

Table 15: Potential Impacts of Natural Heritage Features and Proposed Mitigation Measures as they relate to Policies.

Potential Impact to Natural Heritage Features	Total Area	Applicable policies	Mitigation
<p>Loss of vegetation (including trees, shrubs, and understory)</p>	<p>The total area to be impacted is up to approximately 4.6ha. This represents approximately 10.66% of the significant woodland identified in the project area. A tree survey would be required to determine the precise number and species of trees that will be removed. These trees are all located within the width of the Significant Stream Corridor.</p>	<p>Alternatives with removal of ecological features (trees) must demonstrate that there would not be a loss of the significance of the natural heritage feature (woodlands- Section 15.3.3 of the OP and Stream Corridors – Section 15.4.6)</p>	<p>Significant vegetation and tree removals will be required to implement the preferred alternative identified for the project. The impacts are expected to be intermediate in duration and within the limits of the Significant Stream Corridor. Efforts will be made through the use of specialized equipment and construction techniques, to remove as little vegetation as possible to complete the construction phase of the project. However, up to 4.6ha may be removed as a result of the lowering of the culvert at the CN Rail by over 2.5m and the associated changes to the channel profile upstream and downstream. To compensate for this, the area will be replanted with native species at a 3:1 ratio, assuming the minimum separation distance for planting can be achieved. Compensation will also be comprised of the enhancement, rehabilitation and restoration of the Significant Stream Corridor which shall include riffles, pools, meanders, and removal of barriers as well as removal of buckthorn in the woodlot south of Oxford Street. This will require off-site compensation and potentially land acquisition.</p> <p>An additional 0.4ha, the area currently ponded north of the CN rail, can be replanted with new trees. The removal of the trees within the grading limits temporarily reduces the overall size of the woodland coverage but does not reduce the significance of these features.</p> <p>Each of the woodlands will still meet the criteria for significance during the restoration phase of the project in that:</p> <ul style="list-style-type: none"> • they will remain ecologically connected to Mud Creek; • they will maintain the patch size required for significance; • it is not anticipated that biodiversity will be lost as the species observed in these woodlots are relatively common; and, • the relative maturity of the woodlands overall will be maintained (see 4.2 of this report for the features that resulted in the woodlands significance). <p>The vegetation removal proposed as part of this project therefore meets policies 15.3.3 and 15.4.6 as the woodlands will remain significant and be improved over the longer term, and the stream corridor will be enhanced as a result. It is anticipated that through appropriate restoration, these woodlands have the potential to be restored to better than current conditions. It is noted that an important component of restoration will include management of invasive species (see Section 6.4).</p>

