

Inspiring sustainable thinking



2018 CANADIAN CONSULTING ENGINEERING AWARDS

Macleod Trail and 162 Avenue Diverging Diamond Interchange

Category:

Transportation

Client/Owner:

The City of Calgary

Subconsultants:

AECOM Canada Ltd.

Tetra Tech Canada Inc.

Canadian Highways Institute Ltd.

Perkins + Will Canada Architects Co.

General Contractor:

Graham Infrastructure LP

April 2018







BACKGROUND

Since 2011, The City of Calgary has dedicated itself to constant improvement – that is, improvement that makes the life of its citizens better. This includes a commitment to transparency, accountability, civic engagement, innovation, citizen orientation and sustainability. While often overlooked as just another road, transportation infrastructure serves a critical role in the development and improvement of the growing City. This was clear when it came to the need for a new interchange at the junction of Macleod Trail and 162 Avenue SE.

AS CANADA'S FIRST DDI, THE DESIGN TEAM COMPLETED EXTENSIVE WORK TO RESEARCH, ADOPT AND ADAPT BEST PRACTICES FROM THE UNITED STATES AND EUROPE FOR IMPLEMENTATION IN CALGARY'S LOCAL CONTEXT.

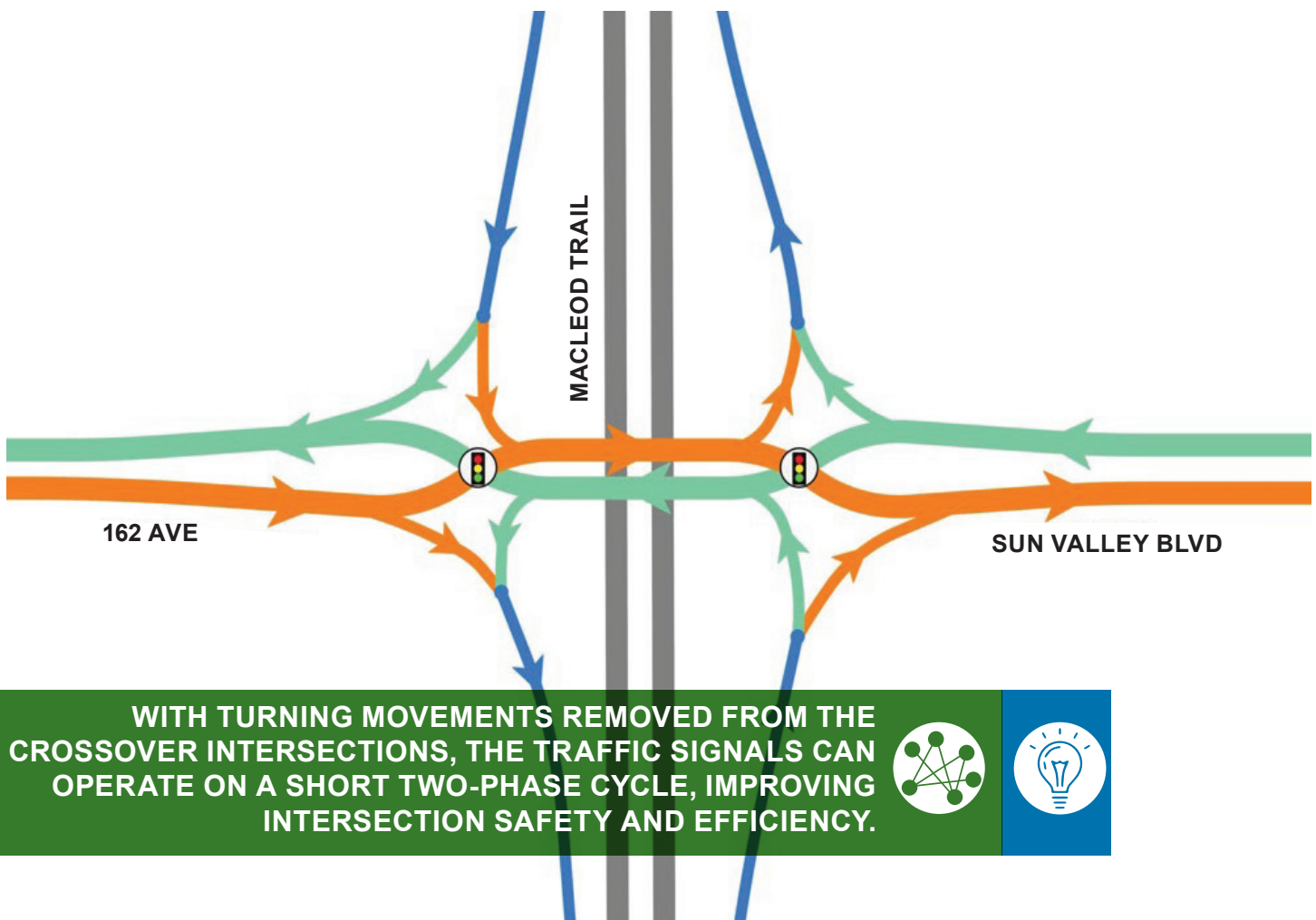
Located in southeast Calgary, the interchange provides access to major shopping and business centres and the surrounding residential communities. Macleod Trail serves approximately 60,000 vehicles/day, connecting south Calgary and surrounding areas to and from the downtown core, while 162 Avenue / Sun Valley Boulevard carries an additional 35,000 vehicles/day. Unfortunately, the former signalized intersection had become a major bottleneck in Calgary's transportation network. This created long queues and frustrating delays for drivers who often had to wait several signal cycles to get through the intersection during both the weekday commuter peaks and weekend shopping peaks. Pedestrians and cyclists shared in these intersection delays, waiting long periods of time to cross multiple lanes of high speed and high volume traffic.

