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City of Calgary

THE IMPLICATIONS OF ALTERNATIVE GROWTH PATTERNS ON INFRASTRUCTURE COSTS

REPORT

APRIL 2, 2009

IBI GROUP

EXECUTIVE SUMMARY

Purpose of Report

Calgary has seen record levels of growth over the last few years and population and economic growth is expected to continue in the future. Over the next 60 years the population in the city itself is expected to grow from approximately 1 million to 2.3 million persons, with another 0.5 million people in the surrounding region. This level of growth offers the opportunity, and the need, to shape the future land use and transportation patterns of Calgary.

Plan It Calgary has commissioned this study to assist in development of an integrated plan for land use and transportation. It examines the infrastructure implications of two growth patterns. The Dispersed Scenario reflects current trends and the continuation of current city policies, while the new Recommended Direction intensifies jobs and population in specific areas of the city, and links them with high-quality transit services. The types of infrastructure investigated in this report are transportation (roads and transit), water and sewer services, police, fire, parks, recreation centres and schools.

Key Findings

- The land required for Plan It Calgary's Recommended Direction is 25% smaller than the Dispersed Scenario (which reflects current policy and trends).
- The cost to build Recommended Direction is 33% less expensive than the Dispersed Scenario.
- The Recommended Direction would be less expensive to operate and maintain over the next 60 years than the Dispersed Scenario.
- The cost to build, maintain and replace aging streets has the largest impact when comparing costs between the two growth patterns. Reduced greenfield growth in the Recommended Direction will result in a 36% cost savings for new streets compared to the Dispersed Scenario, and will also reduce maintenance and replacement costs.
- Enhanced Primary Transit service proposed in the Recommended Direction would actually be less expensive to build than extending transit to suburban communities in the Dispersed Scenario. Increased transit ridership in Recommended Direction, which provides double the service compared to the Dispersed Scenario, means that it would cost approximately the same to operate transit in both growth patterns.
- Reduced greenfield growth in Recommended Direction will result in a 55% cost savings for water and wastewater systems compared to the Dispersed Scenario. There would be no net difference in costs for the existing parts of Calgary since replacement of water and wastewater systems will be required as infrastructure ages. Significant intensification of existing areas and growth in new greenfield communities could both trigger the need to upgrade existing systems.

Comparison of Capital Costs for Each Growth Pattern

A summary of the costs to build the new infrastructure (referred to as "capital costs") that will be needed to accommodate 1.3 million additional people are shown in the following table. This analysis

demonstrates that the Recommended Direction developed by Plan It Calgary will be **33% less expensive** to build than if the city were to continue to grow following existing patterns.

Total Cost ($billion)

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Road Capital Cost	$17.6	$11.2	$6.4	-36%
Transit Capital	$6.8	$6.2	$0.6	-9%
Water and Wastewater	$5.5	$2.5	$3.0	-54%
Fire Stations	$0.5	$0.3	$0.2	-46%
Recreation Centres	$1.1	$0.9	$0.2	-19%
Schools	$3.0	$2.1	$1.0	-32%
Total	$34.5	$23.1	$11.4	-33%

The fiscal estimates provided in this report provide for a relative comparison of the two growth patterns. The numbers are useful for comparing the implications of the growth scenarios but are less reliable in absolute terms and should not be used for the purposes of budgeting due to the long range nature of the projections on which they are based.

The largest difference in costs is represented by the road capital costs. The higher capital costs of roads in the Dispersed Scenario are due to:

- the broader area developed under the Dispersed Scenario which results in longer trips and requires more roads; and
- less travel by transit, walking and cycling resulting from the long distances between homes, jobs and services which creates more automobile use and again requires more roads.

Roads also require reinvestment to maintain their useful lives as pavement, structures and other elements wear out over time. The broader extent of the road system under the Dispersed Scenario therefore requires greater road rehabilitation and is therefore more costly.

With respect to transit infrastructure, the two growth patterns are expected to have similar LRT networks. In the Dispersed Scenario the LRT lines will have to be longer to reach the outer edges of development. The Recommended Direction is expected to include more dedicated busways in existing parts of the city however. The capital cost difference for these is estimated at $600 million, with the higher cost for the Dispersed Scenario largely due to increased LRT system costs.

In examining the water and wastewater systems the Dispersed Scenario will require significantly more pipe to service the larger development footprint. The capital costs for expansion of the distribution system for the Dispersed Scenario are more than twice those of the more compact Recommended Direction. Investment in treatment facilities (new water and sewer plants) respond to growth in the number of people not growth in the size of the footprint of the city and therefore under both growth patterns will be similar, with no significant cost differences.

With respect to fire services a difference of approximately $200 million was calculated in favour of the more compact Recommended Direction growth pattern. This is because, with greater densities, fewer fire stations are required although approximately the same number of personnel and engines will be needed. This cost savings includes the need to upgrade some existing fire stations to accommodate additional fire vehicles in Recommended Direction.

With respect to police services it was determined that costs are dependent on population not growth pattern or the footprint of the city; therefore, there would not be a cost difference.

Small differences in capital costs were also calculated for recreation centres and regional parks. Although there would be increased demand on existing recreation centres and parks in Recommended Direction, the costs would be more than offset by reduced construction of new recreation centres and regional parks required for the greenfield developments in the Dispersed Scenario. The cost difference for Parks is significantly smaller than the other infrastructure examined in this study at $30 to $40 million, and therefore has not been shown on the main summary table.

With respect to schools, kindergarten to grade 12 for public and Catholic schools, there is a significantly higher requirement for the Dispersed Scenario. With the development of more greenfield areas more schools are required. With the more compact patterns of Recommended Direction a higher utilization of older schools is possible. The difference between the two growth patterns is approximately $800 million.

The details of these calculations are included in the following report and in the appendices attached.

Comparison of Operating Costs for Each Growth Pattern

Impacts on operating costs have also been evaluated as part of this report. Overall the City would also see cost savings for the operation and maintenance of infrastructure over the next 60 years with the Recommended Direction growth pattern compared to the Dispersed Scenario. These costs are summarized in each section of the report, and in the following table. Cost shown are per year, based on the “horizon year” (approximately 60 years in the future).

"Horizon Year" Annual Operating Cost Comparison ($billion)

Total Cost ($billion)

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Road Operations	$0.23	$0.19	$0.04	-18%
Transit Net Operating	$0.30	$0.30	$0.00	0%
Water and Wastewater	$0.06	$0.03	$0.03	-55%
Fire Stations	$0.28	$0.23	$0.05	-18%
Parks	$0.13	$0.12	$0.01	-9%
Total	$0.99	$0.86	$0.13	-14%

The largest savings in operating cost for Recommended Direction would be with respect to the road system and fire stations. Water and wastewater services would also see operational cost savings, as would parks. The water and wastewater number is for the operation of the new parts of the infrastructure, not a city-wide total. The transit system is expected to have a similar net operating cost with both growth patterns after increased revenues are taken into account with the Recommended Direction.

The operating costs for recreation facilities are not seen as being significantly different between growth patterns. Schools are expected to have similar operating costs under the two growth patterns because the number of students is identical.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY I

1. INTRODUCTION 1

1.1 Purpose of Report 1

2. THE TWO ALTERNATIVE GROWTH PATTERNS 2

2.1 Plan It Calgary 2

2.2 The Dispersed Scenario ("Dispersed") 2

2.3 The Recommended Direction ("Recommended Direction") 3

2.4 Comparison of Alternative Growth Patterns 4

3. TRANSPORTATION 5

3.1 Road Network Supply and Demand 5

3.1.1 High Capacity Road Network 5

3.1.2 Other Road Networks 5

3.1.3 Summary of Road Costs 6

3.2 Road Operations 6

3.3 The Environment and the Road Network 7

3.4 Auto Accidents 7

3.5 Public Transit Costs 7

3.6 Total Transportation Capital Costs 9

4. PIPED SERVICES 10

4.1 Water Treatment 10

4.2 Water Distribution Systems 10

4.3 Wastewater Treatment 10

4.4 Wastewater Collection Systems 11

4.5 Summary of Water and Wastewater Costs 11

5. COMMUNITY SERVICES 13

5.1 Fire 13

5.2 Police 14

5.3 Recreation Centres 14

5.4 Parks 14

5.5 Social Support Services 15

6. SCHOOLS 16

6.1 Public Schools 16

6.2 Post Secondary Education 17

7. SUMMARY 18

APPENDICES

A. Road Capital Costs
B. Public Transit Needs
C. Relative Costs of Water and Sewer Distribution Networks
D. Fire Services
E. Recreational Facilities
F. Park Costs
G. Relative Costs of New Schools
H. Staff Members Consulted

LIST OF EXHIBITS

Exhibit 2-1: Conceptual Growth Pattern Diagrams 3
Exhibit 2-2: Change in Urbanized Area 4
Exhibit 3-1: Summary of New Road Costs 6
Exhibit 3-2: Road Operating and Maintenance Costs ($billions) 6
Exhibit 3-3: Summary of Transportation Capital Cost Comparison ($billions) 8
Exhibit 3-4: Summary of Transportation Capital Cost Comparisons 9
Exhibit 4-1: Relative Costs of Water and Wastewater Systems 12
Exhibit 5-1: Cost of New Fire Stations 13
Exhibit 5-2: Comparison of Recreational Facility Costs 14
Exhibit 5-3: Comparison of Regional Park Costs 15
Exhibit 6-1: Population and Calgary Board of Education Enrolment 16
Exhibit 6-2: Total School Capital Costs ($billions) 16
Exhibit 7-1: Summary of Capital Cost Comparisons 18
Exhibit 7-2: Summary of Operating Cost Comparisons 19

1. INTRODUCTION

Calgary has seen record levels of growth over the last few years. Growth in the economy and population is expected to continue into the future. Over the next 60 years the population of the city itself is expected to grow from approximately 1 million people today to 2.3 million persons. Over the same period the region is expected to increase to approximately 2.8 million. This large increase in population, with commensurate increases in employment, means that there is considerable opportunity to shape the future land use patterns of Calgary.

In looking at alternative growth patterns, one question to be addressed is whether different patterns have different implications in terms of infrastructure costs. The study is in response to this issue. It does so by comparing two alternative growth patterns for the city.

1.1 Purpose of Report

This report compares the infrastructure costs of two different growth patterns in order to understand the fiscal implications of different growth choices for The City of Calgary. The two growth patterns incorporate an additional 1.3 million people, distributed in different ways. The Dispersed Scenario demonstrates the continuation of current City land use policies and infrastructure investments, while the new Recommended Direction growth pattern is based on the analysis and research of the Plan It Calgary project proposing a more compact and strategic approach to development. Types of infrastructure costs which are investigated are transportation (roads and transit), water and sewer services, fire, police, recreation centres, parks, and schools. These are seen to be the costs that could have a significant variation by growth scenario. The next section describes the two growth patterns used to estimate differences. The following sections of this report present an analysis of the cost differences.

The fiscal estimates provided in this report provide for a relative comparison of the two growth patterns. The numbers are useful for comparing the implications of the growth scenarios but are less reliable in absolute terms and should not be used for the purposes of budgeting due to the long range nature of the projections on which they are based.

2. THE TWO ALTERNATIVE GROWTH PATTERNS

2.1 Plan It Calgary

The new integrated land use and transportation plan developed by Plan It Calgary is based upon eleven Council-approved sustainability principles:

Principle 1: Create a range of housing opportunities and choices.

Principle 2: Create walkable environments.

Principle 3: Foster distinctive, attractive communities with a strong sense of place.

Principle 4: Provide a variety of transportation options.

Principle 5: Preserve open space, agricultural land, natural beauty and critical environmental areas.

Principle 6: Mix land uses.

Principle 7: Strategically direct and manage redevelopment opportunities within existing areas.

