Report

Associated Engineering

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

City Of Saskatoon

East Sector Feasibility Study
Final Report

May 2006

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

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May 9, 2006
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Re: CITY OF SASKATOON
EAST SECTOR FEASIBILITY STUDY
FINAL REPORT

Dear Mr. Wallace:

We are pleased to submit six (6) copies of our final report on the above noted study.

On behalf of Associated Engineering (Sask.) Ltd and our team of Crosby Hanna & Associates, ND Lea Engineers and Planners, Johnson Weichel Resource Management Consultants and Golder Associates, we extend our sincere appreciation to the City of Saskatoon, and to the members of the Project Steering Committee for the opportunity to complete this study, and for their cooperation throughout the process.

We wish you success in the planning and implementation of our final recommendations. Should you require additional input on this work, please do not hesitate to contact us.

Yours truly,

Bert Munro, P.Eng.
Vice-President, General Manager

Scott Miller, P.Eng.
Project Engineer

SM/lp

Enclosure

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CITY OF SASKATOON
EAST SECTOR FEASIBILITY STUDY
FINAL REPORT

ASSOCIATION OF PROFESSIONAL ENGINEERS AND GEOSCIENTISTS OF SASKATCHEWAN
CERTIFICATE OF AUTHORIZATION

ASSOCIATED ENGINEERING (SASK.) LTD.
NUMBER C116

Permission to Consult Held By:

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Prepared by Associated Engineering (Sask) Ltd.

Executive Summary

The purpose of this study was to determine the feasibility of establishing a new suburban development area in the "East Growth Sector" of the City of Saskatoon (COS) as defined in the *1999 Future Growth Study.* The sector is to cover roughly 1,600 hectares, consisting of up to ten new neighbourhoods and housing approximately 50,000 people.

Initially opportunities and constraints were identified for the designated development area related to terrain analysis, natural resources, heritage resources, land use, transportation, and utilities. This analysis resulted in determination of suitable development areas or "windows of opportunity". The areas of constraint identified as most critical were considered to be U of S Agricultural Research Lands and the future Perimeter Road corridor.

Development concepts for the area related to form and functionality at the neighbourhood level were then determined during a day-long workshop with the Project Steering Committee, along with a number of representatives from the City of Saskatoon Infrastructure Services, Lands, Transportation, Traffic, Planning and Parks Branches, University of Saskatchewan, the R.M. of Corman Park and the Consultants made up of Associated Engineering, Crosby Hanna Associates, NDLea, and Golder Associates.
At the end of the workshop the concepts were presented. Through review it was determined by the Consultants that there were two relatively different development concepts. These were drafted to report form as Concept 1 and Concept 2.

Concepts 1 and 2 were analysed from transportation and municipal infrastructure perspectives to determine conceptual design layouts, and corresponding development costs. Cost information and relative advantages and disadvantages for each option were then considered to arrive at the recommendation that Concept 1 is the most suitable for development in the East Sector. Given the sensitivity of conceptual cost estimates, overall development costs may be in the range of $482M - $804M.

Based on the investigation undertaken, reviews with and input from the Steering Committee and the broader advisory group, and the analysis of alternatives, it is recommended that should the City of Saskatoon proceed with development in the East Sector, Concept 1 represents the most suitable long term development alternative.

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1 Introduction

1.1 AUTHORIZATION

The Consulting team, made up of Associated Engineering (Sask.) Ltd, Crosby Hanna & Associates, ND LEA Inc., and Golder Associates, received authorization to proceed with the study of infrastructure requirements and feasibility analysis of the East Sector in October of 2004.

The purpose of this study is to determine the feasibility of establishing a new suburban development area in the "East Growth Sector" of the City of Saskatoon as defined in the *1999 Future Growth Study*[1]. The East Growth Sector is one of three potential growth areas identified in the 1999 study as having the necessary attributes to support the long-term future growth of Saskatoon. This study examined the East Sector area in more detail to determine the technical feasibility and opportunities for development of a New Suburban Development Area of roughly 1,800 hectares, consisting of up to ten new neighbourhoods and housing approximately 50,000 people. The report follows on similar studies conducted for the West and North East sector future development areas.

1.2 BACKGROUND

In 1999, the City of Saskatoon conducted the first phase of the Future Growth Study, which looked at feasible growth strategies for the City and the Rural Municipality of Corman Park. This included examining land requirements to support a population growth to 400,000 residents. The study identified three possible growth sectors, which included West of Saskatoon, North East and East Sectors. This report deals with the East Sector.

The following outlines the project requirements:

- Up to ten (10) new residential neighbourhoods ranging in size from 180 - 200 hectares, with average residential densities of approximately 5 units per gross acre and land use mixes and internal circulation networks consistent with the provisions of the City of Saskatoon Development Plan.
- A Suburban Centre, consisting of integrated, mixed-use development, which will provide a focus for the East Sector and provide the commercial, institutional and recreational lands to serve the basic needs of sector residents, as well as opportunity for medium to high density residential development.
- An employment area of approximately 180 - 200 hectares, consisting of light industrial, business park, and commercial development.
- A framework for provision of District and Multi-District Parks as defined in the Park Development Guidelines.

[1] Community Services, City Planning Branch (June 2000), Future Growth Study, 1999, City of Saskatoon

- Identification of opportunities and constraints through preliminary analysis of terrain, natural and cultural heritage resources, land use, transportation and municipal utilities in or adjacent to the area.

The East Sector of the City of Saskatoon's Future Growth Study is located in Townships 36 and 37 Range 4 W3M. Sections in Township 36 Range 4 W3M include NE 17, NE 19, 20, 21, W/2 27, 28, 29, 30, SE 31, 32, 33, and the W/2 34. In Township 37 Range 4 W3M Sections include the W/3, 4, 9 and the W/2 of 10. The study area encompasses approximately 2360 ha between the current east limits of the city to the base of an upland feature known as the Strawberry Hills. The north and south boundaries are defined by Fleury Road (Twp. Rd. 372) and the Canadian Pacific Railway respectively. The majority of the study area occurs on privately owned land that is currently used for agricultural purposes. A number of existing and abandoned farmyards, as well as acreages, and businesses are also located within the study area.

The East Sector Study Area as defined by Drawing One (1) is attached in Appendix A. A series of oblique aerial photographs in Appendix E also provide an overview of the study area.

2 Opportunities And Constraints

This section of the report highlights the various issues that could affect future development plans for the East Sector. It includes a review of physical, ecological, heritage and land use issues to determine the opportunities that may influence future development patterns.

2.1 TERRAIN ANALYSIS

The terrain analysis component of the study identifies the surface and subsurface features and their significance to the development of municipal infrastructure. It assesses topographic and surface drainage conditions, soils and bedrock as well as groundwater. This information is summarized in Drawing Three (3) in Appendix A for reference in the development of opportunities and constraint mapping.

The information presented has been obtained from existing available sources including Geology and Surficial Geology Maps, existing air photos in the consulting team's possession and the Saskatchewan Water Corporation (Sask Water) water well database.

2.1.1 Bedrock Geology

The overburden deposits at this site consist of approximately 55 m to 90 m of glacial till and stratified drift overlying the noncalcareous silty clay of the Bearpaw formation. The Bearpaw Formation is the uppermost marker bed in the area.

2.1.2 Hydrogeology

According to Christiansen (1967)[2], sand and gravel aquifers occur on the surface, between tills, between till and bedrock and within tills. The Forestry Farm aquifer underlies much of the study area and extends from the Strawberry Hills, east of the study area, towards the South Saskatchewan River.

A water well record search of the Sask Water database indicated 56 water wells in the study area, as listed in Table 2-1, shown on the following page.

[2] Christiansen, E.A. (1967), Geology and Groundwater Resources of the Saskatoon Area (73-B), Saskatchewan, Saskatchewan Research Council Geology Division, Saskatoon, Canada, Map No. 7.

Table 2-1
Summary of Water Wells from Saskatchewan Watershed Authority

Land Location	Depth (m)	Water Level* (m)	Type of Well	Registered Owner	Town/City	Installation Date
NE1/4-25-36-5-W3M	108.8	0.0	Research - Water Test Hole	SASK RESEARCH COUNCIL	SUTHERLAND	
SE1/4-25-36-5-W3M	25.0	0.0	Research - Water Test Hole	SASK RESEARCH COUNCIL	SUTHERLAND	
SW1/4-25-36-5-W3M	25.3	18.3	Domestic - Withdrawal	ROYALITE SERVICE	SASKATOON	
NW1/4-36-36-5-W3M	106.7	0.0	Domestic - Water Test Hole	STADOLE REDI MIX	SASKATOON	
SE1/4-36-36-5-W3M	14.9	6.1	Domestic - Withdrawal	CASWELL VERN	GRANDORA	12-May-94
8-37-4-W3M	26.8	14.6	Research - Observation	SASK RESEARCH COUNCIL	SASKATOON	15-Oct-67
NE1/4-8-37-4-W3M	36.6	14.6	Research - Observation	SASK RESEARCH COUNCIL	SASKATOON	18-Nov-67
SW1/4-10-37-4-W3M	16.5	0.0	Domestic - Water Test Hole	WILSON DALE	SASKATOON	7-Apr-80
SW1/4-10-37-4-W3M	21.9	6.4	Domestic - Withdrawal	WILSON DALE	SASKATOON	10-Apr-80
10-37-4-W3M	85.3	0.0	Domestic - Water Test Hole	CARROLL JOHN		2-Jul-90
10-37-4-W3M	91.4	45.1	Domestic - Withdrawal	CARROLL JOHN		13-Jul-90
SE1/4-10-37-4-W3M	22.3	6.7	Domestic - Withdrawal	FLEURY MIKE	SASKATOON	6-Sep-94
SE1/4-10-37-4-W3M	22.9	10.4	Domestic - Withdrawal	GROVES JOHN	SASKATOON	27-May-97
SE1/4-10-37-4-W3M	73.2	40.5	Domestic - Withdrawal	METANCZUK ROB	SASKATOON	6-May-98
NW1/4-16-36-4-W3M	96.0	0.0	Domestic - Water Test Hole	CREIGHTON DAN	SASKATOON	6-Aug-74
SW1/4-8-36-4-W3M	27.1	2.4	Domestic - Withdrawal	WERSCHNER E & SONS	SASKATOON	24-Nov-70
SW1/4-8-36-4-W3M	7.9	0.0	Domestic - Withdrawal	WERSCHNER E	SASKATOON	27-Oct-72
NE1/4-15-36-4-W3M	65.5	0.0	Research - Water Test Hole	SASK RESEARCH COUNCIL	SUTHERLAND	16-Nov-61
SW1/4-16-36-4-W3M	9.1	6.1	Domestic - Withdrawal	POPOFF G G	SASKATOON	12-Oct-61
SW1/4-16-36-4-W3M	6.1	0.0	Domestic - Withdrawal	MALNESS SCHOOL UNIT	SASKATOON	
SW1/4-20-36-4-W3M	62.8	3.0	Irrigation - Withdrawal	HILL CREST GARDENS	SASKATOON	12-Jun-62
SW1/4-29-36-4-W3M	14.6	1.8	Industrial - Withdrawal	WELLS CONSTRUCTION	SASKATOON	28-May-69
SW1/4-29-36-4-W3M	13.7	2.1	Industrial - Withdrawal	WELLS CONSTRUCTION	SASKATOON	28-May-69
NE1/4-20-36-4-W3M	128.0	0.0	Domestic - Water Test Hole	BOYCHUCK FRED	SASKATOON	25-Aug-74
NE1/4-20-36-4-W3M	61.0	24.4	Domestic - Withdrawal	BOYCHUCK FRED	SASKATOON	23-Aug-74
NE1/4-22-36-4-W3M	30.5	0.0	Domestic - Withdrawal	FARKAS GERALD	SASKATOON	14-May-75
NW1/4-33-36-4-W3M	30.5	12.5	Domestic - Withdrawal	BESENKI R H DUFFY	SASKATOON	16-Jun-76
NW1/4-33-36-4-W3M	10.1	0.9	Domestic - Withdrawal	STURN JOHN	SASKATOON	17-Jun-76
NE1/4-32-36-4-W3M	10.7	0.0	Domestic - Withdrawal	IMPERIAL OIL RESOURCES	CALGARY	17-Nov-76
NW1/4-16-36-4-W3M	18.3	0.0	Domestic - Withdrawal	CREIGHTON HOLDINGS	SASKATOON	15-Apr-77
SW1/4-32-36-4-W3M	48.2	4.6	Domestic - Withdrawal	PARAGON FARMS	SASKATOON	30-May-77
SE1/4-9-36-4-W3M	19.2	0.0	Domestic - Water Test Hole	LAVIRE ROBERT	ASQUITH	1-Jul-78
SE1/4-22-36-4-W3M	25.0	0.0	Domestic - Water Test Hole	BLACKLOCK BOB	SASKATOON	22-Jul-79
SE1/4-22-36-4-W3M	21.9	0.0	Domestic - Withdrawal	BLACKLOCK BOB	OUTLOOK	30-Jul-79
NE1/4-20-36-4-W3M	26.2	0.0	Domestic - Withdrawal	BOYCHUK FRED	SASKATOON	20-Aug-79
SE1/4-17-36-4-W3M	12.8	0.0	Domestic - Water Test Hole	PIPPIN ALLAN	SASKATOON	23-Feb-81
NE1/4-32-36-4-W3M	15.2	0.0	Domestic - Withdrawal	RACHEY MORRIS		27-Jul-82
NE1/4-32-36-4-W3M	16.5	0.0	Domestic - Withdrawal	HAMOLINE MARK		6-Aug-82
SE1/4-27-36-4-W3M	15.2	0.0	Domestic - Withdrawal	CURTIS FRANK	SASKATOON	11-Jul-84
SE1/4-22-36-4-W3M	18.6	6.7	Domestic - Withdrawal	BLACKLOCK AUCTIONS	SASKATOON	22-May-84
NW1/4-22-36-4-W3M	10.4	0.0	Domestic - Withdrawal	CHASTAKOFF EVELYN	SASKATOON	2-May-85
SE1/4-22-36-4-W3M	19.8	9.1	Domestic - Withdrawal	READER JIM	SASKATOON	14-Jul-86
SW1/4-32-36-4-W3M	48.8	7.6	Domestic - Withdrawal	PICHLER DOUG	SASKATOON	14-Oct-86
NW1/4-19-36-4-W3M	54.9	0.0	Domestic - Water Test Hole	TAYLOR BROTHERS CONCRETE	SASKATOON	12-Aug-87
NW1/4-19-36-4-W3M	50.3	3.0	Domestic - Withdrawal	TAYLOR BROTHERS CONCRETE	SASKATOON	15-Aug-87
SE1/4-32-36-4-W3M	22.9	19.8	Domestic - Withdrawal	ZIMMERMAN DWAYNE	SASKATOON	24-Aug-87
SE1/4-27-36-4-W3M	8.5	0.0	Domestic - Withdrawal	EPP TIM	SASKATOON	15-Jul-88
NW1/4-33-36-4-W3M	32.0	9.1	Domestic - Withdrawal	BROWN JAKE	SASKATOON	16-Nov-88
NE1/4-9-36-4-W3M	15.2	3.0	Domestic - Withdrawal	MILNE CORTNEY	SASKATOON	10-Oct-89
21-36-4-W3M	75.0	0.0	Domestic - Water Test Hole	BICKNER RUSS	SASKATOON	14-Sep-90
21-36-4-W3M	30.5	0.0	Domestic - Withdrawal	BICKNER RUSS	SASKATOON	13-Sep-90
NE1/4-8-36-4-W3M	33.5	0.0	Domestic - Withdrawal	FRANCIS ROBERT	SASKATOON	14-May-92
SW1/4-29-36-4-W3M	9.1	0.0	Domestic - Withdrawal	LUX CONSTRUCTION LTD	SASKATOON	20-Oct-92
SE1/4-22-36-4-W3M	54.6	0.0	Domestic - Withdrawal	R D AGRO SERVICE LTD	SASKATOON	16-May-96
SW1/4-27-36-4-W3M	21.3	8.2	Domestic - Withdrawal	ANTOSH WES	SASKATOON	18-Jun-97
NW1/4-27-36-4-W3M	61.0	0.0	Domestic - Water Test Hole	CANITZ BLAINE	SASKATOON	27-Oct-99

Note: * at time of completion.

2.1.3 Landforms

The landforms in the area consist of glacio-lacustrine plains and glacio-lacustrine hummocky plains. The landforms in the study area have been shown on Drawing Three (3).

Existing mapping, assessment of aerial photographs and a site reconnaissance indicated the presence of numerous localized topographic depressions, which may pond water. Two of the depressions along the east border of the study area have small outlet channels that flow to the east.

2.1.4 Geotechnical Considerations

2.1.4.1 Soil Stratigraphy and Groundwater

The general soil stratigraphy in the study area consists of up to 10 m of silts and clays overlying till. In some of the study area, till will be located at surface. There may also be areas that may have in the order of 10 m of sand and silt overlying till.

The study area is located outside the mapped area of a known cobble/boulder lag; however, till deposits are known to contain cobbles/boulders, either in random distributions or in concentrated layers. **The area generally appears to be suited for development/ construction.**

The water levels in the shallow aquifers appear to be between 2 m and 10 m below ground surface and between 10 m and 20 m below ground surface for the deeper aquifers. Water levels may be higher in some of the surficial silts, sands, and gravels, which exist in the study area, and in the vicinity of water-filled depressions.

2.1.4.2 Foundation Considerations

The surficial soils should generally be capable of supporting lightly loaded structures. Heavier loads or structures which are sensitive to movements could be supported on piles founded on/in the tills.

All foundations should be provided with adequate subsurface drainage for the local conditions. Where surficial gravels, sands, and silts are encountered, they could potentially produce significant flows into excavations, depending upon the amount of precipitation and ponded water in the area, which will recharge these strata with water.

2.1.4.3 Slope Stability

The natural slopes in the area appear to be stable, as the area has relatively low relief.

2.2 NATURAL RESOURCES

Agricultural activity and various commercial activities have continued to intensify land use and cause habitat losses in the study area in recent decades. The Natural Resources component of the East Sector study involved a two-step process in the identification and evaluation of remnant natural habitats; an initial overview using available information, followed by field reconnaissance (summer, 2005) to update and confirm conditions. The initial overview was based on:

- Review of the 1992 Natural Areas Inventory;
- Examination of 1:50,000 topographic maps;
- Interpretation of aerial photography (ca. 2000);
- Interpretation of 2001 ASTER satellite imagery.

A total of 75 natural area remnants were identified in the first step (Drawing 4). The majority of these are quite small, shallow, scattered depressions consisting of ephemeral, sedge dominated wetlands ringed by shrubs and aspen poplars. The remnants were grouped as follows:

2.2.1 Type 1

These 61 sites were deemed to be of low priority for additional consideration, due primarily to their size and anticipated condition. This initial conclusion was confirmed during the field reconnaissance, and measures to mitigate development impact on these sites are not considered warranted.

2.2.2 Type 2

The 12 sites in this group were considered to be of comparatively higher priority within the study area and were more closely examined during field reconnaissance. It was concluded that, although each of these sites exhibits detrimental effects from past and ongoing human activity, all continue to provide some natural habitat value, and also have some potential to be of ecological value.

It is therefore recommended that these sites receive further detailed evaluation prior to approval of individual neighbourhood concept plans. Consideration could be given at that planning stage to the potential for integration of all or a portion of these sites as natural green space within or adjacent future neighbourhoods

2.2.3 Type 3

These 2 sites were identified as relatively large depressions capable of supporting significant wetland habitats. However, closer examination confirmed that they have in recent years been hayed and / or cultivated on a regular basis. Consequently, as with the Type 1 sites, mitigation is not considered warranted.

2.3 HERITAGE RESOURCES

The Heritage resources review is intended to highlight, in a preliminary fashion, archaeological, paleontological and historical resources that may affect development opportunities. Drawing 5 Heritage Resources and Sensitivity provides a summary of the areas of importance to the East Sector.

2.3.1 Scope

This heritage screening is required to provide information on several key aspects of the project. Accurate baseline information is required to describe the existing environmental conditions in the project area. Thorough knowledge of existing conditions in the project corridor is required to predict the potential impacts of the project on the environment and heritage resources. The primary steps required for the completion of this section of the Screening Report are as follows:

1.0 Review of regulatory requirements
2.0 Review of existing information;
3.0 Identification of data gaps; and, documentation of information required to fill data gaps.

This initial screening level is designed to identify any "red flags" that could affect the completion of a project. The information collected will provide the necessary details to help project engineers and planners avoid/reduce conflicts with significant heritage resources in the East Sector.

2.3.2 Background

2.3.2.1 The Heritage Property Act

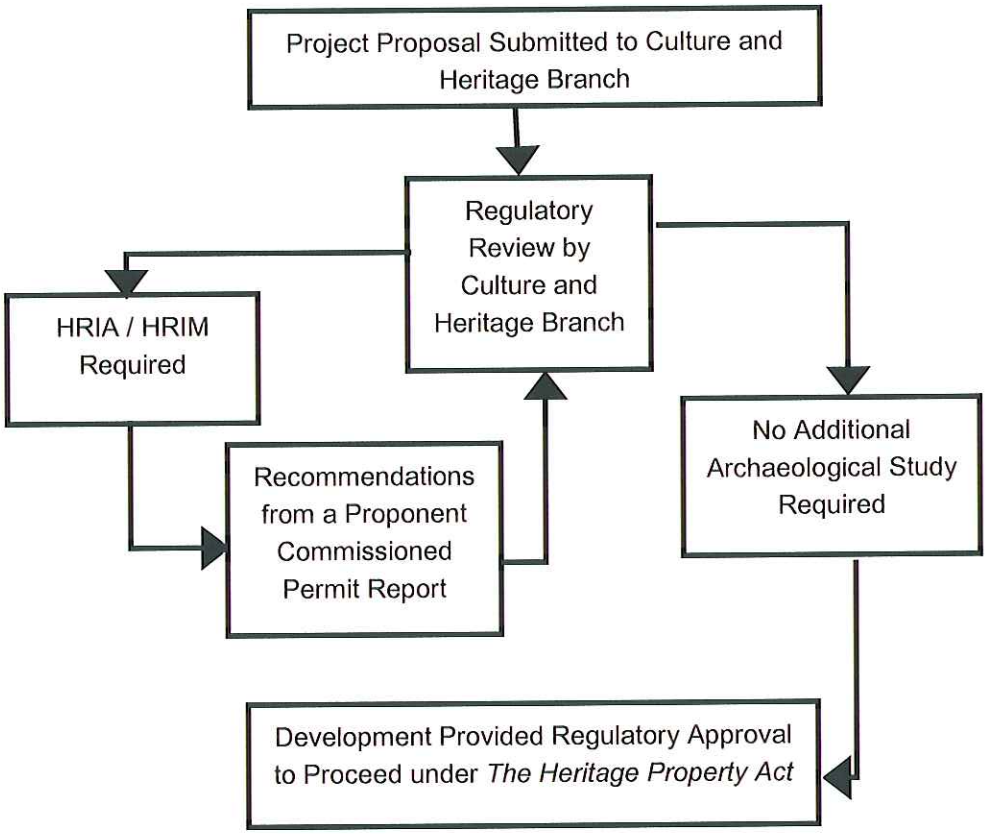
Heritage resources as defined under *The Heritage Property Act* include all of Saskatchewan's historic and precontact archaeological sites, architecturally significant structures, and paleontological resources. As per Section 66 of *The Heritage Property Act* all heritage resources on privately owned land, Provincial Crown Land and those Prairie Farm Rehabilitation Administration lands that are leased from Saskatchewan Agriculture and Renewable Resources are considered to be property of the Crown. These sites are managed by the Culture and Heritage Branch at the Department of Culture, Youth and Recreation. Cultural resources on Federal Lands are protected under the *Canadian Environmental Assessment Act* and to a limited degree by the *Indian Act* and are administered by the Archaeological Services Branch at Parks Canada.

Section 63 of *The Heritage Property Act* empowers the Minister to require a developer to conduct a heritage assessment for any project that has the potential to impact significant heritage resources. It is the responsibility of the developer to submit all proposed development plans for regulatory review; developers are obligated to commission a

qualified archaeologist to conduct any required assessment or mitigative procedures. Figure 2-1 outlines the regulatory review process.

There are several general types of assessment requirements (or combinations thereof) the Culture and Heritage Branch may assign during a review. The most common requirement is a pre-construction Heritage Resources Impact Assessment (HRIA). In some situations, a post-impact assessment may be recommended. If construction activities occur in winter conditions where a pre-construction HRIA is not possible, a heritage monitor may be recommended to be on site to observe activities in sensitive areas. Finally, if construction activities are planned to impact a known significant heritage resource, a Heritage Resource Impact Mitigation (HRIM) may be required. Normally, mitigation involves salvage excavation and/or intensive feature mapping and surface collection.

Figure 2-1
Culture and Heritage Branch Project Review Process
(Adapted from Germann and Spurling 1986; Business Services Improvement Branch 2001)



2.3.2.2 Regulations

The majority of the East Sector Study Area has never been examined by a professional archaeologist. Following the screening criteria developed and maintained by the Culture and Heritage Branch, locations within the corridor were classified according to their heritage and paleontological sensitivity. Heritage sensitivity was ascertained through analysis of 1:50 000 topographic maps, air photos, locations of previously recorded sites, and prior experience with the study area. Based on the collected data, all locations within the corridor were considered for their potential to contain significant heritage sites. In accordance with Saskatchewan archaeological guidelines and standards, site significance rankings are based on the following criteria:

- Site of a Special Nature designation;
- Presence of cultural features, diagnostic artifacts and tools;
- Aerial extent of the occupation;
- Density of cultural deposits;
- Age of cultural deposits; and,
- Uniqueness of the cultural deposits.

All locations considered having a high to moderate potential to contain unidentified heritage resources were identified in consultation with the Culture and Heritage Branch at the Department of Culture Youth and Recreation (File No. 05-128). According to their guidelines, locations adjacent to major water bodies such as lakes and streams, hummocky terrain and significant landscape features are considered to have a high potential to contain significant archaeological deposits. In contrast, flat, featureless terrain is considered to be of low heritage potential.

2.3.2.3 Cultural Setting

Previous archaeological investigations in the Saskatoon region and on the Northern Plains have documented the presence of people living in the region for at least 12 000 years. The archaeological history of the Saskatoon region is divided into three major periods: the Early, Middle and Late Precontact Periods (see Dyck 1983, Linnamae *et al.* 1988, and Walker 1999). (Table 2-2) These correspond to phases of cultural development that are marked by changes in the weapon systems used, but also reflect complex cultural evolutionary processes that include major technological advances. Archaeologically, the different nomadic and semi-nomadic hunters and gatherer cultures that occupied the Northern Plains are defined by the presence of diagnostic projectile point and ceramic vessel styles.

Table 2-2
Archaeological Cultures of Saskatchewan (after Meyer 1993; Dyck 1983)

RADIOCARBON YEARS BEFORE PRESENT	PERIOD	PLAINS/PARKLANDS CULTURES
1000	Late Precontact	Mortlach Phase Old Women's Phase
2000		Avonlea Phase Besant Phase
3000	Middle Precontact	Pelican Lake Phase
4000		McKean Complex
5000		Oxbow Phase
6000		Mummy Cave Series
7000	Early Precontact	Terminal Paleoindian Complex
8000		Cody Complex
9000		Hell Gap Phase Agate Basin Phase
10 000		Folsom Complex
11 000		Clovis Complex

During the Early Precontact Period, dating between 11,500 - 7500 B.P., highly nomadic hunting groups are thought to have employed long throwing or thrusting spears to hunt the big game animals of the region. Initially these people appeared to focus on the utilization of the large megafauna of the Late Pleistocene, primarily mammoth. However, with the disappearance Pleistocene species, bison became the main prey. Stone spear points associated with occupation during this period are distinctive; they generally lack notches and are larger and longer than during later periods.

The early portion of the Middle Precontact Period (7500 - 2400 B.P) coincides with a warm, dry period known as the Altithermal climatic interval. During this Period there was an increase in the mean annual temperature and a decrease in precipitation. For the first time, projectile points exhibit side and corner notches near their base, allowing them to be more securely bound to wooden shafts. These are believed to be associated with a delivery system known as the "atlatl", which increased the speed and thrust of the projectile by increasing the length of the throwing arm. Atlatl dart points are typically smaller than the spear points of the Early Precontact Period; they are assumed to have tipped long, feather-fletched wooden shafts.

Along with the atlatl/dart weapon system, the Middle Precontact Period saw the development of several cultural traits that persisted through the remainder of Plains prehistory (Reeves 1990). Chief amongst these is the use of large-scale communal hunting methods, which generated large meat surpluses and required complex processing and storage techniques such as the manufacture of pemmican. Other distinctive traits include the introduction of the tipi, as represented archaeologically by distinctive stone circle features.

The beginning of the Late Precontact Period (2400 - 200 B.P.) coincides with the appearance of several new technological advances to the material culture of the region. Changes in hunting equipment include the replacement of the atlatl by the bow and arrow. This is recognized archaeologically by a reduction in the size of the projectile point, especially around the neck, because the arrow shaft is necessarily smaller in diameter than the atlatl dart shaft. The bow and arrow allowed for more effective exploitation of bison because of its superior rate of fire, accuracy and the fact that no startling body movement is necessary to deliver the weapon (Reeves 1990).

Other developments during this time include the manufacture and use of ceramic vessels (Meyer 1993). The introduction of ceramics into southern Saskatchewan occurred at approximately 2000 B.P. by groups with ties to the Middle Missouri River system. A second introduction took place approximately 1500 years ago from the eastern woodlands through the boreal forest.

The transition from the archaeological record to the historic record is virtually unknown in the Saskatoon region, making it difficult to show continuity between the two periods

(Linnamae *et al.* 1988). However, the early fur trade journals indicate central Saskatchewan was clearly utilized by several aboriginal groups who were engaged in the fur trade, while maintaining a lifestyle of bison hunting (Russell 1988, 1991).

European settlers in the Saskatoon region began to take permanent residence in the early 1800s. The Temperance Colony was granted a tract of land in 1882 and the first settlers build sod houses or lived in tents. Although the Temperance Colony had limited success in attracting large numbers of people, other settlements including Nutana and Riverdale (Riversdale) were well established by the early 1900s. With the influx of urban settlers to the region matched by a spectacular growth in rural areas; much of the study area was broken for agricultural purposes in the first decades of the 1900s.

2.3.3 Sensitivity Rating

Following the criteria of the Culture and Heritage Branch, sensitivity rating is based on three main factors: nature of the development (disturbance to soils and sediments), significance of previously documented heritage resources, and the potential for additional undocumented heritage resources to be identified within the local topography.

2.3.3.1 Development Types

The future growth of the City of Saskatoon into the East Sector study area will dramatically alter the landscape. Developments such as housing, roads, commercial areas, parks, and associated infrastructure generally involve large amounts grading, trenching, excavation, and land recontouring.

These alterations may involve the displacement of artifacts resulting in the loss of valuable contextual information, or the destruction of the artifacts and features themselves, resulting in the complete loss of important heritage information. For this reason, appropriate investigation is required prior to development in accordance with the screening process as outlined in Section 2.3.1.

2.3.3.2 Previous Archaeological Investigations

The study area occurs on NTS map sheets 73 B/1 and 73 B/2. There are 265 archaeological sites on file with the Culture and Heritage Branch for these map sheets (Table 2-3).