In 2014, Calgary City Council approved funding for a new interchange at this location and The City of Calgary enlisted the help of ISL Engineering and Land Services (ISL) to plan, design and construct the most suitable interchange configuration.

From prior planning dating back to the 1980s, land had historically been reserved at this location for a partial cloverleaf interchange and the thought at the onset of this project was that this remained the leading candidate. However, ISL took Calgary's desire for constant improvement to heart by focusing on innovation (i.e., new ideas and approaches that make living and working in Calgary even better), civic engagement (i.e., commitment to bring together citizens, organizations and City employees in the planning and development of the City), citizen orientation (i.e., ensuring that a project is designed with citizens in mind) and sustainability (i.e., long-term thinking that makes for a healthy community, environment and economy now and in the future). Following a rigorous evaluation and community engagement process, the Diverging Diamond Interchange (DDI) configuration was selected as the functional design for this location because it enhances mobility for commuters, transit users and cyclists; increases access to surrounding businesses and services; and allowed for innovative construction staging that avoided major detours and accommodated active modes of transportation.

As Canada's first DDI, the design team completed extensive work to research, adopt and adapt best practices from the United States and Europe for implementation in Calgary's local context. The DDI officially opened to traffic in August 2017.





WHAT IS A DDI?

The DDI concept originated in France, which has had three in service since the 1970s. Since 2009, the DDI has evolved primarily in the US where there are now over 80 in service and many other locations in various stages of planning, design or construction.

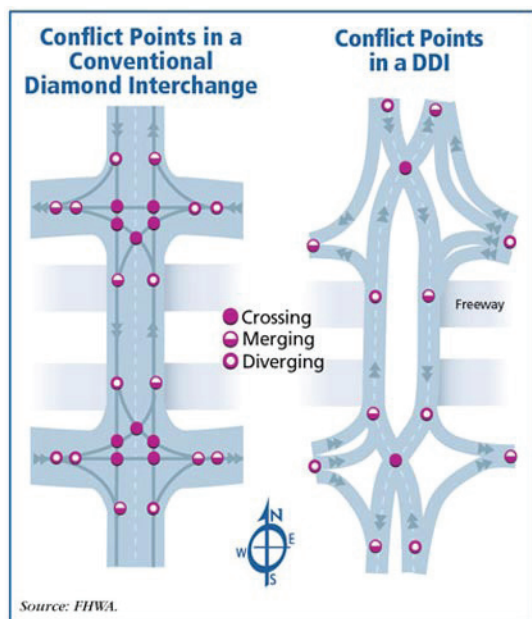
Sometimes called a Double-Crossover Diamond, the operation of the interchange follows its namesake by “diverging” traffic on the minor street to the left-hand side of the road through two crossover intersections. This enables left-turning traffic to access the major thoroughfare without waiting for a signal or crossing oncoming traffic, nearly halving the number of conflict points compared to a typical diamond interchange. Right-turning vehicles use slip lanes away from the intersection to bypass the crossovers. With turning movements removed from the crossover intersections, the traffic signals can operate on a short two-phase cycle, improving intersection safety and efficiency.

