Terry Fox Drive Extension Richardson Side Road to Second Line, Storm Water and Floodplain Management Final Report

June 2010 Update

City of Ottawa

09-1518

Submitted by

Dillon Consulting Limited

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1.0 INTRODUCTION

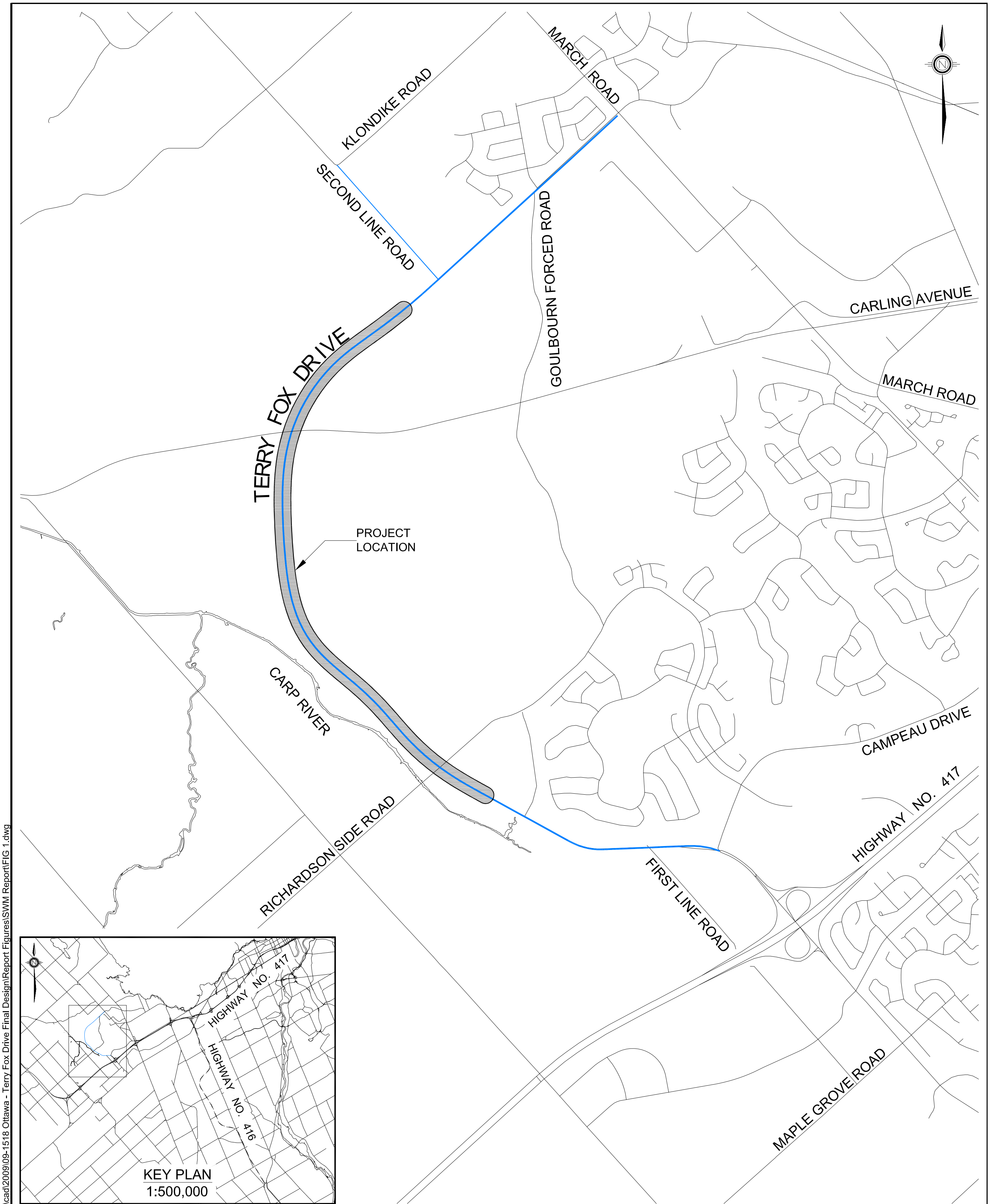
This report documents the recommended Storm Water Management Strategy for the extension of Terry Fox Drive from just south of the existing Richardson Side Road alignment to Second Line Road. Terry Fox Drive is located in the former City of Kanata, a satellite community in the western portion of the City of Ottawa. The project limits for this report are shown in **Figure 1**.

1.1 Background

An Environmental Study Report (ESR) dated October 2000 was completed for the extension of Terry Fox Drive from Eagleson Road / Hope Side Road to March Road. Dillon Consulting Limited was retained in November 2000 to undertake the Preliminary Design and Detailed Design for Terry Fox Drive from realigned Richardson Side Road to March Road. In December 2000, the assignment was divided into phases due to budget constraints and Dillon was authorized to proceed with Phase 1 of the Preliminary Design. In 2007, Dillon completed an EA Addendum for revisions to the original ESR, along with supporting documents, including a Preliminary Design Report and a Draft SWM Report.

In 2009, the City of Ottawa received federal Infrastructure Stimulus funding to complete the Terry Fox Drive project. A stipulation of the funding is that the project must be completed by March 2011. This report reflects the current status of adjacent development, updated environmental data and related reports and studies. Reflecting timing constraints, SWM facilities for Terry Fox Drive have not been integrated with SWM facilities for future development since most development is not yet at the detailed design stage.

Dillon is currently completing the Detailed Design of Terry Fox Drive. This report provides an update of issues and key design decisions related to SWM since the 2007 Preliminary Design. The report is also intended to support the application to MOE for a Certificate of Approval, as well as provide the City with the documentation required for the project to proceed.



22 December 2009 9:42:35 AM G:\cad\2009\09-1518 Ottawa - Terry Fox Drive Final Design\Report Figures\SWM Report\FIG 1.dwg

DILLON CONSULTING

DATE **DECEMBER 2009**

PROJECT LOCATION

TERRY FOX DRIVE EXTENSION
RICHARDSON SIDE ROAD TO SECOND LINE ROAD
STORMWATER MANAGEMENT REPORT

PROJECT NO. **09-1518**

FIGURE NO. **1**

1.2 Goals, Objectives and Performance Targets

1.2.1 Surface Water Management Goals

This Storm Water Management Report was completed to evaluate the impact of the proposed roadway realignment on surface water systems and to ensure that both water quality and water quantity management and floodplain management goals are achieved.

These goals are:

Goal 1: To convey upstream runoff through the proposed roadway without adverse impacts on the roadway, upstream and downstream properties, or the local natural environment; and

Goal 2: To convey runoff from the proposed roadway without adverse impacts on the roadway, upstream and downstream properties, or the local natural environment;

Goal 3: To improve or maintain existing surface water conditions where practical and cost-effective; and

Goal 4: To develop design and mitigation management alternatives, which are technically effective and cost effective (capital and maintenance) and, which minimize social and environmental impacts (e.g., property requirements and wetlands).

1.2.2 Surface Water Management Objectives

The following objectives for the SWM strategy have been developed to achieve these goals:

Goal 1 Objectives:

1a) Minimize diversion of upstream drainage areas (i.e. provide conveyance through the ROW) to minimize the potential for i) water quantity impacts at diversion outlets, and ii) quantity impacts at existing outlets which may affect the natural environment (e.g., flow reduction);

1b) Provide sufficient conveyance capacity through the ROW (i.e., adequately sized culverts or bridges) to minimize upstream water level impacts; and

1c) Minimize design velocities, to reduce the potential for erosion and need for extensive revetment at cross culvert outlets by means of suitable hydraulic design.

Goal 2 Objectives:

2a) Minimize water quantity impacts by providing a conveyance system and / or outlet area (end of pipe) management measure to match existing condition flow conditions; and

2b) Minimize water quality impacts by providing a conveyance system and / or outlet area management measure with suitable levels of treatment based on environmental sensitivities of receiving waters (i.e., quality of fisheries habitat).

Goal 3 Objectives:

3a) Reduce peak flows to downstream outlets with identified capacity deficiencies by implementing i) upstream drainage area diversions to adjacent outlets, ii) ROW drainage area diversions to adjacent outlets, or iii) over-control of ROW and upstream drainage area runoff to the existing outlet; and

3b) Provide centralized outlet area management measures (e.g. water quantity or water quality control facilities) to the extent possible.

Goal 4 Objectives:

4a) Consider alternative water quality and quality management measures, which have no property requirements beyond the proposed mainline ROW (e.g. quality treatment in ditches and quality control detention at ditch outlets);

4b) Consider outlet area management measure types, which minimize the extent of property requirements in areas where property beyond the ROW is required;

4c) Consider outlet area management measure design details, which minimize the extent of property requirements in areas where property beyond the ROW is required (e.g., minimize required storage area by i) maximizing side slopes, ii) using low head extended detention outlets (e.g., reverse flow pipes), and iii) setting permanent pools below gravity outlet grades);

4d) Minimize the extent of downstream channelization (outlet improvements) and property requirements by minimizing grade requirements at outlet area management measures (e.g. the use of low head outlets and below grade pools in SWM facilities); and

4e) Consider outlet area management measure functions, which minimize the extent of property area where property beyond the ROW is required (i.e. limit outlet area detention facility function to quantity control only and address quality control in the ROW conveyance system) (note - may be applicable only where outlet environment sensitivities support the use of conveyance treatment, as opposed to outlet area / end of pipe treatment).

1.2.3 Surface Water Management Targets

Specific surface water management targets, or design performance measures were developed to achieve these goals and objectives, and guide the development of the SWM strategy. **Table 1** provides a summary of the surface water management targets and objectives for this study. The targets are based, in part, on design criteria included in subwatershed studies for the Carp River and Shirley's Brook.

The Carp River Subwatershed Study was completed in 2004 (Robinson Consultants Inc.). According to the study, the instantaneous peak flows in the Carp River do not significantly increase if quantity control is not implemented in future development as documented on the fact sheet on page 197 for the portion of the Carp River subwatershed relevant to this project. Carp River implementation of flood erosion control measures, such as quantity control SWMPs is not recommended. This criterion was not reflected in the SWM strategy developed as part of the 2000 ESR or the 2007 Draft Storm Water Report, which reflected the assumption, at that time, that quantity control was required.

Water quality control is recommended in the Carp River Subwatershed Study. Level 2 control suitable for warm-water species is required for facilities discharging to the Carp River or any other tributaries within the subwatershed. This level of water quality control requires that 70% of total suspended solids in the incoming stormwater be removed by stormwater best management practices. This is consistent with the goals and objectives of the 2007 Dillon Draft Report. As well, the Richardson Ridge Stormwater Servicing Report (IBI 2007) based the SWM plan on the principles of 'first flush' water quality management.

The Shirley's Brook Subwatershed Study (Dillon, 1999) recommends water quality and water quantity treatment of stormwater for development in the subwatershed. Water quality objectives are based on MNR fish habitat classification. The reaches impacted by Terry Fox Drive are classified as Type 2 and, in some places, Type 1 habitat, requiring Level 1 and Level 2 protection or a 70 – 80 % TSS removal rate. For water quantity, "the recommended target level of quantity control would be to control post-development peak flows to their corresponding pre-development levels for the 100-year return period event, such that no new flooding hazards are created and existing hazards are not aggravated," (Dillon, 1999 p. 6-10).

Table 1: Surface Water Management Targets and Objectives

Objective	Target
1a	Convey all large external areas through the ROW.
1b	Design cross culverts to prevent excessive upstream surcharging under design flow conditions (i.e. satisfy minimum freeboard depth). Design cross culverts to manage upstream flood level impacts (i.e. increase in regulatory flood level of 100mm or less).
1c	Limit culvert outlet velocities to 3 m/s or less. Provide erosion protection at culvert outlets (150mm rip rap for outlet velocities to 3.5 m/s or less). Avoid supercritical culvert flow conditions and need for extensive outlet structures/ basins.
2a	Reduce 100-year peak discharge rates to existing peak discharge rates based on existing drainage area to outlet, for the portion of the project within the Shirley's Brook Subwatershed. There are no quantity control targets for the portion of the project within the Carp River Subwatershed.
2b	Provide Level 1 (Enhanced) quality treatment for discharges to coldwater (Type 1) fishery receiving systems, and Level 2 (Normal) quality treatment for discharges to warm (type 2) water fishery receiving systems.
3a	Divert upstream drainage areas from existing outlets with capacity deficiencies to adjacent outlets with spare capacity.
3b	Provide centralized outlet area management measures where technically feasible.
4a	Develop conveyance system or end-of-pipe quality treatment and quantity detention alternatives for all areas, including the use of oil grit separators.
4b	Use a wet pond or wetland for end-of-pipe management measures.
4c	Maximizing wet pond side slopes. Use reverse flow pipe extended detention outlets (low head). Set permanent pools below gravity outlet.
4d	Use reverse flow pipe extended detention outlets (low head). Set permanent pools below gravity outlet.
4e	Provide quality treatment in the ROW conveyance system for all areas with low outlet environment sensitivities (i.e. no fisheries habitat potential).

2.0 EXISTING ENVIRONMENT

2.1 Physiography and Soils

The soils in the Carp River area of Terry Fox Drive are primarily clay or rock land, with very low surface slope. Infiltration throughout the watershed is severely limited by the low porosity of the underlying soils. The low surface slope, while normally encouraging infiltration, has contributed to the installation of tile drains in the low-lying floodplain of the Carp River.

Based on geotechnical investigations by Golder Associates (2003 & 2009), the floodplain area includes a large deposit of sensitive silty clay overlying bedrock. The bedrock slopes up and daylights just east of Terry Fox Drive.

Bedrock in the Carp River Watershed is comprised of two main types. A prominent ridge of Precambrian metamorphic rock forms the Carp Ridge along the east boundary of the watershed, extending across the watershed north of Kinburn. The southern portion of the watershed is underlain by a broad flat-topped ridge (mesa) of younger Paleozoic sedimentary rocks (Ordovician era, approximately 500 million years in age). The rocks consist of predominately limestone, dolostone, sandstone, and shale.

The bedrock plains of the Shirley's Brook sub-watershed are characterized by numerous bedrock outcrops, relatively thick overburden cover, and local poorly drained wetlands and marshes which act as headwaters to Shirley's Brook. The poor draining wetlands flow into narrow stream reaches within deep channels that have been cut into ridges. The middle and lower reaches of the sub-watershed area consists of highly eroded terraces characterized by offshore deep-water marine deposits of silt and clay. Bedrock exposures within the lowland area are numerous owing to terrace cutting effects.

2.2 Natural Environment

Terrestrial Conditions

The proposed construction of Terry Fox Drive from the existing Terry Fox Drive alignment at Goulbourn Forces Road to south of Richardson Side Road crosses through one of Kanata's ecologically sensitive areas. The Terry Fox Drive alignment will pass through a number of future land uses including the General Urban Area (GUA), Enterprise Area (EA), and Natural Environment Area (NEA). The latter area is of most concern.

It is clear from recent studies, and the diversity of herpotofauna collected through trapping efforts and incidental sightings that the Terry Fox Drive area does provide key habitat for these and other wildlife species. While some of these animals may spend their entire lives within a small breeding pond, other such as wood frogs, spring peepers, turtles and toads may travel hundreds of metres to a few kilometres throughout their lifetime to complete their life processes.

The Ministry of Natural Resources has identified a number of Provincially Significant Wetlands (PSW) within the South March Highlands. The wetlands impacted directly by Terry Fox Drive are identified as swamps.

2.3 Topography and Overland Drainage

Existing surface water drainage conditions were assessed to define baseline conditions and identify areas with existing drainage problems, which could be considered in the development of the surface water management strategy. In addition, these baseline conditions were used to assess relative impacts of the proposed realignment and set control targets for mitigation.

Existing drainage information, studies, and field investigations were reviewed to characterize existing conditions. Additionally, staff and personnel from all affected municipalities, relevant authorities, and local landowners were consulted to obtain input on local drainage issues.

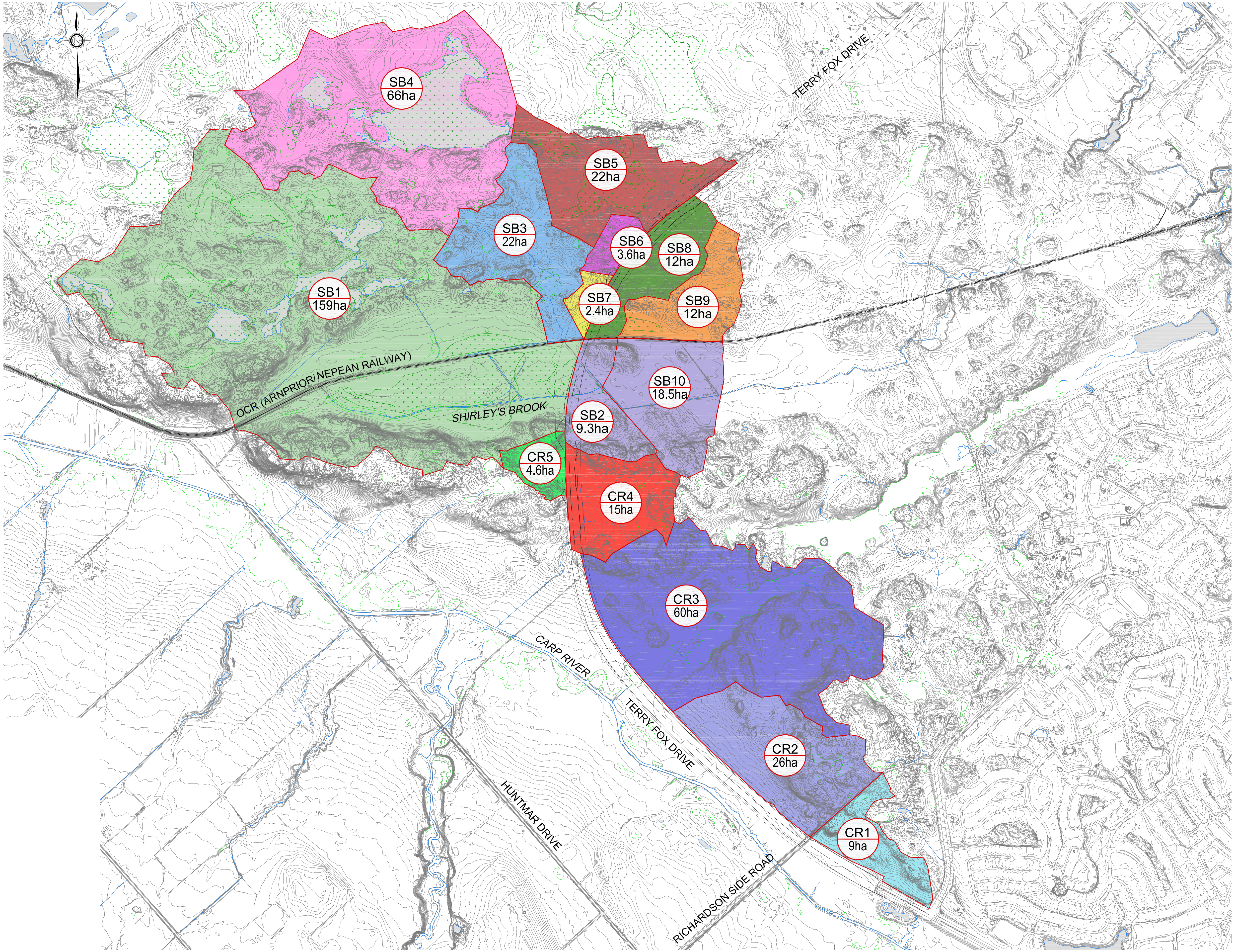
The study area is divided by the boundaries of the Carp River and Shirley's Brook / Watts Creek Sub-watersheds. Lands to the north of Station 14+450 fall within the Shirley's Brook / Watts Creek Sub-watershed while, lands to the south of Station 14+450 fall within the Carp River Sub-watershed. Each of the two respective sub-watersheds falls within the jurisdiction of the Mississippi Valley Conservation Authority. **Figure 2** provides an overview of the drainage areas relevant to Terry Fox Drive. The drainage areas that discharge to the Carp River are designated with a CR# and those that fall within the Shirley's Brook watershed are designated with a SB#.

2.3.1 Shirley's Brook Sub-Watershed

The Shirley's Brook sub-watershed covers an area of approximately 2,700 ha with 39% consisting of forest, wetland or exposed rock. The remainder has been cleared for agricultural purposes including pastureland, hay, mixed grain and corn, but many of these areas are being developed for estate residential or small-scale commercial/retail development. Several distinct natural areas are located within the Shirley's Brook sub-watershed, including the South March Highlands and Trillium Woods Park.

Within the northern portion of the study area (Shirley's Brook sub-watershed), surface water runoff currently traverses the Terry Fox Drive alignment via defined channels and overland flow routes, which drain easterly toward the main branch of Shirley's Brook. The main branch of Shirley's Brook runs parallel to the CNR tracks through the study area crossing the proposed alignment at Station 14+560. A complex system of tributaries conveys intermittent flow from the local drainage areas on the northwesterly side of the proposed alignment. The main Shirley's Brook tributary flows in a generally southerly direction, meandering back and forth across the proposed alignment at Station 15+335, 14+950 and finally at Station 14+910.

The local upstream external drainage areas adjacent to Terry Fox Drive, illustrated on **Figure 2**, are a small sub-set of drainage areas in the Shirley's Brook sub-watershed. These areas range in size from several hectares to over 200 hectares. Low-lying swampy areas connected by intermittent channels and ditches running parallel to the CNR corridor dominate the landscape in the vicinity of the CNR tracks and the proposed alignment. This complex system of flat-gradient drainage ditches are linked from the northerly to the southerly side of the CNR tracks via a system of systematically located small diameter pipe culverts and all eventually outlet into the main branch of Shirley's Brook. Downstream of the proposed alignment, surface water runoff is conveyed through residential and other developed areas via Shirley's Brook and other intermittent channels, prior to discharging into Shirley's Bay and ultimately the Ottawa River.



LEGEND:

- TDF-SB1
- TFD-SB2
- TFD-SB3
- TFD-SB4
- TFD-SB5
- TFD-SB6
- TFD-SB7
- TFD-SB8
- TFD-SB9
- TFD-CR1
- TFD-CR2
- TFD-CR3
- TFD-CR4
- TFD-CR5
- PROVINCIALLY SIGNIFICANT WETLANDS
- POND
- MARSH
- RIVERS AND STREAMS
- SB1 159ha — WATERSHED AND AREA

FIGURE 2
OVERVIEW OF TRIBUTARY AREAS (EXISTING CONDITIONS)

TERRY FOX DRIVE EXTENSION
RICHARDSON SIDE ROAD TO SECOND LINE ROAD STORMWATER MANAGEMENT REPORT

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22 June 2010 3:30:40 PM G:\cad\2009\09-1518 Ottawa - Terry Fox Drive Final Design\Report Figures\SWM Report\FIG 2 Overview of Tributary Areas.dwg

2.3.2 Carp River Sub-Watershed

Within the southern portion of the study area (Carp River sub-watershed), overland drainage currently traverses the ROW via overland flow routes and intermittent channels, which drain westerly towards the Carp River. The Carp River runs parallel with the proposed alignment through the study area on the west side of Terry Fox Drive, flowing in a north-westerly direction. Overland drainage patterns are generally perpendicular to the proposed ROW through a low-lying, flat, floodplain adjacent to the Carp River.

The local upstream external drainage areas adjacent to Terry Fox Drive represent a very small portion of the Carp River sub-watershed. These areas range in size from several hectares to over 50 hectares. The drainage patterns of the Carp River area are undefined and are typical of low-lying, flat, agricultural floodplain adjacent to a watercourse. Seasonal, low-flow channels can be found throughout agricultural fields and floodplain area flowing in a generally westerly direction towards the Carp River. One notable crossing is an intermittent drainage channel located within drainage area CR-3 (Station 13+325 of the proposed alignment).

2.4 Meteorology

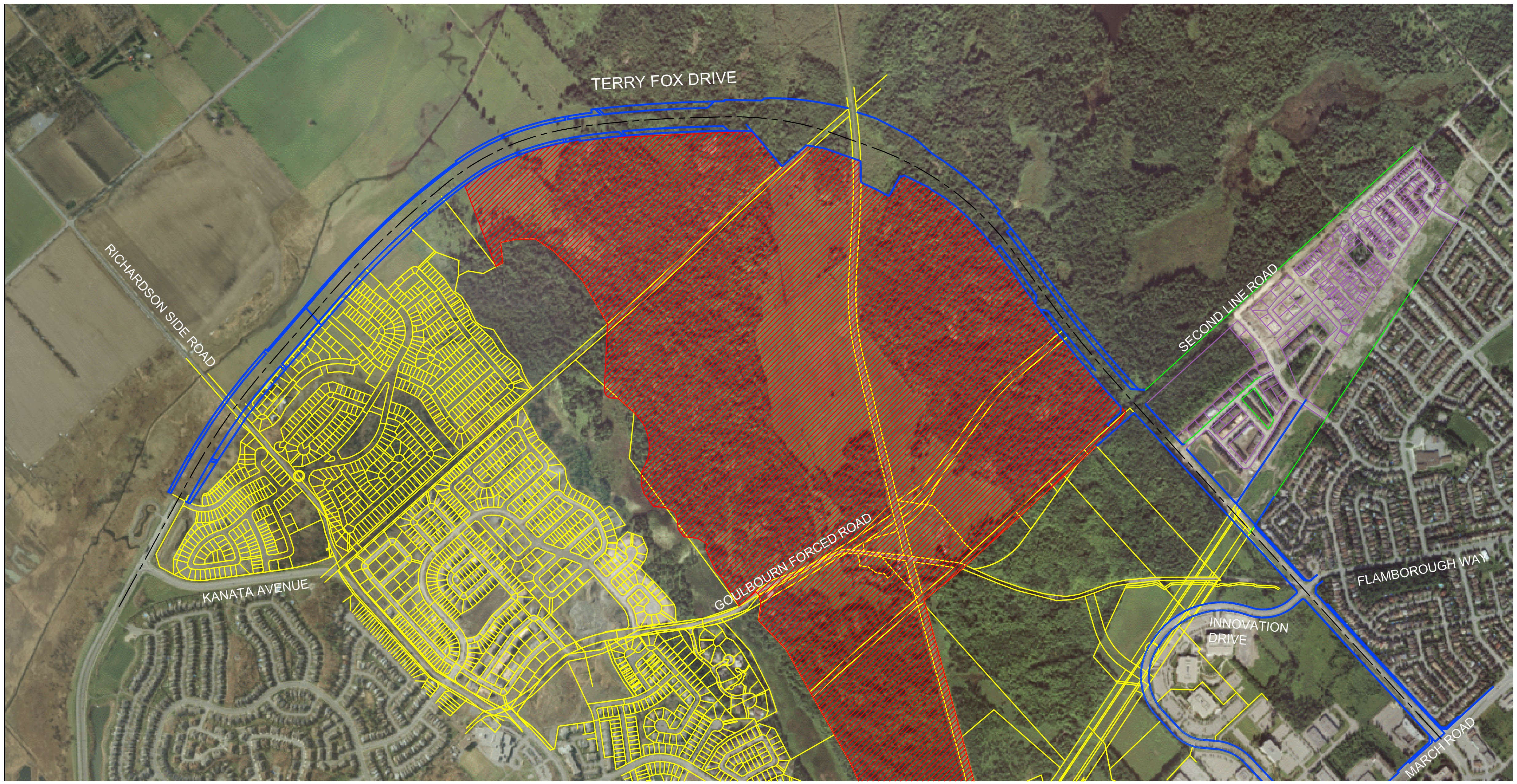
Rainfall data provided in the City of Ottawa Design Guideline document was utilized to complete the hydrologic calculations and modelling within the Carp River and Shirley's Brook subwatersheds. The Rational Method was used for peak flow computations of small drainage areas and the Airport Formula was used to determine the time of concentration and subsequent intensities based on the City of Ottawa IDF equations. For larger drainage areas requiring hydrologic modelling (Visual Otthymo V.2.0) the SCS Type II distribution and a 12 hour total storm duration was used to calculate peak flows and runoff volumes.

2.5 Fisheries and Fish Habitat

As part of the detailed design of the Terry Fox Drive extension for the City of Ottawa, Dillon was retained to investigate the aquatic environment that may be affected by the proposed alignment. Dillon biologists completed fish habitat assessments along the proposed ROW to investigate the presence / absence of fish or fish habitat within the study area. This work was also conducted to form the basis for planning and design of fish habitat mitigation and compensation alternatives, where necessary, and stormwater management measures. The report entitled 'Terry Fox Drive Phase II - Aquatic Resources Assessment' summarizes the findings of field visits during the fall of 2001 and the summer of 2002.

2.6 Planning and Development Plans Adjacent to the Terry Fox Drive Extension

In the years since the Terry Fox Drive project was first proposed, the City has developed to the west and the road now forms the western urban boundary of the City. As a result, land-uses on to the east side of the road have changed and include proposed and Draft Plan approved Plans of Subdivisions. Development plans have advanced since previous SWM work was completed for the project in 2007. **Figure 3** illustrates the planned development adjacent to Terry Fox Drive.



LEGEND:

- FUTURE DEVELOPMENT
- DRAFT APPROVED FUTURE DEVELOPMENT
- EA APPROVED TERRY FOX DRIVE RIGHT-OF-WAY / GRADING EASEMENTS
- PROPOSED TERRY FOX DRIVE CENTERLINE

FIGURE 3

ALIGNMENT AND ADJACENT PROPOSED DEVELOPMENT

TERRY FOX DRIVE EXTENSION

RICHARDSON SIDE ROAD TO SECOND LINE ROAD STORMWATER MANAGEMENT REPORT

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31 August 2009 1:53:16 PM G:\cad\2009\09-1518 Ottawa - Terry Fox Drive Final Design\Report Figures\SWM Report\FIG 3 Alignment and Adjacent Prop Dev.dwg

3.0 ROADWAY DESIGN ELEMENTS AND SURFACE WATER IMPACTS

3.1 Alignment

The road alignment from Richardson Side Road to approximately 2.1 kilometers westerly (Sta 12+100 to Sta 14+200) follows the Carp River. In this area the footprint of the roadway is within the Carp River regulatory floodplain and lies on low-lying clay soils. The alignment turns in an easterly direction and climbs out of the floodplain into the South March Highlands, an outcrop of the Canadian Shield. The alignment is designed to travel through Roger's Pass, a small pass between two large rock outcrops. The alignment then navigates between wetlands and rock outcrops through the Highlands to and connects with existing Terry Fox Drive at March Road on the southerly side of the Morgan's Grant subdivision. The north-easterly portion of the alignment borders a Natural Environment Area defined by the City of Ottawa's official plan. According to the Plan, "The Natural Environment Area designation applies to land having a high environmental value as assessed through federal, provincial and municipal studies. This designation identifies sensitive areas where development could unduly stress ecological functions and where careful management, restoration and enhancement are required." (Section 3.2.2).

3.2 Profile

The roadway profile fits the previously constructed works south of Richardson Side Road and consists of a saw-tooth configuration through the Carp River floodplain. Since this portion of the project overlies clay soils which will be subject to long term consolidation, pre-loading and surcharging is required. The saw-tooth profile results in a drainage system that consists of several independent storm sewer systems. The drainage system design approach results in a significantly lower profile than that envisioned in the 2007 Draft report. The original drainage system design was based on a continuous storm sewer to a single outlet.

3.3 Cross-Section

SWM facilities, grading and drainage have been located and designed to accommodate the ultimate cross-section. Terry Fox Drive will be built in two phases with an initial 2-lane configuration constructed followed by a future expansion to 4 lanes when traffic demands warrant. The interim cross section will consist of two traffic lanes, a multi-use path, and sidewalk. The proposed 45-metre ROW will ultimately include four traffic lanes, cycling lanes, and a multi-use pathway on the east/south side of the road (i.e., the inside of the road). The impervious area within the ROW will drain via sheet flow into curbed median and edge-of-pavement gutters intercepted by curb-inlet catch basins. Catch basins will drain via a closed pipe storm sewer system located beneath the roadway. SWM facilities and features have been designed and located based on this ultimate roadway configuration.

The Terry Fox Drive alignment, profile and typical sections are included in **Appendix A** of this report.

The total percentage of impervious area within the right-of-way for the ultimate four-lane condition will be 61%, and the estimated volumetric runoff coefficient is calculated to be 75% for extreme design conditions (based on a runoff coefficient for the impervious areas of 100% and a runoff coefficient for granular materials of 40%).

3.4 Pavement Drainage Design

The pavement drainage design for the Terry Fox Drive corridor was completed in accordance with City of Ottawa design standards. The final pavement drainage system is illustrated by the Grading and Drainage contract drawings included in **Appendix A**. The drainage system has been designed with consideration of both major and minor flow routes and outlets.

Based on the saw-tooth profile design through the Carp River floodplain area, storm sewer outlets 2 to 6 have been designed as both major and minor outlets for the roadway, in both interim 2-lane and ultimate 4-lane configuration. Outlets 2 to 6 are all located in profile sag locations and pavement drainage at these sag locations is facilitated by a series of ditch inlet catch basins offset from the edge of pavement. The offset ditch inlet catch basins connect to storm sewer systems, that incorporate Oil-Grit Separators, sized to convey the flows generated by the major storm event. Flow is then conveyed to outlet locations along the Terry Fox Drive embankment adjacent to the Carp River. Storm outlets 7 to 11 are located in the Shirley's Brook drainage area. Storm sewer outlet 8 represents a modified major/minor storm sewer outlet and the remaining outlets (7 and 9-11) represent minor-only storm sewer outlets for Terry Fox Drive. The storm sewer outlet design details are included in **Appendix A**.

The storm sewer design has been completed utilizing the Rational Method to determine peak flows for the minor design storm event (10-year) and the major design storm event (100-year). Use of the Rational Method was justified as the preferred methodology based on the fact the contributing drainage areas are limited to the roadway corridor and range in size from 0.1 to 0.5 Ha with exception of one external catchment area that contributes flow to storm outlet 1. Time of concentration for the external storm sewer catchment area was estimated using the Airport formula and the main-line storm sewer was designed with an inlet time of 10 minutes. Rainfall intensities were calculated based on inlet and flow time using the City of Ottawa IDF equations. Storm sewers servicing the Terry Fox Drive corridor have been designed with catchment areas corresponding to the ultimate 4-lane roadway configuration. The interim 2-lane configuration results in reduced flows to the storm sewer and outlet systems discharging to the Carp River and Shirley's Brook tributaries. Storm sewer sizes for Terry Fox Drive range from 300 to 900mm with pipe slopes ranging from 0.3 to 3.1% and pipe flow velocities ranging from 0.9 to 2.8 m/s.

Surface drainage for the Terry Fox Drive corridor is generally facilitated by a series of curb inlet style catch basins spaced along the edge of pavement of the left and right hand lanes. Catch basin spacing was determined using the Rational Method, assumed inlet times, and the Manning's Equation modified for gutter flow. Catch basin inlet capacities, for the City of Ottawa S22 inlets were calculated using Bentley's Flow Master and cross-referenced against design charts in the City of Ottawa Design Guidelines as well as adjacent projects. Design spread for Terry Fox Drive had to considered both interim and ultimate lane configurations. Based on the interim lane configuration, spread was limited to the width of the bike lane (2.0m) plus approximately 1.0m at the sag locations. The maximum spread depth occurs at the sag locations and does not exceed 0.11m and a Velocity/Depth ratio of 0.12. Cross street flow was not permitted at any location along Terry Fox Drive including super-elevation transition points. In the ultimate 4-lane configuration at least one lane will be open in both north and south-bound directions during the major storm event.

The detailed calculations related to the pavement drainage system and storm sewer design have been included in **Appendix B.**

3.5 Design Considerations

Construction of the proposed roadway has the following potential environmental impacts:

Water Quantity Impacts

- Displaced flood storage;
- Reduced infiltration and increased run-off volume;
- Reduction in the time of concentration resulting in increased peak flow rates;
- Increased flow velocities;
- Reduction of base flow in streams due to reduced infiltration and flow diversion;
- An increase in the frequency of erosive run-off events resulting from typical, highly frequent rain storms;
- Increased frequency of upstream flooding resulting from misdirection of overland drainage; and
- Habitat disruption.

Potential Water Quality Impacts

- Sediment transport as a result of erosion during construction process;
- Contaminant transported from the roadway and external lands, to the receiving system;
- Reduction in receiver assimilative capacity for contaminants resulting from a decrease in base-flow; and
- Increased run-off water temperature due to an increase in paved area and retention times within the SWM facilities.

In addition to the potential impacts of the project, the physical setting of the project provides a number of design considerations, which are described below.

Geophysical

According to recent geophysical analysis, the clay deposit along the Carp River requires special design considerations. According to Golder Associates, "The rate of settlement is highly dependent on the rate of drainage and traditionally in this clay deposit it is anticipated that settlement will continue to occur for several years after the roadway embankment has been constructed, which is unacceptable for roadways containing services and paved surfaces. Therefore the majority of the settlement will need to be accelerated by methods of installing artificial drainage within the silty clay and placing temporary surcharge loads on the embankment to have the settlement occur during or prior to the construction period."(Golder Associates, 2009). Furthermore, "where embankments overlie areas of soft or firm grey silty clay they will settle by an amount that is relative to the height of the embankment." (Golder, 2003). Therefore, the higher the embankment through this stretch of road the more settlement can be expected and the more pre-loading required.

Natural Environment

Terry Fox Drive traverses several areas identified as providing important habitat to wood frogs, spring peepers, turtles and toads. Special design considerations are required to ensure that wildlife can move safely from one side of the road to the other. From the wildlife studies conducted to date, critical crossings should be placed within the 'saddle' area north to Station 15+350. The wet/dry crossings will also ensure that important biological linkages found in soils and water is maintained from protected lands on the easterly side of Terry Fox Drive and the natural lands on the westerly side of the alignment.

The wetlands indentified in the Shirley's Brook watershed have been identified as Provincially Significant Wetland (PSW) by the Ministry of Natural Resources (MNR). Special drainage design considerations are targeted to minimize the impact on these natural features. The ESR identifies that Terry Fox Drive crosses a PSW and identifies a loss of 0.5 ha of wetland in the potential impacts of the project. A detailed mitigation plan is required as part of the ESR (Table 7.2). Furthermore, in the project description discussion (Section 7.2.3) stormwater quality control measures are proposed for Terry Fox Drive including:

> *Maintaining existing drainage patterns where the existing road drains to wetland areas in lieu of direct discharge to a watercourse. It is important to note that total suspended solid loadings may result in the degradation of a wetland. Furthermore, the MNR would not allow any stormwater discharge to any provincially significant wetland since heavy metals and other pollutants are attached to TSS. Prior to discharging to a wetland, pre-treatment (i.e. removal of coarse particles) may be mandatory (p. 7-14).*

4.0 STORMWATER MANAGEMENT STRATEGY

The SWM design in the ESR and Preliminary Design Report was based on the assumption that upstream lands would remain generally undeveloped. Based on this assumption, clean storm water runoff from upstream areas would not be conveyed to the roadway's storm water management facilities (SWMF), but rather directed to the existing downstream receivers, without passing through the SWMF. This requires a separate conveyance system for the roadway flow (i.e. sewer and / or ditches) and upstream external flow (interceptor ditches and road crossing culverts). Upstream lands are still generally undeveloped but development plans have advanced since the 2007 EA Addendum.

The Terry Fox Drive Phase 2 project crosses two distinctively different watersheds. From the southern limit of the project near Richardson Side Road to approximately Station 14+000, the alignment in located in the Carp River Subwatershed. The remainder of the project is within the upper reaches of the Shirley's Brook watershed. Since the subwatersheds have different criteria, separate management strategies have been developed to achieve the goals outlined in Section 1.0 of this report. The following summarizes SWM constraints and criteria for both subwatersheds:

Carp River Watershed Drainage/SWM Design Considerations

- Since the clay soils require surcharging of embankment, the lower road profile is preferred;
- The clay soils limit potential for infiltration BMPs;
- Since the new roadway is within the Carp River Floodplain, a lower profile will reduce the floodplain displacement;
- Since the alignment is located within the regulatory floodplain, an end-of-pipe stormwater facility will displace floodplain storage;
- A floodplain embayment is located on the easterly/upstream side of Terry Fox Drive, which must remain connected to the main floodplain; and
- 'Normal' stormwater quality control (i.e. 70% TSS removal) is required according to the Carp River Subwatershed Study (December 2004 Robinson Consultants Inc.). Stormwater quantity control (flood and erosion) are not required for tributary area within subcatchment C4 (Figure 8.6 Carp River Watershed/Subwatershed Study, Volume 1 – Main Report).

Shirley's Brook Watershed Drainage/SWM Constraints

- Since the alignment crosses a railroad track, planning for future grade separation is required;
- The location identified for SWM facility identified in the 2007 Study north of the railway is within a PSW;
- The location identified for SWM facility identified in the 2007 Study south of the railway is in an area of important habitat (Blandings turtle);
- Clay soils are identified immediately adjacent to Shirley's Brook and limit infiltration BMPs; and;
- The small size of the contributing areas from the right-of-way limit the use of wet ponds

and constructed wetlands as a SWM alternative;

- 'Enhanced' stormwater quality control (i.e. 80% TSS removal) and pre-development runoff equal to post-development runoff for the 1:100-year event stormwater quantity control is required according to subwatershed study.

4.1 Screening of Potential SWM Practices

Both conveyance and outlet area (end of pipe) controls measures have been considered in the development of the surface water management strategy. **Table 2** summarizes the screening of potential stormwater management practices.

Table 2: Screening of Potential SWM Practices

Stormwater Management Practice	Applicable?	Rationale
Pervious Catch Basins	No	Clay soils prohibit infiltration. Not acceptable standard City of Ottawa.
Pervious Sewer Systems	No	Clay soils prohibit infiltration. Not acceptable standard City of Ottawa.
Grassed Swales	Yes	Potential to be used in conjunction with other measures, especially in the Carp River area, where longitudinal grades are low. According to MOE guidelines, grasses swales are effective when drainage areas are < 2 ha and they are most effective when depth of flow is minimized and bottom width maximized. Grassed swales with slopes up to 4% can be used for water quality purposes.
In-Line Devices (Oil-Grit Separators)	Yes	Acceptable for quality control subject to drainage area size and City agreement related to maintenance requirements.
Wet Ponds	Yes	Acceptable for quantity and quality control. Drainage area should be 5 ha or more to maintain permanent pool.
Dry Ponds	No	Dry ponds provide quantity control, but will not achieve required quality control for either subwatershed.
Constructed Wetlands	Yes	Surface area required not available in the Carp River portion of the project, but this type of facility has good potential in the Shirley's Brook subwatershed, especially if it can be integrated with the existing wetland features.

4.2 Storm Water Management – Carp River Subwatershed

4.2.1 Alternatives and Evaluation

The stormwater management alternatives for the portion of Terry Fox Drive that falls within the Carp River subwatershed area have been developed considering the quality control objectives previously defined in **Section 4.0** of this report for the ultimate Terry Fox Drive roadway configuration. The characteristics of the roadway and surrounding area imposed significant constraints on the applicability of certain types of stormwater management techniques. Additional consideration has been given to satisfy the interim conditions imposed by the 2-lane roadway configuration and maintenance of floodwater access to the embayment area to the east of the Terry Fox corridor.

Based on design constraints a number of alternatives have been developed to address the stormwater management requirements for the Carp River subwatershed area. Each alternative was then evaluated based on technical effectiveness, feasibility, constructability, cost and long-term maintenance and operation requirements.

Alternative 1 – Do Nothing

With this alternative, this portion of Terry Fox Drive would have no SWM quality or quantity controls. The 'do nothing' alternative was rejected because of the adverse impacts of not treating runoff.

Alternative 2 – Two Ponds located on West Side of Terry Fox Drive in Floodplain Area

Figure 4 is an excerpt from the 2007 Preliminary Design Report, which recommended two SWM facilities located on the 'downstream side' of Terry Fox Drive in the flood plain of the Carp River. The need for two facilities rather than one larger one arose from the need to maintain connectivity between the main floodplain and an embayment, east of the road alignment as shown in **Figure 5**. The concept presented in the 2007 Preliminary Design was based on connectivity being provided by a concrete culvert across Terry Fox Drive, which would divide the stormwater facility into two parts.

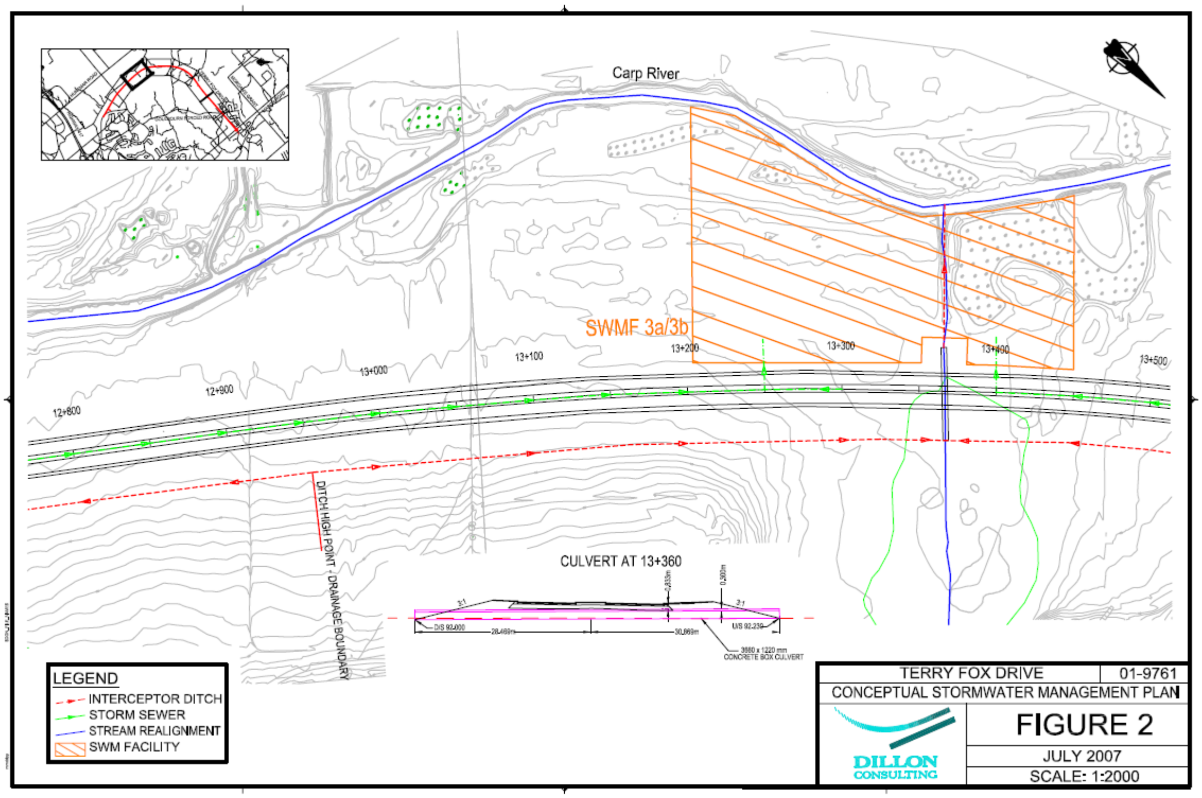
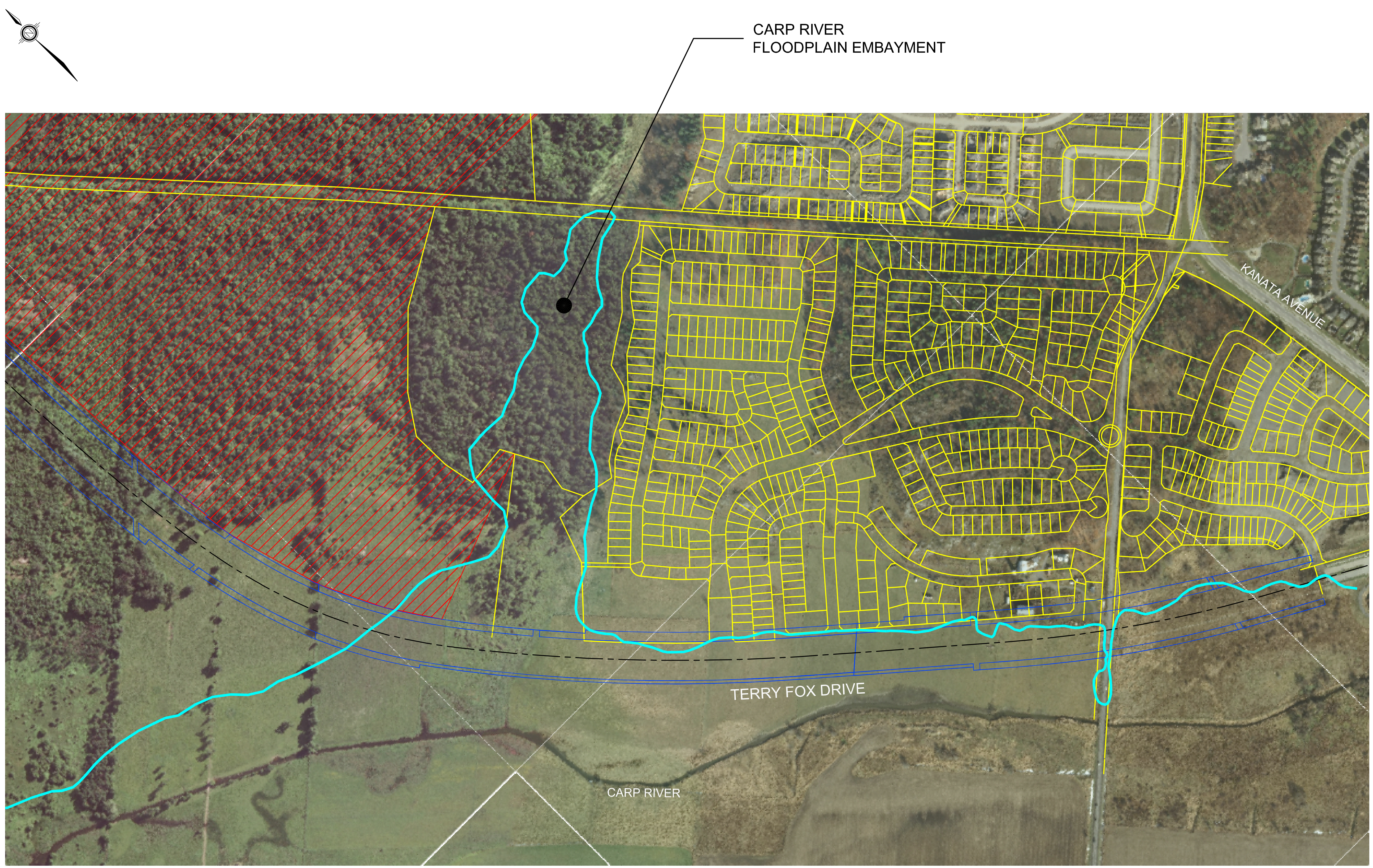


Figure 4: Location of SWMF 3a and 3b from the 2007 Draft PDR



LEGEND:

- OUTLINE OF CARP RIVER FLOODPLAIN
- FUTURE DEVELOPMENT
- DRAFT APPROVED FUTURE DEVELOPMENT

FIGURE 5
CARP RIVER FLOOD PLAIN AND TERRY FOX DRIVE

TERRY FOX DRIVE EXTENSION
RICHARDSON SIDE ROAD TO SECOND LINE ROAD
STORMWATER MANAGEMENT REPORT

DILLON CONSULTING

DATE: DECEMBER 2009

SCALE: N.T.S.

09-1518

22 June 2010 4:42:24 PM G:\cad\2009\09-1518 Ottawa - Terry Fox Drive Final Design\Report Figures\SWM Report\FIG 5 Carp River Flood Plain.dwg

In 2007, SWM facilities 3a and 3b were designed to provide both quantity and quality control - the criteria in place when the ESR was prepared in 2000. This design concept was developed to service the roadway only and required a single storm sewer on Terry Fox Drive through the floodplain area to convey flows to SWMF 3a. A drawback of the location of these facilities is the displacement of floodplain storage resulting from construction of the facilities within the regulated floodplain area. The Mississippi Valley Conservation Authority (MVCA) has indicated that the location of these two ponds within the primary part of the floodplain is not desirable. Also, since the original conceptual design was completed, the 2004 Subwatershed Study updated the design criteria for the Carp River, such that only water quality treatment is required prior to discharge to the river.

Alternative 3 – Combined Facility on Easterly Side of Terry Fox Drive

Since the Draft PDR was prepared in 2007, the IBI Group has prepared a conceptual SWM plan for the Richardson Ridge development, upstream of Terry Fox Drive. The conceptual plan consists of a joint stormwater facility for quality control for both the development and Terry Fox Drive.

The MVCA has indicated that the location of this proposed pond is preferred to a downstream location, but more details are required to ensure that a facility can be provided in this area and still maintain the floodplain connectivity. Also, it may be difficult to coordinate the timing of the design of the joint use facility with the design and construction timing of Terry Fox Drive since design and approvals for Terry Fox Drive are required by late 2009. Conveying flows along Terry Fox Drive to a centralized facility will also raise the height of the road profile significantly, complicating the geotechnical design, increasing costs and significantly increasing floodplain impacts.