Table 2-3
Site Types Recorded for Map Sheets 73 B/1 and 73 B/2

Site Type	Number of Site
Artifact Find	84
Artifact Scatter	126
Artifact/Feature Combination	27
Midden	3
Multiple Feature	1
Recurrent Feature	6
Single Feature	3
Site of Special Nature	7
Unknown	8
Total	**265**

The majority of the known sites are artifact scatters and artifact finds. Artifact scatters are likely the result of campsites that range in date from approximately 11, 500 years ago to the historic period. Other significant sites include bison kills and processing sites. Multiple feature and recurrent feature sites include features such as stone circles. Stone circles are likely the remains of campsites where cobbles were utilized to hold down the flaps of tipis. Sites of Special Nature include human burials, medicine wheels and rock alignments. They are provided with special protection under Section 64 of The Heritage Property Act.

Within the East Sector study limits there has been one permit issued to complete an archaeological assessment (Table 2-4). This assessment was completed in 1983 on behalf of the City of Saskatoon for their 10 year growth plan (Walker 1983).

Table 2-4
List of Archaeological Investigation Permits Issued within the Study Area

Permit Number	Reference
83-017	Walker 1983

Walker's 1983 assessment included approximately 33 ha (~ 1%) of the East Sector study area. This included 15 ha in SW-29-36-4 W3M and 18 ha in the NE-19-36-4 W3M. One archaeological site was identified within the East Sector. The portion of a white chert projectile point was recovered from the surface of the reconnaissance in NE-19-36-4 W3M. Subsurface shovel tests were excavated, but no intact occupation layer or any additional artifacts were identified. Walker (1983) recommended that no further archaeological work be required at this location. However, information regarding this site remains incomplete and does not meet the current standards of the Culture and Heritage Branch. A

Saskatchewan Archaeological Resource Record form was not completed and this site was not assigned a Borden Number. As a result, the exact provenience of the site remains unknown.

There are no other previously recorded heritage resources located within the East Sector Study Area study area. This includes federal, provincial or municipal heritage designations as well as cultural resources on federal lands that are not covered under *The Heritage Property Act* such as Prairie Farm Rehabilitation Act or Indian Reserves including those acquired under Treaty Land Entitlement.

2.3.3.3 Moderate to High Heritage Sensitivity

Based on the screening criteria and consultation with the Culture and Heritage Branch (File No. 05-128) two locations within the study area exhibit moderate to high sensitivity for heritage resources (Drawing 5, Table 2-5).

Table 2-5
Areas of Moderate to High Sensitivity within the Study Area

Location	Heritage Sensitivity
LSD 16-19-36-4 W3M	Moderate to High
LSDs 4 and 5-10-37-4 W3M	Moderate to High

In LSD 16-19-36-4 W3M, one previously documented archaeological site has been discovered (Walker 1983). The site is situated in terrain characterized by undulating topography surrounded by several small to moderately sized wetlands. Although limited archaeological study was undertaken at this site, the investigation does not meet current standards with regards to recording and documenting archaeological materials in Saskatchewan. The Culture and Heritage Branch may require additional archaeological assessment to ascertain the integrity of this site before any development is to proceed at this location.

LSDs 4 and 5-10-37-4 W3M are considered to have moderate to high archaeological sensitivity based on the presence of a previously recorded archaeological site in that Quarter Section. FaNo 11 is located on the slope of a gentle hill at the western edge of the Strawberry Hills. The site was recorded in 1978 prior to the inception of *The Heritage Property Act* in 1980. As a result, the site has never been assessed by a professional archaeologist and its scientific significance cannot yet be determined. The Culture and Heritage Branch may require additional archaeological work at this location prior to any further developments.

2.3.3.4 Low Heritage Sensitivity

The Culture and Heritage Branch has determined that the **remaining areas within the East Sector study area are of low heritage sensitivity.** These areas consist largely of flat to rolling terrain that has been previously disturbed by cultivation. It is not anticipated that formal HRIA will be required in these locations.

Although this area is considered by the Culture and Heritage Branch to have low heritage sensitivity, there remains the possibility that significant, intact archaeological components may exist. If cultural materials are identified at any time within the study area, they must be reported to the Culture and Heritage Branch and further assessment and/or mitigation may be required.

2.3.3.5 Paleontological Sensitivity

Pleistocene gravels exposed in gravel pits, commercial excavations, and road cuts in the Saskatoon region are well known for their paleontological resources (Heritage Branch 1989, Skwara 1988). However, none of these have been previously reported within the study area limits; as a result, no paleontological materials have been identified in the East Sector. As the study area is well removed from the known deposits of paleontological materials, the sensitivity of the region is considered low.

2.3.4 Summary and Recommendations

A review of the East Sector was completed to determine whether a formal HRIA was required in advance of proposed developments in this region. **Two small portions of the study area occur in terrain considered to have a moderate to high potential to contain undocumented heritage resources:** LSD 16-19-36-4 W3M and LSDs 4 and 5-10-37-4 W3M. Despite being located in cultivated fields, little is known about these two sites and it is difficult to adequately define their significance without additional study. As a result, **the Culture and Heritage Branch may require a HRIA on these locations in advance of any development.**

The remaining portions of the East Sector have been classified as low heritage potential. Therefore, **additional archaeological assessment will not likely be required for the vast majority of the study area prior to development activities occurring on these lands.** There still remains a possibility that archaeological or paleontological materials may be identified during the development of these properties. As all archaeological and paleontological materials are protected, they must be reported to Culture and Heritage Branch in a timely fashion to determine if additional study is warranted.

It is recommended that a formal Heritage Resource Review be obtained from the Culture and Heritage Branch once the developments plans are finalized. The Culture and Heritage Branch will evaluate the development and determine the nature and scope of any HRIA that may be required.

Depending on the results of the HRIA, additional work, including mitigation of any significant archaeological or paleontological sites may be necessary.

2.4 LAND USE

2.4.1 Land Use Program

This section of the report summarizes the land use requirements to be addressed and incorporated into an assessment of the feasibility of developing and servicing a new suburban development area in the East Growth Sector identified in the *1999 Future Growth Study*[3].

The City of Saskatoon Development Plan (referred to here as the *Development Plan*) sets out the policy context for the make-up of such suburban development areas. This policy context and supplementary descriptions of the intended land use components of a suburban development area, are noted below.

2.4.1.1 Suburban Development Areas

According to the *Development Plan* (Section 3.1.2 f), *"Long range planning for neighbourhoods and community facilities shall be organized within the context of Suburban Development Areas. Suburban Development Areas contain approximately 8 to 10 neighbourhoods and the housing and community facilities necessary to accommodate about 50,000 people."*

- Anticipated extent: approximately1,600 ha (4,000 acres) plus areas required for suburban centre and employment centre

2.4.1.2 Suburban Centres

As stated in the Development Plan (Section 3.1.2 g), *"Suburban Centres are the primary mixed use focal point for a Suburban Development Area, providing commercial, institutional and recreational lands and activities serving the basic needs of the Suburban Development Area population. Medium to high density residential development is encouraged within Suburban Centres. Suburban Centres shall be designed as comprehensively planned areas, promoting a compatible integration of land uses and development densities."*

- Anticipated extent: 60 - 80 ha (150 - 200 acres)
- Key location considerations: readily accessible to all parts of the Suburban Development Area by way of arterial roads and public transit

[3] Ibid. (1-1)

- Key land use components:
  - Medium density (20 - 50 units / acre) to high density (more than 50 units / acre) residential development
  - Suburban Centre Commercial (Section 6.2.1 of the *Development Plan*):
    - Suburban Centre Commercial Areas provide a broad range of shopping centre services and associated commercial activities necessary to meet the needs of the population within the Suburban Development Area (SDA). The land area shall be determined by:
    - the needs of the SDA population
    - the supply and demand for retail and commercial space on a City-wide basis
    - the potential effect on the viability of downtown retail development
  - A Suburban Centre Commercial Area shall form part of the Suburban Centre, and shall be readily accessible to all parts of the SDA by way of arterial roads and public transit
  - anticipated extent: 8 - 12 ha (20 - 30 acres)
  - Institutional: intermixed with residential; no preconception of anticipated relative balance between these uses; total area: 50 - 70 ha (125 - 175 acres)
  - Parks and Open Space (Multi-District Park) (from COS Park Development Guidelines):

    Purpose:
    - to serve the complementary activities associated with a suburban recreation complex
    - to serve leisure requirements not otherwise stated by Neighbourhood and District parks

    Function:
    - provide a variety of active and passive recreation activities in all seasons of the year
    - provide siting for a suburban recreation complex
    - provide siting for official competition sized sports fields and facilities adequate for national / international athletic events
    - accommodate sports spectators
    - allow programming for uses not found in neighbourhood or district parks (e.g. cultural facilities, multi-purpose leisure centre)

Size:

- minimum 16 ha, minimum one per suburban development area; may be dispersed over more than one site

Location:

- multi-district land associated with a suburban recreation complex to be in close proximity to the commercial portion of the suburban centre, to minimize traffic disruptions in residential neighbourhoods and create the opportunity for joint-use of parking facilities
- multi-district land associated with active recreation uses to be in close proximity to the commercial portion of the suburban centre, or in an industrial area, or in a parcel surrounded by arterial roads and/or non-residential use, to minimize traffic disruptions in residential neighbourhoods and allow for elements no suitable for residential areas (e.g. floodlighting sports fields)
- location of multi-district land associated with passive uses is discretionary

Site Access, Visibility and Frontage:

- 100 per cent visibility of site interior from park / street boundaries, but not necessarily from any one point on the boundary
- site boundaries to have 50 per cent street exposure
- parking to be provided, quantities according to programming, with access from a collector street

2.4.1.3 District Commercial

"*District Commercial Areas provide a focal point for commercial and mixed use activity, at a smaller scale than the Suburban Centre, serving from two to five neighbourhoods. Medium density housing and related commercial services are encouraged to locate in and near District Commercial Areas. District Commercial Areas shall be oriented to serve automobile traffic or pedestrian traffic, with appropriate development standards depending on the specific nature of the area involved.* (*Development Plan*, Section 3.1.2 h)

- Likely 2 - 3 district commercial development areas
- District commercial not integrated with other district facilities (residential, educational and park / open space development areas)

- Key Land Use Components:

  - <u>District Commercial</u> Areas are intended to provide a level of service and a range of commercial uses above that found at the neighbourhood level, but less than that found at the Suburban Centre Commercial Area. Possible uses include retail stores, restaurants, service stations, small shopping

centres, medial clinics and related health services. District Commercial Area shall be of a size sufficient to serve the needs of from two to five neighbourhoods.

- District Commercial Areas shall generally be located at the intersection of arterial roads or collector roads, and shall be in close proximity to existing or planned public transit routes. (*Development Plan*, Section 6.5.1)
- anticipated extent:
  - 1 ha+/- for each

- Parks and Open Space (District Park) (from COS Park Development Guidelines):
  - Purpose:
    - to serve active and passive recreational needs of residents of four to five neighbourhoods
    - may serve athletic needs of high schools
  - Function:
    - accommodate inter-neighbourhood sports leagues for youth and adults
    - accommodate community-wide events (e.g. outdoor concerts)
    - accommodate informal recreational activities
    - accommodate passive recreational activities
  - Size:
    - average dedication of 5.2 ha per (standard) neighbourhood (i.e. 21,000 m collectable frontage); a district park typically serves 4 neighbourhoods, giving a total of 20.8 ha
  - Location:
    - close to centre of catchment area served
    - District and Neighbourhood parks to be separate from each other
    - on arterial or collector streets with City transit service
  - Site Access, Visibility and Frontage:
    - 100 per cent visibility of site interior from park/street boundaries, but not necessarily from any one point on the boundary
    - site boundaries no abutting school property to have 50 per cent street exposure

- parking to be provided, quantities according to programming, with access from a collector street

- Residential:
  - medium density housing (15 - 35 units / acre)
  - 2 - 4 two high schools in entire SDA

2.4.1.4 Employment Area

- Anticipated extent: 180 -200 ha

- Key location considerations:
  - readily accessible to all parts of the Suburban Development Area by way of arterial roads and public transit
  - shipping / other transportation linkages are important (major highway / perimeter road in proximity)

- Key land use components:
  - light (IL1) industrial and office (IB) commercial development, with more of the former than of the latter

2.4.1.5 Residential Neighbourhoods:

- likely 8 - 10 neighbourhoods total
- each neighbourhood 180 - 200 ha in extent
- development density of at least 12.5 dwelling units per gross ha

2.4.2 Land Use Factors Affecting Development

The final report of the *1999 Future Growth Study*[4] outlines relevant land use and other variables that have the potential to affect future development in the East Sector. Because of changes to East Sector boundaries and land use / ownership changes in the Sector since 1999, Drawing 6, was prepared to highlight those land use factors currently considered to have the potential to affect decisions regarding future development in the Northeast Sector. These factors are discussed briefly below:

2.4.2.1 University of Saskatchewan Agricultural Research Lands / Activities

Mr. Fred Kernen donated the Kernen Crop Research Farm (KCRF) to the University of Saskatchewan Department of Plant Sciences in 1977. The farm occupies 600 ha (1,280 acres) in Sections 5 and 8-37-4-W3M, immediately west of the study area boundary. Of

[4] Ibid. (1-1)

this, 450 ha (960 acres) are used for plant breeding, crop research and breeder seed production. One of the conditions of Fred Kernen's gift of this land to the University was that the cultivated land be used for crop research and that the 130-ha (320-acre) native prairie be preserved. Thus, two quarter sections in the Farm (NE and SE of Section 8, which abut the study area) remain as native fescue prairie (Kernen Ecological Reserve).

The Kernen Crop Research Farm is the main land base that supports the Crop Development Centre's plant breeding programs. Since its establishment in 1972, the Crop Development Centre (CDC) has released over 250 varieties of wheat, barley, oat, flax, canary seed, field pea, lentil, chickpea, dry edible bean, fenugreek, coriander and caraway, many of which have set national and international standards for quality.

These varieties generate between $700,000 and $800,000 in royalties each year. A further $250,000 is earned from the sale of Breeder Seed and $150,000 - $250,000 from the sale of commercial grain each year. The availability of this research land base helps the CDC and the Department of Plant Sciences attract approximately $8,000,000 in research funding each year.

In the mid-1980's the Department of Plant Sciences / Crop Development Centre purchased two other quarters of land to the immediate east of the Kernen Ecological Reserve (NW and NE of Section 9). This is referred to as the Sutherland Crop Research Farm. Most of this land and the KCRF are very uniform and ideally suited to field crop research and plant breeding operations for which they are primarily used.

According to the CDC, previous land use and crop rotation are extremely important to maintaining genetic purity of plant breeding material and to ensure that it does not become contaminated with seeds of other crops. Thus, plant breeding and crop research require a large land base with fields that are of equal size. Each year, plant breeding and research programs utilize a specific number of acres in a four-year rotation so a plant breeding or research program requires an allocation of land that consists of four equally sized areas. These areas need to be rectangular in shape because that is the most efficient way to arrange plots in the field.

Any intrusion into or disruption of research land areas that results in fields of unequal size or in fields of irregular shape will reportedly have a major negative impact on the CDC's ability to carry out its plant breeding and research programs. It is also reported that throughout the growing season, daily access is required to the research lands that involves the movement of large farm equipment, smaller plot equipment and many vehicles. CDC also indicates that, from time to time, they need to be able to treat all of their research land with insecticides or fungicides to protect valuable research and plant breeding material from insects and diseases. Quite often the most efficient way to do this is by aerial application.

In 2004, the College of Agriculture leased two partial quarter-sections northwest of Highway #41 (SE of Section 9 and NE of Section 4) for agricultural research purposes. This land is being made available to the Department of Plant Sciences / CDC. This land consists of two triangular parcels and so is not ideally suited to use for research because of its shape. Nevertheless, the proximity to their existing land base reportedly makes it a valuable addition to research infrastructure.

A spatial separation at least equivalent to the existing Highway 41 right-of-way should be maintained between U of S Agricultural Research Lands and other uses.

2.4.2.2 SuperDARN Radar Station

The SuperDARN Radar Station is located on the north east corner of the NE ¼ of Section 5 in the Kernen Farm area. The station emits a radar array used to conduct research into weather patterns in space. Each SuperDARN station is paired with another to monitor 4 million sq. kms. There are ten such stations in the northern hemisphere, which are operated by other entities and Universities. Seven other installations operate in the southern hemisphere and more are planned with the objective that there will be a global network of 30 radars.

Substantial research grants are received annually by the University of Saskatchewan from NSERC and the Canada Space Agency. The University of Saskatchewan is a key centre for the network, being the Canadian headquarters for Canadian radar operations as well as the international SuperDARN Data and Copy Control Centre responsible for the release of all scientific interpretation of data generated by the network.

The University of Saskatchewan SuperDARN Radar Station emits a 52 degree wedge pattern with the midline at 23° east of geographic north. Eight beamlines are emitted to the east and west of midpoint. Traffic flow, dense urban development, structures constructed with metal, etc. would interfere with the operation of the radar. To reduce interference from traffic flow, Perimeter Road north of Highway 41 should provide a 2.4 km separation from the station. The station could affect residential and other land uses, which have consumer electronics such as TVs, computers, etc.

The portion of the study area that would be affected by the radar band is currently designated as highly constrained (U of S Agricultural Research Land). Based on this, the SuperDARN Radar Station is not expected to be a land use constraint for development areas identified on Drawing 7.

2.4.2.3 Non-Agricultural Uses / Development Proposals

Three "clusters" of non-agricultural development exist within the study area. The first is located along the north side of the rural municipal grid road, which is an eastward

extension of 8th Street (in SW-29-36-4-W3M.). This cluster contains a mix of office commercial and light industrial uses, as well as the City of Saskatoon Nicholson Yards. Just south of these uses (in NW-20-36-4-W3M), a SaskTel cellular telephone network tower has been erected.

Near the intersection of Highway #5 and Highway #41 (in NE-32 and NW-33-36-4-W3M) is a cluster consisting of highway commercial agricultural service uses along with a drive-in theatre.

Near the intersection of McOrmond Drive and Highway #5 (in SE-31-36-4-W3M), Wilson's Greenhouse has developed a garden centre and driving range and has applied for a development permit that would see development of a golf course, RV park and associated facilities.

None of these non-Agricultural land uses or development proposals is considered a major constraint with respect to future urban development, although it is anticipated that development plans will need to recognize the needs of the cellular telephone network. Indeed, depending on ultimate plans for urban uses and development, it may be possible that some of the existing uses (especially those in close proximity to Highway #5) could continue into the long-term future.

2.5 TRANSPORTATION

The East Sector development will be primarily affected by Highway 5, Highway 41, the Canadian Pacific Railway, and the proposed Perimeter Road Corridor. However, no significant constraints appear to exist. There is no constraint related to the SuperDARN Radar installation if Perimeter Road north of Highway 41 is developed to provide a 2.4 km separation. There is a private airstrip on Paragon Farms land in Section 32 near Highway 5 that is also non-constraining.

The *Saskatoon Long Term Transportation Planning Study* identified two potential interchanges along the proposed Perimeter Road Corridor, at Highway 16 to the south, and Highway 5 to the north. It is also expected that an interchange will be required at a realigned Highway 41 further north, and at intermediate locations between Highways 5 and 16 to accommodated East Sector-related traffic needs.

The primary connection points to adjacent development areas include:

- College Drive, 8th Street, and Taylor Street to the west
- McOrmond Drive, Blackley (farm) Road to the north
- The future Perimeter Road running north-south along the east boundary of the East Sector

Analysis of development concepts in Section 4 will provide more detail regarding these areas.

2.6 UTILITIES

Based on the given Geotechnical conditions and the proximity of existing municipal service, utilities provision for the East Sector is not expected to be a significant constraining issue relative to development. However, there may be some storm water management influences on the relative arrangement of neighbourhoods and transportation corridors.

2.7 CONCLUSION

The analysis and summary of results of the terrain analysis, natural and heritage resources review and assessment of land use, transportation and municipal utilities resulted in determination of areas or "windows" of opportunity, as illustrated in Drawing 7.

Based on our review with the Steering Committee and other interested parties at the March 23, 2005 Design Charette, and August 29, 2005 draft review meeting, there are degrees of constraint that must be considered. Those most critical to the Steering Committee were considered to be the U of S Agriculture Research Lands, and the Future Perimeter Road Corridor.

The following conclusion statements were highlighted under Section 2 – Opportunities and Constraints.

- **Terrain Analysis** – The area generally appears to be suited for development/construction.

- **Heritage Resources** – Two small portions of the study area occur in terrain considered to have a moderate to high potential to contain undocumented heritage resources. The Culture and Heritage Branch may require a HRIA on these locations. Additional archaeological assessment will not likely be required for the vast majority of the study area prior to development activities occurring on these lands.

- **Land Use** – A spatial separation at least equivalent to the existing Highway 41 right-of-way should be maintained between U of S Agricultural Research and other uses. The portion of the study area that would be affected by the SuperDARN radar band is currently designated as highly constrained (U of S Agricultural Research Land). Based on this, the SuperDARN Radar Station is not expected to be a land use constraint for development areas identified on Drawing 7.

  None of the non-Agricultural land uses or development proposals is considered a major constraint with respect to future urban development, although it is anticipated that development plans will need to recognize the needs of the cellular telephone network. Indeed, depending on ultimate plans for urban uses and development, it may be possible that some of the existing uses (especially those in close proximity to Highway #5) could continue into the long-term future.

3 Development Concepts

3.1 DEVELOPMENT CONCEPTS

In March of 2005, the Project Steering Committee, along with a number of representatives from the City of Saskatoon Infrastructure Services, Lands, Transportation, Traffic, Planning and Parks Branches, University of Saskatchewan, the R.M. of Corman Park and the Consultants gathered together at a workshop to review the opportunities for and constraints to urban development in the East Sector. The goal of this day-long workshop was, once armed with the background information, to "brainstorm" a number of potential development concepts.

To facilitate this, the attendees were broken into four groups composed of individuals with diverse backgrounds and interests. This allowed for maximum interaction between interests and the consideration of pertinent development constraints through the exercise.

Each of the four groups presented their concepts graphically and through discussion with the workshop as a whole. The Consultants then lead discussions on all of the presented concepts and determined that there were two relatively different development concepts.

These concepts were refined and drafted to report form as illustrated by Drawing 8 and 9, Concept 1 and Concept 2.

The concepts included four designated land use development types. These are suburban centres (SC), residential neighbourhoods (N), employment areas (EA), and District Facilities. These land use types are described in Section 2.4.

4 Analysis Of Alternatives

4.1 TRANSPORTATION

4.1.1 Development Concepts

Two concepts have been prepared. Concept 1 has eight residential neighbourhoods, an employment area at the northeast portion of the study area, and a suburban centre near the centre of the study area, with residential neighbourhoods around it. There are two sets of District Facilities within the residential areas.

Concept 2 has nine residential neighbourhoods, an employment area at the south end with the employment area extending south of the study area boundary, and a suburban centre near the centre of the study area, with residential neighbourhoods around it. There are two sets of District Facilities within the residential areas:

The East Sector is bounded by major transportation facilities, with College Drive/Highway 5 and Highway 41 along the north, Highway 16 to the south of the study area, the proposed Perimeter Road Corridor along the east boundary, and a CPR line along the west. Existing City streets extend into the East Sector to provide the arterial street system. These include 8th Street (which continues through the sector in an east-west direction, Blackley (farm) Road, (which continues through the sector as an eastern arterial road in a north-south direction), and Taylor Street and McOrmond Drive (which extend into the Sector to either join or intersect with one another).

In terms of the general arterial concept, both appear workable. Both concepts have three arterial streets bounding the suburban centre, and major roads serve both employment areas.

Comments related to Concept 1 (Drawing 8) include:

- The employment area is served by Highway 5 and Highway 41; the peripheral location may minimize the intrusion of large trucks into the Sector, although there is no direct rail access
- The employment area is situated between the North East and East Sectors, allowing easy access from both
- The suburban centre is well situated with good arterial connections to the residential areas
- There are two arterial-arterial intersections within the residential areas, and five major intersections along the periphery
- The length of the internal arterial roads is 25 percent less than in Concept 2

Comments related to Concept 2 (Drawing 9) include:

- The employment area is served by the Perimeter Road and Taylor / McOrmond; the peripheral location may minimize the intrusion of large trucks into the Sector; there is the potential for direct rail access

- The suburban centre is well situated with good arterial connections to the residential areas
- There are three arterial-arterial intersections within the residential areas, and six major intersections along the periphery
- The length of the internal arterial roads is one-third greater than in Concept 1

4.1.2 Transportation Model

The consultant used the City of Saskatoon's TMODEL transportation planning model, as well as modelling files developed directly for the North East Sector study, as a base to develop the modelling for the East Sector study. The final files from Option 3 in the North East Sector study (13Febop3.lnx and 13Febop3.nde) were used as the starting point for the East Sector study.

The base case TMODEL has established land uses, trip generation rates, base road network, and PM peak hour traffic associated with a future population of 400,000 in the City of Saskatoon (the 400K scenarios). The consultant reviewed the model and modified it to update the land uses and the road network. Key issues in terms of land use and the road network are highlighted below. Additional technical details can be found in Appendix D: Transportation Model Input.

4.1.3 Land Use

In order to apply the planned land use densities and test maximum population in the East Sector for transportation (and to be consistent with population used for municipal service modelling) a population of 64,505 and employment of 4,950 was modelled in the East Sector. This is a higher population and a lower employment total than was modelled in the 2003 North East Sector Study (56,000 population and 7,000 employment). No open areas were assumed in calculating modelled population.

In order to maintain a 400K TMODEL, population and employment are transferred from other zones to the East Sector zones to make up the 64,505 population and 4,950 employment, rather than adding additional population and employment. The base model had 42,634 population and 1,418 jobs in the East Sector, therefore an additional 21,871 residents and 3,532 jobs were moved to the East Sector. As discussed with the COS, the population was primarily transferred from the North East Sector and the employment was transferred from Downtown and the North East Sector. Details of the land use transfer can be found in Appendix D.

The land use mix for employment land uses approximates target levels for Institutional (LU3), Commercial (LU4), Professional (LU5) and Industrial (LU6) in the East Sector transportation model. Due to existing land uses assigned to the East Sector base model, the proportion of single-family homes (LU1) is higher than multi-family homes (LU2). After land use transfers there are approximately 60% single-family homes and 40% multi-family homes in the East Sector. The target mix is approximately 45% single family and 55% multi-family homes. Since single-family homes have higher trip generation rates than multi-family homes, the higher proportion of single-family

homes in the model means that conservative (high) traffic estimates for the East Sector are tested in TMODEL.

The select zone feature in TMODEL is used to isolate traffic associated with the East Sector on the city-wide road network. In TMODEL nine zones (186-194) represent the nine neighbourhoods, one zone (195) represents the Suburban Centre and three zones (196-198) represent the employment Centre. Since Concept 1 only has eight neighbourhoods, zone 194 is empty in the Concept 1 model run.

The trip generation rates established for each of the eight TMODEL Superzones were applied using the methodology developed for the earlier North East Sector study. This methodology is described in Appendix D. The trip generation rates develop traffic volumes associated with each of the six land uses for each of the 228 traffic zones in the model.

4.1.4 Road Network

As the East Sector area of the City's transportation model was reviewed in more detail, several adjustments were made to the road network to better reflect the existing and future road network that will be required in the area. These network adjustments include:

City-Wide Road Network Issues

- In the base model, the road network in the Marquis Drive Industrial Area and near Agri Place has been set to 1km/h (i.e., closed to traffic or not built). However land use was still assigned to zones 1, 167, 171, 215, and 216 in this area forcing traffic to use the 1km/h roads. A minimal road network was set to speeds of 50 to 70 km/h (appropriate to the road classification in the model in order to facilitate access to the area and eliminate unrealistic delays).

- The turn penalty file was inspected and adjusted to eliminate traffic shortcutting through zone centroid connectors. It was also noted that in the base model originally received by the consulting team that some of the nodes in TMODEL were deleted, causing all of the 1600 nodes in the model to be renumbered. The turn penalty file that also prohibits particular turning movements such as u-turns on highway ramps was therefore also recreated for the East Sector model. Additional information is shown in Appendix D.

East Sector Road Network Issues

- Highway 5 was combined with Highway 41 on the east side of Saskatoon in the base model. Since Highway 5 will be a key route in the East Sector, the location where Highway 5 and Highway 41 diverge near the Perimeter Road is explicitly modelled. Fifty percent of the traffic using Highway 41 outside the City was transferred to Highway 5.
- The East Perimeter Highway Functional Planning Study was completed in June 2005, after the North East Sector Study. The currently planned alignment of the Perimeter Road near

Highway 5 and Highway 41 allows interchanges at both highways without realigning Highway 41. The TModel files from the East Sector Study were adjusted to reflect this change.

Interchanges are located at:

- Perimeter Road / Highway 41 as per the East Perimeter Highway Functional Planning Study. Current plans for Highway 41 will connect to the Perimeter Road on the east and west on its existing alignment (i.e. at the north edge of the East Sector.
- McOrmond / Highway 5 as per the City's 400K Population Transportation Network Improvement Plans.
- Highway 41 (Blackley Road Alignment) / Highway 5 to accommodate East Sector traffic.
- Highway 41 access to the East Sector (Employment area access in Concept 1 and Neighbourhood 9 access in Concept 2) to accommodate East Sector Traffic. This interchange may not be required should Highway 41 become a lower speed access road in the future (50 - 70 km/h). However, on the Study Drawings it is included, assuming Highway 41 will remain a 90-100 km/h facility.
- Perimeter Road / Highway 5 as per the City's 400K Population Transportation Network Improvement Plans.
- Perimeter Road / Highway 16 (Yellowhead) as per the City's 400K Population Transportation Network Improvement Plans – the separation between Highway 394 and Highway 16 is assumed to be east of the Perimeter Road and not explicitly included in the transportation model.
- Perimeter Road / 8th Street and / or Perimeter Road / Taylor Street at the north edge of Employment Area to accommodate East Sector traffic.

- An interchange at the Perimeter Road / Taylor Street connecting to the East Sector south of the CPR tracks in the Brookside area is not included since it would be within 700 metres of the Perimeter Road / Highway 16 interchange.

- Highway 5, 8th Street and McOrmond - Taylor are all assumed to be four lanes in order to facilitate access to the East Sector. Highway 5 and 8th Street were previously set at a single lane in each direction east of McOrmond.

- Highway 5 is assumed to be a 4-lane 90-100 km/h facility with a capacity of 3,000 vehicles per hour each direction (Class 2 or 5 link in TMODEL). Other roads in the East Sector (8th Street, Taylor, McOrmond, Eastern Arterial on Blackley Road alignment) are assumed to be 4-lane 70km/h facilities with a capacity of 2,400 vehicles per hour each direction (Class 116 links in TMODEL).

4.1.5 Concept Analysis

Alternative network scenarios were considered based on the two development concepts, but with different locations for future interchanges along the periphery of the sector in Concept 2. The two

concepts are compared based on traffic entering the East Sector, bridge traffic volumes, Perimeter Road traffic volumes and overall traffic speeds on the road network.