Potential Impact to Natural Heritage Features	Total Area	Applicable policies	Mitigation
Loss of wildlife habitat	See above	See above	<p>The woodlands were confirmed to be habitat for a variety of wildlife species including several birds, mammals, amphibians, and turtles. The species found in the study area are tolerant of urban influence. It is expected that during the construction phase of the project these species will find other suitable habitat to utilize in the study area. Vegetation clearing is recommended to be completed outside of the bird breeding season, or a qualified biologist must ensure that there are no active nests in the area prior to clearing. Wildlife fencing will be used to deter wildlife from entering construction areas. Any wildlife found inside the construction area will be removed, and safely relocated by a qualified environmental monitor. The new vernal pools created in the floodplain north of the CN rail will provide off-line amphibian breeding habitat to replace the online pond which is proposed for removal. In addition, bat boxes will be installed as well as replicating conditions for the successful continuation of wood thrush and other bird nesting areas.</p>
Loss of aquatic habitat	<p>The total channel length is currently 1.7km. With realignment the new channel length will be 1.6km, for a total loss of 100m of fish habitat.</p>	<p>The alterations to stream corridors are permitted under section 14.4.6 if they include restoration of the banks, introduction of a more natural meander, and creation of natural pools and riffles.</p>	<p>The stream realignment will include introduction of a more natural meander to many parts of the stream and the incorporation of riffles and pools into the stream profile. These activities will improve the quality of fish habitat and mitigate the loss of approximately 100m of poor fish habitat. Removal of barriers to fish passage will also help mitigate the loss. These include the log jam barrier upstream of the CN culvert, as well as cleaning out the culverts filled with sediment.</p> <p>As a result of these mitigation measures, it is anticipated that the water quality in the system will improve. Riffles will help oxygenate the water, and the removal of the ponded water will help keep oxygen levels above the PWQO of 4mg/L. The new riffles will provide vital structure to the stream, and provide spawning areas for various species. Benthic invertebrate communities are also anticipated to improve, thereby enhancing the biodiversity of the system and providing a more diverse food source for fish and other insectivores, The newly designed natural channel is also expected to provide cover for fish in high flow events, something that is currently lacking in the system south of Oxford Street.</p> <p>These activities meet the applicable City of London policies. All works would need to be reviewed by the DFO to determine if an authorization is required under the Fisheries Act. However, it is anticipated that improving stream structure and in-stream fish habitat will be considered self-compensation such that a full Fish Act Authorization can be avoided.</p>
Loss of wetland habitat (online pond upstream of CN Rail culvert)	<p>Loss of 0.4ha of open water wetland habitat from the ponded area north of the CN Rail.</p>	<p>City of London's policies for wetlands concern provincially and locally significant wetlands. The wetland north of the CN rail does not qualify as locally significant</p>	<p>The ponded area north of the CN rail was created due to a backwater effect created by an undersized culvert under the CN embankment. This wetland has served as storage for water. This function will be replicated in the newly designed flood plain with the creation of vernal pools in the newly restored woodland. This will provide habitat for any amphibians that are currently using the existing pond. It has been noted that there is little use from amphibians at the moment, it is the aim that the new vernal pools will improve and enhance the amphibian breeding habitat.</p>

Potential Impact to Natural Heritage Features	Total Area	Applicable policies	Mitigation
Loss of potential maternal roosting sites for endangered bat species	Potential loss of 15 candidate maternal roosting snag trees. Details on final number of trees and candidate snag trees would need to be determined at detailed design stge.	Section 15.3.2 of the OP permits the creation or maintenance of infrastructure in significant habitat for endangered species, with appropriate studies and mitigation (Section 15.3.3). The MNRF has established that tree removals outside of maternal roosting periods and installation of bat boxes are appropriate mitigation measures for bat species. A permit may be required for this work, further consultation with the MNRF will be required at the detailed design stage.	Mitigation would include removal of trees outside of the maternal roosting period of April 15 to September 31. Potential maternal roosting trees can be replaced using specially designed bat boxes. The total number needed would be determined in consultation with the MNRF during the permitting stage.
Sedimentation	Potential sedimentation of fish habitat during construction	Alterations to fish habitat are permitted in accordance to federal and provincial requirements (OP section 15.4.8). Consultation with the Department of Fisheries and Oceans will be required for the alteration to fish habitat for this project and to ensure no harm to fish.	Adhere to the warm water fish timing window of July 2 to March 14 to protect fish during sensitive spawning periods (no work permitted March 15 to July 1) Use best management practices and appropriate ESC measures to prevent sedimentation. Removal of excess sediment currently in the system.
Bank hardening	Permanent hardening of the banks to reduce erosion	See above	Adhere to the warm water fish timing window of July 2 to March 14 to protect fish during sensitive spawning periods Use best management practices and appropriate ESC measures to prevent sedimentation.

The following sections summarize general mitigation measures for both terrestrial and aquatic communities in the study area. While they are presented separately, the mitigation measures are often combined in practice. Compensation measures for aquatic habitat will in turn protect the terrestrial habitat and vice versa.

6.3.1 Terrestrial Habitat and Communities

The following outlines mitigation recommendations for construction and operational effects to vegetation communities in general, and also includes communities that are woodlands or wetlands. These mitigation measures are designed to prevent or significantly reduce impacts to terrestrial habitat communities.