Alternative 4 – Series of Oil Grit Separators along the Portion of Terry Fox Drive Located within the Carp River Floodplain

Alternative 4 will provide quality control of runoff through the use of regularly spaced oil-grit separators and naturalized swales along the length of Terry Fox Drive in the floodplain. This concept is based on the use of groups of catch basins with an oil grit separator located at the outlet of each group of catchbasins. For the initial two lane section, there will be significantly less impervious surfaces draining to the outlets, resulting in higher treatment efficiencies than the ultimate target of 70% annual total suspended solids removal. In it's ultimate condition, the stormwater management system will achieve the required suspended solids removal rates specified by the 2004 Carp River Watershed/Subwatershed Study. This concept reflects the focus on water quality treatment and water quantity goals in the Carp River Watershed/Subwatershed Study. As well, extremely challenging geotechnical constraints were a key factor for exploring this alternative.

Oil grit separators provide the required quality control and avoid the impact of constructing SMWF 3a and 3b in the floodplain area. The reduced length and size of the storm sewer required to convey surface water runoff to each outlet significantly lowers the roadway profile compared to the design included in the Preliminary Design Report. The concept of groupings of catchbasins directed to several outlets was presented at the Public Open House (June 22, 2009).

Table 3 summarizes the evaluation of SWM alternatives for the portion of roadway within the Carp River Subwatershed.

Table 3: Evaluation of SWM Alternatives in Carp River Watershed

Alternative Carp River Subwatershed	Description	Evaluation
1	Do Nothing	Not an acceptable alternative since it does not meet study goals and design criteria
2	Two Wet Pond SWMFs located in the floodplain west of Terry Fox Drive, for management of flows from Terry Fox Drive only	Meets water quality control criteria and provides quantity control. MVCA does not support location in floodplain due to floodplain displacement The single storm sewer required to carry flows to the SWMFs results in a relatively high roadway profile to maintain design cover
3	Single Wet Pond SWMF located east of Terry Fox Drive, as a joint use facility for Terry Fox Drive and upstream development	Meets water quality control criteria. May be a challenge to maintain connection to floodplain embayment. Requires detailed design coordination with design of Richardson Ridge. This development is only at conceptual design stage. The single storm sewer required to carry flows to the SWMFs results in a relatively high roadway profile to maintain design cover
4	Series of smaller diameter storm sewers with multiple outlets and an Oil – Grit Separator on the outlet from each group of catchbasins	Meets water control criteria of the Carp River Subwatershed Study, provides opportunity to lower road profile, which in turn reduces floodplain impacts. Helps to meet geotechnical challenges (consolidation and settlement) Drainage areas are well within acceptable ranges for use of oil-grit separators.

4.2.2 Recommended Design Option – Carp River Subwatershed

The preferred solution for stormwater management within the Carp River floodplain utilizes a system of storm sewers, oil grit separators and enhanced swales to treat and convey roadway runoff to the Carp River. The recommended design was further developed through the detailed design process and is illustrated in the Grading and Drainage design drawings included in **Appendix A.**

Table 4 summarizes the drainage areas and the runoff generated from the 10-year and 100-year events calculated using the Rational Method and the City of Ottawa IDF curves.

Table 4: Summary of Oil Grit Separators along Carp River Floodplain

OGS #	Location Station	Drainage Area	10-year peak flow (m3/s)	100-year Peak flow (m3/s)	Target TSS Removal Rate	Major/Minor Drainage System Outlet
1	12+100	1.34	0.24	0.35	70%	By Others – Not included in contract
2	12+475	0.91	0.19	0.27	70%	At Sag – Major System Outlet
3	12+715	0.91	0.19	0.27	70%	At Sag – Major System Outlet
4	12+955	0.91	0.19	0.27	70%	At Sag – Major System Outlet
5	13+195	0.91	0.19	0.27	70%	At Sag – Major System Outlet
6	13+490	3.33	0.58	0.84	70%	At Sag – Secondary Major System Outlet

OGS-1 will be a shared facility servicing a portion of the Broughton Lands subdivision and Terry Fox Drive. The remaining storm sewer outlets direct roadway runoff to oil grit separators and then to enhanced swales conveying treated runoff to the Carp River. This design takes advantage of natural low points along the ROW, minimizing construction requirements and environmental impacts. According to the MOE Stormwater Management Planning and Design Manual (2003), for swales with typical urban swale dimensions (0.75 bottom width, 2.5:1 side slopes and 0.5 m depth), the contributing area is generally limited to < 2 ha to maintain contact area between the water and the swale so that TSS removal is effective. The MOE recommend channel gradients of 0.5%, maximum allowable flow rates of 0.15 m3/s and maximum allowable velocity of 0.5 m/s. The design of grassed swales is based on MOE guidelines to achieve polishing benefits for water quality. The channels will be designed to ensure channel stability under a range of flows since a number of the outlet locations represent both major and minor system outlets.

The road profile has been designed to provide small drainage areas to allow standard sized oil-grit separator units to adequately treat the runoff for oil-grit separators units 2 to 6. The storm sewer outlet systems have been designed to accommodate the tail-water condition from 100-year water levels in the Carp River. The resultant hydraulic grade line within the individual sewer systems provides in excess of 1.0 m of freeboard from the projected water level to the elevation of the lowest catch basin. The storm sewer systems service the roadway and are not hydraulically linked to any storm sewer systems that service residential, commercial, industrial or institutional development adjacent to the proposed alignment. In order to maintain the lowest possible road profile elevation a balance between frost protection and the City of Ottawa's requirement for a free-flowing outlet was considered for storm outlets 2 to 6. **Table 5** summarizes a number of key design parameters for each of the outlet systems, including frost cover depth and outlet hydraulics for the design storm (10-year).

Table 5: Summary of Storm Outlet System Design Parameters

Outlet System / OGS #	Outlet Location Station	Depth of Cover (minimum)	Outlet Obvert Elevation / 10-year Freeboard Depth (m)	Design Storm HGL Elevation / Internal Flow Control Structure Elevation	100-year HGL Elevation at Low CB / Freeboard Depth (m)
1	12+100	2.5	93.3/0.13	93.20/93.95	94.00/2.40
2	12+475	1.9	93.01/-0.19 (submerged)	93.20/93.73	93.73/1.32
3	12+715	1.9	93.00/-0.20 (submerged)	93.20/93.71	93.71/1.35
4	12+955	1.9	92.94/-0.26 (submerged)	93.20/93.65	93.72/1.28
5	13+195	1.9	93.43/-0.24 (submerged)	93.20/93.67	93.72/1.36
6	13+490	1.6	92.89/-0.35 (submerged)	93.20/93.44	93.81/1.00

Consultation with the City identified Vortech units as the preferred hydrodynamic (oil grit)separators based on maintenance considerations. Each system is designed based on site size, site runoff coefficient, regional precipitation intensity distribution and anticipated pollutant characteristics. "Typically Vortechs are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for either 50 μm particles, or a particle gradation found in typical urban runoff" (Contech Stormwater Solutions, p. 2). The Vortech units will be designed so that the internal flow control structure remains unsubmerged during the 10-year design storm event During the 100-year flood event, when the obvert and internal flow control structure of the OGS is submerged, the unit acts like a settling chamber rather than a hydrodynamic separator. **Table 6** provides a summary of the projected performance parameters for the Vortechs Oil Grit Separators (OGS 2 to 6) specified in the detailed design contract package for Terry Fox Drive construction project.

Table 6: OGS Performance Parameters

Outlet System / OGS #	Vortechs Model #	Total Drainage Area Serviced (Ha)	Sediment Removal Efficiency *	Treatment Capacity (L/s)	Sediment Storage Capacity (cu.m)	Oil Storage Capacity (cu.m)	Total Holding Capacity (cu.m)
2	7000	0.91	90	311	3.06	1.69	9.52
3	7000	0.91	90	311	3.06	1.69	9.52
4	7000	0.91	90	311	3.06	1.69	9.52
5	7000	0.91	90	311	3.06	1.69	9.52
6	PC1319	0.91	89	850	5.81	3.61	20.98

* Net annual solids load reduction based on average particle size of 75 microns

4.3 Storm Water Management - Shirley's Brook Subwatershed

4.3.1 Alternatives and Evaluation

The stormwater management alternatives for the portion of Terry Fox Drive that falls within the Shirley's Brook subwatershed area have been developed considering the quality control objectives previously defined in **Section 4.0** of this report for the ultimate Shirley's Brook condition. The characteristics of the roadway and surrounding area imposed significant constraints on the applicability of certain types of stormwater management quality control techniques. Additional consideration must be given in order to satisfy the interim conditions imposed by the 2-lane roadway configuration and maintain the Shirley's Brook tributary flows through the Terry Fox Drive corridor to the Provincially Significant Wetlands in the corridor's ultimate 4-lane configuration.

Based on design constraints a number of alternatives have been developed to address the stormwater management requirements for the Shirley's Brook subwatershed area. Each alternative was then evaluated based on technical effectiveness, feasibility, constructability, cost and long-term maintenance and operation requirements.

Alternative 1 – Do Nothing

With this alternative, this portion of Terry Fox Drive Phase would have no SWM quality or quantity control. The 'do nothing' alternative was rejected because of the many adverse impacts of not providing quality control of runoff generated by the Terry Fox Drive corridor. This approach is also not consistent with the Shirley's Brook subwatershed design criteria. The 'do nothing' alternative does not address interim stormwater management quality or quantity requirements for the interim 2-lane roadway configuration.

Alternative 2 – Wet Ponds at Right of Way Drainage Outlets

This concept was presented in the 2007 PDR and draft SWM report (referred to as SWMF 4a and 4b). However, given the small drainage areas of both 4a (2.1 ha) and 4b (3.7 ha), and the MOE recommendation of a minimum of 5 ha to sustain a wet pond, this alternative is not recommended. The sensitive nature of Shirley's Brook and the PSWs at both locations requires that some end-of–pipe treatment be applied. The reduced runoff potential from the interim 2-lane roadway configuration is not conducive of sustaining a wet pond configuration for both SWMF 4a and 4b.

Alternative 3 – Constructed/Improved Wetlands at 4a and 4b

The small drainage areas of related to the SWMF 4a and 4b identified in the 2007 PDR also restrict the feasibility of constructed wetlands. MOE recommends a minimum drainage area of 5 – 10 ha for these kinds of facilities. It is not feasible to meet the fore-bay design criteria for the small volumes generated by the drainage areas. Also, a constructed wetland would have direct impacts on the adjacent PSW. Enhancement of the existing wetlands was also considered, but construction activities could potentially cause significant disturbance to this important environmental feature. The reduced runoff potential from the interim 2-lane roadway configuration is not conducive of sustaining a wet pond configuration for both SWMF 4a and 4b.

Alternative 4 – Oil Grit Separators/Grassed Swales

This alternative utilizes oil-grit separators to provide quality control for the road drainage areas within the Shirley's Brook Subwatershed. The oil-grit separators will discharge flow into enhanced swales located adjacent to the roadway embankment. The enhanced swales will subsequently discharge to Shirley's Brook or the appropriate receiving watercourse. The swales will be designed to provide further quality control, targeting the minor increase in peak flows during the initial portion of design storms. Peak flow reduction will be achieved by providing storage of runoff within a wide flat bottom ditch arrangement with minimal longitudinal grade and the assimilative capacity of adjacent wetlands. Low gradient will help to keep velocities low during frequent storm events. Velocity control will help reduce downstream erosion potential in Shirley's Brook. This alternative can be configured to provide water quality and quantity measures that will meet the Subwatershed objectives for both the interim and ultimate configuration of Shirley's Brook and Terry Fox Drive.

Table 7 summarizes the evaluation of the SWM alternatives for the portion of roadway within the Shirley's Brook Subwatershed.

Table 7: Evaluation of SWM Alternatives in Shirley's Brook Subwatershed

Alternative	Description	Evaluation
1	Do Nothing	Not an acceptable alternative as it does not meet study goals and design criteria
2	Wet Pond SWMF	Meets water quality and quantity control criteria. However, the contributing drainage areas are considered to be too small to maintain a wet pond according to MOE guidelines. The footprint of a wet pond impacts PSW and habitat for species at risk.
3	Constructed Wetland SWMF	Meets water quality and quantity control criteria Drainage areas are considered to be too small to maintain a wet component of the wetland, according to MOE guidelines The footprint of a wetland impacts PSW and habitat for species at risk.
4	Oil-Grit Separator and Enhanced Swales	Takes advantage of naturally existing features and minimizes impacts to significant wetland and habitat for species at risk. Meets water quality and quantity criteria.

4.3.2 Recommended Design Option – Shirley's Brook Subwatershed

The recommended SWM concept for the Shirley's Brook watershed consists of oil-grit separators servicing the Terry Fox Drive corridor drainage areas used in conjunction with enhanced swales and minor modifications to the stage-storage relationships of PSW 1 and 2. Quality control will be provided by the oil-grit separators and quantity control will be provided by the enhanced swales located adjacent to the Terry Fox Drive road embankment and the assimilative capacity of the adjacent wetlands. A detailed discussion of the hydrologic analysis completed for the impact evaluation on the adjacent PSW's and stormwater quantity management is provided in **Appendix C**. Quality management of roadway runoff will permit discharges to the sensitive Shirley's Brook watercourses to maintain critical base flow and integrated with the surrounding wetlands while modifications to the stage-storage relationships within the affected PSWs will mitigate the impacts of additional runoff volumes entering the wetlands from the roadway. The recommended design option minimizes the hydrologic and ecological impact on PSW 1 and PSW 2 as well as the Shirley's Brook East channel.

Based on MOE Design Guidelines and the Shirley's Brook Subwatershed Study, the SWM solution should provide an 'Enhanced' level of protection for cold water habitat receiving waters and remove 80% of TSS. Field investigations in 2009 highlighted the significance of the area located adjacent Terry Fox Drive where the road crosses a forested swamp. The oil-grit separator design is based on annual sediment loading and can provide the enhanced protection required by the MOE. The enhanced swales provide additional polishing of runoff to protect this environmentally sensitive area.

The preferred solution for stormwater management utilizes a system of storm sewers, oil grit separators and enhanced swales to treat and convey roadway runoff to Shirley's Brook. The recommended design was further developed through the detailed design process and is illustrated by the Grading and Drainage design drawings included in **Appendix A.**

Table 8 summarizes the drainage areas and the runoff generated from the 10-year and 100-year events calculated using the Rational Method and the City of Ottawa IDF curves.

Table 8: Summary of Oil Grit Separators within the Shirley's Brook Subwatershed

OGS #	Location Station	Drainage Area (ha)	10-year peak flow (m3/s)	100-year Peak flow (m3/s)	Target TSS Removal Rate	Major/Minor Drainage System Outlet
7	12+100	1.21	0.23	0.33	80%	On Grade – Minor System Outlet
8a	14+670	0.23	0.06	n/a	80%	On Grade – Minor System Outlet
8b	14+730	0.17	0.05	n/a	80%	On Grade – Minor System Outlet
9	14+850	1.17	0.22	0.32	80%	On Grade – Minor System Outlet
10	15+160	0.76	0.15	0.22	80%	On Grade – Minor System Outlet
11	15+360	1.17	0.21	0.31	80%	On Grade – Minor System Outlet

Table 9 provides a summary of the projected performance parameters for the Vortechs Oil Grit Separators (OGS 7 to 11) specified in the detailed design contract package for Terry Fox Drive construction project.

Table 9: Projected Performance Parameters for the Vortechs Oil Grit Separators

Outlet System / OGS #	Vortechs Model #	Total Drainage Area Serviced (Ha)	Sediment Removal Efficiency *	Treatment Capacity (L/s)	Sediment Storage Capacity (cu.m)	Oil Storage Capacity (cu.m)	Total Holding Capacity (cu.m)
7	7000	1.21	89	311	3.06	1.69	9.52
8a	2000	0.23	89	79	0.91	0.63	3.40
8b	2000	0.17	90	79	0.91	0.63	3.40
9	7000	1.17	89	311	3.06	1.69	9.52
10	5000	0.76	90	241	2.45	1.38	7.73
11	7000	1.17	89	311	3.06	1.69	9.52

* Net annual solids load reduction based on average particle size of 75 microns

5.0 EXISTING STORM WATER MANAGEMENT FACILITIES

The 2007 Terry Fox Drive EA and Functional Design Report identified the need to provide storm water management at the northeasterly end of the Terry Fox Drive project limits. The storm water management of runoff for Terry Fox Drive from station 15+475 to 16+500 has been described in detail in the Design Brief for Morgan's Grant Phase 10A Stormwater Management Facility (report dated January 2006 by CCL/IBI) and subsequently detailed in a technical memo prepared by IBI (April 2010) that supported the Terry Fox Drive Phase I MOE Certificate of Approval application and stormwater management approach for the interim 2-lane configuration of Terry Fox Drive. Minor runoff (for the 10-year event) will be conveyed to the Morgan's Grant Phase 10A facility, while major runoff from the area will be conveyed to the existing drainage course on the south side of Terry Fox Drive. The quality and quantity requirements for the facility (consisting of runoff from Terry Fox Drive and Morgan's Grant Phase 10A) are also covered by the 2006 report. This facility has now been constructed.

6.0 SURFACE WATER MANAGEMENT STRATEGY

The Surface Water Management Strategy comprises three main parts: Carp River Floodplain management; overland flow/cross drainage features; and, Shirley's Brook Realignment. The management strategies for each part have been developed to satisfy the study goals and objectives and mitigate potential impacts identified by the performance targets set in Section 1.3. The strategy recommends drainage structures, drainage features, and floodplain compensation. Each feature has been designed to meet or exceed performance targets.

Overland ditch design, and location and sizing of cross culverts are based on the maintenance of existing major (overland) flow routes. These design features address the need to maintain macroscopic drainage patterns for the various drainage areas associated with Terry Fox Drive. Required overland drainage cross culverts are necessary if the construction of Terry Fox Drive progresses independently of adjacent development. Associated issues pertaining to development, lot grading, stream realignment, and interceptor ditch configuration may dictate the need to update crossing locations as the detailed design progresses. The following subsections describe the surface water management strategy for the two main watercourses found in the Study Area, as well as the management of smaller natural drainage features and overland flow.

6.1 Carp River Floodplain Impacts

6.1.1 Summary of Carp River Floodplain Analysis from 2007 Preliminary Design

During the Preliminary Design stage completed in July 2007, the encroachment on the floodplain by the Terry Fox Drive project was calculated to be approximately 45,000 m^3. The volume calculation was based on modelled flood water elevations provided by MVCA. Based on HEC-RAS modelling the encroachment raised water levels very marginally (i.e. by 1 cm) at only two of the modeled cross-sections. Despite this minimal impact on flood-levels, it was recognized that a displacement of flood storage can adversely affect design flow rates in downstream reaches of a system due to a reduction in flow attenuation capacity. Therefore, a compensation plan was developed at a conceptual level to compensate for lost storage volumes at corresponding elevations. The compensation plan proposed in the 2007 PDR consisted of a large cut just north of the project area. **Figure 6** shows the conceptual compensation plan included in the 2007 Draft Stormwater Management Plan.

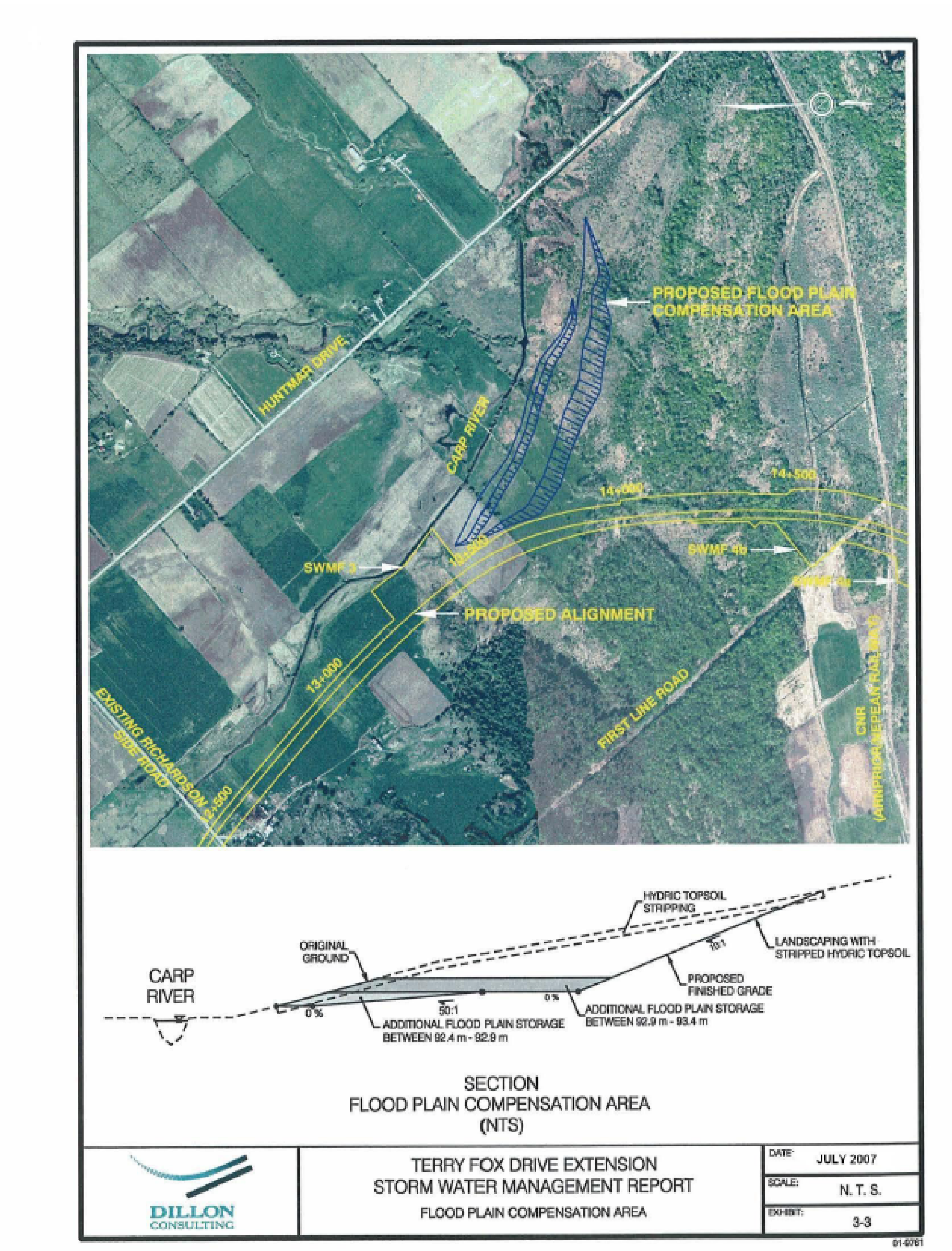


Figure 6: Floodplain Compensation Conceptual Plan Provided in 2007 Preliminary Design Report

6.1.2 Summary of Planning and Development Issues in Carp River Floodplain

A number of suburban developments have been planned in the Carp River watershed, upstream of the Terry Fox Drive Study Area. These developments will result in a re-definition of the Regulatory floodplain. The rationale for allowing development to proceed was based in part on the Carp River Restoration Plan (CRRP), developed to rehabilitate the Carp River from the impacts of development and agriculture. The CRRP was a component of the Carp River Watershed/Subwatershed Study prepared by Robinson Consultants in 2004. Since the Subwatershed Study area included the Carp River watershed upstream of Richardson Side Road, it did not extend into the Terry Fox Drive Study Area.

The Carp River Restoration Plan includes a plan to construct a low flow channel with meander bends and other naturalized features designed to improve the degraded channel and habitat. The Carp River is surrounded by farm land and is located in silty clay plain. The high sediment load and low gradient channel has resulted in artificial and natural widening and straightening of the river over time. The plan to re-establish a low-flow channel in the river includes the addition of a fish habitat pond in the floodplain area. The Carp River Restoration Plan overlaps with the Terry Fox Drive project area for approximately 700 m near Richardson Side Road.

In 2007 and 2008, a number of issues were raised with respect to the Carp River Restoration Plan, including the validity of the two-zone floodplain policy as it applies to the Carp River floodplain, the hydrologic and hydraulic models used to support the plan and other planning decisions and environmental assessment rulings in the watershed. The models and policy were reviewed by Greenland Consulting Engineers who were retained by the City of Ottawa. The exercise reviewed a number of hydrologic models and hydraulic models including:

- CHM2Hill HEC-RAS Carp River existing conditions 2005 and revised 2008; and
- Totten Sims Hubicki (TSH) HEC-RAS Carp River restoration project 2006.

The review was completed in the spring of 2009 and identified necessary revisions to the models. Dillon obtained a copy of the revised model incorporating revisions from the Third Party Review in April 2009. The revised model predicted higher floodplain elevations in the vicinity of the Terry Fox Drive Study Area.

The results of the Third Party Review highlighted the uncertainty in the modelling of the most upstream reaches of the Carp River watershed. The uncertainty was related to the modelling of bedrock in the headwaters, which could either have a high infiltration capacity due to weathering and fractures, or a very low infiltration capacity based on the traditional understanding of runoff from bedrock. The Third Party ran the model at the two limits of the uncertainty, the best and worst case scenarios. The results indicate that under high infiltration conditions, the Carp River floodplain will have sufficient capacity to accommodate flows from the development as planned now. Under high runoff/low infiltration conditions, the floodplain will require another 85 000 m^3 of storage. Until the model can be refined with monitored data, the City has required development in Kanata West, upstream of the Terry Fox Drive Study Area, to provide an extra 125 m^3/ha of storage to account for the potential shortage of storage. Once the models are calibrated and development in Kanata West is complete, the updated regulatory floodplain of the Carp River will be modeled and mapped. The current regulatory flood-line based on previous modelling and design flood levels date back to 1985.

The Auditor General concluded that the two-zone flood plain management approach, as applied to the Carp River upstream of Richardson Side Road, is not in keeping with the intent of the Provincial Policy Statement. However, the Third Party Review concluded the opposite. Currently, the City's Official Plan includes a policy allowing the City to request MVCA or MNR to consider defining the flood plain as two distinct zones. According to the policy, where the two-zone approach is applied, development may be considered in the flood fringe, subject to review by the City and MVCA.

6.1.3 Floodplain Compensation Approach

Flow through a natural watercourse system can be characterized based on the watercourse's ability to convey and store flood flows. The conveyance capacity of a watercourse is characterized by the size and configuration of its channel and floodplain and may be limited by the size and type of hydraulic structures (bridges and culverts) throughout the system. The storage capacity of a watercourse system is characterized by the size and configuration of its floodplain, as well as the relative depth or stage at which flood waters can access it.

Floodplain plays an important role in both the conveyance capacity and storage capacity of a natural watercourse system. As floodwaters rise in the watercourse system, the size and shape of its floodplain allows the system to convey much greater flow based on a larger cross-sectional area. In instances where other restrictions exist, such as limited floodplain width or restrictive hydraulic structures, floodplain provides storage of runoff and attenuates peak flows, therefore limiting potential downstream adverse effects on public and private property and public safety.

The construction of the Terry Fox Drive road embankment from south of Richardson Side Road, north to the 'saddle' area, directly impacts the Carp River floodplain. During Preliminary Design (completed July 2007), the Carp River floodplain encroachment was assessed both in terms of its impact on conveyance capacity and resultant floodwater depths and the physical displacement of floodplain storage. Based on model and floodwater elevation information provided by MVCA, the proposed encroachment raised water levels by approximately 1.0cm, resulting in the displacement of approximately 45,000 m^3 of floodplain storage. Despite this minimal impact on flood levels, it was recognized that a displacement of flood storage, even at the edges of the floodplain area, can adversely affect the peak flow due to a reduction in flow attenuation capacity.

Floodplain management guidance was provided by the MVCA during Preliminary Design phase. MVCA identified the following general requirements for Terry Fox Drive within the Carp River Floodplain:

- The road surface must be above the 100-year floodplain elevation to ensure appropriate flood proofing;
- The loss of floodplain storage due to the roadway footprint will be compared to additional floodplain storage created from the construction of any stormwater management and required fish habitat compensation works. Local grading that creates additional storage can be used to compensate for any residual loss of flood plain storage; and

- The cross culvert near Sta 13+400 must remain to allow the existing backwater floodplain storage to remain upstream of the road.

Although the Preliminary Design Report (SWM Report) noted several options for floodplain compensation, the final determination of impacted floodplain volume and required compensation was left to Detailed Design. The following section summarizes the impact assessment and a number of potential options for floodplain compensation measures.

6.1.4 Floodplain Impact Assessment

Several minor revisions have been made to the design of the Terry Fox Drive roadway embankment through the floodplain area as a result of geotechnical and geometric design considerations during Detailed Design. To minimize preloading requirements for the consolidation of sensitive soils within the Carp River floodplain area, adjustments have been made to the profile of the road and the side-slopes of the roadway embankment. The final Detailed Design profile and typical sections were presented to stakeholders at the Terry Fox Drive Public Open House on June 22, 2009. The profile presents a saw-tooth configuration along the Carp River floodplain section that allows for the collection and discharge of stormwater along short sections of the road. The revised design allows the profile of the road to be lowered considerably, thereby reducing the height of fill placement on sensitive soils and overall floodplain impact.

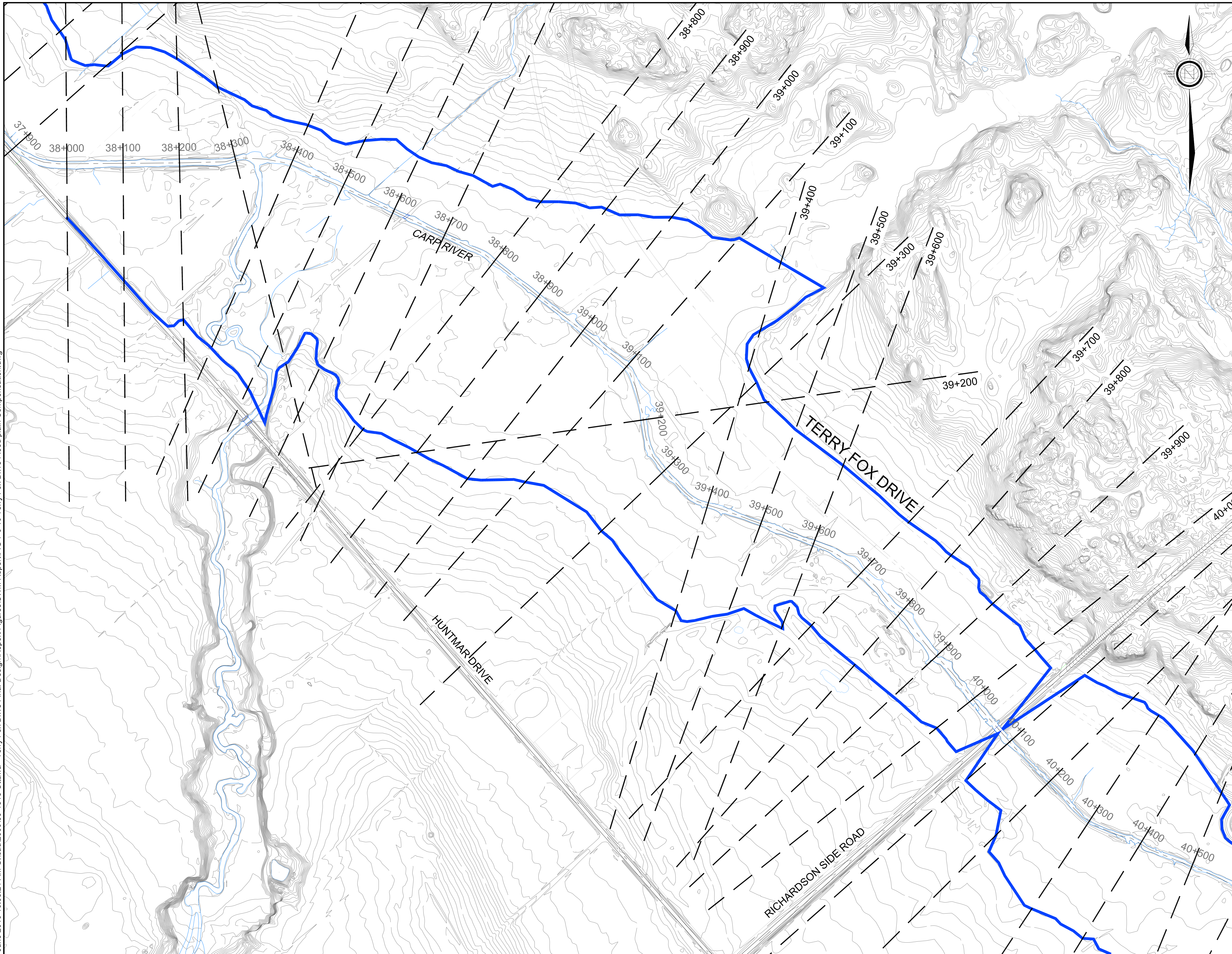
Consistent with the Preliminary Design approach, the approach to the impact assessment and compensation planning has been to assess impact and corresponding compensation on a volumetric basis. This approach was previously approved by the MVCA and is consistent with the approach taken on other projects within the Carp River watershed.

The general approach to mitigate the impact of floodplain displacement of the volume displaced within certain elevation bands is to compensate for the loss within the same elevation range. For example, 1,000 m^3 of volume displaced between 92.75 and 93.00 m.a.s.l. should be compensated for by excavation of 1,000 m^3 within the same 0.25 m elevation band. There are several different methods used in this approach. The most direct method to provide floodplain compensation is to achieve the compensation at the same cross-section of the river as the displacement occurs. The second method uses a similar approach, providing volumetric compensation at the appropriate elevation, not at the same cross-section but still within the same river reach as the displacement is caused. Both of these approaches have technical merit and were considered for the following options.

6.1.4.1 Regulatory Flood-Line Mapping

The regulatory flood-line mapping for the Carp River has been the subject of much debate over the past several years. Recognizing the technical and political complexities surrounding the Carp River, the Carp River Restoration Plan, and the Third Party Review, the MVCA was again contacted to provide guidance on hydraulic modelling of the Carp River and appropriate floodwater elevations within this section of the Carp River. Based on personal correspondence with John Price (Watershed Management Coordinator), the MVCA has directed Dillon to use the regulatory flood mapping from 1985 and increase the flood levels to reflect the revisions made during the modelling revisions and Third Party Review of the Carp river hydraulic and hydrologic models. This results in a floodplain with an elevation of 93.40 m through the reach impacted by Terry Fox Drive. To account for a potential increase in elevations as a result of future development, we have assumed a 100yr flood level of 93.5 m through this 1,500 m reach of the Carp River for the purposes of impact analysis. The magnitude of the likely increase to the floodplain elevation was deemed to be acceptable although refined modelling to reflect future impacts is not currently available (Greenland Consulting Ltd. and J. Price Personal Communication).

Figure 7 illustrates the location of Terry Fox Drive relative to the location of the Carp River and the 100yr flood-line. **Figure 7** also shows the Carp River river-station IDs through the Study Area.



LEGEND:

ESTIMATED CARP RIVER FLOODPLAIN (93.5m)

39+500 HEC-RAS CROSS SECTION ID

FIGURE 7
CARP RIVER FLOODPLAIN
HEC-RAC SECTIONS

TERRY FOX DRIVE EXTENSION
RICHARDSON SIDE ROAD TO SECOND LINE ROAD
STORMWATER MANAGEMENT REPORT

DILLON CONSULTING

DATE: DECEMBER 2009

SCALE: NTS

09-1518

23 June 2010 10:03:21 AM G:\cad\2009\09-1518 Ottawa - Terry Fox Drive Final Design\Report Figures\SWM Report\FIG 7 9 10 Terry Fox Drive Flood plain Compensation.dwg

6.1.4.2 Volumetric Impacts

The volume of encroachment was calculated by projecting the 100-year water elevation of 93.5 from the center-line of the existing Carp River Channel onto the adjacent topography of the east and west banks of the watercourse. The hydraulic gradient of the Carp River included in the existing conditions model provided by Greenland Consulting Engineers indicates a negligible lowering of the water surface elevation at the downstream end of the floodplain encroachment. For the Detailed Design of Terry Fox Drive, the road embankment was modeled in AutoDesk Civil3D utilizing the ultimate 4-lane road cross-section and 4:1 embankment side-slopes projected onto the original ground surface. The volume of storage lost was calculated using cross-sections spaced every 100m along the center-line of the existing Carp River channel through the area of encroachment.

Figure 8 schematically illustrates a typical section from the proposed Terry Fox Drive roadway embankment located within the Carp River floodplain. The typical section shows the elevation bands used to define the displaced floodplain volume as it relates to the water surface elevation and the existing ground surface.

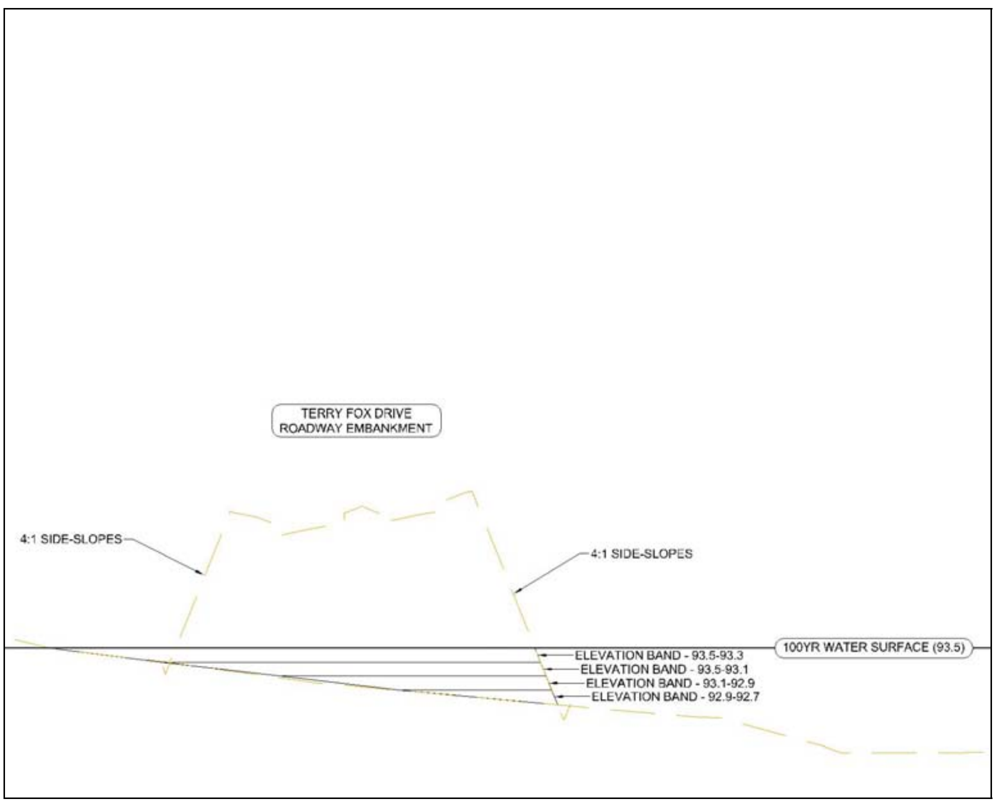


Figure 8: Terry Fox Drive Typical Section within Floodplain Area (includes vertical exaggeration)

Figure 9 illustrates the spatial extents of the floodplain displacement resulting from the construction of the Terry Fox Drive roadway embankment. The area of encroachment starts at approximately Sta 12+100 and extends to approximately Sta 13+600 (Terry Fox Drive). **Figure 9** also illustrates the area of maintained floodplain on the 'inside' of Terry Fox Drive. Access to this area by Carp River floodwaters will be maintained via backflow through a proposed culvert structure located near Sta 13+350 and therefore has not been included in the calculation of lost floodplain storage.

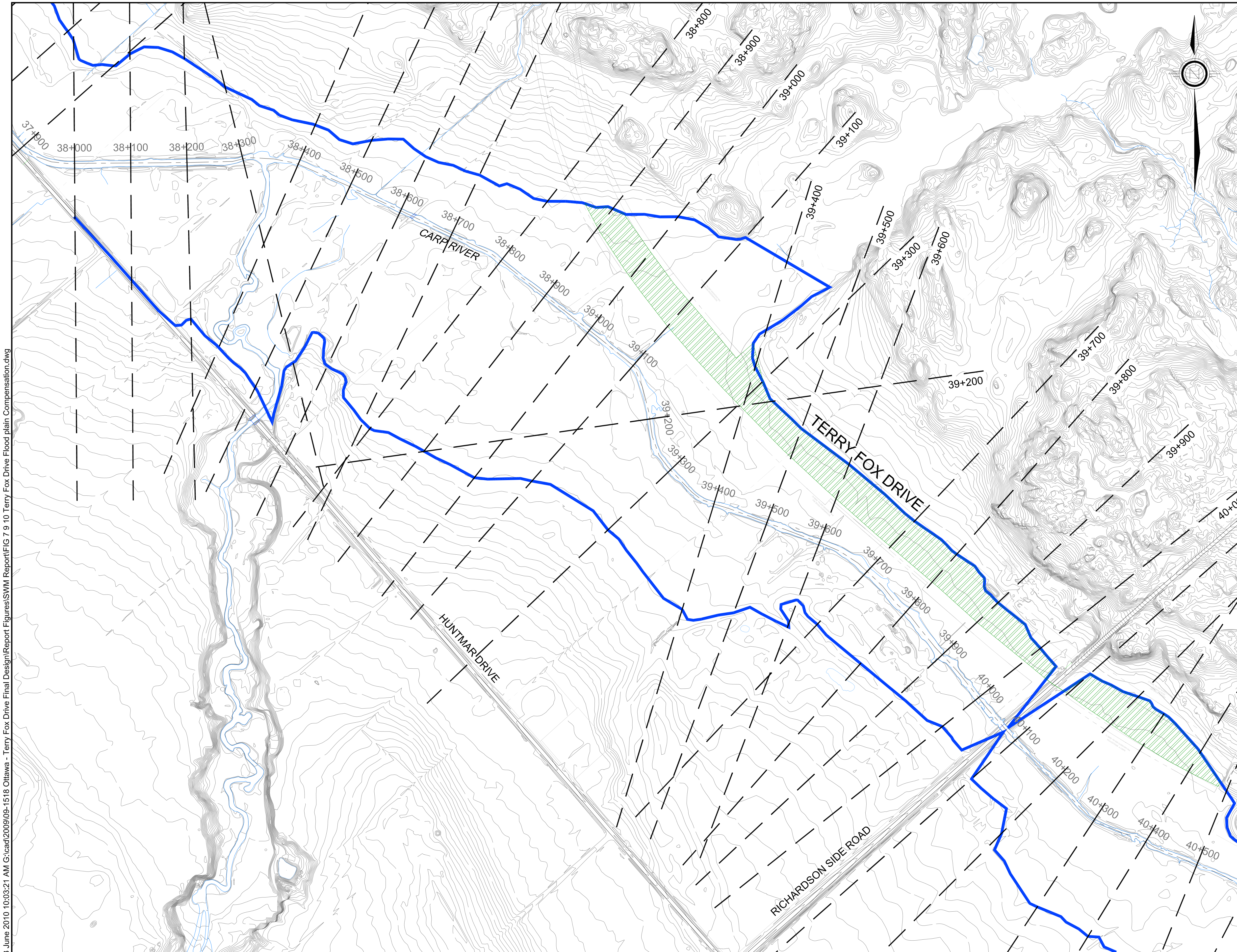
The following data (**Table 10** and **Table 11**) provide the volumetric displacement of floodplain volume, both in an incremental elevation basis and on a stream section basis.

Table 10: Summary of Displacement Volumes

Elevation Range (m)	Displacement volume (m3)	Percent of Total Displaced Volume
93.5-93.3	14,437.14	34%
93.3-93.1	11,748.05	28%
93.1-92.9	8,007	19%
92.9-92.7	4,132.94	10%
92.7-92.5	2,664.18	6%
92.5-92.3	1,418.28	3%
92.3-92.1	91.33	2%

Table 11: Summary of Displacement Volumes between Cross-Sections

Cross-Section Station	Incremental Displacement Volume (m3)	Percent of Total Displaced Volume
38+800	0	0%
38+900	0	0%
39+000	1,099	3%
39+100	3,831	9%
39+300	11,674	27%
39+500	5,841	14%
39+600	2,857	7%
39+700	2,858	7%
39+800	2,894	7%
39+900	2,570	6%
40+000	1,832	4%
40+100	654	2%
40+200	1,639	4%
40+300	2,352	6%
40+400	1,957	5%
40+500	440	1%
40+600	0	0%



LEGEND:

FLOODPLAIN DISPLACEMENT

ESTIMATED CARP RIVER FLOODPLAIN (93.5m)

39+500 HEC-RAS CROSS SECTION ID

FIGURE 9
TERRY FOX DRIVE FLOODPLAIN ENCROACHMENT AREA

TERRY FOX DRIVE EXTENSION
RICHARDSON SIDE ROAD TO SECOND LINE ROAD STORMWATER MANAGEMENT REPORT

DILLON CONSULTING

DATE: DECEMBER 2009

SCALE: NTS

09-1518

6.1.5 Floodplain Compensation Options

There are a variety of different sites in the general vicinity of the Terry Fox Drive extension project that have appropriate topographic relief suitable for providing volumetric floodplain compensation. Floodplain compensation should be provided as close to where the displacement of floodplain occurs. General practice dictates that compensation be located within the same river reach to replicate the hydrologic and hydraulic characteristics of the watercourse.

The section of Terry Fox Drive within the floodplain is within the river reach between Richardson Side Road and Huntmar Road. Throughout this reach, the Carp River is characterized as having similar low-flow channel and floodplain configurations, hydraulic gradient, hydraulic properties, and resultant floodwater elevations. In addition, the bridges located at Huntmar Road and Richardson Side Road further influence water levels at these two locations and act as hydraulic controls on the river along this reach. Based on the hydrologic and hydraulic uniformity of the subject reach, storage lost but compensated for within the reach should have little impact on the hydraulic dynamics of the watercourse upstream and downstream of the Study Area.

Three options for floodplain compensation have been developed to mitigate the impacts of lost floodplain storage caused by the construction of the Terry Fox Drive extension. The three compensation options are:

- **Option 1** - All displaced storage compensated for on an "elevation basis" in one large area located west of Terry Fox Drive and east of the Carp River between river-station 38+000 and 38+950.
- **Option 2** - High-level displaced storage compensated for on an "elevation basis" in one large area located west of Terry Fox Drive and east of the Carp River between river-station 38+000 and 38+950 and low-level displaced storage compensation on a cross-sectional basis along the westerly Terry Fox Drive toe-of-slope between river-station 38+950 and 40+075.
- **Option 3** - All displaced storage compensated for on a "cross-sectional basis" along the west side of the Carp River between river-station 38+800 and 40+450.

These options have been developed to a preliminary design level of detail to verify its ability to provide the appropriate level of compensation within the impacted elevation ranges noted in **Table** 10. **Table 12** outlines the design criteria and characteristics of the 3 compensation areas.

Table 12: Summary of Compensation Option Details

Design Detail	Option 1	Option 2	Option 3
Location - River-station Range	38+000 to 38+950 East Bank	38+000 to 38+950 East Bank 38+950 to 40+075 East Bank	38+800 to 40+450 West Bank
Elevation Range of Compensation	92.1 to 93.5	Part 2a – 92.7-93.5 Part 2b – 92.5-93.5	92.1-93.5
Physical Area Impacted by Grading	12.4 Ha	Part 2a – 10.4 Ha Part 2b – 1.3 Ha	18.2 Ha
Compensation Volume Provided	63,690 m3	Part 2a – 56,624 m3 Part 2b – 6,467m3	50,899.3 m3
Excavation Volume above 100yr Floodwater Elevation	Approx 140,000 m3	Approx 140,000 m3	Approx 25,726.2 m3

Figure 10 illustrates the spatial extents of the floodplain compensation options summarized in **Table 12.** The limits shown for each option represent the physical grading limits required to achieve the required floodplain compensation volumes within given elevation ranges. The grading limits vary based on the existing topography and application of some basic grading design criteria such as using a minimum 0.5% transverse slope and a maximum 4:1 grading 'daylight' slopes.

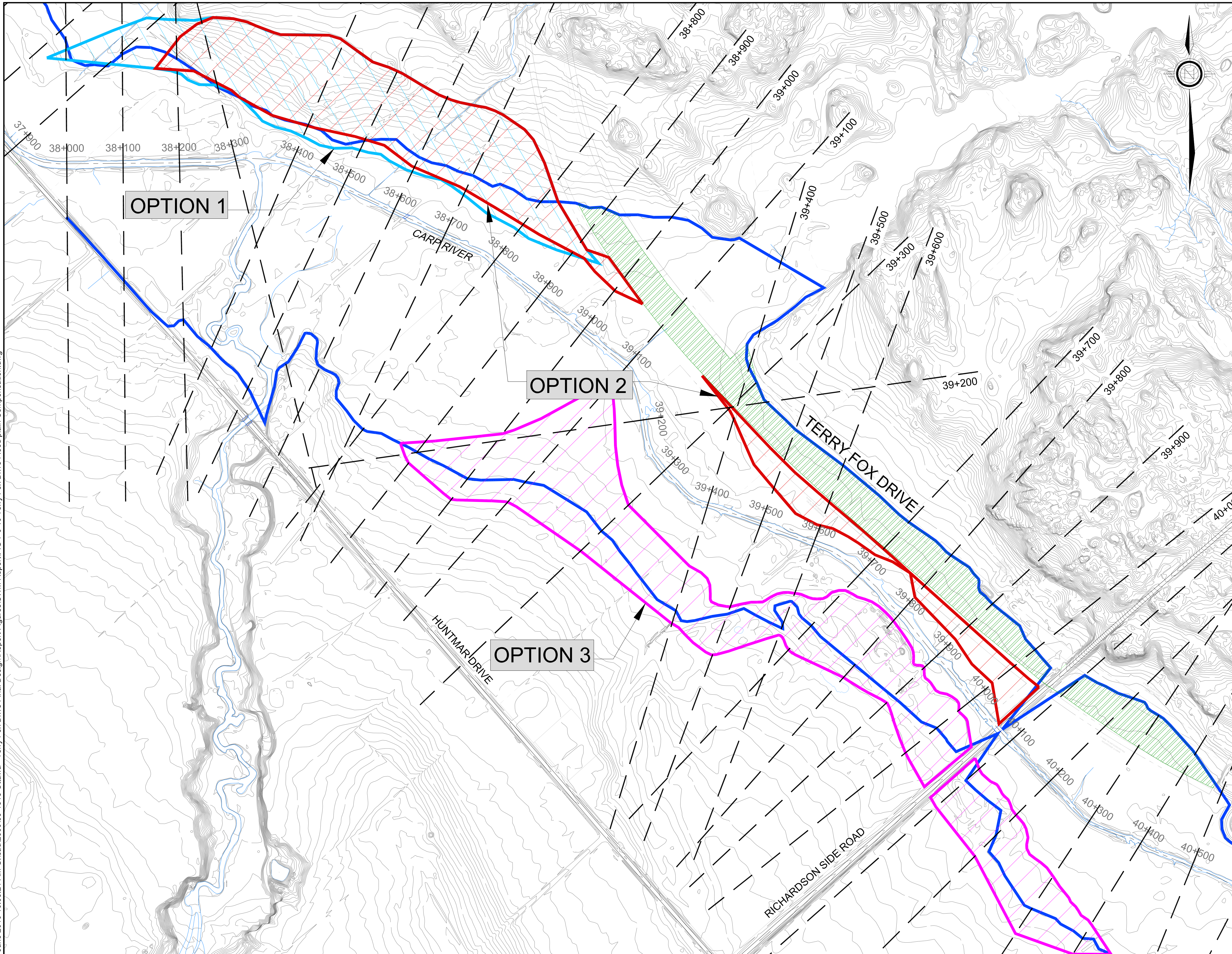


FIGURE 10
TERRY FOX DRIVE FLOODPLAIN COMPENSATION OPTIONS

TERRY FOX DRIVE EXTENSION
RICHARDSON SIDE ROAD TO SECOND LINE ROAD STORMWATER MANAGEMENT REPORT

DILLON CONSULTING

DATE: DECEMBER 2009

SCALE: NTS

09-1518

23 June 2010 10:03:21 AM G:\cad\2009\09-1518 Ottawa - Terry Fox Drive Final Design\Report Figures\SWM Report\FIG 7 9 10 Terry Fox Drive Flood plain Compensation.dwg

6.1.6 Evaluation of Floodplain Compensation Alternatives

Based on information available to date, there is no significant difference between the three options with respect to fishery resources, surface water resources or archaeology resources. From the perspective of terrestrial resources, Options 1 and 2 have slightly greater impacts on trees and related avian habitat.

The lands required for Options 1 and 2 are designated "General Urban" in the Official Plan. An application for an Official Plan amendment for the Richcraft Homes Ltd. lands has been submitted but has been deemed incomplete since applications to expand the urban boundary are not permitted by the Planning Act. As well, an application for Draft Plan of Subdivision approval has been submitted for the Richardson Ridge Inc and Uniform Real Estate Holding Corp lands but has not been approved (although draft conditions have been prepared). The draft plan conditions include a condition requiring all lands west of Terry Fox (between Terry Fox and Carp River) be dedicated to the city at no cost at time of registration as open space. The lands required for Option 3 are designated "Agricultural Resource" in the Official Plan. No planning applications are currently active for these lands.