Comparison of Traffic Volumes Accessing the East Sector

Since the East Sector is located on the east side of the City, it is convenient for most drivers to access the area from the west, rather than from the Perimeter Road. Reasonable access from the west is provided on McOrmond Drive, Highway 5, and 8th Street. Taylor Street, being a 50km/h facility through a residential area provides a lower speed access. CPR tracks and existing neighbourhoods limit additional arterial access from the west. Highway 16 provides high speed additional access to the Perimeter Road on the south side of the East Sector, which is convenient in Concept 2 since the employment area is at the south of the sector.

Since Highway 5 is modelled as a 90-100 km/h limited access facility with interchanges at 2km spacing (McOrmond Drive, Hwy. 41-Blackley Road alignment and Perimeter Road), additional signals or interchanges on Highway 5 are not favoured. However, a new interchange was tested between Blackley Road and the Perimeter Road on Highway 5 to see if it would attract more traffic to use the Perimeter Road to access to East Sector. The interchange did not encourage traffic to re-route to the Perimeter Road and did not reduce traffic on Highway 5 west of McOrmond, and was therefore removed from the model.

Table 4-1 compares traffic volumes on routes entering the East Sector for Concept 1 and Concept 2. In Concept 1, due to the northern location of the employment centre, more traffic accesses the area on northern routes, especially Highway 5. The East Sector traffic accounts for substantially more westbound traffic on Highway 5 in Concept 1 (857 vehicles / hour) than in Concept 2 (535 vehicles / hour) since drivers heading west leaving work would use this route.

Concept 2 has higher volumes on the Perimeter Road at the south edge of the study area than Concept 1, since it provides more direct access to the Concept 2 employment area.

As shown in Table 4-1, both Highway 5 and 8th Street are operating at or slightly over capacity eastbound with a volume / capacity (v/c) ratio of 1.15 and 1.04, respectively for Concept 1 and v/c of 1.19 and 0.95 in Concept 2. For the screen line entering the East Sector, the eastbound v/c ratio is 0.74 and 0.75 for Concepts 1 and 2 respectively.

As a sensitivity analysis, Concept 1 was tested with three lanes in each direction on 8th Street east of Boychuck Drive (Con183L.LLX). Discussion with the City of Saskatoon indicates three lanes each direction on 8th Street is more realistic than on Highway 5. Three lanes on 8th Street increases the directional capacity of 8th Street from 2400 to 3600 vehicles per hour, but has a minimal effect on traffic routing on the road network. Since 8th Street is modelled with a speed of 70 km/h and Highway 5 is modelled with a speed of 90-100km/h in the East Sector, traffic does not transfer from the over-capacity Highway 5 to 8th Street. With three eastbound lanes on 8th Street, the v/c ratio is 1.18 on Highway 5, 0.66 on 8th Street and 0.69 for the screen line entering the East Sector. A summary table comparing Concept 1 with two and three lanes each direction on 8th Street can be seen in Appendix D.

Table 4-1
Traffic Projections For Roads (Screenline) Into East Sector

		Con1IC.LLX					Con2BIC.LLX (Emp. Cntr. I/C, No 8th St. I/C)				
Screenline Location	Travel Direction	Total Traffic	East Sector Traffic (1) Volume	% of Total	Modeled Capacity	Future V/C Ratio	Total Traffic	East Sector Traffic (1) Volume	% of Total	Modeled Capacity	Future V/C Ratio
McOrmond (N of Hwy. 5)	S Bound	2202	1692	76.8	3000	0.73	2350	1875	79.8	3000	0.78
	N Bound	2793	1408	50.4	3000	0.93	2749	1429	52.0	3000	0.92
	Two Way	4995	3100	62.1			5099	3304	64.8		
Highway 5	E Bound	3458	1840	53.2	3000	1.15	3560	2019	56.7	3000	1.19
	W Bound	1456	857	58.9	3000	0.49	1166	535	45.9	3000	0.39
	Two Way	4914	2697	54.9			4726	2554	54.0		
8th Street	E Bound	2488	2411	96.9	2400	1.04	2285	2173	95.1	2400	0.95
	W Bound	820	693	84.5	2400	0.34	898	765	85.2	2400	0.37
	Two Way	3308	3104	93.8			3183	2938	92.3		
Taylor St.	E Bound	1069	679	63.5	2400	0.45	1046	591	56.5	2400	0.44
	W Bound	708	361	51.0	2400	0.30	826	476	57.6	2400	0.34
	Two Way	1777	1040	58.5			1872	1067	57.0		
Perimeter Rd.	N Bound	1031	646	62.7	3000	0.34	1177	705	59.9	3000	0.39
	S Bound	671	318	47.4	3000	0.22	1103	725	65.7	3000	0.37
	Two Way	1702	964	56.6			2280	1430	62.7		
Total Above	Into E Sec.	10248	7268	70.9	13800	0.74	10418	7363	71.8	13800	0.75
	Out E. Sec.	6448	3637	56.4	13800	0.47	6742	3930	60.9	13800	0.49
	Two Way	16696	10905	65.3			17160	11293	67.6		

Notes 1. Zones 186-198

Concept 2 was tested with several different interchange configurations:

- Concept 2B includes an interchange at the Perimeter Road / Taylor Street on the north edge of the employment area and no interchange at Perimeter Road / 8th Street.
- Concept 2C includes an interchange at the Perimeter Road / Taylor Street and at Perimeter Road / 8th Street.
- Concept 2D includes an overpass across the Perimeter Road at Taylor Street and an interchange at Perimeter Road / 8th Street.

It should be noted that the Taylor Street Interchange or overpass provides the only access to the parts of the employment centre east of the Perimeter Road – the southern part is accessed via an overpass over the railway tracks. Due to the diverge in Highway 16 and Highway 394, just east of the Perimeter Road, it is conservatively assumed that direct access from Highway 16 to the employment area will not be available. As the interchange at the Perimeter Road / Highway 16 is planned, the option to provide access from

Highway 16 to the land located between the CPR tracks, the Perimeter Road and Highway 16 should be explored.

Table 4-1 shows Concept 2B together with Concept 1 and Table 4-1a shows Concept 2C and 2D. The interchange at Taylor Street / Perimeter Road encourages East Sector Traffic to use Highway 16 and the Perimeter Road rather than Taylor Street to access the East Sector. Concept 2B and 2C that include the Taylor Street interchange have 700-740 East Sector vehicles per hour each direction on the Perimeter Road (via Highway 16) compared to 115-290 for Concept 2D. Concept 2D has higher East Sector traffic (760-795 each direction) on Taylor St. compared to 470-600 each direction in each concept 2B and 2C. Residents in the Taylor Street area would likely prefer to see more traffic on the Perimeter Road and Highway 16 rather than on Taylor Street. Therefore Concepts 2B and 2C with an interchange at the Perimeter Road / Taylor Street would operate better than Concept 2D.

Table 4-1a
Traffic Projections For Roads Into East Sector

		Con2CIC.LLX (Emp. Cntr. I/C, 8th St. I/C)					Con2DIC.LLX (Emp. Cntr. O/P, 8th St. I/C)				
West of McOrmond	Travel Direction	Total Traffic	East Sector Traffic (1) Volume	% of Total	Modeled Capacity	Future V/C Ratio	Total Traffic	East Sector Traffic (1) Volume	% of Total	Modeled Capacity	Future V/C Ratio
	S Bound	2358	1880	79.7	3000	0.79	2329	1811	77.8	3000	0.78
McOrmond	N Bound	2741	1428	52.1	3000	0.91	2896	1566	54.1	3000	0.97
(N of Hwy. 5)	Two Way	5099	3308	64.9			5225	3377	64.6		
	E Bound	3545	2016	56.9	3000	1.18	3570	2065	57.8	3000	1.19
Highway 5	W Bound	1166	527	45.2	3000	0.39	1192	563	47.2	3000	0.40
	Two Way	4711	2543	54.0			4762	2628	55.2		
	E Bound	2273	2157	94.9	2400	0.95	2512	2356	93.8	2400	1.05
8th Street	W Bound	899	765	85.1	2400	0.37	1053	917	87.1	2400	0.44
	Two Way	3172	2922	92.1			3565	3273	91.8		
	E Bound	1046	592	56.6	2400	0.44	1072	756	70.5	2400	0.45
Taylor St.	W Bound	825	472	57.2	2400	0.34	1051	795	75.6	2400	0.44
	Two Way	1871	1064	56.9			2123	1551	73.1		
	N Bound	1179	715	60.6	3000	0.39	697	291	41.8	3000	0.23
Perimeter Rd.	S Bound	1106	737	66.6	3000	0.37	438	116	26.5	3000	0.15
	Two Way	2285	1452	63.5			1135	407	35.9		
	Into E Sec.	10401	7360	70.8	13800	0.75	10180	7279	70.0	13800	0.74
Total	Out E. Sec.	6737	3929	58.3	13800	0.49	6630	3957	58.7	13800	0.48
Above	Two Way	17138	11289	65.9			16810	11236	65.6		

Notes 1. Zones 186-198

The traffic volumes entering the east sector are very similar for Concept 2B and 2C, indicating the additional interchange at the Perimeter Road / 8th Street in Concept 2C does not relieve traffic pressures in the area. It is therefore suggested a single interchange at Taylor Street / Perimeter Road would be the

preferred arrangement if Concept 2 is selected. Therefore additional analysis of Concept 2 refers to Concept 2B with the single interchange at the Perimeter Road / Taylor Street.

Comparison of Bridge Traffic

Since Saskatoon's bridges are key transportation elements in the City, bridge traffic associated with the two concepts was compared. Table 4.2 shows traffic volumes associated with all of the bridges for Concept 1 and Concept 2.

Traffic volumes associated with the East Sector (population 64,505) and the North East Sector (population 34,759) are also shown in Table 4-2. The North East Sector population of 34,759 is remaining after population has been transferred to the East Sector in the 400K transportation model. In the 2003 North East Sector Study higher (56,000) population was tested in the North East Sector and lower (42,643) population was tested in the East Sector. In the current model runs, total traffic on all bridges is approximately 32,000 two-way vehicles / hour. The select zone traffic volumes indicate a total volume of approximately 4,100 two-way vehicles / hour on all bridges are associated with the 64,505 population in the East Sector and approximately 3,750 vehicles / hour on all bridges are associated with 34,759 population in the North East Sector.

Both Concept 1 and Concept 2 have very similar bridge traffic. East Sector traffic accounts for approximately 10% and 20% of peak direction (eastbound or southbound) p.m. peak hour bridge traffic on the four southern and three northern bridges, respectively. North East sector traffic accounts for about 50% of the new north crossing and 6% or less of peak direction traffic on other bridges. Because the East Sector is more centrally located than the North East Sector, bridge traffic associated with the East Sector is more evenly distributed over all of the City's bridges.

At the 400K population level, with full development of the East Sector, total bridge traffic v/c ratio is 1.00 and 1.01 for Concept 1 and Concept 2, respectively. The high demand for eastbound / southbound river crossing during the afternoon peak is due to most of the City's employment being on the west side of the river and most residences on the east side of the river. The development of the East Sector requires a new north bridge or alternative river crossing capacity in order for the City's transportation system to function at a reasonable level of service.

Comparison of Perimeter Road Traffic

The Perimeter Road will provide convenient access between the East Sector and the North East Sector. However, other than the North East Sector, the rest of the City of Saskatoon is located west of the East Sector. Therefore the Perimeter Road plays a more minor role in providing access to other parts of the City. The Perimeter Road is modelled with a speed limit of 100 km/h, two lanes and a capacity of 3,000 vehicles per hour each direction.

Table 4-3 shows traffic projections for the Perimeter Road near the East Sector. The Perimeter Road is forecast to be well used north of Highway 41. Total traffic north of Highway 41 on the Perimeter Road is projected to be 750 to 1,800 vehicles per hour each direction in the p.m. peak hour for both Concept 1 and Concept 2. Traffic volumes associated with the East Sector and the North East Sector are also shown in Table 4-3. All traffic on this section of the Perimeter Road is associated with the East Sector, the North East Sector, or both. In the columns that identify "Other Traffic" (i.e., traffic not associated with the East or

North East Sectors), the negative numbers indicate traffic volumes associated with both the East Sector and the North East Sector.

TABLE 4-2: Traffic Projections For River Crossings PM Peak Hour Traffic

		Concept 1 Con1IC.LL X									Concept 2 Con2BIC.LLX (Emp. Cntr. I/C, No 8th St. I/C)								
River Crossing	Travel Direction	Total Traffic	East Sector Traffic (2)		NE Sector Traffic (1)		Other Traffic		Modeled Capacity	Future V/C Ratio	Total Traffic	East Sector Traffic (2)		NE Sector Traffic (1)		Other Traffic		Modeled Capacity	Future V/C Ratio
			Volume	% of Total	Volume	% of Total	Volume	% of Total				Volume	% of Total	Volume	% of Total	Volume	% of Total		
New North	E Bound	5656	1206	21.3	2601	46.0	1849	32.7	5000	1.13	5736	1209	21.1	2624	45.7	1903	33.2	5000	1.15
	W Bound	1002	230	23.0	456	45.5	316	31.5	5000	0.20	926	171	18.5	453	48.9	302	32.6	5000	0.19
	Two Way	6658	1436	21.6	3057	45.9	2165	32.5			6662	1380	20.7	3077	46.2	2205	33.1		
Circle Drive	E Bound	4615	829	18.0	113	2.4	3673	79.6	3000	1.54	4555	858	18.8	113	2.5	3584	78.7	3000	1.52
	W Bound	2767	310	11.2	217	7.8	2240	81.0	3000	0.92	2737	298	10.9	222	8.1	2217	81.0	3000	0.91
	Two Way	7382	1139	15.4	330	4.5	5913	80.1			7292	1156	15.9	335	4.6	5801	79.6		
University	E Bound	2374	498	21.0	161	6.8	1715	72.2	2100	1.13	2413	540	22.4	156	6.5	1717	71.2	2100	1.15
	W Bound	1624	146	9.0	31	1.9	1447	89.1	2100	0.77	1660	117	7.0	39	2.3	1504	90.6	2100	0.79
	Two Way	3998	644	16.1	192	4.8	3162	79.1			4073	657	16.1	195	4.8	3221	79.1		
Broadway Bridge	S Bound	1694	171	10.1	18	1.1	1505	88.8	2400	0.71	1697	153	9.0	13	0.8	1531	90.2	2400	0.71
	N Bound	1242	33	2.7	3	0.2	1206	97.1	2400	0.52	1204	22	1.8	8	0.7	1174	97.5	2400	0.50
	Two Way	2936	204	6.9	21	0.7	2711	92.3			2901	175	6.0	21	0.7	2705	93.2		
Victoria Bridge	S Bound	1363	129	9.5	7	0.5	1227	90.0	850	1.60	1454	128	8.8	9	0.6	1317	90.6	850	1.71
	N Bound	559	17	3.0	9	1.6	533	95.3	850	0.66	556	12	2.2	10	1.8	534	96.0	850	0.65
	Two Way	1922	146	7.6	16	0.8	1760	91.6			2010	140	7.0	19	0.9	1851	92.1		
Idylwyld Bridge	S Bound	3454	183	5.3	9	0.3	3262	94.4	4500	0.77	3376	187	5.5	10	0.3	3179	94.2	4500	0.75
	N Bound	1642	31	1.9	18	1.1	1593	97.0	4500	0.36	1658	60	3.6	13	0.8	1585	95.6	4500	0.37
	Two Way	5096	214	4.2	27	0.5	4855	95.3			5034	247	4.9	23	0.5	4764	94.6		
New South	E Bound	1788	220	12.3	22	1.2	1546	86.5	3000	0.60	1764	219	12.4	25	1.4	1520	86.2	3000	0.59
	W Bound	2044	122	6.0	24	1.2	1898	92.9	3000	0.68	2094	223	10.6	18	0.9	1853	88.5	3000	0.70
	Two Way	3832	342	8.9	46	1.2	3444	89.9			3858	442	11.5	43	1.1	3373	87.4		
All Crossings Total	E Bound	20944	3236	15.5	2931	14.0	14777	70.6	20850	1.00	20995	3294	15.7	2950	14.1	14751	70.3	20850	1.01
	W Bound	10880	889	8.2	758	7.0	9233	84.9	20850	0.52	10835	903	8.3	763	7.0	9169	84.6	20850	0.52
	Two Way	31824	4125	13.0	3689	11.6	24010	75.4			31830	4197	13.2	3713	11.7	23920	75.1		

Notes 1. Zones 173-185 2. Zones 186-198

TABLE 4-3: Traffic Projections For Perimeter Road PM Peak Hour Traffic

Concept 1

Perimeter Road	Travel Direction	Total Traffic	East Sector Traffic (2)		NE Sector Traffic (1)		Other Traffic		Modeled Capacity	Future V/C Ratio
			Volume	% of Total	Volume	% of Total	Volume	% of Total		
North of Hwy. 41	S Bound	1666	1197	71.8	134	8.0	335	20.1	3000	0.56
	N Bound	751	536	71.4	396	52.7	-181	-24.1	3000	0.25
	Two Way	2417	1733	71.7	530	21.9	154	6.4		
North of Hwy. 5	S Bound	849	255	30.0	356	41.9	238	28.0	3000	0.28
	N Bound	468	56	12.0	309	66.0	103	22.0	3000	0.16
	Two Way	1317	311	23.6	665	50.5	341	25.9		
South of Hwy. 5	S Bound	766	264	34.5	328	42.8	174	22.7	3000	0.26
	N Bound	499	69	13.8	291	58.3	139	27.9	3000	0.17
	Two Way	1265	333	26.3	619	48.9	313	24.7		
South of 8th St.	S Bound	671	318	47.4	164	24.4	189	28.2	3000	0.22
	N Bound	1031	646	62.7	189	18.3	196	19.0	3000	0.34
	Two Way	1702	964	56.6	353	20.7	385	22.6		
North of Hwy. 16	S Bound	671	318	47.4	164	24.4	189	28.2	3000	0.22
	N Bound	1031	646	62.7	189	18.3	196	19.0	3000	0.34
	Two Way	1702	964	56.6	353	20.7	385	22.6		
South of Hwy. 16	S Bound	80	29	36.3	10	12.5	41	51.3	3000	0.03
	N Bound	58	35	60.3	9	15.5	14	24.1	3000	0.02
	Two Way	138	64	46.4	19	13.8	55	39.9		
Total Above	S Bound	3865	2381	61.6	1156	29.9	1166	30.2	18000	0.21
	N Bound	3838	1988	51.8	1383	36.0	467	12.2	18000	0.21
	Two Way	8541	4369	51.2	2539	29.7	1633	19.1		

TABLE 4-3: Traffic Projections For Perimeter Road (continued)

Concept 2

Perimeter Road	Travel Direction	Total Traffic	East Sector Traffic (2)		NE Sector Traffic (1)		Other Traffic		Modeled Capacity	Future V/C Ratio
			Volume	% of Total	Volume	% of Total	Volume	% of Total		
North of Hwy. 41	S Bound	1790	1224	68.4	159	8.9	407	22.7	3000	0.60
	N Bound	743	449	60.4	432	58.1	-138	-18.6	3000	0.25
	Two Way	2533	1673	66.0	591	23.3	269	10.6		
North of Hwy. 5	S Bound	695	93	13.4	272	39.1	330	47.5	3000	0.23
	N Bound	790	261	33.0	558	70.6	-29	-3.7	3000	0.26
	Two Way	1485	354	23.8	830	55.9	301	20.3		
South of Hwy. 5	S Bound	618	107	17.3	253	40.9	258	41.7	3000	0.21
	N Bound	888	337	38.0	539	60.7	12	1.4	3000	0.30
	Two Way	1506	444	29.5	792	52.6	270	17.9		
South of 8th St.	S Bound	618	107	17.3	253	40.9	258	41.7	3000	0.21
	N Bound	888	337	38.0	539	60.7	12	1.4	3000	0.30
	Two Way	1506	444	29.5	792	52.6	270	17.9		
North of Hwy. 16	S Bound	1103	725	65.7	138	12.5	240	21.8	3000	0.37
	N Bound	1177	705	59.9	228	19.4	244	20.7	3000	0.39
	Two Way	2280	1430	62.7	366	16.1	484	21.2		
South of Hwy. 16	S Bound	108	49	45.4	9	8.3	50	46.3	3000	0.04
	N Bound	78	33	42.3	16	20.5	29	37.2	3000	0.03
	Two Way	186	82	44.1	25	13.4	79	42.5		
Total Above	S Bound	4932	2305	46.7	1084	22.0	1543	31.3	18000	0.27
	N Bound	4564	2122	46.5	2312	50.7	130	2.8	18000	0.25
	Two Way	9496	4427	46.6	3396	35.8	1673	17.6		

Notes 1. Zones 186-198 2. Zones 173-185

Highway 41 provides a 1.6 km shorter route than the Perimeter Road for southbound traffic to access the City Centre. The distance from Highway 41 / Perimeter Road to Highway 41 / Highway 5 (Blackley Road Interchange) is approximately 2.6 km via Highway 41 and approximately 4.2 km via the Perimeter Road and Highway 5. Since both routes are modelled at 100 km/h, traffic not destined to the East Sector uses Highway 41 rather than the Perimeter Road and Highway 5 to Access Highway 5 west of Highway 41 (Blackley Road). Therefore traffic volumes south of Highway 41 are smaller than north of Highway 41.

Traffic volumes south of Highway 41 and south of 8th Street are in the range of 470 to 1,035 vehicles per hour each direction in the direction in the p.m. peak hour for both Concept 1 and Concept 2. Due to the interchange at the Perimeter Road / 8th Street in Concept 1, the traffic volumes vary on either side of 8th Street. Since no interchange is planned at Perimeter Road / 8th Street in Concept 2, the traffic volumes are constant on either side of 8th Street.

North of Highway 16, southbound traffic volumes on the Perimeter Road are 1,100 vehicles per hour for Concept 2 and 690 for Concept 1. Higher volumes in Concept 2 on this section are evident because traffic leaving the employment centre at the south side of Concept 2 is expected to use the interchange at Taylor / Perimeter Road to access Highway 16 via the Perimeter Road. As shown earlier in Table 4-1, Concept 1 has additional westbound (off-peak direction) traffic on Highway 5 compared to Concept 2.

Traffic volumes on the Perimeter Road south of Highway 41 do not exceed a single lane capacity in each direction. It is therefore suggested that the Perimeter Road in this section could be planned as a two-lane facility to the 400K population level, unless significant changes in land uses are planned.

Comparison of Travel Speeds

Within the TMODEL runs for the development options, statistics have been prepared that represent the total peak hour travel that takes place on the future road network. Table 4-4 shows the vehicle kilometres and the vehicle hours of travel on the entire modelled network for each development option. The statistics represent total travel at the 400K level, not just the travel associated with the East Sector.

In preparing the statistics, care has been taken to exclude the modelled travel that takes place on all the artificial zone centroid connector links (Class 38 and 138 links). Simple division of vehicle kilometres by vehicle hours calculates overall travel speeds. The total travel speeds seem low since they include delays at signals and delays due to congestion in the downtown and at bridges to the 400K population level.

Table 4-4 shows that all Concepts have similar overall travel speeds. Concept 2D has the slowest overall travel speeds due to the less convenient overpass access to the employment area. Concept 1, with about 25% less length of road network in the East Sector, has the next slowest overall travel speeds. Concept 2C has higher overall travel speeds than Concept 2B since it has the additional interchange at Perimeter Road / 8th Street. However, as noted earlier, the traffic volumes entering the East Sector are very similar for Concept 2B and 2C, indicating the additional interchange at the Perimeter Road / 8th Street in concept 2C does not relieve traffic pressures in the area. It is therefore suggested a single interchange at Taylor Street/Perimeter Road would be the preferred arrangement if Concept 2 is selected.

Table 4-4
Vehicle Kilometers Travelled, Vehicle Hours Travelled and Speeds

Concept	All		Class 38		Class 138		Total		Speed (km/hr)
	VKT	VHT	VKT	VHT	VKT	VHT	VKT	VHT	
1	938,417	42,113	39,608	1,009	43,181	864	855,628	40,240	21.3
2B	942,226	41,130	39,426	1,003	39,836	797	862,964	39,330	21.9
2C	941,623	40,575	39,424	1,003	39,906	798	862,293	38,774	22.2
2D	939,793	42,289	39,467	1,004	39,926	799	860,400	40,486	21.3

VKT = vehicle kilometres travelled; VHT = vehicle hours travelled.

4.1.6 Summary of Transportation Model Findings

The East Sector is located on the east side of the City, therefore it is convenient for most drivers to access the area from the west, rather than from the Perimeter Road. Reasonable access from the west is provided on McOrmond Drive, Highway 5, and 8th Street. Taylor Street, being a 50km/h facility through residential area provides a lower speed access. CPR tracks and existing neighbourhoods limit additional arterial access from the west. Highway 16 provides high speed additional access to the Perimeter Road on the south side of the East Sector, which is convenient in Concept 2 since the employment area at the south of the sector.

While either Concept 1 or Concept 2 would be acceptable, Concept 1 has more convenient access to its employment area.

Interchanges are proposed at: (Refer to Drawings 8 and 9)

.1 Perimeter Road / Highway 41 as per the East Perimeter Highway Functional Planning Study. Current plans for Highway 41 will connect to the Perimeter Road on the east and west on its existing alignment (i.e. at the north edge of the East Sector.

.2 McOrmond Drive/ Highway 5 as per the City's 400K Population Transportation Network Improvement Plans.

.3 Highway 41 (Blackley Road Alignment) / Highway 5 to accommodate East Sector traffic.

.4 Highway 41 access to the East Sector (Employment area access in Concept 1 and Neighbourhood 9 access in Concept 2) to accommodate East Sector Traffic.

.5 Perimeter Road / Highway 5 as per the City's 400K Population Transportation Network Improvement Plans.

.6 Perimeter Road / Highway 16 (Yellowhead) as per the City's 400K Population Transportation Network Improvement Plans – the separation between Highway 394 and Highway 16 is assumed to be east of the Perimeter Road and not explicitly included in the transportation model.

.7 Perimeter Road / 8th Street and / or Perimeter Road / Taylor Street at the north edge of Employment Area to accommodate East Sector traffic.

In Concept 2 a single interchange between Highway 5 and Highway 16 on the Perimeter Road at the Perimeter Road / Taylor Street at the north edge of Employment Area produces similar traffic patterns to providing an additional interchange at the Perimeter Road / 8th Street. This indicates the additional interchange is not essential.

It should be noted in Concept 2, that the Taylor Street Interchange or overpass provides the only access to the parts of the employment area east of the Perimeter Road – the southern part is accessed via an overpass over the railway tracks. Due to the diverge in Highway 16 Highway 394, just east of the Perimeter Road, it is conservatively assumed that direct access from Highway 16 to the employment area will not be available. As the interchange at the Perimeter Road / Highway 16 is planned, the option to provide access from Highway 16 to the land located between the CPR tracks, the Perimeter Road and Highway 16 should be explored.

Traffic volumes on the Perimeter Road south of Highway 41 do not exceed a single lane capacity in each direction. It is therefore suggested that the Perimeter Road in this section could be planned as a two-lane facility to the 400 K population level, unless significant changes in land uses are planned.

4.2 MUNICIPAL INFRASTRUCTURE (WATER & SEWER)

This section outlines the basic analysis of the two proposed development concepts related to municipal water supply, sewage collection and storm water management. It is intended to provide adequate background for overall feasibility, comparative assessment, and basic costing for each concept.

4.2.1 Water Supply

4.2.1.1 Water Demand

Trunk mains for the development Concepts 1 and 2 were sized to consider the peak hourly demand plus fire demand as specified in the City of Saskatoon Water and Sewer Design Standards. Peak hourly demand was determined based on a rate of 70 m^3/ha/day for residential areas. Demands for employment area and suburban centre areas were calculated comparatively based on their relative population densities. Population densities used for municipal infrastructure modelling are shown in Table 4-5 below:

Table 4-5
Population Densities

Land Use	Population Density
Residential Neighbourhood	37 per/ha + 80 jobs per neighbourhood
Employment Area	15 jobs/ha
Suburban Centre	69 per/ha + 13 jobs/ha

* For the municipal servicing modeling, it was assumed that one job equals one person
No open areas were assumed in calculation of modelled population

Fire flow was determined based on a standard maximum fire flow of 220 L/s based on discussion with COS. This flow demand was applied at the suburban centre.

4.2.1.2 Water Supply

The proposed water supply and distribution for the East Sector development options includes tie-ins to existing primary water mains at Taylor St. and Briarvale Road, and Attridge Drive and McOrmond Drive. As well, the system is proposed to tie-into a future storage reservoir and pumping station located N.E. 1/4 of Section 21-36-4. This reservoir location has been designated by the City of Saskatoon Infrastructure Services Planning and Design for supply to the existing and future development in the east sector area.

4.2.1.3 Water Distribution

A preliminary distribution pipe layout consisting of a skeleton network of mains was determined for each option to provide service to all areas proposed for development (residential, suburban centre, employment area).

System performance was simulated for each option using the hydraulic modeling program Water Cad to determine adequate pipe sizes under the peak hourly demand plus fire flow condition at critical conditions, as well as the average day condition. A model methodology description is included with the model results in Appendix C.

Based on the model simulations, pipe sizes were chosen to minimize head loss, achieve maximum flow velocities of 1.5 m/s, and operating pressures within the range of 275 kPa to 680 kPa. Preliminary pipe sizes within the network range from 200mm to 1200mm. The distribution network is shown for each concept in Drawings 10 and 11.

Based on discussion with the City of Saskatoon, it is understood that a new reservoir and pumping station is planned to provide full capacity for the East Sector development. For the initial development of neighbourhoods 1, 2 and 3, before the East Sector reservoir is constructed, water supply may be provided by the proposed North East Sector reservoir which has been planned for earlier development.

This East Sector reservoir concept was incorporated in modelling with a reservoir located in Section N.E. 21-36-4. The existing 1050 mm primary main at Taylor Street and Briarvale Road was continued to the proposed reservoir to serve as a fill main and a primary service main. A flow control valve was modelled to maintain a fill rate of 1000 L/s for Concepts 1 and 2 to provide velocities acceptable in the fill main during average day demand conditions. It is assumed that the reservoir would not be filling during peak hour conditions.

Based on the model results, it was determined that the proposed East Sector reservoir and pumping station will be required to deliver approximately 1380 L/s at 500 kPa for Concept 1, and approximately 1070 L/s at 450 kPa for Concept 2 to produce the desired pipe pressure and velocity conditions in the East Sector, during the peak hour plus fire condition.

It was determined that the tie-in point at Taylor Street and Briarvale Road would provide approximately 650 L/s at 540 kPa for Concept 1 during maximum demand conditions, and approximately 1100 L/s at 530 kPa for Concept 2 during maximum demand conditions (peak hour plus fire flow with no reservoir filling).

It was determined that for both options, the tie-in point at Attridge and McOrmond could not provide the required pressure to contribute flow during both average day, and peak hour plus fire flow conditions.

Based on the long term and conceptual level of the above analysis it is recommended that the East Sector water distribution system be modeled again prior to initial development include any future demands applied to the existing COS system. Proposed pipe sizes, and pumping requirements should be verified.

The City's existing distribution system as a whole, including distribution pumps, requires modelling with the inclusion of planned future reservoirs and fill mains in order to determine and verify a long term plan for the COS primary distribution system.