6.3.1.1 Construction Mitigation

Construction mitigation largely relates to the grading and removal of vegetation communities, active installation of new infrastructure such as culverts, creek banks, etc. Construction mitigation recommendations include:

- Restoration or replacement of any impacted terrestrial communities in a minimum one-for-one land basis at a 3:1 tree replacement ratio to be determined in consultation with the City at detail design;
- Any vegetation removals must be in compliance with the Migratory Birds Convention Act (MBCA) including, but not limited to, adhering to timing restrictions during breeding season for tree pruning or removal during construction activities. The breeding bird season typically lasts from May 1st to July 31st for forests and May 1st to July 23rd for wetlands (Core Breeding Bird Period for Bird Conservation Region 13);
- Any tree removals should also occur outside of the maternal roosting period for bat species in Ontario, which is similar to the MBCA timing windows but should be verified with Aylmer District MNR (the core nesting period for breeding birds is identified as the end of March until the end of August for most of southern Ontario, as per Environment Canada);
- Prior to any tree removals, a snag survey should be conducted to determine if any snag trees can be protected from the construction area. If they require removal, a compensation plan will need to be implemented to ensure there are no negative impacts to the bat population and to ensure compliance with the ESA;

- Should construction activities be required during the breeding season, they should only be completed after a qualified avian biologist has completed a bird nesting survey to ensure no impacts to breeding birds and to ensure compliance with the MBCA (it should be noted that in forested settings, a bird nest survey may not be possible);
- Any wildlife found within the construction zones should be removed by qualified individuals;
- Setbacks from natural features and trees should be clearly demarcated with the installation of silt fencing and/or tree protection fencing along the disturbance limit. No construction activities are to occur outside of these fences (including overhead), nor the piling of construction materials;
- Minimize the construction disturbance area to the extent feasible;
- Conduct an arborist survey or develop a vegetation management plan during detailed design to document trees or vegetation communities with potential to be impacted by construction activities;
- Identify, locate and target plants or trees of value/significance that should be preserved or protected through avoidance. If these species cannot be preserved, they can be relocated elsewhere within the general area where conditions are similar. This will ensure the preservation of local native plant biodiversity;
- Ensure that temporarily disturbed areas are adequately restored with native vegetation post-construction, and monitor the effectiveness of restoration making adjustments as necessary;
- Re-vegetate and restore disturbed areas with native vegetation immediately after construction or for periods of inactivity. Use of native, non-invasive species and complementary vegetation in all open spaces created;
- Use bioengineering techniques where feasible at steeper slopes to reduce footprint due to cut/fill; and,
- Pre-stress the future edges of woodlands as part of an edge management plan, if feasible, to allow for the establishment of edge vegetation prior to construction activities (in edges to be retained and not disturbed during construction).

6.3.1.2 Operational Mitigation

Ongoing operational mitigation relates to the maintenance of culverts with limited operational effects anticipated on the naturalized channel and adjacent areas.

Operational mitigation recommendations include:

- Establishing and maintaining ongoing maintenance route to access and maintain the culverts;
- Minimizing the extent of any maintenance/access routes;
- Monitoring and maintenance of restoration planting success and replacement where warranted ;and,
- Monitoring and control invasive species such as Phragmites and Buckthorn.

6.3.2 Aquatic Habitat and Communities

The following sections outline construction and operation mitigation recommendations for aquatic habitat. The potential for direct fisheries impacts are most likely to occur during the construction phases for Mud Creek.

6.3.2.1 Construction Mitigation

Construction activities can increase the potential for silt/sediment and deleterious substances to enter aquatic habitat communities through drainage and overland transport. Mitigation recommendations include:

- No net loss of fish habitat;
- No in-water work shall be permitted during the warm water timing window of March 31 to July 1;
- In-water work will be performed 'in the dry', where construction works are isolated from creek flows;
- In-water work will only commence when all materials are at hand, in order to minimize the duration of in-water work;
- Heavy equipment will avoid watercourses or banks where works are not directly related to stream reconstruction;
- Staging of in-water work and project activities, to minimize the area and duration of exposed soils;