Pedestrians and cyclists are also uniquely accommodated through the DDI by converging the exterior pathways from all quadrants of the interchange into the centre of the overpass to cross Macleod Trail. This approach reduces the total number of road and lane crossings for pedestrians, and improves travel times by allowing all users to cross “kitty corner” through the centre of the interchange.

As with any road innovation, the risk of driver confusion for new or unfamiliar users was top of mind for the ISL designers. While an aerial view of the DDI can lead to some apprehension, once at street level, the roadway configuration, approach angles, placement of curb lines and islands, strategic use of signage and clear road markings significantly aid drivers’ understanding of the interchange configuration. On a practical level, it is no different than driving on a one-way street. The roadway geometry helps to control vehicle speeds and mitigates potential wrong-way movements, while the wide separation of the bridges helps provide clear visual delineation between the opposing directions of travel.

To help stakeholders visualize the configuration from the street level and understand how the DDI works, ISL called in the support of its in-house 3D visualization team who worked with The City to develop 3D renderings and animation. These videos were used at different project stages but were especially critical in the evaluation and decision making processes, and in the lead-up to the DDI's official opening. Generally, with the right information and context, public stakeholders were enthusiastically in support of the DDI, a factor which helped support The City's ultimate decision to confirm the DDI as the correct solution at this location.

Since most of the prior US applications were retrofits of existing diamonds, there are no fixed standards for the greenfield construction of new DDI interchanges. The US Federal Highway Administration published an informational guide for DDIs in 2014 and guidelines are available from various state-level Departments of Transportation. Conscious of the responsibility the team was carrying by implementing the first DDI in Canada, ISL thoroughly surveyed these best practices and ultimately developed a design that reflected the site-specific context, Calgary's typical design standards and best engineering judgement based on first-principles. As one of the few relatively greenfield DDIs to be implemented to date, ISL found a number of opportunities to innovate and improve on existing geometric design practices while also reducing construction time and cost.



LEFT-TURNING TRAFFIC ACCESSES THE MAJOR THOROUGHFARE WITHOUT WAITING FOR A SIGNAL OR CROSSING ONCOMING TRAFFIC, NEARLY HALVING THE NUMBER OF CONFLICT POINTS COMPARED TO A TYPICAL DIAMOND INTERCHANGE

WHY HERE?

In the former at-grade intersection configuration, Macleod Trail at 162 Avenue was one of Calgary's most critical transportation bottlenecks, carrying six lanes north-south and four lanes east-west, with dual slotted left-turn bays in all directions. Peak queues at the intersection were typically in excess of one kilometer, often approaching or extending beyond adjacent interchanges to the north and south.

A Good Fit

Historic planning studies had identified a partial cloverleaf interchange at this location, with loop ramps serving the heavier downtown-oriented commuter traffic movements. Over time, development around the intersection generated different traffic patterns, with high left-turn demands in all directions. With the tight spacing between adjacent intersections and poor accommodation of pedestrians and cyclists across higher speed ramps, the partial cloverleaf was no longer favoured at this location. Among many alternatives, the DDI jumped out as a leading candidate because it provided higher capacity while staying within the property footprint that had been previously reserved for the interchange.

Enhances Mobility

The Macleod Trail DDI includes three bridge structures: one carrying each direction of 162 Avenue over Macleod Trail and a third basketweave structure to accommodate local access ramps to the adjacent shopping centre. Design of the DDI put pedestrians, cyclists and transit users at the forefront; it was a better option for transit priority accommodations and provided a better balance across all transportation modes. Queue jumps and bus priority signals at the crossover intersections enhance transit service, while multi-use pathways on both sides of 162 Avenue accommodate pedestrians and cyclists comfortably. These multi-use pathways connect all corners elegantly by converging users to a single central pathway at the centre of the bridges. This provides significant travel-time benefit and enhanced connectivity for these active modes of transportation and improves access to area destinations such as the Shawnessy Shopping Centre, recreation facilities, schools, LRT stations and Fish Creek Provincial Park.

Safety

The DDI encourages lower vehicular speeds, has fewer conflict points overall and where conflict points do exist, they are spread out throughout the interchange. Road crossings pass a single direction of vehicular traffic and walking distance at crosswalks is significantly reduced by allowing all four quadrants to be accessed from the single central pathway.



