

EDMONTON

Erosion and Sedimentation Control

FIELD MANUAL

This Field Manual was prepared by Stantec Consulting Ltd. under contract to The City of Edmonton, Drainage Services. Guidance and direction for the development of the Field Manual was provided by the Drainage Services Working Group comprised of the following individuals:

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- Environment Canada
- Strathcona County
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1.1 USE AND CONTENTS

The *Erosion and Sedimentation Control Field Manual* (Field Manual) is intended for use by consultants, contractors and inspectors out in the field or at construction sites. Additional information is provided in the *Erosion and Sedimentation Control Guidelines* (Guidelines).

The City of Edmonton, Drainage Services Branch (Drainage Services) **ESC Framework** calls for the preparation and submission of **ESC information**, an **ESC strategy** and an **ESC Plan** at various stages of the planning process, and the implementation of the ESC Plan during construction and post-construction stages.

The term “erosion and sedimentation control” or ESC means:

- n Minimizing the amount of erosion that occurs
- n Managing drainage across the site
- n Managing sediments

1.2 OBJECTIVE

The objective of this Field Manual is to assist field representatives in carrying out their respective roles in the development of a site in order to:

- Minimize erosion and release of sediment from the site
- Minimize the risk of environmental damage
- Protect adjacent areas, watercourses, and other environmentally sensitive receptors
- Comply with all applicable environmental regulatory requirements

This Manual provides:

- Information on release reporting and other regulatory requirements
- General ESC principles
- Guidance on implementing and monitoring an ESC Plan
- Selected Best Management Practices (BMPs)
- Sources for additional information

It does NOT:

- Provide an exhaustive list of all possible BMPs. There are many other ESC measures/BMPs in addition to those cited in this document that may be acceptable for use on a given project. The Field Manual should be supplemented by other materials as required.
- Provide detailed guidance on how to prepare an ESC Plan (see ***Chapter 5.0 – Erosion and Sedimentation Control Plan*** of the Guidelines for ESC Plan requirements and preparation)

The ESC Plan is an important part of the project. However, changes will be required in the field when unexpected field conditions, weather conditions or emergencies arise. Field personnel are in the best position to assess the ESC measures that are and are not working, and can assist in developing solutions before environmental problems occur.

1.3 ELEMENTS OF AN EFFECTIVE ESC PLAN

There are ten elements of an effective ESC plan:

1. Phase Construction to Limit Soil Exposure
2. Minimize Needless Stripping and Grading
3. Stabilize Exposed Soils Immediately
4. Protect Waterways and Stabilize Drainage Ways
5. Protect Steep Slopes and Cuts
6. Install Perimeter Controls
7. Employ Advanced Sediment Settling Controls
8. Ensure Contractors are Trained in ESC Plan, Implementation, Inspections, Maintenance, and Repairs
9. Adjust ESC Plan at Construction Site
10. Assess ESC Practices After Storms

1.4 STRIPPING AND GRADING

Pre-construction stripping and grading activities are often the most significant activities in a construction project that contribute to erosion and sedimentation.

In some cases, owners/developers are undertaking stripping and grading activities one to two years or longer before construction of municipal improvements has commenced. Owners/developers are strongly encouraged to plan for and time their stripping and grading operations such that the potential for erosion and sedimentation is minimized. Once stripping and grading of a site has begun, ESC measures should be implemented (e.g., temporary seeding or mulches)¹.

¹ Note that stripping and grading activities that result in the conversion or loss of wetlands can lead to enforcement action by provincial or federal regulators under legislation such as the provincial *Public Lands Act and Water Act*, and federal *Fisheries Act*. Authorizations or approvals may be required from provincial or federal regulatory agencies prior to disturbing wetlands or others areas protected under environmental legislation. Additional information on these and other requirements can be found in *Chapter 2.0 – Regulatory Requirements*.

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2.1 REGULATORY LIST

The following federal, provincial and municipal acts, regulations, bylaws, codes of practice, standards, and guidelines may be applicable to urban development activities that result or could result in erosion, sedimentation and adverse effects on the environment (see the Guidelines, *Chapter 2.0 – Regulatory Requirements* for detailed information on regulatory requirements):

Note: The list below identifies the PRIMARY regulatory requirements that may apply to activities and projects that result in erosion and sedimentation. It is NOT exhaustive, and specific legal advice should be sought to ensure that all relevant legislation has been identified when a specific regulatory issue arises. This information is not offered, nor intended to be offered, as any form of legal advice.

Federal

- *Fisheries Act*, R.S.C., 1985, c. F-14
- *Navigable Waters Protection Act*, R.S.C. 1985, c. 22
- *Migratory Birds Convention Act*, 1994 (1994, c. 22)
 - *Migratory Birds Regulations*, C.R.C., c. 1035
- *Canadian Environmental Protection Act*, 1999, S.C. 1999, c. 33

Provincial

- *Environmental Protection and Enhancement Act*, R.S.A. 2000, c. E-12
 - *Release Reporting Regulation*, A.R. 117/93
 - *Release Reporting Guideline* (June 2001)
 - *Wastewater and Storm Drainage Regulation*, A.R. 119/1993
 - *Code of Practice for Wastewater Systems Using a Wastewater Lagoon*
 - *Code of Practice for Wastewater Systems Consisting Solely of a Wastewater Collection System*
 - *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems*
- *Water Act*, R.S.A. 2000, c. W-3
- *Soil Conservation Act*, R.S.A. 2000, c. S-15

- *Public Lands Act*, R.S.A. 2000, c. P-40

Municipal

- *Municipal Government Act*, R.S.A. 2000, c. M-26
 - *Sewers Use Bylaw No. 9675*
 - *Sewers Bylaw No. 9425*
 - *Surface Drainage Bylaw No. 11501*
 - *North Saskatchewan River Valley Area Redevelopment Plan Bylaw No. 7188*
 - *Design and Construction Standards, Volume 3, Drainage*

Current versions of all federal and provincial legislation, and municipal bylaws are available online at the following websites:

- Justice Canada at: <http://laws.justice.gc.ca/en/index.html>
- Alberta Queen's Printer at:
<http://www.qp.gov.ab.ca/index.cfm>
- City of Edmonton Bylaws at:
<http://www.edmonton.ca/portal/server.pt>
(click on "Bylaws").

2.2 RELEASE REPORTING REQUIREMENTS

Field personnel should be aware of the various regulatory requirements that may be triggered when a harmful or deleterious substance, such as silt, sediment or hydrocarbons, is released or spilled into the environment (air, land, water). There are federal, provincial, and municipal reporting and remediation requirements that may apply (Table 2.1 below summarizes the primary ones).

Whether there is a legal requirement to report a release can only be determined on a case-by-case basis. Seek legal/regulatory advice as required when an incident occurs to determine whether you need to report and ensure you are in compliance.

As per the AENV *Release Reporting Guideline* (June 2001), reports under EPEA should be made to the Environmental Service Response Centre as follows:

Verbal reports can be phoned to: **(780) 422-4505** or **1-800-222-6514** on a 24-hour basis. A reference number will be provided at the time of the oral report to confirm that the report of the release was made.

Written reports can be faxed to: **(780) 427-3178**, or mailed to the Environmental Service Response Centre, 111 Twin Atria Building, 4999 – 98 Avenue, Edmonton, Alberta, T6B 2X3

Table 2.1: Summary of Release Reporting & Remediation Requirements

Legislation	Provision	Description
Federal		
Fisheries Act	s. 38(4)	<p>Where, “out of the normal course of events, there occurs a deposit of a deleterious substance in water frequented by fish or a serious and imminent danger thereof by reason of any condition, and where any damage or danger to fish habitat or fish or the use by man of fish results or may reasonably be expected to result...” it must be reported to an inspector by any person who:</p> <ul style="list-style-type: none">owns the deleterious substance or has charge, management or control thereof, orcauses or contributes to the causation of the deposit or danger thereof. <p>Duty on person who</p> <ul style="list-style-type: none">owns the deleterious substance or has charge, management or control thereof, orcauses or contributes to the causation of the deposit or danger thereof, to take all reasonable measures to prevent any deposit or to counteract, mitigate or remedy any adverse effects that result or may result from a deposit.
Canadian Environmental Protection Act, 1999	ss. 95-99	<p>Where a “toxic substance” (listed in Schedule 1 of Act) is released into the environment, any person who owns or has the charge, management or control of a substance, or causes or contributes to the release or increases the likelihood of the release, must report the release and take measures to prevent the release and remedy/mitigate the effects.</p>

Provincial**Environmental Protection
and Enhancement Act**

s. 110(1)

Duty on person who releases or causes or permits a release that has caused, is causing or may cause an adverse effect on the environment to, as soon as they know or ought to know of the release, report it to:

- the Director,
- the owner of the substance,
- their employer,
- the person having control of the substance, and
- any other person who may be directly affected by the release.

s. 111(1)

Report in s. 110(1) must be made in person or by telephone and must include the information in s. 111(1).

s. 111(2)

Written report must be submitted within 7 days (unless waived by Director) and include the information in s. 4(3) of the Release Reporting Regulation, A. R. 117/93.

s. 110(3)

A police officer or employee of a local authority or other public authority who is informed of or who investigates a release of a substance into the environment that may cause, is causing or has caused an adverse effect shall immediately notify the Director of the release unless the police officer or employee has reasonable grounds to believe that it has been reported by another person.

s. 112

Person responsible for a substance that may cause, is causing, or has caused an adverse effect must, as soon as they become aware or ought to have become aware of the release, take all reasonable measures to:

- repair, remedy and confine the effects of the substance,
- remove or otherwise dispose of the substance in such a manner as to effect maximum protection to human life, health and the environment, and
- restore the environment to a condition satisfactory to AENV.

