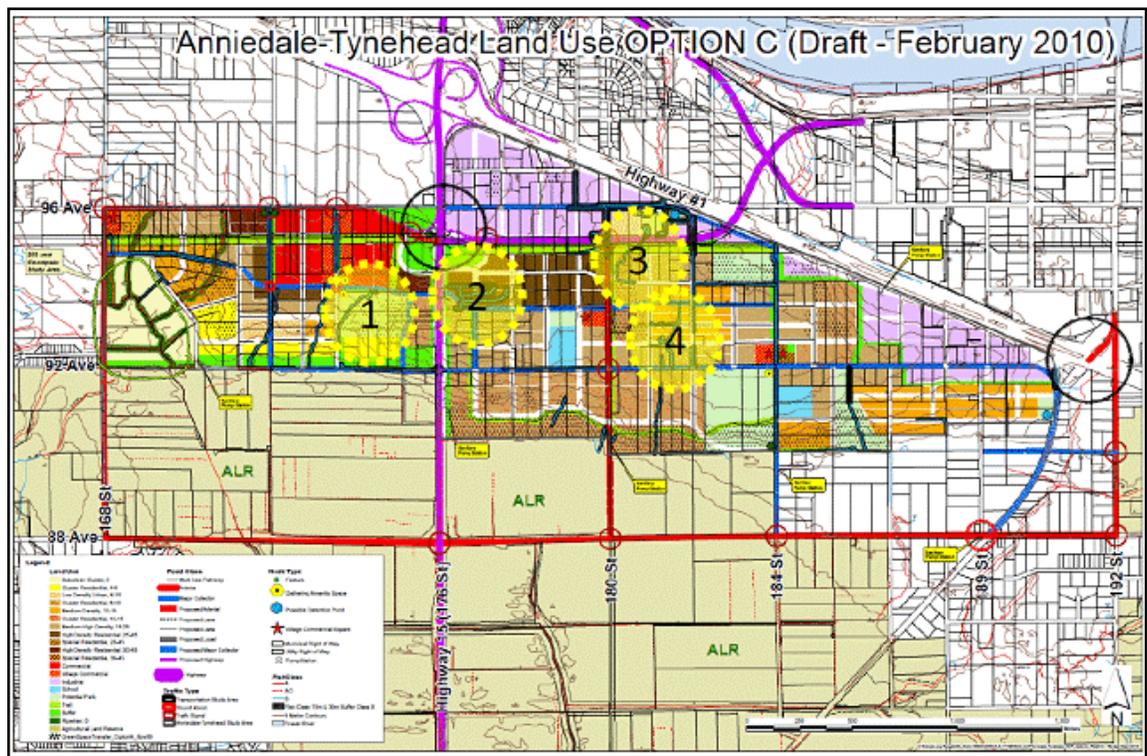
**Response to questions in focal areas 1 – 4 - Anniedale-Tynehead NCP.**

Dear Ms. Heer,

Further to the completion of the Anniedale – Tynehead – NCP Area Overview Environmental Assessment (Madrone – September 2009), we understand that you have specific questions related to four separate areas, highlighted on the map you provided us with (Figure 1). The scope of the initial assessment was limited to an overview-level study, but the following responses have been formulated using a higher level of detail.

It is difficult to predict all potential impacts to sensitive zones at this stage, given that no detailed development footprints have been specified. Our responses are based on potential impacts and how these impacts can be reduced by using generalized mitigation measures. Ascertaining the full range of potential impacts related to development would only be possible through detailed on-the-ground surveys that address specific development footprints.

In responding to your request for more information, we have conducted brief site-specific follow up field work in Areas 1 and 4. We have also reviewed our original EA report, along with some of the literature we referenced in writing the report. Context maps for each of the focal areas (Figures 2 – 7) were modified from the original EA report.



**Figure 1.** Focal Areas of Interest 1 – 4.

Your questions (and our responses) for each of the areas of interest are listed here:

*Area 1. – What types of impacts will large format commercial development to the north of this riparian area (Class B) have on flow patterns and water quality? What type of mitigation measures may be needed to ensure that stream flow is not marginalized by development to the north (Roadway/Large Format Retail)? Is this riparian area likely fed by areas to the north? Can wildlife movement patterns be helped through ample street tree/greenway designs?*

## Response

### Riparian:

We found evidence of a narrow, poorly defined channel in the moist, forested area to the northeast of 173A Street. Water flows to the southwest, but any natural channel system has been impacted by historical development along the eastern side of 173A Street. A very poorly-defined shallow swale parallels 173A Street, which suggests that the majority of water originating from the moist forest to the north east is piped underground. Numerous catch basins along the edge of 173A Street further suggest that water in this Class B drainage is piped (Figure 2).