Principle 8: Support compact development.

Principle 9: Connect people, goods and services locally, regionally and globally.

Principle 10: Provide transportation services in a safe, effective, affordable and efficient manner that ensures reasonable accessibility to all areas of the city for all citizens.

Principle 11: Utilize green infrastructure and buildings.

The Plan It Calgary project has developed a recommended growth pattern, called Recommended Direction, as the basis for the new integrated land use and transportation plan. The new plan will have a number of implications. One of these implications is the impact on infrastructure costs for the development of the City. IBI Group was commissioned to compare the potential infrastructure costs of the Plan It Calgary growth pattern with those that would develop from following current City policy.

2.2 The Dispersed Scenario ("Dispersed")

This scenario was developed based on current City policy. It represents a continuation of current trends and existing policy. It assumes that the majority of new housing will be developed on the urban fringes although there is some redevelopment in key areas of the city near LRT stations and along commercial corridors such as MacLeod Trail.

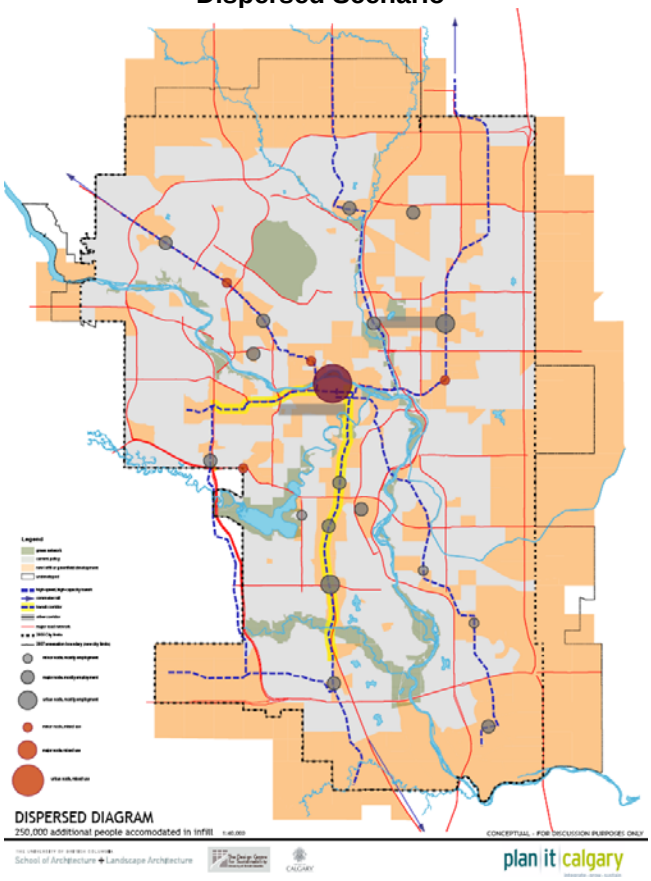
The Dispersed Scenario also assumes that rapid transit will continue to expand in a radial pattern with the city centre as the hub and the various lines extending outwards like the spokes on a wheel. It includes all roads that are within current plans and policies and two new river crossings which would accommodate transit, automobiles, bikes and pedestrians.

The Dispersed Scenario also assumes that a portion of future growth would occur in the region beyond the limits of the City. Current planning takes account of regional growth through road connections and the introduction of commuter rail to the north, west and south. Overall the Dispersed Scenario represents some intensification compared to today's growth patterns, with the majority of growth occur in suburban communities on the edges of the city. Overall total density increases under the Dispersed Scenario over that in place today.

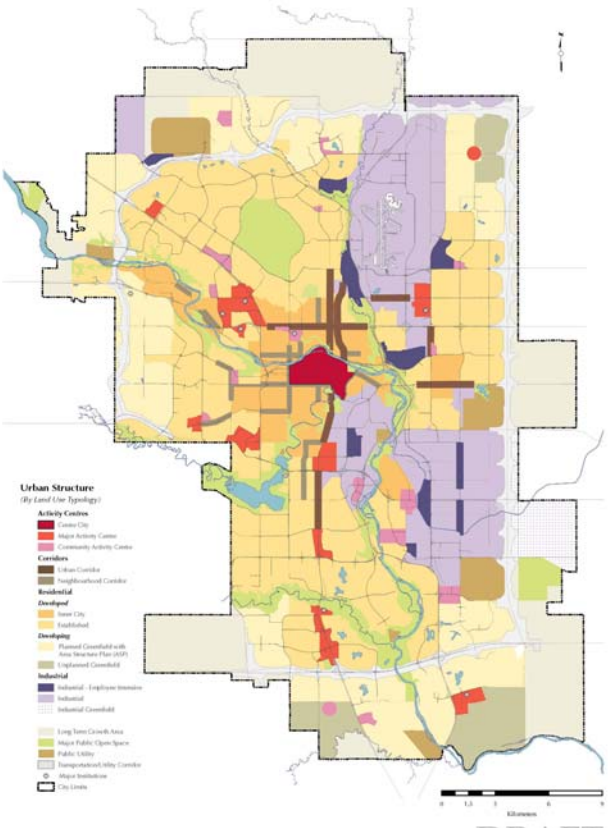
Exhibit 2-1 shows a conceptual diagram of the Dispersed Scenario on the left. To the right is the conceptual diagram of Recommended Direction based on the Municipal Development Plan (MDP). These diagrams were generated from different processes, and therefore show specific land use and transit systems in different ways. They provided here to show the relative difference in land area required between the two growth patterns, and to highlight the differences in redevelopment areas.

Exhibit 2-1: Conceptual Growth Pattern Diagrams

Dispersed Scenario



Recommended Direction



2.3 The Recommended Direction ("Recommended Direction")

The Recommended Direction growth pattern was developed based on a comprehensive planning process undertaken by Plan It Calgary starting in 2007. That process examined a variety of long range growth patterns for Calgary, including the development and analysis of three city-wide scenarios. The growth pattern proposed in the Recommended Direction is also based on the Plan It Calgary scenario planning process plus several pieces of empirical research, including anticipated changes in demographics, health and urban form, housing affordability, commercial development and two previously commissioned studies on the cost of growth in urban centres. The development of Recommended Direction also involved considerable engagement with over 5,000 members of the public and key stakeholders.

The Recommended Direction assumes a balance of growth between greenfield development and redevelopment of existing areas within the 2005 urban footprint. Most of the redevelopment is

contained in mixed-use, higher density nodes and corridors located in strategic areas throughout the city. These nodes and corridors are linked by a more comprehensive "primary transit network", composed of light rail transit (LRT), bus rapid transit (BRT) and frequent bus services. Unlike the current radial transit system focused on the downtown, the new primary transit system forms a grid of routes across the city, anchored by the major nodes. Fewer new streets are required for greenfield development, and some existing streets have been redesigned to accommodate a wider variety of transportation modes. Two new river crossings are assumed in the Recommended Direction, but would be for transit, walk/cycle and emergency services only.

Exhibit 2-1 also shows the conceptual urban plan for the Recommended Direction from the proposed Municipal Development Plan, and as a result does not specify which Long Term Growth Areas (shown as tan-coloured areas at the edge of the city) would be required over the next 60-years. For the purposes of determining infrastructure requirements, it has been assumed that the new residential greenfield development in Recommended Direction would occur to the north (between Nose Creek and Deerfoot Trail) and to the east along 17th Avenue. Both of these corridors were selected since they align with future regional transit services. New industrial development is also assumed in the Shepard lands to the southeast. Extensions of high capacity roads and Primary Transit services have been based on these assumed growth corridors. Based on the analysis of land requirements, remaining Long Term Growth areas would not need to be developed in the next 60 years. It is important to note that actual future greenfield growth areas will be determined based on the Strategic Framework for Growth and Change included in the proposed MDP.

The Recommended Direction assumes the same pattern of growth in the region outside of the City as the Dispersed Scenario with a total of about 500,000 people in both and takes account of this regional growth through road connections, the introduction of commuter rail to the west and south, and extension of an LRT line to the north.

2.4 Comparison of Alternative Growth Patterns

The concept behind the comparison of the two growth patterns is that they each have the same overall population and employment characteristics. It is the distribution and intensity of land use and associated infrastructure investments that vary between growth patterns. The 2005 urbanized area in Calgary is approximately 55,000ha. The future urbanized areas in the two growth patterns are as follows:

Exhibit 2-2: Change in Urbanized Area

	Total Urbanized Area (ha)	New Urbanized Area (ha)
Dispersed Scenario	101,000	46,000
Recommended Direction	76,000	21,000
Percentage Difference	-25%	-54%

As discussed in Section 2.3, specific areas for greenfield growth are not shown in Exhibit 2-1. However, the land area and associated infrastructure requirements have been calculated based on the population, housing and employment needs of the Recommended Direction, and are reflected in the total urbanized area shown above.

3. TRANSPORTATION

3.1 Road Network Supply and Demand

The development of the city from its current population of approximately 1 million to a future population of 2.3 million implies a commensurate increase in travel demand. Over the same period the Region is forecast to increase from 100,000 to 500,000. However, this growth factor of 2.3 cannot be applied directly; sustainable growth, greater use of transit, and other travel demand management approaches can lower road system travel demand in the Recommended Direction relative to the Dispersed Scenario.

3.1.1 HIGH CAPACITY ROAD NETWORK

The need for "high-capacity" roads such as Skeletal Roads (traditionally referred to as expressways and freeways) and Arterial Streets can be correlated with demand, but is also based on the size of the developed urban area. Generally the greater the auto travel an urban area experiences the greater the roadway needs in terms of Skeletal Roads and Arterial Streets. The analysis of Skeletal Roads and Arterial Streets requirements in the Dispersed Scenario and with the Recommended Direction is included in Appendix A. In total, the Dispersed Scenario has a requirement of approximately 3,300 lane-kms of new high capacity roads while the Recommended Direction has 1,900 lane-kms. Based upon a cost per lane kilometre of $5 million for Skeletal Roads and $2.5 million per lane-km for Arterial Streets, the difference in capital cost between the two growth patterns is estimated at $5.3 billion.

There is also a further category of road improvements identified. Arterial Streets in strategic redevelopment areas will be upgraded to Urban and Neighbourhood Boulevards, while others near natural areas will be upgraded to Parkways. These new types of arterials place more emphasis on the pedestrian realm and urban design, and therefore have additional costs associated with them. The length of Parkways is the same in both the Dispersed Scenario and the Recommended Direction, but the Recommended Direction will have twice as many Boulevards, corresponding to the increased focus on redevelopment in existing parts of the city. Overall, the Recommended Direction will cost an additional $300 million for Boulevard upgrades compared to the Dispersed Scenario.

3.1.2 OTHER ROAD NETWORKS

Generally at a neighbourhood level with local roads and collectors, and to a lesser extent for urban arterials, the road network is not defined by the amount of travel it must accommodate but by accessibility and mobility needs and connections to other land uses and facilities. For example, the road network in a high density central business district (CBD) residential neighbourhood is similar in terms of lane-km and pavement requirements to the road network in a lower density suburban neighbourhood. The higher density areas will make greater use of the roads, with higher traffic volumes, but the demand cannot be associated directly with the supply.

The major difference between the two growth patterns is that the Dispersed Scenario will require more new roads associated with Greenfield development while the Recommended Direction places greater emphasis on redevelopment, which makes use of existing roads.

As described in Appendix A, it is estimated that the Dispersed Scenario requires approximately 7,800 new lane-km of local and collector roads whereas the Recommended Direction requires

approximately 5,700 lane-km of new road, resulting in a cost savings of $1.4 billion for the Recommended Direction.

