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SOCIÉTÉ IMMOBILIÈRE DU CANADA

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Former CFB Rockcliffe Master Servicing Study

IBI

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by IBI Group
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1 Introduction

1.1 Background

The former Canadian Forces Base (CFB) Rockcliffe has a long and honourable history of service to the Canadian public. The base was originally established by the Department of Defence in 1898 and at its peak totalled more than 326 ha. Over the years, the base has provided a wide assortment of military support operations beginning originally as a rifle range and broadening into a permanent airbase and an experimental aerial photography station in the 1920s.

The base continued as the headquarters of the Air Marshal Command into the 1950s and during the period following the Second World War, 467 housing units were built on the site to accommodate the short-term housing needs of returning military personnel.

In the 1960s, air operations at the base were terminated and by 1984 the Department of National Defence (DND) had indicated that its operational facilities were to be vacated. The residential component of the base, however, was to be retained for a short period. Today, no DND buildings remain on the site.

Over the years, large portions of the original site have been transferred from DND to other departments and agencies including the Royal Canadian Mounted Police (RCMP), the National Research Council (NRC), the National Capital Commission (NCC) and the Canadian Aviation and Space Museum, among others. The remaining property owned by DND totalled approximately 135 ha.

By the mid-1990s, the former CFB Rockcliffe site was identified as a potential major land disposal candidate for transfer to Canada Lands Company (CLC). Negotiations continued between CLC, DND and the Treasury Board Secretariat (TBS) for the ultimate transfer of the lands to CLC for development. The transfer occurred in 2011.

The acquisition of the decommissioned base by CLC offers the opportunity today to reconnect this site back into the urban fabric of the City and create a highly desirable mixed-use community for approximately 9,500 residents. The long-term development period to full build out is estimated to be 15-20 years. There is also the opportunity to provide space for a variety of employment uses providing up to 2,500 permanent jobs.

Due to the proximity to the downtown, the new community will allow for more intensive development than in the outer suburbs, yet at a lower scale than one would see closer to the core.

A variety of housing types will be built to provide a range of choices for people with different housing needs. A community core will have the greatest mix of land uses to provide amenities to the new neighbourhoods, and it will also have the most active and vibrant streets in the community.

1.2 Study Area

The study area measures 130.6 ha and is made up of 125.3 ha of CLC lands, and a 5.3 ha parcel of NRC lands located northeast of Montreal Road and Burma Road. The study area location is indicated on **Figure 1.1** and is situated on a plateau overlooking the Ottawa River and Gatineau Hills. It is bordered on the west by the Aviation Parkway; on the north by the Rockcliffe Parkway; on the east by the NRC Campus; and on the south by established residential communities (Thorncliffe Village, Fairhaven and Foxview) as well as the Montfort Hospital and Montfort Hospital Woods. The Rockcliffe Airport is also located in the vicinity of the site immediately to the north of the Rockcliffe Parkway.

There are currently three access points to the study area. Codd's Road extends north to the site from Montreal Road. From the west, access is from Hemlock Road, a two lane road which links with St. Laurent Boulevard and provides access to the Aviation Parkway. The third access point is through the NRC Campus to the east. Currently, this access is only open during business hours.

1.3 External Areas

Due to topography, existing drainage and municipal servicing, several adjacent areas external to the study area have been considered. They are summarized below and identified on **Figure 1.2**.

- Existing NRC Campus east of the study area;
- existing Thorncliffe Village, Foxview and Fairhaven residential developments south of the study area;
- portion of Codd's Road abutting study area to the south
- existing Montfort Hospital and Montfort Hospital Woods;
- existing NCC lands located between the study area and the Rockcliffe Parkway; and
- existing NCC lands identified as future museum site, abutting the study area to the northwest.

Each of the above is discussed in more detail in **Sections 2, 4, 5** and **6**.

1.4 Objective

This Master Servicing Study is being completed in conjunction with the Community Design Plan (MMM Group and Meloshe & Associates, July 2015). The CDP is supported by an Existing Conditions Report, a Community Transportation Study, and by this Master Servicing Study (MSS). The MSS provides technical support to the CDP to develop a preferred municipal servicing alternative. The Terms of Reference for the MSS are enclosed in **Appendix A**.

The MSS is a high level study prepared based on the City's Water Master Plan (WMP) and Infrastructure Master Plan (IMP). A Design Brief to support the Plan of Subdivision approval must be prepared as per City guidelines such as the Water and Sewer Design Guidelines, the Fire Underwriters Survey (FUS), Related Technical Bulletins, etc.

The new infrastructure proposed for the site requires approval under the Ontario Environmental Assessment Act through the Municipal Class Environment Assessment. The MSS is prepared following the integration of the Municipal Class Environmental Assessment (EA) and Planning Act process as outlined in the Municipal Engineers Association (MEA) Municipal Class EA document. Specifically, the MSS has been completed to satisfy Phases 1 & 2.

1.5 Study Process

The process that has been followed in the development of this MSS is outlined below.

The existing conditions for water, wastewater, stormwater and shallow utilities were established based on review of as-built plans, historical drawings and reports, and field survey. Constraints and opportunities associated with the existing infrastructure and the natural environment that directly impact the development of the concept plan and municipal servicing alternatives were identified. The existing conditions data has been compiled in the "Existing Conditions Report Municipal Services" (IBI Group, July 2014).

Preliminary concept plans developed by the project's consulting team were evaluated through an extensive review process which included consultation with the Algonquins of Ontario, the public,

and review agencies. The overall consultation process is documented in the 'Final Public Consultation Report' (Momentum, June 2014). Out of the process, a preferred development concept plan was established. That plan has been refined as part of the on-going planning process, and the latest version is presented on **Figure 1.3**. As part of this process, building heights and block densities have been established and are presented on **Figure 1.4**.

With the establishment of a preferred concept plan, criteria were established for water, wastewater and stormwater to evaluate municipal servicing requirements. Potential servicing design solutions have been identified and evaluated and a preferred solution identified. A summary of this process is provided in this document.

An integral component of this process is the City of Ottawa and CLC's desire to advance the Rockcliffe CDP as a pilot project for low impact development (LID). CLC's goal is for the development to be a model community for LID.

Since proposed LID elements are to be constructed as pilot projects for which the stormwater benefit's are presently unknown, at least the early developments of the subject site will include traditional stormwater management infrastructure based on current City and MOE criteria. LID measures will be incorporated into specific areas of the site as additional stormwater management elements with an aim of future monitoring to confirm potential benefits. CLC Aquafor Beech was retained by CLC to prepare the 'Stormwater Management Existing Conditions & LID Pilot Project Scoping' (May 2015). That report includes a detailed environmental review in the form of stormwater management existing conditions as part of the LID evaluation. That report should be read in parallel with this MSS document.

*During the design of Phase 2B, it was decided to make a change to the recommended minor storm plan that is presented on **Figure 6.7 Recommended Storm Sewer System** from the 2015 Master Servicing Study. In particular, the changes included minor storm sewer routing along storm sewers between nodes 312 and 201 in the street north of and parallel to Main Street and Codd's Road between nodes 201 and 155.*

The 2015 Master Servicing Study also recommended that storm sewers between nodes 300 and 201 discharge northwards into the future Phase 3 sewers which in turn would outlet into the proposed 1650 mm diameter storm sewer to be located in the north community park. A second recommendation in the 2015 MSS was that stormwater runoff to be collected in the Major Collector Road between nodes 126 and 300 be routed northward towards node 310. However, because that section of the Major Collector Road was part of Phase 2B and not 3, it was necessary to direct flows in that street into the node 300 which will now route westward toward node 201. This is a change from the recommendations in the 2015 MSS Report.

Early in the Phase 2B design process, the City of Ottawa advised Canada Lands Company that it could not accept a Phase 2B design that included an outlet to the proposed 1650 mm diameter storm sewer in the large community park. The reason for that decision was because a Record of Site Conditions Report had not been completed for the park. Because of the phasing limits and the inability to outlet minor storm flows to the north, the decision was made to deviate from the recommendations contained in the 2015 MSS. Namely, the stormwater flows in the Major Collector Road sewers would be routed westward to Codd's Road in the node 300 to node 201 sewers and not northward. The flows would then be routed south on Codd's Road towards node 155 on Main Street.

*The Phase 2B design also demonstrated that the proposed 1650 mm diameter storm sewer to be located in the north community part should be relocated because of topographical reasons. **Figure 6.7** has been updated to reflect this change. By default, the Central Dry Pond has also been slightly relocated.*

Tributary to the Eastern SWM Facility, hydraulic grade line analysis has been completed with each subsequent phase of detailed design. This updated report includes the latest modeling completed in support of the most recently approved phase, Phase 2B, which accounts for the post-development conditions of all lands tributary to the Eastern SWM Facility. The conclusion from that analysis is that the minor storm sewer changes are acceptable and have no negative impact on the subdivision or any other phase of development.

Other than the change noted above, very little of the original text of the 2015 MSS has changed as a result of this update. To assist the reader, we have italicized any text changes. In addition to the changes within this section, there are text changes in ***Sections 6.5.3.2*** *and* ***6.6.2****, including changes to* ***Table 6.19****. The storm sewer design sheets and hydraulic grade line summary in* ***Appendix E*** *have been revised. The balance are changes to figures which are italicized in the List of Figures on Page ix.*

1.6 LID Stormwater Pilot Project

The City of Ottawa and CLC have agreed to pursue phased stormwater management demonstration projects for former CFB Rockcliffe using LID Best Management Practices (BMPs). As noted in **Section 1.5**, traditional stormwater servicing and LID stormwater alternatives were reviewed in parallel as two independent studies, namely, this MSS and the 'Former CFB Rockcliffe LID Stormwater (SWM) Pilot Project Study' (Aquafor Beech, May 2015).

The MSS has been completed using sound engineering principles in the development of the preferred stormwater solution applying conventional stormwater practices including, but not limited to, piped stormwater infrastructure and stormwater management facilities. The preferred stormwater solution using conventional stormwater practices has been developed in accordance with regulatory requirements to service the proposed development as a stand-alone system and to accommodate the potential LID practices identified in the independent study detailed below.

The 'Former CFB Rockcliffe LID Stormwater (SWM) Pilot Project Study' prepared by Aquafor Beech is intended to permit the implementation, monitoring, and evaluation of alternative stormwater management systems based upon the principles of low impact development. The work program for the LID Stormwater Pilot Project Study was developed in consultation with the City of Ottawa and will provide direction for the implementation of LID controls in parallel with the conventional storm servicing presented in this MSS.

A SWM Working Group was formed and consisted of key members of the City of Ottawa, CLC staff, and consultants engaged by CLC. The SWM Working Group will:

- Make recommendations to the City of Ottawa staff working on former CFB Rockcliffe
- Determine the information required to design the integrated LID SWM system
- Determine the information to be collected during the monitoring programs
- Review the collected monitoring data from each successive phase of development
- Determine how and to what extent LID measures will be implemented beyond the initial phase based upon monitoring and whether accounting for some or all LID benefits in the design of the conventional storm servicing can be supported.

The proposed LID implementation process for former CFB Rockcliffe was developed using a phased Adaptive Management System (AMS) approach whereby a science-based methodology is developed and applied to understand and quantify the function, potential benefits and drawbacks from the proposed LID approaches. In this regard, each phase of potential LID implementation corresponding to the phases of development will involve the completion of six steps:

1. Planning (subject of the LID SWM Pilot Project Study)
2. Construction
3. Monitoring
4. Reporting
5. Quantification of benefits
6. Refinement of the LID approach prior to the subsequent phase of LID implementation

Steps 5 and 6 (Quantification of benefits and Refinement) are critical process elements, allowing 'real-world' results to be communicated to and vetted by City of Ottawa staff and agencies and subsequently translated into direction for both the refinement of future LID implementation and refinement of the conventional storm servicing presented in the MSS. In this manner, it is only the quantifiable benefits that will influence stormwater servicing of former CFB Rockcliffe.

As discussed in the previous section, the LID SWM Pilot Project Study report should be read in parallel with this MSS document as it relates to storm sewer servicing. Furthermore, forthcoming monitoring reports which quantify the performance of LID practices as it relates to water quality, water balance, volume, and peak flows should also be considered and related to the aforementioned two independent documents. The implementation of stormwater servicing for the redevelopment of former CFB Rockcliffe will be flexible and realizes that stormwater BMPs, techniques and approaches will change as the knowledge base advances, that future phases and associated monitoring will refine the findings from the MSS and LID SWM Pilot Project Study and that this overall stormwater servicing approach is not static.

An overall study process is detailed in **Figure 1.5**. It summarizes the MSS, CDP, LID SWM Pilot Project Study and the proposed LID implementation process for former CFB Rockcliffe and uses the AMS approach.

1.7 Synopsis of Previous Studies

In addition to the above-noted studies, the following reports have been referenced in the preparation of this document.

The report "Stormwater Management Study – Burma Road Development, City of Ottawa" prepared by J.L. Richards (February 1991) outlined the design of the Burma Road Stormwater Management Facility providing water quantity control for the Thorncliffe Village development, located to the southeast of the Rockcliffe site off Burma Road. The report identified the drainage areas tributary to the SWM facility, which functions as a dry pond; described the downstream receiving storm sewers within the Rockcliffe lands; and, outlined the peak controlled discharge rate to each of the dual receiving outlet sewers.

The report "Stormwater Management Report – Montfort Long Term Care Facility, City of Ottawa" prepared by Stantec (September 2002) outlined the design of the Montfort SWM Facility that provides water quantity control for a portion of the Montfort Hospital site.

The report "Alvin Heights/Rockcliffe Airbase Sanitary Sewer System Study Phase II" prepared for the former Regional Municipality of Ottawa Carleton (RMOC) by J.L. Richards and Associates Limited in 1998 was completed in recognition of the fact that the existing wastewater collection system in the vicinity of former CFB Rockcliffe contributed excess combined sewer flows to the Ottawa Interceptor Sewer (IOS) and Combined Sewer Overflows (CSOs) to the Ottawa River. In 1997, the RMOC developed a CSO policy to both decrease flows into the IOS sewer and decrease CSOs to the Ottawa River. It commissioned the 1998 study to review ways of achieving the new CSO policy performance objectives and to limit flows into the IOS to less than its locally allocated capacity, each in a cost effective manner. Among other items, the 1998 report recommended

replacement and enlargement of the Alvin Heights, Blasdell and Airbase Pull-Back sewer system; construction of a separated sewer system when the former CFB Rockcliffe site is redeveloped; and replacement of the RCAF Pull-Back Sewer. The RMOC completed the first of these recommendations in 1999 and 2000.

The City of Ottawa Infrastructure Master Plan (September 2013) is a City-wide document that supports the Official Plan by ensuring there is enough infrastructure capacity to accommodate development until 2031. The 2013 IMP accomplishes this by taking high-level directions on infrastructure growth, operation and renewal from relevant long term planning documents. The 2013 IMP sets out a series of projects that will have to be undertaken in order to achieve the City infrastructure, land use and affordability goals, including redevelopment of CFB Rockcliffe.

The City of Ottawa Infrastructure Master Plan Wastewater Collection System Assessment (2013) documents the approach, assessment findings and recommendations stemming from the City's wastewater collection system assessment component of the 2013 IMP. The objective of the report is to identify growth-related upgrades to the trunk wastewater collection system. The report required the assessment of historical and recent sanitary sewer flow monitoring data to determine characteristic flow parameters throughout the City.

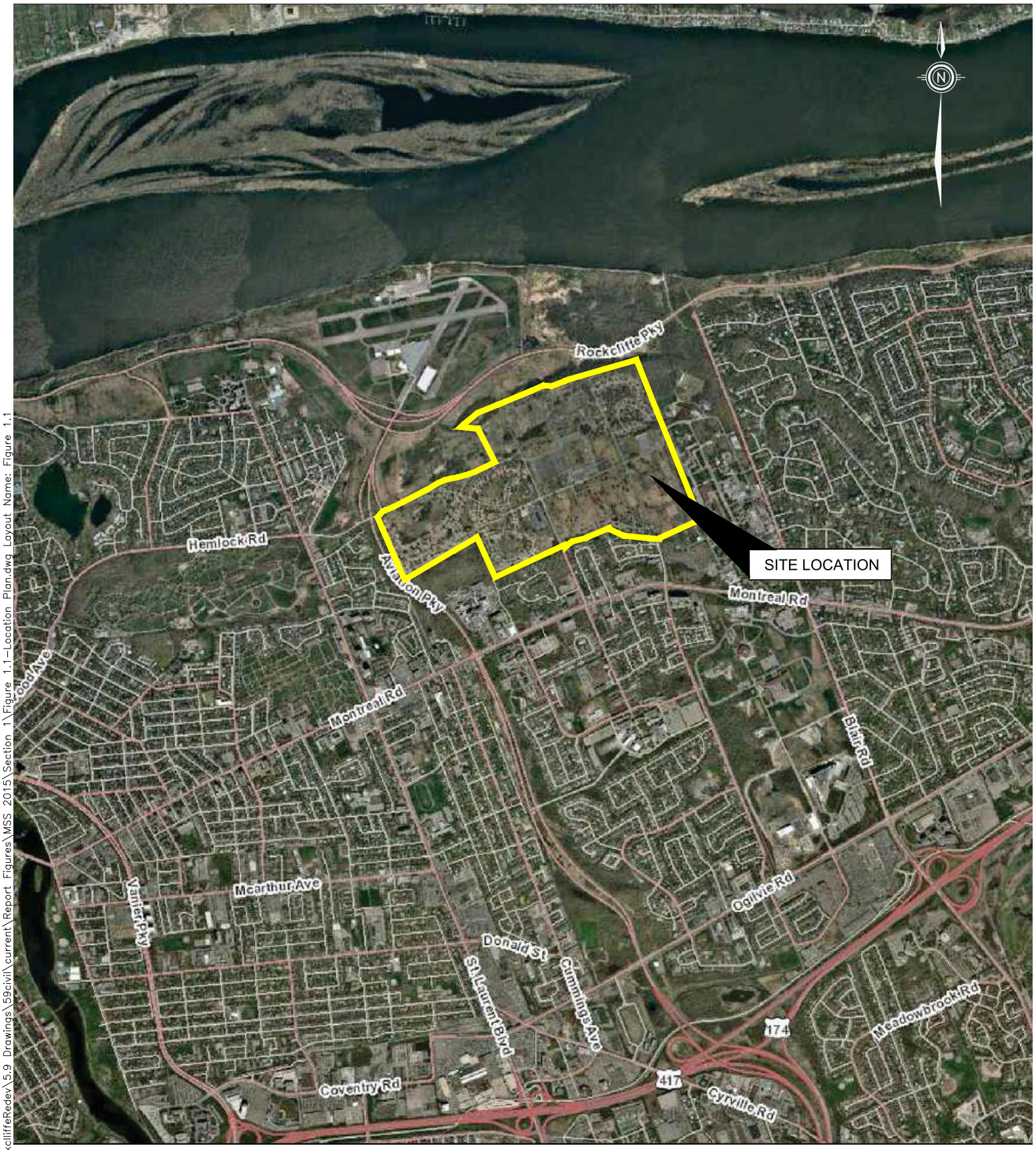
The City of Ottawa Water Master Plan (2013) documents the assessment of the City of Ottawa's water supply and distribution system infrastructure to determine the infrastructure upgrade requirements to meet growth, reliability and renewal needs in the medium (to 2031) and longer terms (to 2060). This WMP provides the City with a number of project recommendations to set the groundwork for long-term planning and timing requirements for the City's water supply and distribution system.

1.8 Development Phasing

The proposed development phasing plan for former CFB Rockcliffe is indicated on **Figure 1.6**. Phase 1 will include about 68 ha of the central and eastern portions of the study area and in time will be sub-phased into phase 1A and 1B. Phase 1A will include Codd's Road up to the Town Centre and most of the low density residential development areas west of Codd's Road; a school site and park. The approximate timing of phasing is summarized in **Table 1.1**.

Table 1.1 Timing of Construction Phasing

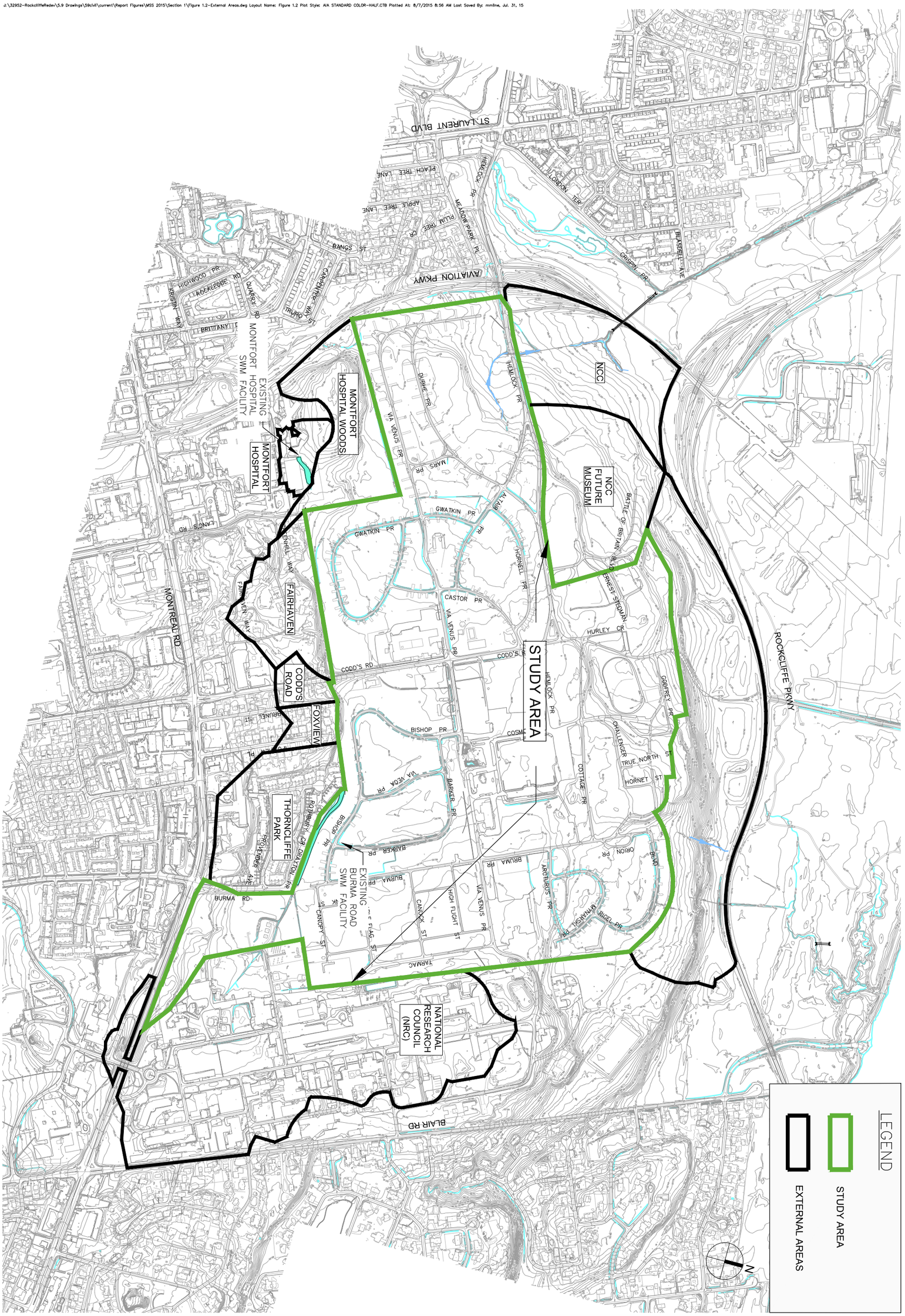
PHASE	CONSTRUCTION PERIOD	COMMENTS
Phase 1A	2015-2016	Servicing in 2015: sales in 2016
Phase 1B	2017-2018	Servicing in 2016: sales in 2017-2018
Phase 2	2019-2024	Servicing in 2018: sales in 2019-2024
Phase 3	Starting 2024	Sales starting in 2024



J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 1\Figure 1.1-Location Plan.dwg Layout Name: Figure 1.1

Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	LOCATION PLAN	FIGURE 1.1

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 1\Figure 1.2-External Areas.dwg Layout Name: Figure 1.2 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 8/7/2015 8:56 AM Last Saved By: mmilne, Jul. 31, 15



Sheet No.

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Project Title

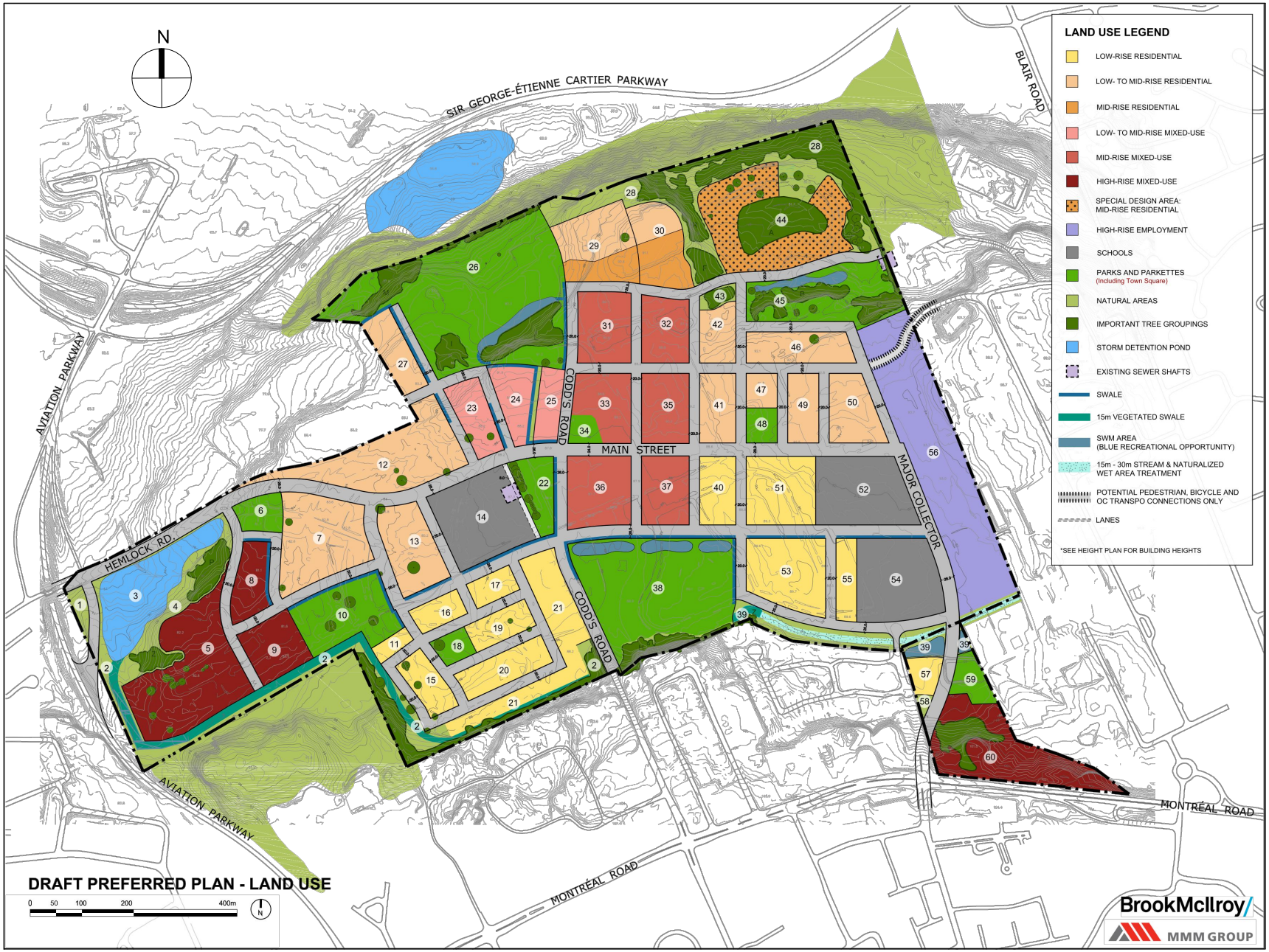
Scale

FIGURE 1.2

EXTERNAL AREAS

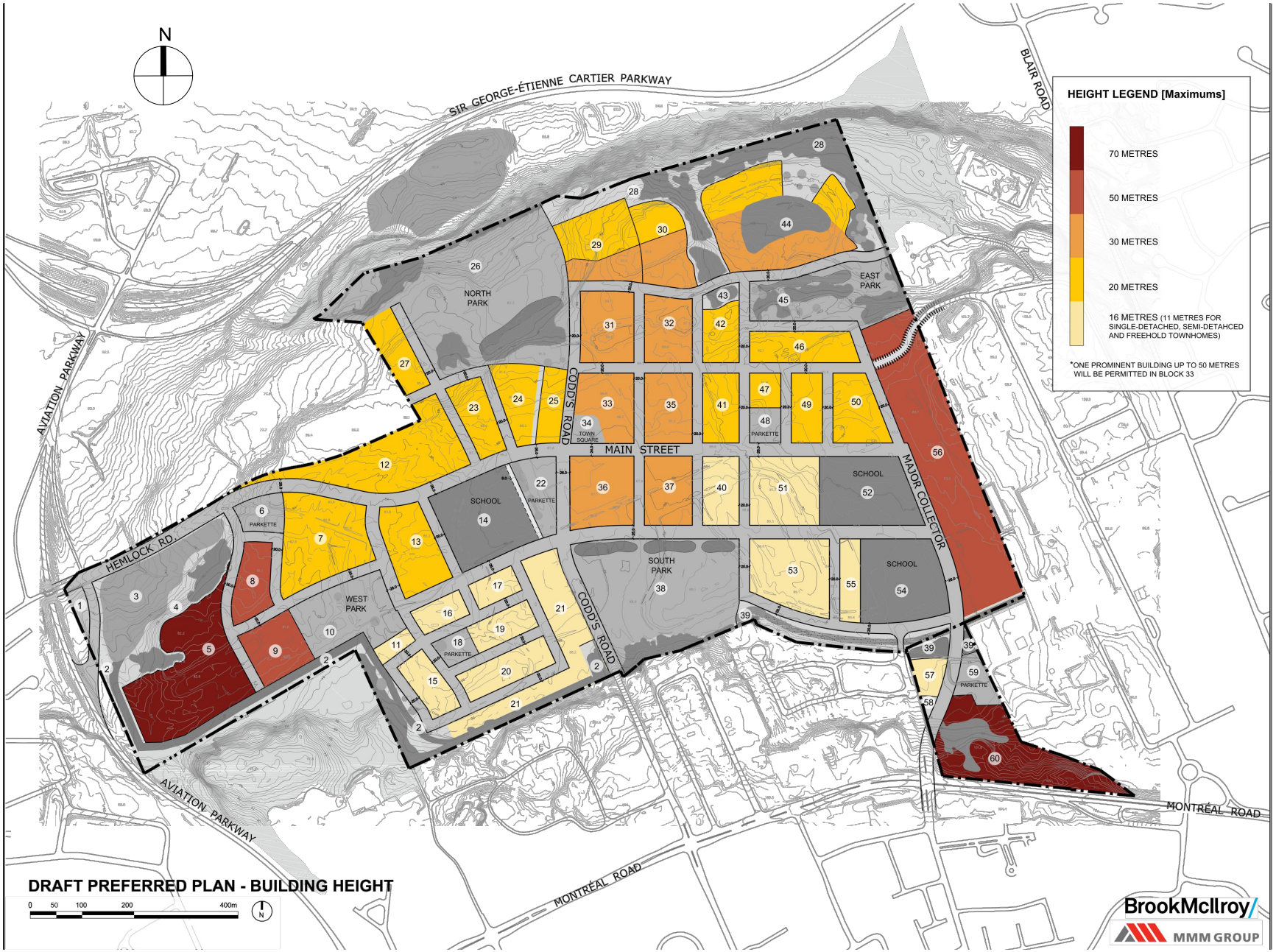
FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

IBI

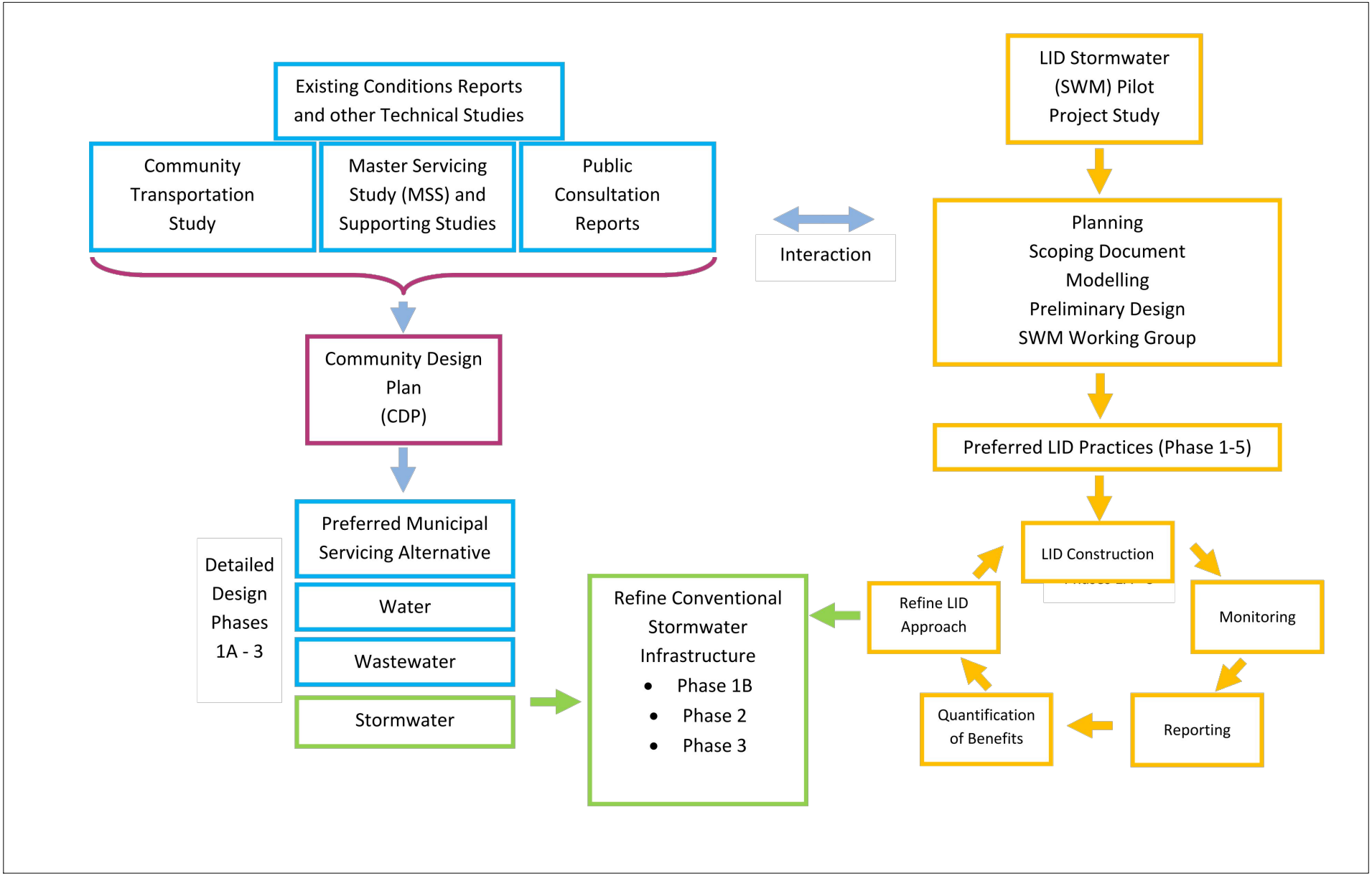


Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	PREFERRED CONCEPT PLAN	FIGURE 1.3

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 1\Figure 1.4-Building Heights and Block Density.dwg Layout Name: Fig 1.4

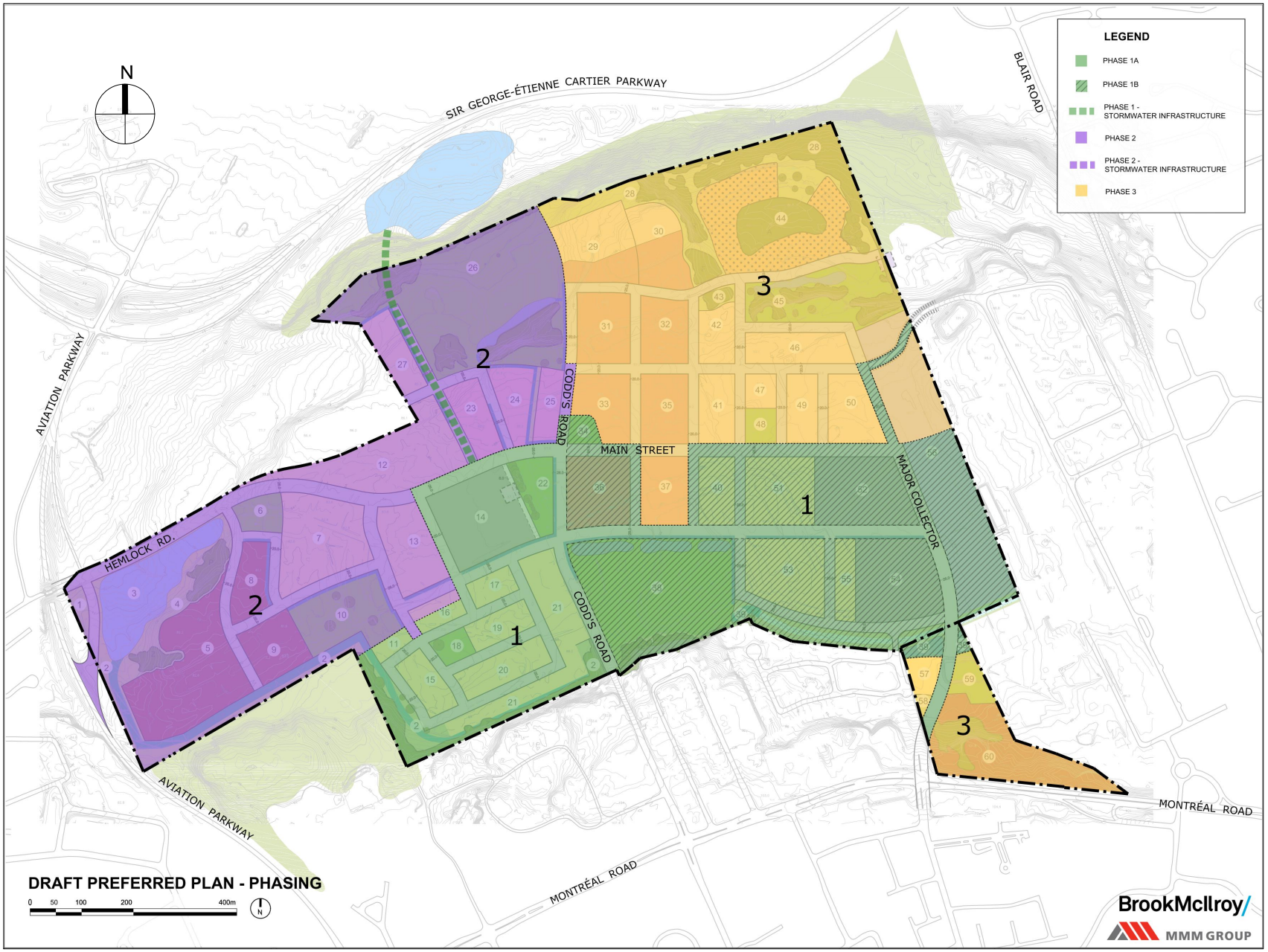


Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	BUILDING HEIGHTS AND BLOCK DENSITY	FIGURE 1.4



J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 1\Figure 1.5-Overall Study Process.dwg Layout Name: Model

Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	OVERALL STUDY PROCESS	FIGURE 1.5



J: \32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 1\Figure 1.6-Development Phasing.dwg Layout Name: Model

Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	DEVELOPMENT PHASING PLAN	FIGURE 1.6

2 Existing Conditions and Background Studies

2.1 Topography

Most of the site is relatively flat, generally sloping from the south boundary downward to the north property line. The elevation across the study area ranges from about 100 to 70 m. Several small terraces bisect the plateau areas and provide additional grade downward from the southeast to the northwest; however the site is characterized by two distinct escarpments. One runs along the south property line and the second is adjacent to the north property line. To the north, the base of the escarpment descends to approximately 55 m at the Rockcliffe Parkway, and about 45 m at the Ottawa River.

Historical drainage patterns include a drainage swale which bisected the former CFB Rockcliffe site, originating in the southeast corner on NRC lands and discharging at the northwest limit crossing the Aviation Parkway via a culvert and outletting to the Ottawa River along the north limit of the RCMP Lands. Most of the plateau lands of the site naturally slope in this direction. A second drainage swale within the former CFB Rockcliffe site drains the northeast quadrant of the site northward over the north escarpment and crosses the Aviation Parkway via a culvert ultimately discharging to the Ottawa River. **Figure 2.1** shows the existing surface drainage patterns of the former CFB Rockcliffe site. These two original overland drainage routes remain the primary outlets for major storm events.

Due to the location of the southern escarpment, there are natural external drainage areas located to both the south and east of the Rockcliffe property. Surface drainage from these areas will have to be accommodated as part of the stormwater management plan during development.

Surface drainage from the NRC Campus, which is located to the east of the Rockcliffe site, routes onto the subject site. The southern portion of the NRC property discharges surface flow towards the existing Burma Road SWM Facility. However, the central portion of the NRC property directs surface runoff towards the subject site near Tarmac Street.

The natural topography through most of Thorncliffe Village is towards the north into the existing SWM facility. There is also surface drainage tributary to the subject site from existing developments located on top of the southern escarpment including Foxview, Fairhaven and the Montfort Hospital. The Foxview residential development, located at Codd's Road, includes a minor storm drainage system but major storm runoff flows over the escarpment onto the subject site. The Fairhaven community, which is a rural estate development located immediately east of the Montfort Hospital, does not have a piped storm sewer collection system but rather uses road side ditches to convey surface runoff. Surface drainage from the northern portion of that development is directed toward the subject site.

The northeastern portion of the Montfort Hospital site is provided with a SWM Facility that outlets to an existing swale through the adjacent Montfort Hospital Woods. Outflow from the SWM facility, as well as major system flow from the northeastern portion of the hospital site, and flow from the Montfort Hospital Woods all makes its way to the road side ditch system near Via Venus Private.

2.2 Geotechnical

2.2.1 General

The following section provides an overview of the geology of the former CFB Rockcliffe site and further describes the surficial and bedrock geology. Several geotechnical investigation reports for the subject site have been completed by DST Consulting Engineers Inc. (DST), including:

- "Former CFB Rockcliffe Stormwater Management Ponds, Ottawa, Ontario" dated June 2014 (DST File No. OE-OT-017184)
- "Community Design Plan Geotechnical Investigation Former CFB Rockcliffe Development, Ottawa, Ontario" dated June 2014 (DST File No. OE-OT-015358)
- "Hydrogeological Report Stormwater Management Support Study" dated June 2014 (DST File No. OE-OT-017184)
- "Preliminary Geotechnical Investigation Study Report Infiltration Ponds" dated November 2013 (DST File No. OE-OT-017184)

Much of the site geology information is extracted from the "Former CFB Rockcliffe Redevelopment Stormwater Management Existing Conditions and LID Pilot Project Scoping" report prepared by Aquafor Beech, May 2015. This section also reviews some of the geotechnical elements and recommendations respecting specific site development parameters.

The geotechnical investigations were completed in support of a concept plan in which both proposed SWM facilities were located off-site. As noted in **Section 1.5**, the plan has since been refined as part of the on-going planning process (the latest preferred plan is presented on **Figure 1.3**). Three major system dry ponds are proposed on-site to attenuate major flow. Ultimately, these ponds may also function as infiltration ponds to encourage localized infiltration of runoff. The geotechnical investigations were completed to support this development concept.

2.2.2 Surficial Geology

The surficial geology is summarized below and presented on **Figure 2.2**. The information is reproduced from St. Onge (2009), supplemented with the DST logs and surface plans.

Bedrock is grey flat-lying limestone, generally unweathered except for the upper 1 m. The basal overburden consists of discontinuous remnants of till, composed of sand (average 67%), silt (average 26%) and clay (average 7%) with some gravel, olive to brown in colour (Kettles and Shiltz, in Fulton 1987). Much of the area is covered by Champlain Sea marine deposits of clay, silty clay and silt, commonly calcareous and occasionally overlain by a thin veneer of sand. Most of the clay is, in fact, not clay minerals but clay-sized (<2 µm) rock flour of quartz, feldspar, carbonate and amphiboles from source bedrock (Scott, 2003). Post Champlain Sea deposits consist of stratified sand with some silt, formed on fluvial terraces and in channels cut in marine clay, including former sand bars and spits (Gadd, in Fulton, 1987). The area marked "Pa" on **Figure 2.2** is characterized by shallow overburden (thickness less than 2 m) over Paleozoic limestone bedrock (Bélanger 2008), that covers approximately 17% of the site; and, elsewhere on the site, overburden thicknesses are up to 10 m (Belanger, 2008).

2.2.3 Site Stratigraphy

The former CFB Rockcliffe contains variable thicknesses and types of overburden materials overlying the bedrock. A shallow overburden soil condition (defined as less than 2 m of overburden thickness overlying bedrock) exists in several areas, covering approximately 17% of the site. In other areas of the site the overburden thickness ranges from greater than 2 m to about 10 m.

The native overburden comprises clay to silt marine deposits over the southern half of the site, silty to sandy till plain in parts of the western and northern portions of the site, and sand/silt alluvial sediments forming parts of the western portion of the site (**Figure 2.2**). Various fill materials are present from previous anthropogenic activities at the former CFB Rockcliffe site.

The generalized surface geology of the NCC-owned land between former CFB Rockcliffe and the Rockcliffe Parkway comprises marine sediments (clay/silt, sand) and fill material, with an overburden thickness of greater than 10m.

The following generally describes the overburden soil units at former CFB Rockcliffe.

2.2.3.1 Surficial Material and Topsoil

Grass and other organic material with roots extending about 10 cm below grade is present over much of the site, with topsoil extending up to about 20 cm in depth. Asphalt, with a thickness of about 10 cm, is present on existing roads and driveways.

2.2.3.2 Fill Material

Fill material consisting of silty sand, sand and gravel or clay is known to be present in various areas of the site. During previous field investigations by DST, fill was identified at many former development areas of the site, with fill thickness ranging from approximately 0.5 to 4.3 m (DST, 2006). Localized fill thickness greater than the observed values may exist. Fill material was also observed in several boreholes north of the site, at the bottom of the escarpment. There the fill, approximately 1 to 4 m thick, consists of compacted grey to orange coloured silt with sand and gravel. Concrete and asphalt materials were encountered within the fill.

2.2.3.3 Clay

Grey-coloured silty clay is the dominant natural overburden type in the central and southern portion of the site. The clay layer extends from near surface to a depth of more than 6 m in the south and thins out to the northeast and north where it overlies silty till deposits at depths of 1 to 2 m. Grey-coloured clay to silty clay with minor silt, sand and gravel was encountered in the NCC land north of the escarpment. The thickness of the clay was not determined.

2.2.3.4 Till

The northern and eastern portion of the site is generally underlain by till material consisting of grey-coloured compact silt, sand and minor gravel. Where encountered during previous drilling, the till is 1 to 3 m thick, underlying several metres of fill material.

2.2.4 Bedrock Geology

The former CFB Rockcliffe is underlain by bedrock from the upper Ordovician Formations, mainly East View Formation and Ottawa Formation (Urban Geology of Canadian Cities, GAC Special Paper 42) (**Figure 2.3**). Rock types in the East View Formation include shale, limestone, dolostone and siltstone. Rock types in the Ottawa Formation include limestone with some shaley partings and some sandstone in the basal part.

The Ottawa formation is subdivided into several formations such as Shadow Lake, Gull River, Bobcaygeon, Verulam and Lower Lindsay Formations. The formations, including East View Formation to Upper Lindsay Formation are often referred to as the Ottawa Group and middle to upper Ordovician in age.

During previous field investigations by DST, boreholes drilled into the bedrock at the Rockcliffe property typically encountered horizontally bedded, grey crystalline to fossiliferous limestone with minor narrow shale bedding, interpreted to be of the Ottawa Group. Minor narrow silt-fine sandstone beds were encountered within the limestone unit in one borehole (BHMW 12, 2004).

The bedrock surface is generally unweathered, or has a narrow weathering zone, less than one metre thick and occasionally limonite-stained. The northeastern portion of the site contains blocky (jointed) limestone in the upper 5 m of bedrock, and fault gouge was observed at depths of about 2.5 m and/or 4.5 m in several boreholes in the northeast of the property. **Figure 2.4** illustrates the

bedrock contours of the site as determined by subsurface investigations as well as the test pit and borehole locations.

2.2.5 Geotechnical Assessment

As noted in **Section 2.2.1**, several geotechnical investigation reports for the subject site have been completed by DST. The results of these reports were based on a subsoil investigation which included numerous test pits excavation and boreholes. The locations of these are included on **Figure 2.4**. The purpose of these investigations is to identify geotechnical/construction challenges and hazards and provide guidelines for various development elements such as infrastructure installation, roadway construction, building foundations, grade raises and stormwater facilities.

The geology and site stratigraphy were detailed in earlier report sections. In summary, the generalized stratigraphy for the east side of the site consists of asphalt surface treatment underlain by granular sand and gravel which is again underlain by silt or clay layer followed by bedrock. The generalized stratigraphy for the west side of the site consists of a thin layer of topsoil underlain by silty clay and sand and gravel layers followed by possible bedrock. **Figure 2.5** identifies the general location of the site overburden materials including clay and silt/sand; clay and sand/silt/gravel regimes.

2.2.5.1 Grade Raise Assessment

Most residential developments attempt to balance the management of existing soil material by establishing final site grades that are usually higher than existing site grades in an attempt to balance and accommodate expected site excavated materials. To assist and guide the development designers, the site geotechnical investigation reports review the ability of a particular site to accommodate site grade increases or grade raises. DST has completed such a review and the generalized grade raise limits are shown in **Figure 2.6**.

In order to limit potential subsurface settlement after site development, it is recommended that grade raises be restricted to a maximum of 2 m through the north and central parts of the site where bedrock overburden is shallowest. In other areas of the site that contain clay layers on top of the site bedrock, grade raises of 1 m are recommended. These recommendations are based on the results of the settlement analysis completed by DST. The details of the approach to establishing these grade raises are included in the above referenced DST reports.

2.2.5.1.1 Grade Raise Impacts on Development

The geotechnical assessment of the impact of site grade raises assumed a limited amount of settlement and recommended that a reasonable criteria for differential settlement would be to not exceed 1:100 angular distortion. The details of this analysis are contained in DST's June 2014 "Community Design Plan Geotechnical Investigation" (DST File No. OE-OT-015358).

The predicted settlements as a result of the grade raise will impact the performance of residential and low rise development to be built on the site. However, the relative differential settlement within a single structure or group of structures will be minimal if grade raise plan is uniform across the property. Should a different grade raise plan/scenario be developed with very specific locations or areas of grade raise, site specific settlement analysis should be performed to confirm that the angular distortion and total settlement are within the tolerances.

2.2.5.1.2 Impacts on Streets

Settlement as a result of the grade raise will affect streets including sidewalks and curbs. Low speed limit roads are generally quite tolerant to settlement and settlement predictions indicate that

differential settlement is acceptable since it is predicted it will meet the suggested reasonable criteria.

2.2.5.1.3 Impacts on Buried Services

Given that the sewers and watermains will be buried within the streets, the street settlement will also be reflected as deflections in the pipes. Settlement predictions indicate that differential settlement is not expected to exceed the reasonable criteria for pipes. Service connections are not expected to be a problem if the buildings are designed to settle less than 25 mm under foundation loads alone.

2.2.5.2 Groundwater Recharge

2.2.5.2.1 Impacts to Groundwater Quantity

Groundwater on site flows from south to northwest, approximately following the local topography descending towards the Ottawa River. In general, the overburden water table is slightly higher than the bedrock groundwater surface across most of the property, with the exception of the top of the escarpment located in the northwest corner of the site.

In general, the development of surface infrastructures will decrease groundwater quantity as a result of decreased infiltration of precipitation. The change in volume of groundwater recharge by infiltration will be affected differently across the property by the development due to different types of overburden materials.

In the central and southern portions of the property, the silty clay overburden presently has very low infiltration rates and low hydraulic conductivity, therefore the development of relatively impermeable surface infrastructure in this area will not significantly decrease the quantity of groundwater recharge. The low hydraulic conductivity of the overburden unit will also impede the horizontal movement of groundwater away from any dry pond designed to promote infiltration, locally raising the water table in the area of the infiltration pond and reducing the capacity for further infiltration.

Development of relatively impermeable surface infrastructure on the till material underlying the northern portion of the property, and on the alluvial sediments underlying the western portion of the property, is in general expected to decrease infiltration and groundwater recharge. However, dry ponds designed to promote infiltration constructed in these materials are expected to effectively provide point sources for groundwater recharge. In this case, when runoff from the areas covered by clay material is diverted into infiltration ponds situated in areas with surficial deposits with higher infiltration rates, the actual groundwater recharge conditions for the area may improve compared to predevelopment conditions.

Impacts of site development (including remedial excavation and construction dewatering) in overburden deposits will be localized due to low permeability of deposits. Though temporary remedial excavation and construction dewatering in overburden is unlikely to impact existing wells, as a precautionary measure, groundwater elevation and quality monitoring in areas serviced by private wells such as the Fairhaven community and the Canadian Aviation and Space Museum is recommended before, during and after site development activities, in order to detect any potential impact in both the area of Fairhaven Way and the Aviation Museum. The groundwater elevation and quality program will include the following:

- a representative number of water samples will be obtained from the domestic wells on Fairhaven Way (up-gradient of the Site) and a sample from the potable well located at the Canadian Aviation and Space Museum (down-gradient of the Site).

- One groundwater elevation monitoring and sampling event will be completed prior to start of construction, which will be utilized as a baseline for background levels.

2.2.5.2.2 Impacts to Groundwater Quality

The development of the property as a residential community is expected to have negligible impacts on groundwater quality. Anthropogenic activities may introduce contaminants to water that recharges the groundwater under and downgradient of the property. Potential contaminants include, amongst others, polyaromatic hydrocarbons and salts. Certain areas of the property are also known to have contamination from its previous historic use as a military base (DST, 2006). An undertaking with regards to soils and groundwater remediation is being completed prior to redevelopment in the environmentally impacted areas. **Figure 2.7** indicates the areas of remediation within the subject site. The program is partially completed and could continue through 2015.

2.2.5.2.3 Impacts to Surface Water

Surface water flow measurements, completed on both the western and eastern creeks after a prolonged dry period, represent baseflow (groundwater discharge) conditions. Development at the property will have an impact on groundwater recharge conditions and may impact baseflow conditions in both creeks. As infiltration ponds enhancing infiltration to groundwater may be built in the area, potential impact on surface water is assumed to be minor.

Previous assessment of the streams originating at the property suggest that there is no fish habitat present downstream of the property. Changes to baseflow resulting from changes to groundwater recharge at the property are therefore not expected to impact any fish habitat.

2.2.5.3 Stormwater Management Facilities

Based on the test hole information completed for the previous concept plan, it is considered feasible to design and construct the stormwater management facilities at the original off-site locations. However, the following preliminary elements will have to be considered in the design of each facility, referred to as the Western and Eastern SWM Facilities. At the time of the investigation, a conservative pond depth of 6 m was considered to ensure all potential geotechnical considerations were identified.

2.2.5.3.1 Western Stormwater Management Facility

DST has reviewed the data included within the Golder's geotechnical investigation for the proposed western stormwater pond (2015). Based on the data provided within this report, and only considering the current design of the proposed pond, a low-permeable membrane will be required to line the pond, and will require a counterweight (i.e. ballasts) to help minimize hydraulic uplift pressure (to prevent possible puncturing or floating of the liner). In order to install the liner, managing of groundwater infiltration into the pond during excavation and installation activities will be required. In order to be able to explore the most efficient method of groundwater management for short and long-termed control such as during the installation and operation stages, currently available hydrogeological information is being updated. Options will vary between a continuous well point system to minimizing groundwater inflow with an impermeable barrier. The magnitude and dimension of scale will depend upon findings from the in depth hydrogeology study. DST is currently conducting an additional investigation on the proposed western pond. This investigation includes additional boreholes (including packer tests), a slope stability analysis, an in-depth hydrogeology study, and recommendations which may include raising the pond depth for a potentially more suitable constructability. Nevertheless, the location as shown in the CDP will not be impacted, nor will this have any impacts on the development blocks or road pattern.

2.2.5.3.2 Eastern Stormwater Management Facility

The test holes at this location indicated the subsurface soils consists of sand fill, silty sand to sand and gravel to depths of 0.2 to 5.0 m underlain by silty clay to depths of 6.4 to 11.5 m overlying a till at 11.5 m. At the east end of the pond, the clay overlies a sand to silty sand at 6.4 m depth. The measured groundwater level was at 1.7 to 4.9 m.

At the proposed pond depth of 6 m below existing grade, it is expected that the base of the pond will be founded within the relatively impermeable silty clay layer. This soil, which has a low hydraulic conductivity value, seems to be suitable for a low permeability barrier at that depth with low potential of leakage provided artesian pressure does not exist at a shallower depth. However, the eastern portion of the facility will be founded in silty sand to sand material with higher hydraulic conductivities. This higher hydraulic conductivity material along the walls of the excavation/pond will produce a level of lateral seepage that may be unsuitable for the proposed design.

To maintain a wet condition in the pond, the silty clay base and sides of the pond are considered to be suitable since the clay is relatively impermeable with a low potential of leakage, provided artesian pressure does not exist at shallower depths. The sand to sand and gravel base and sides will permit lateral and vertical seepage that may be unsuitable for design of the pond. Therefore, a liner may be required in the east portion of the base of the pond and along portions of the walls or sides of the pond consisting of silty sand to sand and gravel.

2.2.5.4 Development Setbacks

The footprint of the future building structures must be set a safe distance from the crest of the north escarpment and the north boundary of Blocks 4, 6, 26 to 30. Safe setback distances should be determined during the final investigation based on an assessment of the slope conditions and type of building foundations. A preliminary opinion with respect to stable slope setback distance is provided. The assessment and opinion is based on a limited visual observation and review of limited subsurface geology at the proposed development site.

A review of the subsurface conditions and a visual inspection of the current surface conditions of the slope on the north escarpment, indicates that localized areas of bedrock are exposed along the face of the slope, mainly at the mid and lower section. The bedrock appears to consist of limestone interbedded with fractured shale. The shale shows evidence of erosion and a weathered condition. Fragments of the eroded shale can be seen accumulated on top of the blocks of the underlying limestone and along the slope face.

A preliminary slope stability analysis using typical value for critical state friction angle for the overburden material and strength equilibrium approach indicates a factor of safety is close to unity. This assessment does not consider the specific seismic hazard of the area.

Considering these geotechnical factors, the presence of silty clay, sand, silt and till and observed bedrock conditions, a preliminary stable slope allowance setback distance of 3 to 4 times the height of bank is recommended for overburden slopes and 1 time the height of bank is recommended for slopes with mainly exposed bedrock. The erosion allowance for the subject slope considering the subsurface soil materials encountered range from 5 to 10 m for the overburden soil and up to 10 m for the weathered bedrock. Thus the setback distances (stable slope allowance plus erosion allowance) for the subject site would range from 75 to 100 metres measured landward from the toe of the slope. Refer to **Figure 2.8** for locations of the preliminary set back limits. To assess more accurately the setback distance, further geotechnical investigation and slope stability analyses including an assessment of seismic effects (based on site classification of the site specific characteristics) will be required to confirm this preliminary assessment. The slopes should be monitored for any signs of instability. Should a reduction of the setback be required, site specific slope stability assessment would have to be carried out.

Slope stability analyses should be undertaken in accordance with the City of Ottawa document titled, “Slope Stability Guidelines for Development Applications”.

2.2.5.5 Wells

The Ontario Water Well Information System (WWIS) was reviewed for records of water wells located within and downgradient of the project site. The WWIS is a database of the Ontario Ministry of the Environment (MOE) records of water wells in Ontario, and is up-to-date to the end of 2012.

Four well records were found for the area downgradient of the project. Three wells drilled in 2007 are located at the Rockcliffe Airport, between the runway and the Ottawa River. One well is recorded as abandoned and the other two wells are noted as test holes, drilled to depths of 3.7 m and 4.9 m, respectively. No groundwater information is provided in these records.

There is one WWIS record for a well drilled in 2007 northeast of the Canadian Aviation and Space Museum. The status of this well is recorded as abandoned. There are no water wells located downgradient of the project site in the WWIS database that are recorded as in use.

Further to the above, DST made an inquiry to the City of Ottawa regarding municipal water supply to all adjacent areas to the project site. The response indicated that adjacent areas are serviced by municipal water, with the exception of the residences on Fairhaven Way and the Canadian Aviation and Space Museum, which are not on the municipal water supply. It is assumed that the Museum uses a local groundwater source, and is therefore a downgradient receiver of groundwater impacts from the project. The area of Fairhaven Way is located upgradient of the project site, where private wells utilize the bedrock limestone aquifer for domestic water supply.

Though temporary remedial excavation and construction dewatering in overburden is unlikely to impact these wells, as a precautionary measure monitoring of groundwater elevations and quality is recommended before, during and after site development activities, in order to detect any potential impact in both the area of Fairhaven Way and the Canadian Aviation and Space Museum.

2.3 Natural Environment

Aquafor Beech prepared the 'Stormwater Management Existing Conditions & LID Pilot Project Scoping' (May 2015). The report includes detailed environmental review in the form of stormwater management existing conditions, some of which is excerpted in the following sections.

2.3.1 Surface Water Features

There are three watercourses flowing within and around the former CFB Rockcliffe site:

- Western Creek
- Eastern Creek
- Northeastern Tributary to the Eastern Creek

The Western and Eastern Creeks serve as outlets from the site with respect to surface drainage and the existing storm sewers. The creeks flow to the Ottawa River via surface drainage, and pipes and culverts. The fluvial geomorphology assessment of the Western and Eastern Creeks is summarized in **Section 2.3.2** and the existing drainage of the site is discussed in more detail in **Section 2.4.3**.

2.3.2 Fluvial Geomorphology

The fluvial geomorphology of the Eastern and Western Creek systems under existing conditions were characterized in the 'Fluvial Geomorphology Assessment Study,' prepared by DST (September 2013). The Western Creek was determined to be geomorphologically stable, with most reaches lacking obvious signs of ongoing erosion. However, sub-reaches between Hemlock Road and the Aviation Parkway did show signs of instability, and a reach immediately downstream of a culvert north of the Aviation Parkway was deemed to be an eroding steep-walled gully with a very steep (5%) channel bed, incising into the consolidated clay base material. It is assumed that the channel was disturbed by flow from the existing culvert, leading to the destabilization of the downstream channel.

Unlike the Western Creek, the Eastern Creek has several sub-reaches that show signs of channel instability, including exposed roots on channel banks and oversized channel dimensions. The most upstream reach appears to be the most destabilized, which is likely attributable to the culvert under the Rockcliffe Parkway and resultant potential augmentation and/or grade change. In both creeks, it was observed that engineering works such as culverts have the potential to destabilize the channel. The recommendations of the Fluvial Geomorphology Assessment Study included the following:

1. It is imperative that any future SWM facility designs minimize perturbation of the Creeks.
    a. Western – estimated bankfull discharge is between 0.7 cms and 1.4 cms downstream of Aviation Parkway, upstream of the confluence.
    b. Eastern – estimated bankfull discharge is between 0.5 cms and 2.5 cms.
2. Implemented SWM facility design should not change the input discharge or sediment load to either creek.

2.3.3 Aquatic Ecology

An aquatic habitat assessment was undertaken for the Western Creek and Eastern Creek and presented in 'Aquatic Habitat Assessment Western and Eastern Creeks,' DST (August 2013). The assessment was undertaken to evaluate the potential impacts on aquatic habitat resulting from the management of stormwater for the site. The assessment was undertaken using the Ontario

Stream Assessment Protocol (OSAP) (Stanfield 2010), and it included examining five reaches of both the Western Creek and Eastern Creek (as indicated on **Figure 2.9**). Key findings included:

- Active Channel: Both the Eastern and Western Creek had an active channel width ranging from 0.5 to 2.0 m. Maximum bank height ranged from approximately 450 mm to 700 mm in the Western Creek and 350 mm to 750 mm in the Eastern Creek.
- Bank Angle: Overall, bank angles for both creeks range from 13° to 26°.
- Water Depth and Flow: The water depth during baseflow conditions in the Western Creek ranged from 52 to 105 mm while the Eastern Creek ranged from 0 to 46 mm. During baseflow conditions, both creeks can be characterized as having shallow flow depths and low flow velocities.
- Bank Vegetation and Instream Cover: The Western Creek was found to have low to moderate levels of bank vegetative cover throughout its length. Whereas, the Eastern Creek is characterized as having low to moderate levels of bank vegetation, it does display consistently high counts of instream cover (20 cover points/site), an important component of aquatic habitat for fish species. Cover is more varied in the Western Creek with higher levels of instream cover observed at upstream locations as compared downstream.
- Bank Undercuts: In general, the Western Creek displayed few severe bank undercuts, whereas the majority of the Eastern Creek displayed undercutting of the right bank. Other signs of erosion within the Eastern Creek including slumping banks were also noted.
- Water Temperature: Water temperature in the Western Creek was highest at the upstream but was considerably cooler in the deeper mid-reach sections of the creek. In general, water temperature in the Eastern Creek was highest at the downstream extent as compared to the upstream. Higher downstream water temperatures are likely a result of prolonged exposure to ambient air temperature due to the lack of outlet to the Ottawa River at the raised pedestrian walkway. The Aquatic Habitat Assessment indicated that temperature mitigation measures should not be required for the outflows from potential future SWM facilities proposed for the development.
- Macroinvertebrates: The community of macroinvertebrates was found to be moderately diverse, ranging from 9 to 15 taxa at each site. Key indicator species were mostly absent.
- Fish and Fish Habitat: Sites in the Western Creek appear to provide marginal fish habitat that could be suitable for some common fish species, however no fish were encountered during the fish surveys. It appears that the lack of connectivity to the Ottawa River (as the final 550 m of the creek runs subsurface) and extensive entombment of creek sections have prevented fish from reaching potentially suitable sites. The Eastern Creek could potentially provide habitat for species that are tolerant of low water levels (sticklebacks for example), though no fish were found during fish surveys. This is likely due to the fact that there was no downstream connection to the Ottawa River at the elevated recreational path and no upstream connection to other habitats.

  Moreover, the OSAP assessment indicated that the creeks did not support any rare or species at risk (SAR) varieties of invertebrates. Due to the poor quality of aquatic habitat and absence of significant open water, the report noted that it is highly unlikely that any wetland-associated SAR birds, reptiles, insects, or fish would be present within the survey area.

2.3.4 Terrestrial Ecology

The terrestrial ecology investigations were completed for the preferred concept plan (refer to **Figure 1.3**). Due to topographical constraints, it was determined that the potential stormwater

management facilities servicing the site would be most suitably located at a lower elevation. The terrestrial ecology investigations were completed to support this development concept.

Terrestrial ecology of the site and environs is supported by the following documents:

- CFB Rockcliffe Vegetation Survey Arborist's Report (Dan Baker, January 2013)
- Butternut Survey for Proposed Stormwater Ponds (DST, August 2013)
- Preliminary Terrestrial Habitat Assessment for Proposed Stormwater Ponds (DST, August 2013)
- Former CFB Rockcliffe Species at Risk Survey (DST, October 2014)

A summary of the findings of the background documents follows.

- Vegetation: it was noted that on-site native tree species identified include Sugar Maple, Basswood, Red Oak, White Pine, White Spruce, and White Cedar as well as Bitternut Hickory, Butternut, and Silver Maple. Non-native tree species identified on site include Black Locust, Norway Maple, Norway Spruce, Blue Spruce, and Weeping Willow. In general, the trees recommended for retention on the site are native trees, as some non-native species tend to be invasive (i.e. Norway Maple). However, some non-native trees are recommended for retention on the site.
- Terrestrial Habitat: The proposed location of the Eastern SWM Facility is within habitat that can be characterised as grassland immediately south of the Rockcliffe Parkway, with thick secondary growth deciduous forest growing around the base of the cliffs and cliff slope further to the south.
- Terrestrial Species at Risk: DST completed the Preliminary Terrestrial Habitat Assessment, which was used to determine the scope of subsequent SAR surveys completed for the Species at Risk Survey. The survey area considered the CLC property, the area north of the property where stormwater management infrastructure may be constructed, and the Eastern Creek.

  The Species at Risk Survey included consultation with the Ontario Ministry of Natural Resources; review of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Species at Risk Ontario (SARO) SAR status reports and range maps for the target species; review of the Natural Heritage Information Center (NHIC) mapping and historical records of SAR occurrences. In addition, the scope of work included identification of species-specific mitigation measures and discussion of anticipated SAR related permitting requirements. Mitigation and permitting information presented in this report should be reviewed and confirmed in the context of the more detailed impact assessments that will be undertaken as part of the forthcoming Environmental Impact Statement (EIS) and Environmental Effects Analysis (EEA) studies.

  Based on the above-noted records review, DST compiled a list of 24 SAR which may potentially be present within the survey area. Survey results indicate the presence of six species, as follows:

  - Butternut trees were identified at the CLC property, north of the property, as well as along the Eastern Creek. The Butternuts are classified as Category 1 (non-retainable, for example, terminally infected with Butternut Canker) or Category 2 (considered retainable). Most of these trees were clustered within the forest patch growing along the edge of the escarpment. No Butternut trees were found within the grassland or within the proposed locations of the stormwater management facilities.

- The Monarch Butterflies were noted at three locations within fields containing Milkweed plants within the survey area. Due to the presence of Milkweed plants, it is presumed that Monarch Butterfly are both foraging and breeding within the survey area.
- Common Nighthawk were heard calling. It is presumed that Common Nighthawk may utilize the survey area for foraging purposes but no evidence of nesting behavior within the survey area was noted (calls were heard outside the survey area) and therefore, no significant habitat features were noted for this species.
- The Preliminary Terrestrial Habitat Assessment identified the potential that exposed rock crevices and rock cracks within the cliffs/exposed bedrock areas could serve as bat maternity roosting or hibernation habitats. The escarpment beyond the northern CLC property boundary is characterized by a steep drop in topography moving from south to north, with areas of exposed rock, rock crevices, and rock cracks creating unusual geologic conditions. Such features have the potential to serve as either summer roosting habitat and/or hibernation sites for some bat species. Three SAR bat species (Little Brown Myotis, Northern Myotis, and Tricolored Bat) were found to occur within the survey area. A comparatively small number of recordings were documented for each of these species, suggesting that while these species are present within the survey area, it is unlikely that a large colony exists for any of the SAR bats. The number of recordings observed for each species is similar to background levels of activity observed by DST for the SAR bats throughout the Ottawa area, and suggests that these species are utilizing the survey area and adjacent grasslands, meadows, and forested areas adjacent to the Rockcliffe and Aviation Parkways for foraging purposes only. It is also possible that small numbers of the SAR bats utilize rock crevices and cracks within the Rockcliffe Escarpment as summer roosting sites. Because all three SAR bats typically hibernate communally in sites with constant temperature conditions (e.g. caves, abandoned mines, large tunnels, etc.) and no large openings or caves have been noted within the escarpment, it is unlikely that the SAR bats would overwinter within the escarpment. There was not an observed significant increase in the number of recordings for the SAR bat species over the course of the survey, and no evidence of swarming activity within the survey area for these species was observed. Migratory Silver Haired Bats (not an SAR) increased in abundance towards the end of August, suggesting that this species is migrating through the survey area at that time.

  Due to the presence of potentially significant bat roosting habitat, which may serve as a summer roosting sites for small numbers of SAR bats and for larger numbers of Big Brown Bats, DST recommends that the future EIS/EEA should evaluate potential impacts to this feature. The Rockcliffe Escarpment is contained wholly within the NCC lands, and hence would be within federal jurisdiction. It should be noted that none of the SAR bats are currently listed under Schedule 1 of SARA, and hence do not require SARA-related permitting. Ontario Ministry of Natural Resources (OMNR) guidance dictates that bat hibernacula and roosting sites should be protected by a buffer of 120 m and that impacts to the habitat within 120 m of the feature should be considered as part of an EIS/EEA (OMNR 2011). Mitigation measures include pre-construction searches of any affected areas of the escarpment and a work timing window.

Several mitigation measures specific to the SAR identified have been outlined in the Species at Risk Survey report. The forthcoming EIS/EEA should elaborate on these mitigation measures to address other environmental impacts that are not specific to these

species, as the list of mitigation measures outlined in the Species at Risk Survey report are not intended to address all potential environmental concerns. Ultimately, the EIS/EEA should include mitigation measures related to environmental impacts from the proposed undertaking.

- Provincially Designated Natural Areas: There are four provincially designated natural areas within one kilometer of the site; however the only area with the potential to be impacted by the redevelopment of the site is the Rockcliffe Airbase Woods. These woods are located northeast of the Rockcliffe Parkway and Airport-Marina Road and are characterized by a rolling landscape of deep marine clay that is lightly and irregularly covered by sand and silty sand and dominated by a young to submature upland deciduous forest. The underlayer of impervious clay has created complex moisture conditions across the site, resulting in equally complex variations in forest dominants. This site supports the largest clay-based upland area of relatively natural vegetation in Ottawa (NHIC, 2013).
- Urban Natural Areas: The City of Ottawa prepares reports on Urban Natural Areas (UNAs) within the City, detailing the fauna and flora, and the general health of the area. Within the vicinity of the former CFB Rockcliffe site, there are five UNAs: the Airbase Woods, the NRC Woods North, the Montfort Hospital Woods, the Carson Grove Woods, and the Assaly Woods.

  From an ecological standpoint, the two most valuable vegetated areas in the vicinity of the site are the Montfort Hospital Woods and the NRC Woods North. The Montfort Hospital woods are owned by the National Capital Commission. The City of Ottawa has confirmed that any development within 30 m of these features will require the completion of an Environmental Impact Statement (EIS).

Existing tree groupings and UNAs are indicated on **Figure 2.10** and Category 2 Butternut locations are indicated on **Figure 2.11**.

2.4 Municipal Servicing

2.4.1 Water

The Rockcliffe site is located in the City of Ottawa's Montreal Road Pressure Zone (MRPZ). The MRPZ is located on elevated lands within the City's Pressure Zone 1E and water pressure increases are required to provide adequate supply to the lands within the MRPZ. The site is serviced from two water pumping stations near Montreal Road. The Montreal Road Pump Station, located near Bathgate and Montreal Roads, supplies increased water pressure to a 400 mm/300 mm diameter watermain in Burma Road north of Montreal Road, which is the principal source of potable water to the Rockcliffe site. The Brittany Drive Pump Station, located to the west near Brittany Drive and Montreal Roads, is primarily used as a backup or secondary feed to the MRPZ, and would supply water to the 400 mm/300 mm Burma Road watermain in the event of a failure of the Montreal Road Pump Station. The existing water supply and distribution system for the Rockcliffe site is shown on **Figure 2.12**.

Because of the elevation drop between Montreal Road and the study area, a pressure reducing valve assembly was installed near the northern end of the Burma Road 400 mm diameter watermain immediately below the southern escarpment near Canopy Street.

As well, it is noted that there are two 300 mm diameter watermains feeding the NRC Campus from Burma Road just north of the Montreal Road Pump Station. It is understood that the old connection from near the Aviation Museum to Blasdell Avenue (connecting the MRPZ and Zone 1E) has been abandoned and is no longer in service.

The local distribution system within the study area consists of 150 mm to 200 mm diameter watermains. These mains are also shown on **Figure 2.12**. It has previously been concluded that the existing system will be replaced during the Rockcliffe site redevelopment since roadway networks will be different and the existing supply system will not be capable of supporting the proposed redevelopment to current City of Ottawa standards. The existing site watermains are no longer in service.

Most of the adjacent neighbourhoods surrounding the Rockcliffe site are serviced by the City's potable water supply system. These include the NRC Campus, Thorncliffe Village, Foxview and the Montfort Hospital. However, Fairhaven, a small neighbourhood located immediately to the east of the Montfort Hospital Woods, is serviced by individual wells and is not connected to the City's municipal supply. It is understood that the Fairhaven neighbourhood wishes to remain on wells and that redevelopment of the Rockcliffe site's water supply and distribution system should not consider any municipal piped water supply to this neighbourhood.

2.4.2 Wastewater

All collected wastewater flow in the City of Ottawa is routed to a central treatment plant, known as the R.O. Pickard Environmental Centre, which is located several kilometers to the east of the Rockcliffe site. Wastewater flows are delivered to the treatment plant by several large trunk sewers including the Ottawa Interceptor Outfall Sewer (IOS) which flows through the middle of the Rockcliffe site in a west to east direction. This major collector sewer is 2.4 m in diameter and was constructed approximately 45 m below the existing ground surface. **Figure 2.13** shows the location of the IOS trunk sewer as well as the location and sizes of the sanitary sewer system in and around the Rockcliffe site.

The existing sewers within the site consist of mostly combined sewers carrying both wastewater and storm runoff. There are only two dedicated storm sewer systems within the site and two short sections of dedicated sanitary sewers which carry sanitary flows from two external areas to the site. These dedicated sewers are also illustrated on **Figure 2.13**.

All combined sewage from the Rockcliffe site is discharged to the IOS trunk sewer. The combined sewers on the site located west of Codd's Road presently outlet to the Alvin Heights Pull-Back Sewer via the 750 mm diameter Airbase Outlet Sewer. The Alvin Heights Pull-Back Sewer eventually connects to the IOS trunk at the Peach Tree Road Shaft. The combined sewers to the east of Codd's Road outlet to the RCAF Pull-Back Sewer, which connects to the IOS trunk sewer at the NRC Shaft.

Both connections to the IOS trunk sewer also contain overflow mechanisms directing dry weather flows to the IOS trunk sewer and discharging some flows to the Ottawa River during major wet weather events. The overflow structures help control surcharging in the IOS trunk sewer beyond the Rockcliffe site.

The remaining combined sewers on the site, located near the north central portion of the site, which are identified as combined sewers on **Figure 2.13** but without any size identifications, are no longer in active service but continue to outlet to the RCAF Pump Station located east of the Aviation Museum and north of the Rockcliffe Parkway. The museum also outlets to that pump station which in turn is connected to the RCAF Pull-Back Sewer via a forcemain system.

The 2013 Infrastructure Master Plan Wastewater Collection System Assessment report includes a discussion on the capacities and duties of the City's wastewater pump stations, including the RCAF Pump Station. Table 6.2 on Page 6.6 of that study indicates that the pump station has a firm capacity of 29 l/s but is currently only pumping about 2 l/s. A copy of the table is included in **Appendix B**.

The IOS trunk sewer has three shafts located along its length within and adjacent to the site. Besides the Peach Tree Road Shaft to the west and the NRC Shaft to the east, a relatively new shaft, located near the middle of the site and referred to as the Codd's Road Shaft, was constructed in the 1990s. Future redevelopment of the site could make use of all three connection points to the IOS.

There are several developed external areas to the site which contribute flows to the existing site sewer system. The Montfort Hospital has a recently separated sewage drainage system consisting of dedicated sanitary and storm sewers. The sanitary outlet from the Montfort Hospital connects to the combined sewers on the Rockcliffe site at Via Venus Private. That sewer is located in an easement which is shown on **Figure 2.13**.

The Foxview residential development is currently serviced with sanitary sewers which outlet to the south.

The existing Fairhaven Community adjacent to the south boundary of former CFB Rockcliffe immediately adjacent to the Montfort Hospital remains a rural estate community with individual septic systems. Although not currently discharging wastewater to the former CFB Rockcliffe site, the natural topography suggests that the majority of this community would drain to the Rockcliffe sanitary system if sanitary sewers were required in the future.

The Thorncliffe Village residential development has a separated sewer system including a dedicated 300 mm diameter sanitary sewer which enters and meanders through the Rockcliffe site but connects directly to the IOS trunk sewer at the Codd's Road shaft. The connection detail is presented on **Figure 2.14**.

The NRC Campus is serviced with combined sewers. Discussions with NRC staff suggest that most of the combined sewage from the NRC lands north of Montreal Road is directed to the IOS trunk sewer in a combined sewer which is located within the Rockcliffe site. The NRC outlet sewer is connected directly to the large IOS trunk sewer complete with an overflow mechanism, as illustrated on **Figure 2.15** and **Figure 2.16**.

2.4.3 Stormwater

The existing surface drainage patterns for the study area and adjacent external lands are presented on **Figure 2.1**, and the existing storm drainage area plan is indicated on **Figure 2.17**. As noted in **Section 1.2**, most of the study area is relatively flat, generally sloping from the southeast to the northwest. Surface runoff discharges at the northwest limit, crossing the Aviation Parkway via a culvert and outletting to the Ottawa River along the north limit of the RCMP Lands. Surface runoff from the northeast quadrant of the site discharges northward over the north escarpment and crosses the Aviation Parkway via a culvert ultimately discharging to the Ottawa River.

In addition to the combined sewer system on the Rockcliffe site, there are two dedicated storm sewer systems. These are identified on **Figure 2.17**. The two existing storm sewers are both 1050 mm in diameter and convey discharge from the existing Burma Road Stormwater Management (SWM) Facility. These two sewers both head north from the facility, one east of Via Vega Private and the other west of that road and are discussed below. The balance of the existing site storm drainage system consists of road side ditches that direct runoff to either the combined sewers or the dedicated storm sewers.

The western 1050 mm diameter storm sewer also collects surface runoff from the central portion of the site near Via Venus Private and Codd's Road and routes those flows westward and outlets to an open ditch system located behind Dubhe Private. The ditch has a fairly steep gradient and naturalized cobble bottom in its headwaters east of Aviation Parkway. The channel crosses Aviation Parkway via a 900 mm (36") diameter corrugated steel pipe (CSP) outletting to a

trapezoidal ditch, referred to as the Western Creek, adjacent to Crispin Private. The downstream end of the culvert is heavily silted to above the obvert, severely restricting flow through the culvert. Due to the limited available data for the culvert, the following information has been compiled from field survey work. The culvert measures approximately 137 m in length. The upstream and downstream inverts were surveyed at elevations 60.25 m, and 60.16 m, respectively, resulting in a slope of 0.07%.

Downstream of the Aviation Parkway culvert, the sediment in the channel continues for approximately 30 m westerly to the point of confluence with another channel from the Alvin Heights neighbourhood to the south. The combined channel flows westerly at a relatively flat slope through several short 900 mm diameter culverts supporting pedestrian crossings and an access road within the RCMP training grounds. The inlet to one crossing within the RCMP site is completely blocked and restricts flow to only that which can filter through the crossing embankment. At the west end of the RCMP site, the channel enters a 900 mm diameter CSP culvert that crosses under the Rockcliffe Parkway and eventually outlets to the Ottawa River. The channel between the Aviation Parkway and the Rockcliffe Parkway crossing is a relatively straight trapezoidal channel and is heavily treed along the section outside the RCMP site. There is also an existing concrete-encased sewer that partially blocks the invert of the channel immediately west of the pedestrian bridge at the end of Crispin Private. **Figure 2.18** identifies some of the creek features discussed above.

The northern 1050 mm diameter storm sewer extends northward through the site, intercepting surface runoff from the lands east and north of Via Vega Private, prior to discharging directly over the escarpment at the north limit of the study area, referred to as the Northeastern Tributary. Flow at the base of the escarpment is directed southeasterly in the southern road side ditch towards an existing roadway culvert under the Parkway. The culvert crossing under the Rockcliffe Parkway is a 1200 mm diameter (48”) CSP. Based on the limited available data for the culvert, the following information has been compiled from field survey work. The culvert measures approximately 28 m in length. The upstream and downstream inverts were surveyed at elevations 52.52 m and 52.15 m, respectively, resulting in a slope of 1.3%. The culvert discharges to a channel, referred to as the Eastern Creek, which is initially relatively straight and destabilized in the vicinity of the Rockcliffe Parkway, but graduates into a wider meandering creek with several sub-reaches as it approaches the Ottawa River. The channel is completely blocked by a pedestrian trail crossing located near the edge of the Ottawa River with no culvert, thereby restricting the discharge rate of the creek to the flow that can infiltrate through the pathway fill. The Eastern Creek is identified in **Figure 2.18**.

There are several sources of external runoff to the site. As noted above, the Burma Road SWM Facility provides treatment of runoff from the Thorncliffe Village development. In addition, an overland ditch at the south end of the NRC Campus at Montreal Road is intercepted by the Burma Road SWM Facility. The outlets from the facility are described above. Runoff from the central portion of the NRC Campus that is in excess of that intercepted by the NRC combined sewer system drains onto the site along the common east boundary. This flow is intercepted by the combined sewer system and/or the road side ditch and dedicated storm system.

The Fairhaven community uses roadside ditches to convey storm flow to the south boundary of the former CFB Rockcliffe site where the flow is intercepted and eventually directed to the western channel via road side ditches. The Foxview development contributes major system flow to the Rockcliffe site. The northeastern portion of the Montfort Hospital site is provided with a SWM Facility that outlets to an existing swale through the adjacent Montfort Hospital Woods. Outflow from the SWM facility, as well as major system flow from the northeastern portion of the hospital site is conveyed to the Rockcliffe site and into road side ditches near Via Venus Private. The runoff is eventually conveyed to the western outlet at the Aviation Parkway.

There is an undeveloped area located between the site and the Rockcliffe Parkway. The western portion contributes runoff to the existing west outlet, while the eastern portion contributes runoff to the existing east outlet.

The external drainage areas are also indicated on **Figure 2.17**.

2.5 Shallow Utilities

Utilities extending to the site, including gas, hydro, and communication lines have been decommissioned over the years as people have moved off the site and the need for services has decreased.

Hydro Ottawa confirms it services this territory. It confirmed that the only existing hydro utility on the site is an existing overhead 4Kv circuit which services the RCAF sanitary pump station located north of the site near the Rockcliffe Parkway. The service extends from Lang's Road between Fairhaven and the Montfort Hospital.

The existing utility infrastructure is presented on **Figure 2.19**. Existing utilities will not be practical for re-use in the development plan, and the redevelopment of the site will require installation of new utility services which will be located mostly underground.

2.6 Opportunities and Constraints

The natural environment and existing municipal infrastructure present several opportunities and possible constraints to the redevelopment of the former CFB Rockcliffe site.

There are significant grade changes along the north perimeter, allowing shallow ponds at the base of the escarpment. The significant slope across the site limits site servicing routing to a general southeast to northwest direction. The rock escarpment provides an opportunity for a natural feature in the form of a waterfall. The escarpment also presents a constraint to development since safe setback distances must be respected.

The shallow rock at northern portion of the site accommodates significant grade raise, while clay soils at the southern portion of the site restrict grade raise.

Under existing conditions, the Eastern and Western Creeks serve as outlets from the study area with respect to surface drainage and existing storm sewers. They provide potential outlets from the stormwater management system proposed as part of the redevelopment. There are constraints associated with each creek; for example there is no outlet to the Ottawa River for the Eastern Creek, and there is debris and sediment build up at the Aviation Parkway culvert and in the Western Creek. In both cases, the restricted outlets limit discharge from the site. In order for the creeks to serve as outlets, enhancement will be considered. Specifically, at the Western Creek, debris and silt is to be removed from the Aviation Parkway culvert and the culvert through the RCMP campus. For the Eastern Creek, the constraint is the capacity of the watercourse.

During fish surveys of the respective creeks, no fish were encountered. It was concluded that the Eastern Creek could potentially provide habitat for species that are tolerant of low water levels, while sites in the Western Creek appear to provide marginal fish habitat that could be suitable for some common fish species. There is the opportunity to improve the existing and/or create fish habitat should creek enhancement works be completed.

Terrestrial surveys identified tree species on site, retention of which is recommended. In the vicinity of the Eastern SWM Facility and Eastern Creek, butternut trees classified as Category 2 (considered retainable) were identified. The Eastern SWM Facility can either be located such that the trees are retained (including a buffer); or should the trees require removal, the process must

follow the 2007 Endangered Species Act regulations. The Rockcliffe Airbase Woods, located adjacent to the Eastern Creek, will be impacted by any works in the creek.

With respect to infrastructure, its age and level of service within the limits of the former base suggest that this infrastructure (water, wastewater, stormwater and shallow utilities) has reached its useful life expectancy and will not be suitable for use in servicing redevelopment of the former CFB Rockcliffe site.

In recognition of this fact, the majority of the existing infrastructure has been taken out of service. The exceptions being the sanitary outlets for the Montfort Hospital, Thorncliffe Village, and the NRC Campus; storm drainage; and, the hydro service to the RCAF pumping station. These services will need to be maintained during redevelopment and be incorporated into any phasing of servicing as the new community is constructed over several years and phases.

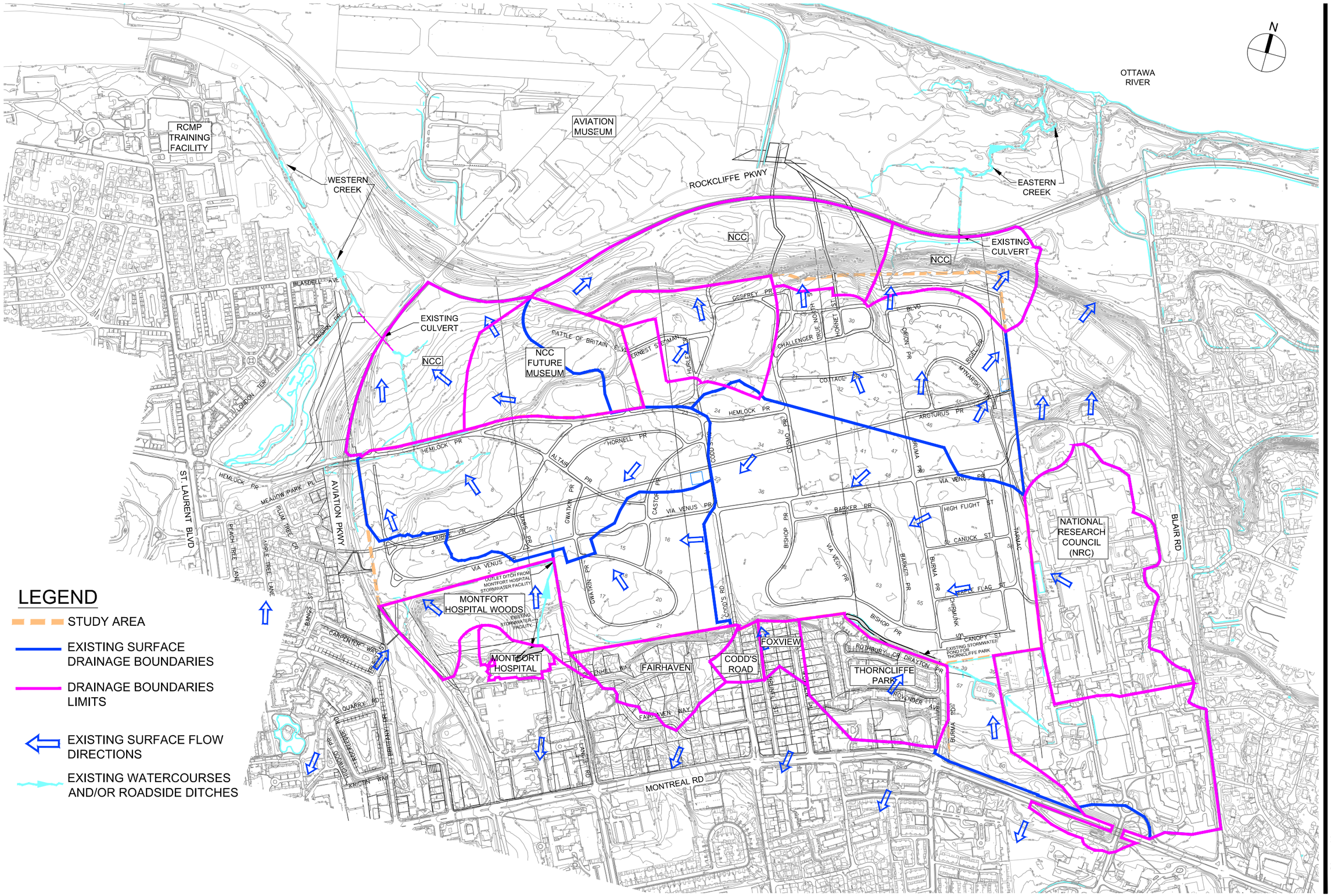
The review of the existing external water distribution system and planned upgrades to this system identified in the City of Ottawa's 2013 IMP suggests that sufficient capacity will be available in this system along Montreal Road to facilitate redevelopment of the former CFB Rockcliffe site.

The existing trunk wastewater infrastructure identified within and immediately adjacent to former CFB Rockcliffe identifies three potential direct connection points available to a major trunk sanitary collector sewer, the Ottawa Interceptor Outfall Sewer (IOS). The 2013 IMP also identifies the IOS as the designated outlet for redevelopment of the former CFB Rockcliffe site.

With regard to storm drainage, the natural topography and the two existing channels which historically provided overland drainage for the former CFB Rockcliffe site, directly to the Ottawa River, are still functioning as storm drainage outlets. The combined sewer system which is used to direct less intense rain events to the sanitary sewer system is also still functioning, but contravenes municipal and provincial policy regarding the use of combined sewers for new developments. The existing storm drainage system is also deficient in that no water quality or quantity treatment is provided for stormwater discharged directly to the natural environment. The redevelopment plan for former CFB Rockcliffe will have to address these deficiencies in the existing storm drainage system, and provide the necessary new infrastructure to meet City of Ottawa and MOE design guidelines recognizing the limitations of the two historical outlets.

The existing combined sewer system currently diverts baseflow away from the creeks. Installation of separate sanitary and storm systems will facilitate baseflow being returned to the natural environment.

The review of available shallow utilities (hydro, gas and communications) reveals that the major infrastructure put in place by these utilities in communities adjacent to the former CFB Rockcliffe over the years recognizes potential redevelopment of the former CFB Rockcliffe site. Although not all this infrastructure is currently located adjacent to the site, discussion with all utilities suggests that service is readily available to meet the demands proposed by the redevelopment plan within a reasonable distance of the site. The exact location of these corridors will need to be determined as design details advance and phasing requirements are identified.