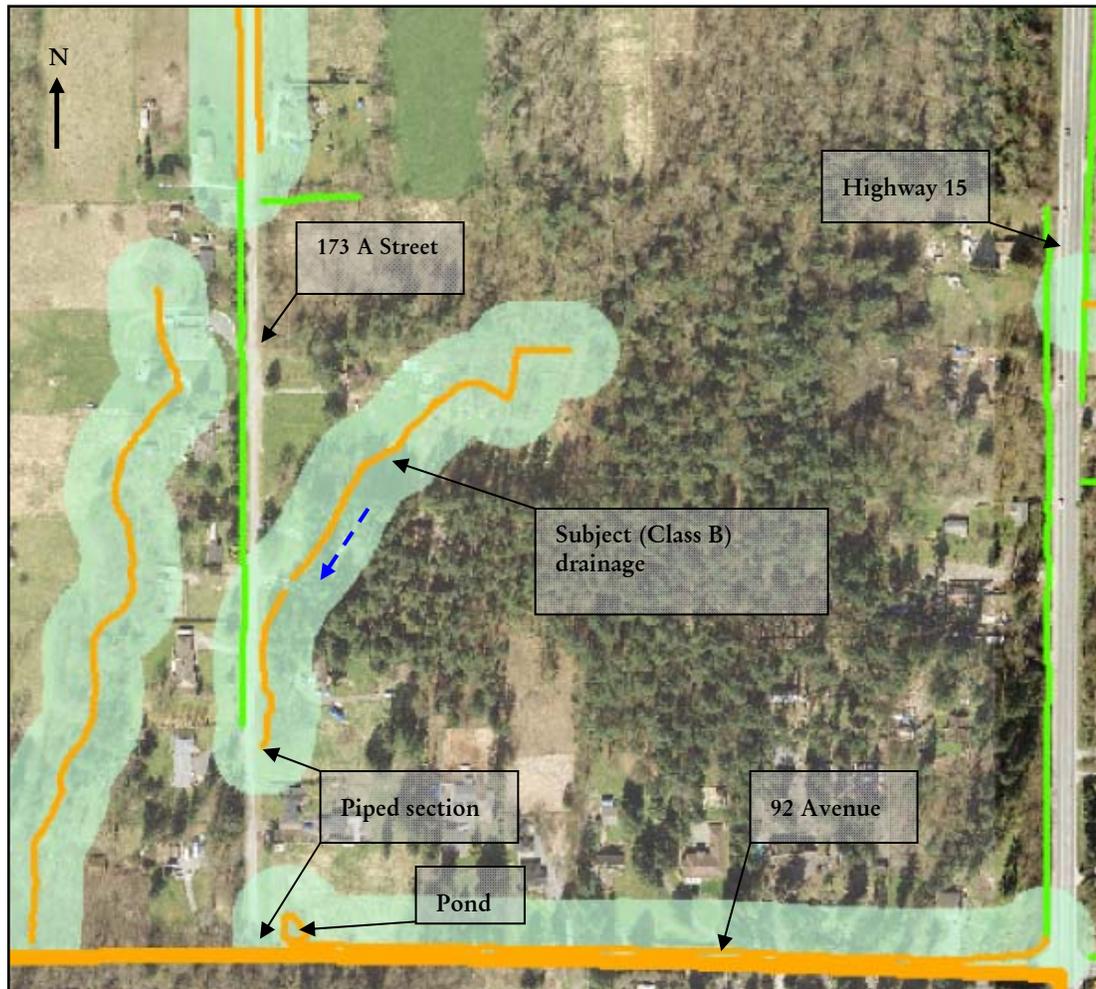
Despite the poorly defined nature of the drainage and the fact that it is piped along the eastern side of 173A Street, surface flow connectivity occurs with the well defined creek located to the south of 92<sup>nd</sup> Avenue. The drainage should, therefore, maintain its Class B status.

The pond located on the corner of 173A Street and 92<sup>nd</sup> Avenue appears to receive subsurface water from the moist area to the north, as no defined surface inflow was detected. The pond is drained by a 20 cm diameter plastic pipe, with water flowing to the south, ultimately into the more well-defined stream located immediately to the south of the study area boundary.

Large-format commercial development to the north of this riparian area may impact both water supply and water quality, although specific impacts would depend upon the precise location of development footprints. Appropriate techniques should be employed during the development phase to ensure that stormwater emanating from the development area is properly managed. Specifically, paving large areas and promoting rapid conveyance of water into a stormwater system would result in substantially reduced flows in the summer and the higher incidence of peak flows in the winter, which could have deleterious implications on connected fish habitat (refer to response for Area 3 for more detail on stormwater management).

Mitigation measures should also be implemented that address water quality, given the potential for contaminants originating from the developed commercial area.

For example, catchment areas should be constructed that capture run-off from parking areas, to help minimize the introduction of hydrocarbons into drainage areas. Oil/water separators should be installed in drains to prevent the movement of hydrocarbons from the development.



**Figure 2.** Subject Class B drainage – Area 1.

#### Wildlife/Ecology:

Area 1 corresponds with Hub 14 in the original EA overview report, which makes reference to study area Polygons 43 and 45, east of 15<sup>th</sup> Avenue and north of 92<sup>nd</sup> Avenue (Figure 3). These polygons are described in Section 8, *Wildlife Assessment* and Section 6, *Vegetation and Ecosystems* in the EA overview. The wildlife hub at Area 1 was identified as one of the most appropriate areas for conservation of wildlife habitat in the study area.



Area 1 is composed of mature forest and, out of the area assessed in the EA overview report, contains the highest habitat suitability for wildlife in all seasons. As discussed in the EA overview, wildlife hubs are based on a number of significant factors, such as high vegetation ratings corresponding with high habitat suitability rating. The valuation of vegetation ratings are based on critical habitat, forest patch size and adjacency of riparian areas. Using these criteria we determined that the vegetation in Area 1 is of the second highest rating in the study area.

A second important reason for the high valuation of Area 1 is due to its proximity to both Tynehead Park and the wildlife hub in polygon number 15, south west of 173A Street and 92<sup>nd</sup> Avenue. Hub 14 in Area 1 is approximately 9 ha. It borders the Hydro right-of-way (ROW), which represents an excellent, virtually permanent, wildlife travel corridor. Area 1 is less than 420 m from Tynehead Park and approximately 200 m from the hub southwest of 173A Street and 92<sup>nd</sup> Avenue.

