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OPUS DAYTONKNIGHT

2014 CANADIAN CONSULTING ENGINEERING AWARDS

CLEARBROOK-MARSHALL INFILTRATION GALLERY

ADVANCED STORM WATER MANAGEMENT FOR SUSTAINABLE GROWTH

ABBOTSFORD

SD SHARP & DIAMOND LANDSCAPE ARCHITECTURE

YARDWORKS

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ASSOCIATION OF CONSULTING ENGINEERING COMPANIES BRITISH COLUMBIA

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CITY OF ABBOTSFORD: CLEARBROOK-MARSHALL INFILTRATION GALLERY

1 EXECUTIVE SUMMARY

In order to implement their Regional Growth Strategy, the City of Abbotsford required an innovative approach to managing the storm water run-off for a proposed industrial zone close to the Abbotsford Airport. Opus DaytonKnight researched, pilot tested, designed and managed the construction of the Clearbrook-Marshall Infiltration Gallery over a period of four years.

The Clearbrook-Marshall Infiltration Gallery is an innovative, advanced storm-water management facility which enables all the storm water run-off from the surrounding light industrial and agricultural areas to be collected, stored and treated prior to infiltrating to an underground drinking water aquifer called the Abbotsford-Sumas Aquifer.

The Abbotsford-Sumas Aquifer covers an area of 260 square kilometers in British Columbia and Washington State. The City of Abbotsford and the surrounding area is situated over this aquifer. The Aquifer is the primary source of drinking, irrigation and industrial water for over 100,000 people in B.C. and Washington. Because the water table is very close to the surface, the aquifer is very susceptible to being contaminated from storm water run-off, particularly from urban areas.

The Infiltration Gallery is constructed from an engineered soil filtration media which removes contaminants from the storm water using physical, chemical and biological processes to treat the water and protect the underlying aquifer. The surface vegetation is also designed to complement the soil filtration media.

Completed on schedule and budget in summer 2013, the Infiltration Gallery has established new standards for the management and infiltration of large volumes of storm water run-off.

2 PROJECT DESCRIPTION

2.1 PROJECT OBJECTIVES, SOLUTIONS AND ACHIEVEMENTS

2.1.1 Background

The City of Abbotsford and the surrounding area is situated over an extensive underground drinking water aquifer called the Abbotsford-Sumas Aquifer. The Abbotsford-Sumas Aquifer covers an area of 260 square kilometers in British Columbia and Washington State. The Aquifer is a drinking water source for over 100,000 people and is the main source of water for a multi-million dollar provincial trout hatchery, and various other important industrial and agricultural uses on both sides of the border.

The aquifer water table is close to the surface which makes it very susceptible to being polluted or contaminated from storm water run-off. Intensive agriculture production, expansion of industrial and commercial activities, and rapid urban development increase the potential for future ground water contamination. This growth also increases the importance of the ground water as a source of water.

Local, State and Provincial governments on both sides of the border have committed to developing strategies to maintain the water quality in the aquifer with continued regional economic growth.

As part of its Regional Growth Strategy, the City of Abbotsford has rezoned lands between Highway 1 and the Abbotsford Airport for light industrial development. The City required that the post-development infiltration from these lands remain the same as before development. All rainfall and surface run-off from the developed area is to be infiltrated to ground to recharge the aquifer in a manner that protects the water quality in the aquifer.

2.1.2 Objectives

The objectives of the project are as follows:

- Provide an economically viable solution for the storage, treatment and safe infiltration of large volumes of storm water run-off from a light industrial and agricultural area into the Abbotsford-Sumas Aquifer.
- Remove contaminants such as trace metals, hydrocarbons, VOCs, particulates, pesticides and nutrients from the run-off to protect the groundwater and prevent contamination of the aquifer.
- Provide sufficient storage to manage the excess storm water run-off from all major rainfall events.
- Provide a system that requires low maintenance and can give long lasting performance without cleaning or replacing the filtration media.