Municipal Municipal Government Act, Sewers Use Bylaw No. 9675		
	s. 13(1)	Duty on person who releases or permits the release of any matter prohibited under s. 10 to, immediately after becoming aware of the release, notify: <ul style="list-style-type: none">• the City Manager,• the owner of the premises, and• any other person who may be directly affected by the release and to provide the City Manager with the information listed in s. 13(2).
	s. 13(4)	Person who released or permitted the release must, as soon as the person becomes aware or ought to have become aware of the release, take measures to confine, remedy and repair the effects of the release, and remove or otherwise dispose of the matter to minimize adverse effects.
	s. 13(5)	A written report must be submitted within seven (7) days of the release and include the information set out in s. 13(5).

2.3 ENFORCEMENT AND DUE DILIGENCE

Penalties for contraventions can include large fines and prison sentences. Other consequences can include stop work orders, delays in projects, costs of remediation, loss of reputation, etc., as well as contractual penalties and the cost of repairs of erosion on the site.

“Due diligence” means that even though the offence has occurred, all reasonable steps were taken prior to an offence to prevent it from taking place. Exercising due diligence can:

- Prevent the occurrence of an offence altogether
- Where an incident does occur and is investigated, it may avoid the laying of charges
- Where charges are laid it may result in an acquittal, or
- If convicted, may reduce the sentence

Although due diligence can be used as a defence, it is not a guarantee of an acquittal and the onus is on the accused to prove their case.

The accused must show that it has a proper system to prevent incidents and has taken reasonable steps to ensure the effective operation of the system. Records showing that a proper ESC plan was implemented, properly monitored and maintained may go a long way to proving due diligence.

Compliance with federal and provincial laws and regulations, and city bylaws results in:

- Protecting the environment
- Fewer erosion problems and more time to devote to other matters
- A good working relationship with regulatory authorities

Non-compliance can result in:

- Regulatory or other enforcement action (administrative penalties, environmental protection orders, prosecution, monetary penalties, stop work orders, etc.)
- Higher costs due to correcting problems and responding to complaints and queries
- Closer scrutiny by regulators and the public on future projects

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A successful ESC Plan and strategy is contingent upon the following steps taking place:

- ESC measures are regularly inspected
- The necessary maintenance is carried out
- A contingency plan is in place in the event of emergencies or failures
- Good inspection and maintenance records are kept

Responsibility for inspections and maintenance:

- **Permanent BMPs** – owner/developer until issuance of Final Acceptance Certificate (FAC); after FAC responsibility turned over to Drainage Services. Permanent BMP's are owned and maintained by City of Edmonton following FAC.
- **Temporary BMPs** – owner/developer until measures are no longer required; owner/develop must then remove them

The developer/owner, or his/her delegate, should appoint a qualified individual to conduct site inspections to check that ESC plans are being followed, and that adequate ESC measures are in place and functioning.

A schedule of planned maintenance activity is to be included with the ESC Plan. When ESC measures are insufficient or not working properly, changes to the ESC Plan must be made to ensure continued compliance.

The importance of regular inspections and maintenance cannot be overemphasized. ESC measures should be inspected at least once per week, and after rainstorms or snowmelt events. All disturbed areas of the site, material storage areas, entrance and exit roads, and all ESC controls should be inspected. The measures must be in good operating condition until the area they protect has been completely stabilized and the construction activity complete. Damage or deficiencies to ESC measures should be corrected as soon as practicable after an inspection.

- Some measures, such as silt fences and inlet protection devices, will require periodic replacement and/or removal of accumulated sediment
- Sediment basins (traps and ponds) will require periodic sediment removal when the design storage level is one third to one half full

Inspection Tips:

- The initial site inspection of the entire site should occur prior to start of construction to verify the location of the BMPs, record existing conditions, and see if changes are needed to the ESC Plan.
- Weekly inspections should cover all disturbed areas of the site, entrances, exits, all ESC measures and storage areas.
- A coordinated grid on the ESC Plan will assist in describing the location of BMPs in preparing inspection reports.
- Inspection reports should note BMPs installed, maintenance or repairs required and completed, storm time, size and duration, and site conditions.
- Monthly inspections of new vegetation should determine if additional measures are needed to support proper growth.
- Supplemental inspections should occur when rain is forecast to see that the BMPs are in place and after a storm to verify they are still in good condition. In the case of a release or spill additional inspections and reports are required.

An **inspection report** must be prepared by the owner/developer, or his/her delegate, following each inspection. The report should include the following information:

- Date and time
- Name of inspector
- Weather
- Types and locations of ESC measures/BMPs implemented
- Deficiencies/damages noted
- BMP maintenance completed
- Discussions with other parties on site (contractor, designer, public, etc.)
- Action items identified
- Follow up to previous action items
- Any regulatory issues
- Photographic record

A sample inspection report can be found in **Appendix A**. This report should be modified to meet site-specific requirements.

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4.1 THE ESC PLAN

The ESC Plan is described in detail in the Guidelines: **Chapter 4.0 – Erosion and Sedimentation Control Framework**, and **Chapter 5.0 – Erosion and Sedimentation Control Plan**. The components of an ESC Plan are described in Section 5.3 and Appendix A of the Guidelines. Field personnel should be able to find all required information in the ESC Plan. If information is not available, check with the Project Manager.

The objectives of the ESC Plan are:

- Prevent erosion and manage sediments
- Tailor the ESC measures to site conditions
- Address varying field conditions
- Clearly show the location and type of necessary BMPs
- Provide a stable, well-vegetated site
- Protect critical areas

4.2 IMPLEMENTING THE ESC PLAN

Steps for field personnel to implement the ESC Plan:

Before Construction:

- Review the project plans and specifications – particularly those dealing with ESC
- Conduct a site inspection
 - Take notes relative to ESC issues
 - Get a photographic record of the site before construction
- Review the project with the ESC designer and Project Manager
 - What are the objectives of the ESC plan?
 - What are the potential problem areas?
 - What are the critical resources?
 - What are the permitting requirements?
 - Who are the stakeholders?
 - What is the contract schedule?

- Have a pre-construction meeting (PRIOR TO STRIPPING AND GRADING) on site with the owner/developer, consultant/engineer, contractor, City, regulator, etc.
 - Review the ESC plan
 - Review everyone's roles and responsibilities
 - Review the permitting requirements – consider where permitting requirements are linked to timelines (such as time periods when work cannot take place, or minimum timeframe within which work needs to be completed)

During Construction:

- Conduct regular inspections and complete inspection reports – these may be weekly and/or coinciding with key construction activities
- Conduct inspections after storm events and complete inspection reports
- Review follow up action arising out of inspections to check that the issue(s) have been addressed
- In the event of a reportable release, report to the regulatory agencies as required

After Construction:

- Conduct a completion meeting on site with owner/developer, consultant/engineer, contractor, City, regulator, etc. to review project status and roles and responsibilities subsequent to construction
- Conduct a site inspection and take a photographic record
- Address immediate issues and assign responsibility for them (this can include removing temporary ESC measures, and fixing problem areas)
- Ensure that everyone knows who is responsible for short-term and long-term maintenance
- Address any outstanding issues

4.3 SCHEDULE AND TIMING

The **Construction Schedule** can be a powerful BMP in the ESC Plan. Clearing and stripping, then grading, followed by surface restoration can be done phase by phase, minimizing the amount of time that the bare soil is left exposed. This is sometimes called “just in time grading.”

Effects of Stripping and Grading:

1. Vegetative cover is removed so rainfall impacts directly on the soil
2. Soil develops a crust that inhibits water absorption and increases runoff
3. There is a loss of filtering capacity and increase in runoff velocity
4. There is a greater capacity to erode soil and carry sediment



1. Stripped and graded site results in no protection of soils, formation of gullies, and concentrated stream flow

4.4 FIELD ISSUES

4.4.1 DIFFICULT SITE CONDITIONS

Difficult site conditions may result from:

- Severe weather events that can result in the exceedence of the capacity of the design assumptions and the BMP installed
- Space limitations
- Poor site access
- Extreme topography/vertical relief
- Problematic soils/silty soils
- Concentrated flows
- Proximity to critical resources
- Rocky soils and outcrops
- Conflicts between permits and specifications
- Off-site sedimentation

TIP: Be prepared to act and respond quickly. Creative thinking may be required to arrive at the best solution. Remember that timely attention to difficult situations will be very helpful in working through them.



2. Steep Topography

4.4.2 CRITICAL RESOURCES

Critical resources can include:

- Water treatment plant intakes
- Sensitive fish habitat
- Parks or undisturbed natural areas
- Wetlands
- Locations of historical or environmental significance

TIP: Sometimes the critical area is not on or adjacent to the construction site but is connected to it by a drainage course or a piped system and is therefore subject to potential impact.