Scale

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

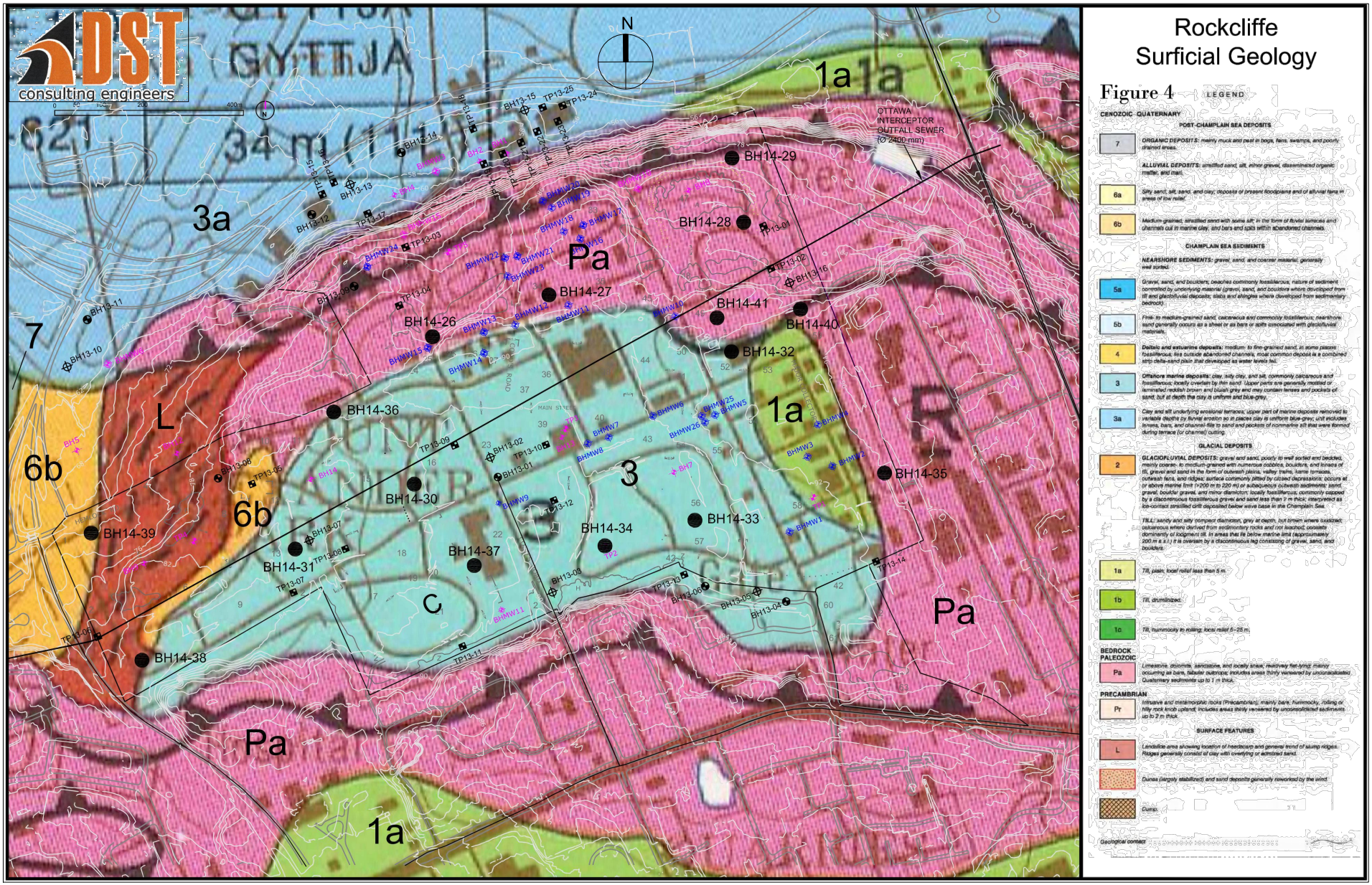
Drawing Title

EXISTING SURFACE
DRAINAGE PATTERNS

Sheet No.

FIGURE 2.1

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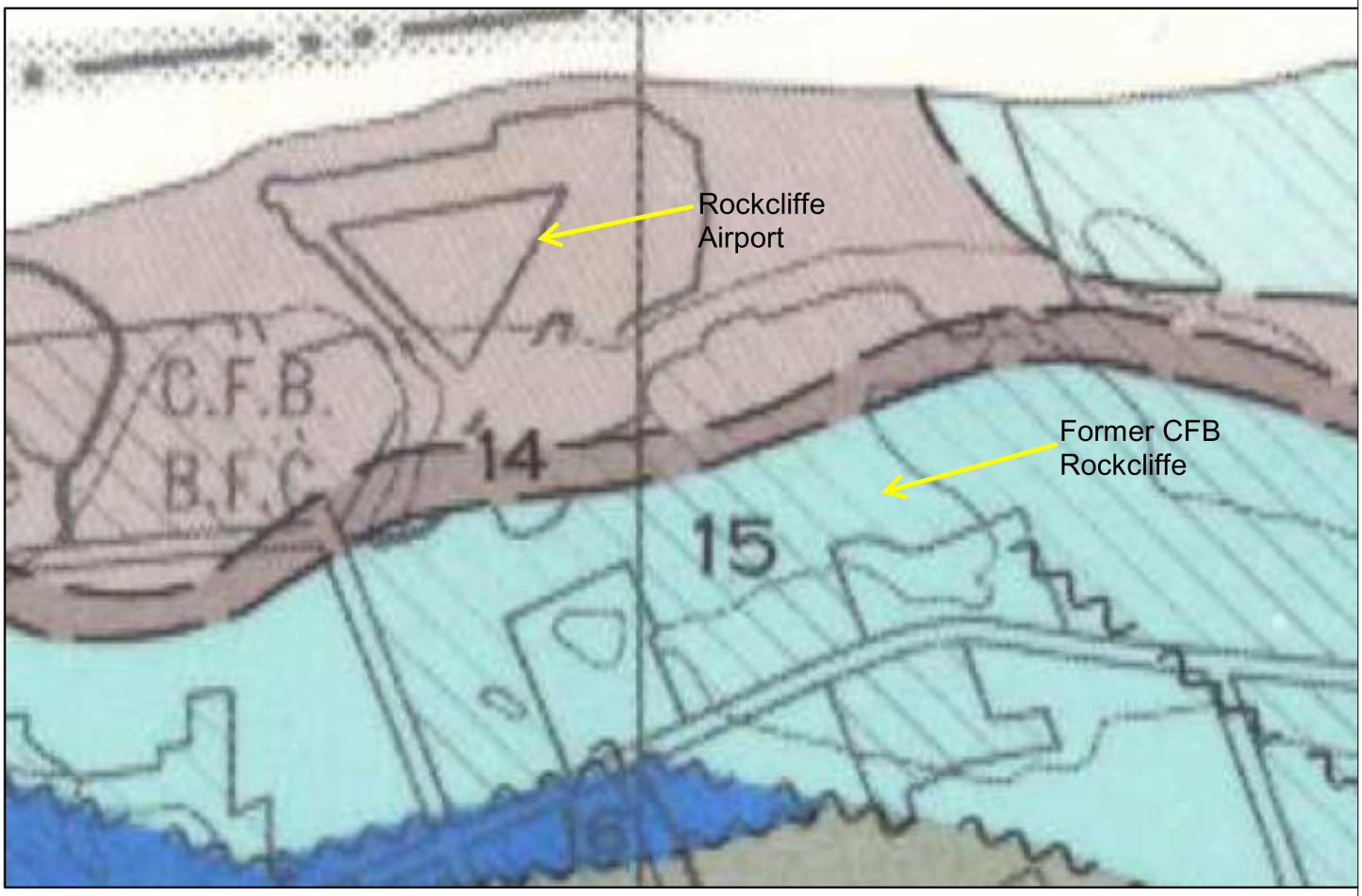


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Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	SURFICIAL GEOLOGY	FIGURE 2.2

Hydrogeological Report
Stormwater Management Support Studies
Former CFB Rockcliffe, Ottawa, Ontario
DST Reference No.: OE-OT-017184

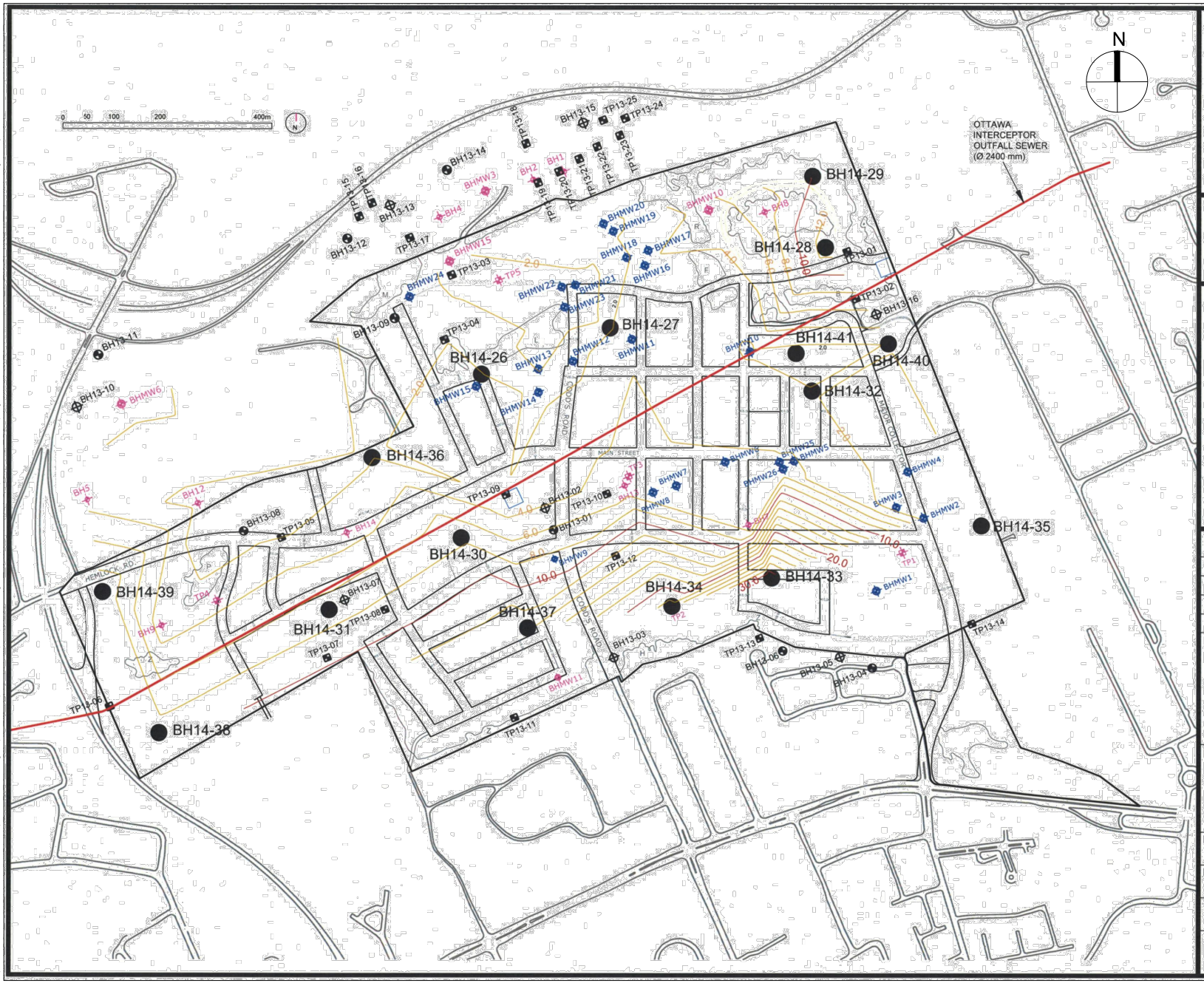
Plate 3.2: Bedrock Geology of the Former CFB Rockcliffe Area. (Generalized Bedrock Geology, GSC, 1976)



PALEOZOIC	15	OTTAWA FORMATION: limestone with some shaly partings: some sandstone in basal part
	14	ST. MARTIN FORMATION: shale, sandstone, impure limestone, dolomite
	13	ROCKCLIFFE FORMATION: shale with lenses of sandstone

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.3-Bedrock Geology.dwg Layout Name: Figure2.3

Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	BEDROCK GEOLOGY	FIGURE 2.3



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NOTES:
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE ASSOCIATED TECHNICAL REPORT.
2. DO NOT SCALE DRAWING.

LEGEND:
- MAJOR CONTOUR (10 m Interval)
- MINOR CONTOUR (2 m Interval)

REV	DATE	ISSUE	APPROVAL
0	APR. 10, 2014	Original	M.W.B.

PROJECT TITLE

Geotechnical Investigation
Former CFB Rockcliffe
Ottawa, Ontario

DRAWING TITLE

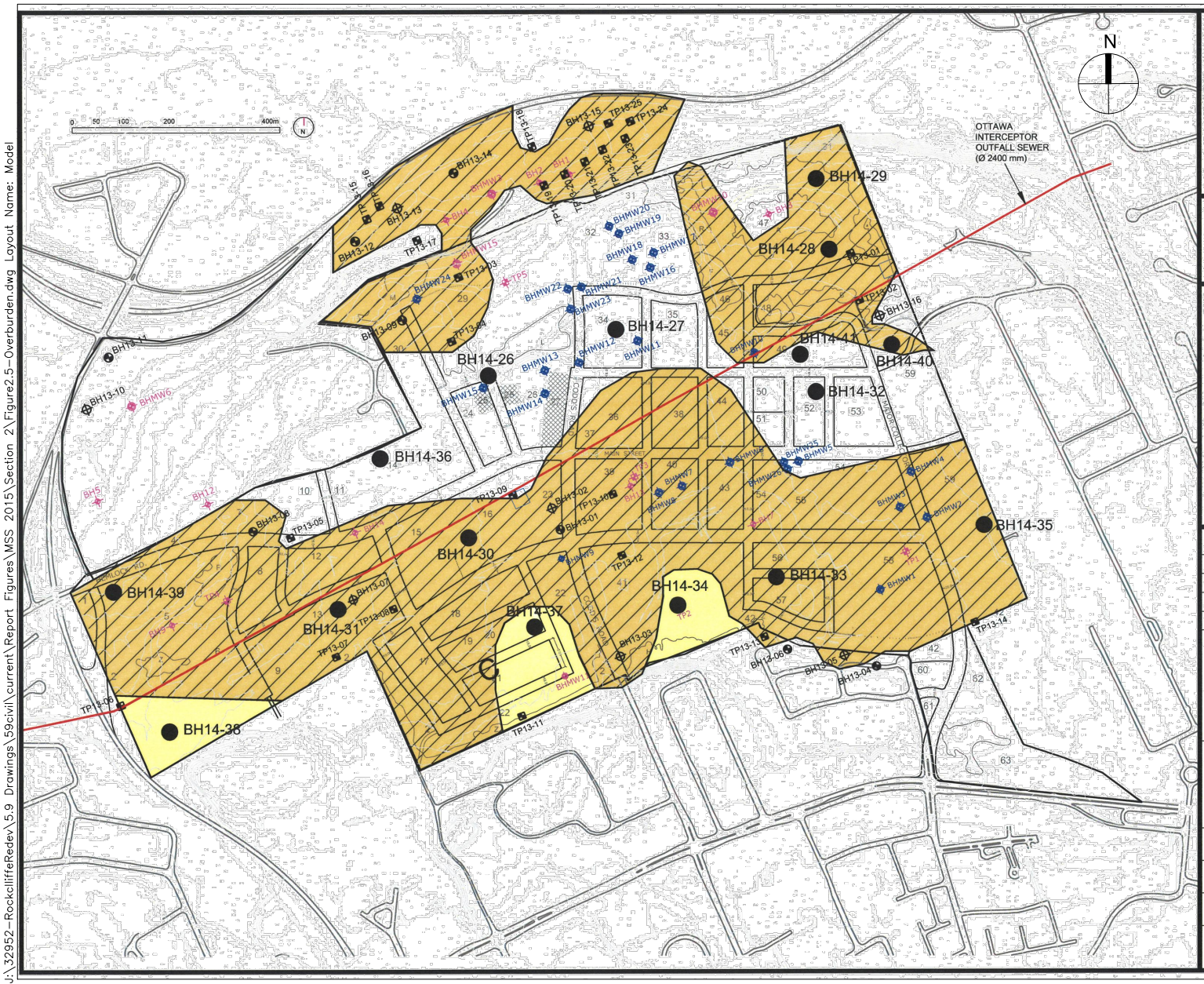
BEDROCK DEPTH CONTOURS

DESIGNED BY B.V.	SCALE As Shown
DRAWN BY M.L.	DATE APRIL 2014
APPROVED BY M.W.B	PROJECT NO.: OE-OT-015358

Figure 9

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.4-Bedrock Contours Boreholes.dwg Layout Name: Model

Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	BEDROCK CONTOURS, LOCATIONS OF TEST PITS AND BOREHOLES	FIGURE 2.4



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2150 THURSTON DRIVE, SUITE 203
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NOTES:
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LEGEND:
- CLAY & SILT/SAND
- CLAY
- SAND/SILT/GRAVEL

REV	DATE	ISSUE	APPROVAL
0	APR. 10, 2014	Original	M.W.B.

PROJECT TITLE
Geotechnical Investigation
Former CFB Rockcliffe
Ottawa, Ontario

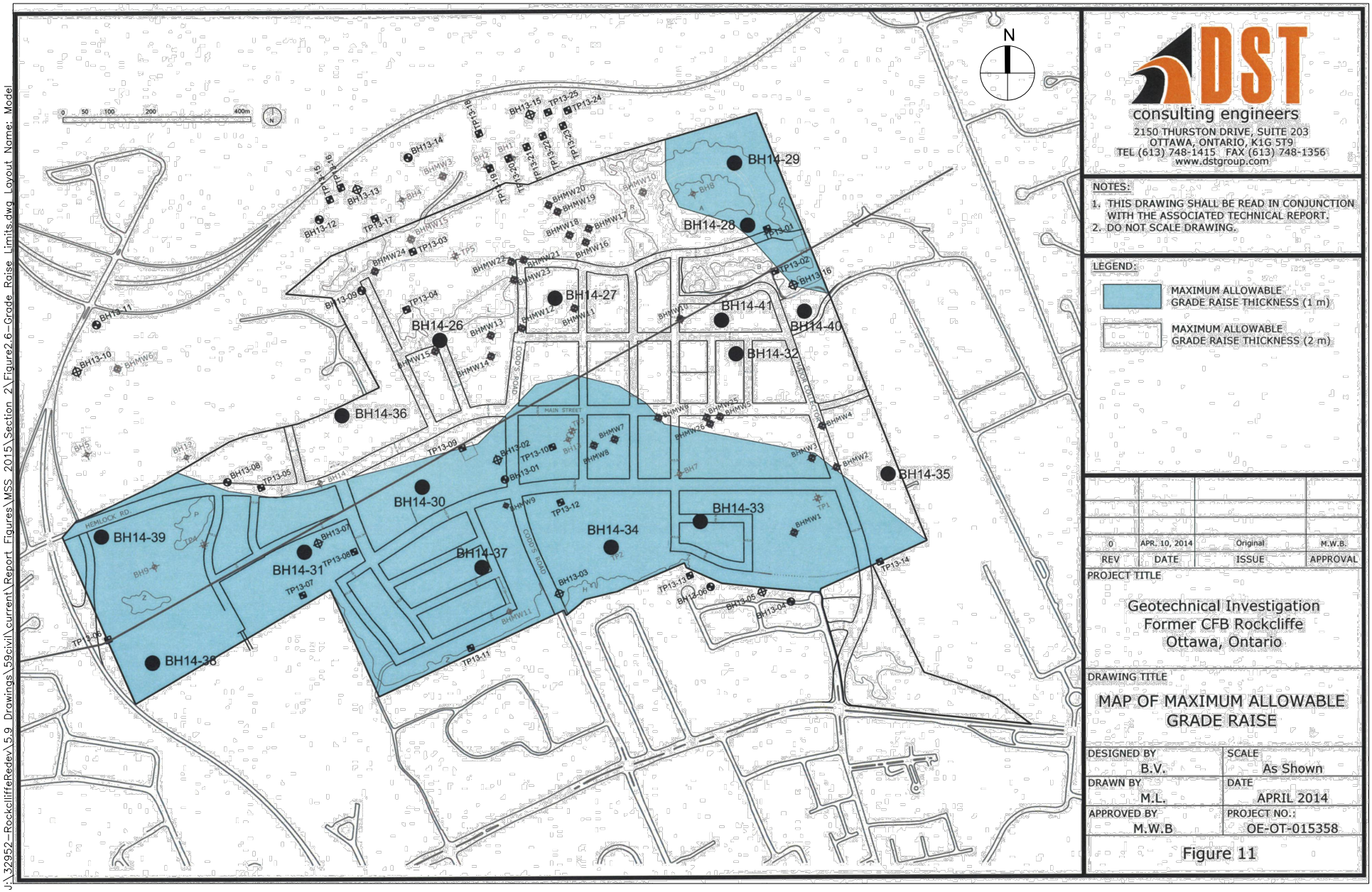
DRAWING TITLE
OVERBURDEN MATERIALS

DESIGNED BY B.V.	SCALE As Shown
DRAWN BY M.L.	DATE APRIL 2014
APPROVED BY M.W.B	PROJECT NO.: OE-OT-015358

Figure 8

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.5-Overburden.dwg Layout Name: Model

Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	OVERBURDEN	FIGURE 2.5



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LEGEND:
- MAXIMUM ALLOWABLE GRADE RAISE THICKNESS (1 m)
- MAXIMUM ALLOWABLE GRADE RAISE THICKNESS (2 m)

REV	DATE	ISSUE	APPROVAL
0	APR. 10, 2014	Original	M.W.B.

PROJECT TITLE
Geotechnical Investigation
Former CFB Rockcliffe
Ottawa, Ontario

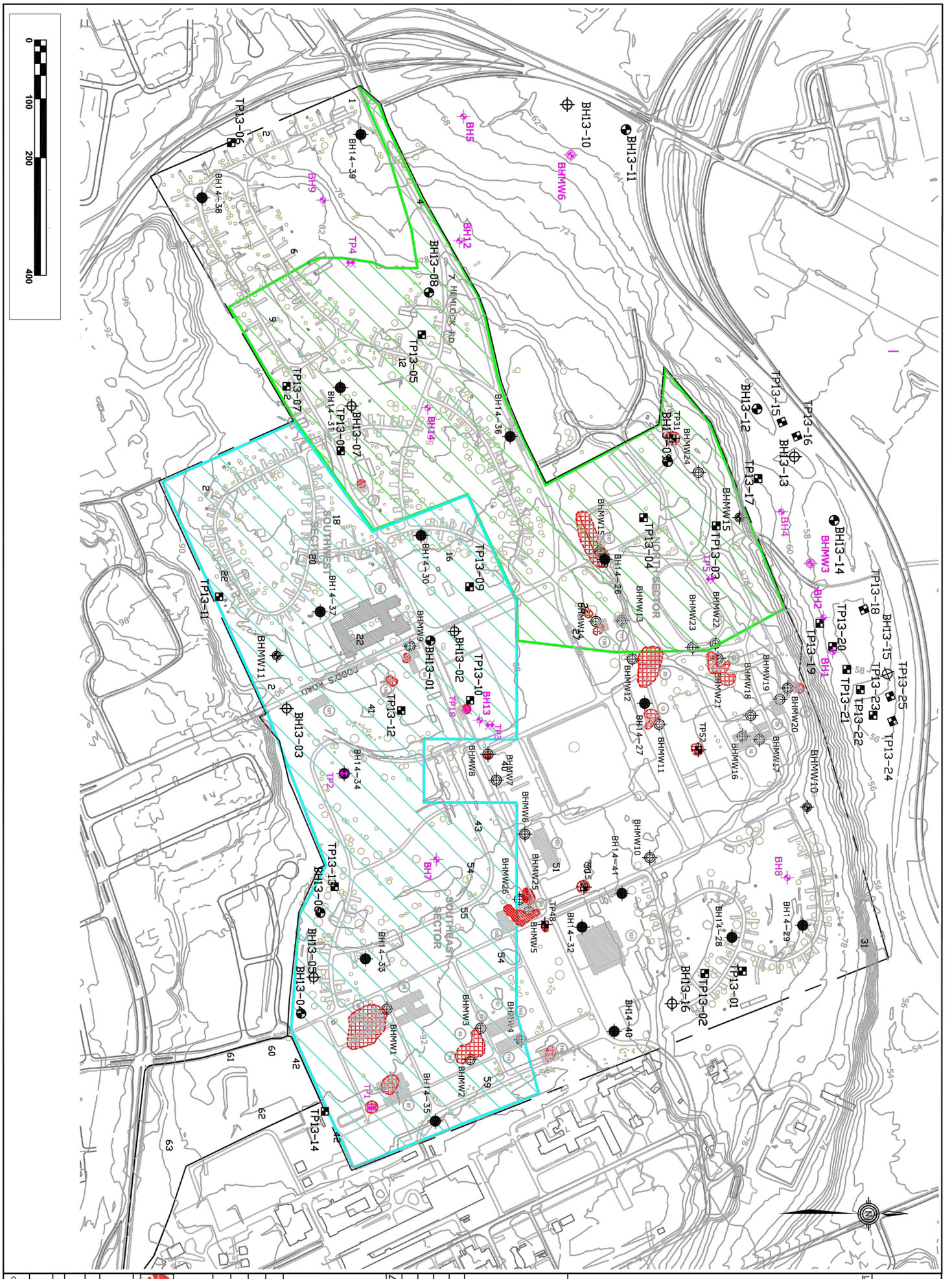
DRAWING TITLE
MAP OF MAXIMUM ALLOWABLE GRADE RAISE

DESIGNED BY: B.V.	SCALE: As Shown
DRAWN BY: M.L.	DATE: APRIL 2014
APPROVED BY: M.W.B	PROJECT NO.: OE-OT-015358

Figure 11

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.6-Grade Raise Limits.dwg Layout Name: Model

Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	GRADE RAISE LIMITS	FIGURE 2.6



Sheet No.

Drawing Title

Project Title

Scale

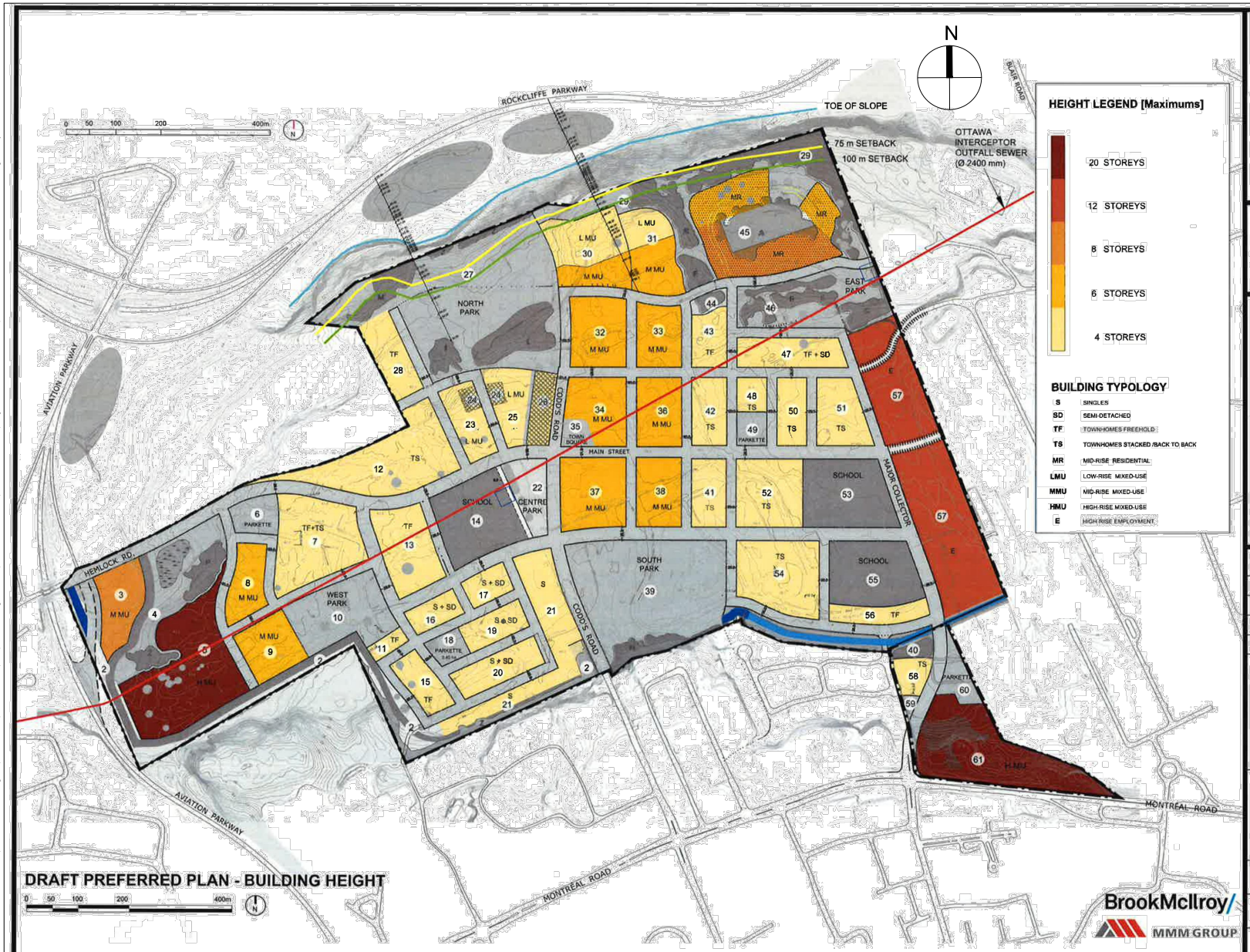
FIGURE 2.7

REMEDIATION LOCATIONS

FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY

IBI

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.8-Development Setback Limits.dwg Layout Name: Model



Base map and survey drawing provided by BrookMcIlroy/MMM GROUP

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LEGEND:
- Toe of Slope
- 75 m Setback
- 100 m Setback

REV	DATE	ISSUE	APPROVAL
0	MAR. 27, 2014	Original	M.W.B.

PROJECT TITLE
Geotechnical Investigation
Former CFB Rockcliffe
Ottawa, Ontario

DRAWING TITLE
SETBACK DISTANCES
NORTH ESCARPMENT

DESIGNED BY B.V.	SCALE As Shown
DRAWN BY M.L.	DATE MARCH 2014
APPROVED BY M.W.B	PROJECT NO.: OE-OT-015358

Figure 10

Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	DEVELOPMENT SETBACK LIMITS	FIGURE 2.8



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LEGEND:

- CREEK LOCATIONS
- OSAP SURVEY LOCATION
- SITE BOUNDARY

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2. SOURCE - GOOGLE EARTH

REV	DATE	ISSUE	APPROVAL
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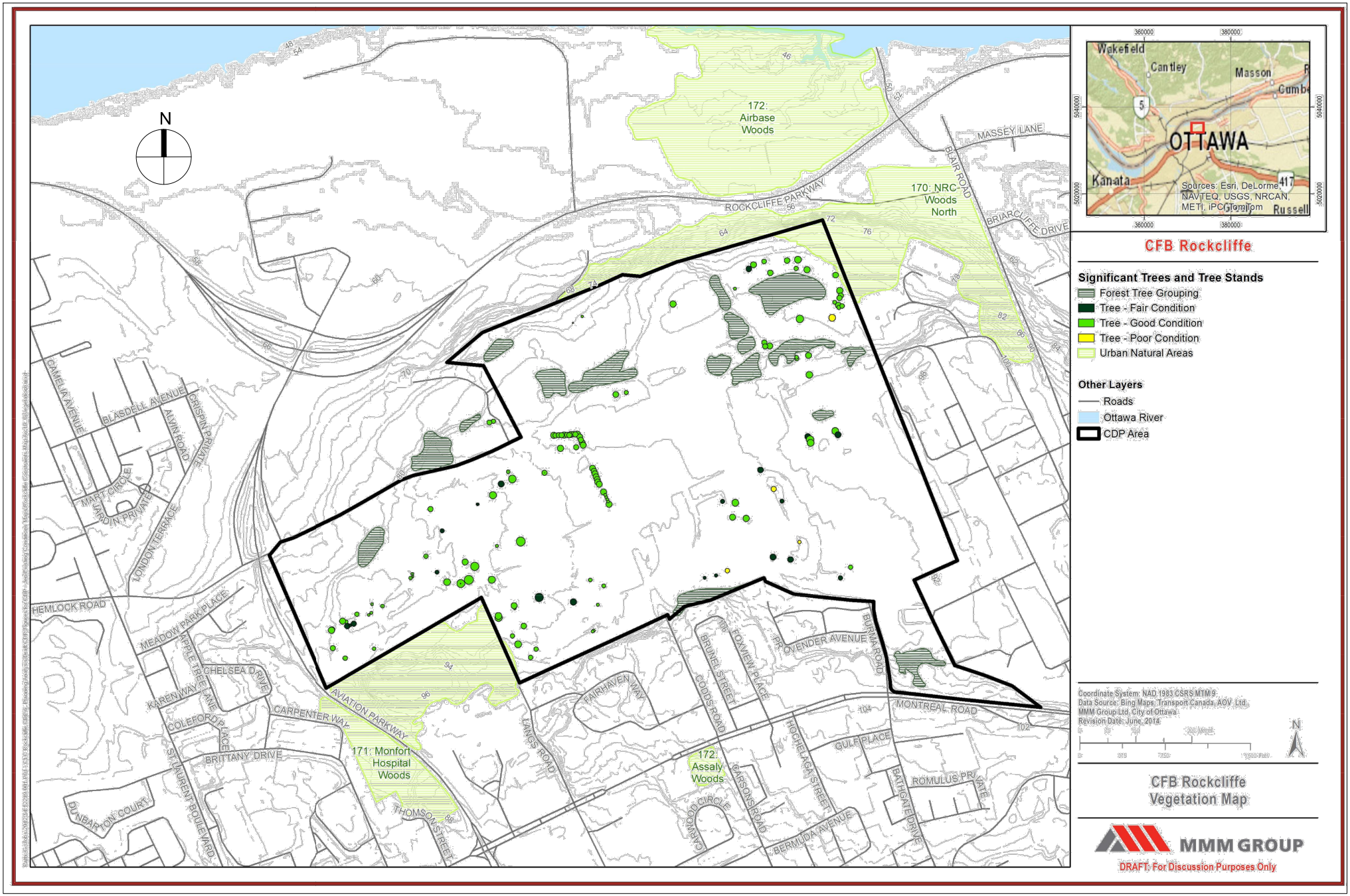
PROJECT TITLE
AQUATIC HABITAT ASSESSMENT: WESTERN AND EASTERN CREEKS, FORMER CFB ROCKCLIFFE

DRAWING TITLE
SITE PLAN

DESIGNED BY: A.M.	SCALE: N.T.S
DRAWN BY: R.P.	DATE: August 2013
PROJECT MANAGER: A.M.	PROJECT NO.: OE-OT-017184
FIGURE No.: FIGURE 2	

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.9-Aquatic Habitat.dwg Layout Name: Model

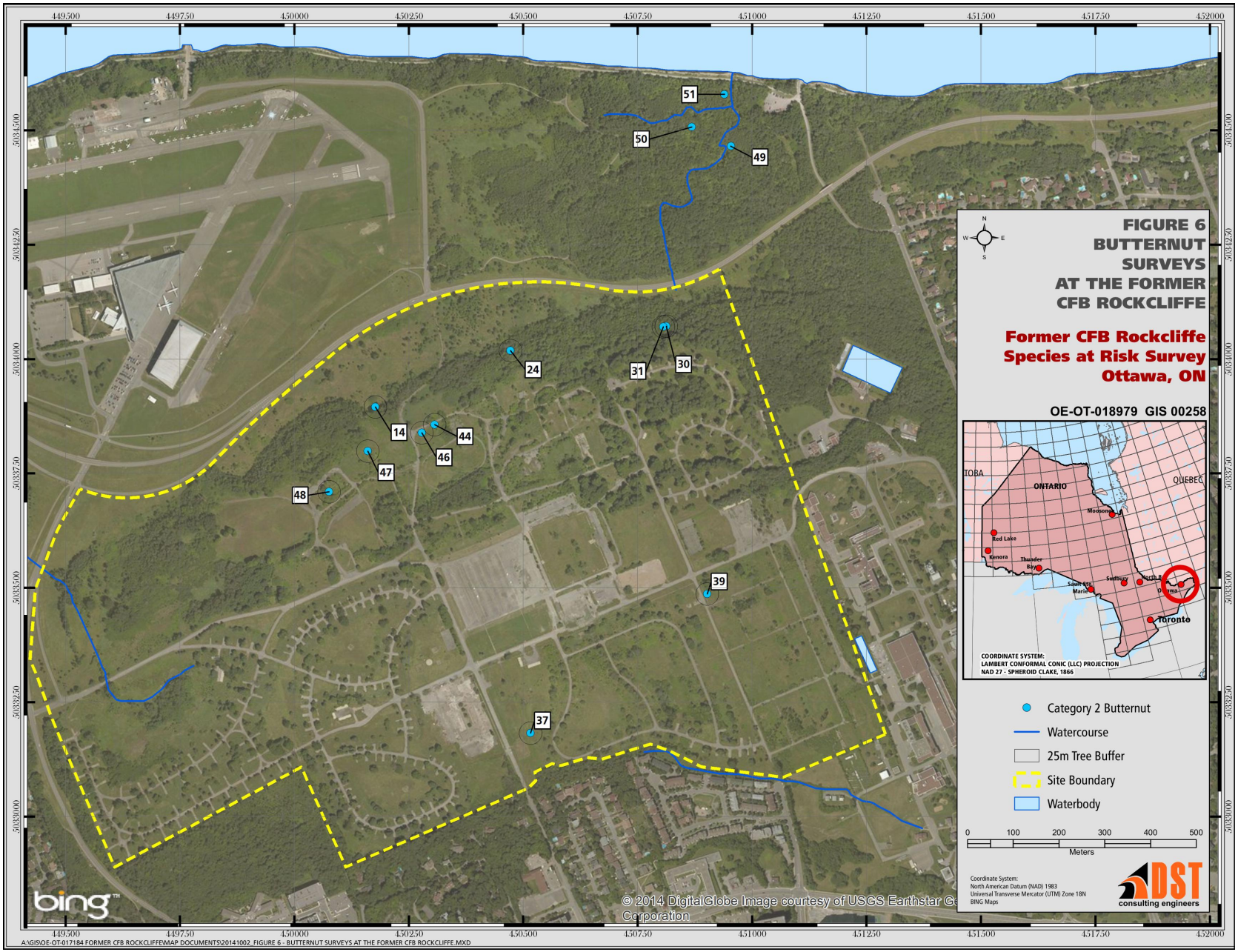
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NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	AQUATIC HABITAT REACH LOCATIONS	FIGURE 2.9



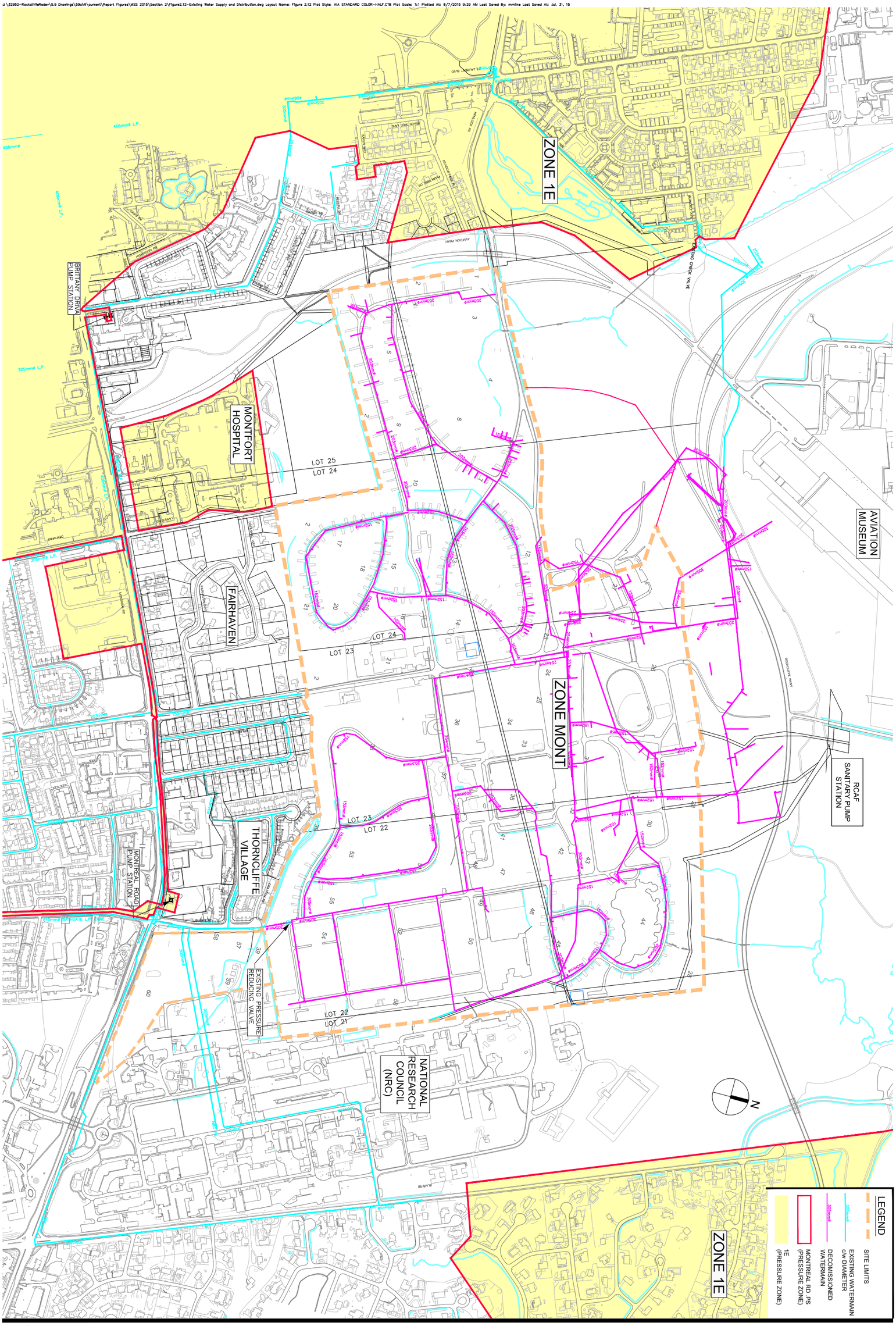
J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.10-Existing Tree Grouping And UNAs.dwg Layout Name: Model

Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	EXISTING TREE GROUPINGS AND URBAN NATURAL AREAS	FIGURE 2.10

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.11-Butternut Locations For SWM Facilities.dwg Layout Name: Model



Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	BUTTERNUT LOCATION PLAN	FIGURE 2.11



Sheet No.

FIGURE 2.12

Drawing Title

EXISTING WATER SUPPLY AND DISTRIBUTION

Project Title

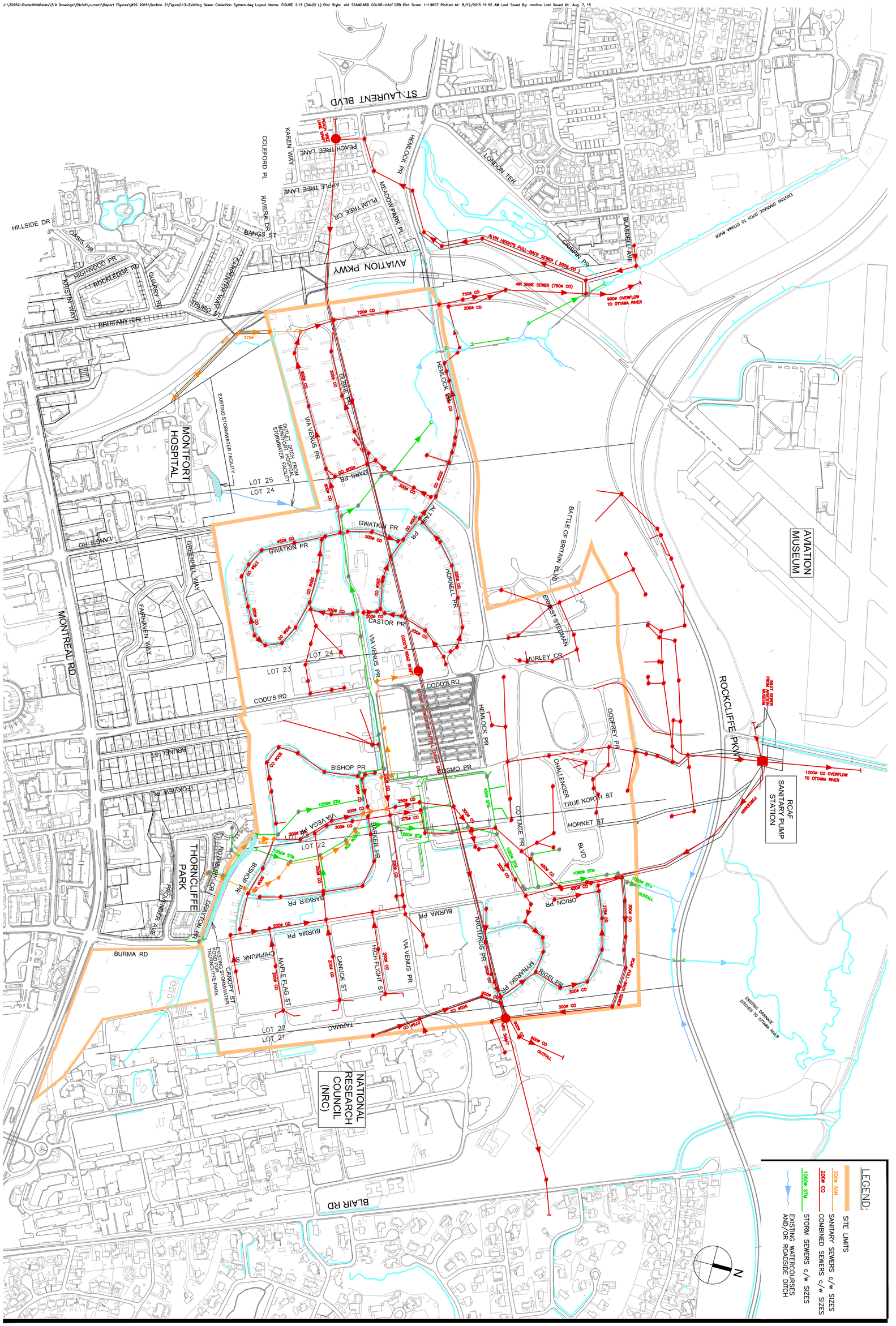
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY

Scale

0 100 200

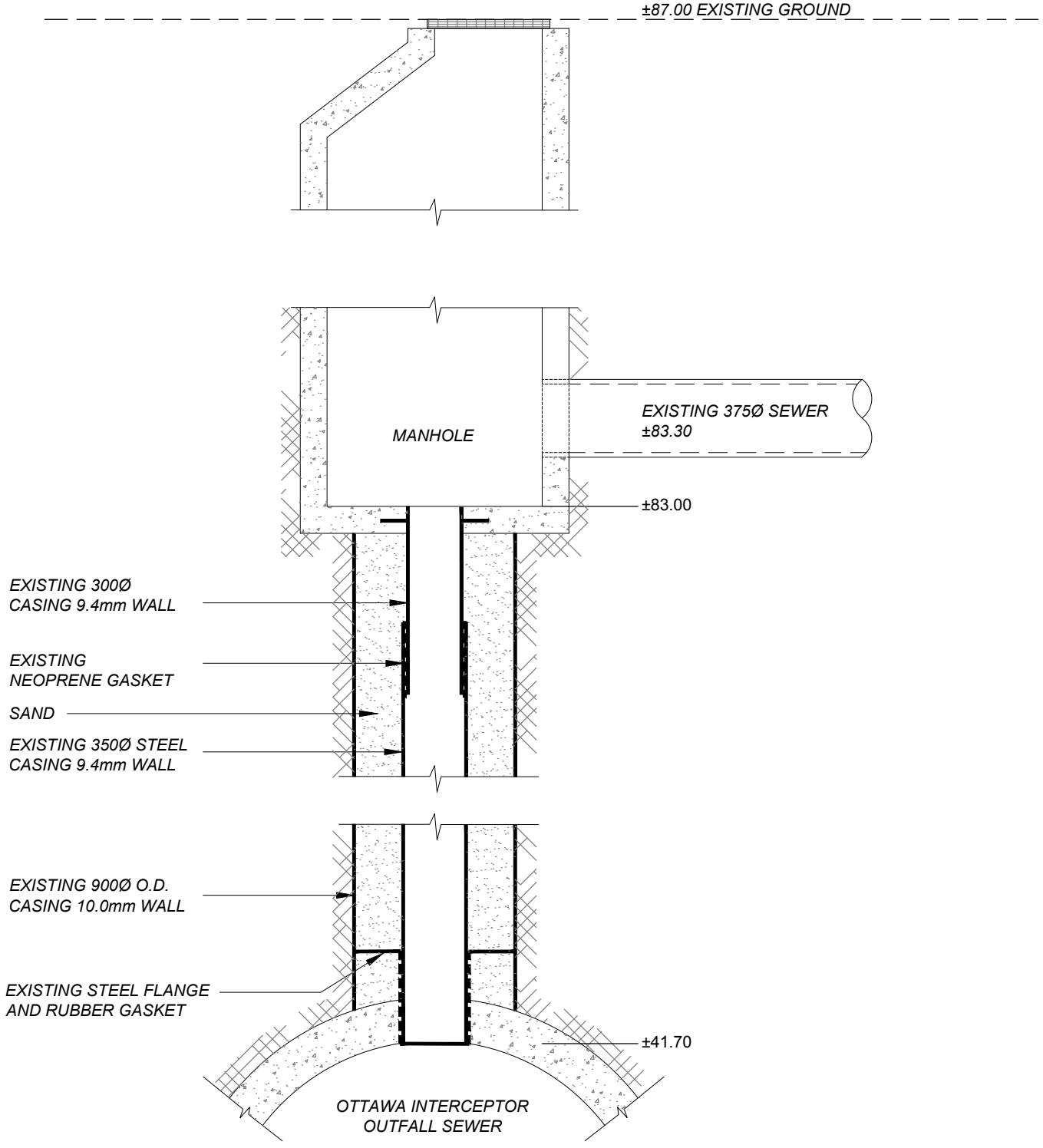
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J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.13-Existing Sewer Collection System.dwg Layout Name: FIGURE 2.13 (34x22 L) Plot Style: AIA STANDARD COLOR-HALF.CTB Plot Scale: 1:1.9607 Plotted At: 8/12/2015 11:55 AM Last Saved By: mmine Last Saved At: Aug. 7, 15



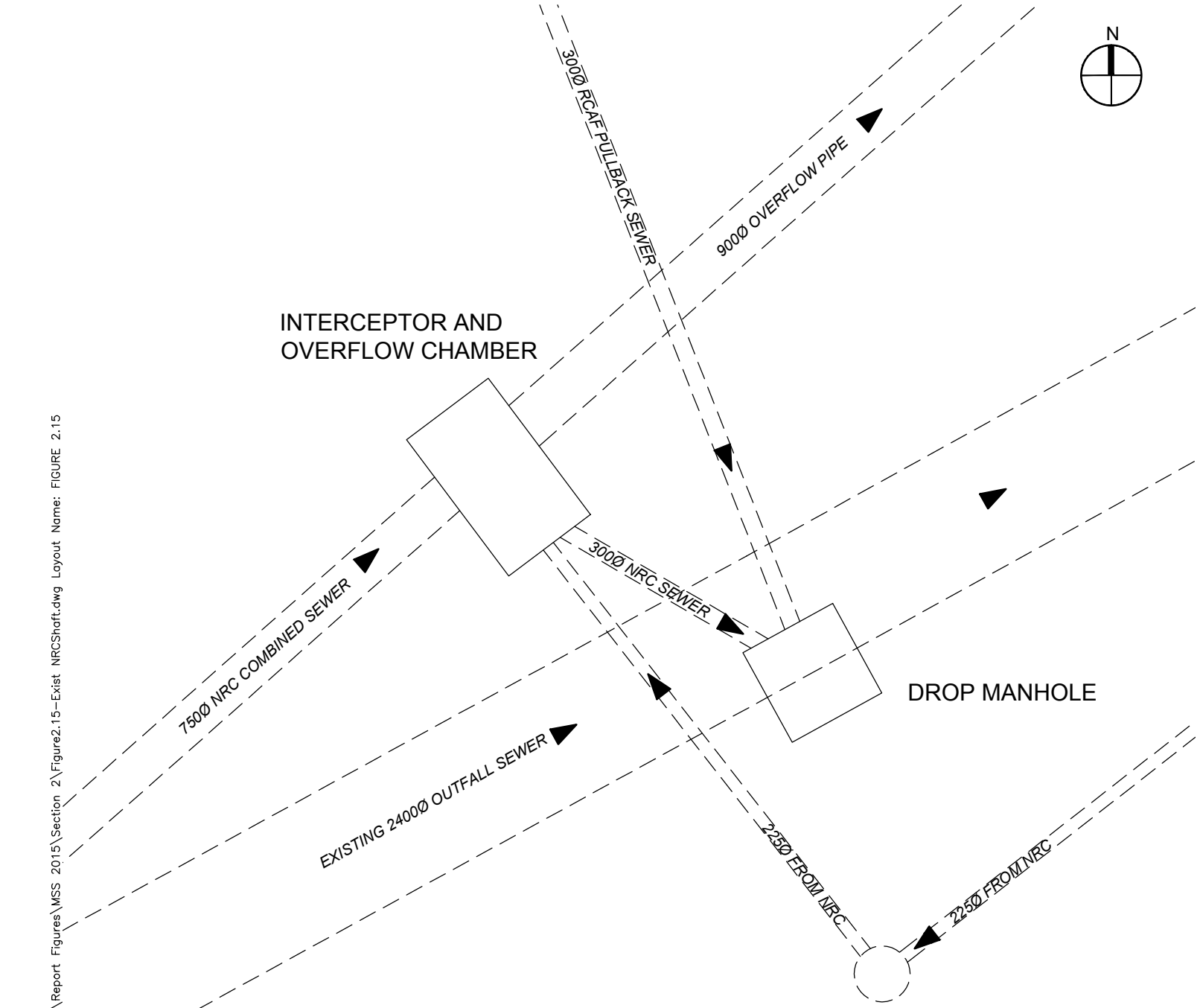
Sheet No.	Drawing Title	Project Title	Scale
FIGURE 2.13	EXISTING SEWER COLLECTION SYSTEM	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	0 100 200

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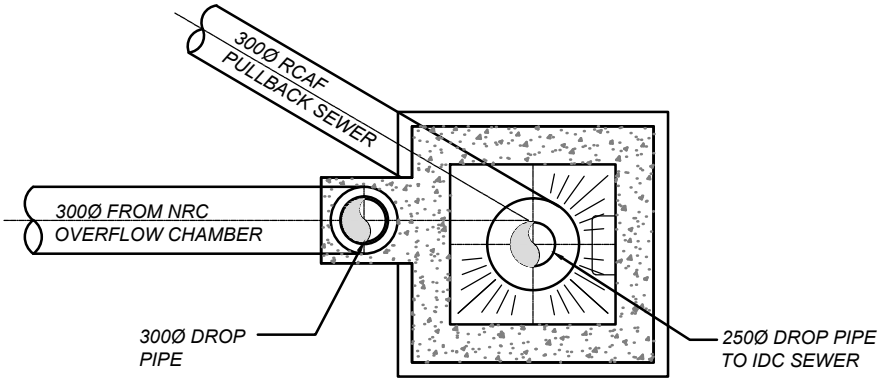
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FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	CROSS-SECTION EXISTING CODD'S ROAD DROP SHAFT	FIGURE 2.14

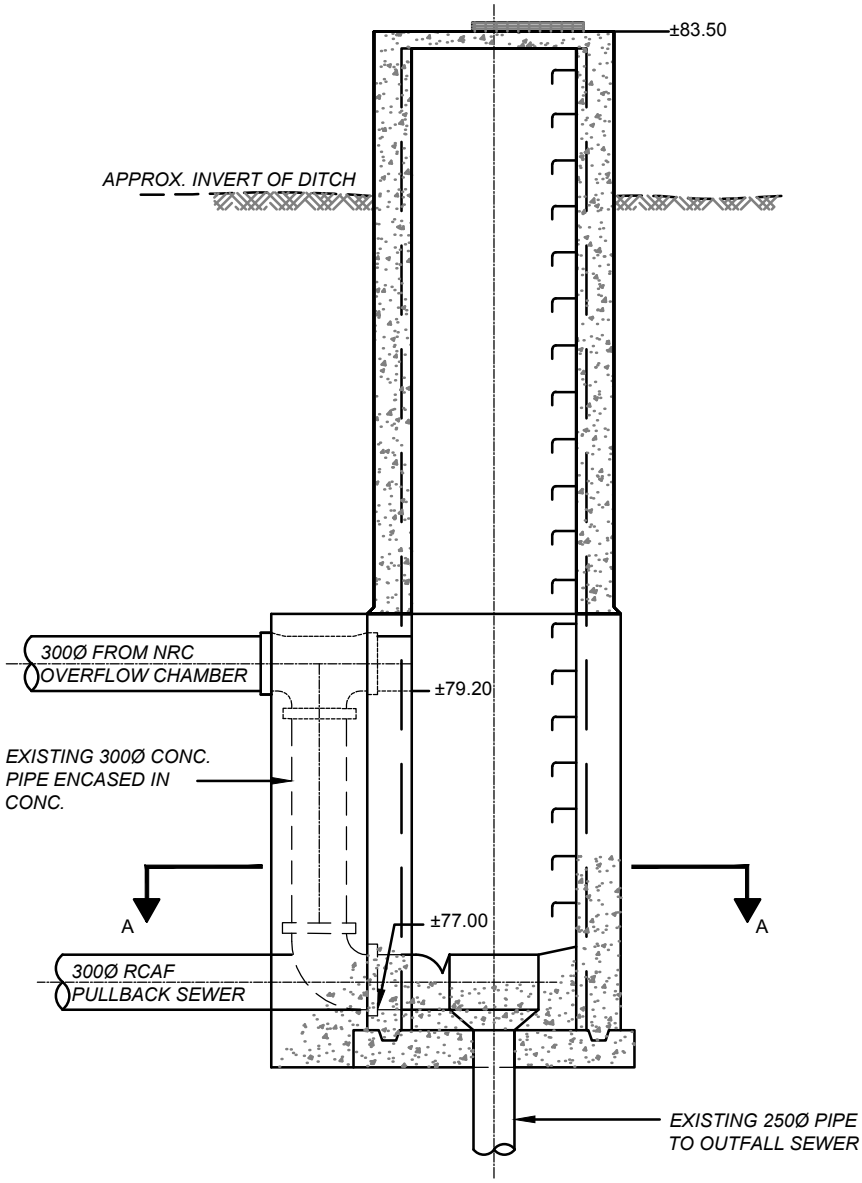


J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.15-Exist NRCShaft.dwg Layout Name: FIGURE 2.15

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FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	EXISTING NRC SHAFT CONNECTION PLAN	FIGURE 2.15



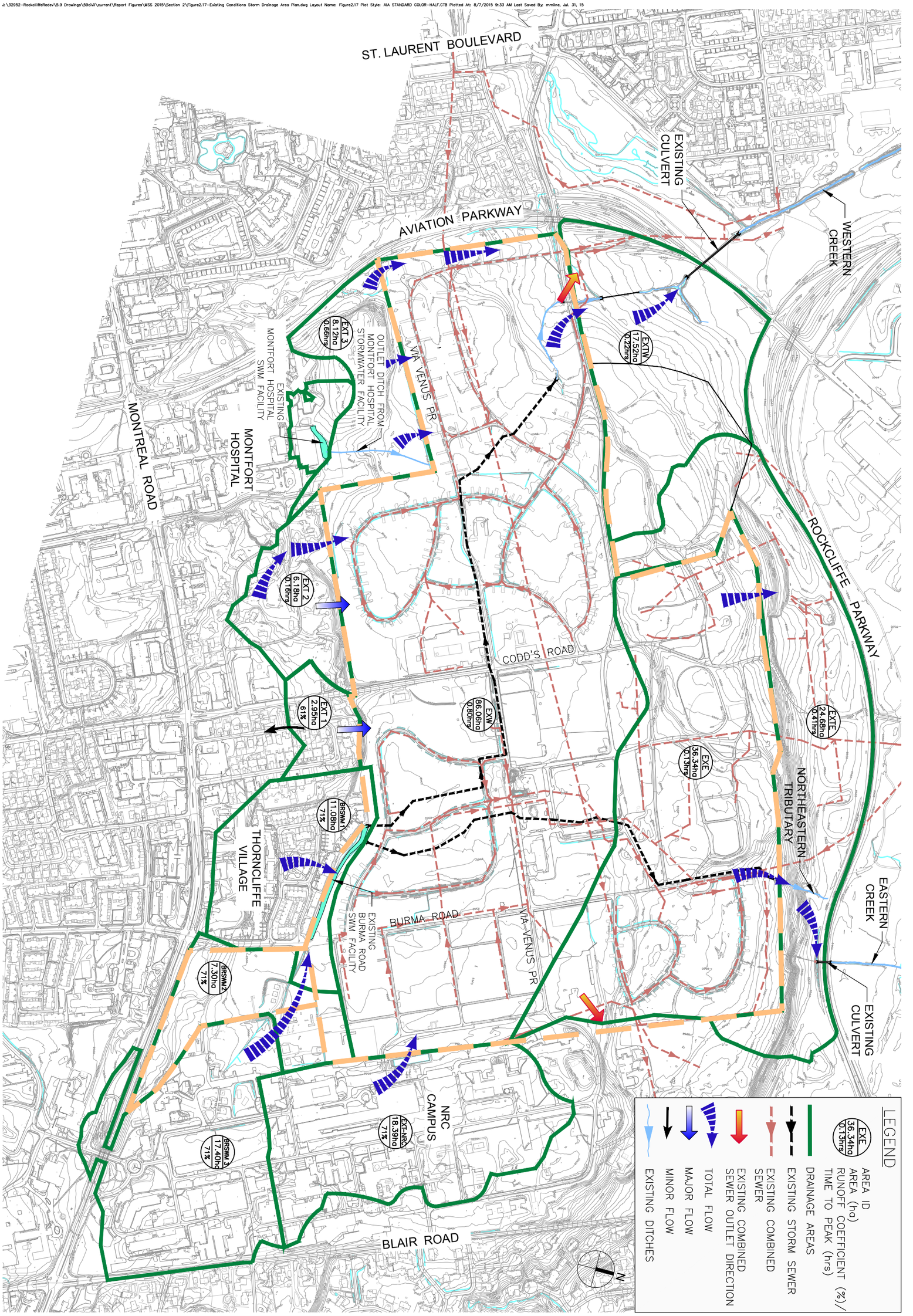
SECTION
A-A



J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.16-X-Sect Exist NRC Drop Shaft.dwg Layout Name: FIGURE2.16

Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	CROSS-SECTION EXISTING NRC DROP SHAFT CONNECTION	FIGURE 2.16

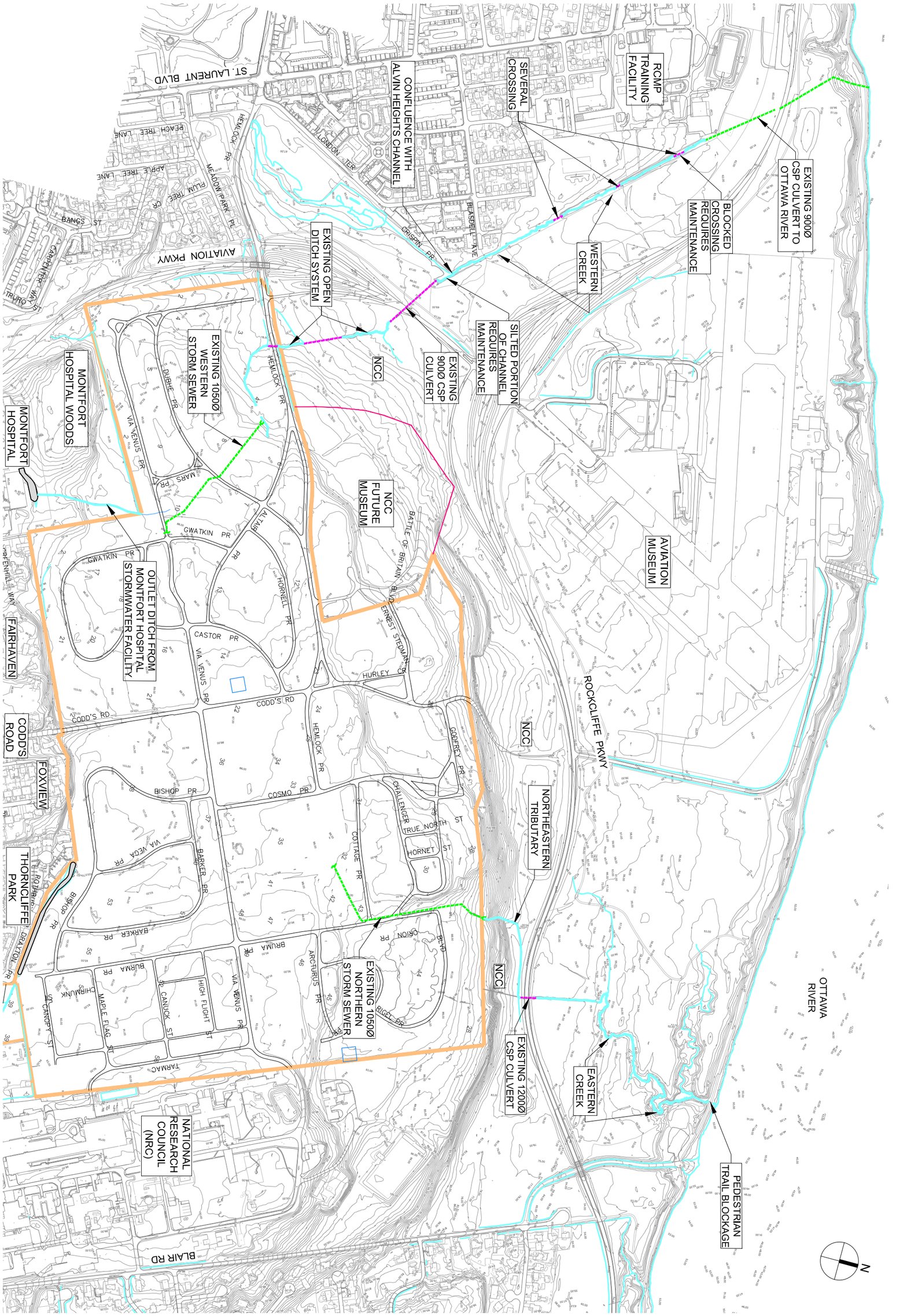
J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.17-Existing Conditions Storm Drainage Area Plan.dwg Layout Name: Figure2.17 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 8/7/2015 9:33 AM Last Saved By: mmilne, Jul. 31, 15



Sheet No.	Drawing Title	Project Title	Scale
FIGURE 2.17	EXISTING CONDITIONS STORM DRAINAGE AREA PLAN	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	0 100 200

IBI

J:\32952--RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.18--Location of Existing Watercourses Outlets.dwg Layout Name: Figure2.18 Plot Style: AIA STANDARD COLOR--HALF.CTB Plot Scale: 1:1 Plotted At: 8/7/2015 9:34 AM Last Saved By: mmilne Last Saved At: Jul. 31, 15



Sheet No.

Drawing Title

FIGURE 2.18

LOCATION OF EXISITNG WATERCOURSES OUTLET

Project Title

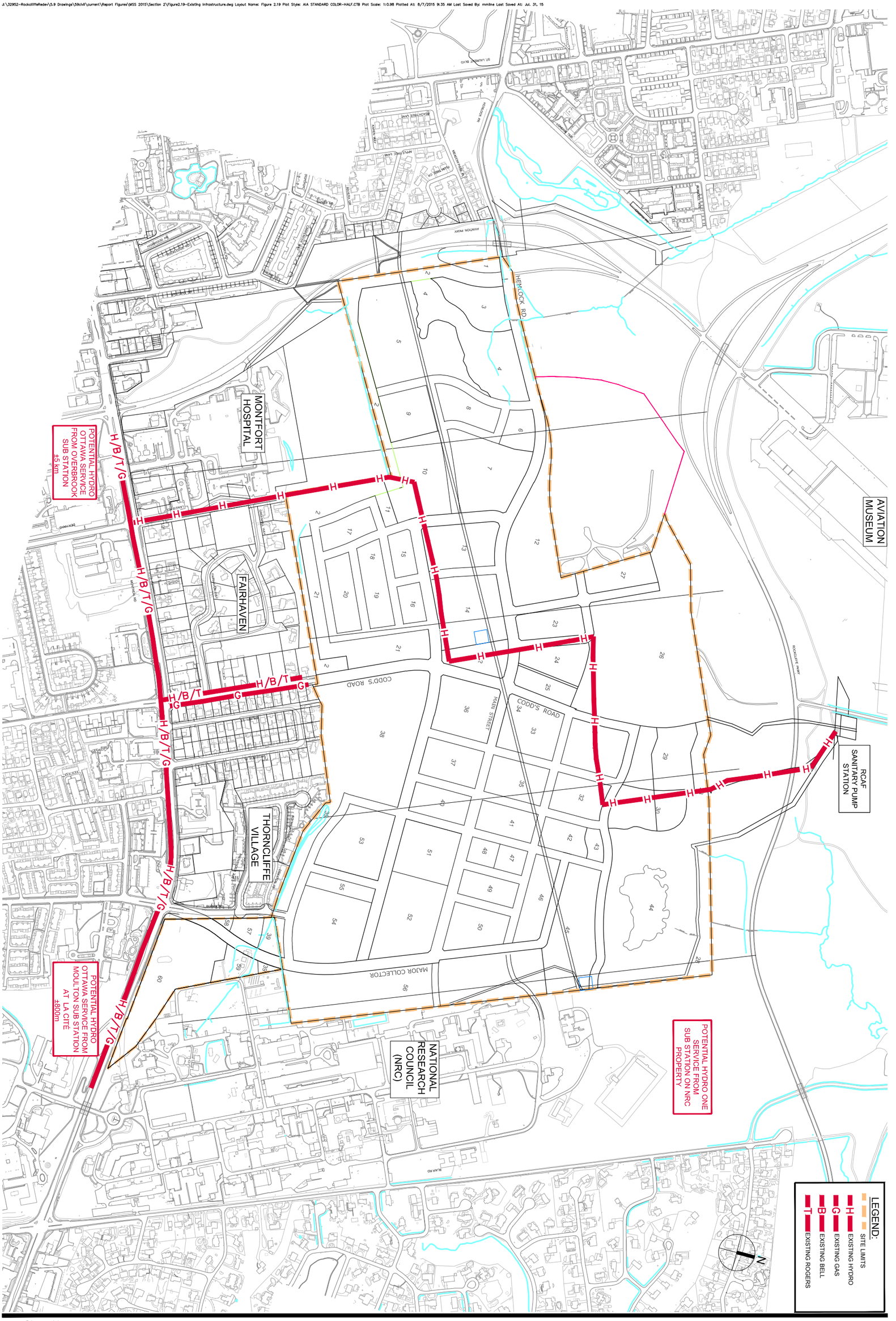
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY

Scale

0 100 200

IBI

J:\32952-Rockcliffe\dev\5.0 Drawings\59civil\current\Report Figures\MSS 2015\Section 2\Figure2.19-Existing Infrastructure.dwg Layout Name: Figure 2.19 Plot Style: AIA STANDARD COLOR-HALF.CTB Plot Scale: 1:0.98 Plotted At: 8/7/2015 9:35 AM Last Saved By: mmilne Last Saved At: Jul. 31, 15



Sheet No.

FIGURE 2.19

Drawing Title

EXISTING UTILTIES INFRASTRUCTURE

Project Title

FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY

Scale

0 100 200

IBI

3 Integrated Environmental Assessment and Planning Process

The Municipal Class Environmental Assessment (EA) process recognizes the benefits of integrating approvals under the Environmental Assessment Act and the Planning Act. Any project which would otherwise be subject to the Municipal Class EA, that meets the intent of the Class EA (Section A.2.9) and receives approval under the Planning Act is considered to be a Schedule A project and may proceed to construction. **Figure 3.1** illustrates the integrated Environmental Assessment Act and Planning Act process followed for the former CFB Rockcliffe project.

Specific municipal servicing projects within the former CFB Rockcliffe development subject to the requirements of the Environmental Assessment Act include:

- watermains beneath roadways connecting to existing services (Schedule B);
- sanitary sewers beneath roadways connecting to existing services (Schedule B)
- western stormwater detention pond and associated sewers (Schedule B)
- eastern stormwater detention pond and associated sewers (Schedule B)

The municipal infrastructure projects for the former CFB Rockcliffe site are being identified, planned and approved through the development application process under Section 51 of the Planning Act in a manner that fulfills the requirements of Phases 1 and 2 of the Municipal Class Environmental Assessment (Section A.2.9) process. As such, these projects will require no additional EA approvals after completion of this process. Section A.2.9 of the Class EA requires the following steps be incorporated into the planning process to fulfill the Phase 1 and 2 EA requirements:

- Identify the problem or opportunity;
- Identify preliminary alternative solutions to the problem/opportunity;
- Inventory social, economic, environmental conditions;
- Select preliminary preferred solution;
- Consult with the review agencies and the public;
- Select preferred solution;
- Identify alternative concept plans and infrastructure design alternatives;
- Select preliminary preferred concept plan and infrastructure design alternatives;
- Consult with the review agencies and the public;
- Select preferred concept plan and infrastructure design alternatives;
- Review and confirm choice of schedule; and,
- Should projects remain Schedule B, a notice of completion listing projects is to be issued, identifying review period and available appeal process.

Following the review and MSS approval by City Council, the study Notice of Completion will be issued for the 30 day public review period and if no Part II Order request is received, these projects are deemed complete and can proceed to detailed design and construction phase.

3.1 Consultation

The study team involved in the development and the evaluation of the CDP and its supporting reports, including the MSS, involved a large group of people representing numerous disciplines and interests. These included representatives of the Algonquins of Ontario (discussed in more detail below); City of Ottawa staff from several departments; representatives from select government agencies and approval bodies; the public through meetings with directly-affected Community Associations as well as general public meetings; and the land owner with his multi-disciplined consultant team. To assist in coordinating and directing the project, a Technical Advisory Committee (TAC) was established consisting of City of Ottawa staff; representatives from select government agencies; and, the land owner and his consultants. A Public Advisory Group (PAG) was also established, including representatives from directly-affected Community Associations; City of Ottawa staff; and, the land owner. Under the guidance of these committees, meetings were held; information was circulated, reviewed and discussed; and, decisions were made in an iterative process.

CLC maintains on-going consultation with the Algonquins of Ontario (AOO). Prior to acquiring the lands, CLC and the AOO entered into an exciting and innovative Participation Agreement, executed in 2010. This Agreement established a direct financial interest for the AOO in the development of one of the most desirable and valuable parcels of land in Canada. Opportunities exist between CLC and AOO which include a host of initiatives pertaining to the commemoration of the history and connection of the Algonquins people with this site. CLC has asked the AOO for ideas for the overall name of the new community, including names for neighborhoods, streets, and parks. This naming process may also provide valuable insights into Algonquin commemoration to be developed in the future. To date, several Consultation Working Groups, as well as meetings were held between CLC and the Algonquin Negotiation Representatives.

Through this extensive consultation process, input was received and factored into the evolution of the preferred concept plan throughout the evaluation process. The consultation process is captured in detail in a separate report entitled ‘Final Public Consultation Report, June 2014, Former CFB Rockcliffe Airbase Community Design Plan,’ prepared by Momentum Planning and Communications (June 2014). The consultation and review process also resulted in the preparation of numerous supporting reports required to adequately address concerns identified during the evaluation process, and the recognition of several existing background reports which were useful in evaluating proposed mitigation measures. The main reports used during this process to support the development of the preferred servicing solution are outlined in **Sections 1.7** and **2**.

3.2 Identification of Problem/Opportunity

The preferred concept plan (**Figure 1.3**) demonstrates that the redevelopment of the site will result in a significant increase in development density from that which existed previously. From the perspective of the Master Servicing Study, the problem presented by this proposed increase in density is the provision of municipal services to adequately service the preferred concept plan, and to incorporate these services into the existing surrounding municipal infrastructure while meeting the design criteria and level of service requirements of the City of Ottawa and other regulatory agencies.

3.3 Identification and Evaluation of a Preferred Servicing Solution for Water, Wastewater and Stormwater

To assist in developing a preferred servicing solution for the redevelopment of former CFB Rockcliffe, a two stage evaluation process has been followed. The first stage is the development

and evaluation of basic servicing alternatives to identify a preferred servicing technique to satisfy the Municipal Class Environmental Assessment Act requirement to assess “alternative solutions.” Alternative solutions are defined in the Environmental Assessment Act as “feasible ways of solving an identified problem (deficiency) or addressing an opportunity from which a preferred solution is selected.” NOTE: Alternative solutions include the “do nothing alternative.” A coarse screening process has been applied to the alternatives to select a preferred servicing approach.

For the second stage of the evaluation process, evaluation criteria and servicing alternatives have been developed based on the previously-selected Stage I preferred municipal servicing technique.

The two stage evaluation process is summarized in the following sections. It should be noted that this evaluation has been carried out in conjunction with the CDP process, out of which a preferred development concept plan and preferred municipal servicing plan are identified. The evaluation has been completed in sufficient detail to satisfy Phases 1 and 2 of the MEA Municipal Class EA process and, as part of the CDP process, included consultation with review agencies, stakeholders, and the public (refer to **Section 3.1**).

Finally, with the identification of a preferred concept plan and preferred municipal servicing plan, design parameters are developed for water, wastewater and stormwater to facilitate more detailed design work for each municipal service. This identifies major trunk sewer sizes, the exact location of major municipal infrastructure within the preferred plan, and elevations. This refinement of the design is required to finalize the project list from an EA perspective, to assist in the determination of environmental effects and required mitigation measures, to facilitate the preparation of preliminary cost estimates and to allow detailed design to progress in a phased approach, with the confidence that the site can be built out to meet the various approval agency design requirements.

3.4 Stage I: Identification and Evaluation of Infrastructure Solutions

The following alternative servicing solutions were identified:

1. The "do nothing" alternative, which, in the case of former CFB Rockcliffe, means redevelopment within the existing land use patterns and using the existing infrastructure.
2. Using the existing infrastructure involves the upgrading of existing services to increase capacity / meet new standards.
3. New infrastructure involves the construction of new services in conjunction with the planned redevelopment.

Evaluation of alternatives:

1. The “do nothing” alternative is not considered a viable solution because the existing infrastructure does not meet current City of Ottawa design guidelines. The existing distribution network is also too inefficient to service the increased density and design objectives. The existing infrastructure systems have reached the end of their useful life cycle. For these reasons it is recommended that this technique not be carried forward.
2. Upgrading existing infrastructure is a viable infrastructure option, if the redevelopment is limited to a similar land use layout. This solution would result in minimal social and environmental impacts while offering the potential added benefit of being a cost effective option. This option however does not permit an overall innovative redevelopment of the area.
3. New infrastructure would be constructed in concert with the proposed land use and redevelopment patterns for CFB Rockcliffe. This alternative would allow the capacity

requirements and current standards to be met. Social and environmental impacts could be mitigated in conjunction with the overall redevelopment. This is considered the most expensive alternative and does not make use of existing infrastructure / residual system capacity.

As a result of the above evaluation, a combination of new and upgraded infrastructure will be carried forward to the development of the CDP (refer to **Table 3.1**) and alternative designs for the infrastructure have been developed.

Table 3.1 Infrastructure Alternatives

Criteria	Infrastructure (Road/Transit/Water/Sewer/Storm) Alternatives		
	Do Nothing	Use Existing	New
Social	Limits innovative redevelopment potential	Limits innovative redevelopment potential	Permits innovative redevelopment potential
Biological	No impacts on biological features	Low impacts on biological features	Moderate impacts on biological features
Physical	No impacts on physical features	Low impacts on physical features	Moderate impacts on physical features
Technical	Does not permit new development Does not meet current city standards (i.e., fire flows, sewage overflow, cycling and pedestrian accommodation) No opportunities for innovation	Requires upgrading for capacity requirements and new standards Some opportunities to separate sewers and integrate pedestrians/cyclists/transit and for innovation	Meets capacity requirements and new standards Opportunities to separate sewers and integrate pedestrians/cyclists/transit and for innovation
Economic	Low capital costs High operational and maintenance costs	High capital costs Moderate operational and maintenance costs	High capital costs Low operational and maintenance costs
Preferred	✗	✓	✓

✓ a combination of new and upgraded infrastructure will be carried forward to the development of CDP options

3.4.1 Preferred Servicing Technique

Based on the above evaluation, the expansion of the existing municipal infrastructure system was determined to be the best servicing technique to advance. The technique will service the former CFB Rockcliffe site while minimizing negative impacts to the social and natural environment. It is summarized as follows:

- Water: A new water distribution system will be constructed. It will connect to the existing system and be designed to current City of Ottawa design guidelines.
- Wastewater: A new separate sanitary sewer system will be constructed. The system will be designed to current City of Ottawa and MOE design guidelines and will connect to the existing trunk sanitary sewer, which conveys flow to the R.O. Pickard Environmental Centre for treatment.
- Stormwater: A separate storm sewer system, complete with end-of-pipe SWM facility(ies) will be constructed. The system will be designed to current City of Ottawa and MOE design guidelines. The system will be designed in parallel with the LID pilot project.

The three development concept plans prepared to assist in determining a preferred concept plan were developed with regard for the corridor requirements for municipal water, wastewater and stormwater.

The comparative evaluation of these concept plans demonstrates that the development of a preferred concept plan is relatively independent of the municipal servicing requirements for all three municipal services, and that municipal servicing is not a determining factor in selecting the preferred concept plan for the redevelopment of former CFB Rockcliffe. Other factors such as natural features, planning rationale, transportation corridors and public and stakeholder input have a much more significant impact in determining the selection of the final preferred concept plan.

3.5 Stage II: Identification and Evaluation of Servicing Alternatives

3.5.1 Identification of Alternatives

In support of the preferred servicing technique established in the Stage I evaluation, three municipal servicing alternatives have been developed for each municipal service (water, wastewater and stormwater). They are summarized below and presented in conceptual form on **Figure 3.2** – **Figure 3.4**.

3.5.2 Evaluation Criteria and Indicators

To complete the evaluation of the three municipal servicing alternatives, a list of criteria and indicators has been developed to assist in evaluating each of their relative benefits. The criteria and indicators are presented in **Table 3.2** – **Table 3.4**.

Table 3.2 Stage II Evaluation Criteria and Indicators – Water

MUNICIPAL SERVICE	CRITERIA	INDICATORS
Water	Serviceability	• Is design compatible with existing infrastructure? • Is design efficient in providing trunk infrastructure corridors? • Is design conducive to long term phasing of construction?
	Social	• Does design impact existing communities or adjacent residential areas?
	Natural Environment	• Does design disrupt natural habitat (aquatic, terrestrial)?
		• Does design impact existing surface water or groundwater?
	Economic	• Is design cost effective? • Are long term operation and maintenance costs reasonable?

Table 3.3 Stage II Evaluation Criteria and Indicators – Wastewater

MUNICIPAL SERVICE	CRITERIA	INDICATORS
Wastewater	Serviceability	• Is design compatible with existing infrastructure? • Does design make efficient use of residual capacity? • Is design conducive to long term phasing construction?
	Social	• Does design impact existing communities or adjacent residential areas?
	Natural Environment	• Does design disrupt natural habitat (aquatic, terrestrial)? • Does design impact existing surface water or groundwater?
	Economic	• Is design cost effective? • Is design efficient in providing trunk infrastructure corridors? • Are long term operation and maintenance costs reasonable?

Table 3.4 Stage II Evaluation Criteria and Indicators – Stormwater

MUNICIPAL SERVICE	CRITERIA	INDICATORS
Stormwater	Serviceability	• Is design compatible with existing infrastructure? • Is design efficient in providing trunk infrastructure corridors? • Is design conducive to long term phasing? • Is storm system design compatible with proposed land use (aesthetically and functionally)? • Does design minimize conveyance to 100 year surface flow across arterial and collector roads?
	Social	• Does design impact existing communities or adjacent residential areas?
	Natural Environment	• Does design disrupt natural habitat (aquatic, terrestrial)? • Does design impact existing surface water or groundwater? • Does design impact existing outlets creeks?
	Economic	• Is design cost effective? • Are long term operation and maintenance costs reasonable?

A relative ranking of best, good, and poor was used to assess the relative benefits of each based on the indicators provided.

3.5.3 Evaluation of Municipal Servicing Solutions

The comparative evaluation of the three potential servicing solutions is presented in **Table 3.5-Table 3.7**. This evaluation was used to assist in determining a preferred servicing solution for the redevelopment of former CFB Rockcliffe. As noted in **Section 3.3**, the evaluation was completed in conjunction with the CDP process, taking into consideration input from review agencies and the public.

Table 3.5 Stage II Evaluation of Municipal Servicing Alternatives – Water

	CRITERIA	INDICATORS	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
WATER	Serviceability	• Is design compatible with existing infrastructure? • Is design efficient in providing trunk infrastructure corridors? • Is design conducive to long term phasing of construction?	Provides direct looped access to primary source but uses remote connection through Fairhaven requiring pressure reducing valves (PRVs). A fairly direct and balanced looping of trunk watermain is provided and trunk watermain network provides looping opportunities internally, but external connection spacing increases initial looping requirement.	Provides direct looped access to primary source but uses remote connection through Fairhaven requiring PRVs. A fairly direct looping of trunk watermain is provided and trunk watermain network provides multiple looping opportunities and phasing options, but trunk loop is concentrated on the site.	Provides direct looped access to primary source using existing roads with useable frontage. A fairly direct and balanced looping of trunk watermain is provided and external connection location provides good looping and phasing potential requiring PRVs.
	Social	• Does design impact existing communities or adjacent residential areas?	Installation results in disruption to existing Fairhaven residential area during the construction of the external watermain but the main works are within new proposed rights-of-way so impact on existing communities and residential areas will be minimal.	Installation results in disruption to existing Fairhaven and Codd's Road residential areas during the construction of the external watermain but the main works are within new proposed rights-of-way so impact on existing communities and residential areas will be minimal.	Installation results in disruption to existing Codd's Road residential area during the construction of the external watermain but the main works are within new proposed rights-of-way so impact on existing communities and residential areas will be minimal.
	Natural Environment	• Does design disrupt natural habitat (aquatic, terrestrial)? • Does design impact existing surface water or groundwater?	All proposed watermains are in existing or proposed rights-of-way except for a relatively short length of watermain proposed through Fairhaven, requiring removal of a few trees. Since the watermains will be constructed within 2 m of the ground surface, standard open cut trenching techniques will be used, minimizing impact on surface water and groundwater.	All proposed watermains are in existing or proposed rights-of-way except for a relatively short length of watermain proposed through Fairhaven, requiring removal of a few trees. Since the watermains will be constructed within 2 m of the ground surface, standard open cut trenching techniques will be used, minimizing impact on surface water or groundwater.	All proposed watermains are in existing or proposed rights-of-way, minimizing impact on natural habitat. Since the watermains will be constructed within 2 m of the ground surface, standard open cut trenching techniques will be used, minimizing impact on surface water or groundwater.
	Economic	• Is design cost effective? • Are long term operation and maintenance costs reasonable?	Significant length of trunk watermain with no useable frontage through Fairhaven. This off-road trunk watermain potentially slightly increases total operation and maintenance costs but the minimum number of connections to the source limits the number of PRVs required, assisting in keeping operation and maintenance costs reasonable.	Significant length of trunk watermain with no useable frontage through Fairhaven. This off-road trunk watermain potentially slightly increases total operation and maintenance costs but the minimum number of connections to the source limits the number of PRVs required, assisting in keeping operation and maintenance costs reasonable.	All trunk watermains are in roads with useable frontage, resulting in a cost effective design. The minimum number of connections to the source also limits the number of PRVs required, assisting in keeping operation and maintenance reasonable.
Rating			***Good***	***Poor***	***Best***

Table 3.6 Stage II Evaluation of Municipal Servicing Alternatives – Wastewater

	CRITERIA	INDICATORS	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
WASTE WATER	Serviceability	• Is design compatible with existing infrastructure? • Does design make efficient use of residual capacity? • Is design conducive to long term phasing construction?	Eliminates combined sewers but does not use all available outlets to minimize onsite sewer sizes and depth. Ignoring the central outlet also limits phasing options.	Eliminates combined sewers and uses all available outlets to minimize sewer size and depth and uses all available outlets and associated capacity. The use of the three outlets across the site also provides good opportunity for phasing.	Eliminates combined sewers and uses all available outlets to minimize sewer size and depth and uses all available outlets and associated capacity. The use of the three outlets across the site also provides good opportunity for phasing.
	Social	• Does design impact existing communities or adjacent residential areas?	Construction of a sanitary sewer in Codd's Road would disrupt access to Codd's Road residents during construction. Otherwise, works are confined to the development area so impact on existing communities and residential areas is minimal.	Construction of a sanitary sewer in Codd's Road would disrupt access to Codd's Road residents during construction. Otherwise, works are confined to the development area so impact on existing communities and residential areas is minimal.	Construction of a sanitary sewer in Codd's Road would disrupt access to Codd's Road residents during construction. Otherwise, works are confined to the development area so impact on existing communities and residential areas is minimal.
	Natural Environment	• Does design disrupt natural habitat (aquatic, terrestrial)? • Does design impact existing surface water or groundwater?	New sewer construction is mostly within proposed rights-of-way so there is minimal disruption to the natural environment due to the installation of the sanitary sewer system. The potentially deeper sewer excavation associated with the single main trunk sewer could increase impact on groundwater but clay dyke installation as part of the trench backfill minimizes this potential.	New sewer construction is mostly within proposed rights-of-way so there is minimal disruption to the natural environment due to the installation of the sanitary sewer system. Use of multiple outlets across the site minimizes the depth of the sanitary trunk sewers, thereby minimizing the potential impact on groundwater.	New sewer construction is mostly within proposed rights-of-way so there is minimal disruption to the natural environment due to the installation of the sanitary sewer system. Use of multiple outlets across the site minimizes the depth of the sanitary trunk sewers thereby minimizing the potential impact on groundwater.
	Economic	• Is design cost effective? • Is design efficient in providing trunk infrastructure corridors? • Are long term operation and maintenance costs reasonable?	One main trunk sewer increases capital cost due to larger and deeper pipe, which may also require a high level sewer to service local frontage along the deeper sections of the trunk sewer. This increases the capital cost and long term operation and maintenance costs.	Use of multiple outlets across the site minimizes depth and size of trunk sewers, as well as minimizes potential for a parallel high level sewer. This alternative is cost effective from both the capital cost and long term operation and maintenance perspective.	Use of multiple outlets minimizes depth and size of trunk sewers as well as minimizes potential for a parallel high level sewer. This alternative is cost effective from both the capital cost and long term operation and maintenance perspective.
Rating			***Poor***	***Good***	***Good***

Table 3.7 Stage II Evaluation of Municipal Servicing Alternatives – Stormwater

	CRITERIA	INDICATORS	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
STORM WATER	Serviceability	• Is design compatible with existing infrastructure? • Is design efficient in providing trunk infrastructure corridors? • Is design conducive to long term phasing? • Is storm sewer design compatible with proposed land use (aesthetically and functionally)? • Does design minimize conveyance of 100 year surface flow across arterial and collector roads?	Uses one SWM facility, directing runoff from the majority of the site to the Western Creek via a pipe under Aviation Parkway. Majority of the trunk storm sewers are in proposed rights-of-way servicing associated frontage, resulting in an efficient design from an overall sewer length perspective; however, use of a single major trunk will result in relatively large and deep sewers. Use of a single SWM facility and single trunk sewer alignment restricts phasing potential from west to east only. Location of the main collector road on the preferred concept plan is such that there are numerous locations where the green space abuts the collector road, offering good opportunity to control major flow along the corridor, if necessary. The proximity of the collector road to the proposed trunk storm servicing corridor also provides the opportunity to increase discharge to the storm trunk system with minimal impact to the local storm system, if necessary. Due to sewers being primarily in proposed rights-of-way, and an off-site SWM facility that is significantly downgradient of the development, the design is expected to have minimal impact on the aesthetics or functionality of the development. A parallel study evaluating the potential to add LID techniques to the storm system may result in further enhancement of the development's aesthetics and functionality of the storm system.	Uses one SWM facility, directing runoff from the majority of the site to an Eastern outlet (via the Eastern Creek or a pipe directly to the Ottawa River). Majority of the trunk storm sewers are in proposed rights-of-way servicing associated frontage, resulting in an efficient design. However, a relatively long and large storm sewer will be required to convey runoff from the lower western portion of the site to the SWM facility, resulting in a relatively inefficient design from an overall sewer length perspective. Use of a single SWM facility restricts phasing potential from east to west, without the expense of constructing large off-site storm sewer to outlet the western portion of the development. Location of the main collector road on the preferred concept plan is such that there are numerous locations where the green space abuts the collector road, offering good opportunity to control major flow along the corridor, if necessary. The proximity of the collector road to the proposed trunk storm servicing corridor also provides the opportunity to increase discharge to the storm trunk system with minimal impact to the local storm system, if necessary. Due to the sewers being primarily in proposed rights-of-way, and a SWM facility that is significantly downgradient of the development, the design is expected to have minimal impact on the aesthetics or functionality of the development. A parallel study evaluating the potential to add LID techniques to the storm system may result in the further enhancement of the development's aesthetics and the functionality of the storm system.	Uses two major SWM facilities, directing runoff from the site to both Western and Eastern Creeks. This two facility system, and the existing topography, offers the opportunity to balance the post-development flow between the two creeks, mitigating the constraints associated with each creek. Majority of the trunk storm sewers are in proposed rights-of-way, servicing associated frontage, resulting in an efficient design from an overall sewer length perspective. Size and depth of the trunk storm sewers is also minimized, relative to the single SWM facility options, and also maximizes phasing potential. Location of the main collector road on the preferred concept plan is such that there are numerous locations where the green space abuts the collector road, offering good opportunity to control major flow along the corridor, if necessary. The proximity of the collector road to the proposed trunk storm servicing corridor also provides the opportunity to increase discharge to the storm trunk system with minimal impact to the local storm system, if necessary. Due to the sewers primarily in proposed rights-of-way, and off-site SWM facilities that are significantly downgradient of the development, the design is expected to have minimal impact on the aesthetics or functionality of the development. A parallel study evaluating the potential to add LID techniques to the storm system may result in further enhancement of the development's aesthetics and the functionality of the storm system.
	Social	• Does design impact existing communities or adjacent residential areas?	Use of a single SWM facility outletting to the Western Creek requires significant upgrades to the creek, from Aviation Parkway to the Ottawa River, to accommodate the post-development flow. Due to topography and proximity of the Aviation Parkway, limited space is available to provide an over-controlled SWM facility, suggesting an increase in release rate above existing culvert capacity will be required. This in turn requires significant upgrading of the creek adjacent to the Alvin Heights Community and through the RCMP Equestrian training facility. The impact of such works is the potential reduction of existing vegetative screening from the Rockcliffe Parkway abutting the residential community, and expansion of the storm outlet within the RCMP facility to the Ottawa River.	The single SWM facility outletting to an Eastern outlet (via the Eastern Creek or a pipe directly to the Ottawa River) is located along the south side of the Rockcliffe Parkway and may require upgrades to the Eastern Creek and/or the construction of a storm sewer from the SWM facility directly to the Ottawa River. Such creek or pipe work is removed from residential areas, so impact to communities is minimal and limited to the construction of an outlet to the Ottawa River.	Construction of two SWM facilities, together with the site topography, offers the opportunity to balance post-development flow. This would assist in minimizing the required upgrades to the Western Creek, thereby lessening impact to the adjacent community. The construction of the Eastern SWM Facility may require upgrades to the existing outlet channel and/or the construction of a new storm sewer outlet from the SWM facility to the Ottawa River due to the restricted space available at this location and potential design constraints imposed by the NCC.
	Natural Environment	• Does design disrupt natural habitat (aquatic, terrestrial)? • Does design impact existing water surface or groundwater? • Does design impact existing outlet creeks?	Existing combined sewer system to be eliminated and replaced by separate sanitary and storm sewers. Baseflow that had previously been diverted to the combined system is now conveyed to the natural environment. Due to the construction of one SWM facility outletting to the Western Creek, the potential baseflow gain is limited to the Western Creek, since baseflow is diverted away from the Eastern Creek. Due to the constraints associated with the Western Creek, anticipated creek upgrades will require tree removal along the creek. Potential use of natural channel design techniques and a reforestation program will minimize long term impact to natural environment. Due to the installation of one large, deep, trunk sewer, there is an increased potential impact on groundwater. Installation of clay dykes limits this potential impact to construction only.	Existing combined sewer system to be eliminated and replaced by separate sanitary and storm sewers. Baseflow that had previously been diverted to the combined system is now conveyed to the natural environment. Due to the construction of a single SWM facility outletting to the Eastern Creek or to the Ottawa River via a pipe, the potential baseflow gain is limited to the Eastern Creek, since baseflow is diverted away from the Western Creek. Due to the construction associated with the SWM facility outlet, anticipated creek upgrades will require tree removal along the creek and/or the construction of a storm sewer directly to the Ottawa River. Potential use of natural channel design techniques and a reforestation program will minimize long term environmental impact to the natural environment. Creek upgrades have the added benefit of creating a positive outlet to the Ottawa River at the recreational pathway along the river bank, which provides an opportunity to enhance the creek's aquatic habitat. Upgrades to the creek will also provide the opportunity to stabilize the slopes and terminate the active erosion currently occurring.	Existing combined sewer system to be eliminated and replaced by separate sanitary and storm sewers. Baseflow that had previously been diverted to the combined system is now conveyed to the natural environment. Since a SWM facility is proposed at the headwaters of both creeks, baseflow to both creeks will be enhanced, and there is the potential to improve aquatic habitat of both creeks. Existing topography of the site also provides opportunity to balance the post-development flow between the two outlets, minimizing impact on both creeks. However, physical constraints associated with the western outlet suggest a limited ability to convey post-development flow, compared to the eastern outlet. Any upgrades required to mitigate constraints in the Eastern Creek will require tree removal and/or the construction of a storm sewer directly to the Ottawa River. Potential use of natural channel design techniques and a reforestation program can be implemented to minimize long term impact to natural environment. Any work in the Eastern Creek has the added benefit of creating an outlet to the Ottawa River at the recreational pathway, which provides an opportunity to enhance the creek's aquatic habitat. It will

	CRITERIA	INDICATORS	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
					also provide opportunity to stabilize the creek slopes and terminate the active erosion which is currently occurring.
	Cost	• Is design cost effective? • Are long term operation and maintenance costs reasonable?	Requires one SWM facility and significant upgrades to Western Creek. Also requires a large and potentially deep storm sewer, necessitating a second high level storm sewer to service adjacent frontage. Capital cost savings associated with the construction of a single SWM facility would be significantly offset by the increased trunk sewer costs. Since most of the storm sewers are located in roads with useable frontage, the system is considered relatively cost effective from a capital and long term operation and maintenance cost perspective.	Requires one SWM facility and significant upgrades to Eastern Creek. Also requires a relatively large and long off-site trunk sewer to drain the lower west portion of the site. Capital cost savings associated with the construction of a single SWM facility would be significantly offset by the cost of the large off-site trunk storm sewer. Since most of the storm sewers are located in proposed roads with useable frontage, the system is considered to be only minimally less cost effective than Alternative I from a capital and long term operation and maintenance cost perspective.	Requires construction of two SWM facilities; however, the overall sewer system is relatively cost effective due to the reduced sewer sizes and sewer depths as a result of multiple outlets. Additional costs associated with constructing two SWM facilities would be significantly offset by the savings in sewer costs throughout the development. Since most of the storm sewers are located in proposed roads with useable frontage, the system is considered to be relatively cost effective from a capital and long term operating and maintenance cost perspective.
Rating			***Poor***	***Poor***	***Best***

3.6 Preferred Municipal Servicing Solution

The comparative evaluation of the water, wastewater and stormwater alternatives identified some preferences to be carried forward in the preferred servicing solution. These preferences are summarized as follows:

- Water: Two primary feeds to Montreal Road be provided via Burma Road and Codd's Road to maximize phasing flexibility and trunk system accessibility.
- Wastewater: The three available connections to the existing IOS collector be used to maximize the use of residual capacity in these outlets, minimize sewer sizes and depth, and facilitate phasing.
- Stormwater: Two end-of-pipe SWM facilities be incorporated to balance stormwater discharge between the existing outlets recognizing the constraints and opportunities associated with these outlets, minimize storm pipe sizes and depth, and to facilitate construction phasing.