2.1.3 Solutions

In an urban or agricultural environment, rainfall can mix with substances on the surface of the ground such as spilled petroleum products, trace VOC compounds, trace metals, pesticides and fertilizers and introduce these unwanted chemicals into the groundwater and contaminate it. In addition, urban development also changes the water balance of the developed area. Historically urban development creates a high proportion

of impervious surfaces, resulting in greatly reduced infiltration to ground. In the past, most of the run-off from urban development has been conveyed, typically in large drainage infrastructure, to the nearest surface water body.

In developing the Regional Growth Strategy, the City committed to maintaining the groundwater balance for the area, and the water quality for the underlying aquifer.

The Clearbrook-Marshall Infiltration Gallery addresses these issues. The Infiltration Gallery is capable of removing contaminants from the run-off from a 40 hectare light industrial development, and a 45 hectare agricultural area, while storing and infiltrating the excess run-off.

The Infiltration Gallery consists of an engineered soil filter media ranging from 500 to 700 mm in depth on a prepared granular base. The filter media is overlain by specialized vegetation (shrubs and grasses) designed to complement the soil filtration media. The soil media is designed to function both as a filtration bed and a growing medium to support the surface vegetation.

The Infiltration Gallery removes contaminants progressively, using a combination of physical, chemical and biological processes in three separate zones.

The first zone – the Sedimentation Zone - is located at the water inlet. An energy dissipating channel directs the incoming water to a flat sedimentation bed, interrupted with rocks and reeds which slow the flow and allow heavier sediments to settle out. The sedimentation pond is lined to prevent infiltration through this pond. Water flows through the pond, spreading out and flowing evenly into the second zone – the Initial Infiltration Zone.

The Initial Infiltration Zone consists of a deep soil filtration bed overlain by a vegetation layer tolerant of submerged conditions and also short drought conditions. A characteristic of urban run-off is that contamination is mainly carried by small rainfall events or the first flush of major storms. Flows from these events carry over 90% of the annual contaminant load which is removed in the Initial Infiltration Zone. In this zone, contaminants are removed by physical processes (settling and filtration), by biological processes (bacteria in the soil consume hydrocarbons and trace organics) and chemical processes (certain organics, pesticides and trace metals are oxidized by chemical reaction in the soil).

The Main Infiltration Zone consists of a shallower soil filtration bed, also overlain by a vegetation layer. Here the vegetation is tolerant of submerged conditions, but longer drought conditions. The Main Infiltration Zone removes contaminants using the same mechanisms as described. As the water level builds up during major storms and spreads over the gallery area, infiltration occurs over a wide area, enabling the Infiltration Gallery to safely infiltrate all the run-off from the catchment area.

The surface vegetation overlying the infiltration media consists of a specialized blend of shrubs and grasses tolerant of submerged conditions and drought periods. The vegetation varies throughout the infiltration gallery. The vegetation maintains the performance of the soil filtration bed by absorbing nutrients from the soil, maintaining moisture and mitigating the build-up of fine surface sediments which could reduce the infiltration rate.

2.1.4 Achievements

The key achievements of the Clearbrook-Marshall Infiltration Gallery are:

- Stormwater run-off from a new 40 hectare industrial area is collected, treated and polished prior to infiltrating to the Abbotsford-Sumas Aquifer. As a result, the City of Abbotsford is able to proceed with the growth and development of the community in accordance with their Regional Growth Strategy.

- Run-off from a 45 hectare agricultural area is collected and treated to remove trace pesticides, fertilizers, nutrients and manure prior to infiltrating into the aquifer, reducing the potential for contamination of the aquifer from agricultural sources.
- In keeping with the principles of sustainability, the entire run-off from the catchment area is contained, treated and infiltrated locally, maintaining the local water balance while charging the aquifer while protecting the aquifer water quality.
- The Infiltration Gallery is an innovative, large scale infiltration facility - one of very few in Canada designed to infiltrate urban and agricultural run-off to a drinking water aquifer.

2.2 TECHNICAL EXCELLENCE AND INNOVATION

Advanced Storm Water Management – Combining the functions of storage, treatment and infiltration of urban and industrial storm water run-off, while recharging an active drinking water aquifer, is a complex undertaking. After a three year period of research and pilot testing and evaluation, Opus DaytonKnight developed the design for the Infiltration Gallery which utilizes physical, chemical and biological treatment processes to retain, treat and polish the stormwater run-off prior to infiltration to ground. The completed Infiltration Gallery manages and treats the combined run-off from urban and agricultural areas successfully in a single, large scale facility.

