

**URBAN WATERSHED  
RIPARIAN AREA HEALTH ASSESSMENT**



*Ellen's Creek*

*Wright's Creek*

Prepared by: Jason MacEachern

January 2013

**URBAN WATERSHED  
RIPARIAN AREA HEALTH ASSESSMENT**

**Table of Contents**

<b>1. About the Riparian Area Health Assessment.....</b>	<b>2</b>
<b>1.1 Overview.....</b>	<b>2</b>
<b>1.2 Interpretation of Terms and Parameters.....</b>	<b>3</b>
<b>1.3 Weaknesses of the Assessment Tool.....</b>	<b>6</b>
<b>2. The Urban Watershed.....</b>	<b>6</b>
<b>3. Wright’s Creek.....</b>	<b>7</b>
<b>3.1 Description.....</b>	<b>7</b>
<b>3.2 Upland Activity.....</b>	<b>8</b>
<b>3.3 Assessment Results.....</b>	<b>9</b>
<b>3.4 Observations.....</b>	<b>15</b>
<b>4. Ellen’s Creek.....</b>	<b>17</b>
<b>4.1 Description.....</b>	<b>17</b>
<b>4.2 Upland Activity.....</b>	<b>18</b>
<b>4.3 Assessment Results.....</b>	<b>20</b>
<b>4.4 Observations.....</b>	<b>24</b>
<b>5. Conclusion.....</b>	<b>26</b>
<b>6. Appendix A: Survey Parameters and Values.....</b>	<b>27</b>
<b>7. Appendix B: Assessment Data.....</b>	<b>28</b>

# **1. ABOUT THE RIPARIAN AREA HEALTH ASSESSMENT**

## **1.1 Overview**

The Riparian Area Health Assessment is a survey designed to determine the overall functionality of the riparian zone. The survey is based on eleven parameters related to riparian health. By evaluating these parameters a score out of 100% is generated for each segment of the riparian area. Using these scores, it is possible to identify areas that are currently functioning properly (>80% = green), functioning with problems (60%-80% = yellow), or are non-functional (<60% = red). It is important to identify problem areas in order to improve the health of the riparian area, which will ultimately improve the water quality, stream flow, and overall habitat. By assessing the riparian zone, it is also possible to recognize areas where upland activities could pose a risk to the health of the watershed.

This assessment evaluates riparian area functionality only, and does not take into consideration the condition of the stream itself. A similar survey structured around stream features (water flow, fish habitat, siltation etc.) is used to assess stream health. In most instances, stream health is a function of riparian health; however, it is possible that a stretch may score high on the riparian assessment, while exhibiting poor stream health. Similarly, the riparian area can score low in functionality, in an area where the stream is in good condition.

A healthy riparian area will contain substantial vegetative cover consisting of native trees and shrubs. The stream banks will be held together with deep rooted plants, and the floodplain will be easily accessed by high water. The healthy riparian area will be void of invasive species and weedy plant species that are typically found in disturbed areas. Human activity resulting in exposed earth, compacted ground, or vegetation loss are also considered detrimental to riparian health. A functional riparian area will act as a corridor for wildlife, while providing food, water and cover to both terrestrial and aquatic species. Vegetation will protect the stream by filtering sediment, nutrients, and contaminants from surface runoff. A healthy riparian area will also minimize erosion, regulate water temperature, and decrease flood severity.

It must be noted that the assessment is not an exact science. Although there are standard guidelines for answering each survey question, results can vary depending on the assessors' interpretation of the guidelines. The survey guidelines are

outlined in the Riparian Area Health Assessment Training Booklet. The following interpretations of terms and parameters were applied to this assessment:

## **1.2 Interpretation of Terms and Survey Parameters**

The Reach:

Referring to the stretch of riparian area included in one survey assessment. From the starting point, the assessment area would continue along the stream, until there is a distinct change in the riparian features. This would include changes in vegetation species or density, riparian width, stream bank condition, disturbance, or any other alteration of the riparian zone (trails, bridges, forestry activity etc.).

The Riparian Area :

The transitional zone, between the stream and upland vegetation. This included the stream banks and floodplain, along with the wetland plant species (cattail, sedges), and drier riparian plant species (alder, spruce).

Survey Questions:

**1.** How much of the riparian area is covered by vegetation?

All types of vegetation were considered, including grasses, herbaceous plants, shrubs and trees. If a drop of rain fell from the sky, would it hit vegetation or bare ground? By asking this question, the ratio can be used to approximate vegetation cover. This survey question is correlated with question 8, which asks about the presence of bare ground.

**2a.** How much of the riparian area is covered by weeds?

In this case, “weeds” are referring to invasive plant species which have the potential to cause environmental harm. A list of invasive species likely to be found in the riparian area has been compiled for the purpose of this assessment.

**2b.** What is the density/distribution of the weeds?

The density of the invasive species was scored in accordance to the table provided in the Riparian Area Health Assessment Training booklet. If the invasive plants were sporadically distributed, “few” was chosen. If the invasive plants were growing in clusters, “patches” was chosen. If the invasive plant dominated the assessment area, “common” was selected.

**Table 1. A table listing invasive plant species likely to be found in the riparian area. Provided by the Prince Edward Island Invasive Species Council.**

Invasive Species Found in the Riparian Area  
(Orange = not common on PEI, but very harmful)

<b>Bittersweet Nightshade</b>	<i>Solanum dulcamara</i>
<b>Common reed grass</b>	<i>Phragmites australis ssp. australis</i>
<b>Common valerian</b>	<i>Valeriana officinalis</i>
<b>Dame's rocket</b>	<i>Hesperis matronalis</i>
<b>Flowering rush</b>	<i>Butomus umbellatus</i>
<b>Garlic mustard</b>	<i>Alliaria petiolata</i>
<b>Giant hogweed</b>	<i>Heracleum mantegazzianum</i>
<b>Glossy buckthorn</b>	<i>Frangula alnus, Rhamnus frangula</i>
<b>Himalayan balsam</b>	<i>Impatiens glandulifera</i>
<b>Japanese knotweed</b>	<i>Fallopia japonica, Polygonum cuspidatum</i>
<b>Marsh hedge-nettle</b>	<i>Stachys palustris</i>
<b>Multiflora rose</b>	<i>Rosa multiflora</i>
<b>Oriental bittersweet</b>	<i>Celastrus orbiculatus</i>
<b>Purple loosestrife</b>	<i>Lythrum salicaria</i>
<b>Reed canarygrass</b>	<i>Phalaris arundinacea</i>
<b>Salt cedar</b>	<i>Tamarix spp.</i>
<b>Sedum 'Herbstfreude' (Autumn Joy)</b>	<i>Sedum herbstfreude</i>
<b>Small-flowered touch-me-not</b>	<i>Impatiens parviflora</i>
<b>Wild cucumber</b>	<i>Echinocystis lobata</i>
<b>Yellow flag iris</b>	<i>Iris pseudacorus</i>

3. How much of the riparian area is covered by disturbance caused vegetation?  
This parameter was answered in regards to *recent* disturbance caused vegetation. Most areas have been disturbed at some point, and may have regrown with alders, spruce, willow etc. These areas were not included as disturbance caused vegetation. The focus was on disturbed areas, with the presence of plants that may have shallow root systems, and were not optimal for preventing erosion. (fireweed, grass, hawkweed)

4. Is woody vegetation present and maintaining itself?  
The presence of all trees and shrubs that have a woody stem were included.

5. Is woody vegetation being used?

This parameter took into consideration all woody vegetation that is currently being harvested or consumed. This would include trees that have been harvested by foresters, or land owners, as well as tree growth that is suppressed near trails, or roadways. Trees that have been felled by beavers or browsed by other wildlife were also included. Technically all trees would be used in some way by various organisms (birds, insects, fungi). Uses from sources like these were not considered.

6. How much dead wood is there?

Deadwood in the form of snags and fallen trees is typically beneficial to the ecology of a natural area. This parameter scores the presence of deadwood in a negative way. For that reason, only the presence of unnatural deadwood was considered. This would include patches of trees that had died due to flooding, disease, or human caused mortality.

7. Are the stream banks held together with deep rooted vegetation?

If the majority of the reach had trees and shrubs present along the stream banks, a score of 6 was applied. If cattails, sedges, and other deep rooted herbaceous plants were present along the stream bank, a score of 4 was applied. If these deep rooted plants were only growing along a portion of the reach, a score of 2 was awarded. If the majority of the reach contained shallow rooted plants like grass, or bare ground, a score of 0 was applied.

8. How much of the riparian area has bare ground caused by human activity?

This parameter is correlated with question number one. Is soil currently visible, and is it the result of a non-natural phenomenon such as sediment deposit. Bare ground could be caused by grazing cattle, farming activity, forestry activity, trails, roadways, excavation etc.

9. Have the stream banks been altered by human activity?

Factors that have changed the structure of the banks, including timber harvest, landscaping, bridges, culverts, and stream crossings are considered. Stream enhancement techniques were not included.

10. Is the reach compacted, bumpy, or rutted from use?

For this parameter, compacted trails, roadways, plowing and tilling were considered, as well as the presence of docks, bridges, or asphalt.

11. Can the stream access its floodplain?

If the floodplain was near the same elevation as the surface water in the stream, a score of 9 was applied. If the floodplain was slightly higher than the surface water in the stream, a score of 6 was applied. If the stream was somewhat entrenched, a score of 3 was applied. If the stream was deeply entrenched, a score of 0 was applied.

