# FINAL - EROSION AND SEDIMENTATION CONTROL REVIEW

Trans-Canada Highway Realignment through New Haven – Bonshaw, Queens County, Prince Edward Island

Prepared for:

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# 1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) has been contracted by the PEI Department of Transportation and Infrastructure Renewal (PEITIR) to conduct a review of erosion and sediment control practices used to date during realignment of the Trans-Canada Highway (TCH) through New Haven – Bonshaw, Queens County, Prince Edward Island (PEI).

## 1.1 REPORT OBJECTIVES

This document has been prepared to fulfill the following objectives:

- summarize construction activities and the associated erosion and sediment control implemented to date at the site (refer to Section 3.0);
- provide an objective third party evaluation of whether construction work carried out to date is environmentally compliant with the Prince Edward Island *Environmental Protection Act* (PEI EPA), Environmental Protection Plan (EPP), Environmental Assessment (EA), the PEITIR Sediment and Erosion Control Plan and associated federal and provincial approvals and commitments issued for the Project (refer to Section 4.0);
- recommend supplemental best management practices (BMPs) to augment PEITIR's Sediment and Erosion Control Plan going forward (refer to Section 6.3); and
- propose site specific BMPs between Station 0+820 and Station 1+900 (TCH New Haven Phase 1) for consideration and implementation by PEITIR. These BMPs are based on a field visit conducted on February 26, 2013 (refer to Section 6.4).

# 2.0 BACKGROUND

## 2.1 PROJECT SUMMARY

The Project consists of the construction of 6.2 kilometers (km) of new and upgraded highway to realign the existing TCH from St. Catherines Road in Bonshaw just west of the West River crossing (*i.e.*, Bonshaw Bridge) heading east to just east of West River Road (Route 9) in New Haven, Queens County, PEI (Figure 1, Appendix A). The Project involves removing large amounts of material from some areas, as well as large fills in other areas to bring the new highway to the appropriate grade. It also includes the installation of three watercourse crossings on three tributaries of West River, as well as a widening of the Bonshaw Bridge crossing of West River. Due to the nature of the Project (*i.e.*, large slopes near watercourses, instream work), a phased construction approach was adopted. Construction started in the fall of 2012 and is scheduled to be completed by fall 2013. The new alignment is broken down into 100 metre (m) sections, each with a Station ID.

The Stations associated with each phase of the Project are as follows:

- TCH New Haven Phase 1 - Station 0+340 to Station 1+900;
- TCH New Haven Phase 2 - Station 2+100 to Station 3+160;
- TCH New Haven Phase 3 - Station 3+160 to Station 3+360;
- TCH New Haven Phase 4 - Station 1+900 to Station 2+100;
- TCH Bonshaw Phase 1 - Station 6+200 to Station 7+960;
- TCH Bonshaw Phase 2 - Station 5+590 to Station 5+620;
- TCH Bonshaw Phase 3 - Station 7+960 to Station 0+340; and
- TCH Bonshaw Phase 4 - Station 4+960 to Station 6+200.

The Station locations are illustrated in Figure 1 (Appendix A).

The EA for the Project outlines mitigation for construction activities with the potential to affect the freshwater environment. Mitigation outlined in the EA includes a water quality monitoring program for total suspended solids (TSS) during construction to determine if sedimentation and erosion controls were functioning properly. As part of the site specific Environmental Protection Plan (EPP), the PEITIR developed the PEITIR Erosion and Sediment Control Plan, which outlines erosion and sediment control measures specific to the Project. Water quality monitoring has been conducted by Stantec in association with precipitation events and/or construction activities with potential to result in sedimentation of the aquatic environment. Interim reports following each monitoring event have been provided to the PEITIR and include weather at the time of sampling, previous 24-hour forecast, TSS results, and any recommended actions to be taken (*e.g.*, additional sediment controls, additional sampling in areas with elevated TSS).

In January 2013, the PEI Department of Environment, Labour and Justice (PEIDELJ) requested an independent review of sediment and erosion controls at the construction site, with additional recommendations for controls to be provided, where necessary. This report is the result of that review.

## 2.2 REGULATORY CONTEXT

Surface water quality is managed through federal guidelines and provincial legislation. The Canadian Council of Ministers of the Environment (CCME) maintains guidelines for the protection of aquatic life for many water quality parameters. These guidelines are generally accepted as best practices to mitigate project activities such that the CCME guidelines are not exceeded, where it is considered technically and economically feasible to do so. The TSS guideline for the protection of marine, estuarine and freshwater aquatic life is set at 25 milligrams per litre (mg/L) over background levels for any single individual monitoring event, or at 5.0 mg/L (average) over background levels for long-term monitoring.

Suspended solids can adversely affect aquatic organisms in several ways, including:

- clogging filtering mechanisms of some immature insects and fish;
- causing injury to eye and gill membranes of fish by abrasion;
- restricting food availability to fish;
- restricting normal movement and migration of fish; and
- inhibiting egg development.

The water quality of watercourses in PEI is protected under the PEI EPA (Chapter E-9).

Federally, fish and fish habitat are protected under the *Fisheries Act*. For the purpose of this aspect of the Project several sections of the Act apply, including:

- Sections 20, 21, and 22 relate to the obstruction of fish passage, and state that where fish passage is obstructed, a fish pass or passage must be provided, and sufficient water must flow to allow for fish migration and movement past the obstruction;
- Section 32 prohibits the killing of fish from means other than fishing; and
- Section 36, which prohibits the release of deleterious substances into any river or harbour or in any water where fishing is carried on.

Prior to the initiation of the Project, approvals were issued by the PEIDELJ, DFO, and Transport Canada as part of the environmental assessment process. Approvals were granted subject to compliance with the mitigation measures, best management practices, and compensation measures outlined in the environmental assessment, the EPP and the Habitat Compensation Plan. Additional conditions were supplied by the PEIDELJ, including:

- stopping construction activities (in the affected area) in the event that sediment enters a watercourse. Implementing measures to divert sediment from the watercourse;
- designing sediment and erosion control measures at the site to withstand a 1 in 25 year rainfall event;
- providing funding to the PEIDELJ to hire a representative for the department to be present onsite for the duration of construction; and
- developing a long-term Management and Protection Plan for all environmentally sensitive lands in the regional assessment area.

### 2.2.1 Compliance Management Strategy

A Compliance Management Strategy was developed by the PEITIR and was included in the Environmental Protection Plan. The Compliance Management Strategy provides a clear, transparent framework for management of the environmental compliance aspects of the highway realignment project. The strategy identifies the roles and responsibilities of key environmental personnel present at the construction site and also identifies initiatives (*e.g.*, site inspections, meetings, *etc.*) to confirm compliance with environmental approvals, the EPP and the PEITIR Sediment and Erosion Control Plan. Key environmental roles during construction included the following:

- PEITIR Environmental Management Section (the Environmental Coordinator and Queens County Environmental Officer);
- PEITIR Environmental Control Manager; and
- Contractor Environmental Control Manager.