Large Scale Storm Water Infiltration – Storm water management is one of the most important environmental challenges for Municipalities while promoting and facilitating growth in the community. Large scale storm water management is especially challenging when infiltration to ground is required. Groundwater recharge, and maintaining the groundwater balance has often been overlooked in the past resulting in pollution, flooding and erosion of natural watercourses. The Clearbrook-Marshall Infiltration Gallery demonstrates that it is possible to manage urban and agricultural storm water run-off on a large scale, while infiltrating large volumes of water to ground, protecting the environment and recharging groundwater in a safe, sustainable manner.

Engineered Soil Filtration Media – The soil media for this facility has been developed specifically for the purposes of removing the contaminants associated with urban and agricultural run-off. The key characteristics of urban run-off contamination - particulate bound hydrocarbons, organics, trace metals and other constituents - are used to advantage in the design an engineered soil product that can capture and hold these constituents. Once held in the soil matrix, the constituents are neutralized and broken down into harmless elements using a combination of physical, chemical and biological processes. Of key importance for infiltration into a drinking water aquifer, the engineered soil must be low leaching and low in nutrients so as not to leach nutrients or other constituents into the underlying waters.

Specialized Vegetation – The vegetation plays a key role in the function of the Infiltration Gallery. The roots introduce air and oxygen to the soil matrix facilitating and maintaining a healthy biological environment. The plants capture and absorb nutrients added to the soil from agricultural or urban sources, and maintain the surface permeability of the soil which is of key importance for the long term performance and low maintenance of the Infiltration Gallery.

2.3 ENVIRONMENTAL, ECONOMIC AND SOCIAL SUSTAINABILITY AND AESTHETIC ASPECTS

Environmental Sustainability –The following specific features of the project enhance long term environmental sustainability and protection:

- Storm water run-off from a 40 hectare urban light industrial area, and a 45 hectare agricultural area, is captured in the catchment area where it falls and is infiltrated to ground in the same area resulting in the natural water balance of the area being maintained.
- The infiltration gallery recharges the Abbotsford-Sumas Aquifer with clean, high quality water from the surface, contributing to the sustainability of the Aquifer as an important source of water for local businesses and industry, agriculture, a fish hatchery and as a source of drinking water for approximately 100,000 people. Maintaining a high quality groundwater resource is essential to the quality of life and the environmental sustainability of the community that depend on the resource.
- The location of the Infiltration Gallery in the center of the catchment area enables the installation of short lengths of smaller drainage pipe, rather than long runs of large piping to collect and divert the run-off to distant watercourses, resulting in reduced greenhouse gas emissions associated with the construction of large drainage infrastructure.

Economic Sustainability – Construction of the Infiltration Gallery has enabled the City of Abbotsford to proceed with the development of the light industrial zoned lands between the Highway and the Airport resulting in stable investment and an increased tax base for the local government. Maintaining the aquifer water quality results in reduced costs for water supply and treatment. Managing storm water run-off in the location that it is produced results in lower costs for drainage infrastructure. Reduced costs associated with a high quality water supply, and low storm water infrastructure needs, results in more competitive and sustainable local economy.

Social Sustainability – The project makes a major contribution to social sustainability by providing local solutions to local problems, by facilitating the sustainable economic development of the community, by enabling the creation of opportunities for long term employment and by fostering an economically competitive local business environment. A major local resource – the high quality groundwater supply – is protected by the project, directly benefiting the community and demonstrating to the members of the community that their taxes are being invested for the long term benefit of the community and the environment.

Aesthetic Aspects – Although function often takes precedence over aesthetics in engineering, the physical appearance of a project usually garners the most attention. The Clearbrook-Marshall Infiltration Gallery has been designed to be an aesthetic and functional facility. The facility is aesthetically pleasing, functionally effective, low maintenance and a satisfactory addition to the local environment. The incorporation of walking and bike paths around the perimeter of the facility encourages walking and biking in a park like setting.