- Consistent with similar construction projects, it is recommended that all construction storage, staging, and refueling areas are located at least 30m away from all watercourses and wetlands;
- Ensure that construction activities are adequately contained with erosion and sediment control (ESC) measures;
- Ensure that any fish that may be trapped in work areas are safely relocated outside of the work zone with the appropriate permits and approvals in place;
- Intercept sediment laden drainage as close to the source as possible;
- The contractor should have available on site supplemental erosion and sediment control (ESC) measures that can be utilized should additional ESC measures be warranted;
- An erosion and sediment control contingency site specific plan should be developed that details the ESC plans and responsibilities;
- Ensure tree protection zones are established and maintained to protect the trees in the adjacent woodlands;
- Ensure that disturbed soils are stabilized and restored as soon as possible after disturbance; and,
- Provide construction monitoring on site by an independent environmental monitor to ensure that erosion and sediment controls are working effectively.

Construction activities as they relate to dewatering may impact water quantity or quality, and the following mitigation recommendations are provided:

- In the event that dewatering is required, appropriate erosion and sediment controls should be employed; and,
- Provide pre-treatment for discharged water prior to release to existing wetlands or aquatic habitat.

6.3.2.2 Operational Mitigation

Operational mitigation recommendations include:

- Stream channel morphology should be assessed and stability designed by a qualified Fluvial Geomorphologist to ensure channel stability and reduce the need for channel stability intervention;
- Develop a monitoring strategy that triggers response from observed streambed or bank erosion, aggradation of fine sediments, or failure of stream plantings as it is common for minor adjustments and spot treatments to be required in the first few years after a channel realignment (see Section 6.4 for adaptive monitoring plan); and,
- Monitor and maintain stream restoration plantings and replace failed plantings.

6.3.3 Species at Risk Mitigation

It was determined that there is potential for Bat SAR in the study area. Mitigation measures for bat species would include timing windows for removal of potential snag/cavity trees and fine tuning during detailed design of access routes and channel design to minimize the extent of habitat loss (e.g. aquatic, terrestrial, or wetland). This measure has been implemented through the iterative design process for the project. The project team should minimize the construction footprint to the extent feasible.

Mitigation measures for bats include avoiding any vegetation removal during sensitive time periods, such as the June maternal roosting period, and into July when young will be leaving maternal roosting sites. This time period coincides closely with the existing breeding bird timing windows, for the protection of birds that are regulated under the Migratory Birds Convention Act. In a forested setting, cavities may also be used by birds that are regulated, and as such, adhering to the timing windows would prevent tree removal at sensitive breeding periods for both birds and bats.

Once the Mud Creek improvements have been constructed, the forest and wetland edges should be managed to minimize snag removal, which may include tree topping to retain some snag function that would be beneficial to wildlife. Further mitigation will involve the installation of bat boxes in areas where any potential snag trees are removed. It is further recommended that mitigation measures be screened with the MNRF through the submission of an Information Gathering Form as described in Section 3.1. The IGF submission to the MNRF will establish the need for a permit under the ESA and confirm the appropriate measures for mitigating impacts to these species.

Mitigation measures will also be provided for the Special Concern species as part of the enhanced compensation strategy. While these species are listed as at risk in the Endangered Species Act (2007), they are not protected by this policy. The two Special Concern species found in the study area are the Snapping Turtle and the Wood Thrush.

The pond providing habitat for the turtle observed has been retained in the proposed designs. This pond will also provide refuge for other turtles or amphibians during the construction phase of the project. In water works will be avoided during their nesting period of late May to June. Should this species be encountered during the construction phase of the project, a qualified biologist should be contacted to remove the individual to a safe location. All construction areas will be fenced off to discourage entry by any wildlife species.

Habitat for the Wood Thrush in the study area is marginal. It prefers mature deciduous or mixed forests with high understory growth. The woodlands in the study area have very little understory growth. To protect this species during nesting, vegetation removal should be limited to periods outside the nesting season. Promoting a healthy understory community in the woodlots will be beneficial to this species.