Responsibilities associated with each of the above roles are outlined in the PEITIR Compliance Management Strategy. Additionally, DFO and the PEIDELJ have independent roles during construction. As per the provincial environmental approval, a representative of the PEIDELJ serves as a full time environmental monitor at the construction site; DFO also has representatives at the site during construction activities in or near watercourses.

The strategy also identifies a Complaint Management System for effective response to concerns brought forth by the regulators or the general public. In the event such concerns are submitted, the PEIDELJ and DFO will be contacted and will be notified of the corrective action.

The Compliance Management Strategy also outlines the Environmental Effects Monitoring (EEM) program. The EEM program is an on-going water sampling program conducted at the construction site in association with heavy rainfall events and/or construction activities that have the potential to release sediment into the aquatic environment. The EEM program serves as a compliance tool to monitor the effectiveness of sediment and erosion controls at the site. To date, Stantec has conducted seven construction monitoring sampling events. Where exceedence of the CCME guidelines occurred, it was recommended that sediment and erosion controls be reviewed and upgraded, where necessary. In each instance where recommendations for additional/upgraded sediment and erosion control were made, the PEITIR re-evaluated the situation and made changes, where necessary.

# 3.0 SITE CONDITIONS

## 3.1 WORK/SEDIMENT AND EROSION CONTROL SUMMARY

Work to date on the site has included site clearing, grubbing in some areas, installation of a concrete arch, installation of a box culvert, installation of a concrete pipe, excavation, and placement of fill. Sediment and erosion control at the site was based on the PEITIR Sediment and Erosion Control Plan. Not all controls identified in the plan were implemented due to the delayed construction schedule (*i.e.*, controls being installed during winter as opposed to fall). The following is a summary of work, and sediment and erosion controls broken down by phases. See Figure 1, Appendix A for phase and station locations.

## TCH New Haven 1

Construction activities in this area have primarily consisted of the installation of a concrete box culvert at Crawford's Brook (between Stations 0+900 and 1+000) and installation of a concrete arch at Crawford's Stream (Station 1+500). Additionally, excavation activities have been conducted between Stations 1+600 and 1+900. Fill has been placed over the concrete arch and also near Crawford's Stream during construction of the new Peter's Road.

In the vicinity of the concrete box at Crawford's Brook, berms were constructed along the western slope to direct runoff into vegetated areas. A stockpile of grubbed material has been bermed, and a sediment pond was installed in the area. Type 1 silt fencing has been installed around the perimeter. Peter's Road has been capped with reclaimed asphalt pavement (RAP) and lined with type 1 silt fence. A berm has been constructed across the northern portion of Peter's Road to direct runoff from the road into a sediment pond. Rock berms have been constructed on both sides of the box structure and type 1 silt fence has been installed to direct site runoff to these areas. Pumps are available at the site to dewater these containment areas, if required.

At Crawford's Stream, the top surface of the grubbed area has been bermed in several places to direct onsite water into several sediment ponds. The new Peter's Road has been topped with RAP, the side slopes have been mulched with straw, and type 1 silt fence has been installed at the toe of slope. A spring from the cut area adjacent to the existing TCH has been directed into a rock lined channel (protected by type 1 silt fence) which drains into a sediment pond. The outflow of the sediment pond filters over weeping tile and is distributed through vegetation. The sediment pond south of the arch also has outflow being filtered through vegetation before collecting behind a type 2 silt fence and again passing through a vegetated area. Additional sediment ponds north of the new alignment have type 1 silt fencing installed to direct the outflow into vegetated areas. The eastern portion of the cut area has been sloped towards the existing TCH to reduce the amount of runoff into Crawford's Stream.

## TCH New Haven 2

Construction activities in this area have consisted of the installation of a concrete pipe at Encounter Creek (between Stations 2+400 and 2+500), excavation activities between Stations 2+100 and 2+350, fill placement over the concrete pipe, and additional fill placement between Stations 2+350 and 2+650.

To control runoff on the site, the area was excavated in a manner to contain all surface runoff. Runoff from the fill area is being directed into five sediment ponds. The exposed slopes have been mulched with straw and the slopes within 30 m of the concrete pipe were mulched with straw and covered with straw blankets.

**TCH Bonshaw 1**

Construction activities in this area included the installation of a storm water pipe, excavation between Stations 6+200 and 6+550, and fill placement between Stations 6+550 and 7+150. Surface runoff in this area is directed into six sediment ponds with approximately 300 m of vegetated buffer between outflows of the ponds and a watercourse in the area. Excavation in this area has been conducted in a manner to contain all runoff. Between Stations 7+550 and 7+800 grubbing has been conducted and runoff has been directed into a sediment pond. All slopes have been mulched with straw.

## 3.2 WINTER STABILIZATION

Work on the Project was suspended for the Christmas break and there was no work being conducted at the highway construction site during the site visit on February 26, 2013. Prior to completion of construction activities for the winter, additional erosion and sediment controls were put in place to stabilize the site. The following is a summary of additional environmental controls implemented prior to shut down of the site. Refer to Appendix B for photographs of construction on the Project, in particular the erosion and sediment controls implemented at the site, prior to the termination of work at the Christmas break.

**TCH New Haven 1**

The newly installed concrete arch at Crawford’s Stream (Station 1+500) has been backfilled with gravel and covered with approximately 2 m of sandstone fill. Drainage from the top of the hill west of the structure, as well as a section of roadway to the east have been directed into a sediment collection area created within the roadway east of the arch. Berms have been built on the roadway over the arch to the north and south to divert water into the sediment collection area. The PEITIR has the ability to dewater this area, if required.

Slopes on both sides of the arch have been mulched with straw and covered with jute mat to safeguard that the mulch remains intact. All barren soil upstream of the arch has been mulched with straw.

The former stream diversion areas upstream and downstream of the arch are now serving as temporary sediment collection areas until construction at the site resumes. The roadway east of the arch has been graded and silt fence has been installed to direct drainage into the existing sediment ponds located north and south of the alignment.

A sediment collection area has been created downstream of the box culvert installed at Crawford’s Brook (between Stations 0+900 and 1+000). The areas on both sides of the structure are acting as temporary sediment collection areas. The PEITIR has the ability to dewater these areas, if required. Retaining berms have been placed near the inlet and outlet of the structure to prevent sediment from entering the water course.

A berm has been created at the mid-point of a steep slope leading down to Crawford’s Brook; the berm will disperse water flowing down the slope.

Two construction roads have been installed on the property north of the wetland adjacent to the eastern side of Peter's Road. The lower of these two roads has been decommissioned and stabilized with straw mulch. A sediment pond has been constructed to prevent any runoff from Peter's Road and the upper haul road from entering the wetland.