We strongly recommend the preservation of the forest patch and wildlife hub in Area 1. We further recommended preserving and reinforcing connectivity to Tynehead Park and the wildlife hub in polygon 15 with wide wildlife travel corridors through the properties at the corners of 173A, 96<sup>th</sup> and 92<sup>nd</sup> Avenues. Wildlife movement patterns will be assisted with wide (10 m to 15 m) travel corridors that are well-vegetated with trees and dense shrubs on the outside. These will discourage human and dog access and provide cover and protection to species using the corridor. We also encourage the City to provide wildlife-friendly roadway crossings to allow safer access to Tynehead Park across 96<sup>th</sup> Avenue.



## Recommendations – Area 1

Stormwater Management and Water Quality	Wildlife and Ecology
Minimize area to be paved.	Preserve the forest patch and wildlife hub in Area 1
Install catchment areas to collect potentially contaminated run-off from paved areas (e.g. parking areas).	Preserve and reinforce connectivity to Tynehead Park. Consider detailed habitat assessment to determine species presence and the feasibility for safe wildlife travel across 96 <sup>th</sup> Avenue.
Capture stormwater flow and filter pollutants through implementation of bioswales and retention ponds.	Consider measures to retain the valuable wildlife habitat south east of 173A and 92 <sup>nd</sup> Avenue intersection.
Install and maintain oil/water separators to prevent transportation of hydrocarbons from paved areas.	Wildlife travel corridors in vegetated areas should be at least 10 m to 15 m wide and preferably buffered by dense native shrub vegetation to deter predation by domestic animals and human encroachment.
Consider using roof-top gardens or “green roof tops” to capture stormwater on large retail-type “factory” development footprints.	Identify and retain wildlife trees and coarse woody debris as they provide beneficial habitat niches for numerous wildlife species.
Use permeable paving and/or gravel surfaces wherever possible.	Wherever possible, it is preferable to top mature trees rather than full removal, as this will provide future wildlife tree habitat.
Strive to achieve a “no net gain” in stormwater run off from the developed area(s). Employ appropriately qualified professionals at an early stage to help meet this goal.	Invasive plants should be removed from wildlife habitat areas.
	Landowners should be educated and informed about not dumping domestic exotic plant clippings in natural areas, as these can cause the spread of invasive species.

*Area 2. – With a high density residential land use in this area, it is unlikely that this riparian area will be maintained upon development. What areas would be best suited to compensate this ‘B’ Class riparian matrix, and in what form? Does this riparian area provide nutrients to any fish bearing areas in its current state? Where?*



**Response:**

This area represents a moist depression, with pockets of hydrophytic vegetation. Hardhack (*Spiraea douglasii*) occurs in dense patches, but specific, defined, drainage channels were difficult to determine. Attributes commonly associated with fluvial environments and flowing water were limited, and there were no alluvial deposits or scoured channels. Surface water was not present during the original overview EA assessment, but seasonal inundation of water was evident in depressions and poorly defined linear “channels”. Vegetation characteristics are also suggestive of seasonal inundation.

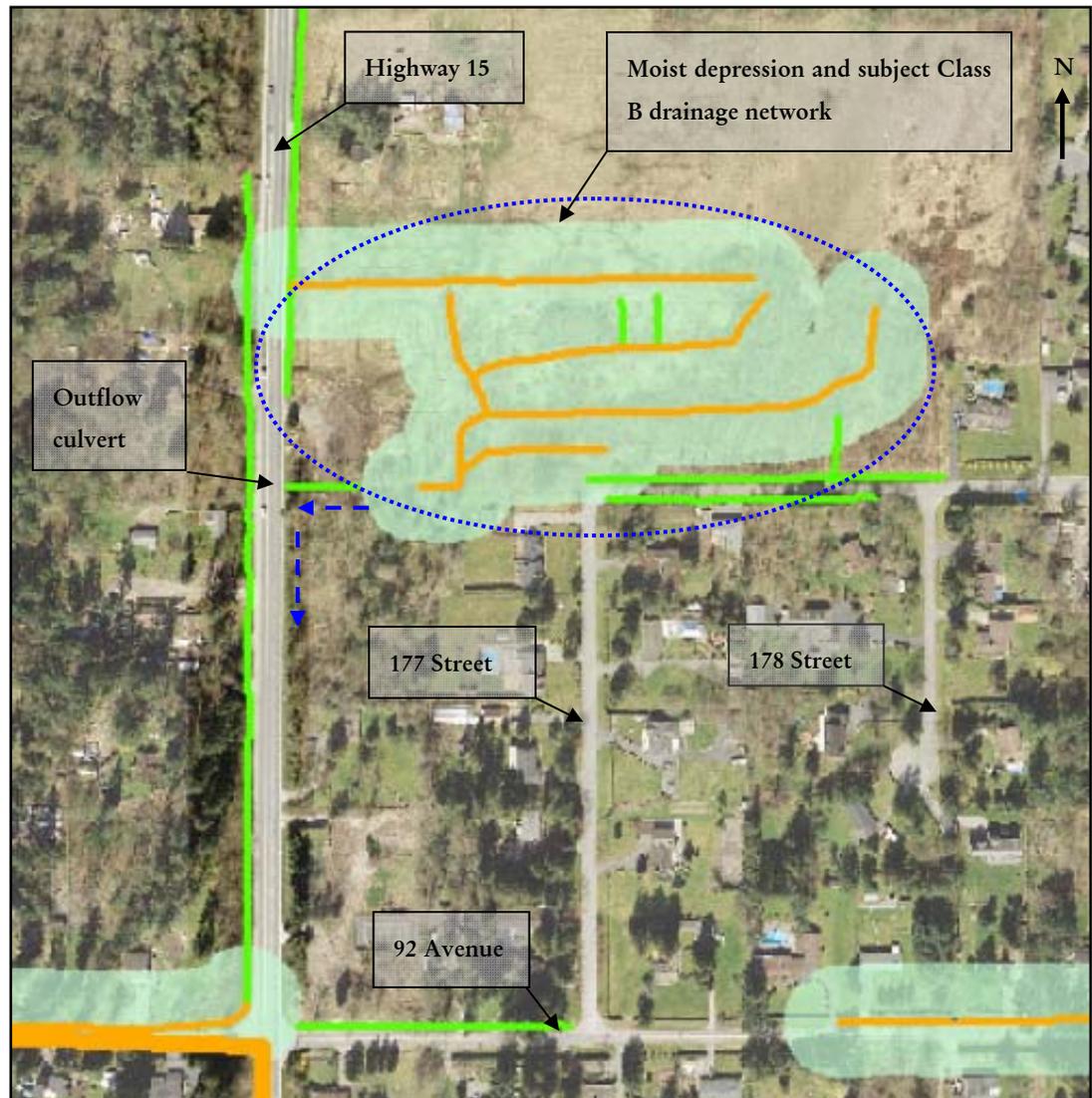
The depression collects water on a seasonal basis, which drains to the west towards Highway 15. Drainage from the depression collects in a poorly defined swale, which connects directly to a culvert running underneath the highway (Figure 4).