6.4 Adaptive Monitoring Plan

The creation of two monitoring plans is recommended for this project, a construction monitoring plan as well as a long term monitoring plan to monitor the restoration efforts post construction.

The **construction monitoring plan** will be developed at the detailed design stage in order to monitor for construction related impacts, and to provide feedback on the success or remediation of the sediment and erosion control plans implemented during this phase of the project.

A detailed **adaptive monitoring plan** will be developed for the restoration efforts. This will include both the terrestrial and aquatic habitats. A monitoring strategy that triggers a predetermined response based on observed impacts will promote an adaptive restoration program and a reduction of the temporal impacts. Items recommended for monitoring include but are not limited to

- Tree and shrub planting survival;
- Streambed or bank erosion;
- Aggradation of fine sediments, and;
- Success of live staking in stream banks.

It is relatively common for minor adjustments and spot treatments to be required in the first few years after a woodland restoration or channel realignment. The adaptive management plan will establish triggers for intervention. These may be in the form of percentage of plantings lost, or visual observation of the failure of stream bank stabilization efforts.

Invasive species management is recommended as a component of this monitoring plan. Efforts will be required to ensure invasive species such as Buckthorn are appropriately controlled. Phragmites, also an invasive species, has established itself in the aquatic community. Efforts will be required to ensure this species does not become established in the newly constructed channel.

It will be important to establish a long timeline for the completion of the monitoring phase of this project as it may take 20 years for the planted vegetation to be established. As a result, the adaptive monitoring plan will be prepared with a 20 year timeline.

6.5 Net Gain/Loss Analysis

The City's guidelines for the preparation of an EIS (City of London 2003), prescribes preparation of a net effects analysis to assess the net impacts of the project. This analysis is summarized in Table 16.

Table 16: Net Effects Table for Mud Creek.

Activity	Potential impact on natural heritage features and functions	Degree and length of impact	Mitigation measures proposed	Compensation measures proposed	Net effects (gains or losses)
Excavation of a new floodplain	Loss of woodland habitat Loss of wildlife habitat Loss of wetland habitat	Moderate, short term construction impacts Significant, intermediate term loss of woodland habitat	See Table 15	Plant 3:1 tree replacement with native tree species, and at a minimum a 1:1 land ratio. Encourage a healthy understory vegetation community	Loss of tree cover for 20 to 40 years Potential reduction of forest bird nesting habitat for 20 to 40 years Gain of edge and early successional species nesting and habitat use in the short to medium term.
Installation of new culvert under CN rail	Construction related impacts such as potential sedimentation	Minor, short term construction impacts	See Table 15	Channel enhancements	Gain of increased water quality due to improved flows (in both Mud Creek and downstream in the Thames River) Gain of improved habitat conditions due to reduced sedimentation

Activity	Potential impact on natural heritage features and functions	Degree and length of impact	Mitigation measures proposed	Compensation measures proposed	Net effects (gains or losses)
<p>Realignment of the watercourse at Oxford Street West and installation of new culvert</p>	<p>Decrease in total channel length (100m)</p>	<p>Moderate, some long term impacts</p>	<p>See Table 15</p>	<p>It is anticipated that the DFO will view the new channel design as compensation for the loss of channel length</p>	<p>Loss of total length of fish habitat (approximately 100m). Gain of increased water quality, cover for fish, and better substrates for benthic communities and morphology for spawning in Mud Creek. Gain of increased water quality for Thames River.</p>
<p>Bed and bank restoration</p>	<p>Natural channel design employed including hardening of some banks (if necessary)</p>	<p>Moderate, some long term impacts</p>	<p>See Table 15</p>	<p>Bioengineering wherever feasible; it is anticipated that the DFO will view the new channel design as compensation for hardening of some of the banks if necessary</p>	<p>Loss of natural banks at areas of extreme erosion potential Gain of naturalized stable banks and reduction of erosion and sedimentation.</p>

Activity	Potential impact on natural heritage features and functions	Degree and length of impact	Mitigation measures proposed	Compensation measures proposed	Net effects (gains or losses)
Dredging of the excess sediment in the channel	Construction related impacts such as potential sedimentation	Minor, short term construction impacts Risk of sediment release	See Table 15	Removal of fine sediments from creek bed. Replace with coarse substrates where possible.	Gain of storage space in subwatershed. Improved aquatic habitat.