4.5 CONSTRUCTION

Site Personnel Should Keep In Mind That:

- Construction activities often reveal site conditions that were not anticipated in the ESC Plan
- Changes in the construction sequence or weather conditions will impact the ESC Plan
- The ESC Plan may address the initial and final phase of construction but may not address interim construction phases with adequate temporary BMPs
- A successful ESC Plan encourages site personnel to recognize and react to changing conditions
- Co-ordinate with the designer before making any changes to be sure you understand the designer's intent and constraints
- Always check the special provisions and permit documents for unusual project conditions

TIP: Remember that the ultimate goal is to protect the environment from erosion and sedimentation, and not simply to follow the ESC Plan.



3. Failure of riprap protection. Even riprap requires maintenance. Water washed rocks away and exposed geotextile.

4.6 MAINTENANCE AND REPAIR

Some typical maintenance requirements include:

- **Sod:** adequate watering; replacement of dead patches
- **Erosion control blankets:** watering; restoration of loose or tenting sections
- **Sedimentation basins:** must be cleaned before sediments fill the basin to one half of its storage volume
- **Silt fences:** remove sediment from behind silt fences before the depth of sediment reaches one third of the height of the silt fence

TIP: Maintenance and/or repair of ESC measures may be required due to weather conditions, construction equipment or third party damage. It is always cheaper to repair, make adjustments and maintain the BMP devices than it is to correct damage to the environment after a failure.

4.7 PROJECT SHUT DOWN

Sometimes projects are shut down prior to completion of the construction due to the end of the construction season, contractual disagreements or extended weather related delays. In these cases, the following ESC measures should be carried out:

- Protect and stabilize stockpiles
- Protect and stabilize exposed surfaces
- Protect critical resources
- Protect all drainage inlets (e.g., culverts)
- Clean out all sediment ponds, basins and traps where sediment may have accumulated
- Install and maintain perimeter control measures
- Install and maintain runoff control measures
- Restrict public access to the site
- Continue inspections and maintenance of the site until construction starts up again

Remember that erosion and sedimentation may be severe during spring thaw and snow melt. Provide protection in the fall!

4.8 PROJECT START UP

Prior to project start up after an extended shutdown period, carry out the following measures:

- Inspect the site prior to starting any construction
- Clean out all sediment ponds, basins and traps where sediment may have accumulated
- Repair any ESC measures that may have been damaged during the shutdown period
- Carry out stripping and grading in a phased approach

4.9 PROJECT COMPLETION

Temporary BMPs that are no longer required should be removed prior to completion of the construction work. Sediment deposits should be removed from permanent BMPs prior to completion of the construction.



4. Post Construction Issues: Remember to remove temporary BMPs

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5.1 INTRODUCTION

This chapter provides general information on BMPs that may be used on projects in the City of Edmonton. The Guidelines (**Chapter 7.0 – Erosion and Sedimentation Control Measures**) provides further information. Additional information on BMPs can be found in the following sources:

- Alberta Transportation, *Design Guidelines For Erosion and Sediment Control for Highways* (March 2003), Appendix C
- The City of Calgary, Wastewater & Drainage, Urban Development, *Guidelines for Erosion & Sediment Control* (February 2001), Section B

TIP: ESC measures/BMPs must be selected based on what is appropriate for the site conditions. BMPs other than those provided in this Manual may be suitable.

This Field Manual has attempted to include BMPs that would be most likely used in an urban setting. Non-inclusion of BMPs in this list does not mean that a BMP is unacceptable in Edmonton. Use flexibility and good judgment to select BMPs appropriate for the site and situation.

5.2 PERMANENT BMPs

Permanent BMPs are incorporated in the final site stormwater plan and may include:

- Stormwater ponds
- Armoring
- Vegetation
- Constructed wetlands

For Permanent ESC installations:

1. Make sure the proper vegetation is being used in each situation.
2. Pond and pipe situations are designed to overflow, therefore plan for the pond overflow situation. Know where the overflow will go and provide the required surface armor.

5.3 TEMPORARY BMPs

Temporary BMPs are intended to address temporary conditions and be easily removed or be biodegradable. They include BMPs such as:

- Mulches
- Erosion control blankets
- Silt fences
- Inlet protection



5. Silt Fence is a good temporary lot control

For Temporary BMPs:

1. Sediment control basins should be installed to detain sediment-laden water.
2. Seeding and mulching should be done in stages and as soon as possible after soil exposure.
3. Use diversions to direct flow away from exposed soil areas.

Install temporary pipes or lined channels where concentrated flows could cause a problem.

5.4 BMP INSTALLATION

The sequence of installation of BMPs must minimize erosion and sedimentation. **The field personnel should consider:**

- Established methods may not meet the objectives of preventing erosion and sedimentation
- If the contractor can demonstrate that substitute materials can provide the same level of protection then alternatives may be considered
- Consider the proposed approach and methods in light of achieving the desired goal as well as the economics

TIPS:

- ☐ Time the grading work to avoid rainy periods where feasible (typically mid June to early August)
- ☐ Leave as much undisturbed vegetation as possible
- ☐ Minimize the duration of soil disturbance
- ☐ Disturb and then restore more small areas rather than fewer large areas
- ☐ Protect soil stockpiles from eroding and trap the sediment
- ☐ Break up slope lengths, reduce slope steepness and control flow concentrations
- ☐ Emphasize erosion control by vegetating, mulching or stabilizing disturbed areas quickly
- ☐ Direct runoff away from disturbed areas
- ☐ Prepare drainage channels and outlets to handle concentrated flow until permanent structures and vegetation are functional
- ☐ Use sufficiently sized temporary sediment basins, traps, etc.
- ☐ Inspect and maintain control measures, especially before and after storms
- ☐ Install backup BMP upstream of critical areas and have materials available for emergencies
- ☐ Keep good records



6. Synthetic ditch check failure – silt build-up upstream, channel erosion downstream

5.5 QUALITY OF WORKMANSHIP

BMPs will not work properly unless they are installed properly and in accordance with specifications and the manufacturer's recommendations. Regular inspection and maintenance of BMPs is required to keep them fully functional. Deficiencies in quality control can make the ESC situation worse and lead to disastrous failures.

- A poorly designed or constructed sediment basin will not hold sediment-laden runoff long enough for the sediment to settle out
- Mulch that is spread unevenly leaves areas of exposed soil vulnerable to erosion
- An improperly installed silt fence or ditch check can concentrate flows and promote erosion
- Poor quality mulch, straw bales or seed can introduce weed seeds to the site

TIP: Regardless of the cause, BMPs that are not working properly should be repaired quickly to prevent erosion and sedimentation problems. Ask yourself why the BMP does not work.



- 7. Silt fences should rarely be installed in active water channels. Maintenance is required to remove silt from upstream side.**

The BMP may not be working because of:

- Incorrect design
- BMP not suited for the function
- BMP installed incorrectly
- No maintenance
- Changing site conditions
- Changing demands for BMP
- No sequencing of BMP

AIM for success in your ESC Plan by:

- Applying the correct BMPs based on site conditions.
- Installing and inspecting the BMPs properly.
- Maintaining and repairing the BMPs as necessary to maintain effectiveness.

5.6 SUMMARY OF BMPs

Table 5.1 provides a summary of the various types of BMPs. For more detailed information refer to the referenced section in this Field Manual.

Table 5.1.: Common BMPs Summary Table

Good Housekeeping Measures (Section 5.7) [Apply to all Projects Including Single Residential Lots]	Erosion Control BMPs (Section 5.8) [First Line Of Defense Against Erosion And Sedimentation]	Transport Control BMPs (Section 5.9) [Control The Direction, Volume And Velocity Of Stormwater]	Sedimentation Control BMPs (Section 5.10) [Last Line Of Defense Against Erosion And Sedimentation]
Place stockpiles away from sensitive areas, and stabilize stockpiles from erosion	Maintain vegetation: minimizes erosion, provides filtration	Grassed channels/swales: convey runoff and are often used with erosion control measures (ECB, etc.) Limited drainage area and grade	Sediment basins: used to trap sediment on disturbed areas
Limit site access	Construction sequencing: conduct clearing, stripping and grading in stages as needed	Buffer strips: used around construction site perimeters, above steep slopes and around protected areas. Not suitable for concentrated flow	Sediment traps: detain sediment laden runoff Limited drainage areas
Protect catch basins and manholes from sediment	Slope treatments: horizontal depressions that are created on a slope to help establish vegetation, reduce runoff and increase infiltration	Silt fences: are a sediment or transport control measure not an erosion control measure. Suitable for short slopes and low flow areas. Are often used inappropriately	Sediment barriers: trap sediment from sheet flow runoff Limited drainage areas

Remove accumulated sediment and debris	<p>Mulching/hydromulching: protect exposed soils from raindrop impact and increase infiltration</p> <p>Mulching should not be used on slopes steeper than 3H:1V or in concentrated water flow</p> <p>Hydromulching is preferred on steeper slopes</p>	<p>Includes Turf Reinforcement Mats (TRM) and Erosion Control Revegetation Mats (ECRM)</p>	<p>Floatation Silt Curtains: used on open, deep water to keep sediment out of the water body</p> <p>Can be used for shore and bank construction, and at a discharge point</p>
	<p>Erosion control netting (ECN): stabilizes soil and provides protection from precipitation in moderate site conditions</p>	<p>Fibre rolls: used to reduce velocities, allow water to filter through and trap sediment</p> <p>Are biodegradable</p> <p>Designed for small areas, low flows, short slopes</p>	<p>Inlet protection measures: considered the last line of defense</p> <p>Consists of a permeable barrier around an inlet to reduce sediment into the water body</p> <p>Includes drop inlet sediment barriers and catch basin inlet barriers</p>
	<p>Dust control: important in windy and high traffic areas.</p> <p>Soil binders can be used on haul roads, stockpiles and exposed slopes</p>	<p>Rock/brush filters: temporary measures to filter sediment out of runoff</p> <p>Used along streams, channels and toe of slopes</p>	<p>Dewatering: may be necessary after heavy precipitation events or due to site conditions (high groundwater table, etc.)</p>
		<p>Energy dissipaters: used as erosion/velocity control measure for outlet protection (pipes, culverts, channels) or flash floods/ intensive flows</p>	<p>Silt fences: are a sediment or transport control measure not an erosion control measure.</p> <p>Suitable for short slopes and low flow areas.</p> <p>Are often used inappropriately</p>

NOTE: The single most effective means of controlling and managing erosion and sedimentation at a construction site is to carry out clearing, stripping and grading activities in a sequential, phased approach, and to not strip and grade the site until absolutely necessary. See section 4.4 of the Guidelines for more information.