Currently, geotechnical information available for the area required for Options 1 and 2 indicates a combination of rock and clay material is expected to be encountered. Although the geotechnical investigation of Option 3 area is not yet complete, the area is expected to consist of clay material. From a geotechnical perspective, a possible advantage of using Option 1 or 2 is that the rock cut material may be used for rock fill in the Terry Fox Drive embankment in the flooplain area.

However, given the sensitivity of the Carp River floodplain related issues, it is felt that the section by section compensation provided by Option 3 is preferred. Further, the section by section approach to floodplain compensation is endorsed by the Third Party Review Report as the most technically appropriate. On this basis, Option 3 is recommended.

6.2 Shirley's Brook Tributary Realignment

Two projects, in close proximity to each other, are being proposed in the Shirley's Brook Sub-watershed, including the Kanata Lakes North Development and the extension of Terry Fox Drive. A position paper was been prepared to outline the planning and coordination principles used to assess and mitigate the environmental impacts of the Kanata Lakes and Terry Fox Drive projects. The primary purpose of the Shirley's Brook Position Paper, prepared in May 2003 was to summarize, in a single document for review by the regulatory agencies, the drainage and storm water works proposed for the two projects.

The realignment of Shirley's Brook has been extensively scrutinized during the detailed design process for Terry Fox Drive. Based on several factors, including ecological and hydrologic impacts, realignment of Shirley's Brook to the north-westerly side of Terry Fox Drive is not being recommended as part of the preferred stormwater management solution for the corridor. The hydrologic analysis and recommended stormwater management strategy for Shirley's Brook has been developed based on Shirley's Brook remaining in approximately the same location as the existing watercourse. Maintaining the existing hydrologic and hydraulic conditions within the subwatershed area ensures that the ecologic and hydrologic impacts to Shirley's Brook are minimized, particularly in terms of the direct impacts assessed to PSW 1 and 2.

The realignment of Shirley's Brook has been limited to a relocation of the Shirley's Brook East channel from Sta. 14+860 to 15+040. This portion of the Shirley's Brook channel would otherwise be located underneath the roadway embankment of Terry Fox Drive. A portion of the Shirley's Brook East channel relocation will be located directly adjacent to the Terry Fox Drive corridor (from Sta. 14+980 to 15+040) within a rock cut, the remaining channel relocation will be constructed within the property envelope previously identified for SWMF 4b. The relocated channel will ultimately discharge to PSW 2 approximately 100m east of the Terry Fox Drive alignment. The alignment, typical sections, and channel profile for the Shirley's Brook East relocation are included in **Appendix D**.

6.3 Drainage Area Designs

6.3.1 Design Criteria and Hydraulic Assessment

Currently, most of the land surrounding the proposed Terry Fox Drive alignment is undeveloped, natural lands, with the exception of the south end of the alignment where development is underway. Stormwater facility SWMF#2 was built prior to 2004 and runoff from the current development is conveyed to the facility prior to discharging to the Carp River. Current development plans for property adjacent to the road are being considered as part of the update to the 2007 PDR, to coordinate drainage infrastructure, where feasible.

The major flow concept in the 2007 Preliminary Design will be used to manage flows from upstream of the Terry Fox Drive right-of-way. Major flow from Terry Fox Drive will be managed as outlined in the 2007 Report except through the area of the Carp River Floodplain, which was designed with a saw tooth (0.5%) profile.

The analysis and design of the temporary and permanent culverts was carried out as indicated in the *City of Ottawa Sewer Design Guidelines (November 2004)* and the *MTO Drainage Management Manual (1995)*.

Terry Fox Drive is considered an urban arterial road based on the City of Ottawa Official Plan Schedule G. The design storm return period for an urban arterial for spans up to 6m is 50 years as per the City of Ottawa standards (*City of Ottawa Sewer Design Guidelines, Section 6.4.2)*. The culverts located in the Station 13+360 (CV3a, CV3b, CV3c) were designed for the 1:100 year event, as these culverts are intended to provide connectivity between the floodplain embayment located on the east or upstream side of Terry Fox Drive and the main portion of the Carp River floodplain.

The drainage areas and watershed slopes for all three watersheds were determined using 0.5 m contours provided by the City of Ottawa in the 1:2000 topographic mapping. The watershed characteristics were interpreted from mapping, satellite imagery, and a field visit. Soil data for the area was obtained from a soil map of Carleton County. The soil survey was performed by the Department of Chemistry, Ontario Agricultural College, Guelph, and the Experimental Farms Service, Dominion Department of Agriculture, Ottawa. Four soil types dominate the area and are summarized in **Table 13**. The CN values for each drainage area were calculated based on a weighted CN value approach depending on the percentage of each soil type within the drainage area. The Hydrologic soil groups were selected based on MTO Design Chart 1-08. CN values were selected based on MTO Design Chart 1-09 and confirmed according to City of Ottawa Sewer Design Guidelines Table 5.9.

Table 13: Soil Types in the Terry Fox Drive Study Area

Soil ID	Soil Name	Description	Hydrologic Soil group	CN value	Runoff Coefficent*
Ccl	Carp Clay Loam	Dark grey brown clay over grey clay grading into brown and grey clay loam, clay and silty clay; gently undulating moderate to slop drainage	C	76	0.3 (Flat pasture)
A	Anstruther Sand	Shallow brown sandy soils over granitic rocks; large areas of bare rock, local clay pockets. Rolling (to hilly) excessive drainage	AB - B	59	0.3 (rolling – hilly open sandy loam)
Ns	Nepean Sand	Shallow sandy soils with sandstone bedrock within 3 feet; gently undulating moderate to excessive drainage	AB	55	0.2
Rc-R	Rideau Clay – rock knob phase	Mixed areas of Rideau clay, sand spote phase and Precambrian rock knobs	C	76	0.3

** for 100 year storms increased by 25% c=0.38 (as per City of Ottawa Sewer Design Guidelines p. 5-28)*

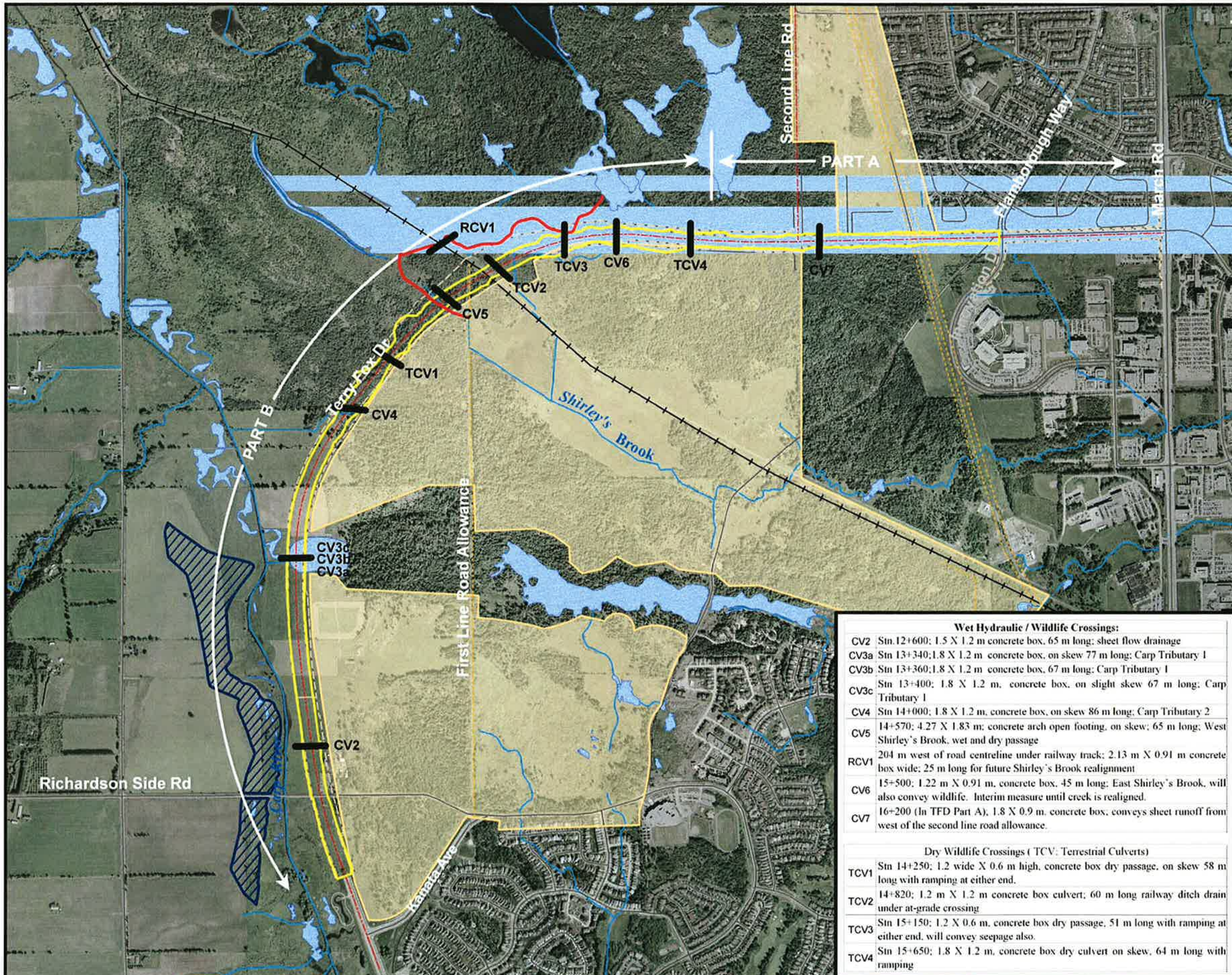
The City of Ottawa Sewer Design Guidelines suggests that the rational method be only applied to drainage areas less than 40ha. Therefore, hydrologic modelling software Visual OTTHYMO V.2.2 was used to calculate peak flows for the CR-3 and Shirley's Brook drainage area, but the rational method was applied to the smaller areas. Total precipitation was calculated based on the IDF curves for the region provided in the City of Ottawa Sewer Design Guidelines. The SCS-Type II 12-hour storm distribution was applied, as this is the distribution recommended for rural drainage area by the MTO and City of Ottawa. The 12-hour and 24-hour events were both modelled and the 12-hour storm was found to provide the highest peak flows. The watershed slope was calculated based on the equivalent slope method and the time of concentration for each drainage area was calculated using the Airport formula. The Airport method is appropriate as it is recommended for drainage basins with runoff coefficients less than 0.4.

The hydraulic performance analysis of culvert options was based on CulvertMaster software. The hydraulic requirements were assessed in accordance with the Canadian Highway Bridge Design Code (CSA-S6-06) and the City of Ottawa Sewer Design Guidelines. For the class of road over the Terry Fox Drive culverts, a freeboard of 1000 mm is required. Freeboard if measured from the edge of the traveled lane to the high water elevation. The culverts must also be able to pass the event corresponding to twice the normal design flood without endangering the integrity of the structure and without approaching embankment failure.

Table 14 summarizes the design of the road culverts crossing Terry Fox Drive. Concrete box culverts were the selected culvert type for all of the cross-drainage features. The drainage areas for these culverts are illustrated on **Figure 2**. **Figure 11** provides a plan of the road crossing culverts. The culverts are also illustrated on the plan profile drawings included in **Appendix A**.

Table 14: Summary of Culvert Designs

Culvert	Status	Length (m)	Spanx Rise (mm)	U/S Invert	D/S Invert	Comments
CV-2	12+600	64.4	1800 x 1200	93.26	92.62	Skewed
CV-3a	13+335	67.4	1800 x 1200	92.10	91.78	
CV-3b	13+366	58.3	1800 x 1200	91.89	91.79	
CV-3c	13+410	58.8	1800 x 1200	91.80	91.76	Skewed
CV-4	14+008	85.7	1800 x 1200	102.93	101.20	Skewed
CV-5	14+571	57.9	427 x 1830	100.56	100.51	
CV-6	15+341	60.8	1800 x 900	106.97	106.39	Arch
TCV-1	14+253	62.8	1800 x 900	106.17	106.17	Terrestrial Culvert
TCV-2	14+829	53.8	1800 x 900	101.38	101.11	Terrestrial Culvert
TCV-3	15+116	54.2	1800 x 900	105.21	104.51	Terrestrial Culvert
TCV-4	15+643	56.1	1800 x 900	109.33	107.81	Terrestrial Culvert



Wet Hydraulic / Wildlife Crossings:

CV2	Stn.12+600; 1.5 X 1.2 m concrete box, 65 m long; sheet flow drainage
CV3a	Stn 13+340;1.8 X 1.2 m concrete box, on skew 77 m long; Carp Tributary 1
CV3b	Stn 13+360;1.8 X 1.2 m concrete box, 67 m long; Carp Tributary 1
CV3c	Stn 13+400; 1.8 X 1.2 m, concrete box, on slight skew 67 m long; Carp Tributary 1
CV4	Stn 14+000; 1.8 X 1.2 m, concrete box, on skew 86 m long; Carp Tributary 2
CV5	14+570; 4.27 X 1.83 m; concrete arch open footing, on skew; 65 m long; West Shirley's Brook, wet and dry passage
RCV1	204 m west of road centreline under railway track; 2.13 m X 0.91 m concrete box wide; 25 m long for future Shirley's Brook realignment
CV6	15+500; 1.22 m X 0.91 m, concrete box, 45 m long; East Shirley's Brook, will also convey wildlife. Interim measure until creek is realigned.
CV7	16+200 (In TFD Part A), 1.8 X 0.9 m, concrete box; conveys sheet runoff from west of the second line road allowance.

Dry Wildlife Crossings (TCV: Terrestrial Culverts)

TCV1	Stn 14+250; 1.2 wide X 0.6 m high, concrete box dry passage, on skew 58 m long with ramping at either end.
TCV2	14+820; 1.2 m X 1.2 m concrete box culvert; 60 m long railway ditch drain under at-grade crossing
TCV3	Stn 15+150; 1.2 X 0.6 m, concrete box dry passage, 51 m long with ramping at either end, will convey seepage also.
TCV4	Stn 15+650; 1.8 X 1.2 m, concrete box dry culvert on skew, 64 m long with ramping

Legend

- Hydraulic Culverts and Wildlife Passage
- Proposed Shirley's Brook Realignment
- Grading Limit Footprint
- TFD Right of Way
- Road Centreline
- Railway
- Hydro Lines
- Wetland
- Floodplain Cut Area
- Watercourse
- Future Baseline Development

FIGURE 11

HYDRAULIC CULVERTS AND WILDLIFE PASSAGE

TERRY FOX DRIVE EXTENSION

RICHARDSON SIDE ROAD TO SECOND LINE ROAD STORMWATER MANAGEMENT REPORT

DILLON CONSULTING

DATE: DECEMBER 2009

SCALE: N.T.S.

09-1518

6.4 Provision for Terrestrial Crossings

Terrestrial crossing features to be integrated in the hydraulics culverts at CV-3a, CV-3b, CV-3c and CV-5 are:

- Concrete culverts (box or round) are recommended over metal
- Open bottom is recommended but if this is not a feasible option then a natural bottom must be installed (placement of substrate throughout the culvert). i.e., no bare culvert bottoms for animal crossing locations
- Minimum height from substrate to top of culvert is 1m
- Minimum width of terrestrial path (not including meander width of streams or flows) through culverts is 2m
- Placement of a grate (for light penetration) in the top of the culverts in the middle of the road, at the centre island (highly recommended)
- Boulder slope on west side of road from approx. Sta. 14+930 (after crossing culvert) to 15+750
- Boulder slope on west/south side of road from approx. Sta. 14+575 (after Shirley's Brook culvert) to 14+780.

Terrestrial only (dry) culvert crossings are recommended at Sta. 14+253 and 15+643. These consist of small concrete box culverts (1220 x 910 mm). The provision of boulder slopes and ramping at either end of the culvert is recommended at these locations to direct animals to the culvert opening. Combination drainage (interim) culvert/terrestrial culvert crossings are recommended near Sta. 14+829 and 15+116. These also consist of small concrete box culverts (1220 x 910mm) and will function as drainage features but remain dry between precipitation events.

7.0 REFERENCES

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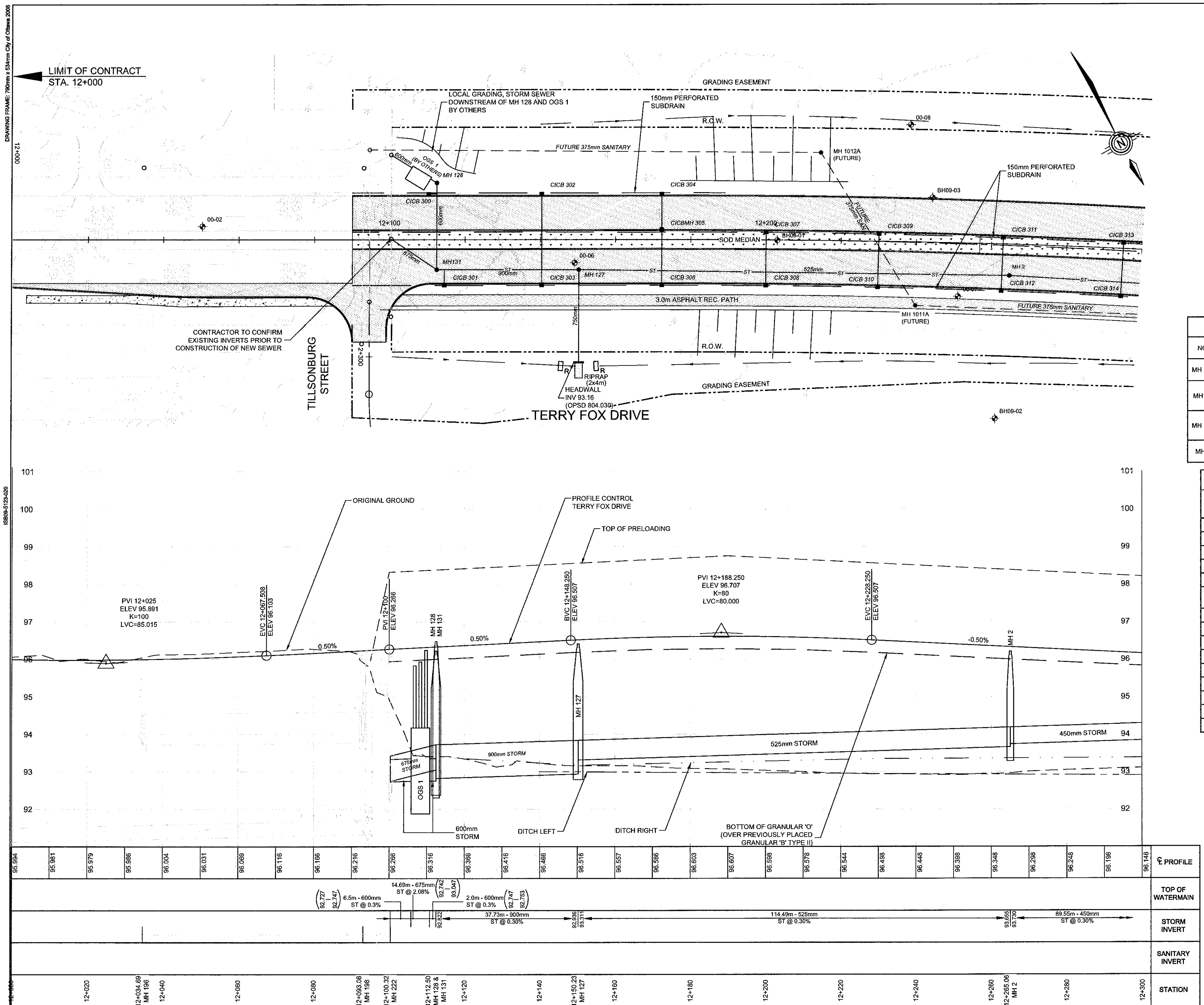
Price, John, watershed Management Coordinator, Mississippi Valley Conservation Authority. Personal Communication.

Brian Huston, P. Eng
Project Engineer

APPENDIX A

Grading and Drainage/Typical Sections – Detailed Design Contract Drawings



TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

Ottawa

Contract No. ISB09-5123 | Dwg. No. 020
Sheet 020 of 101

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 12+000 TO STA. 12+300

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

Des. R.J.G. | Chk'd. B.G.H.
Dwn. R.S.S. | Chk'd. B.G.H.

Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 128	12+112.5	15.15 Lt.	ST	701.011	S24.1	96.472	92.75	92.75
MH131	12+112.5	8.00 Rt.	ST	701.013	S24.1	96.221	92.82	93.05 92.82
MH 127	12+150.2	8.00 Rt.	ST	701.013	S24.1	96.410	W 93.31 N 93.09	92.94
MH 2	12+265.1	8.00 Rt.	ST	701.010	S24.1	96.200	93.73	93.65

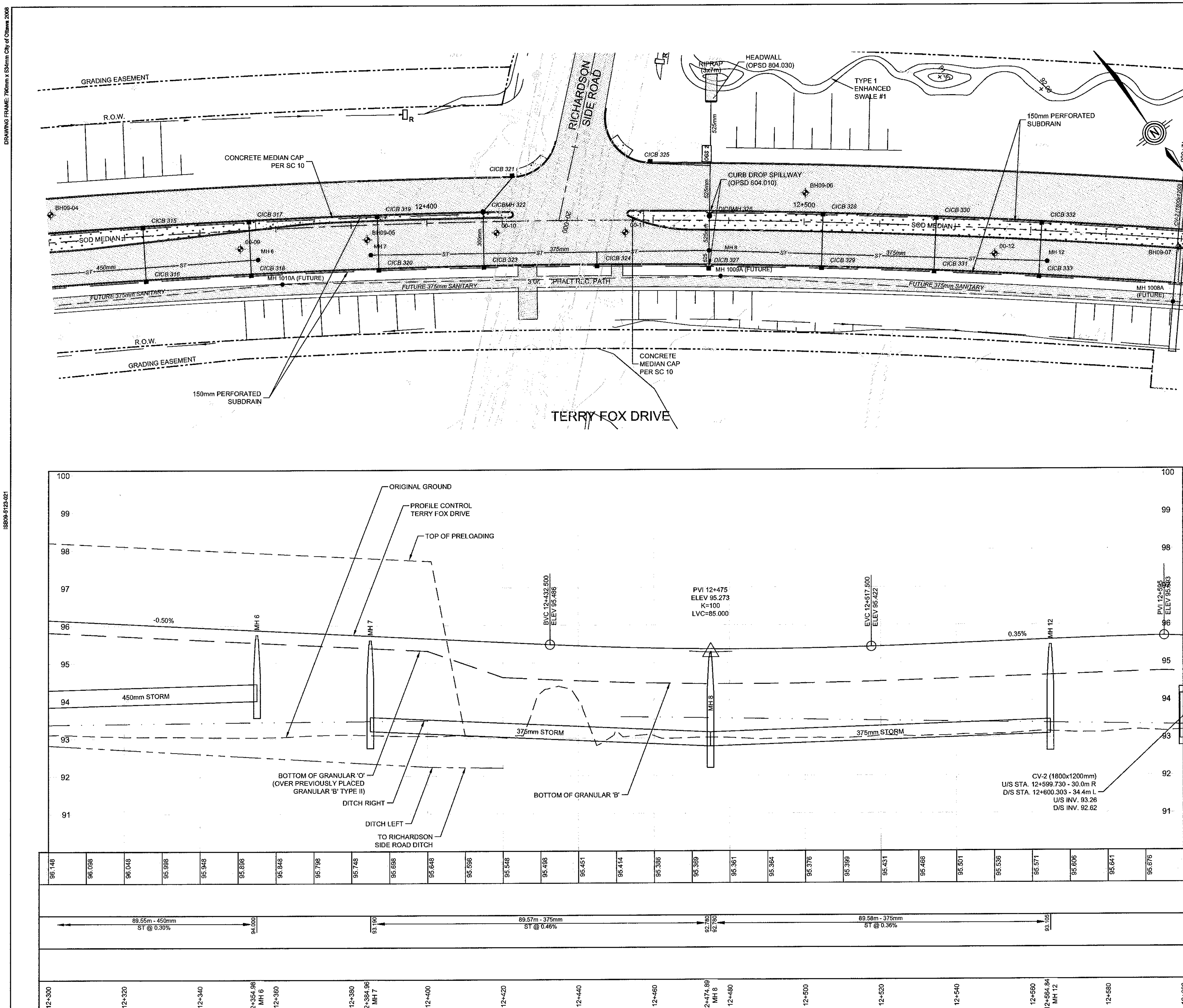
CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 300	12+110.3	11.6 Lt.	ST	705.010	S22	96.19	94.94
CICB 301	12+114.5	11.6 Rt.	ST	705.010	S22	96.16	94.91
CICB 302	12+140.3	11.6 Lt.	ST	705.010	S22	96.42	95.17
CICB 303	12+140.3	11.6 Rt.	ST	705.010	S22	96.29	95.04
CICB 304	12+172.3	11.6 Lt.	ST	705.010	S22	96.65	95.40
CICBMH 305	12+172.3	2.7 Lt.	ST	701.010	S22	96.59	95.0 94.9
CICB 306	12+172.3	11.6 Rt.	ST	705.010	S22	96.41	95.16
CICB 307	12+200.0	2.7 Lt.	ST	705.010	S22	96.60	95.35
CICB 308	12+200.0	11.6 Rt.	ST	705.010	S22	96.41	95.16
CICB 309	12+230.0	2.7 Lt.	ST	705.010	S22	96.50	95.25
CICB 310	12+230.0	11.6 Rt.	ST	705.010	S22	96.29	95.04
CICB 311	12+263.1	2.7 Lt.	ST	705.010	S22	96.33	95.08
CICB 312	12+263.0	11.6 Rt.	ST	705.010	S22	96.13	94.88
CICB 313	12+295.0	2.7 Lt.	ST	705.010	S22	96.17	94.92
CICB 314	12+295.0	11.6 Rt.	ST	705.010	S22	95.97	94.72

GENERAL NOTES:

1. SEE DRAWING 025.

ISB09-5123-021



TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD

PHASE TWO

GRADING AND DRAINAGE TERRY FOX DRIVE STA. 12+300 TO STA. 12+600

R.HOLDER, P.ENG. — *Manager-Construction Services West*

S.STODDARD, P.ENG. — *Senior Project Engineer*

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON PROVINCE OF ONTARIO

Ottawa

Contract No. ISB09-5123	Dwg. No. 021
Sheet 021 of 101	
Asset No.	
Asset Group	
Des. R.J.G.	Chk'd. B.G.H.
Dwn. R.S.S.	Chk'd. B.G.H.
Utility Circ. No.	Index No.
Const. Inspector	
Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2	

NOTE:
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DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

MAINTENANCE HOLE TABLE

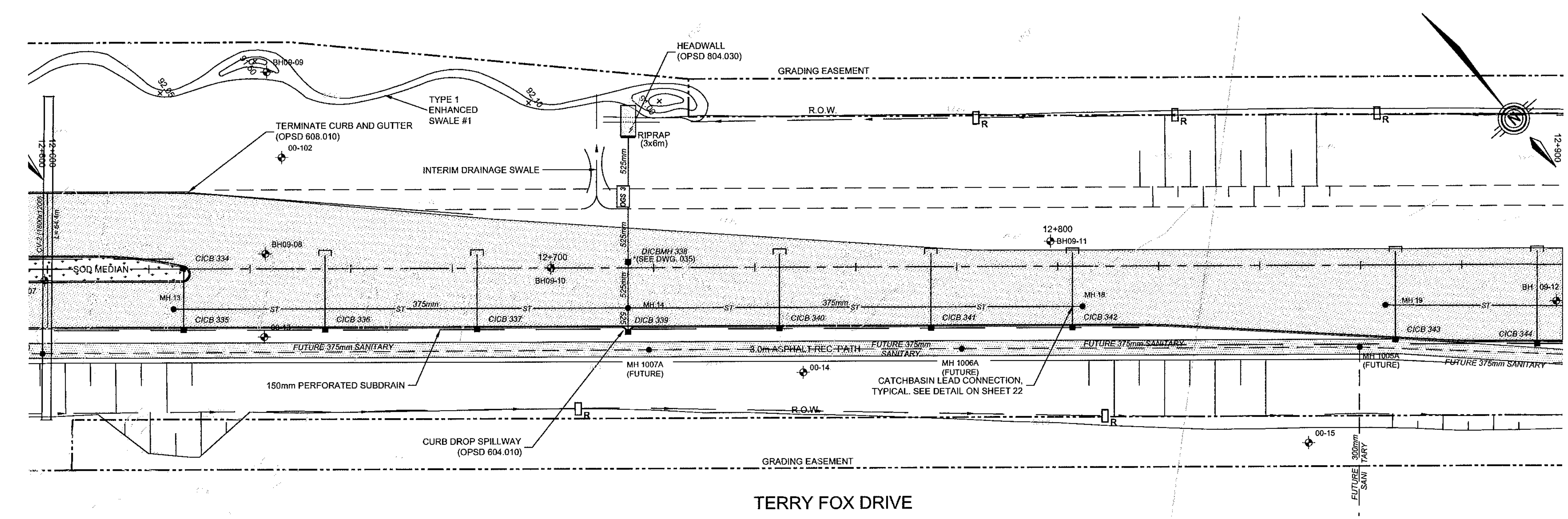
NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 6	12+355	8.00 Rt.	ST	701.010	S24.1	95.751		94.00
MH 7	12+385	8.00 Rt.	ST	701.010	S24.1	95.601		93.19
DICBMH 326	12+474.9	1.17 Lt.	ST	706.010	403.01(A) (4:1)	95.400	92.63	92.58
MH 8	12+474.9	8.00 Rt.	ST	701.011	S24.1	95.242	92.78 92.78 92.70	92.46
MH 12	12+564.8	8.00 Rt.	ST	701.010	S24.1	95.465		93.10

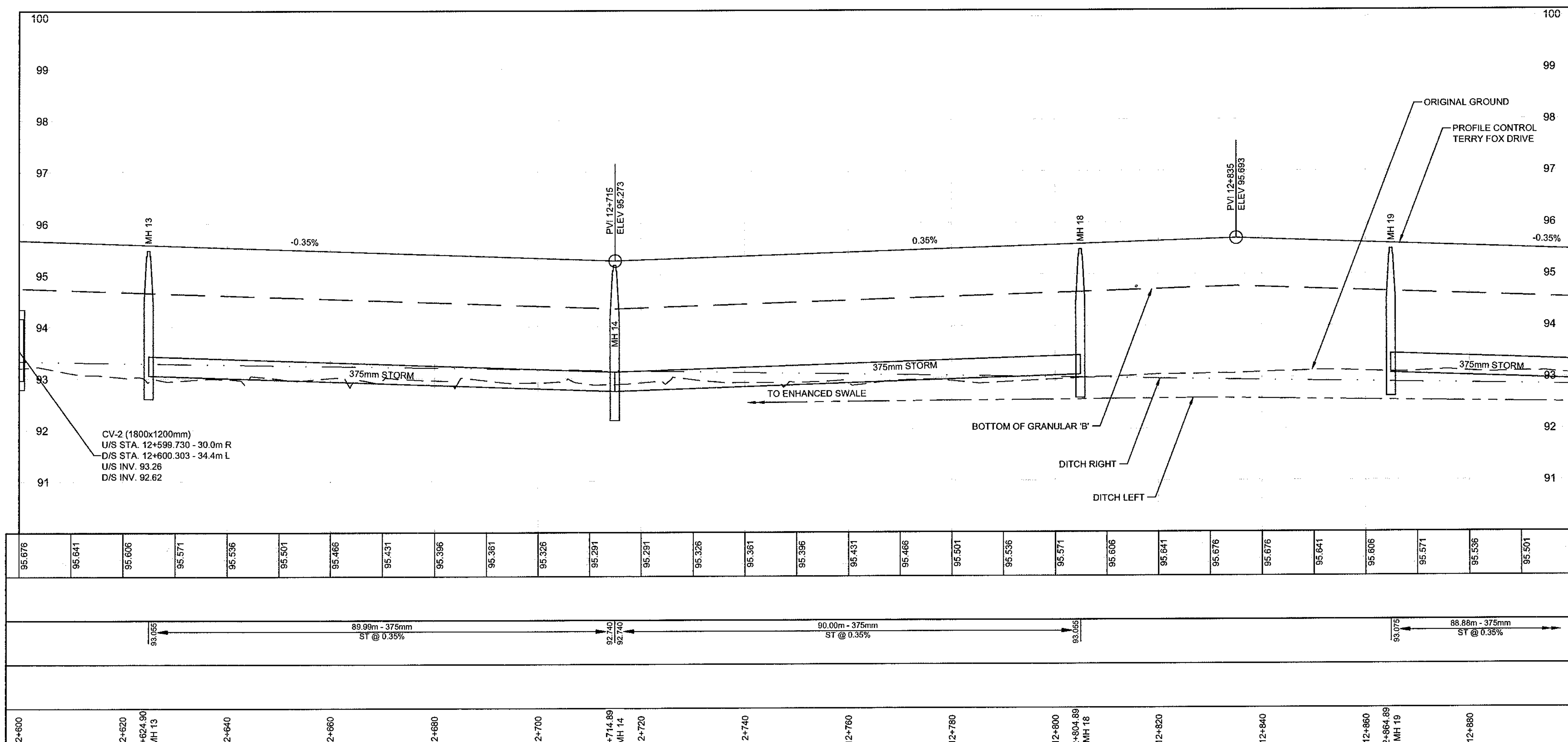
CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 315	12+325.0	2.7 Lt.	ST	705.010	S22	96.02	94.77
CICB 316	12+325.0	11.6 Rt.	ST	705.010	S22	95.82	94.57
CICB 317	12+353.0	2.7 Lt.	ST	705.010	S22	95.88	94.63
CICB 318	12+353.0	11.6 Rt.	ST	705.010	S22	95.68	94.43
CICB 319	12+387.0	2.7 Lt.	ST	705.010	S22	95.71	94.46
CICB 320	12+387.0	11.6 Rt.	ST	705.010	S22	95.51	94.26
CICB 321	12+422.8	11.6 Lt.	ST	705.010	S22	95.74	94.49
CICBMH 322	12+415.0	2.7 Lt.	ST	701.010	S22	95.57	94.00 93.90
CICB 323	12+415.0	11.6 Rt.	ST	705.010	S22	95.37	94.12
CICB 324	12+445.1	11.6 Rt.	ST	705.010	S22	95.23	93.98
CICB 325	12+459.1	15.1 Lt.	ST	705.010	S22	95.67	94.42
DICB 327	12+472.9	12.8 Rt.	ST	705.040	403.01 (A) (4:1)	95.15	92.72
CICB 328	12+504.9	2.7 Lt.	ST	705.010	S22	95.39	94.14
CICB 329	12+504.9	11.6 Rt.	ST	705.010	S22	95.18	93.93
CICB 330	12+534.9	2.7 Lt.	ST	705.010	S22	95.48	94.23
CICB 331	12+534.9	11.6 Rt.	ST	705.010	S22	95.28	94.03
CICB 332	12+562.8	2.7 Lt.	ST	705.010	S22	95.58	94.33
CICB 333	12+562.8	11.6 Rt.	ST	705.010	S22	95.38	94.13

GENERAL NOTES:

1. SEE DRAWING 025.





TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 12+600 TO STA. 12+900

R.HOLDER, P.ENG. — *Manager-Construction Services West*
S.STODDARD, P.ENG. — *Senior Project Engineer*

LICENSED PROFESSIONAL ENGINEER — D.G. HUSTON — PROVINCE OF ONTARIO

Ottawa

Contract No. ISB09-5123 | Dwg. No. 022
Sheet 022 of 101
Asset No.
Asset Group
Des. R.J.G. | Chk'd. B.G.H.
Dwn. R.S.S. | Chk'd. B.G.H.
Utility Circ. No. | Index No.
Const. Inspector
Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

MAINTENANCE HOLE TABLE

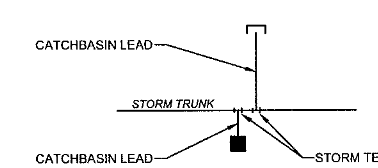
NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 13	12+624.9	8.00 Rt.	ST	701.010	S24.1	95.482		93.05
DICBMH 338	12+714.9	1.20 Lt.	ST	706.010	S24.1	95.356	92.59	92.55
MH 14	12+714.9	8.00 Rt.	ST	701.011	S24.1	95.184	92.74 92.74 92.67	92.62
MH 18	12+804.9	8.00 Rt.	ST	701.010	S24.1	95.481		93.06
MH 19	12+864.9	8.00 Rt.	ST	701.010	S24.1	95.482		93.08

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 334	12+626.9	0.6 Lt.	ST	705.010	S22	95.79	94.54
CICB 335	12+626.9	11.6 Rt.	ST	705.010	S22	95.40	94.15
CICB 336	12+654.9	11.6 Rt.	ST	705.010	S22	95.30	94.05
CICB 337	12+684.9	11.6 Rt.	ST	705.010	S22	95.20	93.95
DICB 339	12+714.9	12.8 Rt.	ST	705.040	403.01 (A) (4:1)	95.00	92.68
CICB 340	12+744.9	11.6 Rt.	ST	705.010	S22	95.20	93.95
CICB 341	12+774.9	11.6 Rt.	ST	705.010	S22	95.30	94.05
CICB 342	12+802.9	11.6 Rt.	ST	705.010	S22	95.40	94.15
CICB 343	12+866.9	14.3 Rt.	ST	705.010	S22	95.35	94.10
CICB 344	12+894.9	15.3 Rt.	ST	705.010	S22	95.23	93.98

GENERAL NOTES:

1. SEE DRAWING 025.



TYPICAL CATCHBASIN LEAD CONNECTION
N.T.S.

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TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

Ottawa

Contract No.	Dwg. No.
ISB09-5123	023
Sheet 023 of 101	

Asset No.

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 12+900 TO STA. 13+200

R.HOLDER, P.ENG. — Manager-Construction Services West
S.STODDARD, P.ENG. — Senior Project Engineer

Asset Group

Des.	R.J.G.	Chk'd.	B.G.H.
Dwn.	R.S.S.	Chk'd.	B.G.H.
Utility Circ. No.		Index No.	

Const. Inspector

Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON 100165503 PROVINCE OF ONTARIO

NOTE:
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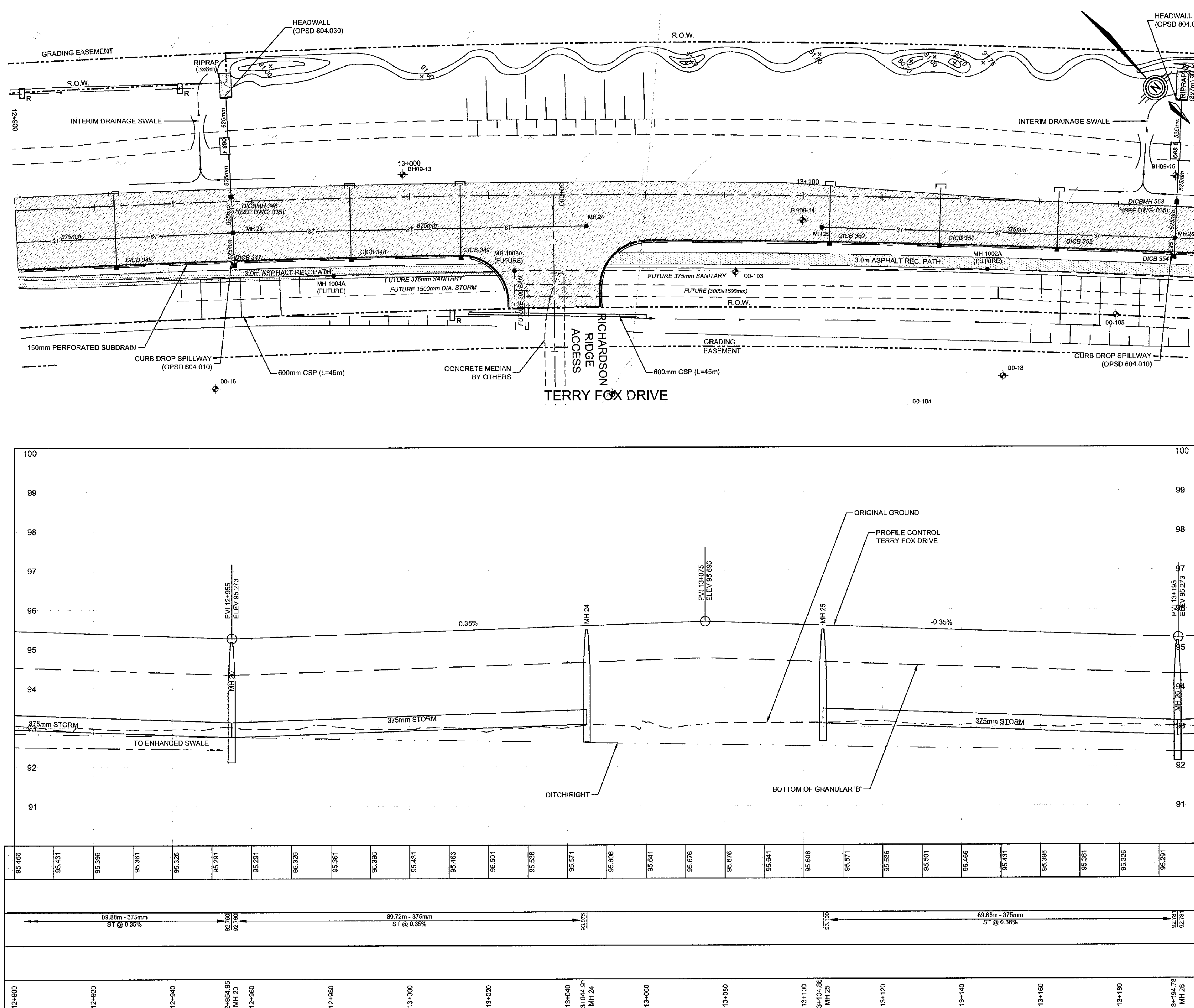
DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10



MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
DICBMH 346	12+954.8	1.20 Lt.	ST	706.010	S24.1	95.503	92.53	92.49
MH 20	12+954.9	8.00 Rt.	ST	701.011	S24.1	95.184	92.76 92.76 92.61	92.56
MH 24	13+044.9	8.00 Rt.	ST	701.010	S24.1	95.481		93.07
MH 25	13+104.9	8.00 Rt.	ST	701.010	S24.1	95.482		93.10
DICBMH 353	13+194.8	1.19 Lt.	ST	706.010	S24.1	95.710	92.55	92.51
MH 26	13+194.8	8.00 Rt.	ST	701.011	S24.1	95.184	92.78 92.78 92.62	92.58

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 345	12+925.0	15.3 Rt.	ST	705.010	S22	95.13	93.88
DICB 347	12+955.1	16.4 Rt.	ST	705.040	403.01 (A) (4:1)	95.00	92.64
CICB 348	12+984.8	15.3 Rt.	ST	705.010	S22	95.13	93.88
CICB 349	13+012.9	15.3 Rt.	ST	705.010	S22	95.22	93.97
CICB 350	13+106.9	11.6 Rt.	ST	705.010	S22	95.40	94.15
CICB 351	13+134.9	11.6 Rt.	ST	705.010	S22	95.30	94.05
CICB 352	13+164.9	11.6 Rt.	ST	705.010	S22	95.20	93.95
DICB 354	13+194.8	12.75 Rt.	ST	705.040	403.01 (A) (4:1)	95.11	92.64

GENERAL NOTES:

1. SEE DRAWING 025.

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

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TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

Ottawa

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 13+200 TO STA. 13+500

Contract No. ISB09-5123	Dwg. No. 024
Sheet 024 of 101	
Asset No.	
Asset Group	
Des. R.J.G.	Chk'd. B.G.H.
Dwn. R.S.S.	Chk'd. B.G.H.
Utility Circ. No.	Index No.
Const. Inspector	
Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2	

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

B.G. HUSTON — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

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DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
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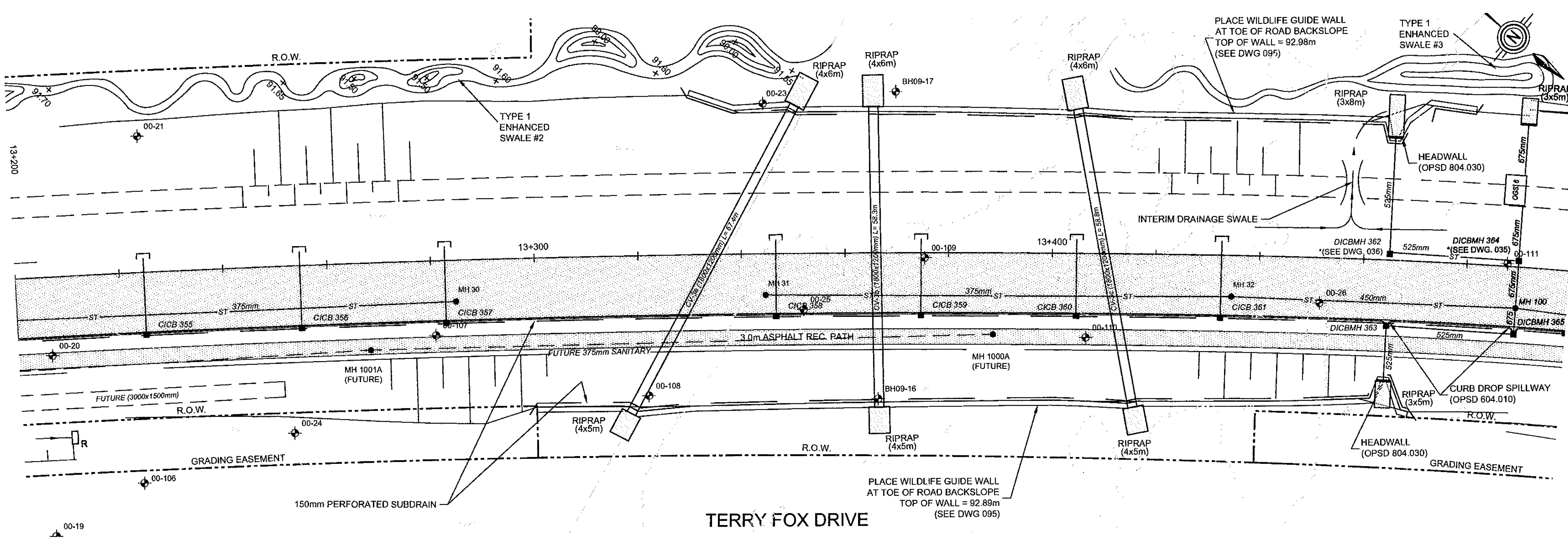
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

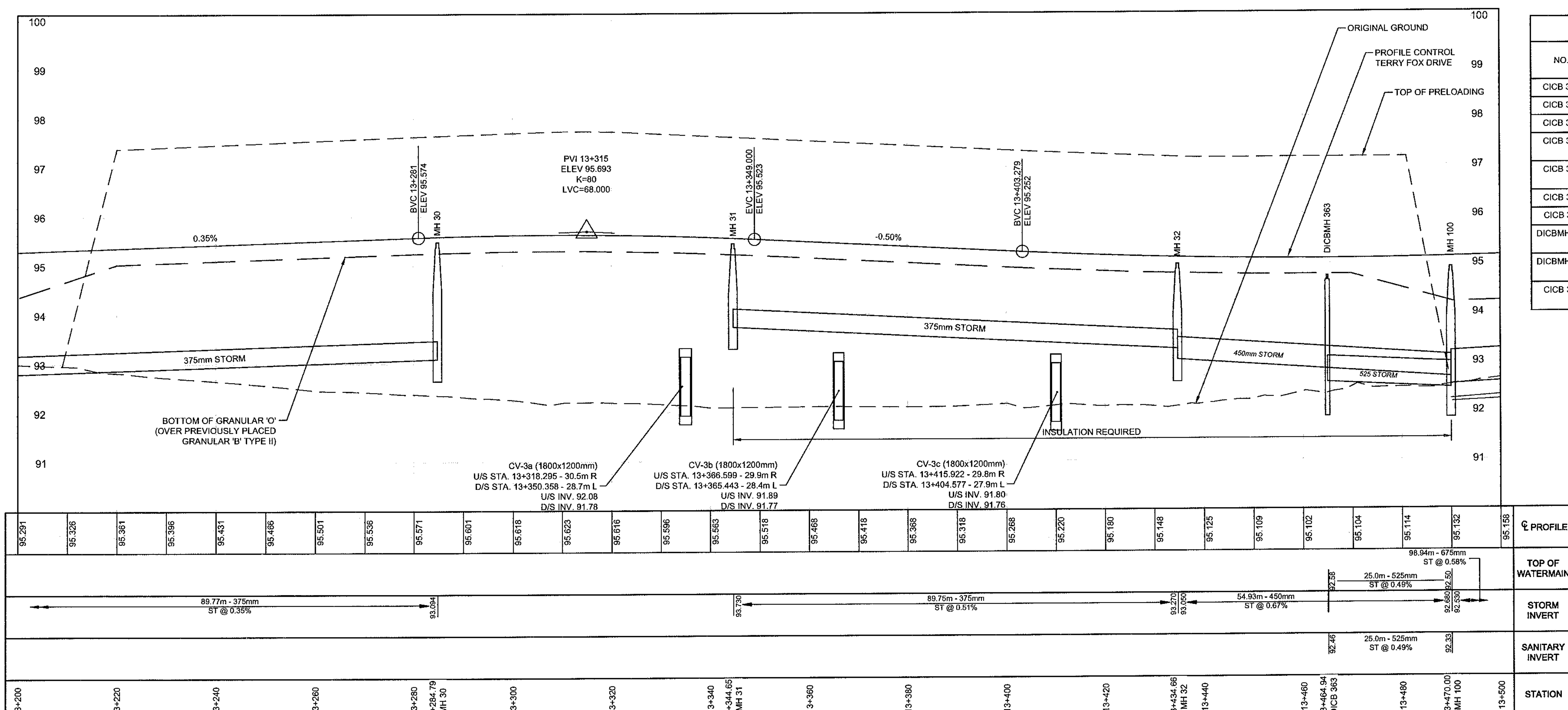


MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 30	13+284.8	8.00 Rt.	ST	701.010	S24.1	95.478		92.09
MH 31	13+344.6	8.00 Rt.	ST	701.010	S24.1	95.435		93.73
MH 32	13+434.7	8.00 Rt.	ST	701.010	S24.1	94.995	93.27	93.05
DICBMH 364	13+490	1.20 Lt.	ST	701.010	S24.1	95.140	92.33 92.35	92.30
MH 100	13+490	8.00 Rt.	ST	701.012	S24.1	94.920	92.53 92.46 92.68	92.41
DICBMH 365	13+490	13.05 Rt.	ST	706.020	S24.1	94.700	92.50	92.49

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 355	13+224.8	11.6 Rt.	ST	705.010	S22	95.20	93.95
CICB 356	13+254.8	11.6 Rt.	ST	705.010	S22	95.30	94.05
CICB 357	13+282.8	11.6 Rt.	ST	705.010	S22	95.40	94.15
CICB 358	13+346.7	11.6 Rt.	ST	705.010	S22	95.35	94.10
CICB 359	13+374.7	11.6 Rt.	ST	705.010	S22	95.22	93.97
CICB 360	13+404.7	11.6 Rt.	ST	705.010	S22	95.07	93.82
CICB 361	13+432.7	11.6 Rt.	ST	705.010	S22	94.91	93.66
DICBMH 362	13+465.0	1.2 Lt.	ST	706.010	403.01 (A) (4:1)	95.06	W 92.98 N 92.46
DICBMH 363	13+464.9	12.8 Rt.	ST	706.010	403.01 (A) (4:1)	94.75	N 92.58 E 93.11
CICB 366	13+500.0	11.6 Rt.	ST	705.010	S22	94.78	93.53



GENERAL NOTES:

1. SEE DRAWING 025.

DRAWING FRAME: 790mm x 534mm City of Ottawa 2006

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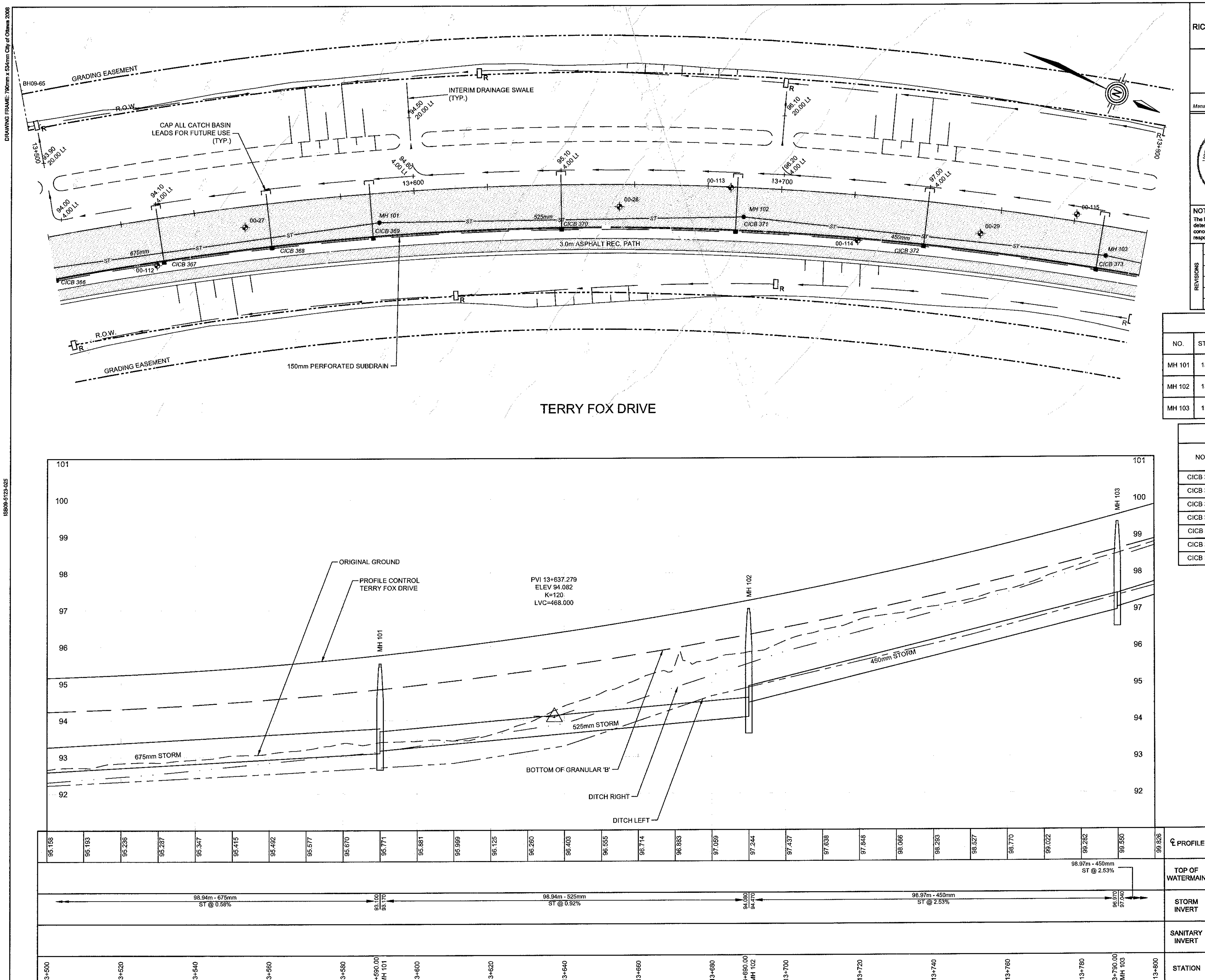

TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD

PHASE TWO

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 13+500 TO STA. 13+800

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

Ottawa

Contract No. ISB09-5123 | Dwg. No. 025

Sheet 025 of 101

Asset No.