6.6 Compensation Strategy

The City has committed to the following compensation for the loss of trees and wildlife habitat within the Significant Woodlands and Significant Corridor:

- Approximately 1600 m of enhanced aquatic habitat including pools, riffles, woody vegetation with removal of fish barriers by lowering existing culverts.
- A 3:1 tree replacement ratio to those removed during construction. All trees planted to be of a higher quality native species and may require land acquisition as indicated by the City.
- Implement an invasive species (buckthorn) mitigation/eradication strategy for all woodlands south of Oxford Street West to the Wonderland culvert.
- Habitat restoration for wildlife including:
 - Vernal pool creation for reptile and amphibian species;
 - Minimizing of forest removal and restoration for loss of habitat for forest species such as Wood Thrush; and,
 - Construction of bat boxes to support the Endangered SAR bat species.
- Long-term ecological monitoring plan.

7.0 Conclusions and Recommendations

This Environmental Impact Study was prepared for the Mud Creek Subwatershed Municipal Class EA. The project was undertaken in order to mitigate and compensate for the impacts associated with infrastructure proposed to manage stormwater flows on both developed and undeveloped land in the area, and to improve the health of the stream system. The project team developed alternatives to reduce flooding at Oxford Street West and to improve terrestrial and aquatic habitat throughout the Mud Creek system.

Natural heritage features in the study area include the Mud Creek Significant Corridor and the assessed Significant Woodlands. Ecological Land Classification (ELC) was used to describe vegetation units in the study area and Mud Creek aquatic habitat was also mapped. It was determined that the aquatic resources in the study area were in poor condition, with poor water quality throughout the system. The majority of the woodlands are typical of urban forests with evidence of past and ongoing human influence (invasive species, garbage, pathways, etc.). The woodlands in the study area

are all considered to meet the criteria for significant according to the policies in the City of London's OP, due to their proximity to the watercourse as well as other criteria such as patch size and potential presence of rare species. The woodlands did not meet the criteria for designation as an ESA.

Alternative 4 was put forward as the preferred alternative in the EA. This alternative included design features such as lowering the creek profile to improve flow, creation of a new channel at Oxford Street West, and installation of a new, and lowered culvert under the CN rail. Natural channel design principals will be used to design the new channel and improve bed and bank conditions in other parts of Mud Creek south of Oxford Street West.

This project will have temporary impacts on the natural heritage system such as short term disruption of aquatic habitat and intermediate term loss of tree cover. With appropriate mitigation and compensation measures to protect and restore the natural heritage system impacts are anticipated to be mitigable. The project will result in better flow in the Mud Creek system, which will in turn improve water quality and fish habitat. Terrestrial areas should be restored using native and non-invasive species, and as the riparian corridor is anticipated to be maintained in the future, no loss of natural heritage is anticipated in the long term.

The project is in accordance with the City of London's OP (2006) policies. The project involves the installation and maintenance of infrastructure, which is a permitted use within natural heritage areas (significant woodlands and corridors) provided an EIS is prepared to evaluate the natural heritage features and functions and identify potential impacts. This EIS has presented that the short to intermediate impacts such as tree loss, reduction in extent of fish habitat, potential loss of bat maternal roosting sites, and sedimentation can be mitigated and compensated to create woodland and aquatic habitat of improved quality. The compensation measures ensure that the woodland corridor will be enhanced over the long term and the project will ensure that the City's arterial road does not flood as frequently to support Rapid Transit initiatives.

This EIS outlined a mitigation/compensation strategy to ensure that:

- (1) tree removals will not deter from the significance of the woodlot over the short term;
- (2) the project will support a healthier and more diverse aquatic habitat within the corridor in the short to long-term; and,
- (3) the project will result in a more sustainable significant woodlot and wildlife habitat in the intermediate to long-term.