3.1.3 SUMMARY OF ROAD COSTS

The overall roadway network would vary quite significantly between the Dispersed Scenario and Recommended Direction. The lower travel demand, associated with fewer auto trips being made, results in a savings of over $5 billion on Skeletal Roads and Arterial Streets. Less new development at the periphery of the city would result in an additional $1.4 billion savings on Collector and Local Streets. Upgrades of selected Arterial Streets to Boulevards and Parkways results in an increased cost of $0.3 billion. Altogether this means a combined savings in the order of $6.4 billion for the new road costs in Recommended Direction.

Exhibit 3-1: Summary of New Road Costs

		Dispersed Scenario		Recommended Direction		
Road Type	Estimated cost per lane-km ($millions)	Length of new Road (lane-km)	Cost ($billions)	Length of new Road (lane-km)	Cost ($billions)	Cost Differences ($billions)
Skeletal Roads	$5.0	1,400	$7.0	700	$3.5	$3.5
Arterial Streets	$2.5	1,900	$4.8	1,200	$3.0	$1.8
Boulevard and Parkway Upgrades	$1.5	400	$0.6	600	$0.9	-$0.3
Collector	$1.0	2,200	$2.2	1,600	$1.6	$0.6
Local	$0.6	5,550	$3.1	4,050	$2.2	$0.8
Total	-	11,050	$17.6	7,550	$11.2	$6.4

Source of Unit Costs: *Canada Housing and Mortgage Corporation for Arterial, Collector and Local Roads, estimated median value for Freeway/Expressway

3.2 Road Operations

The City of Calgary Roads Business Unit has an Advanced Asset Management Program (AAMP). Using information from the 2008 report, it is possible to estimate the operational cost implications for the two growth patterns, as shown in Exhibit 3-2. Additional details are provided in Appendix A,

Exhibit 3-2: Road Operating and Maintenance Costs ($billions)

	Dispersed Scenario	**Recommended Direction**	**Cost Difference**	**Percent Difference**
Total Operations Costs	$9.1	$8.2	$0.9	-10%
Operations in Last Year	$0.23	$0.19	$0.04	-18%

The first line is the cost of operating the city road system over the next 60 years. The second line shows the operating cost in the horizon year; the difference in cost is in the order of $40 million per year.

3.3 The Environment and the Road Network

The environmental implications of the two growth patterns are a large sub-topic that cannot be explored in detail in the context of this report. Impacts include emissions of pollutants and greenhouse gases, environmental issues associated with new construction and redevelopment, lost green space, noise and social aspects. Putting a dollar cost on these is very complex...

Generally it is observed that the total distance traveled by vehicles in a city is correlated with negative environmental implications such as noise and emissions. The more travel there is using automobiles, and greater the distance, the greater the greenhouse gas emissions. Appendix A demonstrates that there would be a significant difference in automobile use between the two growth patterns, with the Dispersed Scenario being the more auto-dependant of the two.

Transport Canada and other agencies and municipalities in Canada have attempted to place a monetary value on greenhouse gas emissions. Generally a figure of $30 to $100 per tonne is used but these values are contentious. There are major issues such as the time horizon under evaluation as GHG emissions are typically a cost paid over the very long term. For these reasons the cost of emissions is not included in this report, but it is recognized that they represent significant environmental and social costs.

3.4 Auto Accidents

Similar to the case with the environment, transportation safety is a large sub-topic that requires detailed evaluation under a variety of criteria. There are clear safety benefits when trips are moved from auto-mode to transit modes. Transit modes have a much higher safety record than auto modes, with far fewer accidents on either a person trip or distance based criteria. Furthermore, the nature of transit accidents tends to be less severe, as high speed accidents are less common than with private modes.

3.5 Public Transit Costs

As outlined in Appendix A of the report, public transit is expected to carry a larger percentage of trips in the Recommended Direction, as compared to the Dispersed Scenario. This is expected because of the following factors:

- Mixed-use, higher-density development creates more opportunities for transit use, and would be provided with higher levels of transit service.

- With a total developed land area that is 25% less than the Dispersed Scenario, most trips in the Recommended Direction will be shorter. There will be less need to use the car for many trips in a more compact urban pattern.

The estimated decrease in auto trips for the Recommended Direction compared to the Dispersed Scenario is in the order of 20%. Increased densities will increase walking, cycling and transit trips. The transfer of trips from the auto mode implies a much larger increase in transit trips because transit is starting from a smaller base. In total, the increase in transit trips with the Recommended Direction is expected to be almost double. Exhibit B-4 in Appendix B shows the expected increase in transit trips per capita.

The increase in ridership would seem to imply an increase in capital and operating costs for a public transit. However there are reasons why the capital and operating costs would not increase proportionally to the number of trips. These include:

- A decrease in average transit trip length with Recommended Direction. Because development is located within a smaller area (with redevelopment located in more compact nodes and corridors) average transit trip length will go down. The total urbanized area in the Recommended Direction is 25% smaller than in the Dispersed Scenario. As the size of the urbanized area is decreased and if trip patterns remain consistent, the average trip length should go down by approximately 15%.

- More efficient transit operations in the Recommended Direction. Higher ridership means that service offerings can be tailored more finely with demand. Larger vehicles can be employed, and greater utilization of the BRT/LRT systems is expected. Concentrations of employment in activity centres located outside the Centre City area means that more balanced two way flows will take place on routes, again increasing efficiency. We have estimated an increase in efficiency in the order of 10% to 15% for the Recommended Direction when compared to the Dispersed Scenario.

Appendix B has a detailed analysis of the expected differences between the two growth patterns. The main differences are:

- The LRT system in the Dispersed Scenario will be more extensive because of the need to build lines further out to serve the larger land area.

- There are expected to be a greater number of exclusive busways in the Recommended Direction to serve the high density neighbourhoods.

Thus the cost for LRT is expected to be higher in the Dispersed Scenario but Recommended Direction will have additional costs for the exclusive busways including additional buses.

The results have the following cost implications:

Exhibit 3-3: Summary of Transportation Capital Cost Comparison ($billions)

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Bus Systems	$0.4	$1.0	-$0.6	150%
LRT	$6.4	$5.2	$1.2	-19%
Total	$6.8	$6.2	$0.6	-9%

As discussed in Appendix B, the increased transit ridership projected for Recommended Direction will offset increased operating costs. As a result, net operating costs of the two growth patterns are expected to be very similar, despite the fact that Recommended Direction offers a significantly enhanced transit system with double the service per person.

3.6 Total Transportation Capital Costs

The total transportation capital and operating costs are shown in Exhibit 3-4.

Exhibit 3-4: Summary of Transportation Capital Cost Comparisons

Capital Cost ($billion)

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Road Capital Cost	$17.6	$11.2	$6.4	-36%
Transit Capital	$6.8	$6.2	$0.6	-9%
Total	$24.4	$17.4	$7.0	-29%

Operating Cost ($billion)

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Road Operations	$0.23	$0.19	$0.04	-18%
Transit Net Operating	$0.30	$0.30	$0.00	0%
Total	$0.53	$0.49	$0.04	-8%

The increased extent of the road system in the Dispersed Scenario will cost increased operating costs. Over the 60 years studied in this project the total operating cost expected to increase by almost $1 billion. In the last year there is a difference of approximately $40 million.

4. PIPED SERVICES

A major part of public infrastructure required for the development of the city is the provision of piped services for bringing water to homes and workplaces and taking waste water away.

4.1 Water Treatment

The City of Calgary has two sites where water is treated for consumption, Bearspaw at the Bow River and Glenmore at the Elbow River. The long term plan for water for the City of Calgary is to maintain these two input sites, increasing capacity as needed. Additional water treatment plants will be required and the timing depends on projected future consumption. However, with respect to water purification and treatment plants there is no difference between the two growth patterns as the additional capacity requirement applies to both growth patterns except for a possible greater need for water for watering lawns in lower density suburban communities of the Dispersed Scenario. This need could possibly be met by the use of “gray” water in the future.

4.2 Water Distribution Systems

Treated water is transported to consumers through a system of water mains and local distribution systems. The relative capital costs of these systems are calculated in Appendix C. The cost implications of each growth pattern are as follows:

- **Water distribution to serve greenfield areas**. Each new area of the city has to be supplied with new feeder mains. As the greenfield area under the Dispersed Scenario is greater than for Recommended Direction, these costs are relatively higher. New greenfield development will also require upgrading of feeder mains in existing parts of the city but it is difficult to differentiate between the two growth patterns. For the Dispersed Scenario the capital cost is estimated as approximately $2.9 billion, compared to $1.3 billion for Recommended Direction.

- **Water distribution to serve redevelopment areas**. The current feeder main systems and redevelopment areas should have sufficient capacity to serve extensive redevelopment. Most of the reconstruction that is necessary is due to age cycle; capacity can be increased when such construction is required without major additional cost implications.

In total the feeder main costs for the Recommended Direction is lower than for the Dispersed Scenario since the overall network for the Recommended Direction will be smaller in extent. This also means less reconstruction will be required for the network over the years and therefore lower operations and rehabilitation costs.

4.3 Wastewater Treatment

City of Calgary Water Resources has developed a new master plan for waste water treatment facilities. The plan is in the final editing stage and will provide overall guidance for the development of treatment facilities.

Currently wastewater treatment is performed at three wastewater treatment plants, all located along the Bow River:

- Bonnybrook is the largest and oldest, and is located in approximately the centre of the city, east and south of the core.
- Fish Creek located on Bow Bottom Trail south of Canyon Meadows Drive.
- Pine Creek near the south city limits.

In terms of total capacity, there is not a measurable difference between the requirements for wastewater treatment associated with the two land use growth patterns developed by Plan It Calgary since overall population and activity is equivalent. The various plants can be expanded in accordance with growing demand, or new plants added if required. There is no reason there would be a capital or operating cost difference between the growth patterns.

4.4 Wastewater Collection Systems

Wastewater is carried from various parts of the city to treatment plants by a network of trunks. For the greenfield areas, new sanitary collection mains and sewer trunks will have to be constructed. In the older parts of the city sewer networks might have to be upgraded if more intensive development occurs but this can be tied in with normal replacement activities. These upgrades might also be triggered by greenfield development where increased flows need to be conveyed through existing communities. In the some of the older areas the original sewer networks were designed to carry both sanitary and storm water runoff, but this is not the case in most parts of the city.

In Appendix C, the costs for sewer distribution are estimated. For sewer systems serving greenfield areas, the Dispersed Scenario has a cost of $2.6 billion for this compared to $1.2 billion for the Recommended Direction. For redevelopment areas, the costs are expected to be similar for the two growth patterns.

4.5 Summary of Water and Wastewater Costs

Exhibit 4-1 summarizes the costs associated with providing water mains, water distribution systems, wastewater trunks and wastewater collection systems for the two development growth patterns.

Exhibit 4-1: Relative Costs of Water and Wastewater Systems

		Dispersed Scenario		Recommended Direction		Difference
	Unit Cost ($/ha)	Development Area (ha)	Capital Cost ($billion)	Development Area (ha)	Capital Cost ($billion)	($million)
Water Services-Greenfield	$63,942	46,000	$2.9	21,000	$1.3	$1.6
Mains			$0.9		$0.4	
Distribution			$2.1		$0.9	
Sanitary Sewer-Greenfield	$55,980	46,000	$2.6	21,000	$1.2	$1.4
Trunks			$0.6		$0.3	
Collection			$1.9		$0.9	
Total			$5.5		$2.5	$3.0

The larger sewer and water systems in the Dispersed Scenario would increase ongoing operating and capital maintenance (O&M) costs. The total incremental annual O&M costs for the Dispersed Scenario have been estimated at $58 million per year (in the “last” year), while these costs have been estimated at $26 million for the Recommended Direction. These are costs for the Greenfield parts of the infrastructure alone, not city-wide totals. The operating costs of the remainder of the network should not differ significantly between the two growth patterns.