### **1.3 Weaknesses of the Assessment Tool**

Potential sources of error found within the assessment were identified upon completion. The subjective nature of some parameters, and terms used in the survey can result in misinterpretation. By following standard guidelines, some of the deviation can be minimized. Two parameters measure the presence and density of invasive plant species. This evaluation does not consider the significant variation in harmfulness between invasive species. Some plants have the potential to destroy the riparian ecosystem, while others may have little detrimental effect. The difference is not reflected in the scoring of these parameters. To a lesser extent, the same concept can be applied to parameters involving the presence and density of woody vegetation. Some species are more desirable than others, and would benefit the riparian area more than others woody plants. Also, because the assessment was completed in the fall months, some of the herbaceous plant material had begun to die off. In some instances, this made identification of certain plants a challenge.

## **2. THE URBAN WATERSHED**

The City of Charlottetown's urban watersheds consist of Ellen's Creek, Hermitage Creek, Wright's Creek, Riverside, and portions of Winter River and North River. Compared to a traditional watershed, the urban watersheds exhibit a more active and developed landscape. Streams flow through residential, commercial, industrial, and agricultural property. Development often borders close to the waterways, resulting in greater risks caused by smaller riparian areas and fragmented habitat. Upland activities are more likely to have an effect on water quality, habitat, and overall stream health. Features such as stream crossings and roadways are more plentiful within the urban watershed, increasing the need for proper management. In order to build a foundation for future management, baseline data must be collected. The Riparian Area Health Assessment provides an insight into the health

of the waterways, and creates a starting point for an urban watershed plan. The assessment is based largely on vegetation, disturbance, and human activity. It is normally conducted along non-urban streams, which have a more natural landscape. Due to the nature of the urban watershed, low levels of riparian functionality may be expected in some areas. Several parameters of the assessment could have been modified to better suit the urban setting. However, no changes were made in order to facilitate a standardized approach. This way, the data collected could be compared to results from similar studies in other watersheds.

### **3. WRIGHTS CREEK WATERSHED**

#### **3.1 Description**

Wrights Creek Watershed is located on the east side of the City of Charlottetown, encompassing most of the community of East Royalty, and a portion of Sherwood. It empties as a second order stream into the Hillsborough River near the bridge once linking Robertson Road and Acadian Drive. The northernmost branches (north of St Peters Road), consist of small streams and springs that flow through woodland, residential development, and agricultural land. These branches flow into Andrews Pond, which is located at the St Peters Road crossing. South of Andrews Pond, Wrights Creek merges into a larger stream which meanders through salt marsh before meeting the Hillsborough River.



**Figure 1. An aerial photograph of the Wrights Creek Watershed with added stream layer.**



## **3.2 Upland Activity**

### **Residential**

The majority of Wrights Creek Watershed consists of residential development. Urban expansion into the rural communities has been ongoing, and new subdivisions are currently being established off Norwood Road, and Robertson Road. Most of the residential development within the watershed consists of single dwelling homes, condos, and small apartment buildings.

### **Commercial**

The Charlottetown Airport is located on the northern portion of the watershed. The airport drains its runways directly into Wrights Creek, resulting in large amounts of sediment being deposited into the stream. This is the only major commercial development found within the watershed, but several small businesses and corner stores are located throughout the area.

### **Industrial**

Industrial activity found within the watershed includes a large shale pit, just south of the airport. The pit contains rubble, construction debris, and piles of exposed earth. The East Royalty lagoon is located off Robertson Road in East Royalty. Effluent from the lagoon drains into Wrights Creek at the salt marsh. A landfill which has been out of operation since 1970 is located on the eastern side of the watershed. Although garbage is no longer dumped here, remnants of waste can be found throughout the surrounding land.

### **Agricultural**

Although not as plentiful as it once was, there is still some farmland found within the Wrights Creek watershed. There are several agricultural fields which border the stream in the northern portion of the watershed, and one along the western side of the salt marsh.

### **Recreational**

There is considerable opportunity for recreation contained in the Wrights Creek Watershed. A popular nature trail in the Royalty Oaks Natural Area stretches along the salt marsh. On the eastern side of the salt marsh, an unofficial trail system is used by mountain bikers. A soccer complex is located off Robertson Road, near the lagoon, and several baseball fields are found within the watershed.

### 3.3 Assessment Results

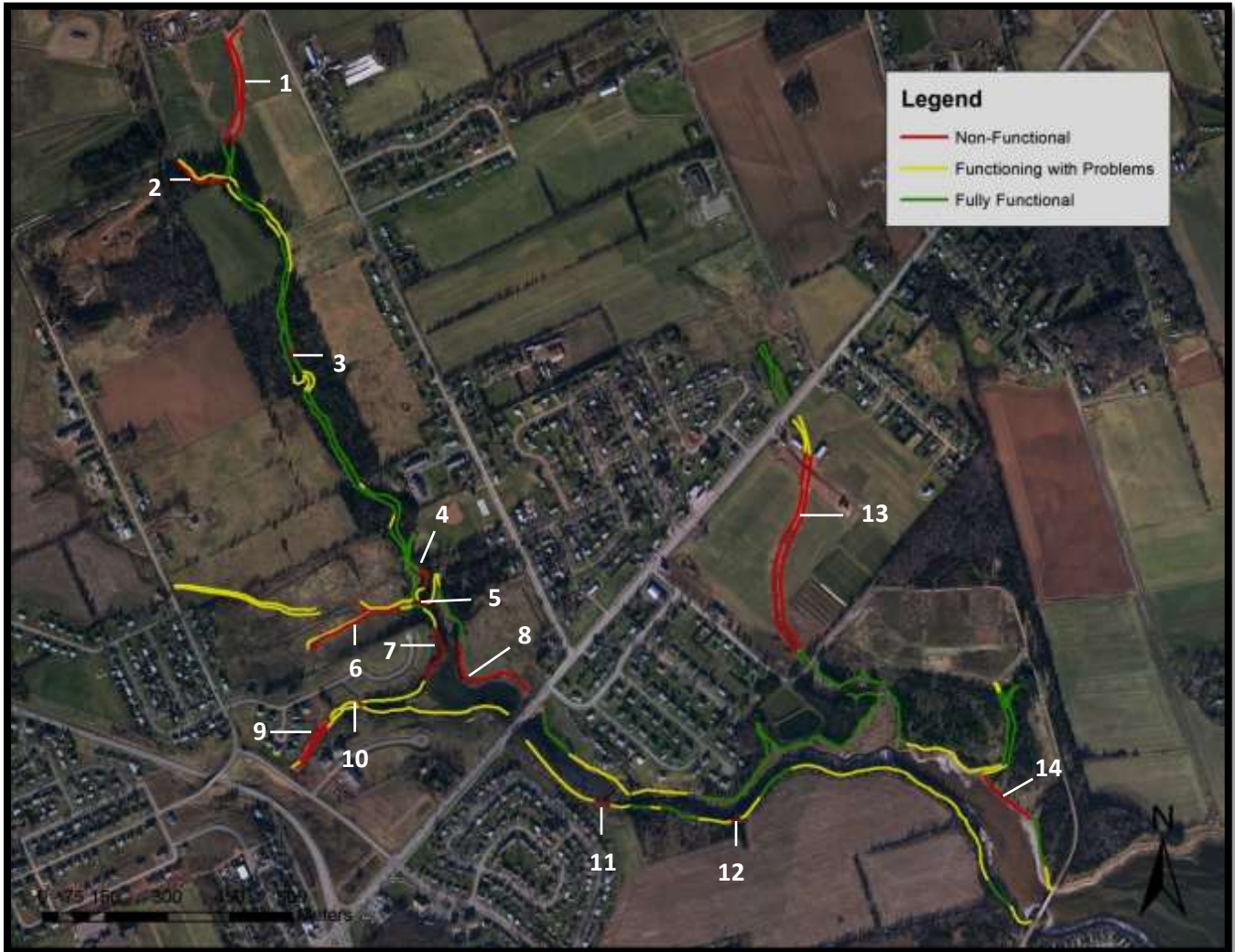


Figure 2. A map of Wright's Creek showing the degree of riparian area functionality.