Asset Group

Des. R.J.G. | Chk'd. B.G.H.

Dwn. R.S.S. | Chk'd. B.G.H.

Utility Circ. No. | Index No.

Const. Inspector

Scale: HORIZONTAL 0m 5 10 20; 0m VERTICAL

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON PROVINCE OF ONTARIO

NOTE:
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DILLON CONSULTING

REVISIONS No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 101	13+590	8.00 Rt.	ST	701.010	S24.1	95.546	93.17	93.10
MH 102	13+690	8.00 Rt.	ST	701.010	S24.1	97.019	94.47	94.08
MH 103	13+790	8.00 Rt.	ST	701.010	S24.1	99.361	97.04	96.97

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 367	13+530.0	11.6 Rt.	ST	705.010	S22	94.91	93.66
CICB 368	13+560.0	11.6 Rt.	ST	705.010	S22	95.12	93.87
CICB 369	13+588.0	11.6 Rt.	ST	705.010	S22	95.38	94.13
CICB 370	13+640.0	11.6 Rt.	ST	705.010	S22	96.03	94.78
CICB 371	13+688.0	11.6 Rt.	ST	705.010	S22	96.83	95.58
CICB 372	13+740.0	11.6 Rt.	ST	705.010	S22	97.92	96.67
CICB 373	13+788.0	11.6 Rt.	ST	705.010	S22	99.18	97.93

GENERAL NOTES:

1. CITY OF OTTAWA STANDARD DRAWINGS GOVERN CONSTRUCTION AND INSTALLATION UNLESS OTHERWISE INDICATED.
2. PIPE MATERIALS AND APPURTENANCES FOR SEWERS, WATERMAINS, AND LATERALS AS PER CITY OF OTTAWA MATERIAL SPECIFICATIONS.
3. STORM SEWER MAINTENANCE HOLE COVER PER S24.1 UNLESS OTHERWISE NOTED.
4. SINGLE CATCH BASINS AS PER OPSD 705.010 WITH MINIMUM PIPE SIZE OF 200mm DIA. @ 1.0% MIN. & 8.0% MAX. DOUBLE CATCH BASINS AND DITCH INLET CATCH BASINS PIPE SIZE OF 250mm DIA. @ 1.0% MIN. & 8.0% MAX. UNLESS OTHERWISE NOTED.
5. PRECAST CONCRETE ADJUSTMENT UNITS FOR MAINTENANCE HOLES AND CATCH BASINS AS PER OPSD 704.010.
6. RIGID BOARD INSULATION SHALL BE USED WHERE STORM SEWER PIPE DEPTH IS LESS THAN 2.0 METERS.
7. ALL UNDERGROUND PLANT SHOWN IN APPROXIMATE LOCATION ONLY AS PER RECORDS. PLANT TO BE LOCATED PRIOR TO CONSTRUCTION. CONTRACTOR TO CHECK, VERIFY, AND BE RESPONSIBLE FOR ALL UNDERGROUND SERVICES AND UTILITIES.
8. CONTRACTOR TO CONTACT UTILITIES FOR LOCATIONS AND TO COORDINATE RELOCATION OF EXISTING UTILITIES.
9. ALL CONNECTION POINTS TO EXISTING STORM SEWER, CONTRACTOR TO VERIFY EXISTING INVERTS PRIOR TO INSTALLATION OF NEW PIPE AND CATCH BASINS, TO ALLOW FOR ADJUSTMENTS IN SLOPE IF REQUIRED.
10. SEE MISCELLANEOUS DETAILS FOR CULVERT SKYLIGHT LOCATIONS AND DETAILS.
11. OFFSETS AND ELEVATIONS SHOWN FOR CICB ARE MEASURED TO THE EDGE OF PAVEMENT.
12. CB - DENOTES SINGLE CATCH BASIN
    CICB - DENOTES CURB INLET CATCH BASIN
    DCICB - DENOTES DOUBLE CURB INLET CATCH BASIN
    DICBMH - DENOTES DITCH INLET CATCH BASIN MANHOLE
    OGS - DENOTES OIL-GRIT SEPARATOR (SEE DWG. 094)

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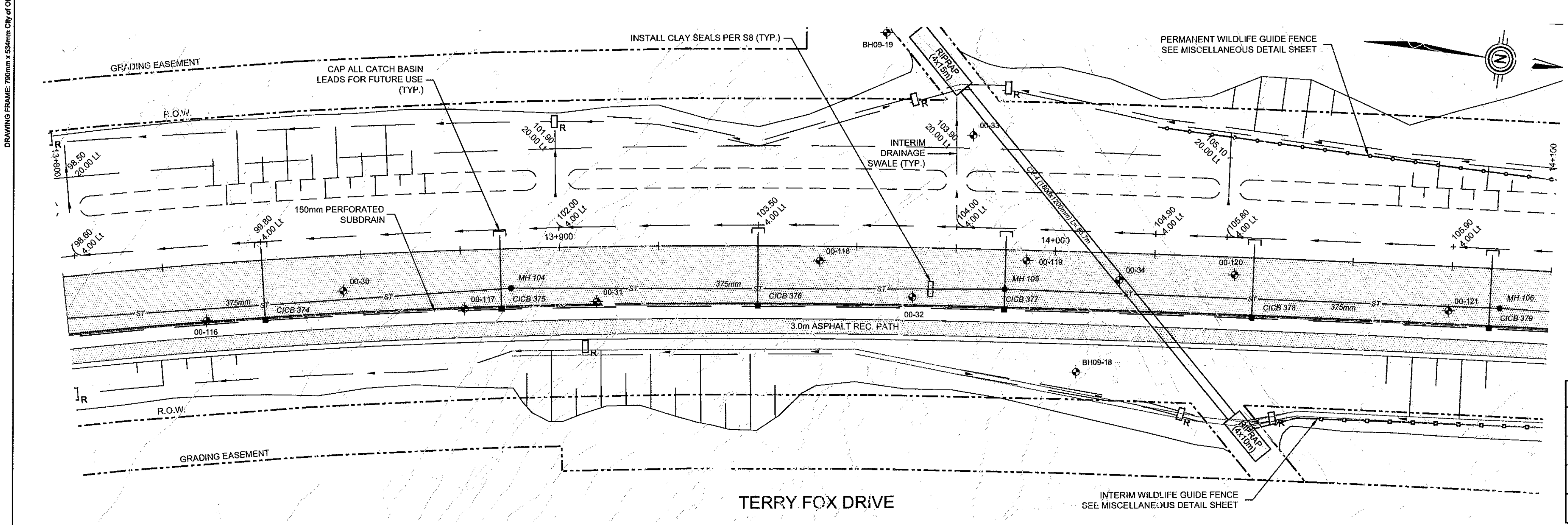

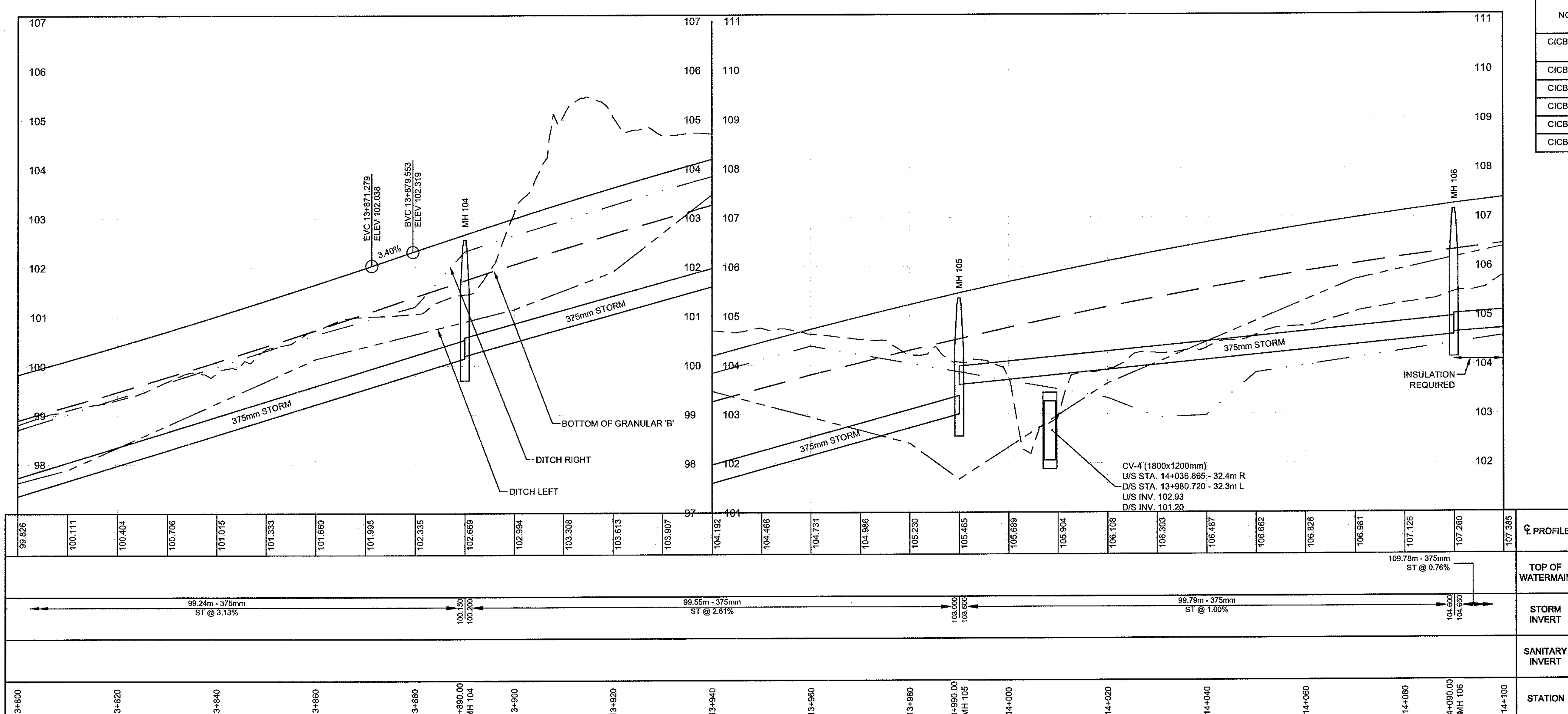

TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

Ottawa

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 13+800 TO STA. 14+100

Contract No. ISB09-5123 | Dwg. No. 026
Sheet 026 of 101
Asset No.
Asset Group

R.HOLDER, P.ENG. — *Manager-Construction Services West*
S.STODDARD, P.ENG. — *Senior Project Engineer*

Des. R.J.G. Chk'd. B.G.H.
Dwn. R.S.S. Chk'd. B.G.H.
Utility Circ. No. Index No.
Const. Inspector

Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON PROVINCE OF ONTARIO

NOTE:
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DILLON CONSULTING

REVISIONS No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 104	13+890	8.00 Rt.	ST	701.010	S24.1	102.562	100.20	100.15
MH 105	13+990	8.00 Rt.	ST	701.010 WITH DROP PIPE	S24.1	105.357	103.60	103.00
MH 106	14+090	8.00 Rt.	ST	701.010	S24.1	107.153	104.65	104.60

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 374	13+840.0	11.6 Rt.	ST	705.010	S22	100.77	99.52
CICB 375	13+888.0	11.6 Rt.	ST	705.010	S22	102.42	101.17
CICB 376	13+940.0	11.6 Rt.	ST	705.010	S22	104.01	102.76
CICB 377	13+990.0	11.6 Rt.	ST	705.010	S22	105.29	104.04
CICB 378	14+040.0	11.6 Rt.	ST	705.010	S22	106.31	105.06
CICB 379	14+088.0	11.6 Rt.	ST	705.010	S22	107.05	105.80

GENERAL NOTES:

1. CITY OF OTTAWA STANDARD DRAWINGS GOVERN CONSTRUCTION AND INSTALLATION UNLESS OTHERWISE INDICATED.
2. PIPE MATERIALS AND APPURTENANCES FOR SEWERS, WATERMAINS, AND LATERALS AS PER CITY OF OTTAWA MATERIAL SPECIFICATIONS.
3. STORM SEWER MAINTENANCE HOLE COVER PER S24.1 UNLESS OTHERWISE NOTED.
4. SINGLE CATCH BASINS AS PER OPSD 705.010 WITH MINIMUM PIPE SIZE OF 200mm DIA. @ 1.0% MIN. & 8.0% MAX. DOUBLE CATCH BASINS AND DITCH INLET CATCH BASINS PIPE SIZE OF 250mm DIA. @ 1.0% MIN. & 8.0% MAX. UNLESS OTHERWISE NOTED.
5. PRECAST CONCRETE ADJUSTMENT UNITS FOR MAINTENANCE HOLES AND CATCH BASINS AS PER OPSD 704.010.
6. RIGID BOARD INSULATION SHALL BE USED WHERE STORM SEWER PIPE DEPTH IS LESS THAN 2.0 METERS.
7. ALL UNDERGROUND PLANT SHOWN IN APPROXIMATE LOCATION ONLY AS PER RECORDS. PLANT TO BE LOCATED PRIOR TO CONSTRUCTION. CONTRACTOR TO CHECK, VERIFY, AND BE RESPONSIBLE FOR ALL UNDERGROUND SERVICES AND UTILITIES.
8. CONTRACTOR TO CONTACT UTILITIES FOR LOCATIONS AND TO COORDINATE RELOCATION OF EXISTING UTILITIES.
9. ALL CONNECTION POINTS TO EXISTING STORM SEWER, CONTRACTOR TO VERIFY EXISTING INVERTS PRIOR TO INSTALLATION OF NEW PIPE AND CATCH BASINS, TO ALLOW FOR ADJUSTMENTS IN SLOPE IF REQUIRED.
10. SEE MISCELLANEOUS DETAILS FOR CULVERT SKYLIGHT LOCATIONS AND DETAILS.
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    CICB - DENOTES CURB INLET CATCH BASIN
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    DICBMH - DENOTES DITCH INLET CATCH BASIN MANHOLE
    OGS - DENOTES OIL-GRIT SEPARATOR (SEE DWG. 094)

ISB09-5123-026

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ISB09-5123-027

TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD

PHASE TWO

Ottawa

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 14+100 TO STA. 14+400

R.HOLDER, P.ENG. Manager-Construction Services West

S.STODDARD, P.ENG. Senior Project Engineer

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON PROVINCE OF ONTARIO

Contract No.	ISB09-5123
Dwg. No.	027
Sheet	027 of 101
Asset No.	
Asset Group	
Des.	R.J.G.
Chk'd.	B.G.H.
Dwn.	R.S.S.
Chk'd.	B.G.H.
Utility Circ. No.	
Index No.	
Const. Inspector	
Scale:	HORIZONTAL 0m 5 10 20; 0m 1 2 VERTICAL

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DILLON CONSULTING

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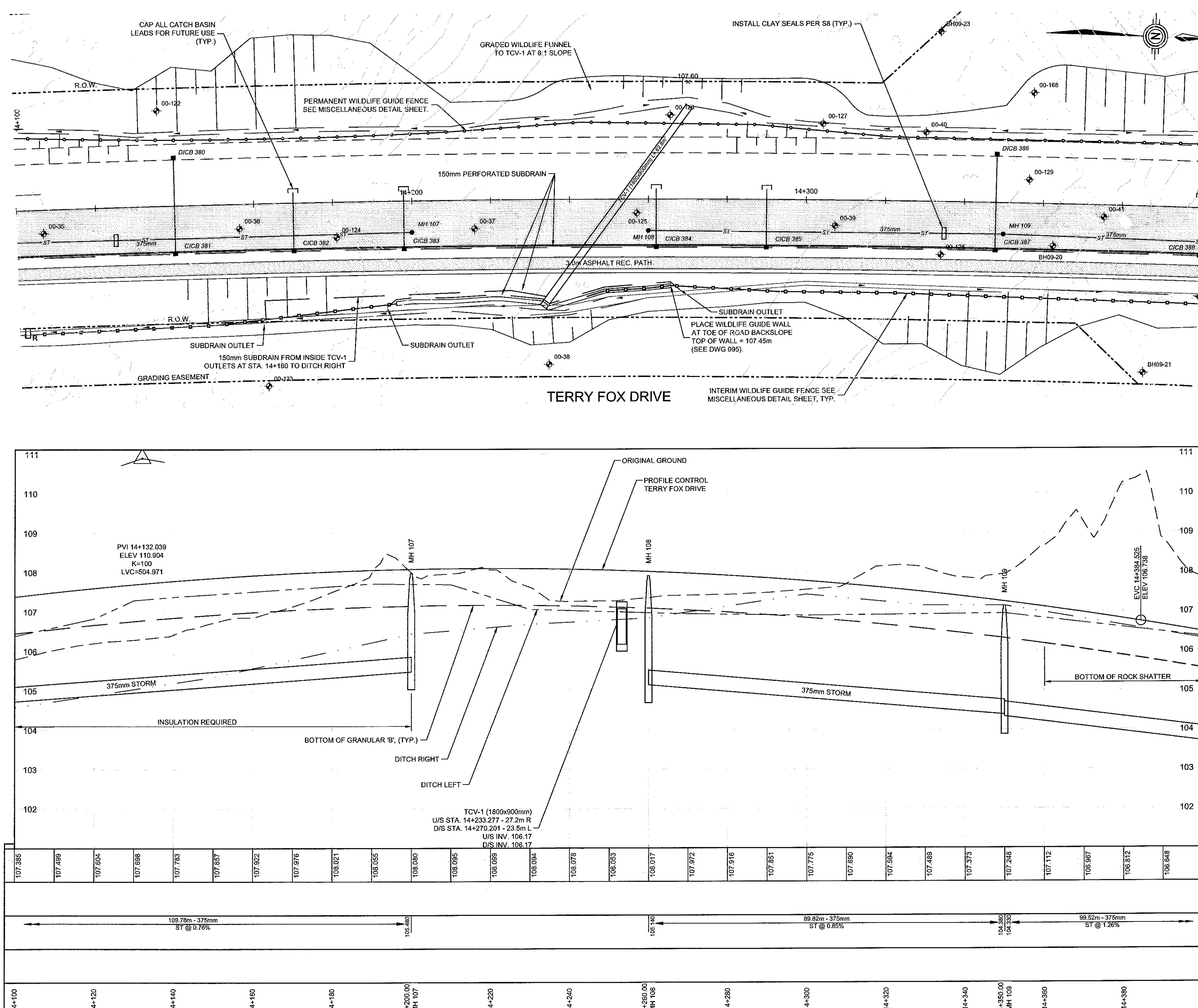
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 107	14+200	8.00 Rt.	ST	701.010	S24.1	107.973		105.48
MH 108	14+260	8.00 Rt.	ST	701.010	S24.1	107.910		105.14
MH 109	14+350	8.00 Rt.	ST	701.010	S24.1	107.141	104.38	104.33

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
DICB 380	14+140.0	12.2 Lt.	ST	705.030	403.01 (4:1)	106.56	105.46
CICB 381	14+140.0	11.6 Rt.	ST	705.010	S22	107.60	106.35
CICB 382	14+170.0	11.6 Rt.	ST	705.010	S22	107.80	106.55
CICB 383	14+198.0	11.6 Rt.	ST	705.010	S22	107.90	106.65
CICB 384	14+262.0	11.6 Rt.	ST	705.010	S22	107.83	106.58
CICB 385	14+290.0	11.6 Rt.	ST	705.010	S22	107.67	106.42
DICB 386	14+348.0	12.2 Lt.	ST	705.030	403.01 (4:1)	106.19	105.09
CICB 387	14+348.0	11.6 Rt.	ST	705.010	S22	107.09	105.84
CICB 388	14+400.0	11.6 Rt.	ST	705.010	S22	106.30	105.05



GENERAL NOTES:

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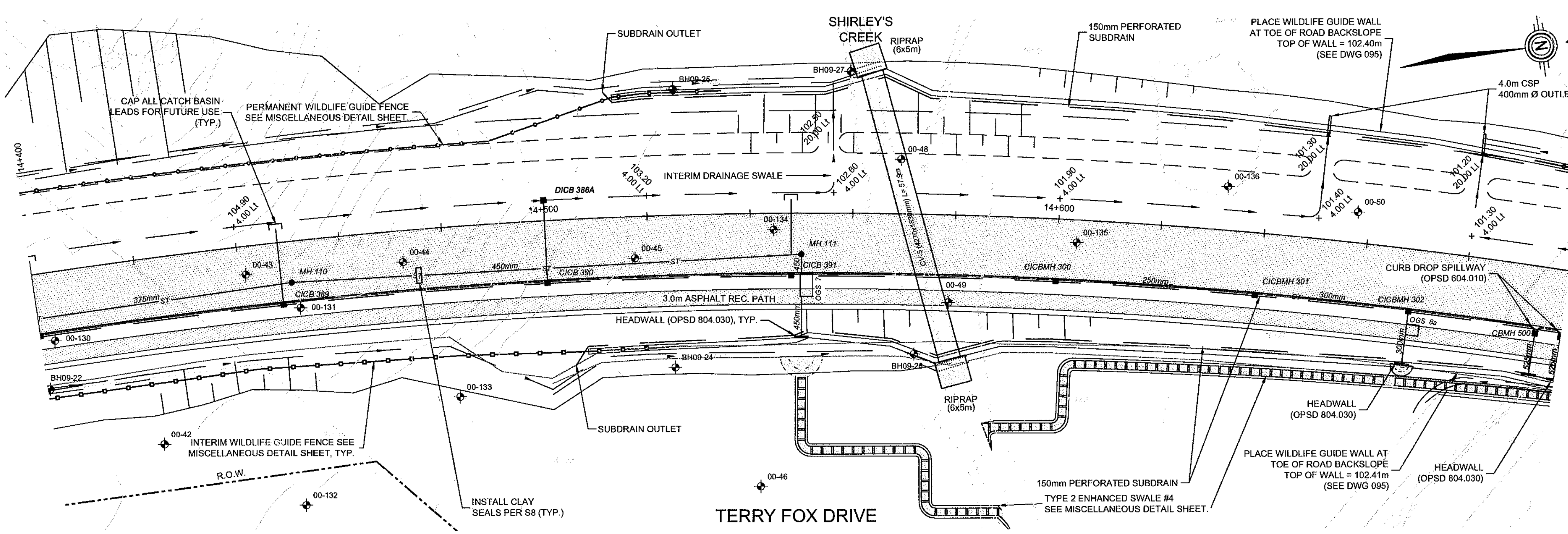
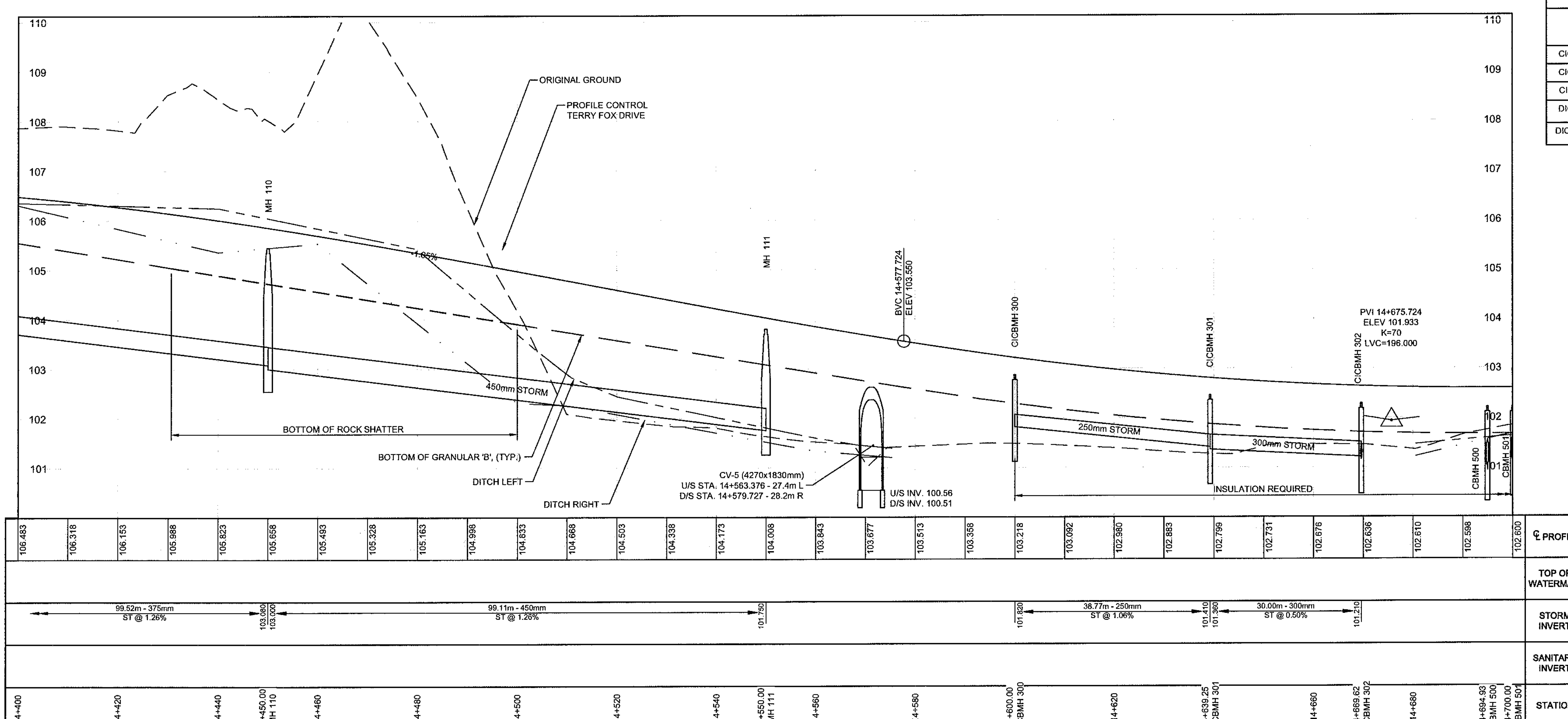
ISB09-5123-028





TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD

PHASE TWO

Ottawa

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 14+400 TO STA. 14+700

Contract No. ISB09-5123	Dwg. No. 028
Sheet 028 of 101	
Asset No.	
Asset Group	
Des. R.J.G.	Chk'd. B.G.H.
Dwn. R.S.S.	Chk'd. B.G.H.
Utility Circ. No.	Index No.
Const. Inspector	

Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

LICENSED PROFESSIONAL ENGINEER
B.G. HUSTON
PROVINCE OF ONTARIO

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DILLON CONSULTING

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MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 110	14+450	8.00 Rt.	ST	701.010	S24.1	105.338	103.08	103.00
MH 111	14+550	8.00 Rt.	ST	701.010	S24.1	103.488	101.75	101.71
CICBMH 300	14+600	11.60 Rt.	ST	701.010	S22	102.869		101.82
CICBMH 301	14+639.3	11.60 Rt.	ST	701.010	S22	102.457	101.41	101.36
CICBMH 302	14+669.6	11.60 Rt.	ST	701.010	S22	102.288	101.21	101.16

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 389	14+448.0	11.6 Rt.	ST	705.010	S22	105.34	104.09
CICB 390	14+500.0	11.6 Rt.	ST	705.010	S22	104.48	103.23
CICB 391	14+548.0	11.6 Rt.	ST	705.010	S22	103.69	102.44
DICB 500	14+694.9	12.6 Rt.	ST	705.040	403.01 (A) 4:1	102.212	101.01
DICB 386A	14+500.0	4.0 Lt.	ST	705.040	403.01 (A) 4:1	103.60	102.50

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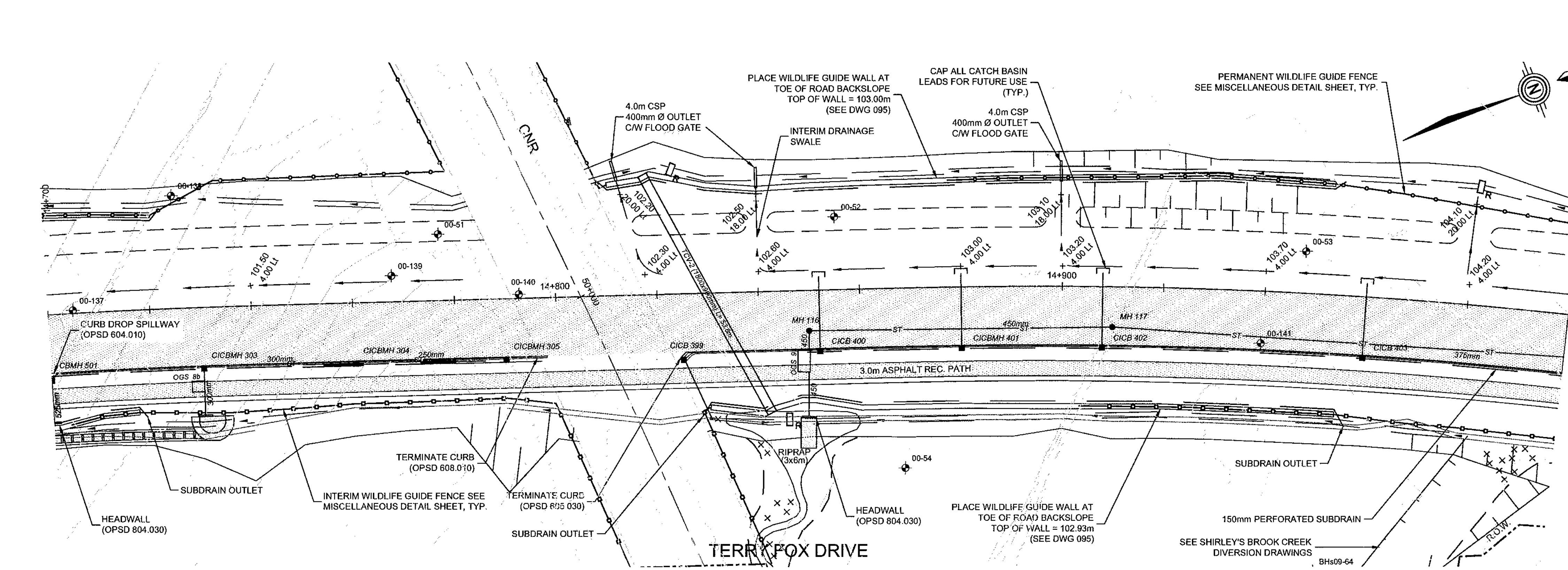

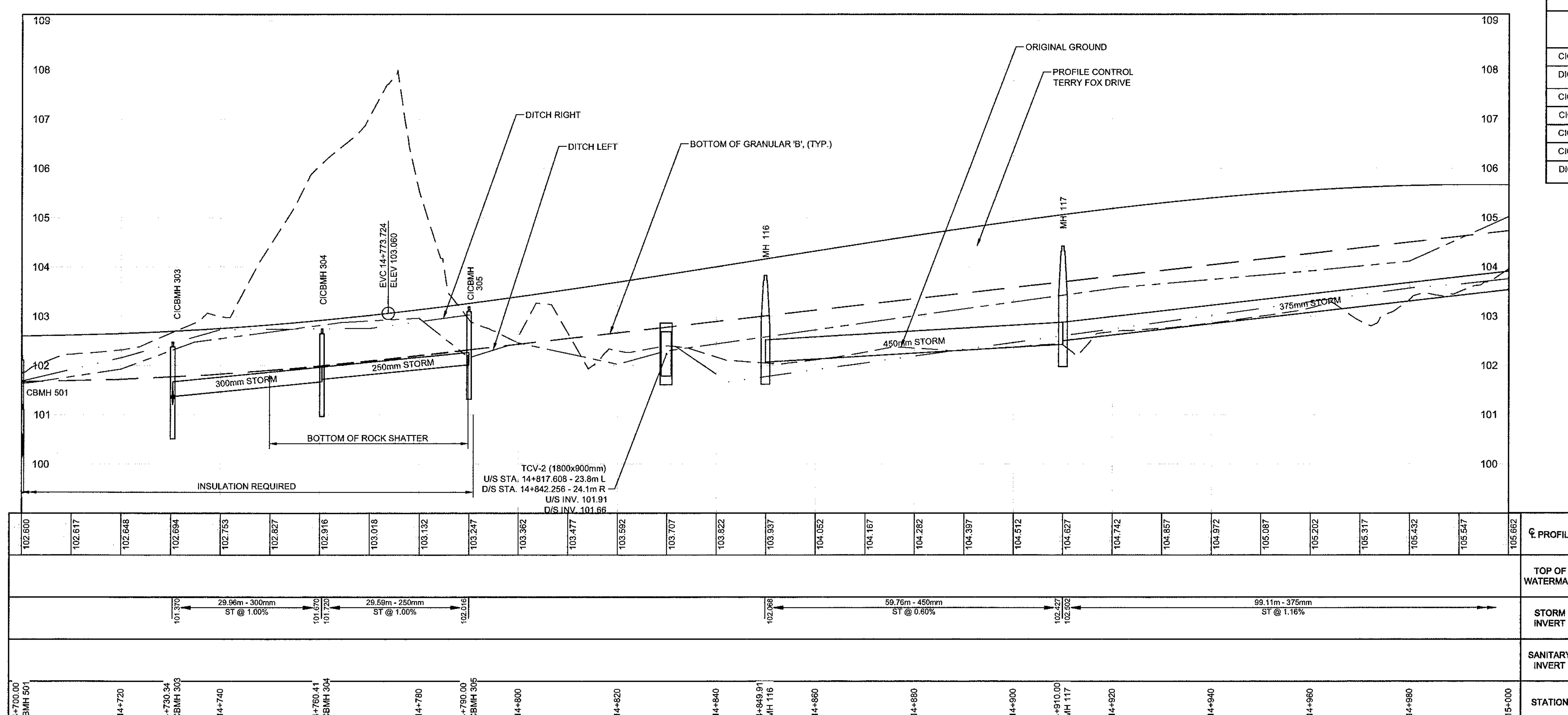

TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD

PHASE TWO

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 14+700 TO STA. 15+000

Contract No. ISB09-5123 | Dwg. No. 029

Sheet 029 of 101

Asset No.

Asset Group

R.HOLDER, P.ENG. — *Manager-Construction Services West*

S.STODDARD, P.ENG. — *Senior Project Engineer*

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON PROVINCE OF ONTARIO

Des. R.J.G. | Chk'd. B.G.H.
Dwn. R.S.S. | Chk'd. B.G.H.
Utility Circ. No. | Index No.
Const. Inspector

Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

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REVISIONS

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MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 116	14+849.9	8.00 Rt.	ST	701.010	S24.1	103.829	102.07	102.07
MH 117	14+910	8.00 Rt.	ST	701.010	S24.1	104.424	102.50	102.43
CICBMH 303	14+730.3	11.60 Rt.	ST	701.010	S22	102.476	101.37	101.21
CICBMH 304	14+760.4	11.60 Rt.	ST	701.010	S22	102.744	101.72	101.67

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 305	14+790.0	11.6 Rt.	ST	705.010	S22	103.19	102.02
DICB 399	14+825.0	12.6 Rt.	ST	705.040	403.01 (A) 4:1	103.50	102.29
CICB 400	14+852.0	11.6 Rt.	ST	705.010	S22	103.78	102.53
CICB 401	14+880.0	11.6 Rt.	ST	705.010	S22	104.05	102.80
CICB 402	14+908.0	11.6 Rt.	ST	705.010	S22	104.26	103.01
CICB 403	14+960.0	11.6 Rt.	ST	705.010	S22	104.86	103.61
DICB 501	14+700.0	12.6 Rt.	ST	705.040	403.01 (A) 4:1	102.211	101.11

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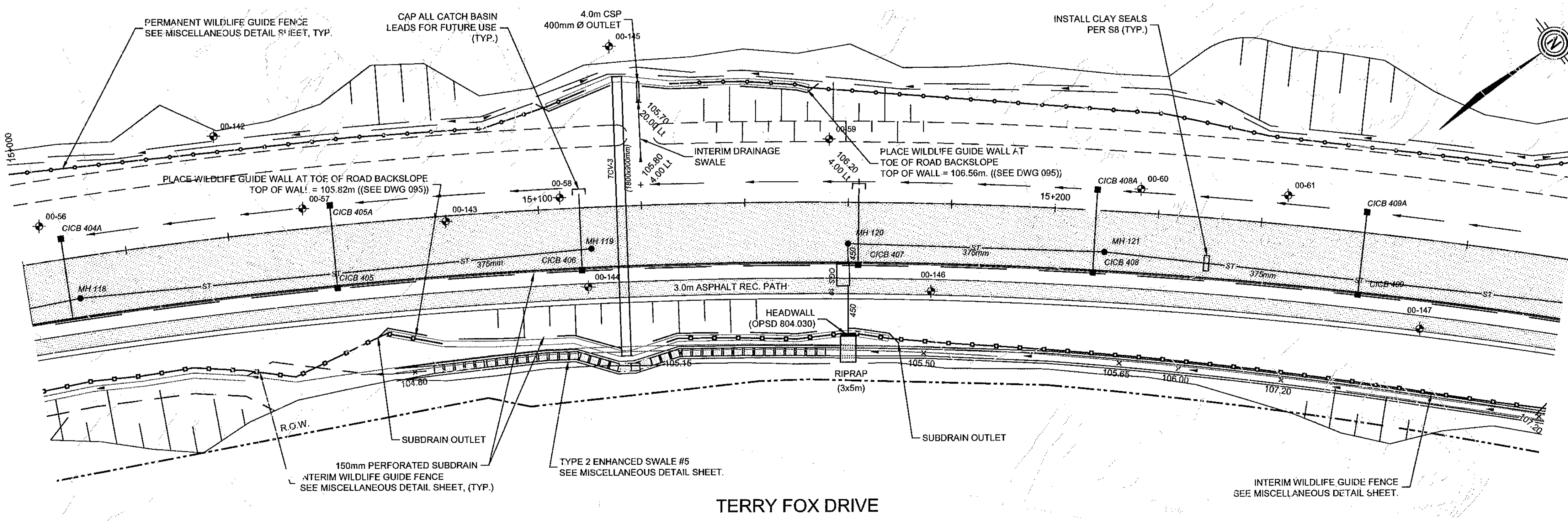
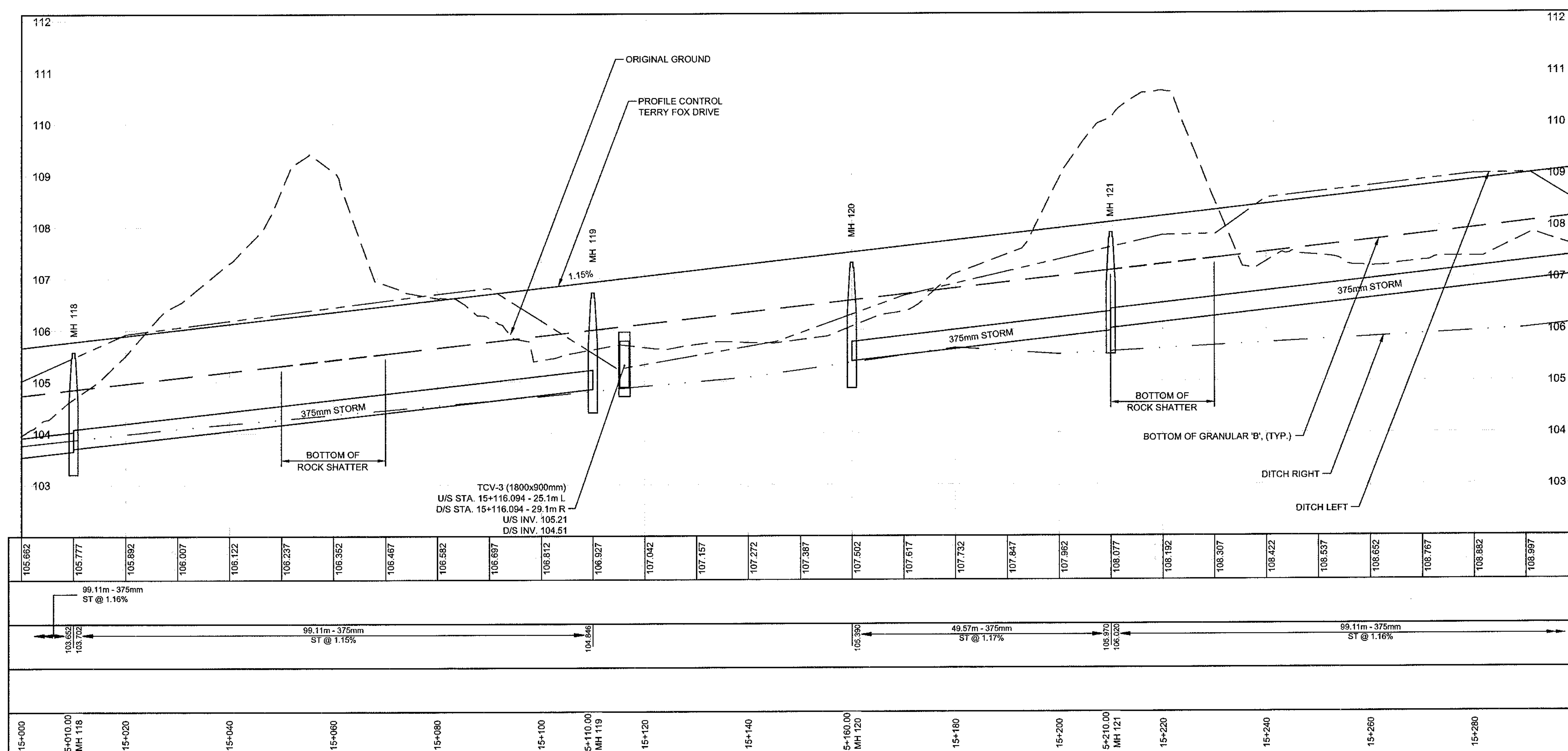
TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 15+000 TO STA. 15+300





Contract No.	Dwg. No.
ISB09-5123	030

Sheet 030 of 101

Asset No.

Asset Group

Des.	R.J.G.	Chk'd.	B.G.H.
Dwn.	R.S.S.	Chk'd.	B.G.H.
Utility Circ. No.		Index No.	

Const. Inspector

Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

R.HOLDER, P.ENG.
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NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 118	15+010	8.00 Rt.	ST	701.010	S24.1	105.574	103.70	103.65
MH 119	15+110	8.00 Rt.	ST	701.010	S24.1	106.724		104.85
MH 120	15+160	8.00 Rt.	ST	701.010	S24.1	107.299	105.39	105.32
MH 121	15+210	8.00 Rt.	ST	701.010	S24.1	107.874	106.02	105.97

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 404	15+008.0	11.6 Rt.	ST	705.010	S22	105.41	104.16
CICB 405	15+060.0	11.6 Rt.	ST	705.010	S22	106.01	104.76
CICB 406	15+108.0	11.6 Rt.	ST	705.010	S22	106.56	105.31
CICB 407	15+162.0	11.6 Rt.	ST	705.010	S22	107.19	105.94
CICB 408	15+208.0	11.6 Rt.	ST	705.010	S22	107.71	106.46
CICB 409	15+260.0	11.6 Rt.	ST	705.010	S22	108.31	107.06
DICB 406A	15+008.0	4.0 Lt.	ST	705.040	403.01 (A) 4:1	104.70	103.80

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7. ALL UNDERGROUND PLANT SHOWN IN APPROXIMATE LOCATION ONLY AS PER RECORDS. PLANT TO BE LOCATED PRIOR TO CONSTRUCTION. CONTRACTOR TO CHECK, VERIFY, AND BE RESPONSIBLE FOR ALL UNDERGROUND SERVICES AND UTILITIES.
8. CONTRACTOR TO CONTACT UTILITIES FOR LOCATIONS AND TO COORDINATE RELOCATION OF EXISTING UTILITIES.
9. ALL CONNECTION POINTS TO EXISTING STORM SEWER, CONTRACTOR TO VERIFY EXISTING INVERTS PRIOR TO INSTALLATION OF NEW PIPE AND CATCH BASINS, TO ALLOW FOR ADJUSTMENTS IN SLOPE IF REQUIRED.
10. SEE MISCELLANEOUS DETAILS FOR CULVERT SKYLIGHT LOCATIONS AND DETAILS.
11. OFFSETS AND ELEVATIONS SHOWN FOR CICB ARE MEASURED TO THE EDGE OF PAVEMENT.
12. CB - DENOTES SINGLE CATCH BASIN
    CICB - DENOTES CURB INLET CATCH BASIN
    DCICB - DENOTES DOUBLE CURB INLET CATCH BASIN
    DICBMH - DENOTES DITCH INLET CATCH BASIN MANHOLE
    OGS - DENOTES OIL-GRIT SEPARATOR (SEE DWG. 094)

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

ISB09-5123-030

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TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD

PHASE TWO

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 15+300 TO STA. 15+600

Ottawa

Contract No.	ISB09-5123
Dwg. No.	031
Sheet	031 of 101
Asset No.	
Asset Group	
Des.	R.J.G.
Chk'd.	B.G.H.
Dwn.	R.S.S.
Chk'd.	B.G.H.
Utility Circ. No.	
Index No.	
Const. Inspector	
Scale:	HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON PROVINCE OF ONTARIO

NOTE:
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DILLON CONSULTING

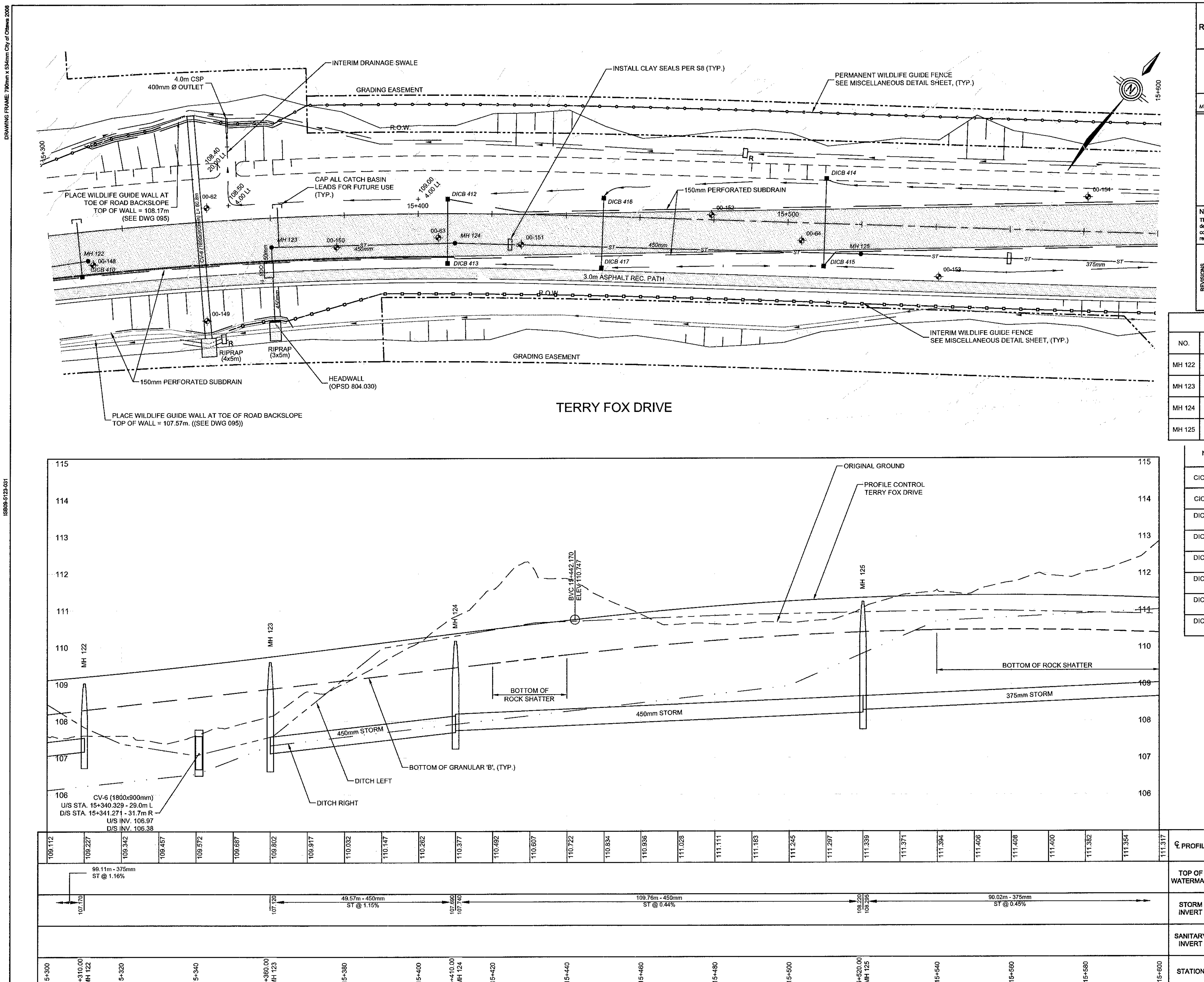
REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
MH 122	15+310	8.00 Rt.	ST	701.010	S24.1	109.024		107.17
MH 123	15+360	8.00 Rt.	ST	701.010	S24.1	109.599	107.12	107.08
MH 124	15+410	8.00 Rt.	ST	701.010	S24.1	110.174	107.74	107.69
MH 125	15+520	8.00 Rt.	ST	701.010	S24.1	111.232	108.30	108.22

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
CICB 410	15+308.0	11.6 Rt.	ST	705.010	S22	108.87	107.62
CICB 411	15+362.0	11.6 Rt.	ST	705.010	S22	109.48	108.23
DICB 412	15+408.0	4.0 Lt.	ST	705.030	403.01 (4:1)	109.00	108.00
DICB 413	15+408.0	13.5 Rt.	ST	705.030	403.01 (4:1)	109.60	108.40
DICB 414	15+510.0	12.3 Lt.	ST	705.030	403.01 (4:1)	109.13	108.70
DICB 415	15+510.0	11.6 Rt.	ST	705.030	403.01 (4:1)	110.00	108.80
DICB 416	15+450.0	5.0 Lt.	ST	705.030	403.01 (4:1)	109.90	108.20
DICB 417	15+450.0	14.5 Rt.	ST	705.030	403.01 (4:1)	109.70	108.20