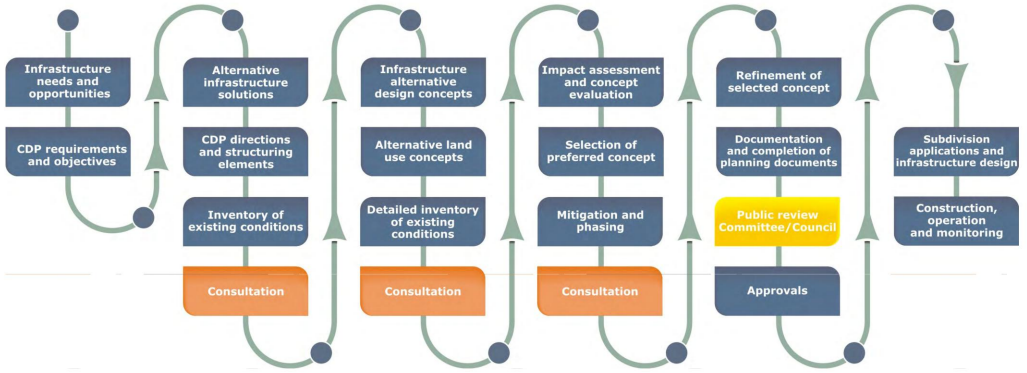
Based on these considerations, Alternative III has been identified as the preferred servicing solution for water, Alternative III has been identified as the preferred alternative for wastewater and Alternative III has been identified as the preferred alternative for stormwater.

The identification of a preferred municipal servicing plan allows for design parameters to be developed for water, wastewater and stormwater to facilitate more detailed design work for each municipal service. This more detailed design is presented in **Sections 4-6**, in which trunk sewer sizes, location, and elevation are identified. As noted in **Section 3.3**, this refinement of the design is required to finalize the project list from an EA perspective (refer to **Section 8** for a detailed project listing), to assist in the determination of environmental effects and required mitigation measures, to facilitate the preparation of preliminary cost estimates and to allow detailed design to progress in a phased approach, with the confidence that the site can be built out to meet the various approval agency design requirements.

This preferred servicing solution also recognizes the preliminary phasing plan developed in the CDP (refer to **Figure 1.6**), and has regard for the direction in the CDP to provide flexibility in the servicing solution to incorporate the LID pilot project.

Class Environmental Assessment / CDP Process

- The Rockliffe CDP process will be coordinated to integrate the *Planning Act* requirements for an implementing Official Plan Amendment, and the requirements of the Municipal Class Environmental Assessment for related environmental and infrastructure projects.
- The planning and coordination of the infrastructure and environmental management requirements for the CDP in consultation with the community will help to ensure that the objectives of the City, the community and approval authorities are fulfilled.
- Key benefits of this approach include:
  - Streamlining efforts and more effectively meet the requirements of both the Planning Act and the Environmental Assessment Act
  - Reduced duplication leading to faster implementation
  - Opportunities to co-ordinate infrastructure with land use planning
  - Improved certainty for land use decision-making
  - Co-ordinated public input
- Key points for integration include:
  - Identification and consolidation of priorities and objectives (public/municipal/owners)
  - Documentation of existing conditions
  - Public consultation
  - Development of infrastructure and land use alternatives



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Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	INTERGRATED PLANNING AND EA PROCESS	FIGURE 3.1

EXISTING STORM SEWER

WESTERN CREEK

AVIATION MUSEUM

RCAF SANITARY PUMP STATION

OTTAWA RIVER

EASTERN CREEK

1200Ø STORM

300Ø CO

RCAF PULL-BACK SEWER

300Ø CO

STORM SCEPTER

NRC SHAFT

EXISTING SANITARY

ALTA VISTA TRUNK SEWER (300Ø CO.)

3600Ø STORM

3000Ø STORM
525Ø SANITARY

EXISTING SANITARY

HEMLOCK RD

3600Ø STORM
525Ø SANITARY

CODD'S ROAD SHAFT

2700Ø STORM
375Ø SANITARY
406Ø WATERMAIN

PEACH TREE ROAD SHAFT

NATIONAL RESEARCH COUNCIL (NRC)

MONTFORT HOSPITAL

FAIRHAVEN

THORNCLIFFE VILLAGE

EXISTING 406Ø WATERMAIN

CODD'S ROAD

MAJOR COLLECTOR

LEGEND

- TRUNK WATERMAIN
- EXISTING WATERMAIN
- TRUNK STORM SEWER
- TRUNK SANITARY SEWER
- EXISTING SANITARY SEWER
- STORMWATER POND AND POND OUTLET
- EXISTING OUTLET CHANNEL

N

Scale

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

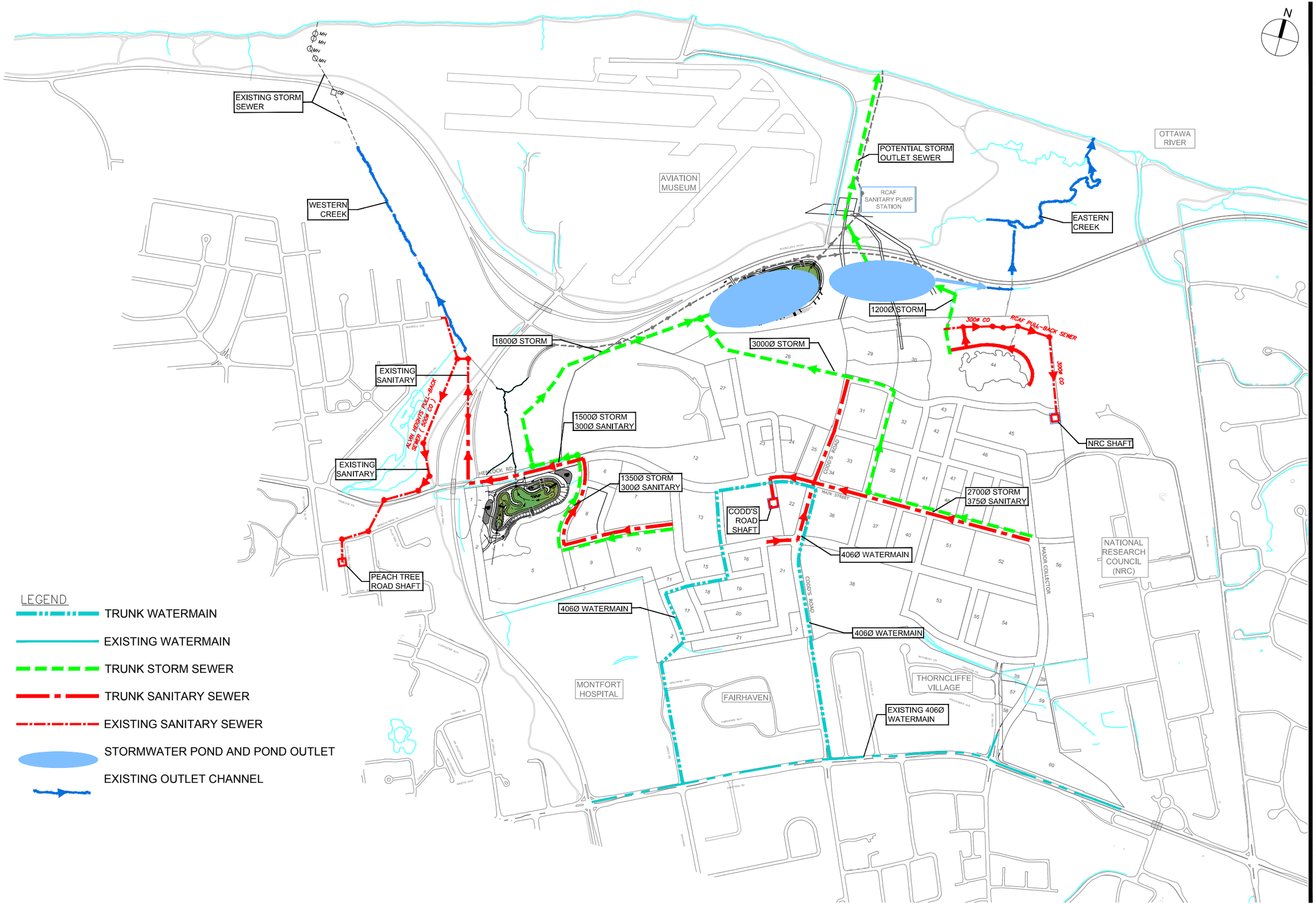
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TRUNK SERVICING
ALTERNATIVE I

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FIGURE 3.2

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Scale

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Drawing Title

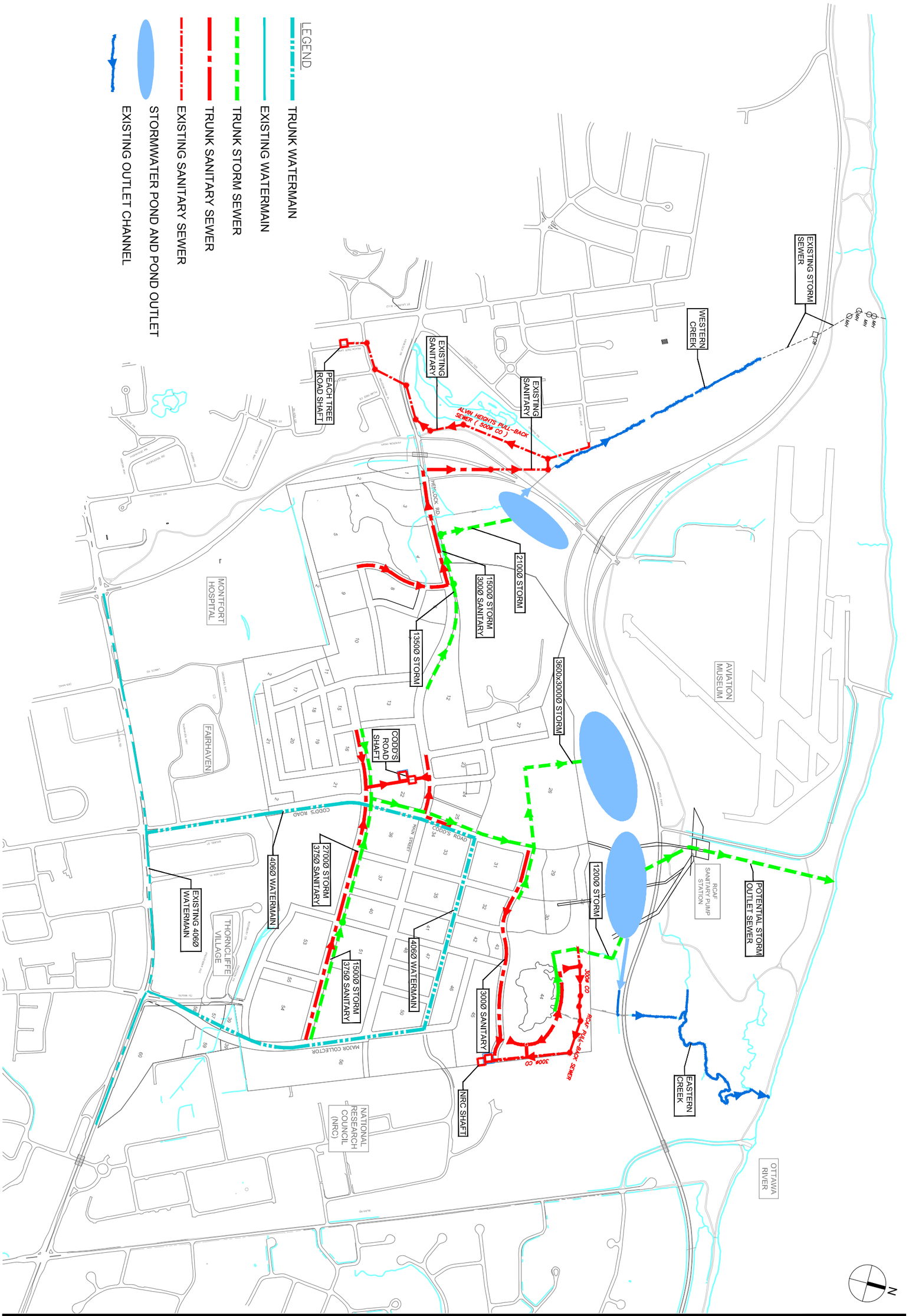
TRUNK SERVICING
ALTERNATIVE II

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FIGURE 3.3

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Sheet No.	Drawing Title	Project Title	Scale
FIGURE 3.4	TRUNK SERVICING ALTERNATIVE III	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	0 100 200

IBI

4 Water Distribution System

4.1 Introduction

4.1.1 Overview

The Former CFB Rockcliffe site is located north of Montreal Road between the Aviation Parkway and the NRC lands, and generally south of the Rockcliffe Air Base.

The entire area included in the proposed development lands is currently serviced with potable water from the City of Ottawa's Montreal Road Pressure Zone (Zone MONT). The Montreal Road Pump Station (MRPS) and the Brittany Drive Pump Station (BDPS) boost the water pressure to these lands from the Pressure Zone 1E, which encompasses the majority of lands east of the Rideau River. Pressure Zone 1E is fed via the Hurdman Bridge Pump Station located near the Rideau River and Highway 417. There are two main watermains feeding the development area from Montreal Road, one on Burma Road and the second on Codd's Road. **Figure 4.1** presents a plan of the major components of the City of Ottawa Water Distribution System in this area.

The following potable water supply analysis consists primarily of the external servicing needs to the development, and focuses on the supply requirements, including linear infrastructure, pumping, and pressure controls as necessary. Internal watermain recommendations are limited to major loops or major feedermains that may be needed within the boundaries of the development. The analysis provides the appropriate boundary conditions for further, more detailed analysis of individual street watermains within the development. It should be noted that the proposed piping in any special study areas (such as the northeast quadrant of the study area) is conceptual as no defined road layout or rights of way have been identified.

Although this report reviews the future internal subdivision watermains at a macro level, it is understood that the detail design of the internal infrastructure will be in accordance with the appropriate City separation guidelines. For instance, all watermains must maintain a horizontal clearance of a minimum of 2.5 m from sewers and a vertical clearance of a minimum of 0.50 m where watermains cross a sewer.

4.1.2 Previous Studies

In 2001, Stantec Consulting Ltd. prepared an engineering brief entitled "Montreal Road Pressure Zone Water Supply Study". This study identified the major piping and pumping infrastructure needs for the Montreal Road Pressure Zone based on anticipated growth projections within the current serviced area boundaries including the NRC lands and the Former CFB Rockcliffe site. The 2001 report included an estimated 10,000 additional persons within the development.

In 2004, Stantec completed an addendum to the 2001 report to address an increase in development growth within the subject site. The report considered a growth potential of 14,625 persons in the Former CFB Rockcliffe site (compared to the originally proposed 10,000 persons). Infrastructure recommendations from both the 2001 and 2004 reports were similar.

In 2007, Stantec Consulting Ltd. completed a potable water supply analysis for the subject lands. The analysis was developed using the previous community design plan (CDP) and proposed the most suitable watermain network and sizing based on that CDP. **Figure 4.2** presents a summary overview of the primary recommendations from this earlier study. Upgrades to the Brittany Drive and Montreal Road Pump Stations were recommended based on the anticipated population growth in the proposed development. These upgrades were previously outlined in two relevant studies on this area – "Montreal Road Pressure Zone – Water Supply Addendum" (Stantec 2004) and "Brittany Drive Pumping Station Functional Design" (Stantec 2006).

The following upgrades were recommended in these two previous reports to sufficiently service the build-out growth in Zone MONT. It is important to note that both of these reports indicated that the majority of the increases in water demand were due to the proposed development of the former CFB/Rockcliffe site north of Montreal Road.

1. Montreal Road PS – maintain existing 4 pumps (13.1, 8.1, 6.5, and 13.1 ML/d rated capacities) and add a 350 KW diesel generator.
2. Brittany Drive PS – replace with new PS with 2 pumps (at 13.3 ML/d).
3. New 406mm/305mm watermain through subject site to connect to the existing 406mm diameter watermain on Montreal Road at Den Haag and Burma/Bathgate.
4. Two connections to 406mm diameter watermain on Montreal Road to watermains north of Montreal within study area.

The City had implemented some of the recommended infrastructure upgrades, which were included in the analysis.

In 2013, the City of Ottawa Water Master Plan (WMP) Update (Stantec Consulting Ltd.) was completed. It determined the immediate and future infrastructure upgrades required to satisfy current and projected water demands throughout the entire city, including Zone MONT. Furthermore, it developed revisions to unit water demands and to system performance parameters that will be carried forward to all subsequent zone level water servicing analyses. For engineering work at the subdivision/site plan level, unit demands provided in the City's Water Distribution Guidelines are to be used. The 2013 WMP identified a need to upgrade the Brittany Drive Pumping Station to meet the 2012 and beyond firm capacity pumping objectives for Zone MONT. Upgrades to the Brittany Drive Pumping Station would satisfy both a growth and reliability requirement.

This report will consider the 2015 modified Community Design Plan (CDP) that was provided to Stantec by IBI Group and re-evaluate the water servicing requirements of Zone MONT infrastructure based on the 2013 WMP demand rates. The analysis will consider the recommendations provided in the 2013 WMP and determine what changes should be made (if any) to service the new Rockcliffe development.

4.1.3 Construction Phasing

Adequate pumping capacity needs to be available to meet the anticipated demands as the proposed development proceeds. The phasing of construction has been defined as well as the approximate timing of each phase (and **Table 4.1** and **Figure 4.3**). **Table 4.1** shows a more aggressive construction schedule for development than what was previously expected to the point that the WMP 2060 demands might now be achieved prior to 2031. As a result, larger capacity pump station upgrades are anticipated initially to meet the increased 2031 demand projections. Pumping requirements are further assessed in **Section 4.3**.

Table 4.1: Timing of Construction Phasing

PHASE	CONSTRUCTION PERIOD	COMMENTS
Phase 1A	2015 - 2016	Servicing in 2015; sales in 2016
Phase 1B	2017 - 2018	Servicing in 2016; sales in 2017 - 2018
Phase 2	2019 - 2024	Servicing in 2018; sales in 2019 - 2024
Phase 3	Starting 2024	Sales starting in 2024

4.2 Hydraulic Assessment

The computer modeling software package used to carry out the analysis for the Former CFB Rockcliffe development was H2OMAP Water by Innovyze.

The City of Ottawa provided Stantec with a complete pipe model of the entire City of Ottawa distribution system. As per correspondence dated March 13th 2014 with the City of Ottawa, permission was given to use the hydraulic model file(s) for the purpose of this current undertaking.

The computer model obtained from the City is a complete pipe model of the entire City of Ottawa water distribution network. The model file was considered to be the most recent model available. Multiple scenarios were included in the City model; present conditions (2012), projected 2031, and projected 2060 conditions each under summer (maximum day) and winter (basic day) demand conditions respectively for a total of six scenarios.

4.2.1 Serviceability

Hydraulic modelling was performed to assess the anticipated pressures in this development to meet minimum servicing requirements. Additionally, a fire flow analysis was used to ensure the system can provide sufficient fire protection.

4.2.1.1 System Pressure

The 2010 City of Ottawa Water Distribution Design Guidelines state that the desired range of system pressures under normal demand conditions (i.e. average day, maximum day and peak hour) is 345 to 483kPa (50 to 70 psi) and not less than 276kPa (40 psi) at the ground elevation in the streets (i.e. at hydrant level). The maximum pressure at any point in the distribution system is 689kPa (100 psi); however, as per the Ontario Building/Plumbing Code, pressure relief measures are required for services when pressures greater than 552kPa (80 psi) are anticipated. Under emergency fire flow conditions, the minimum pressure in the distribution system is allowed to drop to 138kPa (20 psi).

The highest serviced land elevation in the existing Montreal Road Pressure Zone is approximately 113m. To ensure the minimum pressures at this location remains above 275kPa (40 psi), the hydraulic gradeline must remain above 141m at this location. Since this elevated location is located in the eastern section of Zone MONT, an allowance for headloss across the network (from the pumping stations) is required. Modeling suggest, approximately 2m of headloss is observed. Therefore, a minimum discharge HGL of 143m at the pumping stations allows pressures to remain above the minimum target under normal operating/network conditions.

4.2.1.2 Fire Flows

A fire flow of 13,000 L/min is recommendations as per the 2013 Water Master Plan Update for system level analysis in the core area. The City also requires a fire flow assessment to be carried out at the subdivision approval phase in which local watermains are checked for their ability to

provide the objective Fire Underwriter Survey (FUS) fire flows. FUS fire flows will need to be confirmed when final site plans and building construction details are available. Should the FUS fire flow required be greater than 13,000 L/min, building fire protection (construction type, space between buildings, sprinkler systems, etc.) will need to be considered. Additionally, upsizing pipes where appropriate and to the City's Water Design Guideline to meet FUS fire flows may also be considered.

4.2.2 Model Development

4.2.2.1 Proposed Piping

Although the model is well developed with respect to demand allocation and the inclusion of most major infrastructure components such as pumping curves and storage dimensions, some modification was necessary to have a model that would reflect current and future hydraulic conditions in Zone MONT and the proposed development lands. The following section identifies the modifications that were carried out to the hydraulic model and the reasoning for the modifications.

Additional piping was added to the model to simulate the proposed network within the proposed development lands. **Figure 4.4** shows the preliminary alignments and sizing of the proposed watermains. In accordance with the 2010 City of Ottawa Water Design Guidelines, the Hazen Williams "C" factors for each pipe diameter were set as shown in **Table 4.2**.

Any proposed piping in the special study areas of this development are, at this point, conceptual and the exact locations of these watermains (and any looping) will be determined at the detailed design stage. For the purposes of hydraulic analysis, these conceptual pipes are intended to illustrate the need for water/looping through the area.

Table 4.2: Hazen Williams C Factors for Different Pipe Sizes

C VALUE	ACTUAL (MODELLED) PIPE DIAMETER	NOMINAL PIPE DIAMETER
100	155mm	152mm
110	204mm	203mm
110	297mm	305mm
120	406mm	406mm

The existing 152mm watermain on Codd's Road will require replacement with a larger 406mm diameter watermain, which is part of the proposed major loop that will service the development. This replacement was included in the model.

Figure 4.5 provides the approximate ground elevations at the computer model junctions within the proposed development. Ground elevations within the development range from 79.4m to 96.1m. If the Montreal Road Pressure Zone is regulated to a maximum of 147m, the highest pressure that would be observed in the proposed development is 662kPa (96 psi) at an elevation of 79.4m.

Since ground elevations in Zone MONT are as high as 112.9m, there is no concern for the HGL dropping below this minimum requirement. According to operational data, the typical maximum HGL observed at the MRPS is 147m and therefore the minimum anticipated pressure in the site is approximately 65 psi (assuming minimal head losses).

If the MRPS discharge pressure is regulated to 143m then the minimum and maximum pressures are anticipated to be approximately 296kPa (43psi) and 621kPa (90 psi), respectively.

4.2.2.2 Zone Reconfiguration Potential

The previous servicing study for this area (Potable Water Supply Analysis CFB/Rockcliffe Development; Stantec, April 27, 2007) discounted the option of servicing part of the study area directly from Zone 1E from the west as the ground elevations are too high to allow minimum pressure requirements to be achieved. The currently proposed service area extends a small amount further to the north and west near Hemlock and the Aviation Parkway ramp, with a ground elevation as low as 71.1m, although only a very small area is situated below 80m elevation (see **Figure 4.5**). Servicing this land from Zone MONT could result in pressures exceeding the City's Water Design Guidelines as well as the Ontario Building/Plumbing Code.

The normal operating HGL in Zone 1E ranges from approximately 112m to 117m, and the Orleans Reservoir has an overflow elevation of 114.7m. With a hydraulic grade line (HGL) of 112m in Zone 1E (lower operating end and considering some pipe losses to this point in the system), lands up an elevation of approximately 77m could be serviced at the minimum desired pressure of 50 psi.

It is thus clear that a connection to Zone 1E across the Aviation Parkway to service this area would only be capable of servicing a very small service area.

Conversely, servicing of this area from Zone MONT could result in pressures exceeding the desired maximum of 100 psi. With an operating HGL of 143m in Zone MONT, pressures exceeding 100 psi would occur for pipes at or below an elevation of 72.6m. This pressure would require a minor relocation of the watermain (to avoid ground elevations below 72.6m) or an increased pipe pressure rating. Additionally, pressure control valves would likely be required on any services in this area.

Given the very small area that could feasibly be serviced from Zone 1E and the high cost associated with installing a watermain from the west under the Aviation Parkway and the low cost of resolving issues associated with servicing this land from Zone MONT, it is recommended that these lands be serviced from Zone MONT as previously proposed. The decision to service the future Aviation Museum will be deferred until a site servicing plan is prepared for the facility.

4.2.3 Growth and Demand Projections

4.2.3.1 Growth Projections

According to email correspondence from IBI Group dated July 24th, 2014, the planned development for the Former CFB Rockcliffe site has been updated as follows.

1. Watermain alignments have been modified to reflect the new CDP
2. Development will be constructed in three phases
3. Unit counts and population densities have been modified
4. Water demands have been modified to reflect revisions as outlined in 2013 WMP

The latest plans call for 5,300 residential units comprised of 2.5% single family, 6.1 % semi-detached and free hold town homes, 24.2% stacked town-homes, 67.2% apartments. The previously proposed residential growth for the subject site in 2007 was 6,250 residential units, 40% (2,500 units) were comprised of singles, semis, and towns; the remaining 60% (3,750 units) were apartments.

The estimated residential population is determined based on projected household sizes as provided by IBI Group in an email correspondence dated July 24th, 2014 and slightly revised on July 21st, 2015. The following **Table 4.3** summarizes the projected population for the development based on the distribution of residential types described above.

Table 4.3: Estimated Residential Population Based on Unit Types

UNIT TYPE	PERSONS/UNIT	UNITS	POPULATION
Single Family	3.4	133	452
Semi-Detached/Freehold Towns	2.7	324	875
Stacked Towns	2.3	1,284	2,953
All Apartments	1.8	3,559	6,406
TOTAL		**5,300**	**10,686**

Therefore the latest residential population projection based is 10,686 persons. In addition to the residential component, Stantec was provided with a break-down of the anticipated Institutional, Commercial and Industrial (ICI) component of the future growth. A significant portion of ICI growth is allocated within Mixed-Use development, with some low-rise retail, employment and schools allocated to the remaining growth. The total number of jobs allocated to each of these land-uses was provided by IBI Group and is summarized in **Table 4.4**.

Table 4.4: Estimated Institutional, Commercial, Industrial (ICI) Job Population

LAND USE	JOBS
Mid-Rise Mixed Use	182
High-Rise Mixed Use	2,200
Low-Rise Retail	52
School	75
Employment	97
TOTAL	**2,606**

Therefore, a total population of 12,650 is expected after full development of the lands, including residential and commercial populations.

Note: a future Aviation Museum located northwest of the development was not included in the hydraulic analysis but was reviewed. The museum is to be developed on an 11.3 ha area with ground elevations varying from approximately 68m to 87m. Using a conservative consumption rate of 28,000 L/ha/d for commercial lands, as per the City of Ottawa's Water Design Guidelines, the total water demand for this museum is calculated to be approximately 0.32 MLD (3.66 L/s) or approximately an additional 12% of projected basic day flows.

4.2.3.2 Demand Projections

For the updated analysis, the criteria outlined in the 2013 Water Master Plan (WMP) were followed to determine water demands of the proposed development. Zone Level demands for populations greater than 3,000 persons were used. The consumption rates from the WMP were applied to the revised population projections based on land use and location with respect to the Greenbelt (inside or outside, denoted as "inside greenbelt" or IGB). It is noted that the Zone Level demands are generally used to assess larger service areas and are not generally used to size smaller internal piping. However, fire flows generally govern the minimum sizing for smaller internal watermain infrastructure, and therefore using these Zone Level demands for this analysis is considered appropriate.

Although the 2013 WMP criteria was used to estimate the water demands at a Zone level for this analysis, the City of Ottawa Water Design Guidelines are to be used upon the subdivision/site plan approval phase.

For residential land-uses, single family and semi-detached homes were considered to have similar demands, with both types of residential home categorized under “single family home” or SFH. Similarly, all free-hold townhomes and stacked townhomes were categorized under “multi-level townhomes” or MLT. All apartments were categorized under APT.

For any land-use that had a designated number of jobs (mixed-use, retail, and employment land-uses), an employment (EMP) water demand was applied. The table below summarizes the consumption rates for each unit type and provides the basic day demands for each unit type with the total basic day demand (BSDY) for the entire development determined to be 2.60 ML/d. A summary of all consumption rates and corresponding basic day demands is shown in **Table 4.5**

Table 4.5: Estimated Basic Day Demands Based on Unit Type

UNIT TYPE	CONSUMPTION RATE (L/cap/d)	TOTAL UNITS	POPULATION	BSDY (L/s)	BSDY (ML/d)
SFH	180	133	452	0.94	0.08
MLT	198	1,608	3,828	8.77	0.76
APT	219	3,559	6,406	16.24	1.40
EMP	137	n/a	2,606	4.13	0.36
TOTAL		**5,300**	**13,292**	**30.09**	**2.60**

To determine the maximum day demand of the development, the 2013 WMP allocates an outdoor water demand to all SFH units located within the development. This outdoor water demand is added to the basic day demand of 2.60 ML/d to obtain the maximum day demand for the development. An outdoor water demand (OWD) of 1,049 L/SFH/d was applied to all SFH units in the development as shown below:

Total Number of SFH Units = 133 units

Outdoor Water Demand = 1049 L/SFH/d * 133 SFH / 1,000,000 L/d = 0.14 ML/d

Maximum Day Demand = 2.60 ML/d + 0.14 ML/d = 2.74 ML/d

The projected BSDY and MXDY demands for the site were distributed to the nodes within the piping network for the corresponding scenarios (i.e. winter/BSDY and summer/MXDY). Demand patterns developed by the City of the entire Zone MONT were applied to the demands within the lands. Peak Hour demands were determined by applying the city developed diurnal patterns to the maximum day demands. The diurnal patterns are different for each unit type and all vary with time. The overall maximum observed demand when patterns are applied is the peak hour demand.

Table 4.6 shows the demands based on the three phases of development. As previously mentioned in **Section 4.2.1**, a fire flow of 13,000 L/min (217 L/s) is used as per the 2013 WMP recommendations. Refer to **Table 4.6** for the estimated time of construction of each phase.

Table 4.6: Demands Projections Based on Phasing

DEMAND (L/s)	PHASE 1A	PHASE 1B	PHASE 2	PHASE 3
BSDY	1.19	5.05	14.92	30.08
MXDY	2.64	6.49	16.54	31.69
PKHR	6.07	11.18	25.56	49.96
BSDY+FF	218	222	232	247
MXDY+FF	220	223	234	249

Table 4.7 shows what was previously anticipated in the 2007 study, what was projected from the 2013 WMP, and what is currently anticipated for the subject site (2014 study). The change in demand from the 2007 study to the 2014 study is shown as well as the percent change in demand.

Table 4.7: Comparison of Estimated Demands (Previous and Revised)

DEMAND TYPE	2007 STUDY (ML/d)	2013 WMP (ML/d)	2014 STUDY (ML/d)	CHANGE IN DEMAND FROM 2007 TO 2014 STUDY (ML/d)	CHANGE (%)
Basic Day (BSDY)	6.10	2.28	2.60	-3.50	-57%
Maximum Day (MXDY)	11.20	3.06	2.74	-8.46	-76%
Peak Hour (PKHR)	20.50	5.13	4.32	-16.18	-79%

Significant reduction in demand has occurred from the 2007 study for several reasons:

1. Reduction in total number of units, unit densities, and total population has decreased the overall number of people that are to be serviced.
2. Reduction in consumption rates (per 2013 WMP) and design based on Zone level has decreased the expected demand per person.
3. Employment demands have changed from area-based to a fixed consumption rate per job (per 2013 WMP).
4. The method in obtaining maximum day and peak hour demands has changed from applying multiplication factors to incorporating an outdoor water demand per SFH and observing peak hour demand patterns (per 2013 WMP).

Additionally, these factors have little impact on internal watermain sizing as they are controlled mostly by fire flow. It should be noted that at the subdivision/site plan approval level, the City of Ottawa's Water Design Guidelines are to be used.

4.2.3.3 External Lands

As per the City's 2013 WMP hydraulic model, 2031 demands for Polygon 55 and 56 of Zone MONT were assumed to be all demands anticipated for the Former CFB Rockcliffe development. As such these demands were adjusted based on the development information and incorporated into the proposed layout in the model. Other 2031 demands that are external to the Former CFB lands are shown in **Table 4.8** and were carried forward in the analysis herein.

Polygon 241 was located at Blair Road and Montreal Road and Polygon 251 was located at St. Laurent Boulevard and Montreal Road in the City's 2013 WMP hydraulic model. Both polygons

are anticipated to contain commercial employment and polygon 241 is anticipated to contain some residential apartment units. The model shows these polygons representing a total demand of 3.54 L/s that includes 0.2 L/s of unaccounted for water. Based on the 2013 WMP consumption rate of 219 L/cap/d for apartments (APT) and 137 L/cap/d for employment (EMP), this equates to a population of 1,987 persons.

Table 4.8: 2031 Growth Polygons External to the Study Area

POLYGON	APT DEMAND (L/S)	EMP DEMAND (L/S)	POPULATION
241	0.50	2.38	1,698
251	0	0.46	289
Total			1,987

4.3 Zone Mont Pumping Capacity

Zone MONT is a closed zone and is serviced by two pump stations: Montreal Road PS and Brittany PS. **Table 4.9** shows the existing operational pump capacity at each pump station and the capacity of Zone MONT. The 2013 WMP identified the need for immediate pump capacity upgrades to meet firm capacity and reliability needs; further discussion is in the following sections.

Table 4.9: Existing Pumping Capacity

	EXISTING OPERATIONAL CAPACITY(ML/D)		
	TOTAL	FIRM	STANDBY
Montreal Rd. PS	39.4	21.9	16.5
Brittany Dr. PS	8.1	2.6	-
Zone MONT	47.5	24.5	16.5

4.3.1 Firm Capacity: Maximum Day and Fire Flow

As per the 2013 WMP Level of Service Criteria, firm capacity in a closed zone is considered to be the largest pump out of service at each source of supply and must be able to supply MXDY+FF. The 2013 WMP Update indicated that an additional 3.6 ML/d of firm pumping capacity was required immediately for either the Brittany Drive PS or Montreal Road PS to meet existing demand requirements up to 2031 growth projections. A second upgrade in 2031 of 3.6 ML/d is also required to meet 2060 projections for a total of 7.2 ML/d. this increases the firm capacity from 24.5 ML/d to 30.1 ML/d.

Following a review of demand projections of the Former CFB Rockcliffe development and the zonal water demands of MONT pressure zone, recommendations for firm capacity upgrades are similar to the 2013 WMP. **Figure 4.6** shows the upgrade requirement timeline for firm capacity. It can be seen that the 2031 projections from the Former CFB Rockcliffe development is slight higher than the 2013 WMP projections for Zone MONT. It is recommended that an immediate upgrade of 4.2 ML/d take place to meet 2031 needs and accommodate build-out of the Former CFB Rockcliffe lands. A total of 7.1 ML/d of pumping upgrades is required to meet 2060 demands.

4.3.2 Reliability: Basic Day and Fire Flow

With respect to the Montreal Road Pressure Zone, the worst case scenario is the shut-down (whether intentional or not) of the MRPS. Under this scenario all flows into Zone MONT would flow from the BDPS. As per the 2013 WMP Level of Service Criteria, if one pump station is out of service, it is assumed the second pump station will have all pumps available to supply BSDY+FF.

The 2013 WMP indicated that BDPS requires an immediate upgrade to meet reliability needs for existing conditions.

It was confirmed during this study herein that capacity upgrade recommendations for reliability will be similar to that of the 2013 WMP. The 2013 WMP indicated that 19.2ML/d and 22 ML/d of total pumping capacity are required at BDPS for reliability purposes by 2031 and 2060, respectively. This increases the pumping capacity at BDPS to 27.3 ML/d to meet 2031 needs and 30.1 ML/d to meet 2060 needs.

As shown in **Figure 4.7** by incorporating the Former CFB Rockcliffe development projections to Zone MONT, a total of 19.5 ML/d is required immediately at the Brittany Drive Pump Station to meet 2031 demands. This increases the total pumping capacity from 8.1 ML/d to 27.6 ML/d. An additional upgrade of 1.9 ML/d will be required following 2031to meet 2060 demands and increase the total pumping capacity at BDPS to 27.6 ML/d.

As a result, in regards to reliability and redundancy where Montreal Road Pump Station is out of service, an additional 27.6ML/d of total temporary pumping at BDPS or an additional 9ML/d of back-up pumping at MRPS is required to meet the level of service during interim conditions of the MRPS and BDPS upgrades.

4.4 Hydraulic Modeling Results

The hydraulic model was tested under 2031 basic day demand conditions, to verify how the proposed network would respond with the complete build-out of the revised configuration. The following presents the results with the subject site serviced by the existing 406mm diameter watermain along Burma Road and a new 406mm diameter feed along Codd's Road.

4.4.1 Basic Day Demands

The discharge HGL at Brittany Drive PS and Montreal Road PS are shown in **Table 4.10**. Maximum pressures in the study area are expected be approximately 662kPa (96 psi).

Table 4.10: Discharge Head at BDPS and MRPS Under BSDY Demands

PUMP STATION	MIN. DISCHARGE HEAD (M)	MAX. DISCHARGE HEAD (M)
Brittany Drive (BDPS)	142.0	147.7
Montreal Road (MRPS)	142.1	147.1

It is noted that a number of the service areas in the development lands are expected to exceed 550kPa (80 psi) and therefore, will require pressure reduction as per the Ontario Building Code requirements. The extent of this area is shown in **Figure 4.8**, and includes all lands below approximately 91m in elevation at a maximum discharge HGL of147m at MRPS.

However, if the maximum HGL at MRPS is reduced to a maximum of143m, the areas within the development experiencing high pressures can be reduced. This would result in lands with elevations lower than 87m to experience pressures above 80 psi as oppose to elevations lower than 91m (discharge head of 147m at MRPS). A pressure distribution map is shown in **Figure 4.9** with MRPS operating at a maximum discharge HGL of 143m.

Areas showing pressures above 80 psi in **Figure 4.9** will require pressure reduction measures. No areas are expected to exceed 689kPa (100psi). If the HGL at MRPS was reduced to a maximum of 143m, one alternative would be two centralized PRV's on the 305mm diameter pipes feeding the development west of Codd's Road since this area shows the highest operating pressures in the development. However, as per the technical bulletin released this year regarding

maximum pressure control measures, centralized pressure reduction stations are not permitted for this application. Therefore, individual PRV's are recommended as a means to reduce high pressures in the development. If the HGL at MRPS is to remain as is (147m), pressure reduction would be required for a larger area (areas with elevations less than 91m).

4.4.2 Peak Hour Demands

The discharge HGL at BDPS and MRPS are shown in**Table 4.11**. With a maximum HGL of 147m into Zone MONT, including the subject site, the minimum pressures in the developing lands do not drop below 386kPa (56 psi). The minimum pressures anticipated will vary according to the minimum discharge HGL from the two pumping stations.

Table 4.11: Discharge Head at BDPS and MRPS Under PKHR Demands

PUMP STATION	MIN. DISCHARGE HEAD (M)	MAX. DISCHARGE HEAD (M)
Brittany Drive (BDPS)	142.6	147.7
Montreal Road (MRPS)	142.7	147.1

With MRPS operating at maximum HGL of 143m, the anticipated minimum pressure is expected to be approximately 386 kPa (56 psi) and well above the minimum objective pressure of 276 kPa (40 psi).

4.4.3 Maximum Day and Fire Flow

A 2031 maximum day demand fire flow analysis was carried out to determine the anticipated available flows at each node within the CFB lands. Within the proposed development, fire flows greater than 13,000 L/min with a residual pressure of 140kPa (20 psi) are anticipated at all locations.

Dead-end nodes were not included in the analysis as they are to show demands to the area. Smaller, local internal watermains will have to be assessed and verified as development planning proceeds. See **Appendix A** for details of available fire flows within the development.

4.4.4 Phasing

As previously mentioned, the immediate pumping upgrades at Brittany Drive PS or Montreal Road PS is required before development can take place to satisfy the City's reliability Level of Service requirements.

The pipe layout shown in **Figure 4.10** was modeled under 2012 conditions (representing existing conditions) to simulate Phase 1A in 2015. Two connections to the existing watermain on Montreal Road from Codd's Road and Burma Road with a looping is recommended. As per the City's criteria, since there are over 50 units in Phase 1A, the secondary feed from Burma Road was necessary to consider. Since the water demands of Phase 1A are quite small, the feasibility of the pipe sizing and arrangement will be governed by MXDY demands + fire flow.

Under existing BSDY and MXDY conditions, without any modifications at the Brittany Drive or Montreal Pumping Stations with respect to the discharge HGL, the areas included in Phase 1A are anticipated to experience pressures in the range of approximately 72 - 89 psi. The maximum pressures observed exceed the 80 psi threshold and would require pressure reduction measures. This further illustrates that if the HGL discharge at the pump stations is not regulated to a maximum of 143m, the majority of the development will experience pressure greater than 80 psi.

As previously mentioned, PRV's will be required for areas with elevations less than 91m while the MRPS is operating at a discharge pressure of 147m. As such, if Phase 1A is constructed before the Zone MONT pump station upgrades, PRV's will be required for areas with elevations less than 91m. However, actual PRV requirements are to be confirmed upon the subdivision approval.

Based on the pipe layout in **Figure 4.10**, the system is be capable of providing adequate fire flow of 13,000 L/min while sustaining a minimum pressure of 20 psi under 2012 MXDY demand conditions and under a pump station failure (given the recommended firm pumping capacities at Brittany Drive PS and Montreal Road PS). See **Appendix A** for details of available fire flows within the development.

4.5 Conclusion

The growth projections of the Former CFB Rockcliffe confirm that there is a need to implement the pumping upgrades to Zone MONT in the near future. As per the 2013 WMP, Brittany Drive PS is currently at a deficiency for pumping capacity and needs to be upgraded to meet the City's reliability Level of Service requirements (if the Montreal Road PS is out of service). An immediate firm pumping capacity upgrade of 4.2 ML/d will be required either at the Brittany Drive or Montreal Road Pumping stations meet 2031 needs and accommodate the Former CFB Rockcliffe development. To satisfy the expected 2060 growth in Montreal Road Pressure Zone, a total of 7.1 ML/d of additional pumping is required. In regards to reliability, a total pumping capacity upgrade of 19.5 ML/d will be required at the Brittany Drive pump station to supply 2031 Zone MONT demands if the Montreal Road Pump Station is taken out of service. It is understood that the City is presently intending to proceed with upgrades at the Brittany Drive Pumping Station to meet both existing and future growth and reliability needs.

As a result, interim measures are required to provide the appropriate level of service while the Brittany Drive and Montreal Road Pump Station upgrades take place. Since the functional design report update is currently underway, details are still being discussed. However, it is understood that additional temporary pumping and back-up power will be required before Phase 1A of the development.

The City of Ottawa is currently implementing a new strategy for the manner in which closed zones are controlled within the City's water distribution system. The report "Closed Pressure Zone Design and Operation Best Practices Review and Conversion of Zone 3C to Closed Zone Operation", June 2013 by Delcan Corporation describes the Best Practices related to the design and operation of Closed Pressure Zones and includes design and operation considerations for the following components: firm pumping capacity, electrical redundancy, instrumentation and control redundancy, system controls and operational response. Future upgrades and modifications to the Brittany Drive and Montreal Road Pumping Stations will require a review of current operations and possible implementation of the recommended Best Practices.

The recommended large diameter pipe network for the former CFB/Rockcliffe lands is shown in **Figure 4.4**; however, pipe sizes can differ upon the subdivision approval stage where detailed information is available and confirmed. Based on the results, **Figure 4.9** shows the maximum pressure distribution map of the areas with pressures exceeding 80 psi and indicates that the proposed water distribution network is capable of supplying most of the projected water demands within the acceptable pressure range of 275kPa to 690kPa (40 to 100 psi) during normal operating conditions and demands (i.e. basic day, maximum day and peak hour). It is noted that within the City of Ottawa, the recommended pressure range for new services is 345 to 550kPa (50 to 80 psi).

Within the subject site there are no concerns with respect to falling below minimum pressure requirements (under normal conditions) due to the fact that the highest elevation of approximately 94m is significantly lower than the highest serviced elevation within Zone MONT (112m). According to operational data, existing discharge HGLs into Zone MONT currently range from 142

to 147m. Based on peak hour modeling results, the maximum head loss anticipated between the pumping stations' discharges to the subject site is approximately 2.5m. Therefore at a discharge HGL of 142m, the resultant minimum pressure at an elevation of 94m would be 470kPa (68 psi).

There are low-lying areas in the proposed development that are expected to experience up to 662kPa (96 psi) on a regular basis, due to their low ground elevations. The Ontario Building Code (OBC) requires pressure reducing valves (PRV's) on new services that are expected to experience greater than 550kPa (80 psi).

Controlling the HGL discharge head at Montreal Road PS to 143m can reduce the pressures to the entire development. This would result in areas with elevations less and 87m to experience pressures higher than 80 psi rather than areas with elevations less than 91m (majority of the Former CFB Rockcliffe area) while operating at the existing maximum HGL of 147m.

Although a large portion of the development will experience high pressures, centralized PRVs are prohibited for this application, as per the City technical bulletin released this year. Individual/private PRV's are recommended as a pressure reducing measure for these areas.

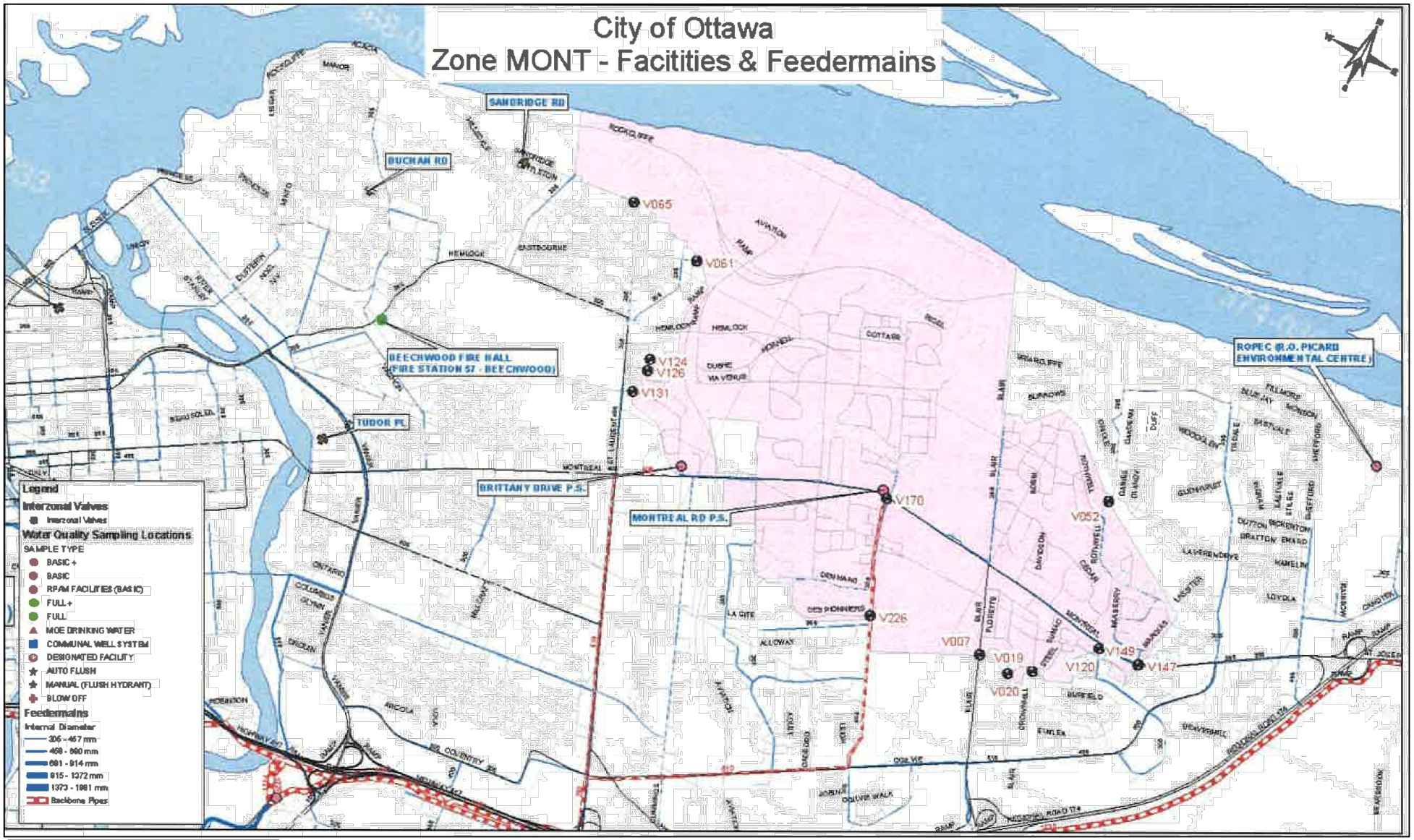
The proposed network is capable of providing the City's typical fire flow requirements of 13,000L/min, under MXDY demands, as indicated in the WMP. Modelling results showed that this required fire flow can be achieved at all location in the Former CFB Rockcliffe development.

During the design stage, the proponent will be required to determine specific fire flow requirements of individual buildings and determine whether the available flows are sufficient. It is recommended that fire flow tests be carried out on the watermain network once constructed to confirm the model results. FUS fire flow will need to be calculated and confirmed at the subdivision approval stage.

Lastly, for the construction of Phase 1A, connections to the existing Montreal Road watermain from Codd's Road and Burma Road with looping is recommended to sufficiently supply water and fire flow. Since the hydraulic analysis herein was based on a zone level water demand, during the subdivision approval stage, demand estimates for Phase 1A will need to be calculated based on the City of Ottawa's Water Design Guidelines when more detailed information is available and confirmed.

The proposed piping through any special study areas in this development is conceptual as no defined road layout or right of ways have been identified at this time. For the purposes of hydraulic modelling, the watermains shown to loop/go through these areas are intended to demonstrate the need for water and looping through the area. The exact location and looping of these watermains will be determined upon detailed design.

In regards to the future Aviation Museum, a review determined that although it is located on low laying lands, it is not feasible to service this area through Zone 1E. The past CFB evaluation of this area ruled out the interconnection from Zone 1E, as it cannot provide pressure greater than 50 psi per the Level of Service requirements. Since pressures are not expected to exceed 100 psi in the proposed watermains that the museum service lines would connect to, it is recommended that the future museum be serviced by Zone MONT pressures with appropriate pressure reducing measures along the service to the museum. The decision to service the future Aviation Museum will be deferred until a site servicing plan is prepared for the facility.

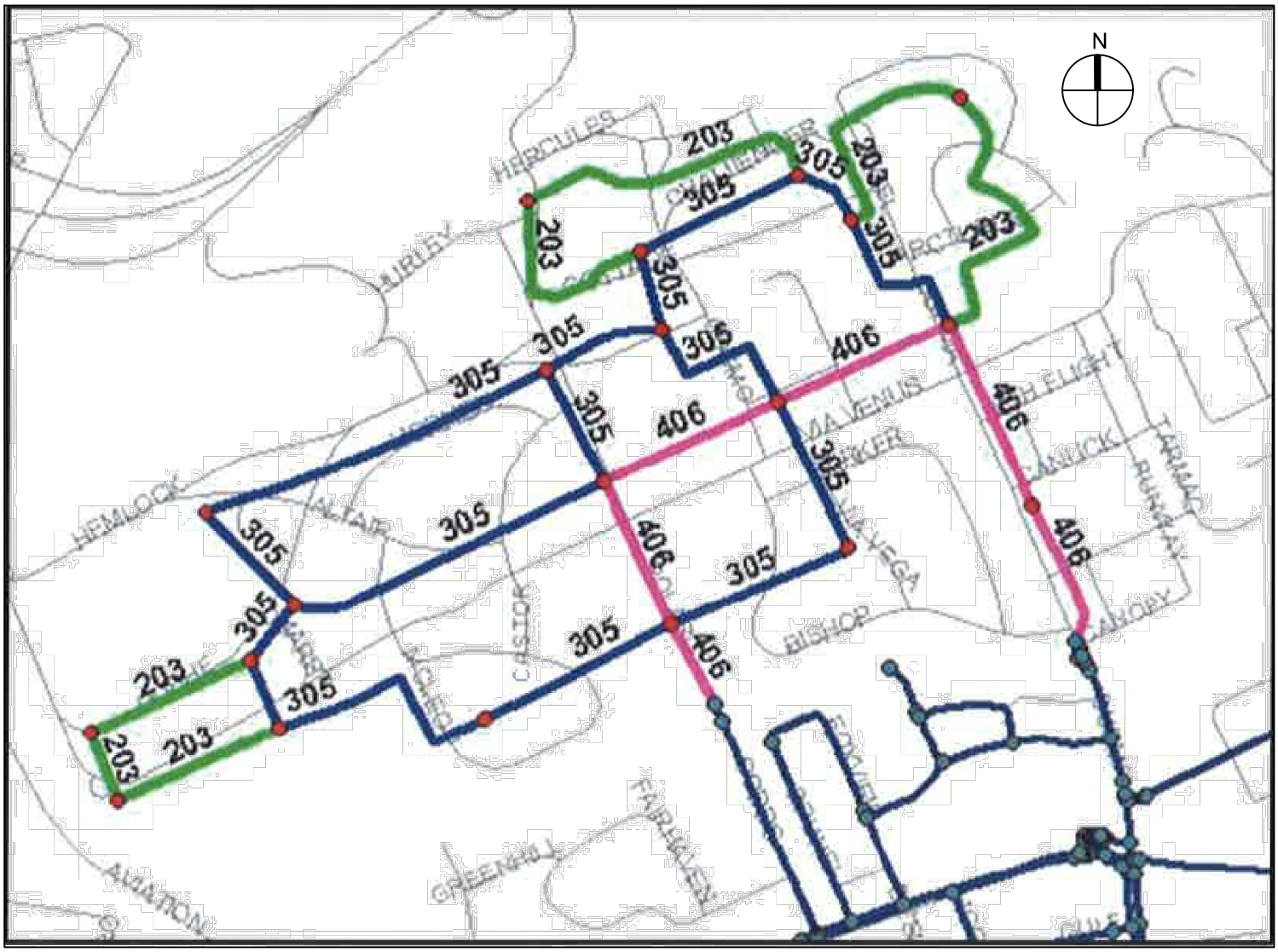


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Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	EXISTING CITY WATER DISTRIBUTION SYSTEM	FIGURE 4.1

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.1 Existing City Water Distribution System.dwg Layout Name: FIGURE4.1

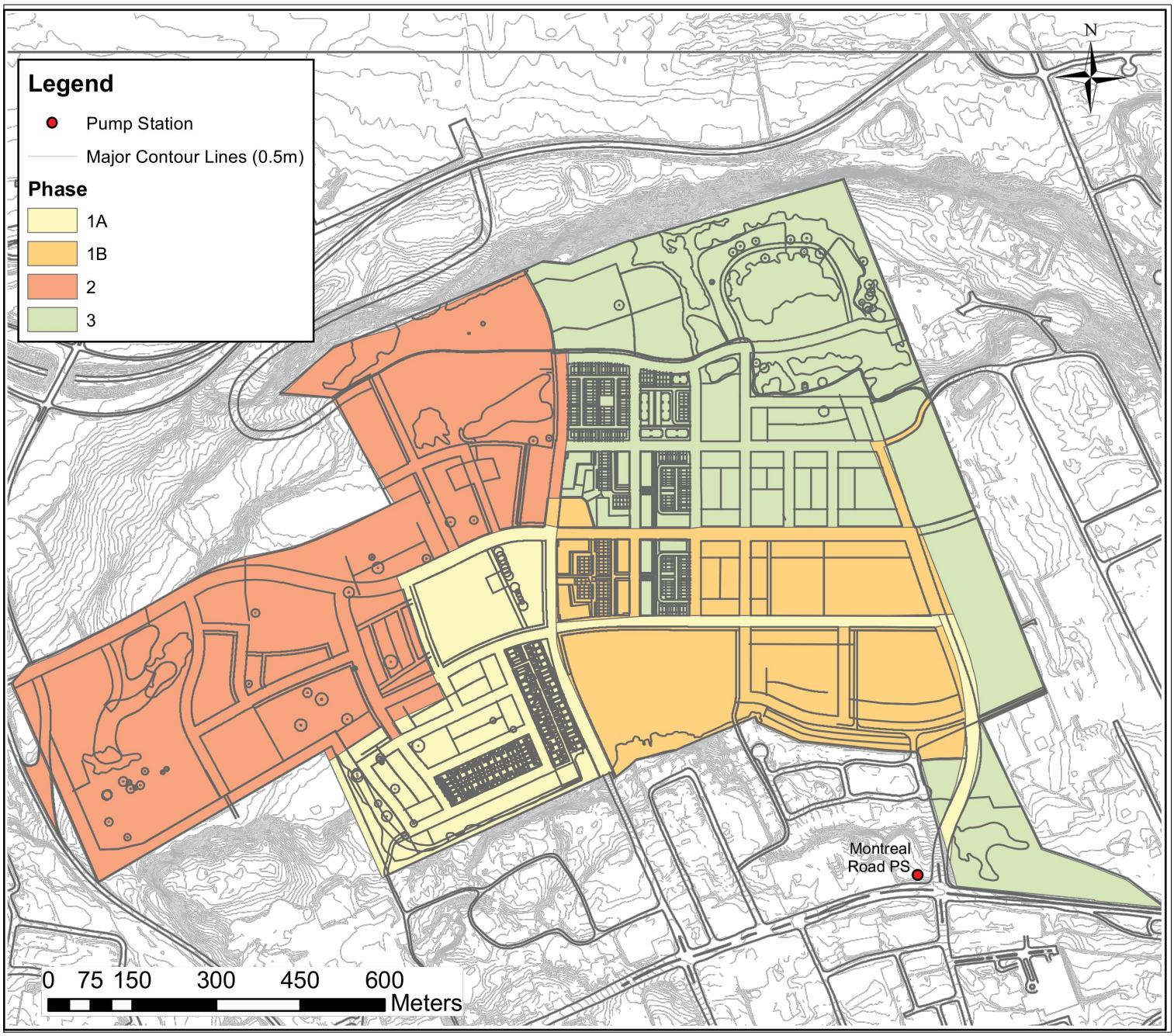


J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.2 Previously Preferred Solution (2007).dwg Layout Name: FIGURE4.2

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Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	PREVIOUSLY PREFERRED SOLUTION (2007)	FIGURE 4.2

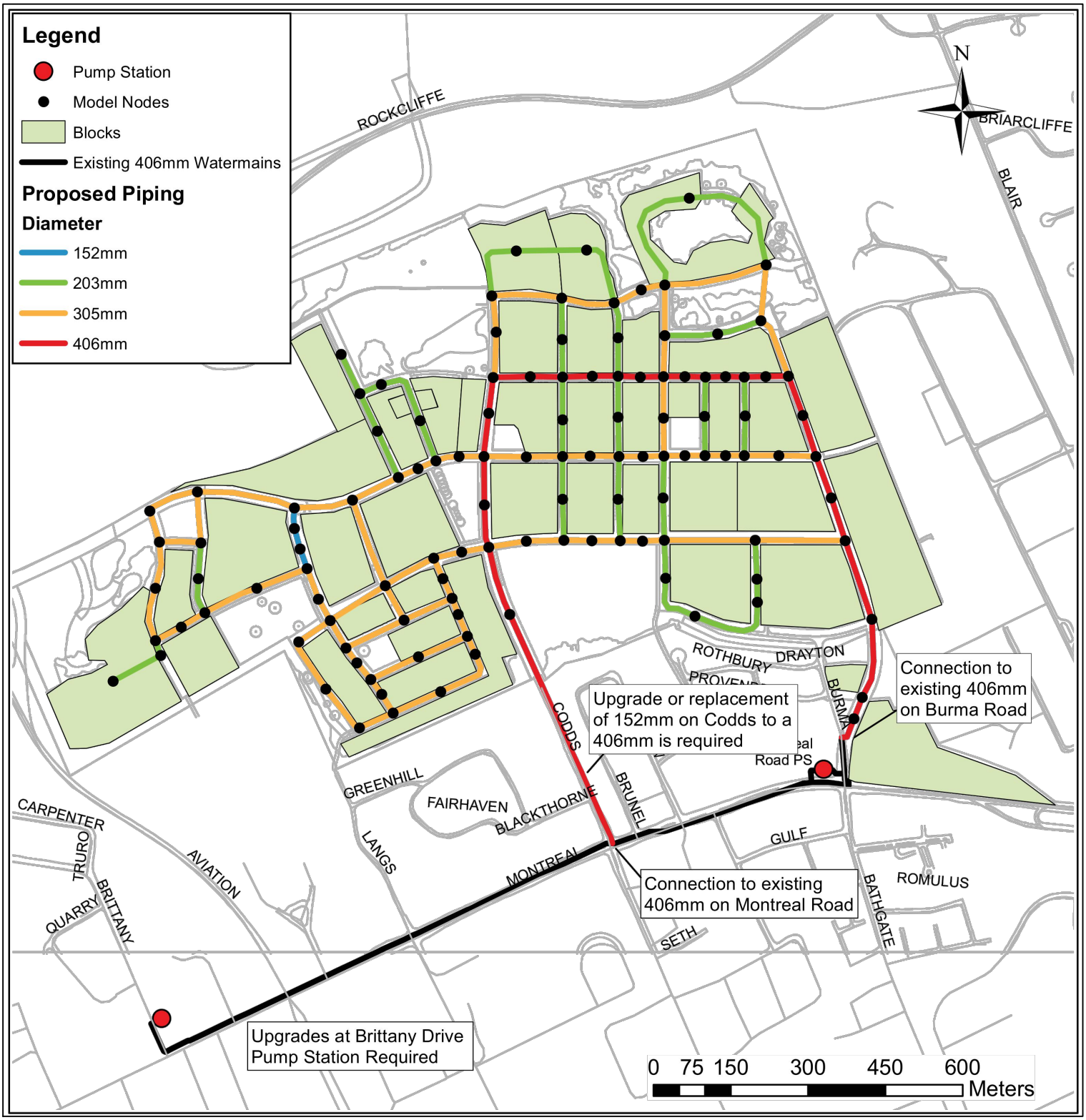


J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\Figure 4.3 Construction Phasing.dwg Layout Name: FIGURE4.3

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Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	CONSTRUCTION PHASING OF PROPOSED DEVELOPMENT	FIGURE4.3

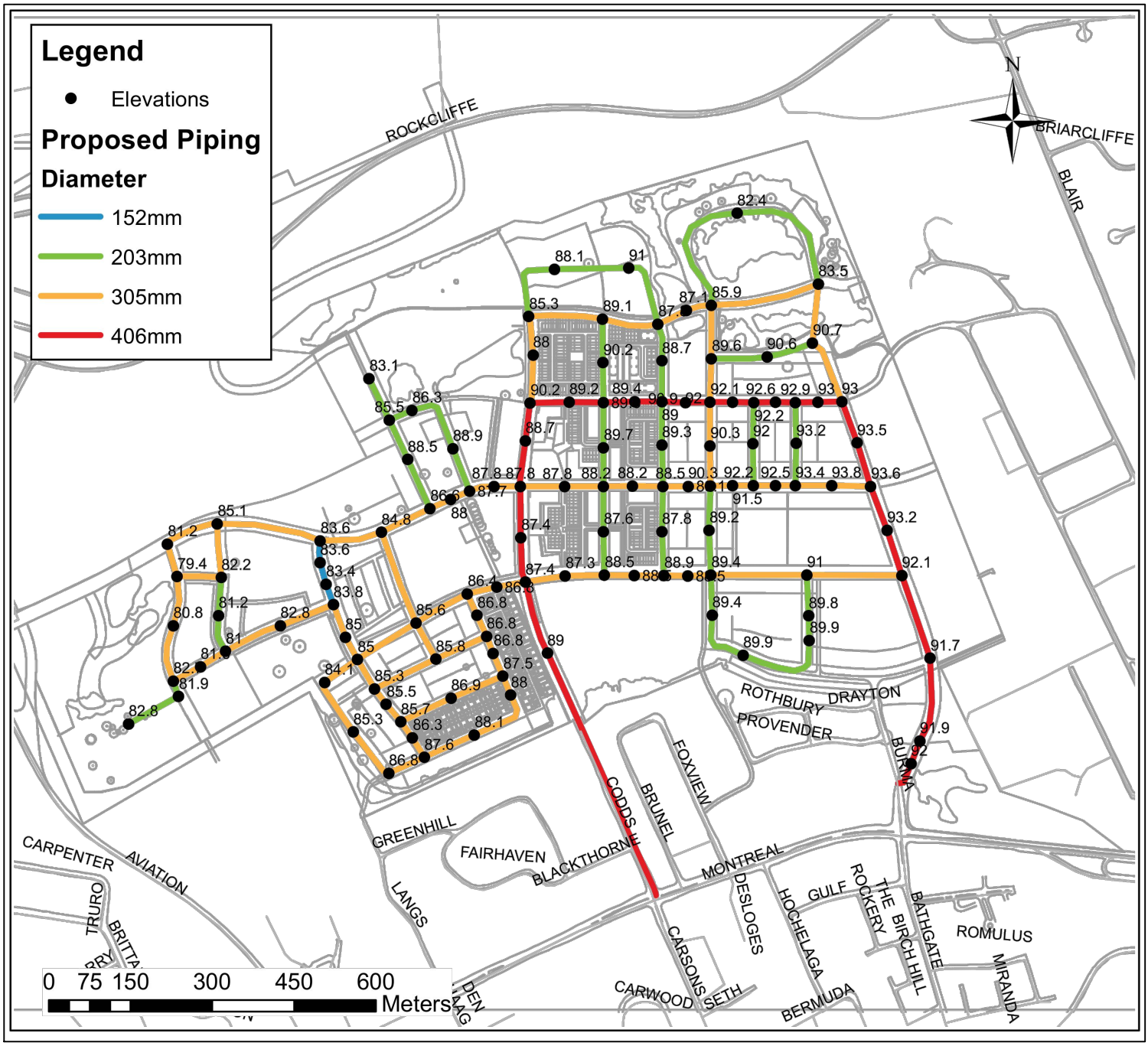


J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.4 Proposed Pipe alignment and Diameters-REV.dwg Layout Name: FIGURE4.4

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Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	PROPOSED PIPE ALIGNMENT AND DIAMETERS	FIGURE 4.4

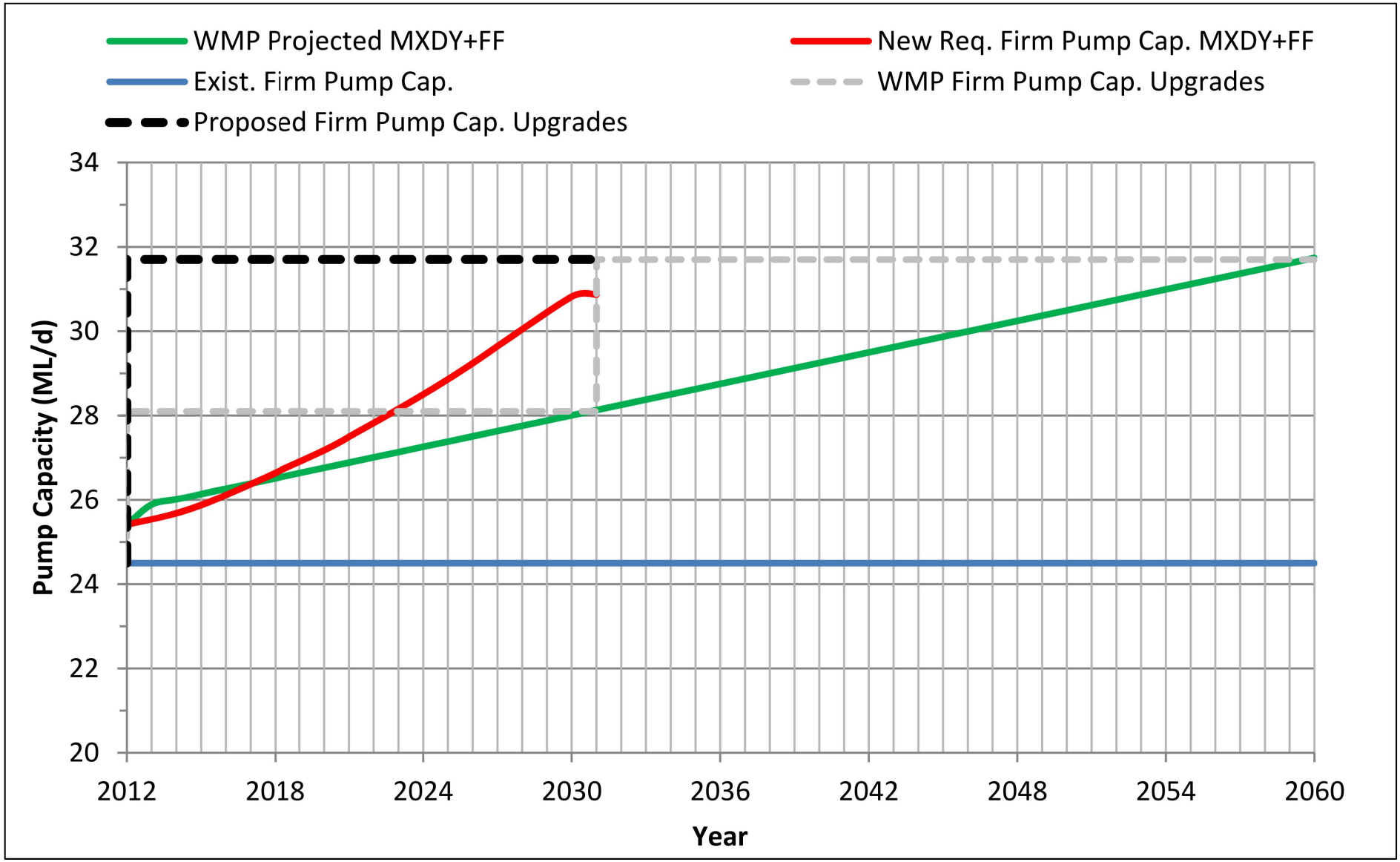


J:\32952–RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.5 Ground Elevations.dwg Layout Name: FIGURE4.5

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Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	GROUND ELEVATIONS	FIGURE 4.5

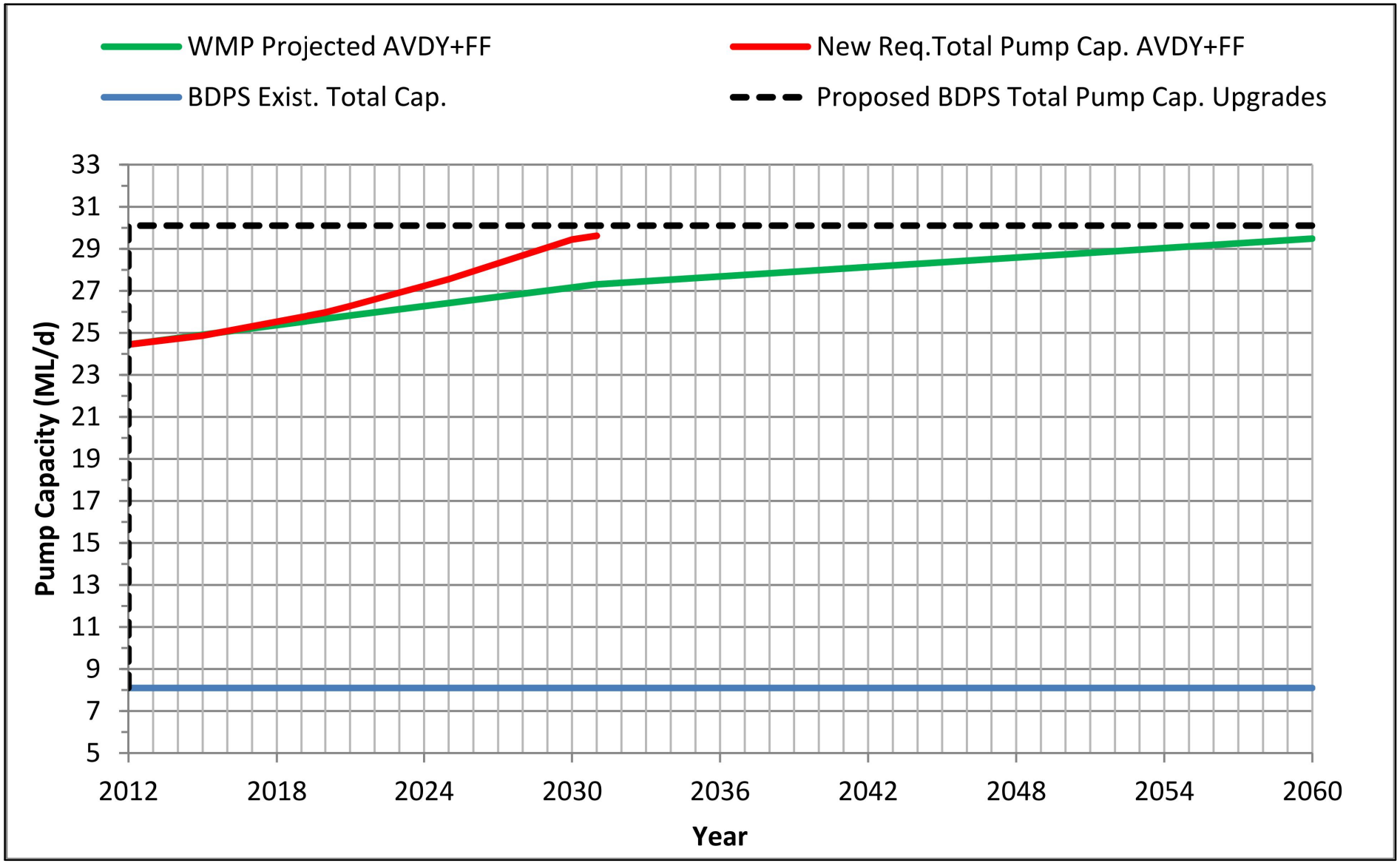


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Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	MONT PRESSURE ZONE FIRM CAPACITY REQUIREMENTS	FIGURE 4.6

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.6 MONT Pressure Zone Firm Capacity.dwg Layout Name: FIGURE4.6

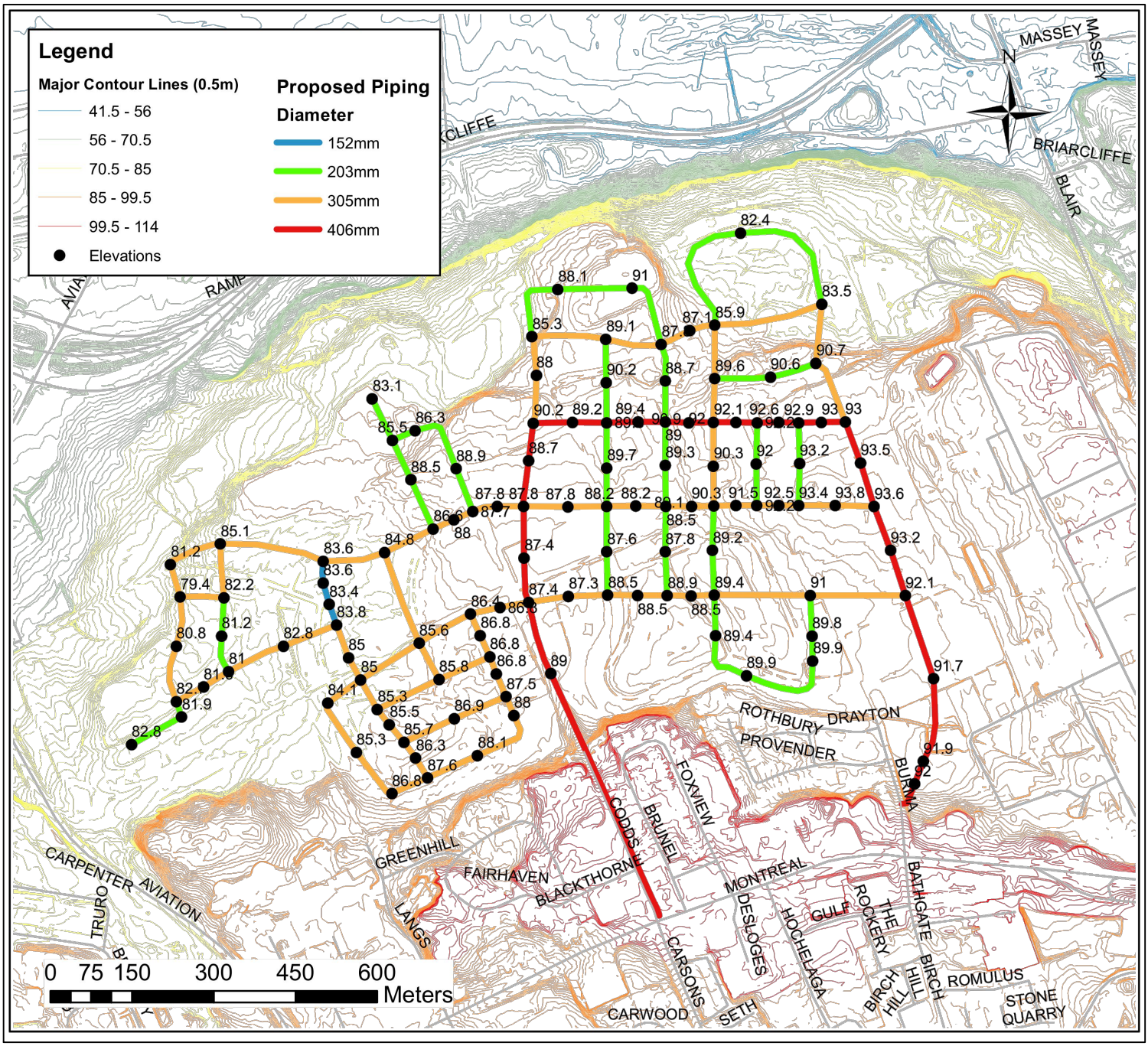


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Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	MONT PRESSURE ZONE UPGRADES AT BRITTANY DRIVE PUMP STATION	FIGURE 4.7

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.7 MONT Pressure Zone Upgrades at Brittany.dwg Layout Name: FIGURE4.7

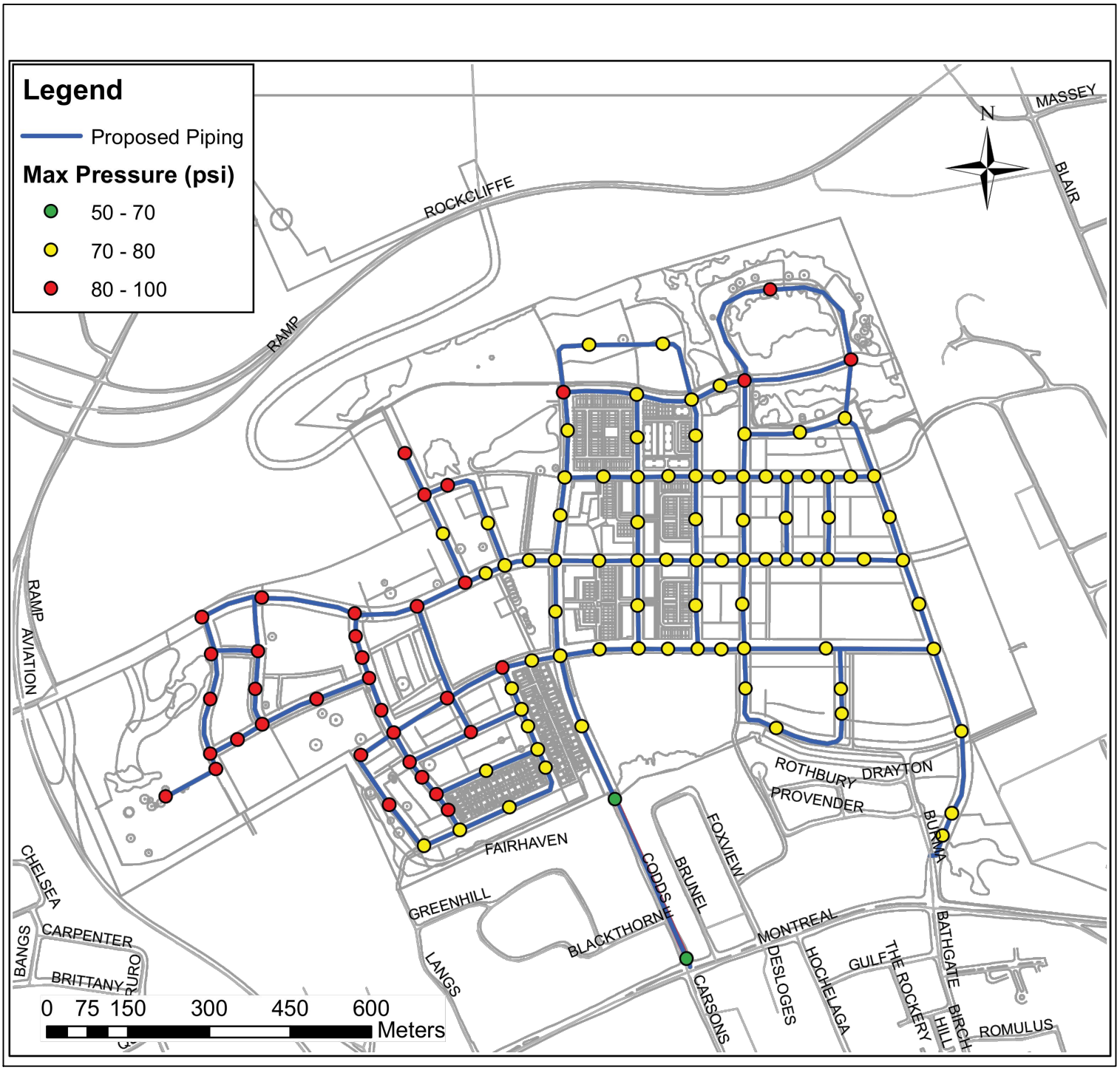


J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.8 Ground Contours and Node elevations.dwg Layout Name: FIGURE4.8

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Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	GROUND CONTOURS AND NODE ELEVATIONS (m)	FIGURE 4.8

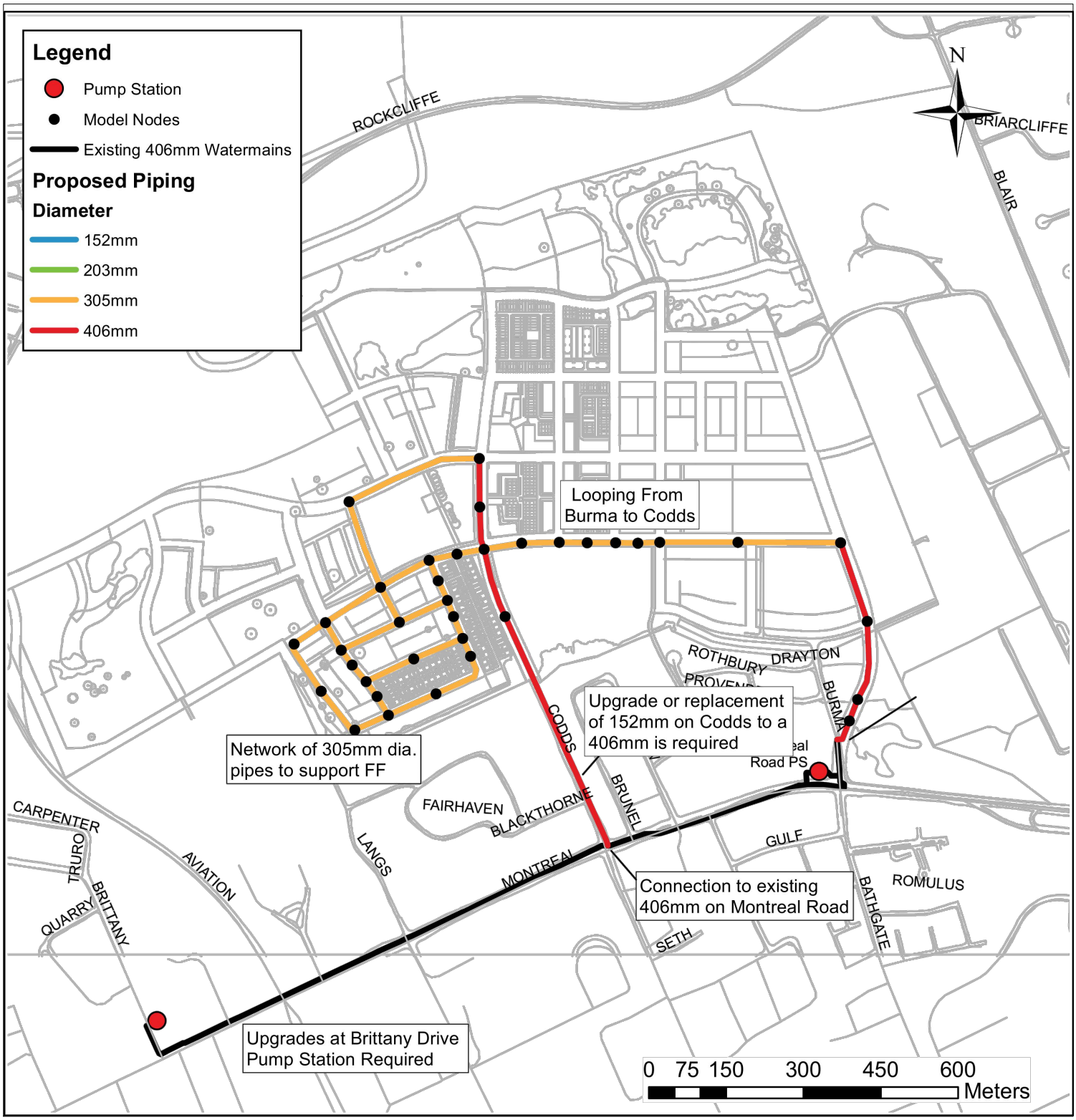


J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.9 Maximum Pressure Distribution.dwg Layout Name: FIGURE4.9

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Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	MAXIMUM PRESSURE DISTRIBUTION (MRPS Max HGL of 143 m)	FIGURE 4.9



J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 4\FIGURE4.10 Phase 1A Pipe Layout.dwg Layout Name: FIGURE4.10

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Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	PHASE 1A PIPE LAYOUT	FIGURE4.10

5 Wastewater Collection System

5.1 Introduction

The former CFB Rockcliffe combined sewer system has reached its useful life and the redevelopment of the site should include the construction of a new separated sewer system. The new sanitary sewers will be designed to not only collect wastewater from former CFB Rockcliffe but should also be oversized to carry wastewater from several external areas, some of which have previously been identified.

Capacity for wastewater flows from the Montfort Hospital and Thorncliffe Village should be provided in the new wastewater system in Rockcliffe. Combined sewage flows from the NRC Campus presently cross the former CFB Rockcliffe site and connect to the IOS sewer at the NRC Shaft. The existing easements for the NRC combined sewer will be protected as the subject site develops. However, if the NRC should complete its own separated sewer system in the future it is assumed that wastewater flows from the NRC Campus will connect directly to the IOS. No wastewater capacity in the proposed new sanitary sewer system for the former CFB Rockcliffe site will be provided for the NRC lands.

The existing Fairhaven development to the south of former CFB Rockcliffe is presently serviced with well and septic systems. Provision for potential future wastewater flows from that area should also be considered in the redevelopment site infrastructure.

As noted in **Section 2.4.2**, the Foxview development is presently serviced with sanitary sewers which outlet to the south. It is therefore proposed that the wastewater system for the subject redevelopment not provide capacity for Foxview.

Although not located inside the site boundaries, CLC has agreed to provide capacity in the proposed site infrastructure, including wastewater, for a 11.3 ha property located north of Hemlock Road. The site is identified as “Future Museum” on **Figure 1.2**. The property is in federal government ownership, which wishes to retain servicing capacity in the proposed site infrastructure to accommodate the needs of a future museum development. The site is partially located on the northern escarpment where existing ground contours range between 68 m and 86 m. The proposed wastewater collection system along Hemlock Road can partially service the site; however, because of the site topography, it is proposed that a separate sanitary sewer be constructed by the site owner at the time of site development and connect to and outlet at node 253A (City sewer node aw 00200) at an invert elevation of 61.69 m.

5.2 Design Criteria

Most of the existing sewers, both combined and sanitary, will be decommissioned while developing the site in favour of a separated sewer system which would include dedicated sewers for wastewater and storm runoff. The new site sanitary sewer system will be designed in accordance with the City of Ottawa Sewer Design Guidelines. These will include the following parameters:

- Average Residential Per Capital Flow Rate 350 l/c/day
- Residential Peaking Factor Harmon Formula (2.0 to 4.0)
- Average Employment Flow Rate 50,000 l/ha/d
- Average Institutional Flow Rate 50,000 l/ha/d
- ICI Peaking Factor 1.5

- Inflow/Infiltration Rate 0.28 l/s/ha
- Minimum Full Flow Velocities 0.60 m/s

Where practical and where there are fewer than ten residential connections, the sanitary sewer will be designed as 250 mm diameter pipes at a minimum slope of 0.65%.

Also in accordance with the City's Sewer Design Guidelines, the following population densities will be included:

- Single Family Units 3.4 ppu
- Semi Detached Units 2.7 ppu
- Freehold Townhouses 2.7 ppu
- Stacked Townhouses 2.3 ppu
- Apartment Units 1.8 ppu

5.2.1 Population Projections

The CDP (Section 5.5) included a discussion on expected unit target densities, jobs and population. To determine overall densities for the community, anticipated densities for individual land uses were applied to the preferred concept plan which is shown on **Figure 1.3**. Table 5.2 Land Use Distribution and Density from the CDP is included in **Appendix D**. The CDP projected a total unit count of 5,346 supporting an estimated population of 9,764.

Recognizing that target densities are projections and actual densities may vary, especially for a development planned over a 20 year horizon where market conditions can fluctuate, this report proposes to use slightly higher densities. A detailed block by block analysis of the projected unit counts and associated population is presented in **Table 5.1** below. In order to provide flexibility in wastewater capacity, this report recommends that the final target for units should be close to 5,300 supporting an estimated population of 10,686.

Table 5.1 Unit Type Quantities and Projected Population

BLOCK NO.	UNITS									POPULATION
	SINGLES (3.4PPU)	SEMIS (2.7PPU)	TH FREEHOLD (2.7PPU)	TH STACKED (2.3PPU)	APARTMENTS (1.8PPU)				TOTAL	
					APT	LRA/ MU	MRA/ MU	HRA/ MU		
5								474	474	853.2
7				234					234	538.2
8							138		138	248.4
9							196		196	352.8
11			12						12	32.4
12				279					279	641.7
13			85						85	229.5
15			38						38	102.6
16	14								14	47.6
17	14								14	47.6
19	19								19	64.6
20	27								27	91.8
21	59								59	200.6
23						102			102	183.6
25						89			89	160.2
27			55						55	148.5
29						156	117		273	491.4
30						71	153		224	403.2

BLOCK NO.	UNITS									POPULATION
	SINGLES (3.4PPU)	SEMIS (2.7PPU)	TH FREEHOLD (2.7PPU)	TH STACKED (2.3PPU)	APARTMENTS (1.8PPU)				TOTAL	
					APT	LRA/ MU	MRA/ MU	HRA/ MU		
31							237		237	426.6
32							171		171	307.8
33							214		214	385.2
35							190		190	342.0
36							285		285	513.0
39							191		191	343.8
40				83					83	190.9
41				84					84	193.2
42			39						39	105.3
44						275			275	495.0
46			62						62	167.4
47				35					35	80.5
48				70					70	161.0
50				110					110	253.0
51				158					158	363.4
53				190					190	437.0
55			33						33	89.1
57				41					41	94.3
60								500	500	900.0
Total	**133**	**0**	**324**	**1284**	**0**	**693**	**1892**	**974**	**5300**	**10686.4**

5.3 Proposed Wastewater Plan

The recommended ultimate wastewater plan for former CFB Rockcliffe is included in **Figure 5.1**. Together with that figure, the supporting Sanitary Sewer Design Sheets and **Figure 5.2**, Sanitary Drainage Area Plan, are included in **Appendix D**. For quick reference, reduced copies of these figures are included herein.