**TCH New Haven 2**

At Encounter Creek (between Stations 2+400 and 2+500), straw blankets have been applied to the slopes at the outlet end of the newly installed 175 m pipe. The straw is covering a 30 m area around the outlet. The remaining slopes at the site have been straw mulched, and the roadway through the site has been graded to direct water into the onsite sediment ponds.

**TCH Bonshaw 1**

Off of Crosby Road between Stations 7+500 and 7+600, a berm has been constructed east of a freshwater spring to direct drainage from the site into a sediment pond. This sediment pond has recently been updated with R5 rip rap protection at the outlet for additional stability.

Between Stations 6+700 and 7+000 the roadway has been graded to drain the area towards the existing onsite sediment ponds. The outlets of these ponds have also been upgraded with R5 rip rap. All exposed slopes have been mulched with straw.

# 4.0 PROJECT CHALLENGES

The following is a brief commentary on the challenges at the Project based on observations during the February 26, 2013 site visit and discussions with PEITIR personnel working on the Project.

These challenges listed below represent unique circumstances that increased the level of erosion and sediment control required during construction.

1. Sediment ponds are only effective in removing sediment down to the medium silt size fraction. Sediment-laden water with smaller size soil fractions (fine silts and colloidal clay) as encountered on this site will not be able to be controlled with sediment ponds unless chemical treatment is used in combination with the ponds.

2. The highway right-of-way available for this Project is narrow and restricts the installation of interceptor ditches at the top of slopes and limits the area for ponding behind the perimeter controls (*e.g.*, silt fence) as well as the construction of larger sediment ponds.

3. Back slopes for some large cuts on this Project have been designed at an inclination of 2:1. The soil erosion potential on these long slopes is significantly greater than slopes constructed at 3:1.

4. Construction on this Project commenced in fall 2012 and work continued up until the Christmas break. Construction during fall and early winter eliminated the natural benefits of evaporation and infiltration that increased the volume and velocity of surface runoff and reduced the filtering capacity provided by native vegetation. Frozen ground conditions also prevented some areas of exposed soil from being effectively covered with straw mulch.

5. While the construction work carried out to date by PEITIR was phased (to limit the time and amount of exposed soil), the fine soil fraction (finer silts and colloidal clay) dramatically increased the requirement to cover exposed soil in a more timely fashion.

   Success with respect to minimizing offsite effects is dependent on minimizing the amount and time that soil is left exposed. The United States Environmental Protection Agency (US EPA) (2007) emphasizes the importance of the prevention of erosion over the capture of sediment with the following statement: **"Once erosion occurs, unless you have some great practices, particulate removal efficiencies are typically less than 50% for most BMPs".**

6. There were numerous springs encountered on this Project that required the separation of these flows from the sediment-laden runoff generated onsite to prevent additional sediment-laden water. This complication appears to have been adequately addressed by PEITIR based on the work observed to date.

Based on the soil type and the large amount of material that has to be moved, it is Stantec' s view that environmental effects due to the release of sediment on this Project can at best be minimized, but not eliminated.

However, additional BMPs have been established to help reduce the environmental effects and augment PEITIR's Sediment and Erosion Control Plan.

# 5.0 OBSERVED EFFECTIVENESS OF MITIGATION MEASURES

Table 1 identifies the commitments included in the *EPA*, EPP, EA, and the PEITIR Sediment and Erosion Control Plan, and approvals issued with respect to erosion and sediment control during construction on this Project. While the list of commitments may not be all inclusive, Table 1 documents observations on the effectiveness of the mitigation measures implemented.

It should be noted that the effectiveness of mitigation measures evaluated in the Commitments Matrix only applies to those implemented on the Project to date (*i.e.*, prior to shutdown at Christmas break).

## Table 1 Commitments Matrix

| Commitments | Effectiveness of Mitgation Measures Implemented | Comments |
|---|---|---|
| **Terms and Conditions pursuant to clause 28(d) of the *Environmental Protection Act* (PEIDELJ)** | | |
| PEITIR shall construct the project as documented in the "Environmental Assessment: Trans-Canada Realignment through New Haven-Bonshaw, Queens County, PEI" document along with subsequent revisions and addendums to the foregoing document. | See section on EA Commitments below | |
| PEITIR shall comply with all provisions of the EPP, along with all subsequent revisions and addendums to the foregoing document | See section on EPP Commitments below | |
| PEITIR shall in the event that sediment associated with the construction project enters a watercourse, immediately cease operations in the affected area and implement measures to divert sediment from entering watercourse. | Partially effective | PEITIR has addressed the source of sediment release and implemented measures to try and divert sediment from entering watercourses in a timely fashion. As a result of the fine grained native soil, it is almost inevitable that there will be some sediment released to adjacent streams including sources outside the highway corridor during rain events. |
| **EPP Commitments** | | |
| Section 3.1 Mitigation Measures - Work conducted in the vicinity of watercourses/wetlands will be conducted in a manner which ensures that erosion and sedimentation of watercourses/wetlands is minimized. | Partially effective | Mitigation measures were only partially effective due to construction being conducted in late fall and early winter, which negated a number of BMPs that could have been implemented. However, PEITIR made an effort to minimize sediment released to watercourses/wetlands. |
| Erodible soils will not remain exposed for longer than absolutely necessary. Progressive and temporary vegetation will be used where establishing permanent vegetation is not possible and where risk of erosion and sedimentation to nearby watercourses, wetlands or other environmentally sensitive areas is a concern. | Partially effective | Construction in late fall and early winter negated erosion control BMPs that could have been implemented. Work was carried out in phases and temporarily stabilized when completed. All slopes in the immediate vicinity of culverts were temporarily stabilized. It is recommended that the Contractor temporarily stabilizes exposed soil concurrently with the construction of slopes going forward. |
| Appropriate erosion control and sediment measures as outlined in Section 3.23 (of the EPP) shall be installed prior to conducting work. | Effective | However, work in late fall and early winter invariably decreased the effectiveness of some of the implemented measures. |