4.2.2 Sanitary Sewer

4.2.2.1 Design Flows

Design flows for the sizing of trunk sanitary sewer mains were determined based on the peak design flow (PDF) as specified in the COS design standards and calculated as follows:

PDF: PF (peaking factor) x ADWF (average dry weather flow) + 0.17 l/s/ha (inflow/infiltration)

PF was calculated using the Harmon Formula where $PF = 1+14/(4+P^{1/2})$, with an ADWF of 290 litres per capita per day used. Populations used to determine flows from East Sector land use areas were based on densities as determined by the project team as listed in Table 4-5.

4.2.2.2 East Sector Collection System

The proposed sanitary sewer collection system for development Concepts 1 and 2 consists of a conventional gravity system draining to an existing 1200 mm diameter main at Attridge Drive and McOrmond Drive. This main continues across the river, draining to the Wastewater Treatment Plant (WWTP)

Trunk main sizes were estimated using Manning's equation to achieve flow velocities in the range of 0.914 m/s to 3.05 m/s. A minimum slope of 0.1 % was used in calculations, a value consistent with COS design standards for trunk mains. Resulting pipe sizes range from 300 mm at the eastern limits of the study area, to 900mm at the connection to the existing Attridge Dr. main.

Should the COS develop plans to service areas outside of the study area, the sanitary sewer layout would require revision including some larger diameter and deeper mains. Some additional system capacity may be required to serve the proposed industrial area east of Rosewood, and to provide potential relief to Rosewood itself.

Preliminary layouts for primary sanitary sewer collection systems for Concepts 1 and 2 are shown in Drawings 12 and 13.

Model results for the sanitary sewer system are included in Appendix C.

4.2.2.3 Existing Collection System

The existing COS Sanitary sewer collection system was analysed to determine whether pipe sizes were adequate to handle the additional flow from the proposed East Sector development.

The analysis considered the existing mains from the McOrmond Drive and Attridge Drive tie-in point to the WWTP with contributing flow from the proposed East Sector population as well as the existing COS population. Existing populations and point flow location information was received from the COS based on sanitary sewer model records. Peak design flows were calculated in the same manner as those for the East Sector Collection System.

Based on the analysis it was determined that existing sewer mains were adequately sized to handle the additional East Sector flow with the exception of the first portion of 1200 mm main on Attridge Drive connecting the East Sector system (slightly over capacity at peak flows), and the 1500mm, and 2100mm mains near the WWTP (significantly over capacity at peak flows)

The above analysis however, considered only projected sanitary sewer waste and inflow/infiltration flows of 0.17L/s/ha from the City's existing population and that projected for the East Sector. Using an inflow/infiltration factor of .28 L/s/ha combined with weeping tile flow of 0.05 L/s/house would result in existing mains being significantly over capacity following the above analysis. Inflow/Infiltration and weeping tile flow is to be addressed in the New Neighbourhood Design & Development Standards Manual.

Based on discussion with the COS at the August 29, 2005 report review meeting, it was noted that many of the City's houses contribute storm water flow to the sanitary sewer from weeping tile systems. During the June 29, 2005 storm event, the existing trunk sanitary system may have experienced surcharge due in part to excessive weeping tile flows.

This issue may limit the size and staging of the East Sector depending on what modifications are made to the existing weeping tile systems, or existing trunk mains in the future, in light of new bylaws. Based on this, the issue of projected sanitary sewer loading should be addressed prior to the initial stage, and each stage following, for development in the East Sector, considering storm water contribution and adequacy of existing main capacity.

4.2.3 Storm Water Management

4.2.3.1 Design Flow

Design flow run-off for each catchment area within the development area used for the preliminary sizing of the storm sewer trunk mains (minor system) was calculated using the Rational Method Q = 2.78CiA where:

Q = design peak flow rate in litres/second (L/s)
C = runoff coefficient
i = the rainfall intensity in mm per hour (mm/hr)
A = the area of the contributing runoff surface in hectares (ha)

The runoff coefficients used were 0.35 for residential areas, and 0.65 for suburban centres and employment areas. In designing for the minor system, consisting of piping, manholes, catch basins and outfall structures, the average intensity used was 31 mm/hr based on a 1 in 2 year return period event at a duration of approximately twenty-five minutes.

The development area was divided into individual catchment areas, each draining to a trunk main making up the minor system. Trunk mains were drained to storm water retention ponds at critical locations to minimize pipe diameters and provide temporary detention capacity for the entire study area in the event of a 1 in 2 year event. Detention ponds were placed to utilize existing sloughs and depressions (type 3 natural areas), allowing for the opportunity to preserve existing wetlands similar to the approach taken in the South East Sector.

The major system consisting of streets, detention facilities and park land is designed to convey runoff from events up to a 100 year event including the rainfall event of 1983 without causing major flood as specified by COS design standards.

In designing for the 1983 storm event for a duration of 25 minutes, the resulting intensity is 106 mm/hr. This intensity results in a flow rate per unit area of .294 m^3/s/ha. The total pipe capacity per unit area is approximately .07 m^3/s/ha for Concepts 1 and 2. Subtracting the storm flow rate from the pipe capacity results in a flow rate of approximately .225 m^3/s/ha. This resulting run-off flow is to be handled by the major system (i.e. conveyed by the streets to parking lots, parklands, and other smaller detention ponds (wet or dry) during the storm event). Existing type 2 natural areas at lower relative elevations could be used for pond locations. Sizing and location of these facilities is to be considered in detailed design of the individual neighbourhoods taking into consideration accumulative rainfall volume over the duration of the storm event.

For the purpose of the conceptual cost estimate presented in Table 4-8, it was assumed that one pond would be required for each neighbourhood to handle the major storm event. This is consistent with past COS neighbourhood design.

4.2.3.2 Drainage and Collection System

The proposed storm water management (minor system) for development Concepts 1 and 2 is assumed to consist of conventional collection of runoff utilizing curbs, gutters, and catch basins internal to the neighbourhoods. Storm water is to be drained by trunk main to discharge points at the proposed storm water detention ponds. From the ponds, the stormwater can then be released at a slower rate and be conveyed by the existing 3300mm diameter main located at Attridge Drive and McOrmond Drive. This main discharges to the South Saskatchewan River near the crossing of the sanitary sewer and water distribution pipelines.

Trunk mains were sized to achieve flow velocities within the range of 0.90 to 3.0 m/s. Due to high slopes in some areas, velocities slightly greater than 3.0 m/s resulted for these mains (high velocities are highlighted in storm sewer model results - Appendix C). Mains in

this area may require invert erosion consideration in more detailed design. For the purpose of modeling the proposed collection system, primary trunk mains are shown to extend the full lengths of each neighbourhood, which may not be required in practice. Based on this, the cost estimate in Table 4-10 has been adjusted to include only 2/3 of the total trunk main length for the outside neighbourhoods.

Should the COS develop plans to service areas outside of the study area, storm sewer layout would require revision including some larger diameter and deeper mains.

Preliminary layouts for the storm water management systems for the development concepts are shown in Drawings 14 and 15.

Model results for the storm water management systems are included in Appendix C.

4.2.3.3 Other Utilities

There are no significant issues expected for the underground installation of other utilities such as gas, power, telephone, and cable.

Based on the *Future Growth Study* (City of Saskatoon, 1999), one SaskEnergy transmission line runs North-South adjacent to a ¼ section line between Range Road 3043 and Range Road 3044. Sask Power lines, with the exception of one running diagonally southwest to North-East, run adjacent to Township and Range roads.

It is expected that electrical substations will be required; as well, there is some potential for a natural gas booster station.

4.3 COST ESTIMATES

4.3.1 Economic Feasibility – Utilities

To assess the economic feasibility of servicing the East Sector development options, the potential levy generated by Concepts 1 and 2 was determined for primary water, sewer, and storm sewer servicing (including ponds) and for arterial roadways based on the following 2005 prepaid rates (Table 4-6 and Table 4-7) per frontage meter for various land uses *(based on communication with the City of Saskatoon)*.

Table 4-6
Land Use Rates – Primary Water and Sewer

Land Use	Trunk Sewers (incl. Sanitary and Storm)	Primary Water	Total ($/f.m.)
Residential	$260.00	$63.15	$323.15
Commercial	$366.00	$63.15	$429.15

Table 4-7
Land Use Rates – Arterial Roadways

Land Use	Arterial Roadways $/f.m.
Residential	$249.40
Commercial	$249.40

After deducting for parks, detention ponds, and arterial roadways from the total area, it is assumed that each hectare of raw land contains 136 frontage metres per hectare (fm/ha) for residential land use, and 169 fm/ha for commercial use.

Based on the above information, the potential levy generation was calculated for each option and is compared to the estimated primary costs in Table 4-8 and Table 4-9. Primary water mains are classified as 400 mm diameter and larger, trunk sanitary sewers 375 mm diameter and larger, and trunk storm sewers 1350mm and larger. Water fill mains are not classified as primary.

Table 4-8
Cost vs. Revenue Comparison – Primary Water and Sewer

	Concept 1 ($ Millions)	Concept 2 ($ Millions)
Revenue from Levy	90.7 M	92.6 M
Estimated Primary Cost (incl. 35% Engineering and Contingency)	120.8 M	125.4 M
Difference	- 30.1 M	- 32.8 M
Rank	1	2

Based on the above Table 4-8, both concepts share a negative cost versus revenue relationship with Concept 1 showing a smaller differential than Concept 2. This negative relationship may be the result of recent large increases in industry construction costs. City levy rates may need adjustment to match these increases. However, given the sensitivity of the development cost estimates and the high degree of detail required to refine them only available through detailed design, we suggest the costs be considered as equal.

Table 4-9
Cost vs. Revenue Comparison – Arterial Roadways

	Concept 1 ($ Millions)	Concept 2 ($ Millions)
Revenue from Levy	65.3	68.1
Estimated Primary Cost (incl. 35% Engineering and Contingency)	37.1	49.0
Difference	+28.2	+19.1
Rank	1	2

Based on the above Table 4-9, both concepts share a positive cost versus revenue relationship. This may be the result of utilizing the proposed Perimeter Road, and existing Highways 5 and 41 within the East Sector's proposed transportation network.

4.3.2 Total Cost Comparison

Very basic order of magnitude assessment of development costs for each of the proposed East Sector Concepts have been generated based on 2005 construction indices to provide an additional means of comparison. These are presented in Table 4-10 on the following page.

From the comparison it appears that both concepts represent a similar cost per hectare of serviced area. Concept 2 includes a larger service area, and therefore, a higher total cost than Concept 1.

4.4 COMPARATIVE EVALUATION

Based on the report analysis it is evident that both Concepts 1 and 2 are adequate for development of the East Sector. Costs are similar in terms of dollars per developed hectare, and the concepts perform similarly in transportation and municipal servicing modeling.

However there remain advantages and disadvantages for each concept as discussed at the August 29, 2005 review meeting, and illustrated by the following comments:

4.4.1 Concept 1

Advantages:

- The employment area is situated between the proposed North East and East Sector development areas allowing easy access from both.
- The location of the employment area provides a more desirable land use for bordering the U of S research lands when compared to Concept 2, which places a residential neighbourhood in this area.

Table 4-10
Total Cost Comparison

Item	Sub	Units	Option 1 -Primary/Levy Funded Unit Cost ($)	Quantity	Extension ($)	Option 1 - Non-Primary Unit Cost ($)	Quantity	Extension ($)	Option 1 Total ($)	Option 2 - Primary/Levy Funded Unit Cost ($)	Quantity	Extension ($)	Option 2 - Non Primary Unit Cost ($)	Quantity	Extension ($)	Option 2 Total ($)
Water	150mm	metres	115			115				115			115			
	200mm	metres	145			145				145			145	3,960	574,200	574,200
	250mm	meters	200			200	1,960	392,000	392,000	200			200			
	300 mm	metres	230			230	640	147,200	147,200	230			230	4,460	1,025,800	1,025,800
	350 mm	metres	290			290				290			290	880	255,200	255,200
	400 mm	metres	345	1,870	645,150	345			645,150	345	3,700	1,276,500	345			1,276,500
	450 mm	metres	380	6,510	2,473,800	380			2,473,800	380	4,150	1,577,000	380			1,577,000
	500 mm	metres	430	5,590	2,403,700	430			2,403,700	430	7,710	3,315,300	430			3,315,300
	600 mm	metres	490	5,840	2,861,600	490			2,861,600	490	2,760	1,352,400	490			1,352,400
	750 mm	metres	630	4,830	3,042,900	630			3,042,900	630	2,230	1,404,900	630			1,404,900
	900 mm	metres	860	970	834,200	860			834,200	860	980	842,800	860			842,800
	1050 mm	metres	1100			1100	5,160	5,676,000	5,676,000	1100	1,500	1,650,000	1100	4,790	5,269,000	6,919,000
	1200 mm	metres	1325	260	344,500	1325			344,500	1325	1,760	2,332,000	1325			2,332,000
Sanitary	300 mm	meters	315			315				315			315	640	201,600	201,600
	375 mm	metres	345	3,580	1,235,100	345			1,235,100	345	8,085	2,789,325	345			2,789,325
	450 mm	metres	400	2,830	1,132,000	400			1,132,000	400	5,630	2,252,000	400			2,252,000
	525 mm	metres	460	3,530	1,623,800	460			1,623,800	460	3,140	1,444,400	460			1,444,400
	600 mm	metres	520	4,615	2,399,800	520			2,399,800	520	2,050	1,066,000	520			1,066,000
	675 mm	metres	660			660				660			660			
	750 mm	metres	800	2,840	2,272,000	800			2,272,000	800	750	600,000	800			600,000
	900 mm	metres	860	0	0	860				860	900	774,000	860			774,000
	900 mm (tunnelled)	metres	5000	1,460	7,300,000				7,300,000	5000	1,460	7,300,000				7,300,000
Storm																
	1050 mm	meters	980			980	1,000	980,000	980,000	980			980			
	1350 mm	meters	1270			1270				1270	1,070	1,358,900	1270			1,358,900
	1500 mm	meters	1440	5,100	7,344,000	1440			7,344,000	1440	5,540	7,977,600	1440			7,977,600
	1650 mm	meters	1550	1,250	1,937,500	1550			1,937,500	1550			1550			
	1850 mm	meters	1950			1950				1950	3,790	7,390,500	1950			7,390,500
	2100 mm	meters	2700	6,890	18,603,000	2700			18,603,000	2700	3,440	9,288,000	2700			9,288,000
	2400 mm	meters	3050	3,200	9,760,000	3050			9,760,000	3050	5,490	16,744,500	3050			16,744,500
	2700 mm	meters	3400	900	3,060,000	3400			3,060,000	3400	0		3400			
	3050 mm (tunnelled)	meters	7000	1,460	10,220,000	4140			10,220,000	7000	1,460	10,220,000	4140			10,220,000
	Ponds	Cu M	5	2,000,000	10,000,000	5			10,000,000	5	2,000,000	10,000,000	5			10,000,000
Reservoir and Pumpstation	Res. And Pump stn (15,000m3 storage)		12000000			12000000	1	12,000,000	12,000,000	12000000			12000000	1	12,000,000	12,000,000
Roadways																
	4LD Arterial	lkm	2,500,000	11	27,500,000	2,500,000			27,500,000	2,500,000	14.5	36,250,000	2,500,000			36,250,000
	Traffic Signal	lump sum	130,000	2	260,000	130,000			260,000	130,000	2	260,000	130,000			260,000
	Interchange	lump sum	11,100,000	2	22,200,000	11,100,000			22,200,000	11,100,000	3	33,300,000	11,100,000			33,300,000
Internal Servicing		ha	172500			172500	1,842	317,745,000	317,745,000	172500			172500	1,949	336,202,500	336,202,500
Sub Total					139,453,050			336,940,200	476,393,250			162,766,125			355,528,300	518,294,425
Engineering	15%				20,917,958			50,541,030	71,458,988			24,414,919			53,329,245	77,744,164
Contingencies	20%				27,890,610			67,388,040	95,278,650			32,553,225			71,105,660	103,658,885
Total					188,261,618			454,869,270	643,130,888			219,734,269			479,963,205	699,697,474
$ per ha					102,205			246,943	349,148			112,742			246,261	359,003
Total Estimate									643 M							700 M
Range +/- 25%									482 M- 804 M							525 M - 875 M

** Roadway costs do not include the Perimeter Highway (except for East Sector - related grade separations) or upgrading to Highway 41, both of which are common items between the options. The costs included major roadways only within the sector, and assume traffic signal control at all arterial intersections.

Disadvantages:

- There is no direct rail access to the employment area for Concept 1.

4.4.2 Concept 2

Advantages:

- There is potential for direct rail access to the employment area.

Disadvantages:

- There are potential access difficulties related to the location of the employment area. This area is intersected by the Perimeter Road and CNR railway, complicating access and restricting movement within this area.

4.4.3 Summary

Based on the above, it is recommended that Concept 1 represents the most preferable option for future development in the East Sector. This concept is more favorable as it places the employment area in the northern portion of the sector where traffic access and manoeuvrability is better than that of Concept 2, which places the employment area to the south. As well, the employment area of Concept 1 presents a more desirable bordering land use to the U of S agricultural research lands, relative to the residential neighbourhood proposed in Concept 2.

4.5 STAGING COSTS

On the basis of the recommended Concept 1, and the cost estimates of Table 4-10, initial and staging costs have been determined relative to the anticipated order of development. This order of development has been determined based on logical progression of proposed water, sewer and roadway infrastructure, and is aimed to provide balanced development costs in terms of dollars per hectare.

Table 4-11 below shows the estimated staging order and associated total costs and cost per hectare of development, including engineering and contingency.

Table 4-11
Staging Costs

Stage	Development Areas Included	Area (ha)	Total Cost Based on Table 4-10 ($)	Total Cost per Unit Area ($/ha)	Off-Site Levy Funded/ Primary Servicing Cost per Unit Area ($/ha)	Non-Primary Servicing Cost per Unit Area ($/ha)
1	N1,N2,N3	542	227 M	419,000	179,000	240,000
2	N4,1/2SC,1/2N5, 1/2N6	391.5	125 M	319,000	35,000	284,000
3	1/2SC,1/2N5,1/2 N6	425.5	155 M	364,000	128,000	236,000
4	N7, N8, EC	483	136 M	282,000	49,000	233,000

NOTE: * 1/2 Neighbourhoods and Suburban centres are included to balance total development costs for each stage in consideration of major roadways and primary water and sewer main construction.

NOTE: ** Note: the cost per area column shown in Table 4-8 of the *North East Sector Feasibility Study* includes only allowance for primary servicing.

Stage 1 illustrates a higher relative cost due to initial servicing costs including the connecting large diameter deep running sanitary sewer and storm sewer to the existing system down McOrmand Drive by tunnelling. The COS has previously estimated this cost to be approximately 15 million based on 2001 prices. 2005 estimates included in this report (Table 4-10), provide the costs at approximately 17.5 million plus contingency.

Based on discussion with the COS, there is some potential to build out part of N1 utilizing existing infrastructure including the 1200 mm diameter Berini Drive sanitary sewer main. As this concept is outside of the above staging plan and conceptual analysis, further analysis would be required related to water, sewer, and storm sewer tie-in capacity.

5 Recommendations and Conclusion

Through the work undertaken in analyzing the feasibility of development of the "East Growth Sector" and this report (City of Saskatoon – East Sector Feasibility Study, Associated Engineering et al, February 2006) which documents the findings, the consultant team recommends as follows:

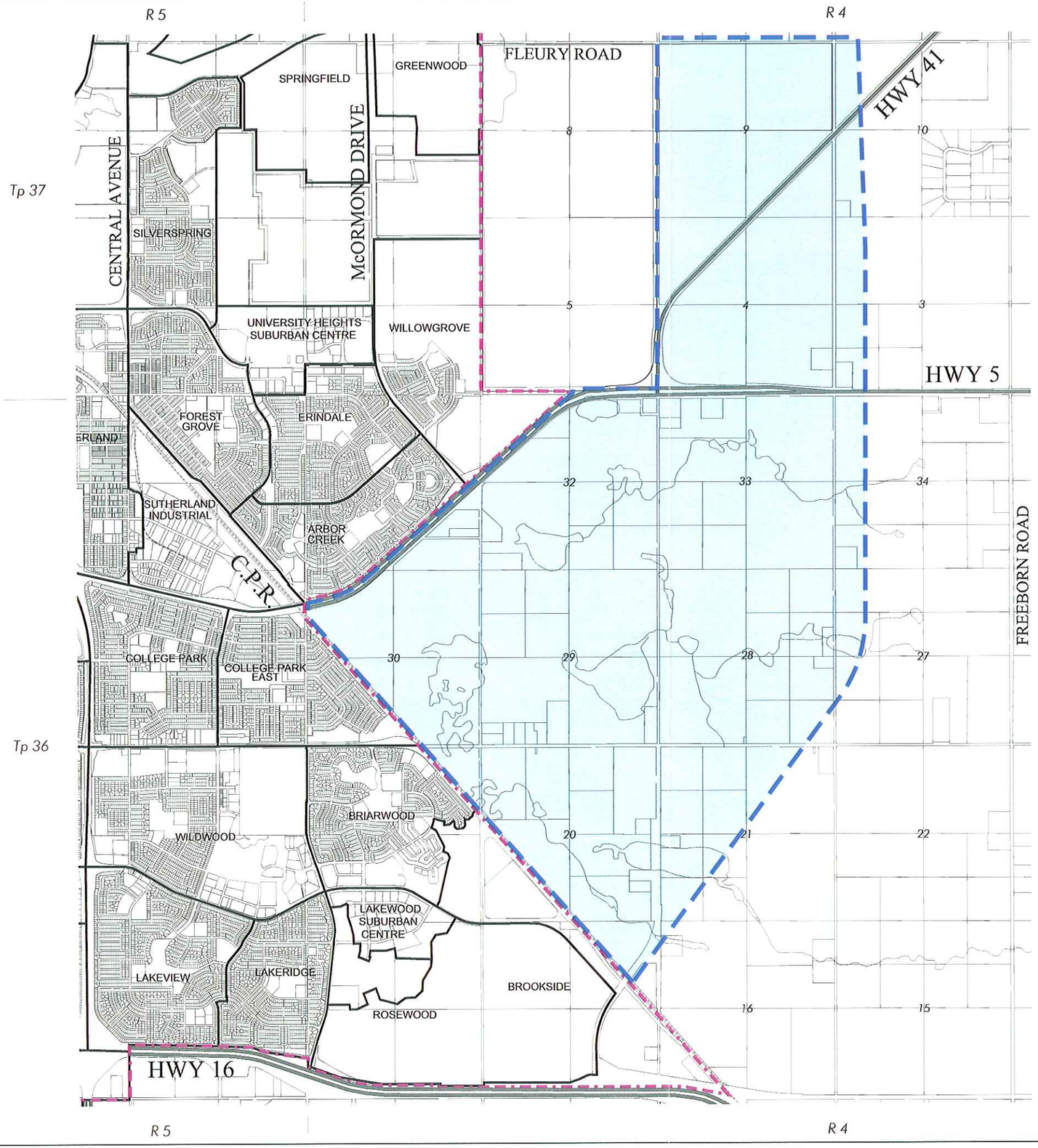
1. Should the City of Saskatoon choose to develop in the East Growth Sector, such development be undertaken in general accordance with the recommended development plan (Concept 1) as shown in Figure 16.

2. Development should be undertaken on the basis of carefully considered neighbourhood plans that integrate well with the overall plan and the City as a whole.

3. Development must respect the natural and heritage resources and considerations identified.

The above recommendations are premised on the assumption that the City's major infrastructure will be in place with adequate capacity to suit the needs of the projected East Sector population. This includes the proposed perimeter roadway, water treatment plant, wastewater treatment plant, water storage and pumping facilities and primary water and sewer mains including north and south river crossings.

A Appendix A - Drawings



Legend

City of Saskatoon Boundary

Area Limits

NO.	DATE	ENG.	BY	SUBJECT
D	06\03\21	AOM	SWT	Final Report
C	05\10\26	AOM	SWT	Draft Final Report
B	05\07\22	AOM	SWT	Options Report
A	05\03\03	AOM	SWT	Interim Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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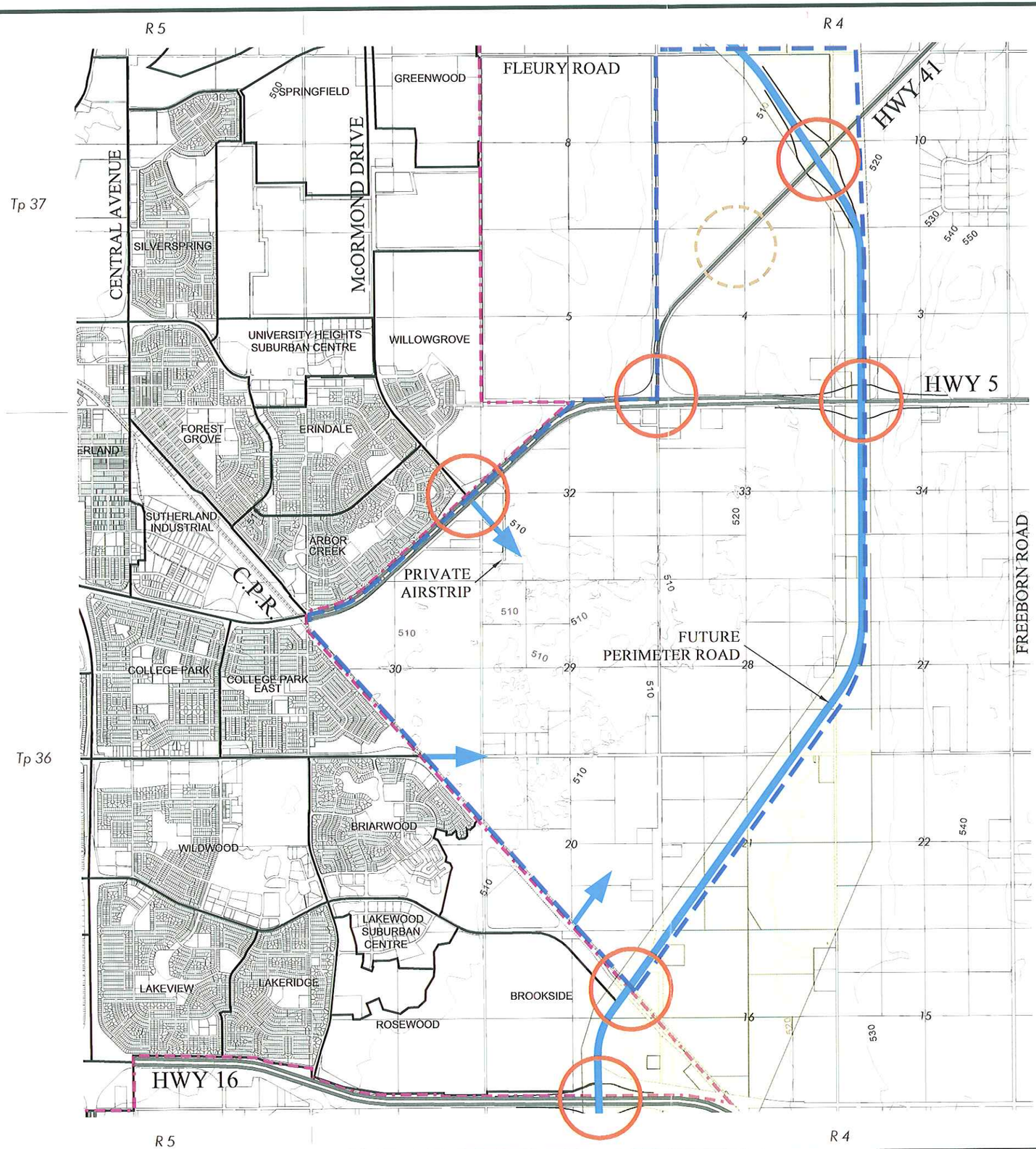
City of Saskatoon

East Sector
Feasibility Study

Study Area

DRAWING NUMBER	REV. NO.	SHEET
Drawing 1	D	1 / 7



Legend

- City of Saskatoon Boundary
- Area Limits
- Transportation Design Corridor
- Elevation (m) — 480
- Future Arterial Roadway
- Existing Roadway
- Future Interchange
- Potential Future Interchange

NO.	DATE	ENG.	BY	SUBJECT
D	06103121	ADM	SWT	Final Report
C	05110126	ADM	SWT	Draft Final Report
B	05107122	ADM	SWT	Options Report
A	05103103	ADM	SWT	Interim Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
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CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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NDLEA

City of Saskatoon

East Sector
Feasibility Study

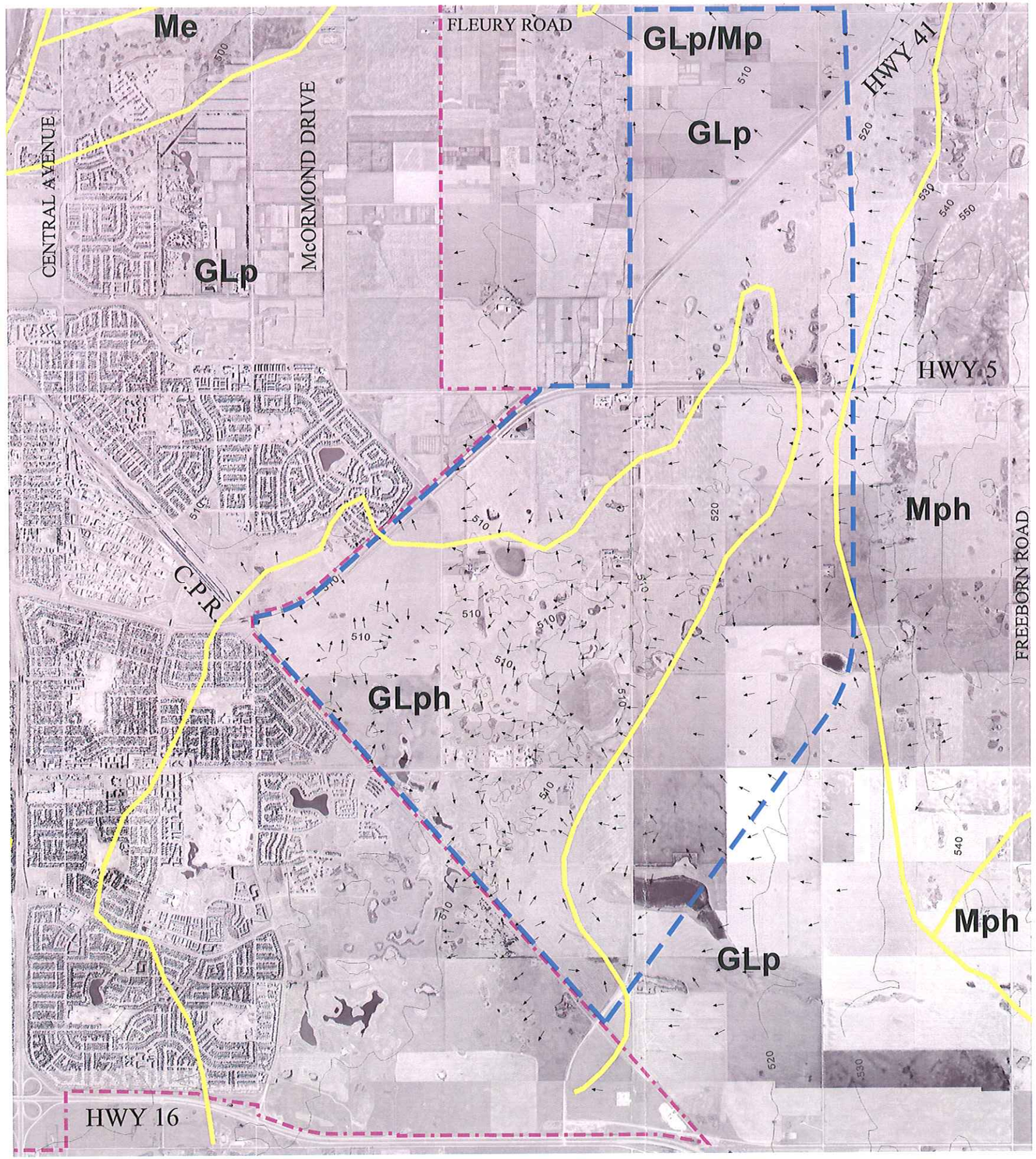
Transportation Desire Lines

DRAWING NUMBER	REV. NO.	SHEET
Drawing 2	D	2 / 7

R 5 | R 4

Tp 37

Tp 36



NOTE:

Me - MODERATE PROBABILITY FOR GRAVEL SOURCE

REFERENCE:

LAND FORMS FROM SURFICIAL GEOLOGY MAP OF SASKATOON AREA (73B) - SASKATCHEWAN RESEARCH COUNCIL

Legend

- City of Saskatoon Boundary
- Area Limits
- Elevation (m) — 480
- Land Form Boundary
- Glacio-Lacustrine Plain — GLp
- Hummocky Glacio-Lacustrine Plain — GLph
- Morainal Glacio-Lacustrine Plain — GLp/Mp
- Hummocky Morainal Plain — Mph
- Eroded Morraine — Me
- Surface Drainage Direction

NO.	DATE	ENG.	BY	SUBJECT
D	06\03\21	ADM	SWT	Final Report
C	05\10\26	ADM	SWT	Draft Final Report
B	05\07\22	ADM	SWT	Options Report
A	05\03\03	ADM	SWT	Interim Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
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DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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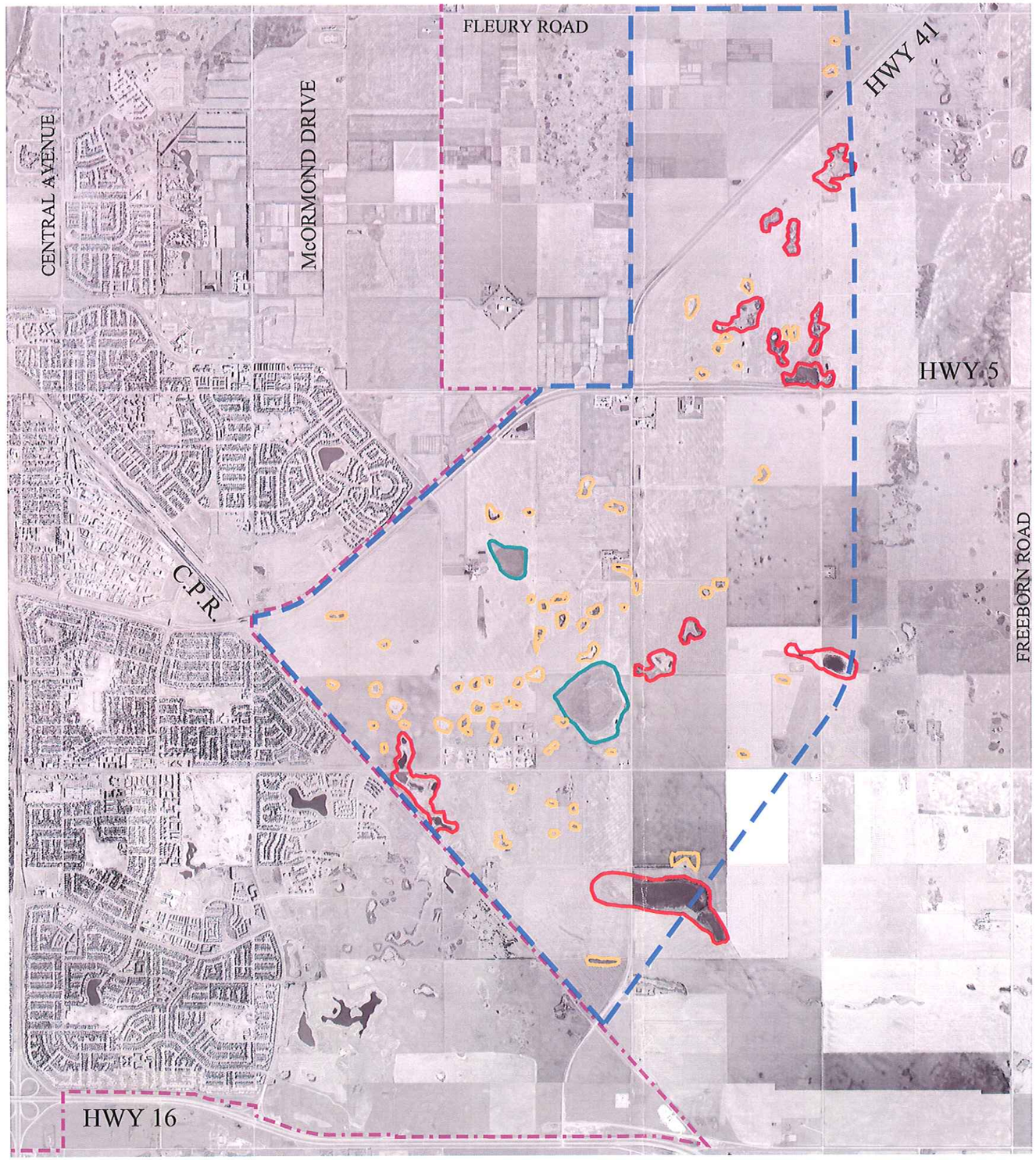
East Sector
Feasibility Study

Terrain Analysis and Drainage

DRAWING NUMBER	REV. NO.	SHEET
Drawing 3	D	3 / 7

R 5 | R 4

Tp 37



Tp 37

Tp 36

Tp 36

R 5 | R 4

Legend

- City of Saskatoon Boundary
- Area Limits
- Natural Area - Type 1
- Natural Area - Type 2
- Natural Area - Type 3

NO.	DATE	ENG.	BY	SUBJECT
D	06103121	AOM	SWT	Final Report
C	05110126	AOM	SWT	Draft Final Report
B	05107122	AOM	SWT	Options Report
A	05103103	AOM	SWT	Interim Report

REVISIONS

SCALE	1 : 40,000		
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DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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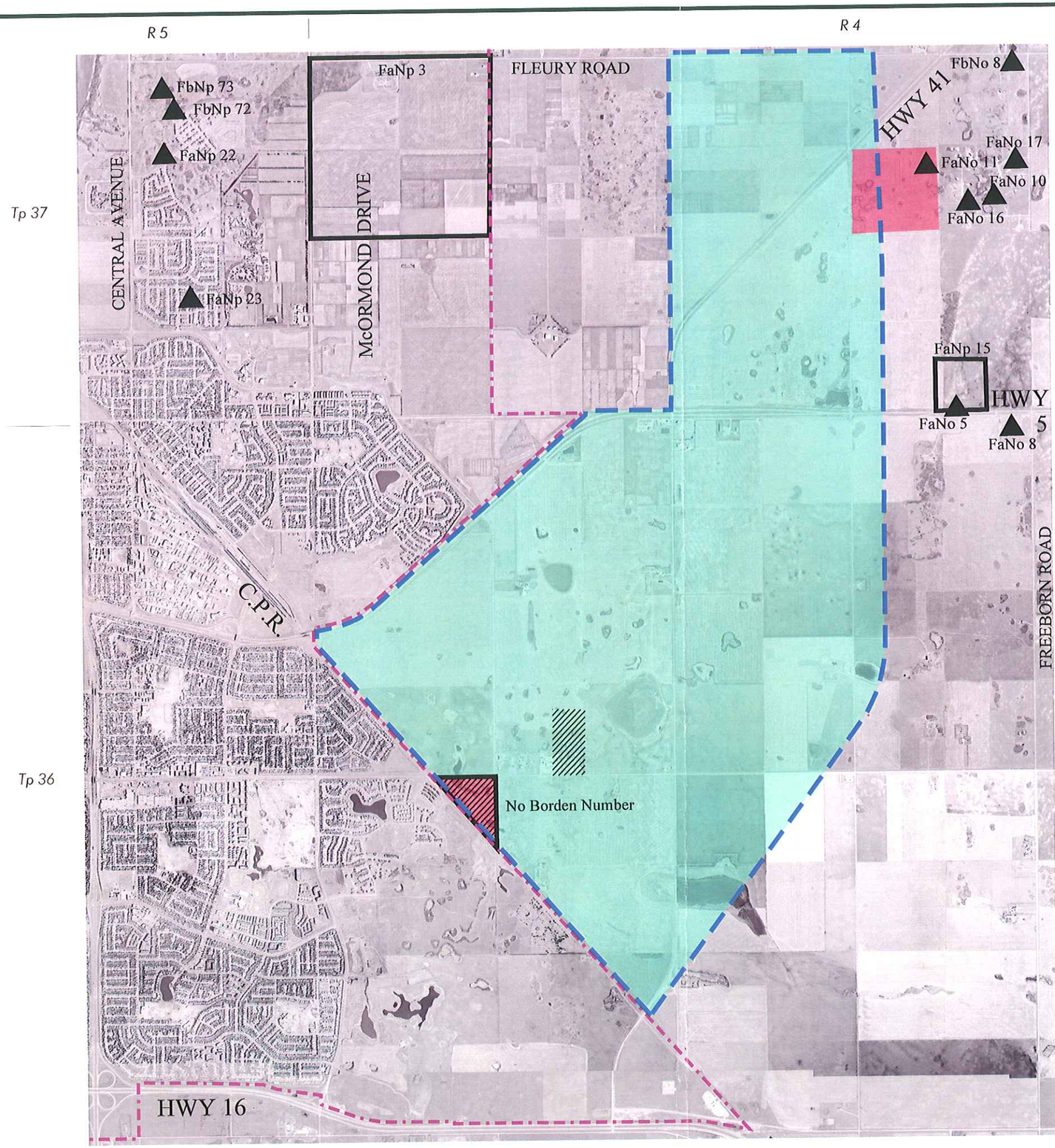
East Sector
Feasibility Study

Natural Resource Overview

DRAWING NUMBER	REV. NO.	SHEET
Drawing 4	D	4 / 7



Legend

- City of Saskatoon Boundary
- Area Limits
- Known Heritage Resource — Borden # / Borden #
- Previously Assessed (Permit 83-017)
- Areas of Relatively High Heritage Sensitivity
- Areas of Relatively Low Heritage Sensitivity

NO.	DATE	ENG.	BY	SUBJECT
D	06\03\21	AOM	SWT	Final Report
C	05\10\26	AOM	SWT	Draft Final Report
B	05\07\22	AOM	SWT	Options Report
A	05\03\03	AOM	SWT	Interim Report

REVISIONS

SCALE	1 : 40,000		
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DESIGNED	S. Miller		
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DATE			

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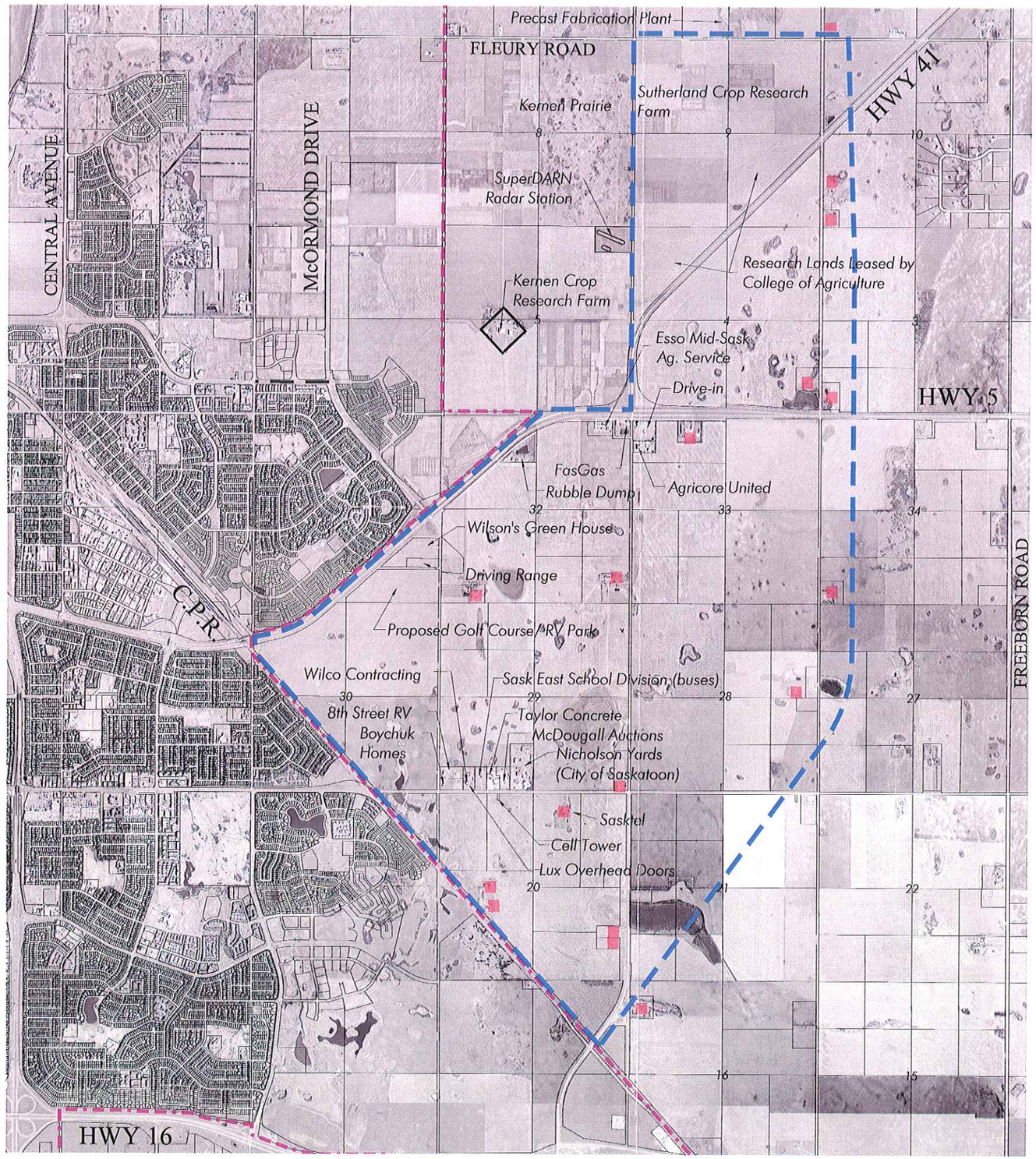
Feasibility Study

Heritage Resource Sensitivity

DRAWING NUMBER	REV. NO.	SHEET
Drawing 5	D	5 / 7



Legend

- City of Saskatoon Boundary
- Area Limits
- Residence

NO.	DATE	ENG.	BY	SUBJECT
D	06\03\21	AOM	SWT	Final Report
C	05\10\26	AOM	SWT	Draft Final Report
B	05\07\22	AOM	SWT	Options Report
A	05\03\03	AOM	SWT	Interim Report

REVISIONS

SCALE	1 : 40,000		
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DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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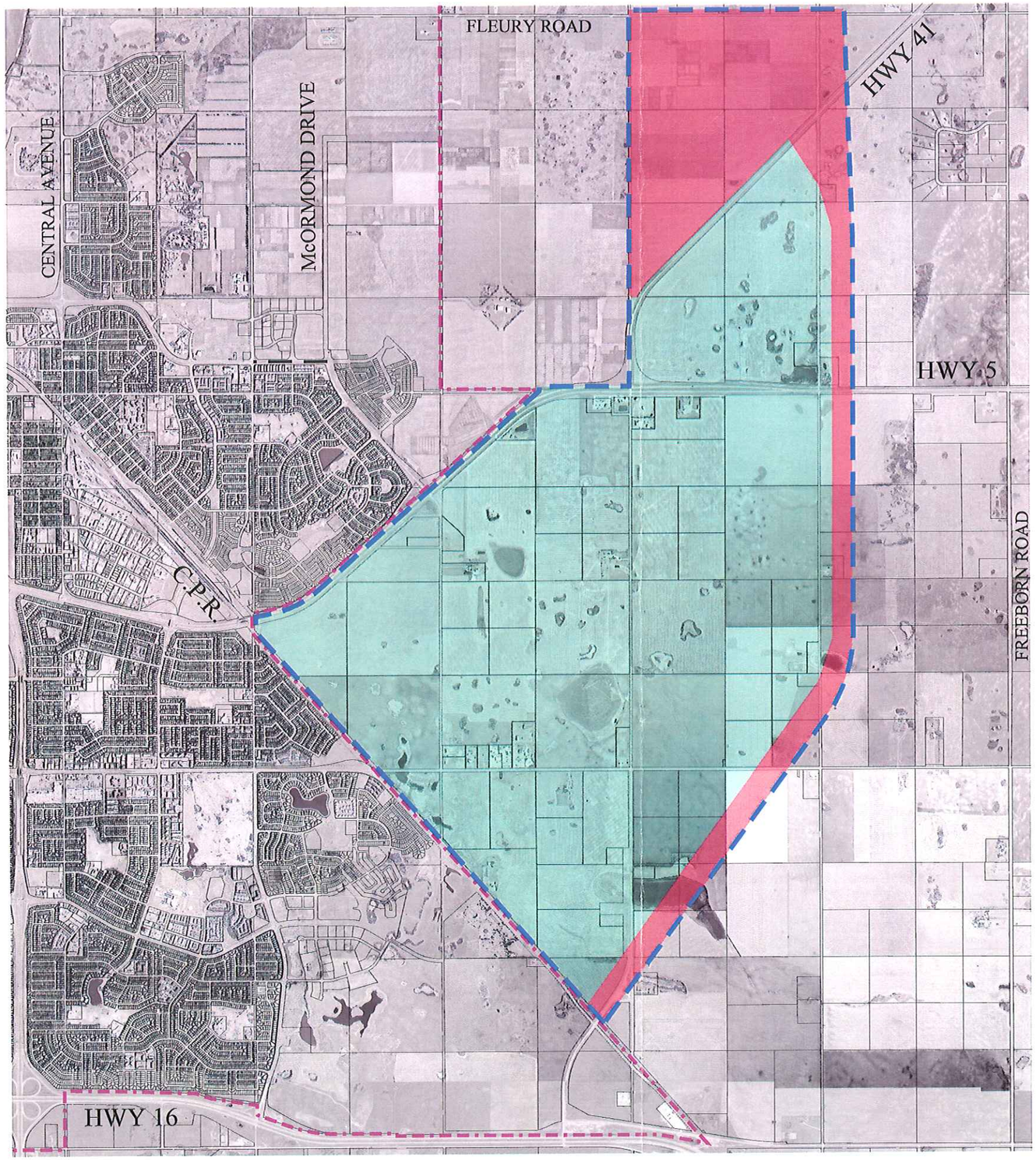
East Sector
Feasibility Study

Existing Land Use

DRAWING NUMBER	REV. NO.	SHEET
Drawing 6	D	6/7

R 5 | R 4

Tp 37



Tp 36

R 5 | R 4

Legend

- City of Saskatoon Boundary
- Area Limits
- Low Constraint
- Moderate Constraint
- High Constraint

NO.	DATE	ENG.	BY	SUBJECT
D	05\03\21	ADM	SWT	Final Report
C	05\10\26	ADM	SWT	Draft Final Report
B	05\07\22	ADM	SWT	Options Report
A	05\03\03	ADM	SWT	Interim Report

REVISIONS

SCALE	1 : 40,000		
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DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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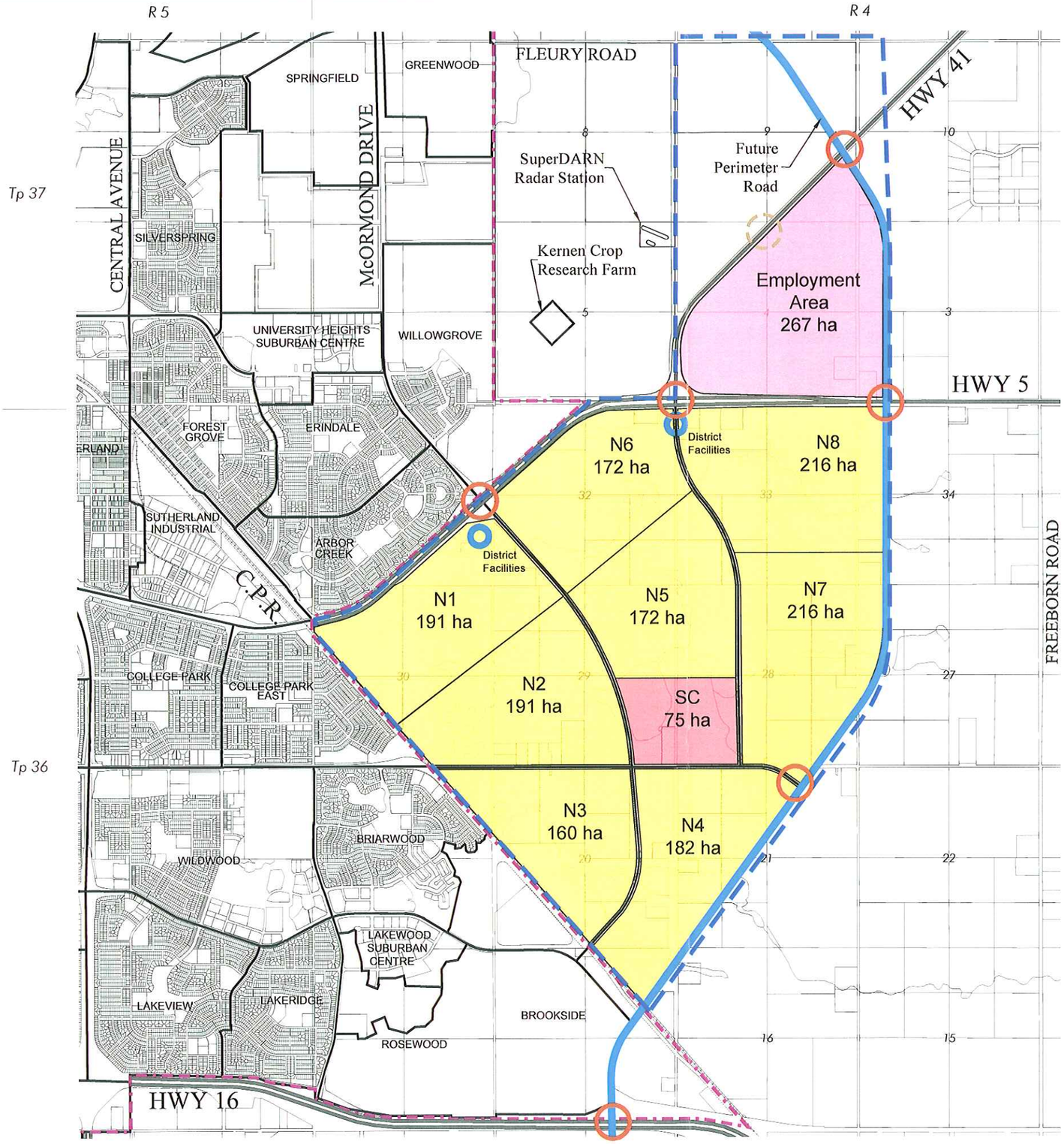
East Sector
Feasibility Study

Opportunity Window

DRAWING NUMBER	REV. NO.	SHEET
Drawing 7	D	7 / 7



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area
- Commercial / Institutional (Suburban Centre)
- Future Interchange
- Potential Future Interchange

NO.	DATE	ENG.	BY	SUBJECT
C	06\03\21	ADM	SWT	Final Report
B	05\10\26	ADM	SWT	Draft Final Report
A	05\07\22	ADM	SWT	Options Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN			
DESIGNED	A. Hanna		
CHECKED	A. Hanna		
APPROVED	A.O. Munro		
DATE			

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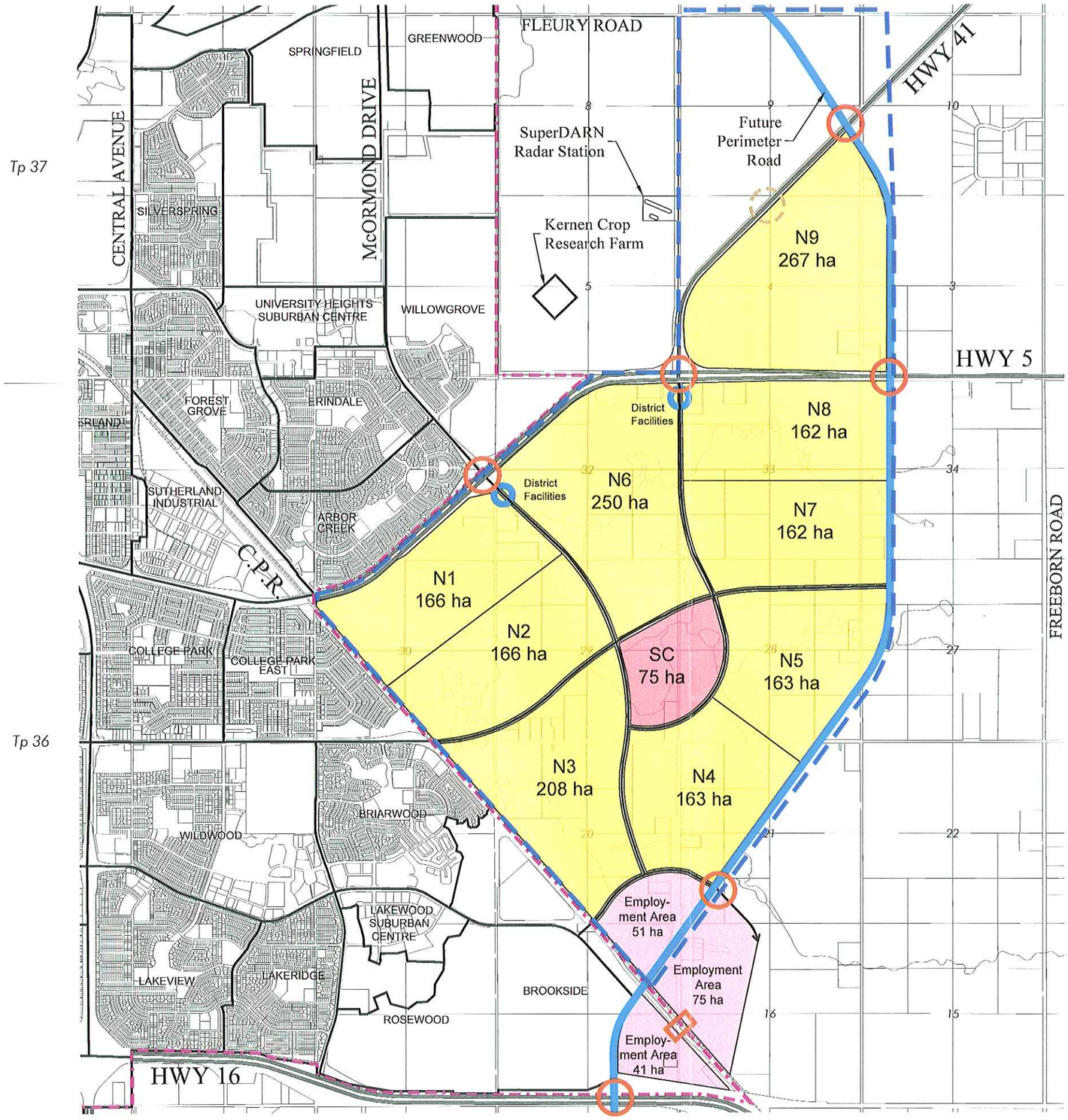
City of Saskatoon

East Sector
Feasibility Study

Development Concept 1

DRAWING NUMBER	REV. NO.	SHEET
Drawing 8	C	1 / 2



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area (EA)
- Commercial / Institutional (SC, EC)
- Future Interchange
- Potential Future Interchange
- Future Overpass

NO.	DATE	ENG.	BY	SUBJECT
C	06\03\21	AOM	SWT	Final Report
B	05\10\26	AOM	SWT	Draft Final Report
A	05\07\22	AOM	SWT	Options Report

REVISIONS

SCALE	1 : 40,000		
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DESIGNED	A. Hanna		
CHECKED	A. Hanna		
APPROVED	A.O. Munro		
DATE			

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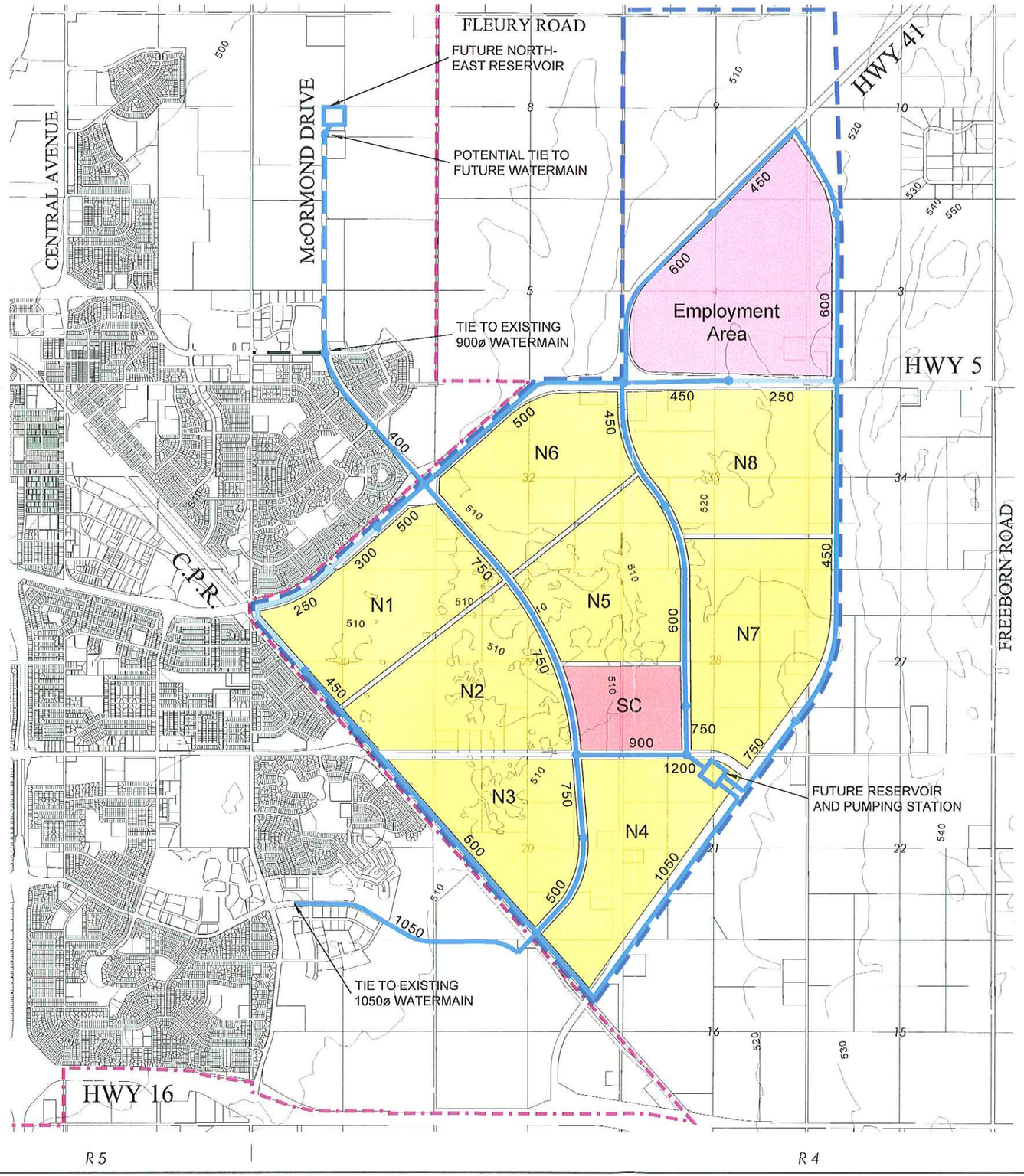
East Sector
Feasibility Study