Stakeholder Preference

When considering the DDI, ISL developed a communications and engagement plan to determine priorities, gauge public appetite for the innovative interchange configuration and minimize construction impacts. Stakeholders included The City, commuters, drivers, transit users, pedestrians, cyclists and businesses. The community engagement process included three public information sessions and one business engagement session.

Of several concepts, two final interchange alternatives were developed in detail: the partial cloverleaf and the DDI. The DDI was selected following the community engagement process and a rigorous evaluation. The methodology used to compare the partial cloverleaf and DDI alternatives included a qualitative and quantitative analysis against The City's triple bottom line (i.e., social, environmental, economic and policy compliance aspects), public feedback in terms of preferred alternative (i.e., DDI) and input from the business stakeholders on the foreseeable impacts on their businesses.

Increased Efficiency

The DDI design differs from traditional diamond interchanges because the two directions of traffic on 162 Avenue briefly cross to the opposite side of each other on bridges over Macleod Trail. This allows more effective traffic flow at the signalized intersections within the interchange and enables left-turning vehicles to proceed without crossing opposing traffic. The design significantly reduces delay and improves efficiency compared to a more traditional diamond interchange.

The DDI was selected for this location because it: did not require any additional land; enhances mobility and safety for drivers, transit users, cyclists and pedestrians; improves access to surrounding businesses and services; meets stakeholder needs; and increases efficiency.



WHEN CONSIDERING THE DDI, ISL DEVELOPED A COMMUNICATIONS AND ENGAGEMENT PLAN TO DETERMINE PRIORITIES, GAUGE PUBLIC APPETITE FOR THE INNOVATIVE INTERCHANGE CONFIGURATION AND MINIMIZE CONSTRUCTION IMPACTS.

UNINTERRUPTED ACCESS – UNIQUE CONSTRUCTION STAGING

Planning for the DDI was wrapping up in April 2015 when the project, originally scheduled to start construction in late 2016, was selected by The City to be accelerated in response to the economic downturn. While in the midst of drafting the functional study report and before the detailed design was even underway, the project team responded quickly by fast-tracking the design process and developing a multi-stage procurement strategy to get construction underway immediately.

Under the adopted procurement strategy, initial detour and utility relocation work was tendered immediately and construction began in July 2015 — just three months after the acceleration decision was made. The balance of the project was tendered in September 2015 at about the 60 per cent design level under an “Early Contractor Involvement” model. This approach brought the Contractor on board during the final stages of design, allowing the team to benefit from their input to gain schedule and cost savings.

Constructing an interchange over an existing active intersection is no easy feat, especially when the existing right-of-way is constrained. Additionally, being that the interchange was located in a commercial area, ISL faced the challenge of constructing the new interchange without limiting access to the nearby residences, schools, businesses and services. The team had to ensure that all citizens and visitors had access — drivers, cyclists, pedestrians and transit users alike.

The traditional approach to address these challenges is to construct a major detour road that relocates the intersection off the bridge construction site. This is usually expensive — involving significant throwaway costs and morphing into a major project in its own right that can take the entire first year of the interchange construction period to complete. The geometric design of the DDI, however, offered a unique construction sequencing opportunity by splitting the opposing directions of travel on two bridges and constructing the first of these two structures offset from the existing intersection. This approach allowed the project to immediately proceed with bridge construction without major detours. Using wireframe walls that were ultimately buried in the interchange fills, the entire south half of the interchange was constructed in the first nine months of 2016 (the south bridge can be seen below). Once completed in October 2016, traffic was shifted onto the new bridge and it became, in effect, an “interchange detour” that opened Macleod Trail up to free-flow traffic a full year ahead of construction completion. The major congestion issues in the area that had originally driven the need for the project were resolved in the middle of the construction period, providing significant relief to all users.



THE UNIQUE DESIGN OF THE DDI AND THE USE OF PERMANENT INFRASTRUCTURE FOR CONSTRUCTION DETOURING ENABLED THE CITY TO CONSTRUCT THE INTERCHANGE WITH MINIMAL TRAFFIC DISRUPTION, LOWER THROWAWAY COSTS AND NO PROPERTY IMPACTS.



Opening Day

The north DDI bridge and connecting ramps were completed in August 2017, allowing the detour interchange to be permanently changed over to the DDI configuration. The transition required the full shutdown of the temporary Parclo A interchange detour starting the night of August 11, with around-the-clock work until opening two days later on August 13.