The proposed plan indicates that wastewater from the subject site and some adjacent external areas will be directed to one of the proposed connection locations to the IOS. The limits of these sub-drainage areas are also indicated on **Figure 5.2**. The following **Table 5.2** summarizes the wastewater elements for each connection point.

Table 5.2 Proposed Macro Drainage Area Elements

CONNECTION LOCATION IOS SHAFT	FORMER CFB ROCKCLIFFE			EXTERNAL AREAS			TOTAL			TOTAL FLOW (L/S)
	AREA (HA)	POPU-LATION	ICI (HA)	AREA (HA)	POPU-LATION	ICI (HA)	AREA (HA)	POPU-LATION	ICI (HA)	
Peach Tree Lane	19.02	2544.2	0.00	0.0	0.0	19.69	19.02	2544.2	19.69	61.86
Codd's Road	68.28	7374.5	13.69	14.50	2112.2	0.0	82.78	9486.7	13.69	156.25
NRC	16.21	767.7	3.18	0.0	0.0	0.0	16.21	767.7	3.18	49.23
SWM Pond										
Total	**103.51**	**10686.4**	**16.87**	**14.50**	**2112.2**	**19.69**	**118.01**	**12798.6**	**36.56**	**267.34**

A wastewater allowance for 1,574 people covering 5.5 ha is proposed for Thorncliffe Village. The drainage limit is shown on **Figure 5.2** and the population estimate is taken from Drawing No. 12381 S1 prepared by J.L. Richards & Associates Ltd (dated 1991), a copy of which is included in **Appendix D**. Existing wastewater flows from Thorncliffe Village are discharged to an existing 300 mm diameter sewer in the location indicated on **Figure 2.13**. It is proposed to intercept and collect those flows near node 114A and route the proposed site sewers to the Codd's Road Shaft (refer to **Figure 5.1**).

Future external flows from the Fairhaven community are also planned to be routed to the site wastewater system at node 190A. In anticipation of potential urbanization of that development, it is proposed to install a 250 mm diameter sewer under the proposed Southwest Channel terminating at the south limit of the former CFB Rockcliffe site. A wastewater allowance of about 11 l/s will be provided for flows from the Fairhaven development.

Wastewater flows from the Montfort Hospital are currently directed into the Airbase Outlet Sewer located near the west portion of the former CFB Rockcliffe site. It is proposed to continue to accept the hospital wastewater flows in a new sanitary sewer starting at node 261A. Based on an average institutional flow allowance of 50,000 l/day/gross ha, peaked at 1.5, an allowance of about 10 l/s is proposed to be provided for the hospital.

Future wastewater flows from the proposed 11.3 ha museum site located north of Hemlock Road are proposed to be routed to the existing 750 mm diameter Airbase Sewer by the site owner at node 253A (City sewer node aw 00200) where it can connect at the existing elevation of 61.69 m. The minimum sewer size from the museum site will be 250 mm diameter.

The Aviation Museum currently discharges wastewater flows into the RCAF Pump Station which is located north of the Aviation Parkway, and north of former CFB Rockcliffe. The pump station currently delivers flows through a 200 mm diameter forcemain to an existing combined sewer near node 332A (City sewer node rc00900) where it is then routed by gravity through the RCAF Pull-Back Sewer to the IOS trunk sewer at the NRC shaft (node 333A).

Although the RCAF Pump Station has a capacity of about 29 l/s, most of the contributing drainage areas on the subject site above the north escarpment will be redeveloped and future wastewater flows from this area are proposed to be re-routed to the RCAF Pull-Back Sewer. The City of Ottawa has estimated that the RCAF pump station is accepting only about 2 l/s from the Aviation Museum, it is however recommended that capacity in the proposed new site sewers continue to provide an allowance of 29 l/s for the pump station. If things change between the present and the time Phase 3 is designed then the question of the pump station allowance can be revisited in the future.

Combined sewage from the NRC Campus currently connects to the IOS sewer at the NRC Shaft. Combined flows from the NRC Campus are routed to an existing overflow chamber (City sewer node nr00100) through two sewers which are partially located on the former CFB Rockcliffe property. Most of the combined flow from the south portion of the NRC lands are routed to the overflow structure in the future commercial block 56 and the open space block 45 (refer to **Figure 1.3**) via an existing 750 mm diameter sewer. Combined flows from the northern portion of the NRC Campus are routed to the overflow structure in an existing 300 mm diameter sewer. The existing overflow structure is designed to pass dry weather flows directly to the NRC shaft structure (City sewer node oc00100) and wet weather flows to the Ottawa River via a 900 mm diameter overflow pipe.

It is proposed to leave the two existing NRC combined sewers intact until such time that the NRC completes its own separation plan. No allowance will be provided in the proposed site sewers for future wastewater flows from the NRC site. If and when the NRC completes a separation plan, it is assumed that plan will include dedicated sewers within its site including a new direct connection to the NRC Shaft without any impact upon the subject site. At that time, the existing NRC combined sewers, which are located on the subject site, can be decommissioned.

5.4 Proposed Outlets

As shown in **Figure 5.1**, there are three proposed sanitary sewer outlets for the former CFB Rockcliffe redevelopment. It is proposed to construct three separate sanitary sewer networks with connections to either the Airbase Outlet Sewer, the Codd's Road Shaft or the NRC Shaft.

5.4.1 Airbase Outlet Sewer

The Airbase Outlet Sewer is shown on **Figure 2.13**. It consists of a 375 mm/750 mm diameter combined sewer located along the western edge of the former CFB Rockcliffe site. Besides providing an outlet for wastewater flow from the Montfort Hospital, it also collects combined sewage from the former Air Force base in areas west of Codd's Road. The existing sewer directs all flows to an existing overflow structure identified as node 255A (City sewer node aw00100) as indicated on **Figure 5.1**. The manhole structure at node 255A is designed to direct dry weather flows to the 300 mm diameter Airbase Pullback sewer and excess wet weather flows to a 900 mm diameter overflow pipe. Wet weather flows eventually outlet to the Ottawa River.

As part of the wastewater plan for the subject site, it is proposed to replace that portion of the existing Airbase Outlet Sewer that is located on site (i.e. between nodes 261A and 272A) as well as about another 120 m north of the subject site up to node 253A (City node aw00200)as indicated on **Figure 5.1**. The existing sewer between nodes 272A and 253A is at an elevation which is too high to permit a gravity outlet from the redeveloped Rockcliffe site without replacement.

It is proposed to continue to use the existing outlet sewer north of node 253A as shown on **Figure 5.1**. The existing invert at node 253A of the Airbase Outlet Sewer is about 61.89 m which is sufficiently deep to accommodate a gravity connection from the proposed site sanitary sewers. At node 253A, an existing 200 mm diameter combined sewer from Hemlock Road also connects to the Airbase Outlet Sewer. It is recommended that the 200 mm diameter pipe be disconnected and decommissioned from the existing structure. A future connection to node 253A is also proposed to carry wastewater from the 11.3 ha museum site. In a similar manner, it is recommended that the existing 900 mm diameter overflow pipe be disconnected from the node 255A structure and the manhole be re-benched. These latter works will ensure that only wastewater flows from the developed subject site will outlet to the Airbase Pull-Back Sewer.

5.4.2 Airbase Pullback Sewer

The existing Airbase Pullback Sewer is a 300 mm diameter pipe with an estimated full flow capacity of about 84 l/s. The sewer was reconstructed in about 2000 by the former Regional Municipality of Ottawa Carleton as part of the Alvin Heights Pull-Back Sewer Reconstruction. As per the Sanitary Sewer Design Sheet and the Sanitary Sewer Drainage Area Plan, both of which are included in **Appendix D**, an estimated peak wastewater flow of 62 l/s, which also includes an allowance for the future museum site, will be directed to the Airbase Pullback Sewer and eventually to the IOS trunk sewer.

5.4.3 Codd's Road Shaft

The Codd's Road Shaft location is indicated on **Figure 2.13**. This connection to the Interceptor Outfall Sewer was added in 1991 as part of the development of the Thorncliffe Village community. A dedicated sanitary sewer from that development collects wastewater and routes it directly to the IOS without any connections to the other existing sewers on the subject property. **Figure 2.14** provides a schematic of the existing Codd's Road Shaft details. Because the existing connection to this shaft delivers only wastewater flows and not combined sewage, there is no overflow at this shaft.

The connection includes a standard manhole with a 375 mm diameter inlet pipe. However, because the site is about 35 m above the Interceptor sewer, the manhole outlet includes a 300 mm diameter vertical steel casing sewer connecting directly to the Interceptor sewer. The existing manhole base elevation is approximately 83.00 m.

Based on the proposed wastewater plan, two connections to the existing manhole are proposed. However, these will both be lower than the existing manhole bottom so it is proposed to replace

the manhole with a new structure. **Figure 5.3** provides some preliminary details of the proposed new connection at the Codd's Road Shaft. Essentially, the current connection will be lowered as needed to accommodate the two new inlet sewers. The elements of the vertical outlet pipe will remain unchanged but will be adjusted to a lower elevation.

The estimated peak wastewater flow proposed to be connected to the Codd's Road Shaft is about 156 l/s. Based on the Ontario Building Code (Section 7.5.8.4, 2012) the capacity of a 300 mm diameter vertical pipe is 2700 GPM or 170 l/s. The OBC assumes only 29% of the pipe area is used by wastewater. A copy of Table 7.5.8.4 and Figure 13-7 from the OBC is included in **Appendix D**.

5.4.4 NRC Shaft

The third proposed connection to the IOS sewer is at the NRC Shaft where combined flows from the NRC property; wastewater flows from the Aviation Museum and combined flows from the eastern portion of the former airbase site are presently connected. **Figure 2.15** and **Figure 2.16** show the existing connection details.

Flows from the NRC Campus enter an existing overflow manhole structure from two separate combined sewers. The overflow structure is designed to direct dry weather flow to the nearby NRC Shaft drop structure which in turn connects to the IOS sewer. The overflow structure has a 900 mm diameter overflow pipe which directs larger wet weather flows away from the site to the Ottawa River. Besides the dry weather flows from the NRC overflow chamber, the drop manhole also receives flows from the 300 mm diameter RCAF Pullback Sewer. The drop manhole outlets through a vertical drop pipe directly to the Interceptor sewer located about 35 m below the drop manhole.

Both the NRC overflow chamber and adjacent incoming and outgoing overflow pipes are proposed not to be impacted by the proposed site development. The drop manhole is also proposed to remain as-is. Future separated flows from Phase 3 and the RCAF Pump Station are proposed to connect directly to the existing 300 mm diameter RCAF Pullback Sewer at a location about 40 m upstream of the NRC Shaft. The balance of the RCAF Pullback Sewer is proposed to be replaced as part of the future design of Block 44, which is considered the Special Design Area (Block 44, refer to **Figure 1.3**). The pullback sewer is connected to the NRC Shaft at an elevation of about 77.0 m. Existing ground is close to the 84.0 m contour, so the existing infrastructure is sufficiently deep to accept a new connection from the proposed site sanitary sewers.

The City has commented that the existing pullback sewer is located in a forested area. It is likely that every reasonable attempt will be made to retain existing significant vegetation. In that event the pullback sewer, as well as incoming pipes such as the pump station forcemain, may be relocated. Those decisions will be made at the time of final concepts and future design the Special Design Area.

The estimated peak wastewater flow proposed to be connected to the RCAF Pullback Sewer is 49 l/s. This includes an allowance of 29 l/s for the RCAF Pump Station. Based on a measured slope of 0.43%, the existing sewer has a capacity of about 63 l/s.

5.5 Phasing Requirements

Figure 1.6 shows the proposed phasing plan for development of former CFB Rockcliffe. Phase 1 will include about 82 ha of the central and eastern portions of the site and will be sub-phased into phases 1A and 1B. Phase 1A will include Codd's Road up to the Town Centre and most of the low density residential development areas west of Codd's Road; a school site and park. The Phase 1 wastewater sewers will also be sized to accept flows from about 14 ha of the western portion of

Phase 3. Wastewater flow from Blocks 29 to 32 is proposed to be collected and directed towards the Codd's Road Shaft.

Because of the need for multiple access points for watermains, vehicles and utility looping, Phase 1A will also include the extension of both Main Street and Burma Road. However, the latter streets are included in Phase 1A only for infrastructure redundancy. No developments along these streets are proposed until Phase 1B is completed. Phase 1A will also include capacity for potential future urbanization of the Fairhaven community as well as interception and collection of existing sanitary flows from Thorncliffe Village. All wastewater from Phase 1, and a portion of Phase 3, will be directed to the proposed reconstructed Codd's Road Shaft. **Figure 5.4**, which is included in **Appendix D**, shows the proposed wastewater plan for Phase 1A. For quick reference, a reduced copy of this figure is included herein.

The ultimate wastewater servicing plan for the subject site includes sanitary sewers in Burma Road. As part of the Phase 1A development, it is proposed to construct Burma Road from Montreal Road to Hemlock Road, including all proposed infrastructure. The Burma Road sanitary sewers in that portion of Burma Road are proposed to connect at node 108A and ultimately outlet westward to node 114A. However, the single loaded local road containing the 108A to 114A sanitary sewer is not planned for Phase 1A construction. Therefore, until Phase 1B is completed, the Burma Road Phase 1A sanitary sewer will remain out of service. Because this sanitary sewer will not be connected to any developments and therefore will not receive wastewater flows until Phase 1B is constructed, it is probable that it could fill with groundwater. To ensure water levels within this sanitary sewer do not surface, it is proposed to cap the sanitary sewer at the west leg (outlet side) of node 108A and construct a temporary drainage pipe designed to outlet to the new Burma Road SWM Facility. The "dry" sanitary sewers in Main Street will naturally outlet to the Codd's Road sewers at node 155A, thus ensuring they will not flood.

Phase 2 will include development of approximately 24 ha west of Phase 1. Wastewater flows from this phase will be directed to a new outlet sewer which will replace most of the existing 750 mm diameter Airbase Outlet Sewer located near the northwest of the subject site. Sanitary sewers in Phase 2 will also intercept and collect existing flows from the Montfort Hospital. The federal government may develop the museum site. Wastewater flows from that site can be collected and directed to the existing Airbase Outlet Sewer at node 253A as indicated on **Figure 5.1**.

Phase 3 will include development of the north and northeast portions of the site. Part of the wastewater in Phase 3 will be directed to the IOS via the new RCAF Pullback Sewer and the balance towards the Codd's Road Shaft via Phase 1 sewers. Also as stated earlier, a wastewater allowance will also be included for the RCAF Pump Station.

Development of Phase 1A will impact the existing Thorncliffe Village sanitary sewer. It is proposed to intercept that sewer at the new Codd's Road alignment near node 150A and convey flows in the new Phase 1A sanitary sewer to the IOS. The balance of the Thorncliffe Village sanitary sewer can remain active until Phase 1B is developed.

5.6 Ottawa Interceptor Sewer

The Ottawa Interceptor Sewer (IOS) is a 2.4 m diameter trunk sewer which carries combined sewage from a large portion of the City of Ottawa to the sewage treatment facility located several kilometres east of the subject site. The sewer bisects the subject site about 35 m below grade. The sewer has been in operation for about 50 years and the City is presently considering twinning the sewer to provide additional capacity and operational redundancy.

The City has not yet completed an Environmental Assessment for the proposed new trunk sewer. Present options are only preliminary and currently there is no work underway to develop and evaluate potential options. Twinning of the IOS is likely a generation away. Until the City advances

the twinning project, it is unknown if the new trunk sewer will be located below the subject site. The sewer could also be located in corridors either north or south of the former CFB Rockcliffe site. Even if the new sewer is ultimately constructed below the subject site, it will most likely be completed by trenchless technologies at similar elevations as the existing pipe.

The proposed development will commence as soon as the CDP, and supporting technical documents such as this report, are reviewed and approved. It is conceivable that the first development applications will be submitted in mid 2015 with construction of Phase 1A starting in 2015.

Through the development review process, a strata easement will be secured to protect the City's ability to access and maintain the existing IOS tunnel. As the CDP accommodates the existing shafts to the IOS within future City parks, full and final easements will be protected. A new permanent IOS shaft is also needed and is anticipated to be built within one of the proposed parks. This has been taken into account through the strategic location of parks where the additional shaft and associated maintenance staging areas would be required.

From an infrastructure perspective, the preferred location for the new IOS shaft has been identified as Parkette #5 – Centre Parkette (block 22), adjacent to the existing drop shaft. Other possible locations include the eastern edge of Park #4 – East Neighbourhood Park (block 45), west of the existing shaft, and the north-west corner of Park #3 – West Neighbourhood Park (block 10). Construction of the new shaft would last a few months and would require 2,000 – 3000 m^2 of staging area. The staging area would revert to park use upon completion of the shaft construction. Criteria for locating the new shaft will be based on consultation with affected stakeholders. If the new shaft is not located on City owned land, a full and final easement will be required for access to the new shaft.

The existing IOS tunnel will also be twinned with a second sewer tunnel in the future. Subject to the ultimate routing selected for the second tunnel and its associated shaft, a second subsurface strata easement may be required to protect for the possible routing of this second tunnel and for its associated access shaft. It is also anticipated that construction of the second sewer tunnel would take place after development and occupancy of surrounding land. Accordingly, the City will engage with affected stakeholders.

5.7 Cost Estimates

As stated earlier in this report, the proposed wastewater plan for the former CFB Rockcliffe site will make use of three different outlets. This means that the proposed plan will require only nominal size sanitary sewers with no sewer being larger than 375 mm diameter. Therefore, based on the current City of Ottawa's Development Charge By-Law, which only starts to share wastewater sewer costs for sewers sized 450 mm diameter and larger, no proposed sewers will be cost shared by the City. Accordingly, no cost estimates of the proposed wastewater system are provided in this report.

5.8 Conclusions

It is recommended that as part of the development of the former CFB Rockcliffe site that all existing combined sewers be replaced with dedicated wastewater and storm sewers. The new wastewater sewers will be designed using the criteria recommended by the City of Ottawa as noted in its Ottawa Design Guidelines for Sewers.

All wastewater flows from the former CFB Rockcliffe redevelopment will be directed to the Ottawa Interceptor Outfall Sewer (IOS), which is located on the site. Wastewater flows are proposed to be routed to one of the three existing connection shafts located either adjacent to or on the site. Flows from the western portion of the site are recommended to be directed to a new sanitary

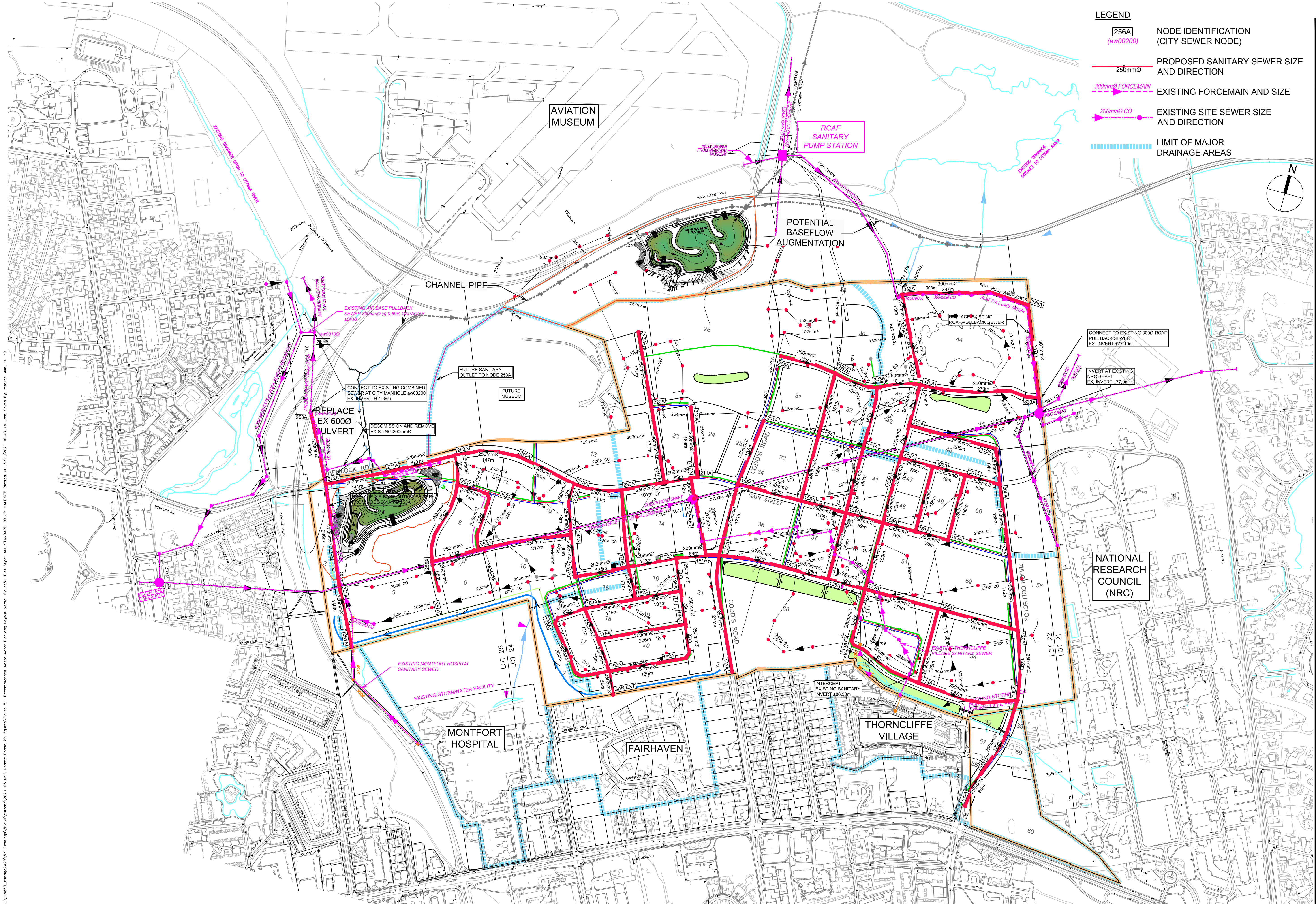
sewer along the western edge of the site which will connect to the Airbase Pullback Sewer and eventually reach the IOS at the Peach Tree Road Shaft via the existing Alvin Heights Pullback Sewer.

The proposed wastewater system is also recommended to be sized to accept existing wastewater flows from the Montfort Hospital. Wastewater flow from the future museum can be directed to the existing Airbase Pullback Sewer at node 253A by the museum site owners.

Separated wastewater flows from the central and southwestern portion of the site are recommended to be routed to the existing Codd's Road Shaft located near the centre of the site. The new wastewater system for Phase 1 will also be sized to accept future flows from the Fairhaven Community in the event the existing private septic systems are replaced with a central piped wastewater system. The Phase 1 sewer will also intercept existing flows from the Thorncliffe Village sanitary sewer system.

Wastewater flows from the northeast portion of the site are recommended to be routed to the IOS at the existing NRC Shaft. It is also recommended that most of the existing RCAF Pullback Sewer be replaced leaving only about 40 m of the lower section, which connects to the drop structure, in place. The new sewer will also be sized to continue to accept flows from the RCAF pump station. Because Block 44, on which the existing RCAF Pullback Sewer is located, is a Special Design Area, details of the development of that area, including new infrastructure, will be reviewed in the future as part of the final plan and design of the block.

It is also recommended that the new site development not impact the two existing NRC combined sewers which are located on the subject site. These sewers will continue to function until such time that the NRC elects to complete its own separation program, at which time the existing sewers can be decommissioned. No provision is proposed to be made in the proposed new wastewater sewer for flows from the NRC Campus.



[B]

Scale

Project Title

FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY

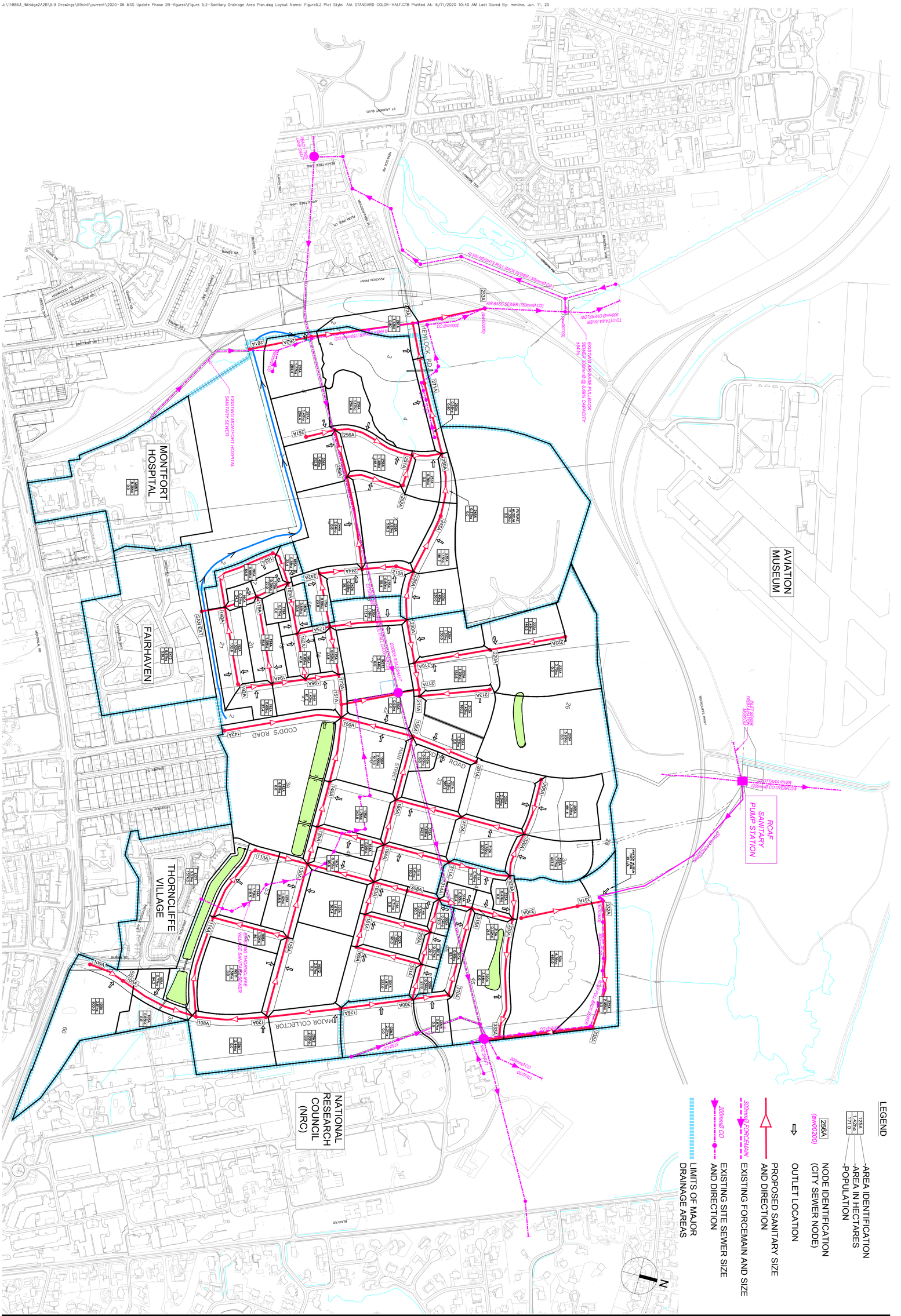
Drawing Title

RECOMMENDED WASTEWATER PLAN

Sheet No.

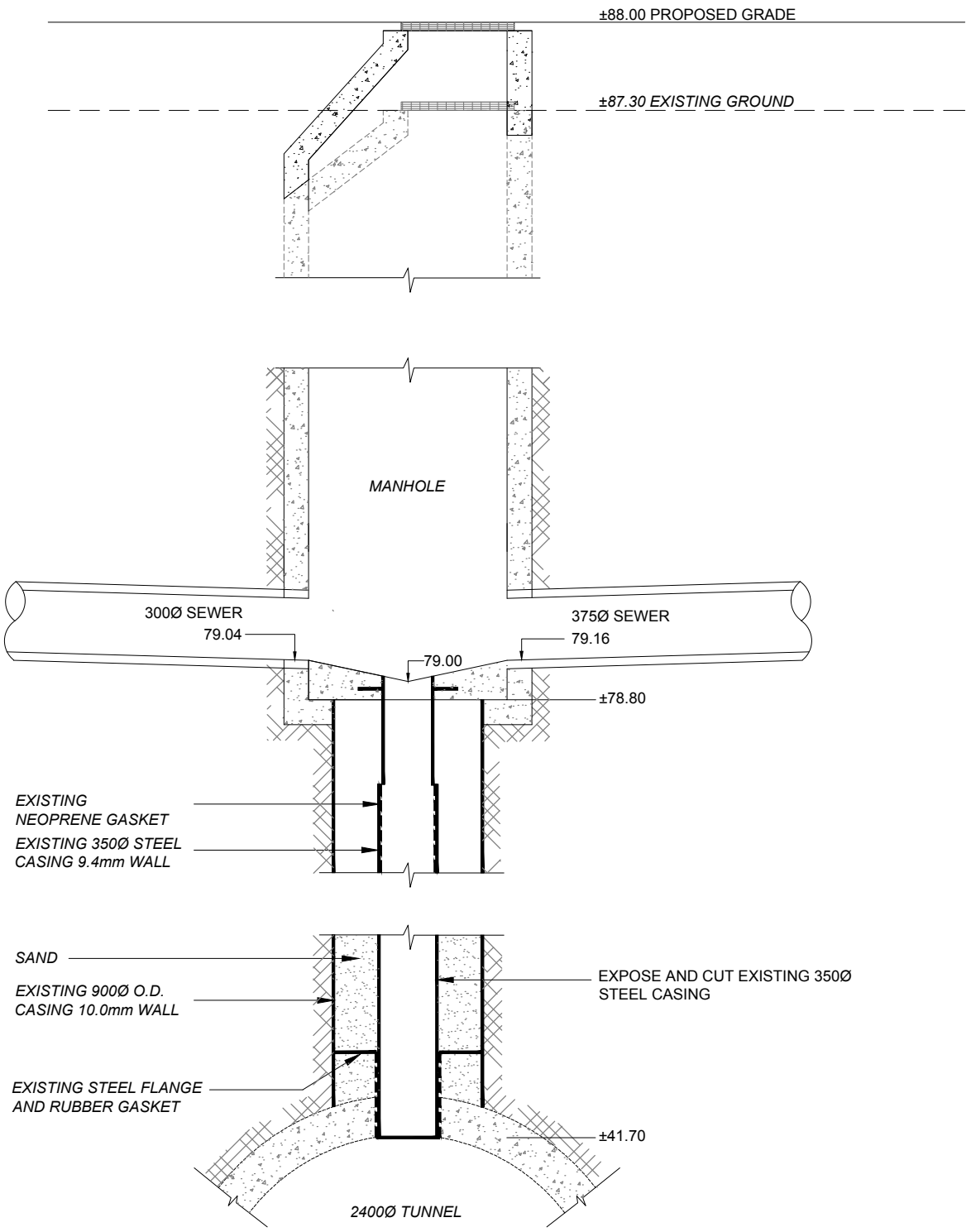
FIGURE 5.1

J:\118863_Wtridge2A28\5.9 Drawings\59civil\current\2020-06 MSS Update Phase 2B-figures\Figure 5.2-Sanitary Drainage Area Plan.dwg Layout Name: Figure5.2 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 6/11/2020 10:40 AM Last Saved By: mmline, Jun. 11, 20



Sheet No.	Drawing Title	Project Title	Scale
FIGURE 5.2	SANITARY DRAINAGE AREA PLAN	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	0 100 200

IBI



J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 5\Figure 5.3-Cross Section Proposed Codds Road Shaft.dwg Layout Name: Figure5.3

Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	PROPOSED CONNECTION CODD'S ROAD SHAFT	FIGURE 5.3

LEGEND

256A (aw00200) — NODE IDENTIFICATION (CITY SEWER NODE)

250mmØ — PROPOSED SANITARY SEWER SIZE AND DIRECTION

300mmØ FORCEMAIN — EXISTING FORCEMAIN AND SIZE

200mmØ CO — EXISTING SITE SEWER SIZE AND DIRECTION

AVIATION MUSEUM

RCAF SANITARY PUMP STATION

INLET SEWER FROM AVIATION MUSEUM

ROCKCLIFFE PKWY

EXISTING 450mmØ SEWER TO OTTAWA RIVER

EXISTING 600mmØ SEWER TO OTTAWA RIVER

EXISTING AIR BASE PULLBACK SEWER 700mmØ @ 0.69% CAPACITY ±94 l/s

aw00108

aw00200

CONNECT TO EXISTING COMBINED SEWER AT CITY MANHOLE aw00200 EX. INVERT ±61.89m

DECOMISSION AND REMOVE EXISTING 200mmØ

REPLACE AIR BASE OUTLET SEWER FROM NODE 261A TO 253A

HEMLOCK RD

FUTURE MUSEUM

CONNECT TO EXISTING CODD'S ROAD SHAFT INVERT 76.80m

CODD'S ROAD SHAFT

EX SHAFT

OTTAWA INTERCEPTOR SEWER

EXISTING MONTFORT HOSPITAL SANITARY SEWER

SAN EXT

PEACH TREE LANE SHAFT

MONTFORT HOSPITAL

FAIRHAVEN

CODD'S ROAD

MAIN STREET

MAJOR COLLECTOR

REPLACE EXISTING RCAF PULLBACK SEWER

INVERT AT EXISTING NRC SHAFT EX. INVERT ±77.0m

INTERCEPT EXISTING SANITARY INVERT ±86.40m

EXISTING THORNCLIFFE VILLAGE SANITARY SEWER

CAP SEWER AND CONSTRUCT TEMPORARY OVER FLOW TO SWM FACILITY

NATIONAL RESEARCH COUNCIL (NRC)

THORNCLIFFE VILLAGE

N

Scale 0 100 200

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Drawing Title

RECOMMENDED PHASE 1A
WASTEWATER PLAN

Sheet No.

FIGURE 5.4

J:\118063_WrridgeX2R\5.0 Drawings\5.6civil\current\2020-06 MSS Update Phase 2B-figures\Figure 5.4-Proposed Wastewater Plan Phase 1A.dwg Layout Name: Figure5.4 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 6/11/2020 10:39 AM Last Saved By: mmilne, Jun. 11, 20

6 Stormwater Management System

6.1 Introduction

It has been concluded that the existing storm sewer system within former CFB Rockcliffe has reached its useful life and the site's redevelopment should include the construction of a new separated storm sewer system including a dual drainage network and end-of-pipe SWM facilities. The proposed storm sewer system is designed to not only convey runoff from the former CFB Rockcliffe site but to also convey runoff from several external areas. Capacity for stormwater runoff from the NRC Campus, Thorncliffe, Foxview, and Fairhaven communities, as well as the Montfort Hospital, is provided in the new stormwater system. Regard has also been given to the long term potential for a new museum to be built in the northwest corner of the proposed development plan.

6.2 LID Stormwater Pilot Project

As noted in **Sections 1.5** and **1.6**, the City of Ottawa and CLC have agreed to pursue phased stormwater management demonstration projects for former CFB Rockcliffe using LID Best Management Practices (BMPs). Aquafor Beech was retained by CLC to prepare the "Former CFB Rockcliffe LID Stormwater Management Pilot Study Project" (May 2015). The report is being read concurrently with this report.

The MSS has been completed using sound engineering principles in the development of the preferred stormwater solution applying conventional stormwater practices including, but not limited to, piped stormwater infrastructure and stormwater management facilities. The preferred stormwater solution using conventional stormwater practices has been developed in accordance with regulatory requirements to service the proposed development as a stand-alone system and to accommodate the potential LID practices identified in the second independent study detailed below.

The 'Former CFB Rockcliffe LID Stormwater (SWM) Pilot Project Study' being prepared by Aquafor Beech is intended to permit the implementation, monitoring, and evaluation of alternative stormwater management systems based upon the principles of low impact development. The work program for the LID Stormwater Pilot Project Study was developed in consultation with the City of Ottawa and will provide direction for the implementation of LID controls in parallel with the conventional storm servicing presented in the MSS.

A SWM Working Group has been formed, consisting of key members of the City of Ottawa, CLC staff, and consultants engaged by CLC. The SWM Working Group will:

- Make recommendations to the City of Ottawa staff working on former CFB Rockcliffe
- Determine the information required to design the integrated LID SWM system
- Determine the information to be collected during the monitoring programs
- Review the collected monitoring data from each successive phase of development
- Determine how and to what extent LID measures will be implemented beyond the initial phase based upon monitoring and whether accounting for some or all LID benefits in the design of the conventional storm servicing can be supported.

The proposed LID implementation process for former CFB Rockcliffe was developed using a phased Adaptive Management System (AMS) approach whereby a science-based methodology is developed and applied to understand and quantify the function, potential benefits and drawbacks from the proposed LID approaches. In this regard, each phase of potential LID

implementation corresponding to the phases of development will involve the completion of six steps:

1. Planning (subject of the LID SWM Pilot Project Study)
2. Construction
3. Monitoring
4. Reporting
5. Quantification of benefits
6. Refinement of the LID approach prior to the subsequent phase of LID implementation

Steps 5 and 6 (Quantification of benefits and Refinement) are critical process elements, allowing 'real-world' results to be communicated to and vetted by City of Ottawa staff and agencies and subsequently translated into direction for both the refinement of future LID implementation and refinement of the conventional storm servicing presented in the MSS. In this manner, it is only the quantifiable benefits that will influence stormwater servicing of former CFB Rockcliffe.

As discussed in the previous section, the LID SWM Pilot Project Study report should be read in parallel with this MSS document as it relates to storm sewer servicing. Furthermore, forthcoming monitoring reports which quantify the performance of LID practices as it relates to water quality, water balance, volume, and peak flows should also be considered and related to the aforementioned two independent documents. The implementation of stormwater servicing for redevelopment of former CFB Rockcliffe will be flexible and realizes that stormwater BMPs, techniques and approaches will change as the knowledge base advances, that future phases and associated monitoring will refine the findings from the MSS and LID SWM Pilot Project Study and that this overall stormwater servicing approach is not static.

An overall study process is detailed in **Figure 1.5**. It summarizes the MSS, CDP, LID SWM Pilot Project Study and the proposed LID implementation process for former CFB Rockcliffe and uses the AMS approach.

6.3 Stormwater Management Criteria

6.3.1 Regulatory Agencies

The following agencies are involved in the review of the SWM servicing for former CFB Rockcliffe:

- City of Ottawa
- Rideau Valley Conservation Authority
- Ontario Ministry of the Environment
- National Capital Commission

6.3.2 Reference Documentation

The following documents were referenced as part of the establishment of the SWM criteria:

- Stormwater Management Planning and Design Manual (Ontario Ministry of the Environment, March 2003);
- City of Ottawa Sewer Design Guidelines (November 2004 and September 2008 Section 8.0), henceforth referred to as the OSDG;

- City of Ottawa Technical Bulletin ISDTB-2012-1 (January 31, 2012), henceforth referred to as Technical Bulletin 2012-1;
- City of Ottawa Technical Bulletin ISDTB-2012-4 (June 20, 2012), henceforth referred to as Technical Bulletin 2012-4; and,
- City of Ottawa Technical Bulletin ISDTB-2014-1 (February 5, 2014), henceforth referred to as Technical Bulletin 2014-1.

6.3.3 Regulatory Requirements

6.3.3.1 Water Quantity Control

As previously noted in **Section 2.4.3**, runoff from the site is currently conveyed to two creeks via two existing culvert crossings of the Aviation and Rockcliffe Parkways.

A preliminary analysis has been completed based on available data for the culvert crossings. Culvert design nomographs for the existing eastern culvert (Rockcliffe Parkway) and normal depth of flow within the existing ditch downstream of the culvert were analyzed to determine maximum capacity of the existing eastern outlet system. The existing western culvert (Aviation Parkway) was modeled in XPSWMM to define the quantity of the flow conveyed through the culvert under the post development condition (further details are provided in **Section 6.6.1)**.

Based on the analysis, runoff from the eastern limit of the site is currently constrained by the capacity of the existing eastern culvert crossing. Modeling results of the western limit of the site shows that runoff from the site will be conveyed through the existing western culvert with no overflow. A summary of the eastern and western culvert analysis is provided in **Table 6.1**. Culvert design nomographs and modeling files are enclosed in **Appendix E.**

- Eastern (Rockcliffe Parkway) Outlet

  The results of the analysis indicate that the culvert will overflow at an elevation of approximately 54.80 m. Based on this condition, the theoretical conveyance of the culvert with no overflow is approximately 3.5 cms.

- Western (Aviation Parkway) Outlet

  The results of the modeling indicate that the culvert will overflow at an approximate elevation of 62.01 m. Based on this condition, the conveyance of the culvert with no overflow is approximately 1.35 cms.

Table 6.1 Summary of Culvert Analysis

OUTLET	CAPACITY (CMS)
Eastern (Rockcliffe Parkway)	3.50
Western (Aviation Parkway)	1.35

As previously discussed, the preferred SWM alternative is comprised of two end-of-pipe SWM facilities with outlets to the Ottawa River. Construction of the Eastern SWM Facility, adjacent to the Rockcliffe Parkway, will include a new pipe conveying outflow from the facility to the Ottawa River. Due to the direct connection to the Ottawa River, the Eastern SWM Facility is not required to provide water quantity control. Additional field work and consultation with the NCC and RVCA will be required as part of detailed design.

The Western SWM Facility is tributary to the Aviation Parkway culvert crossing. Enhancement to remove debris from the Aviation Parkway culvert, remove silt build up in the creek at the outlet of

the Aviation Parkway culvert, and remove the blockage in a culvert within the RCMP campus is required to restore a positive outlet.

6.3.3.2 Water Quality Control

The SWM facilities servicing the site will provide an Enhanced Level of Protection, which corresponds to 80% TSS removal as per the Stormwater Management Planning and Design Manual (Ontario Ministry of the Environment, March 2003).

6.3.3.3 Erosion Control

It is recommended that the future SWM facility designs minimize perturbation of the creek channels. The Eastern and Western Creeks are characterized in the Fluvial Geomorphology report.

The Eastern Creek is characterized by eroding, incising reaches separated by depositional wet grassy areas. The estimated bankfull discharge is between 0.5 cms and 2.5 cms. Since the proposed stormwater management approach calls for dedicated storm sewers which will outlet to either one of two central SWM facilities, potentially less water from the subject site will discharge to the exiting Eastern Creek. All excess flows are proposed to be directed away from the Creek. From the fluvial geomorphology perspective, the estimated flow generated by the contributing drainage area during the 25 mm storm event is 0.56 cms, which is at the lower end of the bankfull estimates. As such, exacerbated erosion is not anticipated. Additionally, runoff reduction by LIDs has not been considered. Therefore, no erosion control or any remediation works are currently proposed for the Eastern Creek.

It is proposed to conduct a 3 year monitoring program within the Eastern Creek starting in spring 2016. The monitoring program will include annual inspection with photo documentations for evidence of erosion, souring or deposition of sediment. In addition, it is proposed to identify two sections, which are most susceptible to erosion, and to conduct yearly topographical surveys after the spring freshet. The locations of monitoring stations will be identified at the detailed design stage. The final monitoring program should confirm if any remedial/mitigation work should be adopted that the Creek is not deteriorating as a result of the proposed development.

The Western Creek is generally stable except a reach immediately downstream of a culvert north of the Hemlock Road. The estimated bankfull discharge is between 0.7 cms and 1.4 cms downstream of the Aviation Parkway and upstream of the confluence with the western tributary, as discussed earlier in **Section 2.3.2.** As stated previously, the SWM approach for the Western Creek is to discharge only that volume of treated flow that matches the capacity of the Aviation Parkway culvert. Flows in excess of that capacity will be diverted away from the Western Creek and routed directly to the Ottawa River via a new pipe. Further discussion is provided within the **Section 6.5.4.4**.

Sections of the Western Creek need to be cleaned out to re-establish its maximum capacity. For a short distance below the Aviation Parkway culvert, the existing Creek is full of silt and farther downstream a Creek crossing is plugged. Part of the SWM plan for the Western SWM facility includes the cleaning of the Creek to restore its maximum capacity. **Figure 2.18** identifies some of the creek features discussed above. It should be noted that cleaning of the Western Creek is proposed to be completed concurrent with construction of the Western Pond during the Phase 2 development.

6.3.3.4 Temperature

With respect to temperature, the Aquatic Habitat Assessment indicates that temperature mitigation measures should not be required for the outflows from future SWM facilities.

6.3.3.5 Water Budget

6.3.3.5.1 Background

A water budget analysis has been completed by Aquafor Beech for existing conditions. It is required to understand the overall hydrology of the study area, and evaluate the relationship between precipitation and the response of the study area to precipitation events over a long timeframe.

Modification of the hydrologic cycle through urban development has impacts on water quantity, water quality, and stream morphology. More specifically, urbanization reduces evaporation, evapotranspiration and infiltration, thereby increasing surface runoff and resulting in more frequent and higher peak flows in rivers and streams causing increased flooding and erosion. Reduction of infiltration decreases groundwater recharge, potentially affecting cool baseflow to streams and wetlands.

The overarching objective of the water budget analysis is to analyze pre-development hydrology in order to establish baseline conditions, which will be used later to carry out an impact assessment of future development and develop stormwater management targets. There are many benefits that result from a water balance assessment. These benefits include:

- Identifying key elements in the Hydrological Cycle, including surface runoff, evapotranspiration and infiltration;
- Defining streamflow regime and variability; and
- Providing baseline conditions to help develop stormwater management targets.

In order to carry out the water budget analysis, background information was obtained from several sources including and not limited to the following:

- Field investigations
    - Field confirmation of watercourse mapping
    - Evaluation of Infiltration capacity using the Guelph Permeameter
- Technical reports covering the study area, including
    - “Fluvial Geomorphology Assessment Study,” DST (September 2013)
    - “Preliminary Geotechnical Investigation Study Report Infiltration Ponds,” DST (November 2013)
    - “Hydrogeological Report Stormwater Management Support Study,” DST (June 2014)
    - “Stormwater Management Existing Conditions & LID Pilot Project Scoping,” Aquafor Beech (May 2015)
- Historical metrological data (Environment Canada and City of Ottawa Weather Stations), including
    - Hourly precipitation values
    - Air temperature
- Soils data, including
    - “Stormwater Management Existing Conditions & LID Pilot Project Scoping,” Aquafor Beech (May 2015)

- Field Observations

6.3.3.5.2 Water Budget Analysis Approach

The hydrologic cycle is a complex process and its natural components are dependent on many factors: soils, topography, vegetation, geology, climate, etc. Any change to these natural factors will result in a change to the hydrologic cycle; these changes accelerate with urbanization. A tool often used in water resources management is Water Budget Analysis, which sums the various components of the hydrologic cycle for a watershed by balancing precipitation input, evapotranspiration output, infiltration and surface runoff input and output.

6.3.3.5.3 Climate Data

Precipitation data from four rain gauges belonging to the City of Ottawa were reviewed. These stations included Lemieux, Hawthorne, Lee's, and ROPEC. The ROPEC rain gauge was eventually used because of long record (1996-2013) and proximity to the study area. Since the ROPEC gauge included only rainfall data, snowfall data was augmented by Environment Canada station (45°23'00.000" N, 75°43'00.000" W, 79.2 masl). Average annual precipitation for the record (1996-2013) was 887 mm (**Figure 6.1**).

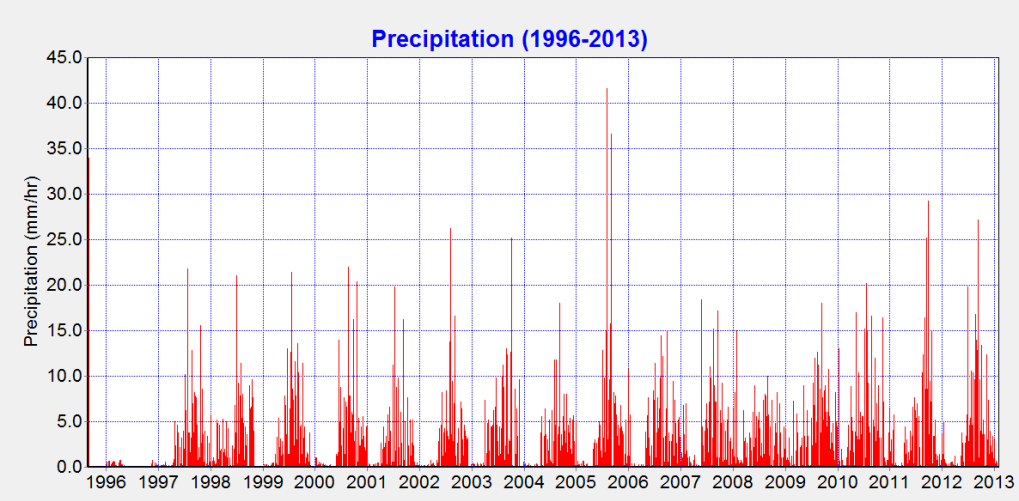


Figure 6.1 Precipitation Record (mm/hr) from 1996 to 2013

The climate normals (1996 – 2013) from Environment Canada (45°23'00.000" N, 75°43'00.000" W, 79.2 masl) were used to obtain monthly potential Evapotranspiration (ET) values using the Thornthwaite and Mather (1957) Procedure (**Figure 6.2**). Based on the ET calculations, the annual evapotranspiration for the study area is 532 mm, which amounts to approximately 60% of annual precipitation; the remaining 40% (355 mm annually) is the water surplus that may be partitioned between infiltration and runoff.

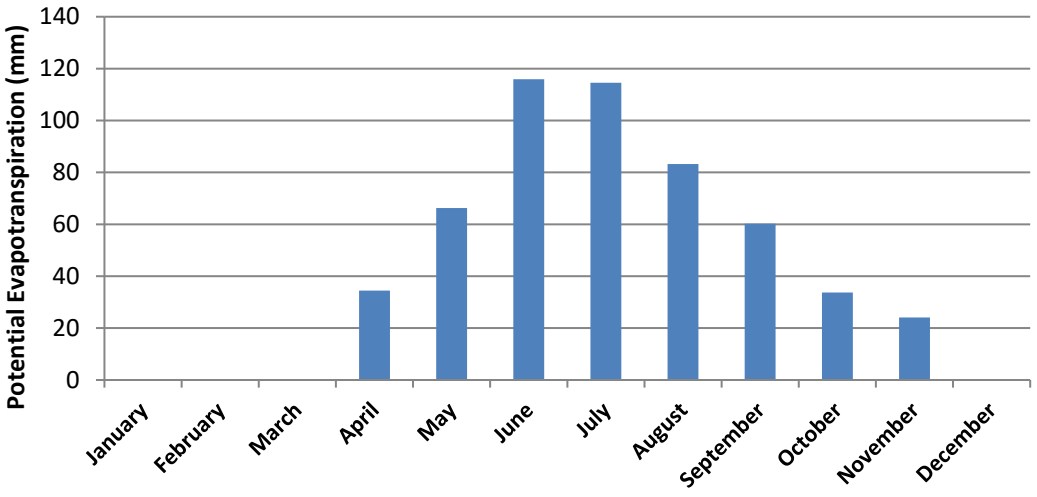


Figure 6.2 Average Potential Evapotranspiration Values between 1996 and 2013

6.3.3.5.4 Hydrologic Model Development

In order to conduct hydrologic analysis for the water budget within the study area, computer models in conjunction with other desktop analyses were developed. The hydrologic analysis of the existing hydrologic conditions in the study area was carried out using the EPA SWMM (Environmental Protection Agency Storm Water Management Model) model, version 5.0.022, a deterministic event-based and continuous hydrologic model that can be used to simulate surface runoff quantity and quality, water budget, and various hydrologic and hydraulic variables.

EPA SWMM version 5.0.022 is suitable for modeling pre- and post-development conditions because it includes several modules that can simulate physical conditions in both cases. For post-development scenarios, EPA SWMM models the hydrologic performance of Low Impact Development (LID) controls, such as porous pavement, bioretention areas, rain barrels, infiltration trenches, and vegetative swales. The model allows engineers and planners to determine the effectiveness of LID measures in managing stormwater and combined sewer overflows under future development conditions.

Subcatchment Characteristics

The EPA SWMM model has used drainage areas and boundaries that had been delineated earlier. **Figure 6.3** shows a schematic of Western Creek and Eastern Creek subcatchments.

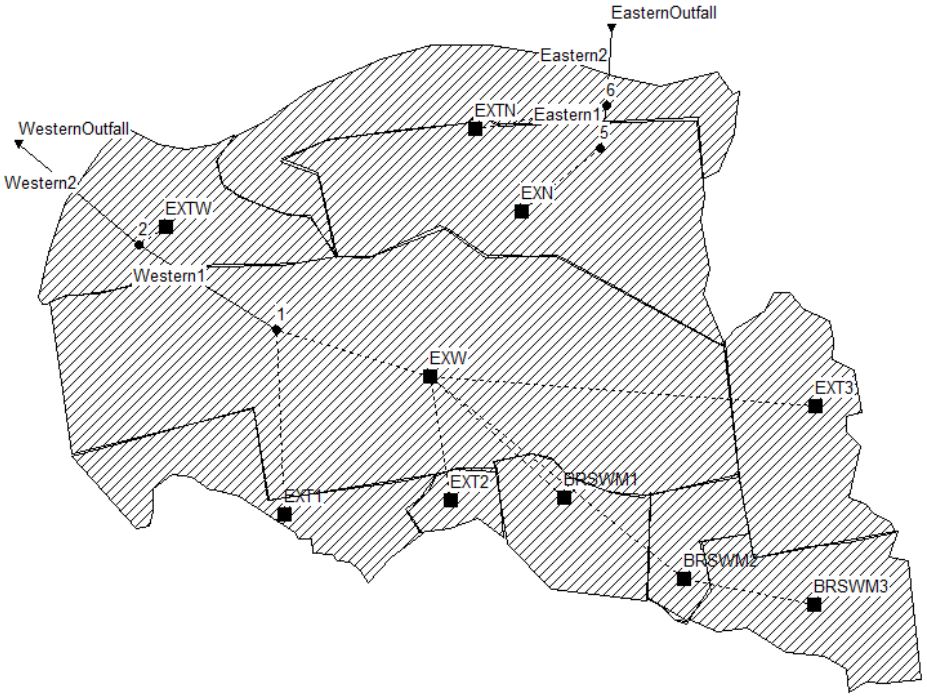


Figure 6.3 The EPA SWMM Model Schematic and Subcatchment Delineation

Imperviousness values and depression storage assumptions were added to the model using the values shown in **Table 6.2**. Aerial photos and previous land cover assessments were used to assign these values. Higher imperviousness values were assigned to areas to the south and to the east of the study area. In addition, depression storage was assumed to be higher for areas with mature trees and vegetation cover (e.g. EXTW).

Table 6.2 Subcatchment Characteristics in the Study Area

SUBWATERSHED	SUBCATCHMENT	AREA (HA)	IMPERVIOUSNESS (%)	DEPRESSION STORAGE (MM) (PERVIOUS)	DEPRESSION STORAGE (MM) (IMPERVIOUS)
Western Creek Subwatershed	EXW*	85.75	20	3	1
	EXTW	18.41	10	5	1
	EXT3	18.39	20	3	1
	EXT2	2.95	50	3	1
	EXT1	14.38	20	3	1
	BRSWM3	15.98	50	3	1
	BRSWM2	6.1	50	3	1
	BRSWM1	10.56	50	3	1
Eastern Creek Subwatershed	EXN*	36.34	20	5	1
	EXTN	23.82	10	5	1

** Location of proposed development*

Infiltration Model

The infiltration model was based on the EPA SWMM Green-Ampt model. According to geotechnical studies and previous field analyses conducted by Aquafor Beech in 2015, the study area consists mostly of loam and silt loam, with an average saturated hydraulic conductivity of 9.5 mm/hr for Western Creek subwatershed, and 5.2 mm/hr for Eastern Creek subwatershed (**Table 6.3**).

Table 6.3 Infiltration Parameters for the Soils Encountered in the Study Area

SUBWATERSHED	SUCTION HEAD (MM)	CONDUCTIVITY (MM/HR)	INITIAL DEFICIT (FRACTION)
Western Creek	133.9	9.5	0.180
Eastern Creek	188.6	5.2	0.159

Hydrologic Model Results

The EPA SWMM model was developed to evaluate the hydrology of the study area for a long term spanning from 1996 to 2013.

The water budget analysis based on climate data input and the EPA SWMM was processed according to the following expression:

Precipitation (P) = Surface Runoff (R) + Infiltration (I) + Evapotranspiration (ET)

With evapotranspiration and infiltration generally referred to as Losses in EPA SWMM platforms.

For the study area, the results were tabulated for all years and average annuals were estimated as follows, in **Table 6.4**.

Table 6.4 Water Budget Analysis Results for the Study Area

WATER BUDGET COMPONENT	VOLUME (MM/YEAR)
Total Precipitation	887
Surface Runoff	120
Evapotranspiration	532
Infiltration	235

The results for average annual infiltration volume (235 mm/year) and surface runoff volume (120 mm/year) agree with previous experience with silt loam and fine sandy loam soils with similar land cover types.

Table 6.4 shows how evapotranspiration and infiltration represent a major part of the annual water budget for the study area. For demonstration purposes, **Figure 6.4** shows how losses (infiltration and evapotranspiration) represented a major part of the water budget in the study area in 2013.

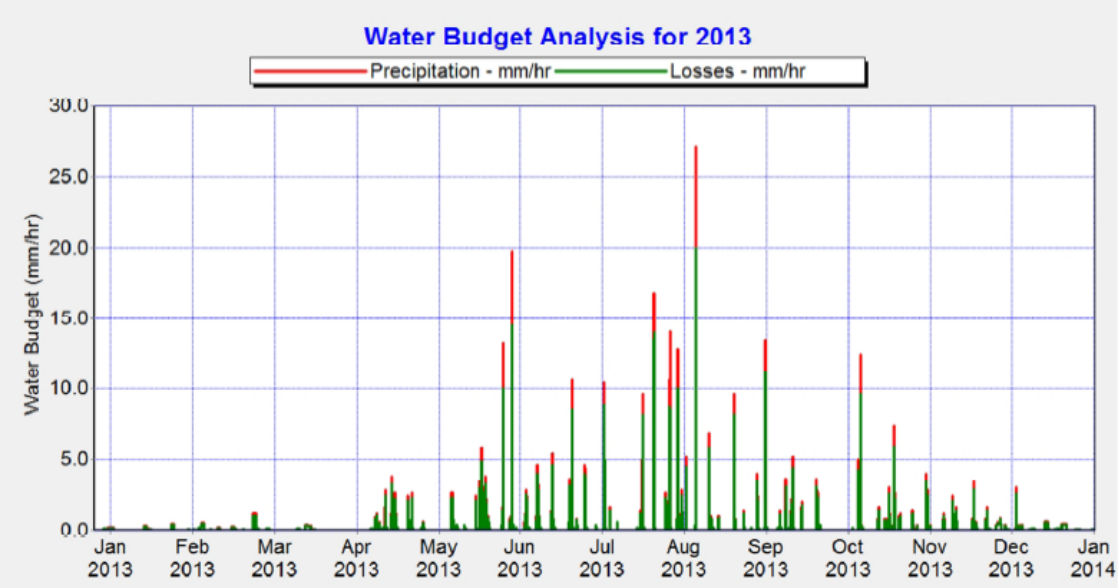


Figure 6.4 Water Budget Analysis Results for the months of 2013

Surface Runoff Regime at Outfalls

The results in **Table 6.5** show annual surface runoff volumes and Mean Annual Flows (MAF) for the two creeks at their respective outfalls (Western Outfall and Eastern Outfall; **Figure 6.3**). Observed baseflow values were added to **Table 6.5** to provide a context for the streamflow regime at the outfalls of both creeks.

Table 6.5 Surface Runoff Volumes and Rates at the Outfalls of Western and Eastern Creeks

SUBWATERSHED	RUNOFF VOLUME/YEAR (X 1000 M^3)	MEAN ANNUAL FLOW (CMS)	MAX ANNUAL FLOW (CMS)	OBSERVED BASEFLOW (L/S) (DST, 2014)
Western Creek	197.6	0.025	5.5	5.3 – 5.4
Eastern Creek	79.2	0.013	4.9	0.4 – 0.8

Figure 6.5 and **Figure 6.6** show the surface runoff hydrographs for Western Creek and Eastern Creek outfalls, respectively.

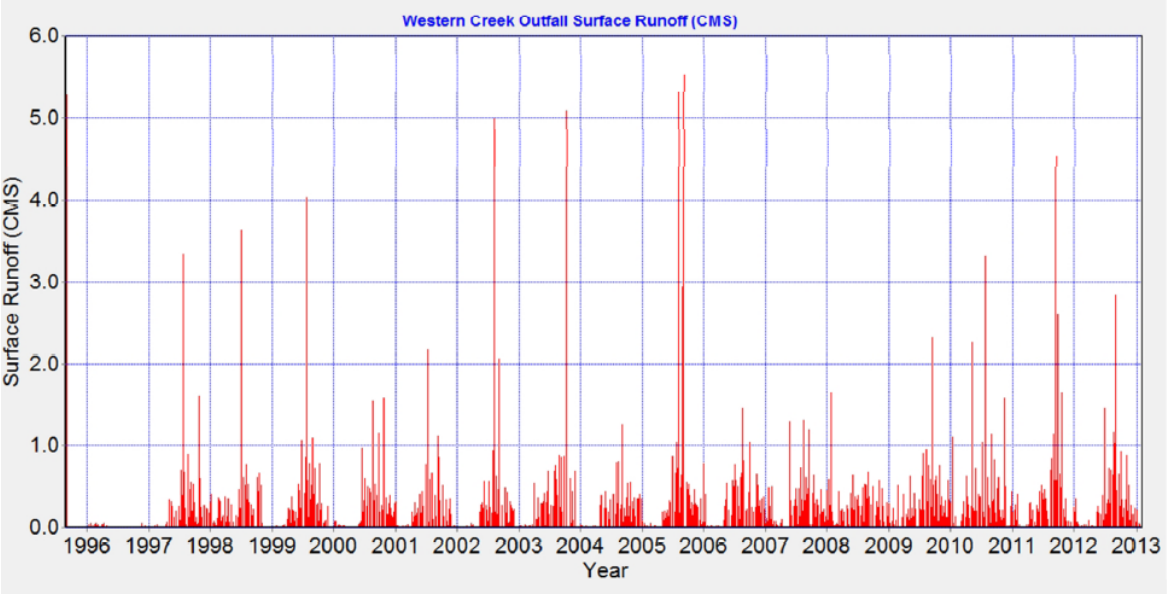


Figure 6.5 Surface Runoff Generated from Western Creek Subwatershed (cms) (1996-2013)

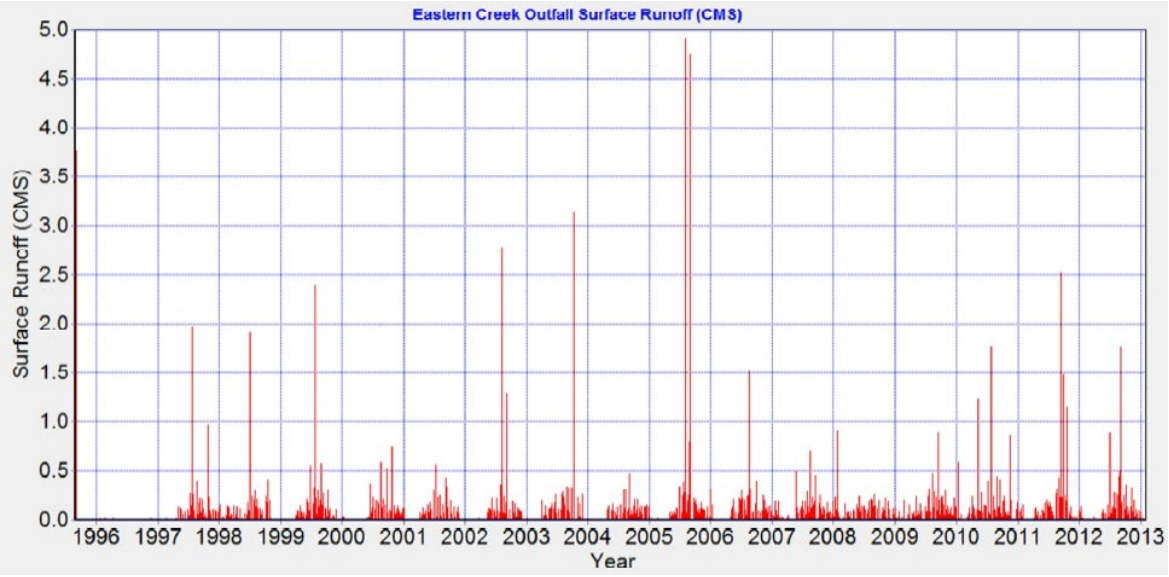


Figure 6.6 Surface Runoff Generated from Eastern Creek Subwatershed (cms) (1996-2013)

6.3.3.6 Storm Events

The following storm events have been simulated:

- 25 mm 4 hour Chicago storm with 12 minute time step (for water quality simulation of the SWM facilities and bankfull flow conditions of the creeks);
- 2, 5 and 100 year 24 hour SCS Type II storms with 12 minute time steps;
- 5 year 3 hour Chicago storm with 10 minute time step (for dual drainage evaluation, specifically minor system capture);

- 100 year 3 hour Chicago storm with 10 minute time step (for dual drainage evaluation, specifically major flow conveyance);
- 100 year 3 hour Chicago storm + 20% increase in intensity with 10 minute time step (applied as a stress test as per Technical Bulletin 2012-4);
- July 1, 1979 historical storm with 5 minute time step (per OSDG);
- August 1988 storm with 5 minute time step (per OSDG); and,
- August 1996 storm with 5 minute time step (per OSDG).

6.3.3.7 Level of Service

The level of service for future development is to be based on the latest City of Ottawa guidelines. The key recommendations of Technical Bulletin 2012-4 are summarized as follows:

- An inlet time of 10 minutes is to be used for all land uses and lot grading configurations. For the sizing of sewer segments (leads) connecting back yard catchbasins to the street sewer the inlet time is 15 minutes.
- In the absence of detail lot configuration and building size and position, the total imperviousness of external future urban areas is to be used for detailed design of infrastructure for the subject phase of development. The imperviousness ratio must be consistent with the runoff coefficient.
- Designs of sewer systems in Greenfield developments are not to be completed on the basis of unit ICD flow rates. ICD flow rates are to be calculated for each drainage area to ensure that the stormwater management (SWM) objectives are satisfied.
- The maximum flow depth on streets under either static or dynamic conditions shall be 300 mm. Flow depth of runoff on street rights-of-way is not to extend onto private property.
- In addition to the use of Historical storms, drainage systems are to be stress tested using design storms calculated on the basis of a 20 % increase of the City's IDF curves rainfall values. Modifications to the drainage system would be required if severe flooding of properties is identified.

6.4 System Concept

The proposed redevelopment of former CFB Rockcliffe will be comprised of low, medium and high density residential, commercial, institutional and park space. As part of the development, the existing combined sewer and storm sewer systems will be eliminated, with installation of new independent storm and sanitary services. The proposed storm system will be designed to provide capacity for the existing external flows that are currently conveyed through former CFB Rockcliffe, including outflows from the northeastern portion of the Montfort Hospital, the Burma Road SWM Facility, and surface flows from the external lands south and east of the site. Further, there is the long term potential for a new museum to be built northwest of the study area.

The conceptual stormwater management system incorporates standard urban drainage design and stormwater management features that can be summarized as follows:

- a dual drainage concept; and,
- two end-of-pipe stormwater management facilities.

The system concept is discussed in the subsequent sections and has been developed based on the reference documentation outlined in **Section 6.3.2**. As discussed in **Section 1.6**, LID techniques are being considered for the site. For the evaluation contained within this report, the

stormwater analysis considers the above-noted standard urban drainage features. The LID features will be evaluated in a parallel process. It should be noted that the system presented in this report is designed with the flexibility to incorporate LID techniques.

It should be noted that as part of the redevelopment of the former CFB Rockcliffe, the Burma Road SWM Facility will be rehabilitated. The facility was designed in the early 1990s as an on-line facility providing water quantity control for the proposed adjacent residential development, as well as a portion of the NRC Campus via a 600 mm diameter CSP culvert just north of the Burma Road cul-de-sac. It is proposed to retrofit the facility to increase the available storage, which will aid in reducing storm sewer sizes in the study area. The outflow from the facility will connect to the new storm sewer system. A new culvert will be installed at the realigned Burma Road and the existing culvert will also be upgraded. Further discussions on Burma Road SWM Facility and culvert capacities are provided in **Section 6.5.4.2.1**.

6.4.1 Dual Drainage Design

Dual drainage design features a combination of on-site detention (surface ponding) with inlet control devices (ICDs) and direct conveyance with no ponding. It accommodates both minor (pipe) and major (surface) stormwater runoff. During frequent storms, the effective runoff collected by catchment areas is directly released via catchbasin inlets into the network of storm sewers, called the minor system. During less frequent storms, the balance of the flow (in excess of the minor flow) is accommodated by a system of rear yard swales and street segments called the major system. The main advantage of this arrangement is its ability to adjust the rate of total inflow into the minor system to satisfy the required level of service. The required total inflow is typically maintained by the restriction of the capacity and the density of the inlets directly connected into this system. As noted, during less frequent storms, the balance of the flow is accommodated by the major system. Typically, this accommodation is achieved by the attenuation on catchment surfaces called on-site detention and/or direct conveyance of the flow to a recipient. For former CFB Rockcliffe, no on-site storage on street segments has been applied to the site.

The dual drainage system was evaluated using the SWMHYMO hydrological model, discussed in **Section 6.5**.

6.4.1.1 Minor System

The minor system storm sewers will be sized based on the rational method, applying standards of both the City of Ottawa and MOE. Some of the key criteria proposed for this site include the following:

- Sewer Sizing: Rational Method
- Design Return Period: 1:5 year (local and collector streets)
  1:10 year (arterial roads)
- Initial Time of Concentration: 10 minutes
- Manning's: 0.013
- Velocity: Minimum 0.80 m/s
  Maximum 3.00 m/s
- Minimum Slope: Refer to below **Table 6.6**

Table 6.6 Minimum Pipe Slopes per OSDG

PIPE DIAMETER (MM)	SLOPE (%)
250	0.432
300	0.340
375	0.250
450	0.195
525	0.160
600	0.132
675	0.113
750 and larger	0.100

With respect to runoff coefficients, this report assumes the values presented in **Table 6.7**.

Table 6.7 Typical Runoff Coefficients

DEVELOPMENT	RESIDENTIAL DEVELOPMENT	RUNOFF COEFFICIENT, C	RUNOFF COEFFICIENT INCREASED BY 25%
Residential	Single Family	0.70	0.87
	Town Houses	0.70-0.80	0.87-1
	High Rise Apartment	0.80	1
Institutional, Commercial and Industrial		0.80	1
Park		0.20	0.25

Where possible, roads are designed to accommodate on-site storage. Inlet control devices (ICDs) will be utilized to control the surcharge in the minor system during infrequent storm events and maximize use of available on-site storage. ICDs will be sized at the detailed design stage.

The recommended minor storm sewer plan is presented on **Figure 6.7** and profiles of the main trunk sewers are presented on **Figure 6.8** (both enclosed in **Appendix E**). The associated storm sewer design spreadsheets are also enclosed in **Appendix E**, along with the corresponding drainage area plan (**Figure 6.9**). All minor storm sewer sizes will be reviewed and confirmed at the time of detailed design.

6.4.2 End-of-Pipe SWM Facilities

To address the water quantity and quality requirements of the redeveloped former CFB Rockcliffe site, it has been concluded that two end-of-pipe SWM facilities will be provided. The locations of the facilities are indicated on **Figure 1.3**. Minor and major flow from the majority of the study area will be conveyed to the facilities for treatment, prior to being released to the Ottawa River.

With respect to water quality, the facilities will be designed to provide an Enhanced Level of Protection. According to the MOE Stormwater Management Planning and Design Manual (March 2003), treatment volume is a function of drainage area, type of pond, urban imperviousness ratio, and Level of Protection. The Enhanced Level of Protection corresponds to end-of-pipe storage volumes required for the long-term average removal of 80% of total suspended solids. The storage requirements are based on the MOE Manual and those provided are summarized in the following **Table 6.8**. Supporting calculations are provided in **Appendix E**. It should be noted that in addition to the Rockcliffe development, the Eastern SWM Facility provides water quality treatment for the lands tributary to the Burma Road SWM Facility (a water quantity facility only) and for the future museum site. The Western SWM Facility provides water quality treatment for the portion of the Montfort Hospital site tributary to the Montfort SWM Facility (a water quantity facility only).

Table 6.8 Water Quality Volumes

SWM FACILITY	LEVEL OF PROTECTION	URBAN DRAINAGE AREA, TYPE OF FACILITY, % IMP	PERMANENT STORAGE (HA-M)		EXTENDED STORAGE (HA-M)		TOTAL STORAGE (HA-M)	
			Req.	Prov.	Req.	Prov.	Req.	Prov.
Eastern	Enhanced	160.58 Wet Pond 63%	2.72	3.59	0.64	1.81	3.36	5.40
Western	Enhanced	44.80 Wet Pond 35%	0.45	1.90	0.18	0.44	0.63	2.34

The proposed Eastern SWM Facility is comprised of 3.59 ha-m of permanent storage and 1.81 ha-m of extended storage based on a 25 mm storm event, exceeding the MOE requirements. The proposed Western SWM Facility is comprised of 1.90 ha-m of permanent storage and 0.44 ha-m of extended storage based on the 25 mm storm event, exceeding the MOE requirements. The area tributary to Eastern and Western SWM Facilities for water quality treatment are indicated on **Figure 6.10**. Relevant calculations are presented in **Appendix E**.

It should be noted that runoff from the Special Design Area (Block 44, refer to **Figure 1.3**) is to be provided with its own stormwater management (for example, potentially an oil-grit separator), outletting to the Eastern Creek. The conceptual location of the on-site water quality treatment system is indicated on **Figure 6.10**. The details of the preferred stormwater management approach for this area will be determined in the future during the Phase 3 design which is presently estimated to be in 2024. The use of LID elements will also be considered for this area.

Similar to the Special Design Area, runoff from the small area west of the Western SWM Facility (**Figure 6.10**) is to be provided with its own stormwater management system (for example, potentially a vortechs system) outletting to Western Creek. The conceptual location of the on-site water quality treatment system is shown in **Figure 6.10**. Details will be provided in the future during the Phase 2 Design.

6.5 Hydrological Evaluation

A SWMHYMO model has been developed to represent former CFB Rockcliffe, as well as the external drainage areas. The SWMHYMO model technique offers single storm event flow generation and routing.

Simulations have been completed for both existing and post-development conditions, each discussed in the following sections.

6.5.1 Existing Conditions Evaluation

Land use, selected modeling routines, and input parameters applied to the existing conditions simulation are discussed below. A drainage area plan is provided on **Figure 2.17**. The corresponding SWMHYMO schematic is provided on **Figure 6.11** (enclosed in **Appendix** E). Model files are also located in **Appendix E**.

6.5.1.1 Land Use

An aerial photograph of the study area is presented in **Figure 1.1**. The official closure of former CFB Rockcliffe was in 2009, and since that time all of the buildings and houses on the site have been demolished. The road network and residential driveways are still in place. Otherwise the majority of the site has grass cover, with individual trees and some tree groupings.

As noted in **Section 1.3**, areas external to the study area are being considered. Specifically related to existing stormwater conditions, the following are relevant: East of the study area, the NRC Campus is a mix of low-density low- and medium-rise buildings. The existing Thorncliffe Village, Foxview and Fairhaven residential developments are located south of the study area. Thorncliffe and Foxview are considered medium density, while Fairhaven is a low-density rural estates development. The Montfort Hospital campus, situated south of the study area, is comprised of medium-rise buildings and surface parking, north of which are the Montfort Hospital Woods, considered an Urban Natural Area. The NCC lands located between the study area and the Rockcliffe Parkway are undeveloped, with a combination of grass and shrub and tree cover.

6.5.1.2 Drainage Area Parameters

The main hydrology parameters are summarized below and in **Table 6.10** and **Table 6.11**.

Area: Catchment areas are based on review of the topography of the site and external areas. Please refer to **Figure 2.17** for delineation of the drainage boundaries.

Infiltration: A composite CN value was applied to the developed portion of former CFB Rockcliffe. Based on review of the available topographic mapping and aerial photography for the subject site, the area was conservatively estimated to contain 25% impervious surfaces. This impervious area was assigned a CN value of 99, and used to calculate a composite CN value for the area. A summary of the calculations are provided in the following **Table 6.9** for reference.

Table 6.9 Composite CN Value

AREA ID	TOTAL AREA (HA)	IMPERVIOUS AREA		PERVIOUS AREA		COMPOSITE CN
		AREA (HA)	CN	AREA (ha)	CN	
EXW	86.06	21.52	99	64.54	78	83
EXE	36.34	9.09	99	27.25	76	82

Initial Abstraction (Depression Storage): Depression storage depths of 0.8 mm and 1.5 mm were used for impervious and pervious areas, respectively. These values are more conservative than those in the OSDG.

Manning's roughness: Manning's roughness coefficients of 0.013 and 0.25 were used for impervious and pervious areas, respectively.

Design Storms: The 2, 5, and 100 year 24 hour SCS Type II design storm events were used in the evaluation of the site.

Table 6.10 Existing Conditions Hydrological Parameters – Study Area

AREA ID	AREA (HA)	CN	TIME TO PEAK (H)
EXW	86.06	83	0.80
EXE	36.34	82	0.13

Table 6.11 Existing Conditions Hydrological Parameters – External Areas

AREA ID	DESCRIPTION	AREA (HA)	CN	IMP (%)		LENGTH, LGI (M)	TIME TO PEAK (H)
				TOTAL	DIRECTLY		
EXT1	Residential	2.95	N/A	61	61	140	N/A
EXT2	Open space, rural estate	6.18	80	N/A	N/A	N/A	0.16
EXT3	Open space, rural estate	8.12	80	N/A	N/A	N/A	0.66
BRSWM1	Residential	11.08	N/A	71	71	261	N/A

AREA ID	DESCRIPTION	AREA (HA)	CN	IMP (%)		LENGTH, LGI (M)	TIME TO PEAK (H)
				TOTAL	DIRECTLY		
BRSWM2	Residential	7.30	N/A	65	65	260	N/A
BRSWM3	Residential	17.40	N/A	71	71	508	N/A
EXT-NRC	NRC Campus	18.39	N/A	71	71	450	N/A
EXTW	Vacant	17.52	72	N/A	N/A	N/A	0.22
EXTE	Vacant	24.68	71	N/A	N/A	N/A	0.41
EXM	Montfort Hospital	2.02	N/A	31	31	114	N/A

6.5.2 Existing Conditions Results

Results of the SWMHYMO computer simulation are summarized in the below **Table 6.12**.

Table 6.12 Summary of Existing Conditions Results

DESIGN STORM	PEAK FLOW TO EASTERN OUTLET (CMS)	PEAK FLOW TO WESTERN OUTLET (CMS)
2 year 24 hour SCS Type II	2.60	3.71
5 year 24 hour SCS Type II	3.89	5.51
100 year 24 hour SCS Type II	8.06	11.13

The above results and **Section 6.3.3.1** indicate that both culverts will theoretically overflow under existing conditions.

6.5.3 Post-development Conditions Evaluation

Land use, selected modeling routines, and input parameters applied to the post-development conditions simulation are discussed below. A drainage area plan is provided on **Figure 6.13** (indicating minor system network) and on **Figure 6.14** (indicating major flow routing). The conceptual end-of-pipe SWM facilities have been included in the SWMHYMO simulation. The corresponding SWMHYMO schematic is provided on **Figure 6.12** (enclosed in **Appendix E**).

6.5.3.1 Land Use

The study area will be developed as a mixed-use community featuring residential (low- and mid-rise), retail, mixed-use, and employment land use, as well as school sites, parks, and natural areas. Further, there is the long term potential for a new museum to be built northwest of the study area.

6.5.3.2 Drainage Area Parameters

The main hydrology parameters are summarized below and in **Table 6.13** and **Table 6.14**.

Area: The various phases of development have been divided into semi-lumped areas based on the minor and major system networks. With respect to external rural areas, the delineation is based on servicing and topography. Refer to **Figure 6.13** and **Figure 6.14**. *The drainage area delineation on **Figure 6.13** has been updated to reflect the Phase 2B detailed design, namely that the minor system runoff from Tawadina Road now drains southward to Hemlock Road storm sewers.*

Imperviousness: In general, total and directly connected imperviousness ratios based on typical runoff coefficients have been applied. The runoff coefficients have been used in similar, recent developments in Ottawa.

Time to Peak: Time to peak for the rural areas was established using the Uplands Method, which accounts for elevation, distance and land use within the drainage area to estimate velocity of runoff. The time of concentration (Tc) is then calculated based on velocity, from which time to peak

is determined applying the formula 0.6Tc (based on the SWMHYMO User's Manual). It is the time to peak that is applied in the model.

Minor system capture:

- **Internal** The minor system capture applied across the study area is based on the 5 year simulated flow, specifically the 5 year 3 hour Chicago storm event. Major system analysis indicated that the inflow rates at two drainage areas (PH1A and PH3G, refer to **Figure 6.13**) required increasing to confine the maximum ponding in street segments to 0.3 m. Minor system inflow rates are summarized in **Table 6.13**.

  For those catchment areas where total flow is captured, flow values are representative of the 100 year 3 hour Chicago storm event.

- **External**
  - Total flow from the NRC Campus (Area EXTNRC, refer to **Figure 6.13**) will be conveyed to the Burma Road SWM Facility through a temparary swale as part of Phase 1A. The proposed swale will be constructed on CLC property.
  - Total flow from the majority of Thorncliffe Village (Area BRM2, refer to **Figure 6.13**) and minor flow from the remainder of the development (Area EXT9, refer to **Figure 6.13**) is conveyed to the facility via the existing storm sewer. The minor system inflow rate for Area EXT9 is based on the 5 year 3 hour Chicago storm event.
  - As noted in **Section 2.4.3**, major system flow from the Foxview community (Area EXT1, refer to **Figure 6.13**) is tributary to the Rockcliffe development. The minor system inflow rate for Area EXT1 is based on the 5 year 3 hour Chicago storm event.
  - Total flow from the Fairhaven community (Area EXT2, refer to **Figure 6.13**) is directed to the proposed Southwest Channel as part of Phase 1A.
  - Outflow from the existing Montfort Hospital SWM Facility, major flow from the northeastern portion of the hospital site (Area EXM, refer to **Figure 6.13**), and total flow from the Montfort Hospital Woods (Area EXT4, refer to **Figure 6.13**) is directed to the proposed Southwest Channel as part of Phase 2.
  - Total flow from part of the Rockcliffe Airport/Aviation Museum Area (Area ROCAIR, refer to **Figure 6.13**) and total tributary flow from the small area close to the Pump Station, north of the Eastern SWM facility (Area PUMST, refer to **Figure 6.13**) is proposed to be conveyed to the Ottawa River via a new outlet storm sewer as part of the Phase 1A.
  - Water quality treatment of runoff from the future museum site (Area EXT7, refer to **Figure 6.13**) has been accounted for in the Eastern SWM Facility. The proposed pipe servicing the site is discussed in **Section 6.5.4.3**. Minor system inflow rates are summarized in **Table 6.13**. For those catchment areas where total flow is captured, flow values are representative of the 100 year 3 hour Chicago storm event.

Surface storage and major flow routing:

- As noted in **Section 6.4.1**, no on-site storage on street segments was applied.
- Major flow from the western part of the site is directed to the Western SWM Facility (refer to **Figure 6.14**).
- Several major flow storage and routing features are provided across the site and are summarized below. The features aid in reducing surface flow to meet City of Ottawa criteria and reduce pipe sizes within the development.

- The retrofitted Burma Road SWM Facility, a dry pond, provides water quantity control for approximately 50 ha of development. Total tributary flow from the NRC Campus east of Burma Road will be conveyed via the new culvert at the realigned Burma Road to the facility. Runoff from the realigned Burma Road north of Montreal Road will also be conveyed to the facility. Total flow from the majority of Thorncliffe Village (Area BRM2) and minor flow from the remainder of the development (Area EXT9) will be conveyed to the facility via the existing storm sewer.
- Three dry ponds are proposed across the site. Major flow from portions of the study area will be directed to the dry ponds for attenuation prior to release. The potential infiltration component of these ponds will be evaluated as part of the parallel LID work; as part of the MSS, however, the storage volume designated for both of the ponds is for major system storage only. The functional design for the major system storage provides flexibility in terms of the potential future use for LID techniques.

  A dry pond is proposed in the park block identified as Block 38 in the concept plan (refer to **Figure 1.3**). Two other dry ponds are proposed, referred to as the eastern and central dry ponds.
- There is a channel proposed around the south and west of the study area, henceforth referred to as the Southwest Channel. It will extend west from Codd's Road, between the redevelopment and the Montfort Hospital Woods, from where it will extend north prior to releasing to the Western SWM Facility (refer to **Figure 6.14**). Major flow runoff from a portion of the study area will be directed to the channel, as will runoff from Fairhaven, the Montfort Hospital Woods, outflow from the Montfort Hospital SWM Facility, and major flow from the northeastern portion of the hospital site. The infiltration potential for this channel will be evaluated as part of the parallel LID work; as part of the MSS, however, the storage volume designated for the pond is for major system storage only. The functional design for the major system storage provides flexibility in terms of the potential future use for LID techniques. Development setbacks are not recommended for this drainage feature.
- NRC Runoff presently drains westward across the subject site especially over the employment block 56 (refer to **Figure 1.3**). A swale is proposed along the eastern and southern edge of block 56 to capture and convey NRC surface runoff and direct it to the improved Burma Pond during Phase 2 construction (refer to **Figure 6.14**). The existing ditch will be modified if and as needed to accommodate the NRC runoff.

- Conceptual major flow routing is presented on **Figure 6.14**. The Macro Grading Plan is provided on **Figure 6.15** which is included in **Appendix E**.

Infiltration: Infiltration losses were selected to be consistent with OSDG. Specifically, Horton's values applied are f_0 = 76.2 mm, f_c = 13.2 mm/h and k = 0.00115 s^{-1}. For simulation of undeveloped or low density areas, the SCS methodology was applied. CN values ranging between 71 and 80 were applied, based on available soils information.

Length: The impervious length applied is based on an average measured length through the catchment and the calculated length based on the SWMHYMO User's Manual. The pervious length is based on average lot depth. This approach is consistent with OSDG.

Initial Abstraction (Depression Storage): Depression storage depths of 0.8 mm and 1.5 mm were used for impervious and pervious areas, respectively. These values are more conservative than those in the OSDG.

Manning's roughness: Manning's roughness coefficients of 0.013 and 0.25 were used for impervious and pervious areas, respectively.

Slope: A slope of 0.5% was used for impervious surfaces and a slope of 2% was used for pervious areas (lot grading).

Table 6.13 Post-Development Conditions Hydrological Parameters – Study Area

OUTLET	AREA ID	AREA (HA)	IMP (%)		TIME TO PEAK (H)	CN	LGI (M)	MINOR SYSTEM CAPTURE	
			TOTAL	DIRECTLY				UNIT (L/S/HA)	TOTAL (L/S)
Eastern SWM Facility	PH3B	3.11	N/A	N/A	0.20	76	N/A	N/A	364*
	PH3D	5.07	81	81	N/A	N/A	262	194	985
	PH3E	0.44	79	79	N/A	N/A	207	198	87
	PH3F	4.36	79	79	N/A	N/A	235	197	858
	PH3G	8.21	83	83	N/A	N/A	279	196	1610
	PH3H	6.92	80	80	N/A	N/A	278	190	1317
	PH3I	2.38	86	86	N/A	N/A	203	216	515
	PH3J	5.23	64	64	N/A	N/A	243	N/A	1778*
	PH2A	1.93	86	86	N/A	N/A	139	232	447
	PH2B	2.50	86	86	N/A	N/A	238	211	527
	PH2C	2.53	N/A	N/A	0.32	76	N/A	N/A	221*
	PH2D	1.14	N/A	N/A	0.06	76	N/A	N/A	246*
	PH2J	5.14	N/A	N/A	0.1	76	N/A	N/A	882*
	PH2L	0.49	86	86	N/A	N/A	49	253	124
	PH1A	16.91	81	81	N/A	N/A	618	156	2645
	PH1B	5.81	74	74	N/A	N/A	293	177	1031
	PH1C	6.10	N/A	N/A	0.36	76	N/A	N/A	493*
	PH1D	1.15	N/A	N/A	0.2	76	N/A	N/A	135*
	PH1E	3.53	86	86	N/A	N/A	216	214	756
	PH1F	8.53	69	69	N/A	N/A	257	172	1469
Eastern Creek via Rockcliffe Parkway Culvert	PH3A	6.68	73	73	N/A	N/A	247	152	1017
Western SWM Facility	PH2E	16.10	70	70	N/A	N/A	361	160	2583
	PH2F	1.09	86	86	N/A	N/A	99	243	265
	PH2G	1.77	86	86	N/A	N/A	124	234	415
	PH2H (Pond Block)	4.52	N/A	N/A	0.15	95	N/A	N/A	1240*
	PH2K	1.57	81	81	N/A	N/A	176	224	351
Western Creek via Aviation Parkway Culvert	PH2I	0.81	86	86	N/A	N/A	132	N/A	352*

** Total flow capture during the 100 year 3 hour Chicago storm event.*

Table 6.14 Post-Development Conditions Hydrological Parameters – External Areas

OUTLET	LOCATION, AREA ID		AREA (HA)	IMP (%)		TIME TO PEAK (H)	CN	LGI	MINOR SYSTEM CAPTURE	
				TOTAL	DIRECTLY				UNIT (L/S/HA)	TOTAL (L/S)
Eastern SWM Facility	Undeveloped, includes Eastern SWM Facility	EXT E1	8.82	N/A	N/A	0.15	95	N/A	N/A	2338**
	Foxview	EXT1	1.52	71	71	N/A	N/A	110	N/A	*Major flow only*
	Museum	EXT7	11.33	86	86	N/A	N/A	342	194	2200
Eastern SWM Facility via Burma*	NRC Campus	EXT-NRC	18.39	71	71	N/A	N/A	450	N/A	5703†
	Thorncliffe Village	BRM1	18.65	71	71	N/A	N/A	541	N/A	5618†
		BRM2	7.04	71	71	N/A	N/A	N/A	N/A	2532†
		BRM SWF	1.47	N/A	N/A	0.15	95	N/A	N/A	374**
		EXT9	7.04	71	71	N/A	N/A	125	62	435
Eastern Creek via Rockcliffe Parkway Culvert	Undeveloped	EXT E2	15.13	N/A	N/A	1.44	71	N/A	N/A	614**
Ottawa River via a New Storm Sewer	Airport/ Museum	ROC AIR	17.74	86	86	N/A	N/A	660	N/A	5.55†
	Undeveloped	PUM ST	0.8	N/A	N/A	0.08	71	N/A	N/A	0.13†
Western SWM Facility via Southwest Channel	Fairhaven	EXT2	6.17	N/A	N/A	0.16	80	N/A	N/A	934†
		EXT3	2.25	N/A	N/A	0.39	80	N/A	N/A	196†
	Southwest Channel, Montfort Hospital and Woods	EXT4	7.84	N/A	N/A	0.66	80	N/A	N/A	470†
		EXT5	1.46	N/A	N/A	0.24	80	N/A	N/A	175†
		EXM	2.02	31	31	N/A	N/A	114	N/A	569**€
Western Creek via Aviation Parkway Culvert	Undeveloped	EXT W	10.59	N/A	N/A	0.19	72	N/A	N/A	1120†

** Water quantity control only is provided by Burma Road SWM Facility; water quality control is provided in the Eastern SWM Facility*
*** Total flow generated by catchment during the 100 year 3 hour Chicago event*
† Total flow capture during the 100 year 3 hour Chicago event
€ Water quantity control only is provided by Montfort Hospital SWM Facility; water quality control is provided in the Western SWM Facility

6.5.4 Post-Development Conditions Results

6.5.4.1 Major Flow Routing on Street Segments

The maximum overland flow on streets has been reviewed at critical downstream locations and is summarized in **Table 6.15**

Table 6.15. The overland flow was evaluated based on proposed grades. Using the channel routing routine in SWMHYMO, maximum normal depth and velocity of flow have been quantified

and results are presented below for the 100 year 3 hour Chicago storm event, which is commonly used to evaluate the urban component of dual drainage. Major flow outlets locations at which flow was evaluated are indicated on **Figure 6.14**. Flow location IDs are also summarized in **Table 6.15**. Model files and supporting calculations are enclosed in **Appendix E**.

It should be noted that non-standard cross-sections are proposed for major roads across the site, and were accounted for in the major system analysis. However, the analysis considered two exceptions where street sawtoothing is expected (identified as flow locations 3 and 5). For these two locations, standard road cross-sections were applied to simplify the analysis.

Table 6.15 Summary of Major Flow at Critical Downstream Street Segments (SWMHYMO file 32952VXD.out)

FLOW LOCATION	STREET SEGMENT LOCATION: *DRAINAGE AREA ID (MH LOCATION, REFER TO FIGURE 6.7, APPENDIX E)*	MAX. CUMULATIVE FLOW (CMS)	DEPTH (M)	VELOCITY (M/S)	D X V (M^2/S)
100 year 3 hour Chicago Storm					
1	PH3H (MH 323 to 320)	1.24	0.15	1.75	0.26
2	PH1A (MH 163 to 130)	0.81	0.15	1.06	0.16
3	PH1A (MH 130 to 115)	1.29	0.23	1.29	0.30
4	PH1A (MH 125 to 130)	1.30	0.20	1.07	0.21
5	PH3G (MH 155 to 150)	0.50	0.17	0.73	0.12
6	PH2E (MH 230 to 235)	0.67	0.15	0.88	0.13
7	PH1F (MH 183 to 185)	0.89	0.13	1.59	0.21
8	PH1F (MH 190 to 185)	0.60	0.12	1.25	0.15
9	PH2E (MH 251 to 250)	2.29	0.20	1.63	0.33
10	PH2E (MH 250 to 271)	3.95	0.23	2.46	0.56

At all locations, the depth of ponding is less than the City guideline of 0.3 m. Further, the depth by velocity does not exceed the City guideline of 0.6 m^2/s.

6.5.4.2 Surface Storage and Major Flow Routing Features

As noted in **Section 6.5.3**, major flow from across the site is routed to various major system features. Each feature is listed in the below **Table 6.16**, with a summary of total flow contributing to the feature during the 100 year 3 hour Chicago storm event. The features are discussed in greater detail below.