**Table 1 Commitments Matrix**

| Commitments | Effectiveness of Mitgation Measures Implemented | Comments |
|---|---|---|
| Work will be suspended, if necessary, during and immediately after intense rainstorms and during periods of increased surface flow, as determined by the PEITIR Environmental Control Manager. | Effective | |
| The area of disturbance will be limited to that which is absolutely necessary to conduct the work. | Partially effective | Efforts should continue to reduce the amount of exposed work areas. |
| **EA Commitments (Project Activities and Construction BMPs)** | | |
| The progression of construction will be carried out in a manner, such that activities in any work area proceed continually and diligently to promote an orderly progression of work and effective protection of the environment. In any given work area, the time between grubbing/cut/fill activities to stabilization will be no greater than 30 days. In the event that the 30 day stabilization period is not met, temporary measures will be taken to stabilize the areas until more permanent measures can be introduced. Additionally, there may be a need to conduct temporary stabilization as weather and site conditions require. | Partially effective | It is recommended that efforts continue to limit the size of exposed areas and erosion prevention and that continued temporary stabilization measures be introduced, as required. |
| Erosion and sediment control BMPs will be implemented as per PEITIR project-specific Sediment and Erosion Control Plan. | Effective | However, the PEITIR Sediment and Erosion Control Plan is not user friendly, as it lacks topography, vertical road grade and explicit construction sequencing. |
| All barren soil will be stabilized for overwintering. Measures will include placing Flexterra within 30 m of watercourses/wetlands as well as hydroseeding and hay mulching the remaining areas. Rip rap lined ditches including sediment traps may be installed in the steepest areas. Instream sediment traps may also be installed in these areas. | Partially effective | Slopes within 30 m of watercourses were stabilized with jute ECB (Flexterra could not be applied to frozen ground); hydroseeding not carried out due to lateness of season, but straw mulching applied to barren soil in sensitive areas. Instream sediment traps are not recommended. |
| Visual monitoring in the vicinity of the project to ensure the turbidity is limited; if an excessive change occurs due to construction activities, work will stop and sediment control measures will be re-evaluated. | Partially effective | Erosion and sediment control measures are being continually evaluated. Recommended that more emphasis be placed on erosion prevention going forward. |
| Construction Manager is required to have an Environmental Control Manager on site at all times during construction. | Effective | |
| A water quality monitoring program for total suspended solids (TSS) will be conducted during construction to ensure erosion and sediment controls are working. | Effective | Ongoing. |

**Table 1 Commitments Matrix**

| Commitments | Effectiveness of Mitgation Measures Implemented | Comments |
|---|---|---|
| **Commitments in Site Specific Sediment and Erosion Control Plan Developed by PEITIR** | | |
| All barren soil within the construction limits will be hydroseeded and mulched. | Partially effective | Construction in late fall and early winter prevented the hydroseeding and mulching of all barren soil. Straw mulch and jute ECB was placed in sensitive areas including 30 m on either side of culverts. |
| Type 1 silt fence will be installed at the toe of slope for a minimum distance of 100 m (inlet and outlet) at the approaches at every cross culvert. | Effective | |
| Sediment ponds will be sized to handle a 1:25 year storm event. | Sediment ponds were installed but ponds alone cannot treat colloidal clay | Due to the very fine soil fraction, sediment ponds cannot solely be used to treat clay colloidal soils. Either chemical treatment (flocculent, coagulant) or filtration (not as effective) are the only two viable methods available. |

# 6.0 RECOMMENDATIONS

## 6.1 OVERVIEW

The following recommendations are submitted based on a review of the PEITIR Sediment and Erosion Control Plan; photographs taken of the project site during construction and in late January; and a visit to the project site (TCH New Haven 1) on February 26, 2013.

The field visit included personnel from PEITIR associated with the Project and Stantec personnel responsible for the preparation of this report. The field visit included a review of the highway section between Station 0+820± and Station 1+900± (TCH New Haven 1), identified by PEITIR as one of the most challenging sections of the Project. This is due to the potential environmental effects at Crawford Brook and Crawford Stream due to the imminent snow melt and precipitation events this spring; the large cut (251,000 $m^3$±) and fill (268,000 $m^3$±) on this section; and the limited sediment pond volume presently available in the area of the aforementioned watercourses to retain the sediment-laden runoff potentially generated during construction on this section.

## 6.2 SCOPE OF RECOMMENDATIONS

The recommendations provided in this report have been grouped into two distinct categories:

1. Supplemental best management practices (BMPs) to augment PEITIR's Sediment and Erosion Control Plan on all sections of the project going forward. These BMPs are summarized in Section 6.3 of this report.

2. Site specific BMPs based on observations and conversations with PEITIR personnel during the February 26, 2013 field visit for implementation on the highway section between Station 0+810± and Station 1+900±. These BMPs are summarized in Section 6.4 of this report. These BMPs, while site specific to the above noted highway section can also be implemented on all sections of the Project going forward where similar conditions exist.

## 6.3 SUPPLEMENTAL BMPS TO AUGMENT THE PEITIR SEDIMENT AND EROSION CONTROL PLAN

### 6.3.1 Keep Clean Water Clean

It is imperative that any surface runoff in active areas of the Project be diverted via diversion or interceptor ditches before earthwork activities commence. This is a standard work practice for the PEITIR during construction projects and will continue at the highway construction site once construction recommences in the spring.

### 6.3.2 Limit the Amount of Exposed Soil

For sections of the Project where work has already commenced, exposed soil should be temporarily stabilized before additional areas of the site are allowed to be opened up. This means that all exposed soil shall be temporarily covered with straw mulch (recommended rate of 4,500 kg/ha) as soon as construction resumes. In areas where mulch has not been applied at the recommended rate, additional straw mulch should be applied to those areas as required.

The only exception would be slopes that are now exposed but can be brought to final grade, hydroseeded, and stabilized with straw mulch or Flexterra (or equivalent FRM) as soon as practically possible (*i.e.*, once vegetation is able to grow) upon recommencement of construction this spring. PEITIR personnel would be responsible for approving areas deemed as exceptions.

### 6.3.3 Limit the Time Soil Left Exposed

Construction phasing as implied in the Sediment and Erosion Control Plan for this Project, where areas are hydroseeded and covered with straw mulch once they are brought to grade, is not acceptable.

Due to the fine soil fraction, temporary mulching will be required. Both embankment slopes and back slopes should be covered with straw mulch concurrently with the construction of slopes.

For all slopes, straw mulch should be applied so that at no time there is no more than a 3 m (vertical height) of exposed slope left open at any one time.

Temporary straw mulch should also be applied to the remaining exposed area of slopes prior to precipitation events, forecasted by Environment Canada or the Weather Network to be ≥ 20 mm or ≥15 mm in combination with an anticipated snow melt.

Once brought to final lines and grade, the slopes shall be tracked or harrowed prior to hydroseeding and the application of straw mulch or the application of Flexterra (or equivalent FRM) as per the requirements of the PEITIR Sediment and Erosion Control Plan.

### 6.3.4 Prevent Sediment from Leaving Site

Sediment should be prevented from leaving the site. Perimeter controls should be in place prior to the commencement of any grubbing.

PEITIR should also assess the areas of the site already opened up to determine if there are any areas where sediment fencing should be installed or repaired to help ensure that sediment-laden water is contained.

If sediment fencing is installed on sloping ground, it should be configured in a “J hook” configuration. If not installed in this configuration, erosion will likely occur along the face of the fence, resulting in its failure and the offsite release of sediment. The need for and the design of the “J” hook configuration is best determined in the field at the time of installation of the fence. Refer to Appendix C for a photograph showing a “J” hook installation of sediment fence.