Upon completion of the Riparian Area Health Assessment on Wright's Creek, a large portion of the riparian area was found to be functioning at a high or acceptable level. These numbers are correlated with the significant amount of woodland found along the watercourses. The northernmost branch of the stream flows through mixed coniferous/deciduous woods. In some sections, large Eastern Hemlock (*Tsuga canadensis*) and Yellow Birch (*Betula alleghaniensis*) grow along the stream banks. These species are indicative of remnant Acadian forest, which is rare to see within city limits. Several springs feed into the stream along this branch, which consistently scored above 80% (green), signifying optimal functionality in

these areas. The branch of the Wrights Creek found south of St Peters Road also exhibits a high level of functionality. Large hardwood trees including Red Oak (*Quercus rubra*) and American Beech (*Fagus grandifolia*) grow along the western side of this stretch. A popular walking trail is found here, which resulted in most of the stretch being scored in the second tier (60%-80% = yellow). This indicates the riparian zone is healthy, but has problems that may pose a risk to its functionality. The trail creates a compacted area of bare ground, which can result in excess runoff carrying sediment or contaminants into the stream. Large patches of Glossy Buckthorn (*Frangula alnus*), grow along the trail. This invasive plant has the potential to outcompete native species, which could pose a risk to riparian health. On the eastern side of this stretch, dense stands of White Spruce (*Picea glauca*) are found along the riparian area. The majority of this section was determined to be functioning properly, with no major risks present (>80% = green). Several stretches of Wrights Creek were flagged as being unhealthy and non-functional (<60% = red). For discussion purposes, these stretches were numbered from 1 to 14. Descriptions of each red zone, along with possible restorative actions are listed:

#### Non-functional Riparian Areas:

- 1- Red zone 1 is one of the larger stretches of unhealthy riparian area in the watershed. A small tributary originates near Union Road, and flows south through agricultural land. Only a small, grass buffer borders the stream along this entire stretch. No woody vegetation exists here due to active farming practices, which suppress such growth. These conditions are typical of smaller waterways which pass through farmland, as farmers attempt to maximize production. By allowing the buffer to naturally regenerate, along with supplemental tree planting, the riparian area will function at a higher level.
- 2- Red zone 2 is found on along the western side of the northern branch, beginning at the corner of Norwood Road. The riparian area has recently been affected by forestry and industrial activity. Trees have been harvested along the reach, which has left bare ground, and loss of vegetative cover. Tracks from large machinery have left ruts along a portion of the reach. This zone has a high potential for sediment to enter the stream from erosion, and runoff from the large shale pit adjacent the stream. The stream banks along this zone have been lined with large boulders in an attempt to curb erosion and hold silt during high water events. Native trees could be planted along the stream to further stabilize

the banks. Additionally, the stream could be better protected from sediment originating at the shale pit, with silt fencing and planting.

- 3- Red zone 3 is a small space found midway down the northern branch, on the east side of the stream. It appears a strip has been cut through the woodland to create an access point to a small pond found at this location. The land is cleared down to the edge of the stream, leaving no woody vegetation along this segment. Piles of harvested brush exist close to the stream. These piles should be moved away from the watercourse, as they could cause a blockage if they are carried into the stream by high wind or high water. The cleared land should be replanted to restore proper stream cover, erosion control and bank stabilization.
- 4- Red zone 4 is located just north of Andrew's Pond, on the eastern side of the stream. Here, a large silt trap has been excavated, and the stream has been slightly diverted. The reach has been cleared of vegetation to allow access for large machinery needed to complete the work. The result is a substantial area of bare ground just above the silt trap. Any heavy rainfall could result in excess sediment entering the stream from this exposed earth. Also, due to a lack of vegetative cover, and slow moving water pooled at the silt trap, the water temperature could see an increase during the summer months. This could lead to further problems stemming from lower levels of dissolved oxygen. Short term remediation could involve covering the exposed earth with hay to reduce the impact of rain. Furthermore, the area could be seeded out to provide more of a long term solution. The planting of woody vegetation here would not be practical, as this zone must accommodate machinery to excavate the silt trap in future years.
- 5- Red zone 5 is a short distance downstream from red zone 4, and exhibits the same riparian characteristics. It appears this area has been cleared during the recent stream alterations, exposing a large area of bare ground. Again, this exposed earth has no vegetation to help reduce sediment from entering the stream during rainfall. The stream flows faster here, and a high water event could cause substantial erosion of the stream banks. The riparian area is very dysfunctional, and the risk of damage to the stream is high. Heavy planting of trees and shrubs, and soil protection in the form of grass or mulch would be beneficial to this zone. For more immediate protection, hay bales, and silt fencing along the stream could be appropriate treatments.





**Figure 3. A photo of red zone 5, a non-functional riparian area.**

- 6- Red zone 6 is found along the westernmost branch of Wrights Creek. This small tributary had not been included on the most recent stream layer map of the watershed. The tributary originates from a small wetland area which flows east to the main branch. It appears as a straight line, and could possibly be carrying water through a manmade trench left from past farming activity. There is no woody vegetation along the reach, as the field consists of grass and weedy plants such as Bull Thistle (*Cirsium vulgare*). Although this zone scored low on the assessment, water flow here is minimal, and there does not appear to be any immediate risks to the stream. Much of the water seems to dissipate into the ground. Several large springs are located just downstream, which feed groundwater to the main branch of Wrights Creek.
- 7- Red zone 7 stretches along the western bank near the back of Andrew's Pond. The reach contains a wide, bare trail that borders the pond near its edge. Upland, a large area has been cleared for residential development, exposing large mounds of earth. In some locations along the trail there are clearings

which form a clear path for runoff from the upland development down to the stream. The wide trail creates a large gap in the riparian area, and further compounds the risk of siltation of the pond. Modifications to the walking trail are necessary to prevent siltation of the stream/pond. The addition of plant material along the edges of the trail would narrow it to an appropriate width. Covering the trail with gravel or mulch would prevent erosion, and help to trap silt.

- 8- Red zone 8 spans nearly the entire east side of Andrew's Pond. The land surrounding the pond has recently been subject to disturbance caused by heavy machinery. The pond has been dredged as part of a restoration project which involved removing excess silt. The riparian zone is currently non-functional, due to the large area of exposed earth, and minimal vegetation. To ensure the success of the restoration project, the riparian area should be improved to prevent the upland sediment from re-entering the pond. The width of the riparian area should be increased by planting native trees and shrubs along the thin sections. Also, the upland area should be seeded to prevent sediment from moving closer to the pond during rainfall. More immediate treatments could include, silt fencing or hay bales along the banks, and hay or erosion control blankets on the adjacent land.
- 9- Red zone 9 is located along the branch that flows between Elena Court and Herbert Street. Residential development in this sub division is ongoing, as new homes and duplexes are being built along Herbert Street. The riparian zone here does not provide sufficient protection from potential upland hazards. The risk of gasoline, oil and other harmful substances entering the stream is high due to the proximity of parking lots. On the south side, a steep hill slopes from a parking lot to the stream, facilitating the flow of runoff and contaminants. In order to function properly, the riparian area needs to be larger in places where the topography presents such a slope. By planting trees and shrubs along this zone, rainwater will be filtered more effectively. On the north side of the stream, the vegetation has been suppressed by mowing, resulting in a lawn like riparian area. This side would also benefit from tree planting and the natural regrowth of the mowed area.
- 10- Red zone 10 is located by a small pathway. This area was flagged as being non-functional due to the direct access to the stream where the trail crosses. The

trail has a compacted gravel base, with little woody vegetation along its border. It connects to the trail which runs along Andrews Pond, and sees frequent use by residents of the area. Modification, here may not be realistic nor necessary, aside from the placement of garbage containers.

- 11- Red zone 11 is located near the dam below St Peters Road. This area received a low score due to the lack of vegetation, compacted reach, and bare ground. Although it does not appear to be an imminent risk, this area could be prone to siltation, as the riparian area is not providing adequate protection. Tree planting could improve functionality along this reach.
- 12- Red zone 12 is a small area near the middle of the Royalty Oaks nature trail. This zone was flagged red due to a large gully that carries runoff directly into Wright's Creek. During heavy rainfall, a high volume of water is channelled through the gully, and has resulted in significant erosion of the bank. Proper drainage is needed to prevent sediment from being washed into the stream. A larger culvert would keep the water from eroding the banks.
- 13- Red zone 13 is a long stretch through agricultural land on the large eastern branch. The stream had minimal flow through this property at the time of the assessment, but appears to carry substantial volumes of water during heavy rain and spring melt. Much like zone 1, a small riparian zone consisting of grass and other disturbance vegetation, borders the stream. By allowing a wider buffer to naturally regenerate, supplemented by tree planting, the functionality of the riparian zone would be improved.