Table 6.16 Summary of Flow to Major Flow Features (SWMHYMO file 32952PD.out)

MAJOR SYSTEM OUTLET	FLOW (CMS)	CONTRIBUTING DRAINAGE AREAS (LOCATION, AREA ID)	
Burma Road SWM Facility	14.9	NRC Campus	EXT-NRC
		Thorncliffe Village	BRM1
			BRMSWF
			BRM2
		Study Area	PH3J
Park Dry Pond	4.2	Thorncliffe Village	EXT9
			EXT1
		Study Area	PH3F
			PH1A
			PH3G
			PH1B
			PH1C
Eastern Dry Pond	2.5	Study Area	PH3D
			PH3E
			PH3B
			PH3H

MAJOR SYSTEM OUTLET	FLOW (CMS)	CONTRIBUTING DRAINAGE AREAS (LOCATION, AREA ID)	
Central Dry Pond	0.5	Study Area	PH2A
			PH2C
Southwest Channel	1.9	Fairhaven	EXT2
			EXT3
			EXT4
		Montfort	EXT5
			EXM
			PH1F
			PH2F
			PH2G

6.5.4.2.1 Retrofitted Burma Road SWM Facility

The Burma Road SWM Facility is located at the northern boundary of Thorncliffe Village, west of Burma Road. It is recommended that the existing facility be expanded to provide water quantity control for approximately 50 ha of development to reduce pipe sizes in the study area. The retrofitted facility will remain a dry pond. The retrofit will involve a new culvert crossing the realigned Burma Road, the addition of an upstream cell, upgrading the existing culvert crossing just north of the existing Burma Road cul-de-sac, expansion of the existing linear facility, and a new outlet structure.

Total tributary flow from the NRC Campus east of Burma Road will be conveyed via the new culvert at the realigned Burma Road to the facility. Runoff from the realigned Burma Road north of Montreal Road will be conveyed to the facility. Total flow from the majority of Thorncliffe Village (Area BRM2) and minor flow from the remainder of the development (Area EXT9) will be conveyed to the facility via existing storm sewers. There are no proposed changes to the minor or major connectivity from Thorncliffe Village to the SWM facility.

The conceptual plan and cross-section of the Burma Road SWM Facility are presented on **Figure 6.17** and **Figure 6.18**. As noted above, it is proposed that a new culvert be installed across the realigned Burma Road to convey flow from the east to the upstream cell of the facility. The new culvert is proposed to be a 900 mm x 3000 mm rectangular box with 2% longitudinal slope. The invert of the culvert is proposed to be set at 89.50m, corresponding to the bottom of the existing ditch upstream of the culvert. The existing culvert crossing just north of the existing Burma Road cul-de-sac will be upgraded to convey flow to the downstream cell of the facility. The upgraded culvert is proposed to be a 1500 mm x 3600 mm box with 1% longitudinal slope. The invert of the culvert is proposed to be set at 88.43m (refer to **Figure 6.17** and **Figure 6.18**).

Each cell is proposed to be provided with a low flow channel at approximately 0.15% longitudinal slope. Above the elevation of the low flow channel, the cell can be designed with a 1% cross-slope. The side slopes of the facility are proposed to be 3H:1V, tying into existing ground on the south and the proposed development to the north. The outlet control structure, located at the western-most point of the facility, will convey flow via a new 30 m – 1500 mm diameter storm sewer to the future storm sewer to be located in the adjacent street.

The elevation of the outlet storm sewer corresponds to the invert of the facility at the downstream end (87.65 m), resulting in there being no permanent pool in the facility. The outflow from the facility is restricted to 8.15 cms. During the 100 year storm event, the water level will reach 89.90 m, matching the 100 year water level of the existing facility and to an average depth of 1.80 m. The total expected volume to be utilized is 1.00 ha-m.

6.5.4.2.2 Dry Ponds

As noted in **Section 6.5.3.2**, three dry ponds are proposed across the study area. Major flow from across a portion of the study area will be routed to one of those three ponds for attenuation prior

to release. As previously noted, the infiltration component of these ponds will be evaluated as part of the parallel LID work; as part of the MSS, however, the storage volume designated for three ponds is for major system storage only. The functional design provides flexibility in terms of the potential future use for LID techniques.

One dry pond is proposed in the park Block 38 (refer to **Figure 1.3**). Total flow from Foxview (Area EXT1), major flow from a portion of Thorncliffe Village (Area EXT9), and major flow from the southeast of the study area will be conveyed overland to the park dry pond for attenuation, prior to being released to the minor system. The areas contributing major flow to the park dry pond are indicated on **Figure 6.14**.

The conceptual plan and cross-section of the park dry pond are presented on **Figure 6.19** and **Figure 6.20**. The facility is divided into three cells, separated by berms which will be fitted with culverts designed to maintain a maximum water depth in each cell of about 0.60 m. The berms have been incorporated into the design to allow for pedestrian access to the rest of the park south of the dry pond. The three cells are designed with flat bottoms, ranging from 88.5 m at the upstream, 87.7 m at the intermediate cell, and 87.5 m at the downstream cell. This will provide flexibility at the detailed design stage, should the dry pond also be used for infiltration purposes. Otherwise, a longitudinal slope can be introduced across each of the cells. Details on how the conveying system functions, such as the connecting culverts capacity and relationship of water levels in these three cells will be provided during the detailed design stage.

On the north, the side slopes of the facility are proposed at 3H:1V. On the south, a 0.7 m armour stone wall is proposed. As with any proposed wall terracing can also be substituted. The outlet control structure, located at the western-most point of the facility, will convey flow to the storm sewer located in the adjacent street. The elevation of the outlet control structure corresponds to the invert of the facility (87.5 m), resulting in there being no permanent pool in the facility. Outflow from the facility is restricted to 160 l/s. During the 100 year storm event, it is anticipated the average depth of ponding will be 0.6 m. The total volume utilized is 3,000 cu-m.

In addition to the park dry pond on Block 38, two additional dry ponds are proposed, and there are referred to as the eastern and central dry ponds (indicated on **Figure 6.14**).

The eastern dry pond is located in the northeast of the site. The bottom of the pond is proposed to be flat, with an invert of about 85.5 m. The side slopes of the pond are proposed to be 3H:1V. The outlet control structure, located at the western-most point of the pond, could convey flow to the storm sewer located in the adjacent street. The elevation of the outlet control structure is suggested to be set at 85.3 m, slightly below the invert of the pond, resulting in there being no permanent pool in the pond. Outflow from the facility is restricted to 147 l/s. During the 100 year storm event, it is estimated the water level will reach 86.1 m, corresponding to an average depth of 0.6 m. The total expected volume to be utilized is 1610 cu-m. The conceptual plan and cross-section of the pond are presented on **Figure 6.21** and **Figure 6.22**.

The central dry pond is proposed to be located in the future part Block 26 (refer to **Figure 1.3**). The bottom of the pond is proposed to be flat, with an invert of 82.3 m. The side slopes of the pond are proposed to be 3H:1V. Outflow from the pond will be conveyed from the western-most point of the pond by either pipe or swale. The outflow will be conveyed to the Eastern SWM Facility. The elevation of the outlet corresponds to the invert of the pond (82.3 m), resulting in there being no permanent pool in the pond. Outflow from the pond is restricted to 98 l/s. During the 100 year storm event, it is estimated the water level will reach 82.5 m, corresponding to an average depth of 0.3 m. The expected total volume to be utilized is 560 cu-m. The conceptual plan and cross-section of the dry pond are presented on **Figure 6.23** and **Figure 6.24**.

It should be noted that the performance of the proposed three dry pond features will be evaluated after these facilities have been in service. These features are the subject of the parallel report

"Former CFB Rockcliffe LID Stormwater (SWM) Pilot Project Study" by Aquafor Beech. It is possible these ponds may provide some stormwater management "credit" and that "credit" could be quantified and incorporated in future SWM pond designs. However at this time, since any dry pond feature "credit" is unknown, the stormwater management concept for the subject site has been developed as standard SWM facilities, assuming all development areas are tributary to the end-of-pipe facilities.

6.5.4.2.3 Southwest Channel

As noted in **Section 6.5.3**, there is a channel proposed to be constructed around the south and west of the study area. It will extend west from Codd's Road, between the redevelopment and the Montfort Hospital Woods, from which it will extend north prior to discharging to the Western SWM Facility (refer to **Figure 6.14**). Major flow from a portion of the study area will be directed to the channel, as will total flow from Fairhaven and the Montfort Hospital Woods, as well as the outflow from the Montfort Hospital SWM Facility.

The proposed channel will consist of a trapezoidal cross-section with a bottom ranging in width from 1-3 m, and 3H:1V side slopes that tie into existing grades to the south and west and the proposed development to the north and east. The proposed longitudinal slope of the channel ranges from between 0.5 and 1.7%. At its downstream end, the total estimated flow to be conveyed to the channel is 2.9 cms. The estimated depth of flow in the channel during the 100 year event is 0.6 m. Two conceptual cross-sections are indicated on **Figure 6.25**. Capacity calculations for four reaches of the proposed feature are included in **Appendix E**. The channel design will be further refined to encourage infiltration, as part of Aquafor Beech's proposed work plan for the LID pilot project.

6.5.4.2.4 NRC Swale

As noted in **Section 6.5.3,** NRC runoff presently drains westward across the subject site especially over the employment Block 56 (refer to **Figure 1.3**). A swale is proposed along the eastern and southern edge of block 56 to capture and convey NRC surface runoff and direct it to the improved Burma Pond during Phase 2 construction (refer to **Figure 6.14**). The existing ditch will be modified if and as needed to accommodate the NRC runoff.

The proposed swale will include a trapezoidal cross-section with a bottom width of 3 m, and 2.5H:1V side slopes that tie into existing grades to the south and east and the proposed development to the north and west. The average longitudinal slope of the swale will be about 0.65%. The total expected flow to be conveyed to the swale is 5.7 cms. The estimated depth of flow in the channel during the 100 year event is 0.93 m. A capacity calculation for the proposed swale is included in **Appendix E**.

6.5.4.3 Storm Sewer Servicing of Future Museum Site

The Eastern SWM facility will be sized to provide quality treatment of minor storm runoff from the future museum site. The design of the SWM facility will include an inflow pipe element designed for the anticipated museum site. The future design of the museum site will include the minor storm sewer pipe from the site to the pond facility.

6.5.4.4 Channel-pipe Configuration

Treated runoff from the western SWM facility will be routed to the Ottawa River via two conduits. Some flows will be routed to the River through the Western Creek starting at the existing 900 mm diameter culvert under the Aviation Parkway. Flows in excess of the culvert capacity will be routed

eastward through a combination channel and pipe conduit, which will be designed to bypass the Eastern facility and outlet directly to the Ottawa River.

At the upstream end of the Aviation Parkway culvert, a short trapezoidal channel is proposed to convey flow in excess of the Aviation Parkway culvert capacity. The upstream channel invert is proposed to match that of the culvert obvert (61.2 m) thereby ensuring the culvert capacity is not exceeded. The channel bottom width is proposed to be about 3 m with 3H:1V side slopes. The channel is proposed to be about 120 m long and be constructed at an average slope of 0.50% and eventually outlet into a 800 m long 1350 mm diameter pipe.

The 1350 mm diameter pipe will be designed to convey the Western facility excess flow around the Eastern SWM Facility, tying into the 2400 mm diameter Eastern SWM Facility outlet sewer, where it will be released to the Ottawa River (refer to **Section 6.5.4.5.1**).

Minor storm runoff from the future museum site development will connect independently to the Eastern facility. A future inlet to the Eastern SWM Facility will need to be constructed to accommodate the museum site runoff. The potential new inlet structure and forebay are schematically noted as “Potential Sediment Forebay” on **Figure 6.26**.

6.5.4.5 Conceptual Design of End-of-Pipe SWM Facilities

The two end-of-pipe SWM facilities were included in the XPSWMM simulation to confirm design and performance. Each facility is discussed below. As noted in **Section 6.4.2**, at this stage of project, it is assumed that all development area, with the exception of the Special Design Area and the small area west of the Western SWM Facility (Area PH3A and Area PH2I respectively, refer to **Figure 6.13** and **Figure 6.14**), is tributary to one of the two end-of-pipe SWM facilities.

6.5.4.5.1 Eastern SWM Facility

As indicated on **Figure 6.13**, the future trunk storm sewer servicing the eastern portion of the study area is proposed to extend north from the development towards the escarpment bordering the study area. It is proposed that the 3000 mm x 3600 mm trunk storm sewer will terminate at the top of the escarpment and the runoff will cascade to the SWM facility below via a waterfall. At the detailed design stage, additional geotechnical field work will be completed to accurately delineate the rock and waterfall profile. Further, the MSS has built in flexibility in the waterfall location to accommodate species at risk (discussed in **Section 2.3.4**).

As noted in **Section 6.5.4.3**, a future storm sewer north of the museum site, extending east towards the SWM facility will convey the minor storm runoff from the museum to the Eastern SWM Facility for water quality treatment. This second inlet to the SWM facility (refer to **Figure 6.13** and **Figure 6.14**) will be constructed only at the time the museum site is developed.

The conceptual Eastern SWM Facility, designed as a wet pond (refer to **Section 6.4.2**), is comprised of a stilling basin, and a wet cell, with an outlet structure to a new storm sewer to the Ottawa River. At the upstream end of the facility, the stilling basin will provide energy dissipation for the proposed waterfall. Runoff will then flow into the sediment forebay, prior to the downstream wet cell. Outflow from the facility is proposed to discharge via the outlet structure to a new storm sewer which will convey runoff from the pond directly to the Ottawa River.

The presence of birds frequenting the stormwater facility is a concern of the nearby Rockcliffe Airport. Among other features, floating islands can act as a bird deterrent. However, the City has indicated that it does not want to endorse floating islands without additional information. It is therefore recommended that as per the “Thermal Mitigation for End-of-the-Pipe Ponds” section in the May 2015 “Former CFB Rockcliffe Redevelopment – Stormwater Management Existing Conditions and LID Demonstration Project Scoping Document” by Aquafor Beech, that floating islands be considered as a LID initiative.

In addition to floating islands, the pond can also be designed with smaller open water surfaces which is considered less desirable to birds. As a further deterrent to birds, the pond edges can be raised with small retaining walls and/or heavily planted. Birds like to travel from water to land or vice versa without navigating a vertical feature and are also suspicious of vegetation in which predatory animals can seek shelter. Therefore, a combination of smaller water surfaces, pond edge treatment and potentially floating islands are recommended elements to discourage the presence of birds.

A conceptual plan, profile and typical cross section of the facility are presented on **Figure 6.26**, **Figure 6.27**, and **Figure 6.31** respectively**.** The bottom of the facility is proposed to be set at 53.70 m and the permanent water level is 2.3 m higher (elevation 56.00 m) resulting in an estimated permanent volume of 3.59 ha-m. The performance of the conceptual Eastern SWM Facility is summarized in **Table 6.17**.

Water quality was simulated using the 25 mm Chicago storm event. During this storm event, the water quality extended storage is 1.81 ha-m with a depth of 0.88 m. The outflow from the facility during the 25 mm event is 0.97 cms. The outflow hydrograph from the facility is provided in **Appendix E**. The results indicate that during the water quality storm event the outflow would be released over 24 hours, as per MOE requirements.

During the 100 year 24 hour SCS Type II event, considered the design storm for the pond, 4.56 ha-m of active storage is expected to be utilized at an estimated depth of 2 m (elevation 58.00 m). The 12.21 cms outflow from the SWM facility, during the 100 year storm event, will be controlled by a 1300 mm diameter orifice (invert 56.00 m) and 4.80 m weir (elevation 57.00 m, see **Figure 6.27**). During less frequent storm events, flow from the facility will be conveyed through the water quality orifice only. The outflow from the facility will be conveyed to the Ottawa River via a new 2400 mm diameter storm sewer. A preliminary eastern SWM facility outlet pipe profile is provided in **Figure 6.28** (enclosed in **Appendix E**)**.** The existing storm sewers servicing the Area ROCAIR and Area PUMST (refer to **Figure 6.13**) will be tied into the new outlet storm sewer. The total tributary flow from these areas will be conveyed to the Ottawa River through the new 2400 mm diameter storm sewer. In a case where the outlet structure becomes fully blocked and the SWM facility continues to receive inflow, runoff from the eastern SWM facility will discharge into Eastern Creek as shown in **Figure 6.26**. An emergency overflow route from the facility into Eastern Creek is provided via a berm located immediately downstream of the structure (**Figure 6.26**). The berm has been graded conceptually 0.05 m below the rest of the berm, at elevation 58.25 m, for approximately 10 m section of berm. If the water level in the facility rises to 58.25 m, then the water will overtop the berm and discharge into Eastern Creek as shown in **Figure 6.26**.

Total flow from Area EXTE2 and Area PH3A (the Special Design Area) and major flow from Area PH3I (refer to **Figure 6.13** and **Figure 6.14**) are tributary to the Eastern Creek. The areas could generate almost 2.89 cms during the 100 year 3 hour Chicago event (the more critical storm event). This value is less than the maximum capacity calculated for the existing culvert (estimated at 3.5 cms, refer to **Section 6.3.3.1**).

Bankfull flow conditions in the Eastern Creek were simulated using the 25 mm storm event. Statistically, the 25 mm precipitation corresponds to a storm event with approximately a 1:5 year return period. The estimated bankfull flows could range between 0.50 cms and 2.5 cms (DST, September 2013). From a fluvial geomorphology perspective the flow generated by the above-noted drainage areas during the 25 mm storm event is 0.56 cms, which is at the lower end of the bankfull estimates.

It is proposed to provide baseflow augmentation to the Eastern Creek from the Eastern SWM Facility by means of a small diameter pipe. Based on a volumetric calculation, 51,081 cu-m/year is to be conveyed from the pond to the creek (refer to supporting calculations in **Appendix E**). It

is recommended that this be confirmed at the detailed design stage. It should be noted that the required baseflow augmentation will be based on the future analysis of the Eastern Creek.

Table 6.17 Performance of Eastern SWM Facility (XPSWMM output files presented on the CD in Appendix E)

STORM EVENT	EXTENDED STORAGE* (HA-M)	DISCHARGE (CMS)
Permanent Storage	3.59	0
25 mm 4 hour Chicago	1.81	0.97
2 year 24 hour SCS Type II	2.64	2.87
5 year 24 hour SCS Type II	3.22	5.09
100 year 24 hour SCS Type II	4.56	12.21
100 year 24 hour SCS Type II + 20%	5.23	15.49
100 year 3 hour Chicago	4.27	10.19
100 year 3 hour Chicago + 20%	4.84	13.24
July 1, 1979	5.36	16.18
August 1988	4.84	13.24
August 1996	3.99	8.67

**It should be noted that extended storage excludes permanent storage*

6.5.4.5.2 Western SWM Facility

The conceptual Western SWM Facility is located at the northwestern corner of the development, abutting Hemlock Road. As indicated on **Figure 6.13**, the proposed 1500 mm diameter trunk storm sewer to service the western portion of the study area extends west along Hemlock Road, terminating on the north side of the Western SWM Facility. To the south, a 525 mm diameter storm sewer will be installed to service Area PH2G, terminating on the south side of the SWM facility. The Western SWM Facility is proposed to be designed as a wet pond (refer to **Section 6.4.2**), with an outlet discharging to the existing Aviation Parkway culvert. Flows in excess of the culvert capacity will be routed eastward through a channel and pipe conduit, designed to bypass the Eastern facility and outlet directly to the Ottawa River as discussed in **Section 6.5.4.4**. A detailed design/ study of the proposed SWM facilities will be undertaken to support the subdivision approval.

Runoff will flow from the two inlets to sediment forebays, from which flow is conveyed to the main cell of the facility. Downstream of the southern sediment forebay, the Southwest Channel will tie into the main cell of the facility. Similar to the Eastern SWM Facility, the proposed design creates a series of smaller open water surfaces, considered less desirable to birds, possibly augmented with floating islands to further discourage waterfowl. The presence of birds is a concern of the nearby Rockcliffe Airport. The use of floating islands also has the added ability to be reconfigured in the future to further assist in this matter.

A conceptual plan, profile and typical cross section of the facility are presented on **Figure 6.29, Figure 6.30**, and **Figure 6.31** respectively**.** The bottom of the facility is at 68.70 m and the permanent water level is 2.3 m higher (elevation 71 m) resulting in a permanent volume of 1.90 ha-m. The performance of the Western SWM Facility is summarized in **Table 6.18**.

Water quality was simulated with the help of 25 mm Chicago storm event. During this storm event, water quality storage of 0.44 ha-m is utilized resulting in a depth of 0.40 m. The outflow from the facility during the 25 mm event is 0.14 cms. The outflow hydrograph from the facility is presented in **Appendix E**. The results indicate that the water quality storm event is released in greater than 24 hours, satisfying the MOE regulatory requirements.

During the 100 year 24 hour SCS Type II event, considered the design storm for the pond, a 2.06 ha-m extended storage is utilized resulting in an elevation of 72.60 m (1.60 m depth). The outflow from the facility is 0.57 cms. In a case where the outlet structure becomes fully blocked and the

SWM facility continues to receive inflow, runoff from the western SWM facility will overtop Hemlock Road at an elevation of 70.00 m as shown in **Figure 6.29**. An emergency overflow route from the facility into Hemlock Road is provided via a berm located west of the facility (**Figure 6.29**). The berm has been graded conceptually 0.05 m below the rest of the berm, at elevation 72.25 m, for approximately 10 m section of berm as shown in **Figure 6.29**.

Total flow from Area PH2I and Area EXTW (refer to **Figure 6.13** and **Figure 6.14**) and outflow from the Western SWM Facility are tributary to the Aviation Parkway culvert. The areas could generate almost 2.56 cms during the 100 year 24 hour SCS Type II event (the more critical storm event). This value is significantly less than the existing conditions flow from the site to the Aviation Parkway culvert (estimated at 11.13 cms, refer to **Section 6.5.2**).

The outlet structure is proposed to be a 500 mm diameter orifice with an invert of 71.00 m (refer to **Figure 6.30**). From the outlet structure, outflow from the facility will be conveyed to the Hemlock Road culvert, where it will flow overland towards the existing Aviation Parkway culvert. The existing Hemlock Road culvert has significant debris build up limiting its capacity; therefore it is proposed to be upgraded. The upgraded culvert is proposed to be a 900 mm diameter pipe with 0.75 % longitudinal slope. The proposed culvert invert is at 69.00 m to facilitate gravity drawdown of the SWM facility. Downstream of the Hemlock culvert, flow will be conveyed to the Western Creek via the existing Aviation Parkway culvert during frequent storm events. During infrequent storm events, flow in excess of the Aviation Parkway culvert capacity will be conveyed east via the proposed channel-pipe configuration discussed in **Section 6.5.4.4.**

Bankfull flow conditions for the Western Creek were simulated with the 25 mm storm event. Statistically, the 25 mm precipitation corresponds to a storm event with approximately the 1:5 return period. The estimated bankfull flows in the downstream Western Creek could range between 0.70 cms and 1.4 cms (DST, September 2013). From a fluvial geomorphology perspective, outflow through the Aviation Parkway culvert during the 25 mm storm event is 0.30 cms, a rate that corresponds to less than bankfull estimates.

Table 6.18 Performance of Western SWM Facility (XPSWMM output files presented on the CD in Appendix E)

STORM EVENT	EXTENDED STORAGE* (HA-M)	DISCHARGE (CMS)
Permanent Storage	1.91	0
25 mm 4 hour Chicago	0.44	0.14
2 year 24 hour SCS Type II	0.77	0.28
5 year 24 hour SCS Type II	1.07	0.37
100 year 24 hour SCS Type II	2.06	0.57
100 year 24 hour SCS Type II + 20%	2.55	0.64
100 year 3 hour Chicago	1.82	0.53
100 year 3 hour Chicago + 20%	2.33	0.64
July 1, 1979	2.35	0.62
August 1988	1.96	0.56
August 1996	1.76	0.52

**It should be noted that extended storage excludes permanent storage*

6.6 Hydraulic Model

6.6.1 Hydraulic Evaluation

The hydraulic evaluation was completed to confirm the hydraulic grade line (HGL) along the trunk storm sewers through the development. The XPSWMM analysis was used to support the

conceptual design of the Burma Road SWM Facility and the two end-of-pipe SWM facilities. This includes the design of the two culvert crossings along the Burma Road (refer to **Section 6.5.4.2.1**), the design of the Hemlock Road culvert (refer to **Section 6.5.4.5.2**), the functioning of the flow split at the Aviation Parkway, and the channel-pipe configuration discussed in **Section 6.5.4.4.** Details about boundary conditions are discussed in **Section 6.6.1.1**.

Minor system hydrographs generated by SWMHYMO have been imported to XPSWMM. Stage-area curves of the SWM facilities have been entered into the model. Minor system losses were accounted for in accordance with Appendix 6-B of the City of Ottawa Sewer Design Guidelines (November 2004).

Simulations were performed for various storm events to confirm the HGL through the development, the results of which are presented in **Section 6.6.2**. The XPSWMM model schematics are provided on **Figure 6.32** and **Figure 6.33** (enclosed in **Appendix E**). Model files are also provided in **Appendix E.**

6.6.1.1 Boundary Conditions at the Eastern and Western Outlets

Based on the topography, there is no effect from the Ottawa River flood levels on the stormwater management facility. The fixed water level assumed at the boundary condition was based on normal river water level indicated on the topographical mapping.

The boundary condition for the dynamic evaluation of the Western SWM facility was based on the results of the western outlet from XPSWMM evaluation, and the maximum possible water level in the Western Creek downstream of the Aviation culvert. For each storm event modeled, the tailwater boundary condition was created based on the western outlet Outflow vs Time rating curve and the backwater elevation of 60.50 m. This elevation is based on the surveyed road elevation at the culvert crossing just downstream of the Aviation culvert on the Western Creek (refer to **Figure 6.14**). Details regarding the development of the tailwater boundary conditions are presented in **Appendix E**.

6.6.2 Hydraulic Grade Line Analysis

Hydraulic grade line elevations throughout the development for the 100 year 3 hour Chicago storm are summarized in the following **Table 6.19**. Hydraulic grade line results for other storm events including the 100 year 3 hour Chicago + 20% increase in intensity, 100 year 24 hour SCS Type II, July 1 1979, August 1988 and August 1996 storms are presented in **Appendix E**.

Tributary to the Eastern SWM Facility, hydraulic grade line analysis has been completed with each subsequent phase of detailed design. The results presented in the below table are reflective of the most recently approved phase, Phase 2B. Underside-of-footing (USF) elevations have been updated to reflect detailed design.

For the storm sewers tributary to the Western SWM Facility, the underside of footing elevations (USF) were assumed to be 2.40 m below future road grades which are referenced on the macro grading plan (**Figure 6.15**).

Table 6.19 Hydraulic Grade Line

XPSWMM NODE ID	MSS MH NO. (REFER TO FIGURE 6.7)	DETAILED DESIGN MH NO. (IF APPLICABLE)	PROPOSED ROAD ELEVATION (M)	USF (M)	100 YEAR 3 HOUR CHICAGO	
					HGL (M)	USF – HGL (M)
Eastern SWM Facility[1]						
ESTSWM[2]	N/A	N/A	N/A	N/A	57.99	N/A
EXSTMH	N/A	194	82.05	N/A	80.48	N/A
MH194	225	195	82.05	N/A	80.44	N/A

XPSWMM NODE ID	MSS MH NO. (REFER TO FIGURE 6.7)	DETAILED DESIGN MH NO. (IF APPLICABLE)	PROPOSED ROAD ELEVATION (M)	USF (M)	100 YEAR 3 HOUR CHICAGO	
					HGL (M)	USF – HGL (M)
MH193	222	193	84.99	82.59	81.09	1.51
MH192	221	192	85.76	83.36	81.41	1.95
MH191	N/A	191	86.36	83.96	81.68	2.29
MH190	N/A	190	86.96	84.56	81.91	2.65
MH180	216	180	88.23	N/A	82.21	N/A
S181	230	181	86.12	N/A	82.37	N/A
S182	N/A	182	85.70	N/A	82.46	N/A
S128	N/A	128	85.68	N/A	82.62	N/A
S127	175	127	85.60	84.36	82.67	1.69
S126	N/A	126	86.38	84.96	82.87	2.09
S125	172	125	86.84	85.34	83.37	1.97
S124	N/A	124	87.46	85.69	83.94	1.75
S106	N/A	106	87.19	85.61	83.76	1.85
S105	195	105	87.30	85.71	83.90	1.81
S103	N/A	103	88.14	86.46	84.36	2.10
S102	194	102	88.28	86.46	84.72	1.74
S101	N/A	101	89.15	87.16	85.55	1.61
S107	N/A	107	87.61	N/A	85.29	N/A
S121	182	121	86.08	84.26	82.80	1.46
S122	N/A	122	86.98	84.86	83.53	1.33
S120	N/A	120	85.82	83.96	82.86	1.10
S116	183	116	85.86	83.71	82.89	0.82
S115	N/A	115	87.30	83.56	83.06	0.50
S114	185	114	85.61	83.91	83.08	0.83
S113	N/A	113	86.40	84.51	83.43	1.08
S112	N/A	112	86.96	84.91	83.41	1.50
S111	N/A	111	87.13	84.96	83.59	1.37
S110	N/A	110	87.19	85.56	83.59	1.97
S118	179	118	86.84	84.71	83.22	1.49
S117	N/A	117	87.12	85.06	83.54	1.52
S109	190	109	86.29	85.36	84.05	1.31
S108	N/A	108	88.76	86.66	85.24	1.43
S100	192	100	89.16	87.16	85.70	1.46
S119	N/A	119	87.51	85.46	83.95	1.51
MH178	211	178	89.00	86.60	83.41	3.19
MH176	155	176	88.03	85.63	83.77	1.86
S142	N/A	142	87.52	85.12	84.02	1.10
S141	150	141	87.32	84.92	84.28	0.64
S140	N/A	140	87.61	N/A	84.35	N/A
S139	N/A	139	87.69	85.66	84.46	1.20
S138	N/A	138	87.55	86.31	84.96	1.35
S137	131	137	88.57	86.91	85.77	1.14
S136	N/A	136	91.24	N/A	87.38	N/A
S135	142	135	94.75	N/A	90.11	N/A
S134	N/A	134	98.18	N/A	93.01	N/A
S133	N/A	133	101.44	N/A	96.52	N/A
S132	N/A	132	104.35	N/A	99.64	N/A
S131	N/A	131	105.30	N/A	101.05	N/A

XPSWMM NODE ID	MSS MH NO. (REFER TO FIGURE 6.7)	DETAILED DESIGN MH NO. (IF APPLICABLE)	PROPOSED ROAD ELEVATION (M)	USF (M)	100 YEAR 3 HOUR CHICAGO	
					HGL (M)	USF – HGL (M)
S130	N/A	130	104.41	N/A	101.25	N/A
S168	N/A	168	87.70	85.30	84.54	0.76
S167	140	167	88.40	86.00	84.71	1.29
S166	135	166	88.90	86.50	84.88	1.62
S165	130	165	89.30	86.90	85.98	0.92
S165B	130	165	89.61	87.21	86.45	0.76
S164	N/A	164	90.22	87.82	87.00	0.82
S163	125	163	90.94	88.54	87.68	0.86
S162	N/A	162	91.34	88.94	88.26	0.68
S161	N/A	161	91.94	89.54	88.57	0.97
S160	N/A	160	92.27	89.87	89.01	0.86
S153	N/A	153	92.78	90.38	89.45	0.93
S222	115	222	89.86	87.46	86.38	1.08
S221	N/A	221	89.88	87.48	86.57	0.91
S220	N/A	220	89.86	87.46	86.74	0.72
S219	N/A	219	90.08	87.68	86.85	0.83
S218	N/A	218	90.40	88.00	87.04	0.96
S217	N/A	217	90.66	88.26	87.13	1.13
S154	N/A	154	91.02	N/A	87.68	N/A
S157	N/A	157	91.24	N/A	89.21	N/A
S148	101	148	92.14	89.74	89.30	0.44
S149	108	149	92.34	89.94	89.42	0.52
S150	N/A	150	92.32	89.92	89.49	0.43
S151	N/A	151	92.50	90.10	89.58	0.52
S152	120	152	92.73	90.33	89.71	0.62
S216	N/A	216	90.85	88.45	87.30	1.15
S215	N/A	215	90.77	88.37	87.58	0.79
S214	N/A	214	93.52	91.12	90.26	0.86
S200	126	200	94.71	92.31	90.73	1.58
S209	N/A	209	88.75	86.35	85.46	0.89
S208	N/A	208	88.77	86.37	85.92	0.45
S211	N/A	211	89.15	86.75	85.94	0.81
S210	N/A	210	89.14	86.74	86.43	0.31
S213	N/A	213	89.74	87.34	86.45	0.89
S212	N/A	212	90.25	87.85	86.86	0.99
MH231	318	231	89.81	87.41	85.81	1.59
MH207	N/A	207	88.53	86.13	84.60	1.53
MH206	165	206	89.10	86.70	85.59	1.11
MH205	164	205	89.35	86.95	85.80	1.15
MH204	163	204	90.40	88.00	87.07	0.93
MH203	161	203	92.38	89.98	88.65	1.33
MH202	160	202	93.91	91.51	90.42	1.09
MH201	N/A	201	94.29	91.89	90.72	1.17
BURMA	N/A	N/A	N/A	N/A	89.41	N/A
S147	N/A	147	93.27	N/A	90.93	N/A
S146	N/A	146	95.28	92.88	90.96	1.92
S145	N/A	145	97.64	95.24	93.01	2.23
S144	N/A	144	99.41	97.01	95.79	1.22

XPSWMM NODE ID	MSS MH NO. (REFER TO FIGURE 6.7)	DETAILED DESIGN MH NO. (IF APPLICABLE)	PROPOSED ROAD ELEVATION (M)	USF (M)	100 YEAR 3 HOUR CHICAGO	
					HGL (M)	USF – HGL (M)
S143	N/A	143	102.40	100.00	98.16	1.84
MH305	N/A	305	91.00	88.80	86.81	1.99
MH304	N/A	304	90.30	88.10	87.32	0.78
MH303	N/A	303	90.67	88.47	87.69	0.78
MH302	N/A	302	92.80	90.60	88.63	1.97
MH301	N/A	301	93.73	91.53	90.20	1.33
MH300	N/A	300	94.00	91.80	90.71	1.09
MH318	N/A	318	94.40	92.20	91.03	1.17
MH326	N/A	326	94.76	92.56	91.33	1.23
MH308	N/A	308	89.68	87.48	86.65	0.83
MH309	N/A	309	90.15	87.95	87.29	0.66
MH310	N/A	310	90.04	87.84	86.94	0.90
MH311	N/A	311	90.69	88.49	87.38	1.11
MH312	N/A	312	91.36	89.68	88.41	1.27
MH313	N/A	313	92.62	90.71	89.34	1.37
MH314	N/A	314	93.00	91.16	89.90	1.26
MH315	N/A	315	93.39	91.36	90.27	1.09
MH316	N/A	316	94.09	91.89	90.96	0.93
MH317	N/A	317	94.08	91.88	91.16	0.72
MH325	N/A	325	86.19	83.99	83.14	0.85
MH323	N/A	323	86.57	84.37	83.19	1.18
MH322	N/A	322	87.50	85.30	84.15	1.15
MH321	N/A	321	87.67	85.47	84.46	1.01
MH320	N/A	320	88.77	86.57	85.16	1.41
MH319	N/A	319	88.81	86.61	86.21	0.40
Western SWM Facility[3]						
SWMW	N/A	N/A	77.00	N/A	72.44	N/A
S360	360	N/A	79.50	77.10	75.04	2.06
MH272	272	N/A	72.50	N/A	72.72	N/A
MH271	271	N/A	74.50	N/A	72.44	N/A
MH(228)	228	N/A	76.29	N/A	72.47	N/A
MH (227)	227	N/A	77.93	N/A	72.55	N/A
S250	250	N/A	79.50	77.10	74.35	2.75
MH(270)	270	N/A	79.50	77.10	75.63	1.47
MH251	251	N/A	81.20	78.80	75.86	2.94
MH252	252	N/A	82.20	79.80	76.42	3.38
MH(266)	266	N/A	82.40	80.00	76.49	3.51
MH(243)	243	N/A	82.40	80.00	76.65	3.35
S258	258	N/A	82.40	80.00	76.77	3.23

(1) Results from Phase 2B detailed design (XPSWMM file 118863-3CHI100_SUB2_2019-03-12.xp)
(2) Results from Eastern SWM Facility detailed design of (XPSWMM file 32952-100CH.xp)
(3) Results from 2015 MSS (XPSWMM file MSS 32952-100CH.xp)

Tributary to the Eastern SWM Facility, the results indicate that the minimum 0.3 m clearance between the USF and HGL is maintained across all tributary storm sewers.

Tributary to the Western SWM Facility, the results indicate that during the 100 year 3 hour Chicago storm event, the trunk storm sewers operate under free flow conditions. Also all the proposed USFs are more than 0.30 m above the predicted sewer HGL and therefore meet the City of Ottawa guidelines for freeboard.

6.7 Macro Grading

A proposed grading and drainage plan is included on **Figure 6.15**, which is enclosed in **Appendix E**. The proposed road grades consider the geotechnical grade raise limitations as well as provide a conveyance corridor for major storm routing. As noted in **Sections 6.4.1** and **6.5.4**, for storms less frequent than the 5 year event, runoff in excess of the minor system capture will be routed via street segments and rear yards and outlet to one of the following features: the retrofitted Burma Road SWM Facility; one of three dry ponds; the southwest channel; or one of the end-of-pipe SWM facilities. The development will be constructed to ensure the safe conveyance of runoff during the 100 year event.

Once the macro grading was determined, a preliminary storm and sanitary sewer design was completed. The two sewer profiles were then adjusted to ensure there were no conflicts at intersections. **Figure 6.16**, which is enclosed in **Appendix E**, provides an analysis of potential sewer crossings and identifies a positive clearance at all sewer crossing locations.

6.8 Phase 1 Requirements

As stated earlier, the development of the former CFB Rockcliffe site will happen in a phased sequence spread over a number of years. The project is proposed to be constructed in three phases as shown in **Figure 1.6**. Additionally, Phase 1 will be divided into two: Phase 1A and Phase 1B. Phase 1A will include Codd's Road to the City Centre area and the lower density residential areas immediately west of Codd's road. The Phase 1A development limits are shown on **Figure 5.4** which is included in **Appendix D**.

Although the Phase 1A development will include only Codd's Road and areas west, it is recommended that Phase 1A also include construction of an east-west link between Codd's and Burma Roads as well as Burma Road to Montreal Road.

Besides being good engineering and planning practice, construction of the latter two streets is necessary because these will provide corridors for redundant infrastructure which are required to meet City guidelines. Main Street and Burma Road will provide two vehicular access points to Phase 1A and also accommodate a looped watermain network and utility system. The City requires a looped watermain network for a development as large as Phase 1A and some of the major utility providers have also indicated they require looped systems for operational redundancy. Codd's Road and Burma Road will provide the opportunity for these requirements. The recommended storm sewer system for Phase 1A is indicated on **Figure 5.4** which is included in **Appendix E**.

Although Phase 1A will include construction of both Main Street and Burma Road, no developments adjacent to those streets are planned until Phase 1B is completed. Most of the sewers constructed in these two streets will remain "dry." Any groundwater or surface infiltration in the east-west link street sewer will naturally empty into the Codd's Road sewer at node 150. However, the storm sewer in Burma Road which is located north of node 108 is proposed to outlet to node 108 and then westward towards node 114. Since the latter sewer system is not proposed as part of Phase 1A, some interim drainage measures are necessary. It is therefore proposed to construct a temporary drainage pipe outletting to the Burma Road SWM facility to ensure a drainage outlet for the Burma Road minor storm system located north of node 108 until such time that Phase 1B is completed. At that time, the temporary drainage measures can be removed.

Stormwater flows from the Burma Road SWM Facility are presently routed through the subject site in a pair of 1050 mm diameter storm sewers. One of those routes westward and outlets near Hemlock Road, where flows are carried under the Airport Parkway and eventually to the Ottawa River. The second storm sewer routes northeast and outlets over the north escarpment.

The Burma Road SWM Facility will continue to operate as-is until it is reconstructed as part of Phase 1B. Therefore, flows from the two existing 1050 mm diameter storm sewers will be intercepted by the Phase 1A storm sewer in the east-west link street as indicated in **Figure 6.34** which is located in **Appendix E**. It should be noted that any interim increase in drainage area and/or runoff to the Burma facility (i.e., before the pond is retrofitted) will be assessed at the time of detailed design to confirm that sufficient freeboard will be maintained for existing basements.

Figure 6.34 also indicates the required local minor storm sewers needed to properly service Phase 1A. All stormwater runoff from this phase will be routed to the new Eastern SWM Facility, which will need to be constructed as part of Phase 1A. Also, the western cell of the proposed Park Dry Pond will need to be constructed as part of Phase 1A in order to accept major storm runoff from Codd's Road.

6.9 Cost Estimates

Cost estimates for the proposed SWM facilities and storm sewers are summarized in **Table 6.20 – Table 6.22**. The total cost is estimated at $15,443,189.40.

Table 6.20 Cost Estimate – Eastern SWM Facility

ITEM	COST ($)
Excavation - 80,000 m^3	1,600,000.00
Inlet Structure - Lump Sum	100,000.00
Outlet Structure - Lump Sum	75,000.00
2400mm Storm Pipe - 600 m	1,692,000.00
Connection from Aviation Parkway Culvert - 800 m	800,000.00
Maintenance Access Lane - 600 m^2	40,000.00
Topsoil & Seed - 10,000 m^2	40,000.00
Aquatic Planting - Lump Sum	100,000.00
Site Landscaping - Lump Sum	200,000.00
Waterfall & Plunge Pool - Lump Sum	300,000.00
Contingency (25%)	1,236,750.00
TOTAL	6,183,750.00

Table 6.21 Cost Estimate – Western SWM Facility

ITEM	COST ($)
Excavation - 40,000 m^3	800,000.00
Rock Excavation - 15,000 m^3	750,000.00
Inlet Structure (2)	100,000.00
Outlet Structure - Lump Sum	75,000.00
Hemlock Road Culvert - Lump Sum	200,000.00
Maintenance Access Lane - 1350 m^2	80,000.00
Topsoil & Seed - 8,500 m^2	35,000.00
Aquatic Planting - Lump Sum	50,000.00
Site Landscaping - Lump Sum	100,000.00
Clean Out Existing Creek & Culvert	50,000.00
Contingency (25%)	560,000.00
TOTAL	2,800,000.00

Table 6.22 Cost Estimate – Storm Sewer

ITEM	COST ($)
2100 mm Storm Sewer - 70 m @ $1,508.96	105,627.20
2700 mm Storm Sewer - 480 m @ $4,225.07	2,028,033.60
3000 mm Storm Sewer - 775 m @ $5,545.87	4,298,049.25
3600 mm x 3000 mm Storm Sewer - 5 m @ $5,545.87	27,729.35
TOTAL	6,459,439.40

The cost estimates for the two SWM facilities are based on preliminary quantities and unit prices based on past projects. Estimates for proposed storm sewers include only sewers 1800 mm diameter and larger as per the City of Ottawa Development Charge By-Law. The unit rate for the trunk storm sewers are the 2014 rates provided by the City. Due to the presence of rock on the site the contingency unit prices were used. The City of Ottawa does not include cost sharing rates for sewers larger than 3000 mm diameter. The estimate for the proposed 3600 mm x 3000 mm sewer is based on the unit price for a 3000 mm diameter pipe.

6.10 Conclusions

It has been concluded that the existing storm sewer system within former CFB Rockcliffe has reached its useful life and the site's redevelopment should include the construction of a new separated storm sewer system including a dual drainage network and end-of-pipe SWM facilities. The proposed storm sewer system is designed to convey runoff from the majority of the study area as well as several external areas, including the NRC Campus, Thorncliffe, Foxview, and Fairhaven communities, the Montfort Hospital, and the potential future museum site.

The City of Ottawa and CLC have agreed to pursue phased stormwater management demonstration projects for former CFB Rockcliffe using LID Best Management Practices (BMPs). Traditional servicing and LID alternatives were reviewed in parallel as two independent studies. This was done recognizing that LID alternatives would be identified for implementation on a trial basis, phase by phase. To maintain this flexibility, the LID alternatives were evaluated independently. Aquafor Beech was retained by CLC to prepare the 'Stormwater Management Existing Conditions & LID Pilot Project Scoping' (May 2015). The report includes detailed environmental review in the form of stormwater management existing conditions as part of the LID evaluation. The report should be read in parallel with this MSS document.

Runoff from the site is currently conveyed to two creeks, the Eastern Creek and Western Creek, via two existing culvert crossings of the Aviation and Rockcliffe Parkways. The Eastern (Rockcliffe Parkway) culvert can theoretically convey 3.5 cms with no overflow and the Western (Aviation Parkway) culvert can convey 1.35 cms with no overflow at an approximate elevation of 62.00 m.

Construction of the Eastern SWM Facility, adjacent to the Rockcliffe Parkway, will include installation of a new storm sewer conveying outflow from the pond directly to the Ottawa River. Due to the direction connection to river, it is not required the Eastern SWM Facility provide water quantity control. Construction of the Western SWM Facility, located in the northwest corner of the development, will include enhancement in the form of debris removal from the Aviation Parkway culvert; removal of silt build up in the creek at the outlet of the Aviation Parkway culvert; and removal of the blockage in a culvert within the RCMP campus.

Both SWM facilities are to provide an Enhanced Level of Protection, corresponding to 80% TSS removal. Since no fish were found in either creek during the aquatic habitat assessment (DST, August 2013) it is concluded that temperature mitigation measures are not required for the outflows from the SWM facilities.

The existing conditions water balance is evaluated in **Section 6.3.3.5**. It should be noted that the water budget will be finalized, including of relevant infiltration techniques and the percentage of the development area tributary to the infiltration features, as part of the parallel study being completed by Aquafor Beech.

The conceptual stormwater management system incorporates standard urban drainage design and stormwater management features, including a dual drainage concept and two end-of-pipe stormwater management facilities.

The dual drainage design accommodates both minor (pipe) and major (surface) stormwater runoff by featuring a combination of on-site detention (surface ponding) and direct conveyance with no ponding. The dual drainage system was evaluated using the SWMHYMO hydrological model.

The minor system storm sewers are sized based on the rational method, applying standards of both the City of Ottawa and MOE. Where possible, roads are designed to accommodate on-site storage. Inlet control devices (ICDs) will be utilized to control the surcharge in the minor system during infrequent storm events and maximize use of available on-site storage. ICDs will be sized at the detailed design stage.

The recommended minor storm sewer plan is presented on **Figure 6.7** and profiles are presented on **Figure 6.8** (both enclosed in **Appendix E**). The associated storm sewer design spreadsheets are also enclosed in **Appendix E**, along with the corresponding drainage area plan (**Figure 6.9**). All minor storm sewer sizes will be reviewed and confirmed at the time of detailed design.

Minor and major flow from the majority of the study area will be conveyed to the two end-of-pipe facilities for treatment, prior to being released to the Ottawa River.

As noted above, the infiltration techniques and the percentage of the development area tributary to the infiltration features will be determined during subsequent stages of design. The stormwater management concept has been developed as standard SWM facilities, assuming all development area, with the exception of Special Design Area and small area west of the Western SWM Facility (Area PH3A and Area PH2I respectively, refer to **Figure 6.13** and **Figure 6.14**), is tributary to the end-of-pipe facilities.

A SWMHYMO model has been developed to represent former CFB Rockcliffe, as well as the external drainage areas, under both existing and post-development conditions.

The results indicate that both Rockcliffe and Aviation Parkway culverts will theoretically overflow under existing conditions.

In terms of post-development conditions, the SWMHYMO simulation was used to evaluate major flow routing on street segments; and performance of the park dry pond, eastern dry pond, and the central dry pond. The XPSWMM simulation was used to evaluate the retrofitted Burma Road pond, and performance of the two end-of-pipe SWM facilities. It is proposed to outlet the Eastern SWM Facility to the Ottawa River via a new storm sewer. It is proposed to outlet the Western SWM Facility to the Ottawa River via the Western Creek.

With respect to major flow routing on street segments, maximum overland flow on streets was reviewed at critical downstream locations and at all locations, the depth of ponding is less than the City of Ottawa guideline of 0.3 m. Further, the depth by velocity does not exceed the City guideline of 0.6 m^2/s.

As part of the redevelopment of former CFB Rockcliffe, the Burma Road SWM Facility will be retrofitted to increase its available storage, which will aid in reducing storm sewer sizes in the study area. Similarly, three major system dry ponds are proposed across the site. The details of the performance of the Burma Road SWM Facility and three dry ponds are summarized in **Section 6.5.4.2**. The potential infiltration component of these ponds will be evaluated as part of the parallel

LID work; as part of the MSS, however, the storage volume designated for all the ponds is for major system storage only. The functional design for the major system storage provides flexibility in terms of the potential future use for LID techniques.

A channel is proposed around the south and west of the study area to convey major flow from a portion of the study area as well as total flow from Fairhaven and the Montfort Hospital Woods, major flow from a portion of the Montfort Hospital site, and the outflow from the Montfort Hospital SWM Facility. The channel releases to the Western SWM Facility. The channel design will be further refined as part of Aquafor Beech's proposed work plan for the LID pilot project.

A swale is proposed along the eastern and southern edge of block 56 to capture and convey NRC surface runoff and direct it to the improved Burma Pond during Phase 2 construction. The existing ditch will be modified if and as needed to accommodate the NRC runoff.

The two end-of-pipe SWM facilities were simulated in XPSWMM to confirm design and performance. As previously noted, at this stage of design is it assumed that all development areas, with the exception of Special Design Area and PH2I, are tributary to one of the two end-of-pipe SWM facilities.

The Eastern SWM Facility, designed as a wet pond, is comprised of 3.59 ha-m of permanent storage and 1.81 ha-m of water quality extended storage, exceeding the MOE requirements. The facility features a stilling basin, a wet cell, and the outlet structure to a new storm sewer to the Ottawa River. At the upstream end of the facility, the stilling basin will provide energy dissipation for the proposed waterfall inlet. Runoff will then flow into the sediment forebay, prior to the downstream wet cell. The performance of the SWM facility during various storm events is summarized in **Table 6.17**.

Total flow from Area EXTE2 and major flow from Area PH3A (the Special Design Area) are tributary to the Eastern Creek. The areas generate 2.89 cms during the 100 year 3 hour Chicago event (the more critical storm event). This value corresponds to less than the maximum capacity calculated for the existing culvert.

The bankfull flow conditions were simulated with the 25 mm storm event. Statistically, the 25 mm precipitation corresponds to a storm event approximating the 1:5 year return period. The estimated bankfull flows in the Eastern Creek could range between 0.50 cms and 2.5 cms (DST, September 2013). From a fluvial geomorphology perspective the flow generated by the above-noted drainage areas during the 25 mm storm event is 0.56 cms, which is at the lower end of the bankfull estimates.

It is proposed to provide baseflow augmentation to the Eastern Creek from the Eastern SWM Facility by means of a small diameter pipe. Based on a volumetric calculation, 51,081 cu-m/year is to be conveyed from the pond to the creek. This is to be confirmed at the detailed design stage, supported by continuous modeling.

The Western SWM Facility, designed as a wet pond, is comprised of 1.90 ha-m of permanent storage and 0.44 ha-m of water quality extended storage, exceeding MOE requirements. The 1500 mm diameter trunk storm sewer servicing the western portion of the study area extends west along Hemlock Road, terminating on the north side of the Western SWM Facility. To the south, a 525 mm diameter storm sewer will be installed to service Area PH2G, terminating on the south side of the SWM facility. The Southwest Channel ties into the main cell of the facility. The Western SWM Facility is designed as a wet pond (refer to **Section 6.4.2**), with an outlet discharging to the existing Aviation Parkway culvert. During the 100 year 24 hour SCS Type II event, considered the design storm for the pond, the outflow from the facility is 1.25 cms, which is significantly less than the existing conditions flow from the site to the Aviation Parkway culvert. The performance of the SWM Facility during various storm events is summarized in **Table 6.18**.

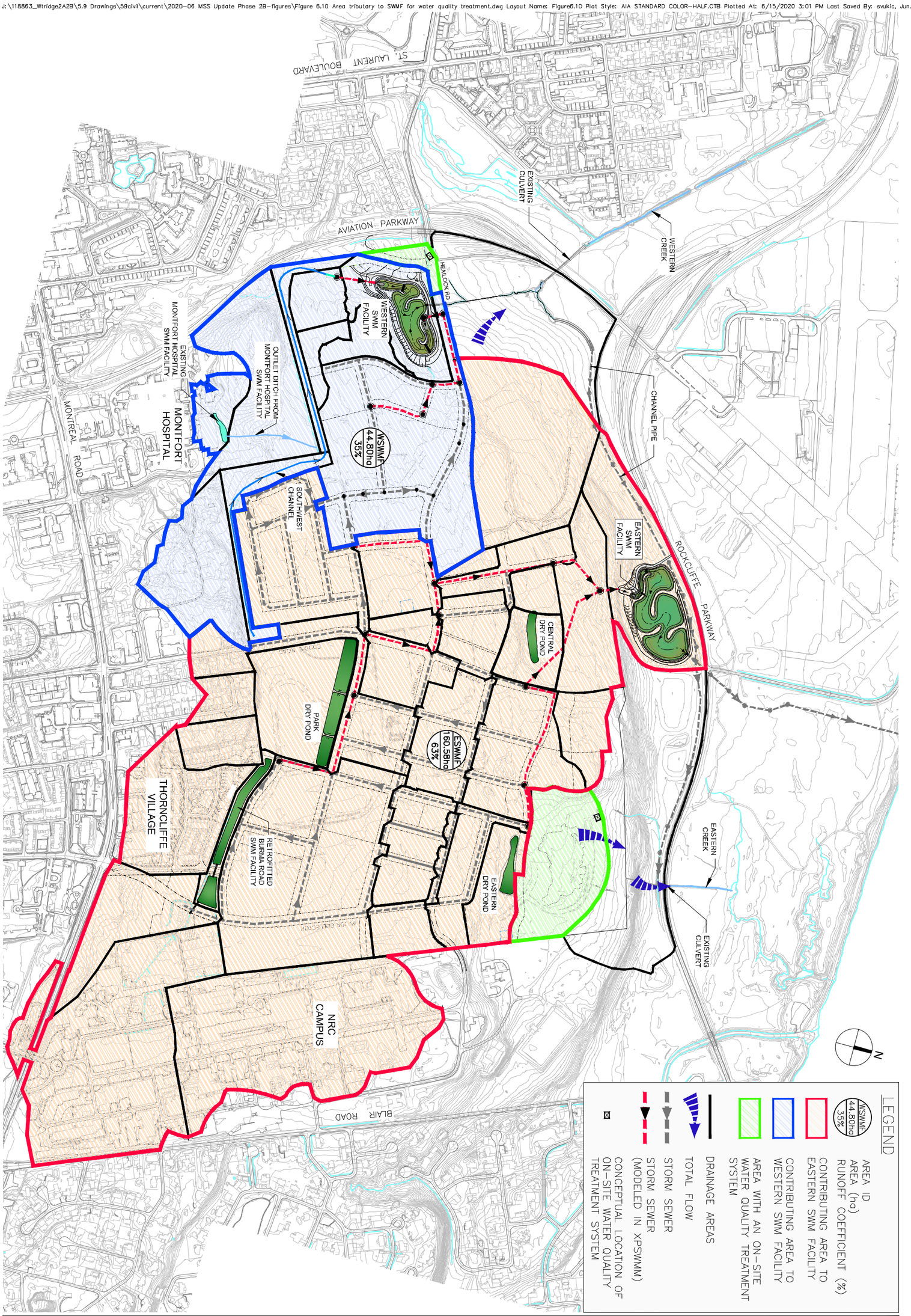
The bankfull flow conditions were simulated with the 25 mm storm event. Statistically, the 25 mm precipitation corresponds to a storm event with approximately the 1:5 return period. The estimated bankfull flows in the downstream Western Creek could range between 0.70 cms and 1.4 cms (DST, September 2013). From a fluvial geomorphology perspective, outflow through the Aviation Parkway culvert during the 25 mm storm event is 0.30 cms, a rate that corresponds to less than bankfull estimates.

The hydraulic evaluation was completed to confirm the hydraulic grade line of the trunk storm sewers through the development. Minor system hydrographs generated by SWMHYMO have also been imported to XPSWMM. During the 100 year 3 hour Chicago storm event, which is considered the design storm, the trunk storm sewers operate under free flow conditions.

The proposed grading and drainage plan is included on **Figure 6.15**, which is enclosed in **Appendix E**. The proposed road grades consider the geotechnical grade raise limitations as well as provide a conveyance corridor for major storm routing. For storms less frequent than the 5 year event, runoff in excess of the minor system capture will be routed via street segments and rear yards and outlet to one of the following features: the retrofitted Burma Road SWM Facility; one of three dry ponds; the southwest channel; or directly to one of the end-of-pipe SWM facilities. The development will be constructed to ensure the safe conveyance of runoff during the 100 year event. **Figure 6.16**, which is enclosed in **Appendix** E, provides an overview of potential sewer crossings and identifies a positive clearance at all sewer crossing locations.

The Phase 1 requirements are discussed in **Section 6.8**.

J:\118863_Wtridge2A2B\5.9 Drawings\59civil\current\2020-06 MSS Update Phase 2B-figures\Figure 6.10 Area tributary to SWMF for water quality treatment.dwg Layout Name: Figure6.10 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 6/15/2020 3:01 PM Last Saved By: svukic, Jun. 15, 20



Sheet No.

FIGURE 6.10

Drawing Title

AREA TRIBUTARY TO SWM FACILITIES FOR WATER QUALITY TREATMENT

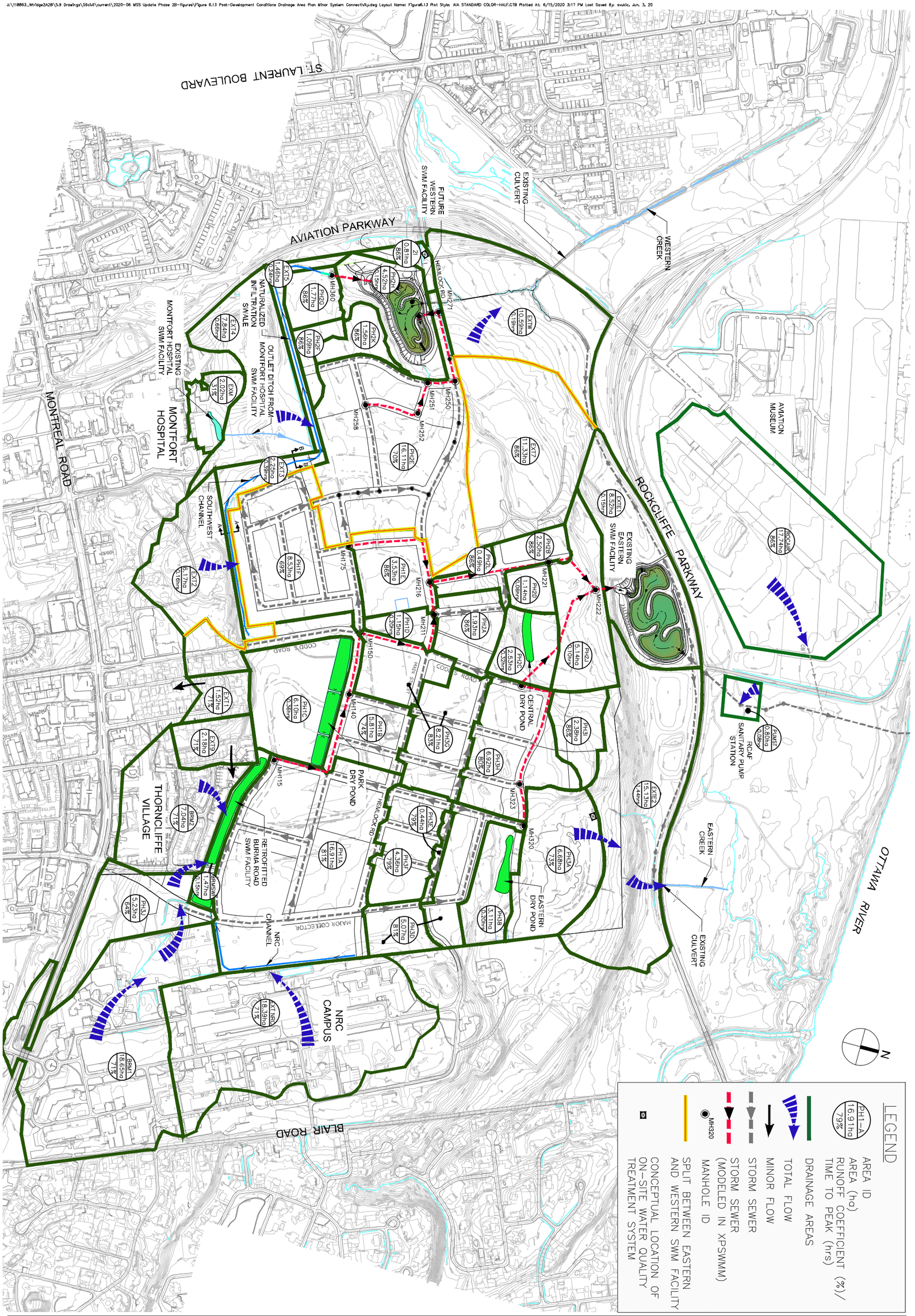
Project Title

FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY

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Sheet No.

Drawing Title

FIGURE 6.13

POST-DEVELOPMENT CONDITIONS
DRAINAGE AREA PLAN
MINOR SYSTEM CONNECTIVITY

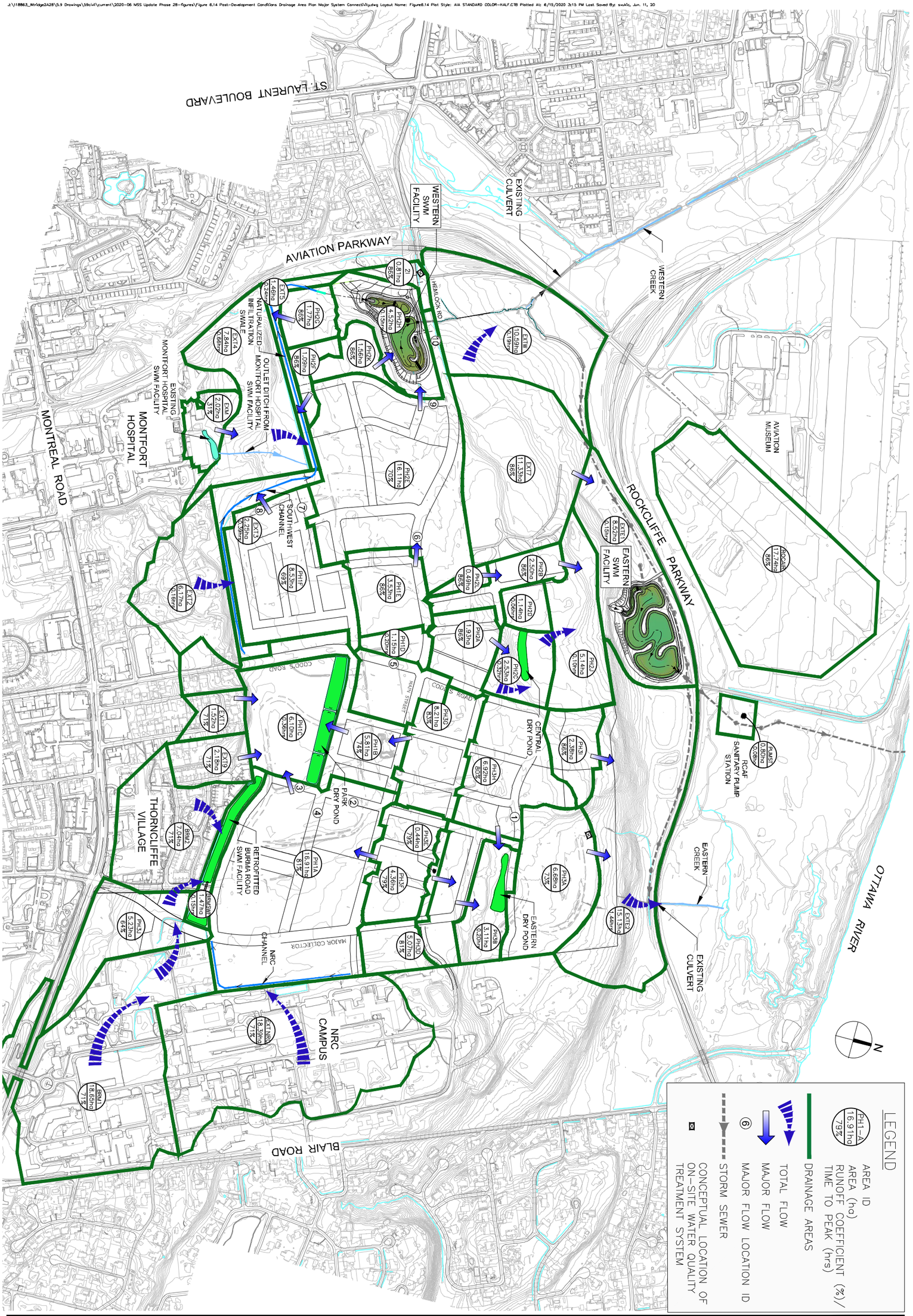
Project Title

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MASTER SERVICING STUDY

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Sheet No.

Drawing Title

FIGURE 6.14

POST-DEVELOPMENT CONDITIONS
DRAINAGE AREA PLAN
MAJOR SYSTEM CONNECTIVITY

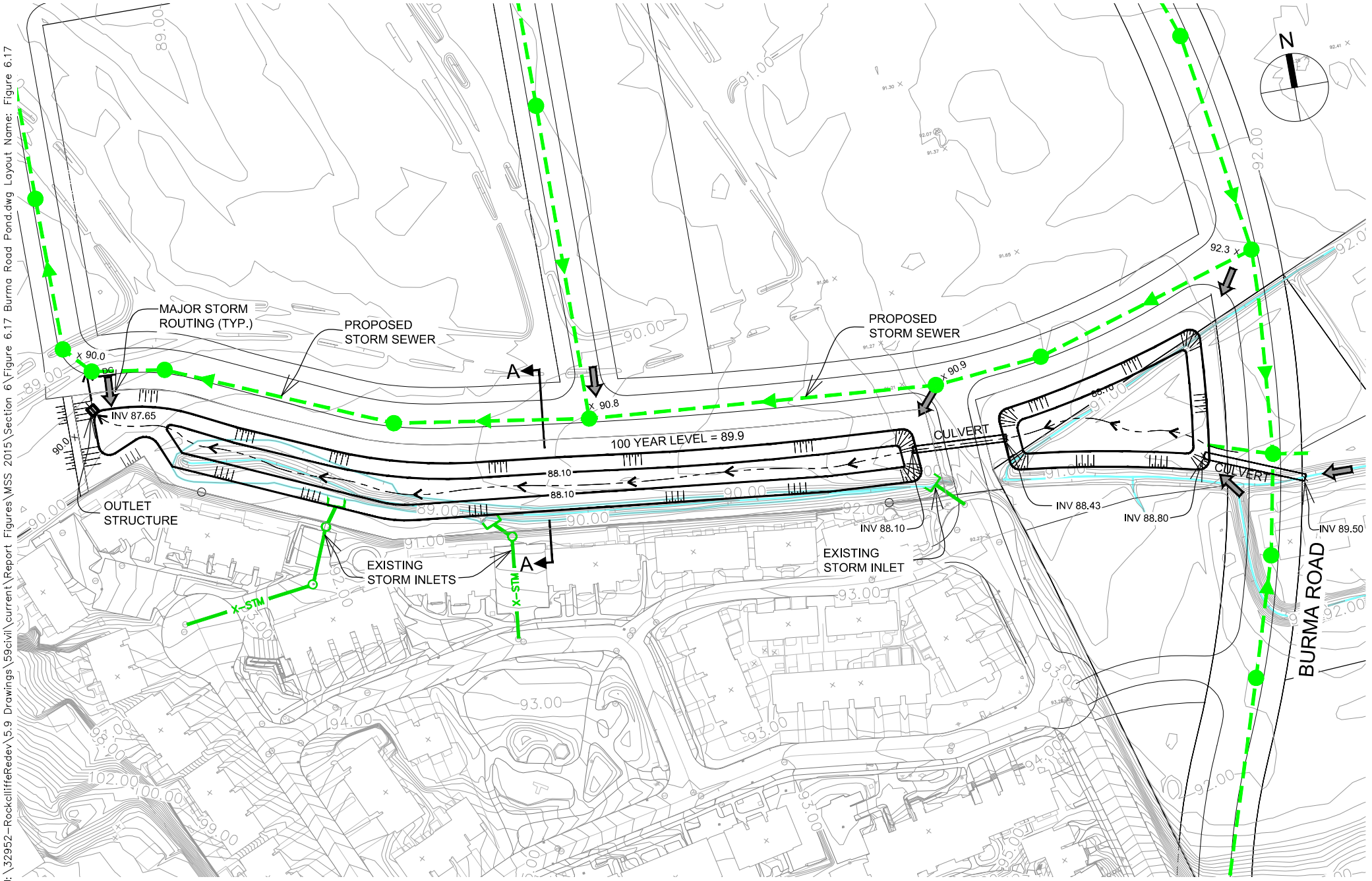
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MASTER SERVICING STUDY

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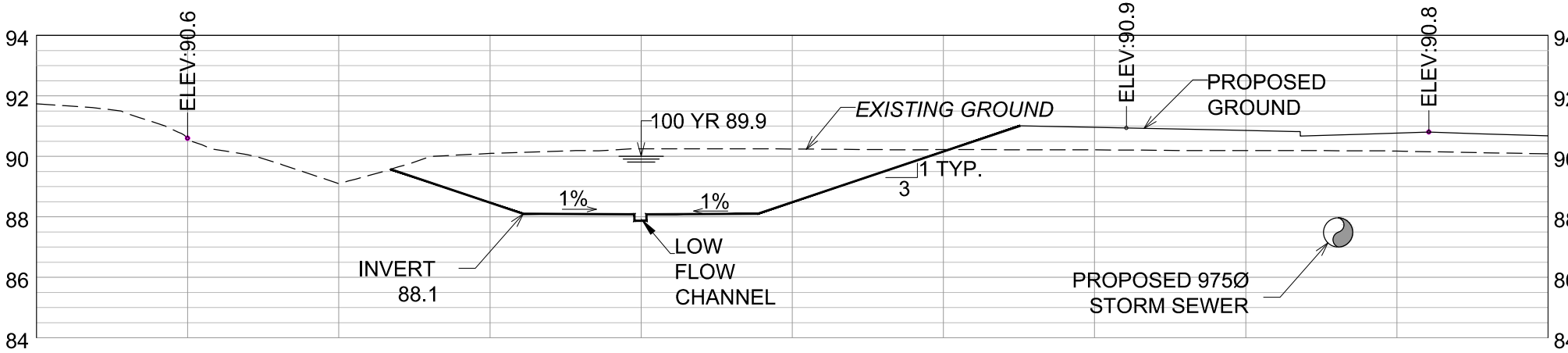
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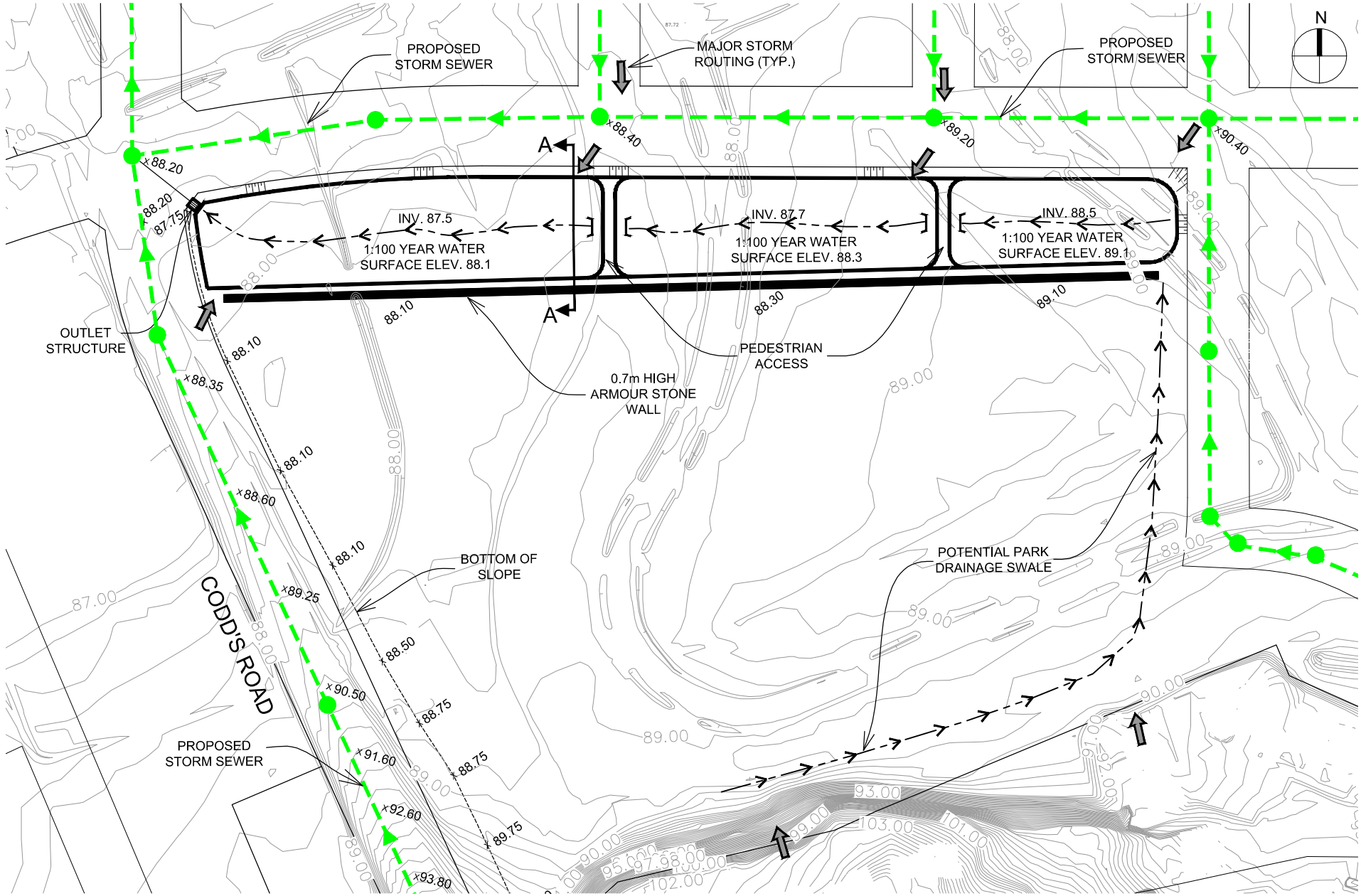
J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\WSS 2015\Section 6\Figure 6.17 Burma Road Pond.dwg Layout Name: Figure 6.17

Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	RETROFITTED BURMA ROAD SWM FACILITY	FIGURE 6.17

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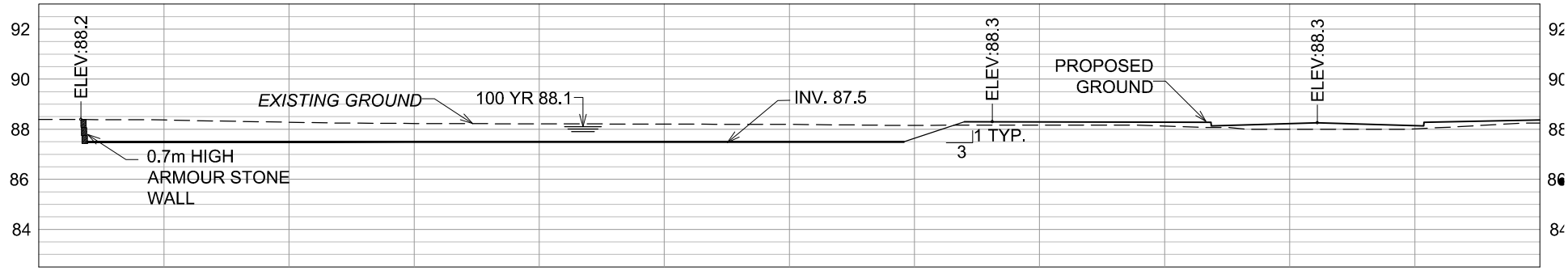


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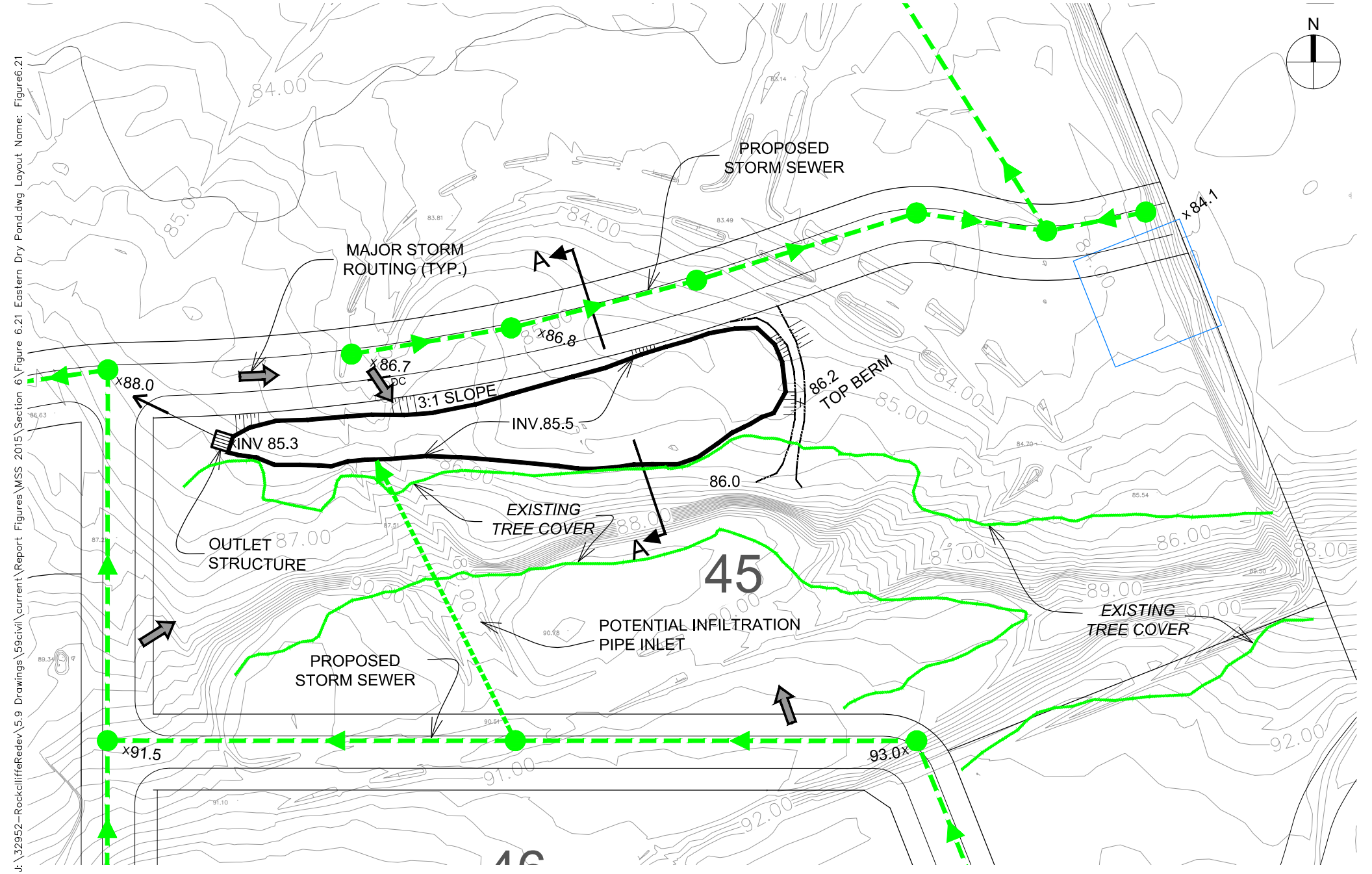


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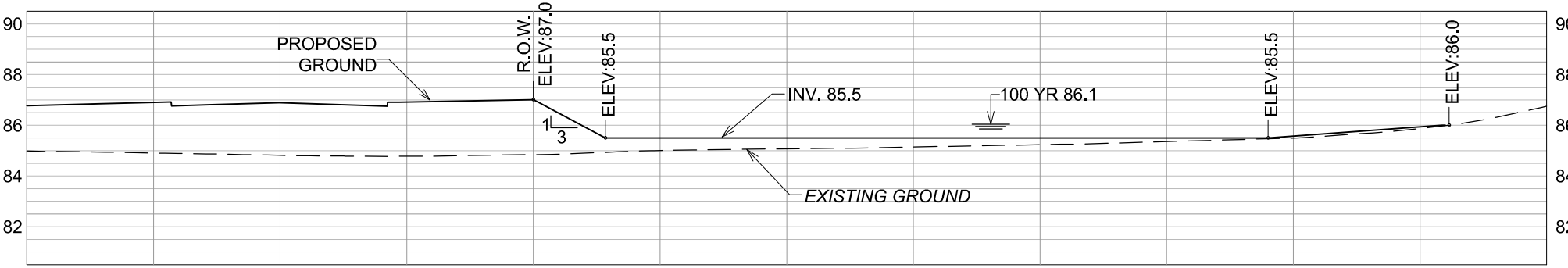
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NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	PARK DRY POND SECTION A-A	FIGURE 6.20



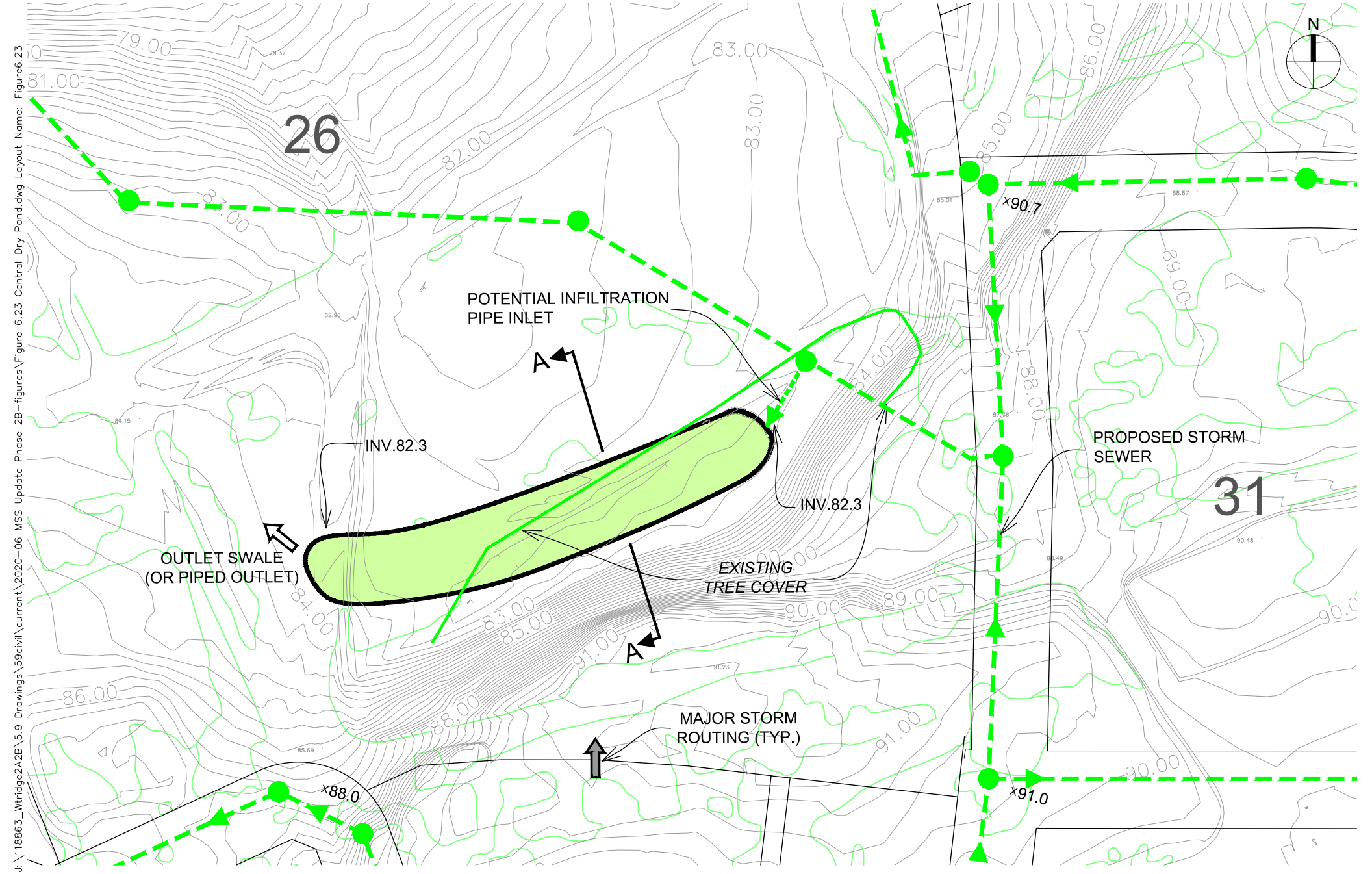
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Scale	Project Title	Drawing Title	Sheet No.
NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	EASTERN DRY POND	FIGURE 6.21

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.22 Eastern Dry Pond Section A-A.dwg Layout Name: Figure6.22



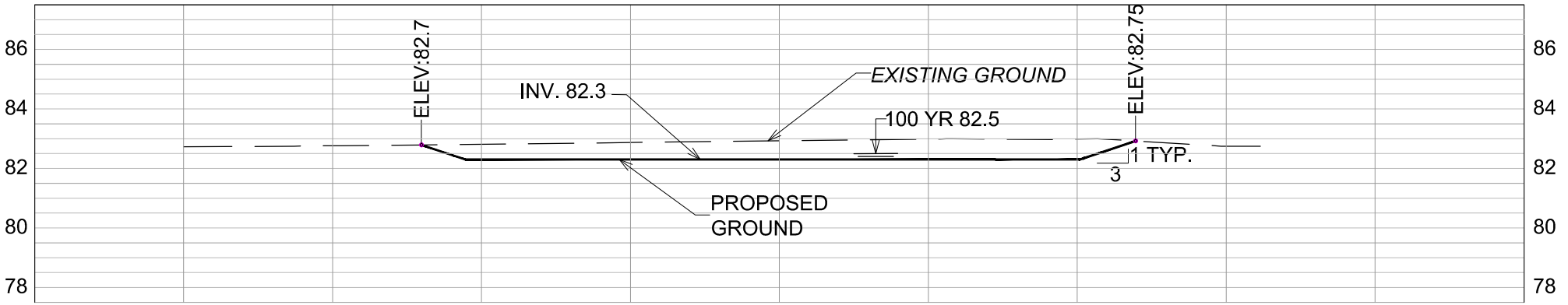
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NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	EASTERN DRY POND SECTION A-A	FIGURE 6.22



J:\118863_Wtridge2A2B\5.9 Drawings\59civil\current\2020-06 MSS Update Phase 2B-figures\Figure 6.23 Central Dry Pond.dwg Layout Name: Figure6.23

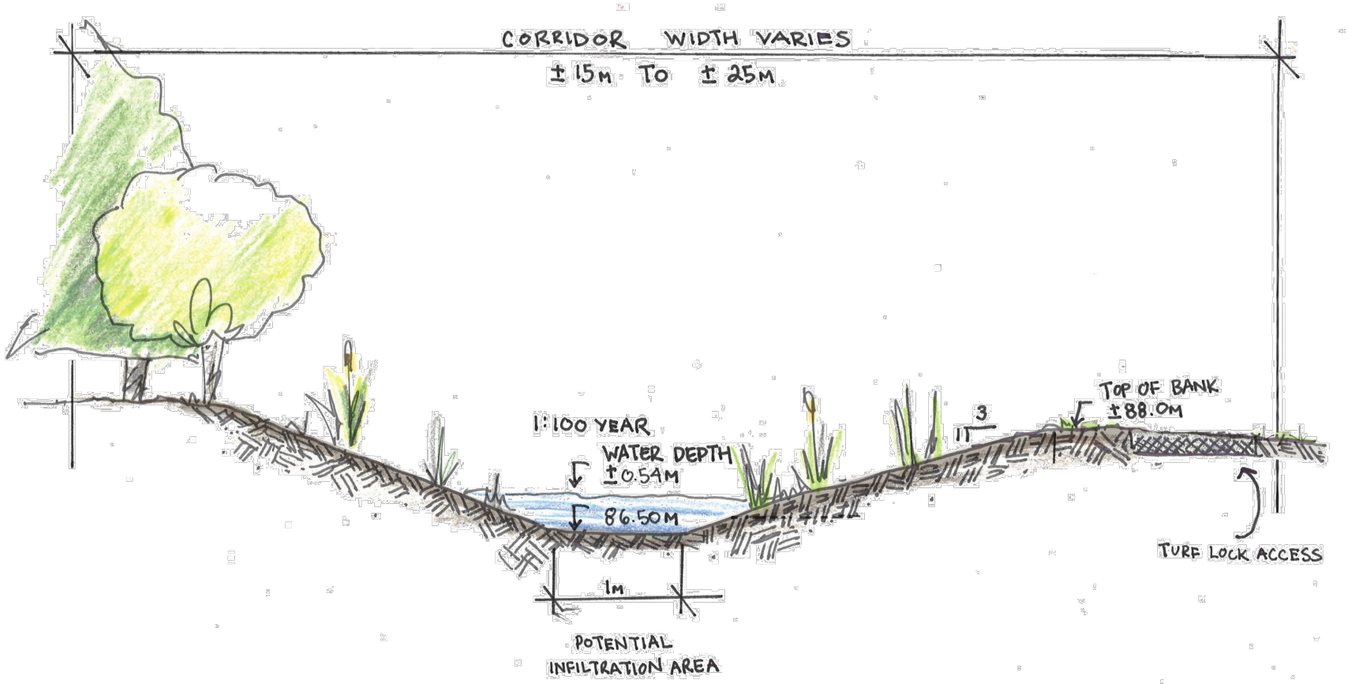
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NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	CENTRAL DRY POND	FIGURE 6.23

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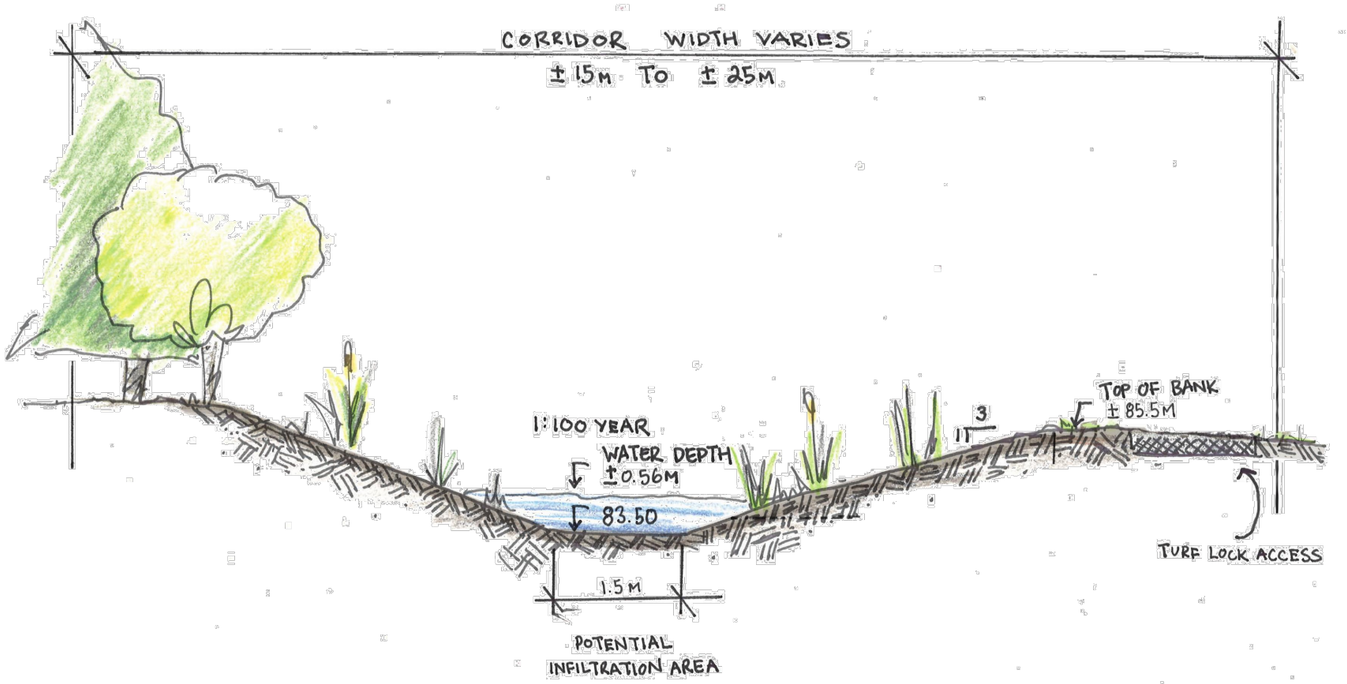


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NTS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	CENTRAL DRY POND SECTION A-A	FIGURE 6.24

o:\32952-RockcliffeRedev\5.0 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.25 Southwest Channel Typical Sections.dwg Layout Name: Figure6.25 (11X17) Plot Style: AIA STANDARD COLOR-HALF.CTB Plot Scale: 1:0.98 Plotted At: 8/7/2015 11:08 AM Last Saved By: mmine Last Saved At: Jul. 31, 15



SECTION A-A
(SEE FIGURE 6-13)



SECTION B-B
(SEE FIGURE 6-13)

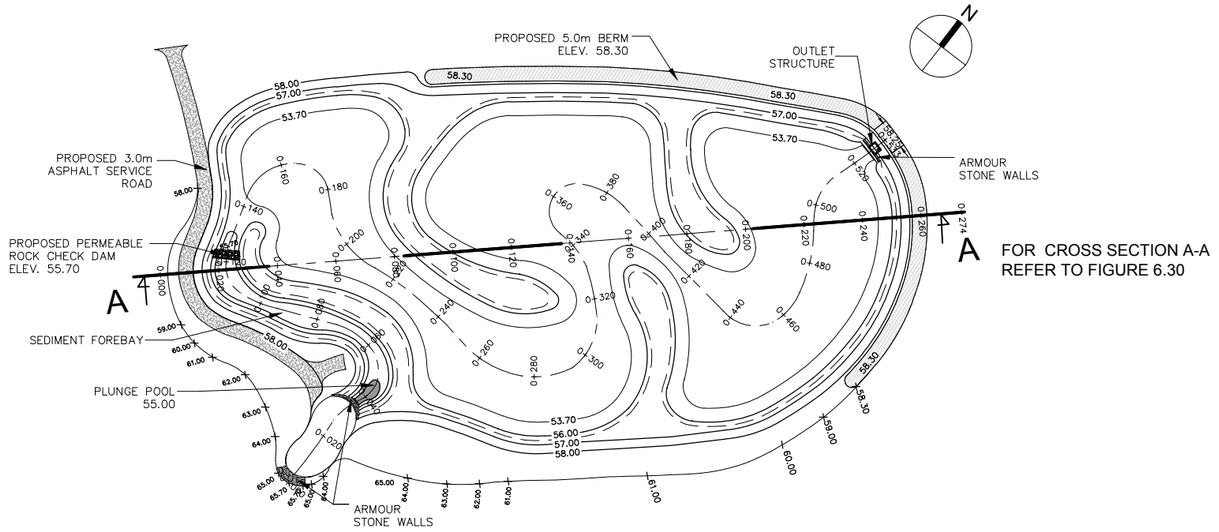
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FIGURE 6.25	SOUTHWEST CHANNEL TYPICAL SECTIONS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	N.T.S.