5. COMMUNITY SERVICES

In this section the capital costs for the two growth patterns for various community services are investigated. Qualitative differences for operating costs are identified where significant.

5.1 Fire

To understand the cost implications of the two growth patterns, the Fire Department estimated the number of stations and engines required in each. The configuration of fire stations are set by three criteria:

1. Response Time: the need to respond to emergencies within a fixed time period implies a certain spatial separation of fire stations. As such the Recommended Direction growth pattern would require fewer fire stations than the Dispersed Scenario given the smaller urbanized area.

2. The Volume of Calls: based on population and sets the number of fire engines required.

3. The level of risk present in the community.

Based on the above, the Recommended Direction growth pattern will require fewer fire stations, but that the total number of fire engines should be similar. The details of this calculation are provided in Exhibit 5-1. therefore there will be more two engine stations with the Recommended Direction compared to the Dispersed Scenario.

To obtain an estimate of the number of stations and engines required, the Fire Department estimated the number of stations and engines required for each growth pattern. The details of this calculation are provided in Exhibit 5-1. The Calgary Fire Department has estimated the cost for a station as between $13 and $25 million; we have used a median value of $18 million in 2008 dollars. Similarly the cost of a piece of apparatus to support operations can vary from $0.6 million to $1.2 million; in this calculation a value of $0.85 million has been used. The estimated capital costs come out to a difference of $220 million between the two growth patterns. There is also expected to be a decrease in operating costs of approximately $50 million per year for the Recommended Direction compared to the Dispersed Scenario.

Exhibit 5-1: Cost of New Fire Stations

	Current	Dispersed Scenario	Recommended Direction	Difference
Urbanized Area(ha)	55,000	101,000	76,000	25,000
Population	1,000,000	2,300,000	2,300,000	0
Fire Stations	41	63	51	12
Additional Stations		22	10	
Area per station(ha)	1,300	1,600	1,500	
Area per Additional Station(ha)		2,100	2,100	
Total Apparatus	64	148	148	0
Additional Apparatus		84	84	
Population per engine	16,000	16,000	16,000	
Additional Station Costs ($bil)		$0.40	$0.18	$0.22
Additional Engine Cost ($bil)		$0.07	$0.07	$0.00
Total Capital Cost ($billion)		$0.47	$0.25	$0.22

5.2 Police

The Financing Growth Study, January 2005, states that "*the new capital required (for police services) is fairly insensitive to the nature of new development as it is based primarily on population"*. This same report indicates there might be some small savings associated with a smaller geographic extent. Logically, if the same number of officers has to be supported in the two growth patterns, the only difference that can occur is whether there can be increases in efficiency with one pattern of development or the other. Consultations with police and officials indicate that generally the same hierarchy is required for a given number of active police officers, no matter how they are organized. Therefore, although there may be some efficiencies associated with a smaller geographic extent, these would be a negligible capital difference between the two growth patterns.

5.3 Recreation Centres

Calgary has a network of recreation facilities of various sizes and functions. These are provided directly by the City of Calgary or through collaboration with community partners. Generally, the more dispersed the growth pattern is, the greater the number of new recreation facilities that will be required. However, in either growth scenario it is critical that upgrades and expansion to existing facilities occur in order to deal with the growth in population. Appendix E explains the differences, but in total, the cost of providing recreation facilities is estimated at $1.1 billion for the Dispersed Scenario and $0.9 billion for the Recommended Direction.

Exhibit 5-2: Comparison of Recreational Facility Costs

			Dispersed Scenario		**Recommended Direction**		**Difference**
		Unit Cost ($million)	Number Required	Capital Cost ($billion)	Number Required	Capital Cost ($billion)	($billion)
Level 2 Facilities	New	$39	13	$0.5	8	$0.3	
	Upgrades of Existing			$0.2		$0.2	
Level 3 Facilities	New	$106	3	$0.3	2	$0.2	
	Upgrades of Existing			$0.1		$0.2	
Total				$1.1		$0.9	$0.2

Increased density in both scenarios might require larger and more complex facilities to be built in the older part of the City. This may cause other capital costs but it is difficult to assess the extent of these

Operating costs should not change between the two growth patterns.

5.4 Parks

The Dispersed Scenario would result in Calgary's parks and open space system growing at the current level of service. Neighbourhood and Community parks will continue to be dedicated through the subdivision process. In addition, a traditional growth pattern will require approximately four new regional parks in the newly developing areas of the city. Provision of open space would continue to target of minimum of 2 hectares/1000 threshold.

The Recommended Direction will likely reduce the open space provision standards with regard to hectares per 1000. To mitigate this impact, a higher level of park design and service will be

required. This is estimated to require a 20% uplift in capital upgrade/lifecycle. The Recommended Direction requires only one new regional park rather than the four under the Dispersed Scenario. The resulting costs are shown in Exhibit 5-3 below.

Exhibit 5-3: Comparison of Regional Park Costs

	Dispersed Scenario			Recommended Direction			Difference
	Unit Cost	Number Required	Capital Cost	Unit Cost	Number Required	Capital Cost	
	($billion)		($billion)	($billion)		($billion)	($billion)
Regional Park Land Purchase	$0.002	4	$0.008	$0.002	1	$0.002	$0.006
Regional Park Development	$0.010	4	$0.040	$0.012	1	$0.012	$0.028
Total			$0.048			$0.014	$0.034

As explained in Appendix F there is also small differences in operating costs between the two scenarios with Recommended Direction being approximately $50 million less per year. Due to the relatively small cost differences for regional parks, when compared to other infrastructure, the capital costs are not included in the overall summary of capital cost implications in Section 7 of the report.

5.5 Social Support Services

As noted earlier a basic assumption in this study is that the overall demographics and population will be identical between the two scenarios. Therefore it can be assumed that the difference in the growth patterns would not result in significant impacts regarding the need for social support; however, the needs for social service supports cannot be based on demographics alone. If we assume that the construction of communities will produce a mix of housing forms and housing types across the developed areas, reducing concentrated poverty and social isolation should be achievable. For example, if one growth pattern tends to cluster social housing or particular demographics/income groups into pockets, then that pattern may require more social support. On this basis no differences between the growth patterns have been included. Differences in transportation to social support services have been covered in the transportation section of this report.

6. SCHOOLS

The next element of the infrastructure we investigated is the need for schools.

6.1 Public Schools

The Calgary Public Board of Education is responsible for public schools although almost all of its capital expenditures come from grants from the Provincial Government. Exhibit 6-1 shows the changes in population in the City of Calgary and the corresponding changes in enrolment over the last few years together with projections up to 2012. Over this period enrolment will have increased less than 2 percent while population increased by almost 24 percent. This is due to a declining birth rate and other changes in the demographics. Within the horizon period of the study, however, the population of the city will increase from approximately 1 million to approximately 2.3 million, and there will be a corresponding increase in school enrolment.

Exhibit 6-1: Population and Calgary Board of Education Enrolment

	Actual					Projections				
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
City Poulation	922,300	933,500	956,100	991,700	1,020,000	1,047,900	1,074,500	1,098,900	1,121,100	1,142,800
CBE Enrolment	99,840	99,160	100,120	101,690	101,040	100,580	100,690	100,950	101,180	101,440

Appendix D provides the detail on the calculation of difference in school costs. The major difference is the need to continue constructing schools in greenfield areas in the Dispersed Scenario with a much lower requirement for similar schools in the Recommended Direction. However, it was found that, with the redevelopment of many of the existing neighbourhoods of the city, the existing schools in some of these areas will not be sufficient to handle the total number of students expected in the future and therefore redevelopment or new development of schools in older areas will also be required. Despite this, however, there is still considerable difference in the total school requirements between the two growth patterns. Exhibit 6-2 summarizes the results, based on consultation with the Calgary Board of Education. This includes the cost for schools from kindergarten to Grade 12 for both the Public Calgary Board and the Catholic School Board.

Exhibit 6-2: Total School Capital Costs ($billions)

	Adjustment for Catholic Schools			
	Dispersed Scenario	**Recommended Direction**	**Difference**	**Percent Difference**
Total Capital Cost ($billion)	$3.0	$2.2	$0.8	-28%

The ongoing operating costs of schools in the two growth patterns should be similar. As pointed out in the various sections of the report operating costs for the Dispersed Scenario should also be somewhat higher than for Recommended Direction but we have not costed this difference.

6.2 Post Secondary Education

Identical demographics and total population, as assumed for the two growth patterns imply that the need for post secondary schools will be the same for each scenario. Differences in transportation to these institutions have been covered under the transportation section of this report.

It has been concluded that differences in capital costs for post secondary education educational institutions cannot be estimated.

7. SUMMARY

Exhibit 7-1 provides an overall summary of the capital cost differences between the two growth patterns. Overall, the more compact Recommended Direction would be 32% less expensive to build than the Dispersed Scenario.

It can be seen that the most significant cost difference is associated with the construction of new road infrastructure. The savings in new capital construction for the Recommended Directions $6.4 billion. Transit capital expenditures show a difference of $0.6 billion.

Water and wastewater systems also show a significant cost difference when comparing Recommended Direction to the Dispersed Scenario, with an overall cost savings in the Recommended Direction of $3.0 billion. Combined savings in capital construction costs for fire stations, recreation centres and education facilities add up to $1.4 billion.

Exhibit 7-1: Summary of Capital Cost Comparisons

Total Cost ($billion)

	Dispersed Scenario	**Recommended Direction**	**Difference**	**Percent Difference**
Road Capital Cost	$17.6	$11.2	$6.4	-36%
Transit Capital	$6.8	$6.2	$0.6	-9%
Water and Waste Water Mains	$5.5	$2.5	$3.0	-54%
Fire Stations	$0.5	$0.3	$0.2	-46%
Recreation Centres	$1.1	$0.9	$0.2	-19%
Education	$3.0	$2.1	$1.0	-32%
Total	$34.5	$23.1	$11.4	-33%

Regional Parks have been left off this tabulation because of their small scale with respect to the other cost categories. The costs for the expansion of the water and wastewater systems do not include increases in capacity of the main plants which are the same in the two growth patterns.

Operating growth assumptions have also been investigated where possible. In all cases the operating costs are expected to be less for the Recommended Direction growth pattern than for the Dispersed Scenario. These costs are summarized in the Exhibit 7-2. Cost shown are per year, based on the “horizon year” (approximately 60 years in the future).

Exhibit 7-2: Summary of Operating Cost Comparisons

"Horizon Year" Annual Operating Cost Comparison ($billion)

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Road Operations	$0.23	$0.19	$0.04	-18%
Transit Net Operating	$0.30	$0.30	$0.00	0%
Water and Waste Water Mains	$0.06	$0.03	$0.03	-55%
Fire Stations	$0.28	$0.23	$0.05	-18%
Parks	$0.13	$0.12	$0.01	-9%
Total	$0.99	$0.86	$0.13	-14%

The operating costs for water and wastewater are for the new parts of the network; the ongoing operating costs for the rest of the network should be the same for the two growth patterns.

Operating costs for recreation centres should not change between growth patterns.

Ongoing costs for education should be similar between the two growth patterns as the demographics of the school population are the same.

This study does not discuss the implications of life-cycle replacement of infrastructure. However, this can represent a significant cost related directly to growth decisions. Calgary is a young city, and is only beginning to see the impact of needing to replace aging infrastructure in order to maintain adequate levels of service to existing built areas. As new infrastructure is added to the city, the long-term costs to replace this infrastructure will continue to grow. Although the specific costs have not been calculated here, it can be concluded that the more compact Recommended Direction, which requires less new infrastructure, will have significantly lower replacement costs for overall infrastructure than the Dispersed Scenario.