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PROJECT PHOTOS AND SKETCHES

Photo 1 – The Completed Infiltration Gallery

Photo 2 – The Infiltration Gallery under Construction – View 1

Photo 3 – The Infiltration Gallery under Construction – View 2

Photo 4 – Pilot Testing Soil Filter Media Bed

Photo 5 – Inlet Structure with Energy Dissipating Rock Channel

Photo 6 – Sediment Pond and Initial Infiltration Zone (Typical at each inlet)

CLEARBROOK-MARSHALL INFILTRATION GALLERY

ADVANCED STORM WATER MANAGEMENT FOR SUSTAINABLE GROWTH

The Clearbrook-Marshall Infiltration Gallery enables the infiltration of urban and agricultural storm water run-off to ground and directly to the Abbotsford-Sumas Aquifer.

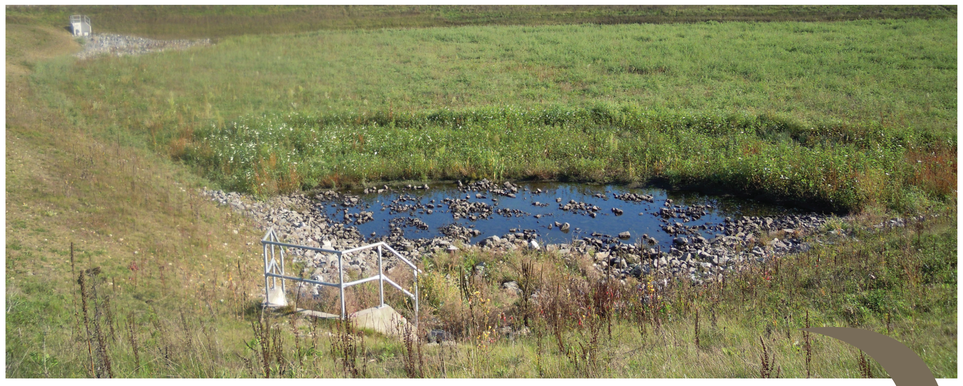
The Abbotsford-Sumas Aquifer is an extensive underground aquifer which covers an area of 260 square kilometers and is a drinking, irrigation and industrial water source for over 100,000 people in British Columbia and Washington State. The water table is very close to the surface which makes the aquifer very susceptible to being polluted or contaminated from storm water run-off. The water supply to the aquifer is the rainfall and snow melt that falls on the surface.

In an urban or agricultural environment, run-off from rainfall events can mix with substances on the surface such as spilled petroleum products, trace metals, pesticides or fertilizers, and introduce these contaminants into the groundwater. The contaminated groundwater can be a potential health risk to those who drink it.

The Clearbrook-Marshall Infiltration Gallery receives the excess storm water run-off from a new 40 hectare light industrial development area, and a 45 hectare agricultural area, including all minor and major storms.

The Infiltration Gallery contains a specialized soil media filtration bed which removes contaminants from the run-off. In the filtration bed, contaminants are removed using a combination of physical, chemical and biological processes. Contaminant free water infiltrates through the underlying soils to recharge the aquifer.

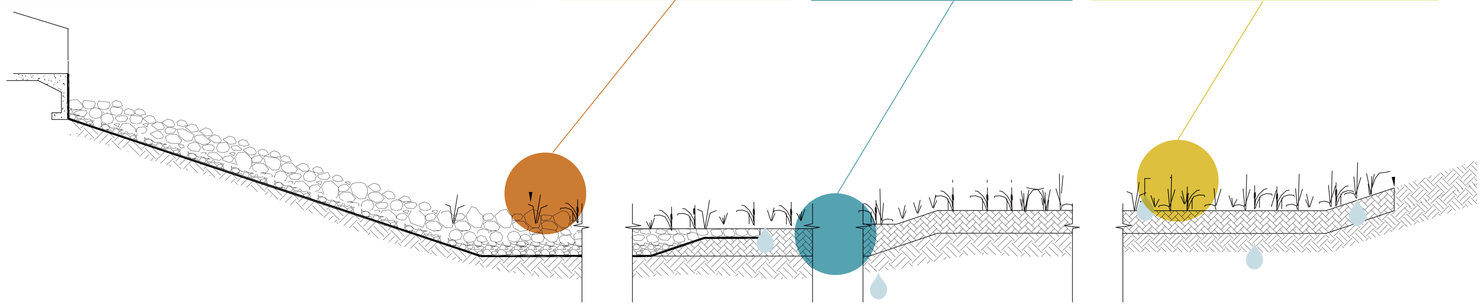
Taking three years to research, pilot test, design and construct, the Infiltration Gallery was completed on schedule and within budget in Spring 2013. The completion of the project enabled the City of Abbotsford to proceed with the development of the light industrial zoned lands close to the Airport and the Highway.