Development Concept 2

DRAWING NUMBER	REV. NO.	SHEET
Drawing 9	C	2 / 2



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area (EA)
- Commercial / Institutional (SC, EC)
- Primary Watermain/ Diameter (mm) — +400
- Secondary Watermain/ Diameter (mm) — -400

NO.	DATE	ENG.	BY	SUBJECT
C	06\03\21	AOM	SWT	Final Report
B	05\10\26	AOM	SWT	Draft Final Report
A	05\07\22	AOM	SWT	Options Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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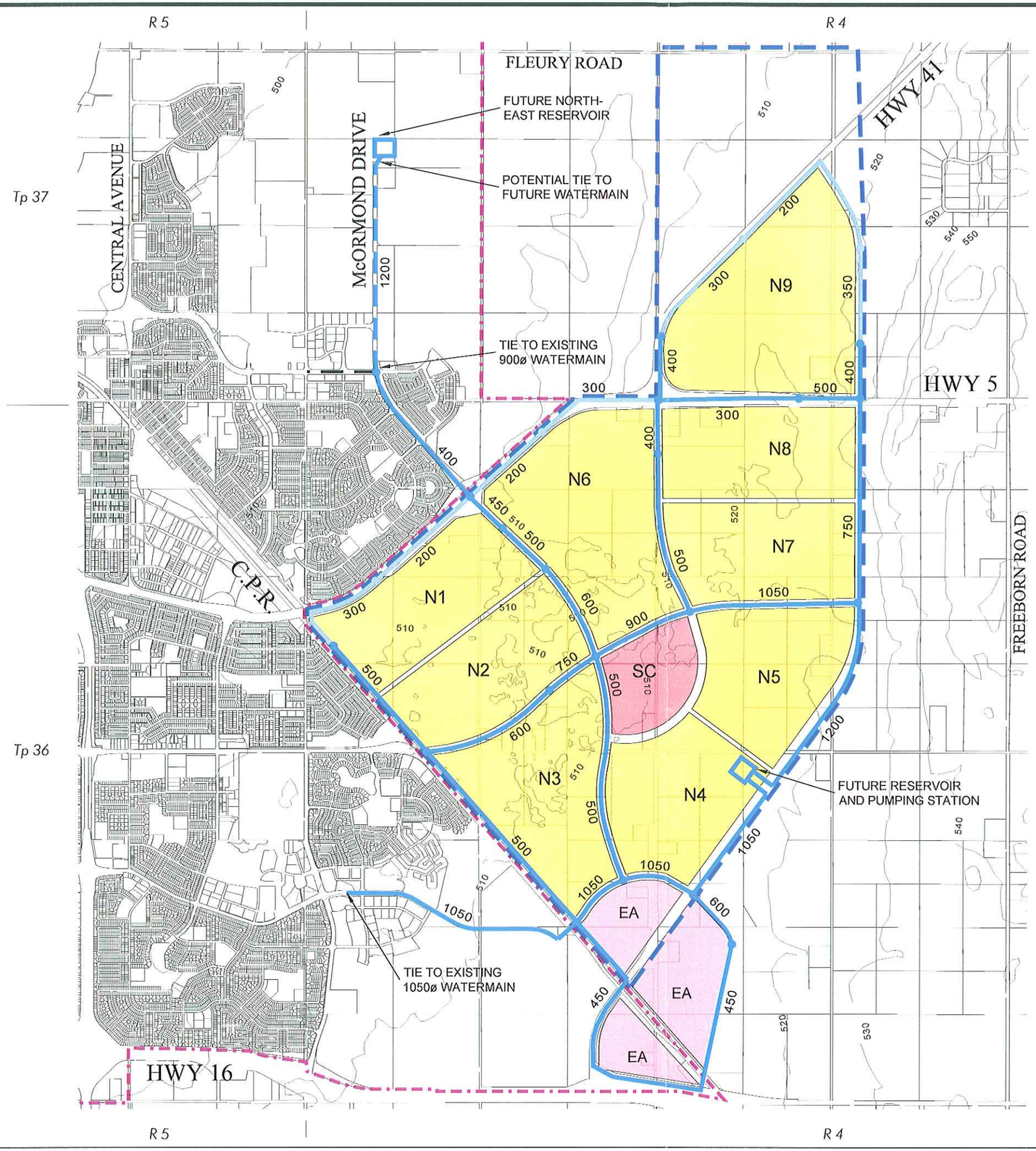
City of Saskatoon

EAST SECTOR
FEASIBILITY STUDY
CONCEPT 1 - WATER

WATER DISTRIBUTION

DRAWING NUMBER	REV. NO.	SHEET
Drawing 10	C	1 / 6



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area (EA)
- Commercial / Institutional (SC, EC)
- Primary Watermain/ Diameter (mm) — +400
- Secondary Watermain/ Diameter (mm) — -400

NO.	DATE	ENG.	BY	SUBJECT
C	05\03\21	AOM	SWT	Final Report
B	05\10\26	AOM	SWT	Draft Final Report
A	05\07\22	AOM	SWT	Options Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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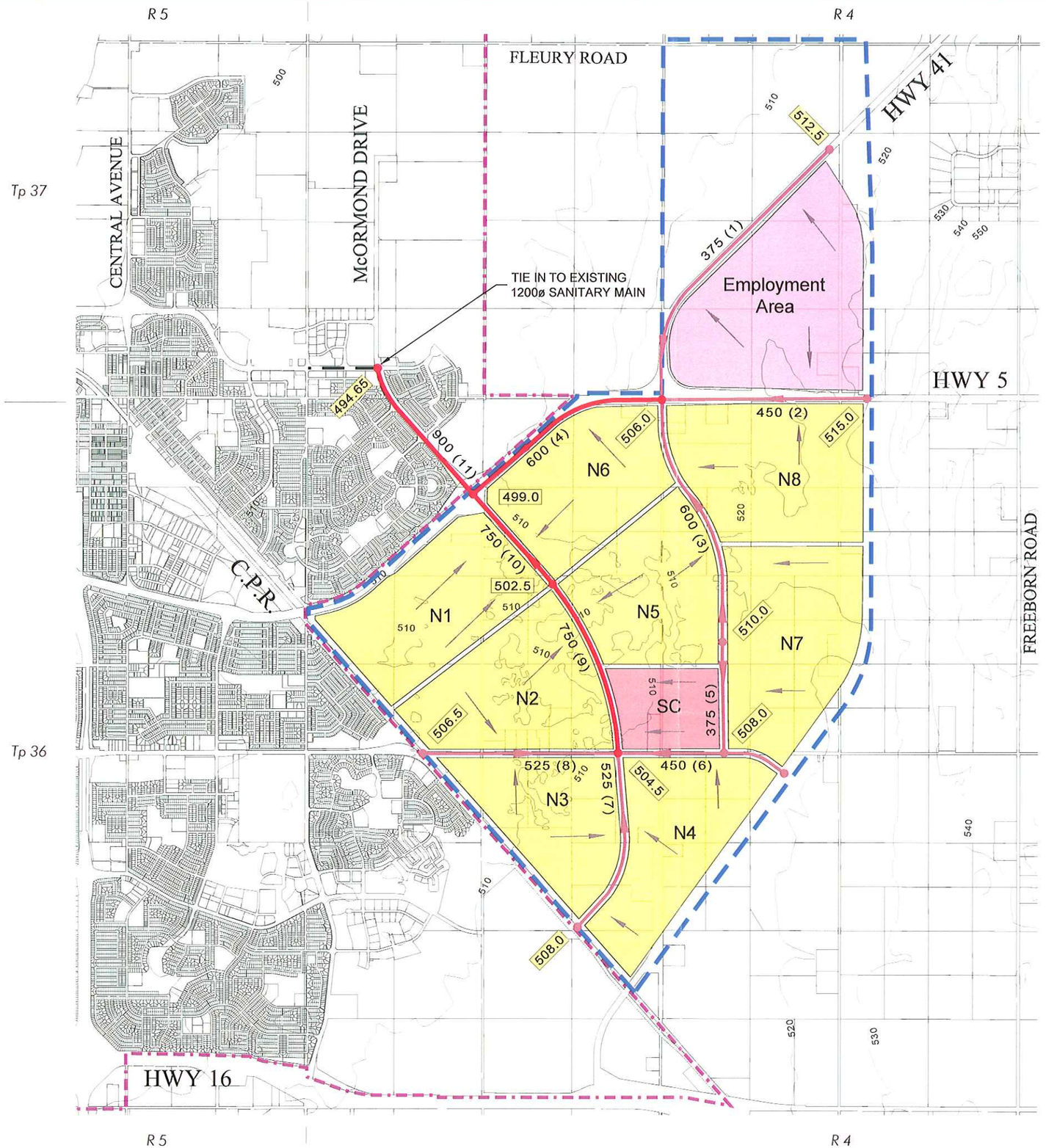
City of Saskatoon

EAST SECTOR
FEASIBILITY STUDY
CONCEPT 2 - WATER

WATER DISTRIBUTION

DRAWING NUMBER	REV. NO.	SHEET
Drawing 11	C	2 / 6



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area (EA)
- Commercial / Institutional (SC, EC)
- Primary Sewermain/ Diameter mm (I.D.#) — +600 (ID#)
- Secondary Sewermain/ Diameter mm (I.D.#) — -600 (ID#)
- Trunk Invert — 499.0

NO.	DATE	ENG.	BY	SUBJECT
C	06\03\21	AOM	SWT	Final Report
B	05\10\26	AOM	SWT	Draft Final Report
A	05\07\22	AOM	SWT	Options Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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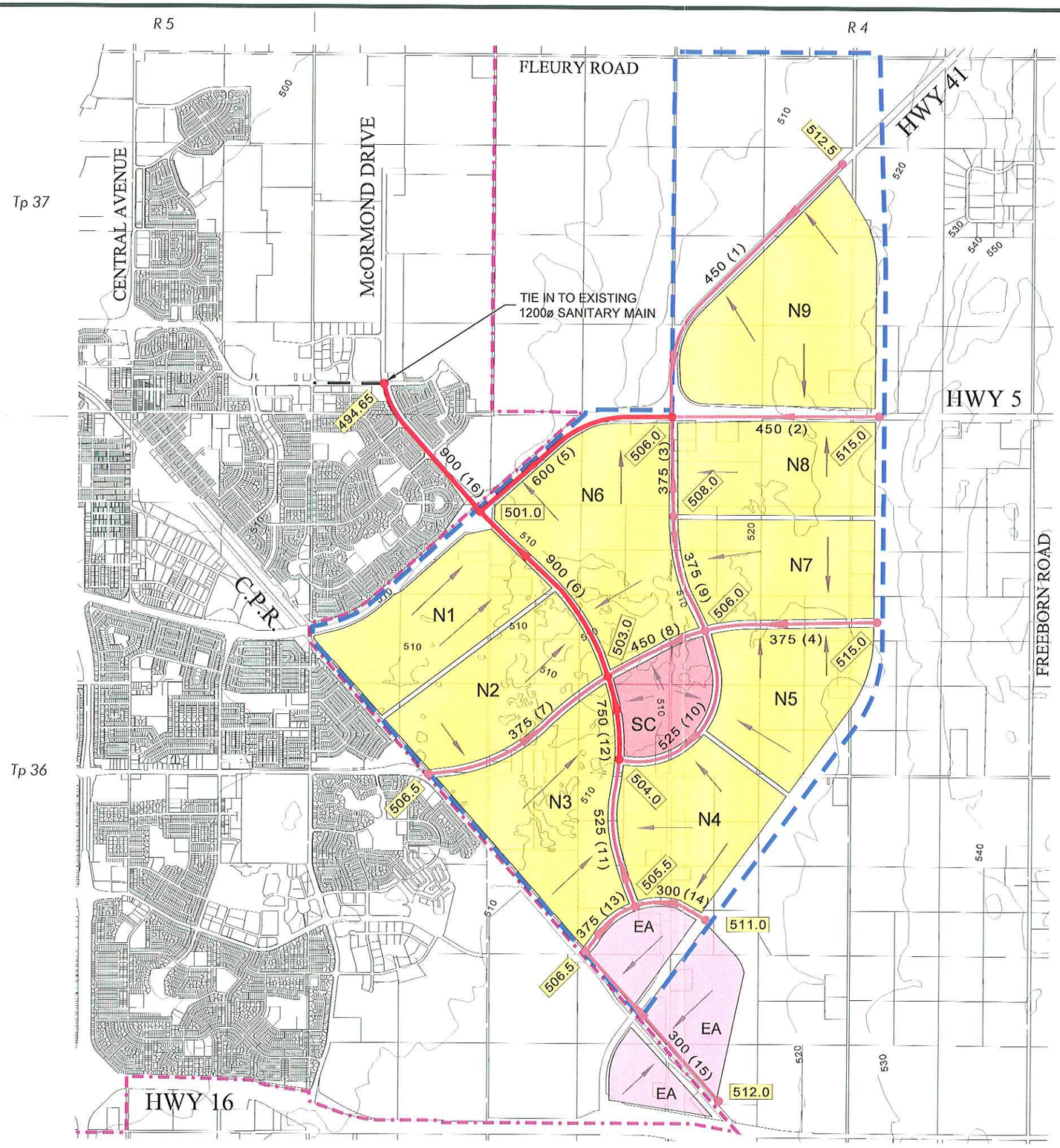
City of Saskatoon

EAST SECTOR
FEASIBILITY STUDY
CONCEPT 1 - SANITARY

SEWAGE COLLECTION

DRAWING NUMBER	REV. NO.	SHEET
Drawing 12	C	3 / 6



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area (EA)
- Commercial / Institutional (SC, EC)
- Primary Sewermain/ Diameter mm (I.D.#) — +600 (ID#)
- Secondary Sewermain/ Diameter mm (I.D.#) — -600 (ID#)
- Trunk Invert — 499.0

NO.	DATE	ENG.	BY	SUBJECT
C	06\03\21	AOM	SWT	Final Report
B	05\10\26	AOM	SWT	Draft Final Report
A	05\07\22	AOM	SWT	Options Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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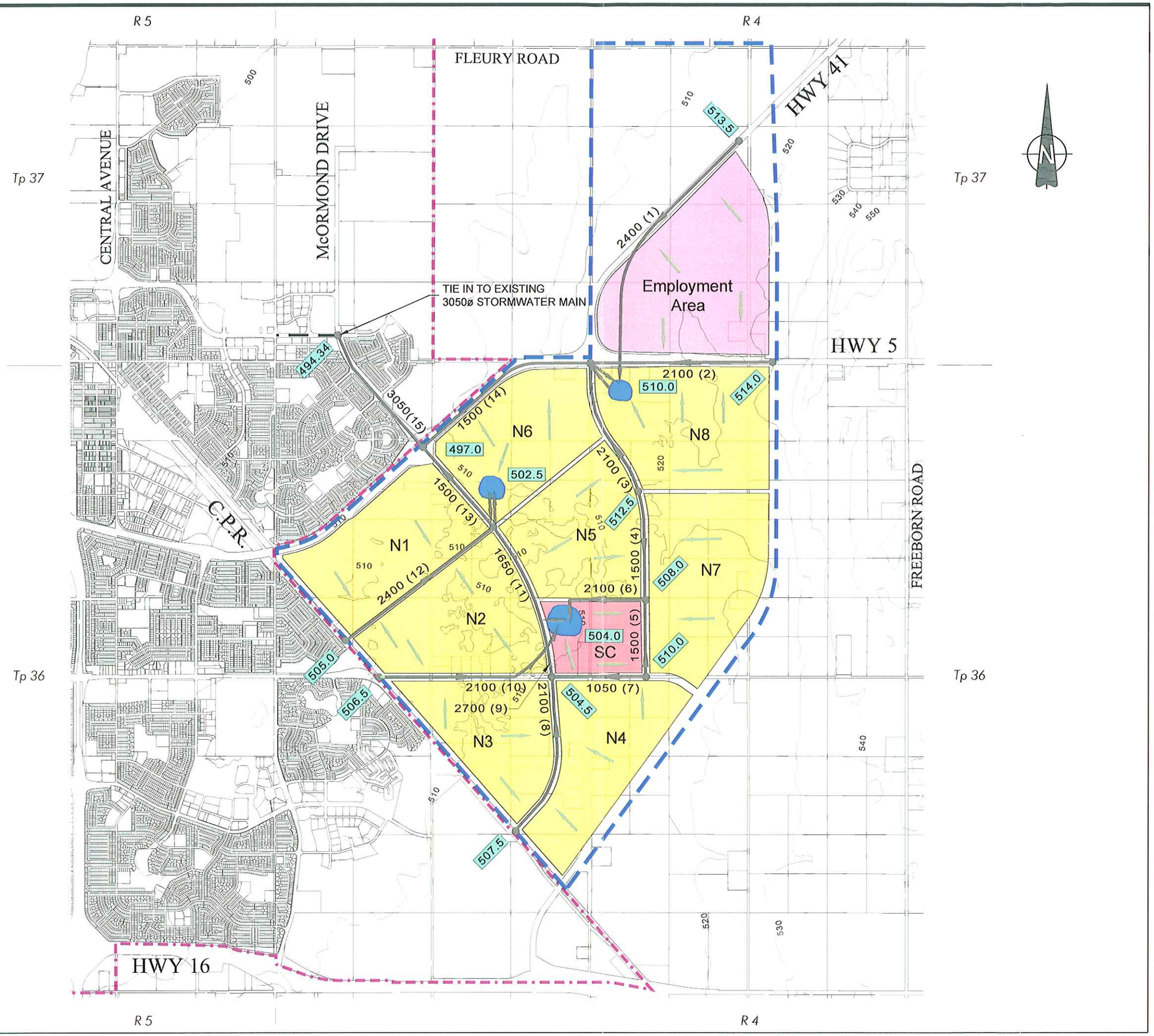
City of Saskatoon

EAST SECTOR
FEASIBILITY STUDY
CONCEPT 2 - SANITARY

SEWAGE COLLECTION

DRAWING NUMBER	REV. NO.	SHEET
Drawing 13	C	4 / 6



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area (EA)
- Commercial / Institutional (SC, EC)
- Primary Stormmain/ Diameter (mm) — +2000 (ID#)
- Drainage and Secondary Collector
- Trunk Invert — 499.0
- Storm Water Retention Pond

NO.	DATE	ENG.	BY	SUBJECT
C	06\03\21	ADM	SWT	Final Report
B	05\10\26	ADM	SWT	Draft Final Report
A	05\07\22	ADM	SWT	Options Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

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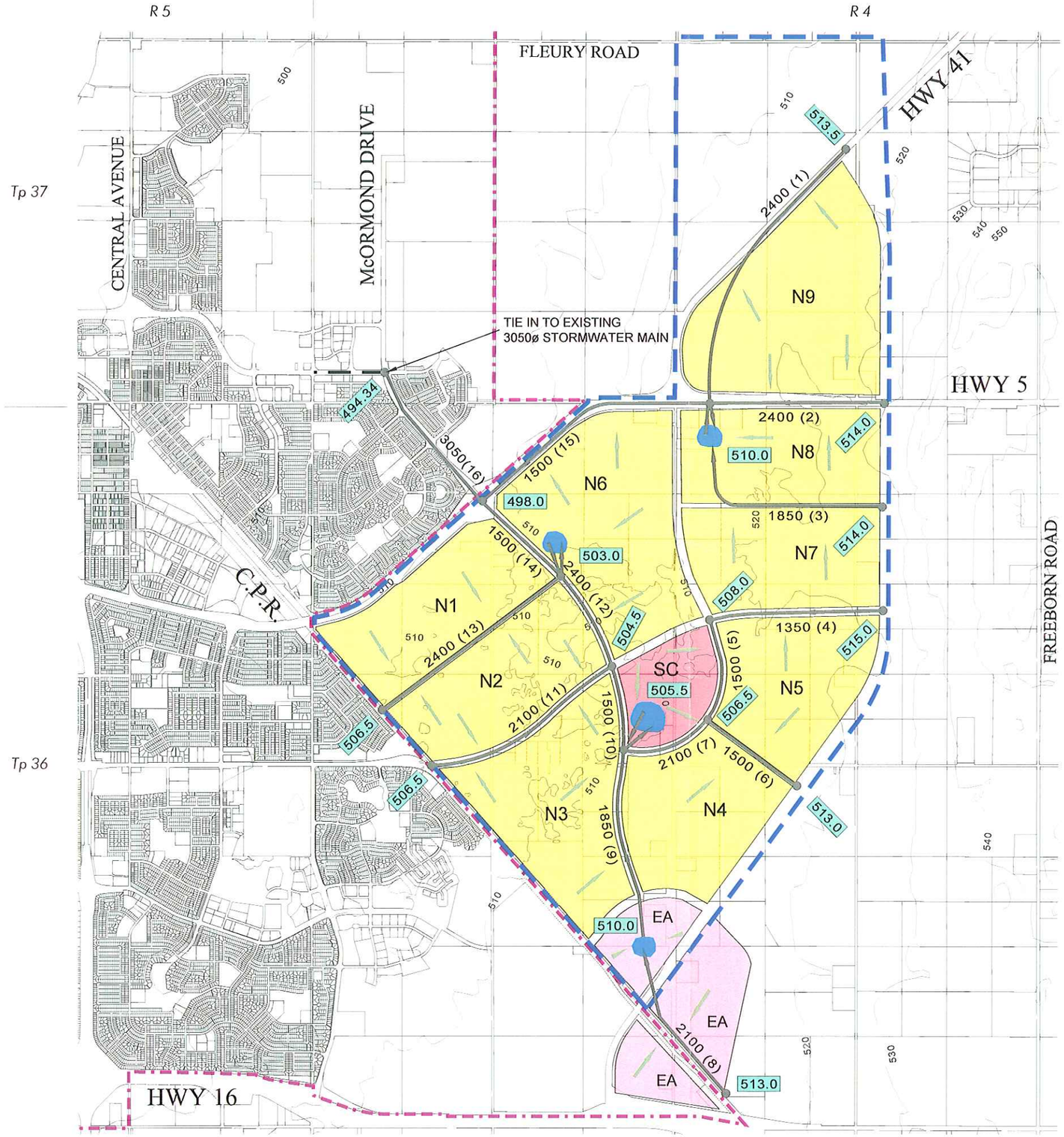
Landscape Architecture and Planning

City of Saskatoon

EAST SECTOR
FEASIBILITY STUDY
CONCEPT 1 - STORM WATER

STORM WATER COLLECTION

DRAWING NUMBER	REV. NO.	SHEET
Drawing 14	C	5 / 6



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area (EA)
- Commercial / Institutional (SC, EC)
- Primary Stormmain/ Diameter (mm) — +2000 (ID#)
- Drainage and Secondary Collector
- Trunk Invert — 499.0
- Storm Water Retention Pond

NO.	DATE	ENG.	BY	SUBJECT
				REVISIONS
C	06103121	ADM	SWT	Final Report
B	05110126	ADM	SWT	Draft Final Report
A	05107122	ADM	SWT	Options Report

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

Associated Engineering

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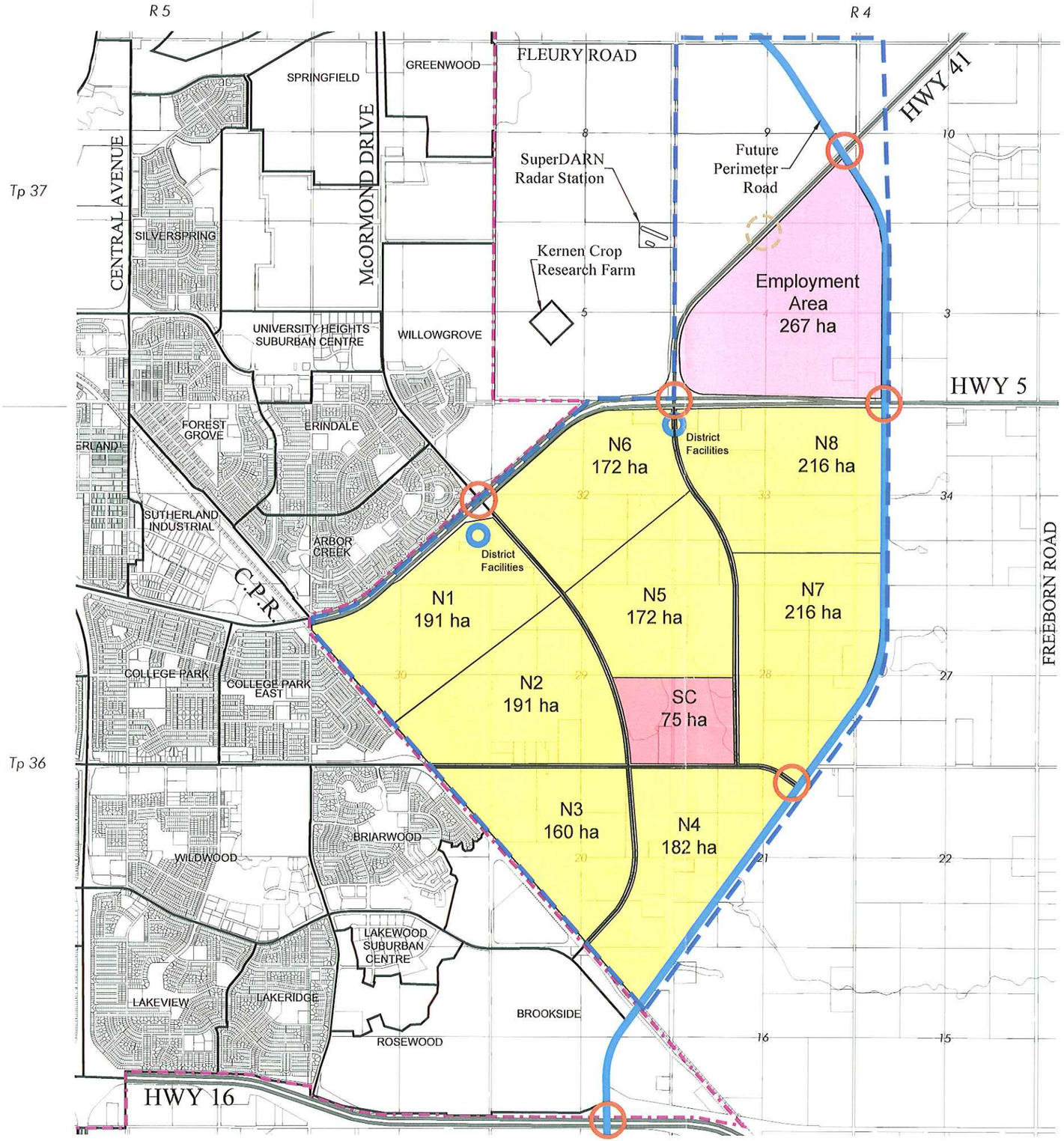
LANDSCAPE ARCHITECTURE AND PLANNING

City of Saskatoon

EAST SECTOR
FEASIBILITY STUDY
CONCEPT 2 - STORM

STORM WATER COLLECTION

DRAWING NUMBER	REV. NO.	SHEET
Drawing 15	C	6 / 6



Legend

- City of Saskatoon Boundary
- Area Limits
- Residential (N)
- Employment Area (EA)
- Commercial / Institutional (SC, EC)
- Future Interchange
- Potential Future Interchange

NO.	DATE	ENG.	BY	SUBJECT
B	06\03\21	AOM	SWT	Final Report
A	05\10\26	AOM	SWT	Draft Final Report

REVISIONS

SCALE	1 : 40,000		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	A. Hanna		
CHECKED	A. Hanna		
APPROVED	A.O. Munro		
DATE			

Associated Engineering

Crosby Hanna & Associates
Landscape Architecture and Planning

City of Saskatoon

East Sector
Feasibility Study

Concept 1 - Recommended

DRAWING NUMBER	REV. NO.	SHEET
Drawing 16	B	1 / 1

B Appendix B - References

REFERENCES

Acton, D.F., G.A. Padbury, and C.T. Stushnoff

1998 The Ecoregions of Saskatchewan. Canadian Plains Research Center. University of Regina.

Business Services Improvement Branch

2001 *The Provincial Regulatory Approval Process in Saskatchewan for Petroleum and Natural Gas Drilling and Exploration*. Economic and Co-operative Development, Regina.

Christiansen, E.A.

1967 Geology and Groundwater Resources of the Saskatoon Area (73-B), Saskatchewan, Saskatchewan Research Council Geology Division, Saskatoon, Canada, Map No. 7.

City of Saskatoon

1999 Future Growth Study, Community Services, City Planning Branch.

City of Saskatoon

2003 Water and Sewer Design Standards Infrastructure Services Department.

Dyck, I.G.

1983 The Prehistory of Southern Saskatchewan. In *Tracking Ancient Hunters*, edited by H.T. Epp and I. Dyck, pp. 63-139. Saskatchewan Archaeological Society, Saskatoon.

Germann, C. and B.E. Spurling

1986 Archaeological Resource Impact Assessment in Western Canada. *Impact Assessment Bulletin* 4(1-2): 75-98.

Heritage Resources - Archaeology

1989 *South Saskatchewan River Basin Study: Heritage Resources*. Submitted to Water Use Technical Committee, South Saskatchewan River Basin Study. Moose Jaw, Saskatchewan.

Linnamae, U., E.G. Walker, and D.L. Kelly

1988 A Summary of the Archaeology of the Saskatoon Area. In *Out of the Past: Sites, Digs and Artifacts in the Saskatoon Area*. Pp. 155-171.

Meyer, D.A.

1993 People before Kelsey: An Overview of Cultural Developments. In *Three Hundred Prairie Years: "Henry Kelsey's Inland Country of Good Report"*, edited by Henry Epp, pp. 54-73. Canadian Plains Research Centre, University of Regina, Regina.

C Appendix C - Municipal Utilities Model Results

East Sector Study - Water Distribution Model Methodology
October 28, 2005

Modelling Objectives:

1. To develop preliminary potable water demand requirements for East Sector development. This includes the demands from each neighborhood and employment area and then total demands for average day, peak day, peak hour, peak hour fire flow at system critical location. Include the entire study area plus additional adjacent future development areas (Willowgrove, Rosewood, Brookeside).
2. To determine preliminary capacity of the proposed East Sector Pump Station to meet the pressure-flow design requirements for the East Sector System.
3. To evaluate preliminary layout and sizing for primary water distribution system mains.

Methodology

WaterCAD will be used to model flows in a simplified distribution system to determine if residual systems pressures are adequate for two flow scenarios: average day, and peak hour with fire flow.