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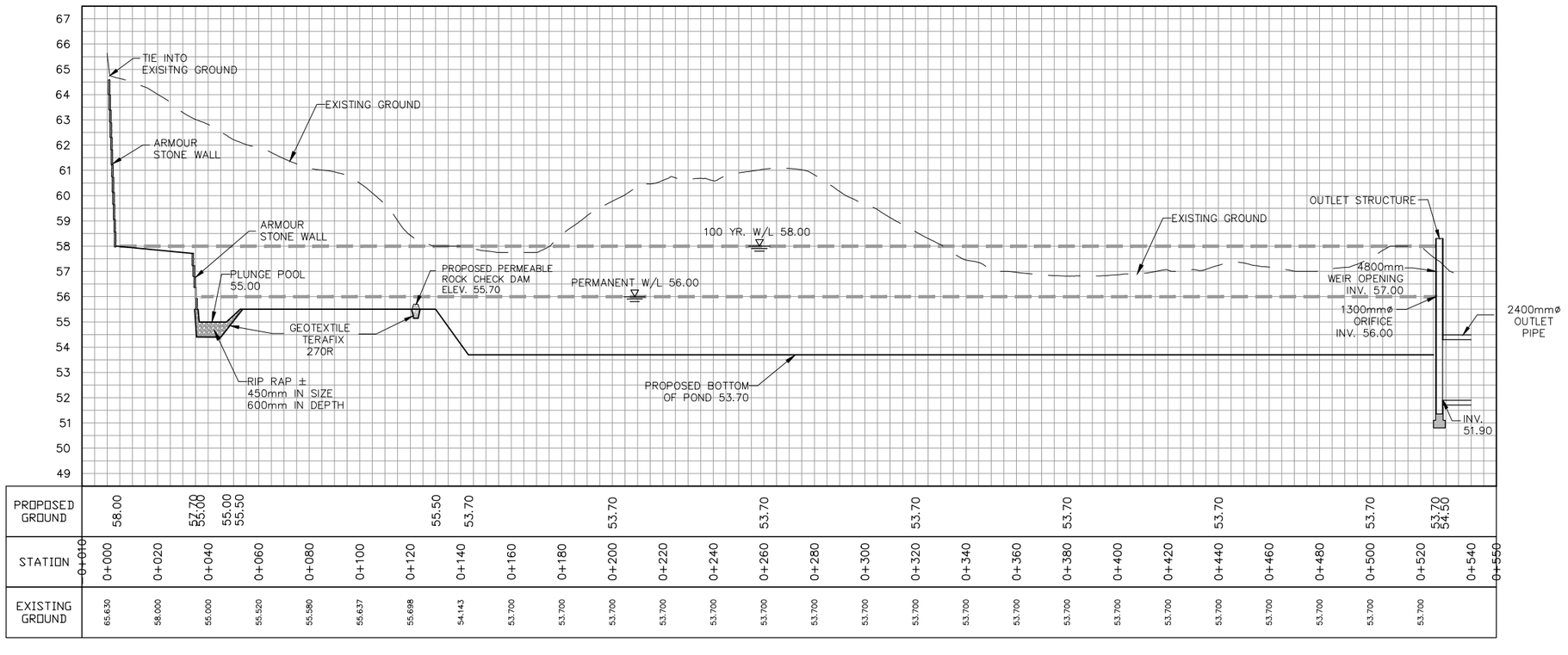
J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.26 EasternSWM Facility Plan View.dwg Layout Name: Figure6.26-8x11 (2)

Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	EASTERN SWM FACILITY PLAN VIEW	FIGURE 6.26



EASTERN POND VIEW

SCALE: 1:2000



EASTERN POND PROFILE

SCALE: VERT. 1:2000, HORIZ. 1:200

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Drawing Title

EASTERN SWM FACILITY
PROFILE

Sheet No.

FIGURE 6.27

Scale

AS SHOWN

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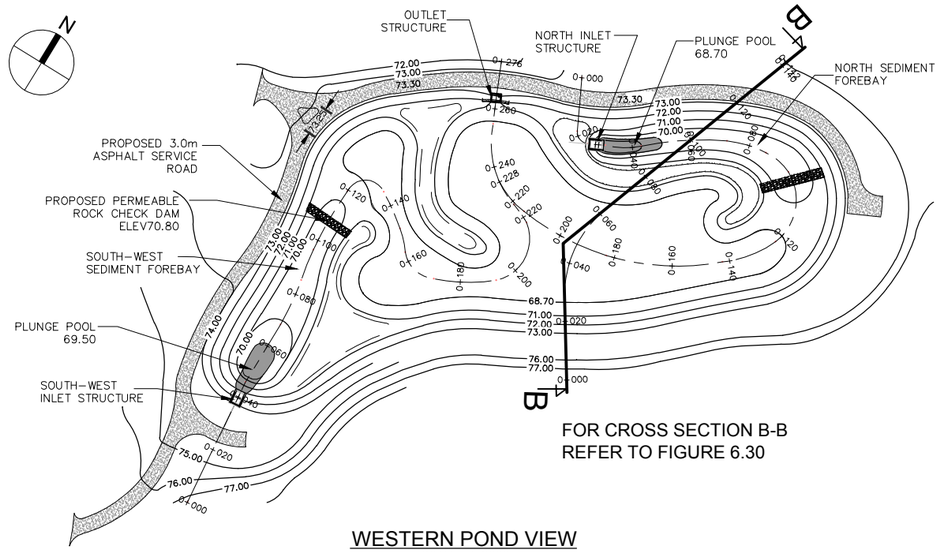


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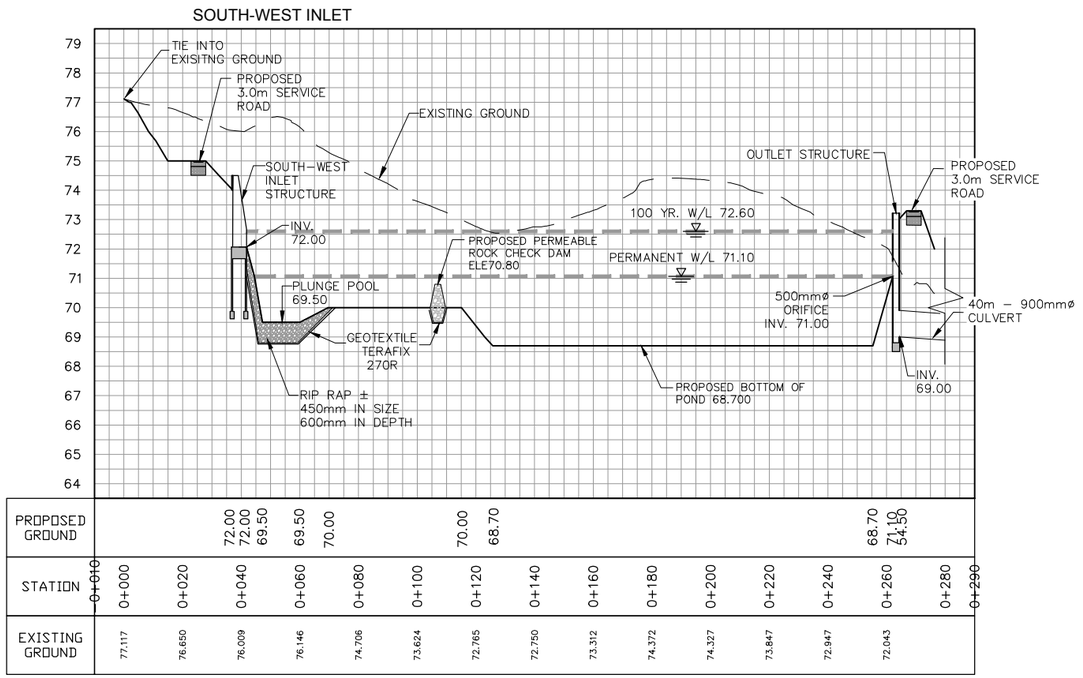
J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.29 WesternSWM Facility Plan View.dwg Layout Name: Figure6.29-8x11

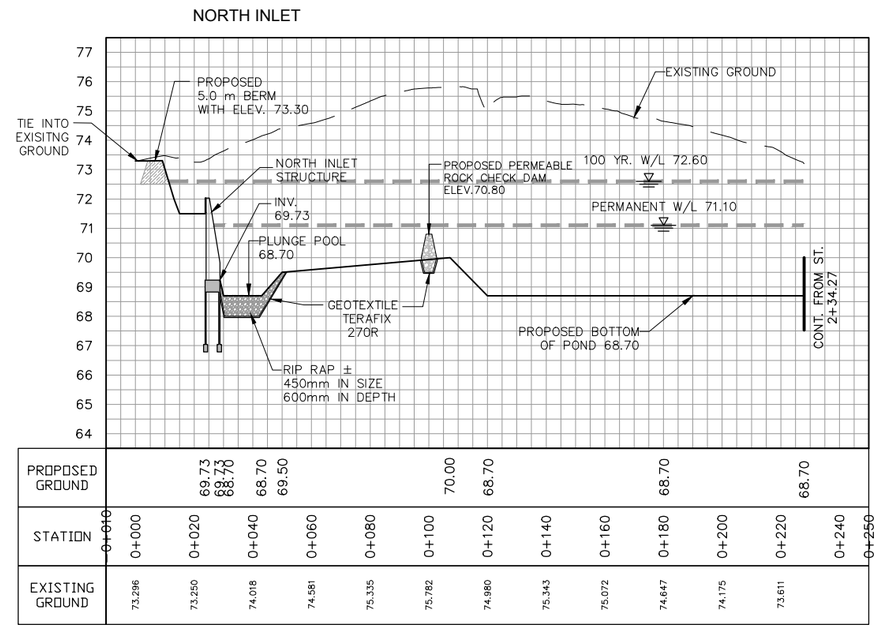
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Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	WESTERN SWM FACILITY PLAN VIEW	FIGURE 6.29



WESTERN POND VIEW
SCALE: 1:2000





WESTERN POND PROFILE
SCALE: VERT. 1:2000, HORIZ. 1:200

FIGURE 6.30

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

WESTERN SWM FACILITY
PROFILES

Scale AS SHOWN

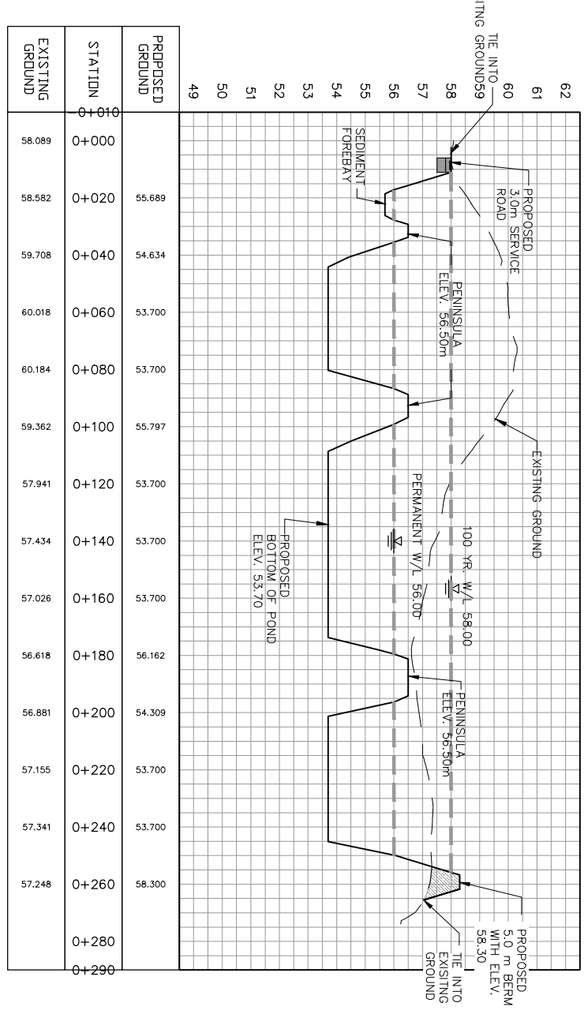
Project Title

Drawing Title

Sheet No.

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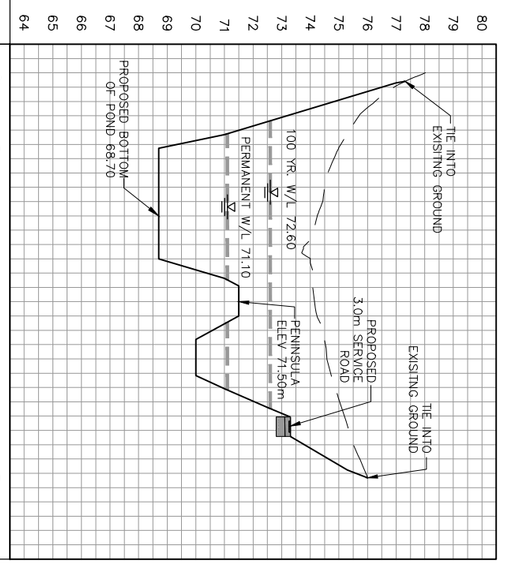
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EXISTING GROUND	STATION	PROPOSED GROUND
	0+010	
58.089	0+000	
58.582	0+020	55.689
59.708	0+040	54.634
60.018	0+060	53.700
60.184	0+080	53.700
59.362	0+100	55.797
57.941	0+120	53.700
57.434	0+140	53.700
57.026	0+160	53.700
56.618	0+180	56.162
56.881	0+200	54.309
57.155	0+220	53.700
57.341	0+240	53.700
57.248	0+260	58.300
	0+280	
	0+290	

EASTERN POND CROSS SECTION A-A

SCALE: VERT. 1:2000, HORIZ. 1:200



EXISTING GROUND	STATION	PROPOSED GROUND
	0+010	
78.021	0+000	77.32
75.372	0+020	68.70
74.501	0+040	
73.840	0+060	68.70
74.147	0+080	71.50
74.581	0+100	71.50
75.191	0+120	68.70
75.939	0+140	68.70
	0+160	73.30
	0+170	73.30
		76.00

WESTERN POND CROSS SECTION B-B

SCALE: VERT. 1:2000, HORIZ. 1:200

Sheet No.	Drawing Title	Project Title	Scale
FIGURE 6.31	EASTERN AND WESTERN POND CROSS SECTIONS	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	AS SHOWN

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7 Shallow Utilities

Select utility companies were circulated a copy of the study area, along with a general description of the intended land use. The purpose of the circulation was to:

- Establish the limits of existing utility infrastructure near the site;
- Alert the utilities that the MSS is underway, and plan for future development;
- Identify if there are any known constraints to extend utility service.

An information meeting was had with representatives of the various stakeholder utility companies on February 7, 2014. A copy of the meeting notes are enclosed in **Appendix F**. The existing utility infrastructure is presented on **Figure 2.19**.

7.1 Hydro One

Hydro One does not service this territory. It does however maintain a 13 Kv service to the adjacent NRC development. That service also includes a sub-station located on the NRC property.

7.2 Hydro Ottawa

Hydro Ottawa indicates that there are three potential sources of power available to service the proposed development. These include extensions from either: the Moulton sub-station; the Overbrook sub-station or the Hydro One NRC sub-station. Hydro Ottawa confirmed that both the Moulton sub-station and Hydro One sources would be radial, or un-looped sources. The Overbrook source would provide a more redundant and reliable service for the property.

7.3 Enbridge Gas

Enbridge reports that it maintains a gas main which serves existing customers on Codd's Road immediately to the south of the site. An extension of that main will provide the required gas service to the subject site. Gas is also available from Montreal Road. There are no known constraints for gas service.

7.4 Communications

Bell Canada reports it has fibre-optic cable along Montreal Road. Bell is ready to extend its infrastructure north along Cobb's Road, and would likely do so in conjunction with Hydro Ottawa pole upgrades.

Rogers Ottawa advises they have the necessary infrastructure to service this community; they have no design constraints to service the subject site.

7.5 Proposed Utility Plan

Details of the initial utility design are premature at this stage of the development. As with other infrastructure, the various higher level utilities encourage redundancy and looping in an attempt to provide a reliable service. Once Hydro Ottawa decides on the best supply source and completes some external improvements, all utilities will be available from Montreal Road and extension of both Codd's Road and Burma Road. Because Phase 1A will include construction of both Codd's Road and Burma Road, it is likely that the various shallow utility designs will take advantage of the multiple supply locations along those streets. It is therefore anticipated that the development of Phase 1A, including Burma Road and Main Street/Hemlock Road, will include shallow utilities.

This information was developed in consultation with the respective utility companies. Hydro Ottawa has an existing 4 Kva circuit which is constructed on the former CFB Rockcliffe and serves the RCAF Pump Station. Development of the subject site will need to include a continued service to the pump station. The higher level utilities have available capacity to service the former CFB Rockcliffe site. All that remains is to extend existing supply to the subject site.

8 Project Listing

This MSS is structured to satisfy the requirements of Phases 1 and 2 of the Municipal Class EA process as outlined in **Section 1.5** and illustrated on **Figure 3.1** for projects as defined in the Municipal Class Environmental Assessment document. This process includes integration with the Planning Act as provided for in Section 2.9 of the Municipal Class EA document.

8.1 Projects

The municipal infrastructure projects associated with the refined municipal servicing plan are:

- Water Distribution Projects
    - Trunk watermains in existing roadways or utility corridors (Schedule A)
    - Trunk watermains in future roadways and utility corridors (Schedule B)
- Wastewater Collection Projects
    - Trunk sanitary sewers in existing roadways or utility corridors (Schedule A)
    - Trunk sanitary sewers in future roadways and utility corridors (Schedule B)
- Stormwater Collection and Treatment
    - Trunk storm sewers in existing roadways or utility corridors (Schedule A)
    - Trunk storm sewers in future roadways and utility corridors (Schedule B)
    - New stormwater retention/detention ponds and appurtenances including outfall (Schedule B)
        - Eastern Stormwater Management Pond and associated sewers and outlet
        - Western Stormwater Management Pond and associated sewers and outlet
        - Park Dry Pond
        - Eastern Dry Pond
        - Central Dry Pond
    - Enlarge stormwater retention pond (Schedule B)
        - Enlarge Burma Road SWM Facility

It should be noted that all the projects listed above are required specifically for the redevelopment of former CFB Rockcliffe and will therefore only be constructed as part of that development process. Given that the listed projects are all site specific, and that the City of Ottawa is not in the practice of constructing site specific infrastructure for developers in advance of the developers' need, it is most probable that the above projects will become a condition of approval as a draft plan condition under the Planning Act prior to the construction of the project. If this is the process followed, all the listed projects automatically become Schedule A projects as defined by definitions 10 and 17 page 1-10 of the Municipal Class EA document, and can proceed directly to final design and construction as Schedule A projects without any further EA requirements.

8.2 Review Process

In addition to the public and agency input to the overall planning of the preferred servicing alternatives described in **Section 3** of this document, review agencies and the public will have the opportunity to review the Class EA documentation prepared for the CFB Rockcliffe project, and have the ability to appeal to the Ontario Municipal Board (OMB). The assessment and review process is being harmonized with the Planning Act because the development application process is occurring simultaneously. Notification of the conditions of planning approvals and the Class EA documents will be advertised through a Notice of Completion and there will be an opportunity to appeal to the OMB.

Under the Planning Act, appeals to the OMB may be made to any of the Official Plan and zoning by-law amendments or to the approval of subdivisions. The deadlines for the appeals to each application are found in the Planning Act. For Draft Plans of Subdivision and Zoning By-law amendments, appeals are to be filed within 20 days after written notice of decisions are provided. In addition, the OMB may dismiss an appeal if the person does not submit either written or oral submissions before the approval authority has granted approval. Once approved, however, the Class EA documents and the preferred municipal infrastructure projects will not be subject to additional EA approval requirements with the submission of subsequent site plans or plans of subdivisions. Once the application is approved under the Planning Act, the requirements of the Class EA are met and projects identified in the Class Environmental Assessments for former CFB Rockcliffe are approved and can proceed to construction and no additional notification under the EA Act is necessary. This allows the integration of both planning processes while ensuring the intent and requirements of both Acts are met.

The implementation of the required supporting infrastructure over time, to facilitate development of the CFB Rockcliffe Lands, will take place as Conditions of Approval. The approvals will be conducted under the Planning Act, and other acts as identified in **Section 9**.

9 Approval Requirements

The former CFB Rockcliffe CDP process satisfies the Municipal Class EA process under the integrated EA and Planning Act provision. In addition to this process and the City of Ottawa subdivision/site plan approval process, the following agency approvals will be required for implementation of the proposed development plan including, but not necessarily limited to:

- Ontario Water Resources Act

  All sanitary sewer, storm sewer and stormwater management projects will require a Environmental Compliance Approval from the Ministry of the Environment.

- Conservation Authorities Act

  All works associated with the enhancement of the outlets to the Ottawa River will require approval by the Rideau Valley Conservation Authority under Section 28 of the Conservation Authorities Act.

- Fisheries Act

  Proponent is to complete the DFO Self Assessment for Projects Near Water. If it is determined through the self assessment that the project has the potential to cause serious adverse harm to fish or fish habitat, contact DFO to request a formal DFO review.

10 Implementation and Phasing

This MSS develops a servicing strategy for the preferred concept plan developed in the CDP. The servicing strategy has built flexibility into the design of the municipal services to allow for changes in land use to be accommodated as build out occurs in several phases over several years. The configuration of the trunk watermains, trunk sanitary sewers and trunk storm sewers has also been arranged to build flexibility into the potential phasing options to accommodate changing market demands for building product type and quantity required to build out. A preliminary phasing plan is presented in **Figure 1.6**. In recognition of the probability that the preferred concept plan may not be entirely built out as currently planned due to unforeseen circumstances, the following process is set out to deal with changes which occur after approval of the Environmental Assessment, but prior to construction.

The change process distinguishes between minor and major changes. A major design change would require completion of an amendment to this EA, while a minor change would not. For either kind of change, it is the responsibility of the proponent to ensure that all possible concerns of the public and affected agencies are addressed.

10.1 Minor Changes

Minor design changes may be defined as those which do not appreciably change the expected net impacts associated with the project. For example, a design change in a utility location within a road right-of-way or the size of a pipe would be considered minor. Changes in utility alignment between road allowances, which do not affect other landowners, would also be considered as minor. All appropriate stakeholders will be provided details of the modification. The majority of such changes could likely be dealt with during the detailed design phase and would remain the responsibility of the proponent to ensure that all relevant issues are taken into account.

10.2 Major Changes

Major changes may be defined as those which change the intent of the EA or appreciably change the expected net impacts associated with the project. An example of a major change would result from a proposed shift in a preferred design alignment or configuration which would warrant changes in mitigation as described in the EA and affect other landowners. If the proposed modification is major, the recommendations and conclusions in this report would require updating. An addendum to the EA would be required to document the change, identify the associated impacts and mitigation measures and allow related concerns to be addressed and reviewed by the appropriate stakeholders.

The preferred servicing solution developed in this MSS presents a high level trunk servicing solution to illustrate the feasibility of servicing the concept plan and guide the final design process, but does not attempt to provide detailed design on a street by street basis. This more detailed level of design will be completed as part of the plan of subdivision or Site Plan Application process when site specific details such as individual lotting, building configurations, and final geotechnical information will be available. This more rigorous level of analysis will undoubtedly result in adjustments to the design presented in this MSS. These adjustments are to be expected as the design evolves in detail and can be dealt with as described above.

10.3 Phasing

Phasing of development of the CFB Rockcliffe site is determined by several key servicing factors which dictate the logical progression of development. Two principal services with limited initial phasing flexibility are the supply of water and vehicular access. In order to provide the necessary

access and redundancy both these services require the extension of Codd's Road and Burma Road connections.

An initial development phase will also require a sanitary outlet and stormwater outlet. The former CFB Rockcliffe site is fortunate to have three existing sanitary outlets in the form of three connection points to a main sanitary collector sewer, one of which is centrally located slightly west of Codd's Road and is known as the Codd's Road Shaft. This central sanitary outlet will provide an efficient and cost effective wastewater outlet for an initial phase of development which recognizes the water and vehicular access constraints. In order to provide a stormwater outlet for the initial phase of development defined by the water and vehicular requirements, it will be necessary to construct the Eastern SWM Facility and associated outlet, including the trunk storm sewer connecting to this pond.

An integral part of the phasing strategy for a staged build out of the CFB Rockcliffe site will be recognition of the sanitary and storm sewers within the proposed development area which must remain in service to outlet the Montfort Hospital, the NRC Campus, and the Thorncliffe development. **Figure 6.17** and **Figure 6.18** and **Figure 6.34** identify these sewers and potential points of interception with new servicing as part of the construction of Phase 1A and 1. **Figure 1.6** illustrates the initial phasing plan for the entire development area and **Figure 4.9**, **Figure 6.17**, **Figure 6.18** and **Figure 6.34** illustrate the municipal services required to support Phase 1A and ultimately Phase 1 as currently proposed.

11 Conclusion

11.1 General

This report provides a planning-level functional design to service the former CFB Rockcliffe site. A servicing design is included to facilitate future detail design work. The servicing solutions presented herein are not intended to be absolute but rather provide specific guidelines for site infrastructure development while recognizing some flexibility is potentially possible over the life of the total development.

Some watermain off-site infrastructure may require upgrades to bring the pressure zone, which includes the former CFB Rockcliffe site, to the City's desired level of service. The City's 2013 Master Water Plan Update (MWP) recognizes this situation and accordingly recommends another watermain feed along Montreal Road to the Brittany Drive Water Pump Station and capacity improvements to both that station and the Montreal Road Water Pump Station.

Although Hydro Ottawa has existing services adjacent to the site, it most likely will have to extend external plant to the site from either the Moulton sub-station or the Overbrook sub-station to meet the service requirements of the former CFB Rockcliffe site.

This report has been completed in accordance with the Municipal Class Environmental Assessment process. Principal findings and recommendations of the Master Servicing Study are summarized below.

11.2 Water Distribution

- The existing external water plant along Montreal Road and Brittany Drive has sufficient capacity to service the pressure zone, but does not currently meet the City's guidelines for reliability redundancy and accepted level of service.
- External watermain improvements are needed to meet long term level of service guidelines for the pressure zone including the former CFB Rockcliffe site.
- The 2013 Water Master Plan has identified the following external improvements to service the pressure zone and the proposed development.
    - P-01 Brittany Drive PS – add 22 ML/d capacity – 2013
    - C-03 Brittany Drive PS – 400 mm diameter Montreal Road watermain – between St. Laurent Boulevard and Brittany Drive – 2013
- Replace all existing site watermains
- Two new 400 mm diameter watermains extended from Montreal Road into the site along Codd's Road and Burma Road will provide water to the subject site.
- Portions of the site, especially west of Codd's Road and in Block 44, will experience pressures above 80 psi and pressure reduction with the use of individual pressure reducing valves (PRVs) is recommended in those areas.
- For the construction of Phase 1A, a piping loop through Main Street with connections to the existing Montreal Road watermain from Codd's Road and Burma Road recommended to provide sufficient water supply and fire flow.

  The proposed piping through the Special Design Area in this development is conceptual as no defined road layout or rights of way have been identified at this time. For the purposes of hydraulic modelling, the watermains shown to loop/go through these areas

are intended to demonstrate the need for water and looping through the area. The exact location and looping of these watermains will be determined upon detailed design.

In regards to the future museum, a review determined that although it is located on low-lying lands, it is not feasible to service this area through Zone 1E. The past CFB evaluation of this area ruled out the interconnection from Zone 1E, as it cannot provide pressure greater than 50 psi per the Level of Service requirements. Since pressures are not expected to exceed 100 psi in the proposed watermains that the museum service lines would connect to, it is recommended that the future museum be serviced by Zone MONT pressures with appropriate pressure reducing measures along the service to the museum.

- The site servicing can be completed by installing a series of small diameter watermains following the proposed road layout.

11.3 Wastewater Collection

- Most of the existing sanitary and combined sewers will be removed and replaced with new sanitary sewers, mostly in the new roadways.
- The wastewater outlet for the site is the existing Ottawa Interceptor Outfall Sewer (IOS). The IOS has three existing connection locations on or adjacent to the site.
- Two existing pullback sewers which are currently connected to the IOS will be used as wastewater outlets. It is proposed to re-use portions of both the Alvin Heights and Airbase Pullback Sewers as well as the RCAF Pullback Sewer.
- The existing connection to the Codd's Road shaft will be modified to accommodate the proposed wastewater plan.
- Existing wastewater flows from both the Montfort Hospital and Thorncliffe Village will be captured in the proposed site sewers and re-routed to the IOS.
- Wastewater capacity will also be provided for the potential urbanization of the external Fairview development, and wastewater flows from the potential future museum site can be routed directly to the Airbase Outlet Sewer.
- No wastewater capacity will be provided for the NRC Campus.
- While the new site development will be serviced with gravity sewers, the new sanitary infrastructure will provide an allowance of 29 l/s for the existing RCAF Pump Station.

11.4 Stormwater Management System

- The stormwater management system incorporates standard urban drainage design and stormwater management features, including a dual drainage concept, which accommodates minor and major flow, and two end-of-pipe stormwater management facilities.
- The dual drainage design and the end-of-pipe SWM facilities have been designed in accordance with City of Ottawa and MOE design guidelines.
- The Eastern SWM Facility provides water quality treatment of urban runoff, outletting to the Ottawa River via a new storm sewer. The Western SWM Facility provides water quality and quantity treatment of urban runoff, outletting to the Ottawa River via the Western Creek.
- The Burma Road SWM Facility will be retrofitted as part of the redevelopment, contributing to a reduction in storm sewer sizes in the development.

- Three dry ponds and one channel will be constructed for surface storage and routing. Each of these features will alleviate surface flow and reduce storm sewer sizes.

11.5 Utility Infrastructure

- Each utility company (Hydro Ottawa, Enbridge Gas, Bell Canada and Rogers Ottawa) has confirmed availability of capacity either adjacent to the site or can be extended to the site.
- The existing 4Kv power circuit between Lang's Road and the RCAF Pump Station must be maintained during site development.

Prepared by

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APPENDIX A

MSS TERMS OF REFERENCE

File: 32952-5.3.1

FINAL (MAY 24, 2013)
Rockcliffe CLC Community Design Plan
Site Servicing Report – Terms of Reference

Introduction:

Canada Lands Company (CLC) is renewing a planning and consultation process to redevelop the lands formally known as Canadian Forces Base (CFB) Rockcliffe in Ottawa. The 310 acres (125 hectares) of the Rockcliffe site are located on an escarpment in the heart of the city.

The general Rockcliffe area is bounded by:

- Rockcliffe Parkway to the north;
- National Research Council to the east;
- Montfort Hospital and various commercial and residential developments along Montreal Road to the south;
- Aviation Parkway to the west.

The project elements covered by this scope of work include evaluation of water and wastewater infrastructure, on-site stormwater drainage, and utility infrastructure for the development area. The intent is to complete this work in coordination with development of the land use plan through a parallel EA process with the Community Design Plan (CDP) planning process. Under this process, the inventory of existing conditions, evaluation of alternatives and the selection of the preferred solutions will be completed in concert with the development and evolution of the land use plan, and the Transportation Master Plan (TMP). All plans would be finalized at the same time, taking into account the two-way feedback between the various components. Current City of Ottawa Sewer and Water Design Guidelines will be followed when designing wastewater collection system and water distribution system including relevant geotechnical information related to sanitary and storm sewer and water construction in accordance with the City of Ottawa Geotechnical Investigation and Reporting Guidelines.

The scope of work is summarized on the following pages and will include input from all pertinent agencies, including the City of Ottawa, Rideau Valley Conservation (RVCA), Ministry of Natural Resources (MNR), and Ministry of the Environment (MOE). The scope of work is general in nature with the intent that work will be undertaken in a manner that will satisfy the requirements of Phases 1 and 2 of the EA process as well as City and agency requirements.

Objectives:

The process to be followed for each element of the study would be the EA planning process for Phase 1 & 2 including:

- Inventory of existing conditions, opportunities and constraints;
- Evaluation of alternatives;
- Selection of preferred alternative.

The process will include the necessary coordination with the Community Design Plan, Community Transportation Study, and pertinent Environmental and Geotechnical Studies, as well as the required public contact and documentation. In addition to satisfying the EA process requirements, the analysis will identify the impact of the proposed development on the environment, and both existing and planned infrastructure.

A comprehensive analysis of the planning alternatives will be completed and documented, in support of the preferred servicing alternative. A cost-benefit analysis will be prepared as part of the evaluation. Development of the preferred alternatives will include identification of specific projects or project modifications that will be required in support development, including the approval process, costs, phasing, and probable timelines. Any interim solutions will also be identified at this point. The study will be completed in accordance with the following key principles for successful environmental assessment planning:

- Consultation;
- Analysis of off-site impacts on existing infrastructure;
- Develop a reasonable servicing alternative for on-site services for each of the planning concepts;
    - Evaluation of stormwater management alternatives will be summarized in the servicing document.
    - Watermains, storm sewers, and sanitary sewer distribution system options that are within proposed road corridors are deemed to have no measurable variables with respect to the environment or social impact, and therefore, the most efficient network will generally be presented.
- Consider the impact on all aspects of the environment (social, fiscal, and natural);
- Systematic evaluation;
- Clear documentation;
- Traceable decision making.

Existing Conditions:

An inventory of existing conditions for the study area will be prepared including:

1. Land Ownership Plan with boundary information.
2. Air photo.
3. Topographical mapping.
4. A drawing with all existing water, wastewater, storm, and utility plant. The plan will include existing facilities, planned facilities, and modelling information on both the existing conditions and planned growth.
5. An inventory of existing natural environment conditions will be prepared including preparation of a Preliminary Geotechnical Report addressing soil parameters required to develop and assess stormwater management criteria, and soil conditions at all potential stormwater management facility locations. These findings will be used, as appropriate, to develop servicing solutions. The resulting information will be consolidated into a separate Existing Conditions Plan and Report that will identify specific constraints and opportunities in the study area. In turn, this will be used to develop a Land Use Plan, and to guide preparation of the alternative servicing solutions.

Wastewater:

Following is the proposed wastewater evaluation process: The capacity and condition of existing infrastructure will be identified through analysis and evaluation of information provided by the City. The connection point and method of connection to the City existing trunk network will be determined. This analysis will include liaising with City staff to investigate the need for additional future access points to the existing IOS tunnel and the need to provide for ultimate twinning of this sewer (including access locations and possible odour control requirements). Design alternatives will be investigated and analyzed, operational issues will be part of the evaluation, sewer sizes, evaluations, grades and catchment boundaries are to be shown on drawings. An Overall Servicing Plan will be prepared that shows the water, wastewater and stormwater infrastructure. The analysis and solutions will identify any pump station requirements, locations and elevations, overflows, HGL analysis and redundancy requirements. Servicing conflicts and water crossing requirements will be identified. Operational issues will be considered (i.e. initial low flow, corrosion, etc.).

Water:

The currently proposed infrastructure for the area may be found in the City's Water Master Plan Update, and in recent design studies related to the Montreal Road Pressure Zone.

It is proposed that low and high unit water demand rates will be utilized to determine the sensitivity of the staging/phasing plan to water demands.

The scope of work for water will consist of the following primary items:

- System level and subdivision level demand sets will be determined considering two development scenarios (base and aggressive). The City will provide unit demand rates for the determination of demands, including fire flows.

- The City will provide their recently updated water system hydraulic model and the Consultant will modify the City model to represent the development as lumped demands linked to existing system via expected connection points. The City will provide growth information outside Zone MTL that could impact infrastructure supplying this area.

- Evaluate hydraulics using "system level" demands considering various scenarios (projected development, zone configuration and supply point options) and reliability/redundancy needs. This will include base and aggressive development scenarios and alternative zone configurations. It is not expected that the demands within the CLC Lands will vary significantly from previous studies and analyses, and as such, significant changes to the distribution system supplying this area are not anticipated. Our work plan considers that this exercise will be limited to confirming existing and previously proposed infrastructure needs and that only minor changes may be needed. If demands vary significantly, additional effort beyond that estimated herein may be required.

- Review with the City if there is a need for elevated storage in the Zone MTL pressure zone (it is expected that an elevated tank will not be required).

- Assess alternatives, considering off-site impacts (suction feedermain and PS capacities). Life-cycle costs will be considered in the evaluation (e.g. consider power and O&M costs that the City will have to take on).

- Prepare a high level conceptual design of Montreal Road and Britanny Drive PS upgrades, and select preferred alternatives. The conceptual design will consist of recommendations for pump sizing and types (with phasing/staging of new pump units), overall power requirements, external supply & discharge piping and a layout of the building structure and property for both pump stations. Our level of effort is based on the assumption that significant changes to previously proposed works will not be required – this is predicated on water demands that are reasonably consistent with previous studies for this area.

- A formal presentation will be made to City staff to present development concept, servicing options, evaluation of alternatives and preferred alternatives.

- The preferred solutions will be modified as required to reflect City comments - updates will also be made if necessary based on revised development information.

- The report will include the following (plans/recommendations as applicable):

    - Plan of conceptual skeleton on-site network showing pipe sizing, connection points, zone delineation, PRVs, pump station, as applicable
    - Confirmation of previously proposed routing of any off-site watermains
    - Expected pressure range in each sub-zone

- Identification of any additional upgrades needed for the MTL zone pump stations, beyond current recommendations
- Phasing plan
- Operations under emergency conditions – short and long term conditions
- Costs for off-site works, identifying any "benefit to existing" contributions.

Storm Drainage:

The following is the proposed scope of work for stormwater servicing:

- Prepare a Servicing Plan of the internal storm sewer network with a solution for both the major and minor drainage systems.
- Analyse the 100-year storm sewer hydraulic grade line.
- Ensure conformance to the Grade Control Plan and any grade raise restrictions.
- Identify the major system storage requirements (surface ponding) and identify stormwater management design criteria specific to the Rockcliffe drainage area including water quality, water balance/runoff volume, flood control and erosion control criteria, all as required by the environmental and existing infrastructure constraints identified on and downstream of the site.
- Integrate the design with findings from Environmental studies for the area.
- Establish, in conjunction with wastewater and water services, a preferred minor system (storm sewer) sizing and configuration plan including profiles with HGL, original ground and proposed grade that is free of conflicts from other infrastructure components. Sizing will be performed using a combination of Rational Method spreadsheets and/or hydrologic/hydraulic modelling (SWMHYMO/XP-SWMM).
- Hydraulic grade line elevations are to be provided for the 5-year and 100-year storms along the recommended trunk sewer alignments.
- Peak flow and depth of flow along the major-system for the 100-year storm are to be provided for road sections identified as major corridors of the overland flow system to ensure compliance with Sewer Design Guidelines criteria.
- Establish a functional-level design for SWM facilities identifying the preferred sizing, configuration and operating levels, using the recommendations of the MOE, and City of Ottawa Design Guidelines. Sediment drying areas, access roads, as well as inlet and outlet structures will be presented on an individual figure with a cross section of the facility.
- Characterize and delineate the overall catchment area and constraint boundaries (detailed topography, environmental protection zones, flood plain, embankment areas, geotechnical constraints, aquatic habitat conditions, existing land uses, etc.).
- Identify and evaluate innovative lot level and conveyance measures which may potentially form part of the overall stormwater management concept for Rockcliffe on a pilot project basis. Prepare conceptual applications specific to the Rockcliffe site and liaise with City staff to identify specific applications to be applied on private and/or public property. Determine whether preferred innovative measures are to be applied on a phase by phase basis or on a community wide basis. Develop criteria to evaluate the performance of individual innovative measures. Develop a proposed monitoring program for each approved application.

Additional specific issues that will be addressed include:

1. Discussions with City staff will be required in regards to the design events and criteria to be used in determining the major-minor drainage. Dynamic modelling will be used to simulate and evaluate the preferred alternative.
2. The proposed surface elevations, HGL, pipe sizes, slopes and obvert/invert elevations will be presented on the Storm Drainage Area Plan.
3. Preferred SWM Facility locations will be identified, with consideration for using rural lands. (NCC Lands) including liaising with NCC to confirm any assumptions which include NCC Lands.
4. The Drainage and Wastewater Services Division will be circulated, with ongoing coordination to ensure their requirements are met and implemented.

Shallow Utilities:

- The final Servicing Report will include a summary of shallow utility requirements to support the preferred Concept Plan as identified through the CDP process. Meetings will be held with Hydro, Bell, Cablevision and Consumer Gas to identify existing major infrastructure, off-site upgrades (if required) to support the proposed development, preferred routing of major feeds within the CDP area, and potential phasing of these works in accordance with the proposed development phasing plan.

Process:

As noted above, the Site Servicing Report will be developed through a step-by-step process, in parallel with the Community Design Plan (CDP), and Community Transportation Study (CTS) through Phases 1 and 2 of the EA process. The process is iterative and incremental by its very nature as alternative solutions are developed, analyzed and discussed amongst the stakeholder groups.

Reporting alternatives and conclusions will be completed in stages. A consolidated report documenting the process, outlining the solutions, and classifying the various required projects will be the final product. The impact on planned and existing infrastructure will be identified. Any upgrades, whether new or incremental, will be determined. Alternative and selected solutions will be developed. The analysis and solutions will be developed in accordance with City of Ottawa criteria and practices. The resulting documentation will identify timing, costs and staging of major infrastructure works, including any interim solutions. The approval requirements and process for implementation will also be outlined.

Deliverables:

The deliverables for the project include:

A detailed Site Servicing Report prepared following the requirements of the Class EA process that details storm drainage, wastewater, and water infrastructure needs in support of the proposed development. This report will include but not be limited to:

1. Master Grade Plan(s), identifying fill constraint areas;
2. Major System Flow Routing Plan;
3. Trunk Storm Sewer Distribution Plan;
4. Trunk Sanitary Distribution Plan;
5. Trunk Water Distribution Plan;
6. Master Stormwater Management Plan, including conceptual SWM facility designs;
7. Digital copies of all models used for the analysis of the proposed infrastructure;
8. Geotechnical Report.

APPENDIX B

2013 IMP WASTEWATER COLLECTION SYSTEM ASSESSMENT:

2060 PUMP STATION RESULTS

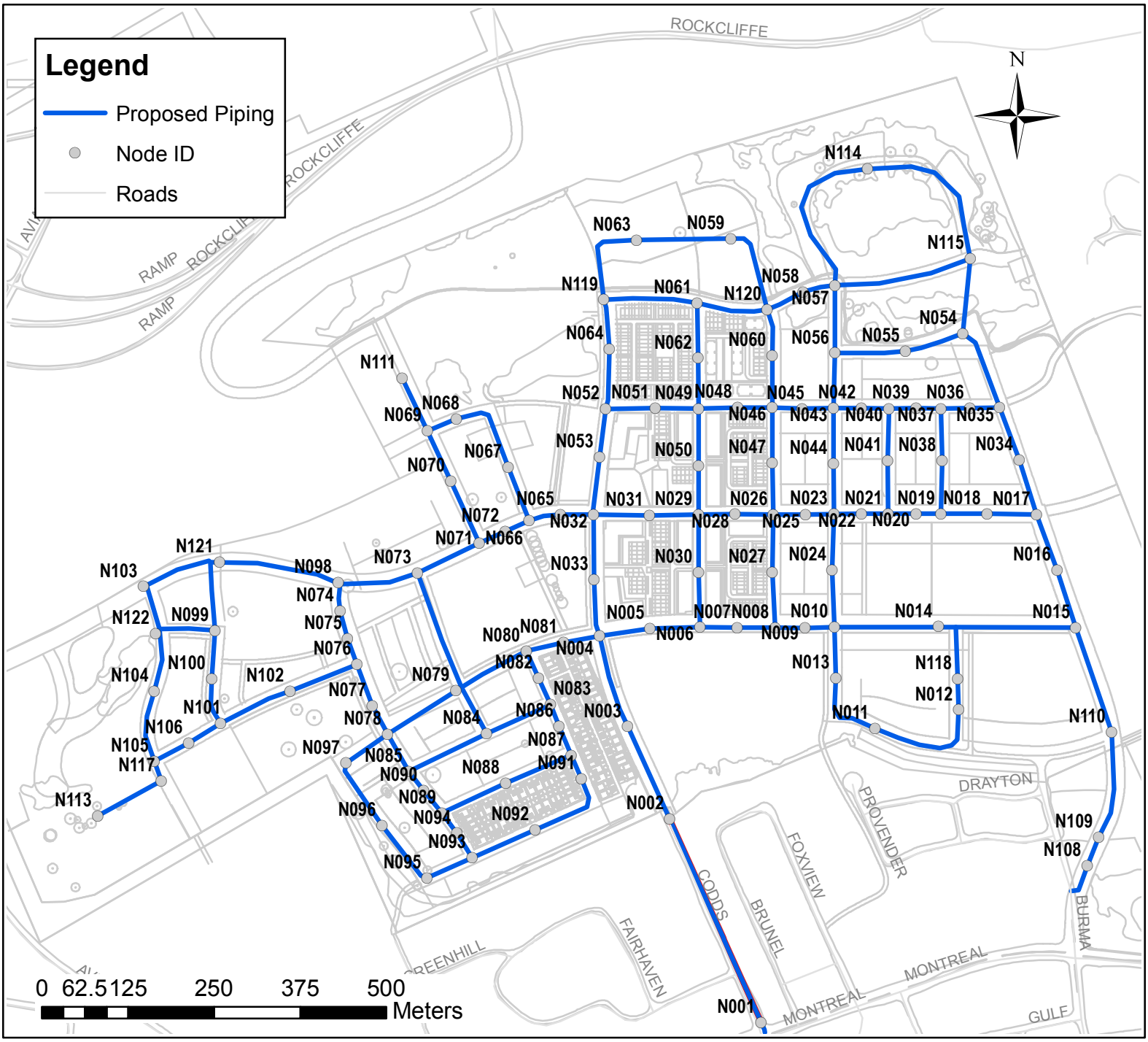
Table 6-2 - 2060 Pump Station Results

Pump Station Name	Future Firm Capacity[a]	Design Event		Hurricane Frances	
		Modeled Peak Flow	Residual Capacity	Modeled Peak Flow	Residual Capacity
	(L/sec)	(L/sec)	(L/sec)	(L/sec)	(L/sec)
Acres	5,200	4,218	982	4,668	532
Briarridge	175	116	59	135	40
Carp	91	90	1	105	(14)
Forest Valley	385	213	172	243	142
Hazeldean	1,225	688	537	732	493
Hemlock	300	249	51	328	(28)
Kanata West	1,253	1,125	128	1,224	29
Leitrim	**381**	**552**	(171)	**622**	(241)
Manotick	322	292	30	355	(33)
March	TBD	586	N/A	623	N/A
RCAF	29	2	27	2	27
RCMP	**12**	**23**	(11)	**33**	(21)
ROPEC Raw Sewage Pump Station	9,861	9,324	537	9,748	114
Signature Ridge	360	169	191	195	165
Stittsville	**108**	**249**	(141)	**272**	(164)
Tartan	216	81	135	111	105
Tenth	**424**	**541**	(117)	**616**	(192)
The following Pump Station have flow restrictions in place or are triggered during wet weather events.					
Crystal Beach[b]	280	434	(154)	541	(261)
Munster1	30	23	7	31	(1)
Richmond[c]	360	401	(41)	497	(137)
Rideau River[d]	1,493	1,081	412	1,278	215
Woodroffe[e]	540	639	(99)	825	(285)

[a] *Future firm capacities as provided by City*
[b] *Diversion from West Nepean to Acres Pump Station.*
[c] *Excess sent to lagoon.*
[d] *Siphon operation is to be triggered by peak DWF greater than 97L/s.*
[e] *Diversion from Woodroffe Collector/West Nepean to Lynwood Trunk.*
Red brackets identify locations without sufficient residual capacity

APPENDIX C

WATER DISTRIBUTION SYSTEM: HYDRAULIC MODELING RESULTS


Legend
Proposed Piping
Node ID
Roads
N
ROCKCLIFFE
RAMP
ROCKCLIFFE
RAMP
ROCKCLIFFE
N114
N115
N063
N059
N119
N061
N120
N058
N057
N054
N064
N062
N060
N056
N055
N111
N052
N051
N049
N048
N045
N042
N039
N036
N069
N068
N046
N043
N040
N037
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N053
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N121
N073
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N118
N079
N083
N012
N077
N101
N078
N084
N086
N003
N011
N110
N106
N105
N097
N085
N087
N117
N090
N088
N091
N109
N113
N089
N002
N096
N094
N092
N108
N093
N095
N001
DRAYTON
PROVENDER
FOXVIEW
CODDS
BRUNEL
FAIRHAVEN
MONTREAL
MONTREAL
BURMA
GULE
0 62.5 125 250 375 500
Meters

BSDY & MXDY Analysis with MRPS at Max. Discharge HGL = 147m

	BSDY		MXDY	
ID	Max Pressure (psi)	Min Pressure (psi)	Max Pressure (psi)	Min Pressure (psi)
N001	62.99	55.65	62.98	56.39
N002	72.31	64.97	72.31	65.71
N003	82.44	75.08	82.43	75.82
N004	84.74	77.37	84.74	78.11
N005	84.90	77.53	84.90	78.27
N006	83.19	75.82	83.19	76.56
N007	83.19	75.82	83.19	76.55
N008	82.60	75.23	82.60	75.96
N009	83.18	75.81	83.18	76.55
N010	81.92	74.55	81.92	75.29
N011	81.21	73.84	81.21	74.58
N012	81.21	73.85	81.21	74.58
N013	81.93	74.56	81.93	75.30
N014	79.65	72.29	79.65	73.03
N015	78.06	70.72	78.06	71.46
N016	76.52	69.17	76.52	69.91
N017	75.83	68.46	75.83	69.20
N018	75.66	68.29	75.66	69.03
N019	76.21	68.83	76.20	69.57
N020	77.39	70.01	77.39	70.75
N021	77.85	70.47	77.85	71.21
N022	78.92	71.55	78.92	72.28
N023	80.58	73.20	80.58	73.94
N024	82.20	74.82	82.20	75.56
N025	82.28	74.90	82.27	75.63
N026	83.14	75.76	83.14	76.50
N027	84.13	76.76	84.13	77.49
N028	83.52	76.14	83.51	76.87
N029	83.61	76.23	83.60	76.96
N030	84.36	76.98	84.36	77.72
N031	84.15	76.77	84.15	77.51
N032	84.17	76.79	84.17	77.53
N033	84.68	77.30	84.68	78.04
N034	75.97	68.60	75.97	69.34
N035	76.76	69.39	76.76	70.13
N036	76.81	69.43	76.81	70.17
N037	76.88	69.50	76.88	70.24
N038	76.47	69.09	76.47	69.83
N039	77.31	69.93	77.31	70.67
N040	77.85	70.47	77.85	71.21
N041	78.20	70.82	78.20	71.56
N042	78.09	70.71	78.09	71.45
N043	78.22	70.85	78.22	71.58
N044	80.52	73.14	80.52	73.88
N045	79.72	72.34	79.72	73.08
N046	82.48	75.10	82.48	75.84
N047	81.99	74.61	81.99	75.35
N048	81.87	74.49	81.87	75.23
N049	82.03	74.65	82.03	75.38

	BSDY		MXDY	
ID	Max Pressure (psi)	Min Pressure (psi)	Max Pressure (psi)	Min Pressure (psi)
N050	81.38	74.00	81.38	74.74
N051	82.10	74.72	82.10	75.46
N052	80.66	73.28	80.65	74.01
N053	82.81	75.43	82.81	76.17
N054	80.01	72.64	80.01	73.37
N055	80.13	72.75	80.13	73.49
N056	81.61	74.23	81.60	74.96
N057	86.86	79.48	86.86	80.22
N058	85.08	77.70	85.08	78.44
N059	79.59	72.20	79.58	72.94
N060	82.83	75.45	82.83	76.19
N061	82.35	74.97	82.35	75.71
N062	80.78	73.40	80.78	74.14
N063	83.74	76.36	83.74	77.09
N064	83.84	76.46	83.84	77.19
N065	84.08	76.70	84.08	77.43
N066	84.25	76.86	84.25	77.60
N067	82.50	75.11	82.50	75.84
N068	86.30	78.90	86.30	79.64
N069	87.43	80.03	87.43	80.77
N070	83.17	75.77	83.16	76.51
N071	85.87	78.48	85.87	79.21
N072	83.90	76.51	83.90	77.24
N073	88.35	80.95	88.34	81.69
N074	90.15	82.75	90.15	83.49
N075	90.42	83.02	90.41	83.75
N076	89.88	82.48	89.88	83.22
N077	88.07	80.67	88.07	81.41
N078	88.09	80.70	88.09	81.43
N079	87.27	79.88	87.27	80.62
N080	86.16	78.77	86.16	79.51
N081	85.50	78.12	85.50	78.85
N082	85.61	78.22	85.61	78.95
N083	85.62	78.23	85.62	78.96
N084	86.96	79.57	86.96	80.30
N085	87.75	80.36	87.75	81.09
N086	85.56	78.17	85.56	78.90
N087	84.50	77.11	84.50	77.84
N088	85.43	78.04	85.43	78.77
N089	87.17	79.77	87.16	80.51
N090	87.42	80.03	87.42	80.76
N091	83.85	76.46	83.85	77.20
N092	83.77	76.38	83.77	77.11
N093	84.43	77.04	84.43	77.77
N094	86.31	78.92	86.31	79.65
N095	85.50	78.11	85.50	78.84
N096	87.76	80.36	87.75	81.10
N097	89.45	82.06	89.45	82.79
N098	91.53	84.13	91.52	84.86
N099	92.14	84.74	92.14	85.48

	BSDY		MXDY	
ID	**Max Pressure (psi)**	**Min Pressure (psi)**	**Max Pressure (psi)**	**Min Pressure (psi)**
N100	93.54	86.13	93.53	86.87
N101	93.75	86.35	93.75	87.08
N102	91.26	83.86	91.26	84.60
N103	93.52	86.11	93.51	86.85
N104	94.12	86.72	94.12	87.45
N105	91.38	83.97	91.37	84.71
N106	92.95	85.55	92.95	86.28
N108	78.16	70.91	78.16	71.66
N109	78.38	71.12	78.38	71.86
N110	78.66	71.36	78.66	72.10
N111	90.82	83.42	90.81	84.16
N113	91.27	83.87	91.27	84.60
N114	91.80	84.42	91.80	85.16
N115	90.31	82.93	90.31	83.67
N117	92.50	85.10	92.50	85.83
N118	81.29	73.93	81.29	74.66
N119	87.69	80.31	87.69	81.04
N120	84.09	76.71	84.09	77.45
N121	87.97	80.57	87.97	81.30
N122	96.12	88.72	96.12	89.45

MXDY+FF Analysis with MRPS at Max. Discharge HGL = 147m

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
N001	0.11	62.9	147.0	13,000	43.4	18,901	20
N002	0.05	72.3	147.0	13,000	51.6	22,380	20
N003	0.05	82.4	147.0	13,000	61.5	27,531	20
N004	0.05	84.7	147.0	13,000	63.7	28,357	20
N005	0.07	84.9	147.0	13,000	62.5	26,183	20
N006	0.07	83.2	147.0	13,000	60.6	25,193	20
N007	0.20	83.2	147.0	13,000	60.3	24,752	20
N008	0.07	82.6	147.0	13,000	59.9	24,681	20
N009	0.07	83.2	147.0	13,000	60.2	24,639	20
N010	0.07	81.9	147.0	13,000	59.0	24,153	20
N011	0.07	81.2	147.0	13,000	37.8	15,457	20
N012	0.07	81.2	147.0	13,000	42.2	16,321	20
N013	0.07	81.9	147.0	13,000	48.7	17,808	20
N014	0.07	79.6	147.0	13,000	56.2	22,254	20
N015	0.07	78.0	147.0	13,000	57.5	25,934	20
N016	0.07	76.5	147.0	13,000	55.6	24,552	20
N017	0.07	75.8	147.0	13,000	54.7	23,871	20
N018	0.20	75.6	147.0	13,000	53.3	21,465	20
N019	0.07	76.2	147.0	13,000	53.8	21,778	20
N020	0.07	77.4	147.0	13,000	54.9	22,366	20
N021	0.07	77.8	147.0	13,000	55.5	22,997	20
N022	0.07	78.9	147.0	13,000	56.7	23,725	20
N023	0.07	80.6	147.0	13,000	58.9	25,322	20
N024	0.07	82.2	147.0	13,000	53.2	18,901	20
N025	0.20	82.3	147.0	13,000	60.2	25,469	20
N026	0.07	83.1	147.0	13,000	61.1	25,990	20
N027	0.07	84.1	147.0	13,000	55.0	19,254	20
N028	0.20	83.5	147.0	13,000	61.1	25,560	20
N029	0.07	83.6	147.0	13,000	61.5	25,999	20
N030	0.07	84.3	147.0	13,000	55.3	19,374	20
N031	0.07	84.1	147.0	13,000	61.7	25,819	20
N032	0.07	84.1	147.0	13,000	63.0	27,759	20
N033	0.07	84.7	147.0	13,000	63.5	27,933	20
N034	0.20	75.9	147.0	13,000	54.6	23,565	20
N035	0.20	76.7	147.0	13,000	55.4	23,969	20
N036	0.20	76.8	147.0	13,000	55.4	23,893	20
N037	0.20	76.9	147.0	13,000	55.5	23,927	20
N038	0.20	76.4	147.0	13,000	48.0	18,254	20
N039	0.20	77.3	147.0	13,000	55.9	24,141	20
N040	0.20	77.8	147.0	13,000	56.4	24,485	20
N041	0.20	78.2	147.0	13,000	49.7	18,497	20
N042	0.20	78.1	147.0	13,000	56.7	24,660	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
N043	0.20	78.2	147.0	13,000	56.9	24,887	20
N044	0.20	80.5	147.0	13,000	58.2	24,323	20
N045	0.20	79.7	147.0	13,000	58.3	25,466	20
N046	0.20	82.5	147.0	13,000	61.1	26,690	20
N047	0.20	82.0	147.0	13,000	53.4	19,004	20
N048	0.20	81.9	147.0	13,000	60.4	26,290	20
N049	0.20	82.0	147.0	13,000	60.5	26,368	20
N050	0.20	81.4	147.0	13,000	52.9	18,940	20
N051	0.20	82.1	147.0	13,000	60.6	26,315	20
N052	0.17	80.6	147.0	13,000	59.2	25,799	20
N053	0.17	82.8	147.0	13,000	61.4	26,838	20
N054	0.20	80.0	147.0	13,000	56.8	22,758	20
N055	0.20	80.1	147.0	13,000	49.1	18,127	20
N056	0.20	81.6	147.0	13,000	59.1	24,553	20
N057	0.20	86.8	147.0	13,000	64.2	26,500	20
N058	0.20	85.1	147.0	13,000	62.0	25,281	20
N059	0.20	79.6	147.0	13,000	39.9	15,951	20
N060	0.20	82.8	147.0	13,000	54.5	19,377	20
N061	0.20	82.3	147.0	13,000	58.8	23,498	20
N062	0.20	80.8	147.0	13,000	51.9	18,751	20
N063	0.20	83.7	147.0	13,000	43.5	16,420	20
N064	0.17	83.8	147.0	13,000	60.6	24,487	20
N065	0.17	84.1	147.0	13,000	61.4	25,452	20
N066	0.17	84.2	147.0	13,000	60.7	24,282	20
N067	0.17	82.5	147.0	13,000	44.8	16,782	20
N068	0.17	86.3	147.0	13,000	42.0	15,966	20
N069	0.17	87.4	147.0	13,000	43.6	16,196	20
N070	0.17	83.1	147.0	13,000	43.8	16,519	20
N071	0.17	85.8	147.0	13,000	61.5	24,009	20
N072	0.17	83.9	147.0	13,000	59.8	23,443	20
N073	0.17	88.3	147.0	13,000	63.7	24,562	20
N074	0.17	90.1	147.0	13,000	62.9	22,377	20
N075	0.17	90.4	147.0	13,000	47.0	16,638	20
N076	0.17	89.9	147.0	13,000	62.6	22,252	20
N077	0.17	88.0	147.0	13,000	61.8	22,691	20
N078	0.05	88.1	147.0	13,000	63.0	24,005	20
N079	0.05	87.3	147.0	13,000	63.0	24,596	20
N080	0.05	86.1	147.0	13,000	62.4	24,832	20
N081	0.05	85.5	147.0	13,000	62.8	25,988	20
N082	0.05	85.6	147.0	13,000	61.0	23,529	20
N083	0.05	85.6	147.0	13,000	60.8	23,337	20
N084	0.05	86.9	147.0	13,000	62.1	23,782	20
N085	0.05	87.7	147.0	13,000	62.6	23,773	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
N086	0.05	85.5	147.0	13,000	60.1	22,493	20
N087	0.05	84.5	147.0	13,000	58.6	21,510	20
N088	0.05	85.4	147.0	13,000	58.4	20,781	20
N089	0.05	87.1	147.0	13,000	61.2	22,644	20
N090	0.05	87.4	147.0	13,000	61.7	23,011	20
N091	0.05	83.8	147.0	13,000	57.1	20,558	20
N092	0.05	83.7	147.0	13,000	56.0	19,979	20
N093	0.05	84.4	147.0	13,000	57.4	20,587	20
N094	0.05	86.3	147.0	13,000	59.7	21,565	20
N095	0.05	85.5	147.0	13,000	56.1	19,524	20
N096	0.05	87.7	147.0	13,000	55.5	18,788	20
N097	0.05	89.4	147.0	13,000	54.7	18,408	20
N098	0.17	91.5	147.0	13,000	63.3	21,940	20
N099	0.17	92.1	147.0	13,000	61.0	20,212	20
N100	0.17	93.5	147.0	13,000	57.0	18,508	20
N101	0.17	93.7	147.0	13,000	63.1	20,742	20
N102	0.17	91.2	147.0	13,000	61.8	20,842	20
N103	0.17	93.5	147.0	13,000	60.4	19,560	20
N104	0.17	94.1	147.0	13,000	61.3	19,841	20
N105	0.17	91.4	147.0	13,000	58.9	19,420	20
N106	0.17	92.9	147.0	13,000	61.2	20,109	20
N108	0.20	78.2	147.0	13,000	59.3	29,049	20
N109	0.20	78.4	147.0	13,000	59.2	28,533	20
N110	0.07	78.6	147.0	13,000	58.6	27,151	20
N114	0.20	91.8	147.0	13,000	46.0	16,361	20
N115	0.20	90.3	147.0	13,000	66.3	25,961	20
N117	0.166	92.5	147.0	13,000	49.734	17,036	20
N118	0.071	81.3	147.0	13,000	47.898	17,670	20
N119	0.2	87.7	147.0	13,000	64.013	25,497	20
N120	0.2	84.1	147.0	13,000	61.101	24,993	20
N121	0.166	87.9	147.0	13,000	57.304	19,507	20
N122	0.166	96.1	147.0	13,000	63.748	20,446	20

BSDY & MXDY Analysis with MRPS at Max. Discharge HGL = 143m

	BSDY		MXDY	
ID	Max Pressure (psi)	Min Pressure (psi)	Max Pressure (psi)	Min Pressure (psi)
N001	57.36	55.65	57.36	56.39
N002	66.67	64.97	66.66	65.71
N003	76.79	75.08	76.78	75.82
N004	79.09	77.37	79.09	78.11
N005	79.25	77.53	79.25	78.27
N006	77.54	75.82	77.54	76.56
N007	77.54	75.82	77.54	76.55
N008	76.95	75.23	76.95	75.96
N009	77.53	75.81	77.53	76.55
N010	76.27	74.55	76.27	75.29
N011	75.56	73.84	75.56	74.58
N012	75.56	73.85	75.56	74.58
N013	76.28	74.56	76.28	75.30
N014	74.00	72.29	74.00	73.03
N015	72.41	70.72	72.41	71.46
N016	70.87	69.17	70.87	69.91
N017	70.18	68.46	70.18	69.20
N018	70.01	68.29	70.01	69.03
N019	70.56	68.83	70.55	69.57
N020	71.74	70.01	71.74	70.75
N021	72.20	70.47	72.20	71.21
N022	73.27	71.55	73.27	72.28
N023	74.93	73.20	74.93	73.94
N024	76.55	74.82	76.55	75.56
N025	76.63	74.90	76.62	75.63
N026	77.49	75.76	77.49	76.50
N027	78.48	76.76	78.48	77.49
N028	77.87	76.14	77.86	76.87
N029	77.96	76.23	77.95	76.96
N030	78.71	76.98	78.71	77.72
N031	78.50	76.77	78.50	77.51
N032	78.52	76.79	78.52	77.53
N033	79.03	77.30	79.03	78.04
N034	70.32	68.60	70.32	69.34
N035	71.11	69.39	71.11	70.13
N036	71.16	69.43	71.16	70.17
N037	71.23	69.50	71.23	70.24
N038	70.82	69.09	70.82	69.83
N039	71.66	69.93	71.66	70.67
N040	72.20	70.47	72.20	71.21
N041	72.55	70.82	72.55	71.56
N042	72.44	70.71	72.44	71.45
N043	72.57	70.85	72.57	71.58
N044	74.87	73.14	74.87	73.88
N045	74.07	72.34	74.07	73.08
N046	76.83	75.10	76.83	75.84
N047	76.34	74.61	76.34	75.35
N048	76.22	74.49	76.22	75.23
N049	76.38	74.65	76.38	75.38

	BSDY		MXDY	
ID	Max Pressure (psi)	Min Pressure (psi)	Max Pressure (psi)	Min Pressure (psi)
N050	75.73	74.00	75.73	74.74
N051	76.45	74.72	76.45	75.46
N052	75.01	73.28	75.00	74.01
N053	77.16	75.43	77.16	76.17
N054	74.36	72.64	74.36	73.37
N055	74.48	72.75	74.48	73.49
N056	75.96	74.23	75.95	74.96
N057	81.21	79.48	81.21	80.22
N058	79.43	77.70	79.43	78.44
N059	73.94	72.20	73.93	72.94
N060	77.18	75.45	77.18	76.19
N061	76.70	74.97	76.70	75.71
N062	75.13	73.40	75.13	74.14
N063	78.09	76.36	78.09	77.09
N064	78.19	76.46	78.19	77.19
N065	78.43	76.70	78.43	77.43
N066	78.60	76.86	78.60	77.60
N067	76.85	75.11	76.85	75.84
N068	80.65	78.90	80.65	79.64
N069	81.78	80.03	81.78	80.77
N070	77.52	75.77	77.51	76.51
N071	80.22	78.48	80.22	79.21
N072	78.25	76.51	78.25	77.24
N073	82.70	80.95	82.69	81.69
N074	84.50	82.75	84.50	83.49
N075	84.77	83.02	84.76	83.75
N076	84.23	82.48	84.23	83.22
N077	82.42	80.67	82.42	81.41
N078	82.44	80.70	82.44	81.43
N079	81.62	79.88	81.62	80.62
N080	80.51	78.77	80.51	79.51
N081	79.85	78.12	79.85	78.85
N082	79.96	78.22	79.96	78.95
N083	79.97	78.23	79.97	78.96
N084	81.31	79.57	81.31	80.30
N085	82.10	80.36	82.10	81.09
N086	79.91	78.17	79.91	78.90
N087	78.85	77.11	78.85	77.84
N088	79.78	78.04	79.78	78.77
N089	81.52	79.77	81.51	80.51
N090	81.77	80.03	81.77	80.76
N091	78.20	76.46	78.20	77.20
N092	78.12	76.38	78.12	77.11
N093	78.78	77.04	78.78	77.77
N094	80.66	78.92	80.66	79.65
N095	79.85	78.11	79.85	78.84
N096	82.11	80.36	82.10	81.10
N097	83.80	82.06	83.80	82.79
N098	85.88	84.13	85.87	84.86
N099	86.49	84.74	86.49	85.48

	BSDY		MXDY	
ID	**Max Pressure (psi)**	**Min Pressure (psi)**	**Max Pressure (psi)**	**Min Pressure (psi)**
N100	87.89	86.13	87.88	86.87
N101	88.10	86.35	88.10	87.08
N102	85.61	83.86	85.61	84.60
N103	87.87	86.11	87.86	86.85
N104	88.47	86.72	88.47	87.45
N105	85.73	83.97	85.72	84.71
N106	87.30	85.55	87.30	86.28
N108	72.51	70.91	72.51	71.66
N109	72.73	71.12	72.73	71.86
N110	73.01	71.36	73.01	72.10
N111	85.17	83.42	85.16	84.16
N113	85.62	83.87	85.62	84.60
N114	86.15	84.42	86.15	85.16
N115	84.66	82.93	84.66	83.67
N117	86.85	85.10	86.85	85.83
N118	75.64	73.93	75.64	74.66
N119	82.04	80.31	82.04	81.04
N120	78.44	76.71	78.44	77.45
N121	82.32	80.57	82.32	81.30
N122	90.47	88.72	90.47	89.45

MXDY+FF Analysis with MRPS at Max. Discharge HGL = 143m

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
N001	0.11	57.3	143.0	13,000	43.4	18,901	20
N002	0.05	66.6	143.0	13,000	51.6	22,380	20
N003	0.05	76.8	143.0	13,000	61.5	27,531	20
N004	0.05	79.1	143.0	13,000	63.7	28,357	20
N005	0.07	79.2	143.0	13,000	62.5	26,183	20
N006	0.07	77.5	143.0	13,000	60.6	25,193	20
N007	0.20	77.5	143.0	13,000	60.3	24,752	20
N008	0.07	76.9	143.0	13,000	59.9	24,681	20
N009	0.07	77.5	143.0	13,000	60.2	24,639	20
N010	0.07	76.3	143.0	13,000	59.0	24,153	20
N011	0.07	75.5	143.0	13,000	37.8	15,457	20
N012	0.07	75.5	143.0	13,000	42.2	16,321	20
N013	0.07	76.3	143.0	13,000	48.7	17,808	20
N014	0.07	74.0	143.0	13,000	56.2	22,254	20
N015	0.07	72.4	143.0	13,000	57.5	25,934	20
N016	0.07	70.9	143.0	13,000	55.6	24,552	20
N017	0.07	70.2	143.0	13,000	54.7	23,871	20
N018	0.20	70.0	143.0	13,000	53.3	21,465	20
N019	0.07	70.5	143.0	13,000	53.8	21,778	20
N020	0.07	71.7	143.0	13,000	54.9	22,366	20
N021	0.07	72.2	143.0	13,000	55.5	22,997	20
N022	0.07	73.3	143.0	13,000	56.7	23,725	20
N023	0.07	74.9	143.0	13,000	58.9	25,323	20
N024	0.07	76.5	143.0	13,000	53.2	18,901	20
N025	0.20	76.6	143.0	13,000	60.2	25,469	20
N026	0.07	77.5	143.0	13,000	61.1	25,990	20
N027	0.07	78.5	143.0	13,000	55.0	19,254	20
N028	0.20	77.8	143.0	13,000	61.1	25,560	20
N029	0.07	77.9	143.0	13,000	61.5	25,999	20
N030	0.07	78.7	143.0	13,000	55.3	19,374	20
N031	0.07	78.5	143.0	13,000	61.7	25,819	20
N032	0.07	78.5	143.0	13,000	63.0	27,759	20
N033	0.07	79.0	143.0	13,000	63.5	27,933	20
N034	0.20	70.3	143.0	13,000	54.6	23,565	20
N035	0.20	71.1	143.0	13,000	55.4	23,969	20
N036	0.20	71.1	143.0	13,000	55.4	23,893	20
N037	0.20	71.2	143.0	13,000	55.5	23,927	20
N038	0.20	70.8	143.0	13,000	48.0	18,254	20
N039	0.20	71.6	143.0	13,000	55.9	24,141	20
N040	0.20	72.2	143.0	13,000	56.4	24,485	20
N041	0.20	72.5	143.0	13,000	49.7	18,497	20
N042	0.20	72.4	143.0	13,000	56.7	24,660	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
N043	0.20	72.6	143.0	13,000	56.9	24,887	20
N044	0.20	74.9	143.0	13,000	58.2	24,323	20
N045	0.20	74.1	143.0	13,000	58.3	25,466	20
N046	0.20	76.8	143.0	13,000	61.1	26,690	20
N047	0.20	76.3	143.0	13,000	53.4	19,004	20
N048	0.20	76.2	143.0	13,000	60.4	26,290	20
N049	0.20	76.4	143.0	13,000	60.5	26,368	20
N050	0.20	75.7	143.0	13,000	52.9	18,940	20
N051	0.20	76.4	143.0	13,000	60.6	26,315	20
N052	0.17	75.0	143.0	13,000	59.2	25,799	20
N053	0.17	77.1	143.0	13,000	61.4	26,838	20
N054	0.20	74.3	143.0	13,000	56.8	22,758	20
N055	0.20	74.5	143.0	13,000	49.1	18,127	20
N056	0.20	75.9	143.0	13,000	59.1	24,553	20
N057	0.20	81.2	143.0	13,000	64.2	26,500	20
N058	0.20	79.4	143.0	13,000	62.0	25,281	20
N059	0.20	73.9	143.0	13,000	39.9	15,951	20
N060	0.20	77.2	143.0	13,000	54.5	19,377	20
N061	0.20	76.7	143.0	13,000	58.8	23,498	20
N062	0.20	75.1	143.0	13,000	51.9	18,751	20
N063	0.20	78.1	143.0	13,000	43.5	16,420	20
N064	0.17	78.2	143.0	13,000	60.6	24,487	20
N065	0.17	78.4	143.0	13,000	61.4	25,452	20
N066	0.17	78.6	143.0	13,000	60.7	24,282	20
N067	0.17	76.8	143.0	13,000	44.8	16,782	20
N068	0.17	80.6	143.0	13,000	42.0	15,966	20
N069	0.17	81.8	143.0	13,000	43.6	16,196	20
N070	0.17	77.5	143.0	13,000	43.8	16,519	20
N071	0.17	80.2	143.0	13,000	61.5	24,009	20
N072	0.17	78.2	143.0	13,000	59.8	23,443	20
N073	0.17	82.7	143.0	13,000	63.7	24,562	20
N074	0.17	84.5	143.0	13,000	62.9	22,377	20
N075	0.17	84.7	143.0	13,000	47.0	16,638	20
N076	0.17	84.2	143.0	13,000	62.6	22,252	20
N077	0.17	82.4	143.0	13,000	61.8	22,691	20
N078	0.05	82.4	143.0	13,000	63.0	24,005	20
N079	0.05	81.6	143.0	13,000	63.0	24,596	20
N080	0.05	80.5	143.0	13,000	62.4	24,832	20
N081	0.05	79.8	143.0	13,000	62.8	25,988	20
N082	0.05	79.9	143.0	13,000	61.0	23,529	20
N083	0.05	79.9	143.0	13,000	60.8	23,337	20
N084	0.05	81.3	143.0	13,000	62.1	23,782	20
N085	0.05	82.1	143.0	13,000	62.6	23,773	20

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
N086	0.05	79.9	143.0	13,000	60.1	22,493	20
N087	0.05	78.8	143.0	13,000	58.6	21,510	20
N088	0.05	79.8	143.0	13,000	58.4	20,781	20
N089	0.05	81.5	143.0	13,000	61.2	22,644	20
N090	0.05	81.7	143.0	13,000	61.7	23,011	20
N091	0.05	78.2	143.0	13,000	57.1	20,558	20
N092	0.05	78.1	143.0	13,000	56.0	19,979	20
N093	0.05	78.8	143.0	13,000	57.4	20,587	20
N094	0.05	80.6	143.0	13,000	59.7	21,566	20
N095	0.05	79.8	143.0	13,000	56.1	19,524	20
N096	0.05	82.1	143.0	13,000	55.5	18,788	20
N097	0.05	83.8	143.0	13,000	54.7	18,408	20
N098	0.17	85.9	143.0	13,000	63.3	21,940	20
N099	0.17	86.5	143.0	13,000	61.0	20,212	20
N100	0.17	87.9	143.0	13,000	57.0	18,508	20
N101	0.17	88.1	143.0	13,000	63.1	20,742	20
N102	0.17	85.6	143.0	13,000	61.8	20,842	20
N103	0.17	87.8	143.0	13,000	60.4	19,560	20
N104	0.17	88.4	143.0	13,000	61.3	19,841	20
N105	0.17	85.7	143.0	13,000	58.9	19,420	20
N106	0.17	87.3	143.0	13,000	61.2	20,109	20
N108	0.20	72.5	143.0	13,000	59.3	29,050	20
N109	0.20	72.7	143.0	13,000	59.2	28,535	20
N110	0.07	73.0	143.0	13,000	58.6	27,151	20
N114	0.2	86.1	143.0	13,000	46.028	16,361	20
N115	0.2	84.6	143.0	13,000	66.263	25,961	20
N117	0.166	86.8	143.0	13,000	49.734	17,036	20
N118	0.071	75.6	143.0	13,000	47.898	17,670	20
N119	0.2	82.0	143.0	13,000	64.013	25,497	20
N120	0.2	78.4	143.0	13,000	61.101	24,993	20
N121	0.166	82.3	143.0	13,000	57.304	19,507	20
N122	0.166	90.4	143.0	13,000	63.748	20,446	20

Phase 1A
With South Loop

ID	Static Demand (Lpm)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (Lpm)	Residual Pressure (psi)	Available Flow at Hydrant (Lpm)	Available Flow Pressure (psi)
N002	2.74	72.51	147	13,000	23.36	15,044	20
N003	2.74	82.64	147	13,000	32.79	21,220	20
N004	2.74	84.94	147	13,000	34.54	21,596	20
N005	0.00	85.10	147	13,000	33.62	20,340	20
N006	0.00	83.39	147	13,000	31.18	18,755	20
N007	0.00	83.39	147	13,000	30.82	18,384	20
N008	0.00	82.80	147	13,000	30.02	17,886	20
N009	0.00	83.38	147	13,000	30.54	18,078	20
N010	0.00	82.12	147	13,000	29.31	17,479	20
N014	0.00	79.86	147	13,000	27.88	16,946	20
N015	1.19	78.26	147	13,000	29.52	19,354	20
N032	0.00	84.37	147	13,000	32.52	19,743	20
N033	0.00	84.88	147	13,000	33.71	20,694	20
N065	0.00	84.28	147	13,000	31.21	18,561	20
N066	0.00	84.45	147	13,000	30.54	17,934	20
N071	0.00	86.07	147	13,000	31.24	17,916	20
N072	0.00	84.10	147	13,000	29.68	17,377	20
N073	0.00	88.55	147	13,000	33.30	18,586	20
N078	2.74	88.29	147	13,000	32.92	18,405	20
N079	2.74	87.48	147	13,000	33.37	19,056	20
N080	2.74	86.36	147	13,000	32.85	19,092	20
N081	2.74	85.70	147	13,000	33.42	19,929	20
N082	2.74	85.81	147	13,000	31.38	18,117	20
N083	2.74	85.82	147	13,000	31.17	17,955	20
N084	2.74	87.16	147	13,000	32.395	18,413	20
N085	2.74	87.95	147	13,000	32.657	18,332	20
N086	2.74	85.76	147	13,000	30.438	17,435	20
N087	2.74	84.70	147	13,000	28.956	16,687	20
N088	2.74	85.63	147	13,000	28.767	16,342	20
N089	2.74	87.37	147	13,000	31.571	17,750	20
N090	2.74	87.62	147	13,000	31.874	17,883	20
N091	2.74	84.06	147	13,000	27.486	15,853	20
N092	2.74	83.97	147	13,000	26.554	15,293	20
N093	2.74	84.63	147	13,000	28.309	16,267	20
N094	2.74	86.51	147	13,000	30.275	17,112	20
N095	2.74	85.70	147	13,000	28.264	16,018	20
N096	2.74	87.96	147	13,000	30.096	16,652	20
N097	2.74	89.65	147	13,000	32.629	17,789	20
N110	0.00	78.86	147	13,000	31.063	21,005	20

APPENDIX D

WASTEWATER COLLECTION SYSTEM: SUPPORTING INFORMATION

- Table 5.2 Land Use Distribution and Density Targets, Former CFB Rockcliffe Community Design Plan
- *Figure 5.1 Recommended Wastewater Plan*
- Sanitary Sewer Design Sheets
- *Figure 5.2 Sanitary Drainage Area Plan*
- Drawing No. 12381 S1 J. L. Richards & Associates Ltd
- Table 7.5.8.4. Ontario Building Code 2012
- *Figure 5.4 Recommended Phase 1A Wastewater Plan*
- January 13, 2015 Meeting Notes

Table 5.2: Land Use Distribution and Density

Land Use	Land Area (ha)	Minimum Density (units/ha)	Minimum Units	Target Employment (jobs)	Estimated Population
Low-Rise Residential	8.94		427		1,167
Blocks 11, 15-17, 19-21, 55	*6.53*	*32*	*209*	*n/a*	*619*
Blocks 53, 57	*2.41*	*91*	*219*	*n/a*	*548*
Low- To Mid-Rise Residential	19.88	105	2,087	n/a	3,964
Forest Special Design Area	3.13	91	285	n/a	461
Low- To Mid-Rise Mixed-Use	2.27	91	206	n/a	393
Mid-Rise Mixed-Use	7.68	143	1,100	n/a	1,430
High-Rise Mixed-Use	7.3	170	1,241	n/a	2,355
Employment	15.54	n/a	n/a	2,610	n/a
Westerly Node (Blocks 5, 8, 9)	*1.56*	*n/a*	*n/a*	*580*	*n/a*
High-Rise Employment (Block 56)	*6.08*	*n/a*	*n/a*	*1,600*	*n/a*
Schools (Blocks 14, 52, 54)	*7.31*	*n/a*	*n/a*	*75*	*n/a*
Mixed-Use Retail (Blocks 23-25, 31-33, 35-37, 60)	*0.59*	*n/a*	*n/a*	*355*	*n/a*
Parks and Parkettes (not including Important Tree Groupings)	19.73	n/a	n/a	n/a	n/a
Natural Areas	5.95	n/a	n/a	n/a	n/a
Important Tree Groupings	10.10	n/a	n/a	n/a	n/a
SWM Features	7.95	n/a	n/a	n/a	n/a
Road Network and Lanes	22.35	n/a	n/a	n/a	n/a
TOTAL	**130.82**		**5,346**	**2,610**	**9,764**

LEGEND

- 256A (aw00200) — NODE IDENTIFICATION (CITY SEWER NODE)
- 250mmØ — PROPOSED SANITARY SEWER SIZE AND DIRECTION
- 300mmØ FORCEMAIN — EXISTING FORCEMAIN AND SIZE
- 200mmØ CO — EXISTING SITE SEWER SIZE AND DIRECTION
- LIMIT OF MAJOR DRAINAGE AREAS

AVIATION MUSEUM

RCAF SANITARY PUMP STATION

POTENTIAL BASEFLOW AUGMENTATION

CHANNEL-PIPE

REPLACE EX 600Ø CULVERT

CONNECT TO EXISTING COMBINED SEWER AT CITY MANHOLE aw00200 EX. INVERT ±61.89m

DECOMISSION AND REMOVE EXISTING 200mmØ

FUTURE SANITARY OUTLET TO NODE 253A

FUTURE MUSEUM

REPLACE AIR BASE OUTLET SEWER FROM NODE 261A TO 253A

EXISTING AIR BASE PULLBACK SEWER 300mmØ @ 0.69% CAPACITY ±84.1%

REPLACE EXISTING RCAF PULLBACK SEWER

CONNECT TO EXISTING 300Ø RCAF PULLBACK SEWER EX. INVERT ±77.10m

INVERT AT EXISTING NRC SHAFT EX. INVERT ±77.0m

INTERCEPT EXISTING SANITARY INVERT ±86.50m

EXISTING MONTFORT HOSPITAL SANITARY SEWER

EXISTING STORMWATER FACILITY

THORNCLIFFE VILLAGE SANITARY SEWER

EXISTING STORMWATER THORNCLIFFE PARK

MONTFORT HOSPITAL

FAIRHAVEN

THORNCLIFFE VILLAGE

NATIONAL RESEARCH COUNCIL (NRC)

CODD'S ROAD

MAIN STREET

MAJOR COLLECTOR

HEMLOCK RD

ROCKCLIFFE PKWY

EXISTING DRAINAGE DITCH TO OTTAWA RIVER

EXISTING DRAINAGE DITCHES TO OTTAWA RIVER

OTTAWA RIVER

N

Scale 0 100 200

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Drawing Title

RECOMMENDED
WASTEWATER PLAN

Sheet No.