We assumed that the culvert was connected to fish habitat, but this was not confirmed during the overview EA survey. The main focus of the overview assessment was to place a priority on assessing currently mapped Class B, C, or unclassified drainages in proximity to Class A or Class AO creeks to check for potential fish presence or the existence of fish habitat. As such, the existing default “Class B” classification was kept.

Future, more detailed site visits may be warranted for this “Class B” network, as it may be a candidate for down-grading. Fish habitat is distally located and there is an absence of clearly defined conveyance zones. It may be difficult, however, to quantify the significance of nutrient supply.

Compensation for negative impacts to this area should focus on maintaining the function of the depressional area as a water retention zone. It will be difficult to quantify appropriate compensation for losses to fish habitat values, due to the lack of habitat attributes and probable lack of reasonable downstream benefits in the form of nutrient supply. Any future development in this area must ensure that water leaving the site is clean and that there is no net increase in stormwater flow. Maintaining water quality and managing stormwater flow should be addressed during both the development phase and post-development (over the long term).





**Figure 4.** Subject Class B drainage network – Area 2.

## Photos – Area 2



Looking towards one of the dense hardhack pockets which represent the Class B riparian network in “Area 2”.



Highlighted area represents an example of a moist depression seasonally inundated with water in “Area 2”. Note lack of alluvial deposits and lack of “stream” characteristics.



Swale draining to the west towards Highway 15 out of the seasonally inundated depression comprising "Area 2".



Inflow of culvert underneath Highway 15, which receives water on a seasonal basis emanating from "Area 2".

## Recommendations – Area 2

Stormwater Management and Water Quality
Confirm value of drainage network to downstream fish habitat.
Maintain the area as a water retention site.
Encourage residential home owners to capture stormwater through site-specific methods (e.g. rain-gardens and/or “green rooftops”).
Capture stormwater flow and help filter pollutants through implementation of bioswales and retention ponds.
Minimize the areas to be paved.
Use permeable paving and/or gravel surfaces wherever possible.
Educate future landowners about stormwater management and maintaining water quality – e.g. limiting use of chemical fertilizers/pesticides.
Employ appropriately qualified professionals at an early stage to help achieve a “no net gain” in stormwater leaving the site.

*Area 3. – This Class ‘B’ Watercourse flows into an area you have designated as an opportunity for enhancement, flowing into the Leoran Brook system, flowing into the Fraser. From your findings, do you consider this an important contributor of nutrients to streams further down the chain?*

*Your findings indicated that this ecological hub was significant. Our land use plan indentifies a cluster housing model within this area (approximately 60% built and 40% preservation). Would tree species and soil types in this area likely be able to withstand this type of development pressure? Are there any mitigation techniques that can be employed in this area to better maintain ecological/water quality health?*

### Response:

Riparian:

While this “Class B” drainage currently resembles a ditch adjacent to 180 Street, it contains perennial flow and connects directly to fish habitat (the “Class A” drainage on the southern side of 96<sup>th</sup> Avenue) – Figure 5. With improved accessibility and habitat improvements (e.g. through riparian planting and/or improvement of instream diversity through LWD placement), it could be used by fish, at least on a seasonal basis.



In its current state, the riparian zone directly adjacent to the subject drainage is providing little in the way of nutrient input, shade and/or litter fall.

The drainage does, however, serve as a conduit for nutrients originating from the seasonally inundated area that is heavily vegetated with hydrophytes (mainly hardhack) underneath the power lines on the southern side of Golden Ears Way. The establishment of a functioning riparian zone over time, albeit on the east bank away from the road right of way, will add benefits to downstream fish habitat. At the very least, therefore, the drainage should maintain its “Class B” status.

Any development in this identified focal area must take into account potential impacts to water quality and water volume, given the proximity of fish habitat. The drainage that parallels the southern side of 96<sup>th</sup> Avenue is known to support fish, as does Leoran Brook. Development-related pressures must be mitigated, to ensure that impacts are identified and addressed.

One of the more obvious potential impacts is related to stormwater flow. Development activities typically result in a decrease in natural infiltration rates and increased stormwater runoff due to the increase in impervious surface cover. Peak flows in streams usually increase as a result of urban development (if not properly managed), which can have direct impacts on numerous fluvial processes, including sediment movement/deposition and bank stability. The frequency of very low summer flows is also increased as a result of an increase in the amount of impermeable surface cover. Proposed development in this area, therefore, must aim to achieve a “no net gain” in stormwater runoff.