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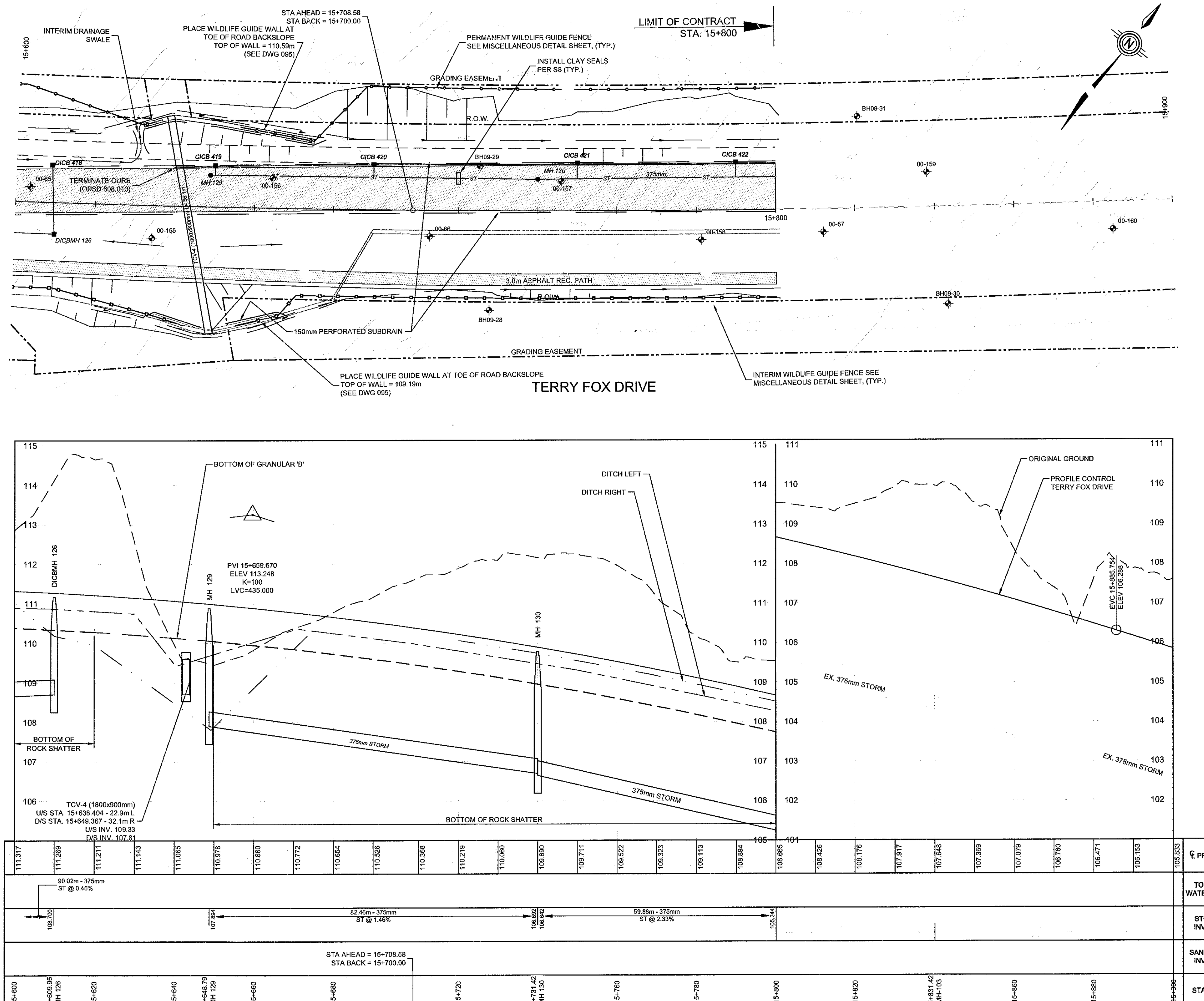
ISB09-5123-031

ISB09-5123-032



TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

GRADING AND DRAINAGE
TERRY FOX DRIVE
STA. 15+600 TO STA. 15+900

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

LICENSED PROFESSIONAL ENGINEER
B.G. HUSTON
PROVINCE OF ONTARIO

Ottawa

Contract No. ISB09-5123
Dwg. No. 032
Sheet 032 of 101
Asset No.
Asset Group
Des. R.J.G. Chk'd. B.G.H.
Dwn. R.S.S. Chk'd. B.G.H.
Utility Circ. No. Index No.
Const. Inspector
Scale: HORIZONTAL 0m 5 10 20; 0m 1 2 VERTICAL

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DILLON CONSULTING

REVISIONS No.	Description	By	Date (dd/mm/yy)
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4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

MAINTENANCE HOLE TABLE

NO.	STATION	OFFSET	TYPE	STRUCTURE	GRATE TYPE	GRATE ELEV.	INVERT IN	INVERT OUT
DICBMH 126	15+610	8.00 Rt.	ST	701.010	403.01 (A) 4:1	110.10	108.80	108.70
MH 129	15+648.8	8.09 Lt.	ST	701.010	S24.1	110.98		107.89
MH 130	15+731.4	8.00 Lt.	ST	701.010	S24.1	109.96	106.69	106.64

CATCH BASIN TABLE

NO.	STATION	OFFSET	TYPE	STRUCT.	GRATE TYPE	GRATE ELEV.	INVERT OUT
DICB 418	15+609.0	9.5 Lt.	ST	705.030	403.01 (4:1)	110.00	109.00
CICB 419	15+650.0	10.01 Lt.	ST	705.010	S22	110.93	109.68
CICB 420	15+690.0	10.94 Lt.	ST	705.010	S22	110.43	109.68
CICB 421	15+750.0	11.55 Lt.	ST	705.010	S22	109.54	108.29
CICB 422	15+790.0	11.60 Lt.	ST	705.010	S22	108.93	107.68

GENERAL NOTES:

1. CITY OF OTTAWA STANDARD DRAWINGS GOVERN CONSTRUCTION AND INSTALLATION UNLESS OTHERWISE INDICATED.
2. PIPE MATERIALS AND APPURTENANCES FOR SEWERS, WATERMAINS, AND LATERALS AS PER CITY OF OTTAWA MATERIAL SPECIFICATIONS.
3. STORM SEWER MAINTENANCE HOLE COVER PER S24.1 UNLESS OTHERWISE NOTED.
4. SINGLE CATCH BASINS AS PER OPSD 705.010 WITH MINIMUM PIPE SIZE OF 200mm DIA. @ 1.0% MIN. & 8.0% MAX. DOUBLE CATCH BASINS AND DITCH INLET CATCH BASINS PIPE SIZE OF 250mm DIA. @ 1.0% MIN. & 8.0% MAX. UNLESS OTHERWISE NOTED.
5. PRECAST CONCRETE ADJUSTMENT UNITS FOR MAINTENANCE HOLES AND CATCH BASINS AS PER OPSD 704.010.
6. RIGID BOARD INSULATION SHALL BE USED WHERE STORM SEWER PIPE DEPTH IS LESS THAN 2.0 METERS.
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10. SEE MISCELLANEOUS DETAILS FOR CULVERT SKYLIGHT LOCATIONS AND DETAILS.
11. OFFSETS AND ELEVATIONS SHOWN FOR CICB ARE MEASURED TO THE EDGE OF PAVEMENT.
12. CB - DENOTES SINGLE CATCH BASIN
    CICB - DENOTES CURB INLET CATCH BASIN
    DCICB - DENOTES DOUBLE CURB INLET CATCH BASIN
    DICBMH - DENOTES DITCH INLET CATCH BASIN MANHOLE
    OGS - DENOTES OIL-GRIT SEPARATOR (SEE DWG. 094)

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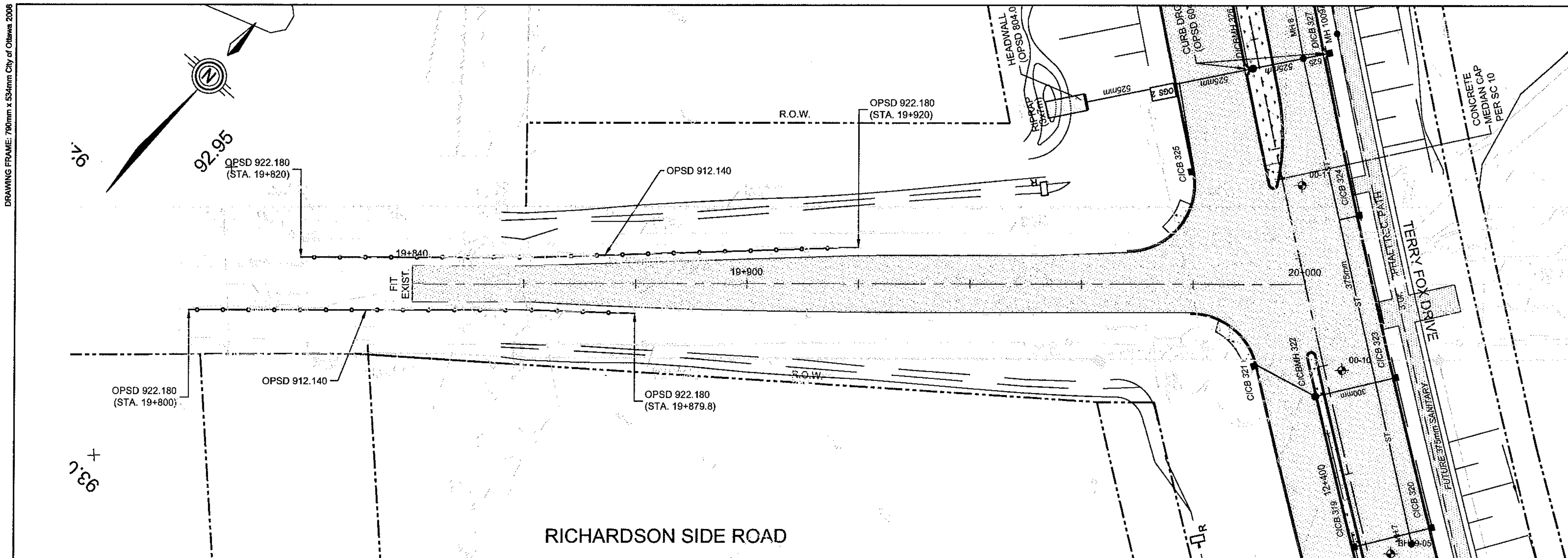

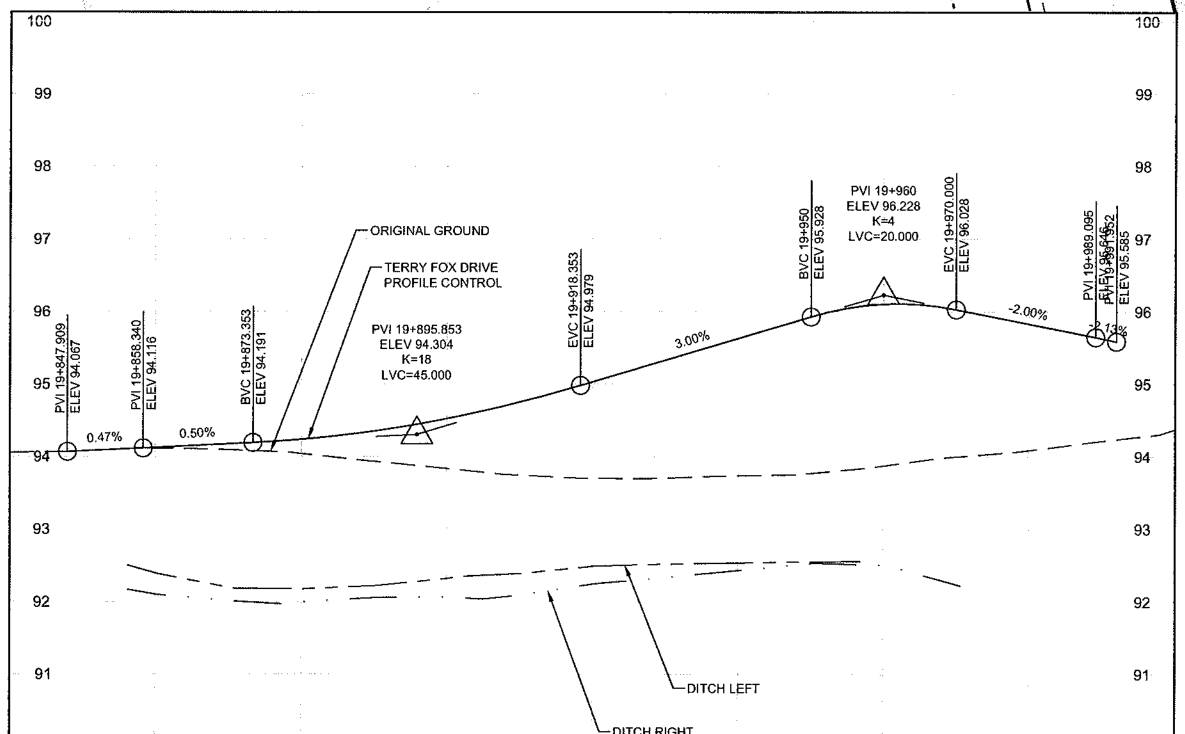

℄ PROFILE	94.077, 94.124, 94.174, 94.237, 94.351, 94.522, 94.748, 95.028, 95.328, 95.628, 95.928, 96.103, 96.028, 95.828, 95.627
TOP OF WATERMAIN	
STORM INVERT	
SANITARY INVERT	
STATION	19+840, 19+860, 19+880, 19+900, 19+920, 19+940, 19+960, 19+980, 20+000

TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

GRADING AND DRAINAGE
RICHARDSON SIDE ROAD
STA. 19+840 TO STA. 20+000

R.HOLDER, P.ENG. *Manager-Construction Services West*	S.STODDARD, P.ENG. *Senior Project Engineer*

LICENSED PROFESSIONAL ENGINEER
B.G. HUSTON
PROVINCE OF ONTARIO

Ottawa

Contract No. ISB09-5123	Dwg. No. 033
Sheet 033 of 101	
Asset No.	
Asset Group	
Des. R.J.G.	Chk'd. B.G.H.
Dwn. R.S.S.	Chk'd. B.G.H.
Utility Circ. No.	Index No.
Const. Inspector	

Scale: HORIZONTAL 0m 5 10 20
0m VERTICAL

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DILLON CONSULTING

REVISIONS

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2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

GENERAL NOTES:

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3. STORM SEWER MAINTENANCE HOLE COVER PER S24.1 UNLESS OTHERWISE NOTED.
4. SINGLE CATCH BASINS AS PER OPSD 705.010 WITH MINIMUM PIPE SIZE OF 200mm DIA. @ 1.0% MIN. & 8.0% MAX. DOUBLE CATCH BASINS AND DITCH INLET CATCH BASINS PIPE SIZE OF 250mm DIA. @ 1.0% MIN. & 8.0% MAX. UNLESS OTHERWISE NOTED.
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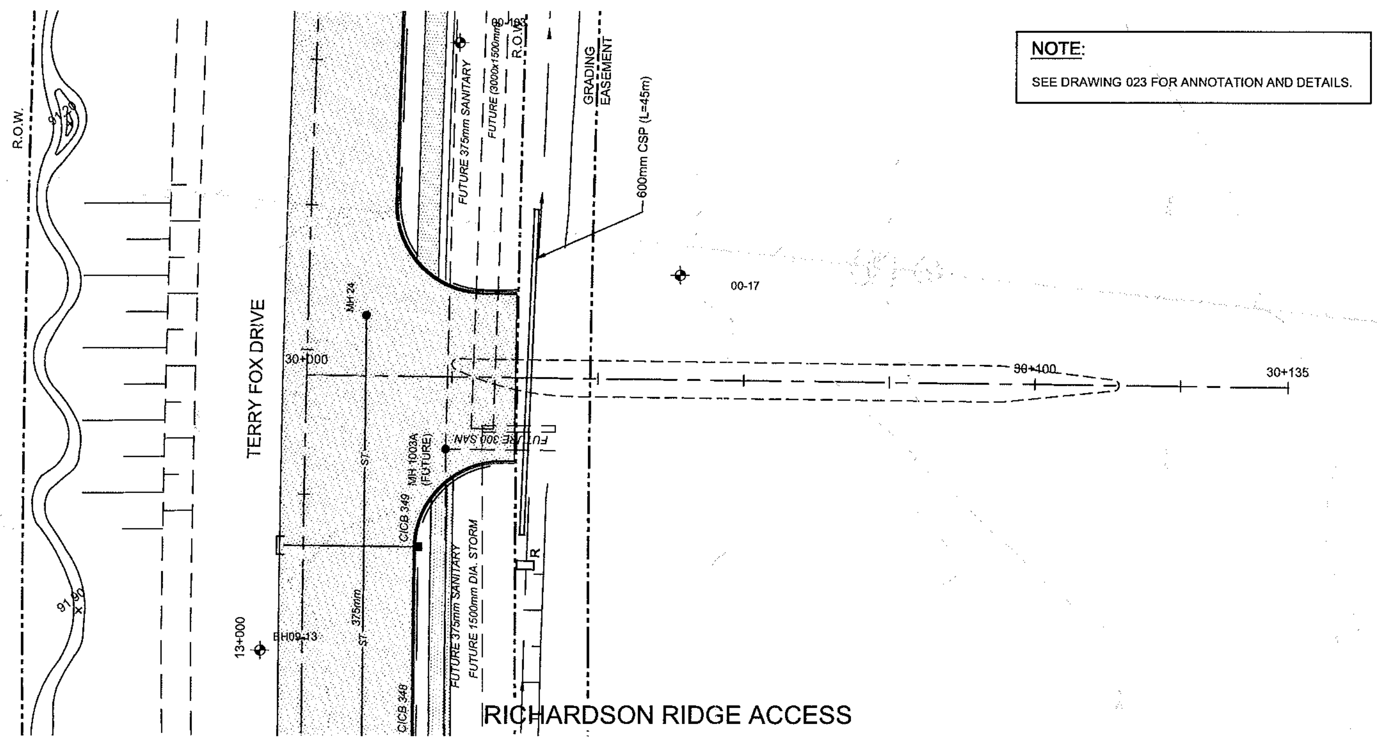
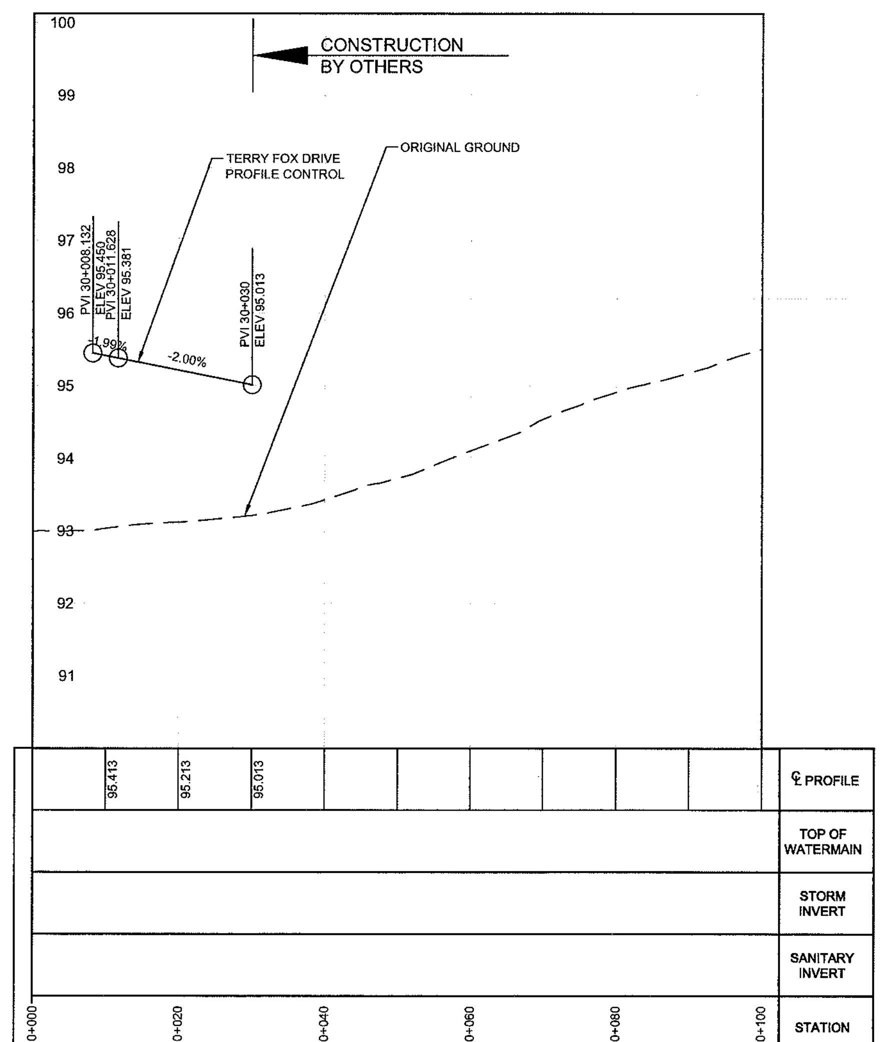
10. PRECAST DITCH INLET CATCH BASIN TYPE 'A' AS PER OPSD 705.030, FRAME AND GRATE AS PER OPSD 403.010, TYPE 'A', 2H:1V.
11. PRECAST DITCH INLET CATCH BASIN TYPE 'A' AS PER OPSD 705.040, FRAME AND GRATE AS PER OPSD 705.010, TYPE 'B', 2H:1V.
12. CB - DENOTES SINGLE CATCH BASIN
    CICB - DENOTES CURB INLET CATCH BASIN
    DCICB - DENOTES DOUBLE CURB INLET CATCH BASIN

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008



NOTE:
SEE DRAWING 023 FOR ANNOTATION AND DETAILS.



TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

Ottawa

GRADING AND DRAINAGE
RICHARDSON RIDGE ROAD
STA. 30+000 TO STA. 30+100

Contract No. ISB09-5123	Dwg. No. 034
Sheet 034 of 101	
Asset No.	
Asset Group	
Des. R.J.G.	Chk'd. B.G.H.
Dwn. R.S.S.	Chk'd. B.G.H.
Utility Circ. No.	Index No.
Const. Inspector	
Scale: HORIZONTAL 0m 5 10 20; 0m VERTICAL	

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON PROVINCE OF ONTARIO

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DILLON CONSULTING

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CICB - DENOTES CURB INLET CATCH BASIN
DCICB - DENOTES DOUBLE CURB INLET CATCH BASIN
DICBMH - DENOTES DITCH INLET CATCH BASIN MANHOLE
OGS - DENOTES OIL-GRIT SEPARATOR (SEE DWG. 094)

ISB09-5123-034

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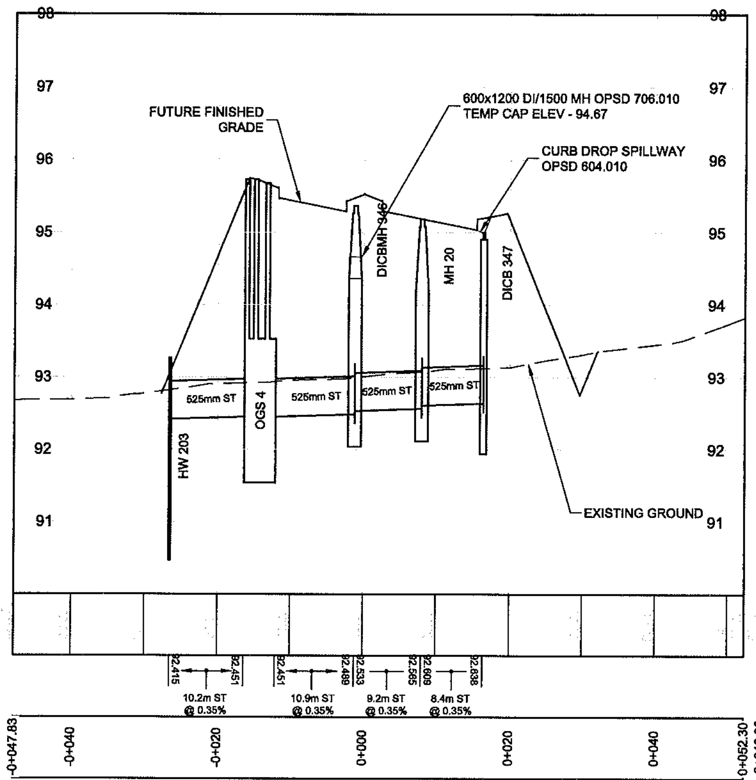
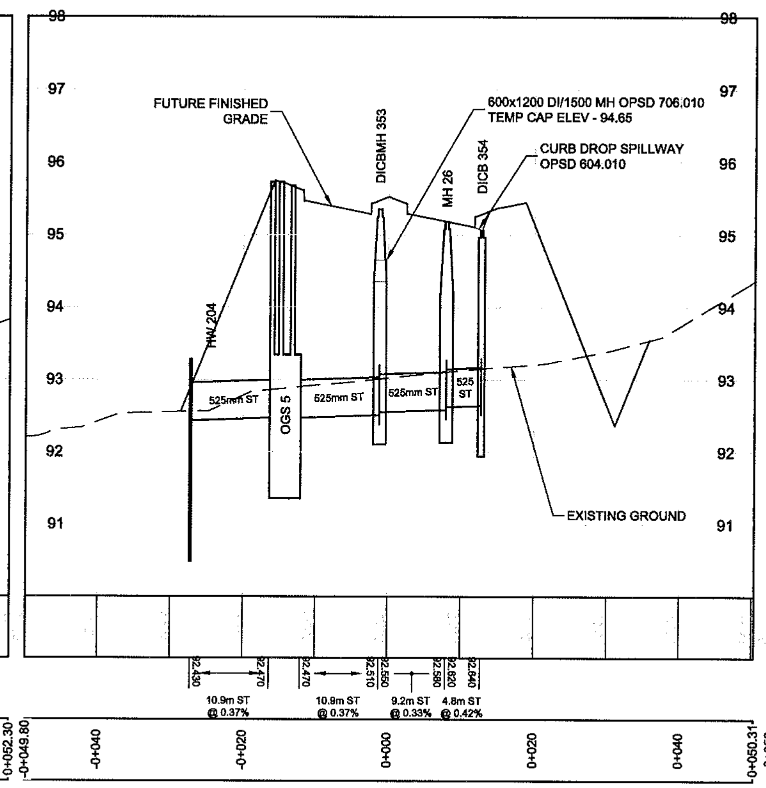
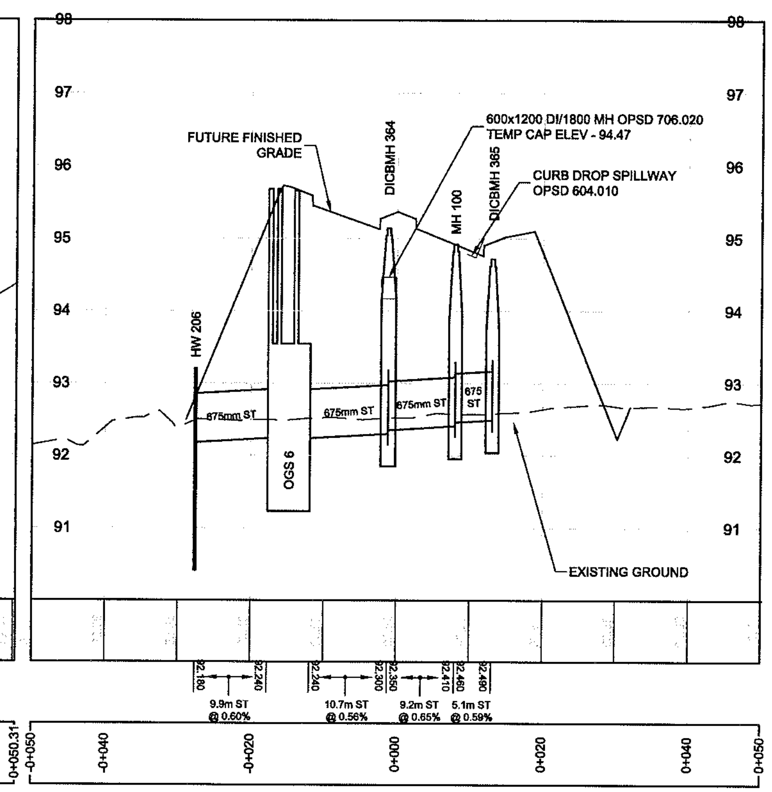
STM Outlet 4



STM Outlet 5



STM Outlet 6



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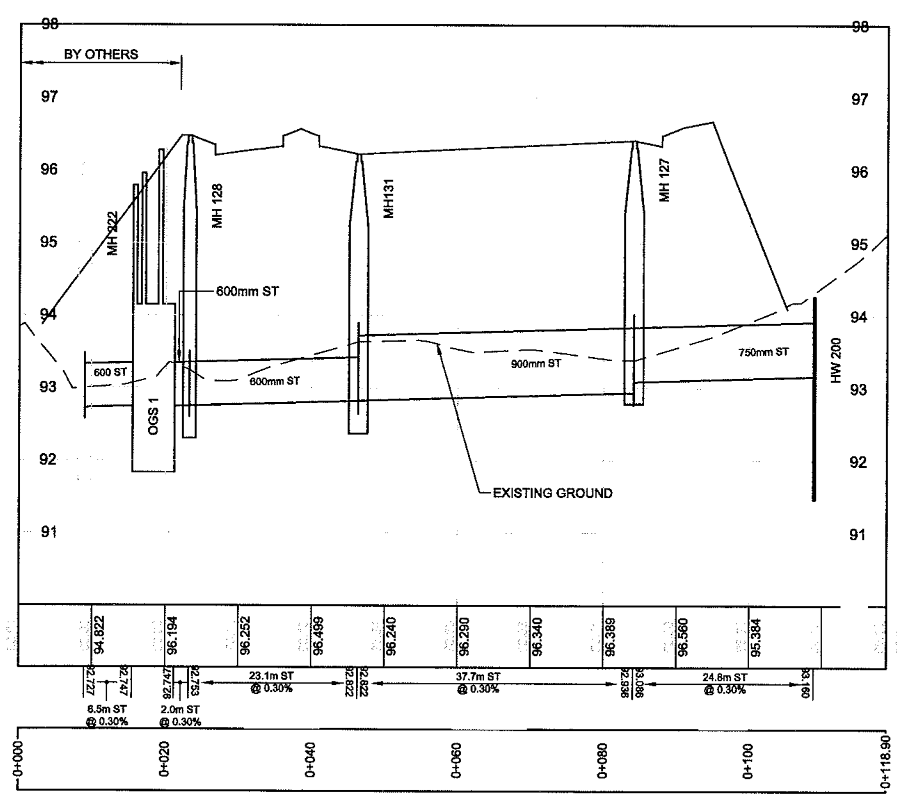

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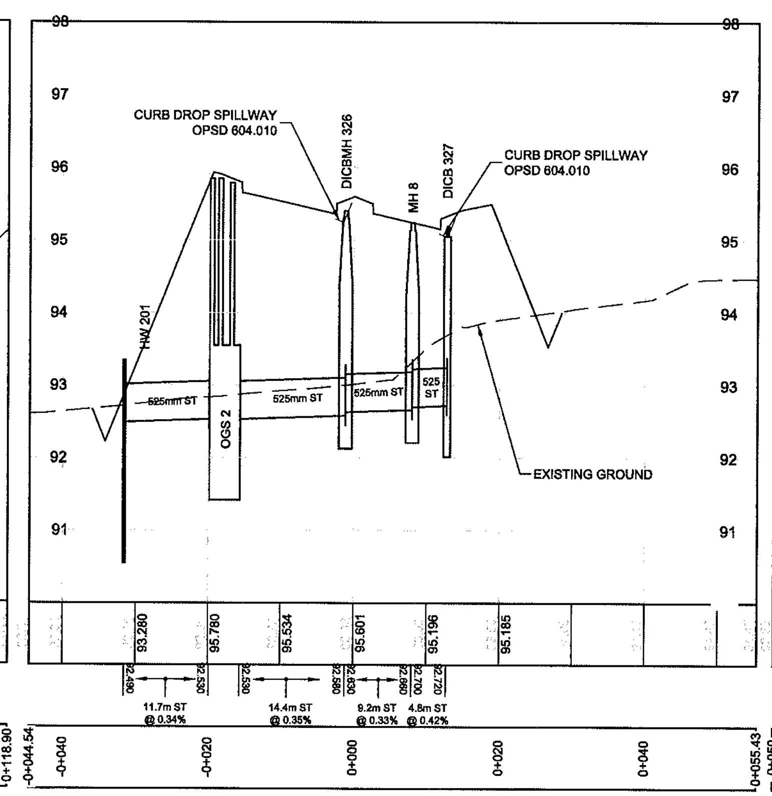
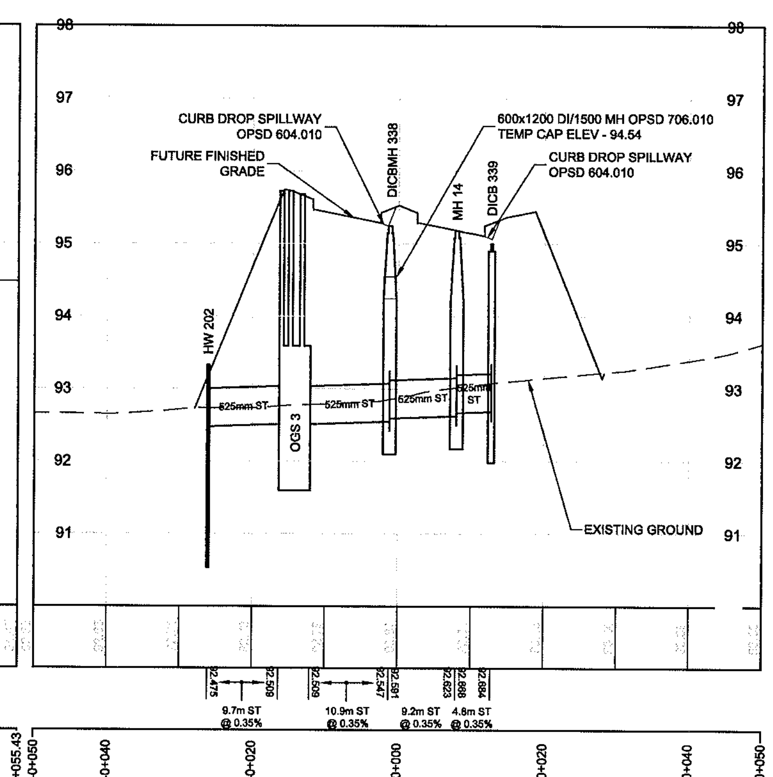


STM Outlet 3



TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

GRADING AND DRAINAGE
TERRY FOX DRIVE
OUTLET PROFILES

Ottawa

Contract No. ISB09-5123 — Dwg. No. 035
Sheet 035 of 101

R.HOLDER, P.ENG. — Manager-Construction Services West
S.STODDARD, P.ENG. — Senior Project Engineer

LICENSED PROFESSIONAL ENGINEER — B.G. HUSTON — PROVINCE OF ONTARIO

Des. R.J.G. Chk'd. B.G.H.
Dwn. R.S.S. Chk'd. B.G.H.
Utility Circ. No. / Index No.
Const. Inspector

Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m 1 2

NOTE:
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DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
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5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

ISB09-5123-035

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TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

GRADING AND DRAINAGE
TERRY FOX DRIVE
OUTLET PROFILES

Ottawa

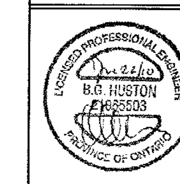
Contract No.	Dwg. No.
ISB09-5123	036

Sheet 036 of 101

Asset No.

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer



Asset Group			
Des.	R.J.G.	Chk'd.	B.G.H.
Dwn.	R.S.S.	Chk'd.	B.G.H.
Utility Circ. No.		Index No.	
Const. Inspector			

Scale:
HORIZONTAL 0m 5 10 20
VERTICAL 0m 1 2

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DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
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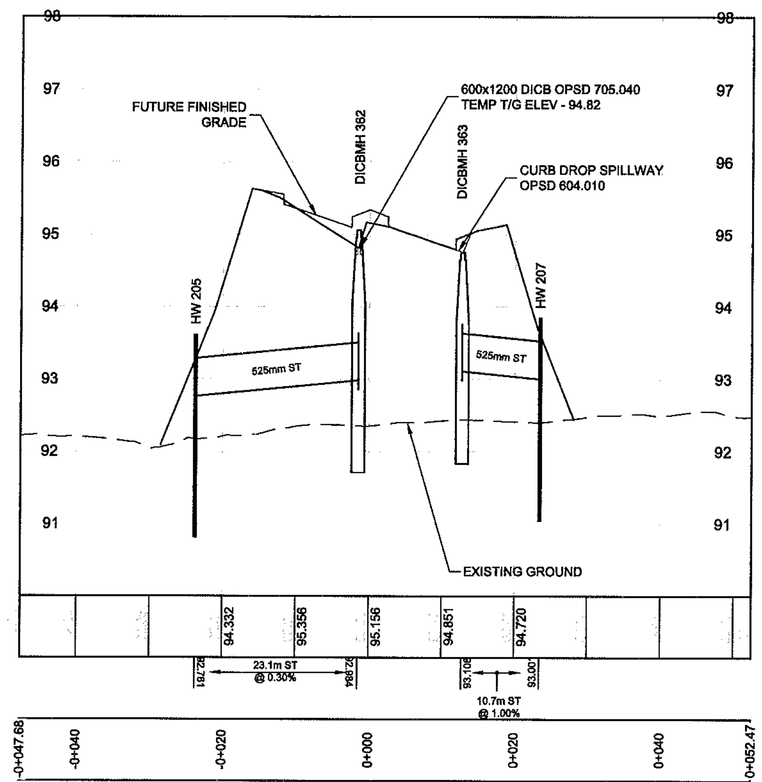
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	ISSUED FOR MOE APPLICATION	M.J.F.	23-06-10

STM Outlet 6 Overflow



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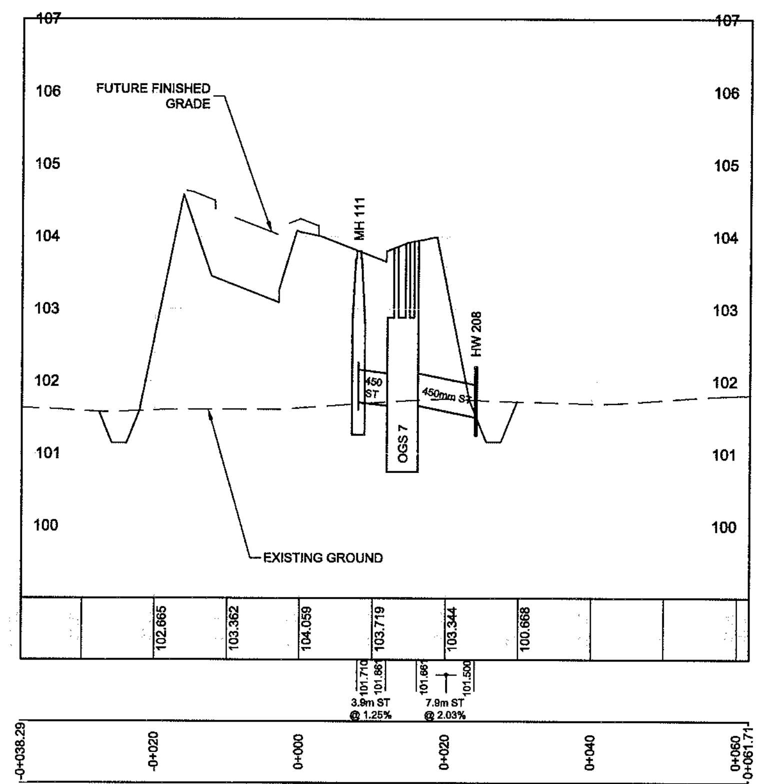
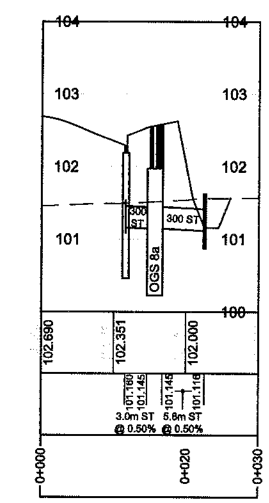
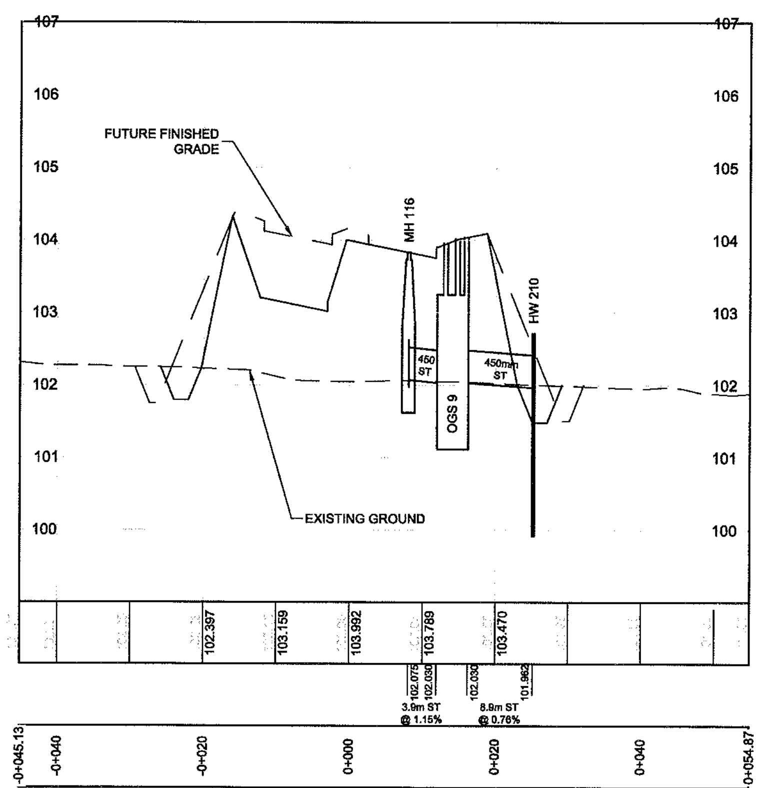


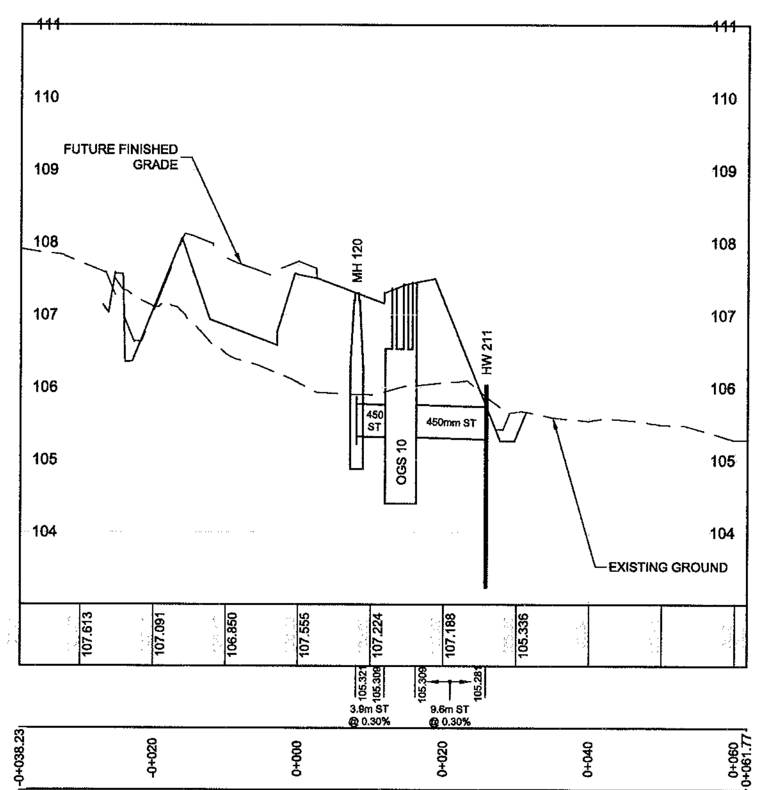
STM Outlet 8a



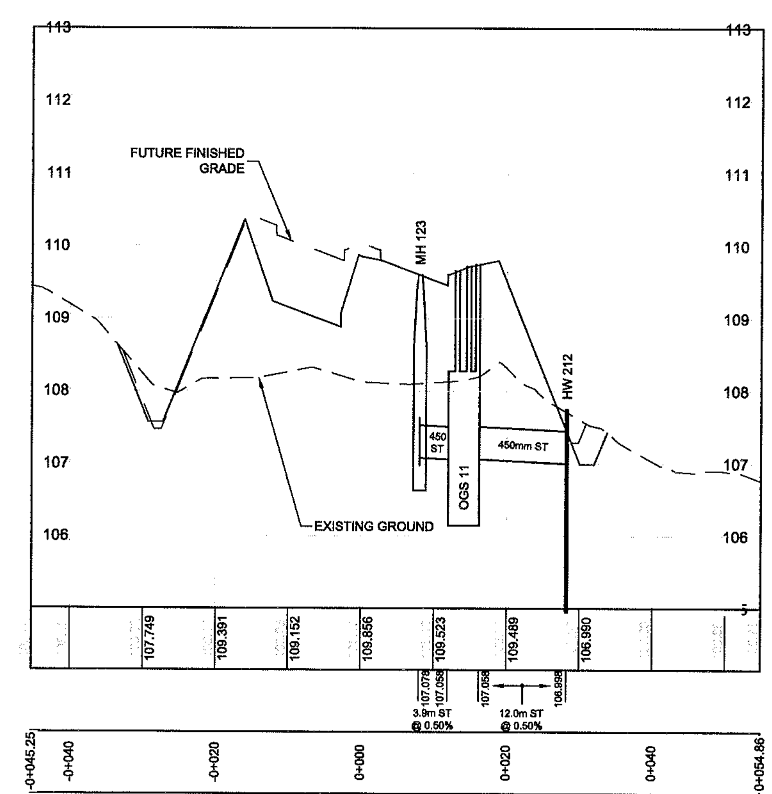
STM Outlet 9



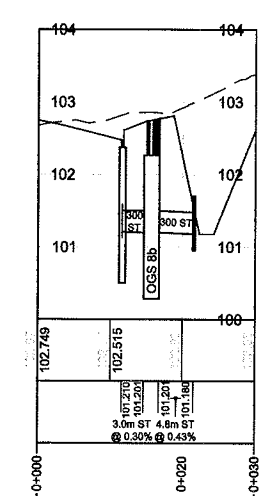
STM Outlet 10



STM Outlet 11



STM Outlet 8b



NOTES:

1. ASPHALT RECREATIONAL PATH TO CONSIST OF:
   40mm SP 12.5 FC1 LEVEL C
   50mm SP19.0 LEVEL C
   300mm GRANULAR 'O'
2. IN SWAMPY AREAS CONSTRUCT EMBANKMENTS PER OPSD 203.010.
3. ALL CURB AND GUTTER SC1.2

TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

TYPICAL SECTIONS

R.HOLDER, P.ENG. — Manager-Construction Services West
S.STODDARD, P.ENG. — Senior Project Engineer

Ottawa

Contract No.	ISB09-5123
Dwg. No.	088
Sheet	088 of 101
Asset No.	
Asset Group	
Des.	R.J.G.
Chk'd.	B.G.H.
Dwn.	R.S.S.
Chk'd.	B.G.H.
Utility Circ. No.	
Index No.	
Const. Inspector	
Scale:	N.T.S.

NOTE:
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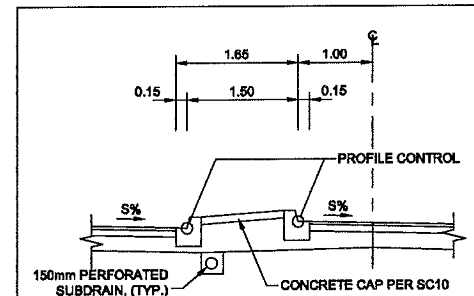
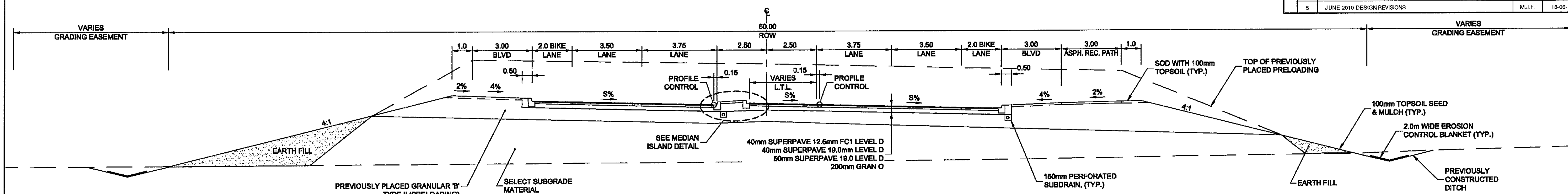
DILLON CONSULTING

REVISIONS

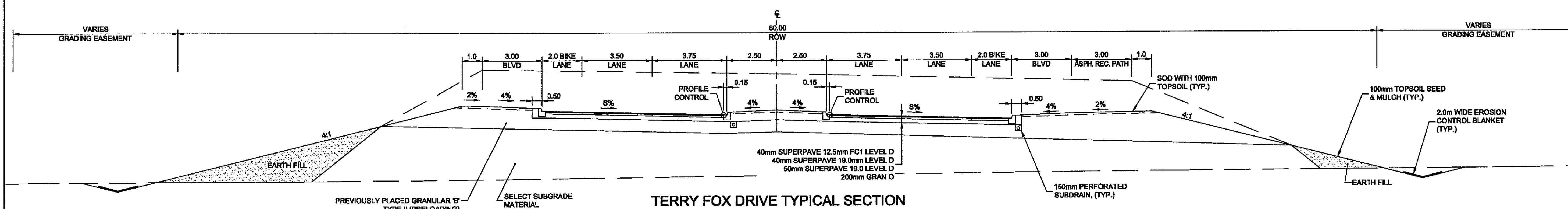
No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	JUNE 2010 DESIGN REVISIONS	M.J.F.	18-06-10



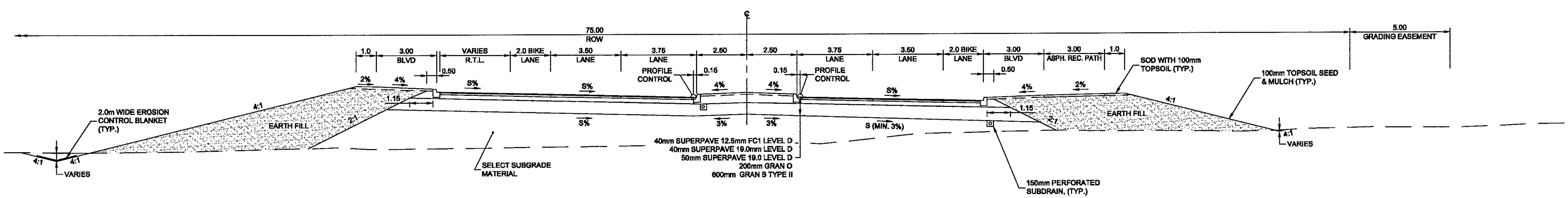
MEDIAN ISLAND DETAIL



TERRY FOX DRIVE TYPICAL SECTION
FROM 12+090 TO RICHARDSON SIDEROAD



TERRY FOX DRIVE TYPICAL SECTION
STA. 12+300



TERRY FOX DRIVE TYPICAL SECTION
FROM RICHARDSON SIDEROAD TO 12+687

ISB09-5123-088

23 March 2010 1:19:43 AM G:\CAD\091518\CIVIL\Production Drawings\ISB09-5123-088-tcs.dwg

NOTES:

1. ASPHALT RECREATIONAL PATH TO CONSIST OF:
   40mm SP 12.5 FC1 LEVEL C
   50mm SP19.0 LEVEL C
   300mm GRANULAR 'O'
2. IN SWAMPY AREAS CONSTRUCT EMBANKMENTS PER OPSD 203.010.
3. ALL CURB AND GUTTER SC1.2

TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD PHASE TWO

TYPICAL SECTIONS

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

Ottawa

Contract No. ISB09-5123	Dwg. No. 089
Sheet 089 of 101	
Asset No.	
Asset Group	
Des. R.J.G.	Chk'd. B.G.H.
Dwn. R.S.S.	Chk'd. B.G.H.
Utility Circ. No.	Index No.
Const. Inspector	
Scale: N.T.S.	