The simplified model will not be coupled directly to the City of Saskatoon distribution system model. Instead, a flow-pressure function will be used as source terms for the model at the following locations:

1. McCormand Dr.and Attridge Dr.
2. Taylor St and Briarvale Road

A reservoir with constant water elevation will be used as a source term for the proposed East Sector Pumpstation.

It is assumed that the City can supply the flow-pressure functions from the results of their full distribution system model. Within the WaterCAD model, a pump element will be used to model these flow-pressure functions.

The analysis will focus on the requirements of the East Sector Pump Station and Reservoir based on the requirements of the East Sector System and the flow available from the other two tie-in points.

The analysis will also be used to determine the preliminary distribution main sizing requirements.

Deliverables

- The required flow and pressure at the East Sector Pumpstation to produce pipe flow conditions meeting design standards under the simulated demand conditions

- The corresponding available flow and pressure at Tie-in points 1 and 2 to produce pipe flow conditions meeting design standards under the simulated demand conditions.

- The estimated primary pipe sizes required to facilitate design velocity and pressure requirements.

Scenario: Peak Hour + fire flow at 31
Steady State Analysis
Pipe Report

Link Label	Length (m)	Diameter (mm)	Material	Roughness	Minor Loss	Initial Status	Current Status	Discharge (l/s)	Start Calculated Hydraulic Grade (m)	Headloss (m)	End Calculated Hydraulic Grade (m)	Friction Slope (m/km)	Velocity (m/s)
P-3	398.00	400	PVC	140.0	0.00	Open	Open	-131.38	557.22	0.92	558.14	2.30	1.05
P-93	70.50	200	PVC	140.0	0.00	Open	Open	0.47e-4	557.22	0.00	557.22	0.00	0.15e-5
P-30	1,145.50	400	PVC	140.0	0.00	Open	Open	-131.38	558.14	2.63	560.77	2.30	1.05
P-79	302.50	750	PVC	140.0	0.00	Open	Open	-437.50	561.76	0.30	562.06	1.00	0.99
P-6	474.50	750	PVC	140.0	0.00	Open	Open	-524.06	562.59	0.66	563.25	1.39	1.19
P-7	399.00	750	PVC	140.0	0.00	Open	Open	-642.26	563.25	0.81	564.06	2.03	1.45
P-14	966.50	900	PVC	140.0	0.00	Open	Open	-633.27	564.06	0.79	564.84	0.81	1.00
P-81	426.00	750	PVC	140.0	0.00	Open	Open	-8.99	564.06	0.33e-3	564.06	0.79e-3	0.02
P-83	242.50	500	PVC	140.0	0.00	Open	Open	-71.00	564.07	0.06	564.13	0.25	0.36
P-26	257.50	500	PVC	140.0	0.00	Open	Open	-133.01	564.33	0.20	564.53	0.79	0.68
P-59	308.00	1,050	PVC	140.0	0.00	Open	Open	-404.61	564.63	0.05	564.68	0.17	0.47
P-100	572.50	1,050	PVC	150.0	0.00	Open	Open	88.65	564.63	0.01	564.62	0.01	0.10
P-103	177.50	750	PVC	140.0	0.00	Open	Open	315.96	564.63	0.10	564.53	0.55	0.72
P-12	683.00	1,050	PVC	140.0	0.00	Open	Open	-645.65	564.86	0.27	565.13	0.40	0.75
P-13	360.00	1,050	PVC	140.0	0.00	Open	Open	-645.65	565.13	0.14	565.27	0.40	0.75
P-85	439.50	750	PVC	140.0	0.00	Open	Open	508.13	564.84	0.58	564.27	1.32	1.15
P-98	262.50	1,200	PVC	140.0	0.00	Open	Open	-1,141.40	564.84	0.16	565.00	0.60	1.01
P-16	513.50	600	PVC	140.0	0.00	Open	Open	266.62	561.34	0.61	560.73	1.18	0.94
P-17	601.00	450	PVC	140.0	0.00	Open	Open	187.90	560.73	1.51	559.22	2.51	1.18
P-35	415.00	450	PVC	140.0	0.00	Open	Open	109.19	559.22	0.38	558.84	0.92	0.69
P-19	743.50	600	PVC	140.0	0.00	Open	Open	166.08	558.77	0.37	558.41	0.49	0.59
P-89	1,009.50	600	PVC	140.0	0.00	Open	Open	148.74	558.41	0.41	558.00	0.40	0.53
P-21	476.50	450	PVC	140.0	0.00	Open	Open	131.41	557.85	0.62	557.23	1.30	0.83
P-22	677.00	450	PVC	140.0	0.00	Open	Open	-105.92	557.23	0.59	557.82	0.87	0.67
P-91	907.50	600	PVC	140.0	0.00	Open	Open	-123.25	557.82	0.26	558.08	0.28	0.44
P-24	476.50	450	PVC	140.0	0.00	Open	Open	-207.37	562.38	1.44	563.81	3.02	1.30
P-65	320.50	450	PVC	140.0	0.00	Open	Open	-207.37	563.81	0.97	564.78	3.02	1.30
P-57	663.50	500	PVC	140.0	0.00	Open	Open	182.95	564.53	0.95	563.58	1.43	0.93
P-49	594.50	250	PVC	140.0	0.00	Open	Open	27.62	561.39	0.75	560.64	1.27	0.56
P-75	521.00	500	PVC	140.0	0.00	Open	Open	182.61	560.77	0.74	560.03	1.43	0.93
P-77	533.00	750	PVC	140.0	0.00	Open	Open	-363.87	560.77	0.38	561.15	0.71	0.82
P-73	180.00	500	PVC	140.0	0.00	Open	Open	147.72	559.35	0.17	559.18	0.96	0.75
P-36	128.00	600	PVC	140.0	0.00	Open	Open	166.08	558.84	0.06	558.77	0.49	0.59
P-71	867.50	450	PVC	140.0	0.00	Open	Open	55.95	558.84	0.23	558.60	0.27	0.35
P-69	555.50	450	PVC	140.0	0.00	Open	Open	-128.47	558.36	0.69	559.05	1.24	0.81

Scenario: Peak Hour + fire flow at 31
Steady State Analysis
Pipe Report

Link Label	Length (m)	Diameter (mm)	Material	Roughness	Minor Loss	Initial Status	Current Status	Discharge (l/s)	Start Calculated Hydraulic Grade (m)	Headloss (m)	End Calculated Hydraulic Grade (m)	Friction Slope (m/km)	Velocity (m/s)
P-63	723.50	1,050	PVC	140.0	0.00	Open	Open	-0.13e-3	564.62	0.00	564.62	0.00	0.16e-6
P-101	127.50	1,050	PVC	140.0	0.00	Open	Open	0.17e-3	564.62	0.00	564.62	0.00	0.2e-6
P-46	329.00	400	PVC	140.0	0.00	Open	Open	-131.38	556.46	0.76	557.22	2.30	1.05
P-48	540.00	500	PVC	140.0	0.00	Open	Open	-49.88	560.70	0.07	560.77	0.13	0.25
P-50	642.50	300	PVC	140.0	0.00	Open	Open	-11.13	560.64	0.06	560.70	0.10	0.16
P-52	494.00	250	PVC	140.0	0.00	Open	Open	27.62	562.02	0.63	561.39	1.27	0.56
P-54	700.00	450	PVC	140.0	0.00	Open	Open	66.37	562.27	0.26	562.02	0.37	0.42
P-56	955.50	500	PVC	140.0	0.00	Open	Open	118.04	562.88	0.61	562.27	0.64	0.60
P-58	703.00	500	PVC	140.0	0.00	Open	Open	150.49	563.58	0.70	562.88	1.00	0.77
P-60	635.00	1,050	PVC	140.0	0.00	Open	Open	-531.20	564.68	0.18	564.86	0.28	0.61
P-62	764.00	1,050	PVC	140.0	0.00	Open	Open	-59.10	564.62	0.36e-2	564.62	0.48e-2	0.07
P-64	745.50	1,050	PVC	140.0	0.00	Open	Open	-29.55	564.62	0.1e-2	564.62	0.13e-2	0.03
P-99	658.00	750	PVC	140.0	0.00	Open	Open	-242.44	564.78	0.22	565.00	0.33	0.55
P-68	323.50	450	PVC	140.0	0.00	Open	Open	-207.37	561.40	0.98	562.38	3.01	1.30
P-70	1,096.50	450	PVC	140.0	0.00	Open	Open	-172.30	559.05	-2.35	561.40	2.14	1.08
P-72	871.50	250	PVC	140.0	0.00	Open	Open	12.12	558.60	0.24	558.36	0.28	0.25
P-74	581.50	500	PVC	140.0	0.00	Open	Open	112.84	559.18	0.34	558.84	0.59	0.57
P-76	702.50	500	PVC	140.0	0.00	Open	Open	147.72	560.03	0.68	559.35	0.96	0.75
P-78	612.00	750	PVC	140.0	0.00	Open	Open	-437.50	561.15	0.61	561.76	1.00	0.99
P-80	378.50	750	PVC	140.0	0.00	Open	Open	-524.06	562.06	0.53	562.59	1.39	1.19
P-82	427.00	750	PVC	140.0	0.00	Open	Open	-71.00	564.06	0.01	564.07	0.03	0.16
P-84	246.50	500	PVC	140.0	0.00	Open	Open	-133.01	564.13	0.20	564.33	0.79	0.68
P-87	781.50	600	PVC	140.0	0.00	Open	Open	406.53	564.27	2.02	562.25	2.58	1.44
P-88	502.00	600	PVC	140.0	0.00	Open	Open	336.57	562.25	0.91	561.34	1.82	1.19
P-90	471.00	600	PVC	140.0	0.00	Open	Open	131.41	558.00	0.15	557.85	0.32	0.46
P-92	786.00	600	PVC	140.0	0.00	Open	Open	-140.58	558.08	0.28	558.36	0.36	0.50
P-95	111.50	1,050	PVC	140.0	0.00	Open	Open	-645.65	509.96	0.04	510.00	0.40	0.75
P-96	80.00	200	PVC	140.0	0.00	Open	Open	0.47e-4	506.00	0.00	506.00	0.00	0.15e-5
P-102	126.50	1,050	PVC	140.0	0.00	Open	Open	-0.18e-3	520.00	0.00	520.00	0.00	0.21e-6

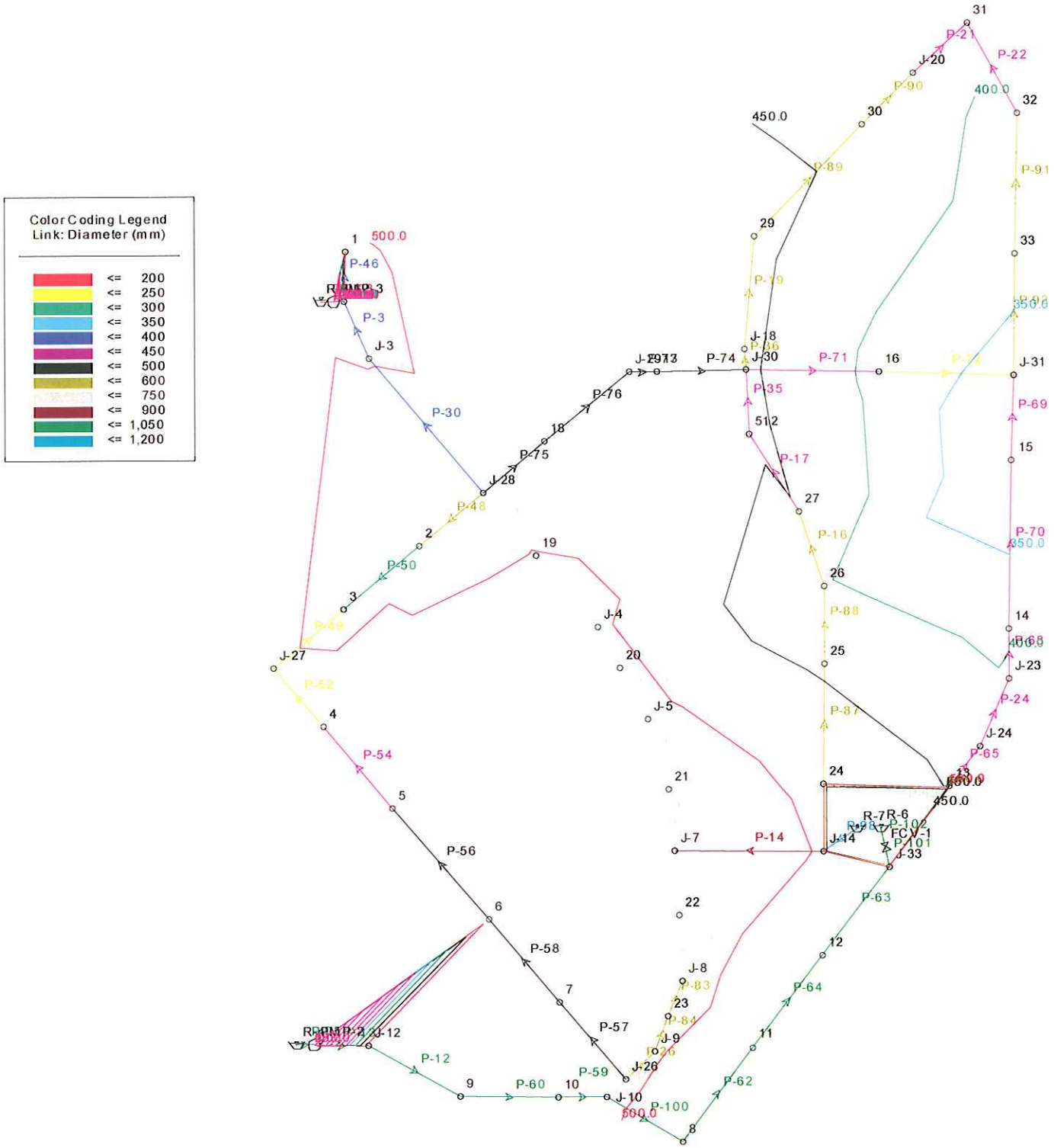
Scenario: Peak Hour + fire flow at 31
Steady State Analysis
Reservoir Report

Node Label	Reservoir Surface Elevation (m)	Reservoir Inflow (l/s)	Calculated Hydraulic Grade (m)
R-4	510.00	-645.65	510.00
R-5	506.00	0.47e-4	506.00
R-7	565.00	1,383.83	565.00
R-6	520.00	-0.18e-3	520.00

Scenario: Peak Hour + fire flow at 31
Steady State Analysis
Pump Report

Link Label	Input Pump Power (kW)	Shutoff Head (m)	Shutoff Discharge (l/s)	Design Head (m)	Design Discharge (l/s)	Maximum Operating Head (m)	Maximum Operating Discharge (l/s)	Current Status	Start Calculated Hydraulic Grade (m)	End Calculated Hydraulic Grade (m)	Discharge (l/s)	Pump Head (m)	Current Water Power (kW)
PMP-2		56.61	0.00	38.37	3,258.94	0.00	6,517.88	On	509.96	565.27	645.65	55.32	349.61
PMP-3		38.07	0.00	26.65	854.56	0.00	1,709.12	Pump cannot deliver head (Clc	506.00	557.22	0.00	0.00	0.00

Contour Plot - Pressure
Scenario: Peak Hour + fire flow at 31



Title: COS East Sector
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05/08/06 11:10:09 AM © Haestad Methods, Inc.

ASSOCIATED ENGINEERING LTD.
37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

Project Engineer: Scott Miller
WaterCAD v3.1 [071]

Scenario: Peak Hour Plus Fire Flow @9
Steady State Analysis
Pipe Report

Link Label	Length (m)	Diameter (mm)	Material	Roughness	Minor Loss	Initial Status	Current Status	Discharge (l/s)	Start Calculated Hydraulic Grade (m)	Headloss (m)	End Calculated Hydraulic Grade (m)	Friction Slope (m/km)	Velocity (m/s)
P-2	460.00	400	PVC	140.0	0.00	Open	Open	-131.45	552.52	1.06	553.58	2.30	1.05
P-56	66.00	200	PVC	140.0	0.00	Open	Open	0.43e-4	552.52	0.00	552.52	0.00	0.14e-5
P-59	1,162.00	400	PVC	140.0	0.00	Open	Open	-131.45	553.58	2.68	556.26	2.30	1.05
P-4	492.50	600	PVC	140.0	0.00	Open	Open	-198.94	557.53	0.34	557.87	0.69	0.70
P-31	395.50	600	PVC	140.0	0.00	Open	Open	-266.43	557.87	0.47	558.34	1.18	0.94
P-101	287.00	500	PVC	140.0	0.00	Open	Open	-32.68	558.35	0.02	558.36	0.06	0.17
P-103	250.00	500	PVC	140.0	0.00	Open	Open	-132.96	558.67	0.20	558.87	0.79	0.68
P-8	395.00	500	PVC	140.0	0.00	Open	Open	-199.79	559.32	0.67	559.98	1.68	1.02
P-126	422.50	500	PVC	140.0	0.00	Open	Open	-266.62	559.98	1.21	561.20	2.87	1.36
P-128	379.50	1,050	PVC	140.0	0.00	Open	Open	495.88	561.29	0.09	561.20	0.24	0.57
P-115	399.50	1,050	PVC	140.0	0.00	Open	Open	-858.43	561.46	0.27	561.73	0.67	0.99
P-127	180.50	1,050	PVC	140.0	0.00	Open	Open	858.43	561.46	0.12	561.34	0.67	0.99
P-13	714.50	1,050	PVC	140.0	0.00	Open	Open	-1,099.43	562.19	0.76	562.95	1.07	1.27
P-14	326.50	1,050	PVC	140.0	0.00	Open	Open	-1,099.43	562.95	0.35	563.30	1.07	1.27
P-16	277.00	1,050	PVC	140.0	0.00	Open	Open	229.26	561.18	0.02	561.17	0.06	0.26
P-81	379.00	1,050	PVC	140.0	0.00	Open	Open	66.17	561.17	0.22e-2	561.17	0.01	0.08
P-125	380.50	600	PVC	150.0	0.00	Open	Open	163.10	561.17	0.16	561.01	0.42	0.58
P-87	199.50	1,200	PVC	140.0	0.00	Open	Open	1,039.47	559.47	0.10	559.37	0.50	0.92
P-27	224.50	1,200	PVC	140.0	0.00	Open	Open	1,006.39	559.25	0.11	559.15	0.47	0.89
P-20	788.50	200	PVC	140.0	0.00	Open	Open	33.73	555.62	4.29	551.33	5.43	1.07
P-111	936.50	200	PVC	140.0	0.00	Open	Open	-9.59	551.33	0.50	551.83	0.53	0.31
P-22	313.50	300	PVC	140.0	0.00	Open	Open	-52.90	553.31	0.54	553.86	1.74	0.75
P-36	743.50	400	PVC	140.0	0.00	Open	Open	-129.08	553.86	1.66	555.51	2.23	1.03
P-24	386.50	500	PVC	140.0	0.00	Open	Open	-166.77	557.18	0.47	557.65	1.21	0.85
P-25	405.50	500	PVC	140.0	0.00	Open	Open	-233.46	557.65	0.91	558.56	2.25	1.19
P-26	559.00	1,050	PVC	140.0	0.00	Open	Open	-584.04	558.56	0.18	558.74	0.33	0.67
P-30	457.50	900	PVC	140.0	0.00	Open	Open	350.59	558.56	0.12	558.43	0.27	0.55
P-107	471.00	1,050	PVC	140.0	0.00	Open	Open	-649.99	558.74	0.19	558.93	0.40	0.75
P-89	497.50	750	PVC	140.0	0.00	Open	Open	290.46	559.15	0.23	558.92	0.47	0.66
P-33	525.50	900	PVC	140.0	0.00	Open	Open	276.03	558.43	0.09	558.34	0.17	0.43
P-32	89.00	500	PVC	140.0	0.00	Open	Open	-32.68	558.34	0.01	558.35	0.06	0.17
P-93	523.50	500	PVC	140.0	0.00	Open	Open	104.38	558.49	0.27	558.23	0.51	0.53
P-113	729.00	400	PVC	140.0	0.00	Open	Open	120.35	558.49	1.43	557.07	1.96	0.96
P-39	677.00	300	PVC	140.0	0.00	Open	Open	42.53	555.51	0.78	554.73	1.16	0.60
P-109	327.00	400	PVC	140.0	0.00	Open	Open	-132.95	555.51	0.77	556.28	2.35	1.06

Scenario: Peak Hour Plus Fire Flow @9
Steady State Analysis
Pipe Report

Link Label	Length (m)	Diameter (mm)	Material	Roughness	Minor Loss	Initial Status	Current Status	Discharge (l/s)	Start Calculated Hydraulic Grade (m)	Headloss (m)	End Calculated Hydraulic Grade (m)	Friction Slope (m/km)	Velocity (m/s)
P-97	424.50	300	PVC	140.0	0.00	Open	Open	42.53	554.73	0.49	554.24	1.16	0.60
P-65	348.50	300	PVC	140.0	0.00	Open	Open	-58.63	557.06	0.73	557.79	2.10	0.83
P-46	441.50	600	PVC	140.0	0.00	Open	Open	25.07	558.34	0.01	558.33	0.01	0.09
P-69	670.00	500	PVC	140.0	0.00	Open	Open	-151.05	558.34	0.67	559.01	1.00	0.77
P-47	510.50	600	PVC	140.0	0.00	Open	Open	-8.60	558.33	0.1e-2	558.33	0.2e-2	0.03
P-105	284.50	600	PVC	140.0	0.00	Open	Open	-8.60	558.33	0.6e-3	558.33	0.21e-2	0.03
P-77	547.50	450	PVC	140.0	0.00	Open	Open	154.04	560.90	0.95	559.94	1.74	0.97
P-51	198.00	450	PVC	140.0	0.00	Open	Open	112.13	559.36	0.19	559.17	0.97	0.71
P-75	382.00	450	PVC	140.0	0.00	Open	Open	112.13	559.17	-0.37	558.80	0.97	0.71
P-53	336.00	450	PVC	140.0	0.00	Open	Open	-125.94	559.24	0.40	559.64	1.20	0.79
P-54	439.00	450	PVC	140.0	0.00	Open	Open	-125.94	559.64	0.53	560.17	1.20	0.79
P-73	467.50	450	PVC	140.0	0.00	Open	Open	-125.94	560.17	0.56	560.73	1.20	0.79
P-118	96.50	200	PVC	140.0	0.00	Open	Open	0.43e-4	506.00	0.00	506.00	0.00	0.14e-5
P-117	211.50	1,050	PVC	140.0	0.00	Open	Open	-1,099.43	509.77	0.23	510.00	1.07	1.27
P-58	280.50	400	PVC	140.0	0.00	Open	Open	-131.45	551.88	0.65	552.52	2.30	1.05
P-99	411.50	450	PVC	140.0	0.00	Open	Open	-131.45	556.26	0.53	556.79	1.30	0.83
P-63	701.00	200	PVC	140.0	0.00	Open	Open	-24.96	553.63	2.18	555.81	3.11	0.79
P-64	595.50	300	PVC	140.0	0.00	Open	Open	-58.63	555.81	1.25	557.06	2.10	0.83
P-67	688.00	500	PVC	140.0	0.00	Open	Open	-92.30	557.79	0.28	558.07	0.40	0.47
P-68	375.50	500	PVC	140.0	0.00	Open	Open	-125.98	558.07	0.27	558.34	0.72	0.64
P-71	744.00	500	PVC	140.0	0.00	Open	Open	-184.79	559.01	1.08	560.10	1.46	0.94
P-133	625.00	500	PVC	140.0	0.00	Open	Open	-218.54	560.10	1.24	561.34	1.99	1.11
P-76	370.00	450	PVC	140.0	0.00	Open	Open	-125.94	558.80	0.44	559.24	1.20	0.79
P-78	605.00	450	PVC	140.0	0.00	Open	Open	112.13	559.94	0.58	559.36	0.97	0.71
P-80	264.00	600	PVC	140.0	0.00	Open	Open	154.04	561.01	0.11	560.90	0.43	0.54
P-83	622.00	1,050	PVC	140.0	0.00	Open	Open	33.08	561.17	0.1e-2	561.16	0.16e-2	0.04
P-136	174.00	1,050	PVC	150.0	0.00	Open	Open	0.12e-3	561.16	0.00	561.16	0.00	0.14e-6
P-86	606.00	1,200	PVC	140.0	0.00	Open	Open	1,039.47	559.77	0.30	559.47	0.50	0.92
P-88	246.00	1,200	PVC	140.0	0.00	Open	Open	1,006.39	559.37	0.12	559.25	0.47	0.89
P-91	856.50	750	PVC	140.0	0.00	Open	Open	257.60	558.92	0.32	558.60	0.37	0.58
P-92	355.00	750	PVC	140.0	0.00	Open	Open	224.73	558.60	0.10	558.49	0.29	0.51
P-95	730.50	300	PVC	140.0	0.00	Open	Open	71.52	558.23	2.21	556.01	3.03	1.01
P-96	515.50	300	PVC	140.0	0.00	Open	Open	38.65	556.01	0.50	555.51	0.97	0.55
P-98	1,371.00	200	PVC	140.0	0.00	Open	Open	8.71	554.24	0.61	553.63	0.44	0.28
P-100	444.00	500	PVC	140.0	0.00	Open	Open	-198.94	556.79	0.74	557.53	1.67	1.01

Scenario: Peak Hour Plus Fire Flow @9
Steady State Analysis
Pipe Report

Link Label	Length (m)	Diameter (mm)	Material	Roughness	Minor Loss	Initial Status	Current Status	Discharge (l/s)	Start Calculated Hydraulic Grade (m)	Headloss (m)	End Calculated Hydraulic Grade (m)	Friction Slope (m/km)	Velocity (m/s)
P-102	392.00	500	PVC	140.0	0.00	Open	Open	-132.96	558.36	0.31	558.67	0.79	0.68
P-104	265.00	500	PVC	140.0	0.00	Open	Open	-199.79	558.87	0.45	559.32	1.68	1.02
P-106	525.50	750	PVC	140.0	0.00	Open	Open	-42.27	558.33	0.01	558.34	0.01	0.10
P-108	451.00	1,050	PVC	140.0	0.00	Open	Open	-715.93	558.93	0.22	559.15	0.48	0.83
P-110	744.50	500	PVC	140.0	0.00	Open	Open	-166.77	556.28	0.90	557.18	1.21	0.85
P-112	855.50	300	PVC	140.0	0.00	Open	Open	-52.90	551.83	1.48	553.31	1.74	0.75
P-114	882.50	350	PVC	140.0	0.00	Open	Open	77.04	557.07	1.45	555.62	1.64	0.80
P-116	538.00	1,050	PVC	140.0	0.00	Open	Open	-972.84	561.73	0.46	562.19	0.85	1.12
P-131	483.00	1,200	PVC	150.0	0.00	Open	Open	1,072.56	560.00	0.23	559.77	0.47	0.95
P-129	254.00	1,050	PVC	150.0	0.00	Open	Open	229.26	561.20	0.01	561.18	0.05	0.26
P-132	200.00	1,050	PVC	140.0	0.00	Open	Open	495.88	561.34	0.05	561.29	0.24	0.57
P-134	396.50	450	PVC	140.0	0.00	Open	Open	144.01	561.34	0.61	560.73	1.54	0.91
P-137	157.00	1,050	PVC	150.0	0.00	Open	Open	-0.35e-4	520.00	0.00	520.00	0.00	0.4e-7

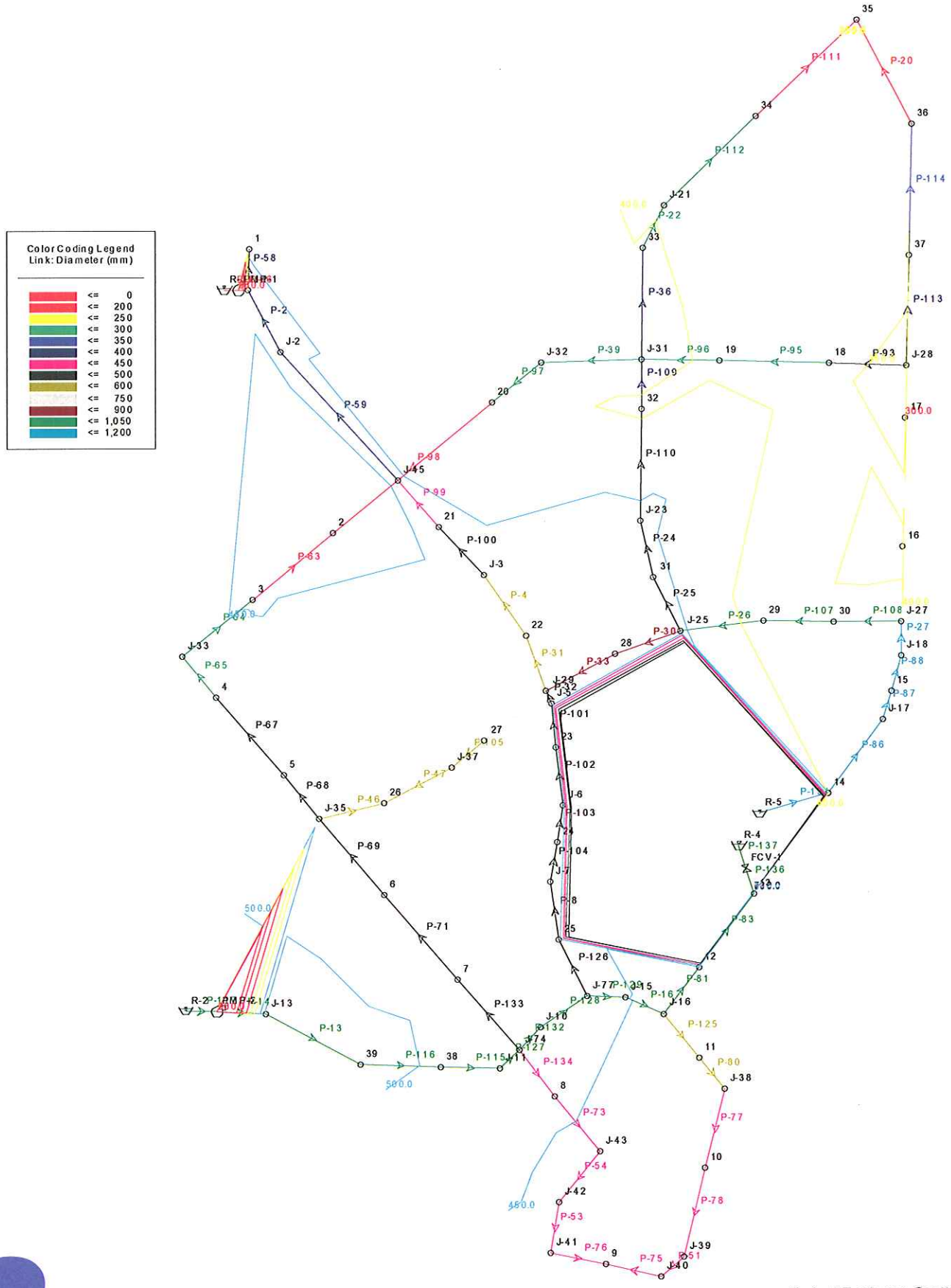
Scenario: Peak Hour Plus Fire Flow @9
Steady State Analysis
Reservoir Report

Node Label	Reservoir Surface Elevation (m)	Reservoir Inflow (l/s)	Calculated Hydraulic Grade (m)
R-2	510.00	1,099.43	510.00
R-3	506.00	0.43e-4	506.00
R-5	560.00	1,072.56	560.00
R-4	520.00	-0.35e-4	520.00