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THE IMPLICATIONS OF ALTERNATIVE GROWTH PATTERNS ON INFRASTRUCTURE COSTS

APPENDICES

APRIL 2, 2009

IBI GROUP

APPENDIX A

ROAD CAPITAL COSTS

A-1: FUTURE AUTO TRAVEL PATTERNS

Travel Demand and Modal Shares

A major difference between the Dispersed Scenario and the Recommended Direction is the density of development in transit oriented areas such as the Central Business District (CBD), Activity Centres and Corridors, and more generally the density of the Calgary Contiguous Urbanized Area (CCUA) as a whole. The proposed mix of land uses in the higher density areas, and linking that development closely to alternative modes of transportation are expected to have a significant impact on travel choices in Recommended Direction when compared to the Dispersed Scenario.

Exhibit A-1 shows the current mode split (how many trips were made by each mode of transportation) and the expected change in transportation modes in each growth pattern. These numbers are for all trips in Calgary over an entire day. This information is based on the transportation analysis completed by Plan It Calgary, and additional information can be found in Appendix A of the draft Municipal Development Plan, which explains the Core Indicators for Land Use and Mobility.

Exhibit A-1: Expected Mode Split Changes

	Daily Mode Split (all trip purposes)		
	Current	Dispersed Scenario	Recommended Direction
Walk/Cycle	14%	11%	20% - 25%
Transit	9%	8%	15% - 20%
Auto (SOV & HOV)	77%	81%	65% - 55%

The Dispersed Scenario shows increasing auto dependency compared to the current Calgary mode split, despite modest efforts to reintensify around existing LRT stations. This suggests a poor connection between the land use patterns and transportation network in that scenario. The Recommended Direction Scenario, with more mixed-use, high-density development, indicates a lower auto mode share than the Dispersed Scenario, in the order of 20%.

A-2: COSTS OF HIGH CAPACITY ROAD NETWORKS

The differences in daily mode split shown above demonstrate that different transportation networks will be required for the two growth patterns. When combined with the differences in total land areas between the two growth patterns, the differences become quite substantial. The Dispersed Scenario requires considerably more road to service a larger development area, and to accommodate more and longer automobile trips. Recommended Direction requires less new road infrastructure since the urban area would be smaller, and automobile use and trip distances would be reduced.

Measurements of the lane-km for different high-capacity street types from the Dispersed Scenario and the Recommended Direction, along with cost implications, are as follows:

- The lane-km of high standard arterial and above roadways in 2005 is estimated to be 3,000 lane-km, based on 1,300 lane-km of Skeletal Roads (freeways and expressways) and 1,700 lane-km of Arterial Streets;

- Calgary staff have developed high level road system for each of the growth patterns. An analysis of the road needs of the Dispersed Scenario shows that approximately 3,300 km of new lane-km of Skeletal Roads and Arterial Streets would be required, for a total of 6,300 lane-km;

- The future Recommended Direction Scenario would require approximately new 1,100 lane-km of Skeletal Roads and Arterial Streets, for a total of 4,900 lane-km;

- Based on a cost per lane-km of $5M for Skeletal Roads (ranges reported vary from $1.6 to $10M per lane-km), and $2.5 million for Arterial Streets, the cost difference is estimated at $5.3 billion in favour of Recommended Direction. The unit costs are based on the Canada Mortgage and Housing Corporation (CMHC) Lifecycle Costing Tool for Community Infrastructure (CMHC website).

There are two additional changes to this. In Recommended Direction, 200 lane-km of Skeletal Road would be reclassified as Arterial Street. No significant costs are anticipated as a result of this reclassification since these streets would not need to be upgraded to free-flow conditions, but some improvements for alternative modes might be required.

Selected Arterial Streets in Activity Centres and Corridors would also be upgraded to Boulevards and Parkways in each growth pattern. Both growth patterns assume 50 lane-km of Parkways, while Dispersed includes 50 lane-km of Boulevards and Recommended Direction includes 100 lane-km of Boulevards. The cost for these upgrades is estimated at $6 million per kilometre or $1.5 million per lane-km.

A-3: COSTS OF OTHER ROAD NETWORKS

Unlike Skeletal Roads and Arterials, the Dispersed Scenario and Recommended Direction do not have sufficient detail to measure the length of collector and local streets directly. However, an estimate of the relative difference in road needs between the two growth patterns can be made using the population differences between them. For a cross section of residential areas surveyed by IBI Group the following table illustrates lane-m of roadway per hectare and the population density.

Exhibit A-2: Typical Observed Suburban Population Density and Road Supply

Neighbourhood	Gross Area (km2)	Population	Gross Population Density (pph)	Observed Length of Road (m/ha)	Estimated lane-m/ha	Estimated lane-m/person
1	2.35	8,940	38	113	320	8.4
2	2.6	5,572	21	92	260	12.1
3	7.01	22,705	32	108	300	9.3
4	6.59	16,494	25	68	190	7.6
5	5.24	21,947	42	123	340	8.1
6	2.03	7,529	37	136	380	10.2

Source: IBI Group

From Exhibit A-2 there is a range of lane-km of roadway for different values of population density. This range can be translated to lane-m of roadway per person by factoring the lane-m per hectare for the area and the population. This results in a range of 7.6 to 12.1 lane-m of roadway per resident. These figures could be improved with detailed analysis of Calgary neighbourhoods.

In order to convert the lane-m of roadway per resident into an approximate cost of roadway, an assumption regarding the amount of development in each growth patterns that is new or infill (re-development) is required. For the purposes of this report, it is assumed that zones on the periphery of the city are largely new development while the remainder is infill. The following table illustrates the lane-km of new roadways assuming a median 9.0 lane-m of roadway per resident.

Exhibit A-3: New Lane-km of Road for Zones on Periphery of CCUA

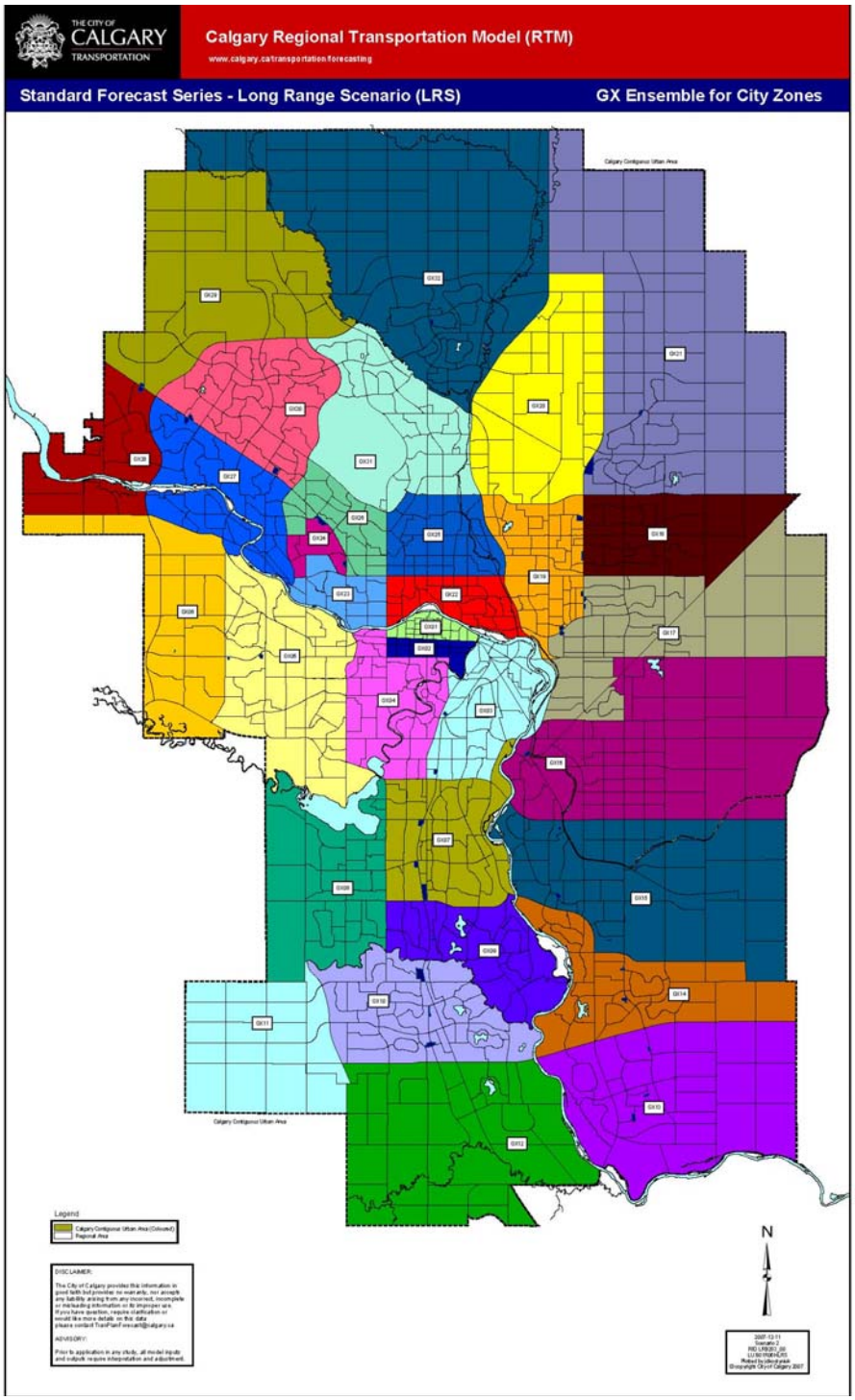
Gx_zone	2005 Population	Population Dispersed Scenario	Population Recommended Direction	Population Difference	% New Development	Dispersed New lane-Km of Road	Recommended New lane-Km of Road
6		58,492	53,496	4996	80%	421	385
8		45,785	38,184	7601	80%	330	275
11		103,399	15,676	87723	80%	744	113
12		148,408	92,166	56242	80%	1,069	664
13		162,568	133,492	29076	80%	1,170	961
14		76,361	56,351	20010	80%	550	406
15		21,330	23,120	-1790	80%	154	166
16		56,735	70,195	-13460	80%	408	505
17		155,967	174,667	-18701	80%	1,123	1,258
18		85,084	56,460	28624	80%	613	407
21		212,334	162,538	49796	80%	1,529	1,170
28		32,640	26,078	6562	80%	235	188
29		119,740	56,657	63083	80%	862	408
32		260,974	169,227	91747	80%	1,879	1,218
Total		1,539,817	1,128,307	411510		**11,087**	**8,124**

The zones used for this analysis are shown on Exhibit A-4.

The totals shown for the neighbourhoods have to be reduced to take account of the proportion which are Skeletal Roads and Arterial Streets. This was estimated at approximately 30% of the lane-kms. It is then possible to estimate the cost implications of the reduced lane-km in the Recommended Direction. The Canada Mortgage and Housing Corporation Lifecycle Costing Tool for Community Infrastructure Planning provides a range of costs for roadway types. Costs for collectors and local roads are $2.0 million per kilometre and $1.1 million per kilometre respectively. These can be converted to lane-km based costs by dividing by an assumed two lanes per roadway. It is also necessary to break down the total lane-km by type for arterial, collector, and local. Under conventional suburban land forms, approximately 50% of lane-km are local roads and 20% collectors. The remaining 30% for arterials lane-km has already been accounted for in the previous calculations for high-capacity roads (using actual measurements from the two scenarios).

The results of applying the CMHC rates to the lane-km breakdown above are were calculated. The cost for local roads under Recommended Direction is approximately $800 million less than the Dispersed Scenario, and $600 million is saved on collector roads.

Exhibit A-4: GX Superzones Used for Growth Pattern Comparison



A-4: SUMMARY OF ROAD COSTS

The overall roadway network would vary quite significantly between the Dispersed Scenario and Recommended Direction. The lower requirement for road infrastructure results in a savings of at least $5.3 billion on Skeletal Roads and Arterial Streets, and an additional $1.4 billion savings on Collector and Local streets, for a combined savings over $6 billion. Exhibit A-5 below provides a summary of these savings.