Gravel filtration berms (same cross section as rock flow checks) could be installed at the toe of the embankment slopes in lieu of sediment fencing at 40 m± intervals (align berms such that they are perpendicular to the anticipated flow) to reduce velocity and promote the filtration of runoff.

### 6.3.5 Rock or Polyethylene Sheeting Slope Drains

This erosion control detail has been included based on the proposed use of rock slope drains or half-culverts as slope drains as outlined in the PEITIR Sediment and Erosion Control Plan to convey runoff from the top of slopes to sediment collection ponds at the toe of embankments.

Rock or polyethylene sheeting slope drains, in combination with sandbags and/or diversion embankments can be an effective way to convey water down the slope and may provide a more effective and efficient method of directing flow from the upslope area during construction. Where slope drains are constructed of rock, a filtration layer of gravel or geotextile material should be used to prevent erosion under the rock.

Refer to Appendix D for detail on polyethylene sheeting slope drains.

## 6.4 SITE SPECIFIC BMPS FOR SECTION ON TCH-NEW HAVEN (PHASE 1)

### 6.4.1 Observations

The following BMPs are provided after a field visit to the section of the Project site between Station 0+0810± and Station 1+900± on February 26, 2013. The following is a brief list of observations based on this "snap-shot in time" inspection of this section of the Project.

1. There is a large area of exposed soil between Station 1+660± and Station 1+990± (large cut section) that will be the source of erosion until this section has been stabilized. This will result in sediment-laden runoff being directed towards two existing sediment ponds at Crawford Stream. This cut area was one of the last areas excavated before winter shutdown and the application of straw mulch was not possible due to frozen ground conditions.

2. The existing sediment collection ponds at Crawford Stream (one on either side of the highway) have limited capacity to handle a combination of snowmelt and spring rain events before pumping of the sediment-laden water from the ponds is necessary.

3. There are BMPs that possibly could be utilized at the Crawford Stream location to treat the colloidal clay in the runoff that will be collected in the sediment ponds and be discharged to prevent a breach of the ponds.

   However, the two areas (one on either side of the highway) where the sediment-laden runoff would be pumped to, presently exhibit frozen ground conditions and dormant vegetation that would dramatically reduce the effectiveness of the existing ground and native vegetation to filter and retain the sediment. Even later when the ground is not frozen and vegetation is thriving, the sheer volume of sediment-laden water that may have to be pumped to these two locations could possibly overwhelm the discharge locations and reduce the effectiveness of these areas to filter and retain the sediment.

   Refer to Section 6.4.2.1 to Section 6.4.2.6 for recommendations presented for this location that could be utilized as a standalone treatment option or be used in combination with the other BMPs to address this issue.

4. It will take approximately 6 to 8 weeks to bring the entire section between Station0+810± and Station 1+900± to final grade. All exposed surfaces should be temporarily covered with straw mulch concurrently with the placement of material (Refer to Section 6.3.3). Once slopes are brought to final lines and grade, they should be tracked prior to hydroseeding and final stabilization.

5. It is recommended that Flexterra (or an equivalent FRM) be used in the final stabilization of the cut area between Station 1+660± to Station 1+900±.

6. Temporary highway ditches between Station 1+660± and Station 1+900± should be constructed and rock flow checks installed in the ditches as excavation advances to reduce the velocity and volume of flow directed towards the sediment ponds. Final

grading and stabilization of ditches (rock-lined or covered with ECB) and the installation of rock flow checks should be carried out as soon as ditches are brought to final grade. If ditches are rock-lined, a geotextile or a filtration layer of gravel should be installed to prevent erosion under the rock.

7. Once infilling between Station 0+810± and Station 1+320± commences, the retention volume of the existing sediment pond at Crawford Brook will almost be completely eliminated, which will require that all sediment-runoff runoff collected near the inlet of the recently installed box culvert will have to be pumped to higher ground for treatment by native vegetation or directed to the remnants of an old building foundation.

8. Refer to Section 6.3.4 to determine whether gravel berms could be incorporated along the toe of the embankment slopes between Station 0+810± and Station 1+320± to reduce the velocity of flow and promote the filtration of runoff from the slopes.

9. For the fill section between Station 0+810± and Station 1+320±, the top of the advancing embankment will have to be constructed so that runoff is allowed to pond to permit evaporation and the channeling of ponded water from the top to the bottom of the slope via temporary or permanent slope drains. Refer to Section 6.3.7 for details on the recommendation to use polyethylene sheeting slope drains as a temporary slope drain.

### 6.4.2 BMPs to Address Sediment-Laden Runoff Directed Towards Crawford Stream

#### 6.4.2.1 Flocculent BMP

Refer to Table 2 for details on the proposed flocculent BMP.

**Table 2 Flocculent BMP**

| BMP: Flocculent used to reduce turbidity during discharge from sediment pond | |
|---|---|
| **DESCRIPTION** | The “140” is an ultra-low charged flocculent designed to achieve high levels of turbidity removal. The flocculent would be introduced into a pump via a drip line with the sediment-laden water being discharged to an area of native vegetation approximately 30 m from any watercourse. The flocculent facilitates the formation of bridges between the particles that causes them to combine into heavier particles that settle out. |
| **PURPOSE** | To minimize the colloidal clay in runoff before treated water is discharged to the environment. |
| **REQUIREMENTS** | If the existing ground is frozen or saturated and/or the native vegetation at the discharge location is dormant then the discharge area should be covered with jute or coir ECB or tubes to provide a medium to retain the heavier particles. |
| **LIMITATIONS** | Because of the slightly cationic charge of this product, it would have to be approved by DFO. It was approved for use by DFO on a project in Nova Scotia for a period of one-and-half years with no adverse aquatic effects. Once the flocculent binds with the soil particles, there should be no negative effects. |
| **COMMENTS** | This BMP would provide an effective method to remove the colloidal clay from suspension. 140 flocculent was tested on sediment-laden water taken from this Project and was extremely effective in controlling the clay turbidity. |

#### 6.4.2.2 Rock and Filtration Berm

Refer to Table 3 for the proposed rock and filtration berm BMP.