Scenario: Peak Hour Plus Fire Flow @9
Steady State Analysis
Pump Report

Link Label	Input Pump Power (kW)	Shutoff Head (m)	Shutoff Discharge (l/s)	Design Head (m)	Design Discharge (l/s)	Maximum Operating Head (m)	Maximum Operating Discharge (l/s)	Current Status	Start Calculated Hydraulic Grade (m)	End Calculated Hydraulic Grade (m)	Discharge (l/s)	Pump Head (m)	Current Water Power (kW)
PMP-1		38.07	0.00	26.65	854.56	0.00	1,709.12	Pump cannot deliver head (Clc	506.00	552.52	0.00	0.00	0.00
PMP-2		56.61	0.00	38.37	3,258.94	0.00	6,517.88	On	509.77	563.30	1,099.43	53.52	576.00

Contour Plot - Pressure
Scenario: Peak Hour Plus Fire Flow @9



COS - NE Sector Feasibility Study - Sanitary Sewer Calculations
044010 - 5.4 100/200
Sept.28 /2005
By: Scott Miller

	Mannings eq-solve for Q full (m3/s)												Solve for Q full req'd (m3/s)							
Option 1	D (m)	Q full (m3/s)	S	V (m/s)	Length	Inv.1	Inv.2	GND Elev Inv.1	GND Elev Inv.2	Cov1	Cov2	Ave Cov	Pop	ADWF (m3/s)	PF	PDF	Q cap (m3/s)	Contributing Areas/Pipes	Area (ha)_	I/I (m3/s)
Pipe 1	0.375	0.08443	0.00232	0.765	2800	512.50	506.00	518	511	5.5	5.00	5.25	2,002	0.00672	3.58545	0.06147	0.08443	1/2EP	133.5	0.03738
Pipe 2	0.450	0.19821	0.00484	1.247	1860	515.00	506.00	525	511	10.0	5.00	7.5	6038	0.02027	3.16811	0.13197	0.19821	1/2EP+1/2N6	242	0.06776
Pipe 3	0.600	0.24233	0.00156	0.858	2565	510.00	506.00	512	511	2.0	5.00	3.5	11294	0.03791	2.90200	0.19457	0.24233	1/2N7+1/2N5+1/2N6	302	0.08456
Pipe 4	0.600	0.35859	0.00341	1.269	2050	506.00	499.00	511	510	5.0	11.00	8	22556	0.07571	2.60013	0.22093	0.35859	P1+P2+P3+1/2N8	86	0.02408
Pipe 5	0.375	0.08873	0.00256	0.804	780	510.00	508.00	518	516	8.0	8.00	8	4036	0.01355	3.32985	0.07535	0.08873	1/2N5	108	0.03024
Pipe 6	0.450	0.17116	0.00361	1.077	970	508.00	504.50	516	510	8.0	5.50	6.75	6307	0.02117	3.15008	0.08377	0.17116	P5+1/3N4	61	0.01708
Pipe 7	0.525	0.19277	0.00201	0.891	1740	508.00	504.50	512	510	4.0	5.50	4.75	8542	0.02867	3.02234	0.15049	0.19277	2/3N4+2/3N3	228	0.06384
Pipe 8	0.525	0.14367	0.00112	0.664	1790	506.50	504.50	510	510	3.5	5.50	4.5	5574	0.01871	3.20094	0.10161	0.14367	1/2N2+1/3N3	149	0.04172
Pipe 9	0.750	0.38505	0.00120	0.872	1670	504.50	502.50	510	510	5.5	7.50	6.5	33369	0.11200	2.43199	0.34435	0.38505	P6+P7+P8+SC+1/2N2+1/2N7	257	0.07196
Pipe 10	0.750	0.60855	0.00299	1.378	1170	502.50	499.00	510	508	7.5	9.00	8.25	43738	0.14681	2.31908	0.42417	0.60855	1/2N6+N1+P9	299	0.08372
																				0
PIPE 11	0.900	0.98760	0.00298	1.553	1460	499.00	494.65	508	506	9.0	11.35	10.175	66294	0.22251	2.15301	0.47908	0.98760	P4+P10		0
EXST PIPE	1.219	1.30396	0.00103	1.118	670	494.65	493.96	506	506	11.4	12.20	11.775	81223	0.27262	2.07590	0.67906	1.30396	WG+ED+AC+TIF	404	0.11312
Option 2																				
Pipe 1	0.450	0.13729	0.00232	0.864	2800	512.50	506.00	518	511	5.5	5.00	5.25	4,980	0.01672	3.24662	0.09179	0.13729	1/2N9	134	0.03752
Pipe 2	0.450	0.19821	0.00484	1.247	1860	515.00	506.00	520	511	5.0	5.00	5	8,016	0.02691	3.04940	0.14225	0.19821	1/2N9+1/2N7	215	0.0602
Pipe 3	0.375	0.08354	0.00227	0.757	880	508.00	506.00	516	511	8.0	5.00	6.5	3,037	0.01019	3.43788	0.05772	0.08354	1/2N7	81	0.02268
Pipe 4	0.375	0.13288	0.00575	1.204	1565	515.00	506.00	526	510	11.0	4.00	7.5	6,093	0.02045	3.16437	0.11035	0.13288	1/2N6+1/2N5	163	0.04564
Pipe 5	0.600	0.30307	0.00244	1.072	2050	506.00	501.00	511	508	5.0	7.00	6	20,698	0.06947	2.63752	0.21824	0.30307	P1+P2+P3+1/2N8	125	0.035
Pipe 6	0.900	0.57796	0.00102	0.909	1960	503.00	501.00	510	508	7.0	7.00	7	48712	0.16350	2.27512	0.47670	0.57796	1/2N8+1/2N2+P8+P12+N1	374	0.10472
Pipe 7	0.375	0.07561	0.00186	0.685	1880	506.50	503.00	508	510	1.5	7.00	4.25	3111	0.01044	3.42895	0.05905	0.07561	1/2N2	83	0.02324
Pipe 8	0.450	0.15846	0.00309	0.997	970	506.00	503.00	510	510	4.0	7.00	5.5	11180	0.03753	2.90641	0.11606	0.15846	1/3SC+P9+P4	25	0.007
Pipe 9	0.375	0.07576	0.00187	0.686	1070	508.00	506.00	516	510	8.0	4.00	6	3037	0.01019	3.43788	0.05772	0.07576	1/2N6	81	0.02268
Pipe 10	0.525	0.14407	0.00112	0.666	1780	506.00	504.00	510	510	4.0	6.00	5	8161	0.02739	3.04178	0.13596	0.14407	1/2N5+1/3SC+1/2N4	188	0.05264
Pipe 11	0.525	0.14274	0.00110	0.660	1360	505.50	504.00	515	510	9.5	6.00	7.75	9449	0.03172	2.97910	0.13508	0.14274	1/4N4+1/2N3+P13+P14	145	0.0406
Pipe 12	0.750	0.40628	0.00133	0.920	750	504.00	503.00	510	510	6.0	7.00	6.5	23548	0.07904	2.58145	0.24015	0.40628	P10+P11+1/2N3+1/3SC	129	0.03612
Pipe 13	0.375	0.06981	0.00159	0.632	630	506.50	505.50	512	515	5.5	9.50	7.5	2123	0.00713	3.56549	0.06517	0.06981	EP2+3 +1/2EP1	142	0.03976
Pipe 14	0.300	0.08959	0.00859	1.268	640	511.00	505.50	518	515	7.0	9.50	8.25	1910	0.00641	3.60125	0.04157	0.08959	1/4N4+1/2EP1	66	0.01848
Pipe 15	0.375	0.09054	0.00267	0.820	2060	512.00	506.50	515	512	3.0	5.50	4.25	1740	0.00584	3.63203	0.05369	0.09054	EP2+EP3	116	0.03248
PIPE 16	0.900	1.19791	0.00438	1.884	1460	501.00	494.60	508	506	7.0	11.40	9.2	72535	0.24346	2.11850	0.51578	1.19791	P5 + P6		0
EXST PIPE	1.219	1.25583	0.00096	1.077	670	494.60	493.96	506	506	11.4	12.20	11.8	87464	0.29357	2.04851	0.71451	1.25583	WG+ED+AC+P16	404	0.11312

* Note all neigbourhood numbering has been revised in production of final report drawings to show revised development sequence. Therefore contributing neigbourhoods shown on this spreadsheet will not match report drawings. Pipe sizes and elevations remain correct regardless of numberir

STORM SEWER DESIGN SHEET

AE

PROJECT Sector-Option #1 | DESIGNED BY S.Miller | DATE June 15/05 | EXPECTANCY PERIOD 2 YEAR

PROJECT # 44010 | CHECKED BY | DATE | PIPE MATERIAL

CLIENT COS | SHEET 1 OF 1 | MANNING'S n 0.013

Catchment #	Pipe	From MH	To MH	Runoff Coeff. C	Increment Area (ha)	Increment C x A (ha)	Time of Conc., t (min)	Intensity i (mm/hr)	Flow Q=CiA (m^3/s)	Line Slope (%)	Line Dia. (mm)	Flow Q_{CAP} (m^3/s)	Velocity V_{CAP} (m/s)	Line Length (m)	Time in Pipe, t^1 (min)	Invert Elevations Upper MH	Invert Elevations Lower MH
.5EC	Pipe 1	1	2	0.65	133	86.45	38.87	31	7.44	0.125	2400	9.13	1.96	2800	23.87	513.5	510
.25N6+.5EC	Pipe 2	3	2	0.51	187	95.37	25.54	31	8.21	0.25	2100	9.04	2.53	1600	10.54	514	510
.25N7+.5N6	Pipe 3	15	2	0.35	151	52.85	42.62	31	4.55	0.0962	2100	5.61	1.57	2600	27.62	512.5	510
.5N5+.25N7	Pipe 4	15	4	0.35	151	52.85	19.82	31	4.55	0.5294	1500	5.37	2.94	850	4.82	512.5	508
.5N5	Pipe 5	5	4	0.35	108	37.80	21.60	31	3.26	0.25	1500	3.69	2.02	800	6.60	510	508
P4+P5+1/2SC	Pipe 6	4	6	0.39	297	115.83	18.73	31	9.97	0.5	2100	12.79	**3.58**	800	3.73	508	504
1/3N4	Pipe 7	5	7	0.35	61	21.35	22.05	31	1.84	0.55	1050	2.11	2.36	1000	7.05	510	504.5
2/3N4+1/2N3	Pipe 8	8	7	0.35	201	70.35	29.52	31	6.06	0.1667	2100	7.38	2.07	1800	14.52	507.5	504.5
P8+P7	Pipe 9	9	10	0.35	262	91.70	25.64	31	7.90	0.0556	2700	8.33	1.41	900	10.64	504.5	504
.5N2+.5N3	Pipe 10	7	10	0.35	176	61.60	30.91	31	5.30	0.1389	2100	6.74	1.89	1800	15.91	506.5	504
.5N7	Pipe 11	10	11	0.35	86	30.10	28.96	31	2.59	0.12	1650	3.29	1.49	1250	13.96	504	502.5
N1+.5N2	Pipe 12	13	11	0.35	287	100.45	29.56	31	8.65	0.1389	2400	9.62	2.06	1800	14.56	505	502.5
Drain only	Pipe 13	11	12	0.35	0	0.00	21.86	31	0.00	0.4783	1500	5.10	2.80	1150	6.86	502.5	497
2/3N8	Pipe 14	2	12	0.35	115	40.25	27.61	31	3.47	0.5652	1500	5.54	**3.04**	2300	12.61	510	497
P14+Future AC,EDWG	Pipe 15	12	14	0.35	86	30.10	23.70	31	2.59	0.1834	3050	20.96	2.78	1450	8.70	497	494.34
P15+Existing AC,EDWG	EXST	14	tie-in	0.35	483	169.05	20.69	31	14.56	0.1	3050	15.47	2.05	700	5.69	494.34	493.64
			Total		2784		27.13	31									

Velocities greater than 3 m/s - invert erosion to be considered

run-off coefficients:0.35 residential, 0.65 commercial

STORM SEWER DESIGN SHEET

AE

PROJECT Sector-Option #2 | DESIGNED BY S.Miller | DATE June 15/05 | EXPECTANCY PERIOD 2 YEAR

PROJECT # 44010 | CHECKED BY | DATE | PIPE MATERIAL

CLIENT COS | SHEET 1 OF 1 | MANNING'S n 0.013

Catchment #	Pipe	From MH	To MH	Runoff Coeff. C	Increment Area (ha)	Increment C x A (ha)	Time of Conc., t (min)	Intensity i (mm/hr)	Flow Q=CiA (m^3/s)	Line Slope (%)	Line Dia. (mm)	Flow Q_{CAP} (m^3/s)	Velocity V_{CAP} (m/s)	Line Length (m)	Time in Pipe, t^1 (min)	Invert Elevations Upper MH	Invert Elevations Lower MH
.5N9	Pipe 1	1	2	0.65	133	86.45	38.87	31	7.44	0.125	2400	9.13	1.96	2800	23.87	513.5	510
.5N9+.5N7	Pipe 2	3	2	0.54	214	115.56	24.64	31	9.95	0.25	2400	12.91	2.77	1600	9.64	514	510
N6	Pipe 3	4	2	0.35	162	56.70	37.40	31	4.88	0.16	1850	5.16	1.86	2500	22.40	514	510
.5N5	Pipe 4	5	6	0.35	82	28.70	25.70	31	2.47	0.4375	1350	3.68	2.49	1600	10.70	515	508
P4	Pipe 5	6	7	0.35	82	28.70	24.09	31	2.47	0.1667	1500	3.01	1.65	900	9.09	508	506.5
.5N5+.5N4	Pipe 6	8	7	0.35	163	57.05	20.90	31	4.91	0.5909	1500	5.67	**3.11**	1100	5.90	513	506.5
P6+P5	Pipe 7	7	9	0.35	245	85.75	23.89	31	7.38	0.1111	2100	6.03	1.69	900	8.89	506.5	505.5
EP2+EP3	Pipe 8	10	11	0.65	116	75.40	27.17	31	6.49	0.1875	2100	7.83	2.19	1600	12.17	513	510
.5N4+2/3N3	Pipe 9	11	9	0.35	220	77.00	27.37	31	6.63	0.2571	1850	6.54	2.36	1750	12.37	510	505.5
Drain only	Pipe 10	9	12	0.35	0	0.00	22.64	31	0.00	0.1429	1500	2.79	1.53	700	7.64	505.5	504.5
1/3N3+.5N2	Pipe 11	13	12	0.35	152	53.20	34.29	31	4.58	0.1053	2100	5.87	1.64	1900	19.29	506.5	504.5
P11+1/3N8	Pipe 12	12	14	0.35	235	82.25	23.98	31	7.08	0.1364	2400	9.54	2.04	1100	8.98	504.5	503
N1+.5N2	Pipe 13	15	14	0.35	249	87.15	31.06	31	7.50	0.1628	2400	10.42	2.23	2150	16.06	506.5	503
Drain only	Pipe 14	14	16	0.35	0	0.00	19.98	31	0.00	0.5556	1500	5.50	**3.01**	900	4.98	503	498
1/3N8	Pipe 15	2	16	0.35	83	29.05	28.13	31	2.50	0.5217	1500	5.33	2.92	2300	13.13	510	498
P15 + Drain+Future WG,ED,AC	Pipe 16	16	17	0.35	83	29.05	22.41	31	2.50	0.2524	3050	24.59	**3.26**	1450	7.41	498	494.34
P16+WG,ED,AC	EXST	17	tie-in	0.35	480	168.00	20.69	31	14.47	0.1	3050	15.47	2.05	700	5.69	494.34	493.64
			Total		2136		27.58	31									

Velocities greater than 3 m/s - invert erosion to be considerec

Intensity based on Table A2 COS Design Standards

run-off coefficients:0.35 residential, 0.65 commercia

D Appendix D - Transportation Model Results

D1 LAND USE TRANSFER

The starting point for future city-wide land use distributions and traffic modelling for the East Sector has been the version of the TMODEL developed for the previous study of the North East Sector. That specific 400K model incorporates a future total of 400,000 population and has been used as the base model for the East Sector analysis.

In order to maintain a 400K TMODEL, population and employment must be transferred from other zones in the City of Saskatoon TMODEL rather than directly adding new population and employment to the East Sector. In this way the 400K East Sector model can be compared to other land use arrangements in the City at the 400K population level. Employment and population in the area covered by the East Sector is located in Zones 186, 187 and 188 in the base model as shown in Table D1.

Table D1: Base Model Statistics in East Sector

Zone	LU1	LU2	Total Residential	LU3	LU4	LU5	LU6	Total Non-Res
186	10172	3811	13983	242	150	44	4	440
187	13529	7882	21411	251	407	74	7	739
188	5425	1815	7240	132	81	24	2	239
Total	29126	13508	42634	625	638	142	13	1418
	68%	32%	100%	44%	45%	10%	1%	100%

Land Use Definitions

Land Use	Description
1	Single family residential
2	Multi family residential
3	Institutional
4	Commercial
5	Professional
6	Manufacturing

A total population of 42,634 with 68% in single-family housing and 32% in multi-family housing is represented in the East Sector area in the base model. Total employment of 1,418 jobs with 44% Institutional, 45% commercial, 5% professional and 1% manufacturing is represented in the East Sector base model.

Based on land use densities and areas, Concept 1 and Concept 2 for the East Sector development would account for a population of 60,675 to 68,334 people and employment of 4,200 to 5,620 jobs. The average of the two concepts was used for both concepts (64,505 people and 4,950 jobs) to simplify the modelling process and to compare the two concepts based on the land use layouts rather than the differences in total population and employment. Table D2 shows the target population and employment levels for the East Sector.

Table D2: Target Population and Employment Levels

	LU1	LU2	Total Residential	LU3	LU4	LU5	LU6	Total Non-Res
Target			64505					4950
East Sector Base			42634					1418
Difference			21871					3532

The population and land use differences between the East Sector development land use targets and the base model statistics for that area are 21,871 people and 3,532 jobs. The differences need to be transferred from other zones in the model in order to maintain the 400K population and employment levels.

The differences in population and employment to be transferred from other zones to the East Sector are not separated into housing types and land use types in Table D2. However, based on land uses in the North East Sector, the assumed target mix for residential is 45% single family and 55% multi-family (50% single family and 50% multi-family in the neighbourhoods and 100% multi-family in the suburban centre) and about 40% each institutional LU3 and commercial LU4, 20% professional and 1% manufacturing. It should be noted that in the base model the population is 68% in single-family homes and 32% in multi-family homes within the East Sector area.

Based on discussions with the City of Saskatoon, the consulting team transferred population and employment as follows:

- All population was transferred out of Zone 153 (the exhibition grounds);
- The remaining population required for the East Sector was transferred from the North East Sector;
- 25% of the employment was transferred from the North East Sector; and
- The remaining employment required for the East Sector was transferred from downtown Saskatoon (Superzone 7).

Table D3 documents the population and employment transfers.

Table D3: Zones From which to Transfer Population and Employment

NE Sector (Zones 173-185)

	LU1	LU2	Total Residential	LU3	LU4	LU5	LU6	Total Non-Res
Existing	25000	31000	56000	2520	2910	1470	100	7000
	45%	55%		36%	42%	21%	1%	
To Transfer	10532	10709	21241	630	728	368	25	1750
	50%	50%		36%	42%	21%	1%	
After Transfer	14468	20291	34759	1890	2183	1103	75	5250
	42%	58%		36%	42%	21%	1%	

Zone 153

	LU1	LU2	Total Residential	LU3	LU4	LU5	LU6	Total Non-Res
Existing	375	255	630	NO Change				
	60%	40%						
To Transfer	375	255	630	NO Change				
	60%	40%						
After Transfer	0	0	0	NO Change				

Downtown Superzone 7

	LU1	LU2	Total Residential	LU3	LU4	LU5	LU6	Total Non-Res
Existing	NO Change			12781	25094	3609	1542	43026
				30%	58%	8%	4%	
To Transfer	NO Change			642	748	374	18	1782
				36%	42%	21%	1%	
After Transfer	NO Change			12139	24346	3235	1524	41244
				29%	59%	8%	4%	

Total Population and Job Transfers to East Sector

	LU1	LU2	Total Residential	LU3	LU4	LU5	LU6	Total Non-Res
To East Sector	10907	10964	21871	1272	1476	742	43	3532

As shown in table D3, totals of 21,871 residents and 3,532 jobs are transferred from the North East Sector, Zone 153 and Downtown Saskatoon to make up the required totals for the East Sector.

Since the base model only has three zones in the East Sector, additional empty zones were transferred from other areas of the City to provide 13 zones for the East Sector. The 13 zones in the East Sector represent 9 neighbourhoods, the suburban centre and the parts parts of the employment centre. Table D-4 shows the land uses for each zone in the East Sector for Concept 1 and Concept 2.

Table D4: Total Population and Jobs in East Sector Including Transfers

Concept 1

Zone	LU1	LU2	Total Residential	LU3	LU4	LU5	LU6	Total Non-Res	East Sec. Land Use
186	5004	2412	7416	18	5	67	0	90	N1
187	5004	2412	7416	18	5	67	0	90	N2
188	5004	2412	7416	18	5	67	0	90	N3
189	5004	2412	7416	18	5	67	0	90	N4
190	5004	2412	7416	18	5	67	0	90	N5
191	5004	2412	7416	18	5	67	0	90	N6
192	5004	2412	7416	18	5	67	0	90	N7
193	5004	2412	7416	18	5	67	0	90	N8
194	0	0	0	0	0	0	0	0	N9
195	0	5175	5175	187	564	186	38	975	SC
196	0	0	0	522	503	54	6	1085	EA1
197	0	0	0	522	503	54	6	1085	EA2
198	0	0	0	522	503	54	6	1085	EA3
Total	40032	24471	64503	1897	2113	884	56	4950	
	62%	38%	100%	38%	43%	18%	1%	100%	

Concept 2

Zone	LU1	LU2	Total Residential	LU3	LU4	LU5	LU6	Total Non-Res	East Sec. Land Use
186	4448	2144	6592	16	4	60	0	80	N1
187	4448	2144	6592	16	4	60	0	80	N2
188	4448	2144	6592	16	4	60	0	80	N3
189	4448	2144	6592	16	4	60	0	80	N4
190	4448	2144	6592	16	4	60	0	80	N5
191	4448	2144	6592	16	4	60	0	80	N6
192	4448	2144	6592	16	4	60	0	80	N7
193	4448	2144	6592	16	4	60	0	80	N8
194	4448	2144	6592	16	4	60	0	80	N9
195	0	5175	5175	187	562	186	40	975	SC
196	0	0	0	470	455	47	5	977	EA1
197	0	0	0	705	682	71	7	1465	EA2
198	0	0	0	391	379	40	4	814	EA3
Total	40032	24471	64503	1897	2114	884	56	4951	
	62%	38%	100%	38%	43%	18%	1%	100%	

Since Concept 1 has eight neighbourhoods, greater numbers of residents are allocated to each neighbourhood than Concept 2 that has nine neighbourhoods. The employment centre is divided into three distinct areas in Concept 2, while it is all in one area in Concept 1.

For both Concept 1 and Concept 2 the population and employment is the same. The mixture of single and multi-family population is 62% / 38% respectively, while the target was 45% single family and 55% multi-family. This difference is due to the 68% single-family, 32% multi-family mix in the base model population already allocated to the East Sector area. Since single-family homes have higher trip generation rates than multi-family homes, the higher proportion of single-family homes in the model means that conservative (high) traffic estimates for the East Sector are tested in TMODEL. The employment land use mix approximates the target of about 40% each institutional LU3 and commercial LU4, 20% professional and 1% manufacturing.

The above adjustments were made in the TMODEL land use files (con2B.LU2 and con1.LU2) and, using trip generation procedures as described below, origin and destination files were created from the adjusted land use files.

D2 TRIP GENERATION RATES

TMODEL applies one trip generation rate for each land use type. Paradigm Consultants, that originally developed the City of Saskatoon's TMODEL, divided the City into eight Superzones, that each have different trip generations rates for the same land use types based on the location of the Superzone. During the development of the modelling system for analysing future traffic patterns for the North East Sector development, the consulting team developed and tested a method to apply the differential trip generation rates to each Superzone. This methodology was followed again for the new East Sector analysis and is described below.

Several steps are required to calculate vehicle trip origins and destinations from land use data. The land use data file has information on the land uses (population and employment) for each zone. The origin and destination file contains information on the number of vehicle trips by trip type. Intermediate steps involving the trip generation files, mode split files, land use parameter files, external trips, trip balancing and intrazonal trips are part of the process.

Eight trip generation rate files for each land use and trip type for each Superzone were reviewed. The three trip types are 1) home based work trips 2) home based non-work trips and 3) non-home based trips. Average trip generation rates for each trip type were developed in a new trip generation file (June05.TGF).

A mode split file (4NDL.MSE), that applies 100% of trips as car trips, was developed during this preliminary calculation.

The consulting team reviewed the original land use parameters file (S14Base.LU3), which varies the vehicle trip rates by traffic zone, and noted that the land use parameter values for each trip type are the same (or very similar) for each Superzone. The consulting team then developed land use parameters (4NDL.LU3) that were used to

create an intermediate origin and destination file that represents person trips by Superzone.

The original mode split file (S14-base.MSE) and land use parameter file (S14-base.LU3) created for the City of Saskatoon are then applied to the intermediate origin and destination file to obtain final vehicle trip origins and destinations. ND LEA tested the methodology using the original files from the 400k model runs and examined again the model results for the North East Sector study. When looking at the estimates of the total numbers of vehicle trips for each vehicle type and the effects of higher or lower trip rates at the Superzone level, it is clear that overall modelled traffic levels are compatible for the original 400k model runs, for the North East Sector study and for the model as now adapted for the East Sector.

The final steps involve adjusting for external trips (trips that begin and end outside the City) and balancing trip origins and destinations. For each of the three trip types, the number of trip origins must be equal to the number of destinations. Intrazonal speeds of 30km/h are used to calculate intrazonal travel times for trips that stay within their own zone.

D3 TURN PENALTY FILE

The consulting team inspected and adjusted the turn penalty file to eliminate traffic shortcutting through zone centroid connectors. Zone centroid connectors provide access to and from the zones where trips originate and end, but do not represent actual roads in the model. Therefore it is important to ensure traffic does not use these artificial roads to represent actual travel. The original model was set up to apply a 10 minute delay to vehicles trying to pass through a zone centroid by turning onto one zone centroid connector from another.

During the inspection process of existing zone centroids in the base model, it was noted that some zones did not connect to the nodes where the 10 minute delays were applied in the original turn penalty file. The node numbers all appeared to be only slightly different than the zone to which it was connected. It was concluded that a few nodes must have been deleted at some earlier stage of development of the base model. When nodes are deleted in TMODEL, the subsequent node numbers are automatically renumbered so that all the node numbers are sequential.

The consultants assigned 550 turn penalties to all the 218 zones in the updated model. Other turn penalty locations in the original file were inspected in detail, making allowances for the probable patterns for deleted nodes. Revised turn penalties were assigned at other locations, such as highway ramps where u-turns are not permitted and at various interchanges where turns are prohibited. This set of revisions involved approximately 60 additional turn penalties.

After careful checking, the revised turn penalty file was incorporated into the model runs for the East Sector.

For future reference it is recommended that the turn penalty file be further reviewed prior to further application.

D4 ADDITIONAL LANES ON 8TH STREET

Due to capacity restraints on Highway 5 and 8th Street in the East Sector, a model run was completed with three lanes instead of two lanes each direction on 8th Street. Table D4 compares Concept 1 with two lanes each direction (Con1ic.llx) to Concept 1 with three lanes each direction (Con 183l.llx) on 8th Street. Since 8th Street is modelled with a speed of 70 km/h and Highway 5 is modelled with a speed of 90-100km/h in the East Sector, traffic does not transfer from the over-capacity Highway 5 to 8th Street. Therefore traffic allocation for both model runs is very similar.

Table D4: PM Peak Hour Traffic on East Sector Roads

		Con1IC.LLX					Con183L.LLX (8th Street 3 Lanes)				
Screenline Location	Travel Direction	Total Traffic	East Sector Traffic (1) Volume	% of Total	Modeled Capacity	Future V/C Ratio	Total Traffic	East Sector Traffic (1) Volume	% of Total	Modeled Capacity	Future V/C Ratio
	S Bound	2202	1692	76.8	3000	0.73	2201	1688	76.7	3000	0.73
McOrmond	N Bound	2793	1408	50.4	3000	0.93	2798	1410	50.4	3000	0.93
(N of Hwy. 5)	Two Way	4995	3100	62.1			4999	3098	62.0		
	E Bound	3458	1840	53.2	3000	1.15	3451	1840	53.3	3000	1.15
Highway 5	W Bound	1456	857	58.9	3000	0.49	1452	855	58.9	3000	0.48
	Two Way	4914	2697	54.9			4903	2695	55.0		
	E Bound	2488	2411	96.9	2400	1.04	2511	2434	96.9	3600	0.70
8th Street	W Bound	820	693	84.5	2400	0.34	822	696	84.7	3600	0.23
	Two Way	3308	3104	93.8			3333	3130	93.9		
	E Bound	1069	679	63.5	2400	0.45	1062	671	63.2	2400	0.44
Taylor St.	W Bound	708	361	51.0	2400	0.30	707	360	50.9	2400	0.29
	Two Way	1777	1040	58.5			1769	1031	58.3		
	N Bound	1031	646	62.7	3000	0.34	1030	644	62.5	3000	0.34
Perimeter Rd.	S Bound	671	318	47.4	3000	0.22	673	319	47.4	3000	0.22
	Two Way	1702	964	56.6			1703	963	56.5		
	Into E Sec.	10248	7268	70.9	13800	0.74	10255	7277	71.0	15000	0.68
Total	Out E. Sec.	6448	3637	56.4	13800	0.47	6452	3640	56.5	15000	0.43
Above	Two Way	16696	10905	65.3			16707	10917	65.4		

Notes 1. Zones 186-198

E Appendix E - Photographs

LOOKING NORTH-EAST

EAST FROM S.E. SECTOR

LOOKING NORTH-EAST

8th STREET LOOKING EAST

LOOKING EAST

LOOKING EAST

RESIDENCE ON MCORMOND DRIVE

LOOKING SOUTH-EAST

RESIDENCE (TYPICAL)

COMMERCIAL HIGHWAY 5 & 41

HIGHWAY 5 EAST & 41 INTERSECTION

HIGHWAY 5 & 41

HIGHWAY 41

HIGHWAY 41 RADIO TELESCOPE

HIGHWAY 41

B	05\07\22	AGM	SWT	Options Report
A	05\03\03	AGM	SWT	Interim Report
NO.	DATE	ENG.	BY	SUBJECT

REVISIONS

SCALE	NTS		
PROJECT NO.	044010	INITIAL	DATE
DRAWN	S. Taylor		
DESIGNED	S. Miller		
CHECKED	A.O. Munro		
APPROVED	A.O. Munro		
DATE			

Associated Engineering

CROSBY HANNA & ASSOCIATES
LANDSCAPE ARCHITECTURE AND PLANNING

City of Saskatoon

East Sector
Feasibility Study

Site Photos

DRAWING NUMBER	REV. NO.	SHEET
Photoplan	B	1 / 1