Exhibit A-5: Summary of Road Capital Costs

		Dispersed Scenario		Recommended Direction		
Road Type	Estimated cost per lane-km (millions of dollars)	Length of new Road (lane-km)	Cost (billions of dollars)	Length of new Road (lane-km)	Cost (billions of dollars)	Cost Differences (billions of dollars)
Skeletal(Freeway / Expressway)	$5.0	1,400	$7.0	700	$3.5	$3.5
Arterial	$2.5	1,900	$4.8	1,200	$3.0	$1.8
Boulevard and Parkway Upgrades	$1.5	400	$0.6	600	$0.9	-$0.3
Collector	$1.0	2,200	$2.2	1,600	$1.6	$0.6
Local	$0.6	5,550	$3.1	4,050	$2.2	$0.8
Total		11,050	$17.6	7,550	$11.2	$6.4

Source of Unit Costs: Canada Mortgage and Housing Corporation Lifecycle Costing Tool using estimated median value for Freeway/Expressway.
Length of new roads does not include upgrades.

A-5: ROAD MAINTENANCE

The City of Calgary Roads Business Unit has an Advanced Asset Management Program (AAMP). Using information from the 2008 report, it is possible to estimate the operational cost implications for the two growth patterns.

For the purpose of this project we have looked at the expected growth in lane kilometres in total for the each growth pattern. This was found to be an annual growth rate of 1.75% for the Dispersed Scenario and 1.36% for the Recommended Direction Scenario. The growth rate for lane kilometres was therefore used in the analysis.

Exhibit A-6: Growth in City Road Systems

	Existing	Dispersed Scenario	Recommended Direction
	Length of Roads (lane-km)	Length of New Roads (lane-km)	Length of New Roads (lane-km)
	6,020	11,050	7,550
Growth Factor		2.84	2.25
Annual Growth		1.75%	1.36%

The same calculations were then undertaken using the same program as for the advanced asset management project using the two different growth rates. The results are shown in Exhibit A-7 below.

Exhibit A-7: Road Operating Costs ($billions)

	Dispersed Scenario	**Recommended Direction**	**Cost Difference**	**Percent Difference**
Total Operations Costs	$9.1	$8.2	$0.9	-10%
Operations in Last Year	$0.23	$0.19	$0.04	-18%

The first line is the cost of operating the city road system over the next 60 years. The second line shows the operating cost in the horizon year; the difference in cost is in the order of $40 million per year.

APPENDIX B

PUBLIC TRANSIT NEEDS

B-1: PUBLIC TRANSIT NEEDS

The following analysis was developed by staff members from Plan It Calgary and Calgary Transit. IBI has reviewed the methodology and confirmed the approach for inclusion in this report. It examines the transit system characteristics, performance and costs associated with servicing the two alternative growth patterns.

Transit Service Overview

The main difference between the two development options is the size of the urban "footprint" of each. The Dispersed Scenario requires an urban form that is over 80% larger than the current built area, and approximately 25% larger than Recommended Direction.

For transit service, in particular, this difference is significant in terms of the service area. Significantly longer bus routes serving much lower densities will be more costly (total operating hours) and less effective (fewer passengers per hour).

The Plan It Calgary analysis has indicated that the transit mode split (travel share) for the Recommended Direction would be about twice that of the Dispersed Scenario. The reasoning is that with a developed land area nearly 25% smaller than the Dispersed Scenario, all trips will be shorter, transit routes will be more direct and connect between activity areas that are closer to trip origins. Simply put, there will be less attraction or need to use a car for many trips in this type of urban form.

The Recommended Direction growth pattern requires somewhat less LRT infrastructure than the Dispersed Scenario as the same network can have shorter lines with a smaller development area. On the other hand, the Recommended Direction Scenario will require a greater number of buses in order to provide the required level of service to meet the higher transit ridership demand that results in a more compact city.

Exhibit B-1: Length of LRT Networks

LRT Line	Existing Length 2005 (km)	Proposed Extensions for Dispersed Scenario (km)	Total Line Length for Dispersed Scenario (km)	Proposed Extensions for Recommended Direction (km)	Total Line Length for Recommended Direction (km)
Downtown	2		2		2
South	17	10	27	6	23
Northeast	13	15	28	11	24
Northwest	13	2	15	2	15
West		8	8	8	8
Southeast		30	30	26	26
North-Central		27	27	21	21
Total LRT System Length	45	92	137	74	119

The Dispersed Scenario would see a uniform urban pattern with much less concentration of development. The transit network would consist of bus and LRT services operating much as they do

today. Bus routes would feed to LRT stations and the LRT network would continue to serve the downtown and some higher density nodes along the outlying transit network.

For the Recommended Direction, a more intensive transit service or Primary Transit Network is proposed to support the more intensive nature of this proposed land use pattern. The Primary Transit Network would consist of a permanent network of LRT, Bus Rapid Transit (BRT), streetcar/tram and regular bus services operating at 10 minute (or better) frequencies, 15 hours per day, seven days per week. The LRT network would have six radial LRT lines – three more than today.

The BRT element of the Primary Transit Network is seen as a significant improvement over today's and the Dispersed Scenario bus routes since it will offer frequent and high capacity, more rapid services with limited stops connecting between multiple higher density activity nodes using busway segments to improve bus travel speeds and operating environment. These higher density activity nodes will be centred on LRT stations and major bus stops and this is where much of the increased population and employment will be located.

The Primary Transit Service concept is only possible under the Recommended Direction development scenario since it requires the higher density nodes in order to generate and attract the kind of transit ridership necessary to support such a service offering.

Transit System Operating Comparison

Exhibit B-2 also compares the urban and transit network characteristics that are evident in today's transit network and the networks that would be appropriate given the size and form of the two growth patterns. For the Dispersed Scenario, the kilometres of both bus and LRT service would be greater to serve the significantly larger urban area.

Exhibit B-2 also provides a summary of operating characteristics and associated costs of a transit network that is designed to serve the two growth patterns. In these tables, the quantity of service provided is based on passenger demand related to the projected transit mode split.

Recommended Direction is expected to result in significantly higher transit ridership and this is reflected in the difference in the transit mode split shown in B-1. In order to meet this demand and to provide the higher level of service required by the Primary Transit Service, this scenario requires a much higher level of service (operating hours). However, the higher ridership results in a more effective service with a greater number of passengers per hour.

For the Dispersed Scenario the investment in operating hours results in a reasonable level of transit ridership but still it would be approximately half of the estimate for Recommended Direction. Since the level of service for the Dispersed Scenario is dictated by the goal of 2.5 hours of service per capita, the revenue cost ratio would be less than the current Council policy. This would mean either a higher level of operating cost subsidy by tax payers or comparatively higher fares in order to maintain the revenue cost ratio goal.

Exhibit B-2: Comparison of Transit Systems

Comparison of Plan It Growth Patterns and Current Calgary Transit Operations			
	Current	**Dispersed**	**Recommended**
Transit Mode Split	9%	8%	17.5%
Population	956,000	2,300,000	2,300,000
Transit Service Area	55,000	101,000	76,000
System Annual Operating Hours	2,000,000	5,750,000	8,500,000
Operating Hours Per Capita	2.12	1.6	3.7
Transit Trips Per Capita	91	90	180
LRT			
LRT System Km	45	137	119
Annual LRT Hours	165,000	500,000	440,000
Bus			
Total Bus Route KM	4,900	9,000	6,800
Total Bus Operating Hours	2,100,000	5,500,000	8,000,000
System Costs (in $ millions)			
Annual System Ridership	95,000,000	210,000,000	410,000,000
Annual System Revenue	$135	$250	$500
Total System Costs	$250	$550	$800
Total Operating Costs (millions)	$115	$300	$300

Comparison of Plan It Growth Patterns and Current Calgary Transit Capital Costs			
Costs are in $ millions			
	Dispersed	**Recommended**	**Difference**
LRT			
LRT route KM to be added	92	74	18
Additional LRVs	300	240	60
Cost of LRT Line Extensions	$4,600	$3,700	$900
Cost of Additional LRVs	$1,200	$1,000	$200
LRV Maintenance Facilities	$600	$500	$100
Total LRV Infrastructure Cost	$6,400	$5,200	$1,200
Bus			
Cost of Exclusive Busways	$0	$150	-$150
Additional Buses	700	1,600	-900
Cost of Buses	$300	$650	-$350
Additional Bus Mtce Garges	$100	$200	-$100
Total Bus Infrastructure Costs	$400	$1,000	-$600
Total Capital Cost (millions)	$6,800	$6,200	$600

Source: Calgary Transit

Capital Costs

Exhibit B-3 provides an estimate of the capital costs required to achieve the transit services described in Exhibit B-2. Bus capital costs include the number of buses required to provide the level of service described above plus bus garages required to maintain and store the fleet. Dispersed Scenario has the lower bus infrastructure requirements since it has the lower level of service. Recommended Direction would require a higher investment in bus infrastructure in order to provide the level of service dictated by transit demand and the requirements of the Primary Transit Network. In total the capital cost for Recommended Direction is expected to be $600 million less than for the Dispersed Scenario.

Exhibit B-3: Comparison of Capital Costs ($billions)

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Bus Systems	$0.4	$1.0	-$0.6	150%
LRT	$6.4	$5.2	$1.2	-19%
Total	$6.8	$6.2	$0.6	-9%

Operating Costs

Exhibit B-4 provides a comparison of operating costs for the system in the horizon year. Despite the additional buses required to operate the Primary Transit Network, the significant increase in ridership that will result from the Recommended Direction growth pattern means that the net operating costs will be virtually identical for the two transit systems.

Exhibit B-4: Comparison of Operating Costs in the Horizon Year ($millions)

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Annual System Revenue	$250	$500	-$250	100%
Annual System Costs	$550	$800	-$250	45%
Net Costs	$300	$300	$0	0%

APPENDIX C

RELATIVE COSTS OF WATER AND SEWER DISTRIBUTION NETWORKS

IBI GROUP

April 2, 2009

C-1: WATER DISTRIBUTION

Treated water is transported from the water treatment plants to the various areas of the city through a system of water mains. These are looped so that no area is dependent on only one link. Local distribution systems link the mains to individual properties.

Water Distribution for Greenfield Areas

For the newly developing Greenfield areas of the city, the position is clear: the water mains have to be extended into each area. Sometimes these extensions can be fed from the existing mains in an adjacent developed area; sometimes the mains have to be extended a considerable way to the point where the network has sufficient capacity. There is not one typical solution. Local water distribution systems must also be extended to serve new development areas.

To understand growth implications of new developments, Water Resources performed an analysis of the water main and local distribution requirements for two newly developing areas, East RCS and Calgary South. The total cost of water distribution for these greenfield areas is estimated at $63,942 per hectare.

Exhibit C-1: Unit Cost of Water Servicing ($/ha)

Case Study	Total cost ($)	Servicing Area (ha)	Unit Cost ($/ha)
Area 1 - East RCS	$102,869,204	6,102	$16,858
Area 2 - Calgary South	$58,259,025	2,328	$25,025
Average (area weighted)			$19,114
Distribution system	$11,476,098	256	$44,829
Total			**$63,942**

Applying these figures to these two scenarios of development, the Dispersed Scenario was found to have a cost for new water services of $2.9 billion and Recommended Direction of $1.3 billion as shown on Exhibit C-3.

Water Services for Redevelopment Areas

In redevelopment areas water distribution services are already in place. If there is a considerable amount of intensification these may have to be increased in capacity but, in most cases, they will have to be replaced in any case as the infrastructure ages. Therefore it has been concluded that there is no major differences between the two scenarios.

C-2: WASTEWATER SERVICES

Wastewater is carried from individual properties to the treatment plants by a network of local sewers and trunks.