**Table 3 Rock and Filtration Berms**

| BMP: Construct rock and filtration berms | |
|---|---|
| DESCRIPTION | Construct a rock berm(s) to increase the retention capacity up gradient or down gradient of the existing sediment ponds. Additional filtration berms could be constructed down gradient of the sediment ponds or rock berm(s) if practical or appropriate area exists. |
| PURPOSE | To minimize the fine to medium silt size sediment in runoff before treated water is discharged to the environment. |
| REQUIREMENTS | Construct a rock berm comprised of 150 to 200 mm crushed glass faced with a 5 to 20 mm clear stone filtration layer upstream or downstream of the existing sediment ponds. Suggested top width of rock berm is 2 m, including a 0.6 m layer of filtration gravel on the upstream face. The rock structure should be 1.5 m± in height with 1.5:1 side slopes. The bottom of the berm should be constructed along the same contour so that runoff is distributed evenly along the entire face of the berm. Ends of the berm should be turned upslope to prevent short-circuiting of the structure. Filtration berms (at 2 m spacing) should then be constructed approximately 3 m down gradient of the last retention structure (*i.e.*, rock berm or sediment pond) and be comprised of 9” Terra Tubes with PAM or similar product in a supported wooden structure with a combined total height of 0.6 m± and that will allow for the placement of additional rows of Terra Tubes or similar product as necessary (to account for captured sediment). Refer to Appendix F for a photograph of a newly constructed rock berm southeast of Crawfords Stream and a typical filtration berm. Both berms should be turned up slope to prevent short-circuiting of the structures. |
| LIMITATIONS | Pumping sediment-laden water from the sediment ponds will still be required. After a precipitation event, the sediment-laden water in the sediment ponds could be pumped to behind the filtration berms for treatment and to recover the capacity of the ponds before the next precipitation event. |
| COMMENTS | The purpose of the rock berm is to reduce the velocity of flow and potentially increase the retention capacity. Please note that prior to the completion of this report, a spring thaw occurred. In anticipation of the thaw event, the PEITIR constructed the above mentioned berms at strategic locations to reduce sedimentation of watercourses at the Project site. |

#### 6.4.2.3 Filter Bag

Refer to Table 4 for the proposed rock and filtration berm BMP.

**Table 4 Filter Bag BMP**

| BMP: Dewater to filter bag | |
|---|---|
| DESCRIPTION | Pump water from sediment ponds to filter bag(s) located 30 m from any watercourses into a densely vegetated area. |
| PURPOSE | To reduce the fine to medium silt size sediment runoff prior to treated water being discharged to the environment. |
| REQUIREMENTS | Filter bags must be sized based on the size of pump discharging to the bags. Refer to Appendix F for a brochure on filter bags. |
| LIMITATIONS | Typically a filter bag 15’ x 50’ should handle the discharge from a 6” pump. As a sediment cake builds up inside the bag there will be a reduction in the pumping capacity to the filter bag. Bags shall be supported on wooden pallets or placed on a 300 mm layer of 20 mm clear stone to improve the efficacy of the filter bags. |
| COMMENTS | Filter bags will not remove the fine colloidal clay fraction. |

#### 6.4.2.4 Perforated PVC Header Pipe and Filtration Tubes

Refer to Table 5 for the proposed perforated PVC header pipe BMP and filtration tube BMP.

**Table 5 Perforated PVC Header Pipe**

| BMP: Dewater to a perforated PVC header pipe | |
|---|---|
| DESCRIPTION | Pump water directly from sediment ponds to a densely-vegetated discharge area located 30 m from any watercourse. |
| PURPOSE | To minimize the colloidal clay in runoff prior to treated water being discharged to the environment. |
| REQUIREMENTS | Discharge will be via a 20-m section of 100 to 150 mm perforated PVC header pipe placed parallel to the ground contour.<br><br>Install filtration tubes down gradient of the discharge location if the existing ground is frozen or saturated and/or vegetation is dormant. |
| LIMITATIONS | The only question is whether the volume of sediment-laden water exceeds the ability of the discharge site to retain the sediment load. |
| COMMENTS | A very efficient BMP if the release site can handle the volume of discharge. |

The PEITIR has been discharging water pumped from onsite sediment ponds through perforated PVC header pipes as a standard practice. Water has been discharged so that it filters through vegetation prior to reaching any watercourse.

## 7.0 SUMMARY

This report presents recommendations to address the erosion and sediment control issues observed at the Trans-Canada Highway Realignment Project site.

Erosion and sedimentation control at the site has been implemented as the Project has progressed. Initial controls (*e.g*., silt fencing) was installed prior to construction activities and the remainder of controls (*e.g*., sediment ponds) were installed along with the phased work progression. To date all sediment and erosion controls onsite have been partially effective to effective. It is recognized that the fine-grained nature of native soil at the site presents a challenge from a sediment and erosion control standpoint. The emphasis of the PEITIR Sediment and Erosion Control Plan going forward must be more directed towards the prevention of erosion due to the fine soil fraction and the fact that best management practices to remove colloidal clay are limited.

There is presently too much exposed soil on the Project site based on the observed work conducted to date. This is largely attributed to early winter construction and the inability to cover exposed surfaces that were frozen. However, the areas of the Project that have been opened up must be either temporarily covered with straw mulch or graded, hydroseeded and permanently stabilized with straw mulch and or Flexterra (or an equivalent FRM) as soon as work commences in the spring (refer to Section 6.3.2). Going forward, temporary mulching will have to be placed concurrently with the construction of slopes to reduce the amount of exposed soil (refer to Section 6.3.3).

For areas of the site that are open and not close to final grade, dealing with the control of sediment-laden water will be an ongoing issue over the spring months with higher than normal precipitation events. A number of recommendations have been presented in this report to help address this issue (refer to Sections 6.4.2.1 to 6.4.2.6).

The flocculent BMP should be explored if only for the TCH New Haven Phase 1 section of the Project, but will require approval by DFO because the 140 flocculent is catonic (has a positive charge). However, the 140 flocculent is near neutral and if the treated sediment-laden water is discharged onto vegetation, there should be no threat to aquatic life. It was approved for use by DFO on a project in Nova Scotia for a period of one-and-half years with no adverse aquatic effects. A representative from Millenium Water, Dartmouth, NS, is prepared to provide a demonstration of their product to PEITIR personnel and meet with DFO staff. The flocculent should only have to be used until the infiltration and filtering capacity of the existing soil and vegetation improves by late spring.

If flocculent is not an option, then it is recommended that where the volume of sediment-laden water to be treated becomes an issue, the retention capacity of the existing sediment ponds should be increased by the construction of gravel berms that will also reduce the velocity of flow and erosion potential in that area. It should be noted that prior to the completion of this report, a spring thaw occurred. In anticipation of the thaw event, the PEITIR constructed berms at strategic locations to reduce sedimentation of watercourses at the Project site. If the sediment ponds still do not have the capacity during storm events, then the sediment-laden water should be pumped to a densely vegetated area located more than 30 m from a watercourse for treatment by filtration. Discharge would be through a 20-m section of perforated PVC header pipe. If the existing ground is frozen or saturated or the vegetation is dormant, then rows of filtration tube should be installed below the discharge location. Filter bags could also be used to augment the volume of sediment-laden water to be treated. The optimum treatment option is the flocculent BMP or dewater to a perforated PVC header pipe BMP (if for the later the ground is not frozen or the vegetation dormant). Constructing two filtration berms below the most down gradient retention structure (*i.e.*, sediment pond or gravel berm) is also recommended.