Mitigation techniques regarding stormwater management may include installing bioswales, constructing rain gardens to capture storm run-off from roof tops, using permeable products for paved surfaces or constructing rock drains to encourage infiltration. An appropriately qualified professional should be involved from the planning phase when proposing development in this area to ensure that a site-specific stormwater management plan is designed and implemented.

Landowner education would also serve to decrease potential impacts from urban development on adjacent fishery resource values. Run-off from urban areas can contain toxins that are transportable into natural watercourses (e.g. via storm drains). Landowners should be informed about the potential impacts and proper management of, for example, hydrocarbons or fertilizers/pesticides.



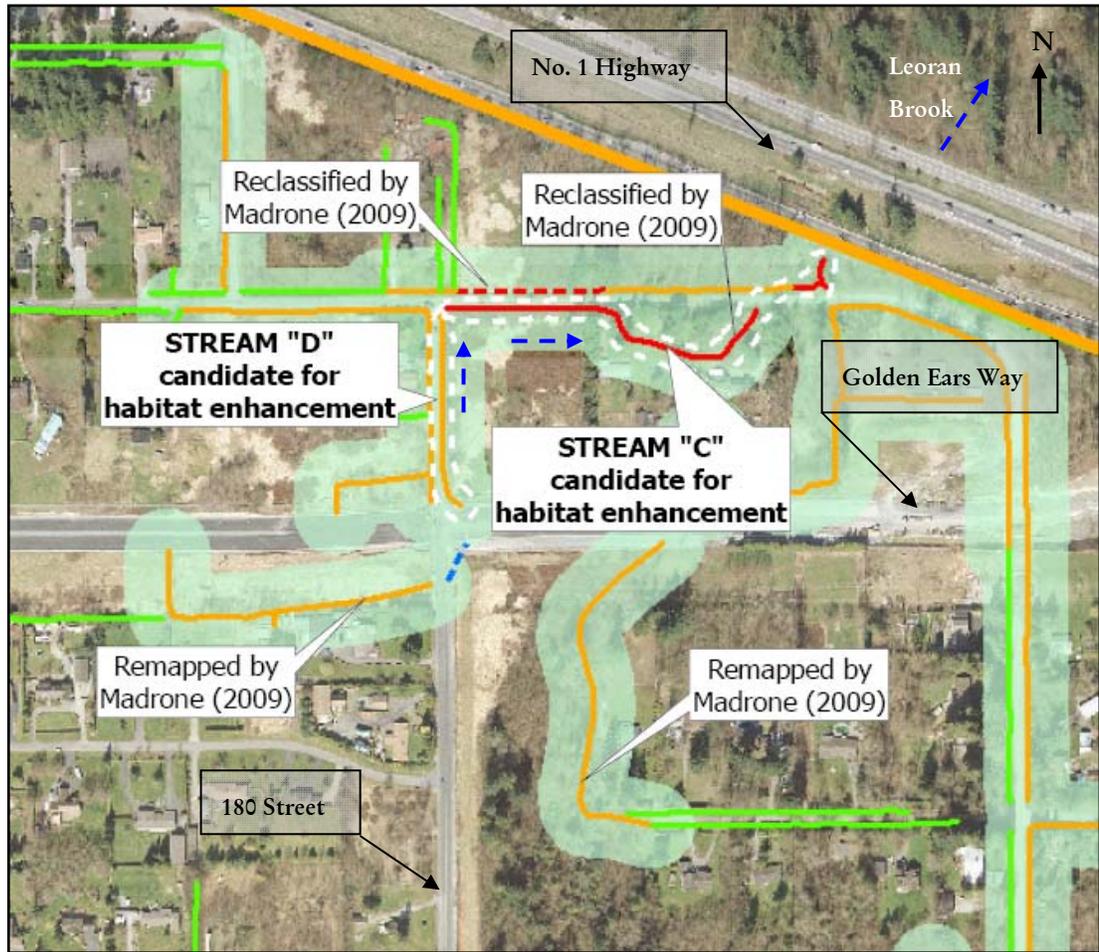


Figure 5. Subject drainage network – Area 3.

### Photos – Area 3



Looking south along the perennial ditch running parallel to 180<sup>th</sup> Street. Note existing lack of functioning riparian vegetation. Riparian vegetation will be perpetually limited on the west side, given the proximity of the road right of way.



Seasonally flooded hardhack-dominated area following the power lines on the southern side of Golden Ears Way. Water collecting in this area drains into the watercourse pictured above and ultimately forms part of the Leoran Brook watershed.