NOTE: All BMPs must be used appropriately, designed and constructed properly, and inspected and maintained regularly.

5.7 GOOD HOUSEKEEPING MEASURES

The following good housekeeping measures should be incorporated on all construction projects:

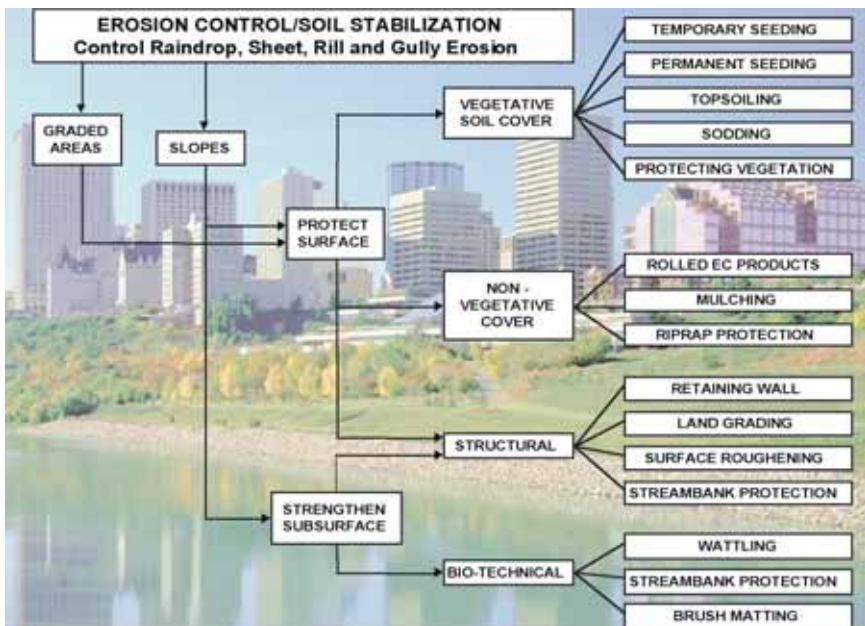
- Place stockpiles away from watercourses, environmentally sensitive areas, drainage courses, ravines and existing adjacent developments. Stabilize stockpiles against erosion immediately following stripping.
- Limit access of construction vehicles leaving the site to designated locations. Graveling or paving of access roads may be required to minimize tracking mud off-site.
- Take measures to minimize sediment and debris from entering sewers. Protect catch basins and manholes from sediment.
- Implement dust control measures such as vegetation, water, windbreaks, screens, and limiting vehicle speeds to prevent wind transport of dust from disturbed soil surfaces.
- Remove accumulated sediment and debris as required. Remove construction related materials and structures upon completion of construction.

5.8 EROSION CONTROL BMPs

Erosion control BMPs protect the soil surface and prevent soil particles from being detached by rain and wind. These tend to be the least expensive and most effective BMPs. Erosion control treats soil as a resource with value and works to keep it in place. Erosion control BMPs are the first line of defense against erosion and sedimentation.

The following **Erosion Control BMPs** are included in this Manual. This list is not exhaustive. Other erosion control BMP's may also be considered.

Section 5.8.1	Preservation of Existing Vegetation
Section 5.8.2	Construction Sequence Scheduling
Section 5.8.3	Just-in-Time Grading
Section 5.8.4	Slope Treatments
Section 5.8.5	Seeding
Section 5.8.6	Mulches
Section 5.8.7	Hydroseeding and Hydromulching
Section 5.8.8	Erosion Control Netting (ECN)
Section 5.8.9	Erosion Control Blanket (ECB)
Section 5.8.10	Riprap



5.8.1 CONSTRUCTION SEQUENCE SCHEDULING

Construction sequence scheduling entails scheduling the project into phases that are executed in sequence. The clearing, grubbing and stripping of the later phases are done just in time while the site restoration is being implemented on the earlier phases. Vegetation is restored on earlier phases of the project as soon as the other construction work in those areas is complete. Work may be scheduled for periods when rainfall is less likely.



- 8. The site was stripped of vegetation and topsoil in the previous year. Erosion and sedimentation occurred during spring thaw and runoff.**

Construction sequence scheduling includes the following elements:

1. Pre-construction protection: identify and protect critical areas/natural resources (wetlands, tree stands, etc.).
2. Construction access: identify construction site entrances/exits, parking/staging areas. Stabilize these areas to reduce off-site tracking.
3. Sediment barriers and traps: install key barriers and traps once construction site is assessed. Continue installation through stripping and grading, as required.
4. Runoff Controls: install runoff controls including diversions, perimeter berms, outlet protection. Continue installation through stripping and grading, as required.
5. Stripping and Grading: conduct pre-construction meeting prior to commencing stripping and grading to check that all controls are in place. Phase stripping and grading where possible. Stabilize stockpiles immediately.
6. Surface Stabilization: immediately after stripping and grading, apply temporary and permanent soil stabilization measures such as seeding, mulching, RECPs, sodding, riprap.

7. Construction Development: install ESC measures as required throughout construction.
8. Landscaping and Final Stabilization: stabilize open areas, including borrow pits and spoil areas. Remove temporary BMPs.

5.8.2 JUST-IN-TIME GRADING

Just-In-Time Grading is the concept of grading only the areas needed for the immediate construction activities. This will leave the existing ground cover in place for as long as possible, minimizing exposed soil and potential erosion. It also includes the prompt restoration of ground cover once the local work is complete.

5.8.3 PRESERVATION OF EXISTING VEGETATION

Prior to construction, vegetation and unique areas that are to be preserved must be assessed, marked and protected. City of Edmonton bylaws, as well as provincial and federal legislation, needs to be checked to determine what areas must be protected.

Construction should be phased to use existing vegetation as an ESC measure as much as possible. Preservation of existing vegetation needs to consider:

1. Install temporary fence around areas to be protected
2. Locate stockpiles, temporary roads away from the protected areas
3. Consider the impact of grade changes to root zones



9. Existing vegetation that needs to be protected must be indicated on the design drawings, and fenced off in the field

Use:

- This is generally the first, best and most economical erosion control measure
- Minimizes erosion from undisturbed ground
- Can provide filtration for sheet flow from a site
- Appropriate for use on floodplains, wetlands stream banks, steep slopes, sensitive habitat and native vegetation

Important Points:

- Vegetation must be protected from construction activity from start of project
- Use construction fencing or silt fence to protect the area from traffic and disturbance

Keys:

- Must be inspected and maintained
- Repair any damaged areas immediately

5.8.4 SLOPE TREATMENTS

Surface roughening is a slope treatment in which horizontal depressions or grooves are provided on slopes to help trap seed, reduce runoff velocity and increase infiltration. It can also help trap eroded soil and create “seeding safe sites.” Tracking is used for slopes less than 3H:1V, but stair stepping or grooving is required on steeper slopes. The slopes should be seeded and mulched immediately after the surface roughening is carried out.

Slope treatments include surface roughening, stair step grading, furrowing and tracking.

Use:

- Soil roughening is intended to help establish plant cover, increase infiltration, reduce runoff velocity, reduce erosion and trap sediment

Important Points:

- Roughening with a prominent profile may not be appropriate for areas that will be mowed regularly
- Roughening can increase grading costs
- In some soils it can increase the risk of sloughing or erosion
- It has limited effectiveness for intense rainfall without the surface protection of mulch, rolled erosion control blankets or vegetation cover
- It is essential that furrows are constructed carefully “on the contour” or grade out at a very shallow slope to a safe discharge point. Failure to construct furrows properly will lead the furrows to a common low point where the collected water will break the furrow ridges and begin gullyng.