It must be emphasized that having too many locations where pumping is required at the same time is not an ideal situation and such a condition is prone to mishaps occurring.

PEITIR personnel should conduct a walkabout on the site prior to commencement of construction to determine if the sediment fence is intact; needs to be repaired or cleaned out; or needs to be replaced (silt fence has an expected life of 6 months). In addition, PEITIR personnel should also investigate to see if stabilized interceptor or diversion ditches can be constructed in areas to divert offsite runoff away from active areas of the site to reduce the amount of sediment-laden water to be treated.

Work during the summer months will reduce the volume of sediment-laden water to be treated as a result of evaporation and increased infiltration. However the requirement for the placement of temporary straw much concurrently with the construction of slopes should be maintained.

## 8.0 CLOSING

This report has been prepared by Stantec for the sole benefit of the PEI Department of Transportation and Infrastructure Renewal (PEITIR). The report may not be relied upon by any other person or entity, other than for its intended purposes, without the express written consent of Stantec and PEITIR.

This report was undertaken exclusively for the purpose outlined herein and was limited to the scope and purpose specifically expressed in this report. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations. Any use of this report by a third party, or any reliance on decisions made based upon it, are the responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

Stantec makes no representation or warranty with respect to this report, other than the work was undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Any information or facts provided by others and referred to or used in the preparation of this report were assumed by Stantec to be accurate. Conclusions presented in this report should not be construed as legal advice.

The information provided in this report was compiled from existing documents and data and by applying currently accepted industry standard mitigation and prevention principles. This report represents the best professional judgment of Stantec personnel available at the time of its preparation. Stantec reserves the right to modify the contents of this report, in whole or in part, to reflect any new information that becomes available. If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

Respectfully Submitted,

**STANTEC CONSULTING LTD.**

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Associate, Environmental Scientist
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Erosion and Sediment Control

# 9.0 APPENDICES

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| Appendix A | Figure 1 |
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| Appendix E | Rock and Filtration Berms |
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# APPENDIX A

## Figure 1


AERIAL IMAGERY PROVIDED BY PEI DEEF.
YEAR OF IMAGERY: 2010



**Project Overview**

**Trans-Canada Highway Realignment Through New Haven-Bonshaw**

| Fig. No.: | Fig By: | Date: | Scale: |
|---|---|---|---|
| 1 | JAB | 11-Feb-13 | 1:10,500 |
| | Appd. By: | Job No.: | Projection: |
| | DC | 121810317 | PEI Double Stereographic |

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# APPENDIX B
# Project Photographs


**PHOTO 1:** Tree clearing at Encounter Creek (Station 2+375, facing east), October 14, 2012.


**PHOTO 2:** Encounter Creek (Station 2+700, facing west), October 19, 2012.

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**PHOTO 3:** Grubbing at Encounter Creek (Station 2+350, facing east), October 21, 2012.


**PHOTO 4:** Temporary berm at Encounter Creek (Station 2+350, facing south), October 21, 2012.

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**PHOTO 5:** Installation of diversion pipe at Encounter Creek (Station 2+450), facing north) October 23, 2012.


**PHOTO 6:** Mulched slopes at Encounter Creek (Station 2+550, facing east), October 24, 2012.


**PHOTO 7:** Encounter Creek (Station 2+475, facing east), October 29, 2012.


**PHOTO 8:** Newly installed sediment pond at Encounter Creek (2+550, facing south), November 1, 2012.

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**PHOTO 9:** Installation of concrete pipe at Encounter Creek (Station 2+400), facing east) November 14, 2012.


**PHOTO 10:** Mulched slopes at Encounter Creek (Station 2+450, facing southeast) on November 24, 2012, following installation of concrete pipe.


**PHOTO 11:** Installation of silt fence at Crawford’s Stream staging area (Station 1+550, facing west) prior to construction, October 4, 2012.


**PHOTO 12:** Rock lined channel for discharging spring at Crawford’s Stream (Station 1+540, facing northeast), October 9, 2012.


**PHOTO 13:** **O**n-going construction of staging area at Crawford's Stream (Station 1+600, facing north), October 11, 2012.


**PHOTO 14:** Construction of sediment pond at Crawford's Stream (Station 1+550, facing west), October 14, 2012.

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**PHOTO 15:** Excavation at Crawford's Stream (Station 1+850, facing west), October 18, 2012.


**PHOTO 16:** Sediment and erosion control at Crawford's Stream (Station 1+640, facing northeast), October 19, 2012.

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**PHOTO 17:** Sediment and erosion control at Crawford's Stream (Station 1+550, facing northwest), October 19, 2012.


**PHOTO 18:** Installation of silt fence for stream diversion channel at Crawford's Stream (Station 1+520, facing southwest), October 22, 2012.

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**PHOTO 19:** Installation of stream diversion channel at Crawford's Stream (Station 1+500, facing north), November 1, 2012.


**PHOTO 20:** Preparation of stream diversion channel at Crawford's Stream (Station 1+500, facing north), November 1, 2012.

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**PHOTO 21:** Construction of concrete arch at Crawford's Stream (Station 1+450, facing east), December 3, 2012.

**PHOTO 22:** Stream diversion channel and on-going construction of concrete arch at Crawford's Stream (Station 1+500, facing south), December 11, 2012.

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**PHOTO 23:** Stream flowing through concrete arch at Crawford's Stream (Station 1+500, facing south), December 21, 2012.

**PHOTO 24:** Winter stabilization at Crawford's Stream (Station 1+575, facing west), late December 2012.

**PHOTO 25:** Crawford’s Brook (Station 1+000, facing northwest), December 8, 2012.

**PHOTO 26:** Crawford’s Brook (Station 0+900, facing southeast), December 12, 2012.

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**PHOTO 27:** Stream diversion pipe and construction of concrete box at Crawford's Brook (Station 1+000, facing north), December 21, 2012.

**PHOTO 28:** Construction of berm at Crawford's Brook (Station 1+000, facing north) for winter stabilization, late December 2012.

**PHOTO 29:** Newly placed reclaimed asphalt pavement on Peter’s Road (adjacent to Crawford’s Brook construction area, Station 1+025, facing south) for winter stabilization, late December 2012.