**WILDLIFE/ECOLOGY:**

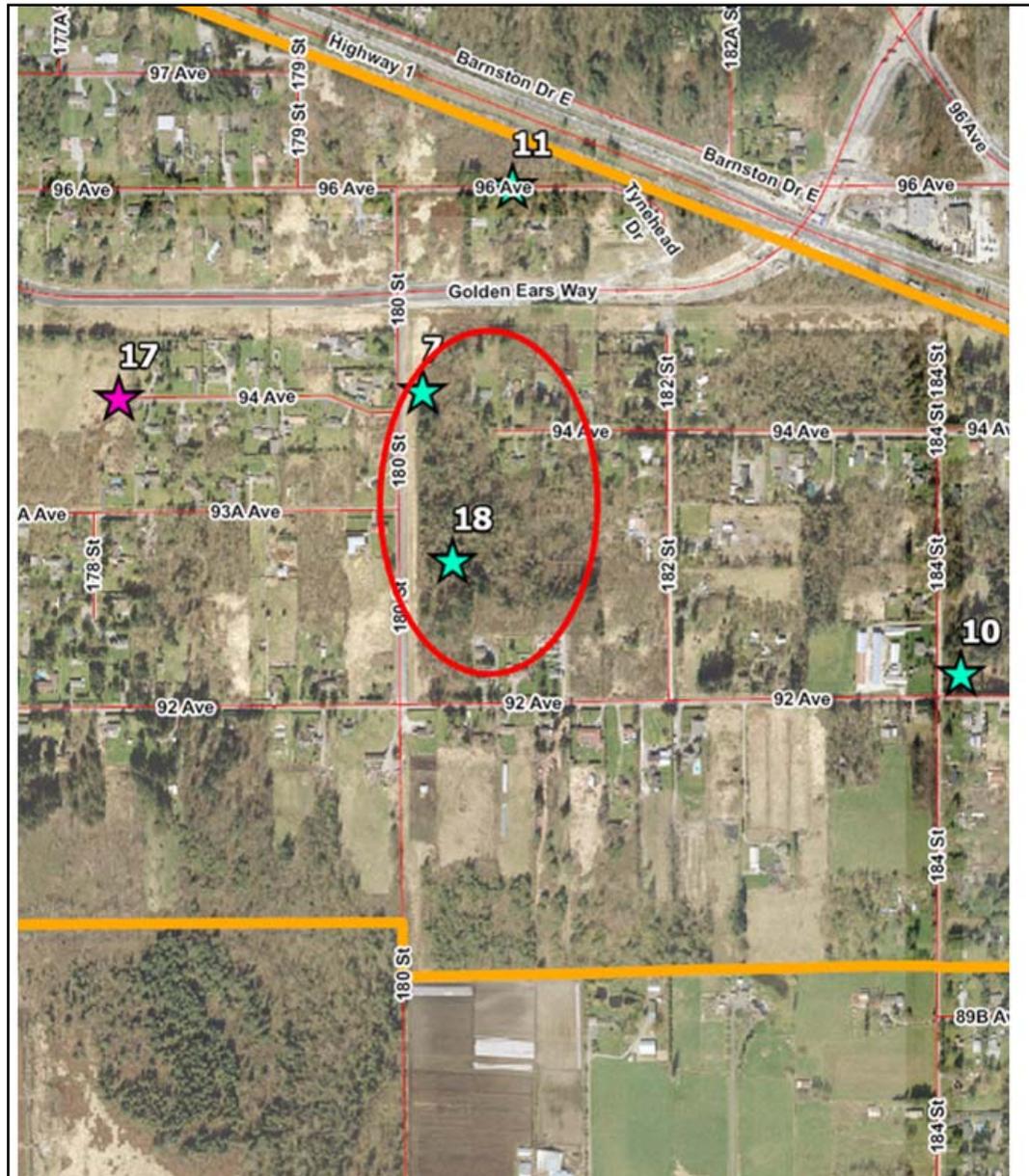
The ecological attributes in Area 3 – Figure 6 - (e.g. vegetation cover, wildlife trees and other significant mature trees) can be maintained with 40% retention if appropriate planning is employed. Development plans should identify wildlife trees and other significant trees and maintain large patches of vegetation (15 m to 20 m diameter or greater). If possible, these wildlife patches should be composed of an even mixture of coniferous and deciduous species in an unevenly aged distribution. The wildlife patches should include berry producing tree and shrub species (e.g. salmonberry – *Rubus spectabilis*, red elderberry – *Sambucus racemosa*, thimbleberry – *Rubus parviflorum*, red huckleberry – *Vaccinium parvifolium* and bitter cherry – *Prunus emarginata*) and wildlife trees, as these promote bird activity and species diversity. Wildlife trees and coarse woody debris left on the ground are beneficial to numerous wildlife species.

In the built portion of the site, significant mature trees should be identified and retained if possible. Other trees destined to be cut should be topped to retain the snag for the production of future wildlife tree habitat, assuming the remaining snag is not a safety hazard.

Area 3 will benefit from removal of invasive plants. Future land owners should be encouraged to respect the adjacent wildlife habitat and discouraged from dumping garden waste, which readily transmits ornamental invasive plants.

In addition, the biological function of the wildlife patches will be improved by buffering the retention areas by planting a dense layer of native shrubs that discourages human and dog encroachment and provides cover and protection to wildlife and birds. Retention areas should be connected by properly designed travel corridors as discussed in Area 1.





**Figure 6.** Existing forest conditions in Area 3 where survey point 18 for the original EA report was taken. Currently this area is lightly developed and is in close proximity to patches of forested habitat. Forty percent tree retention could achieve wildlife conservation goals if appropriate management practices for urban land development are implemented.



**Recommendations – Area 3**

<b>Stormwater Management and Water Quality</b>	<b>Wildlife and Ecology</b>
Maintain (and enhance) existing riparian areas.	Identify and retain wildlife trees.
Capture stormwater flow and filter pollutants through implementation of bioswales and retention ponds.	Establish retention patches around wildlife trees. Retention patches should be at least 15 m to 20 m in diameter.
Minimize the areas to be paved.	Retention patches should be connected to provide a travel corridor between them.
Use permeable paving and/or gravel surfaces wherever possible.	Wildlife travel corridors should be at least 10 m to 15 m wide.
Educate future landowners about the proximity and value of adjoining fish habitat to achieve a sense of stewardship.	Retention patches and travel corridors should be buffered by dense native shrub vegetation to deter predation by domestic animals and human encroachment.
Educate landowners about stormwater management techniques and maintaining water quality – e.g. limiting use of chemical fertilizers/pesticides and installing raingardens or “green rooftops” to capture, or reduce, stormwater run-off from impermeable surfaces.	Retention patches should be composed of an even mixture of coniferous and deciduous tree species. Preferably the patches should be composed of an uneven aged distribution to ensure habitat complexity at the herbaceous layer, mid layer and canopy layer.
Aim towards a “no net gain” in stormwater leaving developed areas by employing appropriately qualified professionals at the early development stage.	Wildlife trees and coarse woody debris should be left in place as they provide beneficial habitat niches to numerous wildlife species.
	Wherever possible, it is preferable to top mature trees rather than full removal, as this will provide future wildlife tree habitat.
	Invasive plants should be removed from wildlife habitat areas.
	Landowners should be educated and informed to not dump domestic exotic plant clippings in natural areas as these can cause the spread of invasive species.