### 3.4 Observations along Wrights Creek

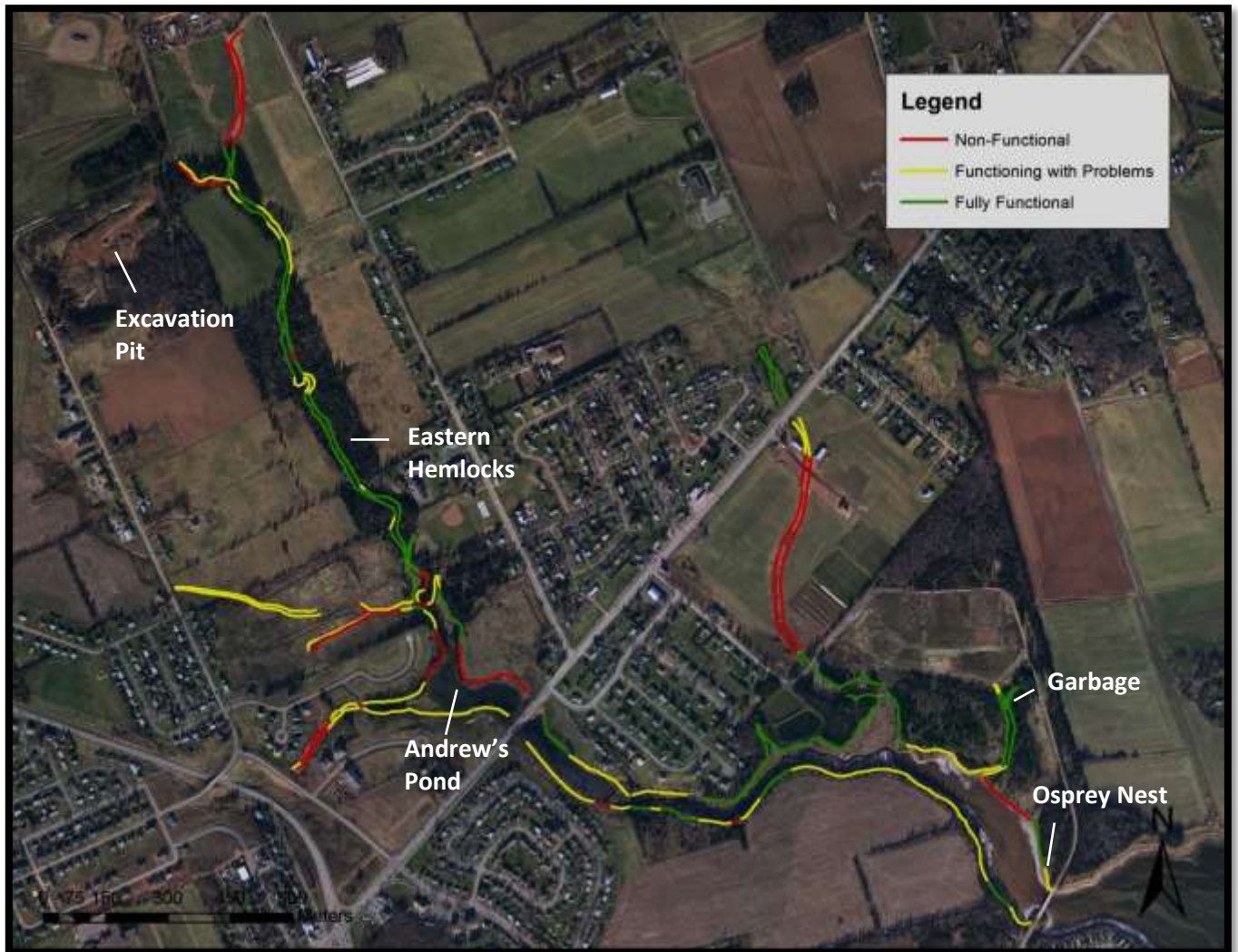


Figure 4. A map of Wright's Creek and notable features.

While conducting the Riparian Area Health Assessment, any notable observations relating to stream conditions, wildlife, and habitat were recorded. These are merely observations and have no bearing on the scores for riparian health.

#### Stream Condition

The main branch of Wrights Creek located north of Andrews Pond, has stretches where the stream is in great condition in regards to fish habitat and stream flow. Several large springs just above Andrews Pond have been cleared and lined with boulders. This water source helps to regulate the stream temperate, and provides



high quality water to the main branch. Further upstream, smaller springs also feed into the creek. Although siltation is a problem along most of Wright's Creek, this northern branch contains stretches where small stones and cobble line the stream bed. This provides suitable spawning locations for fish. Stream enhancement techniques aimed at controlling silt levels are improving spawning habitat. Such improvements to this branch, along with the recent restoration of Andrew's pond will create desirable conditions for fish, and other aquatic life. To the south of St. Peters Road, a small branch feeds the salt marsh from the east. It flows from the old landfill site near Robertson Road. A large amount of garbage, presumably remnants of the landfill, covers the streambed to the point of obstructing water flow. Although this tributary is very small, and volume of water is minimal, the excessive amount of garbage is concerning.



**Figure 5. A photo of garbage along the stream bed near the old dump site.**

## Riparian Habitat

Wrights Creek watershed contains a significant amount of woodland bordering the streams. Along the northern branch, a substantial strip of mixed woods offers excellent habitat for wildlife to thrive near the waterway. The woodland also shelters the stream, providing shade and cover for aquatic life. On the western side of the creek near the salt marsh, a trail runs through hardwood forest. This land provides great habitat for birds, and mammals. On the eastern side of the salt marsh, dense stands of spruce provide animals with cover and nest sites. Near the old landfill site, the riparian area is littered with plastic and other garbage. This is hazardous to wildlife, and inhibits the growth of ground vegetation.

## Wildlife

While surveying Wrights Creek, it became clear that the riparian area and adjacent woodland was rich in wildlife. Near the bridge at Acadian Drive, an Osprey nest is found on top of an electrical pole. A group of Mallards and American Black Ducks were also seen in the estuary south of the bridge. While walking along the eastern side of the salt marsh, a Snowshoe Hare was spotted sitting in the dense spruce. Trails through the bush, and scat indicated the presence of Red Fox. Also, a Ruffed Grouse was flushed from the woodland in this area. An adult Bald Eagle was spotted perched atop a White Spruce midway up the eastern tributary. Along the main branch, north of St Peters Road, signs of Red Fox and Eastern Coyote were found along the stream. Small Brook Trout darted from cover in the stream near the recently restored springs. Approximately 30 Mallards sat in the water at Andrews Pond. Throughout the riparian area, birds typical of the habitat and season were often spotted (Black-capped Chickadee, Red-breasted Nuthatch, Golden-crowned Kinglet).

## **4. ELLENS CREEK WATERSHED**

### **4.1 Watercourse Description**

Ellen's Creek Watershed is located on the western side of the City of Charlottetown, and includes most of the communities of West Royalty and Winsloe. The two main branches flow south, where they empty into North River as a second order stream. The largest branch originates from a spring near Royalty Junction Road, and flows through agricultural, residential and woodland

properties. The smaller branch originates from a wetland area, near the Charlottetown Bypass Highway, east of University Avenue. It flows mostly through residential properties, until it joins the main branch, south of MacNeil's Pond, near Capital Drive and North River Road. The southernmost portion of the stream consists of salt marsh, near the estuary.



**Figure 6. An aerial photograph of Ellen's Creek watershed, with added stream layer.**

## **4.2 Upland Activity**

### **Residential**

A substantial portion of Ellen's Creek Watershed contains residential properties. Large sub divisions are located in the Spring Park, Lewis Point and Winsloe areas. New residential development is currently taking place in the northern portion of the watershed, near the Highfield and Winsloe communities. Most of the residential land consists of single dwelling homes, and small apartment buildings. Recently, several larger apartment buildings have been erected along North River Road.

### **Commercial**

Major commercial development dominates portions of the land within the watershed. Retail outlets, car dealerships, hotels, and parking lots are present

throughout the area, but are especially concentrated along University Avenue, and Capital Drive. As a result of such development, high volumes of water directly enter Ellen's Creek as runoff from the asphalt lots and roadways. Many small businesses and stores have also been established throughout the watershed. Commercial development is ongoing, including areas along Malpeque Road and University Avenue.

### Industrial

Industrial activity within the watershed includes, scrap metal recycling, product manufacturing, heavy transport operations, and waste management services. Most of the industrial activity is contained around the Sherwood Road area, as well as the Industrial Park in West Royalty. The Island Waste Management Corporation operates off Mount Edward Road, near the smaller branch of Ellen's Creek. Contaminants from such industries could pose a risk to the health of the waterways if not properly managed.

### Agricultural

Most of the Ellen's Creek Watershed encompasses an urban landscape; however, some agricultural activity is present in the northwestern portion of the watershed. Most of the farmland in this area appears to have adequate buffer zones, which allows the riparian area to maintain its functionality. The stretch of stream from Sherwood Road, north to Royalty Junction Road is bordered by agricultural fields.

### Recreational

The Confederation Trail intersects both branches of Ellen's Creek, and presents a recreational opportunity for walkers, runners, and cyclists. Several smaller trails also exist around the watershed including one near the West Royalty Community Centre, and one near the Ellen's Creek Reforestation Project off of Irwin Drive. There are several baseball and soccer fields, as well as small community parks and playgrounds which are utilized by local citizens.



### 4.3 Assessment Results



**Figure 7. A map of Ellen's Creek displaying various degrees of riparian functionality**

The results of the Riparian Area Health Assessment on Ellen's Creek show the majority of the riparian area to be functioning at an acceptable level. However, several 'red' areas were discovered. These non-functional zones are relatively small in length, but require action to prevent damage to the waterway. Some of the 'yellow' stretches along Ellen's Creek may also be treated as high risk due to their proximity to major commercial and residential development. This intensifies the risks to riparian functionality, and may require special attention in regards to upland management. In particular, the 'yellow' stretch on the east of the salt marsh may be considered high risk. The assessment results show the healthiest stretch of

riparian area in the watershed is found along the northernmost portion of the stream. North of Malpeque Road, the stream flows through a wooded buffer of desirable species (White Spruce, White Birch), resulting in mostly 'green' scores (>80%). Between Malpeque Road and the Charlottetown Bypass, riparian functionality alternates through 'green' and 'yellow' stretches. Residential properties border close to the stream at some locations along this section, which pose problems to riparian area functionality. Sections of mixed woods meet dense alder and cherry growth near the residential development. South of the Charlottetown Bypass, the riparian area becomes more fragmented in regards to wooded habitat. Although these areas may maintain functionality, they are at risk of becoming non-functional. The branch of Ellen's Creek found on the eastern side of the watershed exhibits an overall healthy riparian area. Potential risks were discovered near MacNeil's Pond and an old field north of here, where gaps in vegetation produced a 'yellow' score. A reforestation project on the northern side of this branch is improving riparian habitat. A description of the nine non-functional red zones found along Ellen's Creek, along with possible remediation strategies are detailed below:

#### Non-functional Red Zones:

- 1- Red zone 1 is found near the origin of Ellen's Creek, by the northern boundary of the watershed. This is a very small stretch, which produced a red score due to its proximity to Royalty Road. Just before the stream enters the culvert, it flows parallel to the road for approximately three to four meters. The bank from the road to the stream could be stabilized with the installation of a gabion. However, this would be expensive and impractical for the minimal water that flows here. The area between the road and the stream is not wide enough to support any tree planting.
- 2- Red zone 2 is located along the section of stream north of Malpeque Road. Here, an old access road or driveway crosses the stream. The stream flow is impeded by poor drainage at the culvert. Also, scrap metal and other waste material has been left in the riparian zone. The stream channel could be dug out to facilitate stream flow by creating a more defined path. Improvement to the riparian area should include the removal of any waste material, and tree planting. If the access road is no longer being used, planting could be expanded to include the roadway.