Keys:

- Choose a method suitable for the slope inclination, soil type and end use



10. Cross furrowing on slope. Watch for low spots where water will collect



11. Track roughening



12. Furrowed in the wrong direction. Furrows should be perpendicular to slope

5.8.5 SEEDING

Seeding is carried out to stabilize disturbed areas and to establish a vegetation cover. Seeding may be either a temporary or permanent practice. Depending on the size of area to be seeded, the slope inclination and site conditions, hydroseeding may be most appropriate. Vegetation established by seed is an economical and efficient method to reduce erosion by 90%. Successful plant establishment is maximized through:

1. Good planning
2. Knowledge of soil characteristics
3. Using appropriate seed
4. Timely planting
5. Adequate watering and maintenance to establish vegetation

Use:

- Temporary seeding uses quick growing plants to stabilize disturbed areas that will be disturbed again
- Permanent seeding establishes a vegetative cover to protect the soil in the long term

- Hydroseeding is one method of seeding to establish either temporary or permanent soil cover along with fertilizer, mulch and/ or tackifiers

Important Points:

- Additional measures may be required for sites prone to erosion or with poor soils
- Seed must be in contact with the soil and have moisture to grow
- Mulches, compost, erosion control blankets, etc. can help promote growth
- Dry grass may pose a fire hazard

Keys:

- Sites may require periodic water and mowing to encourage grasses to spread
- All seeded areas should be inspected for failures and reseeded where required



13. Rills forming along stripped slope; vegetated slope resists erosion. Terracing also breaks up slope and, where properly constructed, helps resist erosion.



14 Seeding a site

5.8.6 MULCHES

Mulches protect exposed soils from raindrop impact and increase infiltration. Mulches are used on suitable slopes where rill erosion may occur. Mulches should not be used on slopes steeper than 3H:1V and should not be used in areas of concentrated water flow.

Application density and contact with the soil are key for effective installation. Often the application must be stabilized with a tackifier, track-walk, etc. Mulches, such as straw mulches, are considered temporary BMPs.

Use:

- Provides temporary ground cover that retards erosion and helps establish vegetation
- Protects against raindrop splash, contributes organic matter to the soil and aids in moisture capture and retention
- Loose mulches include straw or hay
- Wood and compost mulches should be tested to ensure pH, salts, contaminants and stability meet regulatory requirements
- Hydraulic mulches include wood cellulose, recycled newsprint, cardboard fibre and/or synthetic fibre and often a tackifier

Important Points:

- Loose mulches can be blown onto the surface or hand applied
- Loose mulches should be anchored to the soil by disking, crimping, studded rollers, netting or tackifiers
- Hydraulic mulch has shorter fibre lengths so does not interlock with the soil as well

Keys:

- Check loose mulch coverage as part of maintenance as it may be blown or washed away
- Check hydraulic mulch for damage by equipment, people or animal traffic
- Make repairs to damaged areas promptly

5.8.7 HYDROSEEDING AND HYDROMULCHING

Hydroseeding consists of application of a mixture of wood fibre, seed, fertilizer, and stabilizing emulsion (tackifier) using hydro-mulching equipment. Hydroseeding is used to protect exposed soils from erosion by water or wind. It works well on steep slopes (3H:1V or greater), stockpiles and large landscaped areas. It may require additional mulch applications to ensure adequate protection of seeded areas over winter.

Hydromulching is the hydraulic application of shredded wood fibre plus stabilizing tackifier. It is suitable for temporary protection of disturbed areas. Wood fibre mulches are typically applied at 2,500 to 5,000 kg/ha and usually requires 5 to 10% by weight of tackifier.



15. Hydroseeding a cut slope along a roadway

Use:

- Hydraulic seeding and mulch application is the preferred method for slopes especially those steeper than 3H:1V.
- The application of seed, fertilizer, mulch and water can give the vegetation a quick start

Important Points:

- There is a practical limit for application to within about 100 metres of vehicle access points
- Chemically bonded mulch matrices may require a cure time and should not be applied if rain is expected within 48 hours

Keys:

- Consistency of ground coverage is important
- Inspect the areas seeded for growth and coverage. Reseed as required.

5.8.8 EROSION CONTROL NETTING (ECN)

Erosion control netting is used to stabilize the soil and protect the soil from precipitation in moderate site conditions where erosion control blankets are not warranted.

Use:

- Can be used over loose mulch, freshly placed sod, hydroseeding, as a reinforcement and in bioengineering applications

Important Points:

- Are not as effective as erosion control blankets

Keys:

- Use the appropriate type of netting for the application

5.8.9 EROSION CONTROL BLANKET (ECB)

Erosion control blankets (ECBs) are typically used on short, steep slopes where there is a high erosion potential and slow vegetation establishment and they assist in the establishment of grassed channels. Erosion control blankets stabilize and protect the soil from raindrop impact, increase infiltration, decrease soil compaction & crusting, and conserve soil moisture. ECBs typically consist of degradable netting enclosing straw, wood fibre or coconut fibre. Rolled Erosion Control Products (RECPs) are manufactured mulch blankets that protect soil from erosion.

Use:

- On steep slopes and stream banks
- Where vegetation is slow to establish
- In channels where flow velocity tends to wash out new vegetation
- Where needed for up to two years

Important Points:

- Cutting corners can cause problems
- Check specs to make sure you are using the right product for conditions
- Place blanket within 24 hours of seeding the area

Keys:

- Complete transport control measures before installing the blanket
- Anchor the blanket in a 150 mm slot at the top of the slope, backfill and compact, or in accordance with product directions

- Unroll in the direction of flow, overlap ends 180 mm, edges 100 mm and staple every 900 mm, or in accordance with product directions
- Use longer anchors or staples in loose soils
- When blankets are laid shingle style, overlap 180 mm and staple every 900 mm, or in accordance with product directions
- Seed the area before installing the blanket for erosion control and revegetation



16. Rock ditch checks, erosion control blanket on lower slope and use of cut material to protect slopes on upper slope



17. Rolled Erosion Control Protection (RECP) being installed along a river bank



18. Channel protection using RECP



19. Erosion control blanket on top of slope, erosion control mat in channel and riprap for energy dissipation

5.8.10 RIPRAP

Riprap can protect and stabilize areas prone to erosion, erodible soils and drainage channels. It can be cheaper than other flexible slope liners and less expensive to repair.

Riprap can also be used in lined swales/channels. It is suitable for grades of 5 to 15%, and where the design flow velocity is between 2 to 5 m/s. Side slopes must be 3H:1V or less. A non-woven geotextile liner should be used at the top of the channel to avoid migration of fines.

Riprap rock must be hard, durable and erosion resistant. Riprap depth should be at least 300 mm and 1.5 times the maximum stone diameter.

Use:

- Cut and fill slopes subject to seepage, weathering, or hard to vegetate conditions
- Stream banks, channel grades and shorelines subject to wave action
- At culverts, ditch intersections, abrupt changes in direction of flow

Important Points:

- Prefer graded stone to uniform size stone as it makes a dense, flexible cover
- Riprap thickness should be 1.5 times the maximum stone diameter
- Compact fill areas, use geotextile or granular filter blanket
- Use right size of rock for application
- Place riprap right after grading
- Good surface preparation is essential for success

Keys:

- Compact subgrade or fill to match the density of surrounding material
- Sub-cut so finished grade of riprap is flush with surrounding area
- Key trench at toe should be about 1.5 times the riprap thickness
- Place geotextile or filter blanket as soon as foundation is prepared
- Don't damage geotextile when placing riprap, use a cushion of granular material under riprap if needed
- Form a dense, well-graded mass with no clusters of small or large stones
- Hand place riprap if necessary to get proper distribution and grading

5.9 TRANSPORT CONTROL BMPs

Transport control practices try to control the direction, volume and velocity of the transport medium and safely convey stormwater so that its potential for erosion is reduced. They help to direct stormwater away from exposed soils. Transport control should direct the flow to areas where the sediment can be trapped and removed.

The following **Transport Control BMPs** are included in this Manual. This list is not exhaustive. Other transport control BMP's may also be considered:

Section 5.9.1	Grass Lined Channels/Swales
Section 5.9.2	Buffer Strips
Section 5.9.3	Silt Fences
Section 5.9.4	Check Dams/Dikes
Section 5.9.5	Geosynthetic Matting

Section 5.9.6	Fibre Rolls
Section 5.9.7	Sandbag Barriers
Section 5.9.8	Energy Dissipaters

The four D's of Transport Control are:

1. Decrease the amount of runoff
2. Detain runoff to reduce its velocity
3. Divert runoff from erodible areas
4. Dissipate the flow of runoff

5.9.1 GRASS LINED CHANNEL/SWALES

Diversion swales, such as grass-lined channels/swales, are shaped, sloped depressions constructed to convey runoff. The drainage area should be 2 ha or less, and grade should be 1% to 5%. Additional erosion protection, as provided by Erosion Control Blankets (ECB) or Turf Reinforcement Mats (TRM), may be required. Small check dams or energy dissipaters may be required to minimize channelization.

Use:

- Typically form part of the major drainage system
- Can be used to divert flow away from steep slopes, fine soils, etc.
- Can be used to direct flow to sedimentation basins

Important Points:

- V ditches concentrate flow in the ditch bottom and tend to create gulley erosion
- Ditches with a wide flat bottom have sheet flow and lower tractive forces
- Desirable maximum depth of flow is 150 mm

Keys:

- Design for the anticipated flows and for the existing soils conditions
- Provide additional protection using ECB, Erosion Control Reinforcement Mats (ECRM), TRM, check dams and other BMPs as required



20. Erosion Control Blanket in a future grassed waterway

5.9.2 BUFFER STRIPS

Buffer strips are used as an ESC measure around construction site perimeters, above steep slopes and around protected areas/critical resources.