The unique design of the DDI and the use of permanent infrastructure for construction detouring enabled The City to construct the interchange with minimal traffic disruption, lower throwaway costs and no property impacts. The DDI was completed on schedule and on budget and the citizens of Calgary enjoyed a higher quality outcome, at lower cost and in less time than a traditional interchange.

CANADA'S FIRST – BUT NOT THE LAST

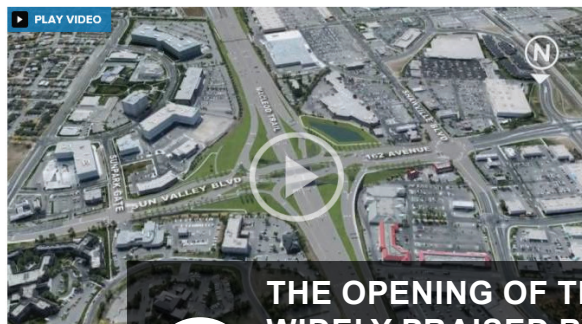
The opening of Canada's first DDI was achieved because of the close collaboration between The City, ISL and Graham Infrastructure. For The City, the decision to build Canada's first DDI at Macleod Trail and 162 Avenue was based on several key criteria including increased safety, improved capacity and ease of construction. Exploring current practices of DDI design in the US, the DDI design by ISL was developed with Calgary's unique context in mind, considering site specific conditions, driver behaviour and climate. The opening of the interchange in August 2017 was widely praised by users, City officials and in media coverage that brought national and international attention to Calgary for its innovative, forward-thinking approach to transportation design.

CALGARY TRAFFIC August 14, 2017 6:55 am Updated: August 14, 2017 6:58 am

Canada's first 'diverging diamond interchange' now open to Calgary traffic

By Heather Yourex-West
Health Reporter Global News

Comments Facebook Twitter Email Print



THE OPENING OF THE INTERCHANGE IN AUGUST 2017 WAS WIDELY PRAISED BY USERS, CITY OFFICIALS AND IN MEDIA COVERAGE THAT BROUGHT NATIONAL AND INTERNATIONAL ATTENTION TO CALGARY FOR THEIR INNOVATIVE, FORWARD-THINKING APPROACH TO TRANSPORTATION DESIGN.

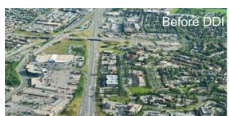
Canada's first diverging diamond interchange

A persistent bottleneck in Calgary has been addressed with the opening of Canada's first diverging diamond interchange (DDI).



The DDI at Macleod Trail and 162 Avenue in south Calgary opened on time and on budget after two years of construction. Chris Delaney, director and project manager at ISL Engineering & Land Services (ISL), said: "This was a challenging location. Land had been reserved here decades ago for a partial cloverleaf interchange but it did not stand the test of time and we needed new thinking. We had evaluated DDIs at a number of locations in Calgary before but it was never the right fit until 162 Avenue. The DDI provides a safe, high capacity, long-term solution that was constructed with minimal traffic disruption and no property impacts."

The design promotes a free flow of traffic both below and above the new overpass. Unlike a standard diamond interchange, traffic is divided based on direction – all left-hand traffic is funneled to the left side of the road and can turn onto the major thoroughfare without waiting at a stop light or worrying about crossing oncoming traffic.



Some of the first cyclists to cross Canada's first diverging diamond interchange (DDI) at 162 Avenue South and Macleod Trail in Calgary.

By: Elizabeth Cameron/For Metro Published on Sat Aug 13 2017

On budget, on time and the first of its kind in Canada.

It's not often those three things can be said about the same major infrastructure project but Mayor Naheed Nenshi and other City of Calgary officials accomplished just that the opening of Canada's first diverging diamond interchange (DDI) on Sunday.

NATIONAL POST

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A first in Canada, this cutting-edge new intersection slashes congestion and saves lives

It dramatically reduces crashes and congestion and will stop Calgarians being 'stolen away from their families' said Mayor Naheed Nenshi



THERE ARE NO LEFT TURN ARROWS. IT'S FASTER, SAFER AND EASIER TO NAVIGATE.