FIGURE 5.1

J:\118863_stm\dgn2d\9.0 Drawings\5.0\Active\current\2020-06 MSS Update Phase 2B~figures\Figure 5.1~Recommended Waste Water Plan.dwg Layout Name: Figure5.1 Plot Style: AIA STANDARD COLOR~HALF.CTB Plotted At: 6/01/2020 10:42 AM Last Saved By: mmilne, Jun. 11, 20

IBI Group
400-333 Preston Street
Ottawa, Ontario
K1S 5N4

SANITARY SEWER DESIGN SHEET

PROJECT: FORMER CFB ROCKCLIFFE
LOCATION: CITY OF OTTAWA
CLIENT: CANADA LANDS COMPANY

LOCATION				RESIDENTIAL										ICI AREAS							INFILTRATION ALLOWANCE				TOTAL	PROPOSED SEWER DESIGN						
				UNIT TYPES					AREA	POPULATION		PEAK	PEAK	AREA (Ha)						PEAK	AREA (Ha)			FLOW	FLOW	CAPACITY	LENGTH	DIA	SLOPE	VELOCITY	AVAILABLE CAPACITY	
STREET	AREA ID	FROM MH	TO MH	SF	SD	TH/F	TH/S	APT	(Ha)	IND	CUM	FACTOR	FLOW (L/s)	INSTITUTIONAL IND	INSTITUTIONAL CUM	COMMERCIAL IND	COMMERCIAL CUM	INDUSTRIAL IND	INDUSTRIAL CUM	FLOW (L/s)	PARKS	IND	CUM	(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	(full) (m/s)	L/s	(%)
PHASE 1 - CODD'S ROAD SHAFT																															
Major Collector	100A	MH100A	MH (52)					500	3.81	900.0	900.0	3.83	13.96									3.81	3.81	1.07	15.03	84.38	48.00	250	1.85	1.665	69.36	82.19
Major Collector		MH (52)	MH105A								900.0	3.83	13.96										3.81	1.07	15.03	84.38	37.62	250	1.85	1.665	69.36	82.19
Major Collector	105A	MH105A	MH (54)				41		0.77	94.3	994.3	3.80	15.31								0.65	1.42	5.23	1.46	16.78	62.04	62.95	250	1.00	1.224	45.26	72.96
Major Collector		MH (54)	MH (55)							0.0	994.3	3.80	15.31										5.23	1.46	16.78	62.04	50.36	250	1.00	1.224	45.26	72.96
Major Collector		MH (55)	MH108A							0.0	994.3	3.80	15.31										5.23	1.46	16.78	43.87	76.71	250	0.50	0.866	27.09	61.76
Major Collector	COM2	MH126A	MH (379)													2.03	2.03			1.76		2.03	2.03	0.57	2.33	60.47	85.08	250	0.95	1.193	58.14	96.15
Major Collector		MH (379)	MH120A														2.03			1.76			2.03	0.57	2.33	60.47	87.33	250	0.95	1.193	58.14	96.15
Major Collector	COM1	MH120A	MH (402)													2.44	4.47			3.88		2.44	4.47	1.25	5.13	43.87	91.89	250	0.50	0.866	38.74	88.30
Major Collector		MH (402)	MH108A														4.47			3.88			4.47	1.25	5.13	43.87	70.26	250	0.50	0.866	38.74	88.30
---	108A	MH108A	MH (375)						1.32	0.0	994.30	3.80	15.31				4.47			3.88		1.32	11.02	3.09	22.28	54.08	80.08	250	0.76	1.067	31.81	58.81
---		MH (375)	MH (376)							0.0	994.3	3.80	15.31				4.47			3.88			11.02	3.09	22.28	54.08	37.59	250	0.76	1.067	31.81	58.81
---		MH (376)	MH114A							0.0	994.3	3.80	15.31				4.47			3.88			11.02	3.09	22.28	54.08	118.80	250	0.76	1.067	31.81	58.81
---	EXT1	Ex	MH114A						5.53	1574.0	1574.0	3.66	23.36									5.53	5.53	1.55	24.91							
---		MH125A	MH (405)			33				89.1	89.1	4.00	1.44				0.00			0.00			0.00	0.00	1.44	44.30	72.00	250	0.51	0.874	42.86	96.74
---		MH (405)	MH114A							0.0	89.1	4.00	1.44				0.00			0.00			0.00	0.00	1.44	44.30	105.98	250	0.51	0.874	42.86	96.74
---	114A	MH114A	MH (65)				95		1.72	218.5	2786.8	3.47	39.17				4.47			3.88		1.72	18.27	5.12	48.16	71.33	69.47	300	0.50	0.978	23.17	32.48
---		MH (65)	MH (66)							0.0	2786.8	3.47	39.17				4.47			3.88			18.27	5.12	48.16	71.33	81.98	300	0.50	0.978	23.17	32.48
---		MH (66)	MH (67)							0.0	2786.8	3.47	39.17				4.47			3.88			18.27	5.12	48.16	71.33	24.65	300	0.50	0.978	23.17	32.48
---		MH (67)	MH113A							0.0	2786.8	3.47	39.17				4.47			3.88			18.27	5.12	48.16	71.33	10.46	300	0.50	0.978	23.17	32.48
---		MH113A	MH119A							0.0	2786.8	3.47	39.17				4.47			3.88			18.27	5.12	48.16	71.33	52.12	300	0.50	0.978	23.17	32.48
---		MH119A	MH130A							0.0	2786.8	3.47	39.17				4.47			3.88			18.27	5.12	48.16	71.33	72.19	300	0.50	0.978	23.17	32.48
---	INST1, INST2	MH120A	MH125A							0.0	0.0	4.00	0.00	*5.55*	5.55					4.82		5.55	5.55	1.55	6.37	58.86	191.19	250	0.90	1.162	52.48	89.17
---	125A	MH125A	MH130A				*253*		*3.09*	581.9	581.9	3.94	9.29		5.55					4.82		3.09	8.64	2.42	16.52	58.86	176.08	250	0.90	1.162	42.33	71.93
---	163A	MH163A	MH (381)				42		0.75	96.6	96.6	4.00	1.57									0.75	0.75	0.21	1.78	35.64	87.43	250	0.33	0.703	33.86	95.02
		MH (381)	MH130A							0.0	96.6	4.00	1.57										0.75	0.21	1.78	35.64	71.87	250	0.33	0.703	33.86	95.02
---	---	MH130A	MH135A							0.0	3465.3	3.39	47.57		5.55		4.47			8.70			27.66	7.74	64.01	100.18	88.80	375	0.30	0.879	36.18	36.11
---	164A	MH164A	MH (383)				41		0.96	94.3	94.3	4.00	1.53									0.96	0.96	0.27	1.80	35.64	87.27	250	0.33	0.703	33.84	94.96
---		MH (383)	MH135A							0.0	94.3	4.00	1.53										0.96	0.27	1.80	35.64	71.78	250	0.33	0.703	33.84	94.96
---	135A	MH135A	MH140A					191	1.76	343.8	3903.4	3.34	52.86		5.55		4.47			8.70		1.76	30.38	8.51	70.06	100.18	107.95	375	0.30	0.879	30.12	30.07
---	---	MH140A	MH (61)							0.0	3903.4	3.34	52.86		5.55		4.47			8.70			30.38	8.51	70.06	100.18	75.16	375	0.30	0.879	30.12	30.07
---		MH (61)	MH150A							0.0	3903.4	3.34	52.86		5.55		4.47			8.70			30.38	8.51	70.06	100.18	76.66	375	0.30	0.879	30.12	30.07
Codd's Road	142A	MH142A	MH (45)																		6.81	6.81	6.81	1.91	1.91	75.98	87.81	250	1.50	1.500	74.07	97.49
Codd's Road		MH (45)	MH (46)																				6.81	1.91	1.91	75.98	70.10	250	1.50	1.500	74.07	97.49
Codd's Road		MH (46)	MH (47)																				6.81	1.91	1.91	33.98	61.03	250	0.30	0.671	32.07	94.39
Codd's Road		MH (47)	MH150A																				6.81	1.91	1.91	33.98	55.07	250	0.30	0.671	32.07	94.39
---	301A	MH301A	MH160A				110		1.87	253.0	253.0	4.00	4.10									1.87	1.87	0.52	4.62	35.64	155.83	250	0.33	0.703	31.02	87.03
---	---	MH160A	MH161A							0.0	253.0	4.00	4.10										1.87	0.52	4.62	70.74	78.00	250	1.30	1.396	66.11	93.46
---	302A	MH302A	MH161A				70		1.25	161.0	161.0	4.00	2.61									1.25	1.25	0.35	2.96	50.02	155.84	250	0.65	0.987	47.06	94.08
Main Street	---	MH161A	MH163A							0.0	414.0	4.00	6.71									0.00	3.12	0.87	7.58	78.47	78.12	250	1.60	1.549	70.89	90.34
---	314A	MH314A	MH308A				35		0.53	80.5	80.5	4.00	1.30									0.53	0.53	0.15	1.45	75.98	75.81	250	1.50	1.500	74.53	98.09
---	314A	MH308A	MH163A							0.0	80.5	4.00	1.30								0.71	0.71	1.24	0.35	1.65	75.98	80.05	250	1.50	1.500	74.33	97.83
Main Street	---	MH163A	MH164A							0.0	494.5	3.98	7.97									0.00	4.36	1.22	9.19	78.47	88.92	250	1.60	1.549	69.29	88.29
---	311A	MH311A	MH164A				84		1.41	193.2	193.2	4.00	3.13									1.41	1.41	0.39	3.53	65.07	155.87	250	1.10	1.284	61.54	94.58
Main Street	---	MH164A	MH165A							0.0	687.7	3.90	10.86									0.00	5.77	1.62	12.48	58.86	107.96	250	0.90	1.162	46.38	78.80
---	205A	MH205A	MH (7)					*510*	*4.39*	918.0	918.0	3.82	14.22								5.93	10.32	10.32	2.89	17.11	50.02	80.40	250	0.65	0.987	32.91	65.79
---		MH (7)	MH326A							0.0	918.0	3.82	14.22										10.32	2.89	17.11	36.70	51.99	250	0.35	0.724	19.59	53.39

---	326A	MH323A	MH (10)					*224*	1.77	403.2	403.2	4.00	6.53									1.77	1.77	0.50	7.03	50.02	29.23	250	0.65	0.987	42.99	85.95
---		MH (10)	MH (9)							0.0	403.2	4.00	6.53										1.77	0.50	7.03	50.02	37.86	250	0.65	0.987	42.99	85.95
---		MH (9)	MH326A							0.0	403.2	4.00	6.53										1.77	0.50	7.03	50.02	36.84	250	0.65	0.987	42.99	85.95

---	312A	MH326A	MH312A					171	1.55	307.8	1629.0	3.65	24.11									1.55	13.64	3.82	27.93	43.87	150.87	250	0.50	0.866	15.94	36.34

---	312A	MH312A	MH165A					190	1.69	342.0	1971.0	3.59	28.67									1.69	15.33	4.29	32.96	43.87	155.81	250	0.50	0.866	10.91	24.86
Main Street	165A	MH165A	MH155A							0.0	2658.7	3.49	37.55								0.60	0.60	21.70	6.08	43.63	63.80	151.90	300	0.40	0.874	20.18	31.62
Codd's Road	201A	MH201A	MH155A					214	1.32	385.2	385.2	4.00	6.24			1.23	1.23					2.55	2.55	0.71	6.96	79.69	157.08	250	1.65	1.573	72.73	91.27

IBI Group
400-333 Preston Street
Ottawa, Ontario
K1S 5N4

SANITARY SEWER DESIGN SHEET

PROJECT: FORMER CFB ROCKCLIFFE
LOCATION: CITY OF OTTAWA
CLIENT: CANADA LANDS COMPANY

LOCATION				RESIDENTIAL									ICI AREAS							INFILTRATION ALLOWANCE				TOTAL	PROPOSED SEWER DESIGN						
				UNIT TYPES					AREA	POPULATION		PEAK	PEAK	AREA (Ha)						PEAK	AREA (Ha)			FLOW	FLOW	CAPACITY	LENGTH	DIA	SLOPE	VELOCITY	AVAILABLE CAPACITY	
														INSTITUTIONAL		COMMERCIAL		INDUSTRIAL		FLOW											
STREET	AREA ID	FROM MH	TO MH	SF	SD	TH/F	TH/S	APT	(Ha)	IND	CUM	FACTOR	(L/s)	IND	CUM	IND	CUM	IND	CUM	(L/s)	PARKS	IND	CUM	(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	(full) (m/s)	L/s	(%)
Codd's Road	150A	MH155A	MH (411)					285	2.55	513.0	3556.9	3.38	48.68				1.23				0.92	3.47	27.72	7.76	56.44	81.80	105.38	375	0.20	0.717	25.36	31.00
Codd's Road		MH (411)	MH150A							0.0	3556.9	3.38	48.68				1.23						27.72	7.76	56.44	91.46	65.59	375	0.25	0.802	35.01	38.28
---		MH150A	MH151A							0.0	7460.3	3.08	93.08		5.55		5.70			9.77		0.00	64.91	18.17	121.02	129.34	30.28	375	0.50	1.134	8.32	6.43
---	190A	MH190A	MH (358)	4		19			0.96	64.9	64.9	4.00	1.05									0.96	0.96	0.27	1.32	63.27	65.18	250	1.04	1.249	61.95	97.91
---		MH (358)	MH (359)							0.0	64.9	4.00	1.05										0.96	0.27	1.32	63.27	17.99	250	1.04	1.249	61.95	97.91
---		MH (359)	MH (360)							0.0	64.9	4.00	1.05										0.96	0.27	1.32	63.27	37.59	250	1.04	1.249	61.95	97.91
---		MH (360)	MH (361)							0.0	64.9	4.00	1.05										0.96	0.27	1.32	63.27	26.53	250	1.04	1.249	61.95	97.91
---		MH (361)	MH185A							0.0	64.9	4.00	1.05										0.96	0.27	1.32	63.27	57.21	250	1.04	1.249	61.95	97.91
---	185A	MH185A	MH (363)			12			0.38	32.4	97.3	4.00	1.58									0.38	1.34	0.38	1.95	35.64	16.83	250	0.33	0.703	33.69	94.52
---		MH (363)	MH183A							0.0	97.3	4.00	1.58										1.34	0.38	1.95	35.64	64.96	250	0.33	0.703	33.69	94.52
---	192A	MH192A	MH (364)	*39*					1.52	132.6	132.6	4.00	2.15									1.52	1.52	0.43	2.57	35.64	89.21	250	0.33	0.703	33.06	92.78
---		MH (364)	MH190A							0.0	132.6	4.00	2.15										1.52	0.43	2.57	35.64	91.02	250	0.33	0.703	33.06	92.78
---	EXT2	BULKHEAD	MH190A						8.97	538.2	538.2	3.96	8.63									8.97	8.97	2.51	11.14	35.64	65.00	250	0.33	0.703	24.50	68.74
---	190A	MH190A	MH179A			9			0.31	24.3	695.10	3.90	10.97									0.31	10.80	3.02	14.00	84.38	78.92	250	1.85	1.665	70.39	83.41
---	194A	MH194A	MH (356)	*24*					1.28	81.6	81.6	4.00	1.32									1.28	1.28	0.36	1.68	48.06	105.74	250	0.60	0.948	46.37	96.50
---		MH (356)	MH179A							0.0	81.6	4.00	1.32										1.28	0.36	1.68	48.06	100.13	250	0.60	0.948	46.37	96.50
---	179A	MH179A	MH (76)			10			0.34	27.0	803.7	3.86	12.56								0.37	0.71	12.79	3.58	16.15	47.65	43.07	250	0.59	0.940	31.51	66.12
---		MH (76)	MH183A							0.0	803.7	3.86	12.56										12.79	3.58	16.15	47.65	34.27	250	0.59	0.940	31.51	66.12
---	183A	MH183A	MH182A	*9*					0.60	30.6	931.6	3.82	14.41									0.60	14.73	4.12	18.54	31.02	119.22	250	0.25	0.612	12.48	40.23
---	195A	MH195A	MH182A	*14*					0.85	47.6	47.6	4.00	0.77									0.85	0.85	0.24	1.01	59.18	107.15	250	0.91	1.168	58.17	98.29
---	---	MH182A	MH175A							0.0	979.2	3.81	15.10										15.58	4.36	19.46	31.02	76.76	250	0.25	0.612	11.56	37.27
---	230A, INST3	MH230A	MH (353)			42			1.08	113.4	113.4	4.00	1.84	2.44	2.44					2.12		3.52	3.52	0.99	4.94	51.91	110.31	250	0.70	1.024	46.96	90.48
---		MH (353)	MH175A							0.0	113.4	4.00	1.84		2.44					2.12			3.52	0.99	4.94	51.91	68.80	250	0.70	1.024	46.96	90.48
---	175A	MH175A	MH (92)	7					0.52	23.8	1116.4	3.77	17.04		2.44					2.12		0.52	19.62	5.49	24.66	45.12	50.21	300	0.20	0.618	20.46	45.35
---		MH (92)	MH172A							0.0	1116.4	3.77	17.04		2.44					2.12			19.62	5.49	24.66	45.12	62.97	300	0.20	0.618	20.46	45.35
---	192A	MH192A	MH(120)	11					0.68	37.4	37.4	4.00	0.61									0.68	0.68	0.19	0.80	43.87	15.79	250	0.50	0.866	43.07	98.18
		MH(120)	MH194A							0.0	37.4	4.00	0.61										0.68	0.19	0.80	43.87	66.64	250	0.50	0.866	43.07	98.18
---	194A	MH194A	MH195A	18					1.43	61.2	98.6	4.00	1.60									1.43	2.11	0.59	2.19	48.06	78.09	250	0.60	0.948	45.87	95.45
---		MH195A	MH172A							0.0	98.6	4.00	1.60										2.11	0.59	2.19	48.06	77.14	250	0.60	0.948	45.87	95.45
---		MH172A	MH151A							0.0	1215.0	3.74	18.43		2.44					2.12			21.73	6.08	26.63	45.12	69.18	300	0.20	0.618	18.49	40.98
---		MH151A	MH (421)								8675.3	3.02	105.98		7.99		5.70			11.88			86.64	24.26	142.12	153.03	124.53	375	0.70	1.342	10.91	7.13
---		MH (421)	EX Shaft							0.0	8675.3	3.02	105.98		7.99		5.70			11.88		0.00	86.64	24.26	142.12	153.03	9.66	375	0.70	1.342	10.91	7.13
---	213A	MH213A	MH (374)					89	1.43	160.2	160.2	4.00	2.60									1.43	1.43	0.40	3.00	35.64	56.18	250	0.33	0.703	32.64	91.59
		MH (374)	MH211A							0.0	160.2	4.00	2.60										1.43	0.40	3.00	35.64	106.64	250	0.33	0.703	32.64	91.59
---	---	MH211A	MH217A							0.0	160.2	4.00	2.60										1.43	0.40	3.00	35.64	15.04	250	0.33	0.703	32.64	91.59
Hemlock Road	230A	MH230A	MH (80)				100		1.51	230.0	230.0	4.00	3.73									1.51	1.51	0.42	4.15	51.16	68.00	250	0.68	1.010	47.01	91.89
Hemlock Road		MH (80)	MH216A							0.0	230.0	4.00	3.73										1.51	0.42	4.15	51.16	32.59	250	0.68	1.010	47.01	91.89
---	222A	MH222A	MH220A			55			1.49	148.5	148.5	4.00	2.41								3.70	5.19	5.19	1.45	3.86	50.78	176.73	250	0.67	1.002	46.92	92.40
---	220A	MH220A	MH216A					102	1.70	183.6	332.1	4.00	5.38									1.70	6.89	1.93	7.31	47.32	177.16	300	0.22	0.648	40.01	84.55
---	---	MH216A	MH (84)							0.0	562.1	3.95	8.99										8.40	2.35	11.34	45.12	37.76	300	0.20	0.618	33.78	74.86
---		MH (84)	MH217A							0.0	562.1	3.95	8.99										8.40	2.35	11.34	45.12	25.15	300	0.20	0.618	33.78	74.86
---	---	MH217A	EX Shaft							0.0	722.3	3.89	11.37									0.00	9.83	2.75	14.12	45.12	48.76	300	0.20	0.618	30.99	68.69
PHASE 3 - NRC SHAFT																																
Major Collector	COM3	MH126A	MH300A							0.0	0.0	4.00	0.00			2.31	2.31			2.01		2.31	2.31	0.65	2.65	41.62	168.74	250	0.45	0.821	38.96	93.63
Major Collector	COM4	MH300A	MH310A							0.0	0.0	4.00	0.00			0.87	3.18			2.76		0.87	3.2	0.89	3.65	53.73	84.20	250	0.75	1.060	50.08	93.20
Major Collector	310A	MH310A	MH (28)			31			0.98	83.7	83.7	4.00	1.36			0.00	3.18			2.76		0.98	4.16	1.16	5.28	53.73	97.88	250	0.75	1.060	48.45	90.17
Major Collector		MH (28)	MH315A							0.0	83.7	4.00	1.36			0.00	3.18			2.76		0.00	4.16	1.16	5.28	53.73	109.91	250	0.75	1.060	48.45	90.17
---	300A	MH300A	MH301A			10			0.34	27.0	27.0	4.00	0.44			0.00	0.00			0.00		0.34	0.34	0.10	0.53	35.64	82.87	250	0.33	0.703	35.11	98.51
---	301A	MH301A	MH302A			11			0.37	29.7	56.7	4.00	0.92			0.00	0.00			0.00		0.37	0.71	0.20	1.12	35.64	78.00	250	0.33	0.703	34.52	96.86
---	302A	MH302A	MH314A			10			0.34	27.0	83.7	4.00	1.36			0.00	0.00			0.00		0.34	1.05	0.29	1.65	43.87	77.94	250	0.50	0.866	42.22	96.24
---	314A	MH314A	MH315A			12			0.38	32.4	116.1	4.00	1.88			0.00	0.00			0.00		0.38	1.43	0.40	2.28	92.02	78.38	250	2.20	1.816	89.74	97.52
---	315A	MH315A	***MH320A***			8			0.32	21.6	221.4	4.00	3.59			0.00	3.18			2.76		0.32	5.91	1.65	8.00	67.96	97.62	250	1.20	1.341	59.96	88.22
---	311A	MH311A	MH (256)			19			0.76	51.3	51.3	4.00	0.83									0.76	0.76	0.21	1.04	50.02	117.03	250	0.65	0.987	48.97	97.91
---		MH (256)	MH323A							0.0	51.3	4.00	0.83										0.76	0.21	1.04	50.02	27.17	250	0.65	0.987	48.97	97.91

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SANITARY SEWER DESIGN SHEET

PROJECT: FORMER CFB ROCKCLIFFE
LOCATION: CITY OF OTTAWA
CLIENT: CANADA LANDS COMPANY

LOCATION				RESIDENTIAL										ICI AREAS							INFILTRATION ALLOWANCE				TOTAL	PROPOSED SEWER DESIGN						
				UNIT TYPES					AREA	POPULATION		PEAK	PEAK	AREA (Ha)						PEAK	AREA (Ha)			FLOW	FLOW	CAPACITY	LENGTH	DIA	SLOPE	VELOCITY	AVAILABLE CAPACITY	
														INSTITUTIONAL		COMMERCIAL		INDUSTRIAL													
STREET	AREA ID	FROM MH	TO MH	SF	SD	TH/F	TH/S	APT	(Ha)	IND	CUM	FACTOR	(L/s)	IND	CUM	IND	CUM	IND	CUM	(L/s)	PARKS	IND	CUM	(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	(full) (m/s)	L/s	(%)
---	323A	MH323A	MH (12)							0.0	51.3	4.00	0.83								0.47	0.47	1.23	0.34	1.18	87.74	41.89	250	2.00	1.731	86.56	98.66
---		MH (12)	MH (13)							0.0	51.3	4.00	0.83										1.23	0.34	1.18	87.74	32.20	250	2.00	1.731	86.56	98.66
---		MH (13)	***MH320A***							0.0	51.3	4.00	0.83										1.23	0.34	1.18	87.74	27.05	250	2.00	1.731	86.56	98.66
---	320A	MH320A	MH (15)							0.0	272.7	4.00	4.42			0.00	3.18			2.76	3.44	3.44	10.58	2.96	10.14	72.08	60.67	250	1.35	1.423	61.94	85.93
---		MH (15)	MH (16)							0.0	272.7	4.00	4.42			0.00	3.18			2.76			10.58	2.96	10.14	72.08	66.68	250	1.35	1.423	61.94	85.93
---		MH (16)	MH (17)							0.0	272.7	4.00	4.42			0.00	3.18			2.76			10.58	2.96	10.14	72.08	82.93	250	1.35	1.423	61.94	85.93
---		MH (17)	MH (18)							0.0	272.7	4.00	4.42			0.00	3.18			2.76			10.58	2.96	10.14	72.08	39.16	250	1.35	1.423	61.94	85.93
---		MH (18)	***MH333A***							0.0	272.7	4.00	4.42			0.00	3.18			2.76			10.58	2.96	10.14	72.08	29.65	250	1.35	1.423	61.94	85.93
---	SDA	MH330A	MH331A					275	6.36	495.0	495.0	3.98	7.97									6.36	6.36	1.78	9.75	35.64	132.70	250	0.33	0.703	25.88	72.63
---		MH331A	MH332A							0.0	495.0	3.98	7.97									0.00	6.36	1.78	9.75	35.64	60.29	250	0.33	0.703	25.88	72.63
---	332A, AVIATION	MH332A	MH (367)							0.0	495.0	3.98	7.97	AVIATION MUSEUM FIXED FLOW FROM 332A TO NRC SHAFT -->						*29.00*	2.45	2.45	8.81	2.47	39.44	45.12	48.21	300	0.20	0.618	5.68	12.58
---		MH (367)	MH (368)							0.0	495.0	3.98	7.97							*29.00*		0.00	8.81	2.47	39.44	45.12	83.95	300	0.20	0.618	5.68	12.58
---		MH (368)	MH (369)							0.0	495.0	3.98	7.97							*29.00*		0.00	8.81	2.47	39.44	45.12	29.01	300	0.20	0.618	5.68	12.58
---		MH (369)	MH (370)							0.0	495.0	3.98	7.97							*29.00*		0.00	8.81	2.47	39.44	45.12	42.26	300	0.20	0.618	5.68	12.58
---		MH (370)	MH338A							0.0	495.0	3.98	7.97							*29.00*		0.00	8.81	2.47	39.44	45.12	94.01	300	0.20	0.618	5.68	12.58
---		MH338A	***MH333A***							0.0	495.0	3.98	7.97							*29.00*		0.00	8.81	2.47	39.44	45.12	217.08	300	0.20	0.618	5.68	12.58
---		***MH333A***	NRC SHAFT							0.0	767.7	3.87	12.04			0.00	3.18			*31.76*			19.39	5.43	49.23	91.46	35.09	375	0.25	0.802	42.23	46.17
PHASE 2 - PEACH TREE LANE SHAFT																															
---	175A	MH175A	MH242A	7					0.69	23.8	23.80	4.00	0.39									0.69	0.69	0.19	0.58	57.20	125.31	250	0.85	1.129	56.62	98.99
---	242A	MH242A	MH (95)			21			0.68	56.7	80.50	4.00	1.30									0.68	1.37	0.38	1.69	53.73	49.67	250	0.75	1.060	52.04	96.86
---		MH (95)	MH244A							0.0	80.50	4.00	1.30									0.00	1.37	0.38	1.69	53.73	49.28	250	0.75	1.060	52.04	96.86
---	235A	MH235A	MH210A			22			0.80	59.4	59.40	4.00	0.96									0.80	0.80	0.22	1.19	48.06	41.66	250	0.60	0.948	46.87	97.53
---		MH210A	MH244A							0.0	59.40	4.00	0.96									0.00	0.80	0.22	1.19	48.06	78.62	250	0.60	0.948	46.87	97.53
---	244A	MH244A	MH (105)							0.0	139.90	4.00	2.27								2.64	2.64	4.81	1.35	3.61	58.86	137.40	250	0.90	1.162	55.24	93.86
---		MH (105)	MH258A							0.0	139.90	4.00	2.27									0.00	4.81	1.35	3.61	58.86	79.88	250	0.90	1.162	55.24	93.86
---	257A	MH257A	MH256A					158	1.40	284.4	284.40	4.00	4.61									1.40	1.40	0.39	5.00	35.64	68.32	250	0.33	0.703	30.64	85.97
---	256A	MH256A	MH258A					196	1.45	352.8	637.20	3.92	10.11									1.45	2.85	0.80	10.91	35.64	111.37	250	0.33	0.703	24.73	69.39
---	258A	MH258A	MH (108)				234		2.83	538.2	1315.30	3.72	19.82									2.83	10.49	2.94	22.76	31.02	32.57	250	0.25	0.612	8.26	26.63
---		MH (108)	MH (345)							0.0	1315.30	3.72	19.82									0.00	10.49	2.94	22.76	31.02	90.36	250	0.25	0.612	8.26	26.63
---		MH (345)	MH252A							0.0	1315.30	3.72	19.82									0.00	10.49	2.94	22.76	31.02	11.96	250	0.25	0.612	8.26	26.63
---	---	MH252A	MH251A							0.0	1315.30	3.72	19.82									0.00	10.49	2.94	22.76	31.02	72.52	250	0.25	0.612	8.26	26.63
---	256A	MH256A	MH (113)					*296*	*2.65*	532.8	532.80	3.96	8.55									2.65	2.65	0.74	9.29	62.04	32.51	250	1.00	1.224	52.75	85.03
---		MH (113)	MH (114)							0.0	532.80	3.96	8.55									0.00	2.65	0.74	9.29	62.04	31.73	250	1.00	1.224	52.75	85.03
---		MH (114)	MH (115)							0.0	532.80	3.96	8.55									0.00	2.65	0.74	9.29	62.04	29.65	250	1.00	1.224	52.75	85.03
---		MH (115)	MH (116)							0.0	532.80	3.96	8.55									0.00	2.65	0.74	9.29	62.04	40.58	250	1.00	1.224	52.75	85.03
---		MH (116)	MH (117)							0.0	532.80	3.96	8.55									0.00	2.65	0.74	9.29	62.04	35.05	250	1.00	1.224	52.75	85.03
---		MH (117)	MH251A							0.0	532.80	3.96	8.55									0.00	2.65	0.74	9.29	62.04	22.97	250	1.00	1.224	52.75	85.03
---	251A	MH251A	MH (347)							0.0	1848.10	3.61	27.04								0.76	0.76	13.90	3.89	30.93	33.98	36.49	250	0.30	0.671	3.05	8.96
---		MH (347)	MH250A							0.0	1848.10	3.61	27.04									0.00	13.90	3.89	30.93	33.98	32.48	250	0.30	0.671	3.05	8.96
Hemlock Road	230A	MH230A	MH (341)				100		1.40	230.0	230.00	4.00	3.73									1.40	1.40	0.39	4.12	67.96	46.37	250	1.20	1.341	63.84	93.94
Hemlock Road		MH (341)	MH (342)							0.0	230.00	4.00	3.73									0.00	1.40	0.39	4.12	67.96	40.25	250	1.20	1.341	63.84	93.94
Hemlock Road		MH (342)	MH235A							0.0	230.00	4.00	3.73									0.00	1.40	0.39	4.12	67.96	27.62	250	1.20	1.341	63.84	93.94
Hemlock Road	235A	MH235A	MH (99)				79		1.15	181.7	411.70	4.00	6.67									1.15	2.55	0.71	7.39	35.64	94.25	250	0.33	0.703	28.25	79.28
Hemlock Road		MH (99)	MH245A							0.0	411.70	4.00	6.67									0.00	2.55	0.71	7.39	35.64	49.39	250	0.33	0.703	28.25	79.28
Hemlock Road	245A, MUSEUM	MH245A	MH212A						0.37	0.0	411.70	4.00	6.67	0.00	0.00					0.00		0.37	2.92	0.82	7.49	62.04	47.70	250	1.00	1.224	54.55	87.93
Hemlock Road		MH212A	MH (102)							0.0	411.70	4.00	6.67	0.00	0.00					0.00		0.00	2.92	0.82	7.49	62.04	44.25	250	1.00	1.224	54.55	87.93
Hemlock Road		MH (102)	MH250A							0.0	411.70	4.00	6.67	0.00	0.00					0.00		0.00	2.92	0.82	7.49	43.87	54.82	250	0.50	0.866	36.38	82.93
Hemlock Road	250A	MH250A	MH (120)							0.0	2259.80	3.54	32.44	0.00	0.00					0.00	0.00	0.00	16.82	4.71	37.15	71.33	58.91	300	0.50	0.978	34.18	47.92
Hemlock Road		MH (120)	MH (121)							0.0	2259.80	3.54	32.44	0.00	0.00					0.00		0.00	16.82	4.71	37.15	71.33	57.91	300	0.50	0.978	34.18	47.92
Hemlock Road		MH (121)	MH271A							0.0	2259.80	3.54	32.44	0.00	0.00					0.00		0.00	16.82	4.71	37.15	71.33	50.47	300	0.50	0.978	34.18	47.92
Hemlock Road	271A	MH271A	MH272A					0	0.43	0.0	2259.80	3.54	32.44	0.00	0.00					0.00		0.43	17.25	4.83	37.27	71.33	141.24	300	0.50	0.978	34.06	47.75
---	MONTFORT	MH261A	MH262A							0.0	0.00	4.00	0.00	8.36	8.36					7.26		8.36	8.36	2.34	9.60	75.98	145.47	250	1.50	1.500	66.38	87.37
---	261A	MH262A	MH272A					158	1.77	284.4	284.40	4.00	4.61	0.00	8.36					7.26		1.77	10.13	2.84	14.70	75.98	236.46	250	1.50	1.500	61.28	80.65
---		MH272A	Ex MH253A							0.0	2544.20	3.50	36.10	0.00	8.36					7.26		0.00	27.38	7.67	51.02	74.82	169.89	300	0.55	1.025	23.80	31.81
Future Museum			Ex MH253A											11.33	11.33							11.33	38.71	10.84	10.84							
Total Flow To Airbase																															
Pullback Sewer																									61.86	*83.80*	*50.00*	*300*	*0.69*	*1.148*	*21.94*	*26.18*

Design Parameters:

Residential

SF	3.4	p/p/u
THF	2.7	p/p/u
APT	1.8	p/p/u
THS	2.3	p/p/u
Other	60	p/p/Ha

ICI Areas

			Peak Factor
INST	50,000	L/Ha/day	1.5
COM	50,000	L/Ha/day	1.5
IND	35,000	L/Ha/day	MOE Chart

Notes:
1. Mannings coefficient (n) = 0.013
2. Demand (per capita): 350 L/day
3. Infiltration allowance: 0.28 L/s/Ha
4. Residential Peaking Factor:
Harmon Formula = 1+(14/(4+P^0.5))
where P = population in thousands

Designed: Michael Black - E.I.T.

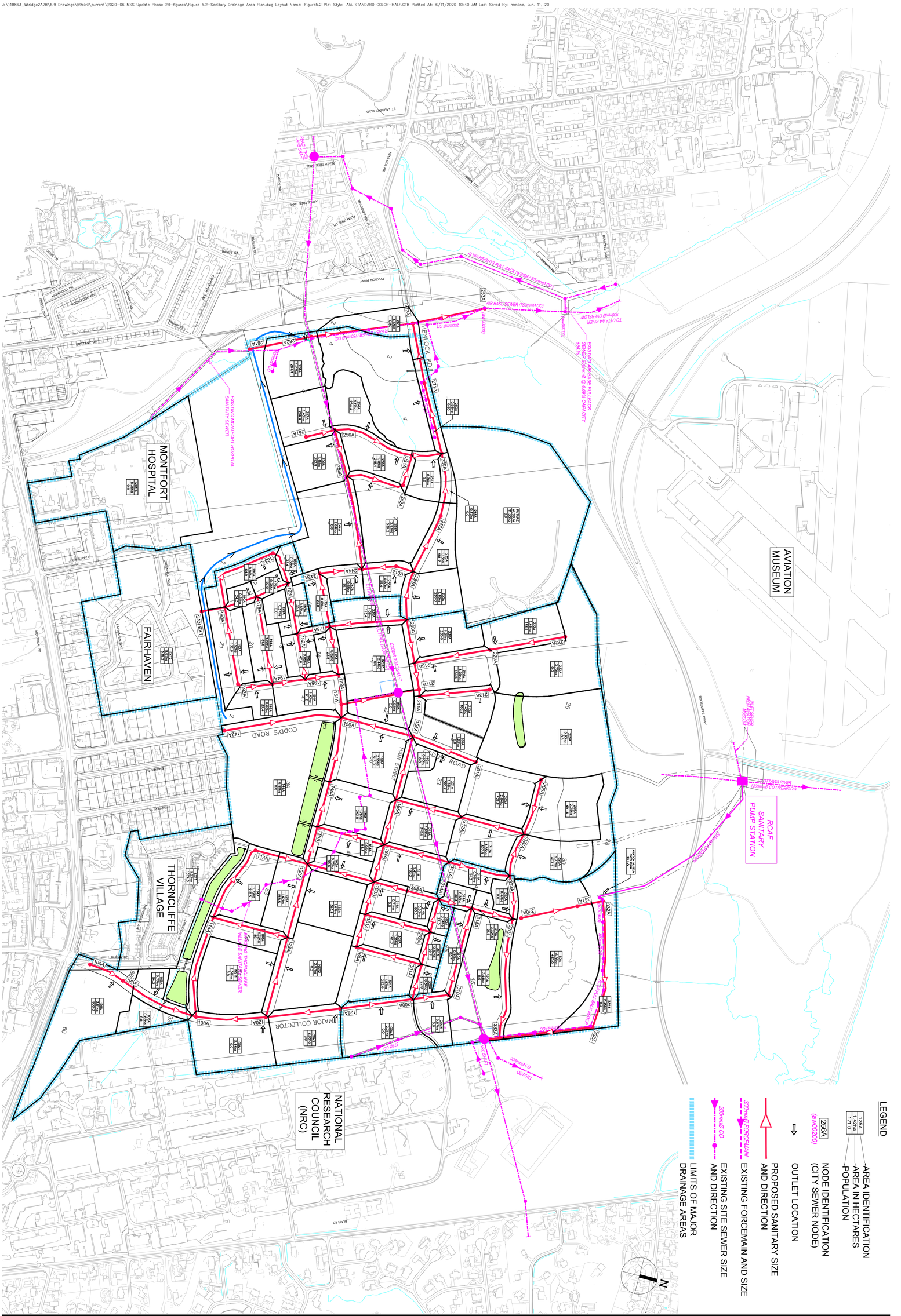
Checked: Jim Moffatt - P.Eng

Dwg. Reference: FIGURE 5.1

File Reference: 32952-5.7.1

No.	Revision	Date
1.	MASTER SERVICING STUDY SUBMISSION 1 FOR CITY REVIEW	2014-10-24
2.	MASTER SERVICING STUDY SUBMISSION 2 FOR CITY REVIEW	2015-02-12
3.	MASTER SERVICING STUDY SUBMISSION 3 FOR CITY APPROVAL	2015-08-14

J:\118863_Wtridge2A28\5.9 Drawings\59civil\current\2020-06 MSS Update Phase 2B-figures\Figure 5.2-Sanitary Drainage Area Plan.dwg Layout Name: Figure5.2 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 6/11/2020 10:40 AM Last Saved By: mmline, Jun. 11, 20



Sheet No.	Drawing Title	Project Title	Scale
FIGURE 5.2	SANITARY DRAINAGE AREA PLAN	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	0 100 200

IBI

NO	DATE	REVISION	BY
1	02/05/91	SUBMITTED FOR APPROVAL	M.F.S.
2	31/07/91	SUBMITTED FOR TENDER	M.F.S.

THORNCLIFFE SWM

PROFESSIONAL STAMP

LEGEND

- SANITARY DRAINAGE AREA – DND LANDS (10)
- PROPOSED SANITARY SEWER AND MANHOLE
- AREA TO BE DEVELOPED
- WATERSHED BOUNDARY
- SUB WATERSHED BOUNDARY
- EXISTING STORM SEWER & MANHOLE
- AREA OF SUB WATERSHED / SUB WATERSHED NUMBER (6.5 ha)

PROJECT
THORNCLIFFE VILLAGE

TITLE
DND LANDS
PROPOSED STORM WATER MANAGEMENT POND AND SANITARY SEWER OUTLET

CLIENT
THORNCLIFFE VILLAGE INC.

J.L. Richards & Associates Limited
Consulting Engineers, Architect & Planners
OTTAWA, KINGSTON, SUDBURY, CANADA.

SCALE 1:2000

DWG No 12381 SI

NORTH TRUNK OUTLET

ROCKCLIFFE AIRBASE (DND)

EXIST. RMOC TRUNK SANITARY SEWER

WEST TRUNK SEWER

NEW SHAFT SEE DETAIL 11382-02

EXIST. WEST TRUNK STORM SEWER

EXIST. NORTH TRUNK STORM SEWER

TO WEST TRUNK OUTLET

DND SAN. FLOW
POPULATION: 3790
AREA: 37 ha

SANITARY FLOW
POPULATION: 1574
AREA: 9.45 ha

POND OUTLETS

REFER TO DWG 12381-01 FOR STORMWATER MANAGEMENT POND DETAILS

EXIST. 600 mm CMP TO REMAIN AS IS

10.0 ha

7.5 ha

6.5 ha

THORNCLIFFE VILLAGE

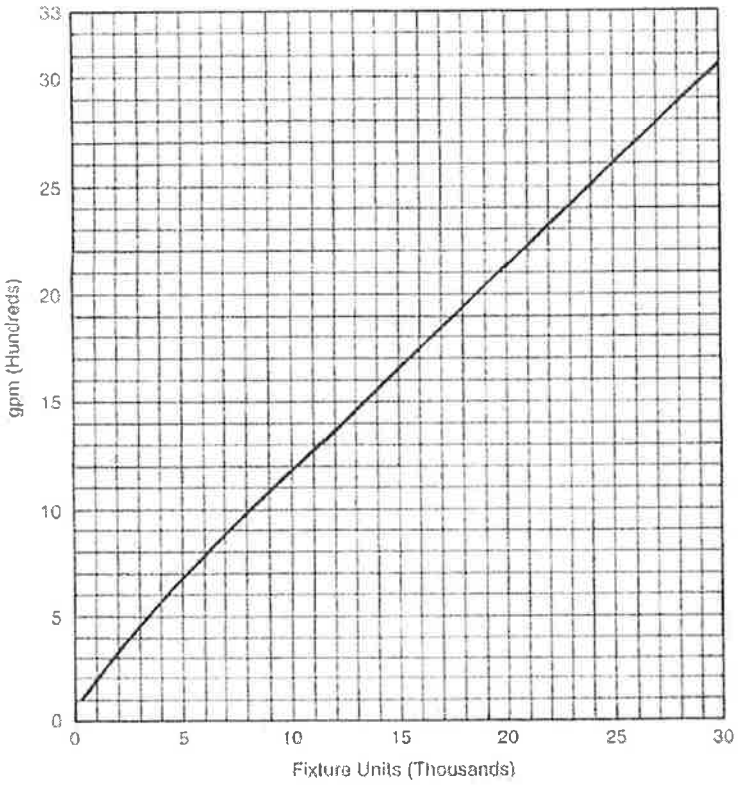
Table 7.5.8.4.
Size and Developed Length of Stack Vents and Vent Stacks

Forming Part of Sentence 7.5.8.4.(1)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13
Size of Soil or Waste Stack, in.	Total Hydraulic Load Being Vented, *fixture units*	Water Occupied Area	*Size of Stack Vent or Vent Stack*, in.									
			1¼	1 ½	2	3	4	5	6	8	10	12
			Maximum Length of *Stack Vent or Vent Stack*, m									
1¼	2	0.29	9									
1½	8	0.25	15	46								
2	12	0.25	9	23	61							
	24	.29	8	15	46							
3	10	0.15		13	46	317	Not Limited					
	21	.20		10	33.5	247						
	53	.25		8	28.5	207						
	102	.29		7.5	26	189						
4	43	0.15	Not Permitted		10.5	76	299	Not Limited				
	140	.20			8	61	229					
	320	.25			7	52	195					
	540	.29			6.5	46	177					
5	190	0.15	Not Permitted			25	97.5	302	Not Limited			
	490	.20				29	76	232				
	940	.25				16	64	204				
	1 400	.29				15	58	180				
6	500	0.15	Not Permitted			10	39.5	122	305	Not Limited		
	1 100	.20				8	30.5	94.5	238			
	2 000	.25				6.5	25.5	79	201			
	2 900	.29				6	23.5	73	183			
8	1 800	0.15	Not Permitted				9.5	29	73	287	Not Limited	
	3 400	.20					7	22	58	219.5		
	5 600	.25					6	19	49	186		
	7 600	.29					5.5	17	43	70.5		
10	4 000	0.15	Not Permitted					9.5	24	94.5	292.5	Not Limited
	7 200	.20						7	18	73	225.5	
	11 000	.25						6	15.5	61	192	
	15 000	.29						5.5	14	55	174	
12	7 300	0.15	Not Permitted						9.5	36.5	116	287
	13 000	.20							7	28.5	91	219.5
	20 000	.25							6	24	76	186
	26 000	.29							5.5	22	70	152
15	15 000	0.15	Not Permitted							12	39.5	94.5
	25 000	.20								9.5	29	73
	38 000	.25								8	24.5	62
	50 000	.29								7	22.5	55

water piping inside the building up to the point where the connection is taken off to the hot water heater supply.

Figure 13-7 Conversion of Fixture Units to gpm (Mixed System)



LEGEND

256A (aw00200) — NODE IDENTIFICATION (CITY SEWER NODE)

250mmØ — PROPOSED SANITARY SEWER SIZE AND DIRECTION

300mmØ FORCEMAIN — EXISTING FORCEMAIN AND SIZE

200mmØ CO — EXISTING SITE SEWER SIZE AND DIRECTION

AVIATION MUSEUM

FUTURE MUSEUM

RCAF SANITARY PUMP STATION

INLET SEWER FROM AVIATION MUSEUM

300mmØ FORCEMAIN TO OTTAWA RIVER INTERCEPTOR SEWER

ROCKCLIFFE PKWY

OTTAWA RIVER INTERCEPTOR SEWER

EXISTING AIR BASE PULLBACK SEWER 300mmØ @ 0.69% CAPACITY ±84.1/s

(aw00100)

AIR BASE SEWER 750mmØ CO

AIR BASE PULLBACK SEWER 1050mmØ CO

(aw00200)

CONNECT TO EXISTING COMBINED SEWER AT CITY MANHOLE aw00200 EX. INVERT ±61.89m

DECOMISSION AND REMOVE EXISTING 200mmØ

REPLACE AIR BASE OUTLET SEWER FROM NODE 261A TO 253A

HEMLOCK RD

EXISTING MONTFORT HOSPITAL SANITARY SEWER

MONTFORT HOSPITAL

FAIRHAVEN

CONNECT TO EXISTING CODD'S ROAD SHAFT INVERT 76.80m

CODD'S ROAD SHAFT

EX. SHAFT

SITTA CANTERA SUBDIVISION OUTFALL (aw00400) 600mmØ CO

SAN EXT

CODD'S ROAD

MAIN STREET

MAJOR COLLECTOR

REPLACE EXISTING RCAF PULLBACK SEWER

(rc00900)

300mmØ CO

RCAF PULL BACK SEWER

INVERT AT EXISTING NRC SHAFT EX. INVERT ±77.0m

NRC SHAFT

INTERCEPT EXISTING SANITARY INVERT ±86.40m

EXISTING THORNCLIFFE VILLAGE SANITARY SEWER

CAP SEWER AND CONSTRUCT TEMPORARY OVER FLOW TO SWM FACILITY

THORNCLIFFE VILLAGE

NATIONAL RESEARCH COUNCIL (NRC)

PEACH TREE LANE SHAFT

N

Scale 0 100 200

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Drawing Title

RECOMMENDED PHASE 1A
WASTEWATER PLAN

Sheet No.

FIGURE 5.4

J:\118863_Wridge2429\5.9 Drawings\29civil\current\2020-06 MSS Update Phase 2B-figures\Figure 5.4-Proposed Wastewater Plan Phase 1A.dwg Layout Name: Figure5.4 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 6/11/2020 10:38 AM Last Saved By: mmilne, Jun 11, 20

CLC Rockcliffe Development
Protection of Interceptor Outfall Sewer and Future Twin
Meeting #2

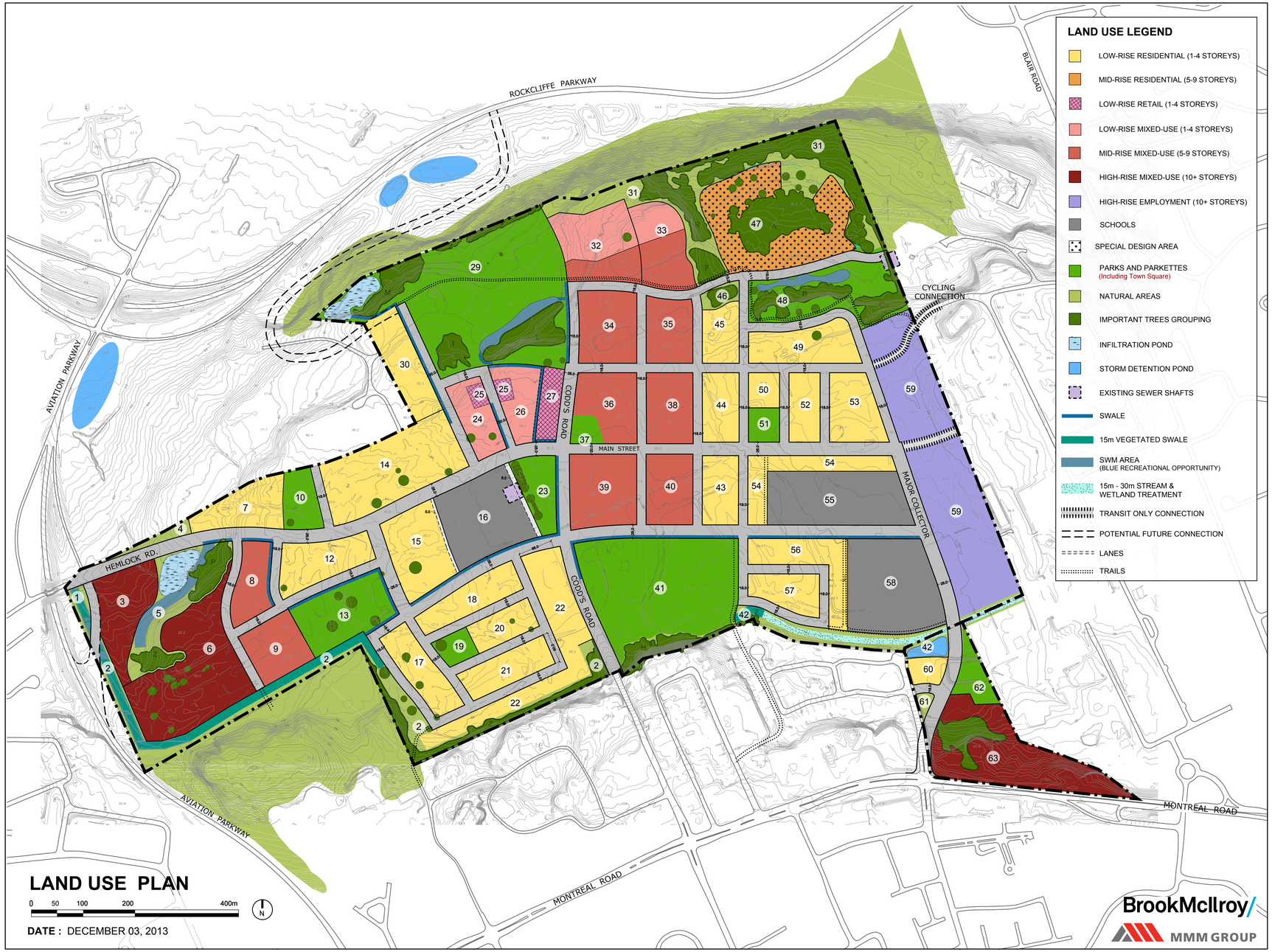
Clyde Avenue Training Room, 1st Floor
January 13, 2017

FINAL MEETING NOTES
(prepared by Chris Rogers)

In attendance:
Chris Rogers (CR), PGM
Selma Hassan, PGM
Louis Julien, ISD
Shelly McDonald, ESD
Michael Burt, ESD
Gerry Taylor, ESD

	ITEM	ACTION
1	January 7 meeting notes corrections: ISD (Peter McKay) is responsible for setting priority condition assessment of drop shafts, not ISD. IBI (Jim Moffat) requested corrections to minutes on how hydraulic capacity of drop shafts are assessed.	
2	January 7 meeting action item update: SH provided information on existing IOS easement. The easement is not registered. City will work with CLC to have the easement registered as first step. This will also allow CLC to obtain "Absolute Plus Title" and proceed with plan of subdivision. Legal has indicated that a blanket easement for future twin can be secured at the subdivision approval stage. (It is anticipated that the entire CDP study area will be included in a single subdivision application.) LJ is working on establishing a single elevation as a maximum depth of excavation to protect IOS / future twin. SH has added Curtis Rampersad, MB, SM to CLC Rockcliffe TAC.	
3	Draft CDP expected to be circulated in February. There will be a 1 month review period (SH). Drop shaft condition assessment should be completed in about a month so that this information is available to support review of the CDP and MSS. GT suggested that this should be feasible, but winter conditions (fog issues) may cause delays. CR to prompt Peter Mckay on making this work a priority.	**CR**
4	Consideration should be given to maintaining surface easement as well as securing strata easement. Steve Dover (attended meeting briefly) thought that this may have been approach taken for US Embassy, which was built over existing IOS. The ultimate dimensions of the strata easements would likely be slightly larger than indicated in the January 7 meeting minutes (LJ).	

5	Following January 7 meeting, LJ and MB concluded that new IOS shaft is needed due to a lack of staging area around existing shafts. Existing IOS alignment intersects 3 proposed parks in the development area. Suitable area within **one** of these parks should be planned to allow for <u>temporary use</u> as staging area at any time in future to allow for O&M activities related to the IOS, as well as potential future renewal (relining) work. LJ to confirm area required for these activities, in consultation with CSST consultant and ESD. This area would be also include a <u>permanent</u> access shaft. On the surface, there would be a 2.5m x 2.5m Bilco-type hatch to access the shaft. A large area concrete structure (6m diameter) could be hidden below grade, but no unrelated structures could be built over this area. Alternative locations include the parks located on Block 23 (potentially adjacent to existing drop shaft) and Block 48 (immediately west of existing drop shaft). Blocks shown on attached land use plan (Dec 3, 2013 version). Criteria for selection would be based on input from CLC, City Parks staff, and ESD/ISD staff. Intent would be to plan and construct the new IOS shaft before occupancy of the land in which these blocks are located (candidate locations are not in the Phase 1 development).	**LJ**
6	Provision for **one** access shaft for future IOS twin is required. Alternative locations include Blocks 29, 41, and 48. (per Dec 3, 2013 land use plan). Criteria for selection to be established as per proposed shaft for existing IOS. Construction would most likely take place after development and occupancy of surrounding land. Construction staging area required is estimated at ~0.5 ha. LJ to confirm. The construction staging area could include ROW area, and could involve protection of features (e.g. trees) within the staging area. Detailed mitigation and reinstatement requirements would be established in consultation with City Parks staff at the time that plans for the IOS twin shaft are prepared. The IOS twin shaft location could also serve as entry/exit point for tunnel boring machine, in which case construction activities could extend over 18-24 months.	**LJ**
7	Intent to add blanket strata easement over entire site for future IOS twin at subdivision stage to be added to CDP documentation. CDP should also identify intent to construct 2 shafts, one for IOS and one for future twin, and also identify alternative locations. Detailed design of land use would need to be compatible with needs associated with the shafts as described above. SH to coordinate.	**SH**


ROCKCLIFFE PARKWAY
BLAIR ROAD
AVIATION PARKWAY
CYCLING CONNECTION
CODD'S ROAD
MAIN STREET
MAJOR COLLECTOR
HEMLOCK RD.
MONTREAL ROAD
LAND USE LEGEND
LOW-RISE RESIDENTIAL (1-4 STOREYS)
MID-RISE RESIDENTIAL (5-9 STOREYS)
LOW-RISE RETAIL (1-4 STOREYS)
LOW-RISE MIXED-USE (1-4 STOREYS)
MID-RISE MIXED-USE (5-9 STOREYS)
HIGH-RISE MIXED-USE (10+ STOREYS)
HIGH-RISE EMPLOYMENT (10+ STOREYS)
SCHOOLS
SPECIAL DESIGN AREA
PARKS AND PARKETTES
(Including Town Square)
NATURAL AREAS
IMPORTANT TREES GROUPING
INFILTRATION POND
STORM DETENTION POND
EXISTING SEWER SHAFTS
SWALE
15m VEGETATED SWALE
SWM AREA
(BLUE RECREATIONAL OPPORTUNITY)
15m - 30m STREAM &
WETLAND TREATMENT
TRANSIT ONLY CONNECTION
POTENTIAL FUTURE CONNECTION
LANES
TRAILS
LAND USE PLAN
0 50 100 200 400m
N
DATE : DECEMBER 03, 2013
BrookMcIlroy/
MMM GROUP

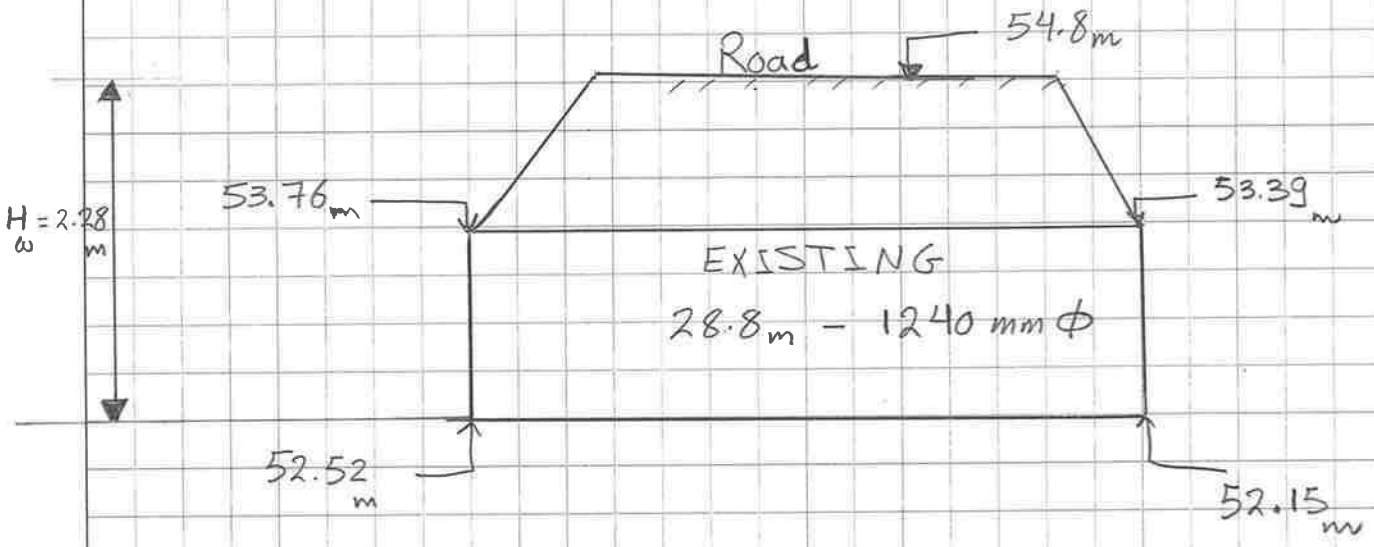
APPENDIX E

STORMWATER MANAGEMENT SYSTEM: SUPPORTING INFORMATION

- Culvert Design Nomographs – Eastern (Rockcliffe Parkway) Culvert
- *Figure 6.7 Recommended Storm Sewer System*
- Figure 6.8 Trunk Sewer Profiles
- *Figure 6.9 Rational Method Drainage Area Plan*
- Figure 6.11 Existing Conditions SWMHYMO Schematic
- Figure 6.12 Post-Development Conditions SWMHYMO Schematic
- *Storm Sewer Design Sheets*
- Water Quality Volume Calculations
- *Figure 6.15 Macro Grading Plan*
- Figure 6.16 Sewer Clearance Plan
- Street Segment Velocity x Depth Summary
- Southwest Drainage Channel Design
- NRC Drainage Swale Design
- 25 mm Outflow from Eastern SWM Facility
- 25 mm Outflow from Western SWM Facility
- Baseflow Augmentation to Eastern Creek
- Boundary Condition for Western Creek Outlet
- *Hydraulic Grade Line Summary*
- Figure 6.32 Post-Development Conditions XPSWMM Schematic – East
- Figure 6.33 Post-Development Conditions XPSWMM Schematic – West
- Figure 6.34 Recommended Phase 1A Storm Sewer System
- CD with model files and report PDF
    - SWMHYMO – Existing Conditions, Post-Development Conditions, Post-Development Conditions Velocity by Depth
    - XPSWMM – all storm events

PROJECT:	PROJECT NO.: 32952	SHEET: OF:
CLIENT:	PREPARED BY:	DATE: 2014-10
DESCRIPTION: FINAL	CHECKED BY:	OTHER:

EASTERN CULVERT (ROCKCLIFFE PARKWAY):



INLET CONTROL:

H_w: 54.80 - 52.52 = 2.28 m

$\frac{H_w}{D} = \frac{2.28}{1.24} = 1.84_m$ → Into Design Chart (D5-1G) → Q = 3.5 cms

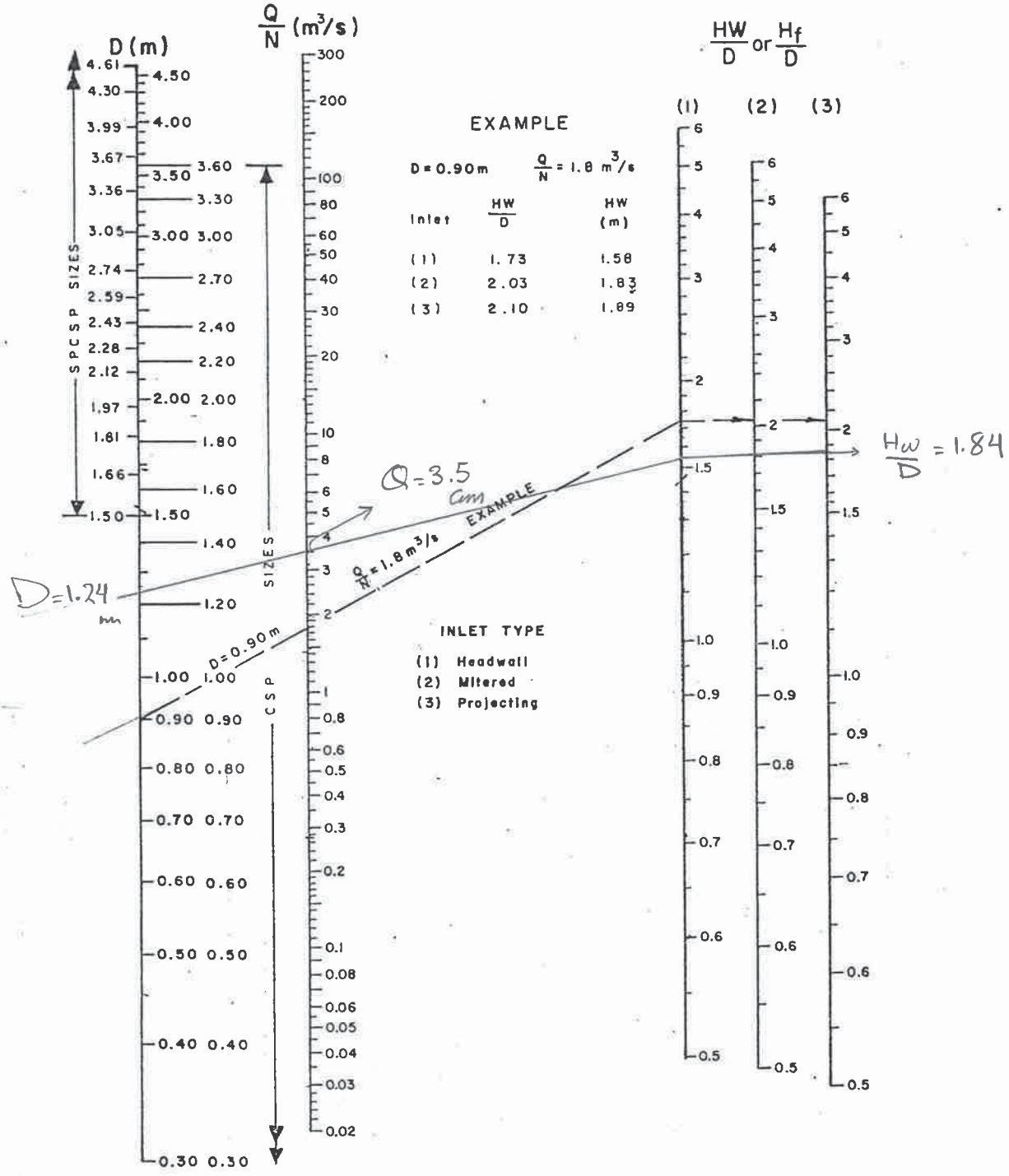
OUTLET CONTROL:

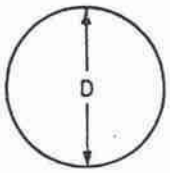
H: 53.39 - 54.80 = 1.41 m → Into Design Chart (D5-2C) → Q = 3.5 cms

D = 1.24 m

EASTERN

CHART D5-1G



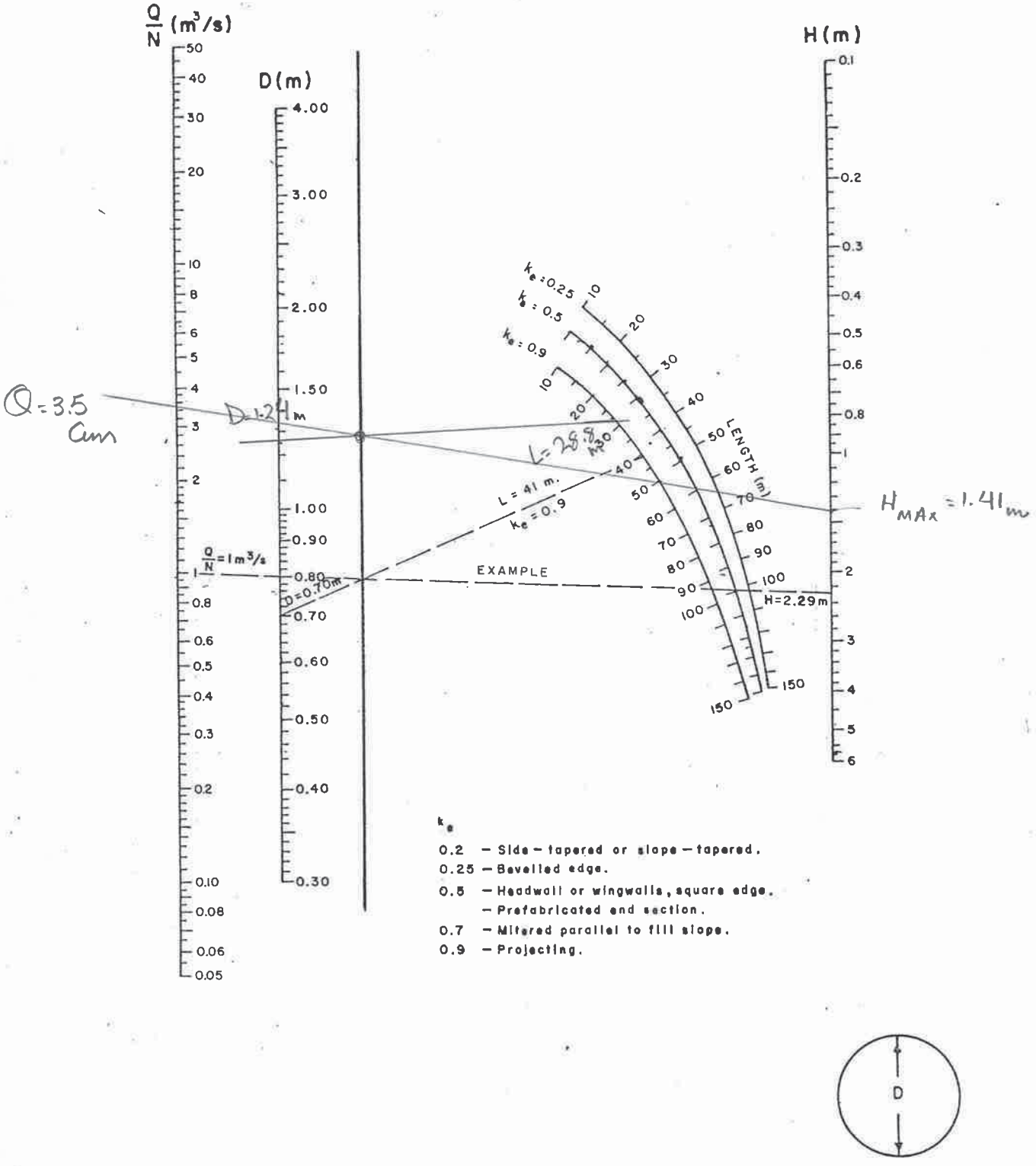


INLET CONTROL
CSP & SPCSP CULVERT

FHA 63 01
METRIC FHA 74 06 (51)

EASTERN

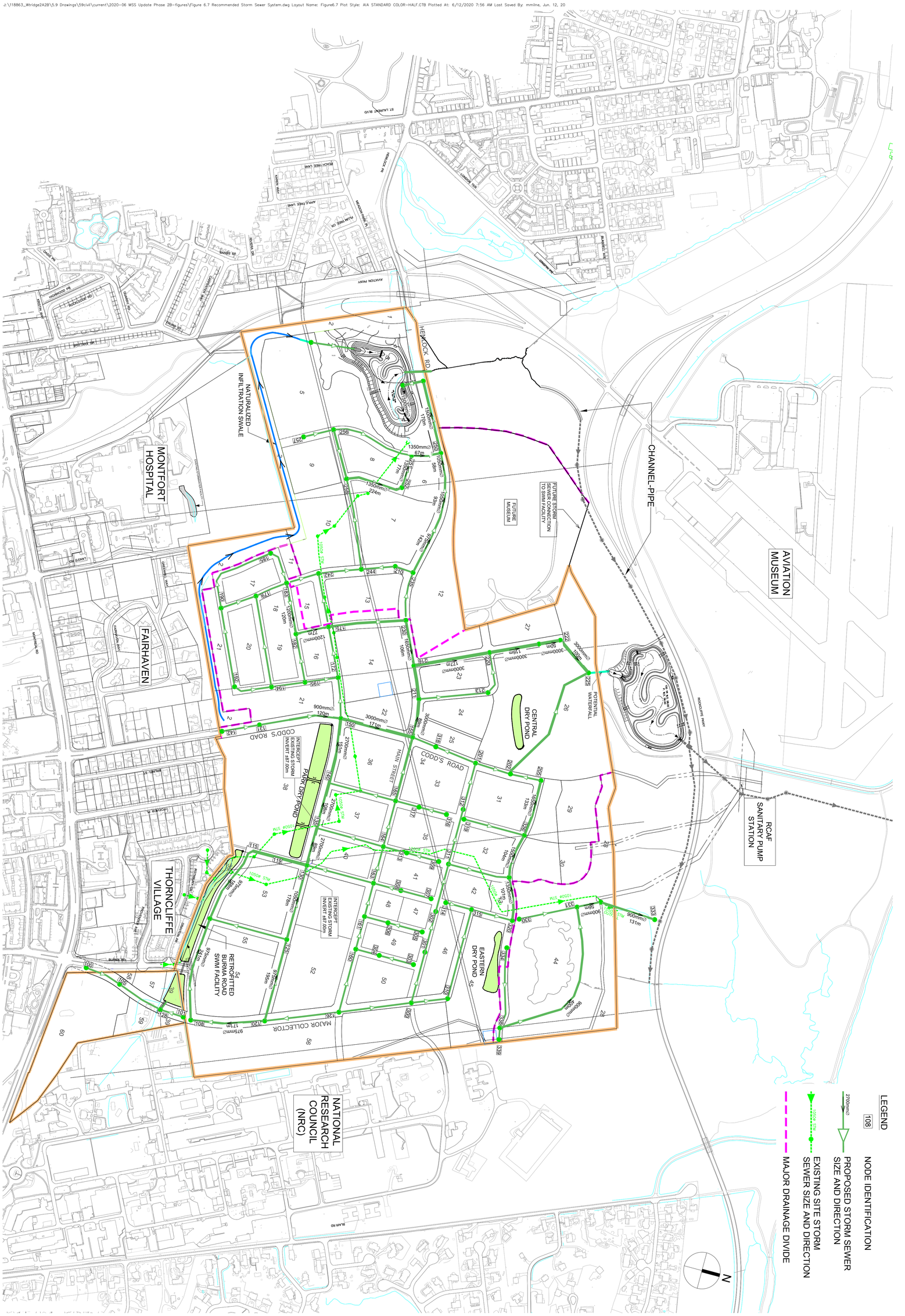
CHART D5-2C



OUTLET CONTROL
CORRUGATED STEEL PIPE
FLOWING FULL
n = 0.024

FHA 6301
METRIC FHA 7406 (51)

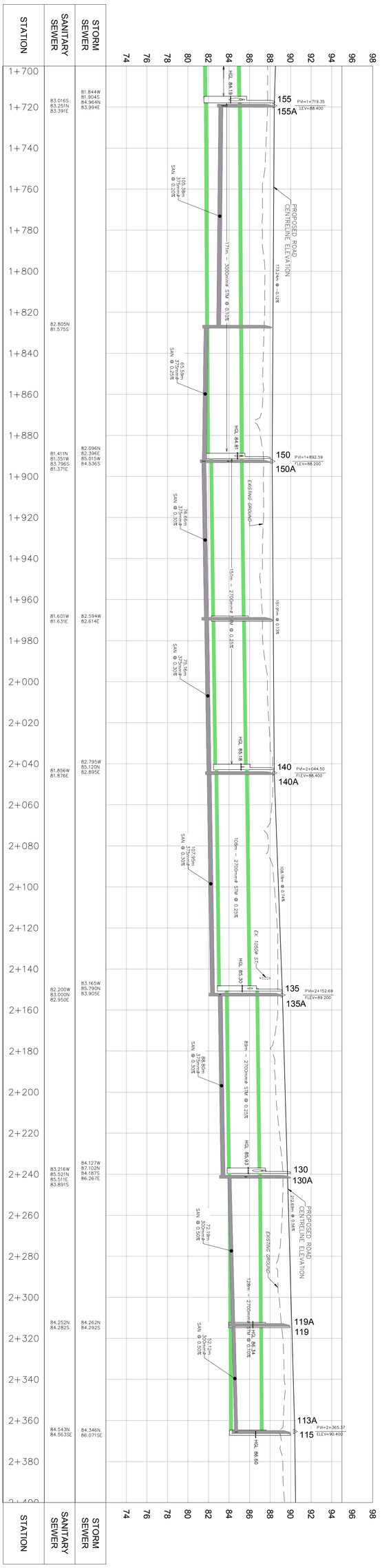
J:\118863_IBridge2A28\5.9 Drawings\59civil\current\2020-06 MSS Update Phase 2B-figures\Figure 6.7 Recommended Storm Sewer System.dwg Layout Name: Figure6.7 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 6/12/2020 7:56 AM Last Saved By: mmine, Jun. 12, 20

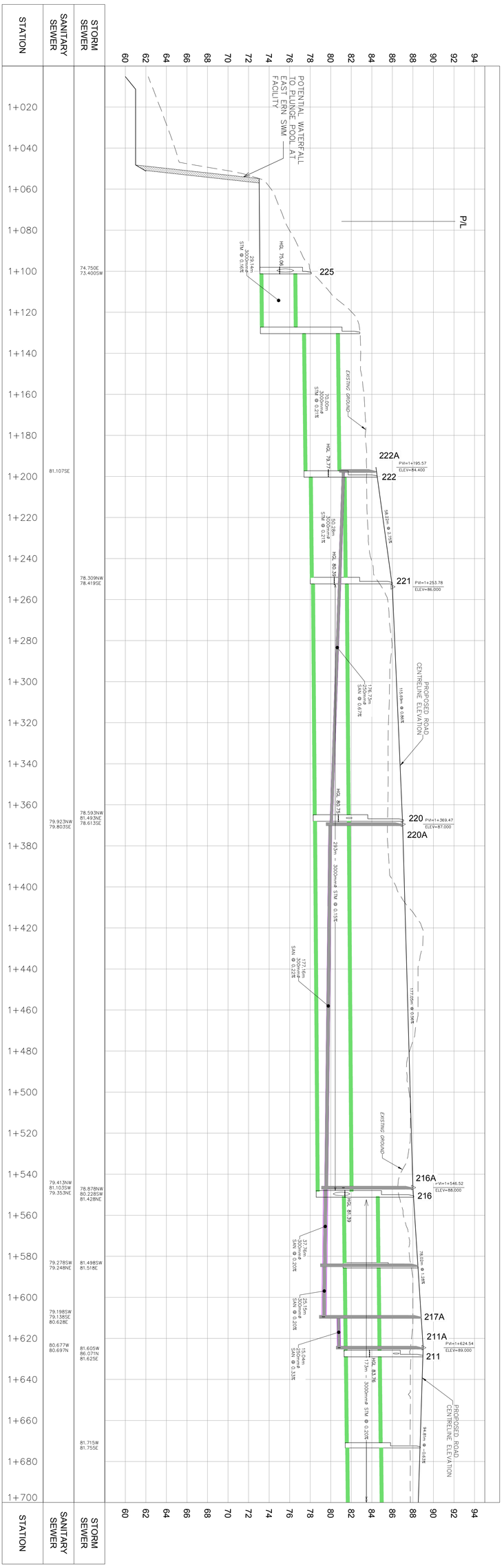


Sheet No.	Drawing Title	Project Title	Scale
FIGURE 6.7	RECOMMENDED STORM SEWER SYSTEM	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	0 100 200

IBI

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.8-Trunk Storm and Sanitary Sewer Profiles.dwg Layout Name: Figure6.8 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 8/7/2015 11:24 AM Last Saved By: mmilne, Jul. 31, 15





Sheet No.

FIGURE 6.8

Drawing Title

TRUNK
SEWER PROFILES

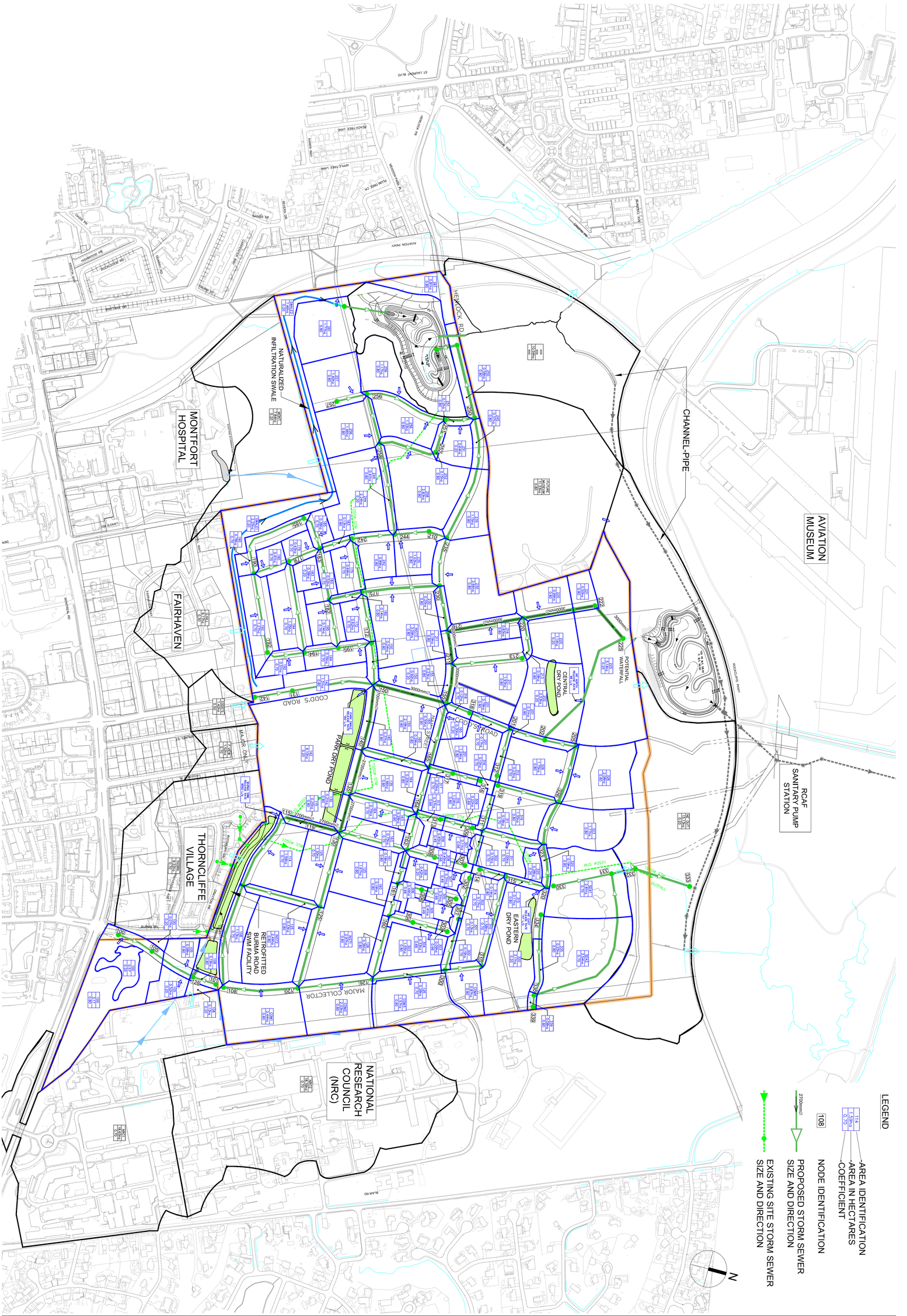
Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Scale

HORIZ 1:100
VERT 1:100

IBI



Sheet No.

FIGURE 6.9

Drawing Title

RATIONAL METHOD
DRAINAGE AREA PLAN

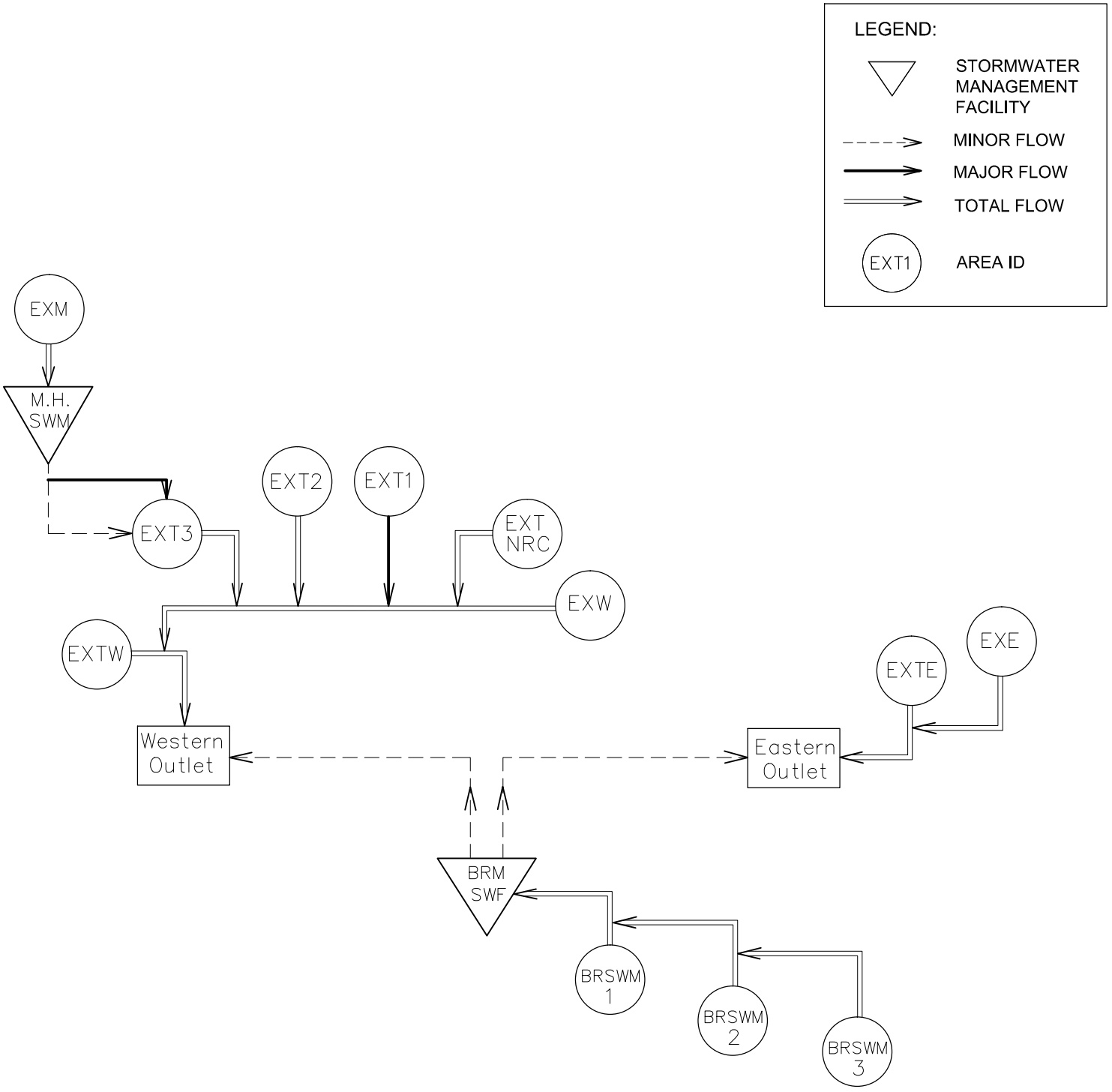
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FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Scale

0 100 200

IBI



J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.11 Existing Conditions SWMHYMO.dwg Layout Name: Figure6.11

Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	EXISTING CONDITIONS SWMHYMO SCHEMATIC	FIGURE 6.11

FIGURE 6.12

POST-DEVELOPMENT CONDITIONS
SWMHYMO SCHEMATIC

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Sheet No.

Drawing Title

Project Title

Scale N.T.S.

IBI

J:\32925-RockcliffeMaster\5.0 Drawings\Sketch\Current\Report Figures\MSS 2015\Section 6\Figure 6.12 Post Development Conditions SWMHYMO.dwg Layout Name: Figure6.12 Plot Style: AIA STANDARD COLOR-HALF.CTB Plot Scale: 1.0UNI Plotted At: 8/10/2015 3:12 PM Last Saved By: mmilne Last Saved At: 8/10/2015 3:12 PM

IBI Group
400-333 Preston Street
Ottawa, Ontario
K1S 5N4

STORM SEWER DESIGN SHEET

PROJECT: FORMER CFB ROCKCLIFFE
LOCATION: CITY OF OTTAWA
CLIENT: CANADA LANDS COMPANY

LOCATION				AREA (Ha)							RATIONAL DESIGN FLOW													SEWER DATA								
STREET	AREA ID	FROM MH	TO MH	C= 0.20	C= 0.49	C= 0.50	C= 0.66	C= 0.70	C= 0.80	C= 0.90	IND 2.78AC	CUM 2.78AC	INLET (min)	TIME IN PIPE	TOTAL (min)	i (5) (mm/hr)	i (10) (mm/hr)	i (100) (mm/hr)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	FIXED FLOW (L/s) IND	FIXED FLOW (L/s) CUM	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PIPE SIZE (mm) DIA	PIPE SIZE (mm) W	PIPE SIZE (mm) H	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP (5yr) (L/s)	AVAIL CAP (5yr) (%)
Major Collector	100	**MH100**	MH (125)	*0.64*					3.17		7.41	7.41	10.00	0.28	10.28	104.19	122.14	178.56	771.65			0.00	771.65	871.26	49.50	600			1.85	2.985	99.61	11.43%
Major Collector		MH (125)	**MH105**								0.00	7.41	10.28	0.21	10.48	102.76	120.45	176.07	761.00			0.00	761.00	871.26	37.24	600			1.85	2.985	110.26	12.66%
Major Collector	105	**MH105**	MH (127)	0.52					0.58		1.58	8.98	10.48	0.41	10.90	101.70	119.21	174.25	913.79			0.00	913.79	1,161.41	63.10	750			1.00	2.547	247.62	21.32%
Major Collector		MH (127)	**MH128**								0.00	8.98	10.90	0.31	11.21	99.68	116.83	170.75	895.63			0.00	895.63	1,161.41	48.05	750			1.00	2.547	265.78	22.88%
Major Collector		**MH101**	**MH128**	0.13					0.19		0.49	0.49	10.00	1.14	11.14	104.19	122.14	178.56	51.56			0.00	51.56	91.46	55.00	375			0.25	0.802	39.90	43.62%
											0.00																				
Major Collector	---	**MH128**	**HW128**								0.00	9.48	11.21	0.22	11.43	98.20	115.08	168.19	930.92			0.00	930.92	1,194.45	23.91	900			0.40	1.819	263.53	22.06%
Major Collector	COM2	**MH126**	MH (310)						2.03		4.51	4.51	10.00	0.67	10.67	104.19	122.14	178.56	470.40			0.00	470.40	624.34	86.13	600			0.95	2.139	153.94	24.66%
Major Collector		MH (310)	**MH120**								0.00	4.51	10.67	0.67	11.34	100.78	118.12	172.65	454.98			0.00	454.98	624.34	86.49	600			0.95	2.139	169.36	27.13%
Major Collector	COM1	**MH120**	MH (298)						2.44		5.43	9.94	11.34	1.02	12.36	97.59	114.36	167.13	970.15			0.00	970.15	1,168.98	92.83	975			0.25	1.517	198.82	17.01%
Major Collector		MH (298)	**MH108**								0.00	9.94	12.36	0.86	13.23	93.17	109.16	159.49	926.18			0.00	926.18	1,168.98	78.49	975			0.25	1.517	242.79	20.77%
---	108	**MH108**	MH (300)					1.13			2.20	12.14	13.23	0.54	13.77	89.76	105.15	153.60	1,089.69			0.00	1,089.69	1,956.07	82.38	975			0.70	2.538	866.38	44.29%
---		MH (300)	MH (299)								0.00	12.14	13.77	0.25	14.02	87.76	102.80	150.15	1,065.42			0.00	1,065.42	1,956.07	37.87	975			0.70	2.538	890.65	45.53%
---		MH (299)	**MH114**								0.00	12.14	14.02	0.80	14.81	86.87	101.75	148.62	1,054.66			0.00	1,054.66	1,956.07	121.42	975			0.70	2.538	901.41	46.08%
---	125	**MH125**	MH (302)						0.33		0.73	0.73	10.00	1.06	11.06	104.19	122.14	178.56	76.47			0.00	76.47	130.62	73.06	375			0.51	1.146	54.16	41.46%
---	---	MH (302)	**MH114**								0.00	0.73	11.06	1.61	12.67	98.90	115.90	169.39	72.58			0.00	72.58	130.62	110.65	375			0.51	1.146	58.04	44.44%
---	114	**MH114**	MH (138)					1.59			3.09	15.97	14.81	0.26	15.07	84.16	98.56	143.94	1,343.92			0.00	1,343.92	1,653.18	32.98	975			0.50	2.145	309.26	18.71%
---		MH (138)	MH (139)								0.00	15.97	15.07	0.27	15.34	83.33	97.58	142.50	1,330.63			0.00	1,330.63	1,653.18	35.10	975			0.50	2.145	322.55	19.51%
---		MH (139)	MH (140)								0.00	15.97	15.34	0.64	15.98	82.46	96.57	141.01	1,316.81			0.00	1,316.81	1,653.18	82.05	975			0.50	2.145	336.37	20.35%
---		MH (140)	MH (141)								0.00	15.97	15.98	0.20	16.18	80.52	94.28	137.65	1,285.71			0.00	1,285.71	1,653.18	25.43	975			0.50	2.145	367.47	22.23%
---		MH (141)	**MH115**								0.00	15.97	16.18	0.10	16.28	79.93	93.59	136.64	1,276.40			0.00	1,276.40	1,653.18	12.64	975			0.50	2.145	376.78	22.79%
---	115	**MH115**	MH119						0.25		0.56	16.52	16.28	0.47	16.75	79.65	93.25	136.15	1,316.11		9,092.00	9092.00	10,408.11	11,180.46	53.40	2700			0.10	1.892	772.35	6.91%
---		MH119	**MH130**								0.00	16.52	16.75	0.66	17.41	78.31	91.68	133.84	1,293.97			9092.00	10,385.97	11,180.46	75.21	2700			0.10	1.892	794.50	7.11%
---	INST1, INST2	**MH120**	**MH125**						*5.41*		12.03	12.03	10.00	1.20	11.20	104.19	122.14	178.56	1,253.63			0.00	1,253.63	2,091.13	194.64	975			0.80	2.713	837.49	40.05%
---	125	**MH125**	**MH130**					1.30	1.67		6.24	18.28	11.20	1.07	12.26	98.28	115.17	168.32	1,796.05			0.00	1,796.05	2,483.52	177.59	1050			0.76	2.779	687.47	27.68%
---	163	**MH163**	MH (304)					0.75			1.46	1.46	10.00	1.66	11.66	104.19	122.14	178.56	152.07			0.00	152.07	195.57	87.43	525			0.19	0.875	43.50	22.24%
---		MH (304)	**MH130**								0.00	1.46	11.66	1.37	13.03	96.15	112.67	164.65	140.33			0.00	140.33	195.57	71.88	525			0.19	0.875	55.23	28.24%
---	130	**MH130**	**MH135**						0.21		0.47	36.73	17.41	0.49	17.90	76.50	89.56	130.72	2,809.65		0.00	9092.00	11,901.65	17,677.86	88.81	2700			0.25	2.991	5776.22	32.67%
---	164	**MH164**	MH (306)					0.75			1.46	1.46	10.00	1.62	11.62	104.19	122.14	178.56	152.07			0.00	152.07	200.65	87.33	525			0.20	0.898	48.58	24.21%
---		MH (306)	**MH135**								0.00	1.46	11.62	1.33	12.95	96.35	112.90	164.99	140.62			0.00	140.62	200.65	71.77	525			0.20	0.898	60.03	29.92%
---	135	**MH135**	**MH140**						1.46		3.25	41.43	17.90	0.60	18.51	75.21	88.04	128.50	3,116.31		0.00	9092.00	12,208.31	17,677.86	107.93	2700			0.25	2.991	5469.55	30.94%
---	165	**MH165**	MH (308)						0.29		0.64	0.64	10.00	1.81	11.81	104.19	122.14	178.56	67.20			0.00	67.20	91.46	87.19	375			0.25	0.802	24.26	26.52%
---		MH (308)	**MH140**								0.00	0.64	11.81	1.49	13.30	95.51	111.91	163.54	61.60			0.00	61.60	91.46	71.60	375			0.25	0.802	29.86	32.65%
---	140	**MH140**	MH (134)						0.37		0.82	42.90	18.51	0.40	18.91	73.71	86.28	125.91	3,162.24		0.00	9092.00	12,254.24	17,677.86	72.45	2700			0.25	2.991	5423.62	30.68%
---		MH (134)	**MH150**								0.00	42.90	18.91	0.44	19.35	72.74	85.13	124.24	3,120.56			9092.00	12,212.56	17,677.86	79.45	2700			0.25	2.991	5465.31	30.92%
Codd's Road	CODD'S	**MH142**	MH131	6.10		1.42			1.31		8.28	8.28	10.00	0.50	10.50	104.19	122.14	178.56	862.60			0.00	862.60	1,074.02	87.78	675			1.50	2.908	211.42	19.69%
Codd's Road		MH131	MH (147)								0.00	8.28	10.50	0.40	10.90	101.61	119.10	174.09	841.20			0.00	841.20	1,074.02	69.94	675			1.50	2.908	232.82	21.68%
Codd's Road		MH (147)	MH (148)								0.00	8.28	10.90	0.65	11.56	99.65	116.79	170.70	824.97			0.00	824.97	1,034.42	61.65	900			0.30	1.575	209.45	20.25%
Codd's Road		MH (148)	**MH150**								0.00	8.28	11.56	0.62	12.18	96.63	113.24	165.48	800.01			0.00	800.01	1,034.42	58.50	900			0.30	1.575	234.41	22.66%
Codd's Road	150	**MH150**	MH (150)	0.92					2.18		5.36	56.54	19.35	0.52	19.87	71.71	83.92	122.46	4,054.18		160.00	9252.00	13,306.18	14,807.43	62.99	3000			0.10	2.029	1501.25	10.14%
Codd's Road		MH (150)	**MH155**								0.00	56.54	19.87	0.89	20.76	70.54	82.55	120.44	3,988.20			9252.00	13,240.20	14,807.43	108.36	3000			0.10	2.029	1567.23	10.58%
Main Street	126	**MH126**	**MH160**						0.36		0.80	0.80	10.00	2.86	12.86	104.19	122.14	178.56	83.42			0.00	83.42	100.18	150.55	375			0.30	0.879	16.76	16.73%
---	303	**MH303**	**MH304**				0.09		1.05		2.50	2.50	10.00	0.85	10.85	104.19	122.14	178.56	260.52		0.00	0.00	260.52	452.94	78.86	600			0.50	1.552	192.43	42.48%
---	304	**MH304**	**MH160**				0.33				0.61	3.11	10.85	0.99	11.83	99.92	117.11	171.17	310.34			0.00	310.34	320.28	65.00	600			0.25	1.097	9.94	3.10%
Main Street	160	**MH160**	**MH161**						0.19		0.42	4.33	12.86	0.48	13.34	91.19	106.84	156.08	394.78		0.00	0.00	394.78	999.86	78.00	675			1.30	2.707	605.08	60.52%
---	305	**MH305**	**MH306**		0.41		0.31				1.13	1.13	10.00	0.99	10.99	104.19	122.14	178.56	117.46		0.00	0.00	117.46	141.68	73.88	375			0.60	1.243	24.23	17.10%
---	306	**MH306**	**MH161**				0.44				0.81	1.93	10.99	0.77	11.76	99.24	116.30	169.98	191.98			0.00	191.98	248.85	70.00	450			0.70	1.516	56.87	22.85%

IBI Group
400-333 Preston Street
Ottawa, Ontario
K1S 5N4

STORM SEWER DESIGN SHEET

PROJECT: FORMER CFB ROCKCLIFFE
LOCATION: CITY OF OTTAWA
CLIENT: CANADA LANDS COMPANY

LOCATION				AREA (Ha)							RATIONAL DESIGN FLOW													SEWER DATA								
STREET	AREA ID	FROM MH	TO MH	C= 0.20	C= 0.49	C= 0.50	C= 0.66	C= 0.70	C= 0.80	C= 0.90	IND 2.78AC	CUM 2.78AC	INLET (min)	TIME IN PIPE	TOTAL (min)	i (5) (mm/hr)	i (10) (mm/hr)	i (100) (mm/hr)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	FIXED FLOW (L/s) IND	FIXED FLOW (L/s) CUM	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PIPE SIZE (mm) DIA	PIPE SIZE (mm) W	PIPE SIZE (mm) H	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP (5yr) (L/s)	AVAIL CAP (5yr) (%)
Main Street	161	**MH161**	**MH163**						0.18		0.40	6.66	13.34	0.44	13.78	89.35	104.67	152.90	595.43		0.00	0.00	595.43	1,109.24	79.62	675			1.60	3.003	513.82	46.32%
---	307	**MH307**	**MH308**		0.31		0.11				0.62	0.62	10.00	0.80	10.80	104.19	122.14	178.56	65.03		0.00	0.00	65.03	112.79	73.88	300			1.25	1.546	47.76	42.35%
---	308	**MH307**	**MH163**	0.42			0.45				1.06	1.68	10.80	0.48	11.28	100.17	117.40	171.59	168.61			0.00	168.61	400.16	70.00	450			1.81	2.437	231.55	57.86%
Main Street	163	**MH163**	**MH164**						0.28		0.62	8.97	13.78	0.49	14.26	87.73	102.76	150.09	786.90		0.00	0.00	786.90	1,105.77	87.42	675			1.59	2.994	318.87	28.84%
---	309	**MH309**	**MH313**		0.45		0.22				1.02	1.02	10.00	0.81	10.81	104.19	122.14	178.56	105.93		0.00	0.00	105.93	173.52	73.88	375			0.90	1.522	67.60	38.96%
---	313	**MH313**	**MH164**				0.37				0.68	1.70	10.81	0.69	11.50	100.11	117.33	171.49	169.73			0.00	169.73	279.02	70.00	450			0.88	1.700	109.29	39.17%
Main Street	164	**MH164**	**MH165**						0.20		0.44	11.11	14.26	0.80	15.07	86.01	100.74	147.13	955.61		0.00	0.00	955.61	1,252.90	109.46	825			0.70	2.271	297.29	23.73%
---	316	**MH316**	**MH317**					0.10	1.24		2.95	2.95	10.00	0.74	10.74	104.19	122.14	178.56	307.62		0.00	0.00	307.62	375.37	74.73	525			0.70	1.680	67.76	18.05%
---	317	**MH317**	**MH165**					0.25			0.49	3.44	10.74	0.44	11.19	100.43	117.71	172.05	345.38			0.00	345.38	536.52	63.97	525			1.43	2.401	191.14	35.63%
Main Street	165	**MH165**	**MH155**	0.30						0.30	0.92	15.47	15.07	1.80	16.86	83.34	97.59	142.52	1,288.96		0.00	0.00	1,288.96	2,083.42	151.92	1350			0.14	1.410	794.46	38.13%
Major Collector	COM3	**MH126**	**MH300**					0.28	1.57		4.04	4.04	10.00	1.53	11.53	104.19	122.14	178.56	420.58			0.00	420.58	452.94	142.17	600			0.50	1.552	32.36	7.14%
---	300	**MH300**	**MH301**					0.19			0.37	4.41	11.53	1.59	13.11	96.77	113.39	165.71	426.38			0.00	426.38	438.47	113.03	675			0.25	1.187	12.09	2.76%
---	301	**MH301**	**MH302**					0.13			0.25	4.66	13.11	0.86	13.97	90.19	105.66	154.35	420.23			0.00	420.23	789.24	110.00	675			0.81	2.137	369.01	46.76%
---	302	**MH302**	**MH311**					0.15			0.29	4.95	13.97	0.69	14.66	87.03	101.94	148.89	430.91			0.00	430.91	1,003.70	111.92	675			1.31	2.717	572.78	57.07%
---	311	**MH311**	**MH312**					0.18			0.35	5.30	14.66	1.55	16.21	84.68	99.17	144.83	448.91			0.00	448.91	580.71	118.37	750			0.25	1.273	131.79	22.70%
---	312	**MH312**	**MH201**					0.23			0.45	5.75	16.21	1.57	17.78	79.85	93.49	136.49	459.05			0.00	459.05	580.71	120.00	750			0.25	1.273	121.66	20.95%
	201	**MH201**	**MH318**					0.17	*2.02*		4.82	10.57	17.78	0.49	18.27	75.54	88.42	129.06	798.61			0.00	798.61	1,324.21	85.55	750			1.30	2.904	525.61	39.69%
	318	**MH318**	**MH155**					0.12			0.23	10.81	18.27	0.45	18.72	74.29	86.96	126.92	802.81			0.00	802.81	1,218.10	71.97	750			1.10	2.671	415.29	34.09%
Hemlock Road	155	**MH155**	MH (159)						0.23		0.51	83.32	20.76	0.26	21.02	68.63	80.30	117.15	5,718.19		0.00	9252.00	14,970.19	20,940.87	44.47	3000			0.20	2.870	5970.68	28.51%
Hemlock Road		MH (159)	**MH211**								0.00	83.32	21.02	0.26	21.28	68.09	79.68	116.23	5,673.75			9252.00	14,925.75	20,940.87	45.30	3000			0.20	2.870	6015.12	28.72%
Hemlock Road	211	**MH211**	MH (161)						0.19		0.42	83.75	21.28	0.25	21.53	67.56	79.05	115.31	5,657.81			9252.00	14,909.81	20,940.87	43.34	3000			0.20	2.870	6031.06	28.80%
Hemlock Road		MH (161)	**MH216**								0.00	83.75	21.53	0.20	21.73	67.06	78.46	114.45	5,615.75			9252.00	14,867.75	20,940.87	34.81	3000			0.20	2.870	6073.12	29.00%
---	190	**MH190**	MH (276)					0.78			1.52	1.52	10.00	0.52	10.52	104.19	122.14	178.56	158.15			0.00	158.15	231.37	63.61	375			1.60	2.029	73.21	31.64%
---		MH (276)	MH (277)								0.00	1.52	10.52	0.17	10.69	101.51	118.98	173.92	154.08			0.00	154.08	231.37	20.18	375			1.60	2.029	77.28	33.40%
---		MH (277)	MH (278)								0.00	1.52	10.69	0.32	11.01	100.69	118.02	172.50	152.84			0.00	152.84	231.37	38.64	375			1.60	2.029	78.53	33.94%
---		MH (278)	MH (279)								0.00	1.52	11.01	0.22	11.22	99.17	116.22	169.86	150.52			0.00	150.52	231.37	26.40	375			1.60	2.029	80.84	34.94%
---		MH (279)	**MH185**								0.00	1.52	11.22	0.48	11.70	98.15	115.03	168.11	148.98			0.00	148.98	231.37	58.52	375			1.60	2.029	82.38	35.61%
---	185	**MH185**	MH (281)					0.38			0.74	2.26	11.70	0.32	12.02	95.98	112.47	164.36	216.67			0.00	216.67	300.45	19.48	600			0.22	1.029	83.78	27.89%
---		MH (281)	**MH183**								0.00	2.26	12.02	1.02	13.04	94.62	110.87	162.00	213.59			0.00	213.59	300.45	63.18	600			0.22	1.029	86.86	28.91%
---	192	**MH192**	MH (283)					1.27			2.47	2.47	10.00	1.30	11.30	104.19	122.14	178.56	257.50			0.00	257.50	332.84	89.00	600			0.27	1.140	75.34	22.64%
---		MH (283)	**MH190**								0.00	2.47	11.30	1.39	12.69	97.79	114.60	167.48	241.68			0.00	241.68	332.84	95.19	600			0.27	1.140	91.16	27.39%
---	190	**MH190**	**MH179**					0.41			0.80	3.27	12.69	0.47	13.17	91.84	107.60	157.20	300.25			0.00	300.25	871.26	85.03	600			1.85	2.985	571.00	65.54%
---	194	**MH194**	MH (286)					1.35			2.63	2.63	10.00	1.21	11.21	104.19	122.14	178.56	273.73			0.00	273.73	347.53	112.65	525			0.60	1.555	73.80	21.24%
---		MH (286)	**MH179**								0.00	2.63	11.21	1.07	12.28	98.22	115.11	168.23	258.04			0.00	258.04	347.53	100.19	525			0.60	1.555	89.49	25.75%
---	179	**MH179**	MH (209)					0.43			0.84	6.73	13.17	0.33	13.50	89.99	105.42	154.00	605.92		0.00	0.00	605.92	892.10	39.25	750			0.59	1.956	286.18	32.08%
---		MH (209)	**MH183**								0.00	6.73	13.50	0.32	13.82	88.74	103.94	151.84	597.47			0.00	597.47	892.10	37.55	750			0.59	1.956	294.63	33.03%
---	183	**MH183**	**MH182**	0.38				0.52			1.22	10.21	13.82	1.65	15.47	87.57	102.57	149.82	894.43		0.00	0.00	894.43	1,408.95	119.58	1200			0.12	1.207	514.53	36.52%