Wastewater Systems for Greenfield Areas

As development occurs in greenfield areas beyond the existing network these trunks have to be extended and the local systems constructed. Again a case study approach was taken to determine the average cost of sewer trunks per area of new development. This was determined by Water Resources, for the same two case study areas examined, to be a total of $55,980 per hectare.

Exhibit C-2: Unit Cost of Sanitary Sewer Servicing ($/ha)

Case Study	Total cost ($)	Servicing Area (ha)	Unit Cost ($/ha)
Area 1 - East RCS - Belvedere (Trunk + Collection System)	$98,299,881	1,514	$64,927
Area 2 - Trunk - Silverado	$25,000,000	2,062	$12,124
Collection System	$9,545,152	256	$37,286
Average (area-weighted)			**$55,980**

Applying these ratios to the two scenarios resulted in a cost of $2.6 billion for the Dispersed Scenario and $1.2 billion for Recommended Direction, as shown in Exhibit C-3.

Wastewater Services for Redevelopment Areas

Developments in the city are now supplied with sanitary sewer services and typically these are not required to be expanded with redevelopment. In some of the oldest parts of the city, the original sewer system was sized to take both sanitary and storm water flows and the storm waters have subsequently been separated from the sanitary sewage; in these areas sewer capacity is higher than currently required.

In many parts of Calgary, the existing wastewater system is usually adequate to accommodate most forms of redevelopment. In some cases, however, these local systems will have to be expanded but this is usually because of the age of the infrastructure and therefore will not vary materially between alternative growth patterns.

C-3: SUMMARY OF WATER AND WASTEWATER CAPITAL COSTS

Exhibit C-3 provides a summary of the costs associated with the two growth patterns for water and for wastewater services. Costs for both mains/trunks and distribution/collection systems are included to reflect the full cost of growth in each pattern.

Exhibit C-3: Relative Costs of Water and Sewer Services

		Dispersed Scenario		Recommended Direction		Difference
	Unit Cost ($/ha)	Development Area (ha)	Capital Cost ($billion)	Development Area (ha)	Capital Cost ($billion)	($million)
Water Services-Greenfield	$63,942	46,000	$2.9	21,000	$1.3	$1.6
Mains			$0.9		$0.4	
Distribution			$2.1		$0.9	
Sanitary Sewer-Greenfield	$55,980	46,000	$2.6	21,000	$1.2	$1.4
Trunks			$0.6		$0.3	
Collection			$1.9		$0.9	
Total			$5.5		$2.5	$3.0

There is an additional effect, however. The total size of the water distribution and wastewater collection systems under the Dispersed Scenario is larger than in the Recommended Direction. While we have attempted to estimate the difference in initial capital costs between the two scenarios, there will be replacement and upgrading of the sewer system. These costs should be lower for Recommended Direction but these have not been estimated.

C-4: OPERATING COSTS

Water resources have also estimated the ongoing cost of operating services in the new areas at $1,261 per year per hectare. This works out to annual cost, in the horizon year, of $58 million and $26 million for the Dispersed Scenario and the Recommended Direction respectively for a difference of $32 million per year. This does not include the cost of ongoing operations in the existing areas of the city. These should not differ between the two growth patterns.

APPENDIX D

FIRE SERVICES

D-1: FIRE SERVICES

A report by Calgary Development and Building Approvals, Financing Growth Study, January 2005, states that "the cost of fighting fire services is highly related to the total area of development". This report goes on to say that this is due to the need to meet benchmarks with respect to standard response times. The current Council approved benchmark for response times is that 90% of calls should be attended by first-in engine emergency response within seven minutes at fire rescue incidents and, within six minutes and thirty seconds at life threatening emergency medical incidents. Functionally in an urban environment this implies that, depending on the road network, a fire station can serve an area within two or three kilometres of road distance around itself. Given that development in the area under the Recommended Direction scenario is approximately 25,000 ha less than the Dispersed scenario, this scenario should be served by fewer fire stations than needed for the Dispersed scenario.

Another report by the Calgary Fire Department, Service Levels and Response Time Target, January 2008, indicates that there is also a relationship between population and the number of fire stations. Calgary is slightly above average today but is close to other major cities in Canada. This implies that the number of fire stations should go up with population, not only with area.

More detailed discussions with Fire Department staff indicate that practical planning is done on a combination of area, population and risk. The number of stations required is basically set by response times, densification and community risk and therefore varies with area. But, as population densities increase, the number of apparatus (engines, aerials, emergency rescue vehicles, etc) required will also increase. For example, a neighbourhood of 20km2 with a population of 25,000 could probably be served by one station with one engine but the same area with 50,000 people probably could potentially be served by one station with two engines.

In addition to engines there are also specialty apparatus that support the front-line engine response. These include vehicles such as aerial trucks that are able to attend all incidents involving high rise structures, and can also provide scene safety support and flood salvage services. Emergency rescue units on the other hand, are uniquely equipped to attend motor vehicle collisions, and can provide vehicle extrication, lighting and air supply services. As the Dispersed Scenario includes more kilometres of roadways, additional emergency rescue vehicles may be required, depending on the configuration of the road network. Conversely, the number of aerial units required may increase in Recommended Direction if part of the intensification is achieved by a higher proportion of use of tall buildings but this is uncertain as more intensification can be achieved without a greater use of tall buildings.

The number of stations required, as well as the configuration of apparatus deployed to these stations is also highly dependent on the types of land use and occupancies of structures within each area. Higher risk occupancies, for example institutional, commercial or industrial uses, require greater emergency protection and response coverage. However, we have used a simplified method to estimate the likely difference between the two scenarios. This methodology estimates only the cost of basic fire services and implicitly assumes that other needs are the same between the two scenarios.

To obtain an estimate of the number of stations and engines required, we have used the current average areas per station and populations per engine and applied these ratios to the alternative futures. The details of this calculation are provided in Exhibit D-1. The Calgary Fire Department has estimated a cost for a station to be between $13 million and $25 million for the structure and land. An average of $18 million has been assumed for the purposes of this analysis. Similar, engine costs vary from $0.6 million to $1.2 million depending on the type of vehicle. An average of $0.85 million

has been assumed in this analysis. The calculations come out to a difference of approximately $200 million for the capital costs and a difference of approximately $50 million in the horizon in annual operating costs between the two scenarios. This equates to the dispersed scenario being 86% more expensive for the initial capital investment and 24% per year more expensive for the annual operating costs.

Exhibit D-1: Cost of New Fire Stations

	Current	Dispersed Scenario	Recommended Direction	Difference
Urbanized Area(ha)	55,000	101,000	76,000	25,000
Population	1,000,000	2,300,000	2,300,000	0
Fire Stations	41	63	51	12
Additional Stations		22	10	
Area per station(ha)	1,300	1,600	1,500	
Area per Additional Station(ha)		2,100	2,100	
Total Apparatus	64	148	148	0
Additional Apparatus		84	84	
Population per engine	16,000	16,000	16,000	
Additional Station Costs ($bil)		$0.40	$0.18	$0.22
Additional Engine Cost ($bil)		$0.07	$0.07	$0.00
Total Capital Cost ($billion)		$0.47	$0.25	$0.22

Exhibit D-2: Fire Station Operating Costs

	Stations	Op cost/ Station/ year ($million)	Annual Costs ($million)
Current	41	$4.45	$180
Dispersed Scenario	63	$4.45	$280
Recommended Direction	51	$4.45	$230
Difference			$50

Source: Calgary Fire Department

APPENDIX E

RECREATIONAL FACILITIES

E-1: RECREATION FACILITIES

The City of Calgary is involved in the development of an integrated recreation service delivery model that includes direct delivery and co-produced public value through collaboration with community partners. A network of recreation facilities that provide neighbourhood, community, regional and city-wide programs and services all contribute to making Calgary a healthy, active and creative city. These recreation facilities vary in size and incorporate a number of different types of amenities such as swimming pools, ice arenas, athletic parks, gymnasiums, arts centres, fitness and dance centres and community gathering spaces. The Recreation Facility Continuum provided in Exhibit E-1outlines the various facility types, service population and distribution, access, land requirements, and building footprints.

The provision of recreation facilities is based on population, public values and the associated needs and preferences of a community. Consideration must be given to the location, size and amenities that will be required to meet the needs of the community. In addition, there will be a large number of existing facilities that will require expansion, upgrades and/or replacement to efficiently accommodate the growth in population and/or densification. In order to provide effective recreation services for the city; no one single type of facility or provider should be used.

Increasing densities in the Recommended Direction may require larger and more complex facilities to be built in order to service a more diverse population. The majority of current recreation facilities are on sites that offer little or no room for expansion. To accommodate this, the City or other providers may need to acquire additional costly inner city lands. Greater densities will also result in a higher demand on recreation centres thereby, requiring increased capital investments for ongoing maintenance and lifecycle. The lower density growth pattern assumed in the Dispersed Scenario would require the construction and operation of more suburban recreational facilities compared to Recommended Direction however.

An issue common to both the Dispersed Scenario and the Recommended Direction is that existing recreation facilities within established communities have an average age of 36 years and as such, will require substantial capital investments to update, refurbish and/or repurpose them to accommodate increased use and current/changing needs.

The total estimated City costs in meeting the recreational needs and preferences of Calgarians for both the Dispersed Scenario and the Recommended Direction for Level 2 & 3 type facilities is provided in Exhibit E-2. In the Dispersed Scenario, the development of new community and regional facilities will be common in the outlying areas; however redevelopment and upgrades of existing facilities within the established areas would also have to occur in order to accommodate increased density. The converse is true in Recommended Direction Scenario. Fewer new facilities would be required in the growth areas while there would be an increased demand, due to densification, for the upgrade and expansion of existing facilities within the established communities. As a result, the overall capital cost of the Recommended Direction Scenario would be estimated at approximately 20 per cent less than the Dispersed Scenario.

Operating costs should not vary significantly between the two growth patterns.

Exhibit E-1: Recreation Facility Continuum

Facility Type	Level 1	Level 2	Level 3	Level 4	Level 5
Service Region	Neighbourhood Facilities ◀ • • • • • • • • • • • • ▶ City-Wide Facilities				
Service Level Population	Under 20,000	40,000 – 80,000	80,000 – 100,000	150,000 – 200,000	Over 250,000
Service Distribution	High local demand, usually developed by community associations or school boards.	Often single purpose focus and stand-alone facilities.	Multi-purpose focus which integrates ages, interests and activities.	Targeted activities and specialized interests.	Highly specialized facilities which are designed for competitive or large spectator use.
Typical Access	Walking, Biking, Driving (less than 5 minutes)	Walking, Biking, Driving (5-10 minutes) or Public Transit	Car (driving 15-20 minutes) or Public Transit	Car (driving 30-60 minutes) or Public Transit	Car (more than 30-60 minutes) or Public Transit
Typical Land Requirement	1-2 Hectares (2-5 Acres)	2-4 Hectares (5-10 Acres)	6-8 Hectares (15-20 Acres)	Size dependent on specialty requirements	Size dependent on specialty requirements
Typical Facility Types	-Community Assoc. Hall - School Gymnasium	- Indoor pool - Arena - Fitness Centre	- Multi-court gymnasia centre - Multi-purpose recreation centre	- Outdoor skate park - Multi-pitch indoor soccer centre - Performance theatre (seating under 1000)	- Aquatic Centre with seating 1000+ - Ski facility - Major spectator stadium - Major heritage site

Exhibit E-2: Total Cost of Providing Recreation Facilities in the New Urbanized Growth Areas

			Dispersed Scenario		**Recommended Direction**		**Difference**
		Unit Cost ($million)	Number Required	Capital Cost ($billion)	Number Required	Capital Cost ($billion)	($billion)
Level 2 Facilities	New	$39	13	$0.5	8	$0.3	
	Upgrades of Existing			$0.2		$0.2	
Level 3 Facilities	New	$106	3	$0.3	2	$0.2	
	Upgrades of Existing			$0.1		$0.2	
Total				$1.1		$0.9	$0.2

APPENDIX F

PARK COSTS

F-1: PARKS GROWTH INFRASTRUCTURE COSTS

Calgary possesses a broad spectrum of open space and park types. These parks and open spaces vary in size and are designed to serve multiple users and meet a wide range of outdoor recreational needs.