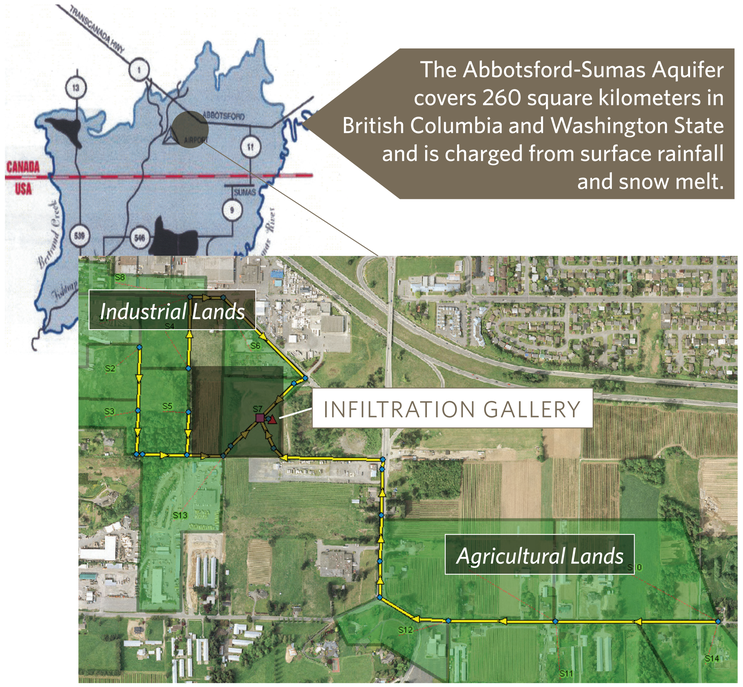


The Sedimentation Zone allows heavier and more contaminated sediments to settle out. There is no infiltration from this zone.

The Initial Infiltration Zone receives 90% of the annual contaminant load and removes this through physical, chemical and biological processes in a deep soil filtration bed.

The Main Infiltration Zone receives and stores the run-off from major storm events and infiltrates the stored water to ground through a shallower soil filtration bed, while removing residual contaminants.





The Abbotsford-Sumas Aquifer covers 260 square kilometers in British Columbia and Washington State and is charged from surface rainfall and snow melt.

THE INFILTRATION GALLERY CONTAINS 3 SEPARATE ZONES:

A **Sedimentation Zone** at each inlet enables heavier and more contaminated sediments to settle out, and allows the incoming water to spread out over the Initial Infiltration Zone.

The **Initial Infiltration Zone** contains a deep soil filtration bed and is planted with vegetation tolerant to submerged and drought conditions. The vegetation maintains surface infiltration capacity in the soil filtration bed, facilitates biological activity in the root system, absorbs nutrients from the soil and prevents the surface from drying out in Summer. The Initial Infiltration Zone removes 90% of the contaminants that enter the Infiltration Gallery.

The **Main Infiltration Zone** covers most of the infiltration area and is designed to store and slowly infiltrate run-off from major storm events. Run-off from major storms contains much lower levels of contamination than typical small run-off events or the first flush of a major event, but much greater volumes of water. This must be stored and polished as it is infiltrated to ground to protect the aquifer. The Main Infiltration Zone is planted with vegetation that is more drought tolerant, but performs the same functions.

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