Use:

- Frequently used around site perimeters, above steep slopes, around watercourses or riparian zones
- Typically not suited for areas of concentrated flow

Important Points:

- Often requires a silt or construction fence to protect from damage and traffic

Keys:

- Needs to be inspected regularly and maintained as required



21 Vegetated buffer used as a Transport Control BMP

5.9.3 SILT FENCES

Silt Fences are considered a TRANSPORT and/or SEDIMENTATION CONTROL measure, NOT an erosion control measure. They are suitable for controlling sedimentation from sheet and rill erosion on relatively short slopes and should not be used where the flow exceeds $0.03 \text{ m}^3/\text{s}$. Silt fences are often used inappropriately or are not installed properly. It is essential that the appropriate use and installation method is employed.

Properly installed, silt fences can be cost-effective for runoff detention and sediment settling. Silt fences should not be installed on a slope, and should be located some distance from the toe of a slope in order that water can pond and settling of the sediment can occur.

It is essential to provide adequate water storage capacity behind the silt fence. The drainage area should be no more than 0.1 ha per 30 m of fence. Posts should be no more than 3 m apart for standard strength fabric and 2 m apart for extra strength fabric. They must be inspected and maintained frequently.

Use:

- Remove sediments from sheet flow runoff
- Not to be used for concentrated runoff
- Common causes for failure:
 - Installed in high flow situations
 - Inadequate quantity relative to the area contained
 - Installed without anchor trench or with a shallow trench and no backfill compaction
 - Inadequate attachment to posts
 - Failure to maintain properly
 - Incorrect installation around the perimeter directs water in the wrong location
 - Sediment not removed when it reaches one third of height or 225 mm
 - Incorrect post spacing
 - Improper geotextile

Keys to Success:

- No single run of silt fence should exceed 100 m
- Pool depth should not exceed 600 mm
- Do not allow any defects
- Follow slope grade/length guidelines

Slope Grade (%)	Maximum Length (m)
< 2	30
2 – 5	23
5 – 10	15
10 – 20	7.5
> 20	4.5



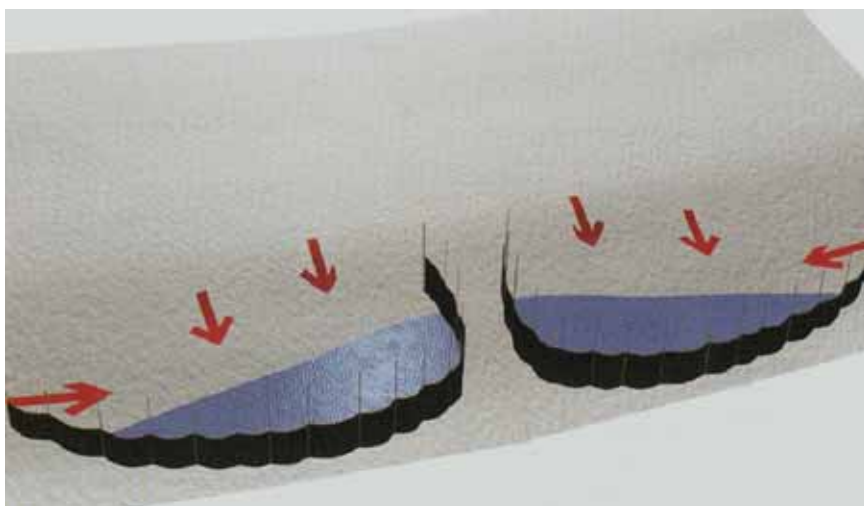
22. Silt fence overloaded to failure



23. Good layout of silt fences in "smiles," however it appears that seepage has gone around the end of the upper silt fence



24. Silt fence used as perimeter fence



25. Silt fences: breaking up a run more than doubles storage area



26. Well installed silt fence, but requires maintenance to remove sediment

5.9.4 CHECK DAMS/DIKES

Check dams/dikes are temporary or permanent berms used to divert or channel runoff to a desired location. These measures are used to divert runoff around the construction site, divert runoff from stabilized areas and to direct runoff to sediment traps or basins.

The drainage areas should be restricted in size and must direct runoff to a stabilized outlet. The berms must not be constructed of highly erodible soils.

Rock check dams may be constructed across a swale or ditch to reduce velocities of concentrated flows. They are suitable for small drainage areas of less than 0.8 ha, and are not suitable for active streams.

Use:

- Check dams form a shallow pool for sediment storage in a channel

Important Points:

- For permanent installations, check dams are typically made from rock, wattles, bundles of willow stakes, fibre or bio-logs or a permeable silt fence

- Check dams should be limited to drainage areas less than 2 ha and to channel slopes of less than 10%
- For temporary installations, check dams are often geotextile triangular dikes, supplemented with rock or silt fence
- They should be limited to drainage areas of less than 1 ha and channel slopes of less than 10%

Keys:

- When used in series, the top of the downstream dam should be level with the bottom of the next dam upstream
- The check dams must extend beyond the tops of the banks and the centrelines must be low enough that flow does not go around the ends
- Need to be wide enough that flows do not go around the ends even in spring thaw conditions

Guideline for Check Dam Spacing

Slope Grade (%)	Maximum Length (m)
2	30
4	23
6	15
8	12
10	7.5



27. Rock ditch checks along highway



**28. Synthetic check dam. Failure due to overtopping and sediment buildup.
Check dam separated when flow overtopped structure.**



29. Rock check dam. Failure due to scour under geotextile. Water velocities may have exceeded the design velocities.



30. Synthetic and rock check dams. Failed due to poor anchors causing flow under synthetic check dam.

5.9.5 GEOSYNTHETIC MATTING

Geosynthetic matting is a transport control measure used in channels where water flow velocity exceeds what natural vegetation can withstand.

Use:

- Often considered as a type of permanent soft armor
- Consist of two distinct types: Turf Reinforcement Mats (TRM) and Erosion Control Revegetation Mats (ECRM)
- Turf Reinforcement Mats (TRMs) are used to help establish vegetation in channels.
- Are used in critical hydraulic applications such as channels where water velocity and tractive forces exceed the limits of mature natural vegetation

Important Points:

- TRM provide superior root entanglement and long term protection
- ECRM provide better short term ground cover and erosion protection

Keys:

- If soil filling is specified:
- After broadcasting one-half of the seed and fertilizer, spread fine topsoil to fill the mat
- Spread topsoil using light equipment, avoid sharp turns
- Broadcast the rest of the seed and fertilizer
- Do not drive heavy equipment over the mat
- Avoid any traffic over the mat if loose or wet soil conditions exist



31. Turf Reinforcement Mat

5.9.6 FIBRE ROLLS

Fibre rolls (sediment logs, wattles) consist of biodegradable fibres wrapped in photodegradable netting. They are porous so they allow water to filter through and trap sediment. There are many variations of the materials and functional properties.

Use:

- Along the face of slopes to shorten the effective slope length
- At grade breaks where slopes become steeper
- In drainage swales to reduce flow velocity
- Along stream banks and shoreline to assist stabilization and revegetation

Important Points:

- Are designed for small areas and low surface flows of less than 1 ft³/sec (0.03 m³/sec)
- Use on short slopes or slopes less than 3H:1V
- Primary purpose is to reduce velocities but does cause some sedimentation
- Can be left in place to decompose at end of job or if in good condition can be salvaged and reused

Keys:

- Install and stake in place as recommended by manufacturer
- Protect against water undercutting the roll
- Require regular inspection and maintenance



32. Seeding around a sediment trap sock filled with compost



33. Installing a lot log

5.9.7 ENERGY DISSIPATERS

Energy dissipaters are used as outlet protection as an erosion/velocity control measure used to prevent scouring at outlets where high concentrated flow velocities occur.

Use:

- At outlets of pipes, culverts, conduits or channels
- At areas subject to flash floods or short intense periods of flow
- At the bottom of ditch slopes or where channel lining ends

Keys:

- Apron should be straight along entire length
- Riprap should consist of well-graded stone
- Apron should have zero grade
- If discharging into a channel extend the riprap across the channel and up the opposite bank
- Finished grade at end of riprap should be flush with surrounding area
- Larger stone should dominate with enough smaller stone to fill the voids



34. Well protected outfall



35. Synthetic energy dissipater working well but needs maintenance to remove sediment



36. Gabion energy dissipation structure

5.9.8 SANDBAG BARRIERS

Sandbag barriers are temporary transport control measures used to divert runoff.