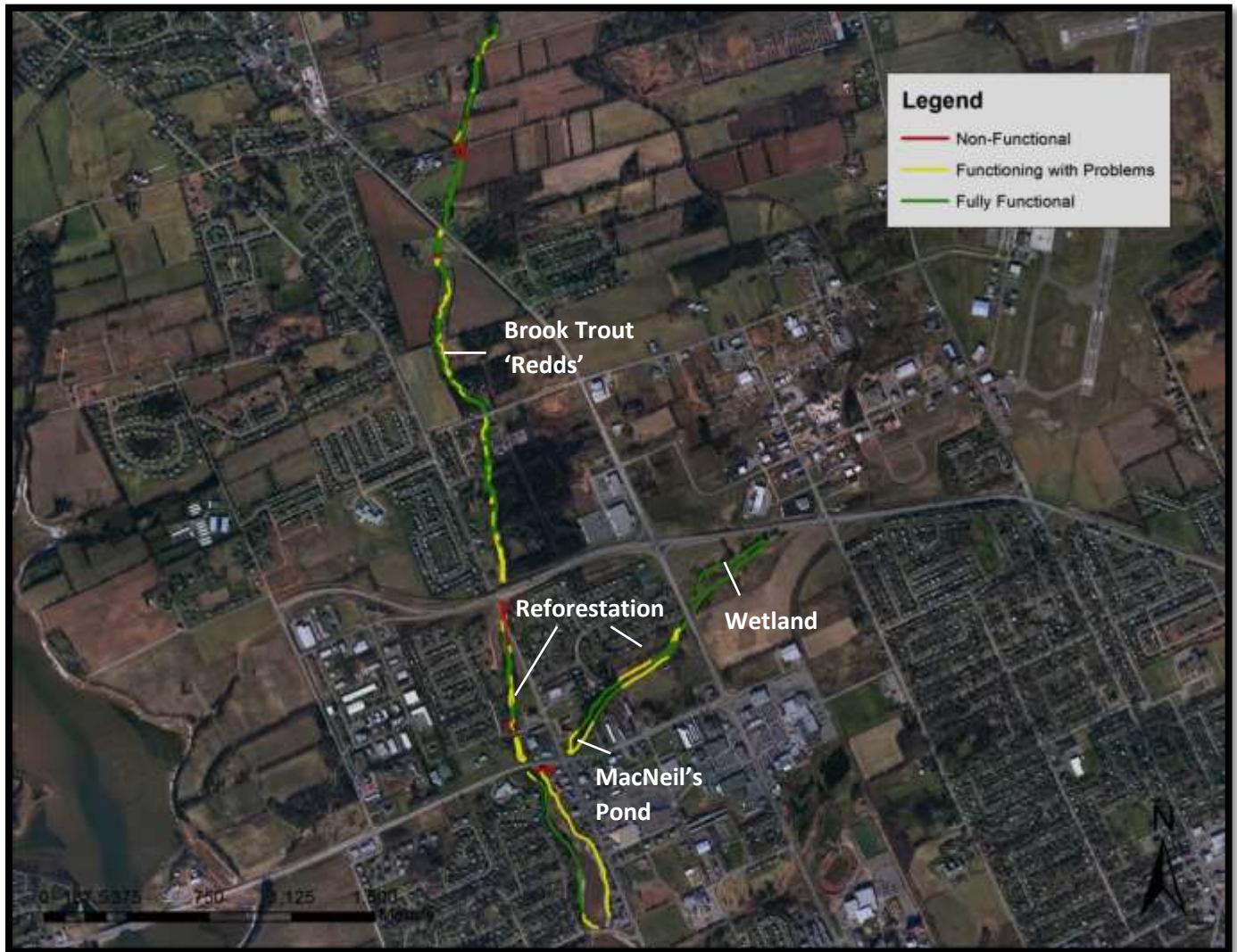
- 3- Red zone 3 is also located in the northern portion of the watershed. An access road crosses the stream here, and poor riparian conditions exist on each side. On the north side of the access road, water flow through the culvert is being obstructed by sediment. This dam is causing water to pool along the bank of the road, and is creating a small wetland area. No woody vegetation is present here, and runoff from the road directly enters the waterway. Stream flow could be improved by clearing the excess sediment in the stream. Riparian health could be improved by stabilizing the banks along the roadway with shrubs, and by planting trees along the stream. Red zone 3 continues on the south side of the stream where a pond has been created. It is possible this pond once acted as a reservoir for a nearby farm. The lack of vegetation, compacted ground, and adjacent land use has resulted in the riparian area being classified as non-functional. The removal of sediment from the pond would allow water north of the roadway to pass through the culvert more easily. Native trees around the pond would help prevent sediment from entering the stream, and improve the overall habitat.
- 4- Red zone 4 is found just south of Malpeque Road, where a driveway crosses the stream. Although stream flow here is unimpeded by the crossing, the riparian area is non-functional due to the lack of vegetation, bare ground, and compacted land. This creates an access point for silt and contaminants to enter the stream via surface runoff. Seeding the bare ground with grass, and trapping silt with hay bales would help repair the riparian area until natural regeneration and tree planting could reclaim the land.
- 5- Red zone 5 is located between Sherwood Road and the Charlottetown Bypass. On the west side of the stream, a residential property borders the stream. Here, mowed grass is suppressing the growth of trees and shrubs, and stretches to the edge of the stream. Bare earth is also exposed at this location, which increases erosion risk. The grass does not provide adequate bank stabilization, and the lack of trees results in insufficient stream protection. By allowing the mowed area to naturally regenerate, woody vegetation would filter runoff, stabilize the banks, prevent erosion, and regulate water temperature. Planting native trees would assist in the regeneration of this area.
- 6- Red zone 6 is found within the small area between the south side of the Charlottetown Bypass and Lower Malpeque Road. The east side of the stream is overgrown with Japanese Knotweed (*Fallopia japonica*), a highly invasive

plant which is harmful to riparian habitat. This plant will out-compete desirable native species, which is the case along this section of the stream. Elimination of the plant is difficult, and would require several years of constant cutting to make significant progress. On the western side of the stream, Lower Malpeque Road borders close by. Compacted ground and the absence of woody vegetation negatively affect riparian functionality. During heavy rains, water flows easily over the asphalt, and can enter the stream directly. Gasoline, oil, and other contaminants from the road have the potential to enter the waterway here.

- 7- Red zone 7 is located just across the road from red zone 6, on the east side of the stream. Similar to zone 6, this area was flagged due its proximity to Lower Malpeque Road. With no real protection from upland activity, access runoff flowing from the road and sidewalk enter the stream. Riparian improvement would be difficult, as there is no more than a few meters between the stream and sidewalk. A large silt trap has been excavated just downstream from this location, which is helping to reduce the negative effects upstream.
- 8- Just north of Kirkdale Road, the stream is bordered by residential properties to the west. This zone was determined to be non-functional because of a lack of vegetation, which is being suppressed by property owners. Furthermore, the risks to stream health are compounded by sloped land, along with significant upland activity. In order to improve the riparian area residents should refrain from mowing and trimming along the stream banks. By allowing this portion to regenerate, improved bank stabilization, filtration, and overall riparian health is possible. Tree planting further would assist the enhancement of the riparian area.
- 9- Red zone 9 is found near the corner of North River Road and Capital Drive. Where the two branches of Ellen's Creek converge, the stream is bordered by the road and a parking lot. This type of landscape makes for a non-functional, high risk riparian area. There is a small space which can support the addition of woody vegetation, but the riparian area cannot be totally restored due to the proximity of development.



## 4.4 Observations along Ellen's Creek



**Figure 8 A map of Ellen's Creek with notable features labeled**

While conducting the Riparian Area Health Assessment, any notable observations relating to stream conditions, wildlife, and habitat were recorded. These are merely observations and have no bearing on the scores for riparian health.

### Stream Condition

Restoration along portions of Ellen's Creek is enabling some areas to operate very healthily. From the Charlottetown Bypass to Malpeque Road, brush mats and digger logs are trapping silt, and improving stream flow. As a result of this, deep

pools are being established, and a stone streambed is being exposed. This creates good habitat for Brook Trout, and several spawning beds were identified here. Multiple springs feed the stream along this stretch of Ellen's Creek. This helps to regulate water temperature and maintain water quality. Watercress, a plant which is typically found near springs, grows along this section. Although some areas have been improved, siltation and reduced stream flow continues to be an issue throughout the watershed. Sediment enters the stream through erosion, heavy rainfall, and seasonal flow, which is increased by surface runoff from the urban landscape. Near the origin of Ellen's Creek, south of Royalty Junction Road, the stream flow is restricted by natural and manmade blockages. Brush and deadwood have been washed into the stream channel during high water events. Two driveway crossings are also resulting in decreased stream flow near this stretch of stream.