---	195	**MH195**	**MH182**					0.74			1.44	1.44	10.00	1.09	11.09	104.19	122.14	178.56	150.04			0.00	150.04	283.73	113.34	450			0.91	1.728	133.69	47.12%

---	182	**MH182**	**MH175**						0.14		0.31	11.97	15.47	0.92	16.39	82.06	96.09	140.31	981.88		0.00	0.00	981.88	1,626.92	77.03	1200			0.16	1.394	645.04	39.65%
---	192	**MH192**	MH(121)					0.51			0.99	0.99	10.00	0.27	10.27	104.19	122.14	178.56	103.41			0.00	103.41	129.34	18.24	375			0.50	1.134	25.93	20.05%
---		MH(121)	**MH194**								0.00	0.99	10.27	1.04	11.31	102.80	120.50	176.15	102.02			0.00	102.02	129.34	70.91	375			0.50	1.134	27.31	21.12%
---	194	**MH194**	**MH195**					0.76			1.48	2.47	11.31	0.84	12.15	97.75	114.55	167.41	241.58			0.00	241.58	347.53	78.13	525			0.60	1.555	105.95	30.49%
---		**MH195**	**MH172**								0.00	2.47	12.15	0.83	12.97	94.07	110.22	161.06	232.49			0.00	232.49	347.53	77.09	525			0.60	1.555	115.03	33.10%
---	150	**MH150**	MH (293)						0.24		0.53	0.53	10.00	0.62	10.62	104.19	122.14	178.56	55.61			0.00	55.61	105.81	53.85	300			1.10	1.450	50.19	47.44%
---		MH (293)	**MH172**								0.00	0.53	10.62	0.47	11.09	101.03	118.42	173.09	53.93			0.00	53.93	105.81	40.80	300			1.10	1.450	51.88	49.03%
---	172	**MH172**	MH (205)					0.62			1.21	4.21	12.97	0.51	13.49	90.73	106.30	155.29	382.15		0.00	0.00	382.15	607.69	64.19	600			0.90	2.082	225.54	37.11%
---		MH (205)	**MH175**								0.00	4.21	13.49	0.44	13.93	88.79	104.00	151.92	373.95			0.00	373.95	607.69	54.95	600			0.90	2.082	233.74	38.46%
---	INST3	**MH175**	MH (289)						3.09		6.87	23.05	16.39	0.77	17.16	79.31	92.86	135.57	1,828.01		0.00	0.00	1,828.01	3,153.62	65.71	1650			0.11	1.429	1325.61	42.03%
---		MH (289)	**MH230**								0.00	23.05	17.16	1.32	18.48	77.17	90.34	131.88	1,778.73			0.00	1,778.73	3,153.62	113.29	1650			0.11	1.429	1374.90	43.60%
Hemlock Road	230	**MH230**	**MH216**						0.25		0.56	23.60	18.48	1.30	19.78	73.77	86.35	126.02	1,741.36			0.00	1,741.36	3,006.86	106.28	1650			0.10	1.362	1265.51	42.09%
---	216	**MH216**	**MH220**						0.83		1.85	109.20	21.73	1.19	22.92	66.66	77.99	113.77	7,279.02		0.00	9252.00	16,531.02	18,135.33	177.18	3000			0.15	2.485	1604.31	8.85%

IBI Group
400-333 Preston Street
Ottawa, Ontario
K1S 5N4

STORM SEWER DESIGN SHEET

PROJECT: FORMER CFB ROCKCLIFFE
LOCATION: CITY OF OTTAWA
CLIENT: CANADA LANDS COMPANY

LOCATION				AREA (Ha)							RATIONAL DESIGN FLOW													SEWER DATA								
STREET	AREA ID	FROM MH	TO MH	C= 0.20	C= 0.49	C= 0.50	C= 0.66	C= 0.70	C= 0.80	C= 0.90	IND 2.78AC	CUM 2.78AC	INLET (min)	TIME IN PIPE	TOTAL (min)	i (5) (mm/hr)	i (10) (mm/hr)	i (100) (mm/hr)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	FIXED FLOW (L/s) IND	FIXED FLOW (L/s) CUM	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PIPE SIZE (mm) DIA	PIPE SIZE (mm) W	PIPE SIZE (mm) H	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP (5yr) (L/s)	AVAIL CAP (5yr) (%)
---	211	**MH211**	MH (297)						1.93		4.29	4.29	10.00	0.99	10.99	104.19	122.14	178.56	447.23			0.00	447.23	516.44	105.62	600			0.65	1.769	69.21	13.40%
---		MH (297)	**MH213**								0.00	4.29	10.99	0.51	11.51	99.22	116.28	169.95	425.87			0.00	425.87	516.44	54.28	600			0.65	1.769	90.57	17.54%
---	213	**MH213**	MH (294)						0.18		0.40	4.69	11.51	0.19	11.69	96.86	113.50	165.87	454.52			0.00	454.52	640.56	24.75	600			1.00	2.195	186.04	29.04%
---		MH (294)	MH (295)								0.00	4.69	11.69	0.23	11.92	96.02	112.52	164.43	450.60			0.00	450.60	640.56	30.15	600			1.00	2.195	189.96	29.66%
---		MH (295)	**MH220**								0.00	4.69	11.92	0.34	12.26	95.03	111.35	162.70	445.92			0.00	445.92	640.56	44.98	600			1.00	2.195	194.64	30.39%

---	220	**MH220**	**MH221**	1.14					0.99		2.84	116.73	22.92	0.78	23.70	64.43	75.37	109.92	7,520.15		0.00	9252.00	16,772.15	18,135.33	115.67	3000			0.15	2.485	1363.18	7.52%
---	221	**MH221**	**MH222**						0.50		1.11	117.84	23.70	0.28	23.98	63.06	73.76	107.56	7,430.29			9252.00	16,682.29	21,458.01	50.28	3000			0.21	2.941	4775.72	22.26%
---		**MH222**	MH (194)								0.00	117.84	23.98	0.40	24.38	62.57	73.19	106.72	7,372.86			9252.00	16,624.86	21,458.01	70.00	3000			0.21	2.941	4833.15	22.52%
---		MH (194)	**MH225**								0.00	117.84	24.38	0.13	24.51	61.90	72.41	105.58	7,294.53		0.00	9252.00	16,546.53	21,458.01	22.14	3000			0.21	2.941	4911.48	22.89%
---	319	**MH319**	**MH326**						1.35		3.00	3.00	10.00	2.41	12.41	104.19	122.14	178.56	312.83		0.00	0.00	312.83	579.98	151.78	825			0.15	1.051	267.15	46.06%
Major Collector	COM4	**MH300**	**MH310**						0.87		1.93	1.93	10.00	0.66	10.66	104.19	122.14	178.56	201.60			0.00	201.60	971.71	84.22	750			0.70	2.131	770.11	79.25%
Major Collector	310	**MH310**	MH (178)					1.58			3.07	5.01	10.66	0.70	11.35	100.84	118.19	172.75	505.15			0.00	505.15	1,296.87	98.01	825			0.75	2.350	791.72	61.05%
Major Collector		MH (178)	**MH315**								0.00	5.01	11.35	0.81	12.17	97.55	114.32	167.06	488.67			0.00	488.67	1,296.87	114.82	825			0.75	2.350	808.20	62.32%
---	314	**MH314**	**MH315**						0.14		0.31	0.31	10.00	0.72	10.72	104.19	122.14	178.56	32.44			0.00	32.44	92.02	78.38	250			2.20	1.816	59.58	64.74%
---	315	**MH315**	**MH320**						0.17		0.38	5.70	12.17	0.55	12.71	93.98	110.12	160.90	535.62		0.00	0.00	535.62	1,640.43	97.47	825			1.20	2.973	1104.81	67.35%
---	320	**MH320**	MH (182)	*3.39*					0.19		2.31	8.01	12.71	0.35	13.06	91.75	107.49	157.04	734.59		147.20	147.20	881.79	1,760.81	24.77	1350			0.10	1.192	879.02	49.92%
---		MH (182)	MH (183)								0.00	8.01	13.06	0.46	13.52	90.40	105.90	154.70	723.74			147.20	870.94	1,760.81	32.67	1350			0.10	1.192	889.87	50.54%
---		MH (183)	**MH323**								0.00	8.01	13.52	0.60	14.12	88.67	103.87	151.73	709.95			147.20	857.15	1,760.81	43.11	1350			0.10	1.192	903.66	51.32%
---	311	**MH311**	MH (321)					1.00			1.95	1.95	10.00	1.01	11.01	104.19	122.14	178.56	202.76			0.00	202.76	311.95	115.02	450			1.10	1.900	109.19	35.00%
---		MH (321)	**MH323**								0.00	1.95	11.01	0.25	11.26	99.15	116.20	169.83	192.95			0.00	192.95	311.95	28.70	450			1.10	1.900	119.01	38.15%
---	323	**MH323**	MH (185)						1.77		3.94	13.89	14.12	0.35	14.47	86.51	101.33	147.99	1,201.53		0.00	147.20	1,348.73	2,332.02	26.99	1500			0.10	1.278	983.30	42.17%
---		MH (185)	MH (186)								0.00	13.89	14.47	0.48	14.96	85.30	99.90	145.90	1,184.73			147.20	1,331.93	2,332.02	37.18	1500			0.10	1.278	1000.09	42.89%
---		MH (186)	**MH326**								0.00	13.89	14.96	0.53	15.48	83.70	98.01	143.13	1,162.44			147.20	1,309.64	2,332.02	40.46	1500			0.10	1.278	1022.39	43.84%
---	326	**MH326**	MH (188)						*3.83*		8.52	25.41	15.48	0.60	16.08	82.02	96.05	140.25	2,084.14		0.00	147.20	2,231.34	3,006.86	48.73	1650			0.10	1.362	775.52	25.79%
---		MH (188)	**MH205**								0.00	25.41	16.08	1.02	17.11	80.22	93.93	137.14	2,038.33			147.20	2,185.53	3,006.86	83.74	1650			0.10	1.362	821.33	27.32%
---		**MH205**	**MH202**								0.00	25.41	17.11	1.04	18.15	77.32	90.52	132.13	1,964.62			147.20	2,111.82	3,006.86	85.00	1650			0.10	1.362	895.04	29.77%
Codd's Road	201	**MH201**	**MH202**						0.31		0.69	0.69	10.00	1.76	11.76	104.19	122.14	178.56	71.83		0.00	0.00	71.83	91.46	84.87	375			0.25	0.802	19.62	21.45%
---		**MH202**	MH (327)								0.00	26.10	18.15	0.06	18.21	74.60	87.33	127.45	1,947.05		98.00	98.00	2,045.05	3,682.64	6.00	1650			0.15	1.668	1637.59	44.47%
---	202	MH (327)	MH (331)	2.53							1.41	27.51	18.21	0.15	18.35	74.45	87.15	127.19	2,047.87			98.00	2,145.87	3,682.64	14.70	1650			0.15	1.668	1536.77	41.73%
---	202	MH (331)	MH (332)								0.00	27.51	18.35	0.75	19.10	74.09	86.72	126.56	2,037.83			98.00	2,135.83	3,682.64	75.27	1650			0.15	1.668	1546.81	42.00%
---		MH (332)	**MH225**								0.00	27.51	19.10	0.55	19.65	72.28	84.60	123.45	1,988.12			98.00	2,086.12	3,682.64	54.94	1650			0.15	1.668	1596.52	43.35%
---	225	**MH225**	**MH226**	5.14							2.86	148.20	24.51	0.04	24.55	61.70	72.16	105.22	9,143.44		0.00	9350.00	18,493.44	22,981.60	5.14		3600	3000	0.10	2.128	4488.16	19.53%
---	SDA1	**MH330**	**MH331**					2.81			5.47	5.47	10.00	1.04	11.04	104.19	122.14	178.56	569.75			0.00	569.75	640.56	136.42	600			1.00	2.195	70.81	11.05%
---		**MH334**	**MH (335)**								0.00	0.00	10.00	0.40	10.40	104.19	122.14	178.56	0.00			0.00	0.00	200.37	42.56	375			1.20	1.757	200.37	100.00%
---	335	**MH (335)**	MH (336)						0.25		0.56	0.56	10.40	0.48	10.88	102.11	119.69	174.95	56.77			0.00	56.77	200.37	50.31	375			1.20	1.757	143.60	71.67%
---		MH (336)	MH (337)								0.00	0.56	10.88	0.57	11.45	99.76	116.92	170.89	55.47			0.00	55.47	200.37	60.52	375			1.20	1.757	144.90	72.32%
---		MH (337)	**MH338**								0.00	0.56	11.45	0.33	11.78	97.09	113.78	166.27	53.98			0.00	53.98	200.37	34.55	375			1.20	1.757	146.39	73.06%
---	339	**MH339**	**MH338**						0.08		0.18	0.18	10.00	0.60	10.60	104.19	122.14	178.56	18.54			0.00	18.54	91.46	28.84	375			0.25	0.802	72.92	79.73%

IBI Group
400-333 Preston Street
Ottawa, Ontario
K1S 5N4

STORM SEWER DESIGN SHEET

PROJECT: FORMER CFB ROCKCLIFFE
LOCATION: CITY OF OTTAWA
CLIENT: CANADA LANDS COMPANY

LOCATION				AREA (Ha)							RATIONAL DESIGN FLOW												SEWER DATA								
STREET	AREA ID	FROM MH	TO MH	C= 0.20	C= 0.49	C= 0.50	C= 0.66	C= 0.70	C= 0.80	C= 0.90	IND 2.78AC	CUM 2.78AC	INLET (min)	TIME IN PIPE	TOTAL (min)	i (5) (mm/hr)	i (10) (mm/hr)	i (100) (mm/hr)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	FIXED FLOW (L/s) IND	FIXED FLOW (L/s) CUM	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PIPE SIZE (mm) DIA	PIPE SIZE (mm) W	PIPE SIZE (mm) H	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP (5yr) (L/s)	AVAIL CAP (5yr) (%)
---	SDA2	**MH338**	MH (339)					3.54			6.89	7.62	11.78	1.33	13.11	95.64	112.06	163.76	729.01		0.00	0.00	729.01	944.29	114.46	900			0.25	1.438	215.28	22.80%
---		MH (339)	MH (340)								0.00	7.62	13.11	0.40	13.51	90.21	105.68	154.38	687.65			0.00	687.65	944.29	34.49	900			0.25	1.438	256.64	27.18%
---		MH (340)	MH (341)								0.00	7.62	13.51	0.47	13.97	88.71	103.91	151.79	676.19			0.00	676.19	944.29	40.17	900			0.25	1.438	268.10	28.39%
---		MH (341)	MH (342)								0.00	7.62	13.97	0.47	14.44	87.02	101.93	148.88	663.37			0.00	663.37	944.29	40.24	900			0.25	1.438	280.93	29.75%
---		MH (342)	MH (343)								0.00	7.62	14.44	0.71	15.15	85.41	100.03	146.09	651.05			0.00	651.05	944.29	60.97	900			0.25	1.438	293.24	31.05%
---		MH (343)	MH (344)								0.00	7.62	15.15	0.37	15.52	83.08	97.30	142.08	633.33			0.00	633.33	944.29	31.89	900			0.25	1.438	310.96	32.93%
---		MH (344)	**MH331**								0.00	7.62	15.52	0.90	16.42	81.92	95.93	140.07	624.48			0.00	624.48	944.29	77.80	900			0.25	1.438	319.81	33.87%
---	--	**MH331**	MH332								0.00	13.09	16.42	0.36	16.78	79.24	92.77	135.44	1,037.30		0.00	0.00	1,037.30	1,689.20	55.85	900			0.80	2.572	651.90	38.59%
---		MH332	**MH333**								0.00	13.09	16.78	0.65	17.43	78.21	91.57	133.68	1,023.90			0.00	1,023.90	1,689.20	100.00	900			0.80	2.572	665.30	39.39%
---	183	**MH241**	**MH242**						0.13		0.29	0.29	10.00	0.93	10.93	104.19	122.14	178.56	30.12			0.00	30.12	62.04	68.00	250			1.00	1.224	31.91	51.44%
---	175	**MH243**	**MH242**				0.69				1.27	1.27	10.00	1.27	11.27	104.19	122.14	178.56	131.91			0.00	131.91	168.64	113.00	375			0.85	1.479	36.73	21.78%
---	242	**MH242**	MH (218)						0.89		1.98	3.53	11.27	0.38	11.65	97.92	114.75	167.70	346.08		0.00	0.00	346.08	759.45	46.80	675			0.75	2.056	413.36	54.43%
---		MH (218)	**MH244**								0.00	3.53	11.65	0.42	12.08	96.21	112.73	164.74	340.04			0.00	340.04	759.45	52.32	675			0.75	2.056	419.41	55.23%
---	235	**MH235**	MH210						1.03		2.29	2.29	10.00	0.46	10.46	104.19	122.14	178.56	238.68			0.00	238.68	347.53	43.37	525			0.60	1.555	108.85	31.32%
---		MH210	**MH244**								0.00	2.29	10.46	0.84	11.31	101.80	119.32	174.42	233.20			0.00	233.20	347.53	78.74	525			0.60	1.555	114.33	32.90%
---	244	**MH244**	MH (240)	2.24					0.41		2.16	7.98	12.08	0.93	13.01	94.37	110.57	161.57	753.30		0.00	0.00	753.30	1,101.81	134.65	750			0.90	2.416	348.51	31.63%
---		MH (240)	**MH258**								0.00	7.98	13.01	0.53	13.54	90.61	106.15	155.07	723.28			0.00	723.28	1,101.81	77.04	750			0.90	2.416	378.53	34.36%
---	257	**MH257**	**MH256**						1.40		3.11	3.11	10.00	1.47	11.47	104.19	122.14	178.56	324.42			0.00	324.42	367.27	71.26	750			0.10	0.805	42.86	11.67%
---	256	**MH256**	**MH258**						1.46		3.25	6.36	11.47	1.09	12.56	97.00	113.67	166.12	616.98			0.00	616.98	821.24	117.34	750			0.50	1.801	204.27	24.87%
---	258	**MH258**	MH (243)						2.83		6.29	20.64	13.54	0.28	13.82	88.60	103.79	151.60	1,828.49		0.00	0.00	1,828.49	2,490.17	28.39	1350			0.20	1.685	661.68	26.57%
---		MH (243)	MH (266)								0.00	20.64	13.82	0.90	14.72	87.58	102.59	149.84	1,807.43			0.00	1,807.43	2,490.17	91.02	1350			0.20	1.685	682.73	27.42%
---		MH (266)	**MH252**								0.00	20.64	14.72	0.14	14.85	84.48	98.94	144.49	1,743.41			0.00	1,743.41	2,490.17	13.86	1350			0.20	1.685	746.75	29.99%
---	252	**MH252**	**MH251**						0.15		0.33	20.97	14.85	0.77	15.62	84.03	98.41	143.71	1,762.14			0.00	1,762.14	2,490.17	77.49	1350			0.20	1.685	728.03	29.24%
---	256	**MH256**	MH (233)						*2.50*		5.56	5.56	10.00	0.21	10.21	104.19	122.14	178.56	579.31			0.00	579.31	876.93	30.59	675			1.00	2.374	297.62	33.94%
---		MH (233)	MH (234)								0.00	5.56	10.21	0.23	10.44	103.07	120.82	176.62	573.08			0.00	573.08	876.93	32.54	675			1.00	2.374	303.85	34.65%
---		MH (234)	MH (235)								0.00	5.56	10.44	0.21	10.65	101.91	119.45	174.61	566.61			0.00	566.61	876.93	30.14	675			1.00	2.374	310.32	35.39%
---		MH (235)	MH (236)								0.00	5.56	10.65	0.28	10.94	100.86	118.21	172.79	560.76			0.00	560.76	876.93	40.35	675			1.00	2.374	316.17	36.05%
---		MH (236)	MH (237)								0.00	5.56	10.94	0.24	11.18	99.49	116.60	170.42	553.14			0.00	553.14	876.93	34.51	675			1.00	2.374	323.79	36.92%
---		MH (237)	**MH251**								0.00	5.56	11.18	0.18	11.36	98.35	115.26	168.44	546.80			0.00	546.80	876.93	25.72	675			1.00	2.374	330.13	37.65%
---	251	**MH251**	MH (270)	0.64					0.12		0.62	27.15	15.62	0.20	15.82	81.60	95.55	139.52	2,215.78		0.00	0.00	2,215.78	4,313.09	35.44	1350			0.60	2.919	2097.32	48.63%
---		MH (270)	**MH250**								0.00	27.15	15.82	0.18	16.01	80.99	94.83	138.46	2,199.08			0.00	2,199.08	4,313.09	32.23	1350			0.60	2.919	2114.01	49.01%
Hemlock Road	230	**MH234**	MH (273)						2.66		5.92	5.92	10.00	0.25	10.25	104.19	122.14	178.56	616.39			0.00	616.39	876.93	35.00	675			1.00	2.374	260.54	29.71%
Hemlock Road		MH (273)	MH (274)								0.00	5.92	10.25	0.27	10.52	102.91	120.63	176.34	608.81			0.00	608.81	876.93	38.92	675			1.00	2.374	268.12	30.57%
Hemlock Road		MH (274)	**MH235**								0.00	5.92	10.52	0.21	10.73	101.53	119.00	173.95	600.63			0.00	600.63	876.93	30.00	675			1.00	2.374	276.30	31.51%
Hemlock Road	235	**MH235**	MH (262)						1.15		2.56	8.47	10.73	1.13	11.86	100.49	117.78	172.15	851.50			0.00	851.50	1,045.56	91.62	975			0.20	1.357	194.06	18.56%
Hemlock Road		MH (262)	**MH245**								0.00	8.47	11.86	0.61	12.47	95.32	111.69	163.21	807.68			0.00	807.68	1,045.56	49.80	975			0.20	1.357	237.89	22.75%
Hemlock Road	245	**MH245**	MH (223)						0.37		0.82	9.30	12.47	0.27	12.74	92.75	108.66	158.77	862.21			0.00	862.21	2,626.46	47.67	1050			0.85	2.938	1764.25	67.17%
Hemlock Road		MH (223)	MH212								0.00	9.30	12.74	0.26	12.99	91.66	107.38	156.89	852.10			0.00	852.10	2,626.46	45.18	1050			0.85	2.938	1774.36	67.56%
Hemlock Road		MH212	**MH250**								0.00	9.30	12.99	0.33	13.32	90.65	106.20	155.15	842.75			0.00	842.75	2,626.46	58.30	1050			0.85	2.938	1783.71	67.91%
Hemlock Road	250	**MH250**	MH (227)						0.46		1.02	37.47	16.01	0.32	16.33	80.44	94.18	137.51	3,014.20		0.00	0.00	3,014.20	5,214.57	54.46	1500			0.50	2.859	2200.37	42.20%
Hemlock Road		MH (227)	MH (228)								0.00	37.47	16.33	0.35	16.68	79.51	93.09	135.91	2,979.34			0.00	2,979.34	5,214.57	60.48	1500			0.50	2.859	2235.22	42.87%
Hemlock Road		MH (228)	**MH271**								0.00	37.47	16.68	0.33	17.01	78.50	91.91	134.17	2,941.67			0.00	2,941.67	5,214.57	56.40	1500			0.50	2.859	2272.90	43.59%
Hemlock Road	271	**MH271**	**MH272**						0.58		1.29	38.76	17.01	0.32	17.33	77.59	90.83	132.60	3,007.56			0.00	3,007.56	4,545.95	47.91	1500			0.38	2.492	1538.39	33.84%
Hemlock Road	271	**MH272**	**HW**						0.58		1.29	40.05	17.33	0.05	17.38	76.72	89.82	131.10	3,072.93			0.00	3,072.93	4,545.95	7.58	1500			0.38	2.492	1473.02	32.40%
---	261	**MH360**	**HW-3**						1.77		3.94	3.94	10.00	0.68	10.68	104.19	122.14	178.56	410.15				410.15	549.49	100.00	525			1.50	2.459	139.34	25.36%

Definitions:
Q = 2.78CiA, where:
Q = Peak Flow in Litres per Second (L/s)
A = Area in Hectares (Ha)
i = Rainfall intensity in millimeters per hour (mm/hr)
[i = 998.071 / (TC+6.053)^0.814] 5 YEAR
[i = 1174.184 / (TC+6.014)^0.816] 10 YEAR
[i = 1735.688 / (TC+6.014)^0.820] 100 YEAR

Notes:
1. Mannings coefficient (n) = 0.013

Designed: Michael Black - E.I.T.
Updated by Karlinda Hinds - P.Eng.
Checked: Jim Moffatt - P.Eng
Dwg. Reference: FIGURE 6.9

No.	Revision	Date
1.	MASTER SERVICING STUDY SUBMISSION 1 FOR CITY REVIEW	2014-10-24
2.	MASTER SERVICING STUDY SUBMISSION 2 FOR CITY REVIEW	2015-02-12
3.	MASTER SERVICING STUDY SUBMISSION 3 FOR CITY APPROVAL	2015-08-14
4.	UPDATED PER PHASE 2B STORM DESIGN	2020-06-10

File Reference: 32952-5.7.1

Water Quality Volume Calculations

Eastern SWM Facility

The Stormwater Management Facility is being designed as a wet pond at an Enhanced Level of Protection.

Drainage area = 160.58 ha (see Table 1)
Total imperviousness ratio = 63% (see Table 1)

From MOE Stormwater Management Planning and Design Manual, March 2003. p. 3-10:

Protection Level	**SWMP Type**	**Storage Volume (m^3/ha) for Impervious Level**	
		55 %	**70 %**
Enhanced 80% long-term S.S. removal	Wet Pond	190	225

Total storage volume for wet pond:

$$Y_3 = Y_2+(X_3-X_2)[(Y_2-Y_1)/(X_2-X_1)]$$
$$= 190 + (225 – 190)[(63 – 55)/(70 – 55)]$$
$$= 208.7 \text{ m}^3\text{/ha}$$

An imperviousness ratio of 66% corresponds to a total storage volume of 209 m^3/ha.

If extended detention = 40 m^3/ha
Then permanent storage = (209 m^3/ha – 40 m^3/ha) = 169 m^3/ha

Therefore:
Permanent storage volume = 169 m^3/ha x 160.58 ha = 27138.02 m^3 = 2.72 ha-m
Extended detention volume = 40 m^3/ha x 160.58 ha = 6423.2 m^3 = 0.642 ha-m

Table 1: Total Area and Total Weighted imperviousness for Water Quality Calculation – Eastern SWM Facility (refer to Table 6.13 and 6.14 for summary of hydrological parameters)

Area ID	Area (ha)	Weighted Total Imperviousness (%, TIMP)	Area (ha) x TIMP
Tributary To Eastern SWM Facility			
PH3B	3.11	0*	0.00
PH3D	5.07	81	410.67
PH3E	0.44	79	34.76
PH3F	4.36	79	344.44
PH3G	8.21	83	681.43
PH3H	6.92	80	553.60
PH3I	2.38	86	204.68
PH3J	5.23	64	334.72
PH2A	1.93	86	165.98
PH2B	2.5	86	215.00
PH2C	2.53	0*	0.00
PH2D	1.14	0*	0.00
PH2J	5.14	0*	0.00
PH2L	0.49	86	42.14
PH1A	16.91	81	1369.71
PH1B	5.81	74	429.94
PH1C	6.1	0*	0.00
PH1D	1.15	0*	0.00
PH1E	3.53	86	303.58
PH1F	8.53	69	588.57
EXT1	1.52	71	107.92
EXT9	2.18	71	154.78
BRM2	7.04	71	499.84
BRMSWF	1.47	0*	0.00
BRMR1	18.65	71	1324.15
EXT-NRC	18.39	71	1305.69
EXTE1 (SWM Block)	8.52	0*	0.00
EXT7	11.33	86	974.38
Total Area (ha) =	**160.58**	**Sum of Area (ha) X TIMP =**	**10045.98**
	Total Weighted Imperviousness (water Quality) =		**63**

*Note: * In rural areas, imperviousness is set at zero.*

Water Quality Volume Calculations

Western SWM Facility

The Stormwater Management Facility is being designed as a wetland at an Enhanced Level of Protection.

Drainage area = 44.80 ha (see Table 2)
Total imperviousness ratio = 35% (see Table 2)

From MOE Stormwater Management Planning and Design Manual, March 2003. p. 3-10:

Protection Level	**SWMP Type**	**Storage Volume (m^3/ha) for Impervious Level**
		35 %
Enhanced 80% long-term S.S. removal	Wet Pond	140

Total storage volume for wetland:

Y_3 = 140 ha-m

An imperviousness ratio of 35% corresponds to a total storage volume of 140 m^3/ha.

If extended detention = 40 m^3/ha
Then permanent storage = (140 m^3/ha – 40 m^3/ha) = 100 m^3/ha

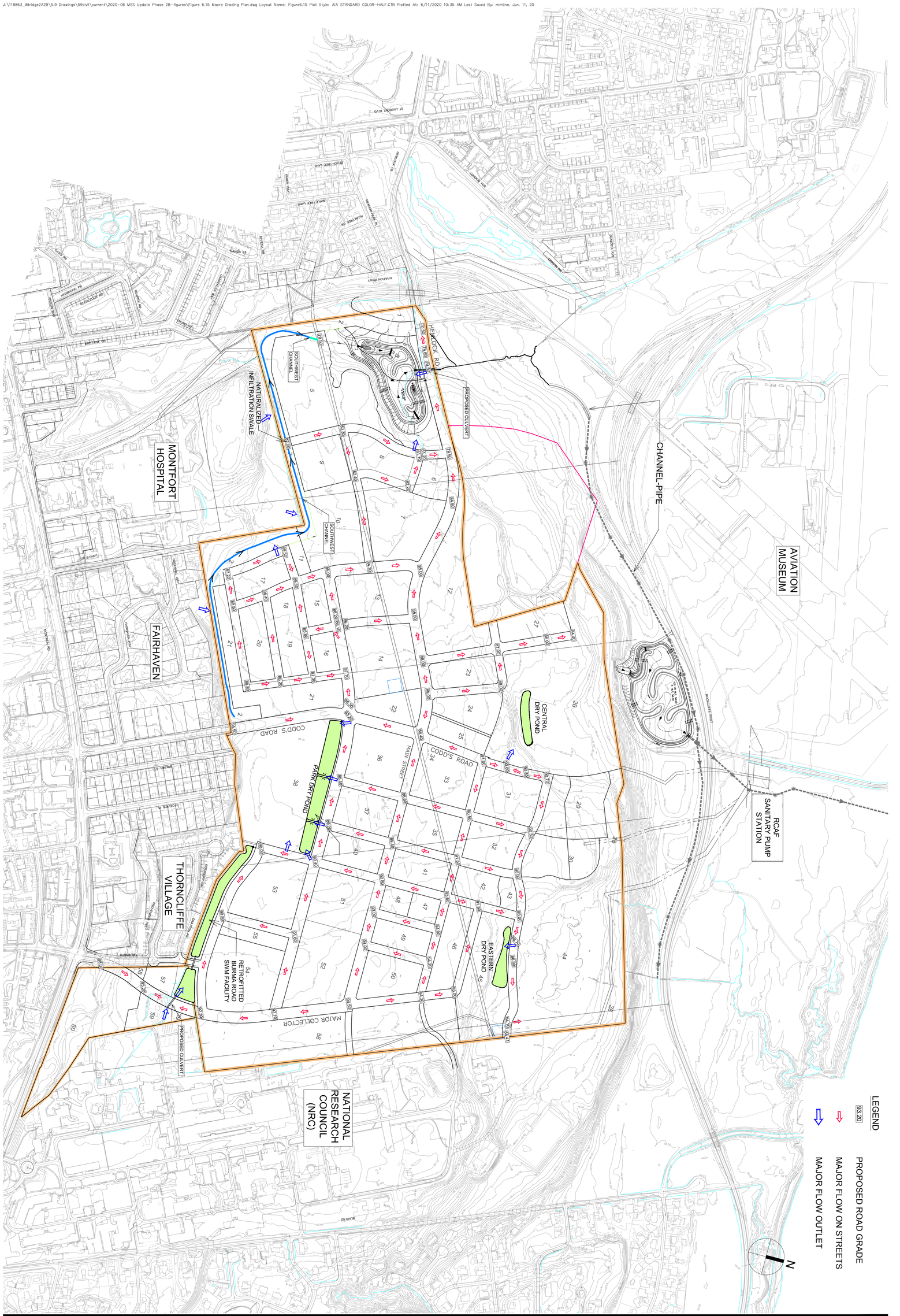
Therefore:
Permanent storage volume = 100 m^3/ha x 44.80 ha = 4480 m^3 = 0.45 ha-m
Extended detention volume = 40 m^3/ha x 44.80 ha = 1792 m^3 = 0.18 ha-m

Table 2: Total Area and Total Weighted imperviousness for Water Quality Calculation – Western SWM Facility (refer to Table 6.13 and 6.14 for summary of hydrological parameters)

Area ID	Area (ha)	Weighted total Imperviousness (%, TIMP)	Area (ha) x TIMP
Tributary To Western SWM Facility			
PH2E	16.11	70	1127.70
PH2F	1.09	86	93.74
PH2G	1.77	86	152.22
PH2H (SWM Block)	4.52	0*	0.00
PH2K	1.57	86	135.02
EXM	2.02	31	62.62
EXT4	7.84	0*	0.00
EXT5	1.46	0*	0.00
EXT3	2.25	0*	0.00
EXT2	6.17	0*	0.00
Total Area (ha)	**44.8**	**Sum of Area (ha) X TIMP**	**1571.30**
	Total Weighted Imperviousness (water Quality) =		**35**

*Note: *In rural areas, imperviousness is set at zero.*

J:\118863_IBridge2A28\5.9 Drawings\59civil\current\2020-06 MSS Update Phase 2B-figures\Figure 6.15 Macro Grading Plan.dwg Layout Name: Figure6.15 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 6/11/2020 10:35 AM Last Saved By: mmilne, Jun. 11, 20



Sheet No.

FIGURE 6.15

Drawing Title

MACRO
GRADING PLAN

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Scale

0 100 200

IBI

J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.16 Sewer Clearances Plan.dwg Layout Name: Figure6.16 Plot Style: AIA STANDARD COLOR-HALF.CTB Plotted At: 8/7/2015 11:28 AM Last Saved By: mmine, Jul. 31, 15



Sheet No.	Drawing Title	Project Title	Scale
FIGURE 6.16	SEWER CLEARANCES PLAN	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	0 50 100

IBI

Street Segment Velocity x Depth Calculation

Iteration equation:

Velocity:

$$v_x = v_{min} + \frac{Q_x - Q_{min}}{Q_{max} - Q_{min}} (v_{max} - v_{min})$$

Depth:

$$d_x = d_{min} + \frac{Q_x - Q_{min}}{Q_{max} - Q_{min}} (d_{max} - d_{min})$$

100 Year 3 Hour Chicago Storm																			
					SWMHYMO (32952VXD.out)					Calculation Sheet: Overflow for Typical Road Ponding Area					Continuous Grade (SWMHYMO 32952VXD.out)			
Area ID (Dummy Segment, if applicable)	Road ROW Section	Longitudinal Slope (%)	Overflow Flowrate		Flowrate (cms)		Velocity (m/s)			Flowrate (cms)		Depth (m)			Depth (m)			Velocity x Depth (m^2/s)
			Qx (l/s)	Qx (cms)	Qmin	Qmax	vmin	vmax	vx	Qmin	Qmax	dmin	dmax	dx	dmin	dmax	dx	
PH3H(323 TO 320)	20	1.49	1237	1.24	1.00	1.32	1.61	1.80	1.75	n/a	n/a	n/a	n/a	n/a	0.14	0.15	0.15	0.26
PH1A (163 TO 130)	20	0.5	808	0.81	0.77	0.98	1.04	1.14	1.06	n/a	n/a	n/a	n/a	n/a	0.15	0.16	0.15	0.16
PH1A (130 TO 115)	20	0.58	1286	1.29	1.06	1.32	1.22	1.30	1.29	1.28	1.35	0.23	0.24	0.23	n/a	n/a	n/a	0.30
PH1A (125 TO 130)	26	0.73	1297	1.30	1.15	1.43	1.04	1.09	1.07	n/a	n/a	n/a	n/a	n/a	0.19	0.21	0.20	0.21
PH3G (155 TO 150)	26	0.54	500	0.50	0.48	0.60	0.72	0.78	0.73	0.49	0.52	0.17	0.17	0.17	n/a	n/a	n/a	0.12
PH2E (230 TO 235)	26	0.71	673	0.67	0.55	0.69	0.82	0.89	0.88	n/a	n/a	n/a	n/a	n/a	0.14	0.15	0.15	0.13
PH1F (183 TO 185)	20	1.65	893	0.89	0.76	1.05	1.51	1.69	1.59	n/a	n/a	n/a	n/a	n/a	0.12	0.14	0.13	0.21
PH1F (190 TO 185)	20	1.19	595	0.60	0.47	0.65	1.19	1.28	1.25	n/a	n/a	n/a	n/a	n/a	0.11	0.12	0.12	0.15
PH2E (251 TO 250)	20	2.86	2290	2.29	2.21	2.61	1.62	1.67	1.63	n/a	n/a	n/a	n/a	n/a	0.20	0.22	0.20	0.33
PH2E (250 TO 271)	26	3.7	3950	3.95	3.84	4.65	2.45	2.52	2.46	n/a	n/a	n/a	n/a	n/a	0.22	0.24	0.23	0.56

Master Servicing Study - Southwest Drainage Channel Design
Former CFB Rockcliffe

South West Channel Design Reach 1 (Section A-A, refer to Figure 6.25

New Swale Section Required flow =	1170	L/s		(	1.17	cms)			
From Seelye use n =	0.040							area =	1.41
Choose Slope S =	0.50	%						wp =	4.42
Ditch Bottom =	1.00	m							
Ditch slopes =	3	:1							
Water depth =	**0.54**	m	(depth needed to carry	1.17	cms)				
						Ditch Bottom =	86.50	m	
Check Ditch Capacity (Q) :						Ditch Top =	88.00	m	
Q =	1.17	cms	and Velocity =	0.83	m/s	Freeboard =	0.96	m	

South West Channel Design Reach 2 (Section B-B, refer to Figure 6.25

New Swale Section Required flow =	2610	L/s		(	2.61	cms)			
From Seelye use n =	0.040							area =	1.78
Choose Slope S =	1.40	%						wp =	5.04
Ditch Bottom =	1.50	m							
Ditch slopes =	3	:1							
Water depth =	**0.56**	m	(depth needed to carry	2.61	cms)				
						Ditch Bottom =	83.50	m	
Check Ditch Capacity (Q) :						Ditch Top =	85.50	m	
Q =	2.63	cms	and Velocity =	1.48	m/s	Freeboard =	1.44	m	

South West Channel Design Reach 3

New Swale Section Required flow =	3440	L/s		(	3.44	cms)			
From Seelye use n =	0.040							area =	2.88
Choose Slope S =	0.75	%						wp =	6.79
Ditch Bottom =	3.00	m							
Ditch slopes =	3	:1							
Water depth =	**0.60**	m	(depth needed to carry	3.44	cms)				
						Ditch Bottom =	80.40	m	
Check Ditch Capacity (Q) :						Ditch Top =	82.60	m	
Q =	3.52	cms	and Velocity =	1.22	m/s	Freeboard =	1.60	m	

South West Channel Design Reach 4

New Swale Section Required flow =	5768	L/s		(	5.77	cms)			
From Seelye use n =	0.040							area =	3.08
Choose Slope S =	1.70	%						wp =	6.98
Ditch Bottom =	3.00	m							
Ditch slopes =	3	:1							
Water depth =	**0.63**	m	(depth needed to carry	5.77	cms)				
						Ditch Bottom =	78.40	m	
Check Ditch Capacity (Q) :						Ditch Top =	79.80	m	
Q =	5.82	cms	and Velocity =	1.89	m/s	Freeboard =	0.77	m	

Q = A*(1.0/n)*R^2/3*S^1/2 where: A = cross sectional area in Sq. m
n = friction coefficient
R = hydraulic radius = A / wetted perimetre (wp) in m
S = ditch slope in %

Master Servicing Study - NRC Drainage Swale Design
Former CFB Rockcliffe

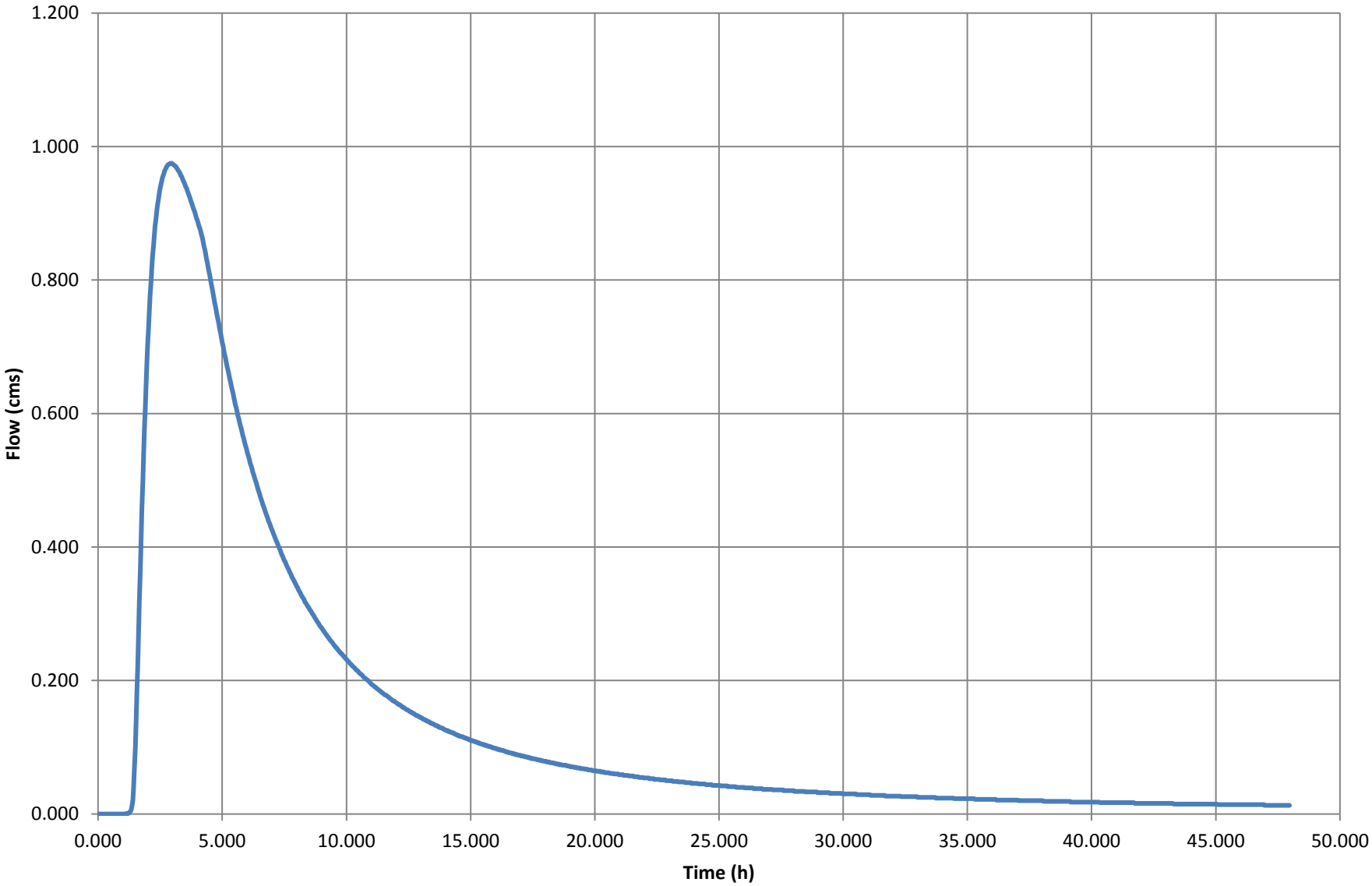
NRC Drainage Ditch Commercial Lands

Commercial Lands Ditch For NRC Surface Drainage

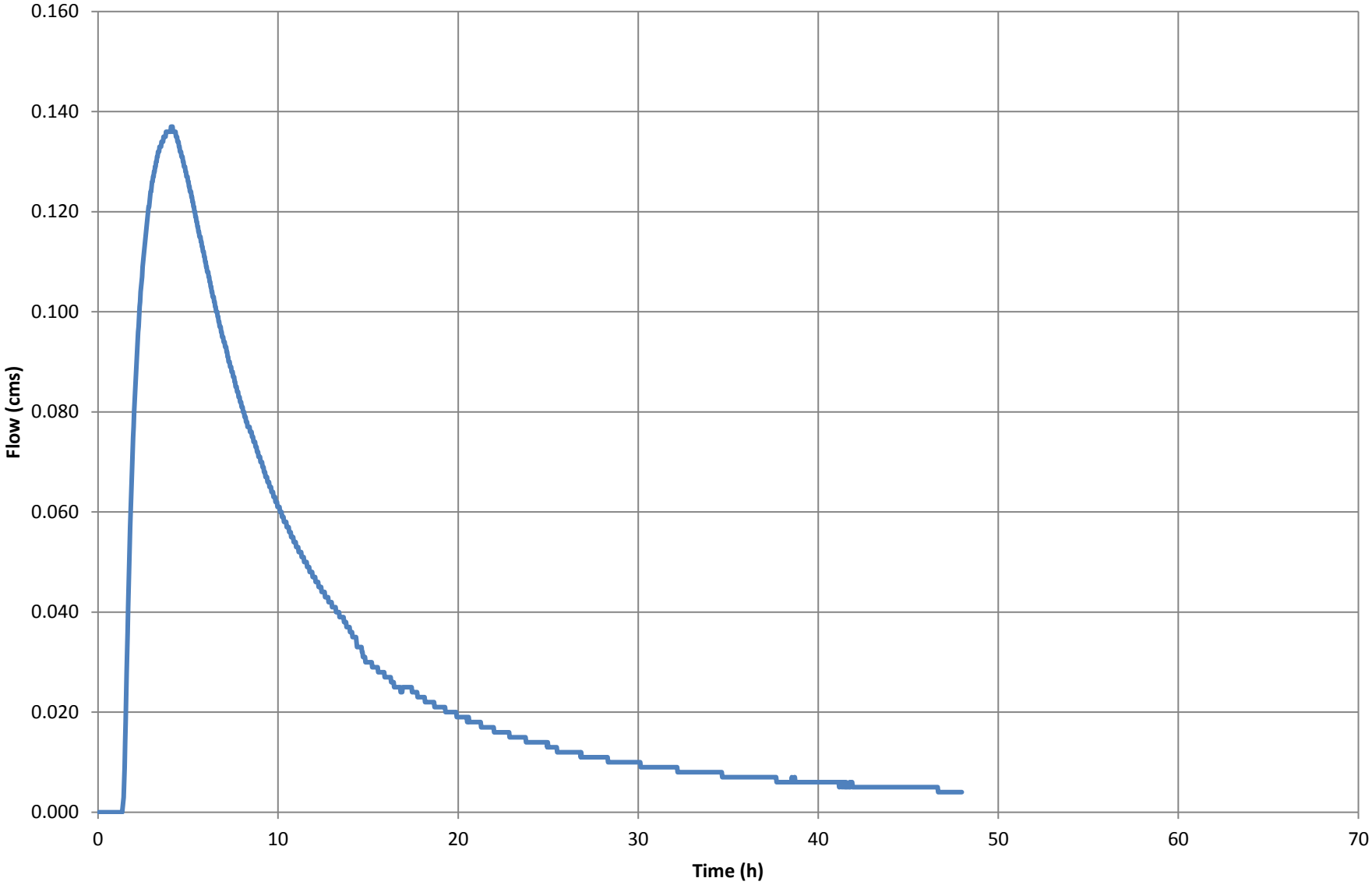
New Swale Section Required flow =	5700	l/s	5.70	Cu m/sec		
From Seelye use n =	0.050				area=	4.95
choose: slope S =	0.65	%			wp=	8.01
Ditch Bottom	3.00	metres	Max Easement width =	9.15 m		
Ditch slopes	2.50	:1				
Water depth	**0.93**	metres	(depth needed to carry 5.70 Cu. M/sec)			
Check Ditch Capacity (Q)						
Q =	5.80	Cu M/sec	and Velocity =	1.17 M/s		

Q = A*(1.0/n)*R^2/3*S^1/2 where: A = cross sectional area in Sq. m
n = friction coefficient
R = hydraulic radius = A/wetted perimetre (wp) in m

Eastern SWM Facility
25 mm Hydrograph Out of Pond



Western SWM Facility
25 mm Hydrograph Out of Pond



Eastern Creek Baseflow Augmentation Calculation

Existing Conditions

Area to Eastern Creek (refer to Figure 2.16): *(36.34 ha + 24.68 ha) = 61.02 ha*

Under post-development conditions, there is no proposed development of Area EXTE2 (refer to Figure 6.12), which measures 15.13 ha, so for the purposes of this calculation, consider: *(61.02 ha – 15.13 ha) = 45.89 ha*

Considering annual infiltration rate per the Aquafor Beech water budget analysis (MSS Table 6.4): *235 mm/year*

Existing conditions volumetric infiltration:

$= 235 \frac{mm}{year} x \frac{1m}{1000mm} x\ 45.89\ ha\ x \frac{10000m2}{1ha}$

$= 107{,}842 \frac{m3}{year}$

It is assumed that approximately 50% of the volumetric infiltration will participate in generating baseflow feeding the Eastern Creek:

$= 107{,}842 \frac{m3}{year}\ x\ 50\%$

$= 53{,}741 \frac{m3}{year}$

Expressed on a per hectare basis, the existing conditions volumetric infiltration:

$= \frac{\left(53{,}741 \frac{m3}{year}\right)}{45.89ha}$

$= 1171 \frac{m3}{year}\ per\ hectare$

Post-Development Conditions

Two drainage areas contribute flow to Eastern Creek, PH3A and EXTE2 (refer to Figure 6.12).

Referring to the 25 mm SWMHYMO simulation results, the runoff coefficients for the drainage areas are as follows:

Area ID	Land Use	Area (ha)	Volumetric Runoff Coefficient
PH3A	Urban	6.68	0.717 ≈ 0.72 *(∴≈ 0.28 infiltrates)*
EXTE2	Rural (no proposed change)	15.13	0.174 ≈ 0.17 *(∴≈ 0.83 infiltrates)*

From the above it is concluded that an urban development can produce approximately 34% of the infiltration in comparison with a rural area.

The post-development urban area contributing flow to the Eastern Creek, PH3A measures: *6.68 ha*

The corresponding infiltrated volume for this urban area:

$= 6.68\ ha\ x\ \frac{1171 m3/year}{ha}\ x\ 0.34$

$= 2660\ \frac{m3}{year}$

The baseflow compensation to the Eastern Creek is therefore:

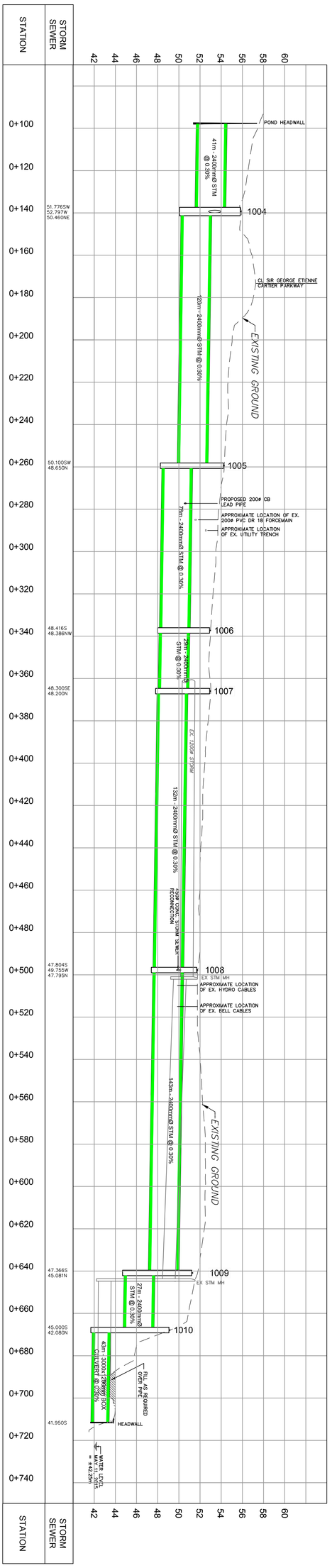
$= V_{Existing} - V_{PostDev}$

$= (53{,}741\ \frac{m3}{year}) - (2660\ \frac{m3}{year})$

$= 51{,}081\ \frac{m3}{year}$

It is recommended that this be confirmed at the detailed design stage, supported by continuous modeling.

J:\32952-RockcliffeRede\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.28 OUTLET PIPE TO EASTERN POND PROFILE.dwg Layout Name: FIGURE 6.28 Plot Style: AIA STANDARD COLOR-FULL.CTB Plotted At: 8/7/2015 11:12 AM Last Saved By: mmilne, Aug. 7, 15



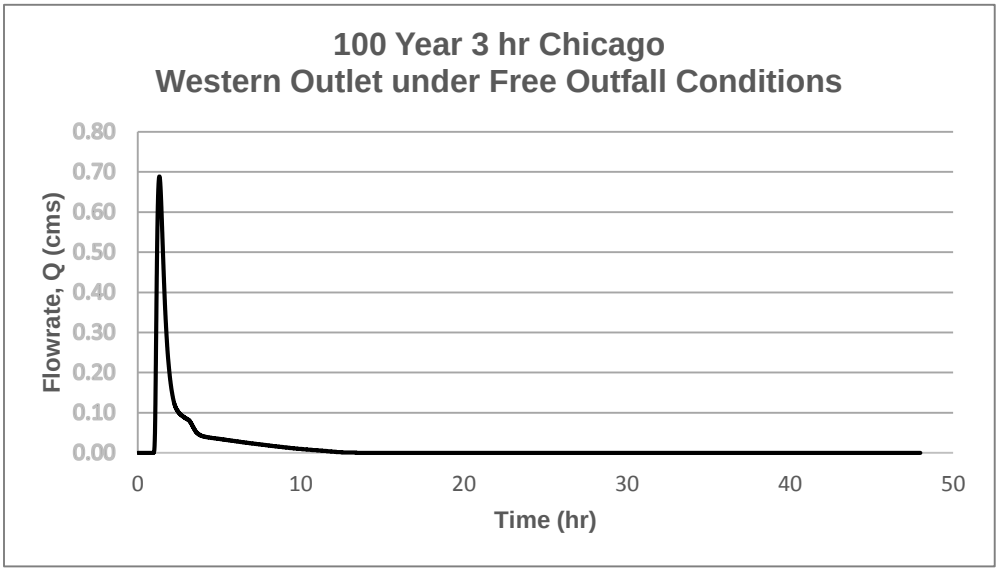
Sheet No.	Drawing Title	Project Title	Scale
FIGURE 6.28	EASTERN SWM FACILITY OUTLET PIPE PROFILE	FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	HORIZ 1:1000 VERT 1:200

IBI

Boundary Condition for Western Creek Outlet

Step 1. Run XPSWMM model assuming "Free Outfall" with the depth criterion "minimum yc_yn". Where yc is critical depth and yn is normal depth.

Step2. Export Outflow vs Time rating curve from "Aviation CH" link between DROP and NODE220 Nodes (see 100 year 3 hour Chicago example below).



Step3. Calculate a ratio based on flow rate for each time step from the Outflow-Time curve from Step 2. See equation below:

Ratio (R_x):

$$R_x = \frac{Q_x - Q_{min}}{Q_{max} - Q_{min}}$$

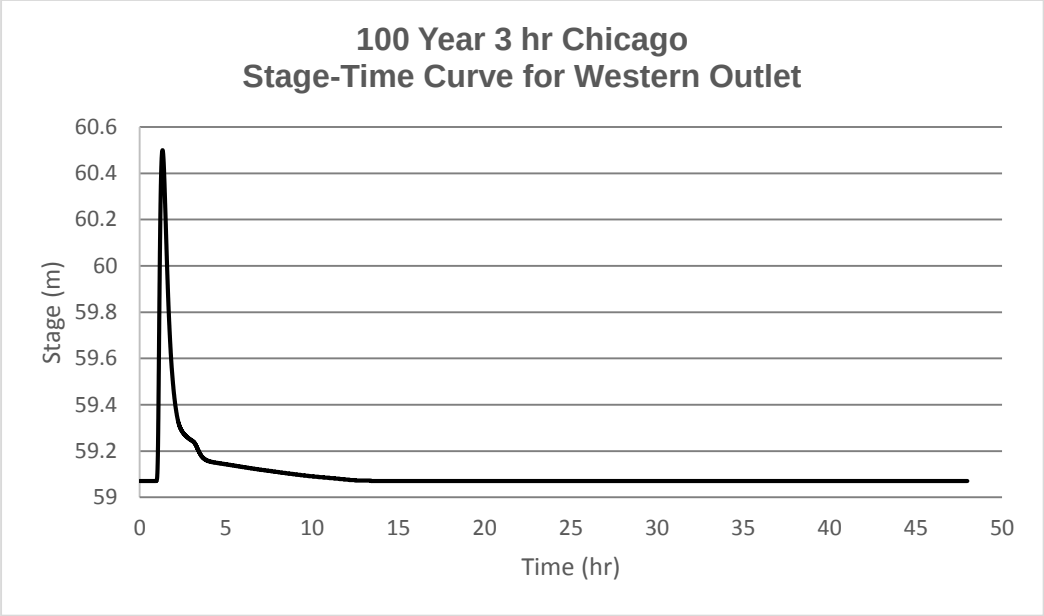
Where: Q_x: Flow rate at time x
Q_{min}: Minimum flow rate from all time steps
Q_{max}: Maximum flow rate from all time steps

Step4. Using the invert of the Western Creek at approximately 113 m downstream of the Aviation culvert (elevation 59.07 m), the maximum possible Western Creek water level (60.50 m), which corresponds to the existing road elevation at the culvert crossing further downstream, and the ratio determined in Step 3, create a Stage vs Time relationship at each time step. See equation below:

Outlet Stage (m):

$$H_x = R_x\,(Cr_{WL} - Cr_{inv}) + Cr_{inv}$$

Where: R_x: Ratio from Step 3
Cr_{wl}: Maximum Western Creek water level (m)
Cr_{inv}: Western Creek invert at approximately 113m downstream of the Aviation culvert (node Drop)



Step5: Copy Stage vs Time curve created in Step 4 into XPSWMM via Node DROP ->Outfall -> 3.3 User Stage History -> Coordinates. Re-run XPSWMM with User Stage History specified as the outlet condition.

The same process is followed for all the storm events modeled.

Hydraulic Grade Line

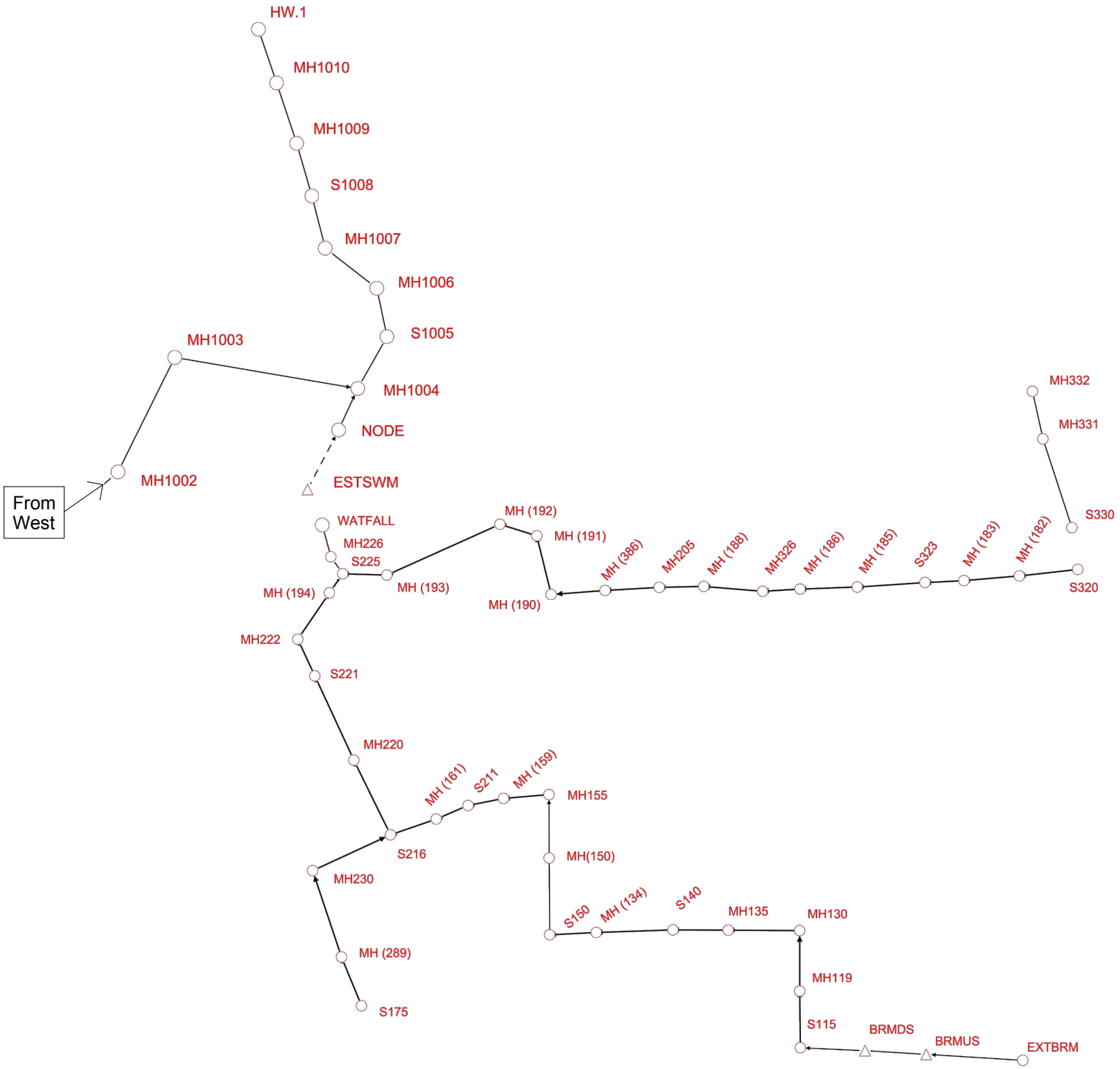
XPSWMM Node ID	2015 MSS MH No.	Detailed Design MH No. (If Applicable)	Proposed Ground (m)	USF (m)	100 year 3 hour Chicago		100 year 3 hour Chicago + 20%		100 year 24 hour SCS		July 1, 1979		August 1988		August 1996	
					HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)
EASTERN SWM FACILITY																
ESTSWM	N/A	N/A	N/A	N/A	57.99	N/A	58.31	N/A	57.96	N/A	58.59	N/A	58.15	N/A	57.63	N/A
EXSTMH	N/A	194	82.05	N/A	80.48	N/A	80.58	N/A	80.39	N/A	80.50	N/A	80.43	N/A	80.16	N/A
MH194	225	195	82.05	N/A	80.44	N/A	80.53	N/A	80.34	N/A	80.45	N/A	80.39	N/A	80.12	N/A
MH193	222	193	84.99	82.59	81.09	1.51	81.24	1.35	80.91	1.68	81.08	1.51	80.99	1.60	80.60	1.99
MH192	221	192	85.76	83.36	81.41	1.95	81.60	1.76	81.21	2.15	81.41	1.95	81.30	2.06	80.89	2.47
MH191	N/A	191	86.36	83.96	81.68	2.29	81.88	2.08	81.43	2.53	81.67	2.30	81.55	2.41	81.06	2.91
MH190	N/A	190	86.96	84.56	81.91	2.65	82.16	2.40	81.65	2.91	81.90	2.66	81.78	2.78	81.22	3.34
MH180	216	180	88.23	N/A	82.21	N/A	82.69	N/A	81.93	N/A	82.20	N/A	82.07	N/A	81.46	N/A
S181	230	181	86.12	N/A	82.37	N/A	82.71	N/A	82.06	N/A	82.36	N/A	82.21	N/A	81.59	N/A
S182	N/A	182	85.70	N/A	82.46	N/A	82.84	N/A	82.13	N/A	82.45	N/A	82.29	N/A	81.67	N/A
S128	N/A	128	85.68	N/A	82.62	N/A	82.93	N/A	82.26	N/A	82.60	N/A	82.43	N/A	81.80	N/A
S127	175	127	85.60	84.36	82.67	1.69	83.00	1.36	82.30	2.06	82.65	1.71	82.47	1.89	81.85	2.51
S126	N/A	126	86.38	84.96	82.87	2.09	83.18	1.78	82.85	2.11	82.85	2.11	82.86	2.10	82.84	2.12
S125	172	125	86.84	85.34	83.37	1.97	83.39	1.95	83.35	1.99	83.36	1.98	83.36	1.98	83.35	1.99
S124	N/A	124	87.46	85.69	83.94	1.75	83.94	1.75	83.93	1.76	83.93	1.76	83.93	1.76	83.92	1.77
S106	N/A	106	87.19	85.61	83.76	1.85	83.75	1.86	83.73	1.88	83.74	1.87	83.75	1.86	83.73	1.88
S105	195	105	87.30	85.71	83.90	1.81	83.91	1.80	83.89	1.82	83.89	1.82	83.90	1.81	83.89	1.82
S103	N/A	103	88.14	86.46	84.36	2.10	84.36	2.10	84.34	2.12	84.35	2.11	84.35	2.11	84.34	2.12
S102	194	102	88.28	86.46	84.72	1.74	84.72	1.74	84.71	1.75	84.71	1.75	84.71	1.75	84.70	1.76
S101	N/A	101	89.15	87.16	85.55	1.61	85.55	1.61	85.54	1.62	85.54	1.62	85.54	1.62	85.54	1.62
S107	N/A	107	87.61	N/A	85.29	N/A	85.29	N/A	85.28	N/A	85.28	N/A	85.28	N/A	85.27	N/A
S121	182	121	86.08	84.26	82.80	1.46	83.06	1.20	82.39	1.87	82.76	1.50	82.57	1.69	81.98	2.28
S122	N/A	122	86.98	84.86	83.53	1.33	83.53	1.33	83.53	1.33	83.53	1.33	83.53	1.33	83.53	1.33
S120	N/A	120	85.82	83.96	82.86	1.10	83.13	0.83	82.43	1.53	82.82	1.14	82.63	1.33	82.06	1.90
S116	183	116	85.86	83.71	82.89	0.82	83.16	0.55	82.46	1.25	82.84	0.87	82.66	1.05	82.10	1.61
S115	N/A	115	87.30	83.56	83.06	0.50	83.34	0.22	82.59	0.97	83.00	0.56	82.79	0.77	82.45	1.11
S114	185	114	85.61	83.91	83.08	0.83	83.35	0.56	82.61	1.30	83.03	0.88	82.81	1.10	82.49	1.42
S113	N/A	113	86.40	84.51	83.43	1.08	83.77	0.74	83.06	1.45	83.39	1.12	83.06	1.45	83.05	1.46
S112	N/A	112	86.96	84.91	83.41	1.50	83.80	1.11	83.18	1.73	83.41	1.50	83.22	1.69	83.22	1.69
S111	N/A	111	87.13	84.96	83.59	1.37	83.83	1.13	83.58	1.38	83.58	1.38	83.59	1.37	83.58	1.38
S110	N/A	110	87.19	85.56	83.59	1.97	83.83	1.73	83.59	1.97	83.59	1.97	83.59	1.97	83.59	1.97
S118	179	118	86.84	84.71	83.22	1.49	83.52	1.19	83.20	1.51	83.21	1.50	83.21	1.50	83.20	1.51
S117	N/A	117	87.12	85.06	83.54	1.52	83.60	1.46	83.53	1.53	83.53	1.53	83.54	1.52	83.53	1.53
S109	190	109	86.29	85.36	84.05	1.31	84.05	1.31	84.05	1.31	84.05	1.31	84.05	1.31	84.05	1.31
S108	N/A	108	88.76	86.66	85.24	1.43	85.23	1.43	85.23	1.43	85.23	1.43	85.23	1.43	85.23	1.43
S100	192	100	89.16	87.16	85.70	1.46	85.69	1.47	85.70	1.46	85.70	1.46	85.70	1.46	85.70	1.46
S119	N/A	119	87.51	85.46	83.95	1.51	83.95	1.51	83.95	1.51	83.94	1.52	83.95	1.51	83.95	1.51
MH178	211	178	89.00	86.60	83.41	3.19	83.48	3.12	83.32	3.28	83.40	3.20	83.37	3.23	83.16	3.44
MH176	155	176	88.03	85.63	83.77	1.86	83.86	1.77	83.67	1.96	83.75	1.88	83.72	1.91	83.48	2.15
S142	N/A	142	87.52	85.12	84.02	1.10	84.13	0.99	83.92	1.20	84.01	1.11	83.98	1.14	83.73	1.39
S141	150	141	87.32	84.92	84.28	0.64	84.39	0.53	84.17	0.75	84.27	0.65	84.23	0.69	83.96	0.96
S140	N/A	140	87.61	N/A	84.35	N/A	84.43	N/A	84.34	N/A	84.34	N/A	84.34	N/A	84.34	N/A
S139	N/A	139	87.69	85.66	84.46	1.20	84.49	1.17	84.46	1.20	84.46	1.20	84.46	1.20	84.45	1.21
S138	N/A	138	87.55	86.31	84.96	1.35	84.96	1.35	84.95	1.36	84.95	1.36	84.95	1.36	84.94	1.37
S137	131	137	88.57	86.91	85.77	1.14	85.77	1.14	85.76	1.15	85.76	1.15	85.77	1.14	85.76	1.15
S136	N/A	136	91.24	N/A	87.38	N/A	87.38	N/A	87.37	N/A	87.37	N/A	87.37	N/A	87.37	N/A
S135	142	135	94.75	N/A	90.11	N/A	90.11	N/A	90.10	N/A	90.10	N/A	90.10	N/A	90.09	N/A
S134	N/A	134	98.18	N/A	93.01	N/A	93.01	N/A	93.00	N/A	93.00	N/A	93.00	N/A	92.99	N/A
S133	N/A	133	101.44	N/A	96.52	N/A	96.52	N/A	96.51	N/A	96.51	N/A	96.51	N/A	96.50	N/A
S132	N/A	132	104.35	N/A	99.64	N/A	99.64	N/A	99.64	N/A	99.64	N/A	99.64	N/A	99.63	N/A
S131	N/A	131	105.30	N/A	101.05	N/A	101.05	N/A	101.04	N/A	101.04	N/A	101.04	N/A	101.03	N/A

Hydraulic Grade Line

XPSWMM Node ID	2015 MSS MH No.	Detailed Design MH No. (If Applicable)	Proposed Ground (m)	USF (m)	100 year 3 hour Chicago		100 year 3 hour Chicago + 20%		100 year 24 hour SCS		July 1, 1979		August 1988		August 1996	
					HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)
S130	N/A	130	104.41	N/A	101.25	N/A	101.25	N/A	101.24	N/A	101.24	N/A	101.24	N/A	101.23	N/A
S168	N/A	168	87.70	85.30	84.54	0.76	84.67	0.63	84.42	0.88	84.53	0.77	84.49	0.81	84.21	1.09
S167	140	167	88.40	86.00	84.71	1.29	84.86	1.14	84.59	1.41	84.70	1.30	84.66	1.34	84.39	1.61
S166	135	166	88.90	86.50	84.88	1.62	85.04	1.46	84.77	1.73	84.88	1.62	84.84	1.66	84.59	1.91
S165	130	165	89.30	86.90	85.98	0.92	86.05	0.85	85.93	0.97	85.99	0.91	85.96	0.94	85.83	1.07
S165B	130	165	89.61	87.21	86.45	0.76	86.45	0.76	86.44	0.77	86.44	0.77	86.44	0.77	86.44	0.77
S164	N/A	164	90.22	87.82	87.00	0.82	87.01	0.81	86.99	0.83	87.00	0.82	87.00	0.82	86.99	0.83
S163	125	163	90.94	88.54	87.68	0.86	87.68	0.86	87.68	0.86	87.68	0.86	87.68	0.86	87.68	0.86
S162	N/A	162	91.34	88.94	88.26	0.68	88.26	0.68	88.25	0.69	88.25	0.69	88.26	0.68	88.25	0.69
S161	N/A	161	91.94	89.54	88.57	0.97	88.58	0.96	88.57	0.97	88.57	0.97	88.57	0.97	88.57	0.97
S160	N/A	160	92.27	89.87	89.01	0.86	89.02	0.85	89.01	0.86	89.01	0.86	89.01	0.86	89.00	0.87
S153	N/A	153	92.78	90.38	89.45	0.93	89.46	0.92	89.44	0.94	89.44	0.94	89.45	0.93	89.44	0.94
S222	115	222	89.86	87.46	86.38	1.08	86.51	0.95	86.32	1.14	86.39	1.07	86.35	1.11	86.19	1.27
S221	N/A	221	89.88	87.48	86.57	0.91	86.72	0.76	86.51	0.97	86.59	0.89	86.54	0.94	86.37	1.11
S220	N/A	220	89.86	87.46	86.74	0.72	86.84	0.62	86.70	0.76	86.75	0.71	86.72	0.74	86.68	0.78
S219	N/A	219	90.08	87.68	86.85	0.83	86.94	0.74	86.82	0.86	86.86	0.82	86.84	0.84	86.81	0.87
S218	N/A	218	90.4	88.00	87.04	0.96	87.10	0.90	87.02	0.98	87.05	0.95	87.04	0.96	87.02	0.98
S217	N/A	217	90.66	88.26	87.13	1.13	87.18	1.08	87.12	1.14	87.14	1.12	87.13	1.13	87.12	1.14
S154	N/A	154	91.02	N/A	87.68	N/A	87.68	N/A	87.68	N/A	87.68	N/A	87.68	N/A	87.68	N/A
S157	N/A	157	91.24	N/A	89.21	N/A	89.20	N/A	89.21	N/A	89.21	N/A	89.21	N/A	89.21	N/A
S148	101	148	92.14	89.74	89.30	0.44	89.29	0.45	89.30	0.44	89.30	0.44	89.30	0.44	89.30	0.44
S149	108	149	92.34	89.94	89.42	0.52	89.42	0.52	89.42	0.52	89.42	0.52	89.42	0.52	89.42	0.52
S150	N/A	150	92.32	89.92	89.49	0.43	89.48	0.44	89.49	0.43	89.49	0.43	89.49	0.43	89.49	0.43
S151	N/A	151	92.5	90.10	89.58	0.52	89.57	0.53	89.58	0.52	89.58	0.52	89.58	0.52	89.57	0.53
S152	120	152	92.73	90.33	89.71	0.62	89.71	0.62	89.71	0.62	89.71	0.62	89.71	0.62	89.71	0.62
S216	N/A	216	90.85	88.45	87.30	1.15	87.30	1.15	87.30	1.15	87.30	1.15	87.31	1.14	87.30	1.15
S215	N/A	215	90.77	88.37	87.58	0.79	87.58	0.79	87.58	0.79	87.58	0.79	87.58	0.79	87.58	0.79
S214	N/A	214	93.52	91.12	90.26	0.86	90.28	0.84	90.26	0.86	90.26	0.86	90.26	0.86	90.26	0.86
S200	126	200	94.71	92.31	90.73	1.58	90.74	1.57	90.73	1.58	90.73	1.58	90.72	1.59	90.73	1.58
S209	N/A	209	88.75	86.35	85.46	0.89	85.45	0.90	85.41	0.94	85.42	0.93	85.45	0.90	85.38	0.97
S208	N/A	208	88.77	86.37	85.92	0.45	85.91	0.46	85.78	0.59	85.81	0.56	85.88	0.49	85.70	0.67
S211	N/A	211	89.15	86.75	85.94	0.81	85.93	0.82	85.93	0.82	85.93	0.82	85.93	0.82	85.92	0.83
S210	N/A	210	89.14	86.74	86.43	0.31	86.43	0.31	86.42	0.32	86.42	0.32	86.43	0.31	86.41	0.33
S213	N/A	213	89.74	87.34	86.45	0.89	86.45	0.89	86.43	0.91	86.44	0.90	86.44	0.90	86.42	0.92
S212	N/A	212	90.25	87.85	86.86	0.99	86.87	0.98	86.83	1.02	86.83	1.02	86.84	1.01	86.82	1.03
MH231	318	231	89.805	87.41	85.81	1.59	85.83	1.58	85.70	1.70	85.80	1.61	85.74	1.67	85.70	1.70
MH207	N/A	207	88.53	86.13	84.60	1.53	84.63	1.50	84.58	1.55	84.58	1.55	84.59	1.54	84.54	1.59
MH206	165	206	89.1	86.70	85.59	1.11	85.62	1.08	85.56	1.14	85.57	1.13	85.57	1.13	85.52	1.18
MH205	164	205	89.35	86.95	85.80	1.15	85.85	1.10	85.77	1.18	85.78	1.17	85.79	1.16	85.72	1.23
MH204	163	204	90.4	88.00	87.07	0.93	87.10	0.90	87.05	0.95	87.06	0.94	87.06	0.94	87.02	0.98
MH203	161	203	92.38	89.98	88.65	1.33	88.68	1.30	88.63	1.35	88.63	1.35	88.64	1.34	88.60	1.38
MH202	160	202	93.91	91.51	90.42	1.09	90.43	1.08	90.41	1.10	90.41	1.10	90.41	1.10	90.39	1.12
MH201	N/A	201	94.29	91.89	90.72	1.17	90.73	1.16	90.72	1.17	90.72	1.17	90.72	1.17	90.71	1.18
BURMA	N/A	N/A	N/A	N/A	89.41	N/A	89.87	N/A	89.24	N/A	89.43	N/A	89.31	N/A	89.04	N/A
S147	N/A	147	93.27	N/A	90.93	N/A	91.78	N/A	90.72	N/A	90.88	N/A	90.98	N/A	90.60	N/A
S146	N/A	146	95.28	92.88	90.96	1.92	91.82	1.06	90.77	2.11	90.91	1.97	91.01	1.87	90.63	2.25
S145	N/A	145	97.64	95.24	93.01	2.23	93.01	2.23	93.01	2.23	93.00	2.24	93.01	2.23	93.00	2.24
S144	N/A	144	99.41	97.01	95.79	1.22	95.79	1.22	95.78	1.23	95.78	1.23	95.79	1.22	95.78	1.23
S143	N/A	143	102.4	100.00	98.16	1.84	98.16	1.84	98.16	1.84	98.16	1.84	98.16	1.84	98.16	1.84
MH305	N/A	305	91	88.80	86.81	1.99	86.91	1.89	86.70	2.10	86.79	2.01	86.72	2.08	86.71	2.09
MH304	N/A	304	90.3	88.10	87.32	0.78	87.44	0.66	87.27	0.83	87.32	0.78	87.31	0.79	87.29	0.81
MH303	N/A	303	90.67	88.47	87.69	0.78	87.85	0.62	87.59	0.88	87.68	0.79	87.66	0.81	87.62	0.85
MH302	N/A	302	92.8	90.60	88.63	1.97	88.63	1.97	88.63	1.97	88.63	1.97	88.63	1.97	88.63	1.97

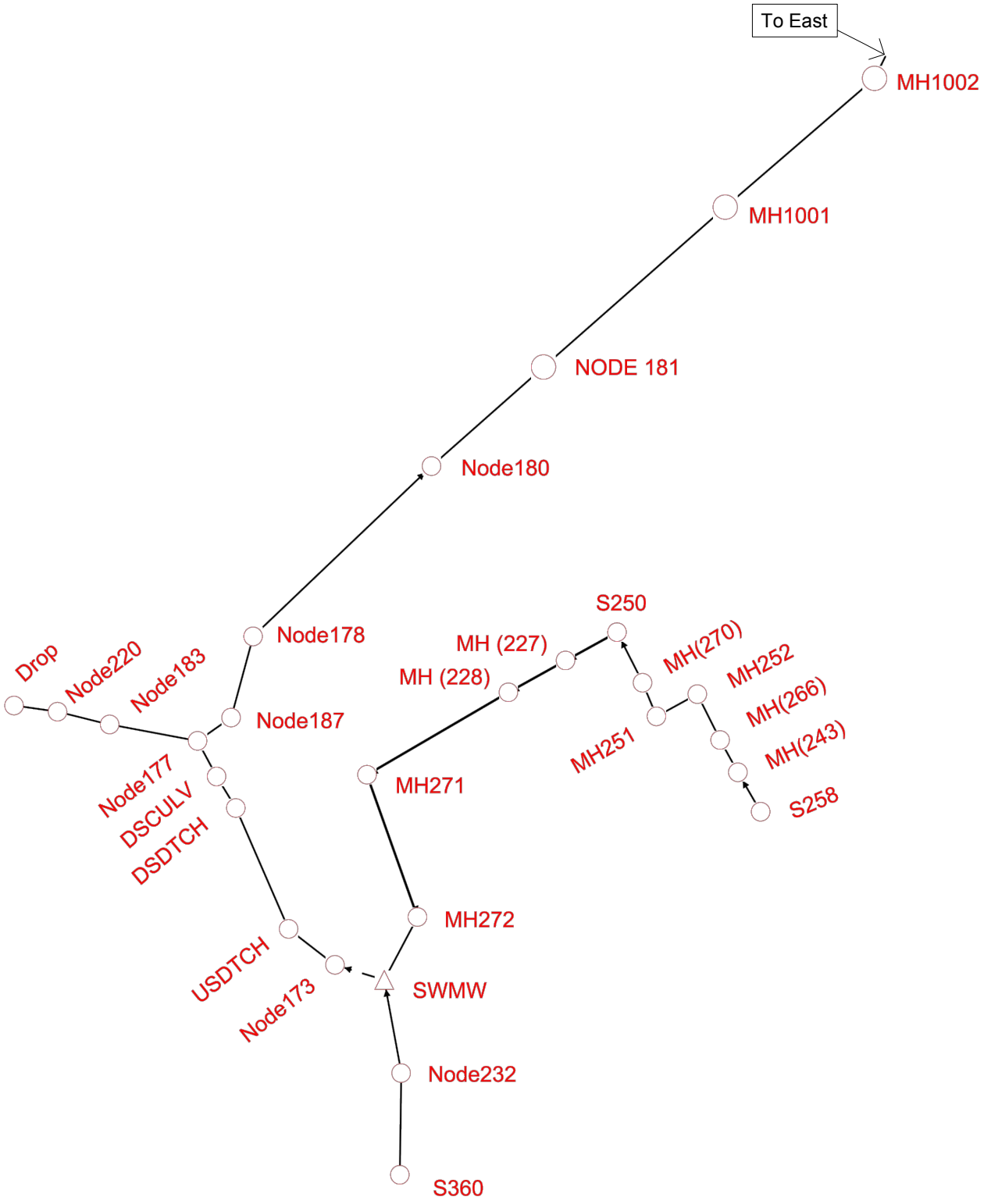
Hydraulic Grade Line

XPSWMM Node ID	2015 MSS MH No.	Detailed Design MH No. (If Applicable)	Proposed Ground (m)	USF (m)	100 year 3 hour Chicago		100 year 3 hour Chicago + 20%		100 year 24 hour SCS		July 1, 1979		August 1988		August 1996	
					HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)	HGL (m)	USF - HGL (m)
MH301	N/A	301	93.73	91.53	90.20	1.33	90.21	1.32	90.20	1.33	90.20	1.33	90.20	1.33	90.20	1.33
MH300	N/A	300	94	91.80	90.71	1.09	90.70	1.10	90.67	1.13	90.68	1.12	90.68	1.12	90.68	1.12
MH318	N/A	318	94.4	92.20	91.03	1.17	91.03	1.17	91.00	1.20	91.00	1.20	91.00	1.20	91.00	1.20
MH326	N/A	326	94.76	92.56	91.33	1.23	91.33	1.23	91.32	1.24	91.32	1.24	91.32	1.24	91.33	1.24
MH308	N/A	308	89.68	87.48	86.65	0.83	86.65	0.83	86.59	0.89	86.61	0.87	86.61	0.87	86.56	0.92
MH309	N/A	309	90.15	87.95	87.29	0.66	87.32	0.63	87.18	0.77	87.19	0.76	87.19	0.76	87.11	0.84
MH310	N/A	310	90.04	87.84	86.94	0.90	87.25	0.59	86.83	1.01	86.84	1.00	86.85	0.99	86.80	1.04
MH311	N/A	311	90.69	88.49	87.38	1.11	87.44	1.05	87.33	1.16	87.34	1.15	87.39	1.10	87.34	1.15
MH312	N/A	312	91.36	89.68	88.41	1.27	88.42	1.26	88.41	1.27	88.41	1.27	88.42	1.26	88.38	1.30
MH313	N/A	313	92.62	90.71	89.34	1.37	89.35	1.36	89.34	1.37	89.34	1.37	89.34	1.37	89.33	1.38
MH314	N/A	314	93	91.16	89.90	1.26	89.91	1.25	89.90	1.26	89.91	1.25	89.91	1.25	89.89	1.27
MH315	N/A	315	93.39	91.36	90.27	1.09	90.29	1.07	90.24	1.12	90.24	1.12	90.28	1.08	90.22	1.14
MH316	N/A	316	94.09	91.89	90.96	0.93	90.96	0.93	90.94	0.95	90.95	0.94	90.94	0.95	90.92	0.97
MH317	N/A	317	94.08	91.88	91.16	0.72	91.18	0.70	91.14	0.74	91.15	0.73	91.14	0.74	91.11	0.77
MH325	N/A	325	86.19	83.99	83.14	0.85	83.14	0.85	83.13	0.86	83.13	0.86	83.13	0.86	83.13	0.86
MH323	N/A	323	86.57	84.37	83.19	1.18	83.28	1.09	83.11	1.26	83.11	1.26	83.13	1.24	83.09	1.28
MH322	N/A	322	87.5	85.30	84.15	1.15	84.19	1.11	84.11	1.19	84.11	1.19	84.12	1.18	84.10	1.20
MH321	N/A	321	87.67	85.47	84.46	1.01	84.51	0.96	84.40	1.07	84.40	1.07	84.42	1.05	84.39	1.08
MH320	N/A	320	88.77	86.57	85.16	1.41	85.23	1.34	85.09	1.48	85.09	1.48	85.11	1.46	85.08	1.49
MH319	N/A	319	88.81	86.61	86.21	0.40	86.58	0.03	85.82	0.79	85.83	0.78	85.92	0.69	85.77	0.84
WESTERN SWM FACILITY																
SWMW	HW	N/A	77.0	74.6	72.44	N/A	72.81	1.8	72.62	2.0	72.85	1.8	72.57	2.0	71.72	2.9
S360	261	N/A	79.5	77.1	75.04	2.06	75.04	2.1	75.04	2.1	75.04	2.1	75.04	2.1	74.68	2.4
MH272	272	N/A	72.5	N/A	72.72	N/A	72.81	N/A	72.60	N/A	72.85	N/A	72.70	N/A	71.76	N/A
MH271	271	N/A	74.5	N/A	72.44	N/A	72.81	N/A	72.60	N/A	72.85	N/A	72.67	N/A	71.89	N/A
MH(228)	228	N/A	76.3	N/A	72.47	N/A	72.81	N/A	72.69	N/A	72.99	N/A	72.88	N/A	72.03	N/A
MH (227)	227	N/A	77.9	N/A	72.55	N/A	72.84	N/A	72.80	N/A	73.12	N/A	73.01	N/A	72.25	N/A
S250	250	N/A	79.5	77.1	74.35	2.75	74.35	2.8	74.35	2.7	74.33	2.8	74.33	2.8	74.33	2.8
MH(270)	270	N/A	79.5	77.1	75.63	1.47	75.63	1.5	75.65	1.5	75.63	1.5	75.63	1.5	75.63	1.5
MH251	251	N/A	81.2	78.8	75.86	2.94	75.86	2.9	75.86	2.9	75.86	2.9	75.86	2.9	75.86	2.9
MH252	252	N/A	82.2	79.8	76.42	3.38	76.42	3.4	76.42	3.4	76.39	3.4	76.39	3.4	76.39	3.4
MH(266)	266	N/A	82.4	80.0	76.49	3.51	76.51	3.5	76.50	3.5	76.49	3.5	76.49	3.5	76.49	3.5
MH(243)	243	N/A	82.4	80.0	76.65	3.35	76.64	3.4	76.64	3.4	76.65	3.4	76.64	3.4	76.64	3.4
S258	258	N/A	82.4	80.0	76.77	3.23	76.77	3.2	76.76	3.2	76.76	3.2	76.76	3.2	76.76	3.2



J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.32 Post-Development Conditions XPSWMM Schematic - East.dwg Layout Name: Figure6.32

Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	POST-DEVELOPMENT CONDITIONS XPSWMM SCHEMATIC- EAST	FIGURE 6.32



J:\32952-RockcliffeRedev\5.9 Drawings\59civil\current\Report Figures\MSS 2015\Section 6\Figure 6.33 Post-Development Conditions XPSWMM Schematic -West.dwg Layout Name: Figure6.33

Project Title	Drawing Title	Sheet No.
FORMER CFB ROCKCLIFFE MASTER SERVICING STUDY	POST-DEVELOPMENT CONDITIONS XPSWMM SCHEDMATIC-WEST	FIGURE 6.33

LEGEND

108 NODE IDENTIFICATION

2700mmØ PROPOSED STORM SEWER SIZE AND DIRECTION

1050Ø STM EXISTING SITE STORM SEWER SIZE AND DIRECTION

AVIATION MUSEUM

RCAF SANITARY PUMP STATION

ROCKCLIFFE PKWY

POTENTIAL BASEFLOW AUGMENTATION

EASTERN STORM FACILITY

POTENTIAL WATERFALL

FUTURE MUSEUM

HEMLOCK RD.

CODD'S ROAD

MAIN STREET

MAJOR COLLECTOR

INTERCEPT EXISTING STORM INVERT ±87,00m

INTERCEPT EXISTING STORM INVERT ±87.00m

CAP SEWER AND CONSTRUCT TEMPORARY DRAINAGE PIPE TO SWM FACILITY

NATIONAL RESEARCH COUNCIL (NRC)

THORNCLIFFE VILLAGE

FAIRHAVEN

MONTFORT HOSPITAL

EXISTING STORMWATER FACILITY

MONTREAL RD

N

Scale 0 100 200

Project Title

FORMER CFB ROCKCLIFFE
MASTER SERVICING STUDY

Drawing Title

RECOMMENDED PHASE 1A
STORM SEWER SYSTEM

Sheet No.

FIGURE 6.34

APPENDIX F

UTILITY MEETING MINUTES

IBI Group
400–333 Preston Street
Ottawa ON K1S 5N4 Canada

tel 613 225 1311
fax 613 225 9868

Notes

To/Attention	Distribution List	**Date**	February 7, 2014
From	Peter Kirkimtzis	**Project No**	32952 - 5.1

Subject Rockliffe Redevelopment – Utility Coordination Meeting
IBI Group Office
February 7, 2014 at 10:00am

Present

Don Schultz	CLC	dschultz@clc.ca
Krista Durie	CLC	kdurie@clc.ca
Tony Stinziano	Hydro	tonystinziano@hydroottawa.com
Mark Wojdan	Hydro	markwojdan@hydroottawa.com
Kristine McNamara	Hydro	kristinemcnamara@hydroottawa.com
Anna Borris	Enbridge	anna.borris@enbridge.com
Jeanne Dubeau	Rogers	jeanne.dubeau@rci.rogers.com
Martin Proulx	Rogers	martin.proulx@rci.rogers.com
Adam Docksteader	Bell	adam.docksteader@bell.ca
Jim Moffatt	IBI	jmoffatt@ibigroup.com
Peter Kirkimtzis	IBI	peter.kirkimtzis@ibigroup.com

Distribution All Present

Item Discussed		Action By
1	The redevelopment will include up to 5,500 units in the mid – high density range. There will be roughly 270 single houses and roughly 75,000 square metres of commercial floor space.	Advisory
2	There will be a couple high rise apartments in the 20 storey range within the residential/commercial sector (red areas on the concept plan)	Advisory
3	The redevelopment will also include about 6 hectares owned by National Research Council (NRC) located south-east of the site.	Advisory
4	Complete build out of the redevelopment could take up to 15 – 20 years	Advisory
5	IBI will forward a phasing plan, a CAD file of the site and copies of the soils reports to all utilities.	IBI
6	CLC and IBI will meet with the City in March to discuss street cross sections. The site will consist of 18.0m, 20.0m and 26.0m ROW's. Non standard structures will be included on the cross sections such as sidewalk on both sides of the 18.0m ROW, swales and possible narrow asphalt laneways.	IBI/CLC
7	The preliminary ROW's will be circulated to the utilities for comments before the meeting with the City.	IBI

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Item Discussed		Action By
8	Hydro will need to bring a high voltage line from a nearby sub-station to provide service to the site. The likely station candidates are; • Moulten sub-station through La Cite • Overbrook sub-station near St. Laurent • Hydro One sub-station on the adjacent NRC property	Hydro
9	The cost of the high voltage trunk line will be considerable and Hydro will provide CLC with a worst case economic evaluation. The price will also be offset by the number of units built within the first 5 years of construction. CLC previously estimated that about 1000 units could be built within the 5 year timeline. CLC will re-evaluate that estimate.	Hydro
10	Hydro stated that there will not be back-up power available to the site from the trunk line from Moulten sub-station due to the style of servicing provided to the sub-station. A more reliable source could be provided from the Overbrook sub-station.	Advisory
11	With its economic evaluation, Hydro will also provide an estimated timeline to build the trunk line to the site. The timeline may be in the 6 – 12 month range.	Hydro
12	CLC will require power for 2017.	Advisory
13	Hydro is currently servicing a pumping station located to the north through the Rockliffe site. A plan will be required to provide service to the pump station through the redevelopment.	Hydro/CLC
14	Enbridge will require gas loads for the site and upon receipt will begin a layout for the site. Gas will likely come from Montreal Road via Codd's Road. CLC to provide gas load summary to Enbridge.	CLC/Enbridge
15	Enbridge will also provide to CLC an economic evaluation including timelines.	Enbridge
16	Bell and Rogers have existing services on Codd's Road pole line suitable to service the site.	Advisory
17	CLC will confirm whether 3-party or 4-party trenching will be used for the site.	CLC
18	Preliminary construction schedule; Phase 1 will be the south half of the site broken into 2 sub-phases. • Phase 1A west of Codd's Road in 2015 • Phase 1B east of Codd's Road in 2016 Stage 1 will consist of roughly 680 units consisting of singles, towns semis, stacked towns and some commercial area.	Advisory

Please report any serious errors or omissions to these notes to Jim Moffatt at jmoffatt@ibigroup.com or to Peter Kirkimtzis at peter.kirkimtzis@ibigroup.com.