The City has, over the years, acquired its parks and open spaces through a variety of mechanisms. The vast majority of parks that constitute Calgary's open space system have been created through reserve dedication at the time of subdivision. These parks represent 10% of developers' net developable area and are typically located and sized for neighbourhood and community use. Regional parks on the other hand, are generally much larger serving a catchment area of several communities. These parks are not typically created as part of the 10% reserve dedication but rather necessitate entire or partial purchase, donation and/or land exchange.

The Dispersed Scenario would result in Calgary's open space system growing at the status quo. The cost incurred by The City (Parks) if Calgary grows as per the Dispersed Scenario would mirror those of growth accommodated today. Provision of open space would continue to target a minimum of 2ha/1000 person threshold. A significant increase in Calgary's footprint necessitates a new outer "ring" of four regional parks as forecasted in the Accommodating Growth Document. These regional open space sites would be purchased as the City grows and local open space would be acquired through the subdivision process. Operational costs would also mirror those of today at $56 per capita. Exhibit F-2 outlines the estimated land and capital costs of the new regional parks in the "Dispersed" column.

If Calgary encourages greater housing and development choice through more efficient use of land, as proposed in Recommended Direction, the resultant increase in densities and greater mix of land uses will have a significant impact on the City's provision of open space and the design of its parks. Minimum open space standards (ha/1000) will change and the demands and use patterns of most parks will be greater and/or different than those for which they were originally designed. The City will have to contemplate new park typologies and/or upgrade existing parks within certain catchment areas. With reduced greenfield development, the necessity for a new ring of 4 additional regional parks will be reduced to one – strategically located in the most underserviced greenfield area. This has significant cost savings for Parks as noted in Exhibit F-2.

The costs of regular greenfield growth within Recommended Direction would be similar to the current model as is outlined above although the rate of growth (consumption of land) would be reduced.

In existing communities or in brownfield redevelopment where densification is encouraged, operational costs of growth will likely be reduced on a per capita basis. Higher densities in activity nodes, TODs or infill developments will result in higher levels of open space maintenance, but the higher densities will drive the operational costs per capita down slightly as Figure 2 illustrates – approximately 20% reduction in per capita operations based on a 50% increase in population density. Capital costs for parks on the other hand, will likely increase slightly, as a higher level of design complexity for quality urban parks (materials, lighting, irrigation, etc.) will be needed to accommodate additional use and greater capacity.

Provision of open space within the Activity Centres, TODs and Corridors of the Recommended Direction Scenario will need to reach a middle ground between that of the current city wide minimum threshold of 2 ha/1000 people and the Beltline minimum threshold of 1 ha/1000 people. The ultimate figure for provision per capita will respond to the site specific context of development. Once established, any development that has negative implications to this minimum provision will

require mitigation through higher carrying capacities in surrounding parks or considerations of additional park purchase.

Exhibit F-1: High Level Cost Comparisons: Dispersed Scenario vs. Recommended Direction

	Dispersed Scenario			Recommended Direction			Difference
	Unit Cost	Number Required	Capital Cost	Unit Cost	Number Required	Capital Cost	
	($million)		($billion)	($million)		($billion)	($billion)
Regional Park Land Purchase	$2.0	4	0.008	$2.0	1	$0.002	$0.006
Regional Park Development	$9.6	4	0.038	$11.5	1	$0.010	$0.029
Total			0.046			$0.012	$0.035

F-2: PARKS OPERATING COSTS

Current parks operating costs are in the order of $56 per person per year. In the future, with the Recommended Direction Scenario with a smaller number of parks it is estimated to go down to $51 per person per year. Applying these to the rising in population of 2.3 million, this works out to an estimate of $129 million and $117 million for the Dispersed Scenario and Recommended Direction respectively with a difference of $12 million per year.

APPENDIX G

RELATIVE COSTS OF NEW SCHOOLS

G-1: ESTIMATING THE COSTS FOR KINDERGARTEN TO GRADE 9 SCHOOLS

The Calgary Board of Education (CBE) has recently published its School Capital Plan for the years 2009 to 2012. Analysis of the information contained in this document reveals some interesting facts:

- Overall there is enough capacity in the school system to more than accommodate the school population. In 2000-2008 there were 71,500 students in elementary and junior high schools with a capacity of 93,500.

- But many of these schools are in the wrong places because of the demographic trends in the various neighbourhoods and areas of the city. For example, in Sector 3 as defined by the Board of Education, the area immediately north of the central area, “local” resident students only utilized 28 percent of the capacity whereas in Sector 9, the newly developing areas in the south and south east, local students represented 169 percent of the capacity of local schools. The school board buses students from one place to another take advantage of the capacity but, in the long term, “it is a strategy of the board of trustees to provide schools where the students reside”.

Discussions with the CBE staff indicate therefore that the demand for schools is actually driven more by the development of new areas than by total enrolments. The need for local schools, particularly elementary and junior high schools, follows a cycle:

- Initially when an area is open to development, there is not the critical population for school. Students are therefore bused out to utilize capacity in other parts of the city, preferably neighbouring parts of the city.

- The demand for school spaces is relatively high because many of the new houses are occupied by young families.

- The school is built and is highly occupied. Usually the CBE builds new schools including relocatable classrooms that are open from the first day.

- As the development areas fill up the demand for schools remains high.

- After about 20 years the children of the initial occupants of the developments have graduated and school demands start to go down. Although there are new families moving into the neighbourhood in total the demand can go to half or less than the initial demand for school enrolment in the local area.

In this way the demand for school and construction is created by new or greenfield development, not by the total number of students. Demand for high schools is not as closely linked to development and is discussed later.

Further analysis of the data on new communities in the School Capital Plan reveals the following:

- For each 200,000 population in new communities approximately two Kindergarten to Grade school are required with a cost of $8.9 million each.

- Similarly for Grade 5 to Grade 9, for every 20,000 person in the communities, one middle school is required for a total cost of $18.7 million each.

- As explained below it was assumed that the number of new high schools required is the same for both scenarios.

Applying these ratios to expected levels of new development in the city for each growth pattern produces the figure shown in Exhibit G-1 for constructions of new schools.

Exhibit G-1: Relative Costs For New Greenfield Schools

	Dispersed Scenario	**Recommended Direction**	**Difference**
Area of Greenfield Development (ha)	45,000	21,000	24,000
Average Population Density (persons/ha)	25	35	
Population Developing Communities	1,125,000	735,000	390,000
Elementary Schools (K-4) required @ 2 per 20,000 population	113	74	
less Elementary Schools (K-4) lag @ 2 per 20,000 population	-25	-25	
Elementary Schools (K-4) constructed	88	40	
Cost ($billions) @ $8.9 million per school	**$0.8**	**$0.4**	$0.4
Middle Schools (Grades 5-9) required @ 1 per 20,000 population	56	37	
less Middle Schools (Grades 5-9) lag @ 1 per 20,000 population	-12	-12	
Middle Schools (Grades 5-9) constructed	44	25	
Cost ($billions) @ $18.7 million per school	**$0.8**	**$0.5**	$0.4
Senior High Schools (Grades 10-12)	6	6	
Cost ($billions) @ $50 million per school	**$0.3**	**$0.3**	$0.0
Total Cost ($billions)	**$1.9**	**$1.1**	$0.8

But do the new greenfield schools supply enough capacity in total for each scenario? Exhibit G-2 shows this analysis. Currently there are approximately 93,000 spaces of capacity (and 71,500 actual students) for Kindergarten to Grade 9 students in the Calgary School System with another 32,000 spaces in the high schools. Under the Dispersed Scenario approximately 20,000 greenfield spaces will have to be added each decade for a total of approximately 160,000 spaces. As shown in the analysis this will supply a sufficient number of spaces to meet the future needs of Calgary. The analysis represents a reasonable cycle given the current dynamics of school expansions in the City of Calgary. For the Recommended Direction, however, with much lesser greenfield development, the provision of greenfield schools does not meet the total future capacity requirements, as shown on Exhibit G-2. Approximately another 9,500 spaces will be needed and presumably will have to be constructed in other parts of the city. When these additional spaces are included in the analysis the difference between the two scenarios drops to approximately $0.5 billion.

Exhibit G-2: Adjustment for Total Capacity

	Dispersed Scenario	Recommended Direction	Difference
Existing CBE Capacity and Utilization - 2007			
K-9 School Capacity	93,276	93,276	
Grade 10-12 School Capacity	32,097	32,097	
Total Capacity 2007 (student spaces)	125,373	125,373	
School Students K-12 (2007)	101,035	101,035	
2007 % utilization	**81%**	**81%**	
Projected CBE Capacity and Utilization - 2066			
Additional K-12 Capacity (2008-2066)	115,625	62,675	
Total Capacity 2066 (student spaces)	240,998	188,048	
School Students K-12 (2066)	160,000	160,000	
2066 % utilization	**66%**	**85%**	
Extra Capacity Required to reach 81% Utilization		9483	
Elementary schools		9	
Middle schools		5	
Cost of Elementary Schools ($billions)		$0.1	
Cost of Middle Schools ($billions)		$0.1	
Total Cost ($billions)		$0.2	
Utilization		**81%**	
Adjusted Comparison			
Total Cost ($billions)	**$1.9**	**$1.3**	**$0.6**

High Schools

High schools represent a somewhat different aspect. Although the Calgary Board of Education attempts to provide given that the total number of high school students will be the same for the two scenarios, we have assumed that there is no basic difference between the two in terms of total cost of capital construction.

Catholic Schools

The Public School Board accommodates only about 60% of the student population. The Catholic School Board represents another 35%. To adjust the above numbers for the Catholic School Board they were multiplied by the ratio of 95 over 60. This results in the following estimates of cost:

Exhibit G-3: Adjustment for Catholic Schools

	Dispersed Scenario	Recommended Direction	Difference	Percent Difference
Total Capital Cost ($billion)	$3.0	$2.2	$0.8	-28%

Operating Costs

The operating costs for the two growth patterns should be similar as the number of students if the same.

School Transportation

At present the Calgary Board of Education has a considerable school bussing program. This school bussing is required when students are at more than an acceptable distance from their school. This can occur under two circumstances:

- Because of the dispersed nature of some communities;
- In new communities, schools are usually not in place when occupation begins.

There should be somewhat less school bussing for the first reason with the Recommended Direction Scenario. Because there is less development of greenfield communities under Recommended Direction bussing under the second circumstance should also be considerably reduced. We have not attempted to make an estimate of these amounts, however.

APPENDIX H

STAFF MEMBERS CONSULTED

H-1: STAFF MEMBERS CONSULTED

Persons consulted within City of Calgary staff and related agencies in this exercise include the following:

- Diane Atkins, Transportation Planning
- Francios Bouchart, Water Resources
- Narinder Bubbar, Roads
- Michael Chau, Water Resources
- Dave Colquhoun, Plan It Calgary
- Devery Corbin, Calgary Fire Department / CS & PS
- Peter Grubor, Transportation Planning
- Brent Hughes, Calgary Board of Education
- Chris Jordan, Calgary Transit
- Zorica Knezevic, Water Resources
- Eric MacNaughton, Plan It Calgary
- Rob McAuley, Recreation
- Neil McKendrick, Calgary Transit
- Ashar Nazir, Transportation Planning
- Laurie VandeSchoot, Calgary Fire Department