### Riparian Habitat

Although no large tracts of woodland are present, much of Ellen's Creek flows through a wooded buffer consisting of mixed coniferous/deciduous stands. Dense alder and cherry growth is also present, which is typical of disturbed areas bordering streams. This habitat provides a corridor for wildlife to occupy the land adjacent the stream. Reforestation efforts along Ellen's Creek are aimed at improving habitat within the watershed. Significant tree planting has occurred along the eastern branch near Irwin Drive, and by the West Royalty Community Centre. Walking trails exist through both of these reforestation sites.

### Wildlife

Although much of Ellen's Creek flows near residential and commercial development, it continues to provide habitat for an abundance of wildlife. The estuary is a haven for waterfowl, which congregate in large numbers near the bridge on Beach Grove Road. Several hundred Canada Geese were seen while assessing the riparian area near the estuary. North of Sherwood Road, an annoyed Belted Kingfisher flew up and down the stream sounding its alarm call at the presence of a human. This stretch was assessed after a dusting of snow, which made multiple sets of fox tracks visible along the stream. Numerous Brook Trout were seen in the stream here, several of which were of substantial size. Evidence of spawning was noted by the presence of egg beds or 'redds' within the streambed. Where the stream originates from a spring north of Royalty Junction Road, a Ruffed Grouse was flushed from a spruce tree. Potential for additional wildlife sightings would be certain during a more active time of year.

## **5. CONCLUSION**

Properly functioning riparian areas are crucial in maintaining healthy waterways. The Riparian Area Health Assessment has provided important insight into the riparian habitat along Wrights Creek and Ellen's Creek. The data creates a base for future management of the urban watershed within the City of Charlottetown. Upon examination of the assessment results, locations along the waterways which may require special attention can be identified. By applying a dynamic and modern approach to management, conservation of the waterways is possible. This is especially important when issues pertaining to water quality and availability are becoming increasingly apparent. The study has also allowed for the identification of highly functional riparian habitat within the urban watershed. It is essential to maintain the functionality of these areas through protection, management, and education. Characteristics exhibited by these areas should be reflected in remediation models for lesser functioning areas, wherever the landscape allows. Due to the urban nature of Wright's Creek and Ellen's Creek, low scoring riparian functionality was expected in certain locations. Although this proved to be true near obvious sites, such as stream crossings and roadways, much of the riparian area displayed adequate to high functionality. Restricted access and early snowfall resulted in some locations to be omitted from the assessment. The portion of Wright's Creek which flows through the Charlottetown Airport property was not completed, as access to the fenced area was not obtained. Expectations to survey Hermitage Creek were limited by the early snowfall, which reduced visibility of the assessment parameters. Accurate data could not be recorded as a result. Completion of these areas will occur in the near future.

## **APPENDIX A: P.E.I. Riparian Health Assessment – Parameters and Values**

1. How much of the riparian area is covered by vegetation? 6=>95% 4=85%-95% 2=75%-85% 0=<75%	6 4 2 0 _____
2.(a) How much is covered by invasive species? 3=none 2=<1% 1=1%-15% 0=>15%	3 2 1 0 _____
(b) What is the density of the invasive species? 3=none 2=few 1=patches 0=common	3 2 1 0 _____
3. How much of the riparian area is covered by disturbance caused vegetation? 3=<5% 2=5%-25% 1=25%-45% 0=>45%	3 2 1 0 _____
4. Is woody vegetation present? 6=>15% 4=5%-15% 2=<5% 0=none	6 4 2 0 _____
5. Is woody vegetation being used or suppressed? 3=none 2=light 1=moderate 0=heavy	3 2 1 0 _____
6. How much unnatural deadwood is there? 3=<5% 2=5%-25% 1=25%-45% 0=>45%	3 2 1 0 _____
7. Are the stream banks held together with deep-rooted vegetation? 6=>85% 4=65%-85% 2=35%-65% 0=0%-35%	6 4 2 0 _____
8. How much of the riparian area has bare ground caused by human activity? 6=<1% 4=1%-5% 2=5%-15% 0=>15%	6 4 2 0 _____
9. Have the stream banks been altered by human activity? 6=<5% 4=5%-15% 2=15%-35% 0=>35%	6 4 2 0 _____
10. Is the reach been altered by human activity? 3=<5% 2=5%-15% 1=15%-25% 0=>25%	3 2 1 0 _____
11. Can the stream access the floodplain? 9=easily accessed 6=stream slightly entrenched 3=stream entrenched 0=deeply entrenched	9 6 3 0 _____
	Total _____ ÷ 57= _____%

**80% - 100% HEALTHY**

**60% - 79% HEALTHY WITH PROBLEMS**

**0% - 59 UNHEALTHY**

## **APPENDIX B: Assessment Data**

### **Reach**

<b>#</b>	<b>Q1</b>	<b>Q2A</b>	<b>Q2B</b>	<b>Q3</b>	<b>Q4</b>	<b>Q5</b>	<b>Q6</b>	<b>Q7</b>	<b>Q8</b>	<b>Q9</b>	<b>Q10</b>	<b>Q11</b>
<b>1</b>	4	2	2	3	4	2	3	2	4	4	3	9
<b>2</b>	6	2	2	3	6	3	3	6	6	6	3	9
<b>3</b>	6	2	2	2	6	3	3	4	4	4	3	9
<b>4</b>	2	2	2	2	4	3	3	4	2	0	1	6
<b>5</b>	6	1	1	3	6	3	3	2	4	2	3	6
<b>6</b>	6	1	1	3	6	3	3	6	4	6	3	6
<b>7</b>	6	2	2	3	6	3	3	6	4	6	3	6
<b>8</b>	6	3	3	3	6	3	3	6	6	6	3	6
<b>9</b>	4	2	2	3	6	3	3	6	4	2	3	9
<b>10</b>	4	3	3	3	6	3	3	6	4	4	3	9
<b>11</b>	4	3	3	3	6	3	3	4	6	6	3	9
<b>12</b>	4	3	3	3	4	3	3	2	6	6	3	9
<b>13</b>	6	1	2	3	6	3	3	6	6	6	3	9
<b>14</b>	6	2	2	0	2	3	3	2	4	2	3	9
<b>15</b>	6	1	1	2	4	3	3	4	4	4	3	9
<b>16</b>	6	0	1	3	6	3	3	6	6	6	3	6
<b>17</b>	6	2	2	3	6	3	3	6	6	6	3	9
<b>18</b>	6	2	2	3	4	3	3	4	6	6	3	6
<b>19</b>	2	2	2	2	6	3	3	4	4	2	2	9
<b>20</b>	2	2	2	3	6	3	3	4	4	2	2	9
<b>21</b>	6	2	2	2	6	3	3	6	2	2	2	9
<b>22</b>	6	2	2	3	4	3	3	4	6	6	3	9
<b>23</b>	6	1	1	3	6	3	3	6	6	6	3	9
<b>24</b>	6	1	1	3	6	3	3	6	6	6	3	9
<b>25</b>	6	1	1	2	6	3	3	4	6	6	3	9
<b>26</b>	6	1	1	3	6	3	3	6	6	6	3	9
<b>27</b>	6	1	2	2	6	3	3	4	6	4	2	9
<b>28</b>	6	1	2	3	6	3	3	4	6	6	3	9
<b>29</b>	6	2	2	3	6	3	3	6	6	6	3	9
<b>30</b>	4	2	2	3	6	2	2	6	2	6	3	6
<b>31</b>	4	1	2	2	6	3	3	6	2	6	2	9
<b>32</b>	4	2	2	2	6	2	2	6	2	4	1	9
<b>33</b>	4	0	1	2	6	2	2	6	2	4	1	9
<b>34</b>	4	1	1	2	6	2	2	6	2	6	1	9
<b>35</b>	4	1	2	2	6	2	2	6	2	6	1	9
<b>36</b>	4	1	2	2	6	2	3	6	2	6	2	9
<b>37</b>	4	1	1	2	6	2	2	6	2	6	2	9
<b>38</b>	4	1	2	2	6	2	2	6	2	6	1	9
<b>39</b>	6	1	2	2	6	2	2	6	2	6	2	9