NOTE:
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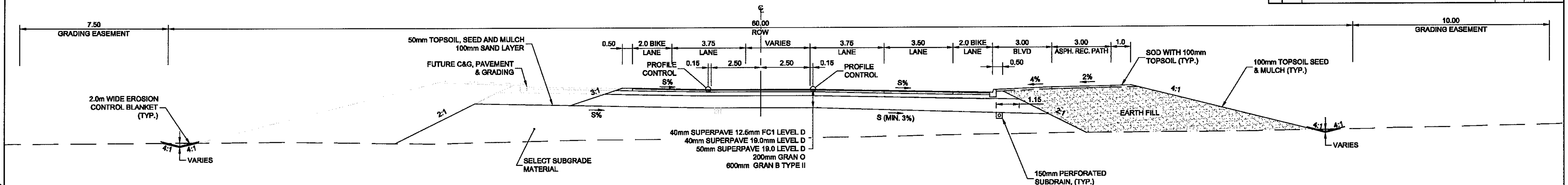
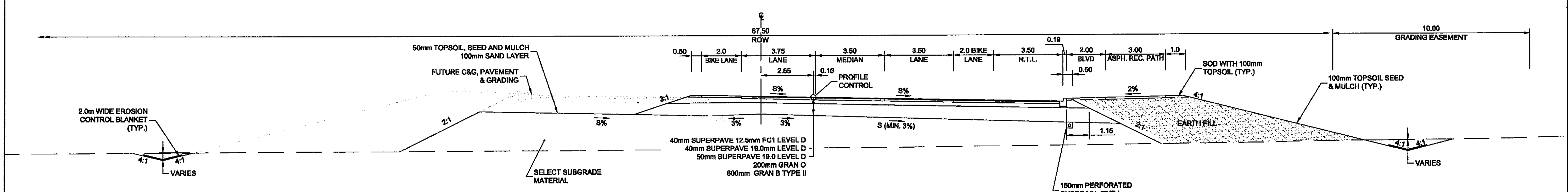
DILLON CONSULTING

REVISIONS

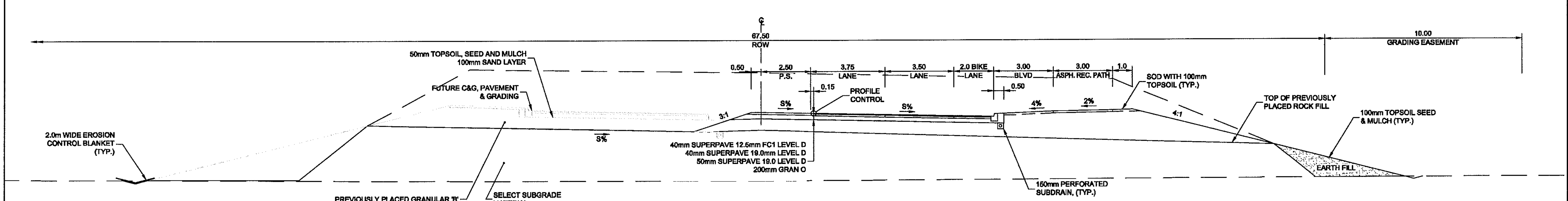
No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	JUNE 2010 DESIGN REVISIONS	M.J.F.	18-06-10



TERRY FOX DRIVE
SECTION AT STA. 12+700



TERRY FOX DRIVE
SECTION AT STA. 13+000



TERRY FOX DRIVE TYPICAL SECTION
FROM 13+220 TO 13+480

DRAWING FRAME: 790mm x 534mm City of Ottawa 2006

ISB09-5123-089

17 June 2010 4:57:51 PM G:\CAD\091518\CMN\Production Drawings\ISB09-5123-089-bx.dwg

NOTES:

1. ASPHALT RECREATIONAL PATH TO CONSIST OF:
   40mm SP 12.5 FC1 LEVEL C
   50mm SP19.0 LEVEL C
   300mm GRANULAR 'O'
2. IN SWAMPY AREAS CONSTRUCT EMBANKMENTS PER OPSD 203.010.
3. ALL CURB AND GUTTER SC1.2

TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

TYPICAL SECTIONS

R.HOLDER, P.ENG. *Manager-Construction Services West*	S.STODDARD, P.ENG. *Project Manager*

Contract No. ISB09-5123	Dwg. No. 090
Sheet 090 of 101	
Asset No.	
Asset Group	
Des. R.J.G.	Chk'd. B.G.H.
Dwn. R.S.S.	Chk'd. B.G.H.
Utility Circ. No.	Index No.
Const. Inspector	
Scale: HORIZONTAL 0m / 0m VERTICAL	

NOTE:
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DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
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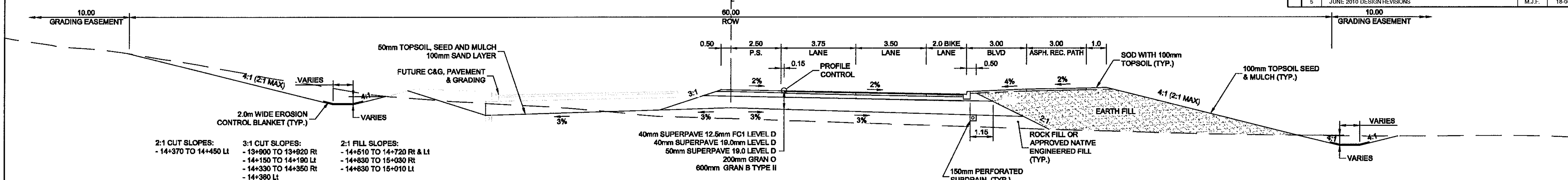
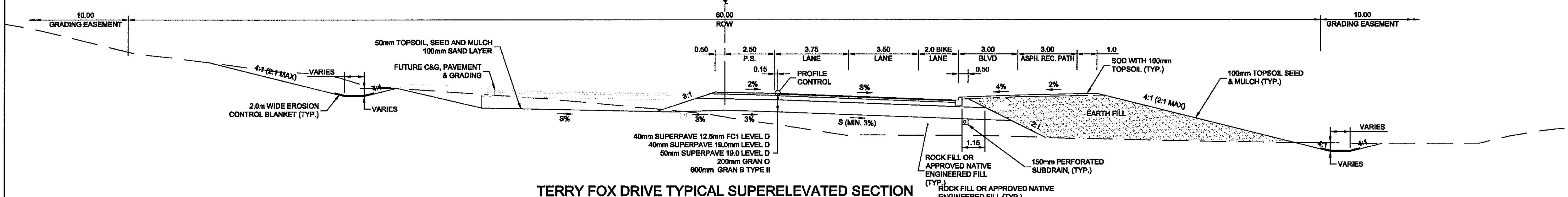
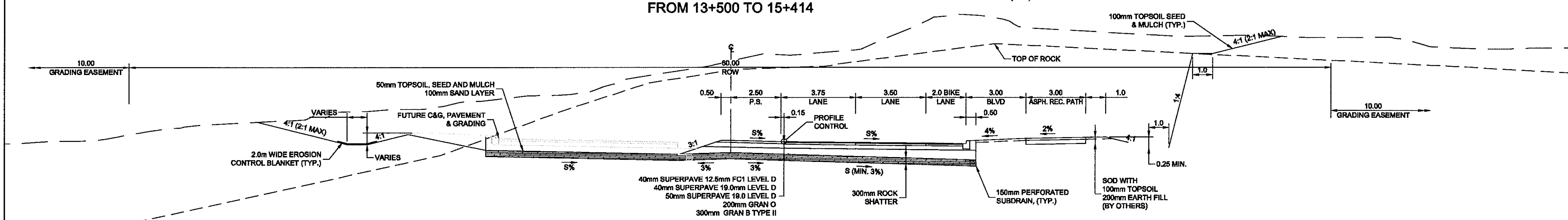
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	JUNE 2010 DESIGN REVISIONS	M.J.F.	18-06-10



TERRY FOX DRIVE TYPICAL NORMAL CROWN SECTION FROM 13+500 TO 15+414



TERRY FOX DRIVE TYPICAL SUPERELEVATED SECTION FROM 13+500 TO 15+414



TERRY FOX DRIVE TYPICAL ROCK CUT SECTION FROM 13+500 TO 15+414

ISB09-5123-090

17 June 2010 4:58:18 PM G:\CAD\091518\Civil\Production Drawings\ISB09-5123-090-txs.dwg

NOTES:

1. ASPHALT RECREATIONAL PATH TO CONSIST OF:
   40mm SP 12.5 FC1 LEVEL C
   50mm SP19.0 LEVEL C
   300mm GRANULAR 'O'
2. IN SWAMPY AREAS CONSTRUCT EMBANKMENTS PER OPSD 203.010.
3. ALL CURB AND GUTTER SC1.2

TERRY FOX DRIVE
RICHARDSON SIDEROAD TO SECOND LINE ROAD
PHASE TWO

Ottawa

Contract No.	ISB09-5123
Dwg. No.	091
Sheet	091 of 101
Asset No.	
Asset Group	
Des.	R.J.G.
Chk'd.	B.G.H.
Dwn.	R.S.S.
Chk'd.	B.G.H.
Utility Circ. No.	
Index No.	
Const. Inspector	
Scale:	HORIZONTAL 0m 5 10 20 / 0m VERTICAL

TYPICAL SECTIONS

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

NOTE:
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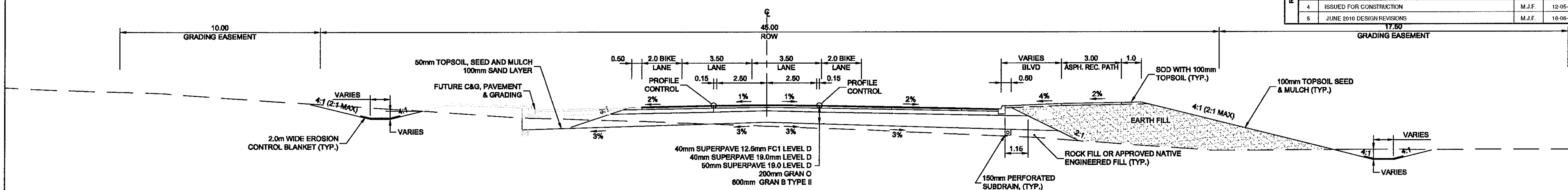
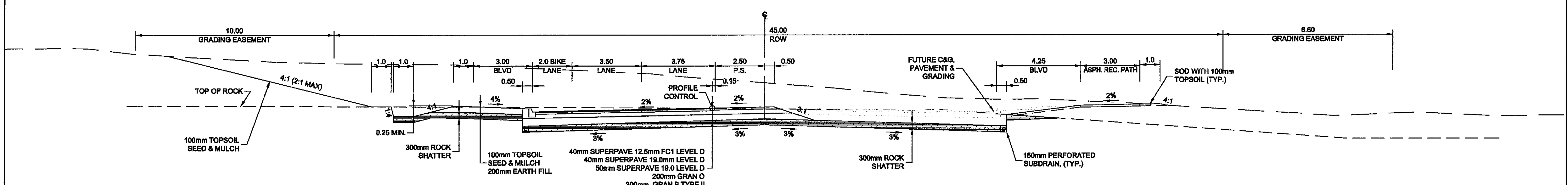
DILLON CONSULTING

No.	Description	By	Date (dd/mm/yy)
1	70% COMPLETE	M.J.F.	03-02-10
2	ISSUED FOR TENDER	M.J.F.	10-03-10
3	ADDENDUM 2	M.J.F.	23-03-10
4	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
5	JUNE 2010 DESIGN REVISIONS	M.J.F.	18-06-10

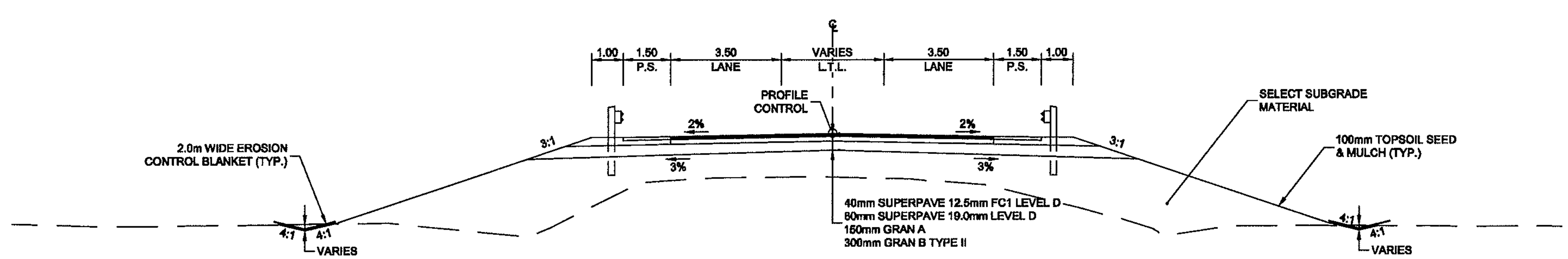
REVISIONS



TERRY FOX DRIVE TYPICAL CROSSOVER SECTION FROM 15+414 TO 15+700



TERRY FOX DRIVE TYPICAL SECTION FROM 15+700 TO 15+800



RICHARDSON SIDEROAD TYPICAL SECTION

17 June 2010 4:59:35 PM G:\CAD\091518\CMN\Production Drawings\ISB09-5123-091-bss.dwg

APPENDIX B

Pavement Drainage and Sewer Design Calculations

FINAL CONDITION

SEWER INLET SPACING CALCULATIONS

HWY No.:	TFD		DESIGN FREQUENCY	10 yr
WP No.:	09-1518		RAINFALL STATION	
DESIGNED BY:		DATE: Jul-09	DESIGN SPREAD	Varies
CHECKED BY:		DATE:	CURB & GUTTER TYPE	
			INLET TYPE	

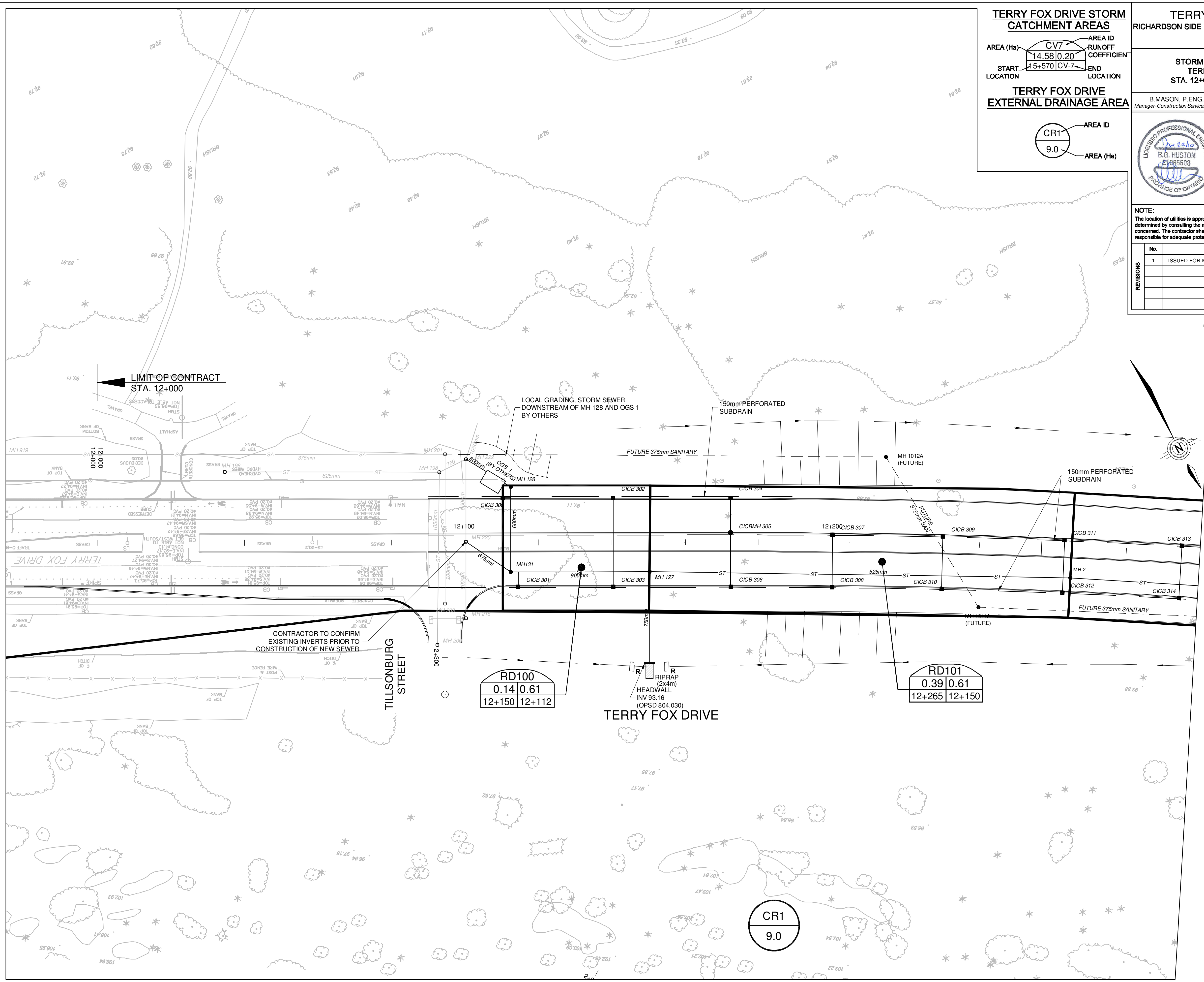
LOCATION								DRAINAGE AREA DETAILS						INLET SPACING							Max Flow/Velocity Check		
FROM INLET No./STA	profile elev	xfall	TO INLET No./STA	profile elev	xfall	GUTTER GRADE	X-FALL	AVERAGE WIDTH W	RUNOFF COEF. C	INLET TIME	RAINFALL INTENSITY i	GUTTER FLOW Qg	LOCAL RUNOFF Qr	INLET SPACING L	SPREAD T	INLET CAPACITY Qi	THEORETICAL CARRYOVER Qc	ACTUAL CARRYOVER Qc	REMARKS	FLOW DEPTH d	FLOW AREA A	FLOW VELOCITY V	DESIGN RATIO (0.6 Max)
						m/m	m/m	m		min	mm/hr	m^3/s	m^3/s	m	m	m^3/s	m^3/s	m^3/s		m	m2	m/s	V/d
14230	108.2	0.02	14200	108.08	0.02	0.0040	0.02	22.5	0.6	10	122	0.014	0.014	30	1.86	0.009	0.005	0.005		0.04	0.03	0.41	0.02
14200	108.08	0.02	14170	107.98	0.02	0.0033	0.02	22.5	0.6	10	122	0.019	0.014	30	2.15	0.011	0.008	0.008		0.04	0.05	0.41	0.02
14170	107.98	0.02	14140	107.78	0.02	0.0067	0.02	22.5	0.6	10	122	0.022	0.014	30	2.00	0.011	0.011	0.011		0.04	0.04	0.55	0.02
14140	107.78	0.02	14090	107.25	0.02	0.0106	0.02	22.5	0.6	10	122	0.034	0.023	50	2.16	0.013	0.021	0.021		0.04	0.05	0.73	0.03
14090	107.25	0.02	14040	106.47	0.02	0.0156	0.02	22.5	0.6	10	122	0.044	0.023	50	2.21	0.013	0.031	0.031		0.04	0.05	0.90	0.04
14040	106.47	0.02	13990	105.46	0.02	0.0202	0.02	22.5	0.6	10	122	0.054	0.023	50	2.27	0.014	0.040	0.040		0.05	0.05	1.04	0.05
13990	105.46	0.02	13940	104.19	0.02	0.0254	0.02	22.5	0.6	10	122	0.063	0.023	50	2.31	0.014	0.049	0.049		0.05	0.05	1.18	0.05
13940	104.19	0.02	13890	102.66	0.02	0.0306	0.02	22.5	0.6	10	122	0.072	0.023	50	2.34	0.014	0.058	0.058		0.05	0.05	1.31	0.06
13890	102.66	0.02	13840	101.02	0.0276	0.0328	0.0238	22.5	0.6	10	122	0.081	0.023	50	2.17	0.011	0.070	0.070		0.05	0.06	1.45	0.07
13840	101.02	0.0276	13790	99.55	0.0352	0.0294	0.0314	22.5	0.6	10	122	0.093	0.023	50	1.96	0.012	0.081	0.081		0.06	0.06	1.54	0.09
13790	99.55	0.0352	13740	98.3	0.042	0.0250	0.0386	22.5	0.6	10	122	0.104	0.023	50	1.85	0.015	0.089	0.089		0.07	0.07	1.57	0.11
13740	98.3	0.042	13690	97.25	0.042	0.0210	0.042	22.5	0.6	10	122	0.112	0.023	50	1.87	0.016	0.096	0.096		0.08	0.07	1.53	0.12
13690	97.25	0.042	13640	96.4	0.042	0.0170	0.042	22.5	0.6	10	122	0.119	0.023	50	1.98	0.018	0.101	0.101		0.08	0.08	1.43	0.12
13640	96.4	0.042	13590	95.79	0.042	0.0122	0.042	22.5	0.6	10	122	0.124	0.023	50	2.14	0.020	0.104	0.104		0.09	0.10	1.28	0.12
13590	95.79	0.042	13560	95.49	0.042	0.0100	0.042	22.5	0.6	10	122	0.118	0.014	30	2.18	0.020	0.097	0.097		0.09	0.10	1.17	0.11
13560	95.49	0.042	13530	95.29	0.042	0.0067	0.042	22.5	0.6	10	122	0.111	0.014	30	2.31	0.023	0.088	0.088		0.10	0.11	0.99	0.10
13530	95.29	0.042	13500	95.16	0.042	0.0043	0.042	22.5	0.6	10	122	0.102	0.014	30	2.43	0.025	0.077	0.077		0.10	0.12	0.83	0.08
13500	95.16	0.042	13470	95.11	0.0356	0.0017	0.0388	22.5	0.6	10	122	0.091	0.014	30	2.92	0.030	0.061	0.061	Sag Location	0.11	0.17	0.55	0.06

LOCATION								DRAINAGE AREA DETAILS						INLET SPACING							Max Flow/Velocity Check		
FROM INLET No./STA	profile elev	xfall	TO INLET No./STA	profile elev	xfall	GUTTER GRADE	X-FALL	AVERAGE WIDTH W	RUNOFF COEF. C	INLET TIME	RAINFALL INTENSITY i	GUTTER FLOW Qg	LOCAL RUNOFF Qr	INLET SPACING L	SPREAD T	INLET CAPACITY Qi	THEORETICAL CARRYOVER Qc	ACTUAL CARRYOVER Qc	REMARKS	FLOW DEPTH d	FLOW AREA A	FLOW VELOCITY V	DESIGN RATIO (0.6 Max)
						m/m	m/m	m		min	mm/hr	m^3/s	m^3/s	m	m	m^3/s	m^3/s	m^3/s		m	m2	m/s	V/d
14230	108.2	0.02	14260	108.01	0.02	0.0063	0.02	22.5	0.6	10	122	0.014	0.014	30	1.70	0.009	0.005	0.005		0.03	0.03	0.48	0.02
14260	108.01	0.02	14290	107.84	0.02	0.0057	0.02	22.5	0.6	10	122	0.019	0.014	30	1.95	0.010	0.009	0.009		0.04	0.04	0.50	0.02
14290	107.84	0.02	14320	107.59	0.02	0.0083	0.02	22.5	0.6	10	122	0.023	0.014	30	1.95	0.011	0.013	0.013		0.04	0.04	0.60	0.02
14320	107.59	0.02	14350	107.25	0.02	0.0113	0.02	22.5	0.6	10	122	0.027	0.014	30	1.94	0.011	0.016	0.016		0.04	0.04	0.70	0.03
14350	107.25	0.02	14400	106.62	0.02	0.0126	0.02	22.5	0.6	10	122	0.039	0.023	50	2.20	0.013	0.026	0.026		0.04	0.05	0.81	0.04
14400	106.62	0.02	14450	106	0.039	0.0124	0.0295	22.5	0.6	10	122	0.049	0.023	50	1.89	0.011	0.038	0.038		0.06	0.05	0.94	0.05
14450	106	0.039	14500	105.37	0.039	0.0126	0.039	22.5	0.6	10	122	0.061	0.023	50	1.71	0.013	0.048	0.048		0.07	0.06	1.07	0.07
14500	105.37	0.039	14550	104.75	0.039	0.0124	0.039	22.5	0.6	10	122	0.071	0.023	50	1.82	0.014	0.057	0.057		0.07	0.06	1.10	0.08
14550	104.75	0.039	14600	104.13	0.039	0.0124	0.039	22.5	0.6	10	122	0.080	0.023	50	1.90	0.015	0.065	0.065		0.07	0.07	1.13	0.08
14600	104.13	0.039	14650	103.5	0.039	0.0126	0.039	22.5	0.6	10	122	0.088	0.023	50	1.97	0.016	0.072	0.072		0.08	0.08	1.17	0.09
14650	103.5	0.039	14700	102.98	0.039	0.0104	0.039	22.5	0.6	10	122	0.095	0.023	50	2.10	0.017	0.078	0.078		0.08	0.09	1.11	0.09
14700	102.98	0.039	14730	102.89	0.0248	0.0030	0.0319	22.5	0.6	10	122	0.092	0.014	30	2.96	0.021	0.071	0.071	Sag Location	0.09	0.14	0.66	0.06

LOCATION								DRAINAGE AREA DETAILS						INLET SPACING							Max Flow/Velocity Check		
FROM INLET No./STA	profile elev	xfall	TO INLET No./STA	profile elev	xfall	GUTTER GRADE	X-FALL	AVERAGE WIDTH W	RUNOFF COEF. C	INLET TIME	RAINFALL INTENSITY i	GUTTER FLOW Qg	LOCAL RUNOFF Qr	INLET SPACING L	SPREAD T	INLET CAPACITY Qi	THEORETICAL CARRYOVER Qc	ACTUAL CARRYOVER Qc	REMARKS	FLOW DEPTH d	FLOW AREA A	FLOW VELOCITY V	DESIGN RATIO (0.6 Max)
						m/m	m/m	m		min	mm/hr	m^3/s	m^3/s	m	m	m^3/s	m^3/s	m^3/s		m	m2	m/s	V/d
15550	111.4	0.02	15520	111.34	0.02	0.0020	0.02	22.5	0.6	10	122	0.014	0.014	30	2.12	0.009	0.005	0.005		0.04	0.04	0.31	0.01
15520	111.34	0.02	15490	111.18	0.02	0.0053	0.02	22.5	0.6	10	122	0.019	0.014	30	1.97	0.010	0.009	0.009		0.04	0.04	0.49	0.02
15490	111.18	0.02	15460	110.93	0.02	0.0083	0.02	22.5	0.6	10	122	0.023	0.014	30	1.95	0.011	0.012	0.012		0.04	0.04	0.60	0.02
15460	110.93	0.02	15410	110.38	0.038	0.0110	0.029	22.5	0.6	10	122	0.035	0.023	50	1.72	0.009	0.026	0.026		0.05	0.04	0.82	0.04
15410	110.38	0.038	15360	109.8	0.038	0.0116	0.038	22.5	0.6	10	122	0.049	0.023	50	1.63	0.012	0.037	0.037		0.06	0.05	0.97	0.06
15360	109.8	0.038	15310	109.23	0.038	0.0114	0.038	22.5	0.6	10	122	0.060	0.023	50	1.76	0.013	0.047	0.047		0.07	0.06	1.01	0.07
15310	109.23	0.038	15260	108.66	0.038	0.0114	0.038	22.5	0.6	10	122	0.070	0.023	50	1.86	0.014	0.055	0.055		0.07	0.07	1.05	0.07
15260	108.66	0.038	15210	108.08	0.038	0.0116	0.038	22.5	0.6	10	122	0.078	0.023	50	1.94	0.015	0.063	0.063		0.07	0.07	1.09	0.08
15210	108.08	0.038	15160	107.5	0.038	0.0116	0.038	22.5	0.6	10	122	0.086	0.023	50	2.01	0.016	0.070	0.070		0.08	0.08	1.12	0.09
15160	107.5	0.038	15110	106.93	0.038	0.0114	0.038	22.5	0.6	10	122	0.093	0.023	50	2.08	0.017	0.076	0.076		0.08	0.08	1.13	0.09
15110	106.93	0.038	15060	106.35	0.038	0.0116	0.038	22.5	0.6	10	122	0.099	0.023	50	2.12	0.017	0.082	0.082		0.08	0.09	1.16	0.09
15060	106.35	0.038	15010	105.78	0.038	0.0114	0.038	22.5	0.6	10	122	0.105	0.023	50	2.18	0.018	0.087	0.087		0.08	0.09	1.17	0.10
15010	105.78	0.038	14960	105.2	0.038	0.0116	0.038	22.5	0.6	10	122	0.110	0.023	50	2.21	0.018	0.092	0.092		0.08	0.09	1.19	0.10
14960	105.2	0.038	14910	104.63	0.038	0.0114	0.038	22.5	0.6	10	122	0.115	0.023	50	2.25	0.018	0.097	0.097		0.09	0.10	1.20	0.10
14910	104.63	0.038	14880	104.28	0.0264	0.0117	0.0322	22.5	0.6	10	122	0.111	0.014	30	2.45	0.058	0.053	0.053	standard drop inlet grate	0.08	0.10	1.15	0.09
14880	104.28	0.0264	14850	103.94	0.02	0.0113	0.0232	22.5	0.6	10	122	0.067	0.014	30	2.51	0.035	0.032	0.032	standard drop inlet grate	0.06	0.07	0.92	0.05
14850	103.94	0.02	14820	103.58	0.006	0.0120	0.013	22.5	0.6	10	122	0.046	0.014	30	3.09	0.015	0.031	0.000	standard drop inlet grate - Carryover Eliminated at Rail	0.04	0.06	0.74	0.03
14820	103.58	0.006	14790	103.25	0.006	0.0110	0.006	22.5	0.6	10	122	0.014	0.014	30	3.26	0.006	0.008	0.008		0.02	0.03	0.44	0.01
14790	103.25	0.006	14760	102.98	0.02	0.0090	0.013	22.5	0.6	10	122	0.022	0.014	30	2.49	0.010	0.012	0.012		0.03	0.04	0.56	0.02
14760	102.98	0.02	14730	102.89	0.0248	0.0030	0.0224	22.5	0.6	10	122	0.026	0.014	30	2.32	0.014	0.012	0.012	Sag Location	0.05	0.06	0.44	0.02

Location			Drainage Area				Rainfall Intensity				Pipe Properties										
From U/S MH		To D/S MH	Area (ha)	Runoff Coeff.	Incrementa A*C	Total A*C	Flow Time - Sect. (min)	Flow Time - Accum. (min	Intensity (mm/hr)	Flow -Q (m3/s)	Pipe Size (mm)	Slope (%)	Mannings n	Capacity (m3/s)	Velocity (m/s)	Pipe Length	Pipe Flow Time (min)	Percent Cap (%)	Fall in Sewer (m)	Inv U.S. (m)	Inv D.S. (m)
Storm Sewer Design - 10yr Return Interval																					
Ultimate 4-Lane Cross-section																					
RD102	12265	12355	0.31	0.6104	0.1868	0.1868	0.0000	10.0000	122.1418	0.0634											
RD102	12355	12265	0.31	0.6104	0.1868	0.3736	0.0000	10.0000	122.1418	0.1267	450	0.30	0.013	0.1561	1.0	90.0000	1.5278	81%	0.27	94.00	93.73
RD101	12265	12150	0.39	0.6104	0.2387	0.6123	1.5278	11.5278	113.3891	0.1928	525	0.30	0.013	0.2355	1.1	115.0000	1.7615	82%	0.345	93.66	93.31
External (N	12150	12150	3.11	0.5500	1.7105	1.7105	0.0000	15.0000	97.8518	0.4649	750	0.30	0.013	0.6097	1.4	24.8000	0.2995	76%	0.0744	93.16	93.09
RD100	12150	12112	0.13	0.6104	0.0789	2.4016	0.2995	15.2995	96.7284	0.6453	900	0.30	0.013	0.9915	1.6	38.0000	0.4064	65%	0.114	92.94	92.82
								11.8273	STM Outlet 1	0.3000	600	0.30	0.013	0.3363	1.2	23.1000	0.3237	89%	0.0693	92.82	92.75
									OGS Bypass	0.3453	675	2.08	0.013	1.2122	3.4	14.7000	0.0723	28%	0.30576	93.05	92.74
RD103a	12355	12385	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD103b	12385	12475	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.46	0.013	0.1189	1.1	90.0000	1.3933	71%	0.414	92.99	92.58
									STM Outlet 2	0.1690	525	0.35	0.013	0.2544	1.2	9.2000	0.1305	66%	0.0322	92.43	92.39
RD104a	12595	12565	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD104b	12565	12475	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.35	0.013	0.1037	0.9	90.0000	1.5973	81%	0.315	92.91	92.59
RD105	12595	12625	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD106	12625	12715	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.35	0.013	0.1037	0.9	90.0000	1.5973	81%	0.315	93.06	92.74
									STM Outlet 3	0.1690	525	0.35	0.013	0.2544	1.2	9.2000	0.1305	66%	0.0322	92.59	92.56
RD108	12835	12805	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD107	12805	12715	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.35	0.013	0.1037	0.9	90.0000	1.5973	81%	0.315	93.06	92.74
RD109	12835	12865	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD1010	12865	12955	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.35	0.013	0.1037	0.9	90.0000	1.5973	81%	0.315	93.08	92.76
									STM Outlet 4	0.1690	525	0.35	0.013	0.2544	1.2	9.2000	0.1305	66%	0.0322	92.61	92.58
RD112	13075	13045	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD111	13045	12955	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.35	0.013	0.1037	0.9	90.0000	1.5973	81%	0.315	93.08	92.76
RD113	13075	13105	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD114	13105	13195	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.35	0.013	0.1037	0.9	90.0000	1.5973	81%	0.315	93.08	92.76
									STM Outlet 5	0.1690	525	0.35	0.013	0.2544	1.2	9.2000	0.1305	66%	0.0322	92.61	92.58
RD116	13315	13285	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD115	13285	13195	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.35	0.013	0.1037	0.9	90.0000	1.5973	81%	0.315	93.08	92.76
RD127	14230	14200	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD126	14200	14090	0.37	0.6104	0.2283	0.2906	0.0000	10.0000	122.1418	0.0986	375	0.76	0.013	0.1528	1.4	110.0000	1.3248	65%	0.836	105.21	104.37
RD125	14090	13990	0.34	0.6104	0.2075	0.4981	1.3248	11.3248	114.4711	0.1584	375	1.07	0.013	0.1813	1.6	100.0000	1.0150	87%	1.07	104.32	103.25
RD124	13990	13890	0.34	0.6104	0.2075	0.7057	1.0150	12.3399	109.2783	0.2142	375	2.80	0.013	0.2934	2.7	100.0000	0.6275	73%	2.8	103.00	100.20
RD123	13890	13790	0.34	0.6104	0.2075	0.9132	0.6275	12.9674	106.3214	0.2697	375	3.11	0.013	0.3092	2.8	100.0000	0.5954	87%	3.11	100.15	97.04
RD122	13790	13690	0.34	0.6104	0.2075	1.1207	0.5954	13.5628	103.6754	0.3228	450	2.50	0.013	0.4508	2.8	100.0000	0.5881	72%	2.5	96.97	94.47
RD121	13690	13590	0.34	0.6104	0.2075	1.3283	0.5881	14.1508	101.2016	0.3734	525	0.92	0.013	0.4125	1.9	100.0000	0.8747	91%	0.92	94.39	93.47
RD120	13590	13470	0.41	0.6104	0.2491	1.5773	0.8747	15.0255	97.7550	0.4283	600	0.57	0.013	0.4635	1.6	120.0000	1.2199	92%	0.684	93.40	92.71
									STM Outlet 6	0.5307	675	0.60	0.013	0.6511	1.8	9.2000	0.0843	82%	0.0552	92.64	92.58
RD117	13315	13345	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD118	13345	13435	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.52	0.013	0.1264	1.1	90.0000	1.3104	67%	0.468	93.59	93.12
RD119	13435	13470	0.12	0.6104	0.0726	0.3217	1.3104	11.3104	114.5487	0.1024	450	0.52	0.013	0.2056	1.3	35.0000	0.4513	50%	0.182	93.05	92.86
RD128	14230	14260	0.10	0.6104	0.0623	0.0623	0.0000	10.0000	122.1418	0.0211											
RD129	14260	14350	0.31	0.6104	0.1868	0.2491	0.0000	10.0000	122.1418	0.0845	375	0.84	0.013	0.1607	1.5	90.0000	1.0311	53%	0.756	105.14	104.38
RD130	14350	14450	0.34	0.6104	0.2075	0.4566	1.0311	11.0311	116.0785	0.1472	375	1.25	0.013	0.1960	1.8	100.0000	0.9391	75%	1.25	104.33	103.08
RD131	14450	14550	0.34	0.6104	0.2075	0.6641	0.9391	11.9702	111.1080	0.2050	450	1.25	0.013	0.3187	2.0	100.0000	0.8316	64%	1.25	103.01	101.76
									STM Outlet 7	0.2050	450	1.25	0.013	0.3187	2.0	3.9000	0.0324	64%	0.04875	101.71	101.66
RD132	14550	14600	0.09	0.8500	0.0803	0.0803	0.0000	10.0000	122.1418	0.0273											
RD133	14600	14640	0.08	0.8500	0.0643	0.1446	0.0000	10.0000	122.1418	0.0491	250	1.06	0.013	0.0612	1.2	40.0000	0.5345	80%	0.424	101.82	101.40
RD134	14640	14670	0.06	0.8500	0.0482	0.1928	0.5345	10.5345	118.9127	0.0637	300	0.50	0.013	0.0684	1.0	30.0000	0.5169	93%	0.15	101.35	101.20
			Note: Minor System Services RHL Only						STM Outlet 8a	0.0637	300	0.50	0.013	0.0684	1.0	14.0000	0.2412	93%	0.07	101.15	101.08
RD138	14820	14790	0.06	0.8500	0.0482	0.0482	0.0000	10.0000	122.1418	0.0164											
RD137	14790	14760	0.06	0.8500	0.0482	0.0964	0.0000	10.0000	122.1418	0.0327	250	1.00	0.013	0.0595	1.2	30.0000	0.4128	55%	0.3	102.02	101.72
RD136	14760	14730	0.06	0.8500	0.0482	0.1446	0.4128	10.4128	119.6316	0.0480	300	1.00	0.013	0.0967	1.4	30.0000	0.3655	50%	0.3	101.67	101.37
			Note: Minor System Services RHL Only						STM Outlet 8b	0.0480	300	1.00	0.013	0.0967	1.4	14.0000	0.1706	50%	0.14	101.32	101.18
0.5*RD135	14670	14700	0.06	0.8500	0.0482	0.0482	0.0000	5.0000	165.7712	0.0222											
			Note: Minor System Services RHL Only						STM Outlet 8	0.0222	525	0.75	0.013	0.3724	1.7	14.0000	0.1356	6%	0.105	101.17	101.07
0.5*RD135	14730	14700	0.06	0.8500	0.0482	0.0482	0.0000	5.0000	165.7712	0.0222											
			Note: Minor System Services RHL Only						STM Outlet 8	0.0222	525	0.75	0.013	0.3724	1.7	14.0000	0.1356	6%	0.105	101.17	101.07
RD139	14850	14820	0.0567	0.8500	0.0482	0.0964	0.0000	5.0000	165.7712	0.0444											
									Railway	0.0444	525	0.75	0.013	0.3724	1.7	3.9000	0.0378	12%	0.02925	#REF!	#REF!
RD143	15160	15110	0.17	0.6104	0.1038	0.1520	0.0000	10.0000	122.1418	0.0516											
RD142	15110	15010	0.34	0.6104	0.2075	0.3595	0.0000	10.0000	122.1418	0.1220	375	1.15	0.013	0.1880	1.7	100.0000	0.9791	65%	1.15	104.85	103.70
RD141	15010	14910	0.34	0.6104	0.2075	0.5671	0.9791	10.9791	116.3680	0.1833	375	1.15	0.013	0.1880	1.7	100.0000	0.9791	97%	1.15	103.65	102.50
RD140	14910	14850	0.20	0.6104	0.1245	0.6916	0.9791	11.9582	111.1684	0.2136	450	0.60	0.013	0.2208	1.4	60.0000	0.7202	97%	0.36	102.42	102.06
									STM Outlet 9	0.2136	450	1.15	0.013	0.3057	1.9	3.9000	0.0338	70%	0.04485	102.01	101.97
RD146	15360	15310	0.17	0.6104	0.1038	0.1038	0.0000	10.0000	122.1418	0.0352											
RD145	15310	15210	0.34	0.6104	0.2075	0.3113	0.0000	10.0000	122.1418	0.1056	375	1.15	0.013	0.1880	1.7	100.0000	0.9791	56%	1.15	107.17	106.02
RD144	15210	15160	0.17	0.6104	0.1038	0.4151	0.9791	10.9791	116.3680	0.1342	375	1.15	0.013	0.1880	1.7	50.0000	0.4896	71%	0.575	105.97	105.40
									STM Outlet 10	0.1342	450	0.30	0.013	0.1561	1.0	3.9000	0.0662	86%	0.0117	105.32	105.31
RD149	15550	15610	0.20	0.6104	0.1245	0.1245	0.0000	10.0000	122.1418	0.0422											
RD149	15610	15520	0.31	0.6104	0.1868	0.3113	0.0000	10.0000	122.1418	0.1056	375	0.44	0.013	0.1163	1.1	90.0000	1.4246	91%	0.396	108.70	108.30
RD148	15520	15410	0.37	0.6104	0.2283	0.5396	1.4246	11.4246	113.9364	0.1708	450	0.44	0.013	0.1891	1.2	110.0000	1.5419	90%	0.484	108.23	107.75
RD147	15410	15360	0.17	0.6104	0.1038	0.6434	1.5419	12.9665	106.3254	0.1900	450	1.15	0.013	0.3057	1.9	50.0000	0.4335	62%	0.575	107.70	107.12
									STM Outlet 11	0.1900	450	0.50	0.013	0.2016	1.3	3.9000	0.0513	94%	0.0195	107.07	107.05

ISB09-1518-400



TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 (AREA ID) — 14.58 | 0.20 (RUNOFF COEFFICIENT) — START LOCATION 15+570 | CV-7 END LOCATION

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID; 9.0 — AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 12+000 TO STA 12+300

B.MASON, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Project Manager

LICENSED PROFESSIONAL ENGINEER
B.G. HUSTON
21865503
PROVINCE OF ONTARIO

Ottawa

Contract No. ISB09-1518 | Dwg. No. 400

Sheet 01 of 15

Asset No.

Asset Group

Des.	Chk'd.
Dwn.	Chk'd.
Utility Circ. No.	Index No.
Const. Inspector	

Scale: HORIZONTAL 0m 5 10 20; 0m VERTICAL

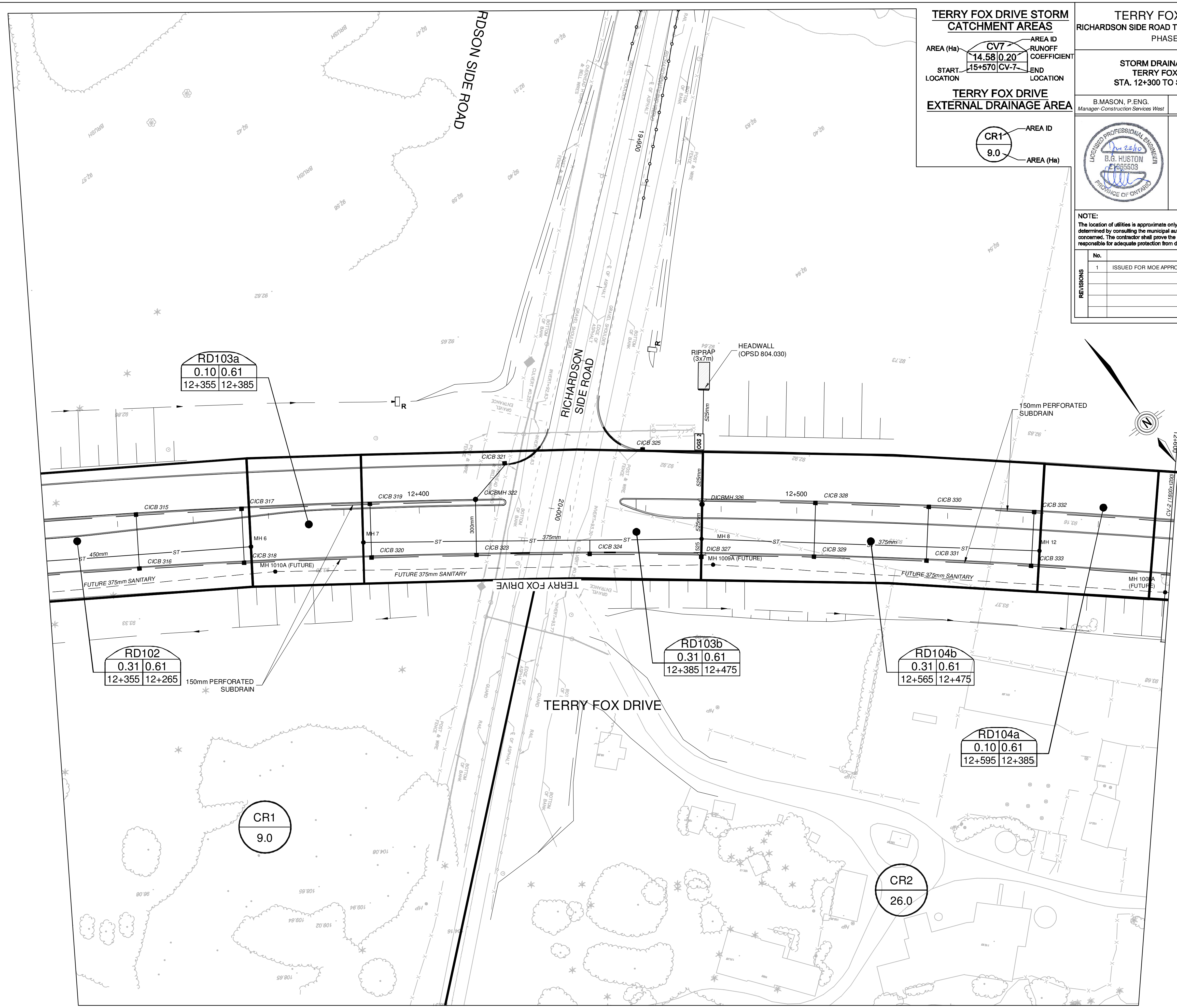
NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR MOE APPROVAL	B.G.H.	23/06/10

23 June 2010 10:15:19 AM G:\CAD\04-3427 Terry Fox Detailed Design\Storm Water Management\TFD Storm Drainage Plan\drainageareas2009IntConditions.dwg



TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 — AREA ID
14.58 | 0.20 — RUNOFF COEFFICIENT
START LOCATION — 15+570 | CV-7 — END LOCATION

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID
9.0 — AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

Ottawa

Contract No. ISB09-1518	Dwg. No. 401
Sheet 02 of 15	
Asset No.	
Asset Group	
Des.	Chk'd.
Dwn.	Chk'd.
Utility Circ. No.	Index No.
Const. Inspector	

Scale: HORIZONTAL 0m 5 10 20; 0m VERTICAL

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 12+300 TO STA. 12+600

B.MASON, P.ENG. *Manager-Construction Services West*	S.STODDARD, P.ENG. *Project Manager*

LICENSED PROFESSIONAL ENGINEER
B.G. HUSTON
21865503
PROVINCE OF ONTARIO
June 22/10

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ISSUED FOR MOE APPROVAL	B.G.H.	23/06/10

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

ISB09-1518-401

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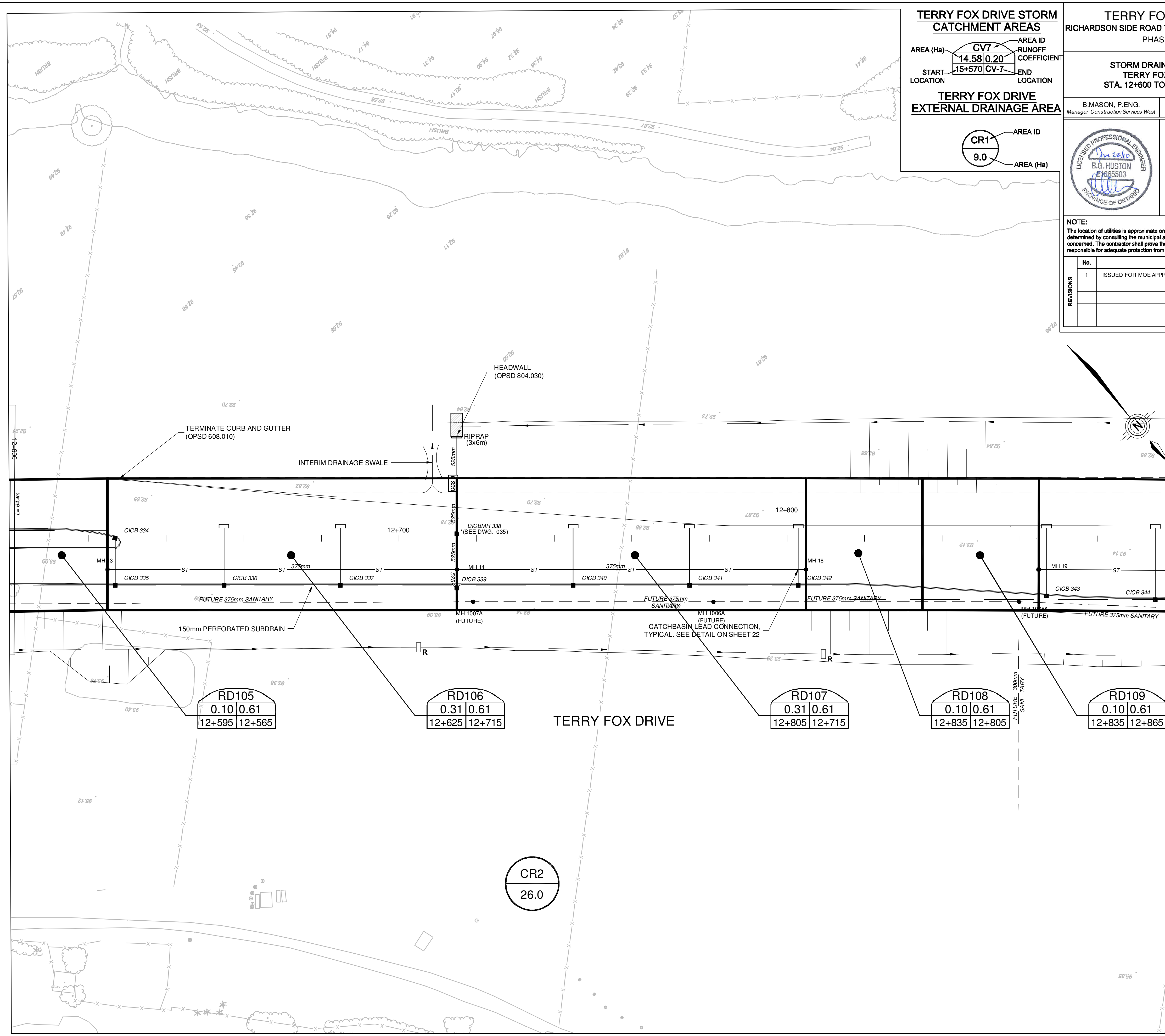

TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 / 14.58 / 0.20 / 15+570 / CV-7 — AREA ID, RUNOFF COEFFICIENT, START LOCATION, END LOCATION

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 / 9.0 — AREA ID, AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD
PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 12+600 TO STA. 12+900

B.MASON, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Project Manager

LICENSED PROFESSIONAL ENGINEER
B.G. HUSTON
100165503
PROVINCE OF ONTARIO

Ottawa

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Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m

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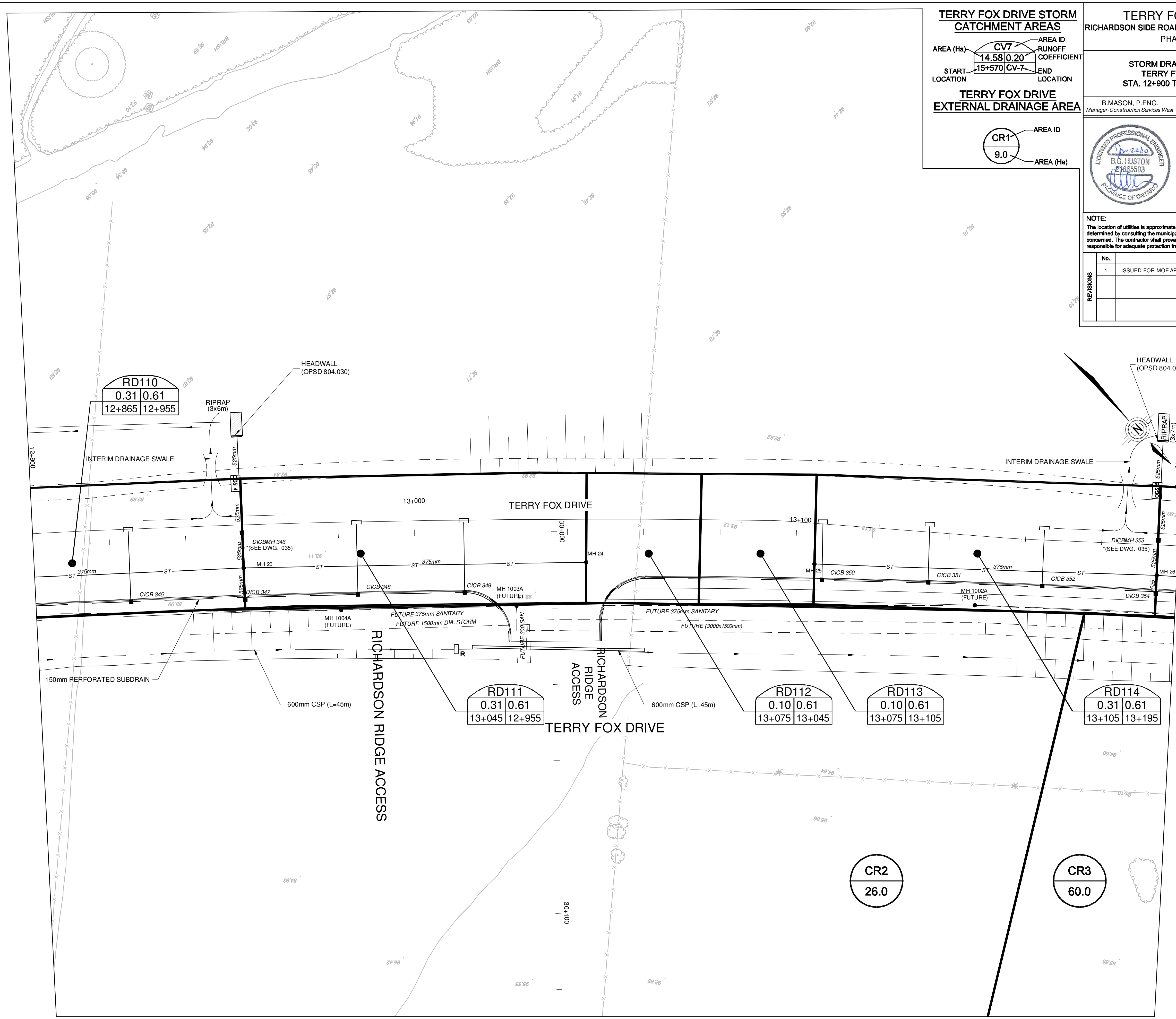

TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 (AREA ID) — 14.58 — 0.20 (RUNOFF COEFFICIENT) — START LOCATION 15+570 — END LOCATION CV-7

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 (AREA ID) — 9.0 (AREA (Ha))

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 12+900 TO STA. 13+200

B.MASON, P.ENG. *Manager-Construction Services West*

S.STODDARD, P.ENG. *Project Manager*

B.G. HUSTON

Ottawa

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Scale: HORIZONTAL 0m 5 10 20; 0m VERTICAL

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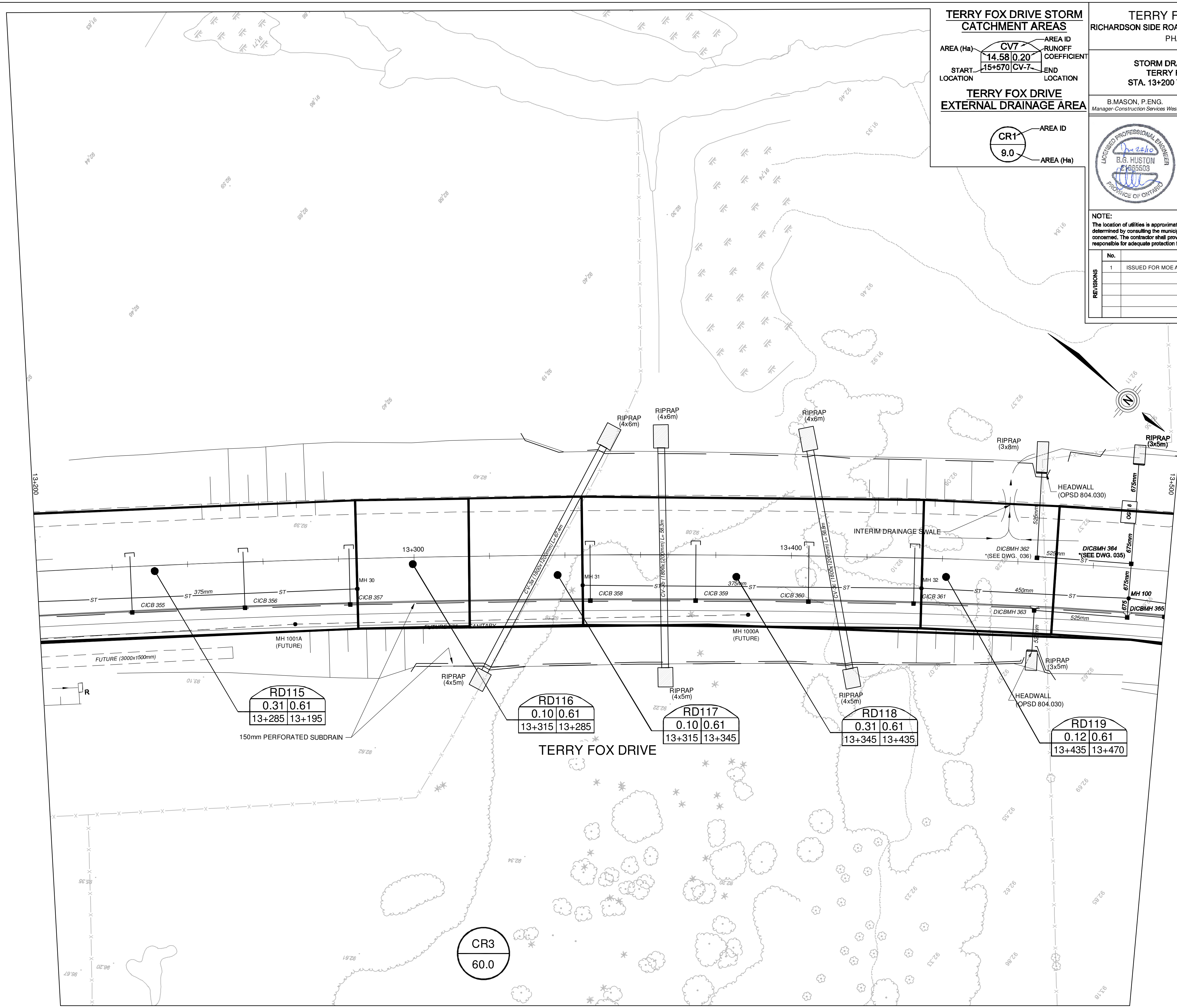

TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 (AREA ID) — 14.58 — 0.20 (RUNOFF COEFFICIENT) — START LOCATION 15+570 — END LOCATION CV-7

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID; 9.0 — AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 13+200 TO STA. 13+500

B.MASON, P.ENG. *Manager-Construction Services West*	S.STODDARD, P.ENG. *Project Manager*

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON 21865503 PROVINCE OF ONTARIO June 22/10

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Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m

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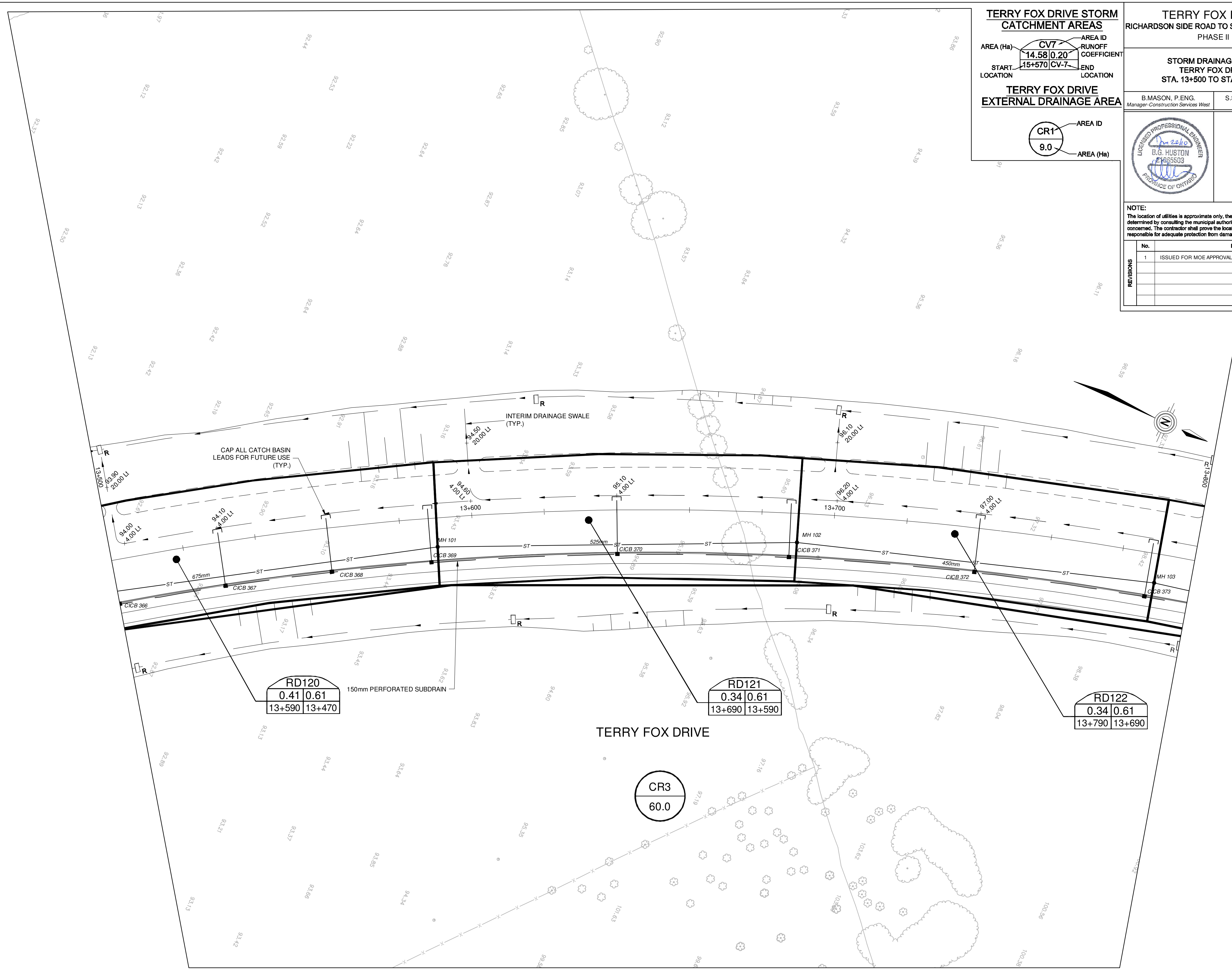

TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 / 14.58 / 0.20 / 15+570 / CV-7 — AREA ID; RUNOFF COEFFICIENT; START LOCATION; END LOCATION

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 / 9.0 — AREA ID; AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 13+500 TO STA. 13+800

B.MASON, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Project Manager

LICENSED PROFESSIONAL ENGINEER
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PROVINCE OF ONTARIO

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Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m

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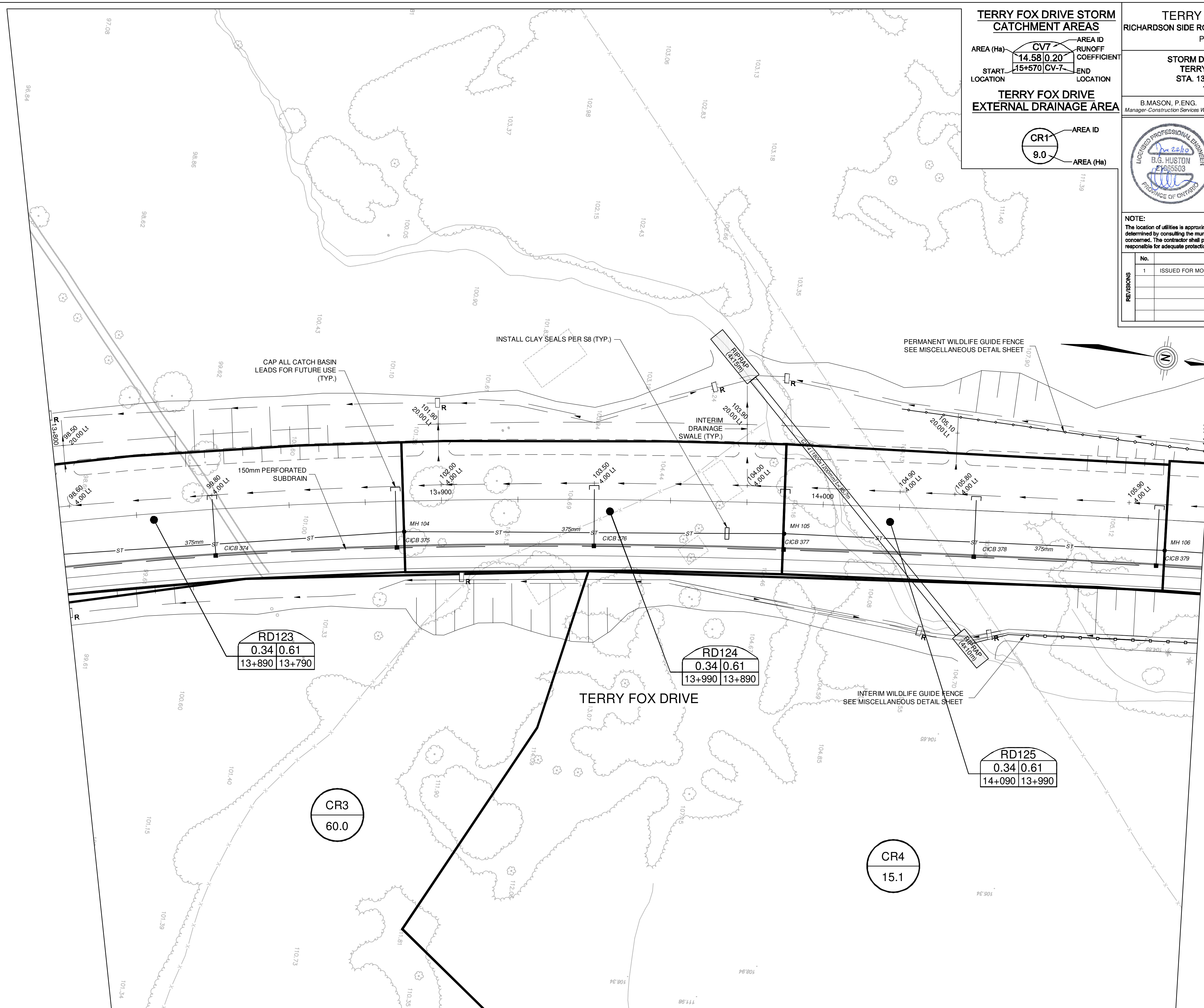

TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — 14.58; CV7 — AREA ID; 0.20 — RUNOFF COEFFICIENT; START LOCATION — 15+570; END LOCATION — CV-7

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID; 9.0 — AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 13+800 TO STA. 14+100

B.MASON, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Project Manager

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Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m

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TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 — AREA ID
14.58 | 0.20 — RUNOFF COEFFICIENT
START LOCATION — 15+570 | CV-7 — END LOCATION

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID
9.0 — AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 14+100 TO STA. 14+400

B.MASON, P.ENG. Manager-Construction Services West	S.STODDARD, P.ENG. Project Manager

LICENSED PROFESSIONAL ENGINEER B.G. HUSTON 21365503 PROVINCE OF ONTARIO

Ottawa

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Scale: HORIZONTAL 0m 5 10 20; VERTICAL 0m

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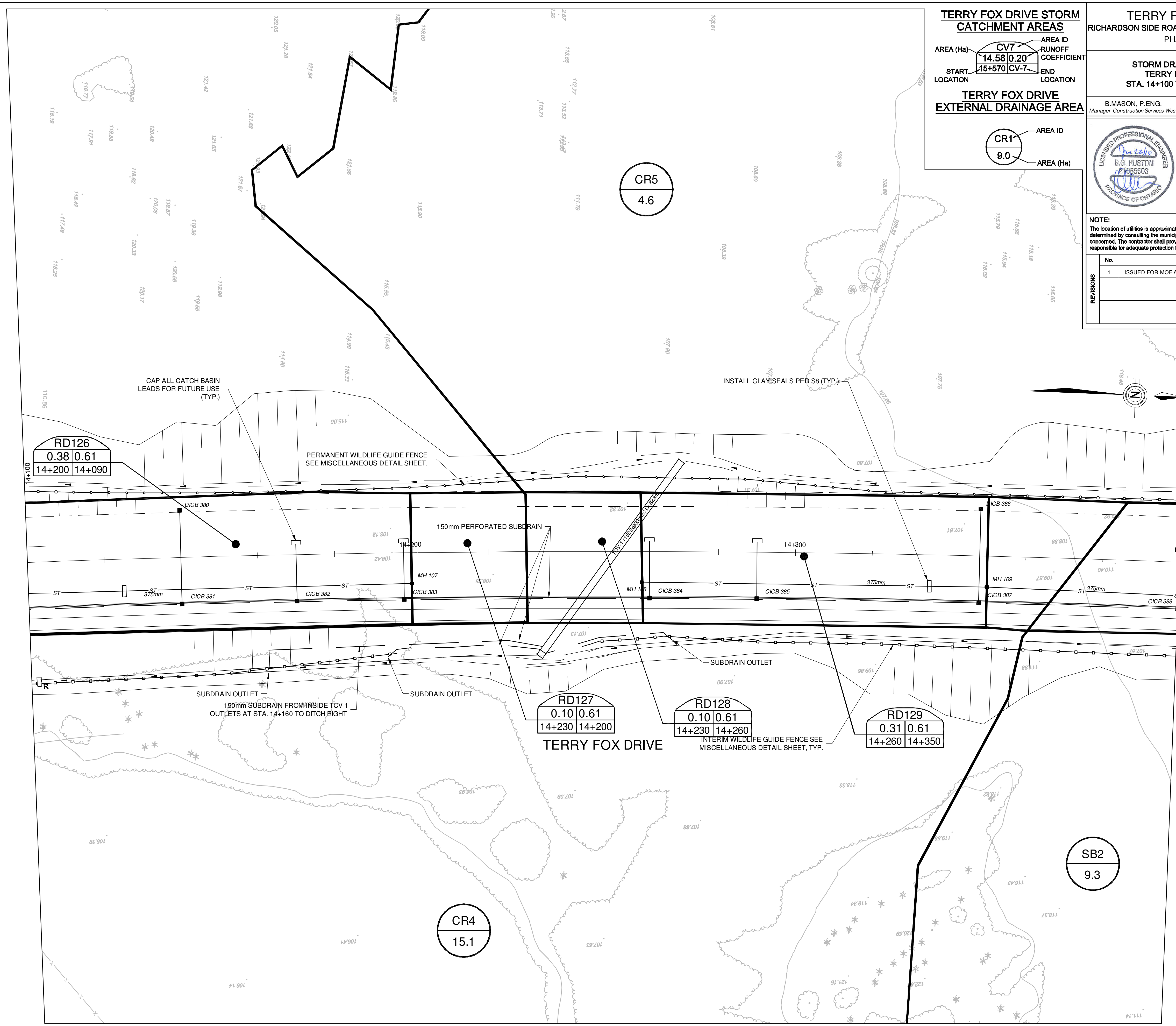

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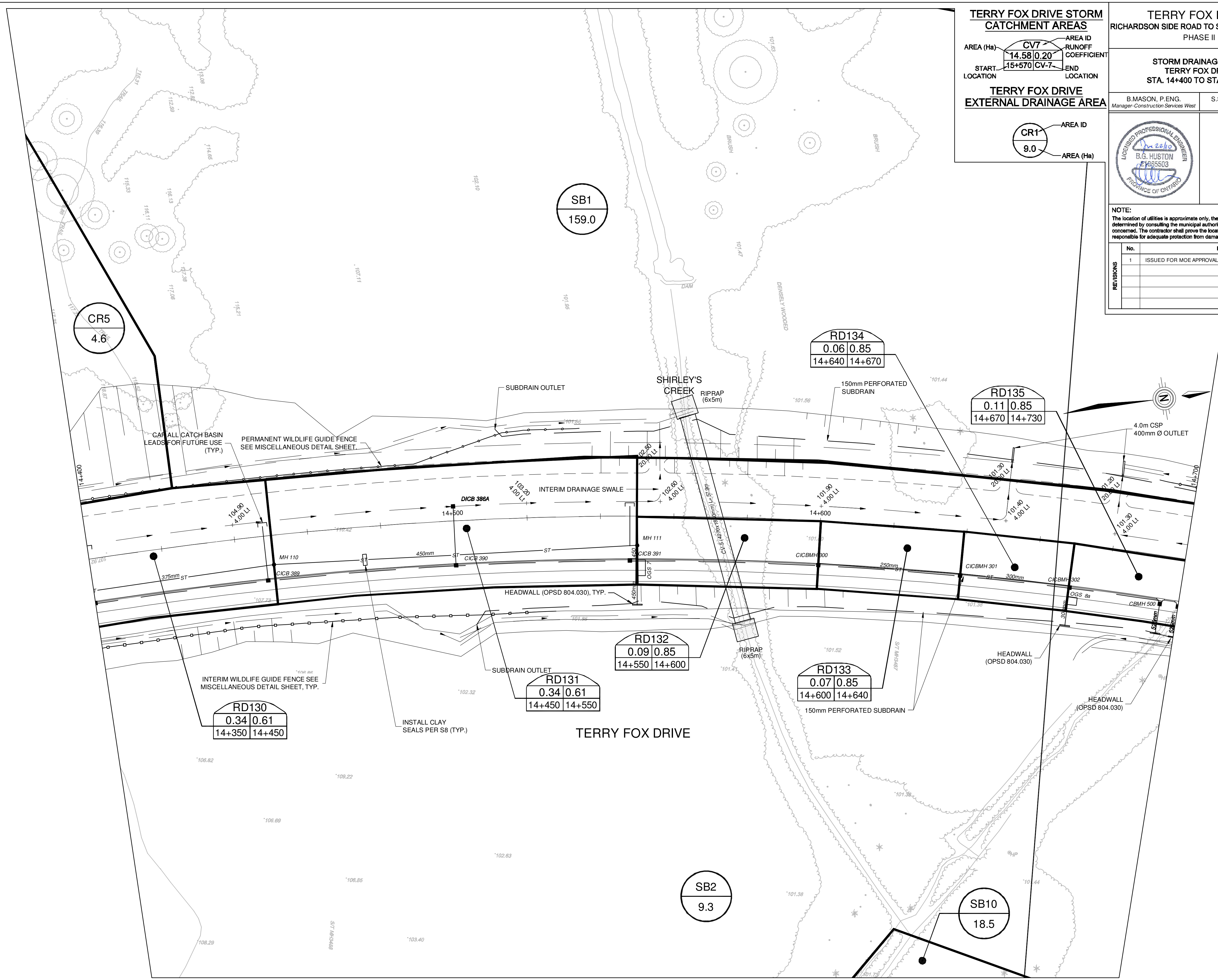

TERRY FOX DRIVE
RICHARDSON SIDE ROAD TO SECOND LINE ROAD
PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 14+400 TO STA. 14+700

B.MASON, P.ENG. Manager-Construction Services West	S.STODDARD, P.ENG. Project Manager

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0m VERTICAL	

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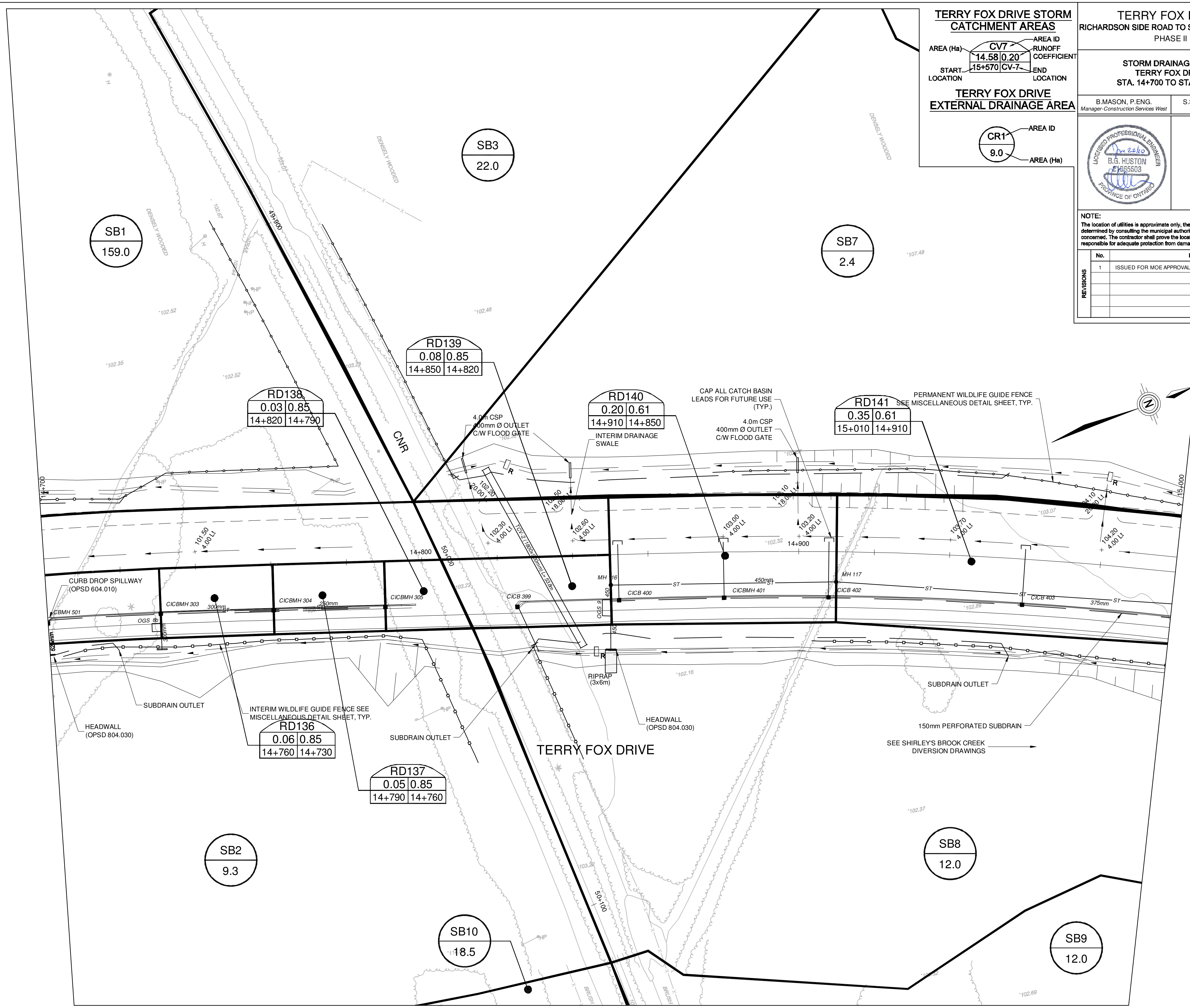

TERRY FOX DRIVE STORM CATCHMENT AREAS

CV7 — AREA ID
AREA (Ha) 14.58 — 0.20 RUNOFF COEFFICIENT
START LOCATION 15+570 — CV-7 END LOCATION

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID
9.0 — AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 14+700 TO STA. 15+000

B.MASON, P.ENG. Manager-Construction Services West

S.STODDARD, P.ENG. Project Manager

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Scale: HORIZONTAL 0m 5 10 20	VERTICAL 0m

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DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

ISB09-1518-410

TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 — AREA ID
14.58 | 0.20 — RUNOFF COEFFICIENT
START LOCATION — 15+570 | CV-7 — END LOCATION

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID
9.0 — AREA (Ha)

TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 15+000 TO STA. 15+300

B.MASON, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Project Manager

LICENSED PROFESSIONAL ENGINEER
B.G. HUSTON
PROVINCE OF ONTARIO

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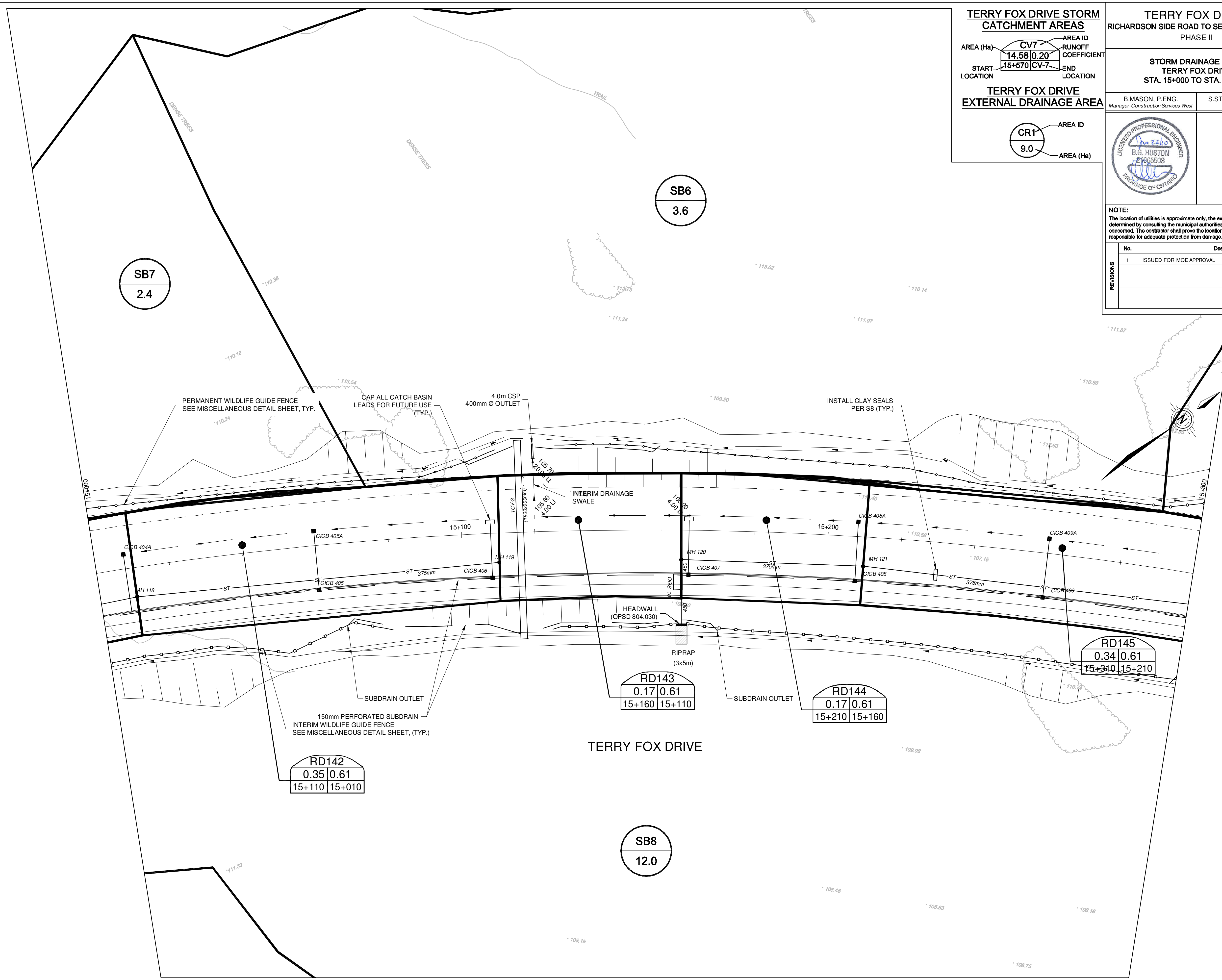

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TERRY FOX DRIVE
RICHARDSON SIDE ROAD TO SECOND LINE ROAD
PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 15+300 TO STA. 15+600

B.MASON, P.ENG. — Manager-Construction Services West
S.STODDARD, P.ENG. — Project Manager

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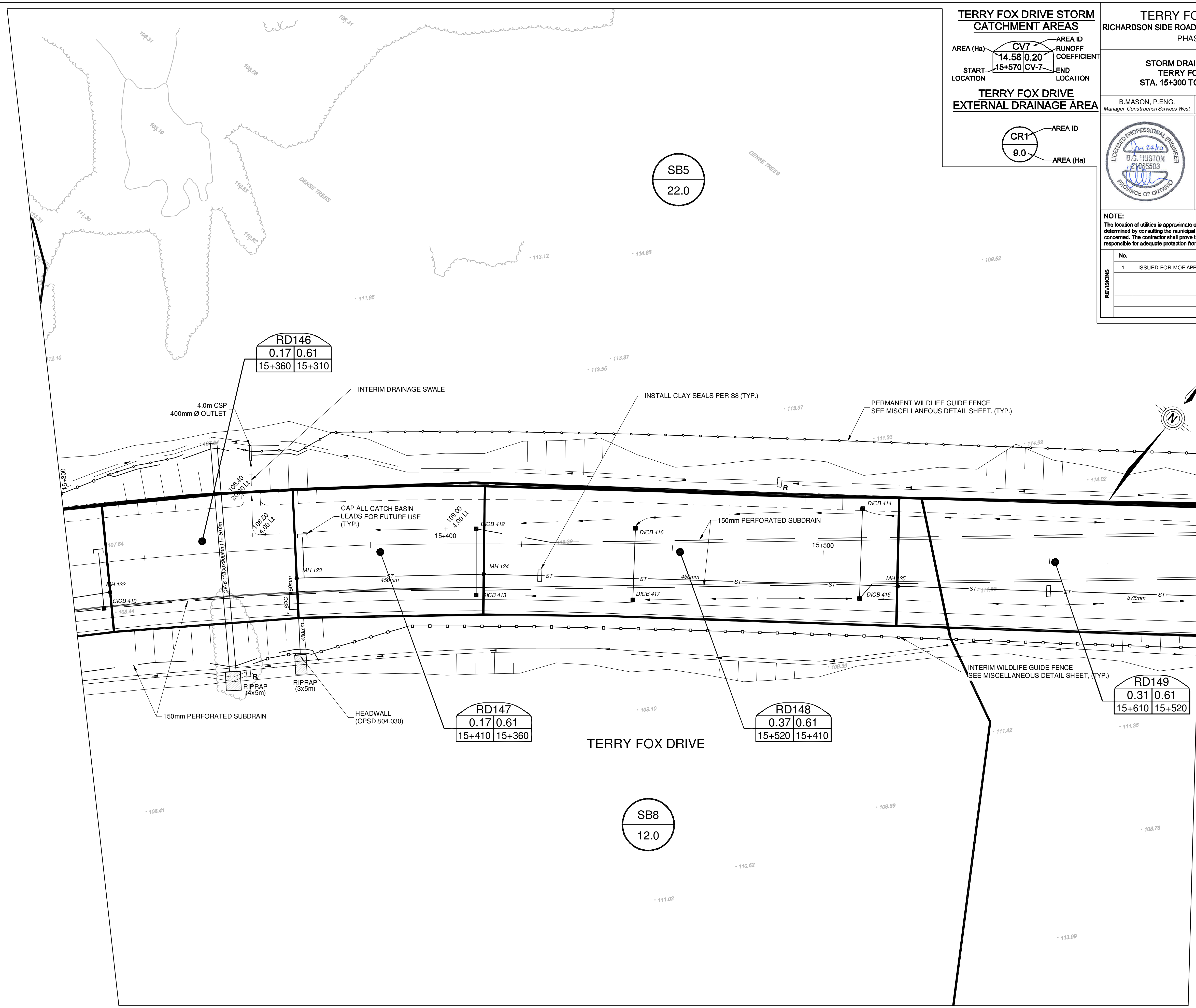
TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 — AREA ID; 14.58 | 0.20 — RUNOFF COEFFICIENT; START LOCATION 15+570 | CV-7 END LOCATION

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID; 9.0 — AREA (Ha)



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TERRY FOX DRIVE

RICHARDSON SIDE ROAD TO SECOND LINE ROAD

PHASE II

STORM DRAINAGE AREA
TERRY FOX DRIVE
STA. 15+600 TO STA. 15+900

B.MASON, P.ENG. — Manager-Construction Services West

S.STODDARD, P.ENG. — Project Manager

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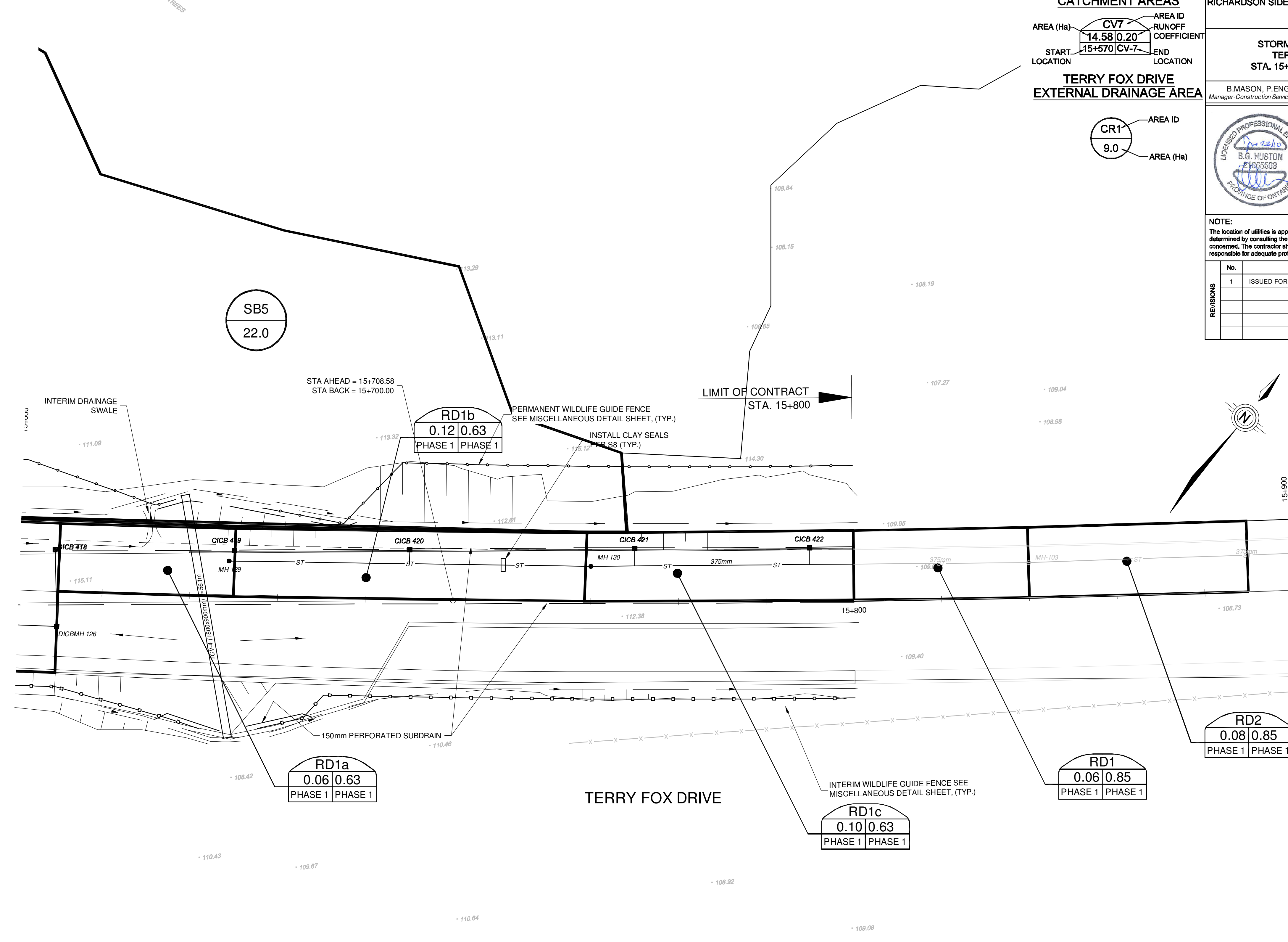
TERRY FOX DRIVE STORM CATCHMENT AREAS

AREA (Ha) — CV7 — AREA ID; 14.58 — 0.20 — RUNOFF COEFFICIENT; START LOCATION 15+570 — END LOCATION CV-7

TERRY FOX DRIVE EXTERNAL DRAINAGE AREA

CR1 — AREA ID; 9.0 — AREA (Ha)



APPENDIX C

Provincially Significant Wetlands (PSW)

Appendix C
Provincially Significant Wetlands (PSW)

Detailed Hydraulic Impact Analysis of Provincially Significant Wetlands

C.1 PSW 1 and 2 Existing and Proposed Conclusions

The impacted PSWs all fall within the Shirley's Brook subwatershed and represent headwater tributaries of the drainage system. The wetland complex that includes PSW 1, 2, 3 and 4 has a total area of approximately 327 ha and is comprised of low lying areas of swampland, marsh, open watercourses and fractured rock outcrops. The terrain within the wetland complex contributes greatly to the hydrologic variability within the drainage area. The area is described as having slopes ranging from very flat to very steep and having soil conditions ranging from pervious to completely impervious. **Figure C-1** illustrates the variability of the topography and the 'cascading' series of reservoirs that make up PSW 2, 3 and 4. These wetlands are either directly or indirectly linked via a series of natural channels that are commonly referred to as Shirley's Brook East. PSW 1, also found within the wetland complex, receives a majority of its surface water input from the areas south of the railway corridor. The open channel watercourse flowing through PSW 1 is commonly referred to as Shirley's Brook West. The PSW 2, 3 and 4 complex measures approximately 140 ha in area while the area contributing surface water flow to PSW 1 measures approximately 168 ha is size

PSW 1, illustrated in **Figure C-1**, is predominantly a marsh type of wetland, with two areas of mineral deciduous forest/willow thicket swamp at the east end. Geotechnical investigations in the area indicate clayey silts and silty clays, overlain by upwards of 360 mm of mineral organic soils exist along Shirley's Brook west. Several areas of the wetland appear perched above the water table, with the surface water trapped above the groundwater layer encountered at greater depths. Within marsh portions of the wetland, groundwater may play a greater role in supporting baseflow, but this is not the case in the eastern swamps near the Terry Fox Drive corridor.

The proposed roadway alignment bisects the lower portion of PSW 1. PSW 1 has a total area of 23.21 ha. The proposed roadway embankment isolates approximately 1.20 ha of wetland to the east of Terry Fox Drive. This leaves approximately 20.94 ha to the west of the proposed alignment. The area of right-of-way within the PSW is 1.06 ha and is located from Sta. 14+505 to 14+700. In total the Terry Fox Drive corridor occupies approximately 1.66 ha of the 187.2 ha area that contributes surface water runoff to PSW 1. This area represents approximately 0.89% of the PSW 1 drainage area and approximately 0.51% of the 327.2 ha wetland complex that includes PSW 1, 2, 3 and 4.

Within the PSW 1 area there are two local storm sewer outlets that service the right-of-way, storm outlet 7 and storm outlet 8. Storm outlet 8 is divided into two sub-sections. The storm sewer outlets 7, 8a and 8b include Oil-Grit-Separators for stormwater runoff quality control and discharge to the east of the proposed alignment into the small remnant area of PSW 1. Storm sewers 7 and 8 outlet to enhanced outlet channels that provide secondary treatment of stormwater runoff prior to discharging to Shirley's Brook. The local storm sewer systems were designed with small catchment areas and multiple outlets to mimic the hydrologic characteristics of the pre-development condition within this portion of the wetland complex.

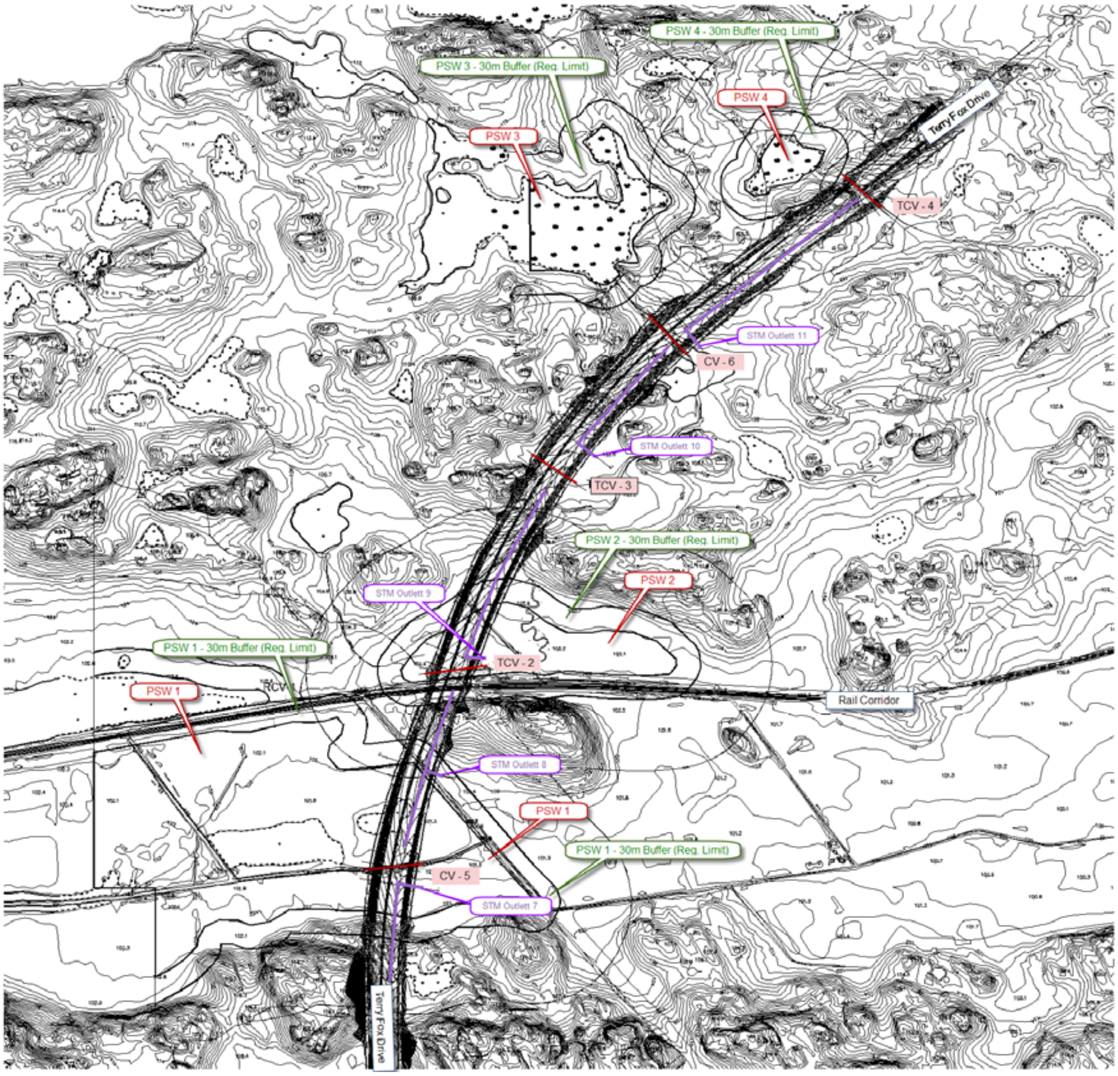


Figure C-1: PSW 2, 3 and 4 Topography

The portion of TFD that falls within PSW 1 has been designed to minimize the impact on the wetland. Design considerations implemented during detailed design include:

- Stormwater Pond 4A was initially proposed to be located on the eastern side of the roadway, but this was eliminated in favour of oil and grit separators (located within the roadway footprint).
- steepening of the roadway embankment side-slopes to reduce the footprint of the road through the PSW;
- introducing enhanced swales at the storm sewer outlets;
- lowering of the roadway profile to further reduce the footprint of the road through the PSW and minimize the length of the open-footing arch culvert that conveys Shirley's Brook flow through the right-of-way (CV-5); and,
- incorporation of a low gradient low-flow channel through CV-5 to allow fish passage during dry periods and assist with flow equalization during wet periods.

PSW 2, also illustrated in **Figure C-1**, measures approximately 2.06 ha is size. PSW 2 is almost entirely dry, even during the early spring. Thin organic soils, less than 240 mm deep, overlay silty clay soils which maintain imperfectly drained conditions, effectively trapping water at the surface. This is also a perched wetland, generally occurring above the groundwater table, and primarily supported by surface water. Geotechnical drilling through the area identified a distinct aquitard that inhibits upward movement of groundwater, maintaining the surface water as a separate system. Adjacent to the railbed, a longstanding beaverdam backs up water, aiding in the retention of some water in the wetland, but generally speaking without this dam, the wetland would be quite dry. The East branch of Shirley's Brook has been channelized through PSW 2, probably by a former land owner attempting to drain the lands to increase the agricultural lands.

Similar to PSW 1, the proposed Terry Fox Drive alignment bisects the westerly portion of PSW 2. The proposed roadway embankment separates approximately 0.14 ha of wetland to the west of Terry Fox Drive, leaving approximately 1.41 ha to the east. The roadway footprint within the PSW is 0.49 ha and is located from Sta 14+815 to Sta 14+950. In total the corridor occupies approximately 2.46 ha of the 139.96 ha area that contributes surface water runoff to PSW 2. This roadway area represents approximately 1.76% of the PSW 2 drainage area and approximately 0.75% of the 327 ha wetland complex that includes PSW 1, 2, 3 and 4.

The roadway will impact the existing channel of the East Shirley's Brook, relocating it to flow into PSW 2 from the east through a rock cut channel. This will require some direct excavation in the wetland. However the soils will be reused immediately in adjacent areas to restore the new creek bottom with wetland vegetation acclimatized to the area. The Terry Fox Drive Phase II contract drawings provide the plan view and details of where and how this watercourse channel will be constructed.

Within this section of roadway there are three local storm sewer outlets that service the right-of-way. The storm sewer outlets include Oil-Grit-Separators for stormwater runoff quality control (STM Outlet 9, 10 & 11) and discharge to the east of the proposed alignment into the Shirley's Brook Tributary that drains into PSW 2 or directly into the remnant PSW. Storm sewer Outlet 10 includes an enhanced outlet channel that provides secondary treatment of stormwater runoff prior to discharging to the realigned portion of Shirley's Brook. The local storm sewer systems were designed with small catchment areas and multiple outlets to mimic the hydrologic characteristics of the pre-development condition within this portion of the wetland complex. TCV-2, TCV-3 and CV-6 have been designed to allow the east and west sides of the TFD right-of-way to remain both hydraulically and physically connected. TCV-2 in particular provides direct hydraulic connectivity of the remnant PSW to the west of TFD to the remaining portion of PWS 2 to the east of the right-of-way.

The portion of TFD that falls within PSW 2 has been design to minimize the impact on the wetland. Design considerations implemented during detailed design include:

- Stormwater Pond 4B was initially proposed to be located on the eastern side of the roadway, but this was eliminated in favour of oil and grit separators (located within the roadway footprint).
- selection of appropriate outlet locations for local storm sewer systems that closely mimic the hydrologic function of the drainage areas;
- steepening of the roadway embankment side-slopes to reduce the footprint of the road through the PSW;
- introducing enhanced swales at the storm sewer outlets;
- lowering of the roadway profile to further reduce the footprint of the road through the PSW and minimize the length of the culverts that convey sheet flow and Shirley's Brook Tributary flow through the right-of-way (TCV-2, TCV-3, CV-6).

PSW 3 and 4 are located just west of the proposed Terry Fox Drive alignment. The proposed construction of the roadway embankment does not directly impact surface water contributions to either provincially significant wetland. In the case of PSW 4, the grading limits narrowly avoid the regulated 30m buffer zone. Based on grading activities within the right-of-way approximately 300 square meters of the PSW 4 drainage area will be diverted via roadside ditches to CV-6 and TCV-4.

C.2 PSW 1 and 2 Hydraulic Drainage Area Characteristics

In order to quantify the impacts that the construction of the Terry Fox Drive corridor will have on the hydrologic function of Shirley's Brook and to support the selection of the recommended stormwater management strategy that will potentially effect the Provincially Significant Wetlands, a detailed hydrologic investigation was undertaken. The primary purpose of the investigation was to quantify the changes in surface water flow regime entering and exiting the wetland complexes based on a quantitative comparison of pre and post construction flow rates, runoff volumes and resultant changes to projected water levels within PSW 1 and 2. The impact assessment was focused on demonstrating the PSWs assimilative capacity and ability to mitigate stormwater quantity impacts from flows from the Terry Fox Drive corridor through minor adjustment to the stage-storage characteristics of PSW 1 and 2. The primary goal adjusting the storage characteristics of PSW 1 and 2 was to achieve the required volumetric increase in storage to reduce post development peak flows leaving the wetlands while minimizing impact on the natural system.

As previously described, both PSW 1 and 2 are directly impacted by the construction of the Terry Fox Drive roadway embankment. PSW 3 and 4, although not directly impacted by construction activities, fall within the drainage areas that contribute flow to PSW 2. Alterations to the hydrologic characteristics of the PSW 3 and 4 subcatchment areas can have an affect on the hydrologic function of downstream resources. As part of the hydrologic investigation, the wetland complex drainage area was broken down into subcatchment areas. The Shirley's Brook pre and post development subcatchment areas and the relative locations of PSW 1, 2, 3 and 4 are illustrated in **Figure C-2**. The post-development subcatchment areas are annotated with reference IDs TFD1-TFD4. Post-development subcatchment areas reflect the hydrologic and hydraulic characteristics of the ultimate 4-lane roadway cross-section of Terry Fox Drive. **Table C-1** summaries the pre and post-development drainage area characteristics included in the hydrologic model. The SCS Type II 12-hour storm distribution was applied for all events with a 10 minute time step. The equivalent slope method was used to calculate the watershed slope for the time of concentration calculations. Segments approach zero slope through the pond reservoir areas were included in an effort to account for some the the attenuation expected from natural storage. CN and initial abstraction values where estimated based on a review of existing soils. Previous modelling work completed as part of the Watts Creek/Shirley's Brook subwatershed study in 1999 formed the bases for the selected model parameters, specifically with respect to the selection of the design storm distribution and initial abstraction values.