Possible Uses:

- As a temporary berm to keep flow off a disturbed slope
- Along top of curb to keep sediment off of pavement
- As a temporary check when moving or repairing other BMPs

Important Points:

- Not suited for large areas or concentrated flows
- Tends to be labour intensive

Keys:

- Can be a traffic hazard on pavement

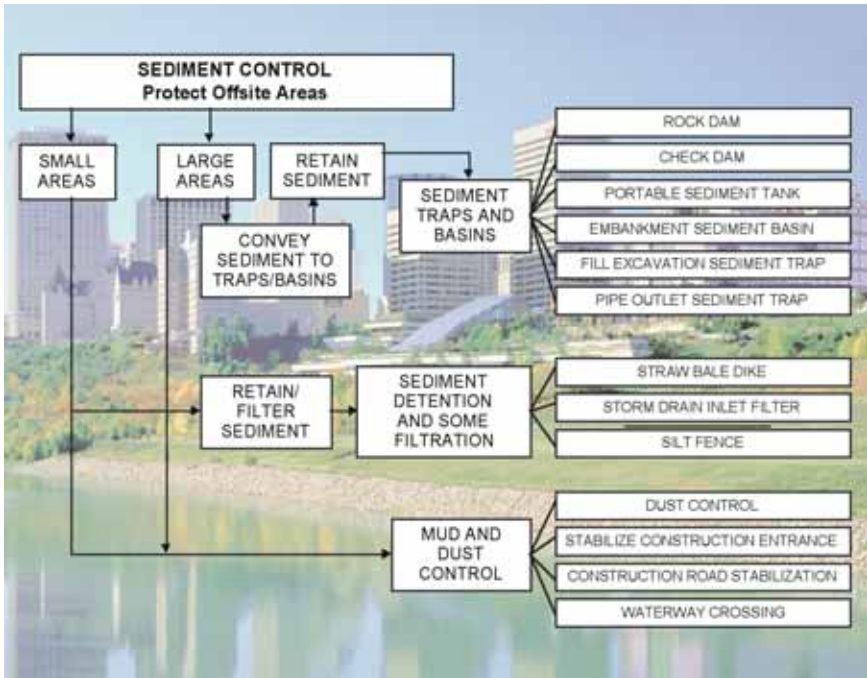
5.10 SEDIMENTATION CONTROL BMPs

Sedimentation control BMPs help collect sediment on the site in selected locations and minimize the sediment transfer off the site. Sedimentation controls are generally passive systems that rely on filtering or settling of soil particles out of the water or air.

Sedimentation control treats soil as a waste product and works to remove it from the transport system. Sedimentation control BMPs are the last line of defense against erosion and sedimentation.

The following **Sedimentation Control BMPs** are included in this Manual. This list is not exhaustive. Other sedimentation control BMPs may also be considered:

Section 5.10.1	Sediment Basins
Section 5.10.2	Sediment Traps
Section 5.10.3	Sediment Barriers
Section 5.10.4	Inlet Protection Measures
Section 5.10.5	Stabilized Construction Entrance
Section 5.10.6	Dust Control
Section 5.10.7	Brush/Rock Filter Berms
Section 5.10.8	Dewatering



5.10.1 SEDIMENT BASINS

Sediment basins are temporary sedimentation control measures used to trap sediment.

Benefits:

- Can be used for disturbed drainage areas of 2 to 40 ha
- Are effective for up to 18 months
- Will manage sediments until permanent drainage and/or vegetation is in place
- Can be drawn down periodically or prior to an expected storm
- Temporary basins can be created across a swale with the construction of an earth berm

Important Points:

- Must be maintained
- Should be located at natural outlets from the site
- A subsurface drain or riser pipe helps with detention time
- The emergency spillway should not be installed in fill

- Embankments and spillways should be stabilized immediately after construction

Keys:

- Maintenance includes periodic removal of sediment (must be done for FAC)



37. Properly designed permanent sediment basins can be an asset to an area

5.10.2 SEDIMENT TRAPS

Sediment traps are temporary sediment containment devices constructed by excavation and/or embankment construction to detain sediment-laden runoff. Outlets must be stabilized, and sediment should be removed when it reaches half the design depth of the trap.

Use:

- Typically for sub-drainage areas less than 2 ha

Important Points:

- Drainage areas should be less than 2 ha, and storage volumes should be at least 25 m³/ha. Berms should not be more than 1.5 m in height, with a minimum top wide of 1.5 m, and slopes no steeper than 3H:1V.
- Field flocculation can be used to increase efficiency. However, misapplication of flocculants or accidental spills can kill fish, and the potential risks of using flocculants must be considered.

Keys:

- Provide regular maintenance. Remove silt buildup before it reaches 1/3 operating depth



38. Sediment trap for a small area



39. Series of sediment traps

5.10.3 SEDIMENT BARRIERS

Sediment barriers are used to trap sediment from sheet flow runoff.

Use:

- For drainage areas of less than 2 ha
- Devices that can serve this function include: silt fence, straw bales, continuous berms, check dams, and inlet protection

Important Points:

- If not installed and maintained properly, they can make a situation worse

Keys:

- Need regular inspection and maintenance

5.10.4 INLET PROTECTION MEASURES

Inlet protection measures are considered the “last line of defence.” The measure consists of a permeable barrier installed around an inlet to reduce sediment content in the water before it enters the inlet. Inlet protection measures are types of sediment traps used around catch basins, drop inlets and culvert inlets. There are two primary types: (i) drop inlet sediment barriers and (ii) catch basin inlet barriers. They must be inspected and maintained regularly and all materials and sediment must be removed when construction is completed and the drainage area stabilized.

Use:

- Maximum of 0.5 ha drainage area

Important Points:

- Use the right material for the flow velocity
- Match the method to the surrounding slope
- Use a slotted riser or a pit excavation to increase sediment storage

Keys to successful use:

- Remove sediment after each storm
- Catch basin inserts should be a last line of defense not the primary tool
- Catch basin inserts must be emptied regularly before they get too heavy or burst



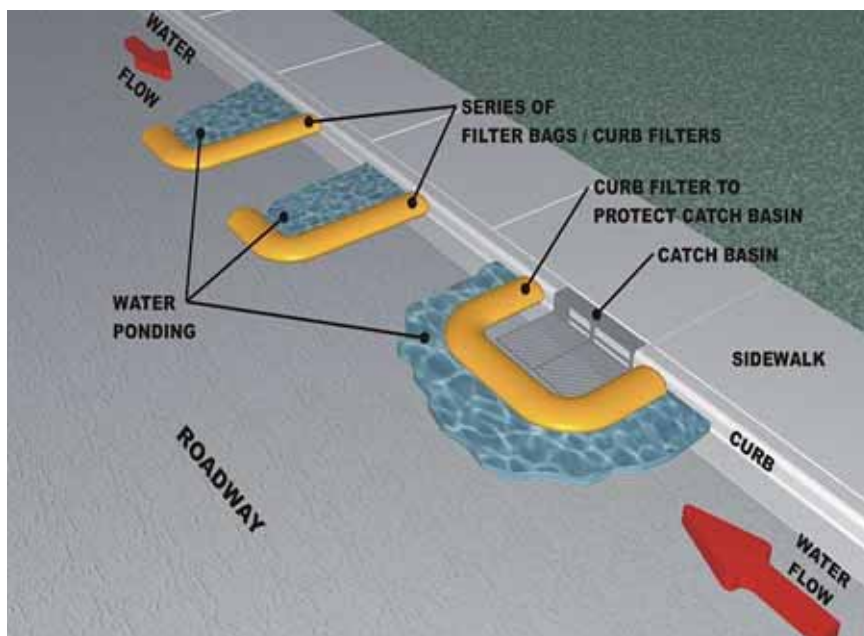
40. Good installation, but is the fence trenched



41. Some protection of inlet, but it needs protection along top of curb



42. Rock sock used for inlet protection



43. Typical Set-up for Inlet Protection

5.10.5 STABILIZED CONSTRUCTION ENTRANCE

The construction entrance/exit must be stabilized to reduce tracking of mud and dirt from the site onto public roads and streets. Typically a gravelled area will be constructed. Additional measures to remove mud and dirt from the vehicles before they leave the site include rumble racks, tire washes, and sediment traps. It can be supplemented by a good street cleaning program and inlet protection.

The gravel pad should be constructed using 75 to 150 mm diameter rock on level ground, and a minimum of 15 m long and 9 m wide.

Use:

- Locate where site traffic exits onto public roads

Important Points:

- Route runoff from entrance through a sediment trapping device prior to discharge
- Design for the heaviest vehicle anticipated on site and construction schedule

Keys:

- Require all site traffic to use the facility
- Clean and maintain the sediment trapping device



44. Gravel pad reduces off-site mud-tracking



45. Tire Wash Operation

5.10.6 DUST CONTROL

Dust control is important in wind prone areas and high traffic areas. Soil binders applied to exposed soil can temporarily reduce erosion due to water, wind, or vehicles. They can be used on haul roads, stockpiles and exposed slopes. Soil binders must be environmentally friendly/inert and be appropriate for the application. Soil binders must be environmentally benign, such as water.

Use:

- Chemical structural or mechanical measures to prevent wind erosion

Important Points:

- Dust control measures are temporary, require reapplication and may have environmental impacts
- For areas not subject to traffic many of the BMP suitable for water erosion also work with wind erosion

Keys:

- Select appropriate materials for the site conditions and environment
- Inspect daily and reapply as required



46. Wind erosion, detachment and transport



47. Water truck for dust control

5.10.7 BRUSH/ROCK FILTER BERMS

Temporary barriers of brush wrapped in filter fabric and secured in place, or rock berms that intercept and filter sediment laden runoff

Use:

- Use temporarily in contributory areas less than 250 m² per 25 m length of barrier
- Along streams, channels and toe of slopes

Important Points:

- Allow sufficient space for water ponding
- Does not divert runoff, only filters it

Keys:

- Remove at end of construction
- Rock filter berms are hard to remove

5.10.8 DEWATERING

Dewatering may be necessary on construction sites, after precipitation events, or due to on-site water features (waterways, high groundwater table, etc). Disposal of the wastewater to the storm or sanitary systems must satisfy the City of Edmonton's bylaws, and approval must be received from the City of Edmonton and Alberta Environment. Suspended solids (sediments) must be removed prior to disposal.