40	4	2	2	2	6	2	3	6	2	6	1	9
41	4	1	2	3	6	2	2	6	2	6	1	9
42	4	2	2	2	6	2	2	2	2	0	1	6
43	4	1	2	2	6	2	2	6	2	6	2	9
44	4	2	2	3	6	2	2	6	4	6	3	9
45	6	1	2	3	6	3	2	6	6	6	3	9
46	2	2	2	2	4	3	3	4	4	2	2	9
47	6	2	2	3	6	3	3	6	6	6	3	6
48	4	2	2	2	4	2	3	4	2	4	2	6
49	2	2	2	2	4	1	3	4	2	2	0	9
50	6	1	2	3	6	2	2	6	4	4	2	6
51	4	3	3	0	4	2	2	2	2	2	2	6
52	4	3	3	0	2	2	3	2	4	2	1	3
53	4	1	2	3	6	3	3	2	6	6	3	6
54	6	1	2	3	6	3	2	4	6	6	3	6
55	6	2	2	3	6	3	3	4	6	6	3	6
56	6	1	1	2	6	3	3	4	6	4	2	6
57	6	1	1	2	6	3	3	6	6	6	2	9
58	6	1	2	2	6	3	3	4	6	6	3	9
59	6	1	2	3	6	3	3	6	6	6	3	9
60	6	1	1	3	6	3	3	6	4	4	3	9
61	6	3	3	3	6	3	3	4	6	6	3	9
62	6	1	1	3	6	3	3	6	6	6	3	9
63	6	1	1	3	6	2	2	4	6	6	3	9
64	6	1	2	3	6	3	3	6	4	4	3	3
65	4	2	2	2	6	3	3	4	4	4	3	3
66	6	1	1	3	6	3	3	6	6	6	3	9
67	6	1	2	3	6	3	3	6	6	6	3	9
68	6	3	3	3	6	3	3	6	6	6	3	6
69	6	2	2	2	6	3	3	6	6	6	3	6
70	6	3	3	3	6	3	3	6	6	6	3	9
71	6	3	3	3	6	3	3	6	6	6	3	9
72	6	1	1	2	6	3	3	6	4	4	3	6
73	4	2	2	3	6	3	3	6	2	4	2	9
74	4	1	1	2	6	3	2	6	4	6	2	9
75	6	2	2	3	6	3	3	6	4	6	3	6
76	6	3	3	3	6	3	3	6	6	6	3	9
77	6	2	2	1	4	3	3	4	6	4	3	6
78	6	2	2	3	6	3	3	6	6	6	3	6
79	6	3	3	3	6	3	3	6	6	6	3	6
80	6	3	3	3	6	3	3	6	6	6	3	9
81	6	2	2	3	6	3	3	4	4	6	2	3
82	6	2	2	2	6	3	3	4	6	4	2	6

83	4	2	2	0	4	1	1	4	2	4	1	6
84	6	1	1	3	6	3	3	6	6	6	3	9
85	6	1	1	3	6	3	3	6	6	6	3	9
86	6	3	3	3	6	3	3	6	6	6	3	9
87	4	2	2	0	0	3	3	4	4	6	1	6
88	6	1	2	2	6	3	3	4	6	6	3	3
89	6	2	2	2	4	3	3	4	4	6	2	6
90	6	1	2	3	6	3	3	6	6	6	3	6
91	4	2	2	3	6	3	3	4	4	0	3	6
92	4	2	2	3	6	3	3	4	4	0	3	6
93	6	3	3	0	4	3	3	4	4	2	3	6
94	4	1	1	2	6	2	3	4	4	2	3	6
95	4	2	2	2	6	2	3	4	4	2	1	6
96	4	2	2	2	4	3	3	4	6	4	2	6
97	4	2	2	2	6	3	3	6	4	4	3	6
98	4	2	2	1	4	3	3	4	4	4	2	6
99	4	2	2	0	2	3	3	4	4	2	1	6
100	4	3	3	1	6	3	3	4	4	2	2	6
101	2	2	2	0	2	3	3	4	4	2	1	6
102	4	2	2	1	2	3	3	4	4	4	2	6
103	0	2	2	2	0	3	3	2	0	0	0	0
104	4	2	2	2	6	2	3	6	2	4	1	9
105	4	2	2	2	6	1	2	4	0	2	0	6
106	4	3	3	2	6	1	2	4	0	2	0	9
107	4	3	3	2	6	3	3	6	4	6	2	9
108	4	3	3	1	2	3	3	4	6	4	3	6
109	2	0	0	0	0	3	3	4	4	6	3	9
110	2	0	0	0	0	3	3	4	6	6	2	9
111	4	3	3	2	6	3	3	6	6	4	2	6
112	4	3	3	2	4	3	3	4	6	6	3	9
113	4	3	3	2	6	3	3	4	6	6	3	9
114	6	3	3	3	6	2	3	6	4	6	3	6
115	6	2	2	3	6	3	3	6	4	6	2	6
116	4	2	2	3	6	3	3	4	6	6	3	6
117	6	3	3	3	6	3	3	6	6	6	3	6
118	6	3	3	3	6	3	3	4	6	6	3	6
119	2	2	2	1	6	2	2	4	0	4	1	6
120	4	3	3	3	6	3	3	4	4	4	2	6
121	0	3	3	2	6	1	2	0	0	0	0	6
122	4	2	2	3	6	3	3	6	4	4	2	6
123	2	1	2	0	2	3	3	2	6	4	2	9
124	2	2	1	0	0	3	3	0	6	4	2	9
125	2	1	1	0	2	3	3	2	6	4	2	9

126	4	1	1	0	4	3	3	4	6	4	3	6
127	2	1	1	0	6	3	3	4	6	4	3	6
128	4	1	1	0	2	3	3	4	6	2	2	9
129	6	2	2	2	6	2	2	6	4	4	2	6
130	2	3	3	2	6	3	3	2	6	4	3	6
131	4	2	2	2	6	3	3	4	6	6	3	9
132	6	1	2	3	6	3	3	6	6	4	3	9
133	2	2	2	1	6	1	2	6	0	2	1	6
134	4	2	2	0	2	3	3	4	4	4	2	9
135	4	2	2	0	2	3	3	4	4	4	2	9
136	0	2	2	1	4	2	3	4	2	4	1	6
137	2	2	2	2	6	3	3	4	4	4	3	9
138	4	2	2	2	6	3	3	4	6	4	2	6
139	6	3	3	3	6	3	3	6	6	6	3	6
140	2	3	3	0	0	3	3	4	4	2	2	6
141	6	2	2	3	6	3	3	6	6	6	3	6
142	2	3	3	0	0	3	3	4	4	2	2	6
143	6	3	3	3	6	3	3	4	6	6	3	9
144	4	1	2	2	6	3	3	6	6	6	3	9
145	4	2	2	2	6	3	3	6	6	4	3	6
146	4	2	2	2	6	3	3	4	6	4	3	9
147	4	2	2	3	6	3	3	4	6	6	3	9
148	4	2	2	2	6	3	3	4	6	4	3	9
149	4	2	2	2	6	3	3	4	4	4	3	9
150	4	2	2	3	6	3	3	4	4	4	3	9
151	2	3	3	0	0	3	3	4	4	2	1	6
152	2	3	3	0	0	3	3	4	4	2	1	6
153	0	3	3	0	0	3	3	2	2	0	0	3
154	0	3	3	0	0	3	3	2	2	0	0	3
155	2	2	2	0	4	3	3	4	4	4	2	6
156	2	2	2	0	4	3	3	4	4	4	2	6
157	4	3	3	3	6	3	3	6	6	6	3	9
158	4	2	2	2	6	2	3	6	4	4	3	9
159	6	3	3	3	6	3	3	6	6	6	3	9
160	6	2	2	3	6	3	2	6	6	6	3	9
161	6	3	3	3	6	3	3	6	6	6	3	9
162	6	2	2	3	6	3	3	6	6	6	3	9
163	6	2	2	3	6	3	3	6	6	6	3	9
164	6	3	3	3	6	3	3	6	6	6	3	9
165	6	2	2	2	6	3	3	6	4	6	3	9
166	6	2	2	2	6	3	3	6	4	6	3	9
167	4	2	2	2	6	2	3	4	2	6	2	9
168	4	2	2	1	6	2	3	4	2	4	2	9



169	4	2	2	1	6	2	3	4	2	4	2	9
170	6	2	2	3	6	2	3	6	4	4	3	9
171	6	3	3	3	4	3	3	4	4	6	3	6
172	6	2	2	2	6	2	3	6	6	6	3	6
173	4	2	2	2	4	3	3	4	4	6	2	6
174	6	2	2	3	6	3	3	6	6	6	3	6
175	4	2	2	1	2	3	3	4	4	4	2	6
176	4	1	1	2	6	3	3	6	4	6	3	6
177	4	2	2	1	2	3	3	4	4	6	3	6
178	6	2	2	2	6	3	3	6	6	6	3	6
179	6	2	2	2	4	3	3	4	6	6	3	6
180	4	2	1	2	2	3	3	4	6	6	3	6
181	6	2	2	3	6	3	3	6	4	6	3	3
182	6	2	2	3	4	3	3	4	6	6	3	6
183	6	2	2	3	6	3	2	6	6	6	3	6
184	6	2	2	3	6	3	3	4	6	6	3	6
185	4	2	2	1	2	2	2	4	4	6	3	6
186	6	2	2	3	4	3	3	6	6	6	3	6
187	4	2	2	2	4	2	2	4	4	4	3	6
188	6	2	2	2	6	3	3	6	4	6	2	6
189	0	2	2	0	4	2	3	6	4	6	3	3
190	6	1	1	2	6	3	3	6	6	4	3	6
191	4	1	1	2	6	3	3	6	6	6	3	6
192	6	1	1	2	4	2	3	6	6	6	3	6
193	6	1	1	2	6	3	3	6	6	4	3	6
194	6	1	1	2	6	3	3	6	6	6	3	6
195	6	0	0	2	6	2	3	6	4	6	3	6
196	4	1	2	0	4	2	3	4	4	4	2	6
197	6	1	2	0	6	2	3	4	6	6	2	3
198	4	1	2	1	6	2	3	4	4	4	2	6
199	6	1	2	1	6	3	3	6	6	6	3	6
200	4	2	2	1	6	2	3	4	4	4	1	6
201	6	0	1	3	6	3	3	6	6	6	3	6
202	6	2	2	3	6	3	3	4	6	4	3	3
203	6	1	2	3	6	2	2	6	6	4	3	6
204	6	2	2	3	6	2	3	6	6	4	3	6
205	6	2	2	2	6	3	3	4	6	4	3	6
206	6	2	2	3	6	3	3	6	6	6	2	6
207	6	2	2	3	6	3	3	6	6	6	3	6
208	6	2	2	1	6	2	2	4	6	4	3	6
209	4	2	2	0	4	1	3	4	4	0	0	6
210	6	2	2	1	6	3	3	6	6	4	3	6
211	6	2	2	0	4	3	3	2	6	4	3	6