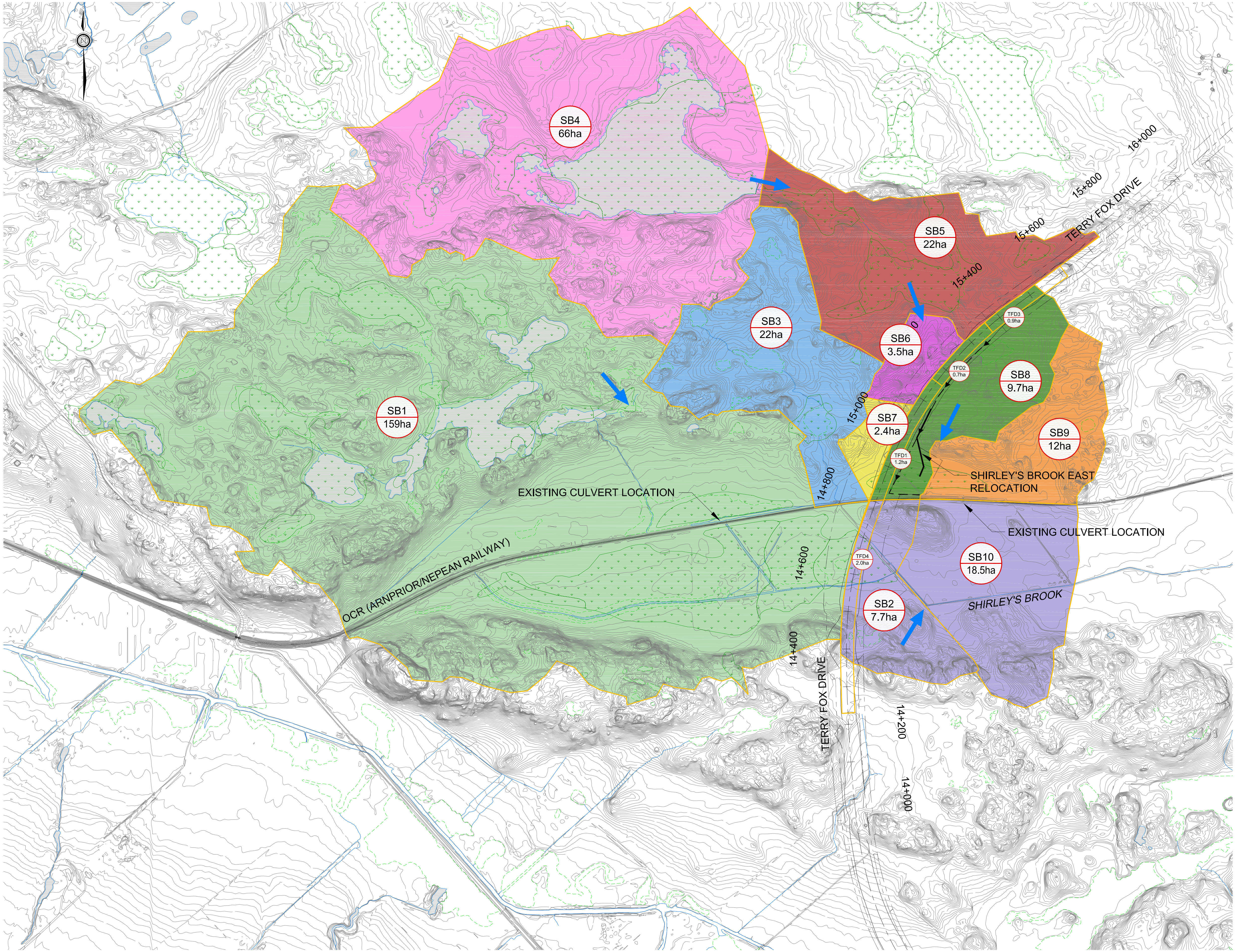


FIGURE C-2
DRAINAGE FEATURES OF SHIRLEY'S BROOK (ULTIMATE CONDITION)

TERRY FOX DRIVE EXTENSION
RICHARDSON SIDE ROAD TO SECOND LINE ROAD
STORMWATER MANAGEMENT REPORT

DILLON CONSULTING

DATE: JUNE 2010
SCALE: 1:10,000

09-1518

22 June 2010 4:14:58 PM G:\cad\2009\09-1518 Ottawa - Terry Fox Drive Final Design\Report Figures\SWM Report\FIG C-2 & 11 SMS- Drainage Features.dwg

Table C-1: Summary of Pre and Post-Development Hydrologic Drainage Area Characteristics

	Pre-Development Hydrologic Characteristics									
Hydrologic Parameter	**SB1**	**SB2**	**SB3**	**SB4**	**SB5**	**SB6**	**SB7**	**SB8**	**SB9**	**SB10**
Drainage Area (Ha)	158.9	9.33	21.69	65.92	22.19	3.57	2.4	12.15	12.02	18.5
Time to Peak (Hrs)	3.60	0.80	1.30	2.84	2.37	0.29	0.18	0.99	0.46	0.60
CN	55	68	50	50	50	50	50	68	68	68
Initial Abstration (IA)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	Post-Development Hydrologic Characteristics (Rural)									
Hydrologic Parameter	**SB1**	**SB2**	**SB3**	**SB4**	**SB5**	**SB6**	**SB7**	**SB8**	**SB9**	**SB10**
Drainage Area (Ha)	158.93	7.67	21.70	65.92	22.19	3.57	2.4	9.70	12.02	18.5
Time to Peak (Hrs)	3.60	0.75	1.30	2.84	2.37	0.29	0.18	0.99	0.46	0.60
CN	55	68	50	50	50	50	50	68	68	68
Initial Abstration (IA)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	Post-Development Hydrologic Characteristics (Urban)									
Hydrologic Parameter	**TFD 1**	**TFD 2**	**TFD 3**	**TFD 4**						
Drainage Area (Ha)	1.23	0.68	0.85	2.03						
Total Imperviousness (%)	0.61	0.61	0.61	0.61						
Directly Connected Imperviousness (%)	0.80	0.80	0.80	0.80						
Depression Storage (mm)	1.0	1.0	1.0	1.0						

C.3 PSW 1 and 2 Hydrologic Modelling

Based on the delineated drainage areas, pre and post-development VO2 models were created. The surface water model includes key features such as reservoirs representing PSW 1 and 2, as well as routed channels representing several key sections of Shirley's Brook East. Both reservoir and channel routing were key components of the model, particularly for the drainage area associated with PSW 2 because of the 'cascading' series of wetlands found within the upper portion of the drainage area. **Figure C-3** illustrates the schematic VO2 for the pre-development or existing condition and **Figure C-4** represents the post-development condition after the construction of the ultimate build-out of Terry Fox Drive.

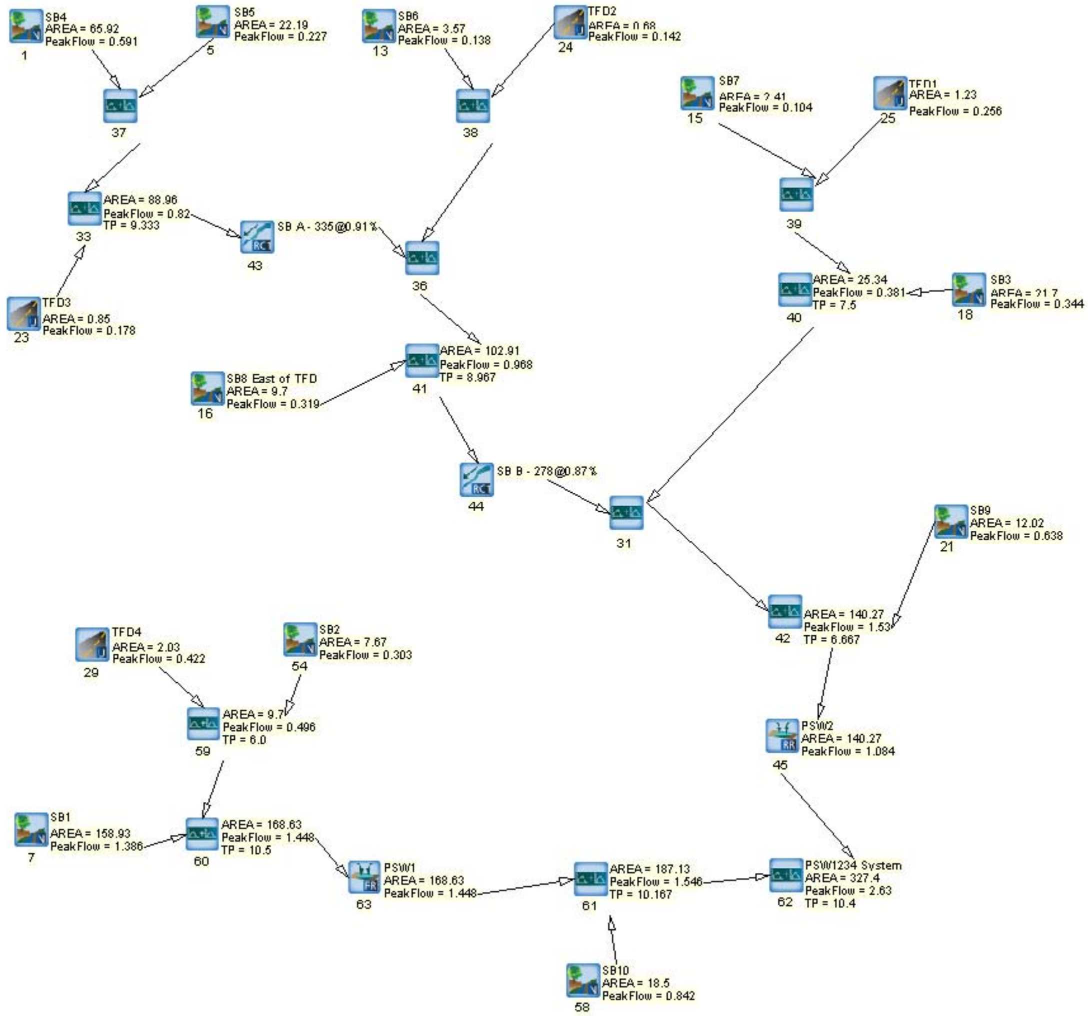


Figure C-3: Pre-Development Hydrologic VO2 Model Schematic

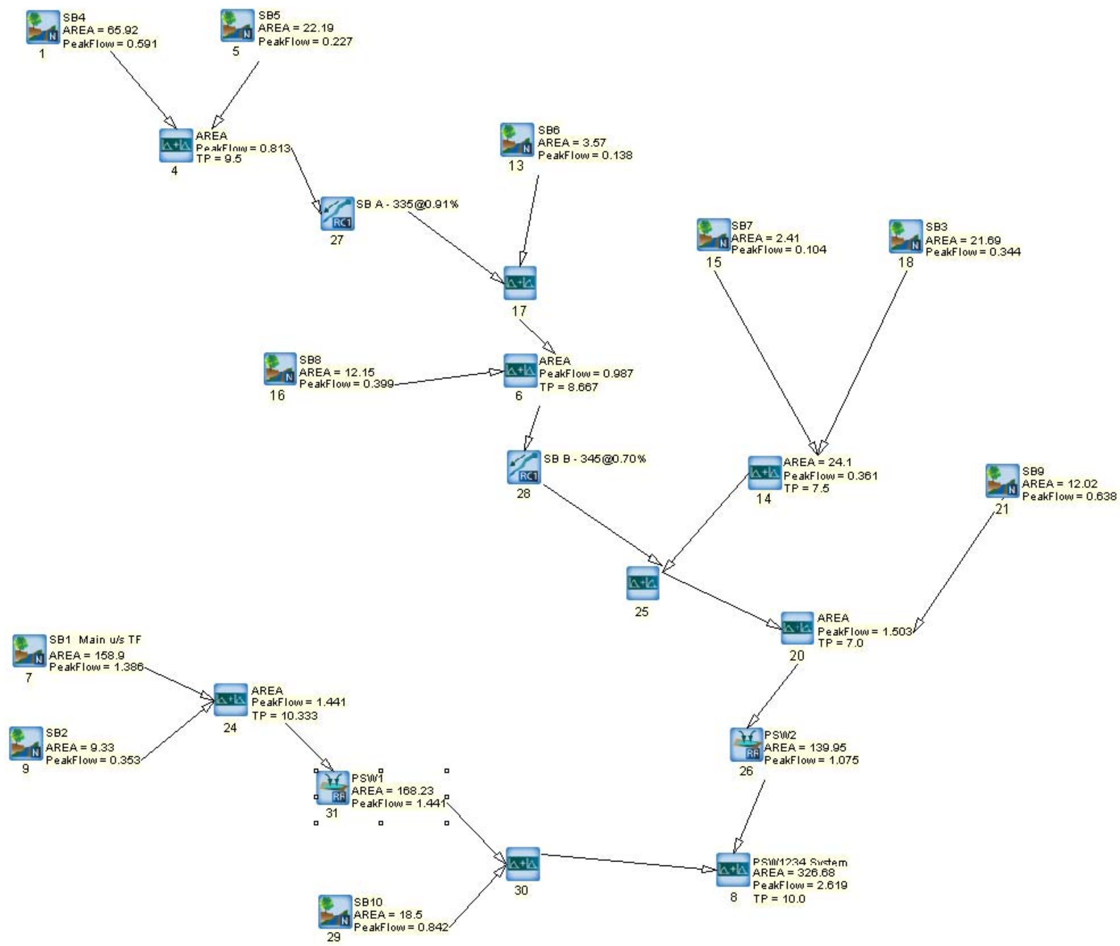


Figure C-4: Post-Development Hydrologic VO2 Model Schematic

The key additions to the post-development hydrologic model include the conversion of a portion of drainage areas SB2, SB5, SB6, and SB7 into StandHYD urban runoff modules, represented in the model by drainage areas TFD1, TFD2, TFD3 and TFD4. The addition of the urban drainage modules allowed quantification of the increased levels of imperiousness within those basins, the relative reduction in time of concentration, the reduction of infiltration losses and the resultant increase in peak flows.

C.4 PSW 1 and 2 Hydraulic Assessment

Both the pre and post-development hydrologic models include reservoir routing that represents available surface water storage within PSW 1 and PSW 2. The post-development storage characteristics have been modified from the original in order to accurately represent the addition of the TFD roadway embankment within the provincially significant wetlands. As illustrated on the Grading and Drainage design drawings, the design of the Terry Fox Drive corridor through PSW 1 includes low gradient flat bottom ditches along the left and right side of the corridor. These drainage features have been incorporated into the roadway cross-section to compensate for the loss of wetland storage under the constructed roadway embankment. CV-5 has also been design with a flat longitudinal gradient to allow flow equalization to occur from left to the right side of the roadway embankment during significant storm events. The net impact of constructing the roadway embankment through PSW 1 and incorporating low gradient ditches into the cross-section is a small loss in low-level storage within the basin and a small increase of high-level storage. The stage-discharge relationship for PSW 1 was also examined in detail as part of the pre and post-development reservoir routing exercise. The outlet of the storage basin consists of a section of natural channel that is somewhat restricted at the abandoned First Line Road allowance. A surveyed cross-section of the natural channel was used to define its hydraulic conveyance capacity at stages or headwater depths corresponding to the appropriate storage contour elevation.

Table C-2 summarizes the pre and post-development stage-storage-discharge relationship for PSW 1, this relationship was used to define the pre and post-development reservoir routing characteristics in the VO2 model.

Table C-2: Pre and Post-Development Stage-Storage-Discharge Relationship – PSW 1

Contour Elevation (masl)	Pre-Development Cumm. Basin Storage (Ha-m)	Post-Development Cumm. Basin Storage (Ha-m)	Corresponding Discharge Rate from Basin (cms)
100.00	0	0	0
101.00	0.0149	0.0097	2.64
101.25	0.0274	0.0516	4.46
101.50	0.2317	0.2518	7.62

Similar to the configuration of Terry Fox Drive through PSW 1, the corridor through PSW 2 includes a configuration of roadside ditches along the left and right side of the roadway embankment. The addition of these low-gradient flat bottom ditches provides some compensation for lost storage now occupied by the fill of the road embankment. TCV-2 has also been designed with a flat longitudinal gradient to allow flow equalization to occur during significant storm events. Unlike PSW 1, PSW 2 has an extensive amount of surface storage that extends outside the formal limits of the PSW. Utilization of this storage basin is made possible by a hydraulic restriction at the outlet of the basin. The net impact of constructing TFD through PSW 2 is that there is a gain of low-level storage within the basin and a reduction of high-level storage. The stage-discharge relationship for PSW 2 was established based on the characteristics of the outlet culvert that conveys flow from north to south through the rail corridor. Survey data was again utilized in order to define the culvert's hydraulic conveyance capacity at stages or headwater depths corresponding to the appropriate storage contour elevation.

Table C-3 summarizes the pre and post-development stage-storage-discharge relationship for PSW 2, this relationship was used to define the pre and post-development reservoir routing characteristics in the VO2 model.

Table C-3: Pre and Post-Development Stage-Storage-Discharge Relationship – PSW 2

Contour Elevation (masl)	Pre-Development Cumm. Basin Storage (Ha-m)	Post-Development Cumm. Basin Storage (Ha-m)	Corresponding Discharge Rate from Basin (cms)
101.00	0	0	0
101.50	0.0021	0.0021	0
102.00	0.0361	0.0700	0.32
102.50	0.8036	0.7927	1.06
103.00	2.8392	2.6102	1.71

C.5 PSW 1 and 2 Post Development Hydrologic Assessment

The effects of urbanization on peak flows and runoff volumes have been well documented over the years. Increased levels of imperviousness not only reduce times of concentration and increase resultant peak flows but it allow reduces opportunities for infiltration therefore increasing runoff volumes. Although the urban StandHYD modules represented in the VO2 model by TFD1, TFD2, TFD3 and TFD4 only represent a small portion of the total drainage area contributing flows to PSW 1 and PSW 2, their high levels of imperviousness have a measurable impact on peak flows and runoff volumes.

In order to illustrate the impact of the project within the contributing drainage areas of PSW 1 and PSW 2 the surface water inflow hydrographs for the 2-year design storm are presented in **Figure C-5**.

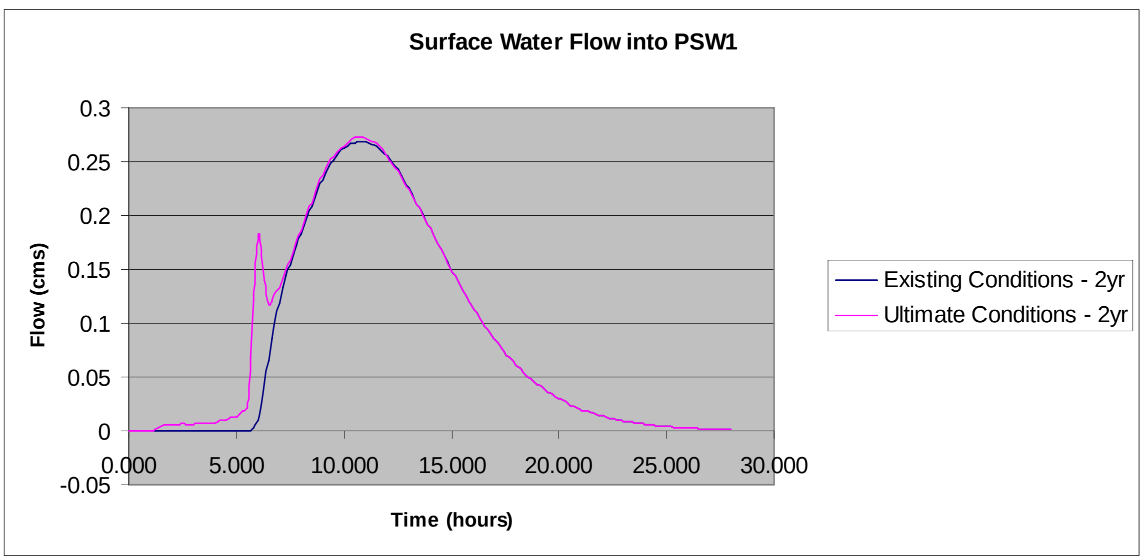


Figure C-5: PSW 1 Inflow Hydrograph

The resulting post-development inflow hydrograph to PSW 1 is very typical of what would be observed when urban development takes place within the lower reaches of a drainage basin. The increase in imperviousness and time of concentration reduction within the small catchment areas at the bottom end of the system creates a spike in the hydrograph that occurs well before the overall peak flow experienced by the system. The increased level of imperviousness and any resultant increase in peak flow occurs over a relatively short duration and is well below the system peak flow rate.

Table C-4 provides a summary of the return period peak flows and runoff volumes for the pre and post-development hydrologic model. The model node reference is located just downstream of TFD and includes contributions from approximately 1.740 ha of drainage area routed through West Shirley's Brook.

Table C-4: Hydrologic Output Summary – PSW 1

Return Period	Pre-Development Model Peak Flow (cms)	Pre-Development Model RV (mm)	Pre-Development Model Runoff Volume (cu m)	Post-Development Model Peak Flow (cms)	Post-Development Model RV (mm)	Post-Development Model Runoff Volume (cu m)
2-year	0.27	4.91	8260	0.27	5.27	8887
5-year	0.51	9.34	15712	0.52	9.79	16509
10-year	0.71	12.91	21718	0.72	13.40	22596
25-year	0.99	17.95	30197	1.00	18.50	31197
50-year	1.21	21.82	36707	1.22	22.42	37807
100-year	1.44	25.95	43655	1.45	26.59	44839

The resultant post-development inflow hydrograph to PSW 2 is also very typical of what would be observed when urban development takes place within the middle and lower reaches of a drainage basin, shown in **Figure C-6**.

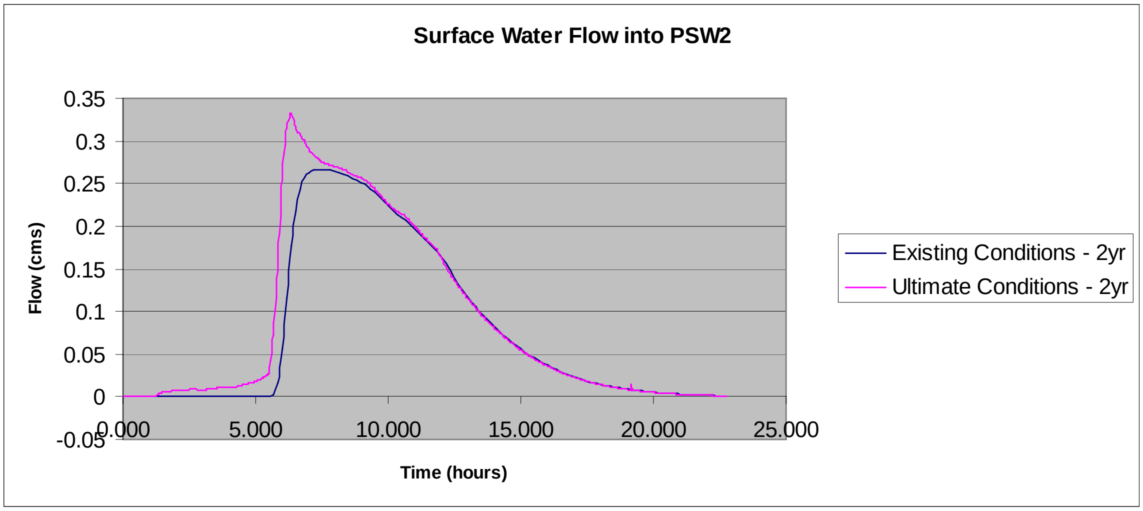


Figure C-6: PSW 2 Inflow Hydrograph

The decreases in time of concentration and increase in peak flow of the lower and middle basins overlap with the time of concentration of the overall basin is such a way that there is a measurable increase in peak flow. Routing of surface water flows through Shirley's Brook East also contributes to the shape of the hydrograph entering PSW 2 from the upstream drainage areas.

Table C-5 provides a summary of the return period peak flows and runoff volumes for the pre and post-development hydrologic model. The model node reference is located just upstream of PSW 2 and includes contributions from approximately 140 ha of drainage area routed through Shirley's Brook East.

Table C-5: Hydrologic Output Summary – PSW 2

	Pre-Development Model			Post-Development Model		
Return Period	Peak Flow (cms)	RV (mm)	Runoff Volume (cu m)	Peak Flow (cms)	RV (mm)	Runoff Volume (cu m)
2-year	0.27	4.59	6424	0.33	5.17	7259
5-year	0.52	8.75	12247	0.58	9.47	13296
10-year	0.73	12.09	16921	0.78	12.89	18098
25-year	1.03	16.82	23541	1.07	17.72	24879
50-year	1.26	20.47	28650	1.29	21.43	30088
100-year	1.50	24.36	34094	1.53	25.38	35634

C.6 Hydrologic and Hydraulic Analysis Results Summary

As expected, alterations to the hydrologic characteristics of the drainage areas contributing surface water flow to PSW 1 and PSW 2 have an impact on the rate and volume of flow entering the provincially significant wetlands. Since the natural function within the wetland complexes could be impacted by changes in the resultant water level fluctuations within the storage basins the pre and post-development storage characteristics and resultant outflow hydrographs of the PSW basins were examined in detail for the 2-year 12-hour SCS distribution design storm event.

Figure C-7 illustrates the comparison of inflow and outflow hydrographs for the 2 and 100-year design storm event for PSW 1. As illustrated there is a small spike in runoff rate resulting from the impervious drainage areas within the new corridor that occurs in advance of the overall time of concentration of the external drainage basin.

The detailed VO2 output indicates that approximately 0.0015 ha-m of available storage in the pre-development model was utilized by the wetland basin which, as illustrated, results in a zero cms reduction in peak flow through the wetland for the 2-year design storm. Approximately 0.0015 ha-m of available storage was also utilized by the post-development wetland basin, resulting in negligible reduction in peak flow through the wetland. The peak outflow for the pre and post-development wetland basin are 0.27 cms and 0.27 cms respectively for the 2-year design storm.

Similarly, approximately 0.0081 ha-m of available storage in the pre-development model was utilized by the wetland basin for the 100-year design storm. Approximately 0.0053 ha-m of available storage was utilized by the post-development wetland basin. The peak outlflow for the pre and post-development wetland basin are 1.44 cms and 1.45 cms respectively for the 100-year design storm.

The stage-storage relationship and outlet configuration of PSW 1 results in very little reduction in peak flows through the wetland from attenuation within the storage basin for the pre and post-development hydrologic conditions. The small reduction in utilized storage and small increase in peak outflow for the post-development condition is consistent with the alterations to the stage-storage relationship of the basin resulting from construction of the Terry Fox Drive roadway embankment.

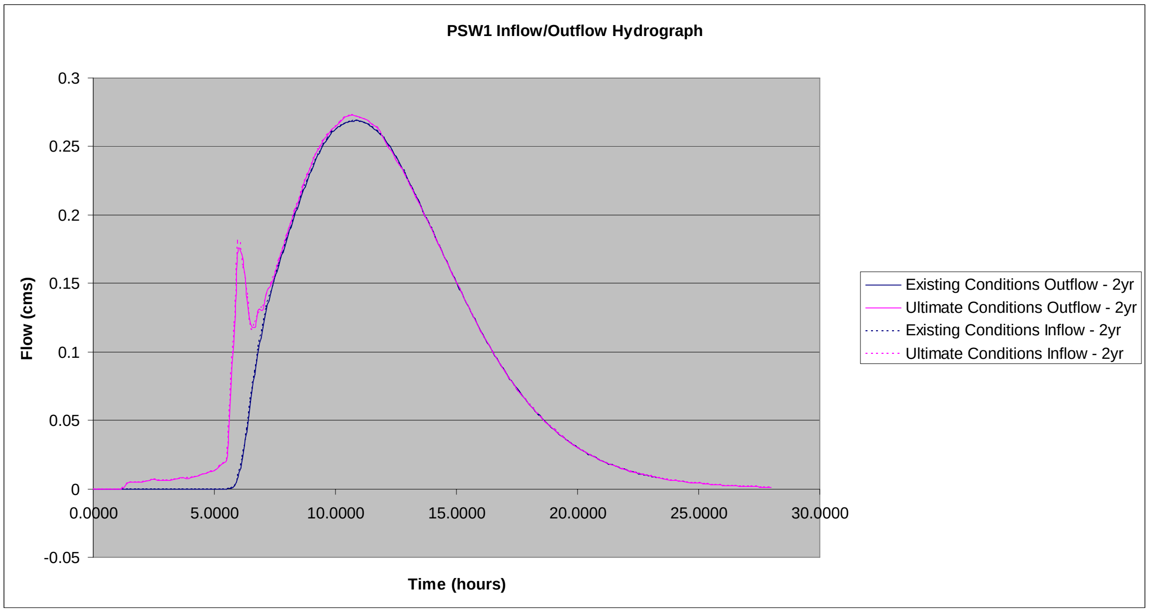


Figure C-7: Comparison of Inflow and Outflow Hydrographs – PSW 1

Table C-6 provides a summary of the pre and post-development hydrologic/hydraulic output for the 2 and 100-year 12-hour SCS Type II distribution design storm. The peak outflow values represent design flows leaving the PSW after routing and attenuation through the wetland storage basin. Table C-6 also provides a summary of the utilized storage volumes and projected water levels within the wetland storage basins for the 2 and 100-year design storm events.

Table C-6: Hydrologic/Hydraulic Output Summary – PSW 1

	Pre-development Model			Post-development Model		
Return Period	Peak Outflow (cms)	Utilized Storage (Ha-m)	Projected Water Level (masl)	Peak Outflow (cms)	Utilized Storage (Ha-m)	Projected Water Level (masl)
2-year	0.27	0.0015	100.000	0.27	0.0010	100.000
100-year	1.44	0.0081	100.000	1.45	0.0053	100.000

Several observations regarding the pre and post-development hydrologic characteristics of PSW 1 can be made, including:

- the controlling PSW outlet (natural channel at First Line Road allowance) does not provide a significant hydraulic restriction for flows generated by the upstream drainage areas
- the lack of an outlet restriction conveys flows through the PSW without utilizing available storage for the lower return interval storms while utilizing a very small portion of available storage for the larger more infrequent storms

- modifications made to the storage characteristics of the reservoir have a small impact on the relative water levels within the PSW but the outflow characteristics remain very similar based on the fact the inflow hydrograph peaks are the same for pre and post-development conditions
- the net impact on flows is that the post-development PSW discharges at a rate less that 0.01 cms higher than the pre-development PSW for the 2 through 100-year design storm event
- the proposed modifications to the stage-storage relationship of PSW 1 provides stormwater quantity control for the additional runoff generated by the improved Terry Fox Drive roadway corridor, reducing post-development flow rates to a level that very closely reflects pre-development conditions
- the hydrologic characteristics of the initial 2-lane roadway cross-section will result in proportionally reduced stormwater quantity impacts to PSW 1 and the ultimate receiving water system, Shirley's Brook

Figure C-8 illustrates the comparison of inflow and outflow hydrographs for the 2 and 100-year design storm event for PSW 2. As illustrated the combination of the outlet restriction and available storage results in the reduction in peak flows through the wetland. The detailed VO2 output confirms that approximately 0.0566 ha-m of available storage in the pre-development model was utilized by the wetland basin which, as illustrated, results in a 0.01 cms reduction in peak flow through the wetland for the 2-year design storm. Approximately 0.0604 ha-m of available storage was utilized by the post-development wetland basin, resulting in a 0.06 cms reduction in peak flow through the wetland. The peak outflow for the pre and post-development wetland basin are 0.26 cms and 0.27 cms respectively for the 2-year design storm.

Similarly, approximately 0.8250 ha-m of available storage in the pre-development model was utilized by the wetland basin, resulting in a 0.43 cms reduction in peak flow through the wetland for the 100-year design storm. Approximately 0.8509 ha-m of available storage was utilized by the post-development wetland basin, resulting in a 0.45 cms reduction in peak flow through the wetland. The peak outlflow for the pre and post-development wetland basin are 1.50 cms and 1.53 cms respectively for the 100-year design storm.

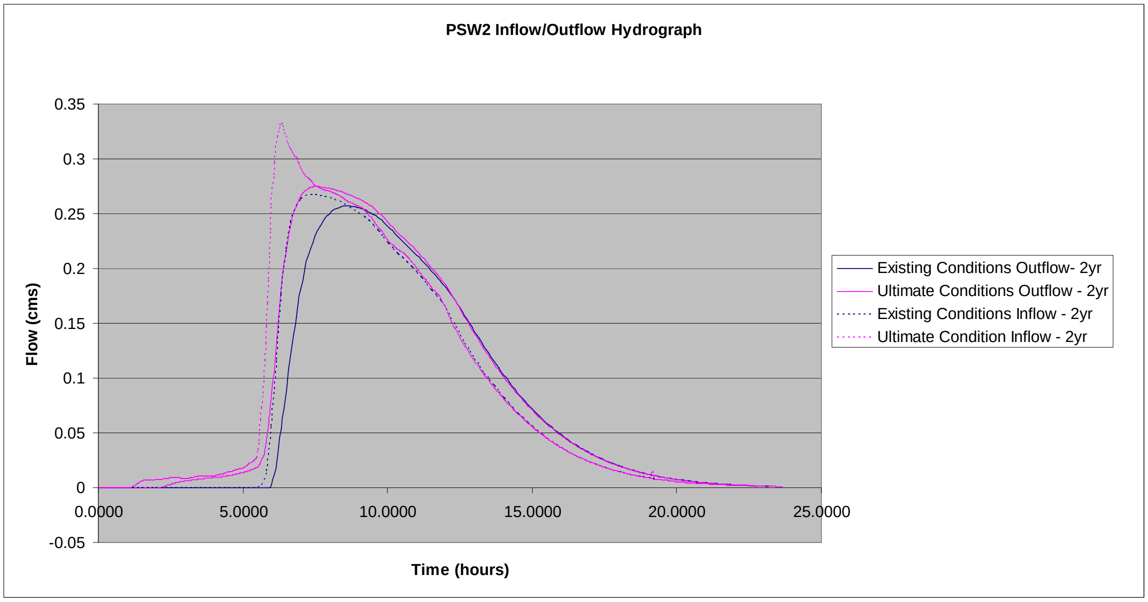


Figure C-8: Comparison of Inflow and Outflow Hydrographs – PSW 2

Table C-7 provides a summary of the pre and post-development hydrologic/hydraulic output for the 2 and 100-year 12-hour SCS Type II distribution design storm. The peak outflow values represent design flows leaving the PSW after routing and attenuation through the wetland storage basin. Table C-6 also provides a summary of the utilized storage volumes and projected water levels within the wetland storage basins for the 2 and 100-year design storm events.

Table C-7: Hydrologic/Hydraulic Output Summary – PSW 2

	Pre-development Model			Post-development Model		
Return Period	Peak Outflow (cms)	Utilized Storage (Ha-m)	Projected Water Level (masl)	Peak Outflow (cms)	Utilized Storage (Ha-m)	Projected Water Level (masl)
2-year	0.26	0.0567	102.032	0.27	0.0604	101.999
100-year	1.07	0.8254	102.589	1.08	0.8509	102.712

Several observations regarding the pre and post-development hydrologic characteristics of PSW 2 can be made, including:

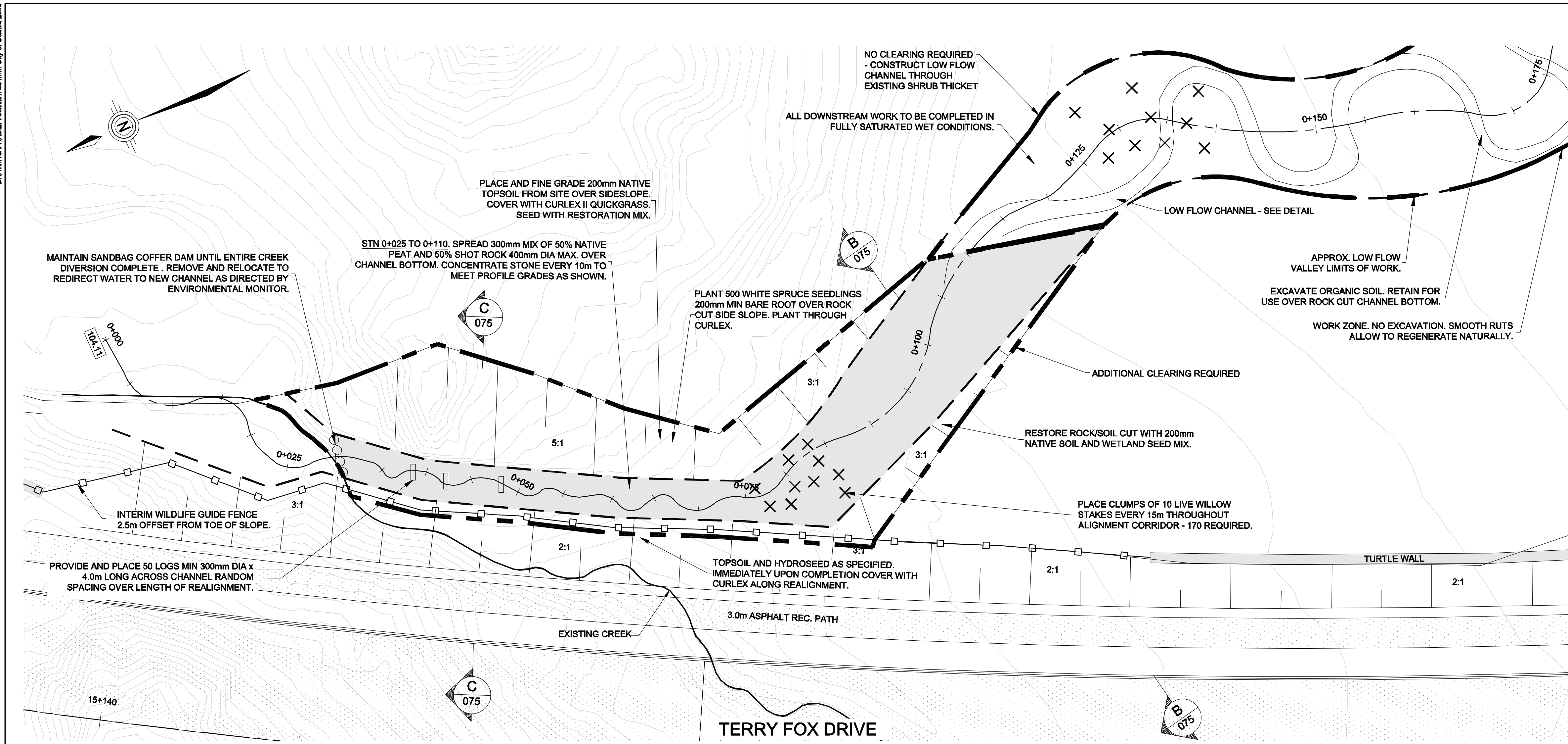
- the controlling PSW outlet (culvert through the rail corridor) provides a significant hydraulic restriction within the drainage system and may be one of the key factors in the formation of PSW 2
- the outlet restriction and available storage within the wetland basin provides significant peak flow attenuation through a range of design storms and likely protects downstream conveyance systems from erosion and scour from high peak flows
- the construction of the Terry Fox Drive roadway corridor and addition of low-gradient roadside ditches through PSW 2 provides compensation for the addition of the roadway embankment through the wetland basin. The post-development basin provides slightly

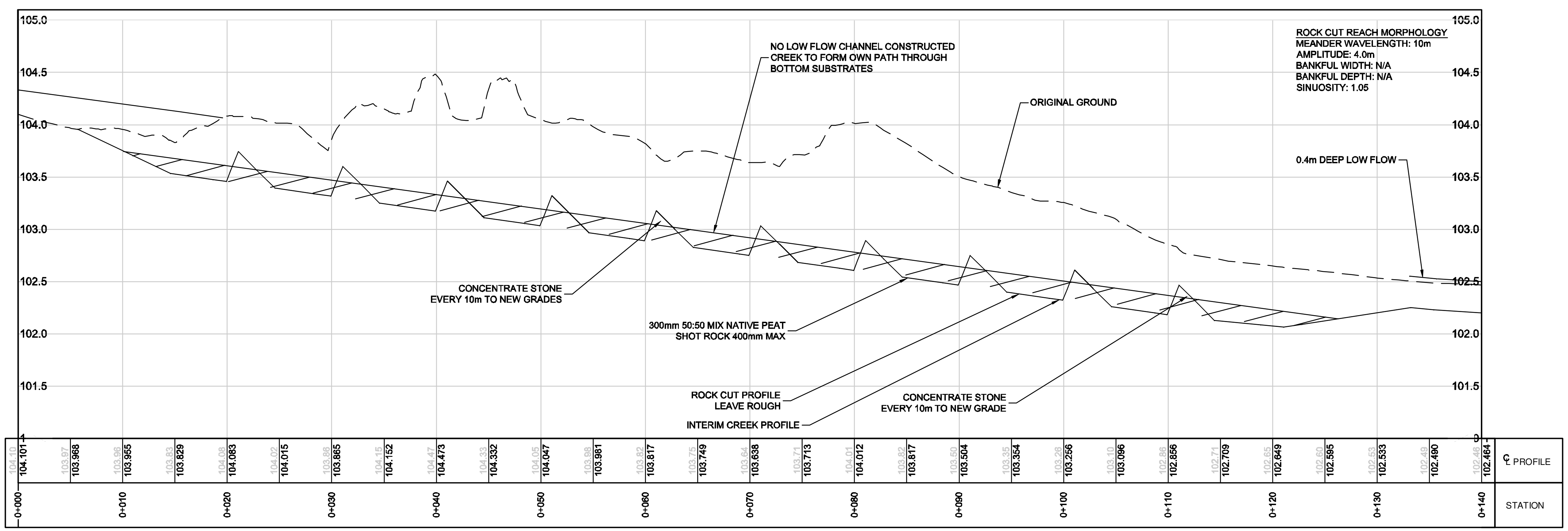
more low-level storage than the pre-development basin and a small reduction in high-level storage

- the changes to the hydrologic characteristics of the Terry Fox Drive drainage areas, modifications to the stage-storage characteristics of the wetland basin, and resultant water levels within the basin, demonstrate PSW 2's ability to provide stormwater quantity control of runoff generated by the improved corridor for all design storms ranging from the 2 to 100-year storm event without significantly impacting the projected hydrologic function of the wetland.
- the proposed modifications to the stage-storage relationship of PSW 2 provides stormwater quantity control for the additional runoff generated by the improved Terry Fox Drive roadway corridor, reducing post-development flow rates to a level that very closely reflects pre-development conditions
- the hydrologic characteristics of the initial 2-lane roadway cross-section will result in proportionally reduced stormwater quantity impacts to PSW 2 and the ultimate receiving water system, Shirley's Brook

APPENDIX D

Shirley's Brook East Relocation Detail





TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD

PHASE TWO

SHIRLEY'S BROOK CREEK DIVERSION
STA. 0+000 TO STA. 0+180

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

Contract No. ISB09-5123
Dwg. No. 073
Sheet 073 of 101
Asset No.
Asset Group
Des. S.R.T. Chk'd. B.G.H.
Dwn. C.G.P. Chk'd. B.G.H.
Utility Circ. No.
Index No.
Const. Inspector
Scale: HORIZONTAL 0m 2.5 5 10; VERTICAL 0m 0.5 1

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

DILLON CONSULTING

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	ADDENDUM 2	M.J.F.	23-03-10
2	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
3	CCN2-03 ADDTIONAL CLEARING AREA ADDED	D.Y.O.	08-06-10

NOTE:
CONSTRUCTION OF CLEARLY-DEFINED LOW FLOW CHANNEL NOT REQUIRED 0+000 TO 0+110.

REMOVAL LEGEND

NO CLEARING REQUIRED

NO CLEARING REQUIRED
- CONSTRUCT LOW FLOW CHANNEL THROUGH EXISTING SHRUB THICKET

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

ISB09-5123-073

22 June 2010 3:25:55 PM G:\CAD\091518\Civil\Production Drawings\ISB09-5123-073-lcd1.dwg

TERRY FOX DRIVE

RICHARDSON SIDEROAD TO SECOND LINE ROAD

PHASE TWO

SHIRLEY'S BROOK CREEK DIVERSION
STA. 0+180 TO STA. 0+248.72

Contract No.	Dwg. No.
ISB09-5123	074

Sheet 074 of 101

Asset No.

Asset Group

Des.	S.R.T.	Chk'd.	B.G.H.
Dwn.	C.G.P.	Chk'd.	B.G.H.
Utility Circ. No.		Index No.	

Const. Inspector

Scale: HORIZONTAL 0m / 0m VERTICAL

R.HOLDER, P.ENG.
Manager-Construction Services West

S.STODDARD, P.ENG.
Senior Project Engineer

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

DILLON CONSULTING

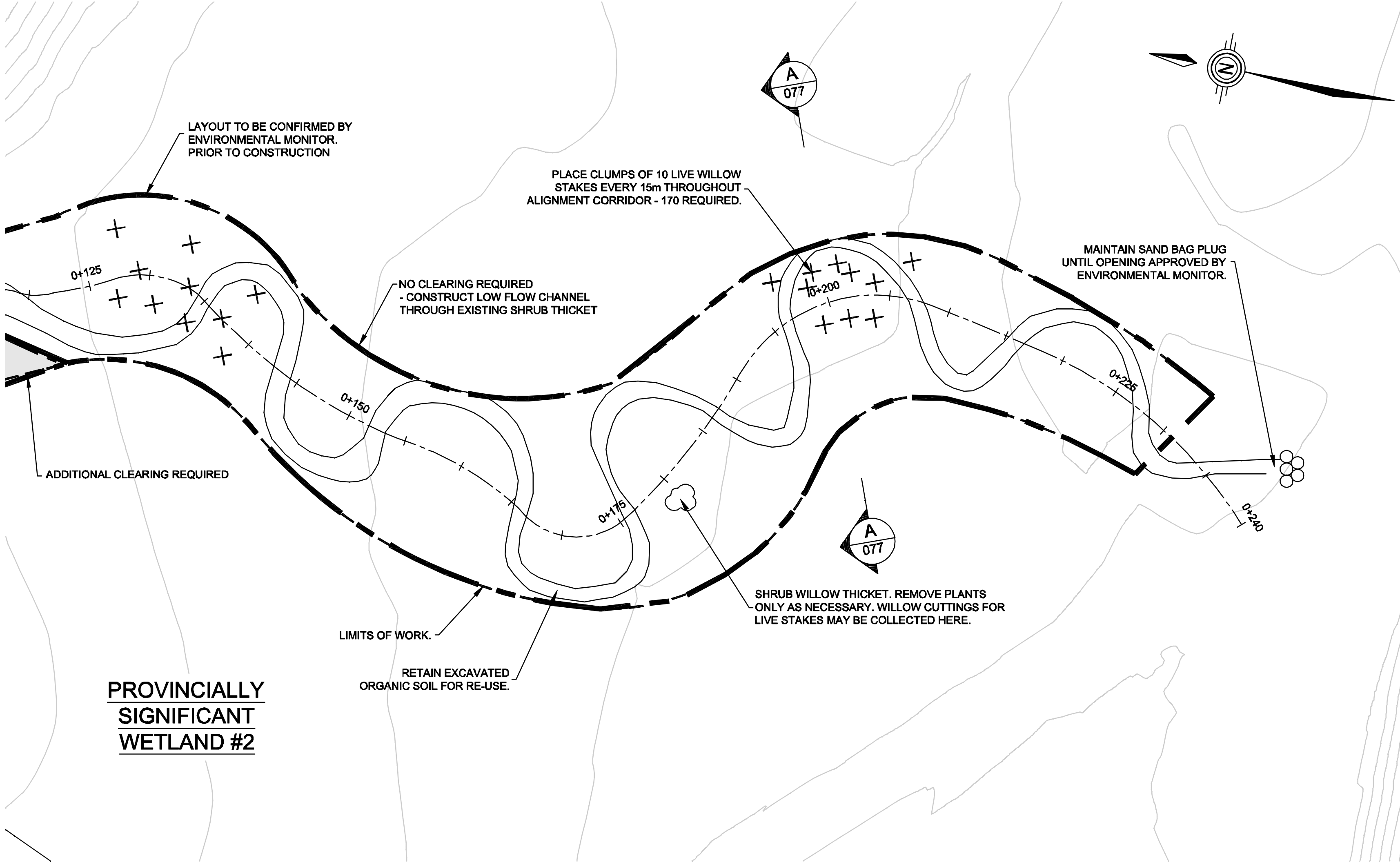
REVISIONS

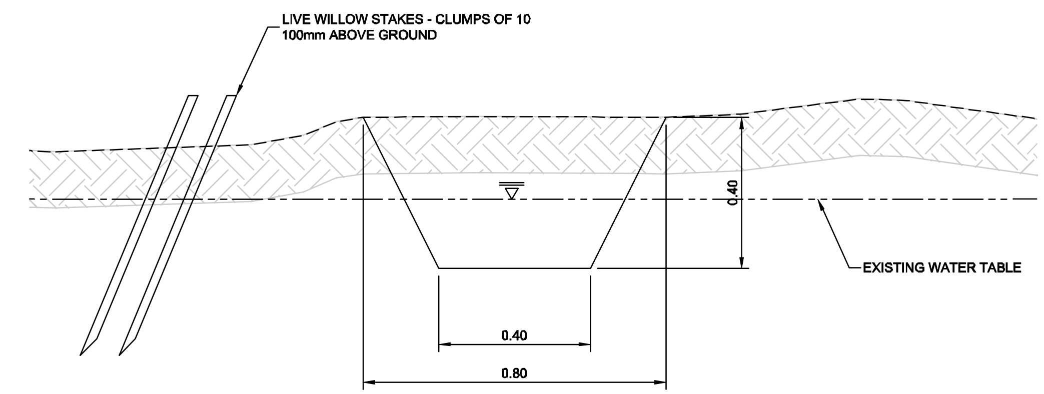
No.	Description	By	Date (dd/mm/yy)
1	ADDENDUM 2	M.J.F.	23-03-10
2	ISSUED FOR CONSTRUCTION	M.J.F.	12-05-10
	JUNE 2010 DESIGN REVISIONS	M.J.F.	18-06-10

REMOVAL LEGEND

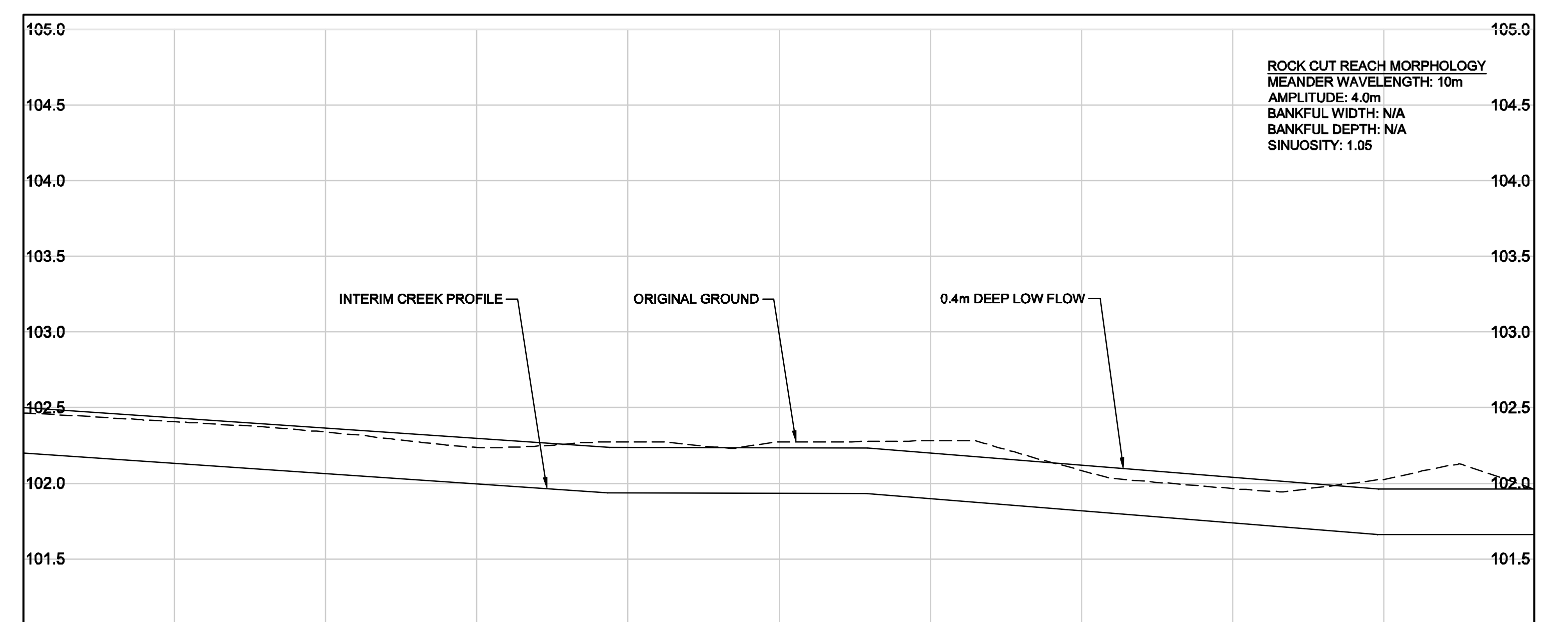
NO CLEARING REQUIRED

NO CLEARING REQUIRED
- CONSTRUCT LOW FLOW CHANNEL THROUGH EXISTING SHRUB THICKET





SECTION A-A - TYPICAL BEAT CUT SECTION WITH WILLOW STAKES
N.T.S.



STATION	℄ PROFILE (grey)	℄ PROFILE
0+140	102.46	102.464
	102.44	102.437
0+150	102.41	102.407
	102.38	102.379
0+160	102.34	102.338
	102.29	102.286
0+170	102.24	102.237
	102.25	102.252
0+180	102.28	102.275
	102.25	102.247
0+190	102.27	102.274
	102.28	102.275
0+200	102.28	102.281
	102.22	102.223
0+210	102.08	102.084
	102.01	102.007
0+220	101.96	101.965
	101.96	101.964
0+230	102.03	102.025
	102.13	102.127
0+239.93	101.96	101.961