*Area 4. – Upon aerial inspection (high definition aerial photos), this area appears to contain a matrix of water courses / ditches and small dykes. The drainage/soils in this area seem quite limited. What type of limitations would small lot medium density housing development have in this area? Do you imagine significant fill required to develop this area would impact drainages to the south significantly?*

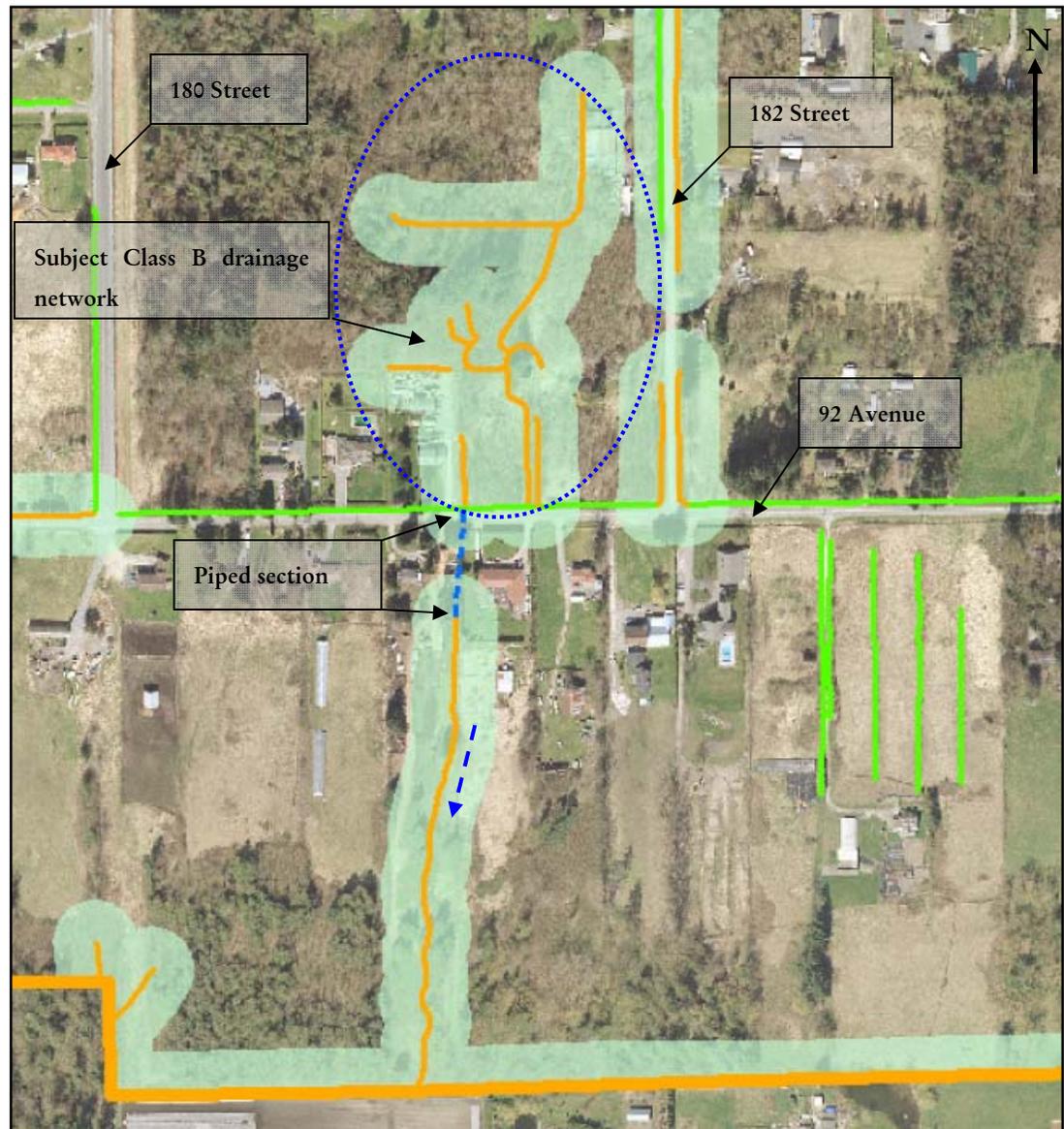
**Response:**

This area is naturally moist, which is a function of the underlying soil type. Vegetation type is indicative of the moist conditions, with red alder (*Alnus rubra*), trembling aspen (*Populus tremuloides*) and black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) occurring. Poorly defined drainages (Non Classified) occur throughout the area, with two main ditches running parallel to an overgrown road access and a main ditch running east-west through the centre of the subject area. A defined, incised channel with natural sinuosity and alluvial deposits exists in the northern portion of the site, although anthropogenic disturbance on the subject area has resulted in the loss of this natural channel further to the south.

Area 4 represents a catchment for water that flows to the south and connects with the Class B drainage on the southern side of 92<sup>nd</sup> Avenue. Water draining from the site is piped from the southern side of 92<sup>nd</sup> Avenue, although it becomes daylighted again, as part of a natural system that connects with a “Class AO” system to the south (Figure 7).