Use:

- Dewatering both surface water and groundwater from trenches

Important Points:

- System to remove sediment must match or exceed pump capacity
- Could consist of a filter box, portable sediment tank, silt bag or other device

Keys:

- Must be inspected, maintained and cleaned regularly
- Dispose of sediment in an acceptable fashion



48. Trench Dewatering

[illegible]

6.1 TRAINING

The owner/developer, through its consultants and contractors, is responsible for ensuring that they are competent in all aspects of ESC design, installation, and maintenance and that they stay current with new research and technologies.

ESC technical training is available through:

- Alberta Transportation
- Alberta Environment
- City of Calgary
- Consulting Engineers of Alberta
- Alberta Roadbuilders and Heavy Construction Association
- University of Alberta and other post-secondary institutions
- International Erosion Control Association (<http://www.ieca.org/>)
- Certified Professional in Erosion and Sediment Control Inc. (<http://www.cpesc.net/>)

6.2 CONTACTS AND WEBSITES

- Alberta Agriculture, Food and Rural Development: <http://www.agric.gov.ab.ca/>
- Alberta Environment: <http://www3.gov.ab.ca/env/>
- Alberta Queen's Printer (provincial legislation): <http://www.qp.gov.ab.ca/index.cfm>
- Canadian Coast Guard: http://www.ccg-gcc.gc.ca/main_e.htm
- Certified Professional in Erosion and Sediment Control Inc. (<http://www.cpesc.net/>)
- City of Edmonton: <http://www.edmonton.ca>
- Environment Canada: <http://www.ec.gc.ca/envhome.html>
- Fisheries and Oceans Canada: <http://www-heb.pac.dfo-mpo.gc.ca/publications/pdf/165353.pdf>
- International Erosion Control Association (<http://www.ieca.org/>)
- Justice Canada (federal legislation): <http://laws.justice.gc.ca/en/index.html>

- U.S. EPA: <http://www.epa.gov/owm/sw/toolbox/>
- U.S. Department of Agriculture: <http://www.usda.gov/>

6.3 TECHNICAL INFORMATION

- Alberta Transportation Design Guidelines and Field Manual for Erosion and Sediment Control for Highways:
 - <http://www.tu.gov.ab.ca/Content/doctype372/production/gtd001ergl.htm>
 - <http://www.tu.gov.ab.ca/Content/doctype372/production/gtd001rev.htm>
 - <http://www.tu.gov.ab.ca/Content/doctype372/production/gtd001field.htm>
 - <http://www.tu.gov.ab.ca/Content/doctype372/production/gtd001fldrev.htm>
- City of Calgary Guidelines and Field Manual for Erosion and Sediment Control:
 - <http://www.calgary.ca/DocGallery/BU/wwd/escguidelines2001-02-12.pdf>
 - <http://www.calgary.ca/DocGallery/BU/wwd/ESCFieldManual2001-02-12.pdf>
- *Protecting Water Quality in Urban Areas, BMPs for Minnesota*, Minnesota Pollution Control Agency:
<http://www.pca.state.mn.us/water/pubs/sw-bmpmanual.html>
- *Erosion Control Handbook*, Minnesota Department of Transportation
- *The Inspectors Erosion and Sediment Control Pocketbook Guide*, Minnesota Department of Transportation
- *Erosion and Sediment Control Field Manual*, California Regional Water Quality Board, San Francisco Bay Region
- *Biotechnical and Soil Bioengineering Slope Stabilization, A Practical Guide for Erosion Control*, Donald H. Gray and Robbin B. Sotir, 1996 John Wiley & Sons, Inc.

6.4 TECHNICAL RESOURCES

Erosion Control Technology Council provides information on erosion control blankets from member manufacturers. They maintain a website at <http://www.ectc.org> that provides information on the products produced. There is no independent verification of the validity of product information provided by the manufacturers.

Wisconsin Erosion Control Product Acceptability List (PAL) includes products that have been tested to conform to their advertised claims and WinDOT standards. The list can be useful to find quality erosion control products. The Department of Transportation for Wisconsin web page for PAL is found at: <http://www.dot.wisconsin.gov/business/engrserv/pal.htm> and is updated periodically.

NOTES FOR THIS SECTION

[illegible]

Best Management

- Practices (BMPs). Activities, practices, products or devices, or combinations thereof, designed to prevent or reduce the release of sediment and other pollutants into receiving water bodies or streams. They operate by preventing the detachment of soil particles, controlling the transport, or by facilitating sedimentation at controlled locations on the site.
- Compliance. Adhering to all provisions, directions and requirements of the legislation, permits, bylaws and contract documents.
- Contractor. The entity contracted to implement the ESC Plan and construct the works.
- Convex Pertaining to a silt fence, the curve of the fence should tend slightly toward the origin of flow.
- Critical Area Environmentally sensitive or ecologically important areas on or near the project site.
- Disturbed Area The portion of the site at any given time that has been subject to disturbance of its surface and vegetation and is without protective cover.
- Erosion The process of detaching soil particles and their transport by wind or water.

Erosion and Sedimentation

Control (ESC) Plan A document or parts of multiple documents that describes and addresses the methods, practices, devices, and products that are to be used to minimize erosion and the transport of sediment from the site.

Erosion Control

Schedule A schedule for the application of the ESC plan including installation, inspection, maintenance and removal.

Erosion and Sedimentation

Control (ESC) Practices that protect the soil from erosive and sediment transport forces during and after construction activities.

Ground Cover Vegetation, mulch or some other material that covers and protects the soil.

Implementation Putting the practices into action, installing devices and products, then carrying out inspections and maintenance to ensure proper function.

Inspection Review of BMPs in place to check for proper function and maintenance. It should also include review of disturbed areas and watercourses for signs of erosion.

- Inspectors Personnel responsible for conducting site inspections to check that ESC plans are being followed and that adequate ESC measures are in place. Typically, the inspector will be a qualified employee of the owner/developer or their consultant, however City of Edmonton inspectors, or employees of the contractor may also carry out inspection duties on behalf of their employer.
- Maintenance Any and all efforts to keep BMPs functioning properly.
- Off-site Areas outside the property boundary or defined work site.
- Project ESC Team Representatives from the City, permitting authority, consultant, developer and contractor that are intimately involved in the design, installation, inspection, maintenance, and/or removal of the materials and methods specified in the ESC Plan.
- Rain Event Events with sufficient rainfall to produce runoff that leaves the boundary of the site.
- Runoff The water from precipitation, snow melt, or dewatering that does not soak into the ground and leaves the site boundary in either sheet or concentrated flow.

- Runoff Control Practices that reduce the erosive and sediment transport capacity of stormwater by reducing velocity, concentration and flow path of the runoff.
- Sediments Soil particles that have been detached and are being transported by wind or water.
- Sedimentation Deposition of soil particles by wind or water. Erosion control practices reduce the amount of sediment.
- Sediment barriers Transport control measures designed to separate sediment from sheet flow runoff. They tend to reduce the velocity of the runoff, create small ponds and allow the sediment to settle out. They require regular removal of collected sediment to function properly.
- Sediment Basin A pond designed to detain runoff long enough to allow the sediment to settle out.
- Sedimentation Control Devices or practices used to keep sediment on site.
- Sediment Laden Runoff Runoff containing sediment. The sediment in the water can strike the soil surface and cause additional soil to erode.

- Sediments, tracked Sediments carried off the site on the wheels, tracks or undercarriage of vehicles and equipment.
- Site Erosion Plan A plan to deal with unexpected, emergency or difficult erosion or sedimentation control situations.
- Stabilized Soil Areas of soil that have been temporarily or permanently covered with vegetation, mulch, blankets, etc. to the extent that erosion will be minimized under most conditions.
- Temporary Measures ESC measures that will be removed or replaced during the course of the project.
- Time of Disturbance The amount of time between stripping or other land disturbing activity and the stabilization of the area again.
- Turbidity The measurement of how “cloudy” or “muddy” the water is. Most turbidity is caused by the presence of soil sediments or other organic matter.
- Turf Establishment Seeding, sodding or otherwise establishing vegetative ground cover.

APPENDIX A SAMPLE ESC INSPECTION/ MAINTENANCE REPORT

APPENDIX A: SAMPLE ESC INSPECTION/ MAINTENANCE REPORT

Project Name:		File No./ Contract No.:		
Inspection Date/ Time:		Date of Last Inspection		
Inspected By:				
Verbal/Written Notification given to:		Date:		
Current Weather		Weather Forecast		
mm of rain in last week			mm of rain in last 24 hours	
Stage of Construction				
Contractors on Site				
Construction Activities on Site				
Heavy Equipment on Site				
INSPECTION CHECKLIST	Yes	No	Comments	Action Required
Has stripping and grading been phased where possible?				
Have stripped areas/exposed soils/steep slopes been protected and stabilized?				

INSPECTION CHECKLIST	Yes	No	Comments	Action Required
Have waterways and drainage ways been protected and stabilized?				
Are perimeter controls in place and functioning adequately?				
Are offsite/ downstream properties/waterways protected?				
Are construction entrances stabilized to minimize tracking of soil and mud offsite?				
Are Sedimentation Control BMP's in place and functioning adequately?				
Are Transport Control BMP's in place and functioning adequately?				
Are Erosion Control BMP's in place and functioning adequately?				