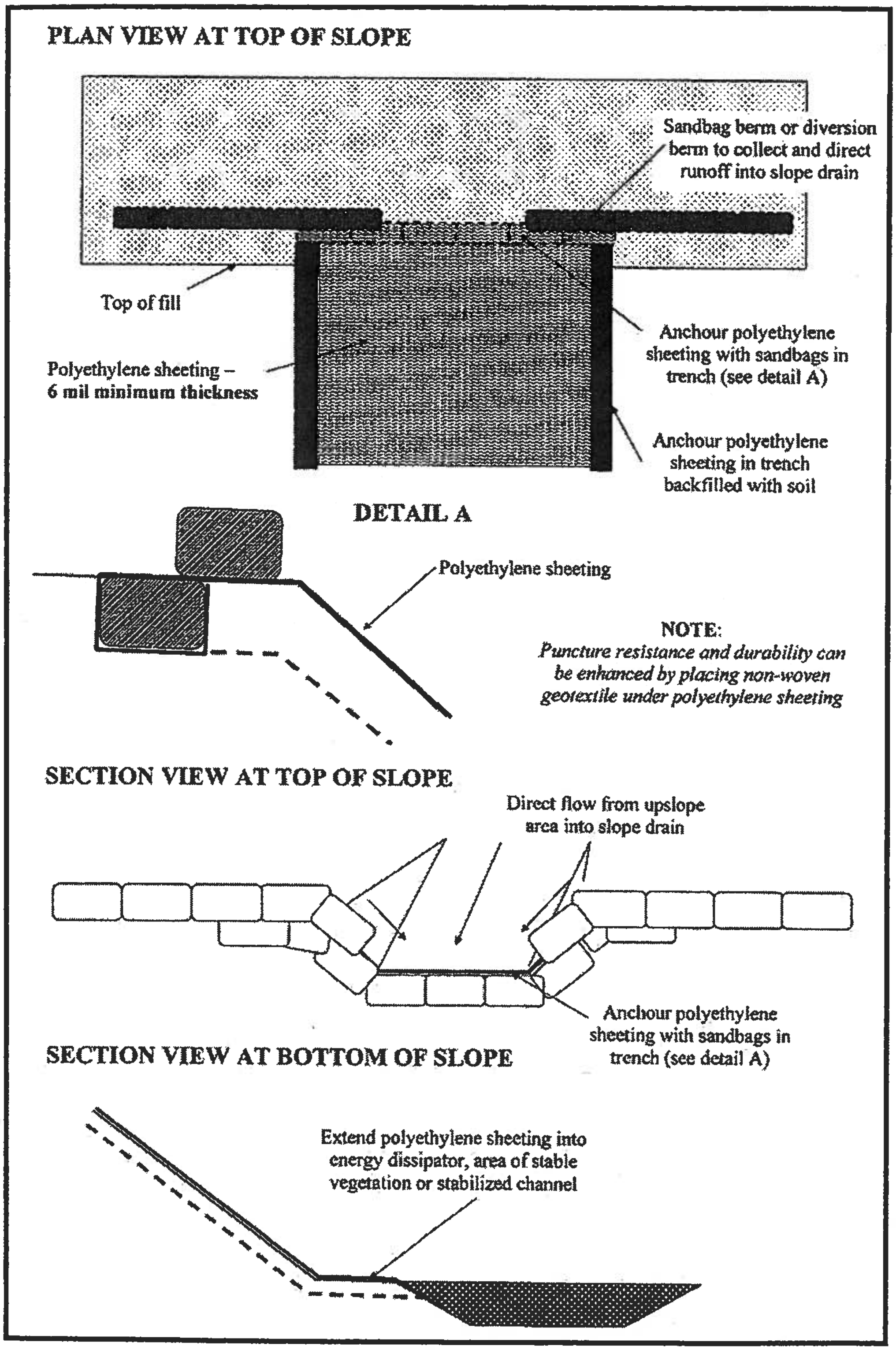
# APPENDIX C

## Sediment Fence

**Silt Fence Installed in “J Hook” Configuration**

# APPENDIX D
# Polyethylene Sheeting Slope Drains

Figure EC BMP #15.5. Polyethylene Sheeting Slope Drain



# APPENDIX E

# Rock and Filtration Berms


**PHOTO 1:** Newly constructed rock berm on southeast side of Crawford's Stream, March 18, 2013.

**PHOTO 2:** Photo showing the final installation of a typical filtration berm.

**PHOTO 3:** Photo showing entire filtration berm relative to the surrounding area.

# APPENDIX F

# Filter Bags

# Soaker Bags & Dewatering Filter Bags

## Soaker bags provide effective environmental protection for dewatering applications!

Creative Canvas' soaker bags are designed with high permittivity (water flow) and have a fine pore structure that allows water to flow through freely, while preventing soils such as silt, sand and other fine particulates from piping through.

Creative Canvas' soaker bags are made of durable non-woven geotextiles that are UV stabilized and resistant to puncture and tearing.

## Installation

To install, simply insert the discharge hose into the PVC nozzle of the bag and secure it with a hose clamp. The bags are typically supplied in 15' widths by 15, 20, 30, 50 and 100 foot lengths. The size of the bag is normally determined based on the diameter of the discharge hose and the expected duration of the installation.

During filling it is important to monitor the Soaker Bag, being careful not to overfill, as rupturing could occur.

We can customize our industrial fabrics and geotextiles to fit yourproject requirements.

## Applications

Soaker bags have a variety of uses in the control of particle contaminated run off water. They are typically used in the following applications:

- Pumping water during construction and excavation
- Control of water run-off from building sites
- Control of sedimentation for culvert, rain and water diversion systems
- Pumping water from flooded basements and ship's bilges
- Pumping water while drilling wells

TenCate Mirafi®

Drainage Separation

# Mirafi® 1100N

Mirafi® 1100N is a needlepunched nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Mirafi® 1100N is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

| Mechanical Properties | Test Method | Unit | Minimum Average Roll Value | |
|---|---|---|---|---|
| | | | MD | CD |
| Grab Tensile Strength | ASTM D4632 | lbs (N) | 250 (1113) | 250 (1113) |
| Grab Tensile Elongation | ASTM D4632 | % | 50 | 50 |
| Trapezoid Tear Strength | ASTM D4533 | lbs (N) | 100 (445) | 100 (445) |
| CBR Puncture Strength | ASTM D6241 | lbs (N) | 700 (3115) | |
| Apparent Opening Size (AOS)[1] | ASTM D4751 | U.S. Sieve (mm) | 100 (0.15) | |
| Permittivity | ASTM D4491 | $sec^{-1}$ | 0.8 | |
| Flow Rate | ASTM D4491 | $gal/min/ft^2$ ($l/min/m^2$) | 75 (3056) | |
| UV Resistance (at 500 hours) | ASTM D4355 | % strength retained | 70 | |

[1] ASTM D4751: AOS is a Maximum Opening Diameter Value

| Physical Properties | Unit | Typical Value |
|---|---|---|
| Roll Dimensions (width x length) | ft (m) | 15 x 300 (4.5 x 91) |
| Roll Area | $yd^2$ ($m^2$) | 500 (418) |
| Estimated Roll Weight | lb (kg) | 320 (145) |

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