Development in Area 4, especially if significant fill is required, would likely lead to an alteration of the existing drainage pattern. Fish habitat located downstream may be adversely impacted, given the connectivity of the Class B drainage to the south of 92<sup>nd</sup> Avenue with seasonal fish habitat.

Again, the goal of the development process must be to properly manage stormwater run-off, which will help to avoid negative impacts associated with increased peak flows and reduced summer flows in connected systems. Mitigation measures for both stormwater management and water quality for this area should follow the same general techniques listed previously. More detailed fieldwork may be required prior to the development phase to properly identify the main water conveyance zones and water retention areas.



**Figure 7.** Subject drainage network – Area 4.

**Recommendations – Area 4**

<b>Stormwater Management and Water Quality</b>
Delineate water retention and conveyance zones in the moist depression.
Emulate existing flow/retention rates from the site through proper stormwater management, to decrease potential flow regime impacts on connected downstream systems.
Minimize the areas to be paved.
Use permeable paving and/or gravel surfaces wherever possible.
Educate landowners about stormwater management techniques and maintaining water quality – e.g. limiting use of chemical fertilizers/pesticides and installing raingardens or “green rooftops” to capture, or reduce, stormwater run-off from impermeable surfaces.
Aim towards a “no net gain” in stormwater leaving the developed area by employing appropriately qualified professionals at the early development stage.

If you have any questions or concerns regarding the responses, please do not hesitate in contacting us.

Sincerely,




Jason Barsanti, B. Sc., R.P.Bio.  
Madrone Environmental Services Ltd.




Trystan Willmott, B.Sc., A.Sc.T.



## **APPENDIX**

### **Example Photographs of Stormwater Management Techniques**

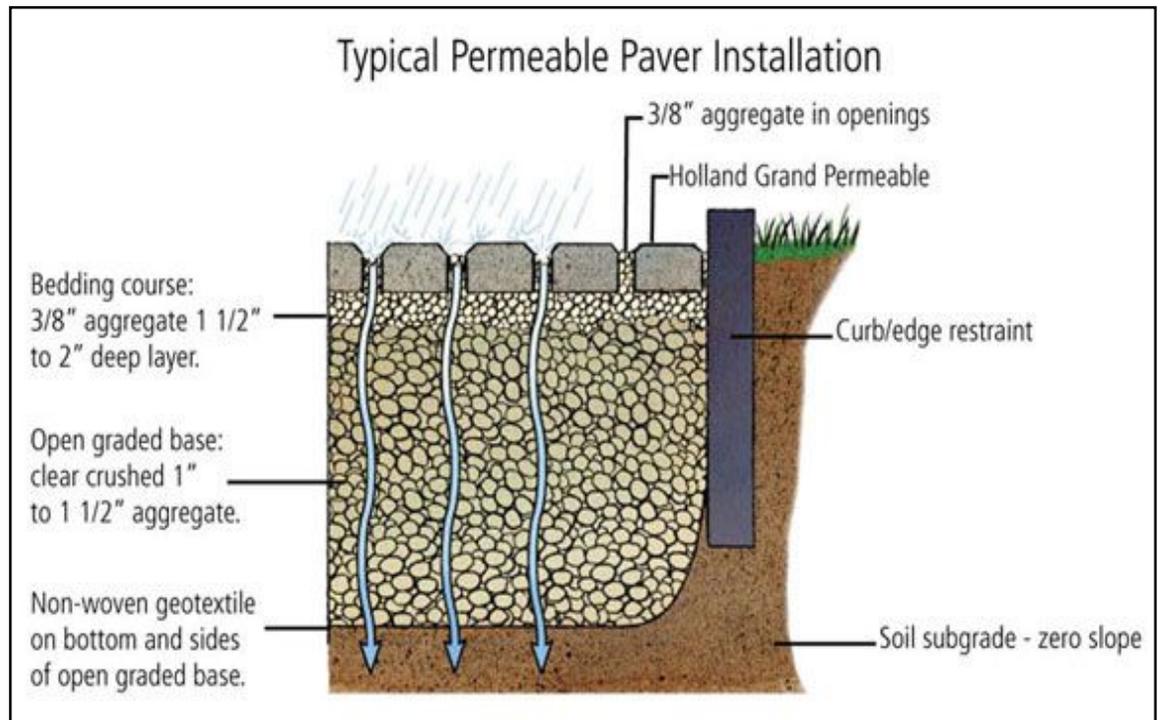


Vegetated roadside bioswale.



Vegetated / gravel-lined bio-swale in subdivision setting.

**Examples taken from:** <http://www.crd.bc.ca/watersheds/lid/swales.htm>



Permeable paving technique example.

**Taken from:**

[http://lh6.ggpht.com/\\_jisbdieVfo/S5alCM5XzZI/AAAAAAAAE9s/Y0GO-9\\_fTXI/permeable-cross-section%5B1%5D.jpg](http://lh6.ggpht.com/_jisbdieVfo/S5alCM5XzZI/AAAAAAAAE9s/Y0GO-9_fTXI/permeable-cross-section%5B1%5D.jpg)



Example of an urban-setting rain garden.

**Taken from:**

[http://api.ning.com/files/J3HCp-w15Y1NMyMmduK2XKh6TFjCqvYeLZYoER3PSYMM8FFXk7Eq1MrYUKEBNqhut8F9b5U-7dDYGwajQ4SGnnMxN9\\*Oodg-/raingarden04.jpg](http://api.ning.com/files/J3HCp-w15Y1NMyMmduK2XKh6TFjCqvYeLZYoER3PSYMM8FFXk7Eq1MrYUKEBNqhut8F9b5U-7dDYGwajQ4SGnnMxN9*Oodg-/raingarden04.jpg)