212	6	2	2	2	6	3	3	6	6	6	3	6
213	4	2	2	1	6	2	3	4	4	6	1	6
214	6	2	2	0	2	2	3	4	4	4	0	6
215	4	3	3	0	4	2	3	4	4	4	3	6
216	6	3	3	0	4	3	3	4	6	4	3	6
217	6	2	2	2	4	3	3	4	6	6	3	6
218	4	1	2	2	6	2	3	4	4	4	3	6
219	6	0	1	3	6	3	3	6	6	6	3	6
220	6	1	1	3	6	3	3	6	6	6	3	6
221	6	1	2	3	6	3	3	6	6	6	3	6
222	6	2	2	3	6	3	3	6	6	6	3	6
223	6	1	2	3	6	3	3	6	6	6	3	6
224	0	3	3	0	0	2	3	2	0	0	0	6
225	6	2	2	0	2	2	3	4	4	4	1	9
226	6	2	2	2	6	3	3	6	4	4	2	9
227	6	2	2	2	6	3	3	6	6	6	3	6
228	6	2	2	2	6	3	3	4	6	4	3	9
229	6	2	2	0	2	3	3	6	6	6	2	9
230	6	2	2	2	6	2	3	6	4	4	3	6
231	6	3	3	0	4	2	3	4	6	4	3	6
232	6	3	3	2	6	3	3	6	6	6	3	6
233	6	2	2	2	4	3	3	4	6	6	3	6
234	6	2	2	3	6	3	3	4	6	4	3	6
235	6	2	2	3	6	3	3	4	6	6	3	9
236	6	2	2	2	6	3	3	4	6	6	3	9
237	6	2	2	3	6	3	3	6	6	6	3	9
238	4	2	2	0	4	2	3	2	4	4	0	3
239	6	3	3	2	4	3	3	4	6	6	3	6
240	6	2	2	0	4	2	3	4	6	4	3	9
241	2	2	2	1	4	2	3	4	4	2	1	6
242	6	3	3	0	4	3	3	4	6	6	3	6
243	4	2	2	0	4	2	3	4	4	2	0	3
244	6	3	3	2	6	3	3	4	6	6	3	9
245	6	2	2	2	6	3	3	4	6	6	3	9
246	6	2	2	2	6	3	3	6	4	2	1	0
247	6	2	2	2	6	3	3	6	6	6	3	6
248	6	2	2	0	6	2	3	4	6	6	3	6
249	6	3	3	1	2	3	3	4	6	4	3	6
250	6	2	2	2	6	3	3	4	4	6	3	6
251	6	2	2	2	4	3	3	4	4	6	3	6
252	6	2	2	2	4	3	3	4	4	6	2	6
253	4	3	3	2	6	2	3	6	4	6	2	6
254	6	3	3	2	6	2	3	4	4	6	2	6

255	4	2	2	1	2	2	3	4	6	4	2	6
256	2	2	2	0	0	3	3	4	2	2	0	6
257	2	2	2	0	2	2	3	4	0	4	0	6
258	0	2	2	0	2	2	3	4	0	2	0	3
259	4	2	2	0	6	2	3	4	2	4	2	6
260	4	0	0	0	4	3	3	2	4	4	3	3
261	2	1	1	0	6	3	3	4	2	4	3	3
262	4	2	2	0	0	2	3	4	4	4	3	6
263	0	2	2	0	2	2	3	4	0	0	0	3
264	6	1	2	0	4	3	3	4	4	4	3	6
265	6	2	2	1	4	3	3	4	6	6	3	6
266	6	2	2	2	6	3	3	4	6	6	3	6
267	6	3	3	2	6	3	3	4	6	4	3	6
268	4	3	3	2	6	3	3	6	4	4	3	6
269	6	2	2	2	6	3	3	6	6	6	3	6
270	6	2	2	1	6	1	2	4	4	6	2	9
271	6	2	2	1	2	2	3	4	6	6	3	9
272	4	2	2	0	4	2	3	4	2	4	1	6
273	6	2	2	1	4	3	3	4	6	6	3	6
274	6	2	2	1	4	3	3	4	6	6	3	6
275	4	2	2	1	4	2	3	4	4	6	3	6
276	4	2	2	1	4	2	3	4	4	6	3	6
277	0	2	2	1	2	2	3	2	0	0	0	3
278	0	2	2	1	2	2	3	2	0	0	0	3
279	6	2	2	2	6	3	3	6	6	6	3	6
280	6	2	2	2	6	3	3	6	6	6	3	6
281	4	2	2	1	4	2	3	4	4	4	2	6
282	4	2	2	1	4	2	3	4	4	4	2	6
283	4	2	1	2	4	2	3	4	6	6	3	6
284	6	3	3	3	6	2	3	6	6	6	3	6
285	6	3	3	3	6	2	3	6	6	6	3	6
286	6	2	2	2	6	2	3	4	6	6	2	6
287	6	2	2	2	6	3	3	4	6	6	3	6
288	6	2	2	2	6	3	3	6	6	6	3	6
289	6	3	3	3	6	3	3	6	6	6	3	6
290	6	3	3	0	4	2	3	4	6	6	3	6
291	6	2	2	2	6	3	3	4	6	6	3	6
292	6	2	2	3	6	3	3	4	6	6	3	6
293	2	2	2	0	2	1	3	4	2	2	2	6
294	4	2	2	0	2	2	3	4	2	0	1	6
295	6	2	2	1	4	3	3	4	4	4	3	6
296	6	2	2	1	4	3	3	4	4	4	3	6
297	4	2	2	0	2	2	3	4	4	4	3	6

<b>298</b>	6	3	3	3	6	2	3	4	6	6	3	9
<b>299</b>	6	3	3	3	6	2	3	4	6	6	3	9
<b>300</b>	6	2	2	1	2	3	3	4	6	4	3	9
<b>301</b>	4	2	2	0	0	3	3	4	4	4	2	9
<b>302</b>	6	3	3	1	4	2	3	4	6	4	3	9
<b>303</b>	6	3	3	1	4	2	3	4	6	4	3	9
<b>304</b>	6	2	2	2	6	3	3	6	6	6	3	9
<b>305</b>	6	2	2	2	6	3	3	6	6	6	3	9
<b>306</b>	4	2	2	0	4	2	3	4	4	4	2	6
<b>307</b>	4	2	2	0	4	2	3	4	4	4	2	6
<b>308</b>	6	2	2	2	6	2	3	6	4	6	3	6
<b>309</b>	6	2	2	2	6	2	3	6	4	6	3	6
<b>310</b>	6	2	2	3	6	3	3	4	6	6	3	6
<b>311</b>	4	2	2	1	6	2	3	4	4	4	2	6
<b>312</b>	6	3	3	3	6	2	3	4	6	6	3	9
<b>313</b>	4	2	2	1	6	2	3	4	6	4	3	6
<b>314</b>	4	3	3	2	6	2	3	6	4	6	3	6
<b>315</b>	4	3	3	2	6	2	3	6	4	6	3	6
<b>316</b>	6	2	2	3	6	3	3	6	6	6	3	6
<b>317</b>	6	2	2	3	6	3	3	6	6	6	3	6
<b>318</b>	6	2	2	2	6	2	3	4	6	6	3	6
<b>319</b>	2	2	2	1	2	1	3	4	2	2	1	6
<b>320</b>	2	2	2	1	2	1	3	4	2	2	1	6
<b>321</b>	6	1	2	1	4	2	3	4	4	4	3	6
<b>322</b>	6	2	2	3	6	2	3	4	6	6	3	6
<b>323</b>	6	2	2	2	6	2	3	4	4	6	3	6
<b>324</b>	4	2	2	1	4	2	3	4	4	6	2	6
<b>325</b>	4	2	2	2	6	2	3	4	6	6	2	6
<b>326</b>	4	2	2	2	6	2	3	4	6	6	2	6
<b>327</b>	4	2	2	1	2	2	3	4	2	4	0	9
<b>328</b>	6	2	2	2	6	2	3	4	6	6	3	9
<b>329</b>	6	1	1	2	6	2	3	4	6	6	2	9
<b>330</b>	4	2	2	2	4	2	3	4	6	2	2	9
<b>331</b>	6	2	2	2	6	2	3	6	4	6	3	6
<b>332</b>	4	2	2	2	4	2	3	4	2	4	2	9