RENEW CANADA BLOG, UNCATEGORIZED

VIDEO: Diverging Diamond Interchange opens in Calgary

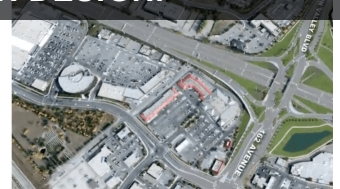
Posted on August 14, 2017
Written by: Andrew Stankovic

Calgary has become the first community in Canada to introduce a Diverging Diamond Interchange (DDI) into its transportation system. The \$75-million project, located at Macleod Trail and 162 Avenue S., allows drivers to make left-hand turns without crossing oncoming traffic.

The City of Calgary has released this video to help guide motorists through the new intersection.



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Transportation, News

Canada's first Diverging Diamond Interchange now open in Calgary (VIDEO)

by Calgary Staff
Aug 14, 2017 7:43 am A 1:27

Two years in the making, Canada's first Diverging Diamond Interchange (DDI) is now open to traffic at Macleod Trail and 162 Avenue in south Calgary.

"This is the second of four major interchange projects opening this summer – projects that

MACLEOD TRAIL / 162 AVENUE INTERCHANGE – AT A GLANCE!



Innovation

- It is the first DDI in Canada and a unique solution for the intersection. Without formal guidelines for geometric design, the team relied on and adopted best practices from around the world into an Alberta context, developing the unique interchange geometry and providing a local case study of future best practices for implementing this design elsewhere in Canada.
- All left-hand traffic was funneled to the left side of the road and could turn onto the major thoroughfare without waiting at a stop light or crossing oncoming traffic, nearly halving the number of conflict points compared to a typical interchange.
- Innovative construction sequencing that avoided construction of major detour roads.
- Crossover intersections operate with two-phase signals instead of the three or four phases seen in typical interchange junctions



Complexity

- Land was reserved in the area decades earlier for a partial cloverleaf interchange but massive growth in the last 15 years and the resulting commercial development meant there was not enough space and a new plan was needed.
- Conscious throughout the design phase of the responsibility the team was carrying in implementing Canada's first DDI, the team thoroughly surveyed current best practices in DDIs implemented in the US and Europe and paid careful attention to getting every detail right for Calgary's unique context.
- Worked within an accelerated construction program required by The City, breaking ground just three months after the DDI was selected.
- Adopted an Early Contractor Involvement procurement model.
- Had to accommodate active traffic throughout project site during construction (i.e., pedestrians, cyclists and transit).
- Implemented unique construction sequencing, completing the south half of the interchange in the first nine months of 2016 and opening up Macleod Trail to free-flow traffic one year ahead of construction completion.



Social / Economic Benefits

- Addressed one of The City's most persistent bottlenecks.
- Extensive community engagement ensured public priorities were met and construction impacts were minimized for commuters and businesses (e.g., no property impacts).
- Encourages lower vehicular speeds at conflict points with pedestrians and cyclists.
- Road crossings pass a single direction of vehicular traffic and walking distance at crosswalks is significantly reduced by allowing all four quadrants to be accessed from the single central pathway.
- Enhances mobility for commuters, transit users, cyclists, pedestrians and access to surrounding business and services.
- Macleod Trail opened to free-flow traffic one year ahead of construction completion, solving the major congestion issues in the area in the middle of the construction period.
- Developed 3D renderings and animation to help the public and stakeholders understand the DDI functions.
- The successful opening of the DDI in August 2017 gained favourable national and international media attention for Calgary.



Environmental Benefits

- Significantly reduced congestion and therefore vehicle idling.
- Decision-making based on the triple bottom line model (i.e., social, environmental and economic).
- DDI had less throwaway detour construction materials than the alternatives would have.
- Used significantly less land than a traditional cloverleaf interchange.



Meeting the Client's Needs

- Met The City's desire for innovation, ease of construction, increased access to surrounding businesses and enhanced mobility and safety for commuters, transit users and cyclists.
- Completed a community engagement process and rigorous evaluation to compare the DDI and partial cloverleaf interchange before making a final decision.
- ISL worked with The City to develop 3D renderings and animation to help the public and stakeholders understand how it functions. These pieces were critical in the evaluation and decision making processes.
- Designed the DDI with Calgary's unique context in mind (i.e., site specific conditions, driver behaviour and climate).
- Increased capacity without the need for additional land.
- Completed the project with minimal traffic disruption, lower throwaway costs and without property impacts.
- Project was completed on schedule and on budget, leaving Calgary to enjoy a higher quality outcome, at a lower cost and in less time than a traditional interchange. DDI has not only been praised by City officials but has also gained favourable national and international media attention.